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DEPARTMENT OF TRANSPORTATION

Federal Aviation Administration

14 CFR Parts 21, 23, 35, 43, 91, 121, and 135

[Docket No.: FAA-2015-1621; Amdt. Nos. 21-100, 23-64, 35-10, 43-49, 91-346, 121-378, and 135-136]

RIN 2120–AK65

Revision of Airworthiness Standards for Normal, Utility, Acrobatic, and Commuter Category Airplanes

AGENCY: Federal Aviation Administration (FAA), DOT.

ACTION: Final rule.

SUMMARY: The FAA amends its airworthiness standards for normal, utility, acrobatic, and commuter category airplanes by replacing current prescriptive design requirements with performance-based airworthiness standards. These standards also replace the current weight and propulsion divisions in small airplane regulations with performance- and risk-based divisions for airplanes with a maximum seating capacity of 19 passengers or less and a maximum takeoff weight of 19,000 pounds or less. These airworthiness standards are based on, and will maintain, the level of safety of the current small airplane regulations, except for areas addressing loss of control and icing, for which the safety level has been increased. The FAA adopts additional airworthiness standards to address certification for flight in icing conditions, enhanced stall characteristics, and minimum control speed to prevent departure from controlled flight for multiengine airplanes. This

rulemaking is in response to the Congressional mandate set forth in the Small Airplane Revitalization Act of 2013.

DATES: Effective August 30, 2017.

ADDRESSES: For information on where to obtain copies of rulemaking documents and other information related to this final rule, see "How To Obtain Additional Information" in the SUPPLEMENTARY INFORMATION section of this document.

FOR FURTHER INFORMATION CONTACT: For technical questions concerning this action, contact Lowell Foster, Regulations and Policy, ACE-111, Federal Aviation Administration, 901 Locust St., Kansas City, MO 64106; telephone (816) 329-4125; e-mail lowell.foster@faa.gov.

SUPPLEMENTARY INFORMATION:

All sections of part 23 contain revisions, except the FAA did not make any changes to the following sections: 23.1457, Cockpit Voice Recorders, 23.1459, Flight Data Recorders, and 23.1529, Instructions for Continued Airworthiness. Sections 23.1459 and 23.1529 were changed to align the cross references with the rest of part 23. The three sections otherwise remain unchanged relative to the former regulations.

Authority for this Rulemaking

The FAA's authority to issue rules on aviation safety is found in Title 49 of the United States Code. Subtitle I, Section 106 describes the authority of the FAA Administrator. Subtitle VII, Aviation Programs, describes in more detail the scope of the agency's authority.

This rulemaking is promulgated under the authority described in Subtitle VII, Part A, Subpart III, Section 44701. Under that section, the FAA is charged with promoting

safe flight of civil airplanes in air commerce by prescribing minimum standards required in the interest of safety for the design and performance of airplanes. This regulation is within the scope of that authority because it prescribes new performance-based safety standards for the design of normal, utility, acrobatic, and commuter category airplanes.

Additionally, this rulemaking addresses the Congressional mandate set forth in the Small Airplane Revitalization Act of 2013 (Public Law 113-53; 49 U.S.C. 44704 note) (SARA). Section 3 of SARA requires the Administrator to issue a final rule to advance the safety and continued development of small airplanes by reorganizing the certification requirements for such airplanes under part 23 to streamline the approval of safety advancements. SARA directs that the rule address specific recommendations of the 2013 Part 23 Reorganization Aviation Rulemaking Committee (Part 23 ARC).

Table of Contents

I. Overview of Final Rule

II. Background

A. Statement of the Problem

B. History

C. Summary of the NPRM

III. Discussion of the Public Comments and Final Rule

A. Delayed Effective Date

B. Overview of Comments

C. General Public Comments

D. Part 23, Airworthiness Standards

1. Legacy Rules

a. Cockpit Voice Recorders (§ 23.1457)/Flight Data Recorders (§ 23.1459)

b. Instructions for Continued Airworthiness (§ 23.1529)

2. Subpart A – General

3. Subpart B – Flight

4. Subpart C – Structures

5. Subpart D – Design and Construction

6. Subpart E – Powerplant

7. Subpart F – Equipment

8. Subpart G – Flightcrew Interface and Other Information

E. Miscellaneous Amendments (§§ 21.9, 21.17, 21.24, 21.35, 21.50, 21.101, Appendix E to Part 43, and 91.323)

1. Production of Replacement and Modification Articles (§ 21.9)

2. Designation of Applicable Regulations (§ 21.17)3. Issuance of Type Certificate: Primary Category Aircraft (§ 21.24)

4. Flight Tests (§ 21.35)

5. Instructions for Continued Airworthiness and Manufacturer's Maintenance Manuals Having Airworthiness Limitations Sections (§ 21.50)

6. Designation of Applicable Regulations (§ 21.101)

7. Special Federal Regulations 23 (SFAR No. 23)

8. Altimeter System Test and Inspection (Appendix E to Part 43)

9. Increased Maximum Certification Weights for Certain Airplanes Operated in Alaska (§ 91.323)

10. Additional Emergency Equipment (§ 121.310)

11. Additional Airworthiness Requirements (§ 135.169)

IV. Regulatory Notices and Analyses

A. Regulatory Evaluation Summary

B. Initial Regulatory Flexibility Determination

C. International Trade Impact Assessment

D. Unfunded Mandates Assessment

E. Paperwork Reduction Act

F. International Compatibility and Cooperation

G. Environmental Analysis

H. Regulations Affecting Intrastate Aviation in Alaska

V. Executive Order Determination

A. Executive Order 13132, Federalism

B. Executive Order 13211, Regulations that Significantly Affect Energy Supply, Distribution, or Use

VI. How to Obtain Additional Information

A. Rulemaking Documents

B. Comments Submitted to the Docket

C. Small Business Regulatory Enforcement Fairness Act

Appendix 1 to the Preamble—Current to Proposed Regulations Cross-Reference Table

Appendix 2 to the Preamble—Abbreviations and Acronyms Frequently Used In This Document

I. Overview of Final Rule

This rule amends Title 14, Code of Federal Regulations (14 CFR) part 23 by replacing current prescriptive design requirements with performance-based airworthiness standards. It maintains the level of safety associated with current part 23 except for areas addressing loss of control and icing where a higher level of safety is established, provides greater flexibility to applicants seeking certification of their airplane designs, and facilitates faster adoption of safety enhancing technology in type-certificated products while reducing regulatory time and cost burdens for the aviation industry and FAA. This final rule also reflects the FAA's safety continuum philosophy,[1] which balances an acceptable level of safety with the societal burden of achieving that level of safety, across the broad range of airplane types certificated under part 23.

This final rule allows the use of consensus standards accepted by the Administrator as a means of compliance to part 23's performance-based regulations. The use of these FAA-accepted consensus standards as a means of compliance will streamline the certification process. However, consensus standards are one means, but not the only means, of showing compliance to the performance-based standards of part 23. Applicants, individuals, or organizations also have the option to propose their own means of compliance as they do today.

In this final rule, the FAA adopts additional airworthiness standards to address certification for flight in icing conditions and enhanced stall characteristics to prevent inadvertent departure from controlled flight. Manufacturers that choose to certify an

[1] The FAA's safety continuum philosophy is that one level of safety is not appropriate for all aviation.

airplane for flight in Supercooled Large Drops (SLD)[2] must demonstrate safe operations in SLD conditions. For those manufacturers who choose instead to certify an airplane with a prohibition against flight in SLD conditions, this final rule will require a means for detecting SLD conditions and showing the airplane can safely avoid or exit such conditions.

This final rule adopts additional airworthiness standards to address enhanced stall characteristics to prevent loss of control (LOC). This final rule requires applicants to use new design approaches and technologies to improve airplane stall characteristics and pilot situational awareness to prevent LOC accidents.

Additionally, this final rule also streamlines the process for design approval holders applying for a type design change, or for a third party modifier applying for a supplemental type certificate (STC), to incorporate new and improved equipment in part 23 airplanes. The revised part 23 standards are much less prescriptive; therefore, the certification process for modifications is simplified. Certification of an amended type certificate (TC) or STC under this final rule requires fewer special conditions or exemptions, lowering costs and causing fewer project delays.

This final rule also revises 14 CFR part 21, "Certification Procedures for Products and Articles," to simplify the approval process for low-risk articles. Specifically, it amends § 21.9 to allow FAA-approved production of replacement and modification articles for airplanes certificated under part 23, using methods not listed in § 21.9(a). This will reduce constraints on the use of non-required, low-risk articles, such as carbon monoxide detectors and weather display systems.

[2] SLD conditions include freezing drizzle and freezing rain, which contain drops larger than those specified in appendix C to part 25, and can accrete aft of leading edge ice protection systems.

Lastly, this final rule removes Special Federal Regulation No. 23 (SFAR No. 23) and contains conforming amendments to 14 CFR parts 21, 35, 43, 91, and 135. These conforming amendments align part 23 references to the part 23 rules contained in this final rule.

The FAA has analyzed the benefits and costs associated with this rule. This rule responds to the Small Airplane Revitalization Act of 2013 (SARA) and to industry recommendations for performance-based standards. This rule reduces new certification processing by streamlining new certification processing. In addition, this rule improves safety by adding stall characteristic, stall warnings, and icing requirements. The following table summarizes the benefit and cost analysis, showing the estimated cost is substantially less than the benefits resulting from the combined value of the safety benefits and the cost savings. The following table shows these results.

Estimated Benefits and Costs (2015 $ Millions)

	Stall & Spin + Other Costs	**Safety Benefits + Cost Savings = Total Benefits**
Total	$0.8 + $3.1 = $3.9	$17.9+ $9.9 = $27.8
Present value at 7%	$0.8 + $3.1 = $3.9	$6.1 + $4.9 = $11.0
Present value at 3%	$0.8 + $3.1 = $3.9	$11.1 + $7.1 = $18.3

***These numbers are subject to rounding error.**

Accordingly, the FAA has determined that the rule will be cost beneficial.

II. Background

A. Statement of the Problem

The range of airplanes certificated under part 23 is diverse in terms of performance capability, number of passengers, design complexity, technology, and intended use. Currently, certification requirements of part 23 airplanes are determined by reference to a combination of factors, including weight, number of passengers, and

propulsion type. The resulting divisions (i.e., normal, utility, acrobatic, and commuter categories) historically were appropriate because there was a clear relationship between the propulsion and weight of the airplane and its associated performance and complexity.

Technological developments have altered the dynamics of that relationship. For example, high-performance and complex airplanes now exist within the weight range that historically was occupied only by light and simple airplanes. The introduction of high-performance, lightweight airplanes required subsequent amendments of part 23 to include more stringent and demanding standards—often based on the part 25 requirements for larger transport category airplanes—to ensure an adequate level of safety for airplanes under part 23. The unintended result is that some of the more stringent and demanding standards for high-performance airplanes now apply to the certification of simple and low-performance airplanes. Because of this increased complexity, it takes excessive time and resources to certify new part 23 airplanes.

B. History

In 2008, the FAA initiated the Part 23 Certification Process Study (CPS)[3] to review part 23. Collaborating with industry, the CPS team's challenge was to determine the future of part 23, given products at the time and anticipated future products. The team identified opportunities for improvements by examining the entire life cycle of a part 23 airplane, including operations and maintenance. The CPS recommended reorganizing part 23 using criteria focused on performance and design complexity. The CPS also recommended the FAA implement general airworthiness requirements, with the means of compliance defined in industry consensus standards.

[3] See docket number FAA-2015-1621.

In 2010, following the publication of the CPS, the FAA held a series of public meetings to seek feedback concerning the findings and recommendations. Overall, the feedback was supportive of, and in some cases augmented, the CPS recommendations.

One notable difference between the CPS findings and the public feedback was the public's request that the FAA revise part 23 certification requirements for simple, entry-level airplanes. Over the past two decades, part 23 standards have become more complex as industry has generally shifted towards correspondingly complex, high-performance airplanes. This transition has placed an increased burden on applicants seeking to certificate smaller, simpler airplanes. Public comments requested that the FAA focus on reducing the costs and time burden associated with certificating small airplanes by restructuring the requirements based on risk. The risk exposure for most simple airplane designs is typically low, because of the small number of occupants.

On August 15, 2011, the Administrator chartered the Part 23 ARC to consider the following CPS recommendations:

- Recommendation 1.1.1 - Reorganize part 23 based on airplane performance and complexity, rather than the existing weight and propulsion divisions.
- Recommendation 1.1.2 - Certification requirements for part 23 airplanes should be written on a broad, general, and progressive level, segmented into tiers based on complexity and performance.

The ARC's recommendations took into account the Federal Aviation Modernization and Reform Act of 2012 (Public Law 112-95) (FAMRA), which requires the Administrator, in consultation with the aviation industry, to assess the airplane certification and approval process. The purpose of the ARC's assessment was to develop

recommendations for streamlining and reengineering the certification process to improve efficiency, reduce costs, and ensure the Administrator can conduct certifications and approvals in a manner that supports and enables the development of new products and technologies and the global competitiveness of the United States aviation industry.[4] FAMRA also directed the Administrator to consider the recommendations from the CPS.[5]

ARC membership represented a broad range of stakeholder perspectives, including U.S. and international manufacturers, trade associations, and foreign civil aviation authorities (FCAAs).

The ARC noted the prevailing view within industry was that the only way to reduce the program risk, or business risk, associated with the certification of new airplane designs was to avoid novel design approaches and testing methodologies. Under existing part 23, the certification of new and innovative products frequently requires the FAA's use of equivalent level of safety (ELOS) findings, special conditions, and exemptions. These take time, resulting in uncertainty and high project costs. The ARC emphasized that although industry needs to develop new airplanes designed to use new technology, current certification costs inhibit the introduction of new technology. The ARC identified prescriptive certification requirements as a major barrier to installing safety-enhancing modifications in the existing fleet and to producing newer, safer airplanes.

The ARC also examined the harmonization of certification requirements between the FAA and FCAAs, and the potential for such harmonization to improve safety while reducing costs. Adopting performance-based safety regulations that facilitate international harmonization, coupled with internationally accepted means of compliance,

[4] Public Law 112–95, section 312(c).
[5] Public Law 112–95, section 312(b)(6).

could result in both significant cost savings and the enabling of safety-enhancing equipment installations. The ARC recommended that internationally accepted means of compliance should be reviewed and voluntarily accepted by the appropriate aviation authorities, in accordance with a process established by those authorities. Although each FCAA would be capable of rejecting all or part of any particular means of compliance, the intent would be to have FCAA participation in the creation of the means of compliance to ease acceptance of the means of compliance.

Based on the ARC recommendations and in response to FAMRA, the FAA initiated rulemaking on September 24, 2013. Subsequently, on November 27, 2013, Congress passed the SARA, which requires the FAA to issue a final rule revising the certification requirements for small airplanes by—

- Creating a regulatory regime that will improve safety and decrease certification costs;
- Setting safety objectives that will spur innovation and technology adoption;
- Replacing prescriptive rules with performance-based regulations; and
- Using consensus standards to clarify how safety objectives may be met by specific designs and technologies.

The FAA has determined that the performance-based-standards component of this final rule complies with the FAMRA and the SARA because it will improve safety, reduce regulatory compliance costs, and spur innovation and the adoption of new technology. This final rule will replace the weight-and propulsion-based prescriptive airworthiness standards in part 23 with performance- and risk-based airworthiness

standards for airplanes with a maximum seating capacity of 19 passengers or less and a maximum takeoff weight of 19,000 pounds or less. The standards will maintain or increase the level of safety associated with the current part 23, while also facilitating the adoption of new and innovative technology in general aviation (GA) airplanes.

C. Summary of the NPRM

On March 7, 2016, the FAA issued a notice of proposed rulemaking (NPRM) proposing to revise part 23 in response to the SARA.[6] In the NPRM, the FAA proposed to—

- Establish a performance-based regulatory regime; and
- Add new certification standards for LOC and icing.

On May 3-4, 2016, the FAA held a public meeting to discuss the NPRM, hear the public's questions, address any confusion, and obtain information relevant to the final rule under consideration.[7] The meeting notice and the transcripts are both in the docket. The FAA considered comments made at the public meeting along with comments submitted by the public to docket number FAA-2015-1621.

The comment period closed on May 13, 2016.

III. Discussion of the Public Comments and Final Rule

A. Delayed Effective Date

The FAA has decided it is necessary to delay the effective date of this final rule for 8 months, until August 30, 2017.

This final rule establishes a new performance-based system that will require additional training for both FAA and industry engineers, as noted in the NPRM

[6] See 81 FR 13452.
[7] See 81 FR 20264.

regulatory evaluation summary. Several commenters expressed concern with the need for additional training and guidance in order to implement the new performance-based standards. The FAA finds that a delayed effective date will alleviate these concerns.

Delaying the effective date will provide the FAA time to conduct the training necessary to implement this rule in a consistent manner. Additionally, the delayed effective date provides the FAA with sufficient time to develop guidance materials to ensure the FAA and industry have sufficient information to implement the new performance-based standards consistently and correctly. Furthermore, while compliance with part 23, amendment 23-62 will remain a means of compliance with this final rule, a delayed effective date will allow industry time to develop new means of compliance and will facilitate the development of harmonized means of compliance among the FAA, industry, FCAAs.

B. Overview of Comments

The FAA received 692 comments. Of the 692 comments, individuals submitted approximately 30 comments and industry and other foreign authorities submitted the remaining comments. The General Aviation Manufacturers Association (GAMA); Aircraft Electronics Association (AEA); Experimental Aircraft Association (EAA); and Aircraft Owners & Pilots Association (AOPA) (hereafter "the Associations") collected comments from their membership and presented these jointly. The vast majority of commenters overwhelmingly supported the proposed changes and provided constructive feedback so the FAA could clarify the safety intent in various sections of this rule.

The FAA did not receive comments on the proposed changes to the following sections. These sections are adopted as proposed, and the explanations for the changes from the former regulations are contained in the NPRM.

- § 23.1515, "Instructions for continued airworthiness"
- § 35.1, "Applicability"
- § 35.37, "Fatigue limits and evaluation"
- § 91.205, "Powered civil aircraft with standard category U.S. airworthiness certificates: Instrument and equipment requirements"
- § 91.313, "Restricted category civil aircraft: Operating limitations"
- § 91.531, "Second in command requirements"
- § 121.310, "Additional Emergency equipment"
- § 135.169, "Additional airworthiness requirements"

C. General Public Comments.

1. Rule Organization and Numbering

In the NPRM, the FAA proposed a new organization and numbering scheme for part 23. Appendix 1 to the NPRM preamble contains a cross-reference table detailing how the current regulations are addressed in the proposed part 23 regulations.

The FAA received several comments suggesting the FAA change the regulation numbering scheme for proposed part 23. Commenters expressed concern that confusion or undue complexity would result because the proposed part 23 regulations do not correlate by section number to the former part 23 regulations. Commenters also noted that certain sections of the proposed rule would have shared the same section numbers as former part 23 regulations but would have contained completely different content.

To avoid confusion, EASA proposed a new numbering system for Certification Specification 23 (CS 23)[8] and part 23, where the new regulations would not share numbers with the former regulations to emphasize the difference in content between these two sets of regulations. EASA suggested the numbering for subpart A begin at § 23.2000, for subpart B at § 23.2100, and so on, with the regulations numbers increasing by incremental steps of 5, i.e., §§ 23.2005, 23.2010, and so on.

The FAA agrees that the proposed numbering scheme would have caused confusion and undue complexity. The FAA has considered EASA's recommended new numbering scheme for part 23 and adopts it in the final rule. This recommendation harmonizes the numbering of part 23 and CS 23 and provides new part 23 with a unique numbering scheme to avoid any confusion with former part 23. The FAA has determined the new numbering scheme also alleviates concerns about situations in which a certification basis would contain a former part 23 rule and a new part 23 rule sharing the same section number, but different subject-matter.

The FAA did not propose to change or renumber §§ 23.1457, 23.1459, and 23.1529; therefore, these sections remain as legacy rules in the new part 23.[9]

Air Tractor, Inc. (Air Tractor) suggested that the FAA retain former part 23, amendment 23-62, and create a new part (e.g., part 22) for the proposed performance-based regulations. It also suggested that proposed appendix A should remain appendix G to avoid over-writing existing appendix A.

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[8] EASA published an Advance Notice of Proposed Amendment (A-NPA) 2015-06 on March 27, 2015, which set forth EASA's concept for its proposed reorganization of Certification Specification 23 (CS-23). EASA also published a Notice of Proposed Amendment (NPA) 2016-05 on June 27, 2016.

[9] The prescriptive requirements of §§ 23.1457, 23.1459, and 23.1529 are consistent in substance and numbering across parts 23, 25, 27, and 29.

The FAA notes Air Tractor's recommendation to retain former part 23 and to create a new 14 CFR part for the proposed regulations. However, this regulation is a rewrite of part 23 by replacing the prescriptive design requirements with performance-based airworthiness requirements, and the creation of an additional part would result in unnecessary confusion and overlap. However, the FAA will accept the use of the prescriptive means of compliance contained in former part 23 as one way to show compliance with new part 23. This will not apply to the sections containing new requirements, such as §§ 23.2135, 23.2150, and 23.2165 (proposed in the NPRM as §§ 23.200, 23.215, and 23.230). In addition, the FAA is issuing a policy statement identifying the means by which the FAA has addressed errors, findings of ELOS to various provisions of former part 23, and special conditions. This policy should be considered in defining means of compliance based on former part 23.

The FAA also considered Air Tractor's recommendation to not rename appendix G. As proposed in the NPRM, the FAA removed appendixes A through F. However, the FAA is renaming former appendix G to part 23, as appendix A to part 23—Instructions for Continued Airworthiness, because this final rule is a complete rewrite and beginning the appendices at G instead of A may cause confusion.

The following table identifies each requirement, its previously-proposed section in the NPRM, and its corresponding section in this final rule.

NPRM	Title	Final Rule
	Subpart A – General	
§ 23.1	Applicability and definitions	§ 23.2000

§ 23.5	Certification of normal category airplanes	§ 23.2005
§ 23.10	Accepted means of compliance	§ 23.2010
Subpart B – Flight		
Performance		
§ 23.100	Weight and center of gravity	§ 23.2100
§ 23.105	Performance data	§ 23.2105
§ 23.110	Stall speed	§ 23.2110
§ 23.115	Takeoff performance	§ 23.2115
§ 23.120	Climb requirements	§ 23.2120
§ 23.125	Climb information	§ 23.2125
§ 23.130	Landing	§ 23.2130
Flight Characteristics		
§ 23.200	Controllability	§ 23.2135
§ 23.205	Trim	§ 23.2140
§ 23.210	Stability	§ 23.2145
§ 23.215	Stall characteristics, stall warning, and spins	§ 23.2150
§ 23.220	Ground and watering handling characteristics	§ 23.2155
§ 23.225	Vibration, buffeting, and	§ 23.2160

	high-speed characteristics	
§ 23.230	Performance and flight characteristics requirements for flight in icing conditions	§ 23.2165
Subpart C – Structures		
§ 23.300	Structural design envelope	§ 23.2200
§ 23.305	Interaction of systems and structures	§ 23.2205
Structural Loads		
§ 23.310	Structural design loads	§ 23.2210
§ 23.315	Flight load conditions	§ 23.2215
§ 23.320	Ground and water load conditions	§ 23.2220
§ 23.325	Component loading conditions	§ 23.2225
§ 23.330	Limit and ultimate loads	§ 23.2230
Structural Performance		
§ 23.400	Structural strength	§ 23.2235
§ 23.405	Structural durability	§ 23.2240
§ 23.410	Aeroelasticity	§ 23.2245
Design		
§ 23.500	Structural design	§ 23.2250
§ 23.505	Protection of structure	§ 23.2255

§ 23.510	Materials and processes	§ 23.2260
§ 23.515	Special factors of safety	§ 23.2265
Structural Occupant Protection		
§ 23.600	Emergency conditions	§ 23.2270
Subpart D – Design and Construction		
§ 23.700	Flight control systems	§ 23.2300
§ 23.705	Landing gear systems	§ 23.2305
§ 23.710	Buoyancy for seaplanes and amphibians	§ 23.2310
Occupant System Design and Protection		
§ 23.750	Means of egress and emergency exits	§ 23.2315
§ 23.755	Occupant physical environment	§ 23.2320
Fire and High-Energy Protection		
§ 23.800	Fire protection	§ 23.2325
§ 23.805	Fire protection in designated fire zones and adjacent areas	§ 23.2330
§ 23.810	Lightning protection	§ 23.2335
Subpart E – Powerplant		
§ 23.900	Powerplant installation	§ 23.2400
§ 23.905	Propeller installation	not adopted

§ 23.910	Powerplant installation hazard assessment	§ 23.2410
§ 23.915	Automatic power or thrust control systems	§ 23.2405
§ 23.920	Reversing systems	§ 23.2420
§ 23.925	Powerplant operational characteristics	§ 23.2425
§ 23.930	Fuel system	§ 23.2430
§ 23.935	Powerplant induction and exhaust systems	§ 23.2435
§ 23.940	Powerplant ice protection	§ 23.2415
§ 23.1000	Powerplant fire protection	§ 23.2440
Subpart F – Equipment		
§ 23.1300	Airplane level systems requirements	§ 23.2500
§ 23.1305(a)(1) § 23.1305(a)(3),(b),(c)	Function and installation Installation and operation	§ 23.2505 § 23.2605
§ 23.1310	Flight, navigation, and powerplant instruments	§ 23.2615
§ 23.1315	Equipment, systems, and installations	§ 23.2510
§ 23.1320	Electrical and electronic system lightning protection	§ 23.2515

§ 23.1325	High-intensity Radiated Fields (HIRF) protection	§ 23.2520
§ 23.1330	System power generation, storage, and distribution	§ 23.2525
§ 23.1335	External and cockpit lighting	§ 23.2530
§ 23.1400	Safety equipment	§ 23.2535
§ 23.1405	Flight in icing conditions	§ 23.2540
§ 23.1410	Pressurized system elements	§ 23.2545
§ 23.755(a)(3)	Equipment containing high-energy rotors	§ 23.2550
§ 23.1457	Cockpit voice recorders	§ 23.1457
§ 23.1459	Flight data recorders	§ 23.1459
Subpart G – Flightcrew Interface and Other Information		
§ 23.1500	Flightcrew interface	§ 23.2600
New	Installation and operation	§ 23.2605
§ 23.1505	Instrument markings, control markings and placards	§ 23.2610
New	Flight, navigation, and powerplant instruments	§ 23.2615
§ 23.1510	Airplane flight manual	§ 23.2620

§ 23.1515	Instructions for continued airworthiness	§ 23.1529
Appendices		
Appendix A to Part 23	Instructions for Continued Airworthiness	Appendix A to Part 23

2. Level of Safety

In the NPRM, the FAA proposed amendments to part 23 to create an adaptive regulatory environment that could quickly embrace new safety-enhancing technologies and potentially increase the level of safety.

Wipaire, Inc. (Wipaire) viewed the proposal as allowing new and emerging technologies an effective means of certification, but one which offered little economic and certification relief to currently-established methods and technologies.

An individual commenter noted that the proposal would allow industry to push new techniques, materials, procedures, and targets without being hindered by the prescriptive requirements of former part 23. However, the commenter stated that the proposal could allow subpar designs to exist before the data suggests a failure in compliance.

The National Transportation Safety Board (NTSB), while recognizing consensus standards provide “a collaborative framework for standards development,” commented on a situation where, in its view, consensus standards did not provide adequate protection from catastrophic aerodynamic flutter. The NTSB expressed concern that design

standards important for safety consideration may be overlooked, and it encouraged the FAA to refine its methodology.

The FAA understands the concerns over the level of safety required by the performance standards. However, by leveraging the expertise of consensus standards organizations and FAA specialists in determining whether those standards are acceptable, those means of compliance should provide at least the same level of safety as under the former process.

The FAA will continue to be responsible for determining that proposed airplane designs meet the applicable standards and ensuring that the proposed standards provide at least the same level of safety as did the former standards. Under new part 23, the first time an applicant presents a new proposal for a means of compliance, the FAA will require sufficient time and resources to determine whether it does, in fact, meet the objectives of those standards. This is the same process as under the former prescriptive standards. However, once the proposed means of compliance is determined to meet these standards, the approval process becomes more efficient. The FAA will no longer be required to issue special conditions (or other formal processes) to approve the means of compliance each time it is proposed, but can accept those means of compliance immediately as it is proposed.

3. Accommodating Hybrid and Electric Propulsion

In the NPRM, the FAA recognized that historical general design and performance assumptions may not be valid today. The FAA noted that former part 23 did not account for airplanes equipped with new technologies, such as electric propulsion systems, which

may have features entirely different from piston and turbine engines. The FAA therefore proposed new regulations based on airplane performance and potential risk.

With respect to allowing new technologies, the Associations and Zee.Aero Inc. (Zee) were particularly concerned with the accommodation of alternative engines. The Associations stated that hybrid and electric propulsion is one of the near-term significant technological developments which absolutely must be accommodated into the new part 23 regulations structure.

Zee also commented on the advancements in hybrid and electric propulsion. Zee noted that new hybrid propulsion, control, and airframe configurations are already beginning to blur the lines between the traditional airplane categories. Zee questioned whether the FAA intends to continue to maintain strict airplane categories and create a new "category" every time a new unique category configuration emerges. Lastly, Zee noted that § 21.17(b) currently captures such airplane and wondered whether that section would become the norm for those cases.

The regulations adopted in this final rule do allow for alternative types of propulsion. The FAA does not intend to continue to use § 21.17(b) for unique category airplanes. The FAA plans to shift these unique airplanes from § 21.17(b) to part 23. Unique airplane that more closely resemble rotorcraft may be treated differently.

4. Impact of Rule on FAA Engineers and Designated Engineering Representatives (DERs)

In the NPRM, the FAA proposed changes to part 23 that would eliminate the workload of exemptions, special conditions, and ELOS findings necessary to certificate

new part 23 airplanes. The NPRM did not specifically address the role of Designated Engineering Representatives (DERs) in the proposed process.

Several commenters addressed the impacts of the proposed rule changes on FAA engineers and DERs.

NetJets Association of Shared Aircraft Pilots (NJASAP) and Kestrel Aircraft Company (Kestrel) expressed concern that the process intended to streamline technological adoption may significantly increase the FAA's workload. Kestrel contended the increased workload for FAA engineers will create certification bottlenecks at the Aircraft Certification Offices (ACOs) as their staff work to understand and implement the changes.

The FAA recognizes workload during the transition to the new system may increase temporarily for industry and the FAA. Under the former part 23, the FAA had a workload of exemptions, special conditions, and ELOS findings necessary to certificate new part 23 airplanes. However, the FAA has determined in the long term, the workload for industry and the FAA will be less than the workload under former part 23. As estimated in the NPRM's regulatory evaluation summary, there will be savings resulting from streamlining the certification process by reducing the issuance special conditions, exemptions, and ELOS findings. The NPRM and final rule regulatory evaluation provides details for these cost savings and the methodology the FAA employed to estimate the cost savings.

Other commenters expressed concerns about how the DER process will fit in with the new regulations. Air Tractor questioned whether DERs will find compliance with accepted means of compliance. The National Air Traffic Controls Association

(NATCA) asked whether DERs will issue acceptance statements or approvals. NATCA asked how the FAA will change the designee policy and asked whether the FAA intends to accept or approve the standards. Textron Aviation (Textron) requested clarification of the FAA's transition plan regarding Organization Designation Authorization (ODA) and DER delegations, in particular regarding continuity of authority from the old amendments to the new.

In response to concerns regarding the role of the DERs and ODA engineers, the FAA is developing transition training for the FAA engineers, ODA engineers, and the DERs. The FAA is also reviewing the relevant orders and policies for needed changes, but does not expect changes to the basic certification process as the FAA engineers and industry designees will still be responsible for finding compliance to the requirements in part 23. Furthermore, the FAA is developing a change management plan that will include formal training for both FAA engineers and staff and industry designees. Under existing policies and processes, designees must demonstrate the capability to make correct determinations of compliance with particular regulations before they are authorized to do so. This is unchanged by this rule. To the extent an applicant uses previously-accepted methods of compliance for which the designee has demonstrated such capability, the FAA may delegate compliance findings. If an applicant is proposing a new method of compliance, the designee's authority may be limited to only recommending a finding of compliance.

Kestrel contended standardization among ACOs would likely decrease due to lack of clearly-defined criteria and that divergent certification expectations would exacerbate existing issues of inconsistent application and interpretation of requirements.

While this final rule adopts high-level performance standards, the FAA intends to ensure consistent application through the process for determining the acceptability of their means of compliance. The FAA's certification standards staff will determine whether proposed consensus standards are acceptable and, if so, will publish a notice of availability of those standards in the Federal Register. The FAA will also maintain a publicly-available list of consensus standards that have been found to be acceptable as methods of compliance.[10] For methods of compliance submitted by individual applicants, the FAA will continue to use the existing issue paper process, which includes full coordination with the standards staff to ensure standardization. The FAA recognizes the importance of having an internationally accepted means of compliance for part 23 airplanes. The FAA believes once there are internationally accepted means of compliance available, manufacturers may be reluctant to bypass these harmonized means to develop their own, unless they have an innovative process or new technology not already addressed. In either case, the FAA's processes should ensure flexibility and transparency to the extent permitted without violating proprietary interests of entities developing methods of compliance. Allowing for innovation and new technology is a major goal of this rule.

In response to NTSB's concerns about new technology, the FAA finds that shifting compliance emphasis to industry consensus standards is critical to ensuring the safety of new technology. This shift will allow the FAA to leverage technical experts

[10] As discussed in the NPRM, the FAA will have a similar process for determining whether a previous acceptance of a method of compliance should be rescinded, based on new information or service experience.

from across the aerospace industry and from outside the traditional aerospace industry to develop standards for new technologies.[11]

5. Necessity of Training

In the NPRM's regulatory evaluation, the FAA assumed that FAA and industry part 23 certification engineers would require additional training as a result of this rule.

Some commenters expressed concern with training needs required by a new system. Kestrel noted the proposed rule would increase the workload of DERs, primarily because they will require additional training and FAA coordination to ensure proper understanding and implementation of the new certification process. NATCA noted the significant changes to part 23 will necessitate training of all FAA engineers, DERs, and ODA engineers. In particular, NATCA said designees and ODAs cannot be authorized to find compliance to part 23 until trained or demonstrated competence. NATCA recommended the FAA amend its delegation and ODA policy documents to reflect the changes to part 23 and implement training as soon as possible.

The NTSB expressed concern about increased demand on FAA engineers to evaluate new technologies as a result of the proposed changes to part 23. It suggested the FAA may face challenges similar to those encountered with the certification of the lithium-ion batteries in the Boeing 787, including insufficient guidance and education to ensure compliance with applicable requirements. The NTSB pointed to several safety recommendations it issued to the FAA in the wake of a lithium-ion battery incident in a Boeing 787 in 2013, which centered around developing and providing adequate written guidance and training to certification engineers.

[11] National Transportation Safety Board, Auxiliary Power Unit Battery Fire, Japan Airlines Boeing 787-8, JA829J, Boston, Massachusetts, January 7, 2013, AIR-14/01 (Washington, DC: NTSB, 2014).

The FAA agrees guidance and training are necessary and has delayed the effective date of this rule in order to complete the training development and implementation for ACOs, DERs, and industry. The FAA will continue to review orders and policies for needed changes.

6. Need for Revised or New Agency Guidance and Directives

The FAA proposed Advisory Circular (AC) 23.10,[12] Accepted Means of Compliance, to provide applicants guidance on the process of submitting proposed means of compliance to the FAA for consideration by the Administrator. The FAA also indicated in the NPRM that it would provide guidance as it determines what satisfies the performance-based standards.

NATCA requested the FAA publish new or revised Orders and policy documents for public review and comment prior to the issuance of the final rule. For example, how would a certification engineer recognize what is a "good compliance showing" to a new part 23 requirement and how would that engineer explain the compliance showing to an authorized representative of the Administrator. Also, how would a certification engineer minimize or avoid allegations from an applicant that the engineer is being inequitable in the application of the new part 23 requirement compared to how the requirements have been applied to other applicants.

NATCA noted applicants often use legal processes for approval of type design changes to obtain less expensive or extensive certification requirements for a design proposal, and that the "number of seats" has been used previously to finesse operating requirements applicability. NATCA questioned whether the FAA will permit this under

[12] See docket number FAA-2015-1621.

new part 23 as established by the airplane certification levels and whether there will be any check or limitation or safety judgment made on this potential use of new part 23. NATCA requested the FAA publish an Order or policy addressing this issue.

One commenter was concerned the FAA will eventually leave the task of developing ACs for means of compliance to consensus bodies and individual applicants and opposed a system where public domain guidance must be purchased from a private entity. The commenter suggested that even if the FAA decides to discontinue updating its guidance, it should retain control and continue to permit the use of its existing guidance as well as provide a list of guidance with its status.

The FAA agrees with NATCA that updated guidance is needed and is in the process of reviewing current orders and policies and will use existing processes to implement those changes. The FAA also recognizes the potential that some applicants will attempt to "finesse" the applicability of requirements for higher airplane certification levels by limiting the maximum passenger capacity of their proposed designs. This potential is inherent in any attempt to establish different levels of safety based on the concept of the "safety continuum." The disincentive for such finessing is the reduction of functionality, and therefore profitability, of the resulting design.

The FAA will continue to use all applicable ACs associated with part 23. Applicants will need to use the cross-reference table in this final rule preamble because the ACs will continue to reference the former section numbers. The FAA will expand the guidance in these ACs to better address the range of part 23 airplanes identified in industry consensus standard documents. The FAA has no plans to cancel the current ACs because they are still needed for older airplane modifications; therefore, the applicable

ACs will still be available to applicants. Consensus standards bodies will develop means of compliance with the new regulations. The FAA will continue to develop ACs, as needed, to provide guidance to the public on what means of compliance would be acceptable. These functions are distinct, but complementary.

7. Inconsistent Language

In the NPRM, the FAA proposed to remove prescriptive design requirements and replace them with performance-based airworthiness standards.

Some commenters expressed concern with the lack of concreteness in the proposed regulations. Transport Canada stated the standards required the definition of a safety objective to clarify the meaning of some terms. The National Agricultural Aircraft Association (NAAA) was concerned the proposed regulations could result in inconsistent interpretations. NATCA viewed the rules as too "stripped down" for non-experienced people and commented that the use of "vague" terms would make it difficult to apply the new rules. Air Tractor contended the proposed rules consolidated existing requirements into fewer "general" or "vaguely" worded rules.

Other commenters addressed perceived inconsistencies in the language of the proposed revisions to part 23. The Associations noted some of the proposed rules focused on the applicant while others focused on the airplane.[13] These commenters observed it is important that the language of part 23 does not contradict part 21, which establishes the procedures for obtaining design approvals. The commenters recommended the FAA adopt the regulatory language used elsewhere in the airworthiness standards, which impose requirements on the airplane design.

[13] For example, some of the proposed rules stated "the applicant must show" or "the applicant must demonstrate," while others stated "the airplane must."

The FAA recognizes the final rule uses high-level performance standards, and in some cases, the requirements are not tightly specified. However, the FAA finds that tight specification is not needed as this final rule is consistent with the safety objectives of the former prescriptive standards. The cross-reference table in this final rule identifies what sections of this final rule are intended to meet the safety objectives of the former regulations. Because this final rule is intended to achieve at least the same level of safety as the former regulations, this comparison may be used as a guide to the various levels of acceptable risk associated with each section.

In response to the comment raised by GAMA and others, part 21 imposes obligations on applicants for design approvals; therefore, the references to the applicant in this final rule are consistent.

8. Need for Additional Provisions in Part 23

NATCA recommended the FAA add several provisions to part 23, including a requirement about loss of propeller or propeller control, provisions defining the levels of software certification needed, requirements that address impact protection from unmanned aircraft systems (UAS), and provisions about the introduction of new technologies.

The FAA considered NATCA's comments; however, the FAA declines to adopt NATCA's recommendations at this time. The FAA is not adding requirements about loss of propeller or propeller control and provisions defining the levels of software needed because these are more appropriately addressed in means of compliance. The FAA also finds it unnecessary to include specific provisions about the introduction of new technologies because all the regulations in new part 23 are intended to allow the

introduction of new technologies. Furthermore, it would be outside the scope of this rulemaking to add requirements addressing impact protection from UAS.

9. Development of Standards

In the NPRM, the FAA described how industry groups associated with the Part 23 ARC discussed the development of consensus standards and how the ARC selected ASTM as the appropriate organization to initiate this effort.

NATCA expressed concerns the FAA was relinquishing standardization and stated the FAA needed to articulate an expected minimum technology maturity level.

The FAA's process for reviewing applicant's submissions to verify compliance with the safety standards will address NATCA's concern regarding technology. This review process will not change from the way the FAA currently reviews an applicant's regulatory compliance. One of the purposes of this rule is to provide greater flexibility to applicants in showing they meet the objectives of the safety standards, and thus "standardization" in the strictest sense goes against this purpose. Similarly, with respect to minimum technology level, another purpose of this rule is to spur innovation and technology adoption. Therefore, requiring a certain technology maturity level would contradict that purpose.

10. Restricted Category Agricultural Airplanes

In the NPRM, the FAA did not specifically address single-engine agricultural airplanes.

The NAAA commented that AC 21.25-1, Issuance of Type Certificate: Restricted Category Agricultural Airplanes, is currently used by the FAA to determine which part 23 certification requirements should not be part of an airplane's TC under § 21.25.

NAAA questioned how the requirements found inappropriate for single-engine agricultural airplanes in AC 21.25-1 will influence the certification process.

The FAA notes the cross reference table located in this final rule correlates the sections referenced in AC 21.25-1 with the new regulations and associated means of compliance. Long term, the FAA recommends NAAA work with the FAA to develop means of compliance specific to restricted category agricultural airplanes.

11. International Cooperation Efforts

In the NPRM, the FAA indicated the part 23 rulemaking was a harmonization project between the FAA and EASA. EASA published an Advance Notice of Proposed Amendment (A-NPA) 2015-06 on March 27, 2015, which set forth EASA's concept for its proposed reorganization of CS 23. The FAA received several comments on harmonization.

Garmin International (Garmin) and Agencia Nacional De Aviacao Civil Brazil (ANAC) commented on the significant differences between the NPRM and EASA's A-NPA. Garmin encouraged the FAA and EASA to resolve all differences before publishing their final regulations. Textron stressed the importance of harmonizing rule language with other major global certification authorities because a lack of harmonization would call into question whether one set of consensus standards would be adequate to achieve certifications worldwide. Textron expressed disappointment that the FAA's NPRM and EASA's A-NPA were not better aligned prior to publication. Textron explained the goal should be 100 percent harmonization with no exceptions. Garmin and Textron both commented on the significant costs that non-harmonized regulations would have on the industry.

EASA commented on the importance of using, as much as possible, the same text in CS 23 and part 23. EASA explained, however, that CS 23 was more of a technical standard, while proposed part 23 addressed the applicant's responsibility. To better align with CS 23, EASA suggested that the FAA require "the applicant's design" to meet certain requirements rather than "the applicant."

Optimal Aerodynamics Ltd (Optimal) recognized the harmonization efforts that have taken place, but sought reassurance from the FAA that revisions to part 23 would not lead to greater differences with other CAA's certification standards. Assuming CS 23 aligns with part 23, Optimal asked if it would be possible to base compliance on EASA's revised CS 23 when applying to the FAA for certification under new part 23.

The FAA agrees that harmonization with EASA's standards is important. While identical language is not the goal, the FAA has worked closely with EASA to ensure the same basic requirements for part 23 and CS 23 in order that both authorities can accept the same set of industry means of compliance. For example, as discussed previously, references to the applicant's obligations ("the applicant must") are consistent with part 21 and with EASA's counterpart requirement that applicants "show" compliance. To further this effort, the FAA has met with EASA,[14] received comments from EASA, and submitted comments on EASA's A-NPA. EASA incorporated many of the FAA's comments on its A-NPA into its Notice of Proposed Amendment (NPA), published on June 23, 2016. In addition, the FAA incorporated many of EASA's comments to the NPRM into this final rule, such as including two new sections in Subpart G.

[14] See docket number FAA-2015-1621-0062.

12. Part 23 ARC Recommendations and the Existing Fleet

As previously discussed in more detail, the FAA chartered the Part 23 ARC in 2011 to consider the reorganization of part 23 based on airplane performance and complexity and to investigate the use of consensus standards. The Part 23 ARC's recommendations were published in 2013 and are available in the docket.

Textron, Garmin, and several individuals commented on those ARC recommendations that were not proposed in the NPRM. In particular, these commenters requested the FAA adopt changes to 14 CFR part 21, "Certification Procedures for Products and Articles"; part 43, "Maintenance, Preventive Maintenance, Rebuilding, and Alteration"; and part 91, "General Operating and Flight Rules"; as recommended by the ARC. These comments related to type certification procedures and airplane maintenance and operations. Similarly, several commenters requested the FAA adopt the ARC's recommendation to establish a "Primary Non-Commercial Category" (PNC), which also would have required revisions to part 21.

Several individual commenters noted that regulations applicable to existing airplanes make it difficult and expensive to implement safety improvements on those airplanes. These commenters questioned whether this rulemaking will address those issues.

While the FAA recognizes the commenters' concerns regarding the need to minimize the certification process burden, the FAA is not making additional changes to parts 21 or 43 because they are outside the scope of this rulemaking. The intent of this rulemaking is to remove the prescriptive design requirements from part 23 and replace

them with performance-based airworthiness requirements. The FAA is, however, contemplating a future rulemaking that would make additional changes to part 21.[15]

The FAA also considers the commenters' recommendations to create a PNC category for aging General Aviation (GA) airplanes to be outside the scope of the NPRM. The FAA did not propose to create a PNC category for aging GA airplanes, as the ARC recommended, because it is also out of scope of this rulemaking. However, the FAA is working to address the ARC recommendations that focused on the existing fleet and part 21 processes.

With respect to the existing fleet, the FAA does not expect the revisions to part 23 to provide immediate benefits to older airplanes. However, when an owner of an older airplane applies for a change to the airplane's TC in accordance with § 21.101, the applicant may choose to use the more flexible performance-based standards. In addition, as discussed later, the revision to § 21.9 will enable expedited approval of certain parts that will benefit the existing fleet.

13. Impacts of the Proposed Rule on the Existing Fleet and on Open/Active Projects

The FAA received several comments on impacts to the existing fleet and on open/active projects.

Kestrel and Garmin asked how, under the proposed rule, the FAA will address active projects, derivative airplanes and changes to existing models. Kestrel noted § 21.101 requires regulatory compliance with the latest amendment while permitting certification on a case-by-case basis to an earlier amendment for changes to existing

[15] The Part 21 SMS ARC published its recommendation reports (appendix A-G and appendix H-P) on January 14, 2015. Copies can be downloaded from the FAA Advisory and Committee site at http://www.faa.gov/regulations_policies/rulemaking/committees/documents/.

models and derivative airplanes. Kestrel noted it is common for applicants to receive significant compliance credit on the basis of "similarity/identicality." Kestrel asked how the FAA would grant permission for an applicant for a derivative airplane to certify entirely to a previous amendment.

As discussed in the NPRM, the applicant has the option of using former part 23, amendment 23-62, as a means of compliance with new part 23 (except in the areas where this final rule raises the level of safety, as discussed previously). Since the new rule, combined with this accepted means of compliance, is identical to the former part 23 requirements (with exceptions noted in this preamble), methods of showing compliance—including "similarity/identicality"—are not affected for changes to existing airplane models. Furthermore, § 21.101 only requires regulatory compliance with the latest amendment for airplanes weighing more than 6,000 pounds. Section 21.101 also provides relief for airplanes weighing more than 6,000 pounds when the change is not significant or when compliance with a later amendment would not contribute materially to the level of safety or would be impractical

Garmin requested more details on the changes the FAA believes would streamline the process for design approval and lower costs and project delays. Garmin also asked the FAA to clarify how existing special conditions, ELOS findings, and exemptions would be handled if an applicant wants to "step up" to the new amendment.

The FAA has determined the cost and time savings will result from the greater flexibility afforded by this final rule to both applicants and the FAA to find compliance for innovative new technologies. For traditional designs, the FAA expects applicants will be able to use the new part 23 in the same way older Civil Air Regulation, part 3 (CAR 3)

airplanes are modified using former part 23 regulations. The FAA will still find compliance with the regulations, and since the new regulations allow greater flexibility by relying on accepted means of compliance, there should be little need for special conditions, ELOS findings, or exemptions, all of which require additional cost and time.

An individual and Air Tractor expressed concern over third-party modifiers of airplanes who were not part of the original certification process. The commenters suggested a third-party modifier could propose its own means of compliance and regard it as proprietary, which may conflict with the means of compliance used in the original basis of certification. The commenters were concerned an STC or field approval could become more difficult and create more work for the FAA.

The FAA notes the situation raised by the commenters currently exists with proprietary means of compliance, and this will not change with the new performance-based regulations. As under the former regulations, STC applicants will continue to be required to demonstrate that their changes, and areas affected by the changes, comply with the applicable regulations. The FAA anticipates no increased potential for conflict with the original design.

NATCA recommended the FAA make changes to the general definitions of 14 CFR 1.1 concurrently with the part 23 rewrite, including revising the definition of "consensus standard" because it applies to more than Light-Sport Aircraft (LSA), adding the definition of "proprietary standard," and reconciling the differences between the International Civil Aviation Organization (ICAO) airplane categories and the new definitions in part 23.

The FAA has determined there is no need to define the terms, “consensus standard” and “proprietary standard” in this final rule. The current definition of “consensus standard,” by its terms, applies only to LSA. For purposes of this final rule, “consensus standard” has the meaning established in SARA, as discussed previously. The FAA does not use the term “proprietary standard” in the regulations adopted by this final rule. Finally, the FAA notes the definitions of the categories need to remain the same because this final rule does not change their applicability to the existing fleet of airplanes. Also, the difference between the ICAO airplane standards and part 23 categories is based on weight and this rule does not affect that difference.

While NJASAP supported the LOC In-Flight and SLD safety enhancements, it stated runway excursions are another significant risk. NJASAP supported requiring secondary or emergency braking systems and recommended a requirement for powerplant reversing systems to be installed on all level 3 and 4 high-speed airplanes to help reduce the top three accident types. For the goal of reducing loss-of-control accidents, NJASAP supported—along with other aerodynamic improvements—the FAA requiring a device that gives a trained pilot immediate feedback on the status of the airplane’s wing. NJASAP recommended level 3 high-speed airplanes be included in the safety enhancements required for level 4 airplanes because they will be flying similar missions, and Original Equipment Manufacturers (OEMs) will target the level 3 certification category and stop certifying as many level 4 airplanes.

The FAA finds that requiring emergency braking systems and powerplant reversing systems is beyond the scope of this rulemaking and would add additional costs. Requiring a device that gives a trained pilot immediate feedback on the status of the wing

is also beyond the scope of this rulemaking, but a device like this could be used (and the FAA encourages its use) as part of the low-speed stall protection. Furthermore, the design specific nature of these recommendations is inconsistent with the FAA's goal of performance-based requirements in this rule revision. The new rule structure will allow for these alternative devices.

The FAA considered NJASAP's recommendation that level 3 airplanes be included in the level 4 safety enhancements because of levels 3 and 4 airplanes' similar missions. In this final rulemaking, the FAA retains the traditional approach of drawing safety distinctions based on airplane capacity and operational risk.

The NTSB commented on the proposed rule's focus on qualitative design methodologies, but recommends the use of both quantitative and qualitative design methodologies as the FAA has done historically. The NTSB pointed to proposed §§ 23.305 and 23.1315 and the continued reliance on the requirements of former § 23.1309, which only addresses the effects of single failures. The NTSB contended that the consideration of multiple failures should be required in the revised part 23 when active systems may potentially be used in commercial operations and the airplane may be more complex.

The FAA's intent in this rule is to maintain the current level of safety. The FAA is currently engaged in rulemaking for transport airplanes to address the NTSB's concerns. Depending on the outcome of that rulemaking, the FAA may consider similar rulemaking for part 23 in the future.

14. Legal Issues

In the NPRM, the FAA proposed to accept consensus standards as a means of compliance with the new part 23 performance-based regulations. Abbott Aerospace SEZC, Ltd. (Abbott) and Kestrel questioned the legality of using ASTM as a means of compliance.

Abbott stated the proposed change is illegal as the new ASTM standards constitute de facto law despite being labelled "advisory" and are the only realistic path to certify an airplane. Abbott claimed this mislabeling will lead to confusion and cause industry to incur the cost of purchasing the ASTM standards under the belief that they constitute law and that compliance is mandatory.

Kestrel also questioned the legality of relinquishing FAA guidance to a private entity and of using ASTM as the single standards body. Kestrel opposed handing over public domain guidance to a private entity for creation of its own standards, which will be provided back to the industry for a fee. Kestrel suggested the FAA retain control and continue to permit the use of its existing guidance.

In light of the comments, the FAA reviewed its approach to use consensus standards as means of compliance with this rule. On November 27, 2013, the President of the United States signed SARA whereby Congress mandated the FAA use consensus standards to clarify how safety objectives may be met by specific designs and technologies. SARA also requires the FAA to comply with the "National Technology Transfer and Advancement Act of 1995" (NTTAA), which directs Federal agencies to use voluntary consensus standards in lieu of government-mandated standards when practicable. This rulemaking also complies with the Office of Management and Budget

(OMB) Circular A-119, “Voluntary Consensus Standards,” which provides guidance on how to comply with NTTAA. OMB Circular A-119 specifically addresses the issues raised by the commenters and establishes the policy that agencies should consider cost to regulated entities of using consensus standards as one factor in determining whether those standards are “reasonably available.” The FAA has considered the cost of ASTM standards and determined, for purposes of this rulemaking, ASTM standards are reasonably available because the interested parties have access to them through their normal course of business and the price is low enough that interested parties can easily purchase them.

In addition, ASTM will not create de facto law nor be the single standard-setting body, or custodian of public domain documents. The FAA expects to accept means of compliance from individuals, companies, and other standards bodies, including ASTM. While the use of a previously accepted means of compliance will likely expedite the certification process, no applicant will be required to use ASTM or any other means of compliance. Instead, an applicant may propose its own means of compliance for acceptance, or demonstrate compliance to the new rule by using the prescriptive provisions in former part 23 and supporting guidance—all of which will remain publically available. As discussed in the NPRM, the long-term benefit and cost reduction provided by this rule is that it will allow the introduction of new technologies without the formal processes that currently increase certification costs and inhibit innovation.

The American Association of Justice (AAJ) commented that the new part 23 performance standards should not preempt state tort law because state tort law functions as a necessary adjunct to federal regulations that impose only minimum standards of care.

AAJ urged the FAA to avoid any language that could allow the new standards to be construed as preempting state law for defectively designed or produced airplane, or characterizing the standards beyond what is authorized by the Federal Aviation Act.

AAJ's comment regarding preemption of state tort law in aviation cases was not a topic of this rulemaking. Rather, it is the subject of current litigation in federal court regarding interpretation of the FAA's enabling legislation. The outcome of that litigation is neither the subject of this rulemaking, nor will this rulemaking affect that outcome. However, as noted by the Supreme Court in previous litigation, it is the applicant's obligation to comply with airworthiness standards; the FAA cannot guarantee such compliance.

15. Regulatory Evaluation

The FAA received comments from five commenters (four companies and one individual) on the summary of the regulatory evaluation published as part of the NPRM. In the NPRM regulatory evaluation, the FAA requested that commenters include data supporting their comments, but no commenter submitted any cost or benefit data with its comments.

a. General

Kestrel stated that all applicants will benefit from decreased certification costs and hopes the cost savings are tangible and can be realized in a short time frame; however, Kestrel anticipates an increased workload after the rule is adopted to train its personnel on the new standards. Abbott, Air Tractor, and one individual commenter characterized the cost benefit analysis as incomplete.

In the NPRM, the FAA stated that if the proposed rule saves only one human life—for example, by improving stall characteristics and stall warning—that alone would result in the benefits outweighing the costs of the rule change. Air Tractor characterized this statement as "vacuous." Air Tractor went on to comment that its industry places a high value on protecting human life and expends enormous energy, talent, and resources to protect it.

The FAA intended this statement as a simplified break-even analysis of the likely benefits of the proposed rule. It was not intended to replace the costs and benefits detailed in the regulatory evaluation. The complete regulatory evaluation, located in the docket, is more comprehensive than the summary that appears in the NPRM preamble and contains the estimates provided to the agency by industry.[16]

Abbott stated there was no clear indication of how the proposed change would reduce net cost or expedite the certification process. Abbott concluded there were "potential significant additional" costs created by the proposed rule, but no obvious or defined cost reduction. Abbott characterized the proposed regulations as having an unknown cost impact and stated these unknown costs represent a yet-unassessed and unavoidable cost for airplane developers. Abbott also stated that any additional cost the proposed rule places on industry that is not offset by cost reduction elsewhere does harm to the industry.

The FAA notes that under the proposed rule, applicants may choose to use an industry consensus standard, the former part 23 standards (available at no cost), or its own means of compliance accepted by the Administrator. The FAA presumes an

[16] See Docket Number FAA-2015-1621.

applicant will use these options to make the best economic choices given the circumstances of design and development for its product. Such choices are an inherent strength of a performance-based standard, but cannot effectively be analyzed for costs or benefits, especially if a design encompasses new technology that was never subject to the former regulation. Similarly, the FAA cannot predict the viability of the products or the financial health of an unknown start-up company under a regulation that allows for, but does not require, its products be used in any airplane design.

b. Impact on Small Entities

Air Tractor commented the FAA's analysis of the proposed rule impact on small entities did not include Air Tractor and Thrush Aircraft (Thrush).

Air Tractor was concerned that data from only 5 entities was used in the regulatory flexibility analysis. It noted the FAA should have included every company that has active manufacturing activities and the data used were non-representative of the overall industry. Air Tractor also indicated the inclusion of Thrush and itself would have doubled the number of employees and annual revenues represented in the analysis. Additionally, Air Tractor believed the FAA should have also included the TC holders of small airplanes that are no longer being manufactured but require TC support and STC holders that certificate products to the part 23 standards.

Finally, Air Tractor concluded that the omission of non U.S.-owned entities that "operate" in the United States presented a "distorted view of the true impact" of the proposed rule on the general aviation industry in the United States.

The FAA conducted its analysis in accordance with the "Small Business Regulatory Flexibility Act." For each regulatory flexibility analysis, an agency is required to provide a description of and, where feasible, an estimate of the number of small entities to which its proposed rule would apply. Many, if not most, small entities do not provide publically available information such as employment data that would allow an agency to determine if a business qualifies as a small entity under the guidelines of the Small Business Administration (SBA). Nor is there publicly available revenue data for these entities that make it possible to determine the burden of a proposed or final rule on these entities. The FAA does not have the authority or the means to require any entity to report its employment or revenue data. Accordingly, the FAA does not have the requisite knowledge of every company that still has active manufacturing activities that might be subject to the proposed rule.

The small business entities the FAA used in its analysis had provided data on their employment and revenue either through the regulations of U.S. DOT Form 41, the Securities and Exchange Commission, or through news releases that the entities made public. Neither Air Tractor nor Thrush have such data on record, and Air Tractor did not provide employment or revenue data for itself as part of its comment.

The five entities examined as part of the FAA's analysis qualified as small entities under the SBA criteria and were either actively manufacturing airplane or were under new ownership and had publically announced they were working toward setting up an airplane manufacturing line that would be subject to part 23. Airplanes previously certificated under part 23 will not be affected by the regulations affecting new certifications, so TC holders of operating airplanes who are not actively seeking some

certification are not appropriately excluded from the analysis. The same holds true for STC holders that used the part 23 standards in effect at the time of these airplane original certifications.

The regulatory flexibility analysis conducted for the proposed rule did not include any non-U.S. entities because, similar to the domestic firms referenced above, the employment and revenue information required for the analysis was not publicly available.

c. Icing

Textron stated that although the FAA identified a need for improved certification standards for operation in severe icing conditions, it did not provide a cost benefit analysis to show that part 23 airplanes would benefit from them.

The FAA did conduct a cost benefit analysis of the icing requirement. Flying into icing is risky and the ARC identified part 23 airplane icing accidents. The FAA contacted industry, and some Part 23 ARC members indicated to the FAA that the new rule and standards reflect current industry practices for detecting and exiting icing conditions. Additionally, the rule to certify that the airplane can operate safely in SLD is voluntary. When compliance is voluntary, or no change in industry practice will occur from a new regulation, the FAA determines the rule to be minimal cost. This determination was made in the initial regulatory impact analysis and is made in the final regulatory impact analysis.

In the NPRM, the FAA proposed that for a part 23 airplane to be certificated to fly in known icing conditions, an applicant would have to demonstrate operation in the icing conditions defined in part 25 appendix C. This requirement did not change from the former part 23 requirements. As a safety matter, for many years airplanes currently

certificated under part 23 have demonstrated the ability to detect and safely exit from freezing rain and freezing drizzle conditions.

The standards and requirements for the various icing certification levels were discussed extensively with the Part 23 Icing ARC (Icing ARC) and the Part 23 ARC. The new rule and standards for detecting and exiting freezing drizzle and freezing rain are consistent with and include significant parts of the Icing ARC's recommendations.

d. Part 23 Limitation

Textron recommended the FAA change the limitation on part 23 airplanes from its proposed gross takeoff weight limit of 19,000 pounds (maintaining the current part 23 limit) to a maximum payload limitation of 6,000 pounds. Textron stated the change would have a dramatic positive impact on the potential costs and benefits of the proposed change.

This change is beyond the scope of this rulemaking for the FAA to consider. This change was not proposed by the FAA and would be a fundamental change to part 23 that could potentially affect certification of airplanes under part 25.

e. Reporting and Recordkeeping Requirements

The FAA stated it expected minimal new reporting and recordkeeping requirements would result from the proposed rule and requested comments on this finding. The FAA received no comments on reporting or recordkeeping requirements.

Therefore, the FAA adopts the regulations as proposed, and will make no change to the regulatory evaluation regarding the reporting and recordkeeping requirements.

16. Out of Scope Statement

Several commenters requested changes to regulations or to existing FAA processes and guidance materials that are not directly related to this rulemaking. The FAA is not addressing these comments specifically because they are beyond the scope of this rulemaking.

D. Part 23, Airworthiness Standards

1. Legacy Rules

a. Cockpit Voice Recorders (§ 23.1457)/Flight Data Recorders (§ 23.1459)

In the NPRM, the FAA proposed to use the same cockpit voice recorder (CVR) and flight data recorder (FDR) standards that exist in former §§ 23.1457 and 23.1459. The proposed rule included revised references to other sections of proposed part 23, but no substantive changes to those standards.

The NTSB stated it is pleased the NPRM retained the needed prescriptive design standards in proposed §§ 23.1457 and 23.1459. The NTSB added it would be appropriate for the FAA to include a requirement for image recorders, which it described in its Safety Recommendation A-13-12, dated May 6, 2013.

The FAA considered the NTSB's request to add requirements for image recorders. No functional or operational requirements to record images has ever been proposed or evaluated for costs and benefits. Any such requirements would constitute significant rulemaking and require public participation, and therefore exceeds the scope of this rule.

EASA and the Associations stated the CVR and FDR requirements stem from ICAO annex 6 requirements, which are already based upon EUROCAE industry standards ED-155; ED-112A, "MOPS for Crash Protected Airborne Recorder System;"

and ED-155, “MOPS Lightweight Flight Recording Systems.” They suggested the FAA redraft the regulations to be more performance-based and number the regulations in accordance with any new numbering scheme, and change the references from the operating regulations as soon as practical.

The interplay between operation and certification regulations remains the reason for carrying the current standards unchanged into the new part 23. Redrafting them to objective standards, as suggested by EASA and the Associations could result in varying data sets between operators without any discernible benefit for such variation. Changing the standards only for part 23 airplanes certificated after a particular date would also require significant changes to the regulations under which the airplanes operate, adding complication without any noted benefit.

NJASAP supported the FAA’s decision to maintain the current standards for cockpit voice recorders (§ 23.1457), noting that removing the current prescriptive requirements could hinder the conduct of future accident investigations. NJASAP did not comment on § 23.1459, “Flight data recorders”.

Commenters opposed to retaining the standards generally characterized them as too prescriptive. While accepting the need to maintain the numbering system to align with other regulations, EASA found the unchanged content to be detailed, design specific, and not providing the safety intent. The EASA-suggested language referenced recorder systems with more generalized statements regarding installation and technical specifications. BendixKing stated that it “seems binary” that the “specifics are invoked” only “if recording is required.” It also noted that the standards use approximately 1,000 words when 100 would be adequate in stating the safety intent. It concluded the

requirement as written will hurt safety in the future by either retarding the technology or creating an environment where manufacturers will avoid recording. BendixKing included the identical comment for both recorder sections.

The primary use of both CVRs and FDRs is for accident investigation. Over the past 30 years, the FAA has worked with the NTSB to adopt and refine the specific requirements that document both flightcrew communication and the functions of airplane that form the basis for airplane accident and incident investigation. The FAA adopted the first significant flight data recorder upgrades in 1997 and made a concerted effort to standardize the operational and certification requirements across the operating and certification parts. The primary requirements for recording voice and data are not contained in the certification regulations, but in the operating regulations. When an airplane is required by an operating rule to record voice or flight data, the operating rule references back to the standards for the equipment in the certification part that applies to the airplane. This is true for large and small airplanes and for helicopters.

Airplane certification requirements do not align perfectly with operating regulations. A part 23 airplane may be operated under part 91 or 135; therefore, the requirement to have and use CVRs and FDRs may differ depending on how the airplane is operated. But the standards for the equipment—when required—do not differ, and are intended to function the same way regardless of the airplane's certification basis. This consistency is central to the needs of the NTSB and all investigative bodies. It makes the design, certification, and function of the equipment standard for the industry as a whole. The FAA last amended the recorder regulations in 2008 to reflect investigative experience with the functions of newer recorder and flight management tools.

Therefore, the FAA finds it appropriate to retain these well-known requirements. The current integration of the operating and certification regulations is well established and functioning as intended. The need for investigative data following accidents and incidents is not forecasted to change. The commenters did not specify which of the current requirements were inappropriate or unnecessary, but merely expressed general concerns that the standards might inhibit safety in future designs. The FAA has long acknowledged the safety intent of flight recorders in providing investigators with the tools to recognize trends and malfunctions following accident and incidents. Consistency in the equipment and data that come from the equipment remains the goal.

BendixKing's observation that the certification rules are invoked only when "recording is required" is accurate. As explained, the certification requirements for installation and use of this equipment are only effective when required by an operating rule. Once required, all the equipment must function to the same standards. The fact that recording is required under different operating regulations, and the certification regulations referenced in those operating regulations, is the reason for not changing them for one certification part. If an airplane is not required by operational rule to record voice or data, then the specificity of the certification regulations is not an issue. The commenters did not include proposed design or functional changes for new airplane that might affect the requirements as stated. If a novel design is proposed in the future that affects recorder function, before approval, the FAA would coordinate with the applicant to ensure such design features meet the needs of accident and incident investigation.

Textron commented on proposed § 23.1457(c), which retains the current language requiring each CVR to be installed so that specified communications are recorded on a

separate channel. The regulation currently and as proposed specifies four separate channels—the first channel for the first pilot, the second channel for the second pilot, the third channel at the cockpit-mounted area microphone, and the fourth channel for the third and fourth crewmembers. Textron commented that these CVR channel assignments are a "legacy" from magnetic tape recorders and there is no physical effect of such assignment on current solid-state recorders. Textron stated the current channel assignments are different and, therefore, paragraph (c) language should be revised to allow for flexibility in channel assignment or be aligned with the assignments manufacturers currently use. In addition, Textron noted that a proposed rule of EASA does not specify channels, but instead references the more detailed requirement of an ASTM standard.

Textron's comment—that the requirement for separate channels does not reflect the reality of currently-manufactured equipment—is limited in its view. While the regulation does require separated recording of different voice communication channels, the rule is flexible enough to avoid the issue raised by Textron. Regardless of an applicant's CVR channel numbering scheme, the regulation is satisfied if the CVR is designed to record audio sources on dedicated channels. This remains the FAA's policy on this regulation, which includes Textron's products already installed in airplanes that meet the former regulation.

An individual commenter noted the proposed rule seemed to anticipate an onboard storage system that must withstand a crash.[17] The commenter suggested that

[17] See docket number FAA-2015-1621-0083. The comment was referenced as "23.1457 Flight Data recorder." Section 23.1457 covers cockpit voice recorders, while 23.1459 addresses flight data recorders. It

because recordings may not be stored onboard in the future, but rather wirelessly transmitted to the ground or a satellite, the FAA should revise the provision to reflect this possibility rather than "locking in old technology."

The FAA is aware that, at some point in the future, recordings may no longer need to be stored on board airplane. The FAA participates in international working groups that monitor these technology trends. There are many technical and legal issues attached to wireless transmission of voice and data communications. A change to allow such transmission and storage would affect several parts of the CFR and the functions of the NTSB, which were not proposed or discussed as part of this rulemaking..

b. Instructions for Continued Airworthiness (§ 23.1529)

In the NPRM, the FAA proposed to relocate the requirements for Instructions for Continued Airworthiness from § 23.1529 to proposed § 23.1515. The FAA also proposed to remove appendixes A through F, and rename Appendix G to Part 23—Instructions for Continued Airworthiness, as Appendix A to Part 23—Instructions for Continued Airworthiness.

Upon further consideration, the FAA has decided to retain the requirements for Instructions for Continued Airworthiness in § 23.1529. A change to § 23.1529 would affect many other parts and guidance documents, which reference the section. Because of the new numbering scheme in part 23, § 23.1529 is located in the "Legacy Regulations" section of the final rule. The appendix for Instructions for Continued Airworthiness is now located in Appendix A to Part 23, as proposed.

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is unclear if the comment addressed one or both sections, but the FAA's response would not change since both require crash protected recording devices.

2. Subpart A - General

a. Applicability and Definitions (proposed § 23.1/now § 23.2000)

In the NPRM, proposed § 23.1 (now § 23.2000) would have prescribed airworthiness standards for issuance of type certificates, and changes to those certificates, for airplanes in the normal category. It also would have deleted references to utility, acrobatic, commuter category airplanes. Proposed § 23.1 also would have included definitions for the following terms specific to part 23: continued safe flight and landing, designated fire zone, and empty weight.

Air Tractor asked why it was necessary to use the term "category" if there is only one "normal" category.

The FAA notes that there is a need to retain the concept of different categories because other parts of the FAA's regulations, including the certification and operating rules, set certain requirements based on an airplane's category.

An individual commenter opposed the elimination of the utility category as related to spin training for existing airplanes. The commenter would support elimination of the utility category if there would be a reevaluation of the airplanes allowed to be used for spin training. This commenter also questioned whether the proposed change would result in a revision and reformatting of the current Type Certificate Data Sheet (TCDS) and whether the airplane would be considered not airworthy until re-placarded to conform to the new standards.

This rule does not affect the category of existing airplanes, nor does it require the TCDS be revised or reformatted. Airplanes currently certified in the utility category for

spin training retain that capability under this new rule. Furthermore, the airworthiness of the existing fleet will not be affected by this rule.

An individual commenter recommended the FAA clarify whether the term "continued safe flight and landing" would not consider weather, environmental, or surface conditions in the event of a forced landing.

The FAA agrees that it should clarify that in the event of a forced landing, the definition of "continued safe flight and landing" does not include consideration of weather, environmental, or surface conditions beyond those already taken into account by the FAA's operating rules. The FAA expects that a pilot will conduct his or her flight within the FAA's operating rules and the airplane's normal operating envelope, and finds doing so will help ensure the pilot has safe landing options. The FAA's intent was to maintain the existing level of safety for small airplanes. Historically, single-engine and light twin-engine airplanes have been required to have characteristics that minimized the resulting hazards when a loss of engine forced an off-airport landing. The requirements for larger, multiengine part 23 airplanes are based on the requirement to continue flight back to an airport after the loss of an engine. This rule retains this requirement as it applies to part 23 airplanes that cannot maintain altitude after a critical loss of thrust. The FAA will provide additional clarification in guidance. It is not appropriate for the FAA to establish airworthiness standards for "continued safe flight and landing" that would require all airplane designs to account for extreme conditions—such as mountainous terrain—and extreme weather, because pilots who decide to fly over dangerous terrain or in weather have chosen to greatly reduce their options for safe landing.

The FAA proposed including a definition of “designated fire zone” that was flexible enough to capture both the historical understanding of fire zones and those areas in airplanes that incorporate novel design concepts that merit the increased safety measures. However, the FAA finds including a definition of “designated fire zone” will cause confusion and result in less flexibility. Rather than include a definition, the FAA will maintain the same understanding as the historical use of the term “fire zone,” a well-understood term that has been in use for decades and generally includes the areas of an airplane in which a powerplant, or some portion thereof, resides. Accordingly, the FAA will remove the definition from the rule and will determine which areas are designated fire zones in the specific means of compliance. Furthermore, specific sections of the new rule have added the term “fire zone” back into the rule so there is a clear link to means of compliance.

EASA commented the proposed definition of “empty weight” is too design specific and should be eliminated. EASA noted future technological developments would necessitate changes and future rulemakings, which is at odds with the objective to make objective rules change resistant for the next 20 years.

The FAA agrees the definition of “empty weight” is too design specific because the list of traditional features included may not apply to all airplanes in the future. Accordingly, the FAA deletes the definition from the final rule and will rely on means of compliance to address the requirements for each airplane. This will allow the FAA to capture the appropriate features for new propulsion systems and configurations without losing the means of compliance for traditional airplanes.

Air Tractor recommended the FAA provide a definition for "minimum flying weight" that would include the weight of the necessary crew and the minimum fuel required for legal operation for the lightest equipped airplane that complies with type design requirements. It asserted there is no point in the FAA certifying an airplane as safe for operation below the minimum weight at which the airplane can be operated.

The FAA finds Air Tractor's recommended definition of "minimum flying weight" is not an appropriate substitute for empty weight. Empty weight is used to provide a baseline for an airplane; establishing a "minimum flying weight" would not work for that purpose.

Embraer suggested the FAA include definitions for "Aircraft Power Unit," "Fuel," "Critical lightning strike," and "Fuel system" in proposed § 23.1(b).

The FAA notes Embraer's suggestion to add definitions to proposed § 23.1(b); however, these definitions are addressed in their respective subparts. The terms "Aircraft Power Unit," "Fuel," and "Fuel System" are addressed in subpart E, and the term "Critical lightning strike" is addressed in subpart D. Furthermore, adding these definitions could lead to more confusion than clarification.

b. Certification of Normal Category Airplanes (proposed § 23.5/now § 23.2005)

In the NPRM, proposed § 23.5 (now § 23.2005) would have applied certification in the normal category to airplanes with a passenger-seating configuration of 19 or less and a maximum certificated takeoff weight of 19,000 pounds or less. Proposed § 23.5 would have also established certification levels based on the passenger seating configuration and airplane performance levels based on speed. Proposed § 23.5 also would have established a "simple" airplane classification.

Normal Category

Air Tractor and Textron questioned the imposition of a weight-based limitation for certification in the "normal" category in proposed § 23.5(a). Both commenters indicated that tying the applicability of part 23 to a maximum takeoff weight of 19,000 pounds would not meet the FAA's objective of replacing the current weight and propulsion divisions in small airplane regulations with performance- and risk-based divisions. Air Tractor also commented there was no basis for weight differentiation between normal and transport category airplanes on the FAA's safety continuum and suggested it would be more consistent to only use certification levels and speed categories. Air Tractor further suggested that applicants should be free to decide between certification under part 23 and certification under "the greater rigor" of part 25. Textron recommended the FAA replace the 19,000-pound maximum takeoff weight limit with a 6,000-pound maximum payload limit.

The FAA notes Air Tractor's and Textron's comments to extend the scope of the normal category. However, these comments are beyond the scope of this rulemaking. The NPRM proposed to replace the prescriptive airworthiness standards of part 23 with performance-based standards, not to change the scope of applicability of part 23.

Textron recommended the FAA include considerations for airplane functional or system complexity as a determining factor in certification requirements.

The FAA notes this rule already considers system complexity during certification. The requirements applicable to an airplane depend on reliable indicators of complexity—the airplane's designed cruising speed or maximum operating limit speed, and the

maximum number of passengers. The airworthiness standards accommodate all degrees of complexity, which will specifically be addressed in accepted means of compliance.

Airplane Certification and Performance Levels

NATCA opposed the FAA's proposal to create certification and performance levels based on passenger capacity and airspeed in proposed § 23.5(b) and (c). NATCA noted that this approach was not consistent with how some foreign authorities with whom the United States has bilateral agreements "bucket" airplane classifications, including EASA, which classifies certification levels based on weight.

The FAA is not required to use the same metrics to classify airplanes as its bilateral partners. For example, Article 15 of the Agreement between the United States of America and the European Union on Cooperation in the Regulation of Civil Aviation Safety expressly reserves the authority for the United States to determine the level of protection it considers appropriate for civil aviation safety and to make changes to its regulations, procedures, and standards. Additionally, foreign authorities, including EASA, have been involved in the FAA's part 23 rulemaking effort since its inception with the Part 23 ARC. All foreign authorities involved in the part 23 reorganization effort agreed on the need to eliminate the divisions in part 23 based on weight and propulsion. Furthermore, the FAA's actions are consistent with EASA's actions.

NATCA also contended the FAA should retain a weight criterion because it relates to crash energy.

The FAA notes the risk associated with operating a 19,000-pound, level 1, low-speed airplane is accounted for in this rule by directly addressing the technologies installed on the airplane. For example, an airplane approved for instrument flight rules

(IFR) has to meet the reliability requirements for IFR, regardless of level. Also, the FAA's operating rules mitigate the airplane's operational risk.

NATCA also asked the FAA to clarify that an applicant would not qualify for a lower certification level simply by removing seats and to publish guidance on determining certification levels.

The FAA notes, as set forth in § 23.5 (now § 23.2005), an airplane's certification level depends only on its maximum passenger seating configuration. This number does not include flightcrew. The maximum passenger seating capacity is known during the certification process; therefore, the airplane must comply with the standards applicable to that certification level. An airplane operator's decision to remove a passenger seat after certification does not affect the standards applicable to that airplane.

NATCA also recommended the FAA review the proposed part 23 certification levels to incorporate LSA and primary category airplane and create equivalent regulations as necessary.

The FAA notes that NATCA's suggestion is beyond the scope of this rulemaking. This rulemaking's purpose is to replace prescriptive design requirements of part 23 with performance-based standards, not expand the scope of part 23's applicability. The LSA and primary category certification processes exist as separate certification paths for airplane that qualify as either a LSA or primary airplane.

NATCA further commented by asking—

- Whether the intent is for airplane models with multiple configurations to have each configuration listed on the TCDS;
- Whether there can be dual or more categories on one TC; and

- Whether an airplane can be moved between levels and speed definitions during operational usage and, if so, whether this needs to be captured as different options on the TCDS.

In response to NATCA's question regarding multiple configurations, the FAA notes that if an airplane model has multiple configurations, the applicant will have to accept as the certification basis the requirements of the most stringent certification and performance levels available in the configuration list. If the applicant chooses not to comply with the most stringent requirements applicable to the configurations, the applicant will have to address each model individually on the TCDS. With respect to the number of categories on a TC, the FAA is eliminating the commuter, utility, and acrobatic airplane categories in part 23 for the reasons explained in the NPRM. Therefore, airplanes certified under new part 23 have only one category: normal.

Lastly, with respect to NATCA's question regarding airplanes moving between certification levels and speed definitions, an applicant either accepts the most stringent certification basis or addresses each model individually on the TCDS or by an STC. In order to move to a higher level, it will be necessary to recertify the airplane to the higher-level standard.

NJASAP supported the proposal to use passenger capacity and airspeed to establish airplane certification and performance levels, but expressed concerns the methodology may go too far in generalizing a very diverse group of airplanes.

The FAA understands NJASAP's concern, but notes the certification and performance levels are used to replace the weight and propulsion divisions in the former

requirements. The levels are general to allow the accepted means of compliance to more accurately address the various technical differences.

Kestrel supported the FAA's proposed airplane certification levels, but expressed concern with the impact of migrating the Airplane Classes in former § 23.1309 (I, II, III, IV)[18] to the proposed combined airplane certification and performance levels. Kestrel noted that Airplane Classes were currently used in the System Safety Analysis process to establish allowable quantitative probabilities. Kestrel asked the FAA to specify what the expected allowable quantitative probabilities would be for each of the eight possible combinations of certification and performance levels (i.e., low-speed levels 1-4 and high-speed levels 1-4).

The FAA notes that there is no direct connection between the systems-based airplane classes from AC 23.1309-1E[19] and the airplane certification and performance levels in § 23.2005, which apply to all subparts. The airplane classes reflect the safety continuum concept in that it may be acceptable for simpler airplanes or airplanes at lower certification levels to have a higher probability of failure for equipment. The airplane's certification level is strictly based on the number of passenger seats. The different means of compliance will address the safety continuum.

Air Tractor commented generally that it does not see a big difference in the certification effort required by the different certification and performance levels. Air Tractor suggested there could be a difference in required levels of safety for equipment, but indicated it was impossible to tell because the FAA had not yet defined the levels of

[18] These Classes are described in AC 23.1309-1E, paragraph 15.
[19] The Airplane Class Levels from former § 23.1309 are still addressed in subpart F of this rule.

safety.[20] Air Tractor suggested the FAA codify the required levels of safety because the rule preamble would not be given the weight of law.

The FAA acknowledges that Air Tractor is correct in that there could be a difference in the required levels of safety between two airplanes based on the FAA's safety continuum philosophy. Differences in products and their associated risks justifies using different levels of safety. While the high-level performance requirements are the same for all products, the required level of safety is best addressed using means of compliance so that each project is assigned the appropriate level of safety. Although language in the preamble does not supersede the language of the regulation itself, the preamble is evidence of the FAA's contemporaneous understanding of its proposed rules, and may serve as a source of evidence concerning contemporaneous agency intent.[21]

Several commenters questioned the meaning of "passengers" as used in the descriptions of certification levels in proposed § 23.5(b), particularly for airplanes that may require 1 or 2 crew depending on operating regulations.

The FAA elects to use the term "passenger" to align with the operating rules, and because passenger count has historically correlated to risk tolerance. The term "passenger" excludes "flightcrew" members. The FAA recognizes the concerns over confusion because the ARC discussed this issue at length and it was again discussed within the FAA. Based on these discussions, the FAA finds "passenger" is the most appropriate term. As one of the commenters noted, the "crew" could include one or more "occupants." Part 23 airplanes can include special use airplanes that may require multiple

[20] Air Tractor pointed out proposed § 23.1300.
[21] Wyoming Outdoor Council v. U.S. Forest Service, 165 F.3d 43, 53 (D.C. Cir. 1999).

flightcrew members, but have no provisions for passengers. Part 23 is also used for airplanes that carry no "flightcrew" or "passengers" today (i.e., unmanned aircraft systems), and may also address airplanes with passengers and no flightcrew in the future. For airplanes that require different numbers of flightcrew for different operations, the applicant must use the smallest number of flightcrew required for any operation, which is typically one, the most conservative number. The FAA finds the approach proposed § 23.5 (now § 23.2005) will allow the most flexibility, least confusion, and focus on risk tolerance, which aligns part 23 with the operating rules.

Several organizations commented specifically on the proposed airspeed limits for the low-speed and high-speed performance levels established in proposed § 23.5(c). NATCA suggested the use of design cruising speed ($V_{C)}$ and maximum operating limit speed (V_{MO}/M_{MO}) may not be appropriate for untrained persons, and recommended the FAA either define those terms or use more common measurements. NATCA also commented that the FAA needs to clarify what "speed" means (i.e., cruise speed versus some other speed standard). NATCA expressed concerns over the use of "common" terms versus speeds used for certification, which are also used in operations.

The FAA notes both V_C and V_{MO} are defined in 14 CFR 1.2. V_C means design cruising speed and V_{MO} / M_{MO} means maximum operating limit speed. The FAA finds that V_C, V_{MO}, and M_{MO} are appropriate for engineering determinations as they relate to structural speeds as well as flight-testing speeds. Furthermore, the FAA clearly states these are calibrated speeds, which typically are used in certification.

Transport Canada commented specifically on the parameters for the low-speed performance level in proposed § 23.5(c)(1). In particular, Transport Canada said V_C and

V_{MO} should both be less than 250 Knots Calibrated Airspeed (KCAS) for an airplane to qualify as low speed. Therefore, Transport Canada concluded the phrase "V_C or V_{MO}" in this provision should actually read "V_C *and* V_{MO}".

The FAA agrees with Transport Canada concerning the use of "and" versus "or" and revises the rule accordingly.

Air Tractor contended that the parenthetical references to M_{MO} limits in proposed § 23.5(c)(1) and (c)(2) are confusing because they are not clear if these values represent either new absolute constraints, or if they are intended to provide an approximate context for what 250 KCAS might mean at some higher altitude. Air Tractor noted that Mach 0.6 corresponds to 250 KCAS at about 23,400 feet in a standard atmosphere, but wondered what performance level would be assigned to an airplane with a V_C of 250 KCAS and an M_{MO} of 0.65.

Garmin commented that some airplanes do not have a M_{MO}, but have a maximum speed of more than Mach 0.6. For example, Garmin noted an airplane with a V_{MO} of 240 KCAS up to its certified ceiling of 35,000 feet and no M_{MO} would be classified as a low-speed airplane but will actually be going Mach 0.71 at 35,000 feet. Garmin recommended the FAA revise the low-speed and high-speed performance levels to remove M_{MO} from parentheticals, clarify that a low-speed airplane must have a V_C or V_{MO} equal to or less than 250 KCAS and a M_{MO} less than or equal to Mach 0.6, and that a high-speed airplane is anything that does not qualify as low speed.

The FAA agrees that the proposed rule was unclear and revises the final rule to clarify that M_{MO} is one of the criteria, not an approximation of the KCAS cutoff. Accordingly, an airplane must satisfy all of the V_C, V_{MO}, and M_{MO} requirements to

qualify as low speed. If an airplane does not satisfy all three, then it is considered a high-speed airplane. After further review, the FAA determined that V_C and V_{MO} are not directly parallel because V_C is a structural speed and V_{MO} is a performance speed. For this reason, the FAA replaces V_C with V_{NO}. V_{MO} historically was a performance value used by turbine-powered airplanes while V_{NO} historically was a performance value used by piston-powered airplanes. By replacing V_C with V_{NO}, the values now reflect parallel operational speeds.

ANAC commented that the FAA should use stall speed instead of V_{MO} and M_{MO} to define performance levels because it would help address loss of control and prevent an applicant from arbitrarily limiting an airplane's V_{MO} and M_{MO} below the airplane's capabilities to avoid more stringent certification standards. ANAC asked the FAA to elaborate on the connection between an airplane's V_{MO} and M_{MO} and takeoff risk.

The FAA does not agree that stall speed is the best parameter to use for determining performance levels. Although an airplane's top speed generally has been aerodynamically limited to a multiple of stall speed that varied depending on propulsion, this is not true for all airplanes and does not provide the necessary flexibility to address airplanes that incorporate new technology. For example, there are airplanes in development that have very low-stall speeds—the airplane can land and takeoff in very little space, or even vertically—but may have V_{NO} or V_{MO} greater than 250 KCAS, making them a high-performance airplane.

Simple Airplane Classification

The FAA proposed to define "simple" airplanes to recognize the entry-level airplane. Simple airplanes would have been limited to airplane designs that allow no

more than one passenger, are limited to VFR operations, and have a low top speed and a low stall speed. The FAA asked for comments concerning the value of creating a simple airplane sublevel given that a simple airplane would have characteristics very similar to a certification level 1, low-speed airplane.

ICON, Transport Canada, BendixKing, NATCA, and two individual commenters supported the inclusion of a separate "simple" airplane classification. However, Zee and the Associations commented that the FAA should not create a "simple" airplane classification, and that each of the proposed certification and performance levels should stand on its own based solely on performance and complexity of operations. The commenters against inclusion of a "simple" category contended that it was more appropriate to address this sort of classification in the means of compliance.

The FAA has decided not to adopt a "simple" airplane classification. The FAA finds the addition of a simple category does not produce benefits over those already provided by the new rule. The FAA finds it is more appropriate to address the requirements for a level 1, low-speed airplanes. Additionally, in the NPRM, the FAA proposed allowing simple airplanes to use non-type-certificated engines and propellers to allow those airplanes to use electric propulsion. The FAA can achieve the same flexibility by approving electronic propulsion as part of an airframe for a level 1, low-speed airplane; therefore, the FAA revises the propulsion requirements in this rule to provide that flexibility.

Airplanes Certified for Aerobatics

The FAA proposed to eliminate the acrobatic airplane category in part 23, but still allow a normal category airplane to be approved for aerobatics provided the airplane was

certified to address the factors affecting safety for the defined limits for that kind of operation.

Velica S.A.S. (Velica) recommended the FAA define "aerobatic category" in proposed § 23.5 to include airplanes without any maneuver restrictions, other than those shown to be necessary as a result of required flight tests.

For the reasons explained in the NPRM, the FAA removed the acrobatic category from part 23. The FAA agrees with Velica that the limitations for an airplane certified for aerobatics should be based on flight tests, but believes more specificity is warranted. Therefore, the FAA will require airplanes certified for aerobatics to comply with the limitations established under subpart G of part 23 in this rule.

c. Accepted Means of Compliance (proposed § 23.10/now § 23.2010)

In the NPRM, proposed § 23.10 (now § 23.2010) would have required an applicant to show the FAA how it would demonstrate compliance with this part using a means of compliance, which may include consensus standards accepted by the Administrator. Proposed § 23.10 would have also required a person requesting acceptance of a means of compliance to provide the means of compliance to the FAA in a form and manner specified by the Administrator. Proposed § 23.10 would have created flexibility for applicants in developing means of compliance and also specifically identify consensus standards as a means of compliance the Administrator may find acceptable.

General Comments

The Associations recommended the FAA revise paragraph (a) to require an applicant to "comply" with part 23, rather than "show the FAA how it will demonstrate compliance" with part 23, using a means of compliance. The Associations also

recommended revising paragraph (b) to require an acceptable means of compliance to be in a form and manner specified by the Administrator.

The Associations also argued that, without these changes, the proposed rule could have been interpreted as requiring each applicant to come to agreement with the FAA on acceptable means of compliance for each certification project, when it appears the FAA intends to issue acceptance of methods of compliance in, for example, standards that are already deemed acceptable. The commenters also noted that part 21 does not currently require a showing of compliance in all cases. The commenters stated that today, and potentially more so in the future, the FAA may accept compliance through demonstration or even a statement of compliance. The commenters contended the above-referenced revisions to proposed § 23.10 are necessary to ensure the designs meeting part 23 can continue to fully utilize part 21.

The FAA agrees with the commenters that proposed § 23.10(a) (now § 23.2010(a)) may have had the unintended result of requiring applicants to get approval from the FAA for each means of compliance even when the FAA had already accepted a means of compliance. This would have been counter to the FAA's intention that a means of compliance, once accepted by the FAA, may be used for future applications for certification unless formally rescinded. The FAA adopts the commenters' recommendation for paragraph (a).

The FAA does not adopt recommendation for paragraph (b) however, because it would not meet the intent of the requirement. Paragraph (b) addresses the situation in which an applicant proposes its own means of compliance, either as an alternative to an accepted means of compliance or as a new means of compliance for new technology. The

FAA intended paragraph (b) to require applicants requesting acceptance of a means of compliance to do so in a form and manner specified by the FAA, not to require already-accepted means of compliance to be documented in a form and manner specified by the FAA. In light of the comment, the FAA revises the proposed rule language to clarify that paragraph (b) applies to applicants who are requesting FAA review and acceptance of a proposed means of compliance.

Air Tractor questioned the need for a new rule specifying that all means of compliance must be accepted by the FAA and asked whether an applicant would need to obtain FAA approval for each means of compliance at the beginning of the process or any time prior to showing compliance.

This final rule is necessary because Congress directed the FAA to issue a rule that replaces the prescriptive requirements of part 23 with performance-based regulations.[22] This change means that applicants for a TC may use any number of unique design elements to attempt to comply with the performance-based requirements but only the FAA can accept these as means of compliance because the FAA is responsible for finding that an airplane satisfies the performance-based requirements in part 23 before issuing a TC. Although the means of compliance process is not new, the FAA adopts § 23.2010 to make the process clear to all applicants and to highlight that applicants have the opportunity to develop alternative approaches to complying with the part 23 performance-based requirements. While an applicant is not required to obtain FAA acceptance of means of compliance at the beginning of the certification process, it is

[22] Small Airplane Revitalization Act of 2013 (Public Law 113-53, 49 U.S.C. 44704 note).

advisable to seek acceptance as soon as possible, or preferably before, to mitigate the risk of having to redesign the airplane should the FAA not accept the means of compliance.

NATCA commented the FAA should require the accepted means of compliance be included on the published certification basis so products can be standardized and post-TC modifiers can know the certification basis used for the underlying product. NATCA also commented that maintenance personnel returning an airplane back to service will need access to adequate documentation on how an airplane is compliant with the rule so they can verify the airplane remains compliant. Assuming the standards are listed, NATCA asked the FAA to clarify how they would be listed in the airplane certification basis.

The FAA partially agrees with NATCA's concerns. Because many of the detailed requirements are no longer in part 23 and will move to means of compliance, it may be hard to know how an applicant showed compliance. That said, many means of compliance today are proprietary, and modifiers and maintenance personnel have no way of knowing what the original manufacturer did to show compliance. The FAA is working with its project support personnel to determine how much of the means of compliance information needs to be listed on the FAA TCDS to address concerns relating to post-TC modifiers and maintenance personnel. This information will be included in the training currently being developed for the ACO engineers and industry designees.

NATCA also recommended the FAA permit design change applicants to use their own alternate means of compliance to gain approval rather than relying on the original means of compliance used for the underlying TC. NATCA suggested this would be in

line with the FAA's statements that it is open to a means of compliance without preferring one over the other.

This option is currently permitted and will continue to be permitted under the new part 23. Applicants requesting a change to type design may propose their own means of compliance rather than using the original means of compliance. However, the FAA will review the request depending on the complexity of the design change or the alternative means of compliance. While this is the current process, AC 23.2010 provides guidance on how to submit a proposed means of compliance to part 23 for FAA acceptance.

NATCA asked the FAA to clarify how the certification basis would be handled for industry consensus standards. NATCA also asked whether an applicant must at least partially use industry consensus standards, or whether an applicant may choose not to use consensus standards at all. Finally, NATCA asked if an applicant could get a part 23 TC by only using the standards in ACs. Air Tractor suggested the FAA revise proposed § 23.10 to mention that the standards included in ACs are an accepted means of compliance.

The FAA notes that the certification basis will be the same as it is today: applicants must show compliance with part 23. An applicant may choose not to use any consensus standards, or a combination of consensus standards and other means of compliance, as long as the applicant's proposed means of compliance complies with part 23 and is accepted by the Administrator. The FAA finds it unnecessary to revise the proposed rule language as Air Tractor suggested. An applicant may already use ACs as means of compliance to part 23, where applicable, under § 23.2010.

Use of Applicant-Proposed Means of Compliance

Air Tractor contended the use of applicant-proposed means of compliance standards would lead to a significant loss in transparency of the certification process, as individual applicants may choose to make both the results and the process of showing compliance a matter of proprietary intellectual property. ANAC commented that the FAA should establish a method to publicize information about approved means of compliance that are not part of a consensus standard. To preserve proprietary information, ANAC recommended the FAA only publish summaries as it currently does for exemptions, special conditions, and ELOS findings. NATCA questioned how the FAA will handle proprietary specifications within a certification basis, arguing it is not in the public interest to have "secret" certification requirements. NATCA recommended the certification basis be published in the Federal Register for public comment. NATCA also recommended the certification basis for proprietary information be "explicitly identified" on the TCDS or STC. Finally, NATCA asked the FAA to clarify whether the FAA will publish FAA issue papers when an applicant uses an applicant-proposed means of compliance and, if so, noted that several FAA orders and policies would need to be revised.

The FAA has a responsibility to protect an applicant's proprietary information, including a proprietary means of compliance. As such, the FAA will not make the proprietary portions of applicant-proposed means of compliance publicly available. The FAA plans to address applicant-proposed means of compliance as it does today, by summarizing the information. The FAA will identify the certification basis (i.e., the applicable airworthiness standards) on the TCDS or STC as is done today. The FAA has not published, and does not plan to publish, the certification basis or FAA issue papers in

the Federal Register for public comment. Each applicant's certification basis is based on part 23 and is agreed to between the applicant and the FAA. The FAA is not required to elicit public comment on proposed means of compliance.

Garmin asked whether the FAA will accept portions of a previously accepted means of compliance, or whether an applicant must use that entire means of compliance. Garmin recommended the FAA revise proposed § 23.10 (now § 23.2010) to permit whole or partial implementation of a previously-accepted means of compliance or, alternatively, ensure AC 23.10 permits this.

The FAA agrees with Garmin and points out that this is acceptable today. The FAA can be flexible in accepting mixed, partial, or entire means of compliance from industry consensus standards as applicable to the specific product. The FAA recognizes that new product innovations will make this flexibility more important in the future. An industry consensus standard can state that, for credit in meeting that standard, the applicant has to meet the entire set of requirements. But the FAA may tailor acceptable consensus standards based on what is appropriate for the intended function.

Use of Current Part 23 as Means of Compliance

Embraer recommended the FAA revise proposed § 23.10(a) (now § 23.2010(a)) to acknowledge that an applicant may use the prescriptive requirements in former part 23 as an alternate means of compliance. Kestrel asked whether the FAA will require issue papers to permit the use of these former prescriptive requirements.

In the NPRM, the FAA noted it will accept the use of the prescriptive means of compliance contained in former part 23 as alternate means of compliance, except for those sections where the level of safety has increased specifically for stall characteristics

and icing protection. The FAA does not need to codify this decision to retain this flexibility and is therefore not revising the proposed language for § 23.10. For applicants relying on satisfaction of the prescriptive requirements in former part 23, amendment 23-62, as a means of compliance, the FAA will only require the G-1 certification basis issue paper to list the means of compliance as "amendment 23-62".

NATCA asked whether the FAA will permit an applicant to use older prescriptive regulations, such as Aeronautics Bulletin, amendment 7a, "Airworthiness Requirements for Aircraft"; CAR 3; and previous versions of part 23, as a means of compliance. If not, NATCA asked the FAA to clarify why those regulations are not appropriate and acceptable for the proposed design.

The FAA will consider the use of the older, prescriptive regulations in cases where it is appropriate for the airplane in question. There have been instances where applicants have approached the FAA with projects to "remake" new versions of vintage airplanes. The FAA has allowed and will continue to allow the use of appropriately-selected design standards on vintage airplanes. However, applicants wanting to use this approach should expect to use newer industry practices where the old standards and practices have, over time, not proven to meet the minimum acceptable safety standard for that class of airplane in part 23.

Manner in which Applicant must Present Means of Compliance

Textron asked how the FAA will document the acceptance of a non-industry standard means of compliance and whether acceptance of a Project-Specific Certification Plan (PSCP) is adequate proof of the FAA's acceptance of the means of compliance.

The FAA plans to include information on the acceptance of non-consensus standards on its Small Airplane Directorate Website. The G-1 issue paper and agreement on the certification basis and compliance checklist will suffice. PSCP acceptance is adequate proof of FAA acceptance of a means of compliance if a G-1 issue paper is not used.

Textron also asked whether there would be a system set-up similar to repair specifications where an applicant could have pre-defined methods for making certain changes to its products, and whether there would be a method for the FAA to accept deviations to the accepted standards.

The Part 23 ARC did not consider and the NPRM did not propose repair specification; therefore, it is beyond the scope of this rulemaking effort.

Air Tractor and Kestrel contended the process proposed by draft AC 23.10—which states that an applicant should list the means of compliance and consensus standards they intend to use to show compliance with part 23 in a certification plan or compliance checklist—is premature and would slow the certification process. The details of an airplane's design are often incomplete when an application is submitted and it can take years to obtain FAA acceptance of a PSCP. Air Tractor suggested that establishing a means of compliance during the process of negotiating the PSCP should be limited to picking one or more of the following: analysis, tests, design review, physical inspection, etc. Air Tractor also commented that a requirement for the FAA to review and approve of particular methods before the analysis can be presented would be new for most regulations. It would also require a new level of required response from the FAA that would drastically slow the process of either establishing the certification plan or showing

compliance. Air Tractor also questioned how this requirement compares with the FAA and Industry Guide to Product Certification.

The FAA finds that including the means of compliance in the PSCP or the compliance checklist will not alter the current practice for new technology because some of the compliance requirements may not be known at the time of application. This initial uncertainty means the agreed compliance may remain as a draft during the development and certification process until the specific means of compliance are determined and agreed upon. This may be a common issue with new technology during the first few years after the new part 23 is implemented. It will take some time to get accepted means of compliance into consensus standards, resulting in these means of compliance being developed during the project. In the long term, the new approach should shorten the time needed for an applicant to get FAA agreement on its means of compliance.

Finally, the FAA clarified the intent of the form and manner of the means of compliance. The FAA does not intend to "specify" the form and manner of means of compliance; the form and manner only need to be "acceptable."

3. Subpart B - Flight

a. Weight and Center of Gravity (proposed § 23.100/now § 23.2100)

In the NPRM, proposed § 23.100 (now § 23.2100) would have required an applicant to determine weights and centers of gravity that provide limits for the safe operation of the airplane. Additionally, it would have required an applicant to show compliance with each requirement of this subpart at each combination of weight and center of gravity within the airplane's range of loading conditions using tolerances acceptable to the Administrator. Proposed § 23.100 would have also required the

condition of the airplane at the time of determining its empty weight and center of gravity be well defined and easily repeatable.

The Associations recommended a clarifying change to proposed § 23.100(a) that would require the applicant to determine limits for weights and centers of gravity that provide for the safe operation of the airplane, rather than determine weights and centers of gravity that provide limits.

The FAA adopts the Associations clarifying change. Accordingly, § 23.2100(a) now requires the applicant to determine limits for weights and centers of gravity that provide for the safe operation of the airplane.

Additionally, the Associations recommended changing proposed § 23.100(b) to require the applicant to comply with each requirement of subpart B at critical combinations of weight and center of gravity. The commenters explained that it is appropriate to demonstrate compliance at critical combinations of weight and center of gravity, but showing compliance at each combination "would present an infinite matrix of test points."

The FAA also adopts the Associations recommended change to proposed § 23.100(b) (now § 23.2100(b)). While proposed § 23.100(b) could have been interpreted to require an infinite matrix of test points, this was not the FAA's intent. Accordingly, § 23.2100(b) now requires the applicant to comply with each requirement of subpart B at critical combinations of weight and center of gravity within the airplane's range of loading conditions using tolerances acceptable to the Administrator.

The Associations also stated that the determination of empty weight and center of gravity in proposed § 23.100(c) is "somewhat confusing and potentially unnecessary."

The commenters suggested clarifying changes that would replace “empty weight” with “weight” and delete “well” and “easily repeatable,” thereby requiring the condition of the airplane at the time of determining its weight and center of gravity to be defined. Similarly, Textron recommended deleting the terms “well” and “easily” from proposed § 23.100(c) because they are vague and subject to interpretation.

The FAA is retaining the terms “well defined” and “easily repeatable” in § 23.2100(c). In the NPRM, the FAA explained proposed § 23.100 would capture the safety intent of § 23.29. Section 23.29 has contained the terms “well defined” and “easily repeated” since it was published in amendment 23-0[23] with no challenges. Furthermore, “easily” is an important modifier for “repeatable” because it ensures that the condition of the airplane at the time of determining its empty weight and center of gravity is not hard for a mechanic to reproduce.

The FAA also retains the term “empty weight” in § 23.2100(c). Determining empty weight is fundamental to baselining an airplane. Removing this term would leave the weight value for baseline open to any weight between empty to gross weight. The ambiguity of not defining the baseline weight would create confusion and problems.

b. Performance Data (proposed § 23.105/now § 23.2105)

In the NPRM, proposed § 23.105 (now § 23.2105) would have required—

- An airplane to meet the performance requirements of this subpart in various conditions based on the airplane’s certification and performance levels for which certification is requested;

[23] 29 FR 17955, December 18, 1964.

- An applicant to develop the performance data required by this subpart at various altitudes and at high temperatures, while also accounting for losses due to atmospheric conditions, cooling needs, and other demands on power sources; and
- The procedures used for determining takeoff and landing distances to be executed consistently by pilots of average skill in atmospheric conditions expected to be encountered in service.

EASA and the Associations stated that some designs may have performance limitations at low temperatures rather than high temperatures, such as batteries in electric propulsion systems. The commenters recommended revising the proposed language to require performance data for low temperatures that can be expected during operation, if those low temperatures could have a negative effect on performance.

The FAA agrees proposed § 23.105(b) (now § 23.2105(b)) should account for possible performance degradation due to the effect of cold temperatures on electric propulsion systems. Proposed § 23.105 was intended to capture the safety intent of former § 23.45, which required the determination of performance data in various conditions that could negatively affect performance. Historically, propulsion systems were gas powered and negatively affected by high temperatures, which resulted in a corresponding negative effect on performance. This explains why former § 23.45 required the determination of performance data at a temperature from standard to 30 degrees Celsius above standard, as performance degradations historically resulted from operation at high temperatures.

As stated in the NPRM, the FAA intended the proposal to account for airplanes equipped with new technologies, such as electric propulsion systems. Additionally, the

FAA intended proposed § 23.105(b) to account for various conditions that could affect airplane performance. However, proposed § 23.105(b) would only have accounted for performance degradations that could result from the operation of systems at high temperatures, as the proposed language reflected former § 23.45. Because cold temperatures, rather than high temperatures, may have a negative performance effect on an electric propulsion system or a hybrid system, the FAA revises the proposed language to account for performance degradations at low temperatures. The FAA also removes the prescriptive language that would have required the determination of performance data at a temperature from standard to 30 degrees Celsius.

Section 23.2105(b)(2) now requires the applicant to develop performance data at temperatures above and below standard day temperature that are within the range of operating limitations, if those temperatures could have a negative effect on performance. This requirement is consistent with the NPRM as it replaces the prescriptive design requirements from the regulation with performance-based airworthiness standards that accommodate new technologies, such as electric and hybrid propulsion systems. Additionally, § 23.2105(b)(2) more accurately reflects the safety intent of former § 23.45 because it requires the development of performance data in conditions that could negatively affect performance, including conditions that account for new technologies.

As a general matter, under § 23.2105(b)(2), an applicant seeking certification of a gas-powered propulsion system must develop performance data at temperatures above standard that are within the airplane's operating limitations, because high temperatures could have a negative effect on the airplane's performance. Alternatively, an applicant seeking certification of an electric or hybrid propulsion system must develop

performance data at temperatures both above and below standard that are within the airplane's operating limitations, if these temperatures could have a negative effect on performance.

Garmin pointed out that limited airflow in a climb configuration may cause non-propulsion systems to overheat during long hot climbs, requiring a different climb speed or configuration for system cooling than addressed in proposed § 23.105(b). Garmin recommended the FAA include the phrase "other essential equipment" in addition to propulsion cooling in paragraph (b)(2).

The Associations similarly suggested that there may be some cases where the performance of equipment other than the propulsion system may drive cooling requirements for hot conditions. The commenters recommended revising the proposed language to include cooling requirements for these equipment, in situations other than climb.

The FAA understands the concerns of Garmin and the Associations, for paragraph (b)(2) to address cooling requirements for more than the propulsion system. However, subpart B—including § 23.2105—is intended to address airplane performance. Therefore, § 23.2105 should only address systems that affect airplane performance. For example, § 23.2105 may apply to avionics that also control propulsion, or flight controls and lift systems needed to develop repeatable airplane performance. Traditional avionics that do not affect performance are addressed in subpart F, which contains requirements for equipment. Therefore, the FAA is not adopting the phrase "other essential equipment" because it may be interpreted to include systems that do not affect performance, such as oxygen or navigation systems. This would be a new requirement that has not been

identified as a safety need, increasing the scope and possibly the cost of this rule. For the same reasons, the FAA is not expanding the scope of the rule to include cooling requirements for equipment other than propulsion systems, in situations other than climb.

Nevertheless, in light of the comments, the FAA acknowledges there may be systems associated with propulsion that are necessary for consistent performance, such as batteries or engine controllers, that could be affected by temperature. Section 23.2105 should address these types of systems. Therefore, § 23.2105(b)(2) will apply to systems associated with electric or other propulsion systems if those systems could negatively affect performance at temperatures above or below standard.

c. Stall Speed (proposed § 23.110/now § 23.2110)

In the NPRM, proposed § 23.110 (now § 23.2110) would have required an applicant to determine the airplane stall speed or the minimum steady flight speed for each flight configuration used in normal operations, accounting for the most adverse conditions for each flight configuration, with power set at idle or zero thrust.

The Associations recommended removing the proposed requirement for power to be set at idle or zero thrust for each determination to enable the introduction of new technologies such as distributed propulsion with reliable electric power. The commenters explained that proposed § 23.110 must account for distributed lift systems because the concept of distributed lift along a wing may be used to facilitate low-speed handling, and reliable systems of this type may dictate operational stall speeds. The commenters asserted their recommended change would ensure that distributed propulsion, with an appropriate reliability level, could be used in a landing condition accounting for a lower stall speed based upon the effects of this equipment.

The FAA agrees that proposed § 23.110 (now § 23.2110) should account for distributed propulsion systems used for thrust, flight controls, and high lift systems. However, the rule must define a thrust level for standardization because stall speeds are important to the development of the performance-based speeds. The FAA finds it appropriate to require traditional designs to determine stall speeds and minimum steady flight speeds with power set at idle or zero thrust. Accordingly, § 23.2110(a) now requires the power to be set at idle or zero thrust for propulsion systems used primarily for thrust. To accommodate distributed propulsion systems, the FAA is adding new § 23.2110(b), which requires a nominal thrust for propulsion systems used for thrust, flight control, and/or high-lift systems. These changes will allow § 23.2110 to accommodate the new technologies identified by the commenters.

Additionally, the FAA revises the proposed rule language to clarify the "stall speed or minimum steady flight speed determination" must account for the most adverse conditions for each flight configuration. This change is consistent with the proposed rule, which would have required "each determination" to account for the most adverse conditions for each flight configuration, because "each determination" referred to the "stall speed or minimum steady flight speed determination."

d. Takeoff Performance (proposed § 23.115/now § 23.2115)

In the NPRM, proposed § 23.115 (now § 23.2115) would have required an applicant to determine airplane takeoff performance, which would have included the determination of ground roll and initial climb distance to 50 feet, accounting for stall speed safety margins, minimum control speeds, and climb gradients. Proposed § 23.115 would have also required the takeoff performance determination to include accelerate-

stop, ground roll and initial climb to 50 feet, and net takeoff flight path, after a sudden critical loss of thrust for levels 1, 2, and 3 high-speed multiengine airplanes, multiengine airplanes with a maximum takeoff weight greater than 12,500 pounds, and level 4 multiengine airplanes.

The Associations suggested the FAA revise proposed § 23.115 to capture the performance-based standards at a "higher objective based level" because the proposed section was too detailed and prescriptive. Textron recommended the FAA adopt language similar to EASA's A-NPA 2015-06, which leaves determination of detailed standards appropriate to airplanes with different certification and performance levels to the means of compliance standards.

The FAA disagrees with the comment, because it is important to ensure the consistency of takeoff performance data across part 23 airplanes. This consistency aids private pilots, who often operate a variety of part 23 airplanes, in determining the airports from which they may operate.

Several commenters recommended the FAA remove the 12,500-pound cutoff in proposed § 23.115(c).

The FAA agrees and removes the weight discriminator from the rule language. Although the FAA proposed to remove the commuter category, along with weight- and propulsion-based certification divisions, and to replace them with divisions based on risk and performance, the FAA also proposed to require multiengine airplanes with a maximum takeoff weight of more than 12,500 pounds to comply with the increased takeoff performance requirements in paragraph (c). Proposed paragraph (c) was intended to ensure that larger business jets carrying fewer than 10 passengers, which would have

been considered commuter category under the former rule, were captured under the takeoff performance requirements because these airplanes would not necessarily fall under level 4. The FAA recognizes that applying paragraph (c) to multiengine airplanes with a maximum takeoff weight of more than 12,500 pounds is redundant. Those airplanes, which are equivalent to airplanes under the former commuter category, are captured by applying paragraph (c) to levels 1, 2, and 3 high-speed multiengine airplanes and to all level 4, multiengine airplanes. Furthermore, while paragraph (c) does not apply to levels 1, 2 and 3 low-speed multiengine airplanes, the FAA may issue special conditions if there is a configuration that presents a higher-than-anticipated risk.

Several commenters objected to requiring the determination of takeoff performance for all airplanes to include the determination of initial climb distance to 50 feet above the takeoff surface. The commenters noted that under the former rule, takeoff distance for commuter category airplanes and multiengine jets weighing more than 6,000 pounds required the initial climb distance be calculated using 35 feet above the takeoff surface. Textron recommended the FAA revise proposed § 23.115(b) to apply the 50-feet-above-takeoff-surface requirement only to single-engine airplanes and levels 1, 2, and 3 low-speed multiengine airplanes rather than to all airplanes. Textron also recommended revising proposed § 23.115(c)(2) from “50 feet” to “35 feet” above the takeoff surface, noting the 35-foot standard has been demonstrated as safe for the classes of airplane to which it has been applied.

The FAA agrees with the commenters and revises proposed § 23.115(b) (now § 23.2115(b)) to require only single-engine airplanes and levels 1, 2, and 3 low-speed, multiengine airplanes to include the distance required to climb to a height above 50 feet

when calculating takeoff performance. The FAA is also changing the altitude for the initial climb in § 23.2115(c)(2) to 35 feet. The service history of airplanes that would be classified as levels 1, 2, and 3 high-speed multiengine airplanes and level 4 multiengine airplanes under this rule, which were certified using a 35-feet-initial-climb requirement, has been sufficiently safe to support the proposition that the 35-feet requirement provides an adequate level of safety for high-speed multiengine airplanes and level 4 airplanes.

The Associations suggested revising proposed § 23.115(b) and (c) to require takeoff performance to include the determination of "ground roll distance required to takeoff," rather than "ground roll."

The FAA notes using "ground roll distance required to takeoff" is not necessary for clarity. The term "ground roll" in the context of takeoff is well-understood.

Several commenters recommended revising proposed § 23.115(b) to include two subparagraphs in what the FAA interprets as an effort to clarify that the applicant must provide two distances, one for ground roll and another for the distance required for the initial climb to 50 feet.

The FAA finds it unnecessary to reorganize paragraph (b) as the commenters proposed. The format, as proposed and adopted, is sufficiently clear.

The Associations suggested the FAA revise the proposed rule language in proposed § 23.115(c)(1) to require the takeoff performance determination to include the distance determination of "an aborted take-off at critical speed," rather than "accelerate-stop."

The FAA agrees that "accelerate-stop" is not as clear a description of the objective of the maneuver as "aborted take-off at critical speed". Therefore, the FAA revises paragraph § 23.2115(c)(1) to reflect the commenters' recommendation.

Embraer recommended the FAA provide special consideration—including freezing the certification bases—for previously-approved light jets with certification bases that include special conditions measuring the takeoff distance as the distance required to takeoff and climb to a height of 35 feet above the takeoff surface. Embraer feared the potential cost associated with an upgrade or modification.

The FAA finds a special consideration unnecessary. There is already a process, prescribed by § 21.101(b), that allows applicants for a change to a TC to show that the change complies with an earlier amendment of a regulation if the newer requirement would not contribute materially to the level of safety of the product or would be impractical.

ANAC recommended the FAA make it clear that takeoff airspeed and procedures must be determined. The FAA disagrees with ANAC's comment as such a change would be redundant with what we proposed for § 23.105 (now § 23.2105).

e. Climb Requirements (proposed § 23.120/now § 23.2120)

In the NPRM, proposed § 23.120 (now § 23.2120) would have required an applicant to demonstrate various minimum climb performances out of ground effect, depending on the airplane's certification level and performance capability.

In light of comments received, the FAA revises proposed § 23.120 (now § 23.2120) by withdrawing paragraphs (b)(4), (b)(5), and (c)(1), and renumbering

paragraphs (c)(2) and (c)(3) as (c)(1) and (c)(2) respectively. This section discusses these changes in more detail.

Textron commented that regulations have historically applied to the airplane, not to the applicant, with demonstration of compliance through flight testing. Textron recommended the FAA offer alternative rule language that reflected its comment. The Associations similarly recommended the FAA change the opening of proposed § 23.120 to focus on the design rather than the applicant. These commenters also recommended re-designating the opening as paragraph (a).

The FAA notes that, historically, the airplane-specific requirements focused on the airplane, and the part 21 certification requirements were targeted more to the applicant. Many sections in this rulemaking effort tried to include applicant accountability, which was why the proposed rule focused on the "applicant." However, based on the comments received, the FAA revises the proposed language throughout this rule by removing "applicant" where the requirement is more logically based on the airplane.

Textron commented on the proposal to apply discriminators based on weight divisions and detailed quantitative climb criteria conflicted with the stated intent of the rulemaking to remove weight-based divisions and develop standards reflecting the diversity of future airplane designs. Textron recommended the FAA adopt language similar to proposed CS 23.120, which leaves determination of detailed standards appropriate to airplanes with different certification and performance levels to means of compliance. The Associations recommended the FAA make the calculation of performances more general, to facilitate the use of standard means of compliance, which

may exist in consensus-based standards. An individual commenter similarly stated the prescriptiveness of proposed § 23.120 was contrary to the stated objective of the proposal. The commenter stated the text of proposed § 23.120 would be more appropriate as a standard rather than a rule. The commenter recommended that the FAA use the language of proposed § 23.125, which would have required the determination of climb performance in certain conditions and configuration, in proposed § 23.120. The commenter also noted the current version of the ASTM standard for climb requirements already fully covers the language of proposed § 23.120.

In response to Textron's comment, the FAA revises proposed § 23.120 so it no longer contains weight divisions. Instead, the requirements of this section are based on certification levels, performance levels, and number of engines. Section 23.2120 does, however, contain quantitative climb criteria. On this topic, the FAA did not adopt the EASA proposed CS 23.120 language as recommended by Textron. While the idea of removing all climb gradient requirements was discussed in the Part 23 ARC, the FAA finds it is not in the best interest of safety to eliminate all required climb gradients. Therefore, the FAA is including the minimum climb gradients in this performance-based rule. But, the FAA consolidated the climb gradient requirements of former part 23 to simplify the requirement. The FAA finds doing so will maintain the former level of safety while reducing the certification burden. The FAA acknowledges the ASTM means of compliance contain the climb gradients in more detail than required from the requirements of this section. However, the ASTM means of compliance has not been accepted by the FAA as of the publication of this rule.

The FAA finds that, while removing as many prescriptive requirements as possible is important for creating a performance-based rule, some requirements should remain because they have been proven over decades of service and are already based on performance. The FAA finds the climb requirements are one such case.

In response to the comment that the FAA should use the language of proposed § 23.125 (now § 23.2125) in proposed § 23.120 (now § 23.2120), the FAA notes that § 23.2125 only requires the performance information be determined for the airplane flight manual (AFM). There is no minimum climb gradient in § 23.2125 as with § 23.2120. The Part 23 ARC discussed this issue at length with the objective of defining a clear, minimum performance-based metric that would allow the prescriptive climb gradients to move to means of compliance. The climb gradients in former §§ 23.65 through 23.77 came from early CAR 3 and have been in place for more than half a century, with the exception of some commuter category requirements, which came from early part 25. Since the FAA has established measureable gradients, any alternative approach would need to maintain the same gradients to provide an equivalent level of safety as the former climb requirements. The ARC considered numerous options, but in every case the proposed metric was subjective such that the FAA may be required to evaluate various other climb gradient schemes against the former climb gradients, when the intent was to maintain the former climb gradients. Finally, the FAA determined keeping the prescriptive climb gradients from the former rules remains the best approach. Furthermore, supporting this position, the FAA could not envision new and novel configurations that could not meet these climb gradients, but would offer the same level of safety. All the new and novel configurations that have been shared with the FAA have

performance that will meet or exceed the minimum gradients proposed in the NPRM. For these reasons the FAA is retaining the proposed language.

Furthermore, it may not have been clear in the NPRM that the FAA intended proposed § 23.120 to address the required minimum climb gradients in former §§ 23.63, 23.65, 23.67, and 23.77, and proposed § 23.125 (now § 23.2125) to address the required publication of the measured performance in former §§ 23.66, 23.69, and 23.71. Therefore, the FAA is not including language similar to proposed § 23.125 (now § 23.2125) in § 23.2120, because § 23.2120 includes required climb gradients, not information requirements.

Textron stated that proposed § 23.120(a) would have applied to the all engines operating (AEO) takeoff climb and that a common terminology should be used. Textron recommended the FAA replace the undefined phrase "initial climb configuration" in proposed paragraph (a) with the unambiguous phrase "takeoff configuration", and remove the phrase "at takeoff" from proposed paragraph (a)(2). Textron also recommended the FAA remove the phrase "at sea level" from proposed paragraph (a)(1) because the FAA already proposed § 23.105 to require an airplane, unless otherwise prescribed, to meet the performance requirements of this subpart in still air and standard atmospheric conditions at sea level for all airplanes.

The FAA notes that replacing "initial climb configuration" with "takeoff configuration" would require the design to comply with the required minimum climb performance out of ground effect, with all engines operating and in the "takeoff configuration". The FAA finds that this change would be more stringent than the former regulations. Former § 23.65(a) allowed for the climb to be demonstrated with the landing

gear retracted, and former § 23.65(b) allowed for the climb to be demonstrated with the landing gear retracted if it could be retracted in 7 seconds. While normalizing both former regulations might appear relieving for airplanes certified as complying with former § 23.65(b), [24] the FAA finds that most airplanes designed in the past 2 decades incorporated landing gear that retracted in less than seven seconds. Therefore, the FAA is retaining the phrase "initial climb configuration" in paragraph (a).

The FAA agrees with Textron's recommendation to delete "at sea level" from proposed § 23.120(a)(1). The FAA proposed the term because it was part of former § 23.65(a). As Textron noted, however, proposed § 23.105(a) (now § 23.2105(a)) would have already required an airplane to meet the performance data of subpart B, including § 23.2120, in still air and atmospheric conditions at sea level for all airplanes. It is therefore unnecessary for paragraph (a)(1) to require a climb gradient "at sea level" of 8.3 percent for landplanes and 6.7 percent for seaplanes and amphibians. However, the FAA is not deleting "at takeoff" as recommended by Textron. The agency is aligning the new rule with former § 23.65 by using "after takeoff" instead of "at takeoff." This requirement is indirectly addressed in § 23.2105(b); however, as proposed, the language was not clear as to intent. By including the term "after takeoff", this requirement reinforces the meaning of "ambient atmospheric conditions" in § 23.2105(b).

The Associations and Transport Canada noted that proposed § 23.120(a) did not address climb performance for level 4 airplanes. Transport Canada stated the FAA should specify all engine operating climb gradient requirements for level 4 airplanes. The

[24] Former § 23.65(b) applied to normal, utility, and acrobatic category reciprocating engine-powered airplane of more than 6,000 pounds maximum weight, single-engine turbine, and multiengine turbine airplanes of 6,000 pounds or less maximum weight in the normal, utility, and acrobatic category.

Associations stated the climb gradient requirements for level 4 airplanes should be the same as the requirement for high-speed level 1 and 2 airplanes and level 3 airplanes.

The FAA considered the comments and in response, revises proposed § 23.120(a) to include an all engines operating climb requirement for level 4 single-engine airplanes. The former climb requirements required all airplanes with 10 or more passengers to have multiple engines and meet the commuter category climb requirements, which were focused on the ability to climb after an engine failure. These one-engine-inoperative climb requirements were extensive. The philosophy was that if the airplane could meet the climb requirements after one engine failed, it would have more-than-adequate performance with all engines operating. This is why there were no all engine operating climb requirements for commuter category airplanes. The FAA agrees with and continues this philosophy in the new rule for multiengine airplanes designed for 10 or more passengers, which are level 4 airplanes under this rule. However, because the new rule eliminates the commuter category and allows for single-engine airplanes to carry 10 or more passengers, there is now a need for single-engine level 4 airplanes to have an all engines operating climb requirement.

The FAA agrees with the Associations that the climb gradient requirements for level 4 single-engines airplanes should be the same as the requirement for levels 1 and 2 high-speed airplanes and level 3 airplanes. This was an oversight in the NPRM and the FAA is correcting it in this final rule. Accordingly, § 23.2120(a)(2) now requires levels 1 and 2 high-speed airplanes, all level 3 airplanes, and level 4 single-engine airplanes to demonstrate, with all engines operating and in the initial climb configuration, a climb gradient at takeoff of 4 percent. This revision is a logical outgrowth of the notice because,

as noted by the commenters, there is no basis for distinguishing between level 3 and level 4 airplanes for this requirement.

Transport Canada commented that the FAA should consider and validate whether a 4 percent climb gradient for high-performance airplanes with all engines operating is sufficient. For example, an airplane climbing at 100 knots (approximately 400 feet per minute) may be acceptable for a level 1 airplane, but not for anything larger. Transport Canada noted that proposed paragraph (a)(2) may govern more frequently, because the all-engine climb capability driven by the one-engine-inoperative requirements has been reduced in proposed paragraph (b)(3). Transport Canada also noted that, given the increasing probability of airplanes with more than 4 engines, it may be more effective to increase the all-engine climb gradient in proposed paragraph (a)(2).

The FAA considered Transport Canada's comments, but notes the intent with this section was to maintain the level of safety in former part 23. Section 23.2120(b) requires the same climb gradient—4 percent—as was required for similar airplanes by former part 23. The FAA notes that requiring more stringent climb requirements is beyond the scope of this rulemaking.

Textron made several comments to proposed § 23.120(b). Textron stated the word "the" should replace the word "a" when referring to critical loss of thrust. For proposed § 23.120(b)(1), Textron suggested referring to climb gradient the same way as in proposed § 23.120(a)(2). Textron also recommended changing "configuration" to "configurations" in proposed paragraph (b)(1) because one airplane may have multiple takeoff and approach configurations. Textron and Kestrel requested clarification regarding the single-engine crashworthiness requirements referred to in proposed

§ 23.120(b)(1). Kestrel asked whether those requirements will be established in the rule or based on an associated standard.

Regarding Textron's comment on the use of the word "the" in the phrase "the critical loss of thrust," the term "the" would assume that everyone knows what that critical loss of thrust is. While that may be true for traditional configurations, it may not be true for future configurations. Therefore, the FAA is keeping the proposed phrase "a critical loss of thrust." However, the FAA agrees with Textron concerning multiple configurations and revises the rule to align the reference to the climb gradient in §§ 23.2120(a)(2) and 23.2120(b)(1) for clarity.

In response to Kestrel and Textron, § 23.2120(b)(1) contains a requirement addressing airplanes that do not meet the single-engine crashworthiness requirements of proposed § 23.600, "Emergency conditions" (now § 23.2270). Section 23.2120(b)(1) is intended to capture the intent of former § 23.67(a)(1), which required airplanes with V_{SO} of more than 61 knots to maintain a steady climb gradient of at least 1.5 percent. Sixty-one knots was a historic stall speed limit for single-engine airplanes and for that reason, it was used as a division between multiengine airplanes that could climb after the loss of one engine and other multiengine airplanes that could not maintain altitude after the loss of one engine. These former requirements assumed that the airplane only had two engines. The FAA is not using the 61 knot stall speed division in this new rule the way it was used in former § 23.562, "Emergency landing dynamic conditions", for crashworthiness requirements. Instead, the FAA is basing these new regulations on actual stall speed. The new regulations should, over time, allow several alternatives to address occupant protection. For this reason, and because the FAA did not intend to increase the

level of safety over the former requirements, the FAA is using the phrase “single-engine crashworthiness.”

Textron asserted that to obtain the best takeoff performance in high and hot conditions, it can be advantageous to use lesser flap settings to improve climb capability after takeoff. However, the proposed climb requirements—defined only in terms of the approach configuration—would have eliminated this capability, and would not have reflected the former part 23 standards. Textron suggested the FAA revise the proposed rule language in paragraph (b)(3) to require multiengine level 3 high-speed airplanes and level 4 airplanes to determine the climb gradients for weight, altitude, and temperature combinations appropriate for takeoff in the takeoff configuration.

The FAA notes that the reason for using the “approach configuration” was not that it reflected an actual configuration, but that it was more conservative than using the “takeoff configuration.” The FAA elected to consolidate the climb requirements from four configurations into one configuration. To do so, the FAA had to make some assumptions. The major assumption used in consolidating the climb requirements was that if the airplane could meet the second segment climb gradient at 400 feet, then it should meet the other traditional requirements and would provide an acceptable level of safety. However, to provide a margin of safety in case one of the other conditions was slightly more critical, the FAA elected to apply the discontinued approach flap configuration, which is “approach” flaps, for this requirement.

Transport Canada commented it would be more conservative to require the four-engine climb gradient of 2.6 percent in proposed § 23.120(b)(3), rather than the two-engine climb gradient of 2 percent.

The FAA explained in the NPRM that the climb gradient associated with the loss of one engine for a two-engine airplane has provided an acceptable safety history for this class of airplane. The historical three- and four-engine climb gradients were based on part 25 regulations regarding gas engine technology, and may not be appropriate for distributed electric propulsion configurations or designs. For this reason, using those historical values may end up with a more conservative approach than intended. This would increase the requirements from the former part 23 regulations, which is outside the scope of this rulemaking.

Several commenters recommended the FAA either delete, clarify, or re-write proposed § 23.120(b)(4) and (5) because the intent of those paragraphs is unclear.

The FAA agrees that proposed § 23.120(b)(4) and (b)(5) are confusing. The FAA intended the conditions in paragraphs (b)(4) and (b)(5) to apply to the determinations required by paragraph (b). However, because § 23.2105(a) requires an airplane to meet the performance data of subpart B for these 2 conditions, paragraphs (b)(4) and (b)(5) are redundant and confusing. For this reason, the FAA withdraws paragraphs (b)(4) and (b)(5).

An individual commented that all multiengine airplanes should be able to climb after an engine failure. The commenter stated this performance is affordable and the FAA should not permit poor performance because a manufacturer wants to refurbish a decades-old design and produce it.

The FAA notes that adding the requirement for all-multiengine airplanes to be able to climb after an engine failure is beyond the scope of this rulemaking. The FAA

finds that the current level of safety in former part 23 regarding climb performance for multiengine airplanes following an engine failure is adequate.

The Associations recommended the FAA revise the proposed rule language to require the applicant to demonstrate a climb gradient of 3 percent during balked landing "without creating undue pilot workload." The commenters also recommended the FAA rewrite proposed § 23.120(c) to include a general requirement for the applicant to determine, as applicable, climb and descent performance for all engines operating; following a critical loss of thrust on take-off; and after a critical loss of thrust during the enroute phase of flight.

The FAA originally determined that adding the phrase "without creating undue pilot workload" in this requirement was redundant with proposed § 23.105(c); however, proposed § 23.105(c) only addressed takeoff and landing distances. The FAA also recognizes that many of the part 23 fatal accidents happen on go-arounds or balked landings and are attributable, at least in part, to high-pilot workload. For this reason, the FAA is adding "without creating undue pilot workload" to § 23.2120(c).

The FAA also addresses the commenters' recommendation to include a general requirement for the applicant to determine, as applicable, climb and descent performance for all engines operating; following a critical loss of thrust on take-off; and after a critical loss of thrust during the enroute phase of flight in § 23.2125(a)(2) and (a)(3).

Textron and Transport Canada also commented on proposed § 23.120(c). Textron stated that it is unclear why takeoff power is specified for the balked landing, but not for any other minimum climb performance requirements. Textron recommended changing

the word “configuration” to “configurations” in proposed § 23.120(c)(3) because an airplane might have multiple landing configurations.

The FAA agrees with Textron that the reference to takeoff power was not needed. Therefore, the FAA deletes the reference from proposed § 23.120(c) (now § 23.2120(c)). The FAA also agrees with Textron’s recommendation to change “configuration” to “configurations” and makes this change in § 23.2120(c).

Transport Canada asked that the FAA justify the reduction in the required landing climb gradients from 3.3 percent to 3 percent.

The FAA notes that former § 23.77, which governed balked landings, required a 3.3 percent gradient for piston airplanes weighing less than 6,000 pounds; a 2.5 percent gradient for piston engine and single-engine turbine-powered airplanes over 6,000 pounds and for multiengine turbine-powered airplanes weighing 6,000 pounds or less; and a 3.2 percent gradient for multiengine turbine-powered airplanes weighing over 6,000 pounds and commuter category airplanes. The FAA is simplifying the former requirement by taking the average of the three climb gradients. The FAA did not receive any negative comments concerning the decrease or increase in climb gradient requirements, so the FAA adopts the language as proposed.

f. Climb Information (proposed § 23.125/now § 23.2125)

In the NPRM, proposed § 23.125 (now § 23.2125) would have required an applicant to determine the climb performance for—

- All single-engine airplanes;
- Level 3 multiengine airplanes, after a critical loss of thrust on takeoff in the initial climb configuration; and

- All multiengine airplanes, during the enroute phase of flight with all engines operating and after a critical loss of thrust in the cruise configuration.

Proposed § 23.125 would have also required an applicant to determine the glide performance of the airplane after a complete loss of thrust for single-engine airplanes.

Transport Canada commented that proposed § 23.125(a) appears to lack the concept of determining climb performance at each approved weight, altitude, and temperature. Additionally, Transport Canada stated it is unclear why proposed § 23.125(a)(2) applies only to level 3 multiengine airplane. Transport Canada recommended the FAA require the determination of climb performance following a critical loss of thrust on take-off in the initial climb configuration for all multiengine airplanes at each weight, altitude, and temperature.

The FAA agrees with Transport Canada that proposed § 23.125(a) would not have expressly required the determination of climb performance at each approved weight, altitude, and temperature. The FAA intended proposed § 23.105(a)—which would have required levels 1 and 2 high-speed airplanes and level 3 airplanes to provide performance data in ambient atmospheric conditions within the operating envelope—to capture this requirement. To comply with the requirement in proposed § 23.105(a) to "meet the performance requirements" of subpart B, an applicant would have had to make these determinations anyway. However, after considering Transport Canada's comment, the FAA revises the proposed language to make clear that § 23.125(a)(2) (now § 23.2125(a)(2)) requires the determination of climb performance at each weight, altitude, and ambient temperature within the operating limitations. This change is consistent with the NPRM, which explained that proposed § 23.125 was intended to

capture the safety intent of former §§ 23.66 and 23.69. Both of these sections required the determination to be made at each weight, altitude, and ambient temperature within the airplane operating limitations.

The FAA agrees that § 23.2125(a)(2) should apply to more than level 3 multiengine airplanes; however, it should not apply to all multiengine airplanes. Section 23.2125(a)(2) captures the safety intent of former § 23.66, which applied only to reciprocating engine-powered airplanes of more than 6,000 pounds maximum weight and turbine engine-powered airplanes. Under the new performance-based regulations, the equivalent airplanes—considering the intent of former § 23.66—are levels 1 and 2 high-speed multiengine airplanes and all level 3 airplanes. Therefore, the FAA revises the proposed rule language to include levels 1 and 2 high-speed multiengine airplanes in addition to level 3 multiengine airplanes, to maintain the same level of safety as former § 23.66. However, because former § 23.66 did not apply to commuter-category airplanes—which were considered the equivalent of level 4 multiengine airplanes—§ 23.2125(a)(2) should not apply to all multiengine airplanes as doing so would make the rule more stringent than former § 23.66.

Textron noted the continuous reference to "a critical loss of thrust" in proposed § 23.125 and recommended the FAA refer to it as "the critical loss of thrust." The FAA understands Textron's comment; however, the term "the critical loss of thrust" assumes there is a critical loss of thrust and that it is a known, finite condition for all multiengine airplanes. This may not be the case. The phrase "a critical loss of thrust" allows for the possibility that there is no critical loss of thrust or that different airplane configurations would have different critical loss of thrust conditions based on a specific configuration.

Textron recommended deleting the undefined phrase “initial climb configuration” from proposed § 23.125. Textron also recommended the FAA not require multiengine airplanes to be in the cruise configuration during the determination of climb performance in the enroute phase of flight. Textron explained that while the enroute phase of flight is typically associated with a “clean” airplane configuration, the applicant should be free to define this configuration.

The FAA agrees with Textron’s intent, but does not accept Textron’s recommendations. The FAA is requiring the airplane to be in the “initial climb configuration” in § 23.2125(a)(2) and the “cruise configuration” in § 23.2125(a)(3). However, the FAA is not defining “initial climb configuration” because a definition would be prescriptive and inflexible for new configurations, which would be contrary to this performance-based regulation. Paragraphs (a)(2) and (a)(3) capture the safety intent of former §§ 23.66 and 23.69, respectively. Former §§ 23.66 and 23.69 contained prescriptive requirements pertaining to the takeoff and enroute configurations, which were based on airplane designs over the past half-century. The FAA finds the new rules should include traditional configurations, but be flexible enough for new configurations in the future. These new configurations may be different from what was traditionally required in part 23 due to a unique propulsion, high lift, and/or flight control configuration. Therefore, § 23.2125(a)(2) and (a)(3) specify the configuration conditions in a performance-based manner that allows flexibility for the applicant to define what the configuration is in means of compliance.

Furthermore, based on another comment from Textron, the FAA deletes unnecessary text in paragraph (b) and moves the phrase “single engine airplanes” in the

same paragraph to make the rule language of § 23.2125(b) read consistently with § 23.2125(a).

g. Landing (proposed § 23.130/now § 23.2130)

In the NPRM, proposed § 23.130 (now § 23.2130) would have required an applicant to determine the landing distance for standard temperatures at each weight and altitude within the operational limits for landing. The landing distance determination would start from a height of 50 feet (15 meters) above the landing surface, require the airplane to land and come to a stop (or for water operations, reach a speed of 3 knots) using approach and landing speeds, configurations, and procedures which allow a pilot of average skill to meet the landing distance consistently and without causing damage or injury. Proposed § 23.130 would have required these determinations for standard temperatures at each weight and altitude within the operational limits for landing.

Transport Canada stated proposed § 23.130 should require the landing performance to account for stall speed safety margins and minimum control speeds to maintain consistency with the take-off requirements in proposed § 23.115 (now § 23.2115) and to ensure the same level of safety as former part 23.

The FAA agrees the landing requirements of proposed § 23.130 (now § 23.2130) should expressly account for stall speed safety margins and minimum control speeds consistent with the takeoff performance requirements of proposed § 23.115 (now § 23.2115). Proposed § 23.130(b) would have generally required the determination of approach and landing speeds. As explained in the NPRM, the FAA intended proposed § 23.130 to capture the safety intent of former § 23.73, which required the reference landing approach speed to account for minimum control speed (V_{MC}) and V_{S1}. The

FAA's intention to account for stall speed safety margins and minimum control speed, which would ensure the same level of safety as former § 23.73, was not clear in the proposed rule language. Accordingly, the FAA is adding language to paragraph § 23.2115(b) to clarify that an applicant must account for stall speed safety margins and minimum control speeds when determining the approach and landing speeds, configurations, and procedures.

Several commenters recommended clarifying changes to proposed § 23.130. The Associations recommended deleting the phrases "the following" and "for landing" in the introductory paragraph. Textron recommended various changes to proposed § 23.130(b), such as replacing "meet" with "achieve," specifying that the landing distance is determined in proposed paragraph (a), and replacing "causing damage or injury" with "endangering the airplane and its occupants."

The FAA deletes the phrase "for landing" from the introductory paragraph of § 23.2130. This phrase is unnecessary because the section is about landing distance. However, the FAA retains the phrase "the following" for clarity. For § 23.2130(b), the FAA agrees that requiring a pilot of average skill "to meet the landing distance" is unclear, but will not replace the term "meet" because changing one word would not make the regulation any clearer. Instead, the FAA revises the language in § 23.2130(b) to require a pilot of average skill "to land within the published landing distance" and finds it unnecessary to specify in § 23.2130(b) that the landing distance is determined in § 23.2130(a). Lastly, the FAA retains the proposed language "causing damage or injury" because the commenter's recommended change is vague and could cause the regulations to be interpreted more stringently.

BendixKing suggested adding language to proposed § 23.130(a) that would require the speed of 3 knots for water operations to be relative to the surface in calm atmospheric conditions. Alternatively, the Associations recommended removing entirely the requirement for water operations to reach a speed of 3 knots. The commenters agreed that the term “stop” would differ for water and land operations, but asserted that the difference is not as simple as stating 3 knots. The commenters stated the appropriate method of compliance for determining a stop for seaplanes or amphibians should be contained in accepted standards.

The FAA agrees with the commenters and removes from the proposed rule language the requirement for water operations to reach a speed of 3 knots. The speed of 3 knots originated from AC 23-8C, which addresses water operations. Former § 23.75, the predecessor to § 23.130, required the airplane to come to a complete stop, and left the surface type undefined. The FAA intended to clarify rule language by specifying the speed of 3 knots to differentiate between land and water operations. However, in light of the comments, the proposed language added confusion and failed to allow the flexibility necessary for water operations. The FAA agrees with the commenters that the 3-knot reference is more appropriate as guidance. Accordingly, § 23.2130(a) now requires the applicant to determine the distance required to land and come to a stop, starting at a height of 50 feet above the landing surface. This change removes the need to address whether the speed of 3 knots must be relative to the surface in calm atmospheric conditions. The information necessary to comply with § 23.2130(a) will be addressed in means of compliance.

NJASAP said that wet runway data, as well as contaminated runway data, should be available for airplane certified to land under the conditions set forth in proposed § 23.130(a). NJASAP also suggested the FAA adopt concepts from the Takeoff and Landing Performance Assessment (TALPA) ARC. NJASAP pointed out that airplanes certified under part 135 fly in all weather conditions. Finally, NJASAP stated that runway excursions are a documented risk for these airplanes and this opportunity offers an additional enhancement.

While the FAA supports the NJASAP recommendation to make wet runway data available, doing so should not be a requirement. The TALPA ARC was primarily a part 25 effort targeting transport operations, not small airplane operations. The FAA is not adopting the TALPA ARC recommendations because they exceed former part 23 requirements and are therefore outside the scope of this rulemaking. The FAA recommends that NJASAP work with industry to add wet runway conditions to the industry consensus standards as possible means of compliance for airplanes used in part 135 operations.

ANAC recommended the FAA require the landing procedures to allow for a safe landing, or a transition to a balked landing configuration, as this would cover the intent of former § 23.75.

The FAA agrees that proposed § 23.130 (now § 23.2130) should address the safe transition to the balked landing conditions. The FAA intended proposed § 23.130 to capture the safety intent of former §§ 23.73 and 23.75. Former § 23.75 required a safe transition to the balked landing conditions of former § 23.77 from the conditions that existed at the 50-foot height. The balked landing conditions are now contained in

§ 23.2120(c), which captures the safety intent of former § 23.77. To ensure § 23.2130 contains the same level of safety as former § 23.75, the FAA revises the proposed rule language to require an applicant to determine the approach and landing speeds, configurations, and procedures that allow for a safe transition to the balked landing conditions specified in part 23.

The Associations also recommended the FAA clarify the introductory sentence of proposed § 23.130 by deleting "each." The FAA agrees with this comment. Requiring determinations to be made at "each" combination of weight and altitude within the operational limits could be interpreted as requiring an infinite matrix of test points, which was not the FAA's intent. Rather than requiring the applicant to determine landing performance at "each" combination of weight and altitude within the operational limits, the FAA is requiring the determinations to be made at "critical combinations" of weight and altitude. This change is consistent with the change the FAA made to § 23.2100(b).

h. Controllability (proposed § 23.200/now § 23.2135)

In the NPRM, proposed § 23.200 (now § 23.2135) would have required—

- The airplane to be controllable and maneuverable, without requiring exceptional piloting skill, alertness, or strength, within the operating envelope, at all loading conditions for which certification is requested. This would have included during low-speed operations, including stalls, with any probable flight control or propulsion system failure, and during configuration changes;
- The airplane to be able to complete a landing without causing damage or serious injury, in the landing configuration at a speed of V_{REF} minus 5 knots using the approach gradient equal to the steepest used in the landing distance determination;

- V_{MC} not to exceed V_{S1} or V_{S0} for all practical weights and configurations within the operating envelope of the airplane for levels 1 and 2 multiengine airplanes that cannot climb after a critical loss of thrust; and
- An applicant to demonstrate those aerobatic maneuvers for which certification is requested and determine entry speeds.

Kestrel questioned whether proposed § 23.200, which is intended to capture the requirements of former § 23.145, would be interpreted to include the former requirement to show the airplane can pitch nose downward when approaching stall, thus avoiding or recovering from stall, or, alternatively, whether the FAA found that requirement to be too prescriptive, representing only one possible means of compliance with the proposed controllability requirements.

The FAA intended proposed § 23.200 (now § 23.2135) to capture the safety intent of the former controllability §§ 23.141 through 23.157 and allow for other possible means of compliance appropriate to new or innovative designs. Therefore, proposed § 23.200 was not related only to former § 23.145 and was not intended to capture the specific requirements of former § 23.145, but did intend to capture its broader safety intent. The former requirement referenced by the commenter is prescriptive and provides a means of compliance for traditional configuration airplanes. Because it is possible for novel configurations and control schemes in the future to need different means of compliance, the FAA finds that the prescriptive language from former § 23.145 is more appropriate as means of compliance.

Textron commented on proposed § 23.200(a)(2). Textron pointed out that former § 23.143(a) and the proposal from the Part 23 ARC referenced “all flight phases,” which

better captures the general intent of former § 23.143(a). Additionally, Textron stated that proposed § 23.215 addresses stall characteristics, making the stall aspect of proposed § 23.200(a)(2) redundant. Textron recommended the FAA maintain language similar to former part 23 by replacing the phrase "low-speed operations, including stalls," with "all flight phases."

The FAA agrees with Textron. The FAA's intent in proposed § 23.200(a) (now § 23.2135(a)) was to capture the safety intent of former § 23.143, which required the airplane to be safely controllable and maneuverable during all phases of flight. The FAA agrees that the phrase "all flight phases" better captures the safety intent of former § 23.143(a). Additionally, upon further review, the language of proposed § 23.200(a)(2) is confusing because, while the FAA proposed to add requirements to essentially avoid the stall maneuver in proposed § 23.215, proposed § 23.200(a)(2) would have required controllability in the stall. While this is a desirable and recommended condition, the FAA does not want to add confusion. The stall requirements belong in proposed § 23.215 (now § 23.2150). For these reasons, the FAA adopts Textron's recommendation.

Textron also commented on proposed § 23.200(a)(3). Textron noted that former § 23.143 and the proposal from the Part 23 ARC did not address failures other than a response to a sudden engine failure. Textron also noted that proposed § 23.1315 already covers general airplane system or equipment failures. Textron claimed the requirements of proposed § 23.200(a)(3) could be interpreted as requiring demonstration of all probable flight control and propulsion failures in a flight-test environment, which the commenter said would not be practical or safe. Textron recommended maintaining the traditional scope of former subpart B controllability requirements, which included normal

operations and, for multiengine airplanes, the response to critical loss of thrust, and using the methods employed for proposed § 23.1315 to evaluate responses to other failures.

In light of Textron's comment, the FAA finds it necessary to clarify that § 23.2135(a)(3) applies to "reversible," which were traditionally mechanical flight controls, not "irreversible" flight controls. The FAA's intent in proposed § 23.200(a) was to capture the safety intent of former §§ 23.145(e) and 23.147(c), which required applicants to address mechanical control system failures. Historically, these requirements targeted control cable failures or push-pull tube disconnects. Former subpart F, which contained requirements on equipment, addressed powered- and computer-controlled flight control systems. Under this final rule, subpart F continues to address equipment, such as powered- and computer-controlled flight control systems, and § 23.2135 addresses mechanical control system failures, which is consistent with former §§ 23.145(e) and 23.147(c).

The Associations and EASA also addressed proposed § 23.200(a)(3).[25] The Associations recommended the FAA delete the word "any" from the phrase "any probable flight control or propulsion system failure." EASA recommended the FAA replace the word "probable" with "likely," to avoid creating ambiguity with probability definitions.

The FAA agrees the term "any" does not add value compared to the potential for confusion coming from an absolute qualifier. The FAA therefore deletes the word "any" in § 23.2135(a)(3).

[25] EASA actually referred to proposed § 23.200(a)(4) in its comment, but the FAA assumes EASA meant to refer to proposed § 23.200(a)(3), which is where the term "probable" is used.

The FAA also agrees the term “probable” has specific meaning relative to systems. Furthermore, the FAA expects a transition from mechanical flight controls to computer-controlled flight control systems, which are covered under the requirements in subpart F. Because the term “probable” has the potential to create confusion between the flight test requirements of subpart B and the systems requirements of subpart F, the FAA is using the term “likely,” rather than “probable,” which will reduce the potential for confusion while maintaining the intent of the requirement. For more detailed discussion on the use of “likely”, please refer to the discussion on proposed § 23.205 (now § 23.2140).

The Associations commented on proposed § 23.200(b), stating that it does not account for preferred technologies, such as angle of attack indicators, for executing safe approach and landing procedures. The commenters recommended proposed paragraph (b) require the airplane to complete a safe landing when following the landing procedures; providing a safe margin below V_{ref} or above angle of attack. EASA recommended removing the configuration details and specific speed margin from proposed § 23.200(b) because future designs would not be able to comply with them.

The FAA agrees with these comments. The FAA intended proposed § 23.200(b) (now § 23.2135(b)) to capture the safety intent of former § 23.153 for control during landings. The FAA agrees that specifying a prescriptive speed of V_{ref} minus 5 knots, which former § 23.153 required, may not be appropriate for entry-level airplanes with very-low landing speeds and may not even apply to new configurations. The FAA therefore removes this prescriptive speed. Instead, the FAA is requiring a reasonable margin below V_{ref} or above approach angle of attack, as recommended by the

Associations. This change from what was proposed is consistent with the safety intent of former § 23.153 as it requires a safe speed margin and it accounts for entry-level airplanes and new technology. The FAA also deletes the phrase "equal to the steepest used in the landing distance determination" and replaces it with "steepest approved" approach gradient procedures as this is clarifying.

Textron recommended proposed § 23.200(b) be modified to require the airplane to land without "endangering the airplane and its occupants," rather than to land without "causing damage or serious injury."

The FAA finds that Textron's recommendation does not capture the safety intent of former § 23.153, which required safe completion of a landing. However, in light of Textron's comment, the FAA is clarifying the term "damage." As proposed in the NPRM, the rule would not have allowed any damage, no matter how trivial. This was not the intent of former § 23.153. The FAA intended to capture the safety intent of former § 23.153 in proposed § 23.200(b) (now § 23.2135(b)); therefore, the FAA revises the proposed rule language by defining the damage that could be accepted during demonstration. Section 23.2135(b) now requires the airplane to be able to complete a landing without causing "substantial" damage or serious injury. Substantial damage is defined in 49 CFR part 830 as requiring major repairs and effectively preclude the use of the airplane for its intended purpose.

Textron also noted that proposed § 23.200 would not have required V_{MC} to be determined. ANAC and Textron recommended the FAA require V_{MC} to be determined, because it must be accounted for in the determination of takeoff performance. Textron recommended adding a new paragraph to proposed § 23.200. Textron recommended the

new paragraph state V_{MC} is the calibrated airspeed at which, following the sudden critical loss of thrust, it is possible to maintain control of the airplane. For multiengine airplanes, the applicant must determine V_{MC} for each flight configuration used in takeoff and landing operations.

The FAA agrees the rule should require V_{MC} to be determined. Proposed § 23.200 was intended to capture the safety intent of former § 23.149, which defined and required the determination of V_{MC}. The FAA is adding language to § 23.2135(c) that is consistent with former § 23.149, but removes the prescriptive requirements of former § 23.149, such as the specific configuration requirements. Section 23.2135(c) now states that V_{MC} is the calibrated airspeed at which, following the sudden critical loss of thrust, it is possible to maintain control of the airplane. Section 23.2135(c) also requires the applicant to determine V_{MC}, if applicable, for the most critical configurations used in the takeoff and landing operations. The FAA is requiring the applicant to determine V_{MC} in the most "critical" configurations rather than in "each" configuration because requiring the determination at each configuration would present an infinite number of test points. Additionally, the FAA added the phrase "if applicable" to the rule language because there are multiengine airplanes that do not have a V_{MC}.

ANAC recommended proposed § 23.200(c) be written in a less prescriptive manner to allow for different technology solutions. ANAC stated that proposed § 23.200(c) should contain only the safety objective stated in the NPRM. For example, proposed § 23.200 should have stated that an airplane should not depart controlled flight at low speeds above stall as a result of asymmetric thrust.

The Associations stated that while proposed § 23.200(c) represented a potential solution to the typical accident scenario involving loss of control in multiengine airplanes, which are unable to climb on a single engine, there are other solutions that may be better depending on the design of the airplane. The commenters noted that instead of assuring V_{MC} is below the stall speed, solutions might include envelope protection, increased awareness of the loss of control condition, or automatic-power response. To ensure the rule allows the best solution for a particular design, the commenters recommended the FAA not adopt proposed § 23.200(c). Instead, the commenters recommended the section on loss of control, proposed § 23.215, require multi-engine airplanes, not certified for aerobatics, not have a tendency to suffer a loss of control after a likely critical loss of thrust. Several other commenters also expressed concerns about proposed § 23.200(c) and made similar recommendations.

As explained in the NPRM, the critical safety issue that the FAA intended proposed § 23.200(c) to address was the loss of control caused by asymmetric thrust. The FAA recognized in the NPRM concerns regarding the effectiveness of the proposed requirement in addressing loss of control caused by asymmetric thrust and requested comments on the proposal. In light of the comments received, the FAA is not adopting proposed § 23.200(c). The FAA agrees with ANAC and the Associations that the rule should allow for different technologies as design solutions to the identified safety issue. The FAA also agrees that § 23.2150 should include the requirement to address this loss of control issue. Therefore, the FAA adopts less prescriptive language similar to that recommended by the commenters, which is consistent with the intent of proposed § 23.200(c). This will allow for alternative design solutions. Section 23.2150(c) now

requires levels 1 and 2 multiengine airplanes, not certified for aerobatics, to not have a tendency to inadvertently depart controlled flight from thrust asymmetry after a critical loss of thrust.

The Associations and EASA recommended the FAA apply this requirement to all multiengine airplanes, rather than only levels 1 and 2. The FAA is not adopting this recommendation. As explained in the NPRM, the FAA does not have the accident history data to support it. The FAA encourages manufacturers of levels 3 and 4 multiengine airplanes to incorporate safety features that prevent inadvertent departure as with levels 1 and 2 multiengine airplanes.

ICON commented an airplane designed in accordance with proposed § 23.200(c) would require less skill and presence of mind during an emergency, resulting in better safety.

While the FAA is not adopting proposed § 23.200(c), new § 23.2150(c) achieves the safety objective of proposed § 23.200(c).

Transport Canada noted the reason for requiring V_{MC} to be less than the stall speed is to avoid loss of control following an engine failure. Transport Canada suggested an airplane designed with a large enough rudder to meet this requirement may be more prone to inadvertent spin entries. Transport Canada recommended requiring all multiengine airplane to have a positive climb gradient following an engine failure.

As explained in the NPRM, while the Part 23 ARC discussed the option that all multiengine airplanes have guaranteed climb performance after a critical loss of thrust, the FAA ultimately rejected this option because it could impose a significant cost on the production of training airplanes.

i. Trim (proposed § 23.205/now § 23.2140)

In the NPRM, proposed § 23.205 (now § 23.2140) would have required the airplane to maintain longitudinal, lateral, and directional trim under various conditions, depending on the airplane's certification level, without allowing residual forces to fatigue or distract the pilot during likely emergency operations, including a critical loss of thrust on multiengine airplanes.

EASA commented the text of proposed § 23.205 failed to take into account residual forces for lateral and directional control for those level 1, 2, and 3 airplanes with ground-adjustable trim tabs.

The FAA agrees with EASA that while the FAA addressed ground-adjustable trim tabs for level 1, 2, and 3 airplanes, the proposed rule failed to account for residual forces in lateral and directional axes. The FAA intended for proposed § 23.205 to maintain the level of safety found in former § 23.161. Former § 23.161(a), which applied generally to all airplanes and to lateral, directional, and longitudinal trim, stated that it must be possible to ensure the pilot will not be unduly fatigued or distracted by the need to apply residual control forces exceeding those for prolonged application of former § 23.143(c) in normal operations of the airplane. In light of EASA's comment, the FAA recognizes that proposed § 23.205 (now § 23.2140) would only have prohibited residual control forces from fatiguing or distracting the pilot during likely emergency conditions. The FAA agrees with EASA that the rule should account for residual control forces in lateral and directional axes for levels 1, 2, and 3 airplanes. However, to maintain the same level of safety as former § 23.161, the rule should also account for residual control forces in longitudinal axes and should apply generally to levels 1, 2, 3, and 4 airplanes.

Accordingly, the FAA is adding the requirement for residual control forces not to fatigue or distract the pilot during normal operations of the airplane to § 23.2140(c). This requirement is consistent with former § 23.161(a).

Textron noted that the reference "normal operations" would require all level 4 airplanes to be able to trim in all three axes from obstacle height to obstacle height. Textron contended that would seem to increase the burden from the former requirements in § 23.161, at least regarding lateral and directional trim.

The FAA considered Textron's comment, but is retaining the reference to "normal operations" in proposed § 23.205(a)(2) (now § 23.2140(a)(2)). While § 23.2140(a)(2) could be interpreted more stringently than former § 23.161(b)(2), the FAA never intended the proposed language to increase the burden from the previous requirements. Former § 23.161 required lateral and directional trim for commuter category airplanes, which are the equivalent of level 4 airplanes, at all speeds from $1.4V_{S1}$ to the lesser of V_H or V_{MO}/M_{MO}. The objective of the proposed rule was to allow the prescriptive requirements of former § 23.161 to be addressed in means of compliance. While specific speeds such as $1.4V_{S1}$ are appropriate as the lower speed limit for defining "normal operations" for traditional configurations of level 4 airplanes, it may not fit new airplanes with novel propulsion, high lift, and flight control system configurations. For this reason, the FAA finds the proposed language of "normal operations" best addresses the top-level safety requirement of former § 23.161(b)(2) while allowing the appropriate speed range to be addressed in means of compliance.

In reference not only to this section, but also to its use throughout the proposed rule, ANAC commented that the term "likely" is not precise and should be clarified or

replaced with more precise terms such as “probable”, “remote”, or “not extremely improbable.”

The FAA infers that ANAC recommended using a quantitative term, such as “probable,” because it is defined in guidance material. While the FAA agrees with ANAC’s comment that the term “likely” is not precise, the FAA intends to allow some imprecision for the objective of providing performance-based standards that are sufficiently flexible to accommodate new technologies. The term “likely” was chosen to mean a reasonable expectation based on the existing conditions. This is consistent with the former usage of the term throughout part 23. Clarification of what should or should not be considered likely for a particular rule will be provided in the means of compliance.

Textron recommended deleting the qualifying term “likely” from proposed § 23.205(c) because it would be subject to interpretation. Textron also recommended adding abnormal operations to those operations during which residual control forces must not fatigue or distract the pilot. Lastly, Textron recommended a few editorial changes, including adding the term “control” to residual forces.

While Textron took exception to the word “likely” to describe emergency operations, the FAA finds the term to be appropriate in this case. Deleting the qualifier “likely” could actually lead to more stringent interpretations of the requirement. The term “likely” bounds the requirement within rational and probable emergencies. Simply using the term “emergency” could be construed as requiring an applicant to address any possible emergency regardless of how improbable it is.

The FAA agrees with Textron concerning the addition of abnormal operations. Former § 23.161 referenced the specific condition of an engine failure, which would have

been based on traditional engine configuration on the wing. Looking ahead, that failure condition could be considered an abnormal and/or an emergency operation depending on the number of engines, location, and control of the engines. Furthermore, there may be other types of failures where trim would be important. For these reasons, the FAA finds that addressing the situation using the performance-based terms of "abnormal" and "emergency" is appropriate and consistent with the objective of providing performance-based standards that are sufficiently flexible to accommodate new technologies.

The FAA also agrees with Textron's recommendation to add "control" to residual forces. The FAA notes that former § 23.161 referenced "residual control forces," not "residual forces." This was an oversight in the NPRM. Accordingly, § 23.2140(c) now prohibits residual control forces from fatiguing or distracting the pilot during likely abnormal or emergency operations.

The Associations and Textron recommended streamlining the proposed rule language by moving a phrase that appeared twice in proposed § 23.205(a)(1) and (2) to a single, earlier reference in proposed § 23.205(a).

The FAA agrees with the commenters and has adopted their recommendation. Section 23.2140(a) now requires the airplane to maintain lateral and directional trim without further force upon, or movement of, the primary flight controls or corresponding trim controls by the pilot, or the flight control system, under the conditions specified in paragraphs (a)(1) and (a)(2). This marks a change from what was proposed in the NPRM in that paragraph (a) no longer addresses longitudinal trim. The FAA removed the reference to longitudinal trim in paragraph (a) because longitudinal trim is addressed by paragraph (b).

Furthermore, the FAA is adding language to paragraph (b) that requires the longitudinal trim to be maintained without further force upon, or movement of, the primary flight controls or corresponding trim controls by the pilot, or the flight control system, under the conditions specified in paragraphs (b)(1) through (b)(4). This requirement, which is consistent with the intent of the NPRM, ensures § 23.2140(b) maintains the same level of safety as former § 23.161. Former § 23.161(a) required each airplane to meet the trim requirements of former § 23.161 after being trimmed and without further pressure upon, or movement of, the primary flight controls or their corresponding trim controls by the pilot or the automatic pilot. This requirement applied generally to lateral, directional, and longitudinal trim.

j. Stability (proposed § 23.210/now § 23.2145)

In the NPRM, proposed § 23.210 (now § 23.2145) would have required airplanes not certified for aerobatics to have the following in normal operations: (1) static longitudinal, lateral, and directional stability, and (2) dynamic short period and combined lateral directional stability. Proposed § 23.210 would have also required airplanes not certified for aerobatics to provide stable control force feedback throughout the operating envelope. Additionally, proposed § 23.210 would have precluded any airplane from exhibiting any divergent stability characteristic so unstable as to increase the pilot's workload or otherwise endanger the airplane and its occupants.

Kestrel suggested removing the phrase "in normal operations" from proposed § 23.210(a)(1) because it could be interpreted to mean that static stability is not required in abnormal operations.

The FAA understands Kestrel's concern with the phrase "in normal operations" in the proposed language. However, the FAA intended proposed § 23.210(a) (now § 23.2145(a)) to capture the safety intent of the stability sections in former part 23, which did not require demonstrations in abnormal or emergency conditions. Former § 23.171 required an airplane to show static stability in "any condition normally encountered in service," which the FAA considers to be normal operations. The former requirements have provided an acceptable level of safety. The FAA adopts the proposed language in § 23.2145(a)(1) as proposed.

Optimal stated that proposed § 23.210(a)(2) appears to require that all lateral modes be stable, implying that airplane need to be spirally stable. This commenter indicated that most airplane have divergent spiral modes and therefore could not meet this requirement as proposed.

The FAA agrees with Optimal that the proposed requirement could be interpreted as including spiral mode. The FAA intended proposed § 23.210(a)(2) to capture the short period and Dutch-roll stability that former part 23 required. "Combined lateral-directional oscillations" means "Dutch roll." The FAA revises the language in § 23.2145(a)(2) to replace "combined lateral-directional stability" with "Dutch roll" stability.

ANAC suggested including the terms "adequate" or "appropriate" to qualify dynamic stability in proposed § 23.210(a)(2).[26] ANAC stated that requiring only a showing of stability may allow for the interpretation that "marginally stable" is acceptable, while current part 23 has minimum damping factors prescribed.

[26] ANAC actually addressed this comment to § 23.205(a)(2), but it appears it was supposed to address § 23.210(a)(2).

The FAA agrees with ANAC that requiring only stability without a qualifier could allow for interpretations outside of the prescriptive standards of former part 23. However, the FAA does not agree with qualifying stability in § 23.2145(a)(2). Under the new part 23, applicants will have to propose a means of compliance. While this is a significant change from the former part 23, the language in § 23.2145(a)(2) will enable the FAA to accept the current prescriptive limits as a means of compliance. Alternatively, if a new technology requires something different, the FAA can accept what is appropriate.

NJASAP suggested the "Dutch roll" characteristic on the EMB505 airplane is close to the language used in proposed § 23.210(b). NJASAP sought to ensure any stability system used to comply with this section is not so dependent on Global Positioning System (GPS) technology that its loss or interruption could cause the electronic augmentation system to fail.

NJASAP's comment is outside the scope of this section as the FAA proposed § 23.210 (now § 23.2145) to include requirements for flight controls, not for their underlying systems. The FAA notes, however, that flight control systems used to comply with this section must also meet the system requirements of subpart F, which adequately address the commenter's concern.

k. Stall Characteristics, Stall Warning, and Spins (proposed § 23.215/now § 23.2150)

In the NPRM, proposed § 23.215 (now § 23.2150) would have required an airplane to have controllable stall characteristics in straight flight, turning flight, and accelerated turning flight with a clear and distinctive stall warning that provides sufficient margin to prevent inadvertent stalling. Proposed § 23.215 would have allowed for alternative approaches to meeting this requirement for levels 1 and 2 airplanes and level 3

single-engine airplanes, not certified for aerobatics, in order to avoid a tendency to inadvertently depart controlled flight. Proposed § 23.215 would have also required airplanes certified for aerobatics to have controllable stall characteristics and the ability to recover within one and one-half additional turns after initiation of the first control action from any point in a spin, not exceeding six turns or any greater number of turns for which certification is requested while remaining within the operating limitations of the airplane. Proposed § 23.215 would have also precluded airplanes certified for aerobatics from having spin characteristics that would result in unrecoverable spins due to pilot disorientation or incapacitation or any use of the flight or engine power controls.

Garmin commented that while the proposal contained a lengthy discussion about requirements to improve the airplane's resistance to departing controlled flight, proposed § 23.215(a) would only have required the airplane to have controllable stall characteristics in straight, turning and accelerated flight. Garmin stated there was no mention of flight characteristics related to control usage at the stall that does not precisely and correctly control the stall. As an example, Garmin noted an applicant can comply with the rule and have an airplane that is controllable through a stall if flown correctly, but if not flown correctly, can enter an uncontrollable spin if the airplane is allowed to stall while not precisely coordinated. Garmin recommended the FAA change either the rule or the preamble to be consistent with each other.

The FAA acknowledges the NPRM preamble discussion may have been unclear. The FAA only intended proposed § 23.215(b) (now § 23.2150(b) to improve an airplane's resistance to departing controlled flight. This increase in level of safety applied only to the smaller part 23 airplanes, not all part 23 airplanes. Furthermore, the FAA

intended for proposed § 23.215(a) to capture the safety intent of former §§ 23.201 and 23.203. Garmin's example will continue to be true for airplanes not required to meet § 23.2150(b). The FAA notes that § 23.2150(a) will not include requirements related to conditions and control usage at the stall. While former §§ 23.201 and 23.203 included these requirements, the FAA finds they are better addressed in means of compliance.

The FAA notes the details from these former rules will be addressed in the means of compliance and will remain essentially unchanged, especially for larger, higher-performance airplanes. The reason is that the accident history of the larger airplanes does not warrant the change. The means of compliance for the level 1 and 2 airplanes and level 3 single-engine airplanes is expected to allow for more alternative approaches from what is acceptable today to meet the higher level of safety in this rule.

Textron and the Associations commented that § 23.215(b) should not require multiengine airplanes to not have a tendency to inadvertently depart controlled flight. The commenters explained that loss of control accidents involving multiengine airplanes result mostly from pilots failing to maintain directional control following a critical loss of thrust. Textron noted that this concern is being addressed by proposed § 23.200(c), which proposes new requirements for airplanes that cannot climb after a critical loss of thrust. Textron also noted former § 23.221 was not a requirement for multiengine airplanes and that proposed § 23.215(b) would have represented a significant new burden with no safety justification.

The Associations stated it believed loss of control accidents predominately involve single-engine airplanes, or multiengine airplanes during a critical loss of thrust event. The Associations recommended that the FAA revise proposed § 23.215 to ensure

the loss of control requirements are applied in a manner that will maximize safety while being applied in an efficient manner. The Associations specifically recommended the FAA revise proposed § 23.215 to require multiengine airplanes, not certified for aerobatics, to not have a tendency to suffer a loss of control after a likely critical loss of thrust. This would be an alternative to adopting proposed § 23.200(c). The Associations also recommended the FAA revise the proposed § 23.215(b) to require single-engine airplanes, not certified for aerobatics, to not have a tendency to inadvertently depart controlled flight.

The FAA agrees that proposed § 23.215(b) (now § 23.2150(b)) should apply only to single-engine airplanes. The FAA proposed to apply paragraph (b) to level 1 and 2 multiengine airplanes in an attempt to address the loss of control accidents in light multiengine airplanes that can occur after an engine failure if the pilot does not maintain a safe single-engine speed. However, as noted by Textron, the FAA proposed § 23.200(c) to address this safety issue by requiring that V_{mc} not exceed V_{s1} or V_{so}. In light of the comments, the FAA recognizes it is more appropriate to address the loss of control issue for light multiengine airplanes in § 23.2150 rather than § 23.2135 because it is redundant to address the issue in both sections. The FAA revises § 23.2150(b) in this final rule to reflect that it only applies to single-engine airplanes in all certification levels to be consistent with former § 23.221. While the FAA did not propose in the NPRM that level 4 single-engine airplanes would be subject to this requirement, extending this requirement to such airplanes is a logical outgrowth from the proposal because the same safety benefit applies regardless of certification level. Also, the FAA finds no valid technical basis for excluding level 4 airplanes from this requirement. The airplane

categories in former part 23 did not provide for certification of single-engine airplanes with passenger capacities greater than nine; however, it is possible that applicants may seek approval for such an airplane in the future. In such cases, these airplanes will have the same level of safety as smaller single-engine airplanes.

As discussed in the preamble discussion of § 23.2135, the FAA is withdrawing proposed § 23.200(c) and adding a new § 23.2150(c). Paragraph (c) requires levels 1 and 2 multiengine airplanes, not certified for aerobatics, to not have a tendency to inadvertently depart controlled flight from thrust asymmetry after a critical loss of thrust. The FAA finds that paragraphs (b) and (c), as revised, more accurately reflect the FAA's intent regarding the prevention of loss of control accidents in both single and multi-engine airplanes.

EASA commented that proposed § 23.215(b) would not have provided the flexibility needed for future designs. EASA recommended the FAA allow levels 1 and 2 airplanes and level 3 single-engine airplanes not certified for aerobatics to meet one of three alternatives: (1) not to have the tendency to inadvertently depart controlled flight; (2) have a benign behavior when departing controlled flight; or (3) have a system preventing departure from controlled flight.

While the FAA understands EASA's recommended approach, § 23.2150(b) and (c) contain the most significant safety improvements in this rulemaking effort. Any departure from controlled flight is likely to result in a fatal accident unless an experienced pilot demonstrating spins in an aerobatic airplane intentionally does it. Allowing levels 1 or 2 airplanes or level 3 single-engine airplanes to have a benign behavior when departing controlled flight would not meet the FAA's safety objective for airplanes that are not

certified for aerobatics. The FAA notes that an airplane that can depart controlled flight with benign behavior can inadvertently depart controlled flight. Furthermore, having a system that prevents departure from controlled flight may be a means of compliance for § 23.2150(b). Therefore, the FAA finds it inappropriate to offer it as an alternative in the regulation.

The FAA did not intend § 23.2150(b) to be absolute in that "spin resistance" is the only way to meet the rule. An airplane using enhanced stall warnings and envelope protection could be very difficult to depart from controlled flight and comply with § 23.2150(b). That same airplane, with some effort, could be made to spin (depart controlled flight) and have good recovery capability and still—because of the stall characteristics and the enhanced warning and systems protection—comply with the new requirement. The FAA is working on means of compliance that will allow numerous combinations of airframe and systems approaches to complying with the new requirement so that applicants have alternative ways to comply with the regulation. Furthermore, this approach will encourage the development of new innovative technology that targets resistance to departure from controlled flight.

Several commenters took issue with the proposed requirement in § 23.215(b) that certain airplanes must not have a tendency to inadvertently depart controlled flight. Air Tractor, Optimal, and an individual commenter noted the proposal does not define this phrase. The individual commenter asked whether this phrase includes proper use of flight controls, improper use of flight controls, conditions beyond and per former § 23.221(a)(2) for spin resistance. Air Tractor stated it would be difficult to prove an airplane meets this requirement.

The FAA purposely used language that would allow flexibility in showing compliance. The FAA recognizes the lack of clear, detailed requirements may increase the difficulty of proving that the airplane meets this requirement. However, the FAA finds providing clear, detailed requirements would prevent the acceptance of alternative approaches to this safety problem. It could also prevent the use of new technology, which would discourage the development of even newer technology. As explained in the NPRM, the FAA envisions numerous alternative approaches to meeting this requirement, ranging from a stick pusher to full spin resistance. The FAA is relying on industry to develop acceptable means of compliance beyond these two acceptable approaches for this requirement, should industry fully leverage the flexibility the FAA built into the rule. The FAA is also relying on industry to incorporate new technologies into the airplane to address stall-based accidents. Currently, the ASTM committee is maturing an innovative approach that incorporates many of the variables associated with stall characteristics to prevent inadvertent departures from controlled flights.

Air Tractor expressed concern that it may not be able to comply with the intent of the proposed requirement because its airplanes are designed to operate close to the ground and sometimes close to a stall. According to Air Tractor, if it were to add some kind of substantial departure resistance to prevent inadvertent stalls resulting in a departure from controlled flight, as described in the NPRM, this modification could potentially increase pilot fatigue significantly.

The FAA notes that Air Tractor's airplanes are certified in restricted category and have the latitude to modify the part 23 requirements where necessary. For example, as Air Tractor pointed out, its airplanes are designed to operate close to the ground and

sometimes close to a stall. For this reason, Air Tractor did not have to meet the one-turn spin requirement from former part 23 as specified on TCDS Number A19SW. However, because Air Tractor's airplanes are operated close to the ground and sometimes close to a stall, characteristics or features that prevent inadvertent departure would be desirable, unless these characteristics or features add control forces that fatigue the pilot or reduce maneuverability. The FAA finds these issues apply only to a small subset of airplanes and can be addressed most efficiently and effectively in the certification context, rather than by revising the regulatory text. Optimal expressed concern with unintended consequences that may result from imposing departure from controlled flight resistance requirements. Specifically, it questioned whether proposed § 23.215(b) can be satisfied without compromising other aspects of the airplane's performance and handling.

The FAA notes that, historically, when only using traditional mechanical controls, there are performance and handling tradeoffs that can come from imposing departure resistance requirements. This is one reason the FAA has been reluctant to push for departure resistant characteristics in the past. However, the development, availability, and cost of new technology to address departure resistance have matured such that the FAA believes it is time to introduce this requirement to reduce loss of control accidents. Aerodynamics and systems combined can address departure resistance without compromising performance and handling. The FAA will not accept a means of compliance that has a detrimental effect on safety.

Transport Canada questioned whether proposed § 23.215(b) would result in designs that have a significant effect on the loss of control accident rate and asked what the flight test requirements would be for demonstrating compliance with paragraph (b).

American Champion Aircraft Corporation (American Champion) stated the regulation should provide a means to determine acceptable departure resistance, or a description of an acceptable means of compliance.

The FAA recognizes that the means of compliance will be very important in the success of this requirement to improve safety. The FAA adopts a general performance-based requirement in § 23.2150(b) to enable numerous alternative approaches to meet the requirement. For this reason, it is impossible to specify a single set of flight test requirements. The flight test requirements will depend on the applicant's approach to complying with this rule and the means of compliance it uses. It would have been impossible to adopt requirements for all combinations of safety features and characteristics that reduce the tendency to inadvertently depart controlled flight in the requirements themselves. However, applicants can still use the spin resistance requirements from former § 23.221 for spins, and a stick pusher compliant with former § 23.691 for artificial stall barrier systems. Additionally, ASTM is developing an expandable matrix concept that will allow credit for combinations of stall warning, stall/envelope protection, and flight characteristics. This matrix should result in not only encouraging manufacturers to install more safety enhancing equipment, but more importantly, it will also encourage the development of innovative approaches to preventing inadvertent departure because of the speed at which new technology can be incorporated into the certification process. To address the wide range of airplane characteristics and solutions, the FAA is adopting a standard that the airplane may not have tendency to inadvertently depart controlled flight.

American Champion noted inconsistencies with the required degree of departure resistance throughout the NPRM. For example, the commenter noted proposed § 23.215(b) stated "must not have a tendency to inadvertently depart controlled flight." Section V of the NPRM referred to departure resistant as "stall characteristics that make it very difficult for the airplane to depart controlled flight," and section VI states certification levels would have required "substantial departure resistance." American Champion recommended the FAA clarify the degree of departure resistance intended by proposed § 23.215(b).

The FAA notes § 23.2150(b) states that single-engine airplanes, not certified for aerobatics, "must not have a tendency" to inadvertently depart controlled flight. Therefore, "must not have a tendency" is the standard. The FAA acknowledges, however, that the NPRM discussions should have been more consistent when discussing the proposed rule language.

Optimal expressed concern about removing the requirement for single-engine airplanes not certified for aerobatics to recover from a one-turn/three-second spin at this time because pilots have been adept at finding unanticipated ways to get spin resistant airplanes to depart from controlled flight and because airplanes that are the most reluctant to spin tend to be the most reluctant to recover. Optimal recommended the FAA retain the requirement to recover from an incipient spin until sufficient certification and operational experience has been acquired with departure resistant airplanes.

The FAA removes the requirement for the one-turn/three-second spin for normal category single-engine airplanes. Historically, airplanes that were reluctant to spin tended to be reluctant to recover. This history is based on airplanes with inherent stability and

reversible controls, which to date are all small airplanes. The FAA intentionally focused on the prevention of the conditions that lead to an inadvertent spin (departing controlled flight) versus the historical focus on spin recovery. For decades, the FAA has focused on spin recovery in certification programs only to have those same certified airplanes depart controlled flight at altitudes so low that even experienced pilots could not recover. For decades, this scenario has accounted for a large percentage of fatal accidents. The FAA has to change the approach to certification in order to reduce the number of departure from controlled flight fatal accidents.

Kestrel expressed concern that demonstrating compliance to proposed § 23.215(d) would be prohibitively expensive and potentially impossible. Kestrel suggested the FAA modify the proposed rule language to read "with any typical use of the flight or engine power controls."

The FAA agrees that proposed § 23.215(d)(1) (now § 23.2150(e)(1)) could have been interpreted as imposing an unbounded requirement, which was not the FAA's intent. The FAA revises the proposed rule language as Kestrel suggested.

EASA commented that proposed § 23.215(d)(2) (now § 23.2150(e)(2)) would have contained a flightcrew interface requirement that does not belong in the airworthiness (design) requirements. EASA recommended the FAA move this requirement to subpart G, which addresses flightcrew interface requirements.

The FAA is retaining the requirement in subpart B because it originated from former subpart B, § 23.221(c). The FAA finds that keeping it in the same subpart, in this instance, will avoid confusion.

American Champion commented that it is unnecessary to restrict certification of dual-purpose airplanes by requiring a mechanical or electronic change, as described in the NPRM, because airplanes can both meet the enhanced stall characteristics and also be suitable for some aerobatic maneuvers. The commenter noted that departure resistance, proposed § 23.215(b), does not preclude an airplane from aerobatic maneuvering, although it may affect the ability of the airplane to enter a spin.

The FAA proposed to restrict certification of new airplanes for dual use to prevent inadvertent stalls, which was one of the proposal's objectives. If an airplane can spin for spin training, then the airplane can inadvertently stall and depart into a spin during normal operations. In light of American Champion's comment, however, the FAA acknowledges there may be airplanes in the future that are approved for limited aerobatics that do not include spins. This would be similar to military fighter airplane. The military approach has historically been to explore thoroughly the post stall regime including spins and departures from controlled flight that do not result in traditional spins. This is done in the military and for civilian aerobatic airplanes to address the situation where a mistake during a planned maneuver results in departing controlled flight. The FAA can envision a flight control system that could prevent departures from all approved maneuvers. To the FAA's knowledge, the F-16 flight control system has been very successful in preventing inadvertent departures from controlled flight even though these airplane are frequently flown "acrobatically." For these reasons, the FAA may allow certification of a new airplane for dual use even if the airplane is not approved for spins. However, an applicant proposing a system, such as a flight control system that could prevent departure from controlled flight during normal operations, should expect to

work with the FAA to thoroughly address FAA concerns for safe margins from inadvertent departure from controlled flight.

Proposed § 23.215(d) would have precluded airplanes certified for aerobatics from having spin characteristics that would result in unrecoverable spins due to pilot disorientation or incapacitation or any use of the flight or engine power controls. Upon further reflection, the FAA revises the proposed rule language to require spin characteristics in airplanes certified for aerobatics to recover "without exceeding limitations." The FAA inadvertently omitted this clause from proposed § 23.215(d) (now§ 23.2150(e)), which was intended to capture the safety intent of former § 23.221(c). Former § 23.221(c) required the applicable airspeed limits and limit maneuvering load factors not to be exceeded. Additionally, including this clause in the requirement will better align the FAA language with EASA's NPA language.

The NTSB commented that while it supports reducing the rate of loss of control accidents in general aviation, it is unclear how proposed §§ 23.200 and 23.215 would have accomplished this. The NTSB explained that the only link it sees to reducing loss of control accidents is the change to V_{MC} and asked the FAA to clarify exactly how the revisions will reduce loss of control accidents.

The FAA notes that the NPRM included a substantial discussion explaining how the FAA envisions the rule reducing loss of control accidents. The new rules allow alternative approaches that an applicant may use, ranging from a stick pusher to full spin resistance. Adding flexibility to the rule will allow alternate approaches to address inadvertent departure by using combinations of new technology not addressed in the former requirements. These alternatives will be addressed in means of compliance. There

is no “exact” approach to meet the new rule because the objective is to encourage new approaches to loss of control that are more effective than the ones that are failing us today.

Additionally, the NTSB submitted detailed comments on the stall departure characteristic exception in the ASTM standard. The FAA will address these comments in the AC because these comments are on the acceptability of an ASTM standard as a means of compliance rather than on the proposed rule.

l. Ground and Watering Handling Characteristics (proposed § 23.220/now § 23.2155)

In the NPRM, proposed § 23.220 (now § 23.2155) would have required airplanes intended for operation on land or water to have controllable longitudinal, and directional handling characteristics during taxi, takeoff, and landing operations. Proposed § 23.220 would have also required an applicant to establish a maximum wave height shown to provide for controllable longitudinal, and directional handling characteristics and any necessary water handling procedures for those airplanes intended for operation on water.

Textron and the Associations noted that the FAA proposed to remove the prescriptive requirements related to establishing demonstrated crosswind capability from former § 23.233, but proposed to retain similar requirements for water operations to establish wave height criteria. These commenters stated that operational specificity related to water landings should be addressed in means of compliance standards and recommended that the FAA not adopt proposed § 23.220(b).

The FAA agrees with the commenters that proposed § 23.220(b) would have been overly prescriptive for water operations and that it would be more appropriate as a means of compliance. While proposed § 23.220(a) would have included the top-level safety

requirements for both land and water operations, proposed § 23.220(b) would have been inconsistent with the approach taken for land airplanes as it would have contained prescriptive requirements only for airplanes intended for operation on water. Accordingly, the FAA is not adopting proposed § 23.220(b). The information necessary to comply with proposed § 23.220(a) (now § 23.2155 in its entirety) and the method to communicate that information to the pilot will be addressed in means of compliance with this section.

EASA also recommended that the FAA not adopt proposed § 23.220(b). EASA explained that the AFM requirements in subpart G should cover "how-to" information and how that information is provided to the pilot, as proposed in the NPRM. Therefore, proposed § 23.220(b) should not require what must be included in the AFM.

The FAA agrees with EASA that the information is more appropriately addressed in the AFM means of compliance. The AFM requirements are located in subpart G.

m. Vibration, Buffeting, and High-Speed Characteristics (proposed § 23.225/now § 23.2160)

In the NPRM, proposed § 23.225 (now § 23.2160) would have—

- Precluded vibration and buffeting from interfering with the control of the airplane or causing fatigue to the flightcrew, for operations up to V_D/M_D;
- Allowed stall warning buffet within these limits;
- Precluded perceptible buffeting in cruise configuration at 1g and at any speed up to V_{MO}/M_{MO}, except stall buffeting for high-speed airplanes and all airplanes with a maximum operating altitude greater than 25,000 feet (7,620 meters) pressure altitude;

- Required an applicant seeking certification of a high-speed airplane to determine the positive maneuvering load factors at which the onset of perceptible buffet occurs in the cruise configuration within the operational envelope and preclude likely inadvertent excursions beyond this boundary from resulting in structural damage; and
- Required high-speed airplanes to have recovery characteristics that do not result in structural damage or loss of control, beginning at any likely speed up to V_{MO}/M_{MO}, following an inadvertent speed increase and a high-speed trim upset.

Textron and the Associations noted that the language from which proposed § 23.220(a) originated (former § 23.251) included the term "excessive fatigue," rather than "fatigue." These commenters recommended that the FAA use the term "excessive fatigue" in proposed § 23.220(a). Textron explained that by omitting the term "excessive," any perceptible level of fatigue could be considered unacceptable and the proposal would result in an unwarranted change in standards for vibration.

The FAA agrees with the commenters and is adding the term "excessive" to § 23.2160(a).

ICON contended that proposed § 23.225(b) would have been fine for landplanes, but not for seaplanes because seaplanes, with their hull step, will always have some buffet in cruise. Additionally, ICON noted that airplane with windows removed will have perceptible buffeting at all speeds.

The FAA agrees with ICON that seaplanes and floatplanes routinely operate with a limited amount of buffet during normal operation. The FAA did not intend for proposed § 23.225(b) to increase the level of safety over former § 23.251, which allowed for the limited buffeting normal to seaplanes and floatplanes. Historically, this level of buffeting

has not interfered with the control of the airplane or caused excessive fatigue to the pilot. Because the proposed rule language originated from former § 23.251, the FAA finds that it does not create a new certification burden on applicants with seaplanes or floatplanes. Accordingly, the FAA adopts the language as proposed. Furthermore, airplanes approved for operations without doors or windows, or those that allow the windows to open in flight, were not intended to be addressed under this rule.

Textron and the Associations noted that the former requirement for a high-speed trim upset (former § 23.255) applied to designs with adjustable horizontal stabilizers. However, the FAA did not specify whether proposed § 23.220(d)(2) would have been limited to airplanes with adjustable horizontal stabilizers. Textron explained that, as proposed, § 23.220(d)(2) would have contained an additional requirement for high-speed airplanes that did not have trimmable horizontal stabilizers. The commenters recommended the FAA limit the application of proposed § 23.220(d)(2) to airplanes that incorporate a flight adjustable horizontal stabilizer.

The FAA intended to keep this requirement as general as possible, not to propose a new requirement on high-speed airplanes that lacked trimmable horizontal stabilizer. As stated in the NPRM, the FAA intended proposed § 23.220(d)(2) (now § 23.2160(d)(2)) to address the current safety intent of former § 23.255, which applied only to airplanes that included trimmable horizontal stabilizers. The FAA adopts language in § 23.2160(d)(2) to clarify that the requirement applies only to airplanes that incorporate trimmable horizontal stabilizers.

n. Performance and Flight Characteristics Requirements for Flight in Icing Conditions (proposed § 23.230/now § 23.2165)

In the NPRM, proposed § 23.230 (now § 23.2165) would have required—

- An applicant requesting certification for flight in icing conditions to demonstrate compliance with each requirement of this subpart. Exceptions to this rule would have been requirements applicable to spins and any requirement that would have to be demonstrated at speeds in excess of 250 KCAS, V_{MO} or M_{MO}, or a speed at which an applicant demonstrates the airframe would be free of ice accretion;
- The stall warning for flight in icing conditions and non-icing conditions to be the same.
- An applicant requesting certification for flight in icing conditions to provide a means to detect any icing conditions for which certification is not requested and demonstrate the airplane's ability to avoid or exit those conditions; and
- An applicant to develop an operating limitation to prohibit intentional flight, including takeoff and landing, into icing conditions for which the airplane is not certified to operate.

Proposed § 23.230 would have also added optional icing conditions where a manufacturer may demonstrate its airplane can either safely operate in, detect and safely exit, or avoid. Finally, proposed § 23.230 would have only applied to applicants seeking certification for flight in icing.

NJASAP stated it viewed proposed § 23.230 as a safety enhancement and noted that several accidents have demonstrated a benefit to having one stall standard—meaning the airplane should be able to remain largely free of ice in conditions within which it is

certified to operate. The NTSB stated that adopting proposed §§ 23.230 and 23.1405 will likely result in Safety Recommendation A-96-54 being classified as "Closed—Acceptable Action."

Textron and the Associations asked the FAA to clarify that proposed § 23.230(a) applies to the airplane's ice protection system when it is operating normally, not when it is in a failed or degraded mode. Therefore, rather than requiring the applicant to demonstrate the requirements of proposed paragraphs (a)(1) and (a)(2), the Associations recommended that the FAA require the normally-operating airplane ice protection systems to include the requirements of proposed paragraphs (a)(1) and (a)(2).

The FAA agrees with the comments made by the Associations and Textron, and the FAA adopts language to clarify that § 23.2165(a) applies to the normal operation of an ice protection system. Accordingly, § 23.2165(a) now requires the applicant to demonstrate the requirements of paragraphs (a)(1) and (a)(2) under the normal operation of the ice protection system.

The FAA is also changing the language in § 23.2165(a) to clarify that § 23.2165 applies to an applicant who requests certification for flight in icing conditions defined in part 1 of appendix C to part 25, or to an applicant who requests certification for flight in these icing conditions and any additional atmospheric icing conditions. This change better reflects the FAA's intent.[27]

Additionally, the FAA is using the phrase "must show" rather than "must demonstrate" in § 23.2165(a), because "must demonstrate" may be interpreted as requiring a flight test, as Textron suggested in its comment on proposed § 23.230(b)

[27] 81 FR 13452, 13462

(discussed later). This change is consistent with the NPRM, which explained that demonstration, as a means of compliance, may include design review and/or analysis and does not mean flight tests are required.[28]

The FAA is also adding the never-exceed speed (V_{NE}) to the exception in § 23.2165(a), under paragraph (a)(1)(ii), to correct an inadvertent omission in the proposal. Because proposed § 23.230(a)(1)(ii) was intended to apply to both piston and turbine airplanes, the addition of V_{NE} is necessary as the proposed V_{MO}/M_{MO} would only have applied to turbine airplanes. This change from what was proposed is consistent with the current guidance in AC 23.1419-2D.

BendixKing, Daher,[29] the Associations, Kestrel, and Textron all requested clarification of the wording of proposed §23.230(a)(2), which proposed that the applicant must demonstrate that the stall warning for flight in the icing conditions and non-icing conditions is "the same." Several of the commenters explained that the stall warning in icing conditions needs to provide a similar notification as the stall warning in non-icing conditions, but it does not need to occur in the same way.

Textron similarly stated that proposed§ 23.230(a)(2) could be interpreted as indicating that the stall warning must be the same in all of its aspects, which should not be the intent. Textron explained that the stall warning system in icing conditions cannot be the same as in non-icing conditions because some designs require a different angle of attack schedule in icing to obtain the same airspeed margin between stall warning and stall. Textron recommended requiring "the means by which stall warning is provided to the pilot" to be the same in icing and non-icing conditions.

[28] 81 FR 13452, 13493
[29] In its comment, Daher quoted 23.230(a)(2) but attributed that quote to 23.300

In response to the comments on proposed § 23.230(a)(2), the FAA did not intend to require the stall warning to be the same in all material aspects for flight in icing conditions and non-icing conditions. Rather, the FAA intended proposed § 23.230(a)(2) to require the same type of stall warning, such as an artificial stall warning system or an aerodynamic buffet. Therefore, the FAA adopts Textron's recommendation. Accordingly, § 23.2165(a)(2) now requires the means by which the stall warning is provided to the pilot to be the same in both icing and non-icing conditions. This change from the proposal addresses the other commenters' concerns by clarifying that the type of stall warning provided to the pilot, rather than the design of the stall warning system, must be the same.

Textron recommended replacing the words "must demonstrate" with the words "must show" in proposed § 23.230(b), because the former typically implies compliance by flight testing, whereas the latter allows more than one means of compliance. Similarly, the Associations commented that proposed § 23.230(b) should ensure the design includes a means to safely avoid and exit icing conditions. However, the FAA should not require the applicant to "demonstrate the airplane's ability" to avoid or exit icing conditions because the means by which the airplane safely avoids or exits icing conditions may not have to be demonstrated under part 21. The commenters noted that amended designs, for example, may use similarity to a previously approved design to show compliance.

The FAA agrees that "must demonstrate" in proposed § 23.230(b) may be interpreted as requiring a flight test. Because the FAA did not intend to preclude other means of compliance, the FAA adopts the phrase "must show," as recommended by Textron. Accordingly, § 23.2165(b) now requires an applicant requesting certification for

flight in icing conditions to show the airplane's capability to avoid or exit icing conditions for which certification is not requested.

Kestrel supports categorizing SLD as an icing condition, but noted that guidance in AC 23.1419-2D is currently used on part 23 icing certification programs to establish SLD detection cues and exit procedures. Kestrel asked the FAA to clarify whether this guidance will continue to be an acceptable means of compliance for the ice detection requirement.

The NPRM stated "many manufacturers already have equipped recent airplanes with technology to meet the standards for detecting and exiting SLD conditions in accordance with current FAA guidance." Although systems to detect SLD are being developed, none have been certified. Inclusion of the pilot cues as listed in AC 23.1419-2D into the AFM have been an acceptable means to detect SLD, and will continue to be an acceptable means of compliance to § 23.2165(b).

ANAC questioned whether proposed § 23.230(c) was intended to prohibit flight into known icing conditions or forecast icing conditions. ANAC recommended including the term "known" before "icing conditions."

The FAA agrees with ANAC's position that only "known" icing conditions should be prohibited. However, § 23.2165(c) prohibits intentional flight into icing conditions. Because the term "intentional" implies that the icing conditions are known, the FAA finds it unnecessary to include the term "known" before "icing conditions." Accordingly, the FAA adopts the language in § 23.2165(c) as proposed.

An individual commenter appeared to criticize the FAA for not requiring de-icing to work and suggested that "[a] wind tunnel at the far North or South may be enough for

a conclusive test." In response to the individual commenter, an icing tunnel is a standard means of compliance to test ice protection systems on new airplane designs. Any resulting intercycle, residual, or runback ice has to be accounted for when showing compliance with the subpart B regulations in icing. No changes are made as a result of this comment.

4. Subpart C—Structures

a. Structural Design Envelope (proposed § 23.300/now § 23.2200)

In the NPRM, proposed § 23.300 (now § 23.2200) would have required the applicant to determine the structural design envelope, which describes the range and limits of airplane design and operational parameters for which the applicant would show compliance with the requirements of subpart C. Proposed § 23.300 would have required the applicant to account for all airplane design and operational parameters that affect structural loads, strength, durability, and aeroelasticity, including structural design airspeeds and Mach numbers.

Several commenters identified concerns with the detailed definitions of airspeeds for which applicants would be required to account. They pointed out that, for some types of airplanes, these airspeeds may not be appropriate in particular circumstances. EASA recommended removal of the speed definitions for a more generic proposal in its proposed CS 23.320.

The FAA recognizes the commenters' concerns on the various issues in proposed § 23.300(a). The FAA believes the best way to address these comments is to adopt regulatory text similar to the text in EASA's section CS 23.320, which removes the need to define individual design airspeeds in the regulation. Some comments on proposed

§ 23.300(a) recommended retaining certain methods of compliance language, such as defining V_C in terms of V_H, which is in former part 23. In keeping with the intent of this rulemaking, however, the FAA believes these types of prescriptive standards are best moved to means of compliance.

Air Tractor commented on proposed § 23.300(b), which addressed design maneuvering load factors for the structural design envelope. Air Tractor raised concerns that obtaining consensus compliance from the FAA without the prescriptive formula established by former § 23.337(a) would be a protracted battle—worse than the existing issue paper process for non-standard design.

Regarding Air Tractor's concerns, the FAA has decided to move the prescriptive formula for determining the design maneuvering load factors to means of compliance. The FAA also reiterates that the phrase "service history" is intended to mean the design maneuvering load factors should be based on those load factors used for airplanes with successful service histories that have similar design, operational capabilities, and intended use. If there are no existing similar designs, the FAA will work with the applicant to identify the most appropriate means of compliance. In general, the FAA does not expect applicants to measure and record maneuvering load factors on new designs.

EASA asserted that the language in proposed § 23.300(c) was too design specific and could be replaced with the text from its proposed CS 23.305.

The FAA finds that proposed § 23.300(c) is not overly design specific, because each of the enumerated items must be taken into account, regardless of the applicant's design. The FAA therefore adopts paragraph (c) as proposed.

Air Tractor recommended the FAA change “empty weight to the maximum weight” to “minimum flying weight to maximum weight,” in proposed § 23.300(c)(1). Air Tractor stated this language applies to all airplanes and is appropriate for certification; while “empty weight” applies only to certain airplanes’ operational requirements.

The FAA notes Air Tractor’s recommendation that “empty weight” in § 23.2200(c)(1) should be replaced with “minimum flying weight.” However, the FAA believes that establishing a design empty weight is necessary so that variations in the mass of properties such as fuel, payloads, and occupants, when added to the airplane, can be accounted for.

The Associations recommended deleting the term “All” from the beginning of proposed § 23.300(c)(1) and (e) for simplification. Textron recommended changing “All” in proposed § 23.300(c)(1) to “Each.” Textron stated the change would be consistent with former part 23, which uses “each weight” throughout the subparts, whereas “all” implies an applicant would have to evaluate an infinite number of weights rather than those that are relevant. Textron also recommended replacing “All” in proposed § 23.300(e) with “Each critical altitude,” because “all” is too encompassing.

The FAA agrees with the recommendation to replace “All” with “Each” in proposed § 23.300(c) and (e) and revises the language in both paragraphs accordingly. The FAA also adds the word “critical” so the subsection text reads “Each critical…”. In this context, “critical” refers to a weight or altitude that results in a maximum or minimum structural loading condition. A “critical weight” will, for example, be the weight of the airplane at its highest possible value with no fuel in the wing. This

condition will reduce the effects of inertia in the wing and result in maximum structural loads. A “critical altitude” will be the altitude where the maximum pressure differential occurs in a pressurized cabin, or an altitude where the effects of atmospheric compressibility cause changes to the airplane aerodynamic coefficients, resulting in maximum structural loads.

EASA commented that proposed § 23.300(d) was too design specific and should cover loads resulting from controls.

The FAA interprets EASA’s comment to mean the FAA should consider non-traditional methods of control, such as vectored thrust. The FAA agrees and revises paragraph (d) to include non-traditional control systems.

EASA also commented on proposed § 23.300(e), stating it would create a requirement that is not applicable to very-light aircraft (VLA) today. EASA asserted that the intent can be covered by the new proposal for flight loads in proposed § 23.310 (now § 23.2210).

While the FAA notes EASA’s concern with proposed § 23.300(e), the FAA finds that paragraph (e), as proposed, would place only an insignificant burden on an applicant using the VLA standard. The FAA finds a simple method of compliance, such as for a maximum altitude of 14,000 feet, could be incorporated into an industry consensus standard to meet this requirement.

b. Interaction of Systems and Structures (proposed § 23.305/now § 23.2205)

In the NPRM, proposed § 23.305 (now § 23.2205) would have provided a regulatory framework for the evaluation of systems intended to modify an airplane’s structural design envelope or structural performance, and other systems whose normal

operating state or failed states may affect structural performance. Compliance with proposed § 23.305 would have provided acceptable mitigation of structural hazards identified in the functional hazard assessments required by proposed § 23.1315.

Textron recommended removing proposed § 23.305 because the NPRM makes clear that, with or without proposed § 23.305, the safety intent of proposed § 23.1315 covers the interaction of systems and structures. Textron also objected to the use of, or reference to, non-part 23 data. As an example, Textron cited the reference in the preamble to FAA special condition number 25-390-SC,[30] which the FAA said would be an acceptable means of compliance with proposed § 23.305. Textron questioned whether there was justification for this requirement if part 23 data was not available.

In response to Textron's comment regarding the necessity of proposed § 23.305, the FAA notes the intent stated in the NPRM was erroneous in its description of the relationship between proposed § 23.305 and proposed § 23.1315 (now § 23.2510). The correct intent of proposed § 23.305 is to provide a requirement for those systems intended to directly affect structural performance. An example of this type of system is a structural load alleviation system. Former § 23.1309 and § 23.2510 do not envision these types of systems and the FAA has previously issued special conditions to address these unique and novel systems. Therefore, the FAA retains proposed § 23.305 as § 23.2205 in this final rule because it provides a way for applicants to address failures in systems intended to directly affect structural performance by accounting for the probability of such failures and the likely pilot reactions to them.

[30] http://rgl.faa.gov/Regulatory_and_Guidance_Library/rgSC.nsf/MainFrame?OpenFrameset

Also, regarding Textron's comment that the NPRM preamble referenced a part 25 special condition that did not contain part 23 data, the FAA notes the reference was used as an example because the wording of the special condition was typical of others relating to Interaction of Systems and Structure, which establish an acceptable method of compliance with this section. The FAA has issued a part 23 special condition (23-258A-SC).[31] However, the FAA did not use the part 23 special condition as an example because, while it is an acceptable method of compliance with this section, the approach used in it is not typical of other special conditions addressing these issues.

Textron also stated the phrase "affect structural performance" was too vague and should be better defined for clarity. Textron noted every trim system, flight control system, and high lift system affects structural performance at some level. Textron recommended either eliminating this phrase or using the preamble to define "structural performance." Textron recommended proposed § 23.305 be revised to provide that, for airplanes equipped with systems intended to alleviate the impact of the requirements of this subpart and affect the structural design envelope, either directly or as a result of failure or malfunction, the applicant must account for the influence and failure conditions of these systems when showing compliance with the requirements of this subpart.

The Associations commented that proposed § 23.305 was intended to address systems, which may use aerodynamic or other means to alleviate loads in certain conditions and to ensure structural integrity remains in the event these systems were to fail. The commenters requested the FAA change the language to ensure the intent of this section is clear and there are no unintended consequences, such as creating a requirement

[31] 78 FR 10055, February 13, 2013.

to perform systems safety assessments on all systems and structure interactions. The commenters asserted that this would create a tremendous burden with no measurable benefit. The commenters proposed § 23.305 be revised to provide that, for airplanes equipped with systems that are intended to alleviate structural loads, the applicant must account for the influence and failure conditions of these systems when showing compliance with the requirements of this subpart.

The FAA agrees with Textron and the Associations that § 23.2205 should address only those systems intended to affect structural performance. In the NPRM, the FAA referred to these types of systems as "structural systems". The FAA referred to other types of systems as "non-structural systems". The FAA agrees that these non-structural systems are adequately addressed by § 23.2510. The FAA is using the NPRM description of structural systems in rewording § 23.2205 to ensure that any airplane equipped with a system intended to affect structural performance would be provided the same level of safety as an airplane not equipped with such a system.

c. Structural Design Loads (proposed § 23.310/now § 23.2210)

In the NPRM, proposed § 23.310 (now § 23.2210) would have required—

- An applicant to determine structural design loads resulting from an externally or internally applied pressure, force, or moment that may occur in flight, ground and water operations, ground and water handling, and while the airplane is parked or moored.
- An applicant to determine structural design loads at all combinations of parameters on and within the boundaries of the structural design envelope that would result in the most severe loading conditions; and

- The magnitude and distribution of these loads be based on physical principles and be no less than service history has shown can occur within the structural design envelope.

The Associations recommended adding the phrase “as applicable” to proposed § 23.310(a) to address the varying bases to determine load calculations. These commenters also recommended replacing the term “any” with the word “likely,” because the calculation of any externally or internally applied pressure, force, or moment would result in boundless design and calculation. Textron recommended the same revisions. Textron noted that the rule implies that all airplanes will be required to determine both ground and water loads, but not all airplanes are amphibious.

The FAA agrees with Textron and the Associations concerning the comments on adding the phrase “as applicable” and removing the word “any” in proposed § 23.310(a). The FAA also agrees with limiting the scope of proposed § 23.310(a) by adding the word “likely” to the description of the loading conditions the applicant must consider. As explained in the discussion of proposed § 23.205, “likely” means reasonably expected based on the conditions that may exist. Accordingly, the FAA revises § 23.2210(a) to capture these changes.

Air Tractor recommended the FAA delete the “service history” clause from proposed § 23.310(c) because there is no “service history” for most new airplanes and there is danger that the FAA will require that service history be collected before certification is granted for a new design. EASA also noted that a “service history” will not always be available for innovative designs.

The FAA partially agrees with Air Tractor regarding the meaning of "service history" in proposed § 23.310(c). Service history, in this sense, refers to the service history and experience gained throughout aviation history. In Air Tractor's case, service history would be the service history of other restricted category agricultural airplanes of similar design. The FAA finds § 23.2200(b) adequately covers the intent of the "service history" requirement and therefore removes it from § 23.2210(c).

d. Flight Load Conditions (proposed § 23.315/now § 23.2215)

In the NPRM, proposed § 23.315 (now § 23.2215) would have required an applicant to determine the loads resulting from vertical and horizontal atmospheric gusts, symmetric and asymmetric maneuvers, and, for multiengine airplanes, failure of the powerplant unit which results in the most severe structural loads.

EASA noted the proposed rule did not cover the objective that loads should be considered for the operational envelope, but instead based the requirement on measured gust statistics. EASA proposed using its CS 23.315 language because it is more objective and does not include design details.

The FAA finds the requirement to consider loads throughout the operational envelope is addressed by proposed § 23.310(b) (now § 23.2210(a)(2)). However, the FAA agrees with EASA's comment that the proposed rule language is too design specific. Therefore, FAA revises the rule language to remove design specifics. In particular, the FAA removes proposed § 23.215(c), which addressed canted lifting surfaces. The FAA finds § 23.2210(c) adequately addresses this requirement. The FAA also changes the wording of proposed § 23.215(d) (now 23.2215(c)) to account for the possibility that a single powerplant, operating two separate propellers, could develop

asymmetric thrust if one propeller system experienced a failure. This would result in a condition similar to an engine failure in a multiengine airplane, described in the former regulations. Although no applicant has submitted such a design for approval to date, given the increased flexibility this rule provides, future applicants may propose such a design. In that case, this design will be subject to the same safety concern and the same need to address it, as applicants for approval of multiengine airplanes.

Air Tractor commented on proposed § 23.315(a) and questioned whether the gust velocities in former part 23 or CAR 3 were based on "measured gust statistics." Air Tractor noted it has never seen a technical report to that effect. Air Tractor also questioned whether the FAA would deem the CAR 3 and current part 23 values sufficient, and raised concerns that making up its own requirements to meet FAA approval would be difficult.

The FAA changed the gust load formula in former § 23.341, amendment 23-7[32] to incorporate the mass parameter approach to calculating gust loads. The mass parameter approach was developed and calibrated against measured gust data on transport category airplanes. The FAA does not intend for applicants for a new TC to measure gust loadings. The former gust formula remains an acceptable method of compliance with this regulation. The FAA developed this regulation so certain airplanes could take advantage of alternate analysis methods, including the power spectral density approach. Examples of these types of airplanes include high altitude and endurance airplanes, where dynamic response of the airplane structure must be considered in the gust load analysis.

[32] 34 FR 13078, August 13, 1969.

e. Ground and Water Load Conditions (proposed § 23.320/now § 23.2220)

In the NPRM, proposed § 23.320 (now § 23.2220) would have required an applicant to determine the loads resulting from taxi, take-off, landing, and ground handling conditions occurring in normal and adverse attitudes and configurations.

EASA proposed using its A-NPA CS 23.325 language because it is more objective and covers more situations, such as landing on snow or other surfaces not covered in proposed § 23.320. BendixKing asked that the FAA delete "sea," stating the word is neither required nor accurate.

The FAA agrees with EASA's comments and revises the text in § 23.2220 to include all operating surfaces, which includes, at a minimum, snow or ice covered land and water. EASA referred to snow and other surfaces not covered in the proposed text, presumably meaning EASA does not consider operations on "snow or other surfaces" to be operations on the ground. While the FAA is using EASA's CS A-NPA 23.325 language, the FAA finds EASA's language citing weight and velocity to be unnecessary. These parameters are addressed in § 23.2200.

Air Tractor asked whether the "ground handling conditions" in proposed § 23.320(a) would be different from the "jacking and towing conditions" in proposed § 23.320(c). If so, the commenter asked what "ground handling conditions" meant. Air Tractor also asked whether this dealt with protection from "hangar rash." Finally, Air Tractor sought clarification on whether it would now need to define the structural loads associated with docking an airplane, or from wave motion causing scuffing when a seaplane is moored against a dock.

The FAA notes the "ground handling conditions" referenced in proposed § 23.320(a) (now § 23.2220) are different than the "jacking and towing conditions" referenced in § 23.320(c) (now § 23.2220). The reference to "handling conditions" is intended to cover both ground handling conditions and jacking and towing conditions. The FAA revises § 23.2220 to cover "taxi, takeoff, landing, and handling conditions."

f. Component Loading Conditions (proposed § 23.325/now § 23.2225)

In the NPRM, proposed § 23.325 (now § 23.2225) would have required an applicant to determine the loads acting on each engine mount, flight control, high lift surface, and the loads acting on pressurized cabins.

EASA commented that proposed § 23.325(b) covered the loads on components subject to earlier defined loads in proposed §§ 23.305 through 23.320. EASA recommended the FAA simplify the requirement to avoid different interpretations by reflecting the relation to the previous requirements as follows:

- Interaction of systems and structures
- Structural design loads
- Flight Load Conditions
- Ground and water load conditions

The FAA finds that a separate rule for component loading conditions is necessary to address structural loading conditions that do not fall under the requirements for flight and ground loads. Examples of these loading conditions include control surface jamming and pressurized cabin loads. The FAA revises § 23.2225 to clarify the types of loads applicants must account for.

Textron and the Associations asked the FAA to revise the "relief valve" language in proposed § 23.325(c), which was a design-specific solution, in favor of more performance-based language. Textron suggested language such as "from zero to the maximum relief pressure combined with gust and maneuver loads." The Associations recommended replacing "valve" with "pressure."

The FAA agrees with Textron and the Associations on the use of the term "relief valve." The FAA revises § 23.2225(c)(1), (2), and (3) by replacing the term "relief valve" with "relief pressure."

The FAA agrees with a comment made at the public meeting by the Associations that proposed § 23.325 should cover sudden engine stoppage loads for turbine engines, as did former part 23. A requirement for the design of engine mounts for turbine engines to be able to withstand a sudden engine stoppage has been in former part 23 since 1980.[33] Former § 23.361(b)(1) required, in pertinent part, that for turbine engine installations, the engine mounts and supporting structure be designed to withstand an engine torque load imposed by a sudden engine stoppage. The requirement applied only to turbine engines because reciprocating engines typically do not have significant rotational moments of inertia. As in former part 23, reciprocating powerplants, with their lower moments of inertia, are not included in this section of the rule. The requirement applies only to turbines and other types of powerplants that have significant rotational moments of inertia created by rotating powerplant components (e.g., electric motor powerplants). Therefore, the FAA adds protection of powerplant mounts and supporting structure from sudden powerplant stoppage for all non-reciprocating powerplants to § 23.2225(a)(2).

[33] 45 FR 60171, September 11, 1980.

This change is consistent with the goal of capturing the safety intent of former part 23, including § 23.361, as stated in the NPRM preamble, and with the performance-based nature of this rule and its goal of more easily accommodating future designs and technologies.

Finally, the FAA revises § 23.2225(b) to clarify the gust loads that must be accounted for and the meaning of "ground operations," making this section consistent with the changes discussed previously for § 23.2220.

g. Limit and Ultimate Loads (proposed § 23.330/now § 23.2230)

In the NPRM, proposed § 23.330 (now § 23.2230) would have described how the applicant must determine the limit and ultimate loads associated with the structural design loads. Proposed § 23.330 retained the current 1.5 safety factor for ultimate loads.

The Associations recommended the FAA revise proposed § 23.330 by deleting the phrase "special or other factors of safety are necessary to meet the requirements of" and replacing it with "ultimate loads are specified in." These commenters noted the section, as written, would not require the establishment of limit loads if a special factor of safety is used to meet the requirement. Textron recommended the same revision, explaining that proposed § 23.330 need not address "special or other factors of safety," other than in some cases when an ultimate load is specified, because proposed § 23.515(c) specified that limit and ultimate loads are multiplied by special factors of safety.

The FAA agrees with the comments regarding cases where loads are expressed only as ultimate loads. The FAA deletes the introductory phrase "unless special or other factors of safety are necessary to meet the requirements of this subpart," in proposed

§ 23.330. The FAA notes § 23.2265(c) specifies that limit and ultimate loads are multiplied by special factors of safety. Furthermore, the FAA revises § 23.2230 by inserting the phrase "unless otherwise specified elsewhere in this part," which captures the intent of former § 23.303.

EASA recommended the FAA should also address the former requirement for redistribution of loads due to deflections under loads. EASA also recommended the regulation cover the specific case where strength specifications are expressed only in ultimate loads and permanent deformation is accepted.

The FAA notes § 23.2210(b) addresses the issue of redistribution of loads. Specifically, 23.2210(b) requires the distribution of loads be based on physical principles. The FAA finds redistribution of load due to deflection is an expression of physical principles and is retaining this requirement in § 23.2210(b) of this rule.

An individual commenter asked the FAA to remove the "arbitrarily prescriptive" 1.5 factor of safety and substitute a more performance-based approach. The commenter explained that advances in probabilistic analysis have increased understanding of actual variables like load predictions, material properties, and airplane operations. The commenter proposed defining the value for structural failure more explicitly and allowing the applicant to account for the variations to achieve the value, allowing for more efficient designs. The commenter suggested retaining the 1.5 factor of safety as a possible approval approach to establish the means of compliance.

The FAA notes the 1.5 factor of safety has been used for many years and has provided an acceptable level of safety. Probabilistic analysis methods and the data necessary to support them are not sufficiently mature to provide the same level of

assurance of safety. As probabilistic methods mature, the FAA will consider their use if applicants can show they provide an equivalent level of safety.

h. Structural Strength (proposed § 23.400/now § 23.2235)

In the NPRM, proposed § 23.400 (now § 23.2235) would have required an applicant to demonstrate the structure will support limit and ultimate loads. The NPRM explained that in this context, "demonstrate" means the applicant must conduct structural tests to show compliance with the structural performance requirements unless the applicant shows that a structural analysis is reliable and applicable to the structure.

The Associations recommended adding "unsafe" at the beginning of proposed § 23.400(a)(1) to clarify the intent of the requirement and ensure it is not viewed as including expected or non-critical types of interference, such as thrust reverser buckets making normal contact with each other. Similarly, Textron recommended inserting the word "safe" before "operation" in proposed paragraph (a)(1) to ensure that "interference" in the regulation will always be interpreted to mean interference that would cause an unsafe condition.

The FAA agrees that inserting the word "safe" in the text of proposed § 23.400(a)(1) will clarify that the structure must support limit loads without interference with the "safe" operation of the airplane. This suggested change is consistent with the corresponding requirements in former part 23, and will resolve the Associations' concern as well. Accordingly, the FAA revises § 23.2235(a)(1) to capture this change.

NJASAP asked why the FAA proposed removing time requirements (the capability of the airplane structure to support ultimate loads without failure for at least three seconds) in proposed § 23.400.

As discussed in the NPRM preamble, the FAA considers the "3-second" rule a statement of physical principles and sound testing practices that does not need to be stated in the requirements for structural strength. It is more appropriate for inclusion in a means of compliance. The FAA makes no change to the regulatory text based on NJASAP's comment.

i. Structural Durability (proposed § 23.405/now § 23.2240)

In the NPRM, proposed § 23.405 (now § 23.2240) would have required an applicant to develop and implement procedures to prevent structural failures due to foreseeable causes of strength degradation, and to prevent rapid decompression in airplanes with a maximum operating altitude greater than 41,000 feet. Proposed § 23.405 would have also required an airplane to be capable of continued safe flight and landing with foreseeable structural damage caused by high-energy fragments from an uncontained engine or rotating machinery failure.

The Associations said proposed § 23.405 remains "far too prescriptive and design oriented." The commenters recommended language that they believed addresses the objectives of the rule without being so design focused. Specifically the Associations suggested the phrase "serious or fatal injuries, loss of the airplane, or extended periods of operation with reduced safety margins" in § 23.2240(a) be replaced with "unsafe conditions."

Textron suggested that the proposed rule is too prescriptive regarding the number of compartments for compartment floor depressurization, as well as in prescribing the "design" structure rather than specifying the required capability of the structure. Textron suggested revising proposed § 23.405 similar to that suggested by the Associations.

An individual commenter recommended the FAA delete the phrase "loss of the airplane" from proposed § 23.405(a). The commenter stated this would address the long-understood interpretation that part 23 does not include certain structures for required evaluation on the effects of fatigue failure, such as landing gear and engine support (or hull loss, as discussed in the NPRM preamble). Without this revision, the commenter noted the intent of the rule not to increase the burden on certification would be nullified. In effect, the commenter found the proposed rule would require the same structure as is currently evaluated in part 25, which is inconsistent with former part 23. The commenter favored incorporating a comprehensive fatigue evaluation of structure as is currently in part 25.

The FAA agrees with the suggestion to delete the phrase "loss of the airplane" in paragraph (a). The FAA finds the prevention of serious or fatal injuries and the prevention of extended periods of operation with reduced safety margins is the objective of § 23.2240. The FAA will not adopt the Associations' recommended change to replace the phrase "serious or fatal injuries, loss of the airplane, or extended periods of operation with reduced safety margins" with "unsafe conditions." The term "unsafe condition" is the threshold for the FAA issuing airworthiness directives under 14 CFR part 39, and is not an accurate term to be used in this section.

The FAA also revises paragraph (a) to reflect more completely the requirements of the former part 23 regulations this section is replacing[34.] Because proposed § 23.405(a) did not refer specifically to the Airworthiness Limitations section (ALS) of the

[34] §§ 23.365(e), Pressurized cabin loads; 23.571, Metallic pressurized cabin structures; 23.572, Metallic wing, empennage, and associated structures; 23.573, Damage tolerance and fatigue evaluation of structure; 23.574, Metallic damage tolerance and fatigue evaluation of commuter category airplanes; 23.575, Inspections and other procedures; and 23.627, Fatigue strength." (81 FR 13476, March 14, 2016).

Instructions for Continued Airworthiness (ICA) (as did former § 23.575), it could be interpreted as allowing the procedures to be placed in another part of the ICA. Therefore, the FAA revises the text in paragraph (a) to clarify that these procedures must be in the ALS. The FAA also clarifies that "inspections" developed under this section must be included in the ALS in addition to the "procedures" developed under the section, because former § 23.575 required both to be in the ALS. Appendix G to former part 23, now appendix A to this final rule, requires the FAA to approve the ALS. Finally, the FAA notes that compliance with the ALS is mandatory under §§ 43.16 and 91.403(c).

EASA suggested replacing the design-specific requirements in proposed § 23.405(b) with more objective requirements from EASA's CS 23.340(b) to allow proportionality for different airplane levels. In particular, EASA said more objective requirements should replace the proposed requirements related to pressurized airplanes and uncontained engine failure.

The FAA notes the language in EASA's proposed CS 23.340 could be interpreted as expanding the scope of the former regulations by requiring evaluation of discrete source damage for all airplanes certificated under part 23. As stated in the NPRM, the FAA intended proposed § 23.405(b) and (c) to capture the intent of former §§ 23.365(e) and 23.571(d), which only addressed airplanes with pressurized compartments. Sudden release of pressure and operating above 41,000 feet altitude present the same hazards to the airplane occupants regardless of airplane category or size.

The FAA moves the content of proposed § 23.405(b) and (c) to § 23.2240(c)(1) and (c)(2) in the final rule. The final rule also adds new § 23.2240(b), which addresses the requirement for level 4 airplanes. This requirement is similar to the former § 23.574

requirement for damage tolerance evaluations of commuter category airplanes. The FAA inadvertently left this requirement out of the NPRM.

The FAA agrees with the comments that proposed § 23.405(b) was overly prescriptive. The FAA deletes the detailed description of the pressurized compartment and emphasizes the sudden release of pressure in § 23.2240(c)(1) and (c)(2). The FAA retains reference to door and window failures as examples of the types of failures that could result in sudden release of pressure.

EASA stated that proposed § 23.405(d) is too specific to engine rotorburst; however, other risks could be expected from new technologies that should also be considered.

The FAA agrees with EASA's comment that paragraph (d) should address all high-energy fragments, not just fragments from an engine rotorburst. The FAA revises § 23.2240(d) to include all high-energy fragments. The FAA also includes turbine engines and rotating machinery as sources of high-energy fragments.

Several other commenters also commented on proposed § 23.405(d), noting that former part 23 required "minimizing" hazards associated with damage from uncontained engine or rotating machinery failures, but the NPRM would require the airplane be able to "continue safe flight and landing" following such damage. The commenters asserted that there is no way to eliminate all the risks that will prevent the "continued safe flight and landing," and asked the FAA maintain the requirement to "minimize" these hazards as in former § 23.903(b)(1).

The FAA agrees that proposed § 23.405(d) is inconsistent with the description in the NPRM preamble. Therefore, the FAA agrees with the commenters' recommendation

to adopt the term “minimize” in § 23.2240(d). The FAA does not intend for applicants to incorporate all possible design precautions against rotorburst hazards, especially those that are resource prohibitive or have a negligible impact on safety. The FAA expects an applicant’s compliance with § 23.2240(d) to incorporate all practical design precautions to minimize the hazards due to high-energy fragments.

j. Aeroelasticity (proposed § 23.410/now § 23.2245)

In the NPRM, proposed § 23.410 (now § 23.2245) would have required an airplane to be free from flutter, control reversal, and divergence at all speeds within and sufficiently beyond the structural design envelope, for any configuration and condition of operation, accounting for critical degrees of freedom, and any critical failures or malfunctions. Proposed § 23.410 would have also required an applicant to establish tolerances for all quantities that affect flutter.

Air Tractor and Transport Canada raised concerns about the phrase “sufficiently beyond the structural design envelope” in proposed § 23.410(a)(1). Transport Canada said the wording is subjective and does not convey a performance requirement and suggested complementing the phrase “sufficiently beyond” with safety objective requirements. Air Tractor noted the existing regulations do not extend beyond the design envelope. Air Tractor asked for clarification on what is considered “sufficiently beyond.”

Regarding Air Tractor’s assertion that the former regulations did not extend beyond the design envelope, the FAA intended proposed § 23.410 to capture the safety intent of former §§ 23.629, 23.677, and 23.687 without introducing the inflexibility created by the former regulations. Former § 23.629(c) required that flutter analysis show freedom from flutter, control reversal, and divergence up to 20 percent above dive speed.

Existing part 25 rule language requires flutter analysis to show this up to 15 percent above dive speed. This is to account for uncertainties inherent in analytical techniques. Part 25 requires a smaller margin above dive speed due to its more rigorous analytical requirements. Additionally, former § 23.629(b)(4) precluded any large or rapid reduction in damping as dive speed is approached in flight tests.

As for Air Tractor's comment requesting clarification on what is considered "sufficiently beyond" in proposed § 23.410(a)(1), the former part 23 requirements for margins on analyses and flight tests worked together to ensure a momentary inadvertent excursion above dive speed in operation, or combined variations in quantities that may affect flutter, did not result in a catastrophic flutter event. Thus, the FAA required a sufficient margin above dive speed in former part 23 for many years. The phrase "sufficiently beyond the structural design envelope" is intended to require a sufficient margin consistent with the requirements of former part 23. However, as technology and analytical techniques evolve and improve, the new language will allow room for the methods of compliance to adapt and possibly change the appropriate margin needed for safe operations. This language is also harmonized with EASA's proposed rule language.

Several commenters raised concerns about the use of the term "any" in proposed § 23.410(a). The Associations asked the FAA to revise proposed § 23.410(a)(2) to require the airplane to be free from flutter, control reversal, and divergence for "approved" configurations and conditions of operation, rather than for "any" configuration and condition of operation. Textron recommended the FAA require the airplane to be free from flutter, control reversal, and divergence for "any likely" configuration and condition

of operation. Similarly, the Associations suggested removing the term “any” from proposed § 23.410(a)(4).

The FAA notes the commenters concerns about the term “any” in § 23.2245(a)(2) and (a)(4). In the NPRM, the FAA explained that § 23.2245 would capture the safety intent of former § 23.629. Former § 23.629(a) has required the airplane to be free from flutter, control reversal, and divergence for “any condition of operation” since 1978. This terminology originated from CAR 3.311, the predecessor to former § 23.629, was adopted in 1947 and required the wings, tail, and control surfaces to be free from flutter, divergence, and control reversal for “all conditions of operation.” The FAA recognizes it is impossible to evaluate an infinite number of data points, but that is not the intent of § 23.2245 nor was it the intent of its predecessor regulations. Rather, the FAA interprets the term “any” in § 23.2245(a)(2) as requiring the applicant to exercise due diligence by accounting for a sufficient number of data points that would enable the applicant to state the entire envelope has been evaluated and is safe. This interpretation is consistent with the way the FAA has interpreted CAR 3.311 and former § 23.629. Because the FAA has used the terms “any” and “all” in its flutter requirements for decades, the FAA is retaining the term “any” in § 23.2245(a)(2) and (a)(4). This maintains harmonization with EASA’s proposed rule language.

Several commenters raised concerns with terminology in proposed § 23.410(b). Textron and the Associations suggested the FAA require the applicant to establish and account for “sensitivities” rather than “tolerances” because the term “tolerances” has a very specific meaning and a proper flutter analysis is a collection of flutter sensitivity

analyses.[35] The Astronautics Corporation of America (Astronautics) sought clarification of the term "quantities" in proposed § 23.410(b) and offered alternative regulatory language in an attempt to clarify its meaning. Textron proposed replacing "quantities" with "parameters."

Regarding Textron, the Associations and Astronautics' comments on the use of "tolerances" and "quantities" in proposed § 23.410(b), the FAA is retaining the terms "tolerances" and "quantities" in § 23.2245(b). The FAA intends § 23.2245 to capture the safety intent of former § 23.629, which has contained the terms "tolerances" and "quantities" since 1978.[36] The FAA has interpreted them consistently from that time, and will continue to do so in § 23.2245. This language is also harmonized with EASA's proposed rule language.

Textron recommended removing the word "establish" from the proposed language. The commenter noted that you cannot account for something without establishing it first.

The FAA agrees with Textron that it would be redundant to require an applicant to establish and account for tolerances. For that reason, the FAA retains the word "establish" and deletes the words "and account for" from § 23.2245(b) in the final rule. This change emphasizes the necessity of fully analyzing these tolerances and harmonizes with EASA's proposed rule language.

k. Design and Construction Principles (proposed § 23.500/now § 23.2250)

In the NPRM, proposed § 23.500 (now § 23.2250) would have required—

[35] Textron specifically noted that proposed § 23.2245(b) "would require the applicant to specify a +/-X% tolerance on things such as cross sectional properties (torsional GJ), cross sectional moments of inertia, or other qualities that affect flutter but aren't intended to have a +/-X% tolerance."
[36] See 43 FR 50592, October 30, 1978.

- An applicant to design each part, article, and assembly for the expected operating conditions of the airplane;
- The design data to adequately define the part, article, or assembly configuration, its design features, and any materials and processes used;
- An applicant to determine the suitability of each design detail and part having an important bearing on safety in operations; and
- The control system to be free from jamming, excessive friction, and excessive deflection when the control system and its supporting structure are subjected to loads corresponding to the limit airloads when the primary controls are subjected to the lesser of the limit airloads or limit pilot forces, and when the secondary controls are subjected to loads not less than those corresponding to maximum pilot effort.

The Associations recommended the FAA change the title of proposed § 23.500 from "Structural design" to "Design and construction principles."

The FAA concurs with the recommendation by the Associations to change the title of § 23.2250 to "Design and construction principles." The FAA agrees the suggested title is a better descriptor and will harmonize with EASA's proposed title for this section, and adopts it for this rule.

Several comments addressed proposed § 23.500(d). Air Tractor recommended that the FAA revise the wording of proposed § 23.500(d) to specify that it applies to flight controls. Air Tractor further noted that it appears that the definition of "maximum pilot effort" has been untethered from former §§ 23.397(b) and 23.143(c), making it necessary for every applicant "to re-invent the wheel."

Regarding Air Tractor's comment proposing to add the term "flight" to further define "control system", the term "control system" has been used consistently for many years in this context in the former regulations, and is understood to refer to "flight" controls. This text also harmonizes with EASA's proposed rule language. Therefore, the FAA adopts the language as proposed in the NPRM.

As for Air Tractor's concern that maximum pilot effort has been untethered from former §§ 23.397(b) and 23.143(c), the FAA notes that under the new performance-based regulations, applicants will be free to use former part 23 or other accepted means, such as industry consensus standards, as a means of compliance. These accepted means of compliance will detail how the airplane will meet the performance-based requirements.

The Associations stated that it is appropriate for means of compliance to specify how airframe and control system interactions will be tested up to limit loads and that, depending on the nature of the control system, it may be more or less appropriate to perform such a test. These tests ensure the appropriate level of testing is always applied to traditional flight controls and also to future systems, which may include fans or thrusters. The commenters suggested the level of detail be contained in accepted standards. Additionally, the commenters recommended the FAA consider revising proposed § 23.500(d) by deleting paragraphs (1), (2), and (3) and adding the phrase "the airplane is subjected to expected limit airloads" to the end of paragraph (d). EASA also recommended the FAA remove details in proposed § 23.500(d) that describe what parts of the system should be subject to which loads because this is design specific and should be covered in the means of compliance.

The FAA agrees with EASA and the Associations to revise proposed § 23.500(d)(1), (d)(2), and (d)(3) and adds the phrase "the airplane is subjected to expected limit airloads" to the end of § 23.2250(d). This change aligns with EASA's recommendation and assists in harmonization with EASA's proposed rule. The FAA considers these suggestions to be more in line with the original intent of the performance standards. Therefore, the FAA adopts the changes proposed by the commenters.

Textron suggested the FAA remove the § 23.500(d)(1) requirement that the supporting structure is loaded with limit airloads while the control system is loaded, which the commenter noted has historically never been a part 23 requirement. Textron further suggested the FAA change the phrase "controls are" in both subparagraphs (2) and (3) to "control system is" to further specify that this is a control system test. Textron commented that the word "controls" could imply something other than the entire system the entire system is the intent.

As noted above in this section, the FAA removes paragraphs paragraph (d)(1), (d)(2) and (d)(3). The FAA adopts the terminology "control system" in the revised proposed § 23.500(d).

EASA also suggested the FAA consider moving the general principle for doors, canopies, hatches, and access panels from proposed § 23.750(f) to a new § 23.2250(e).

The FAA concurs with EASA's recommendation to move the general principle for doors, canopies, hatches, and access panels from proposed § 23.750(f) to a new § 23.2250(e). The requirement is more appropriate in this section because it states a general design principle rather than a requirement relating to emergency evacuation. The

FAA also notes that making this change further helps to harmonize FAA and EASA regulations.

l. Protection of Structure (proposed § 23.505/now § 23.2255)

In the NPRM, proposed § 23.505 (now § 23.2255) would have required an applicant to protect each part of the airplane, including small parts such as fasteners, against deterioration or loss of strength due to any cause likely to occur in the expected operational environment. Proposed § 23.505 would have also required each part of the airplane to have adequate provisions for ventilation and drainage and would require an applicant to incorporate a means into the airplane design to allow for required maintenance, preventive maintenance, and servicing.

Textron recommended clarifying the intent of proposed § 23.505(a) by including a reference to specific sources of damage because it is unclear whether the proposed rule would be an increase from what was previously required.

The FAA considered Textron's comment. However, as far back as 1949 (§ 3.295, "Protection"), the regulations required all members of the structure to be "suitably protected against deterioration or loss of strength in service due to weathering, corrosion, abrasion, or other causes…." The CAR 3 requirement was included in the 1965 recodification as former § 23.609, which included a non-exhaustive list of possible causes of deterioration. In the NPRM, the FAA removed the listed examples, but maintained the requirement to account for deterioration or loss of strength due to "any cause likely to occur."

Textron further stated that it is unclear whether the phrase "expected operational environment" is intended to include any environment that might occur during failure

conditions, or just the environment during normal operating conditions. Textron recommended replacing the phrase “expected operational environment” with “intended operational environment” or “normal operational environment.”

The FAA considered Textron’s recommendation to change “expected operational environment” to “intended operational environment” or “normal operational environment.” The FAA did not intend to limit this requirement only to the normal operational environment because, if the failure conditions are an expected environment, then an applicant should consider those conditions and protect the structure. Deterioration or loss of strength due to corrosion, weathering, and abrasion are all examples of failure conditions because capability has been degraded. For many years, the rule has expressly required consideration of these causes. It was an expected environment for items to be corroded, weathered, and abraded, but applicants had to consider any other causes too.

m. Materials and Processes (proposed § 23.510/now § 23.2260)

In the NPRM, proposed § 23.510 (now § 23.2260) would have required—

- An applicant to determine the suitability and durability of materials used for parts, articles, and assemblies, the failure of which could prevent continued safe flight and landing, while accounting for the effects of likely environmental conditions expected in service;, and
- The methods and processes of fabrication and assembly used to produce consistently sound structures and, if a fabrication process requires close control to reach this objective, an applicant would have to perform the process under an approved process specification.

Additionally, proposed § 23.510 would have required an applicant to justify the selected design values to ensure material strength with probabilities, accounting for—

- The criticality of the structural element; and
- The structural failure due to material variability, unless each individual item is tested before use to determine that the actual strength properties of that particular item would equal or exceed those used in the design, or the design values are accepted by the Administrator.

Proposed § 23.510 would have required a determination of required material strength properties to be based on sufficient tests of material meeting specifications to establish design values on a statistical basis. Proposed § 23.510 would have also required an applicant to determine the effects on allowable stresses used for design if thermal effects were significant on an essential component or structure under normal operating conditions.

Textron commented that, as proposed, the regulatory text in paragraph (a) was unclear as to whether an applicant must account for the effects of likely environmental conditions expected in service on parts, articles, and assemblies. Textron proposed combining the two sentences in paragraph (a) to clarify the FAA's intent for the effect of specific environmental conditions on parts, articles, and assemblies to be considered in determining the suitability and durability of materials.

The FAA concurs with Textron's comment regarding the lack of clarity in paragraph (a), and revises the regulation accordingly. Although the revision creates a slight disharmony with EASA's proposed rule language, the intent of the two regulations remains the same, and the change helps to clarify the FAA's intent.

Textron also requested the FAA to replace the word “essential” with the word “critical”. The commenter stated the word “essential” has not been used or defined historically in part 23 structural compliance, whereas the word “critical” is used more frequently and is better defined.

Based on Textron’s comment for clarity, the FAA revises § 23.2260(e) to replace the word “essential” with the word “critical”, since “critical” is a more common and widely used term of art amongst structural engineers than “essential.” Specifically, the failure of a critical component or structure is potentially catastrophic.

In the public meeting, Aspen Avionics asked the FAA to clarify whether the requirement in proposed paragraph (b) to perform the process under an “approved process specification” refers to an FAA-approved process specification or an accepted industry standard or some other approved process specification. Aspen Avionics also commented on proposed paragraph (d), which stipulates that if material strength properties are required, a determination of those properties must be based on sufficient tests of material meeting the specifications. Aspen Avionics questioned whether this requirement applies to the applicant or whether the applicant can rely on statements from a manufacturer – i.e., Aspen asked the FAA to clarify who has to do what testing for the materials. Aspen also asked whether the testing requirement applies to primary, secondary, or tertiary structure.

Regarding Aspen Avionics’ request for clarification of what constitutes an approved process specification for paragraph (b), the FAA does not intend any change from current practices under former regulation § 23.605(a), where nearly identical language was used. The process specification is “approved” by the FAA, and the FAA

expects to have access to the specification in order to review and determine whether it contains sufficient control to substantiate compliance with the regulation. The specification may be proprietary to the OEM or sub-contractor, but should have formal document approval and control procedures like other engineering reports, documents and drawings necessary for the type design.

As for Aspen Avionics' question regarding the test requirements and whether the requirement is for primary, secondary, or tertiary structure, the FAA does not intend any change from current practices under former regulation § 23.613(a), where nearly identical language was used. The TC holder is responsible for data used to substantiate its type design. Whether the required testing is performed by the OEM or a sub-contractor does not matter as the FAA holds the OEM responsible, and expects the data to be available for FAA review to ensure compliance with the regulation. This requirement for statistically based material properties applies to any airplane primary structure. Existing published FAA guidance and widely used industry practices should be consulted for the finer divisions of structure, such as secondary and tertiary, and the material properties typically used.

n. Special Factors of Safety (proposed § 23.515/now § 23.2265)

In the NPRM, proposed § 23.515 (now § 23.2265) would have required an applicant—

- To determine a special factor of safety for any critical design value that was uncertain, used for a part, article, or assembly likely to deteriorate in service before normal replacement, or subject to appreciable variability because of uncertainties in manufacturing processes or inspection methods;

- To determine a special factor of safety using quality controls and specifications that accounted for each structural application, inspection method, structural test requirement, sampling percentage, and process and material control; and
- To apply any special factor of safety in the design for each part of the structure by multiplying each limit load and ultimate load by the special factor of safety.

The Associations recommended changing § 23.515(a) by requiring special factors of safety be "established and applied", rather than determined, by the applicant. Additionally, they suggested the language of the regulation focus on critical design values "affecting strength."

The FAA has used "determine" in numerous other places in the NPRM. The commenters' suggested change would not imply a different meaning. As for the commenters' suggestion that the term "critical design value" should be limited to those values "affecting strength," there may be other critical design values aside from strength that warrant the use of special factors of safety. For example, former part 23 specified bearing factors for certain applications. These were intended to account for not only strength, but also for durability and consideration of possible dynamic loading. In a performance-based standard where these factors are not specified, it is necessary to make sure that future designs, materials, and applications, not yet envisioned, account for any critical "design values," in the same way the former regulations account for known critical values in those applications today. The FAA adopts § 23.2265(a) with minor modifications.

Air Tractor commented that proposed § 23.515(b) added unwarranted specificity and is worded such that the special factor must account for each inspection method,

whether or not it is critical. Air Tractor further commented that certain conditions, such as structural test requirements, sampling percentages, and process and material controls, would be defined in a quality system approved under a production certificate (PC), not as part of a type design. Air Tractor contended that a type design should be approved independently of any quality system or production system requirements.

The FAA agrees with Air Tractor that conditions, such as structural test requirements, sampling percentages, and process and material controls, would be defined in a quality system that is approved under a PC. However, there are instances where those items are defined by type design or inspection methods in an approved type design. As with the former § 23.621, "Casting factors," special casting factors of safety are to be applied to any structural casting, not just critical ones. The specific casting factor used in all those cases is inseparably tied to the applicable tests and inspections, both of which include sampling percentages specified for the part being produced. Former § 23.621(a) required these factors to be defined in the type design, and they are in addition to whatever tests and inspections are required for foundry quality control. Therefore, proposed § 23.515(b) is not substantively different from the former regulations.

The FAA generally agrees with Air Tractor's comment that approval of a type design is independent of any quality system or production system requirements. However, as explained previously in this section, the special factor of safety used to substantiate the type design is approved for use based completely on the part criticality, inspections, tests, and sampling percentages specified for a particular part.

Additionally, the Associations recommended changing proposed § 23.515(b)(1) by replacing "structural" application with "kind of" application. The commenters

contended it would ensure that special factors of safety continue to be applied in the same manner as they are applied in the former rule, while also providing for more flexibility for new materials and construction techniques.

The FAA agrees with the Associations that the term “structural” in proposed § 23.515(b)(1) should be revised. However, the FAA believes the words “type of” is more accurate than “kind of” in this application, and revises the text of § 23.2265(b) accordingly.

The Associations recommended changing proposed § 23.515(c) to require a factor of safety established under proposed § 23.330(b) to be multiplied by the highest pertinent factor of safety established under proposed § 23.515(b). The commenters explained that this change would ensure special factors of safety are applied in the same manner as they are applied in the former rule, while also providing for more flexibility for new materials and construction techniques.

The FAA disagrees with the Associations as such a change has led to convoluted regulations in the past. Further, the limit and ultimate loads are clearly defined in this subpart, so this cross-reference is unnecessary.

Additionally, EASA noted that although the strict wording in former part 23 and CS 23 did not require special factors to be applied to ultimate loads that do not have corresponding limit loads (e.g., emergency landing conditions), this is not reflected in the NPRM. Referring to proposed § 23.515(c), EASA noted that former part 23 and CS 23 use the highest pertinent special factor, instead of any special factor as proposed in the NPRM. EASA suggested that coordination is necessary for harmonization.

The FAA does not agree with EASA's assertion that a narrow interpretation of former part 23 would not require special factors of safety to be applied to ultimate loads that do not have corresponding limit loads. Former § 23.625(d) required the attachments of seats, berths, and safety belts and harnesses to multiply the inertia loads in the emergency landing conditions in former § 23.561 by a special factor of safety (i.e., fitting factor) of 1.33. However, the FAA concurs with EASA that new part 23 should require the use of the "highest pertinent" special factor of safety, and not "any" special factor of safety. Therefore, the FAA revises § 23.2265(c) accordingly.

Additionally, upon further review, the FAA finds that the proposed wording in § 23.515(c) appears to require an applicant to multiply not only each ultimate load by the special factor of safety, but also each limit load by the same factor even though sometimes there is no corresponding limit load. Therefore, the FAA also revises § 23.2265(c) to state that the special factor of safety is applied regardless of whether there is a limit load condition corresponding to the ultimate load condition. Although the FAA's language may not be harmonized with EASA's NPA, the intent is the same.

o. Emergency Conditions (proposed § 23.600/now § 23.2270)

In the NPRM, proposed § 23.600 (now § 23.2270) would have required—

- The airplane, even if damaged in emergency landing conditions, to provide protection to each occupant against injury that would preclude egress;
- The airplane to have seating and restraints for all occupants, consisting of a seat, a method to restrain the occupant's pelvis and torso, and a single action restraint release, which meets its intended function and does not create a hazard that could cause a secondary injury to an occupant;

- The airplane seating, restraints, and cabin interior to accommodate likely flight and emergency landing conditions and should not prevent occupant egress or interfere with the operation of the airplane when not in use;
- Each baggage and cargo compartment be designed for its maximum weight of contents and for the critical load distributions at the maximum load factors corresponding to the determined flight and ground load conditions; and
- Each baggage and cargo compartment to have a means to prevent the contents of the compartment from becoming a hazard by impacting occupants or shifting, and to protect any controls, wiring, lines, equipment, or accessories whose damage or failure would affect operations.

Air Tractor, commenting on proposed § 23.600(a), said the NPRM preamble suggested that future certification endeavors will require more effort (e.g., possibly full-scale crash testing of the fuselage) to meet necessary requirements. Air Tractor also noted that inertial loads likely to occur in an emergency landing were not defined. Additionally, Air Tractor presumed the conditions defined in former § 23.561 would be accepted, but doing so would not make things under the proposed rule any easier, faster, or less expensive. Air Tractor also claimed that should some other inertial loads likely to occur in an emergency landing be proposed, the applicant should expect a protracted discussion with the FAA to defend any differences.

The FAA disagrees that future certification endeavors will require more effort and possibly full-scale crash testing of the fuselage to meet the requirements. Existing conditions of current static and dynamic testing would remain as a means of compliance. Proposed § 23.600(a) would not have required full-scale crash testing of the fuselage.

The FAA's intent was to allow for an evaluation of a "crash landing" considering the performance of the entire airframe, safety equipment, and occupant. The former requirements only required evaluation of the seat from the floor up, and the restraints, using generic floor impulses independent of airframe reaction. Additionally, the FAA did not define inertial loads because one of the goals of creating performance-based standards was to move away from mandated prescriptive standards, which inhibit innovation and safety enhancing technology adoption. The inertial loads likely to be encountered will be contained in the means of compliance. An applicant may propose inertial loads other than those contained in industry standards already accepted by the Administrator, and substantiate why they are adequate, representative, and equally safe as accepted loads. This rule will allow applicants to evaluate crash landing conditions considering the entire airplane and its performance, instead of limiting applicants to just these tests.

The NTSB noted the NPRM stated that proposed § 23.600 would capture the safety intent of former §§ 23.561 and 23.562, which the FAA described as containing prescriptive design standards. The NTSB disagreed that former §§ 23.561 and 23.562 are prescriptive design standards, and stated former §§ 23.561 and 23.562 were performance-based standards that do not specify any elements of the design, but instead prescribed a test and measureable levels of performance needed to ensure safety.

The NTSB shared the FAA's concern regarding consideration of occupiable space in a post-crash situation, and agreed former standards do not address these issues. However, the NTSB disagreed with the FAA's suggestion that analysis techniques available in the automotive industry are transferable to new airplane designs. The NTSB said it is likely that differences between airframe and automotive structures will require a

significant number of full-scale aircraft crash tests before analytical techniques have been validated to the point they can be used as means of compliance. Pointing to NTSB Safety Recommendation A-11-3, which it issued in 2011 after conducting a study of the performance of airbags in general aviation airplane, the NTSB recommended the FAA consider the variation in the sizes and anthropometry of airplane occupants when evaluating a proposed means of compliance.

The FAA understands the NTSB's comments, but does not agree. Former §§ 23.561 and 23.562 assessed only the seat, attachment, restraints, and head strike. The generic floor impulse used did not take into account the variables inherent to the airplane, such as the ability to protect the survivable volume, crushable airplane structure, or features that absorb impact energy or offer the ability to evaluate how all of these variables can work together to enhance crashworthiness. This rule will allow a more holistic approach to crashworthiness. Not prescribing a specific seat test opens the door for future technology and advances in analytical techniques to demonstrate equivalent and even enhanced safety, utilizing all advances available to the engineer. At the same time, until these enhanced techniques become available and proven, the existing seat test methods are still acceptable for showing compliance with this rule and will be contained in a means of compliance.

Additionally, the FAA will accept the former regulations as an acceptable method of compliance, despite their limitations. Testing in accordance with the former regulations has provided a certain level of safety for many years; therefore, continuing to accept them for future designs will maintain that level of safety. However, the FAA contends that having a prescriptive set of tests in the rule has prevented the industry from

moving beyond this one standard of protecting occupants. This is because the former regulations required a very specific seat sled test; detailing seat mounting misalignment, impulse force peak and rise times, and maximum forces allowed to be experienced by the restraint system, and the occupant's lumbar spine among other things. Due to the rule specifying all these details, it is nearly impossible for the FAA to find equivalency in applicants proposed alternatives. By changing the requirement from a prescriptive test to the safety intent behind the test, the FAA will only need to evaluate whether new methods meet the safety intent, and not have to evaluate their relative safety against the former requirements. The determination that likely crash scenarios do not generate loads on the occupants that exceed the limits of human injury was the basis of the former rule language, and how the test and crash impulse was derived. It was a combination of various scenarios, represented by one specific set of tests. The new rule will allow a holistic approach to enable designs to achieve occupant protection more effectively.

While the automotive industry generally has a more-developed crashworthiness analysis capability than that used in the aviation industry, the FAA wants to allow for incorporation of holistic crashworthiness in addition to conventional compliance. The FAA notes the NTSB's concern that automotive technology will not directly transfer to aerospace applications because it requires significant numbers of full-scale aircraft crash tests for validation to yield the confidence in the analytical techniques. However, the FAA disagrees. The FAA has not yet determined how much and what type of validation will be required for a given crash scenario. This determination will depend on the particular design and what the validation is attempting to demonstrate. The automotive and other industries have gained a lot of knowledge on what is needed to demonstrate

valid models using dynamic transient analysis. The FAA believes that the knowledge from these industries can be leveraged to reduce or eliminate the need for full-scale aircraft crashes for validation. For example, there may be scenarios where only a small part needs validation for demonstration of its energy absorption. This rule will provide an applicant with the option to examine the performance of more than just the seat and restraints, and avoids defining methods of restraint. This will allow consideration of a myriad of ways to protect an occupant in an emergency landing, such as using airbags.

Also, the FAA notes the NTSB's recommendation that the FAA consider the variation in the sizes and anthropometry of airplane occupants when evaluating a proposed means of compliance. This would be an increase in the burden to the manufacturers, and this burden has not been justified.

Several organizations commented on proposed § 23.600(b). Kestrel noted that proposed § 23.600(b)(1) referred to impact at stall speed, but did not specify the configuration and atmospheric conditions associated with this stall speed. Kestrel also requested clarification on whether applicants must design for stall speed in icing conditions.

The FAA revises the proposed rule language. The configuration and atmospheric conditions will be located in the means of compliance based on a determination of the conditions that are likely to occur.

In discussing proposed § 23.600(b)(1), ICON questioned whether industry can deliver on this "new requirement." Textron noted that proposed § 23.600(b) referred to the emergency landing conditions specified in paragraph (a), which would mean the items of mass specified in paragraph (a) must meet the dynamic conditions specified in

paragraph (b). Textron noted this is a significant departure from the former rule and assumed it was not the FAA's intent to require dynamic conditions for items of mass. Similarly, the Associations commented that § 23.600(b) would be a new requirement without foundation. They believed the FAA intended to apply the requirement only to occupant restraint systems.

The FAA agrees with Textron and others that an unintentional new requirement would have been imposed by the proposed wording of paragraph (b)(1). The FAA did not intend to apply dynamic loading requirements to items of mass that previously required accounting only for static loads. The FAA modifies the text of paragraph (b) to refer only to subparagraphs (a)(1) and (a)(2) instead of all of paragraph (a), thereby eliminating reference to items of mass.

EASA said the "dynamic" condition specified in paragraph (b)(1) should be in the means of compliance, not in the rule. ICON noted that proposed § 23.600(b)(1) would require a very long list of variables be considered in an impact, which seems prohibitively difficult to achieve with any degree of confidence.

The FAA agrees with ICON and EASA. The long list of variables is reduced to simply "emergency landing" conditions, which can then be further detailed as part of the means of compliance.

Transport Canada said the requirement in proposed § 23.600(b)(2) appeared inaccurate. It noted that what must not exceed established injury criteria for human tolerance are the loads experienced by the occupant, not the emergency landing conditions. Transport Canada recommended a rewrite of paragraph (b)(2) that would state

that the occupants would not experience loads which exceed established injury criteria for human tolerance due to restraint or contact with objects in the airplane.

The FAA agrees with Transport Canada. The FAA adopts the recommended language and revises the rule to clarify it is the loads experienced by the occupant, not the emergency landing conditions that should not exceed the established injury criteria for human tolerance.

BendixKing suggested replacing the word “restraints” with “protection” in the two instances the word occurs in proposed § 23.600(c). BendixKing suggested this change is appropriate because the intent of the rule is to ensure crash protection for the occupant, which may or may not be what is understood to be restraint. BendixKing also stated it is important not to assume a particular solution, but to focus on the safety intent or occupant protection from harmful motion during an impact. Therefore, it suggested words used in proposed § 23.600(d) like “restraint,” “pelvis,” “torso,” be replaced with language like “protection” or “securing the occupant from harm.” EASA commented that proposed §§ 23.600(c) and (d) should be an accepted means of compliance, not regulatory requirements. The Associations commented that the language in proposed § 23.600(d) should be aligned with current DOT practices related to automobile safety. The commenters noted the proposed language may preclude some better methods of safety in crashworthiness and might unnecessarily restrict design capabilities.

The FAA agrees with BendixKing that using design-specific solution terminology such as “restraints” is not appropriate for a performance-based regulation. While the occupant needs to be restrained, restraints should be considered on a broader basis. The FAA also agrees with EASA that the portions of §§ 23.600(c) and (d) that use design-

specific terminology should be in the means of compliance. As such, the FAA will use more generic terms like “protection” or “occupant protection system” in lieu of the design-specific terms proposed in paragraphs (c) and (d), to allow for other methods of compliance to meet the safety intent of the rule. Finally, due to these word changes, the FAA moved the consideration of “ground loads” from paragraph (d) to paragraph (c).

Transport Canada noted the reference to water loads is missing in paragraphs (d) and (e)(1). Transport Canada recommended those paragraphs be modified by adding the word “water” in the phrase “For all flights and ground loads.”

The FAA considered Transport Canada’s comment, but one of the goals of adopting performance-based regulations is to remove some of the specificity, to enable the flexibility to adapt to changing technologies and environments. Specifying every possible landing surface would not align with this goal. Therefore, the FAA is not incorporating Transport Canada’s changes into the final rule.

Transport Canada also commented that proposed § 23.600(e) should provide a performance-based standard for the requirements in former § 23.787(b) for baggage or cargo sharing the same compartment as passengers.

The FAA agrees baggage and cargo sharing the same compartment with passengers should be restrained. However, a change to the proposed rule is not necessary to address this. Section 23.2270(a) of this rule requires restraint of items of mass within the cabin utilizing static inertial loads, including baggage or cargo that is in the cabin.

The Associations and Textron addressed the requirement in proposed § 23.600(e)(3) that baggage and cargo compartments must protect controls, wiring, lines, equipment, or accessories whose damage or failure would “affect operations.” Textron

noted that any kind of damage or failure would arguably "affect operations," making it difficult to comply with the rule. Textron recommended the FAA qualify the requirement by adding the word "safe" in front of "operations." The Associations recommended the FAA delete the word "any" in front of "controls," delete the word "affect," and add the words "limit safe" in front of "operations."

The FAA agrees with the comments from Textron and the Associations and is adding "safe" to modify "operations." Adopting this change will harmonize the text with EASA's proposed rule language. The FAA will not adopt the other recommended changes as they would not have a substantive effect on the rule.

Daher commented generally on § 23.600, indicating the phrase "rolling and pitching" would be more appropriate than "pitching and yawing." Daher did not indicate where these phrases were, but the FAA believes it is referring to a statement made in the NPRM preamble discussion of proposed § 23.600 that stated dynamic seat testing requirements address the ability of seat assemblies to remain attached to the floor, even when the floor shifts during impact. Pitching and yawing of the seat tracks during dynamic seat tests demonstrates the gimbaling and flexibility of the seat.

Furthermore, the FAA believes Daher was specifically inferring that "rolling and pitching" would be more appropriate in § 23.2270(b)(1) because the rule language in former § 23.562 required the seat rails to be misaligned by 10 degrees in the "pitch" and "roll" axis, not the "pitch" and "yaw" axis. The FAA's intent was not simply to mimic the original § 23.562 misalignment requirements, but to identify static airplane orientation at impact in order to assess the level of airframe crushing and energy absorption. However, based on other comments on proposed § 23.600, the FAA has

removed specific references to the terms “flight path angle,” “flight pitch angle,” “yaw,” and “airplane configuration.” These parameters will be included in the means of compliance.

An individual commenter in the seatbelt manufacturing industry suggested putting a life limit of 10 years on seatbelts, because the webbing loses its strength due to exposure to UV lights and heat. The FAA notes that a seat belt life limit is not within the scope of this rulemaking. The details of seat belts and seat belt webbing materials are controlled by industry standards and Technical Standard Orders (TSOs). Additionally, specifying those types of design-specific solutions is counter to performance-based regulations.

5. Subpart D – Design and Construction

a. Flight Control Systems (proposed § 23.700/now § 23.2300)

In the NPRM, proposed § 23.700 (now § 23.2300) would have required an applicant to design airplane flight control systems to prevent major, hazardous, and catastrophic hazards. Proposed § 23.700 would have required an applicant to design trim systems to prevent inadvertent, incorrect, or abrupt trim operation. In addition, proposed § 23.700 would have required an applicant to design trim systems to provide a means to indicate—

- The direction of trim control movement relative to airplane motion;
- The trim position with respect to the trim range;
- The neutral position for lateral and directional trim; and
- For all airplanes except simple airplanes, the range for takeoff for all applicant requested center of gravity ranges and configurations.

Proposed § 23.700 would have also required an applicant to design trim systems to provide control for continued safe flight and landing when any one connecting or transmitting element in the primary flight control system failed, except for simple airplanes. Additionally, proposed § 23.700 would have required an applicant to design trim systems to limit the range of travel to allow safe flight and landing, if an adjustable stabilizer is used.

Furthermore, proposed § 23.700 would have required the system for an airplane equipped with an artificial stall barrier system to prevent uncommanded control or thrust action and provide for a preflight check. The FAA also proposed requiring an applicant seeking certification of a level 3 high-speed or level 4 airplane to install a takeoff warning system on the airplane, unless the applicant demonstrates that the airplane, for each configuration, could takeoff at the limits of its trim and flap ranges.

In light of comments received, the FAA revises proposed § 23.700 to withdraw paragraphs (a)(1) and all its subparagraphs, rename proposed paragraph (a)(2) as (a)(1), add new paragraph (a)(2), withdraw proposed paragraphs (b)(3), (b)(4), and paragraphs (c) and (d) and all their subparagraphs. This section discusses these changes in more detail.

Textron and Kestrel questioned how the term “prevent” was intended to be used with the system safety analysis terms “major,” “hazardous,” and “catastrophic.”

The FAA acknowledges the term “prevent” caused confusion in proposed § 23.700(a)(1), and replaces “prevent” with “protect against” in § 23.2300(a)(2). The FAA did not intend to require additional safety analysis in this section, as suggested by these comments.

The Associations, Kestrel, Air Tractor, and Textron expressed concern that proposed § 23.700 appears to require that applicants perform System Safety Assessments (SSAs) for traditional mechanical flight control systems that have never been subject to this requirement in the past. They note this would impose substantial new costs on applicants. The commenters acknowledge that SSAs would be appropriate for unconventional designs, such as fly-by-wire systems.

The FAA did not intend to imply that a safety analysis would be required for all flight control systems, including simple mechanical flight control systems in proposed § 23.700(a). The FAA deletes the terms that could have been associated with safety analysis and revises § 23.2300(a)(2) to require the applicant to design airplane flight control systems to protect against likely hazards. The FAA intends "protect against likely hazards" to be a high-level requirement to consider potential hazards to the flight control system, and incorporate features in the design to protect against these hazards. One way for a traditional flight control system to satisfy this would be to use the former part 23 regulations, which addressed hazards such as jamming, chafing, interference, incorrect assembly, asymmetric flaps, control system lock inadvertent engagement in flight, etc.

The FAA agrees with the comments stating that safety analysis is necessary, as required by § 23.2510 (proposed as § 23.1315), for fly-by-wire flight control systems, powered flight control systems, and automatic flight control systems. The FAA withdraws the safety analysis requirement in § 23.2300 because § 23.2510 adequately addresses the requirement for safety analysis. The FAA notes the applicability of the § 23.2510 safety analysis requirements will be addressed as a means of compliance, similar to the current practice in AC 23.1309-1E.

The Associations and Textron recommended the FAA eliminate proposed paragraph § 23.700(a)(1)(iii), which lists "flutter" as one of the possible major, hazardous or catastrophic hazards, because it is redundant and unnecessary as the safety intent of flutter is covered in the aeroelastic section, proposed § 23.410 (now § 23.2245). The FAA agrees because § 23.2245 "Aeroelasticity" adequately addresses flutter for normal operation, exceedances and failure conditions. The FAA also withdrew the other examples of hazards in proposed § 23.700(a)(1) so that they can be addressed more completely in means of compliance.

The Associations and Textron also questioned the use of the term "misconfiguration" in proposed § 23.700(a)(1)(v). Textron asked the FAA to clarify whether the term refers to items like rigging and installation or items like wing configurations (e.g., flaps, speed brakes) and trim. The Associations recommended "misconfiguration" be replaced with "misrigging" for clarity and anticipated the traditional misrigging practices would continue to apply. Proposed § 23.700(a)(1)(v) was intended to address the requirement from former § 23.685(d) that each element of the flight control system must have design features, or must be distinctively and permanently marked, to minimize the possibility of incorrect assembly that could result in malfunctioning of the control system. The FAA agrees that "misrigging" incorporates the intent of this requirement more clearly than "misconfiguration." However, the FAA has decided to remove proposed § 23.700(a)(1)(v) from the final rule as discussed.

With the withdrawal of the list in proposed § 23.700(a)(1), the FAA renumbers proposed § 23.700(a)(2) as § 23.2300(a)(1) and adds a new paragraph (a)(2).

Textron commented that proposed § 23.700(a)(2) could seem reasonable for all systems and recommended moving the paragraph to proposed § 23.1305 (now § 23.2505).

The FAA disagrees with applying proposed § 23.700(a)(2) to all systems and equipment because the requirement to "operate easily, smoothly and positively enough to allow normal operation" does not apply to all systems. For example, evaluating a flight data recorder for "smoothness" would not make sense. The FAA revises § 23.2300(a)(1) to be consistent with former § 23.671(a) because it states the intent of the requirement more clearly.

The Associations proposed revising § 23.700(b) to state "the trim systems must…" instead of "[t]he applicant must design trim systems to". They made a similar comment on proposed § 23.700(a).

The FAA used "the applicant must design…" throughout the NPRM. The FAA retains this wording because it's consistent with part 21 to impose the obligation on the applicant.

Textron noted that proposed § 23.700(b)(1) was a general concept that should actually apply to all systems, and therefore recommended changing the word "trim" to "system," and moving proposed § 23.700(b)(1) to proposed § 23.1305. Textron also questioned whether the term "prevent" in proposed § 23.700(b)(1) meant "meet the associated requirements of a system safety assessment." Textron recommended rewriting proposed paragraph (b)(1) to provide that the applicant must design trim systems to meet system safety requirements, according to the assessment mandated by proposed § 23.1310, and that the evaluation of the system shall include hazards caused by

inadvertent (uncommanded) trim operation and incorrect (motion in the opposite direction than commanded) trim operations.

The FAA notes the requirement to "prevent inadvertent, incorrect, or abrupt system operation" would not be appropriate for some systems. For example, evaluating a flight data recorder for "abrupt system operation" would not make sense. Therefore, the FAA did not incorporate Textron's recommendation in this rule. The FAA also declines to move the regulation to proposed § 23.1305 (now § 23.2505) because that section applies to all systems, while this requirement is only intended for flight control trim systems. In light of Textron's comment, the FAA has changed "prevent" to "protect against" for consistency with § 23.2300(a)(2). However, the FAA did not incorporate Textron's recommendation to change proposed § 23.700(b)(1) because this section does not require safety analysis. This section applies to all trim systems while § 23.2510 does not apply to trim systems that are considered "flight control surfaces and their simple systems" as discussed in AC 23.1309-1E.

Several organizations commented on proposed § 23.700(b)(3). The Associations recommended deleting proposed paragraph (b)(3). They stated that addressing the loss of any single flight control link with traditional mechanical flight controls has provided a substantial level of safety and as new stability and fly-by-wire systems are discussed, it will be increasingly important to develop adequate means of compliance in acceptable documents.

EASA asserted the proposed requirement to have a trim system as a means of control in case of failure of a connecting or transmitting element was too prescriptive and

should be captured by the intent that a flight control system must prevent major, hazardous, and catastrophic hazards for likely failure conditions.

The FAA agrees that proposed § 23.700(b)(3) was too prescriptive because means other than trim could be used to safely control the airplane when any one connecting or transmitting element in the primary flight control system fails. The requirement to protect the airplane from loss of control when any one connecting or transmitting element in the primary flight control system fails is captured in § 23.2300(a)(2) at a high level. Therefore, the FAA withdraws proposed § 23.700(b)(3). In addition, the FAA adds "if installed" to § 23.2300(b) in light of the comments that future designs may not use trim systems.

Transport Canada observed that VLA rules permit trim systems that do not provide safe flight and landing following failure of the primary control system. Transport Canada said it did not believe this alleviation should be carried into the part 23 revisions, even for small airplanes. Transport Canada recommended the level of safety for trim system failures be raised for simple airplanes.

As discussed elsewhere, the FAA has decided to withdraw the simple category, proposed in § 23.5(d), and also to withdraw proposed § 23.700(b)(3) because § 23.2300(a)(2) captures the requirement. The FAA has determined that the level of safety for trim system failures should not be raised for entry-level airplanes. One of the goals of the NPRM was to provide appropriate standards for "entry-level airplanes", and the FAA finds § 23.2300(a)(2) meets that goal. As discussed in this section, § 23.2300(a)(2) requires the applicant to design airplane flight control systems to protect against likely hazards. While the FAA's intent is that flight control systems that meet the

former part 23 requirements adequately protect against the likely hazard of failures in any one connecting or transmitting element in the primary flight control system, those airplanes certified under EASA's Certification Specification – Very Light Aeroplanes (CS-VLA), were not certified under part 23. Rather, they were imported to the U.S. and certificated as special class airplanes in accordance with § 21.17(b). Under § 23.2300(a)(2), these airplanes could be certified under part 23, using the CS-VLA to meet the requirements.

Upon further consideration of proposed § 23.700(b)(4), the FAA decided the safety intent of the requirement to limit the range of travel to allow safe flight and landing, if an adjustable stabilizer is used, is already incorporated in the regulations through the requirement for the applicant to design airplane flight control systems to protect against likely hazards. The proposed requirement was prescriptive and may not be appropriate for non-traditional airplane designs. Therefore, the FAA withdraws proposed § 23.700(b)(4).

The Associations asserted including specific information for the verification of stall barrier systems in proposed § 23.700(c) is not beneficial because the issue being addressed is already covered by "flight control reliability aspects." The commenters also noted the simple checks being specified may not be appropriate for all stall barrier systems and that addressing stall barrier flight controls would be better detailed in means of compliance. The commenters recommended deleting proposed § 23.700(c).

The FAA agrees that there is no benefit to including § 23.700(c) because § 23.2510 adequately addresses stall barrier system failure conditions and checks for latent failures. Therefore, the FAA withdraws § 23.700(c).

Textron, ANAC, and Air Tractor commented that proposed § 23.700(d) would require a takeoff warning system without explanation of what it would be, and this could increase complexity.

The FAA withdraws proposed § 23.700(d) because the safety requirement of warning a pilot who is attempting to takeoff with the trim or flaps in an unsafe configuration is adequately addressed in § 23.2605(c).

b. Landing Gear Systems (proposed § 23.705/now § 23.2305)

In the NPRM, proposed § 23.705 (now § 23.2305) would have required—

- The landing gear and retracting mechanism be able to withstand operational and flight loads;
- An airplane with retractable landing gear to have a positive means to keep the landing gear extended and a secondary means for extending the landing gear that could not be extended using the primary means;
- A means to inform the pilot that each landing gear is secured in the extended and retracted positions; and
- Airplanes, with retractable landing gear, except for airplanes intended for operation on water, to also have a warning to the pilot if the thrust and configuration is selected for landing and yet the landing gear is not fully extended and locked.

Furthermore, if the landing gear bay is used as the location for equipment other than the landing gear, proposed § 23.705 would have required that equipment be designed and installed to avoid damage from tire burst and from items that may enter the landing gear bay. Proposed § 23.705 would have also required the design of each landing gear wheel, tire, and ski account for critical loads and would require a reliable means of

stopping the airplane with kinetic energy absorption within the airplane's design specifications for landing. For level 3 high-speed multiengine and level 4 multiengine airplanes, proposed § 23.705 would have required the braking system to provide kinetic energy absorption within the design of the airplane specifications for rejected takeoff as the current rules do for multiengine jets over 6,000 pounds and commuter category airplanes.

Several commenters argued that proposed § 23.705 was too design specific and recommended the FAA replace specific design elements such as brakes, wheels, and tires with objectives that would work for a wide array of technologies.

In light of comments received, the FAA revises proposed § 23.705 to withdraw proposed paragraphs (a)(1) through (d), to be replaced with new paragraphs (a)(1), (a)(2), (b), (c)(1) and (c)(2). This section discusses these changes in more detail.

The FAA reassessed the need for the language of proposed § 23.705(a)(1) and (b) and decided not to adopt the proposed paragraphs. The FAA has determined these requirements are adequately addressed by proposed §§ 23.310 (now § 23.2210), 23.320 (now § 23.2220), and 23.400 (now § 23.2235). Section 23.2210 requires structural design loads to be determined that result from likely externally or internally applied pressures, forces or moments, that may occur in flight, ground and water operations, ground and water handling, and while the airplane is parked or moored. This includes operational and flight loads on the landing gear and retracting mechanism, including the wheel well doors specified in the FAA's proposed § 23.705(a)(1). Section 23.2235 requires the structure to support these loads. Section 23.2220 requires the applicant to determine the structural design loads resulting from taxi, takeoff, landing, and ground handling conditions

occurring in normal and adverse attitudes and configurations. This includes the critical loads on wheels, tires, and skis specified in proposed § 23.705(b). Section 23.2235 requires the structure to support these loads.

Commenters noted proposed § 23.705 diverged from EASA's proposed CS 23.425, and recommended the FAA work with EASA to achieve harmonization. Several commenters recommended the FAA reject the language originally proposed for § 23.705 and replace it with the language from EASA's proposed CS 23.2325.

The FAA agrees that it should harmonize § 23.2305 as much as possible with CS 23.2325, and has done so where appropriate.

The Associations recommended the FAA revise proposed paragraph (a), which would define landing gear. Textron recommended the FAA add a requirement to provide stable support and control to the airplane during ground operation. The commenters noted the change to paragraph (a) would harmonize with EASA.

The FAA finds the recommended language for paragraph (a) unnecessary. The FAA also finds the accepted means of compliance will describe what is considered landing gear for a particular airplane design. The FAA notes the recommended language is overly broad and can be read to encompass rudder systems and other systems that do not directly interact with the ground, but are necessary to control the airplane during surface operation. The FAA notes rudder systems and other systems are adequately addressed elsewhere.

The FAA revises § 23.2305(a)(1) to adopt CS 23.2325(b)(1) by requiring the landing gear to be designed to provide stable support and control during surface operation. Although the NPRM did not specifically address this requirement, the FAA

intended for the revised regulations to capture the safety intent of the former part 23 regulations. This also harmonizes with EASA.

The FAA will not adopt the landing gear loads and energy absorption requirements in CS 23.2325(b)(2) and (b)(3) because these requirements are adequately addressed in §§ 23.2210, 23.2220, and 23.2235. The FAA notes the airplane has to be designed for the anticipated loads, and energy absorbed by the landing gear affects the airframe loads, which are addressed in these sections. Additionally, proper function of any systems related to absorption of energy in the landing gear is addressed in § 23.2505.

The FAA adopts CS 23.2325(b)(4) as § 23.2305(a)(2), requiring the landing gear to be designed to account for likely system failures and likely operation environment, including anticipated limitation exceedances and emergency procedures. As a result of this revision, the FAA withdraws proposed § 23.705(a)(3).

Although the NTSB supported proposed § 23.705(a)(3), the FAA notes proposed § 23.705(a)(3) only addressed tire failures on airplanes with retractable landing gear based on the assumption that tire burst and foreign object risk is greater on airplanes with retractable landing gear. This is generally true for traditional airplane designs. The risk is generally more severe on airplanes with large numbers of passengers, flight critical systems near the landing gear, complex systems, and high-speed operation on the ground. These factors generally exist on airplanes with retractable landing gear, but they could exist on airplanes with fixed landing gear. Conversely, the risk is generally less severe on airplanes with no passengers, no flight critical systems near the landing gear, simple systems and low-speed operation on the ground. These factors generally exist on airplanes with fixed landing gear, but they could exist on airplanes with retractable

landing gear (e.g., powered gliders). Therefore, the proposed § 23.705(a)(3) assumption that airplanes with retractable landing gear should be protected from the risks of tire failures and foreign objects, but airplanes with fixed landing gear should not be protected, may not be correct for future designs.

Section 23.2305(a)(2) applies to all landing gear and requires landing gear failures to be considered more generally. The FAA finds § 23.2305(a)(2) will allow traditional designs to comply using current practices as means of compliance, with the flexibility to develop new means of compliance more appropriate for potential future designs. This furthers the goal of moving to performance-based requirements.

The FAA notes § 23.2305(a)(2) captures the intent of former §§ 23.721, 23.729, 23.735, and 23.1309, which required that applicants account for likely landing gear failures. It also captures the intent of former §§ 23.603, 23.721, 23.729, 23.735, 23.1301, and 23.1309, which required that applicants account for likely operation environments, and/or anticipated limitation exceedances and emergency procedures.

The commenters recommended that the FAA move the substance of proposed § 23.705(a) for airplanes with retractable landing gear to proposed § 23.705(c) and replace the proposed language with CS 23.2325(d), which deals with airplanes that have a system that actuates the landing gear.

The FAA has considered the comments and has decided to adopt CS 23.2325(d)(1) and (4) as § 23.2305(c)(1) and (2). CS 23.2325(d)(1) and (4) require a positive means to keep the landing gear in the landing position and an alternative means available to bring the landing gear in the landing position when a non-deployed system position would be hazardous. The FAA adopts § 23.2305(c)(1) because it is less

prescriptive than proposed § 23.705(a)(2)(i). The FAA notes the recommended phrase "in the landing position" is less prescriptive than "extended" and better expresses the intent of the requirement. Moreover, § 23.2305(c)(1) does not increase the burden on traditional designs; provides flexibility to allow new designs to be certified because it applies to all landing gear actuated by a system, not just retractable landing gear; and assists in harmonization.

The FAA adopts the language of CS 23.2325(d)(4) as § 23.2305(c)(2), with one minor change. The FAA is using the phrase "a hazard" instead of "hazardous" to avoid confusion with former § 23.1309's use of the phrase "hazardous failure condition." The language of CS 23.2325(d)(4) better captures the safety intent of former § 23.729(c), which did not require a secondary means for landing gear that could be extended manually, and is less prescriptive because it only requires an alternative means to bring the landing gear to the landing position if a non-deployed position would be a hazard. Additionally, moving the location of this requirement has no technical impact and harmonizes with CS 23.2325.

The FAA does not adopt proposed § 23.705(a)(2)(iii) or the language from CS 23.2325(d)(2) and (d)(3) because the FAA considers both proposals to be adequately addressed by proposed § 23.1500(b) (now § 23.2600(b)). Section 23.2600(b) requires the applicant to install flight, navigation, surveillance, and powerplant controls and displays so qualified flightcrew can monitor and perform defined tasks associated with the intended functions of systems and equipment. The systems and equipment design must minimize flightcrew errors which could create additional hazards. Section 23.2600(b) incorporates the safety intent of previous requirements for landing gear indications and

effectively requires the pilot to be informed of the landing gear position (secured in extended or retracted position) should the pilot need that information.

Textron recommended the FAA remove the requirement for a secondary means of extending the landing gear in proposed § 23.705 and rely instead on the requirements of proposed § 23.1315.

The FAA disagrees as Textron's recommendation does not capture the intent of the former regulation, which was a specific requirement for a secondary means of deploying landing gear. Furthermore, this requirement in proposed § 23.705 was not covered by the general systems failure requirements of proposed § 23.1315.

Several commenters recommended deleting proposed § 23.705(a)(2)(iv), in part, because it was too prescriptive. One commenter recommended rewriting the rule as a performance-based regulation to encourage alternate—and perhaps better—means of detecting wrong configurations for landing.

The FAA agrees that proposed § 23.705(a)(2)(iv) is too prescriptive, and finds it is adequately addressed by the requirements of new § 23.2605(c), which requires information concerning an unsafe system operating condition must be provided in a timely manner to the crewmember responsible for taking corrective action. Accordingly, the FAA withdraws proposed § 23.705(a)(2)(iv).

Textron recommended the FAA add the word "essential" before "equipment" in proposed § 23.705(a)(3),[37] asserting that non-essential equipment is not important to protect in the landing gear bay.

[37] Textron referenced "the 2nd line of the 2nd paragraph," but the FAA infers they intended to reference proposed § 23.705(a)(3) because this is the provision that would require protection of equipment.

The FAA disagrees with Textron's recommendation as it is possible that failures of non-essential equipment like a fuel line for a combustion heater may result in hazards more severe than the loss of the non-essential function. Therefore, the FAA is not adopting this change in the final rule.

Textron recommended rewording proposed §§ 23.705(c) and (d) to limit their applicability to airplanes with wheels, asserting these paragraphs required airplanes without wheels to have brakes. Alternatively, Textron suggested moving the requirement to proposed § 23.1300(a) (now § 23.2500(a)) because an airplane with wheels will need a braking system to meet proposed § 23.1300(a), making § 23.705(c) redundant. Other commenters recommended the FAA replace proposed § 23.705(c) and (d) with the CS 23.2325(c), which addresses kinetic energy absorption.

The FAA concurs with the recommendation to replace proposed § 23.705(c) and (d) with CS 23.2325(c). The FAA notes CS 23.2325(c) has the same meaning as proposed § 23.705(c) and (d), but harmonizes with EASA's NPA 2016-05. The FAA has determined the removal of the phrase "within the airplane's design specifications for landing" and replacement with "sufficient…to account for landing" has no technical impact. The FAA adopts the change as § 23.2305(b).

The FAA disagrees with Textron's recommendation to reword § 23.705(c) and (d) to limit their applicability to airplanes with wheels. The FAA notes proposed paragraphs (c) and (d) would not require brakes. While the FAA has considered Textron's alternative recommendation, the specific energy absorption requirement of proposed § 23.705(c) is not adequately addressed by the general system performance requirements of proposed § 23.1300(a). Therefore, the FAA is not adopting this change in the final rule.

Textron suggested the FAA should harmonize its proposed regulations on this topic with CS 23.600 by removing language related to brakes as a subset of meeting the requirements of proposed § 23.1300(a).

The FAA agrees with harmonizing with EASA wherever possible. However, specifically requiring a reliable means of stopping the airplane is not excessively prescriptive and provides clarity to the regulation. Furthermore, Textron's suggested text would not harmonize with CS 23.2325.

EASA recommended eliminating the reference to level 3 and 4 airplanes in proposed § 23.705(d), and replacing it with a reference to airplanes "required to demonstrate aborted take-off capacity," which links the requirement to takeoff performance. Similarly, all of the comments on this section recommended making proposed § 23.705(d) applicable to the same airplanes covered by proposed § 23.115(c)(1) (now § 23.2115(c)(1)). [38] Textron also suggested directly referencing proposed § 23.115 to prevent the link between the two requirements from being inadvertently broken.

The FAA agrees with the recommendation to make § 23.2305(b) applicable to the same airplanes as § 23.2115(c)(1) for several reasons. First, in order to comply with § 23.2115(c)(1), applicants must design airplanes with a means to decelerate the airplane after a rejected takeoff, regardless of the requirements in § 23.2305(b), so adopting the recommended change would not increase the burden on applicants. Second, making the applicability of § 23.2305(b) different from § 23.2115(c)(1) could cause confusion,

[38] Proposed § 23.115(c)(1) would have applied to "levels 1, 2, and 3 high-speed multiengine airplanes, multiengine airplanes with a maximum takeoff weight greater than 12,500 pounds and level 4 multiengine airplanes."

especially because the proposed applicability would have included airplanes excluded from § 23.2115(c)(1). In former §§ 23.55 and 23.735(e), the FAA applied the requirement to determine the distance for an aborted takeoff at critical speed to the same airplanes required to provide kinetic energy absorption in the brakes for a rejected takeoff, and there is no reason to discontinue this practice. Additionally, adopting this recommendation harmonizes the FAA requirement with CS 23.2325(c).

c. Buoyancy for Seaplanes and Amphibians (proposed § 23.710/now§ 23.2310)

In the NPRM, proposed § 23.710 (now § 23.2310) would have required airplanes intended for operations on water to provide buoyancy of 80 percent in excess of the buoyancy required to support the maximum weight of the airplane in fresh water. Proposed § 23.710 would have also required airplanes intended for operations on water to have sufficient watertight compartments so the airplane will stay afloat at rest in calm water without capsizing if any two compartments of any main float or hull are flooded.

The FAA noted in the NPRM that it was proposing to remove the requirement that each main float must contain at least four watertight compartments of approximately equal volume because it was a specific design requirement that would be addressed by the proposed performance-based standard.

All of the comments on this section noted a problem with the prescriptive design specificity of proposed § 23.710(b); in particular, the requirement to have watertight compartments. The commenters noted an erroneous assumption that all airplanes intended for operations on water would have watertight compartments. The commenters noted that manufacturers could employ a different solution—such as foam-filled floats—eliminating the need for compartments, and still meet the buoyancy intent. BendixKing

commented that the buoyancy requirement needs to be "more generic to address the core safety intent, which is adequate floatation in the event of a failure." The Associations and Textron offered alternative regulatory language that would remove the requirement to have watertight compartments and provide a general performance-based standard for demonstrating buoyancy.

The FAA agrees that proposed § 23.710(b) is excessively prescriptive. The FAA recognizes there are other ways to meet the safety goal of protecting the airplane from capsizing. Therefore, the FAA revises proposed § 23.710(b) to establish a more performance-based standard for demonstrating buoyancy.

ICON noted that hull type and float seaplanes were treated differently in former part 23, and recommended that they be treated differently in the new part 23 as well, because they deal with a loss of buoyancy in different ways. In particular, ICON noted differences in the rate of capsizing, the ability to detect an intrusion of water, and the pilot's ability to remove the water while operating the airplane. ICON asked the FAA to eliminate the separate compartment requirements for hull-type seaplanes.

The FAA agrees that, as proposed, the combination of hulls and floats into one regulation would have imposed a requirement on hulls that is more stringent than the requirements in former part 23. The FAA revises the proposed language to remove the prescriptive requirement for watertight compartments. As such, § 23.2310 contains a more general standard for buoyancy that is appropriate for both floats and hulls.

d. Means of Egress and Emergency Exits (proposed § 23.750/now § 23.2315)

In the NPRM, proposed § 23.750 (now § 23.2315) would have required—

- The airplane cabin exit be designed to provide for evacuation of the airplane within 90 seconds in conditions likely to occur, excluding ditching, following an emergency landing. For ditching, proposed § 23.750 would have required the cabin exit for all certification levels 3 and 4 multiengine airplanes be designed to allow evacuation in 90 seconds;
- Each exit to have a simple and obvious means, marked inside and outside the airplane, to be opened from both inside and outside the airplane, when the internal locking mechanism is in the locked position; and
- Airplane evacuation paths to protect occupants from serious injury from the propulsion system, and require that doors, canopies, and exits be protected from opening inadvertently in flight.

Proposed § 23.750 would have precluded each exit from being obstructed by a seat or

seat back, unless the seat or seat back could be easily moved in one action to clear the exit. Proposed § 23.750 would have also required airplanes certified for aerobatics to have a means to exit the airplane in flight.

The Associations, BendixKing, Textron, and EASA recommended the FAA remove the 90-second evacuation requirement in proposed § 23.750(a) and replace it with less prescriptive language. EASA stated that the 90-second evacuation time was not contained in the former part 23 regulations and would not be reasonable for all airplanes. EASA stated that leaving the acceptable design solutions to an acceptable means of compliance would be better. As alternatives to the proposed language, BendixKing suggested a requirement for “adequate and timely” evacuation, Textron suggested a

requirement for “rapid” evacuation, and the Associations suggested a requirement for “rapid and safe” evacuation.

The FAA agrees and removes the airplane 90-second evacuation requirement because specifying the time limit in the regulation is unnecessarily prescriptive. The FAA replaces the evacuation requirement with the requirement to “facilitate rapid and safe evacuation of the airplane in conditions likely to occur following an emergency landing, excluding ditching for level 1, level 2, and single-engine level 3 airplanes.” This harmonizes more closely with EASA’s proposed CS 23.2335.

The Associations specifically proposed revisions to the regulatory text, which appeared to align with EASA’s proposed regulation. In accordance with their recommendation, the FAA revises the beginning of proposed § 23.750(a) to move a portion of its content into § 23.2315(a)(1). Section 23.2315(a) is revised to read: “With the cabin configured for take-off or landing, the airplane is designed to,” followed by more detailed requirements in the subparagraphs. The FAA believes this change more clearly preserves the intent of former regulations. It also harmonizes with EASA’s proposed regulation.

Textron also commented that the FAA should either replace the word “likely” in proposed § 23.750(a) or ensure the “likely conditions” referred to in paragraph (a) are clearly defined in the ASTM standards. The FAA intends the term “likely” to be nonprecise or within a mathematical certainty. As explained in the discussion of proposed § 23.205, the FAA finds the most appropriate location for defining “likely conditions” is in a means of compliance, because these conditions may vary for different airplanes; therefore, the FAA retains the word “likely” in paragraph (a).

Textron also noted that proposed § 23.750(a) specifies “likely conditions,” but excludes ditching for all but levels 3 and 4 multiengine airplanes. However, Textron stated that ditching as a likely condition associated with emergency evacuation had not been required previously. It recommended the FAA add a requirement to proposed § 23.750, to require a means on levels 3 and 4 multiengine airplanes to evacuate the airplane safely following a ditching event.

The FAA notes the requirement to safely evacuate the airplane during ditching is already addressed generally in § 23.2315(a)(1). The methods for meeting this requirement will be in a means of compliance.

Textron further commented on using former § 23.807(e) as a means of compliance to show that occupants have a means available to safely evacuate the airplane. Textron stated that former § 23.807(e) only prescribes one exit on each side of the airplane to be above the waterline or alternative methods must be employed.

The FAA agrees that providing one exit on each side of the airplane above the waterline is an acceptable means of compliance. While this may be one means of compliance that is acceptable for traditional designs, the FAA’s goal in this rule is to use means of compliance, developed by industry or individuals, to allow for non-traditional designs.

Transport Canada commented on proposed § 23.750(a), noting that cabin exit design is just one of several elements that affect evacuation performance. Transport Canada also noted that the expectation to meet the evacuation performance with the airplane’s maximum certified occupancy should be made explicit. Transport Canada suggested a revision to proposed paragraph (a) stating that the airplane design, including

the cabin exit design, must provide for evacuation of the airplane of the maximum number of occupants within 90 seconds in conditions likely to occur following an emergency landing.

The FAA agrees that cabin exit design is just one of several elements that affect evacuation performance and that rapid evacuation with the airplane's maximum certified occupancy is required, but the regulation does not have to explicitly include this requirement. Section 23.2315 addresses generally all the likely conditions that affect emergency evacuation, which would include an airplane with maximum certificated occupancy. Therefore, the FAA is not adopting the language proposed by Transport Canada.

The Associations recommended the following revisions to proposed § 23.750(a), which deleted or combined portions of proposed paragraphs (a), (b), (c), (d) and (f) into a new paragraph (a), and renumbered paragraph (e) as paragraph (b). Their proposed paragraph (a)(1) appears to correlate with proposed § 23.750(a). They proposed a revision to proposed paragraph (a)(1) stating that, with the cabin configured for take-off or landing, the airplane is designed to facilitate rapid and safe evacuation of the "aeroplane" in conditions likely to occur following an emergency landing, excluding ditching for level 1, level 2, and single-engine level 3 airplanes.

The FAA adopts this language as § 23.2315(a)(1), except for spelling "aeroplane" as "airplane." This is better organized and more understandable than the proposed language, while still retaining the intent of former regulations and harmonizes the regulations between FAA and EASA.

Textron commented that the phrase “when the internal locking mechanism is in the locked and unlocked position” in proposed § 23.750(b) is not necessary and should be deleted. The FAA agrees and removes the phrase because this is a detailed design consideration, which is more appropriately addressed in means of compliance.

Textron also recommended the FAA add a requirement similar to the requirement for auxiliary locking devices in former § 23.783(c)(6), which would provide, in pertinent part, that auxiliary locking devices that are actuated externally to the airplane may be used but such devices must be overridden by the normal internal opening means. Textron’s view was that auxiliary locking devices used to secure the airplane would likely be needed to prevent unauthorized entry into the airplane when it is left unattended.

The FAA disagrees with Textron’s recommendation as the suggested text because it is more appropriate for a means of compliance.

The Associations proposed revisions to proposed § 23.750(a)(2) that coincidently address Textron’s comment on internal locking mechanisms. They suggested adding language stating that, with the cabin configured for take-off or landing, the airplane is designed to have means of egress (openings, exits or emergency exits), that can be readily located and opened from the inside and outside. The means of opening must be simple and obvious.

The FAA adopts this language as § 23.2315(a)(2), except the proposed marking requirement is retained. This revision captures the safety intent of the former regulations more clearly and harmonizes regulations between the FAA and EASA.

The Associations recommended deleting proposed § 23.750(c). The FAA agrees because paragraph (a)(1), as revised, already addresses similar requirements, rendering paragraph (c) redundant.

Textron commented on proposed § 23.750(d) by recommending the FAA address obstructions more generally (i.e., not just seat backs), and offered the language stating that each exit must not be obstructed unless the obstruction can be easily moved in one action to clear the exit.

Transport Canada similarly suggested the requirement should more generally address that any component of the interior should be considered as a potential obstruction, and also address temporary obstructions during flight. Transport Canada proposed a revision to proposed paragraph (d) stating that each exit must not be obstructed by any interior component during taxi, take-off or landing. In addition, a seat or seat back may obstruct an exit if the seat or seat back can [be] easily moved in one action to clear the exit.

The FAA considered Transport Canada's proposed wording, but moving a seat back easily in one motion to reach an emergency exit is more appropriate as a means of compliance. The FAA agrees with Textron's and Transport Canada's comments on proposed § 23.750(d) that obstructions that could potentially block exits should be addressed more generally and not limited to seat backs, because other items could block exits and impair evacuation. The FAA revises the regulation accordingly as § 23.2315(a)(3).

The Associations proposed a revision to proposed § 23.750(a)(3) stating that, with the cabin configured for take-off or landing, the airplane is designed to have easy access to emergency exits when present.

The FAA is incorporating this suggestion in § 23.2315(a)(3). The new language captures the safety intent of the former regulations more generally and harmonizes the FAA language with the EASA NPA language.

The Associations recommended to renumber proposed § 23.750(e) as proposed § 23.750(b) (now § 23.2315(b)). The FAA agrees and adopts the proposed renumbering. This relocation will not change the substantive content of the paragraph, but matches with EASA's numbering and will lessen confusion.

The Associations recommended deleting proposed § 23.750(f). EASA commented that the requirement in proposed § 23.750(f) for doors, etc. is too design-specific and can be covered by generic principles covered in § 23.2250 (proposed as § 23.500).

The FAA understands EASA's comment, but requiring doors, canopies, and exits to be protected from opening inadvertently in flight is a general requirement that does not limit possible design solutions. However, the FAA moves this requirement to § 23.2250(e) to harmonize the location of the requirement with EASA's rule.

Upon further review, the FAA is replacing the word "approved" in proposed § 23.750(e) (now § 23.2315(b)) with the word "certified". This change does not affect the original intent of paragraph (e), but harmonizes the language with EASA.

e. Occupant Physical Environment (proposed § 23.755/now § 23.2320)

In the NPRM, proposed § 23.755 (now § 23.2320) would have required an applicant to design the airplane to allow clear communication between the flightcrew and passengers and provide a clear, sufficiently undistorted external view to enable the flightcrew to perform any maneuvers within the operating limitations of the airplane. Proposed § 23.755 would have also required an applicant to design the airplane to protect the pilot from serious injury due to high-energy rotating failures in systems and equipment, and protect the occupants from serious injury due to damage to windshields, windows, and canopies.

Additionally, proposed § 23.755 would have required, for level 4 airplanes, each windshield and its supporting structure directly in front of the pilot to withstand the impact equivalent of a two-pound bird at maximum approach flap airspeed and allow for continued safe flight and landing after the loss of vision through any one panel.

Furthermore, proposed § 23.755 would have required any installed oxygen system to include a means to determine whether oxygen is being delivered and a means for the flightcrew to turn on and shut off the oxygen supply, and the ability for the flightcrew to determine the quantity of oxygen available. Proposed § 23.755 would have also required any installed pressurization system to include a pressurization system test and a warning if an unsafe condition exists.

EASA commented the requirement in proposed § 23.755(a)(2) for the airplane design to provide a clear, sufficiently undistorted external view should be covered in the "crew interface" paragraph.

The FAA agrees with EASA that the § 23.755(a)(2) flightcrew visibility requirement is more directly related to flightcrew interface than occupant environment. The FAA is including the words “including pilot view” in § 23.2600(a). This change harmonizes § 23.2600(a) more closely with proposed CS 23.2600(a).

Similarly, the FAA relocates the proposed § 23.755(b)(2) requirement to § 23.2600(c), because this change harmonizes § 23.2600(c) more closely with EASA’s proposed CS 23.2600(d). Additionally, the FAA adopts the language in EASA’s proposed CS 23.2600(d), except for the spelling of “aeroplanes” versus “airplanes” for improved clarity and harmonization.

The Associations suggested the FAA delete the word “any” from the phrase “any maneuvers within the operating limitations of the airplane,” in proposed § 23.755(a)(2). The commenters did not provide a rationale for this suggestion.

The FAA disagrees as removing the word “any” could unduly restrict the scope of the rule. The FAA’s intent is that adequate visibility must be provided to perform any maneuvers within the operating limitations of the airplane. Therefore, the FAA adopts § 23.2600(a) as proposed in the NPRM.

The Associations, Transport Canada, EASA, and ANAC questioned proposed § 23.755(a)(3), which would require the airplane design to protect the pilot from serious injury due to high-energy rotating failures. The Associations stated there may be new systems which may include high amounts of energy that is not the result of rotating equipment. The commenters suggested proposed § 23.755(a)(3) be broadened to include the new systems, such as high voltage systems. EASA similarly suggested amending the

protection of pilots against serious injury due to high-energy rotating failures to include any high-energy risks.

The FAA has considered the commenters' suggestion to change proposed § 23.755(a)(3) as recommended. However, the FAA has concluded that the safety requirements contained in § 23.2510, "Equipment, systems and installations," (proposed as § 23.1315) of this rule adequately address hazards from high-energy sources. Therefore, no change is being made to the final rule based on the commenters' suggestion.

ANAC referenced former § 23.1461(d) and asked the FAA to explain why proposed § 23.755(a)(3) excluded protection for airplane occupants other than the pilot from certain hazards. Additionally, Transport Canada commented the proposed language requires protecting the pilot from high-energy rotating failures, which suggests a lower level of safety for the other airplane occupants. It recommended replacing the word "pilot" with "occupants".

The FAA agrees with ANAC and Transport Canada that proposed § 23.755(a)(3) would effectively lower the level of safety because it did not protect all occupants from high-energy rotor failures. It also did not protect the airplane from high-energy rotor failures, and allowed the pilot and pilot controls to be in the inboard propellers' plane of rotation. The FAA intended to incorporate the safety intent of former §§ 23.771(c) and 23.1461.

Therefore, the FAA adopts § 23.2550 to better capture the safety intent of former § 23.1461. Section 23.2550 requires equipment containing high-energy rotors to be designed or installed to protect the occupants and airplane from uncontained fragments.

The FAA also revises § 23.2320(a)(2) (proposed as § 23.755(a)(3)) to capture the safety intent of former § 23.771(c). Section 23.2320(a)(2) will require the pilot and flight controls be protected from propellers.

Textron and NJASAP commented on the requirement in proposed § 23.755(b)(1) for level 4 airplanes to ensure that the windshield and its supporting structure directly in front of the pilot can withstand the impact equivalent of a two-pound bird. Textron noted the 14 CFR part 33 engine requirement for medium bird ingestion is based on a 2.5-pound bird and questioned why the FAA did not use 2.5-pounds in proposed § 23.755(b)(1). Textron also recommended the FAA consider language from CS 23.440(a) with weight/type specifics being defined in the industry standards.

The FAA notes NJASAP's and Textron's comment on the weight of the bird in proposed § 23.755(b)(1). Former § 23.775(h)(1) required windshield panes directly in front of pilots in the normal conduct of their duties, and the supporting structure for these panes, to withstand, without penetration, the impact of a two-pound bird when the velocity of the airplane (relative to the bird along the airplane's flight path) is equal to the airplane's maximum approach flap speed for commuter category airplanes. The FAA codified this requirement in part 23, amendment 23-49.[39] The preamble of the NPRM[40] for amendment 23-49 explains that the two-pound bird requirement was based on ICAO bird strike data that occurred on airplanes of 19,000 pounds or less from 1981 through 1989. Also, this requirement is well established in the former regulations and has

[39] Final Rule, Airworthiness Standards; Systems and Equipment Rules based on European Joint Aviation Requirements, 61 FR 5151, 5166 (Feb. 9, 1996).
[40] NPRM, Airworthiness Standards; Systems and Equipment Rules based on European Joint Aviation Requirements (59 FR 37620, July 22, 1994).

provided an acceptable level of safety. Therefore, the FAA retains the two-pound bird requirement.

NJASAP commented the methodology used to discriminate between level 3 and 4 airplanes will motivate OEMs to certify more airplanes within level 3. The commenter also noted that airplanes in this category have experienced fatal accidents due to bird strikes. NJASAP recommended the FAA apply the requirements of proposed § 23.755(b)(1) to level 3 high-speed airplanes.

The FAA acknowledges the requirement in former § 23.775(h)(1) applied to commuter category airplanes, while the proposed requirement would have applied only to level 4 airplanes. Under the former regulations, a commuter category airplane was limited to multiengine airplanes with a seating configuration, excluding pilot seats, of 19 or less and a maximum certificated weight of 19,000 pounds or less.[41] Additionally, a normal category airplane was limited to those airplanes that had a seating configuration, excluding pilot seats, of nine or less, a maximum certificated takeoff weight of 12,500 pounds or less, and intended for nonacrobatic operation.[42] Under the proposal, level 4 airplanes would be airplanes with a maximum seating configuration of 10 to 19 passengers. Thus, the proposal would have the effect of providing relief to a percentage of part 23 airplanes with a maximum certified takeoff weight more than 12,500 pounds, but have fewer than 10 passengers seating configuration.

Under NJASAP's proposal, this requirement would apply to airplanes with 7 to 9 passengers and a maximum certified takeoff weight of 12,500 pounds or less, which would increase the certification requirements of former § 23.775(h)(1). This regulation

[41] See § 23.3(d), amendment 23-62.
[42] See § 23.3(a), amendment 23-62.

has proven to be an acceptable level of safety. Additionally, adding level 3 airplanes would increase the cost for a number of these airplanes that weigh less than 12,500 pounds.

Transport Canada and ANAC noted that former § 23.831 addresses smoke, which was not included in proposed § 23.755(c). Transport Canada recommended the FAA add the phrase "and solid or liquid particulates" after the word "vapors" in proposed paragraph § 23.755(c) because smoke is a collection of airborne solid and liquid particulates and gases.

The FAA agrees with Transport Canada and ANAC and revises § 23.2320(c) to require the air provided to each occupant be free of hazardous concentrations of smoke during normal operations and likely failures. The FAA intended proposed § 23.755(c) to incorporate the safety intent of former § 23.831(b), which requires the ventilating air in the flightcrew and passenger compartments to be free of harmful or hazardous concentrations of gases and vapors in normal operations and in the event of reasonably probable failures or malfunctioning of the ventilating, heating, pressurization, or other systems and equipment. It also requires smoke evacuation be accomplished quickly if accumulation of hazardous quantities of smoke in the cockpit area is reasonably probable.

The FAA chose the term "smoke" instead of "solid or liquid particulates" because it is a more common term. Section 23.2320(c) requires air at a breathable pressure, free of hazardous concentrations of gases, vapors, and smoke, to be provided to each occupant during normal operations and likely failures.

ANAC questioned whether general rules (like proposed § 23.1315) would address the concern of smoke evacuation capability and requested the FAA clarify how airplane

manufacturers would be driven to develop a smoke evacuation system in case there is no explicit requirement, just general ones.

The FAA considers § 23.2320(c) to be an explicit requirement for cockpit smoke evacuation but general regulations may also require smoke evacuation to be considered. A pressurized airplane design that cannot evacuate smoke from the cockpit sufficiently to allow the flightcrew to safely perform their duties, does not provide each occupant with air at a breathable pressure, free of hazardous concentrations of gases, vapors and smoke, during normal operations and probable failures. Therefore, an effective smoke evacuation system is necessary to comply with § 23.2320(c) of this rule.

The Associations recommended reordering proposed § 23.755(d) and (e) to place the oxygen requirements after the pressurization requirements. The FAA agrees with the recommendation and notes this change harmonizes with EASA's regulation. In EASA's regulation, pressurization system requirements precede the oxygen systems requirements.

Textron commented that the FAA should remove proposed § 23.755(e)(1), as it covers the same subject area as proposed § 23.1305(c). Proposed § 23.1305(c) would have required information concerning an unsafe system operating condition to be provided in a timely manner to the crewmember responsible for taking corrective action. Presentation of this information must be clear enough to avoid likely crewmember errors.

The FAA agrees with Textron's comment, as both sections would require the crewmembers to be made aware of unsafe conditions. Therefore, the FAA adopts § 23.2605(c) as proposed and withdraws proposed § 23.755(e)(1).

Proposed § 23.755(e)(2) would have required pressurization systems, if installed, to include a pressurization system test. The FAA intended to capture the safety intent of

former § 23.843, “Pressurization system tests,” which required specific tests for demonstrating compliance with safety requirements. Upon further review, the FAA finds that proposed § 23.755(e)(2) contains prescriptive requirements, which is inconsistent with the FAA’s goal of establishing performance-based requirements as was set forth in the NPRM. Therefore, the FAA withdraws proposed § 23.755(e)(2).

The FAA reviewed the former regulations related to proposed § 23.755 to determine if it inadvertently omitted any safety requirements for pressurization systems. As a result of this review, the FAA has identified the following omissions, which are addressed in this rule.

This final rule now requires pressurization systems, if installed, to be designed to protect against decompression to an unsafe level, which captures the safety intent of former §§ 23.841(c), (d)(2) and (d)(3). This final rule also requires pressurization systems, if installed, to be designed to protect against excessive differential pressure, which captures the safety intent of §§ 23.841(b)(1), (b)(2), (b)(3) and (b)(8).

Section 23.2320(e)(1) specifically requires that if an oxygen system is installed in the airplane, it must effectively provide oxygen to each user to prevent the effects of hypoxia and be free from hazards in itself, in its method of operation, and its effect upon other components. This requirement captures the safety intent of former §§ 23.1441(a) and (d); 23.1443, and 23.1447(a), (b), (c), (d), (e), and (g). These provisions require pressure/demand oxygen equipment for the crew on high altitude airplanes; minimum oxygen flowrates and pressures at specified conditions; standards for oxygen mask and cannula effectiveness; ease of donning, retention, and accessibility; and standards for

crew communication while using oxygen equipment[43]. The FAA revises 23.2320(e)(1) to capture the safety intent of these former regulations, but without their prescriptive requirements, by requiring that if an oxygen system is installed in the airplane, it must effectively provide oxygen to each user to prevent the effects of hypoxia.

The FAA has also decided to add the specific language from former § 23.1441(b) into § 23.2320. Requiring an oxygen system, if installed, to be free from hazards in itself, in its method of operation, and its effect upon other components restates former § 23.1441(b) verbatim and captures the safety intent of former §§ 23.1441(b) and (e), 23.1445, 23.1447(f), 23.1449, 23.1450(b), 23.1451, and 23.1453. These provisions required—

- A means for the crew to turn on and shut off oxygen supply at the high-pressure source in flight;
- Materials that could be used for oxygen tubing to be considered;
- A means to reserve oxygen for the flightcrew if a source is shared with passengers;
- A manual means to deploy passenger oxygen masks (or other units) for high-altitude airplanes;
- A means to allow the crew to determine whether oxygen is being delivered;
- Hazards from chemical oxygen generator temperature and pressure to be addressed;
- Protection of oxygen equipment and lines from fire hazards; and

[43] These specifications were intended to protect against hypoxia.

- Protection against overload, unsafe temperatures, and hazards in a crash landing.

The FAA withdraws proposed § 23.755(d)(1) as it is rendered redundant by adopted § 23.2600(b).[44] Furthermore, by making the revisions described previously, the FAA is able to eliminate proposed § 23.755(d)(2) and (3) as redundant. Proposed § 23.755(d)(2) and (3) would have required oxygen systems to include a means to determine if oxygen is being delivered and a means to permit the flightcrew to turn on and shut off the oxygen supply at any high-pressure source in flight. The FAA considers these requirements redundant because failure to deliver oxygen to a user who needs oxygen for protection against hypoxia with no way to determine that oxygen is not flowing is a hazard in the oxygen system; and an oxygen leak that cannot be shutoff at the high pressure source is a hazard in the oxygen system. If oxygen is needed for the survival of the pilots or passengers and it is turned off at the high-pressure source (intentionally or inadvertently), the inability to turn it on would be a hazard in the oxygen system.

f. Fire Protection (proposed § 23.800/now § 23.2325)

In the NPRM, proposed § 23.800 (now § 23.2325) would have required the—

- Insulation on electrical wire and electrical cable outside designated fire zones be self-extinguishing;

[44] Proposed § 23.755(d)(1) would have required oxygen systems to include a means to allow the flightcrew to determine the quantity of oxygen available in each source of supply on the ground and in flight. Adopted § 23.2600(b) requires the applicant to install displays so qualified flightcrew can monitor and perform defined tasks associated with the intended functions of systems and equipment.

- Airplane cockpit and cabin materials in certification levels 1, 2, and 3 be flame-resistant;
- Airplane cockpit and cabin materials in level 4 airplanes be self-extinguishing;
- Airplane materials in the baggage and cargo compartments, which are inaccessible in flight and outside designated fire zones, be self-extinguishing; and
- Electrical cable installation that would overheat in the event of circuit overload or fault be flame resistant.

Additionally, proposed § 23.800 would have precluded thermal acoustic materials outside designated fire zones from being a flame propagation hazard. Proposed § 23.800 would have also required sources of heat that are capable of igniting adjacent objects outside designated fire zones to be shielded and insulated to prevent such ignition.

Proposed § 23.800 would have required airplane baggage and cargo compartments, outside designated fire zones, to be located where a fire would be visible to the pilots, or equipped with a fire detection system and warning system, and—

- Be accessible for the manual extinguishing of a fire;
- Have a built-in fire extinguishing system, or
- Be constructed and sealed to contain any fire within the compartment.

Proposed § 23.800 would have required a means to extinguish any fire in the cabin, outside designated fire zones, such that the pilot, while seated, could easily access the fire extinguishing means, and for levels 3 and 4 airplanes, passengers would have a fire extinguishing means available within the passenger compartment. Where flammable fluids or vapors might escape by leakage of a fluid system, proposed § 23.800 would

have required each area, outside designated fire zones, be defined and have a means to make fluid and vapor ignition, and the resultant hazard, if ignition occurs, improbable. Additionally, proposed § 23.800 would have also required combustion heater installations outside designated fire zones be protected from uncontained fire.

EASA commented that the fire protection outside designated fire zones requirements proposed in § 23.800 were design solutions instead of objectives. EASA contended these proposed provisions would hamper the development of different, but acceptable future designs. EASA recommended the FAA follow the A-NPA text from CS 23.445.

The FAA does not share EASA's view that the proposed § 23.800 requirements were design specific solutions. For the foreseeable future, there will be wiring, cabling, insulating, and covering materials used in airplane cabins, cockpits, and baggage and cargo compartments. The performance standard requires certain materials be self-extinguishing, flame resistant, etc., in order to prevent the initiation or propagation of a fire. The way to demonstrate compliance with the performance standard is now moved to accepted methods of compliance instead of being specified in rule language or appendices. Additionally, the former part 23 regulations for commuter category airplanes, and the proposed regulations for level 4 airplanes, intended for personnel to be alerted to the presence of a fire and a way to extinguish it. Based on the FAA's understanding of the current technology available, for the foreseeable future, fire detection systems and extinguishers are the methods to achieve this. The FAA is not prescribing the technology and design of those systems.

Additionally, the FAA finds that following the A-NPA text from CS 23.445 would be a new approach to achieving the safety intent of preventing the initiation or propagation of a fire, which was not set forth for notice and comment. Further, the FAA has concerns whether EASA's proposed rule language would meet the same level of safety as provided for in the former part 23 regulations, as EASA's proposed text would require minimization of the risk of "fire initiation" and "fire propagation". The word "minimize" has not historically been used in this safety standard where specific tests were used with specific pass/fail criteria. The FAA also finds using the word "minimize" may introduce ambiguity in the rule. While the FAA is not adopting EASA's recommendation, the FAA contends the requirement in § 23.2325 harmonizes with EASA's requirements because the effect is the same.

Embraer recommended modifying the title of proposed § 23.800 to remove the word "designated," as well as removing the phrase "Outside designated fire zones" from the lead sentence of the proposed rule.

The FAA agrees with Embraer's comment that it is unnecessary to state "designated" in the title. The FAA eliminates the phrase "fire zones" as well because the term may lead to confusion. This revision aligns the final rule with the safety intent of former regulations and has the benefit of aligning the title with EASA's proposed title. Furthermore, the FAA changes the title of § 23.2325 to "Fire protection" and deletes the lead-in sentence "Outside designated fire zones:". Finally, the FAA adds "…in the fuselage…" to subparagraph (c) so as not to expand the applicable area of the rule.

Transport Canada recommended the FAA define several terms used in this section, specifically, "self-extinguishing," "flame resistant," and "flame propagation

hazard", because this section would otherwise be subject to a wide range of interpretation. Transport Canada stated the performance statement, as expressed, may not ensure the level of safety of former § 23.853.

The FAA finds that defining these terms is not necessary, nor that this rule will be subject to a wide range of interpretation. Putting the parameters necessary to precisely define these terms would mean specifying test standards, which is contrary to the rule's intent to move away from prescriptive standards. The specifications for meeting these requirements will be contained in an accepted means of compliance. One means of compliance accepted by the FAA is to use the former prescriptive means of compliance contained in former part 23, together with a policy statement issued by the FAA identifying means by which the FAA has addressed errors, ELOS findings to various provisions of former part 23, and special conditions (i.e., "prescriptive means"). The performance standard, plus this accepted means of compliance, will ensure the same level of safety as former § 23.853. The FAA notes that to be acceptable, any future proposed means of compliance would have to provide at least an equivalent level of safety.

Transport Canada questioned whether proposed § 23.800(a) would cover components located in between the fuselage skin and the compartment liners that were explicitly covered under former § 23.853. The commenter recommended the FAA consider these components.

The FAA finds it unnecessary to list these specific parts in the rule since all materials in those compartments must meet the standards specified for that compartment. The FAA notes, just as under former § 23.853(d)(3)(ii), items behind compartment liners are considered materials that exist in those compartments.

In level 4 airplanes, proposed § 23.800(a)(3) would have required materials in the cockpit, cabin, and baggage and cargo compartments be self-extinguishing. NJASAP stated level 3 high-speed airplanes should also be required to have self-extinguishing cockpit and cabin materials. NJASAP noted many business jets that fly at high altitude will fall into the level 3 high-speed category in the future. NJASAP indicated if a fire were to break out in this airplane type, it could take several minutes to detect it and to make an emergency landing.

The FAA notes under the former § 23.853(d), only commuter category airplanes needed to meet the self-extinguishing requirement for these specified items. In the NPRM, the FAA correlated level 4 airplanes to the commuter category. Therefore, adding the requirement to make cockpit and cabin materials self-extinguishing for level 3 airplanes would impose requirements beyond those imposed under former § 23.853 and would be beyond the scope of the notice. Furthermore, the FAA is unaware of service experience with level 3 airplanes that would justify the increased cost associated with the NJASAP's comment.

Textron and the Associations requested clarification regarding the use of "or" in proposed § 23.800(b)(2) with respect to circuit overload or fault. The Associations asked whether the FAA intends to allow some electrical systems, such as high-reliability primary power wires in electrically-powered airplanes, to use reliable design practices in place of circuit protection for some wires. Textron thought the use of "or" meant both overload and failure of the protective device do not need to be considered and asked whether the intent is to allow some circuits without overload protection, such as main start cables.

The FAA notes the focus of this rule is fire protection rather than circuit design. The FAA's intent is to make certain electrical cable installations that could overheat are flame resistant, regardless of whether this is due to a circuit overload or fault. Proposed § 23.800 nearly mirrors former § 23.1365(b), which used the same phrase "…circuit overload or fault...." [45] The FAA did not intend to change the meaning of former § 23.1365(b). To address the commenters' concerns, the FAA revises § 23.2325 to reflect the language as stated in former § 23.1365(b).

Also, the FAA noted a typographical error in proposed paragraph (c). A slash ("/") between "thermal" and "acoustic" was missing. The absence of the "/" indicate only insulation that was both thermal and acoustic must comply. The FAA's intention was either thermal or acoustic, as required under the former § 23.856. The FAA has corrected this inadvertent omission in this rule.

Textron and the Associations submitted comments on proposed § 23.800(d), which would have required sources of heat that are capable of igniting adjacent objects, to be shielded and insulated to prevent such ignition. Textron noted the proposed rule broadened the scope of the former requirement from "cargo and baggage compartments" to anything that is not a designated fire zone. Textron recommended the FAA modify proposed § 23.800(d) to include the phrase "located in the cargo and baggage compartments" after "Sources of heat." Textron also commented that preventing hot equipment from starting fires in normal operation is needed, but in the case where materials and proximities are controlled by type design (i.e., other than the cargo and baggage compartments), this is sufficiently addressed by proposed § 23.1300 (now

[45] See 61 FR 5151, February 9, 1996.

§ 23.2500). The Associations recommended modifying proposed § 23.800(d) by adding the phrase "located in the cargo compartment."

The FAA agrees the proposed rule would have unintentionally broadened the prior requirements. The FAA revises the rule language to add "within each cargo and baggage compartment". The FAA also agrees with Textron that other regulations in subpart F sufficiently address the issue of preventing hot equipment from starting fires in normal operation where materials are located in places other than the cargo and baggage compartments.

The Associations proposed removing the word "any" in front of "fire" from proposed § 23.800(e)(2) and (f). The commenters did not provide a reason for the proposal. Although "any" is implied, the FAA prefers to leave the word in the rule language to be explicit.

Regarding proposed § 23.800(g)(2),[46] Textron asked whether the probability of the leak is considered (i.e., the "improbable" requirement is for ignition and hazard after a leak). Textron recommended the FAA clarify whether the requirement presumes a leak. Transport Canada commented that the language of proposed § 23.800(g)(2) was not consistent with AC 23.1309-1E. An individual commenter submitted a similar comment. Transport Canada recommended the FAA revise this provision to be consistent with AC 23.1309-1E, thereby changing the qualitative probability to be remote, extremely remote, or extremely improbable.

The FAA agrees the wording of proposed § 23.800(g)(2) was problematic because the term "improbable" was associated with quantitative failure rates in former § 23.1309.

[46] Textron cited proposed"§ 23.2325(a)(2)", but it appears the commenter intended to refer to § 23.2325(g)(2).

The FAA did not intend to require an assessment of the probability of a flammable fluid leak or ignition of a flammable fluid leak. The FAA's intent is that reasonable design precautions are used to reduce (i) the likelihood of flammable fluid leaks, (ii) the likelihood of flammable fluid ignition, and (iii) the severity of flammable fluid ignition. The FAA agrees that since the proposed rule would have required ignition to be assumed, it does not make sense to make the hazard improbable "if" ignition occurs.

The FAA intended to capture the safety intent of the requirement in former § 23.863. The FAA considered the suggestions for revising proposed § 23.800(g), and is using the text of former § 23.863(a). Former § 23.863(a) was a performance-based requirement and former § 23.863(b) and (c) provided details on how former § 23.863(a) must be addressed. New § 23.2325(g)(2) requires a means to minimize the probability of ignition of the fluids and vapors and the resultant hazard if ignition does occur in each area where flammable fluids or vapors might escape by leakage of a fluid system. "Minimize" means to reduce the probability and consequences of occurrence to the extent practical. It does not establish a probabilistic requirement, but rather requires application of sound engineering judgment to use effective means to achieve the safety objective.

g. Fire Protection in Designated Fire Zones and Adjacent Areas (proposed § 23.805/now § 23.2330)

In the NPRM, proposed § 23.805 (now § 23.2330) would have required—

- Flight controls, engine mounts, and other flight structures within or adjacent to designated fire zones be capable of withstanding the effects of a fire;
- Engines inside designated fire zones to remain attached to the airplane in the event of a fire or electrical arcing; and

- Terminals, equipment, and electrical cables, inside designated fire zones, used during emergency procedures, be fire-resistant.

Embraer recommended modifying proposed § 23.805 to change the title from "Fire protection in designated fire zones" to "Fire protection in fire zones and adjacent areas."

The FAA agrees with the recommendation to add "and adjacent areas" to the title for clarification. The FAA notes that § 23.805(a) references flight controls, engine mounts, and other flight structures adjacent to a designated fire zone.

However, "designated fire zone" has a particular meaning. Embraer viewed this proposed definition as prescriptive and recommended the FAA use the definition of "fire zone" contained in the draft of AC 25.863-1. That definition stated a fire zone means a "zone that contains a nominal ignition source and may be exposed to a flammable fluid/material as a result of a failure." The FAA reviewed the definition of "fire zone" in AC 25.863-1 and determined this definition would impose requirements beyond those in the former part 23 regulations.

Embraer also recommended removing the modifying phrase "inside designated fire zones" contained in the proposed regulation. Embraer stated that "former § 23.1181 defined the 'hot' parts of an engine installation is an ignition source and considering that there are fuel, oil, and hydraulic fluids being carried around such areas, they shall be considered a fire zone, and then the term 'designated' would apply, which means that it is not necessary [for] further analysis to define if it is a flammable fluids zone or a fire zone."

The FAA agrees with Embraer's recommendation and removes the modifying phrase from the first line of the proposed text for § 23.805(b). The FAA will clarify within each requirement if it applies in designated fire zones, or designated fire zones and adjacent areas.

EASA stated that proposed § 23.805(b) reflects current design-specific requirements that should be amended to cover other "new" designated fire zones, such as for batteries. Proposed § 23.805(b) would have required engines inside designated fire zones to remain attached to the airplane in the event of a fire or electrical arcing. EASA recommended revising proposed § 23.805(b) to read: "A fire in a designated fire zone must not preclude continued safe flight and landing".

The FAA finds EASA's proposal is beyond the scope of the NPRM. The FAA intended proposed § 23.805 to capture the safety intent of former §§ 23.865 and 23.1359(b). Former § 23.865, in part, required engine vibration isolators to incorporate suitable features to ensure the engine is retained if the non-fireproof portions of the vibration isolators deteriorate from the effects of a fire. The FAA finds this requirement is still applicable to engines that use flammable fuels and should be retained. However, the FAA agrees proposed § 23.805(b) reflected current design-specific requirements that would not be applicable to other potential designs that do not use flammable fuels for propulsion. Therefore, the FAA is making this requirement only applicable to engines in designated fire zones. The FAA also withdraws the proposed requirement for engines to remain attached to the airplane in the event of electrical arcing, because the FAA finds that the threat of electrical arcing causing structural failure is addressed adequately in the electrical systems requirements in subpart F.

Embraer commented that the word “engine” should be replaced with the phrase “power unit” in proposed § 23.805(b). The FAA understands Embraer’s rationale, but the FAA’s authority to issue TCs refers to “aircraft engines,” not power units (49 U.S.C. 44704(a)(1)) so the term “aircraft engines” needs to be retained. Therefore, the FAA is not adopting EASA’s recommendation in the final rule.

Textron recommended the FAA replaces “terminals, equipment, and electrical cables” with the word “equipment” in proposed § 23.805(c). Paragraph (c) would have required terminals, equipment, and electrical cables inside designated fire zones, that are used during emergency procedures, be fire resistant. Textron stated that if this provision is supposed to apply to anything in a fire zone that gets used in an emergency, it is potentially misleading.

The FAA disagrees with Textron’s comment. The FAA intended proposed § 23.805(c) to capture the safety intent of former § 23.1359(b), which stated “Electrical cables, terminals, and equipment in designated fire zones that are used during emergency procedures must be fire-resistant.” Accordingly, the FAA is not making any change to the language proposed in § 23.805(c)(now § 23.2330(c)).

h. Lightning Protection (proposed § 23.810/now § 23.2335)

In the NPRM, proposed § 23.810 (now § 23.2335) would have precluded primary structure failure caused by exposure to the direct effects of lightning, that could prevent continued safe flight and landing for airplanes approved for IFR. Proposed § 23.810 would have required airplanes approved only for VFR to achieve lightning protection by following FAA-accepted design practices found in FAA-issued ACs and in FAA-accepted consensus standards.

Air Tractor and Transport Canada commented that "FAA-accepted design practices" does not establish a performance standard in proposed § 23.810(b). Air Tractor also noted this proposed regulation would make the ACs required and regulatory. Transport Canada further stated that specifying "FAA" in the rule is not conducive to harmonization between authorities and recommended replacing "FAA-accepted design practices" with a performance-based requirement in the form of a safety objective.

The FAA agrees that proposed § 23.810(b) is not consistent with the goal to develop performance-based standards and to spur innovation. The FAA recognizes new methods of protecting the airplane from catastrophic effects from lightning may be developed that are not currently FAA-accepted design practices and these methods should be permitted if found acceptable to the FAA.

In light of the comments received for this section, the FAA revisited the goal of proposed § 23.810. The FAA intended to capture the safety intent of the former lightning regulations in former § 23.867. Former § 23.867(a) was a high-level performance-based requirement requiring the airplane to be protected against catastrophic effects from lightning. Former § 23.867(b) and (c) were means of compliance with § 23.867(a). Former § 23.867(b) specified how metallic components must be designed to protect the airplane against catastrophic effects from lightning, while former § 23.867(c) specified how non-metallic components must be designed to protect the airplane from catastrophic effects from lightning. The FAA also intended to establish safety requirements for direct and indirect effects of lightning on all systems and structure in proposed §§ 23.810, 23.930, and 23.1320. Proposed § 23.810 would have addressed protection of structure, proposed § 23.930 would have addressed protection of fuel systems, and proposed

§ 23.1320 would have addressed protection of electrical and electronic systems. However, upon review, proposed § 23.810 did not address all structure and proposed § 23.1320 did not address all systems and equipment.

The FAA has determined that retaining the language of former § 23.867(a) would more appropriately capture the FAA's intent for § 23.2335 because it applies to the entire airplane including all systems, equipment and structure. Therefore, the FAA revises § 23.2335 to require the airplane to be protected against catastrophic effects from lightning, which is a performance standard. The FAA finds this revision addresses Air Tractor's and Transport Canada's remaining concerns.

The FAA also identified an error in the proposed correlation table in the NPRM. Former § 23.867(b) was correlated with proposed § 23.1320, "Electrical and electronic system lightning protection", and not proposed § 23.810, "Lightning protection of structure". This reference was incorrect because proposed § 23.1320 did not address all aspects of protecting the airplane against catastrophic effects from lightning for metallic components. The FAA corrected the correlation in the table provided in this final rule.

EASA commented that the requirement of lightning protection of the structure should relate to the type of environment that causes the risk, instead of the type of operation. EASA recommended replacing IFR with instrument meteorological conditions (IMC), and replacing VFR with visual meteorological conditions (VMC).

The FAA agrees with EASA's comment that the requirements for lightning protection should be related to the risk of lightning. Rather than drawing a distinction between IFR and VFR, or IMC and VMC, the language provided in this final rule now reflects a performance-based standard. The standard will be met by an accepted means of

compliance. The FAA finds this approach provides greater flexibility to allow development of means of compliance that are appropriate for different types of airplanes and different types of operation depending on the risk of lightning.

6. Subpart E – Powerplant

a. General Discussion

In the NPRM, the FAA proposed substantial changes to former subpart E based on two considerations. First, the FAA stated many of the former regulations could be combined to provide fewer regulations that accomplish the same safety intent. Second, the FAA also stated part 23 overlaps with the requirements in parts 33 and 35.

Textron noted that subpart E appeared to be missing performance requirements for key propulsion aspects. Textron recommended the FAA include rules that address engine controls, powerplant accessories and components, and powerplant instruments and indicators as set forth in former §§ 23.1141, 23.1163, and 23.1225 of appendix E of the Part 23 ARC Report.

The FAA reviewed each requirement mentioned by the commenter and finds those requirements have been addressed in the final rule using less prescriptive language. In most cases several regulations, rather than any single rule, capture the intent of the former regulations referenced by the commenter. Requirements contained in regulations for powerplant installation, airplane level systems, and flightcrew interface combined with more specific requirements found in regulations for powerplant fire protection, instrument markings, control markings, and placards, address the specific requirements noted by the commenter.

An individual commenter stated the FAA's removal of all references to part 33 and part 35 from proposed part 23 was inappropriate. The commenter contended the FAA's conclusion that those references are redundant because the requirements are already addressed during the certification of the engine or propeller is incorrect. The commenter noted that compliance with specific performance standards for engines and propellers is only ensured by requiring a product to be approved to a specific amendment level of part 33 or 35, before it is eligible for installation on a particular airplane. The commenter also noted that engines and propellers approved prior to a specific part 23 amendment level may not have met a specific installation level requirement specified by that amendment. For example, the commenter noted that former § 23.903 required minimum engine ingestion performance by the installation of an engine certified to a specific amendment level of part 33, thereby ensuring that any installed turbine engine had met a minimum performance level mandated by the FAA through that amendment level.

The individual commenter also stated engine and propeller limitations are established during the type certification of the engine or propeller, and that these limitations are required to be included in the TCDS and associated installation manuals. The installer must comply with these limitations. The commenter further implied that, if the installed engine or propeller limitations cannot be complied with, safe operation of the product cannot be ensured. For example, the commenter stated that former §§ 23.1041 through 23.1047 required the engine installation to be designed such that the temperature limitations—established under part 33 for the engine—are maintained in the installed configuration.

The individual commenter also noted that some components of an engine or propeller are approved at both the engine or propeller level and at the airplane level, but that all components require approval at the airplane level. According to the commenter, the approval of the engine or propeller TC can include items such as a propeller reversing system or a turbocharger, and this data can be used for approval of these systems at the airplane level. If an applicant prefers approval at the airplane level only, this commenter noted, the former rule provided a reference to the requirements contained in part 33 or 35, as appropriate. Without the inclusion of these references in proposed part 23, certification may require special conditions.

The commenter recommended the FAA include—

- References to parts 33 and 35 for type certificated engines and propellers being installed and consider the inclusion of similar standards when the installation of non-type certificated engines or propellers are permitted;
- A specific rule stating the powerplant installation design must be such that all installed type certificated engines and propellers remain within their respective approved limitations and installation manual requirements and that a similar provision be included when the installation of non-type certificated engines and propellers is permitted; and
- Reference in the proposal to the applicable provisions of parts 33 and 35 for engines, propellers, and any related components of those products being installed only at the airplane level.

The FAA agrees with the general intent of the commenter. The FAA notes that while some requirements in the former part 23 indeed overlap with those of parts 33 and

35, the FAA did not intend to imply that compliance with those requirements necessary for type certification of an engine or propeller were no longer applicable to the certification of the installed configuration of a type certificated engine or propeller. Historically, TCs have been required for engines and propellers installed in airplanes certificated under part 23 and this rule retains this requirement for all airplanes certificated under part 23, with the exception of level 1 low-speed airplanes.[47] Essentially, this requirement makes the requirements in parts 33 and 35 for type certificated engines and propellers applicable to the certification of airplanes under part 23, because the part 33 and 35 requirements must be met in order to install these engines and propellers on part 23 airplanes. As a result, data used to show compliance for an engine or propeller TC is considered FAA approved, and can be used to show compliance with any applicable part 23 requirement. In many cases, this permits a single showing of compliance such that a re-showing of compliance at the airplane installation level may not be required. Approval of some components, such as propeller controls or turbocharges, have been permitted at the airplane level by referencing the applicable part 33 or 35 requirements and using those requirements as an acceptable means of compliance. This certification approach will continue to remain acceptable.

The FAA does not intend to accept a means of compliance for an engine or propeller installation that would result in a level of safety lower than that set forth in a part 33 or 35 amendment level specifically referenced in former part 23.

Limitations set forth in the approval of an engine or propeller must be maintained in the installation on the part 23 airplane. These operating limitations are established in

[47] Discussed in the preamble discussion for § 23.2400.

accordance with §§ 33.7 and 35.5. Installation instructions are provided to the installer in accordance with §§ 33.5 and 35.3. This regulation does not change this approach.

Additionally, the FAA is adding a requirement from existing § 23.901(e) to § 23.2400, requiring installed powerplant components—which include engines and propellers—to meet the FAA-approved component limitations and installation instructions, or be shown not to create a hazard. This requirement will ensure that any operating limitations and installation instructions applicable to the engine or propeller remain applicable to the certification of the airplane.

In the NPRM, an exception permitting the installation of non-type certificated engines and propellers as part of the airplane was proposed for simple airplanes. The proposal mirrors the precedent established for the certification of airplanes under EASA CS-VLA. The rule slightly expands the relief provided by the proposal, and permits the certification of engines as part of the airplane for level 1 low-speed airplanes. This change encompasses the same class of airplanes as originally proposed while removing the restriction that these airplanes be limited to VFR-only operations.[48]

In response to the individual commenter's concerns that the proposal does not require certain engines to meet a specific amendment level of part 33, as set forth in former regulations, and the commenter's specific concern that engine ingestion performance was not specifically addressed, the FAA notes those sections of former subpart E that required compliance with a specific amendment level for an engine installation are addressed in this performance-based rule. The engine ingestion requirements of former § 23.903(a)(2), for example, are addressed by the performance-

[48] Discussed in the preamble discussion for § 23.2400.

based requirements of § 23.2400(c). The former rule specified that an applicant must construct and arrange each powerplant installation to account for likely operating conditions including foreign object threats and likely hazards in operation. Although § 23.2400(c) does not refer to a specific requirement or amendment level of part 33, the FAA expects the means of compliance with this regulation will include provisions for certificating engines with acceptable foreign object ingestion performance as required by former § 23.903(a)(2), which may include references to different amendment levels of part 33 where appropriate. Additionally, the FAA intends to accept part 23 through amendment 23-62, which contained references to specific requirements in part 33, as a means of compliance to the performance-based requirements of this rule. The FAA will only accept a means of compliance for a performance-based regulation that encompasses the safety intent of a former regulation requiring compliance with a particular amendment level of part 33 or 35, if that means of compliance provides a level of safety equivalent to the level of safety found in former part 23.

b. Powerplant Installation and Propeller Installation (proposed §§ 23.900 and 23.905 /now § 23.2400)

In the NPRM, proposed §§ 23.900 and 23.905 (now § 23.2400) would have clarified, for the purpose of this subpart, that the airplane powerplant installation must include each component necessary for propulsion, affects propulsion safety, or provides auxiliary power to the airplane. Proposed § 23.900 would have required the applicant to construct and arrange each powerplant installation to account for likely hazards in operation and maintenance, and, except for simple airplanes, each aircraft engine would have to be type certificated. Proposed § 23.905 would have retained the requirement that

each propeller be type certificated, except for propellers installed on simple airplanes. Proposed § 23.905 would have retained the requirement that each pusher propeller be marked so it is conspicuous under daylight conditions.

EASA commented that design-specific requirements for propeller installations should be covered by proposed § 23.900, not proposed § 23.905.

The FAA adopts the regulatory approach taken by EASA for propeller installation. Under this approach, the FAA includes the requirements for propeller installation within § 23.2400. Specifically, the requirements of proposed § 23.905(a) are addressed by § 23.2400(b), proposed § 23.905(b) are addressed by § 23.2400(c)(3), and proposed § 23.905(c) are addressed by § 23.2400(c)(4). These revisions also clarify that a propeller installation must not deviate from any limitations or installation instructions as required by § 23.2400(e). Addressing propeller installation requirements in the section of the rule that establishes powerplant installation requirements also results in closer harmonization of the rule with EASA's proposed requirements in NPA 2016-05.

The FAA received numerous comments regarding the issue of whether "power units" should be certified under part 23 as part of the airplane type certification. The Associations noted the proposed language would allow engine and propellers that meet required standards to be certified as part of the airframe, provided the airplane is certificated as a simple airplane. The commenters contended the ability to certificate these components as part of an airframe should be based on the complexity of the components rather than on the certification or performance levels of the airplane in which they are installed. The commenters supported permitting the certification of engine and propellers that comply with traditional engine and propeller type certification

requirements either through the issuance of a standalone TC or through the certification process for the airframe. The commenters also noted since electric propulsion is “on the threshold of becoming mainstream”, the ability to certify engines and propellers as part of the airframe is critical to the successful and safe integration of that technology.

EASA asserted the need to type certify an engine should be addressed by part 21; therefore, the powerplant either could be type certificated or certified as part of the airplane. EASA noted the type certificate-related design and production controls that are part of the current type certification process are also expected to be applicable for other components such as batteries and converters. EASA stated certification of the engine should not be related to the size or speed of the airplane; therefore, EASA did not support limiting the installation of propulsion systems that are not individually type certificated to airplanes classified as simple airplanes.

Textron noted the purpose of the proposed rule is to enhance the ability to introduce new technology efficiently, and contended that treating each powerplant installation (e.g., electric propulsion) using a unique ELOS finding would not be an effective way to address the issue. Textron recommended either adding the requirements for certifying the power unit as part of the airplane, or changing and including the specific requirements in the industry standard to avoid the need for unique ELOS findings. Additionally, Textron recommended adopting proposed CS 23.500(b), which would not restrict the installation of non-type certificated engines that meet an industry standard to simple level 1 airplanes.

An individual commenter expressed support for the proposal to not require certified engines for “simple” airplanes, but suggested expanding the definition of

“simple” to at least four-seat airplanes with V_{S0} < 55kts and permitting IFR operations. The commenter stated certain airplanes should not require a type-certified engine with all of the associated costs, paperwork, and outdated technology. The commenter also noted the requirement for a certified engine in most airplanes precludes the use of electric propulsion in anything but "simple" airplanes, since part 33 does not allow for the certification of electric motors. The commenter also suggested revisions to part 33 aimed at realizing the same kind of cost reductions and to allow certain technologies on small airplane engines without requiring full authority digital engine control (FADEC) levels of “design assurance.” Additionally, other commenters specifically recommended the proposed regulation be revised to permit all power units installed in airplanes certificated in accordance with part 23 to be type certificated or meet accepted specifications.

Air Tractor questioned whether alternative types of powerplant units would receive a TC specific to that unit “from within part 23” and distinct from the airplane in which it is installed. If so, Air Tractor expressed concern this approach would create a series of rules for the purpose of issuing a TC for an unconventional powerplant design and stated part 23 rules should not be applied to the certification of unconventional powerplants. Air Tractor also recommended all engines and propellers be either “type certified” or “possess a type certificate.”

NATCA noted if neither the engine nor the propeller would be required to be type certified when installed on a simple airplane, it is unclear how those products would be approved. Furthermore, NATCA noted by allowing non-certificated engines on simple level 1 airplanes, it was unclear how an airworthiness directive would be issued if an unsafe condition were found to exist on the engine. NATCA also recommended the FAA

specify the minimum level of engineering safety certification testing necessary to demonstrate how the engine and propeller for simple airplanes could be approved, if they were not type certificated.

The FAA notes the recommendation to expand the scope of proposed § 23.900 to permit all engines and propellers installed in airplanes certificated under part 23 to be certificated under the TC of the airplane in which the engine or propeller is installed. The FAA evaluated the commenters' recommendations to base the need for an engine or propeller TC on the complexity of the powerplant system rather than on the complexity of the airplane. The FAA has established standards in parts 33 and 35 that ensure an acceptable level of safety and adequate standardization for certification of all aircraft engines and propellers. Certification of an engine or propeller with the airplane instead of requiring a separate engine or propeller TC essentially requires a showing of compliance equivalent to the airworthiness standards contained in part 33 for aircraft engines or part 35 for propellers. The FAA finds that placing these requirements in part 23 and using an accepted standard as a means of compliance (with the limited exception for airplanes that can be certificated as level 1 low speed), would not significantly reduce the regulatory burden on engine and propeller manufacturers. Additionally, at this time the FAA does not want to place the administrative responsibility for the certification of all engines and propellers installed in part 23 airplanes on two separate Aircraft Certification Directorates, with the ensuing risks of delaying implementation of the significant changes set forth in this final rule and creating the possibility of differing interpretations or regulatory requirements. The FAA is, however, open to revisit this option in the future. If, for example, actual certifications or advances in technology indicate that expanding

this approach to include larger airplanes would provide a manufacturer certification efficiencies, the FAA would be willing to consider this expanded approach.

The FAA notes the Engine and Propeller Directorate (EPD) has been responsible for establishing standards for engines and propellers and continues to remain the best source for developing policy and guidance for determining compliance with those standards, to include standards for the certification of electric engines. While many commenters believe the introduction of electric engines is imminent, and shifting the responsibility for the certification of all engines and propellers installed in airplanes that meet the airworthiness standards of part 23 from the EPD to the Small Airplane Directorate (SAD) would facilitate certification of those engines, the FAA finds such action could delay both the certification of electric engines and other more conventional engine designs. Such a realignment of certification responsibilities would increase the burden on both applicants and the FAA as the involvement of two directorates would be required during the certification process for aircraft engines and propellers. Additionally, certification of an engine or propeller with the airplane increases the burden of showing compliance when the product is installed in multiple airplane models, as compliance with the basic engine and propeller requirements must be shown for each specific airplane model installation.

Accordingly, the FAA retains the basic approach discussed in the NPRM requiring that all engines and propellers require a separate TC except for those engines and propellers installed in airplanes that can be certificated as level 1 low speed. Those standards permit the certification of the engine and propeller with the airplane and do not require those products possess a separate TC. However, the FAA has slightly revised the

proposal to expand the approval of aircraft engines and propellers under the airplane TC from simple airplanes, as originally proposed to all level 1, low-speed airplanes. Section 23.2400 will allow level 1 airplanes with engines not separately type certificated to be used for both VFR and IFR operations. Additionally, the FAA has added language that indicates an acceptable standard for the certification of an engine or propeller, contains airworthiness criteria the Administrator has found appropriate and applicable to the specific design and intended use of the engine or propeller, and provides a level of safety acceptable to the FAA. This language mirrors the language contained in former § 21.17(f)(1) for primary category aircraft whose engines and propellers are certificated under the airplane TC. This approach allows some streamlining for the engine approval based on a specific installation verses the generic engine TC which might be more thorough to account for the possible installation variables. The FAA's concept of the safety continuum in this context bases certification requirements on potential risk and considers the number of potential passengers and the performance of the airplane, rather than the complexity of the engine or propeller installed.

As future aircraft engines and energy sources become available, both SAD and EPD may utilize ELOS findings, special conditions, and exemptions to establish appropriate certification standards. These processes will assist the agency in developing standards to address new and novel technology, and can be applied regardless of whether the design approval for an engine or propeller occurs as the part of the airplane or as a separate engine or propeller approval. Additionally, in response to those commenters concerned with the approval of electric aircraft engines, part 33 airworthiness standards will be developed to address those products as they are presented to the FAA for type

certification. Currently those standards do not exist in part 33, therefore, special conditions will likely be used to establish standards for the issuance of a TC before those standards have been promulgated.

In response to commenters' concerns related to uncertainty as to what minimum level of testing would be required for approval of engines not separately type certificated and how potential airworthiness concerns would be addressed for those products, the FAA expects any engine or propeller will meet standards that provide a level of safety at least equivalent to that achieved with the certification of those products today. The FAA may accept or reject any means of compliance proposed for acceptance and will only accept a means of compliance that ensures the design meets the performance standards set forth in part 23. An applicant intending to use this approach would have to re-establish compliance for the specific non-type certificated product in accordance with an applicable FAA accepted standard under the TC of each airplane model in which the product is installed rather than only once as would occur with an engine or propeller TC. As stated earlier, this provision permitting the type certification of both the engine and propeller under the airplane TC is limited to level 1 low-speed airplanes. Any unsafe condition related to "non-TC'd" engines or propellers will be addressed by issuance of an airworthiness directive requiring corrective action against the airplane TC under which those engines or propellers have been approved.

Textron questioned whether proposed § 23.900(c) includes auxiliary power units, as those units are not type certificated, but instead meet a TSO. Textron requested proposed § 23.900(c) be clarified to indicate it would apply to each aircraft power unit "used for propulsive power." Embraer, however, suggested including an alternate means

of compliance in proposed § 23.900(c) for electric engines, auxiliary power units, and other alternate sources of propulsion.

The FAA revises the rule to ensure APUs may be approved under the airplane TC in accordance with a standard accepted by the FAA, such as a TSO. The FAA does not intend to require a TC for these units.

The Associations stated the proposal should include provisions to address propulsion-specific hazards. The provisions include environmental issues unique to propulsion systems; ingestion of foreign object debris (FOD); and the dangers of propulsion aspects to ground personnel. To address their concerns, the commenters recommended revising proposed § 23.900 to specifically require an applicant to account for all likely operating and environmental conditions, including foreign objects threats; sufficient clearance of moving parts to other airplane parts or their surroundings; and likely hazards in operation, including hazards to ground personnel.

The FAA agrees with the commenters and revises the rule to specifically require all likely operating conditions (which include environmental conditions), including foreign object threats; sufficient clearance of moving parts to other airplane parts and their surroundings; and likely hazards in operation, including hazards to ground personnel are accounted for in each powerplant installation. Proposed § 23.900(b) referred to these conditions as “likely hazards in operation and maintenance,” but the FAA finds that specifically enumerating them will facilitate development of acceptable means of compliance. The FAA also notes that former subpart E required that applicants address these conditions.

To ensure compatibility between the airplanes and the power unit design, as well as the safe operation of the power unit, ANAC recommended including language, which would require the powerplant installation comply with the limitations and installation instructions provided by the power unit manufacturer. The Associations requested the proposed section include additional requirements specifying the installation of powerplant components that deviate from the component limitations or installation instructions be safe and applicable powerplant installations account for vibration and fatigue.

The FAA agrees with the commenters' intent to ensure the safe operation of the powerplant and has added paragraph (e) to § 23.2400 to specifically require powerplant components comply with their component limitations and installation instructions or be shown not to create a hazard. This requirement applies to the engine, propeller, and any other components of the powerplant installation. The rule is also revised to require powerplant installations account for vibration and fatigue. The FAA notes component limitations and an installation manual should be included as part of any powerplant installation. The evaluation of the powerplant installation should also include an evaluation of propeller vibration and compliance with proposed installation manual limits, as the installed propeller is a component of the powerplant installation.

Textron stated proposed § 23.900 does not address automatic power reserve (APR) systems. Textron recommended revising proposed § 23.900 based upon proposed CS 23.500. Textron also suggested including specific language from appendix E from the final Part 23 ARC Report, which states that an APR system that automatically advances the power or thrust on the operating engine(s), when any engine fails during takeoff, must

comply with the applicable requirements of the subpart. The FAA notes proposed § 23.915 addressed the requirements for APR systems referenced by the commenter and the FAA adopted these requirements in § 23.2415 of this rule.

Textron contended the proposed rule language does not include critical items from current part 23 or redefines current requirements. For instance, Textron noted proposed § 23.900(b) appears to change the current requirement that the powerplant installation be accessible for preflight inspection and maintenance and adds a hazard assessment requirement. Textron recommended revising proposed § 23.900(b) to state each powerplant installation must ensure safe operation and be accessible for preflight inspection and maintenance.

The FAA has determined the performance-based regulations set forth in the proposal, as revised by the changes made in this rule, address all critical items in current part 23. With regard to Textron's specific comments, the FAA did not intend to remove the requirement for the powerplant installation to be accessible for preflight inspection or require a new hazard assessment. The FAA intends that § 23.2400(c) capture the current requirement that the powerplant installation be accessible for preflight inspection. Likely hazards include those that could result from lack of adequate preflight or maintenance, which includes inspection. Additionally, the regulation has not introduced a requirement to complete any hazard assessments not required under current regulations.

An individual commenter noted the proposed rules in subpart E only appear to address a design review that considers failures and hazards. The commenter elaborated by stating that unlike the current rules, the proposed rules do not require a design review for proper operation in the normal non-failed condition. The commenter stated this

change is not discussed in the NPRM and appears to leave gaps in the traditional certification effort where the airplane is certified to operate properly within the approved operating envelope. The commenter recommended including an additional requirement to ensure all powerplant components and systems remain within all limitations and function properly when operated within the approved airplane operating envelope.

The FAA agrees the proposed regulatory language was not sufficiently clear and revises proposed § 23.900 (now § 23.2400) to clarify the powerplant installation must be constructed and arranged to account for likely operating conditions, likely hazards, and all component limitations are maintained or otherwise shown to not create a hazard throughout the approved operating envelope.

Textron noted proposed § 23.900(b) should require not just powerplants, but rather all systems, and particularly those installed in future airplanes, to account for likely hazards in operation and maintenance. Accordingly, Textron recommended removing the specific provisions of the proposal referring to powerplants from proposed § 23.900 and revising proposed § 23.1305 to address all systems.

While the FAA agrees all systems should be designed to account for likely hazards, the FAA notes powerplant installations have unique requirements that may not directly apply or would be burdensome when applied to the design of other systems. Accordingly, the FAA is not expanding the applicability of this specific regulation to address all systems.

In the NPRM, the FAA proposed replacing the term “engine” with “power unit,” which would have included “auxiliary power unit” (APU). This change was intended to ensure new requirements would be clearly applicable to various power sources, such as

those using liquid fuel or electrical power, and to other power sources not yet envisioned. After further review, the FAA has determined it would be more appropriate to retain the term “engine” in the final rule because “engine” is used throughout 14 CFR, TCs are specifically issued for aircraft engines, and the term “aircraft engine” is specifically defined in 49 U.S.C. 40102 and 14 CFR 1.1. The operating regulations also refer to required engine indicators and engine maintenance, and Airworthiness Directives issued for aircraft engines, as opposed to “power units.” Introducing the term “power unit” could lead to unnecessary confusion and potential disagreements regarding the applicability of specific regulatory requirements. Additionally, the FAA notes the term “engine” includes any device that converts any form of energy into force that propels an airplane. The FAA finds the term “engine” can be used to address both current and new sources of propulsion and accordingly has replaced the term “power unit” with “engine”, or “auxiliary power unit”, where appropriate in this rule. The intent of this change is to clarify the requirements of this subpart are applicable to any device that propels an airplane regardless of its source of power and to avoid potential conflicts with both the statutory and regulatory definitions of the term “aircraft engine.”

The FAA has also added paragraph (d) to address the hazardous accumulation of fluids, vapors or gases. This paragraph is virtually identical to proposed CS 23.2430(b), “Energy storage and distribution system hazard mitigation,” and corresponds to the safety intent of former § 23.1193(b) that addressed cowling drainage. It is designed to ensure the hazards resulting from the accumulation of these materials can be isolated from the airplane and personnel compartments and these materials can be either safely contained or discharged.

c. Powerplant Installation Hazard Assessment (proposed § 23.910/now § 23.2410)

In the NPRM, proposed § 23.910 (now § 23.2410) would have required an applicant to assess each powerplant separately and in relation to other airplane systems and installations to show that a failure of any powerplant system component or accessory will not—

- Prevent continued safe flight and landing;
- Cause serious injury that may be avoided; and
- Require immediate action by crewmembers for continued operation of any remaining powerplant system.

Several commenters expressed concern that proposed § 23.910 would have been impossible to meet for certain existing airplane designs. The FAA response to these comments is below.

The Associations stated that proposed § 23.910 should apply to the "likely" failure of powerplant systems. The commenters asserted that applying the proposed requirements to any failure would require complete redundancy, which cannot be achieved in traditional single-engine airplanes and smaller twin-engine airplanes. The commenters contended the slower stall speeds and higher levels of crashworthiness in the designs of these airplanes mitigate all but "unlikely" powerplant failures. These commenters recommended the FAA require the applicant to assess each powerplant separately and in relation to other airplane systems and installations to show that "hazards resulting from a likely failure of any powerplant system component or accessory are minimized."

Textron stated proposed § 23.910 was “too high level” and would not have established adequate performance-based requirements for an applicant to demonstrate compliance. As an example, Textron contended that proposed § 23.910(a) would have been an impossible requirement to meet, especially for a single-engine airplane. Textron recommended replacing the language of proposed § 23.910 with language from EASA CS 23.510, “Powerplant Hazard Mitigation”

EASA, Garmin, and Air Tractor stated the requirements of proposed § 23.910(a) would have been applicable to single-engine airplane certification. Garmin stated, however, that a single-engine airplane cannot meet proposed § 23.910(a) unless the FAA clarifies the loss of the thrust from the propulsion unit will not necessarily prevent continued safe flight and landing. Garmin recommended the FAA either revise proposed § 23.910 or revise the definition of “continued safe flight and landing” to allow for failure of the engine or propeller in a single-engine airplane.

Air Tractor stated proposed § 23.910(a) would have ruled out the certification of single-engine airplanes. Air Tractor observed, for example, that under the proposed rule, if a fuel line or hose were considered a “system component,” then the failure of one fuel line that feeds the engine would certainly result in an engine failure. Air Tractor noted that there may be similarly insurmountable scenarios involving the controls for an engine. Air Tractor stressed the need for clearly-written rules to prevent unforeseen interpretations of provisions that have the potential to make the design and certification of light airplanes much more difficult than previously, or even impossible.

An individual commenter stated that proposed § 23.910(a) appears to be a derivation of former § 23.903(c)(1), which only applied to multiengine installations and

only required continued safe operation of the remaining engines. The commenter asserted the proposed rule would have increased the requirement from “ensuring continued safe operation of the remaining engines” to “ensuring continued safe flight and landing of the airplane.” The commenter further noted proposed § 23.910 would have applied to single-engine airplanes with no justification and could have resulted in elimination of some airplanes from certification, such as large single-engine or multiengine airplanes where rotor non-containment effects on the remaining engine cannot be eliminated. The commenter also stated the proposed rule would have made “continued safe flight and landing” a part of the regulation, where previously it only existed in guidance material. The commenter indicated this may make it difficult to provide a conditional definition of the term. To ensure safe design of multiengine airplanes, the commenter recommended using the wording of former § 23.903(c)(1) rather than requiring a system safety approach to powerplant installation that does not permit single failures. The commenter also recommended using the term “minimize” when specifying the evaluation criteria for powerplant installations. The commenter noted that term has been used for many years, is well understood, and best describes the regulatory intent for those powerplant unique systems where a single failure cannot be reasonably eliminated from the design.

Another individual commenter said compliance with proposed § 23.290 would neither be practical nor possible in all situations that may result in a forced landing; therefore, the proposed rule should not include a requirement for completely eliminating hazards, which the commenter asserted is not achievable. The commenter asserted that replacing a standard based on minimization with an absolute standard is not an acceptable alternative. Ultimately, the commenter recommended revising the definition of

“continued safe flight and landing” to allow for catastrophic outcomes of forced landings, and to either maintain the minimization standard, or withdraw the requirement. The commenter further noted that compliance with the proposed requirement of absolute prevention of hazards would be impractical or impossible for many conventional multiengine airplane configurations regarding rotor non-containment. This is also true for all single-engine and many multiengine airplanes regarding a propeller blade loss—especially since the proposed rule applies to uncontained engine failure and engine case burn-through failures for which former § 23.903(b)(1) only required the design to minimize the hazard.

Embraer observed that for turbine or reciprocating engine rotor failure and/or burn-through events, there is no way to eliminate all the risks that will prevent continued safe flight and landing. Embraer recommended revising the language to clarify certain proposed provisions and to add additional provisions that would require applicants to show operating limitations, which may adversely affect rotating component structural integrity that would not be exceeded in service. Embraer’s revisions would require design precautions to minimize hazards to the airplane in the event of an uncontained engine rotor or rotating component failure or a fire originating within the engine, which burns through the engine case.

The FAA concurs with the commenters’ recommendations to revise proposed § 23.910 to make its requirements only applicable to likely failures and to permit minimization of certain hazards, which could prevent continued safe flight and landing. The FAA notes the inclusion of the term “likely” in the requirement for the applicant to address hazards resulting from failures is intended to place reasonable and prudent

bounds on the scope of analysis necessary to meet the requirement and not to require consideration of all possible failures, however remote. The scope of this analysis will be set forth in accepted means of compliance for this regulation.

In response to commenters' concerns that the term "minimize", or the philosophy encompassed by the use of the term, will be included in the rule, the FAA notes that the term "minimize" has been included in § 23.2410(a) to permit the applicant to address those hazards, which may prevent continued safe flight and landing of an airplane, that cannot reasonably be eliminated. The FAA will consider incorporation by an applicant of all practical design precautions, which minimize hazards to the airplane, associated with a particular failure acceptable in complying with this regulation. The FAA has historically accepted this compliance approach when a minimization of hazards has been required. This approach provides a simple means to continuously improve airplane safety as new technologies and design approaches evolve. It also permits acceptance of existing designs that cannot reasonably eliminate hazards resulting from certain failures, even if accepted design precautions have been incorporated into the airplane's design. Such failures could include rotor non-containment, engine case burn-through, and engine failures on single-engine airplane. This change specifically addresses a concern expressed by all commenters that the proposed regulation would make it impossible for an applicant to show compliance with the regulation for many existing airplane designs. Additionally, the rule will continue to permit the use of simple parts, such as fuel lines and control cables, in airplane designs. The FAA has traditionally considered their use acceptable without requiring redundancy where it is neither practical nor likely that a failure of the

component would occur. The FAA's revisions to the proposed regulation account for the normal use of these types of simple components.

In response to the commenter who noted the term "continued safe flight and landing" in proposed § 23.910(a) appears to be based on former § 23.903(c), which only applied to multi-engine airplanes, the FAA agrees that proposed § 23.910(a) does not properly address certain failures on single-engine airplanes. The FAA believes the revisions discussed above addresses the individual's concerns.

Textron also recommended the FAA withdraw proposed § 23.910, as its subject area overlaps with proposed § 23.1315 (now § 23.2510).

The FAA revises proposed § 23.910 to clarify that any failure resulting in the loss of a single powerplant on an airplane with multiple powerplants cannot result in the failure of other powerplants unless those failures cannot be reasonably eliminated, in which case the hazards must be minimized. So, while § 23.2510 does apply to all powerplant systems, the FAA notes § 23.2410 includes an exception to the general requirement of § 23.2510 to account for certain powerplant failures that may prevent continued safe flight and landing or for which use of a traditional system safety compliance approach may not be appropriate. Examples of such failures include engine rotor non-containment and fire. Therefore, the FAA does not adopt Textron's recommendation to withdraw proposed § 23.910.

Garmin commented that proposed § 23.910(b) seemed highly subjective and recommended eliminating paragraph (b).

The FAA notes § 23.2410(b) requires consideration of failures affecting passenger safety such as a fan disconnect on fuselage embedded engines or exhaust heat

exchanger failures that may allow hazardous fumes to enter the occupant compartment. The FAA finds withdrawing paragraph (b) would eliminate the requirement for an applicant to assess potential causes of serious injury to airplane occupants. Additionally, it serves as the underlying requirement for the development of a more-detailed means of compliance. Therefore, the FAA adopts the language in § 23.2410(b) as proposed.

ANAC observed that there is no requirement in proposed § 23.910 to ensure powerplant-driven components, necessary for airplane operation, are suitable for installation in airplanes certificated under part 23, and the powerplant installation requirement in proposed § 23.900 (now § 23.2400) is related only to components that affect propulsion safety. ANAC noted the rule does not capture the design precautions established in the former §§ 23.933 and 23.1155. The commenter also asserted that while proposed § 23.910 addresses hazard mitigation in the event of powerplant systems failure, compliance with proposed § 23.910 for turbine engines would be directly related to protection against inadvertent thrust reverser deployment.

The FAA notes ANAC's concerns; however, as discussed in the preamble for § 23.2400, the FAA has added paragraph (e) to § 23.2400 to address powerplant component installation. Additionally, the FAA addresses the design precautions of former §§ 23.933 and 23.1155, which provided reversing system requirements for turbojets, turbofans, and propellers, in the performance-based requirements contained in § 23.2420, "Reversing systems" (proposed as § 23.920).

d. Automatic Power or Thrust Control Systems (proposed § 23.915/now § 23.2405)

In the NPRM, proposed § 23.915 (now § 23.2405) would have required a power or thrust augmentation system that automatically controls the power or thrust on the

operating powerplant to provide an indication to the flightcrew when the system is operating, provide a means for the pilot to deactivate the automatic functions, and prevent inadvertent deactivation.

Textron commented the requirements of proposed § 23.915 could easily be addressed by revising proposed § 23.900 to state that state an automatic power reserve (APR) system that automatically advances the power or thrust on the operating engine(s), when any engine fails during takeoff, must comply with the applicable requirements of the subpart. Textron noted that this language is included in Appendix E of the Part 23 ARC Report. Also, Textron recommended deleting the prescriptive requirement in proposed § 23.915(a) for the system to provide an indication that it is operating, stating that such a requirement and other high level requirements are redundant.

The FAA finds the adoption of the proposed Part 23 ARC language, as recommended by Textron, would limit the scope of this rule to existing APR type systems. The FAA also finds the intent of the ARC language is better captured in this rule, which can apply to a wider range of potential future automatic power or thrust control systems. The FAA partially agrees with the commenter's request to remove the requirement for annunciation from proposed § 23.915(a). Although the proposal did not specifically state there must be an annunciation of the system's status, it did require the system to provide an indication of the status. The proposal has been revised to require a means to indicate the system is in an operating condition. The FAA finds this revision will provide applicants with more flexibility in designing a system to provide the flightcrew with information regarding the operational status of this critical safety system.

ANAC stated the proposed requirements of this section are too prescriptive and the requirements of proposed §§ 23.1310, 23.1500, and 23.910, which address system reliability, status monitoring, flightcrew interface, and warning indications, provide equivalent requirements that eliminate the need for a specific regulation to address APR systems.

The FAA does not find the provisions of proposed § 23.915 are adequately addressed by the requirements in proposed § 23.900. The requirements in § 23.2405 (proposed § 23.915) provide additional specific requirements the FAA considers necessary for the certification of APR systems in airplanes. The FAA does not find the requirements of § 23.2400 (proposed § 23.900) alone would adequately address the requirements necessary for approval of an automatic power control system. The specific requirements in the rule for the system to provide indication to the flightcrew that it is operating are necessary given the critical nature of both existing and future APR systems that may vary thrust or power to provide airplane control during the failure of an engine. In response to ANAC's comment that § 23.915 could be replaced with a more general rule covering system reliability, crew interface, monitoring, and warning, the FAA finds attempting to address too many systems under a general system safety requirement may result in the excessive application of non-standard performance requirements across the industry. Accordingly, for systems where basic performance requirements can be established, without requiring specific knowledge of the system's design, those requirements will be contained in a specific rule. This concept is further discussed under § 23.2420.

EASA suggested the FAA address auto power control systems and reverser systems (proposed §§ 23.915 and 23.920) in a single requirement that would address other systems such as those that use asymmetric thrust to provide directional control. EASA recommended changing the title of the proposed section to “Propulsion Augmentation Systems” to ensure systems that augment propulsion in any direction (drag, thrust, direction, lift) are addressed.

The FAA notes the basic performance requirements for automatic power control systems are different from those required for reverser systems. Additionally, the FAA also notes adopting the term “augmentation” implies that only a system’s use of additional thrust or power would be addressed, whereas systems are envisioned that may also reduce power on an operating propulsion system or use aerodynamic means to respond to power or thrust abnormalities. The FAA considers an automatic power or thrust control system to be a system that automatically intervenes and provides direct or modified control to each engine, leaving the pilot indirectly in control or possibly not in control for an automatic recovery type function. Reversing systems simply change the direction of thrust or power at the direct control of the pilot. As these systems are significantly different, the FAA has determined it is necessary to retain a specific section for both automatic power or thrust control systems and reversing systems.

The FAA reviewed the draft language of CS 23.2405, Propulsion augmentation systems, and found it directly applicable to automatic power or thrust control systems. Its provisions also address many of the commenters’ concerns, especially with respect to the certification of airplanes with advanced automatic control systems. This language is consistent with, but less prescriptive than, the requirements of former appendix H to part

23. Accordingly, the FAA revises proposed § 23.915 by adopting the language from CS 23.2405(b) through (e) in § 23.2405(a) through (d).

Textron noted it was unclear if the proposed rule was attempting to address "auto throttle" applications exclusively.

The FAA did not intend proposed § 23.915 to address autothrottle or autothrust systems unless the system has the capability to command a change to power or thrust that is not directly commanded by movement of the primary power setting control. Such a system might vary power on multiple powerplants to maintain level flight or add thrust beyond that commanded by the throttle when an engine failure is detected.

Garmin and the Associations suggested eliminating proposed § 23.915(b). Garmin stated that emerging technology may include systems that have sufficient design integrity and provide enough safety benefit that permitting deactivation as required by proposed § 23.915(b) could have the unintended effect of reducing safety. The Associations noted in the event the automatic power control systems of less reliability are used, compliance with proposed § 23.910 should result in designs that achieve the risk mitigations intended by the requirements of proposed § 23.915(b).

The FAA agrees that requiring a means for a pilot to deactivate the automatic function may have an adverse effect on safety. The FAA also agrees emerging technology may result in the development of a system with sufficient integrity the flightcrew does not directly control the thrust of each engine, but rather the power control system takes commands from the flightcrew and automatically controls each engine to execute that command, in both normal conditions and in the event of a failure of an engine. Accordingly, the FAA revises the rule to account for the possibility of a broader

range of automatic power or thrust control systems and has removed the requirement for pilot deactivation of the automatic function of these systems where a system failure is shown to be extremely remote. The type of system that would have this level of authority is envisioned to be similar to an automated flight control or fly-by-wire system, and an applicant would be expected to show the system has sufficient design integrity to meet this standard. To provide applicants with greater design flexibility, the FAA also revises the proposal to require the flightcrew to be able to override, rather than deactivate systems with lower design integrity. It is intended this requirement will apply to those systems whose failure can be reasonably detected by the flightcrew and for which overriding the automatic function would not have an adverse effect on safety. Such a situation typically exists with traditional automatic power reserve systems.

ANAC suggested the requirement to maintain the maximum thrust/power increment limit be specifically retained in the regulation and not serve as a possible means of compliance. ANAC believes that although it is arbitrary, the 10 percent limit for the APR is considered in the current regulation to be a straightforward and acceptable decrement from a safety standpoint in limiting both runway critical takeoffs and degradation of all-engine climb performance factors that are not addressed by former part 23 Appendix H, paragraphs H23.4(b) and (c).

The FAA notes any automatic power or thrust control system will be required to meet all applicable regulations including § 23.2415, which requires that failures that would prevent continued safe flight not result from a single failure or from a likely combination of failures. In addition, the FAA notes that takeoff performance is determined considering a critical loss of thrust. Although the 10 percent value referred to

by ANAC may be considered an arbitrary limit on the additional thrust that can be provided by an APR system, the FAA considers it unlikely an APR design would be proposed that reserves a significant amount of thrust for use only in the event of an engine failure during takeoff. Yet given the broader scope of this rule, limiting automatic power control thrust to 10 percent may not realistically permit system designs intended to augment lift, control, or stability through the propulsion system. Therefore, the FAA has decided not to include the 10 percent limit in the rule.

Kestrel questioned whether the proposed section would permit alternate automatic power control systems (such as those without thrust lever drivers) that could meet the intent of proposed § 23.1500 (now § 23.2600) without an ELOS finding or an issue paper. Kestrel noted former § 23.779 requires commanded engine thrust and actual engine thrust agree, which the commenter said has historically been accomplished by the thrust levers being mechanically driven to the actual engine thrust position.

The FAA notes that § 23.2600 does not specifically require a throttle lever, only powerplant controls. Therefore, if a design were proposed that allowed a qualified flightcrew member to perform all tasks associated with the intended powerplant control functions, an ELOS finding would not likely be required to obtain approval of that automatic power control system.

NJASAP supported the language of proposed § 23.915 and noted automatic power control system technology will be available to more airplanes in lower certification categories in the not-too-distant future.

e. Reversing Systems (proposed § 23.920/now § 23.2420)

In the NPRM, proposed § 23.920 (now § 23.2420) would have required an airplane to be capable of continued safe flight and landing under any available reversing system setting.

Textron stated the proposed language is too "high-level" and does not provide adequate performance-based requirements for an applicant to show compliance with the rule. Textron also stated the rule was "a bit severe" and noted the rule could be interpreted to mean that a single- or multiengine turboprop may now need a reverser lock out system for flight. Textron also claimed the flight testing required to demonstrate compliance with the proposed requirement may be complicated and dangerous. To address its concerns, Textron recommended using the language from CS 23.505.

Air Tractor commented that it seems impossible to expect an airplane to be capable of safe flight and landing with application of full reverse thrust. Air Tractor suggested the proposed language expected the airplane to "know" the difference between a pilot command for reverse thrust when the airplane is on the ground versus when it is in air, and to overrule the pilot command if the airplane is still flying. Air Tractor observed that while this might be an easy control issue when combined with a squat switch, many airplanes with spring steel fixed landing gear do not have squat switches. Air Tractor also noted that it has not been a safety issue to have reverse thrust capability on certain types of single-engine turboprop airplanes, all of which employ multiple means to prevent inadvertent selection of the reverse range and warn when that range is selected.

The Associations noted the proposed rule could be misconstrued to indicate the FAA will no longer permit throttle gates, which are traditionally used on turboprop

designs. The commenters contended this would necessitate the development of weight on wheels lockouts and other complex designs that were not required by the former rule, and for which there is no measurable safety data to indicate this was an area of safety concern. The commenters recommended revising the rule to state the airplane must be capable of safe flight and landing under any "easily selectable" reversing system setting, rather than "any available" reversing system setting.

ICON asked for clarification as to whether proposed § 23.920 was intended to mean that if a reversible pitch setting exists on a propeller, an airplane must be able to continue flight even with selection of full reverse pitch. ICON also believed the proposed rule could be interpreted to require a demonstration of safe flight and landing at full reverse power.

The FAA notes that numerous commenters expressed concern with the proposed requirement that the airplane must be capable of continued safe flight and landing under any available reversing system setting. The FAA recognizes this language did not account for many airplane designs that do not incorporate a system that detects when the airplane is on the ground, which can be used to lockout or prevent manual inflight reversal. Additionally, the FAA recognizes the proposed rule did not provide a basic performance requirement to ensure safe operation of the reverser system under normal operating conditions, and the airplane is capable of continued safe flight and landing after failures of the reversing system.

As explained in the NPRM, proposed § 23.920 (now § 23.2420) was intended to capture the safety intent of former § 23.933(a) and (b). Therefore, given the variety of the commenters' concerns, the FAA revises proposed § 23.920 based on former § 23.933 to

address the comments. The FAA intends § 23.2420 to address the requirements for propeller, turbojet, and turbofan reversing systems specified in former § 23.933. Section 23.2420 now requires each reversing system to be designed so that the airplane is capable of continued safe flight and landing after any single failure, likely combination of failures, or malfunction of the reversing system. This rule accounts for existing reversing system designs that use a mechanical throttle gate to prevent inadvertent in-flight reversing system operation that could result in an unsafe condition. For turbofan or turbojet engine reversing systems intended for ground use only, the FAA notes that a reverser lock out system for flight is not specifically required by the rule. However, the FAA expects that in the event of an inflight reverser deployment, the engine will revert to idle thrust, and the reverser can be restowed as required by former § 23.933(a)(1). The FAA also notes that § 23.2420 should result in the inclusion of these features in airplane designs, as the FAA finds they are currently the only likely means to prevent the occurrence of an unsafe condition and permit continued safe flight and landing after a failure resulting in a reverser deployment in flight. In addition to basing the revisions to the proposed rule on former § 23.933(a)(1) and (b) for ground use only reversing systems, the FAA has included in § 23.2420(a) the requirement from former § 23.933(a)(2) for reversing systems intended for use in-flight that no unsafe condition result during normal operation. The FAA finds this action responds to commenters' concerns and will readily permit future approval of systems intended for use in-flight, which incorporate new technology.

Regarding Textron's recommendation that the FAA adopt requirements for reversing systems proposed by EASA in CS 23.505, proposed CS 23.505 combines

requirements for reverser systems, thrust augmentation systems, and automatic power controls in a single regulation. For the reasons discussed in responding to this comment in the context of § 23.2405, the FAA determines the requirements for a reversing system should remain separate from those for thrust augmentation or automatic power or thrust control systems (referred to as automatic power reserve systems in former regulations), and that the basic performance requirements for these systems are significantly different.

Additionally, § 23.2405, "Automatic power or thrust control systems," applies to future systems that may automatically adjust thrust to manage airplane control and stability. Such a system might operate upon a single command from the flightcrew and automatically manage multiple powerplants to perform a requested action. For this type of system, in-flight reversing of a particular propulsion unit may occur (as commanded by a flight management system) even though the flightcrew may not have specifically requested application of reverse thrust. For certification of this type of system as part of an airplane's design, the FAA envisions the requirements of both §§ 23.2420 and 23.2405 will apply.

Both Embraer and Garmin expressed concern the proposed requirement would not permit the use of a system safety approach for a reverser system under certain conditions that may prevent continued safe flight and landing, as long as those conditions are shown to be extremely improbable. Embraer recommended replacing the phrase "under any available reversing system setting" in proposed § 23.920 with the phrase "at normal operating conditions and the failures not shown to be extremely improbable." Garmin recommended revising the proposed rule to permit the use of a safety analysis to

demonstrate that certain conditions, which would potentially prevent safe flight and landing, are extremely improbable.

In response to Garmin's and Embraer's concern, the FAA notes that § 23.2420, as revised, permits the use of a system safety approach for certification of an airplane with a reverser system.

NJASAP believed a thrust reverser must have an override or the ability to emergency stow in the unlikely event of inflight deployment.

The FAA notes NJASAP's recommendation to reintroduce the requirement to stow reversers after inadvertent deployment; however, specifically requiring a system to have the capability to restow a reverser in-flight may limit or prevent the certification of certain acceptable reversing system designs. As noted in Garmin's comment, for a reverser system that cannot be shown to result in safe flight and landing of the airplane after an in-flight deployment, an applicant may include a robust control and monitoring system in its design that could be shown to make an in-flight deployment extremely improbable and not resulting from any single failures. Including this capability could prevent the system from complying with the requirement that no single failure prevent continued safe flight and landing.

f. Powerplant Operational Characteristics (proposed § 23.925/now § 23.2425)

In the NPRM, proposed § 23.925 (now § 23.2425) would have required the powerplant to operate at any negative acceleration that may occur during normal and emergency operation within the airplane operating limitations. Proposed § 23.925 would have required the pilot to have the capability to stop and restart the powerplant in flight.

Proposed § 23.925 would have also required the airplane to have an independent power source for restarting each powerplant following an in-flight shutdown.

Embraer commented that although the preamble indicated that proposed § 23.925 intended to address the requirements of former § 23.939(a) and (b), proposed § 23.925 did not appear to require evaluation of traditional operational characteristics and did not address the adverse effects evaluation of air inlet distortion, powerplant handling, operating characteristics, and other adverse effects of an installed engine or power unit. Textron and ANAC had similar concerns. Embraer recommended the FAA revise proposed § 23.925(a) to require the powerplant handling and operating characteristics to be investigated in flight to determine that no adverse characteristics are present, to a hazardous degree, during normal and emergency operation within the range of operating limitations of the airplane and of the aircraft power unit. Textron also noted the intent of former § 23.939 was to require demonstration of proper operation of the powerplant, as installed. Textron stated it was inappropriate to claim that the tests necessary to meet part 33 requirements will demonstrate proper operation of the powerplant as installed, which the NPRM preamble seemed to imply. Textron also suggested engine vibration requirements be incorporated into § 23.2425.

Additionally, ANAC stated that proposed § 23.910 addressed hazard mitigation in powerplant failure conditions and proposed § 23.900 addressed "likely hazards in operation." ANAC noted the term "hazards in operation" might be construed to mean external threats to the engine from foreign object ingestion or a crosswind, causing confusion for applicants seeking to meet the proposed requirements and making it difficult to accurately interpret proposed § 23.925. To remedy this concern, ANAC

recommended that proposed § 23.925 include a requirement for an applicant to demonstrate the proper functioning of the powerplant in normal operation within the range of operating limits of the power unit.

In light of these comments, the FAA revises proposed § 23.925(a) (now § 23.2425(a)) to require the installed powerplant to operate without any hazardous characteristics during normal and emergency operation within the range of operating limitations for the airplane and the engine. The FAA finds this change from what was proposed indicates that evaluation of all traditional operational characteristics required by former regulations is also required by § 23.2425(a). The FAA has added the term "installed" before "powerplant," in response to Textron, to clarify that § 23.2425(a) applies to the operation of the powerplant, as installed. The FAA notes if the installation of powerplant components do not remain within established limits, § 23.2400 requires any deviation from the component limitations or installation instructions must be shown to not create a hazard. Additionally, the requirement to evaluate the powerplant installation for vibration and fatigue characteristics is contained in § 23.2400.

Textron also recommended the FAA revise proposed § 23.925(a) to require the powerplant to operate at any condition, including negative acceleration. The Associations suggested the FAA remove the term "negative acceleration" from paragraph (a) and replace it with "acceleration or deceleration."

In response to Textron and the Associations, the FAA has removed the term "negative acceleration" from the regulation because the more general reference to "normal and emergency operation" in the revised language includes "negative acceleration." Additionally, the FAA notes that § 23.2400(c) requires an applicant to

construct and arrange each powerplant installation to account for likely operating conditions and likely hazards in operation. This requirement addresses all components and systems that comprise the powerplant installation, such as the oil and fuel systems, and establishes a requirement for the applicant to address all likely conditions and hazards, which may not be specifically encountered in the approved operating envelope. The original intent of former § 23.943 was to ensure no hazardous condition resulted when a powerplant or APU is exposed to negative accelerations expected in flight. The FAA finds that § 23.2425(a), together with § 23.2400(c), adequately address this need.

The Associations also submitted comments regarding proposed § 23.925(c), which would have required an airplane have an independent power source for restarting the engine after an in-flight shutdown. These commenters contended the FAA's intent in drafting § 23.925(c) was to ensure that engines can be reliably restarted in flight following an in-flight shutdown. However, these commenters noted while an independent power source may be an adequate solution for some designs, there are many designs for which an independent power source would be inappropriate. For example, the Associations stated that electric propulsion systems may include a single power source that manages many cells, which start and stop in flight, but will not have independent sources of power to restart them. As written, the commenters suggested proposed § 23.925(c) could be interpreted to require that a two-engine airplane needs three batteries for restarting (one main and an independent source for each powerplant). To address these concerns, the commenters recommended the FAA require the airplane to have a "reliable" power source, rather than an "independent" power source.

Textron, Garmin, and an individual commenter had similar concerns regarding proposed § 23.925(c). Garmin recommended either withdrawing proposed § 23.925(c) or clarifying its intent. Textron commented that proposed§ 23.925(c) was “too high level” and did not provide adequate performance-based requirements for an applicant to demonstrate compliance. Textron recommended the FAA revise proposed § 23.925(c) based upon language contained in appendix E of the ARC’s final report.” The individual commenter noted that proposed § 23.925(c) would appear to require multiengine airplanes to have multiple and possibly duplicate electronic distribution systems for in-flight restarts by battery power. The commenter suspected this was an unintended expansion of the requirements of former §§ 23.903(g) and (or alternatively) § 23.1165. The commenter stated this unintended consequence would impose cost and weight penalties beyond former part 23 requirements, which the commenter maintained were not addressed in the regulatory analysis or the preamble to proposed § 23.925(c), or otherwise justified by service experience. The individual commenter recommended the FAA either withdraw proposed § 23.925(c) or clarify its intent.

In response to the significant number of comments the FAA received regarding the proposed requirement that each airplane have an independent power source for restarting the engine after an in-flight shutdown, the FAA withdraws § 23.925(c). The FAA’s intent in drafting proposed § 23.925(c) was to ensure a power source, independent from any power generated by a particular engine shutdown in flight, be available for restarting the powerplant. This requirement was originally adopted as former § 23.903 to address ignition systems on turbine engines and to ensure a source of ignition energy for in-flight engine restarting exists in the event of a loss of combustion in all engines during

flight. The requirement in § 23.2425(b), which requires the pilot have the capability to stop the powerplant in flight and restart the powerplant within an established operational envelope, establishes the performance-based requirement the prescriptive requirements of proposed § 23.925(c) were intended to address. The FAA's intent was not to require redundant electrical power; rather, the intent was to require power independent from that of the engine-driven electrical power generating system to be available if insufficient power was available at the minimum windmilling restart speed. If an engine power generating system is capable of providing sufficient power to operate all required systems at the minimum windmilling restart speed, or in a normal shutdown state, an independent power source would not be required.

In recognition that an aircraft engine may not be able to be restarted within an airplane's entire flight envelope, the FAA revises proposed § 23.925(b) (now § 23.2425(b)) to require restart capability within an established operational envelope, which in accordance with § 23.2620 (proposed as § 23.1510), must be documented in the AFM.

g. Fuel Systems (proposed § 23.930/now § 23.2430)

In the NPRM, proposed § 23.930 (now § 23.2430) would have required that each fuel system provide an independent fuel supply to each powerplant in at least one configuration and avoid ignition from unplanned sources. It would have required that each fuel system provide the fuel required to achieve maximum power or thrust plus a margin for likely variables in all temperature conditions within the operating envelope of the airplane and provide a means to remove the fuel from the airplane. Finally, proposed § 23.930 would have required each fuel system to be capable of retaining fuel when

subject to inertia loads under expected operating conditions and prevent hazardous contamination of the fuel supply.

The Associations asserted that proposed § 23.930 does not permit the certification of electric propulsion systems. These commenters recommended the FAA delete the word “fuel” from the title of proposed § 23.930 and adopt the provisions of proposed CS 23.530. Additionally, the commenters suggested replacing “fuel” with “energy” to clarify the requirements of this regulation are applicable to all energy sources and not just traditional petroleum-based fuels.

EASA, while recognizing that the term “fuel” covered other energy sources, stated it believed a more independent set of design requirements would be needed to address all energy systems, rather than those that are more appropriate for propulsion systems and APUs. Additionally, EASA specifically recommended adoption of its set of requirements for energy supply systems, set forth in A-NPA 2015-06, which provided useful requirements for a variety of systems, including fuel, electric, and hybrid systems. EASA also noted that its A-NPA 2015-06 created several new subparagraphs to address particular functions of an energy system.

The FAA did not intend to preclude the certification of electric propulsion systems or other non-fossil-fuel-based propulsion systems in part 23. The FAA agrees the use of the term “fuel” rather than the term “energy” could lead individuals to reach this conclusion. However, the FAA is concerned that adoption of the term “energy” in this rule, and throughout this subpart, could lead to confusion, because the term “energy” is used in numerous regulations and in guidance material to address requirements for other systems and components (i.e., braking systems and rotating machinery) and also to

describe environmental conditions (i.e., those involving lightning). Therefore, the FAA retains the term “fuel” in the regulation, but notes the term “fuel” in this subpart includes any form of energy used by an engine or powerplant installation, such as provided by carbon-based fuels or electrical potential. Fuel systems will also include the means of energy storage for the power provided (i.e., batteries that provide power to an electric motor) or devices that generate power for propulsion (i.e., solar panels or fuel cells). Furthermore, while the FAA agrees with many of the provisions proposed by EASA, the FAA is electing to retain the requirements for energy systems under a single section, titled “Fuel system.” While § 23.2430 and EASA’s proposed language may not be identical, the FAA finds § 23.2430 harmonizes with the intent of EASA’s requirements.

The FAA notes EASA’s recommendation to adopt EASA’s proposed language to address powerplant support systems to replace its current regulatory requirements for induction and exhaust section systems. The FAA has decided to retain a specific section to address powerplant induction and exhaust systems. The FAA will address future energy systems that incorporate systems such as converters or battery cooling as part of the powerplant installation. The FAA notes the requirements for those future systems will be adequately addressed in §§ 23.2400, 23.2410, and 23.2430.

ANAC stated that proposed § 23.930 does not address the requirements of former § 23.951(d), which required fuel systems for turbine engine airplanes to meet the fuel venting requirements of part 34. ANAC stated the former requirement applied to airplanes and not engines, and should therefore be specifically included in the rule. ANAC also recommended the reference in the former rule to part 34, which prevents intentional fuel venting, be included in the new rule.

The FAA notes part 23 historically provided only a reference to part 34, and those requirements continue to remain applicable to the certification of any airplane. Sections 21.17 and 21.101 require part 34 to be always included in the certification basis of airplanes. Requirements such as fuel venting will therefore continue to apply to the certification of these airplanes.

Textron suggested deleting the term “avoid” and inserting the phrase “prevent hazardous” in proposed § 23.930(a)(2), which addressed the avoidance of ignition from unplanned sources. Textron noted that using the term “prevent” would be consistent with the use of the term in other sections of part 23.

An individual commenter also raised concerns about the undefined term “avoid”, and questioned whether the term was an absolute, probability, or minimize requirement, or whether it covers single or multiple failures. Presuming the proposed requirement covered fuel ignition by lightning strikes addressed in former § 23.954, the commenter requested the proposed rule not be more stringent than the former rule, which imposes an absolute requirement to prevent ignition hazards but only for certain types of strikes and strike locations. The commenter noted the FAA did not discuss the rationale, interpretation, or intent of this requirement in the NPRM preamble. The commenter also noted that the draft ASTM standard was identical to former § 23.954, and remarked that it was unclear why proposed § 23.910 did not address this requirement. The commenter agreed with Textron and recommended inserting the term “hazardous” before “ignition” in paragraph (a)(2) to better clarify the proposed requirement.

Embraer and other commenters raised concerns about use of the term “unplanned sources” in proposed § 23.930(a)(2). Embraer noted there are no “planned” ignition

sources, making compliance with the rule impossible. Embraer proposed revising the requirement to account for ignition sources not shown to be extremely improbable, and proposed the rule require that each fuel system be demonstrated that it is designed and arranged to prevent catastrophic ignition from sources not shown to be extremely improbable; taking into account flammability, critical lightning strikes, and failures within the fuel system. Textron noted the NPRM preamble discussion for "unplanned sources" or "unknown sources" was impossible to design for because it was too vague.

The FAA agrees the proposed requirement for unplanned sources was vague and could result in numerous interpretations. Section 23.2430(a)(2) is intended to prevent catastrophic effects resulting from ignition of an airplane's fuel source due to lightning, or from corona or streamering at fuel vent outlets, as former § 23.954 required. It is not intended to impose additional requirements to protect the fuel system from other ignition sources. The FAA revises § 23.2430(a)(2) based upon former § 23.954 to more accurately convey this requirement and to ensure its application to any fuel used to power an airplane. This revision also addresses the commenters' concerns regarding the meaning of "avoid" and "unplanned sources" by using the phrase "prevent ignition" and by enumerating the specific ignition sources that must be addressed.

Embraer also stated the phrase "margin for likely variables" in proposed § 23.930(a)(3) could generate confusion as to what margins must be observed when providing the fuel required to provide maximum power or thrust. The commenter explained that "margin" is usually used to define a rate higher than what is required for an engine's proper operation in the expected envelope and for the expected life of operation, but stated the meaning of the term "likely variables" is not clear. The

commenter noted that the former rule considered a determination of the worst fuel rate for proper operation. Embraer suggested using text similar to that found in former § 23.951(a).

The FAA agrees with Embraer's comment that proposed § 23.930(a)(3) could generate confusion as to what margins must be observed when providing the fuel required to provide maximum power or thrust. Therefore, the FAA revises paragraph (a)(3) to require the fuel system provide fuel necessary to ensure proper operation of each powerplant and APU, in all likely operating conditions. This requirement ensures adequate fuel can be provided for proper operation of any powerplant or APU. The FAA notes an applicant's means of compliance with this requirement should consider the worst case conditions for fuel flow, including any additional demand due to expected efficiency losses, consumption by other systems, or secondary requirements such as engine cooling.

Embraer stated that it understood proposed § 23.930(a)(4) required a means to remove fuel and referred to fuel storage. Therefore, Embraer suggested the FAA move the requirement in proposed paragraph (a)(4) to § 23.930(b), which addressed fuel storage systems. Embraer suggested that the cross-reference table be updated accordingly for former § 23.971 and § 23.999.

An individual commenter requested the proposed regulations include a requirement for determining or indicating usable or unusable fuel or energy quantities, as was formerly required. This commenter noted that because fuel starvation is "always" cited as one of the top reasons for off-field landings in general aviation accidents, it should be adequately addressed by a specific performance requirement in part 23.

The FAA agrees with the recommendation to add a requirement to the final rule to ensure the flightcrew is provided with information on the total useable fuel available. The FAA adds this requirement as § 23.2430(a)(4), corresponding to the requirement in former § 23.1337(b), which required a means to indicate to the flightcrew members the quantity of usable fuel in each tank. The intent of this revision is to require applicants to both determine the usable quantity of fuel that can be stored and provide information to the flightcrew regarding the remaining useable fuel in the airplane.

The FAA has decided not to move proposed paragraph (a)(4) as Embraer suggested. Since different types of fuel systems could be certificated under the rule, the FAA has added the term "isolate" in § 23.2430(a)(5). The FAA recognizes that certain fuel sources may not be removable from the system, and that isolating the fuel from the system will provide the appropriate minimum level of safety.

Additionally, the FAA clarifies § 23.2430(a)(5) to require the fuel system be designed to retain fuel under all likely operating conditions and minimize hazards to the occupants during any survivable emergency landing. The FAA also includes a requirement in § 23.2430(a)(6) that these failures be taken into account, consistent with former § 23.967. For the certification of level 4 airplanes, the paragraph also provides that any failure due to an overload of the landing system is taken into account in airplanes equivalent to those currently certificated in the commuter category, consistent with former § 23.721.

An individual commenter asked the FAA to revise proposed § 23.930(a)(6), which would require the fuel system prevent hazardous contamination of the fuel supply, to specify that the requirement was intended to prevent hazardous contamination of fuel

delivered to engines. The commenter noted this revision was necessary if, as the preamble indicated, this requirement replaces former § 23.997. The proposed requirement could be interpreted to require prevention of contamination of fuel within the fuel tank, which would be more stringent than the former rule and of questionable practicality. The former rules only required removal of contamination from the fuel being provided to the engine, and not necessarily from the fuel in the tank.

The FAA agrees with the commenter and revises § 23.2430 to require removal of hazardous contamination from the fuel supplied to each powerplant and APU. This requirement is now in new § 23.2430(a)(7).

Embraer recommended the FAA revise proposed § 23.930(b)(1) to require fuel storage systems to also withstand without failure, the vibration, inertial loads, and pressures under expected operating conditions.

The FAA agrees with Embraer that fuel storage systems must be able to withstand loads and pressures under expected operating conditions without failure and has added the term “without failure” to paragraph (b)(1). However, the FAA does not add specific references to vibration, inertia, fluid, and structural loads as the FAA believes the use of “loads under likely operating conditions” addresses all applicable loads, including those resulting from vibration and other sources.

The FAA revises § 23.2430(b)(2) to require the fuel storage system be isolated from personnel compartments and protected from hazards due to unintended temperature influences. The FAA recognizes that it did not adequately address these requirements in the NPRM. This revision addresses the requirements of former § 23.967(c) and (d), which restricted installation of fuel tanks around engine compartments and firewalls, and

required fuel systems to be isolated from personnel compartments. It is also consistent with the provisions of CS 23.2465(b)(2), which requires each energy storage and supply system to be installed in such a way to be protected against hazards due to unintended temperature influence.

Air Tractor requested adding the term “significant” after “prevent” in proposed § 23.930(b)(2). Embraer concurred with this revision because it would allow for small amounts of fuel loss through vent lines, such as when the tanks are full and there is normal “sloshing” during taxi or takeoff, or when fuel expands as it warms. An individual commenter also requested revising proposed § 23.930(b)(2) to specify the fuel storage system must prevent hazardous fuel loss during maneuvers. The commenter believed the proposal would require the prevention of even minor fuel loss from vents, which is more stringent than the former standard. The commenter believed the more stringent standard was of questionable utility and practicality, and noted it was not justified in the preamble.

An individual commenter requested the FAA delete proposed § 23.930(b)(3), which would require each fuel storage system to prevent discharge when transferring fuel, because other proposed regulations would address any potential hazards associated with fuel transfer. The commenter further stated it was unclear if the proposed requirement would apply to fuel returned from the engine to other than the specified tank. This commenter explained that some multiengine airplanes feature fuel-transfer cross feeding, which can result in a fuel discharge if the receiving tank is full. This approach has both advantages and disadvantages, but should not be prohibited by regulation. The commenter also noted this proposal was not justified in the preamble or addressed in the

Regulatory Analysis, was more stringent than the former rule, and would require additional hardware or revised architecture for some designs.

The FAA agrees with the recommendation to delete the requirement in proposed paragraph (b)(3) that each fuel storage system prevent discharge when transferring fuel. The FAA recognizes it has approved the design of certain fuel systems under former regulations that may result in a non-hazardous discharge of small amounts fuel when fuel is transferred between fuel tanks or fed from a specific fuel tank and returned to another tank under certain conditions. To ensure the continued acceptability of these systems under the new rule, the FAA has combined proposed paragraph (b)(2) and (b)(3) into paragraph (b)(3) in this final rule. Paragraph (b)(3) now requires the fuel system to be designed to prevent significant loss of stored fuel from any vent system due to fuel transfer between storage or supply systems under likely operating conditions.

One commenter stated the proposed rule did not specifically address the potential of water in the airplane's fuel system, and the commenter proposed it should contain a requirement to include fuel tank water sensors. The commenter noted that water accumulates in fuel tanks in a number of ways, such as when temperature changes or when air enters a tank from which fuel has been consumed.

The FAA notes the specific hazard associated with water in petroleum-based fuels is addressed generally in § 23.2430(a)(7), which requires the prevention of hazardous contamination of the fuel supplied to the powerplant. Additionally, the FAA notes that a compound such as water may not necessarily be considered a contaminant or hazard in certain future fuel systems. The commenter's proposal would introduce specific language that may not be appropriate for future fuel systems and has therefore not been adopted.

Finally, the FAA revises § 23.2430(c) to remove the restrictive language applicable only to pressure refueling systems. The rule now applies to fuel storage refilling and recharging systems. This revision will establish more appropriate requirements to accommodate the introduction of new propulsion systems such as electric motors. Accordingly, the FAA adopts performance-based requirements that will require prevention of improper refilling or recharging, prevention of stored fuel contamination during likely operating conditions, and the prevention of the occurrence of any hazard to the airplane or to persons during refilling or recharging.

h. Powerplant Induction and Exhaust Systems (proposed § 23.935/now § 23.2435)

In the NPRM, proposed § 23.935 (now § 23.2435) would have required the air induction system to supply air needed for each power unit and its accessories under expected operating conditions, and provide a means to discharge potential harmful material.

EASA recommended removal of the design-specific requirements in proposed § 23.935 because those requirements should be addressed as a means of compliance. Textron requested a complete rewrite of proposed § 23.935, stating the section was "too high level" and did not provide adequate performance-based requirements for an applicant to be able to demonstrate compliance. Textron asked the FAA to derive the language for proposed § 23.935 from appendix E of the final Part 23 ARC Report.

The FAA notes EASA's recommendation to remove § 23.935 based on its contention the section appears to be a means of compliance instead of a performance-based requirement. However, the FAA finds the provisions of the rule set forth performance-based requirements for induction and exhaust systems that are appropriate

for inclusion in this rule. Rather than stipulating a specific means of compliance, these requirements serve as high-level performance-based requirements for which a number of alternative means of compliance could be developed by applicants.

The FAA partially agrees with Textron's comment that the rule is "too high level." Accordingly, the FAA revises § 23.2435 based on the requirements for powerplant induction and exhaust systems contained in former §§ 23.1091, 23.1121, 23.1123, 23.1125, and the final Part 23 ARC Report. Section 23.2435 now sets forth performance-based requirements that encompass these prescriptive regulations and the Part 23 ARC's proposed requirements. The FAA notes while it is adding all of the ARC's proposed requirements for exhaust and induction systems in this rule, not all of its recommendations for revisions to this section were appropriate. Some of the ARC's recommendations are more appropriately addressed by other sections of this rule. For example, the ARC's proposed requirement for the system that supplies air to the cabin to prevent hazardous quantities of toxic gas from entering the cabin is addressed by § 23.2400(d) while the engine accessory component cooling requirements are addressed by § 23.2400(e), which requires powerplant components to comply with their limitations and installation instructions, or be shown not to create a hazard.

Embraer requested the FAA revise proposed § 23.935 to clarify the design and induction system must prevent distortion as described in former § 23.939(c). Embraer also recommended the FAA revise the proposal to include a requirement that the air induction system for each power unit and its accessories must not, as a result of airflow distortion during normal operation, cause vibration harmful to the power unit.

The FAA notes that former § 23.939(c) addressed distortion as a cause of vibration and required the air inlet not, as a result of distortion during normal operation, cause vibration harmful to the engine. Embraer's general concerns are addressed by § 23.2435(a)(1), which requires the air induction system for each powerplant or auxiliary power unit and its accessories to supply the air required under likely operating conditions. Embraer's specific concern that the air induction system not cause "vibration harmful to the power unit" is addressed by the powerplant installation requirements contained in § 23.2400(c)(4), which requires the applicant to "construct and arrange each powerplant installation to account for . . . vibration and fatigue," which occur as a result of distortion.

Air Tractor and ANAC raised concerns about whether proposed § 23.935(b) was intended to address exhaust systems or air induction systems. Air Tractor stated it did not believe the FAA intended proposed § 23.935(b) to mandate the use of an inertial bypass particle separator (as proposed § 23.935(b) could have been interpreted to require), and recommended the FAA clarify proposed § 23.935(b) to indicate the requirement applies only to exhaust systems. ANAC commented that proposed § 23.935(b) should require the exhaust system to ensure safe disposal of exhaust gases, as the former rule required.

The FAA agrees with Air Tractor and ANAC's concern that proposed § 23.935(b) is unclear because it only appears to discuss induction systems (whereas the title of proposed § 23.935 includes exhaust systems). Accordingly, the FAA has modified § 23.2435 to clearly indicate the requirements of paragraph (a) apply to induction systems and the requirements of paragraph (b) apply to exhaust systems. This makes it clear the rule does not require use of an inertial bypass particle separator as a means for the induction system to discharge potential harmful material.

If a complete rewrite of proposed § 23.935 is not adopted, Textron requested clarification as to whether the proposed requirements were intended to address the cooling air requirements for powerplant accessories in former §§ 23.1041 through 23.1047, and the intent of former § 23.1091. If proposed § 23.935 was intended to match the provisions of former § 23.1091, Textron commented that the proposed section was adequate. However, if proposed § 23.2435 was intended to address §§ 23.1091 and 23.1041 through 23.1047, Textron asked for clarification of the proposed section's requirements. Textron also specifically recommended revising the regulatory text to clarify the intent of the proposed requirements were "to ensure proper operation within established limitations" of the air induction system for each power unit and its accessories.

The FAA notes the engine cooling requirements are not specifically addressed in § 23.2435, other than in a requirement that the induction system be designed to supply the air required by each powerplant or auxiliary power unit and its accessories under likely operating conditions. However, the powerplant cooling requirements are addressed more directly by § 23.2400(e), which requires powerplant components to comply with their limitations and installation instructions, or be shown not to create a hazard. This requirement ensures an applicant addresses engine cooling.

Additionally, the FAA revises proposed § 23.2435(b) to specifically indicate exhaust systems include exhaust heat exchangers for each powerplant or APU. Specifically referencing these systems as part of the airplane exhaust system continues the FAA's practice of applying exhaust system requirements to exhaust heat exchangers. The FAA also revises requirements for exhaust systems by adding paragraph (b)(2) to

ensure these systems are designed to prevent likely hazards from heat, corrosion, or blockage. These requirements address the specific requirements of former § 23.1121(a) and (h) and § 23.1123(a).

i. Powerplant Ice Protection (proposed § 23.940/now § 23.2415)

In the NPRM, proposed § 23.940 (now § 23.2415) would have required the airplane design to prevent foreseeable accumulation of ice or snow that would adversely affect powerplant operation. Proposed § 23.940 would have also required the powerplant design to prevent any accumulation of ice or snow that would adversely affect powerplant operation, in those icing conditions for which certification is requested.

Textron recommended withdrawing proposed § 23. 940, as it believed the requirement to protect engines could be adequately addressed in proposed § 23.910 by including language that would ensure safe powerplant operation under all likely operating conditions or enable satisfactory powerplant functioning in icing conditions. Alternatively, Textron proposed consolidating the requirements of proposed § 23.940 by removing paragraph (b) and revising paragraph (a) to require the airplane design prevent "any accumulation"—rather than "foreseeable accumulation"—of ice or snow that adversely affects powerplant operation in those icing conditions for which certification is requested.

The FAA does not agrees that eliminating proposed § 23.940 (now § 23.2415) and adding a requirement to proposed § 23.910 (now § 23.2410) would result in designs that would prevent the accumulation of ice or snow that could adversely affect powerplant operations. Including Textron's proposed regulatory language in § 23.2410 as part of the powerplant installation hazard assessment could permit designs that only

address ice accretion as part of a powerplant installation assessment, and not airframe ice accretion that may pose an ice shed hazard. Additionally, Textron's proposal could be interpreted to only require the powerplant's performance be evaluated for the environmental icing conditions for which certification is requested, and not for other conditions that may be conducive to ice accretion in reciprocating engine induction systems. In contrast, the FAA finds § 23.2415 establishes specific requirements that will apply to all airplane designs, to include those for which certification in icing conditions was not requested, and adds requirements that will apply to powerplant designs for airplanes intended for certification for flight in icing conditions.

The FAA also finds Textron's recommendation to revise proposed § 23.940(a) and withdraw paragraph (b) would specifically eliminate the applicability of the requirement to the powerplant design. By only setting forth a requirement for the airplane design and not the powerplant design, Textron's proposed revision would neither ensure an independent assessment of the adequacy of the engine design for icing conditions, nor require an evaluation of the engine's tolerance for ice ingestion. Additionally, it would not apply to propellers, which are considered powerplant components. The FAA's intent in paragraph (b) is to require an applicant to assess the adequacy of the engine's certification basis for installation in an airplane, the engine's service history of ice ingestion, and propeller design.

The FAA expects that an acceptable means of compliance would specify an evaluation of the engine's tolerance for ice ingestion that would not be limited to the conditions specified in part 25, appendix C, and that such an evaluation would show that it meets, or exceeds, those standards prescribed in former § 23.903(a)(2).

Textron also commented that proposed § 23.940 does not address ice accretion that could affect the performance of cooling air inlets for the engine and its accessories.

In light of Textron's comment, the FAA is adding the term "installation" to proposed § 23.940(b) to clarify the regulation, like former § 23.929, applies to "other components of complete engine installations," which include cooling air inlets. Accordingly, § 23.2415(b) now requires the "powerplant installation design" to prevent any accumulation of ice or snow that adversely affects powerplant operation, in those icing conditions for which certification is requested. This change from what was proposed is consistent with the NPRM, which explained that powerplant design in proposed § 23.940(b) refers to the engine, propeller, and other powerplant components such as cooling inlets.

Additionally, the FAA is inserting the phrase "including the induction and inlet system" after "airplane design" to clarify that § 23.2415(a) is intended to address the engine induction ice protection requirements found in former part 23. This change from what was proposed is consistent with the NPRM, which explained that the airplane design in proposed § 23.940(a) refers to the engine induction system and airframe components on which accumulated ice may shed into the powerplant. The FAA also reiterates that paragraph (a) applies to all airplanes regardless of whether certification for flight in icing conditions is sought, and requires applicants to address ice accretion anywhere on the airplane that may pose a threat to the powerplant if that ice is shed. "Foreseeable" accumulation of ice and snow, rather than "any" accumulation as recommended by Textron, is used in paragraph (a). The icing and snow conditions to be evaluated are not simply the icing conditions for which the airplane is to be certified, as

in paragraph (b). For example, on non-icing certified airplanes, conditions to be evaluated range from carburetor icing on reciprocating powered airplanes to part 25, Appendix C icing on turbine powered airplanes.

j. Powerplant Fire Protection (proposed § 23.1000/now § 23.2440)

In the NPRM, proposed § 23.1000 (now § 23.2440) would have required a powerplant be installed in a designated fire zone and would have required an applicant to install a fire detection system in each designated fire zone for levels 3 and 4 airplanes. Proposed § 23.1000 would have also required an applicant to install a fire extinguishing system for levels 2, 3, and 4 airplanes with a powerplant located outside the pilot's view that uses combustible fuel.

Additionally, proposed § 23.1000 would have required each component, line, and fitting carrying flammable fluids, gases, or air subject to fire conditions to be fire resistant, except components storing concentrated flammable material would have to be fireproof or enclosed by a fireproof shield. Proposed § 23.1000 would have also required an applicant to provide a means to shut off fuel or flammable material for each powerplant, while not restricting fuel to remaining units, and prevent inadvertent operation.

EASA noted the proposed regulation contained too many design details, which are better addressed as means of compliance. EASA contended that the sole objective of proposed § 23.1000 should be to require a means to isolate and mitigate hazards to the airplane in the event of a powerplant system fire or overheat in operation.

Although the FAA concedes that some of the proposed requirements are prescriptive in nature, the FAA has determined that inclusion of these requirements for

fire protection are critical to safety and should be retained to prevent any potential degradation of safety. Fire, while not a common occurrence, greatly reduces the likelihood of survival when occurring in flight. Detection, isolation, and extinguishing have historically provided an acceptable means for mitigating hazards from powerplant-related fires. Accordingly, the final rule retains what the FAA considers to be sufficient prescriptive requirements to ensure the existing level of fire protection. In response to EASA's comment, as discussed in more detail later, the FAA has added a requirement in § 23.2440(b), requiring each designated fire zone provide a means to isolate and mitigate hazards to the airplane in the event of a powerplant system fire or overheat.

Zee questioned whether the requirement in proposed § 23.1000(a) for all powerplants to be installed in a designated fire zone is appropriate. The commenter noted electric propulsion systems can be designed and installed with no flammable liquids or materials, thus eliminating the need for fire protection. Zee requested the FAA revise proposed paragraph (a) to indicate installation in a fire zone is not required if not applicable. The Associations also recognized the same issue and proposed revising the requirement to only apply to flammable powerplant components. Embraer recommended the FAA delete proposed § 23.1000(a).

ANAC observed that the intent to define "designated fire zones" in the proposal is to identify areas of the airplane in which a high degree of safety precautions must be taken, recognizing that fire will occur in these regions because of the presence of both ignition sources and flammable fluid. ANAC contended proposed § 23.1000 could be interpreted as the region where a powerplant is to be installed must first be evaluated for ignition sources and flammable fluids. ANAC noted the proposed requirement could also

be interpreted as the powerplant can only be installed in regions that already contain ignition sources and flammable fluids. Embraer contended that former § 23.1181 defined the "hot" parts of an engine installation as ignition sources, and considering that there are fuel, oil, and hydraulic fluids being carried around such areas, they should be considered fire zones. Thus the term "designated" would apply, obviating further analysis.

The FAA has considered the comments regarding the requirement to install all powerplants in proposed § 23.1000(a) (now § 23.2440(a)) in a designated fire zone. The FAA notes that while virtually every kind of powerplant (to include electric motors) may present a potential fire hazard, some types of powerplants may not present a likely fire hazard or require installation in a designated fire zone. Accordingly, the FAA revises § 23.2440(a) to require a powerplant be installed in a designated fire zone only if it includes a flammable fluid and an ignition source for that fluid. The term "flammable fluid" includes any flammable substance such as liquids, gases, or gels that are capable of flowing. This change is intended to alleviate the need to install powerplants that do not present a likely fire hazard in a designated fire zone. The FAA also adds the term "combustion heater" to § 23.2440(a), which are required to be located in designated fire zones under former § 23.1181. The devices were inadvertently omitted from consideration under the fire and high-energy protection requirements of proposed subpart D.

ANAC noted the NPRM preamble discussion indicated that fire must be evaluated in the powerplant installation hazard assessment required under proposed § 23.910. ANAC expressed concern the dedicated requirement for powerplant fire protection in proposed § 23.1000 could be interpreted to require evaluation of fire

hazards beyond the scope of proposed § 23.910. ANAC recommended the FAA include a requirement for a firewall that ensures a fire originating in any fire zone will not be a hazard to the airplane.

The FAA did not intend to require the use of a hazard assessment process in proposed § 23.1000 (now § 23.2440). The FAA notes the purpose of the firewall discussion in proposed § 23.1000 is to determine if a particular component or system would need to be placed in a designated fire zone. If a component is required to be located in a fire zone by a rule other than § 23.2410, such as § 23.2440(a), that requirement must be complied with regardless of the results of any hazard assessment. The FAA revises § 23.2440(a) to require that a powerplant, APU or combustion heater, that includes a flammable fluid and an ignition source for that fluid, be installed in a designated fire zone. In response to ANAC's recommendation to add a requirement for a firewall that ensures a fire originating in any fire zone will not be a hazard to the airplane, the FAA notes § 23.2440(b) requires each designated fire zone provide a means to isolate and mitigate hazards to the airplane in the event of a powerplant system fire or overheat. Isolation of a designated fire zone is typically accomplished by use of a firewall or other equivalent means.

An individual commenter raised concerns that proposed § 23.1000(b) fails to address critical fire protection requirements and only requires components carrying flammable liquid to be fire resistant. Specifically, the commenter noted that former § 23.1141(f) required powerplant controls required to operate in the event of a fire to be fire resistant, former § 23.1189 required shutoff valves to be outside the fire zone, former § 23.1203 required certain fire detector components to be fire resistant, and former

§ 23.1201 required fire extinguisher components in the fire zone to be fireproof. To resolve this, the commenter recommended implementation of basic system performance requirements for fire protection, preserving the former fire protection standards, but not compromising future designs. Another commenter noted the proposed rule did not capture some of the specific fire protection requirements for items such as powerplant controls, shutoff valves, fire detectors and extinguishers.

The FAA agrees the proposed language was not sufficiently comprehensive to establish clear requirements necessary for the prevention of hazards resulting from fire. The FAA revises proposed § 23.1000(b) and renumbers it as § 23.2440(c) to ensure adequate fire protection is maintained for those noted components, along with any other components determined critical to safety. The FAA adds paragraph (c)(1) to ensure the design of components and the placement within the airplane not only prevent fire hazards but also account for the effects of fire in adjacent fire zones. This requirement addresses the requirements in former § 23.1183(a) to ensure flammable fluid-carrying components be shielded, or located to safeguard against the ignition of flammable fluid. These requirements are also consistent with the provisions of former § 23.1182.

Embraer recommended the FAA revise proposed § 23.1000(c) to allow for the flow of quantities of fuel that are small enough not to be hazardous to enter into the powerplant. Textron similarly asserted proposed § 23.1000(c) was unnecessary and could be addressed by proposed § 23.910. Textron recommended the FAA revise its proposal to conform with CS 23.510(e), or § 23.906(i) in appendix E of the Part 23 ARC Report.[49] Alternatively, Textron recommended revisions to proposed § 23.1000(c), (d), and (e).

[49] In each area or component where flammable fluids or vapors might escape by leakage of a fluid

The FAA agrees with Embraer's comment that small amounts of fuel may still enter a powerplant after a shutoff means has been activated. The FAA revises paragraph (c) and paragraph (d) to require that the applicant provide a means to prevent hazardous quantities of flammable fluid from flowing into the designated fire zone. Accordingly, this revision will permit the flow of small amounts of residual flammable fluid if it is shown not to present a hazard, after activation of any shutoff means.

With respect to Textron's comment, the FAA finds the requirements for a means to shut off fuel or flammable material for each powerplant necessary. The FAA has determined § 23.2410 does not adequately address this requirement because § 23.2410 sets forth the requirements for a powerplant hazard assessment in which an applicant could feasibly conclude that a means to shut off fuel flow for each powerplant would not be necessary to comply with the stated requirement. At this time, the FAA does not intend to permit the certification of airplanes without a means to shut off fuel to their powerplants.

The FAA also considered Textron's recommendation to revise proposed § 23.1000 to conform to CS 23.510(e) or the Part 23 ARC's proposed § 23.906(i). The FAA finds the hazard minimization requirements contained in these provisions do not specifically preclude the certification of an airplane without a means to shut off fuel flow to each powerplant, a requirement the FAA considers essential for hazard mitigation. Accordingly the FAA does not adopt that recommendation, and considers such action to be outside the scope of this rulemaking effort.

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system, there must be means to minimize the probability of ignition of the fluids and vapors, and the resultant hazard if ignition does occur and prevent the introduction of hazardous toxic gases into the cabin.

Textron recommended the FAA revise the introductory text of proposed paragraph (c) to require the applicant to provide a means to shut off both fuel and flammable material for each powerplant. Textron recommended changing “or” to “and”; otherwise, the language would suggest there is no requirement to shut off other flammable fluid flow. Textron also requested the FAA to clarify that the applicant must only demonstrate that the means of shut off, and not each powerplant, meets the requirements of proposed paragraphs (c)(1) and (c)(2).

The FAA agrees with Textron’s concern that proposed § 23.1000 could be interpreted to require shutoff of either fuel or flammable material, which could permit a design that does not shutoff all flammable materials to the fire zone. Therefore, the FAA removes the term “fuel” from the requirement. Section 23.2440(d) now requires prevention of all hazardous quantities of flammable fluid from entering a fire zone. This is consistent with former § 23.1189(a)(1). During review of the existing shutoff requirements, the FAA also determined a critical flammable fluid shutoff valve fire performance requirement was not included in the proposed rule. Therefore, the requirement of former § 23.1189(a)(4) is included in the final rule as § 23.2440(d)(3).

The FAA notes that proposed § 23.1000(d) included a qualifier that required only powerplants that use a combustible fuel to have a fire extinguishing system. Based on the commenter’s concerns, the FAA removes this specific requirement and revises § 23.2440(a) to require any powerplant or APU that includes a flammable fluid source and an ignition source for that fluid be located in a fire zone. This regulatory approach is consistent with former requirements for designated fire zones that contain a flammable fuel and an ignition source where any leakage of flammable fluid would likely result in a

fire. Concerns relating to possible electrical engine fires are noted, but not considered likely such that they would require installation in a designated fire zone. Electric motors are commonly used on airplanes, although not for propulsion, and have not required the protection of a designated fire zone.

Additionally, the FAA adds paragraph (d)(3) to the final rule. The revision requires the applicant to provide a means to prevent hazardous quantities of flammable fluids from flowing into, within, or through each designated fire zone located outside the fire zone unless an equal degree of safety is provided with a means inside the fire zone. This revision is based on the provisions of former § 23.1189(a)(4) and intends to ensure the specific requirements of that section are met by an applicant.

Textron also reiterated the concept that fire protection actually applied to all systems and recommended removing proposed § 23.1000(c)(2) and broadening its applicability to all systems by placing the requirement in proposed § 23.1305.

While the FAA understands Textron's comment that fire protection applies to all systems, the FAA notes the fire protection for areas outside of fire zones are addressed by § 23.2325 of the final rule. The requirements for fire protection in fire zones are more extensive than those for other areas of the airplane. The FAA requires designated fire zones, and their corresponding extensive fire protection requirements, for those areas where both nominal ignition sources and flammable fluids must be co-located such that a single failure is likely to result in a fire. Zones of the airplane that are outside a fire zone should not contain both nominal ignition sources and flammable fluids. Because there is a lower likelihood of fire in these areas, they have correspondingly less extensive requirements.

Textron also recommended revising proposed § 23.1000(d) because it believed the proposal would limit the applicability of the requirement for a fire extinguishing system to those powerplants "outside the pilot's view" and those powerplants that use "combustible fuels." The commenter believed the intent of the proposal was not clear, and recommended the FAA consider the need for extinguishing systems in hybrid electric configurations where fire extinguishing systems may be needed to address an electrical fire. Textron also did not believe the rule's requirement should be limited to level 3 and 4 airplanes. Textron recommended the FAA retain the provisions of former § 23.1195, which required extinguishing systems for "all airplanes with engine(s) embedded in the fuselage or in pylons on the aft fuselage." Textron also recommended the FAA incorporate additional provisions from the Part 23 ARC Report, which recommended requiring that fire extinguishing systems be installed in all airplanes with engines embedded in the aft fuselage or in pylons on the aft fuselage, and for an APU, if installed. The systems must not cause a hazard to the rest of the airplane.

Textron asserted that fire detection systems should not be mandatory for all level 3 and 4 airplanes as proposed in § 23.1000(e), but rather should be required based upon the type and location of engines used in the airplane. The commenter recommended using the proposed requirements from the Part 23 ARC Report, which describes the top level safety requirements and then would allow the industry standard to provide more specifics as to what engine types and configurations would require a fire detection system. Textron further commented that proposed § 23.1000(e) should be revised to only require fire detection systems for those airplanes that have the characteristics specified in former § 23.1203(a).

An individual commenter also noted that proposed § 23.1000(d) and (e) were inconsistent with the requirements of the former rule and, in some cases, would impose more stringent requirements without providing justification. Specifically, the commenter stated that, as proposed, a level 1 or 2 airplane with the engine located outside the view of the pilot could be required to have a fire extinguisher, but not a fire detector. The commenter also noted a single-engine level 3 or level 4 airplane, such as a Cessna 208 or Pilatus PC-12, was not required to have a fire detection system under the former rule, but would be required to have such a system under the proposed rule. The commenter further noted that the requirements of former § 23.1203 were based on designs determined to be at greater risk for fire (e.g., multiengine turbines and reciprocating engines with turbochargers), which justified inclusion of a fire detection system. The commenter also noted the former rule addressed other designs and required fire extinguishing systems for all commuter category airplanes, whereas the proposed rule lacks these specific requirements. The commenter recommended the FAA revise proposed § 23.1000(d) and (e) to ensure no additional burden would be placed on future designs unless justified and to ensure the former level of fire protection would be retained.

The FAA agrees with the commenters that proposed § 23.1000(d) and (e) were confusing and inconsistent with former fire extinguishing and detection requirements. The FAA revises those paragraphs, now located in § 23.2440(e) and (f), to be consistent with former requirements by removing the language limiting the applicability of the requirements to only level 3 and level 4 airplanes, and basing the need for a fire extinguishing system on the location of a fire zone instead of on the location of the powerplant. However, the FAA retains the specific requirement for a means to extinguish

fires within fire zones on level 4 airplanes, because these airplanes are functionally equivalent to airplanes currently certificated in the commuter category. These changes make § 23.2440(e) and (d) consistent with the requirements of former §§ 23.1195, "Fire extinguishing systems," and 23.1203, "Fire detector system."

Finally, Air Tractor also recommended adding "if installed" after "fire detection system" in proposed § 23.1000(f) and (g) to avoid the perception a fire detection system is a requirement.

The FAA notes that, if a particular system is not required and not installed on the airplane, any specific requirements related to that system will not be applicable. Therefore, the FAA does not add the text proposed by Air Tractor to the final rule.

7. Subpart F – Equipment

a. General Discussion

The FAA proposed substantial changes to former subpart F. The thirty-seven former system sections were consolidated into eight sections. An effort was made to maintain the safety intent of the rules while removing the prescriptive nature of these rules which were based on technology available at the time the rule was introduced. This was intended to increase future flexibility to facilitate the installation of systems that enhance safety as new technology becomes available.

EASA recommended the FAA add an additional requirement to proposed subpart F that describes what system and equipment information should be determined. EASA further suggested subpart G cover how this information is displayed.

The FAA finds EASA's recommendation to add a new requirement for system and equipment information unnecessary because this information is already addressed in

several requirements, including proposed § 23.1305 (now § 23.2505), Function and installation; proposed § 23.1400 (now § 23.2540), Safety Equipment; proposed § 23.1505 (now § 23.2605), Installation and operation; proposed § 23.1310 (now § 23.2615), Flight, navigation and powerplant instruments; and proposed § 23.1515 (now § 23.1529), Instructions for continued airworthiness. The FAA agrees, however, that subpart G should address how the information is presented.

b. Airplane Level Systems Requirements (proposed § 23.1300/now § 23.2500)

In the NPRM, proposed § 23.1300 (now § 23.2500) would have required equipment and systems required for an airplane to operate—

- Safely in the kinds of operations for which certification is requested;
- Be designed and installed to meet the level of safety applicable to the certification and performance levels of the airplane; and
- Perform their intended function throughout the operating and environmental limits specified by an applicant.

Proposed § 23.1300 would have also mandated that non-required airplane equipment and systems, considered separately and in relation to other systems, be designed and installed so their operation or failure would not have an adverse effect on the airplane or its occupants.

NATCA observed the requirements of proposed § 23.1300 and § 23.1305 (now § 23.2505) appeared similar and requested the FAA combine the two sections.

While the FAA agrees there is some similarity between § 23.2500 and § 23.2505, the requirements of § 23.2500 are at the airplane level and create a distinction between "required" and "non-required" equipment and systems. In contrast, the requirements of

§ 23.2505 are at the system level and apply to all installed equipment, regardless of whether it is required.

Garmin asked the FAA to clarify whether proposed §§ 23.1300 and 23.1305 are of general applicability and do not supersede other specific part 23 requirements. Garmin noted that CS 23.600(a) includes such clarifying language concerning CS 23.600 and CS 23.605, and that the FAA's decision to omit similar wording from proposed § 23.1300 makes it unclear whether the FAA agrees with EASA in this respect or not.

In light of Garmin's comment, the FAA revises proposed §§ 23.1300 and 23.1305 to clarify the requirements of these sections apply generally to installed equipment and systems. However, the requirements do not apply if another section of part 23 imposes specific requirements on a particular piece of installed equipment or systems. The FAA finds this revision is consistent with the NPRM. The FAA intended proposed §§ 23.1300 and 23.1305 to capture the safety intent of former § 23.1309. Former § 23.1309 was a regulation of general requirements that did not supersede any requirements contained in other part 23 sections. Sections 23.2500 and 23.2505 are harmonized with CS 23.600 and CS 23.605.

Air Tractor stated proposed § 23.1300(a)(l) failed to define a standard for the required level of safety for systems.

The FAA is construing Air Tractor's comment as referring to the qualitative levels of safety for systems, which were previously contained in former § 23.1309(c). These qualitative levels of safety are now contained in § 23.2510 (proposed as § 23.1315), which provides system-level requirements. The FAA notes § 23.2500(a)(1) provides airplane-level requirements, and does not specify the level of safety because the

acceptable level of safety varies depending on the certification level of the airplane. Former part 23 is one acceptable means of compliance for the new part 23. Therefore, applicants may use as a means of compliance the levels of safety defined in figure 2 of AC 23.1309-1E, "System Safety Analysis and Assessments for Part 23 Airplanes", which were a means of compliance to former § 23.1309 and varied depending on the certification class of airplane. Alternatively, applicants—individuals or organizations—may assist in the development of industry-consensus standards, or propose their own means of compliance to § 23.2500(a)(1).

ANAC commented the phrase "operating and environmental conditions specified by the applicant" in proposed § 23.1300(a)(2) could lead to misinterpretation. ANAC asserted these conditions may not be adequate or achieve the minimum requirements for certification. ANAC suggested using the phrase "conditions for which the airplane is certified."

The FAA agrees with ANAC and revises the proposed rule language for clarity. Accordingly, § 23.2500(a)(2) now requires the equipment and systems required for an airplane to operate safely, in the kinds of operations for which certification is requested, to be designed and installed to perform their intended function throughout the operating and environmental limits "for which the airplane is certificated."

Several commenters commented on the use of the phrase "non-required" in proposed § 23.1300(b). EASA stated that the proposed provisions of § 23.1300(a) and (b) raised ambiguity regarding what systems and equipment are "required." EASA recommended clarifying the distinction between "required" and "non-required" in paragraphs (a) and (b), respectively, by revising the proposed rule language in paragraph

(b) to make clear “non-required” systems and equipment are those not covered by paragraph (a). The Associations recommended the FAA clarify what non-required systems and equipment include and offered rule language similar to that proposed by EASA. Lastly, ANAC recommended replacing “non-required” with “each” in proposed § 23.1300(b) because the requirements should apply to all systems and equipment.

The FAA agrees the distinction between proposed § 23.1300(a) and proposed § 23.1300(b), which would have applied to “non-required” equipment, was unclear. The FAA adopting EASA’s recommended rule language, which clarifies the distinction between the two requirements by linking them together. Accordingly, § 23.2500(b) (proposed as § 23.1300(b)), now requires the systems and equipment not covered by § 23.2500 (a) to be designed and installed so their operation does not have an adverse effect on the airplane or its occupants.

While the FAA agrees with ANAC that both “required” and “non-required” equipment and systems must be designed and installed so their operation does not have an adverse effect on the airplane or its occupants, the FAA finds it unnecessary to apply new § 23.2500(b) to “required” equipment, because § 23.2500(a) (proposed as § 23.1300(a)) already covers this requirement. Required equipment and systems that are designed and installed to meet the level of safety applicable to the certification and performance level of the airplane, in accordance with § 23.2500(a)(1), and that perform their intended function, in accordance with § 23.2500(a)(2), will not have an adverse effect on the airplane or its occupants. Furthermore, the FAA is intentionally making a distinction between “required” and “non-required” equipment in § 23.2500(a) and (b) because “non-required” equipment and systems should not always be required to perform

their intended function throughout the entire operating and environmental limits of the airplane.

Air Tractor suggested the FAA compare former § 23.1309 and proposed § 23.1300(b). They noted the proposed rule may make it easier to certify non-required equipment; however, the proposed rule still seemed to require a Functional Hazard Assessment (FHA) and System Safety Assessment (SSA). Air Tractor suggested the FAA relieve the undue burden associated with the required system safety analysis for non-required equipment and systems.

The FAA has determined some method of assessment is necessary to ensure that equipment and systems installed on an airplane meet an acceptable safety level. The safety assessment must show that a logical and acceptable inverse relationship exists between the average probability per flight hour and the severity of failure conditions effects. The depth and scope of the safety assessment will depend on the types of functions performed by the systems, the severity of failure conditions, and whether the system is complex. For simple and conventional systems with well-established designs, the safety assessment may be satisfied by a qualitative assessment such as the single-failure concept and experience based on service-proven designs and engineering judgment. Former guidance for complex systems relied on industry standards such as ARP 4761, "Guidelines and Methods for conducting the Safety Assessment Process on Civil Airborne Systems and Equipment," and ARP 4754A, "Guidelines for Development of Civil Aircraft and Systems," as well as AC 23.1309-1E, to define an acceptable means of compliance. As explained in the NPRM, former part 23 and associated guidance may be used as one means of compliance with the new part 23. Alternatively, applicants may

rely on industry consensus standards, or develop their own methods of compliance appropriate to the various airworthiness certification levels.

Garmin stated it was unclear what the phrase "or failure does not have an adverse affect" in proposed § 23.1300(b) means and that failures would be covered under proposed § 23.1315. Garmin implied that proposed § 23.1300(b) was redundant with proposed § 23.1315, which already addressed the failure of a non-required system as it would have provided the basis for assessing the implications of any failure for installed equipment. The commenter requested that the FAA delete "or failure" from the proposed rule.

The FAA agrees with Garmin and deletes the words "or failure" from the proposed rule language. Section 23.2510 (proposed as § 23.1315) addresses failure conditions of all equipment. Therefore, proposed §§ 23.1300 and 23.1315 would have been redundant by requiring the same showing of compliance. Additionally, the phrase "failure does not have an adverse effect on the airplane or its occupants" could have been misinterpreted as requiring the failure to have no effect on the airplane. For example, if the equipment was installed to provide a benefit, although not required, it could have been wrongly interpreted that the failure of that benefit would have an "adverse effect" on the airplane.

c. Function and Installation (proposed § 23.1305/now § 23.2505)

In the NPRM, proposed § 23.1305 (now § 23.2505) would have required each item of installed equipment to perform its intended function, be installed according to limitations specified for that equipment, and the equipment be labeled, if applicable, as to its identification, function, or operation limitations, or any combination of these factors.

Proposed § 23.1305 would have required a discernable means of providing system operating parameters required to operate the airplane, including warnings, cautions, and normal indications to the responsible flight crewmember. Proposed § 23.1305 would have also required information concerning an unsafe operating condition be provided in a clear and timely manner to the crewmember responsible for taking corrective action.

In light of comments received, the FAA revises proposed § 23.1305 to withdraw paragraph (a)(2), merge paragraph (a) and (a)(1) into new paragraph (a), and relocate paragraphs (a)(3) through (c) to new § 23.2605 in subpart G. This section discusses these changes in more detail.

The Associations, Textron, and ANAC commented on proposed § 23.1305(a)(1). Textron commented that proposed § 23.1305(a) appears to be redundant with proposed § 23.1300(a) and asked the FAA to clarify whether proposed § 23.1305(a)(1) would apply to the non-required equipment addressed in proposed § 23.1300(b).

ANAC recommended that the FAA remove proposed § 23.1305(a)(1) because the requirement is adequately addressed in § 23.1300(a)(2) for required equipment. ANAC explained that proposed § 23.1305(a)(1) would contradict the requirement for non-required equipment in proposed § 23.1300(b). The Associations, noted that one of the reasons for distinguishing “required” and “non-required” equipment in proposed § 23.1300 was to alleviate the issues with requiring non-required equipment to prove their intended function. The commenters contended the rule should only require non-required equipment and systems (which are not required for safe flight) to verify their operation or failure does not interfere with required equipment. The commenters

recommended confining the proposed requirement of § 23.1305(a) to "required" systems and equipment.

The FAA considered the comments to proposed § 23.1305(a)(1) and recognizes the confusion between §§ 23.1300 (now § 25.2500) and 23.1305. The FAA notes § 23.2505 applies to both required and non-required equipment. All equipment, when installed, should function as intended to maintain a minimum level of safety. The requirement of § 23.2505 is not addressed by § 23.2500(a)(2) as § 23.2505 applies to both required and non-required equipment when the equipment is installed on the airplane. Section 23.2500(a)(2) applies only to required equipment in operation. The FAA finds § 23.2505(a) does not contradict the requirement of § 23.2500(b), which applies to non-required equipment during airplane operations once in service. As explained in the NPRM, § 23.2500(b) would not require non-required equipment and systems to function properly during all airplane operations once in service, provided all potential failure conditions do not affect safe operation of the airplane. However, the non-required equipment or system would have to function in the manner expected by the manufacturer's operating manual for the equipment or system when installed. To clarify the FAA's intent and better harmonize with EASA, the FAA is merging proposed paragraph (a) with (a)(1) to revise § 23.2505 to require each item of equipment, when installed, to function as intended.

The Associations also maintained that proposed § 23.1305(a)(2) and (3) were unnecessary because installed equipment needs to operate safely despite any markings.[50]

[50] The commenters actually stated they believe proposed § 23.1305(a)(1) and (2) were unnecessary. However, based on the rest of their comments and the recommendation to delete paragraphs (a)(2)

The commenters recommended the FAA not adopt paragraphs (a)(2) and (a)(3). Alternatively, EASA recommended moving the pilot interface issues of proposed § 23.1305(a)(3) through (c) to subpart G, which covers flightcrew interface. Textron recommended the FAA move the labeling requirement to proposed § 23.1300(a)(3). Transport Canada recommended clarifying proposed § 23.1305(a)(3) to provide the criteria to determine the applicability of the labeling requirement.

The FAA withdraws proposed § 23.1305(a)(2) as it is redundant of paragraph (a)(1). In order to function as intended, the equipment would have to meet its limitations. As previously noted, the FAA has revised proposed § 23.1305 by merging paragraph (a) with (a)(1). The FAA agrees with EASA's recommendation to move certain flightcrew interface requirements to subpart G and is relocating the requirement of proposed § 23.1305(a)(3) to subpart G, § 23.2605(a) in this rule. The commenters are correct that while a system needs to operate safely despite any markings, markings related to identification, function, and limitations are necessary to aid the aircrew and other personnel to safely operate the systems. The requirement for equipment to be labeled, if applicable, dates back to CAR 3.652 effective December 7, 1949. If further criteria to determine the applicability of the labeling requirement are found to be necessary, additional guidance will be developed either by the FAA or in an industry consensus standard.

After further analysis, the FAA finds the proposed requirements to provide system operating parameters, including warnings and cautions, were not adequately covered in proposed subpart G. Based on this and EASA's comments, the FAA relocates the pilot

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and(a)(3) (and retain (a)(1)), the FAA assumes the commenters meant to state that § 23.1305(a)(2) and (3) are unnecessary.

interface requirements of proposed § 23.1305(b) and (c) to new § 23.2605 in subpart G to adequately address these issues.

Garmin, Textron, and ANAC commented on the second sentence of proposed § 23.1305(c). Garmin recommended the FAA delete the phrase "presentation of", as it could be interpreted as requiring a light or other visual alert. Textron recommended the FAA replace the phrase "clear enough to avoid likely crewmember errors" with the phrase "designed to minimize crewmember errors." ANAC contended the term "likely" is ambiguous and recommended the FAA replace the phrase "to avoid likely crewmember errors" with the phrase "to minimize crewmember errors, which could create additional hazards."

The FAA agrees with the commenters as the FAA did not intend to limit the presentation to visual displays only. Warning information can include visual, aural, tactile, or any combination. The FAA deletes "presentation of" in the proposed § 23.1305(c). Although both "minimize" and "likely" may be ambiguous, as was the concern from ANAC, the term "minimize"—associated with the mitigation of hazards in the rule language—can be traced back to CAR 3, effective December 7, 1949. Although using a new term such as "likely" may be interpreted as a new requirement or standard for the minimization of errors, this was not the FAA's intent. Therefore, the FAA replaces the term "minimize flightcrew errors" in place of "avoid likely crewmember errors" in § 23.2600(b).

Embraer noted that the cross-reference table in the proposal stated that the intent of former § 23.1023 is addressed in proposed § 23.935(b)(1); however, there is no § 23.935(b)(1) in the proposed rule. To address this mistake, Embraer suggested

including a similar requirement from former § 23.1023 in proposed § 23.1305, which would apply to any equipment. Specifically, Embraer recommended an addition to proposed § 23.1305(a)(4) stating equipment be able to withstand without failure, the vibration, inertia and loads (including fluid pressure loads) to which it would be subjected in operation.

Embraer stated that it understood that part 33 would not address all the concerns if the radiator is installed by the airframer, and noted that its same comment applies to former §§ 23.1013 and 23.1015.

The FAA has corrected and updated the table to accurately reference the relationship between the former rule and the final rule. Also, the FAA does not adopt Embraer's recommendation to add a requirement to § 23.2505 to address specific environmental conditions equipment must be able to withstand. The FAA notes Embraer was describing a specific failure mode, which is covered by §§ 23.2500(a)(2) and 23.2510.

d. Flight, Navigation, and Powerplant Instruments (proposed § 23.1310/now § 23.2615)

In the NPRM, proposed § 23.1310 (now § 23.2615) would have required installed systems to provide the flightcrew member who sets or monitors flight parameters for the flight, navigation, and powerplant information necessary to do so during each phase of flight. Proposed § 23.1310 would have required this information include parameters and trends, as needed for normal, abnormal, and emergency operation, and limitations, unless an applicant showed the limitation would not be exceeded in all intended operations. Proposed § 23.1310 would have prohibited indication systems that integrate the display of flight or powerplant parameters to operate the airplane or are required by the operating

rules of this chapter, from inhibiting the primary display of flight or powerplant parameters needed by any flightcrew member in any normal mode of operation. Proposed § 23.1310 would have required these indication systems be designed and installed so information essential for continued safe flight and landing would be available to the flightcrew in a timely manner after any single failure or probable combination of failures.

In light of comments received, the FAA renumbers § 23.1310 to § 23.2615, and moves this section to Subpart G. The section for § 23.2615 in Subpart G discusses these changes in more detail.

e. Equipment, Systems, and Installation (proposed § 23.1315/now § 23.2510)

In the NPRM, proposed § 23.1315 (now § 23.2510) would have required an applicant—

- To examine the design and installation of airplane systems and equipment, separately and in relation to other airplane systems and equipment, for any airplane system or equipment whose failure or abnormal operation was not specifically addressed by another requirement in this part;
- To determine if a failure of these systems and equipment would prevent continued safe flight and landing, and if any other failure would significantly reduce the capability of the airplane or the ability of the flightcrew to cope with adverse operating conditions; and
- To design and install these systems and equipment, examined separately and in relation to other airplane systems and equipment, such that each catastrophic failure condition is extremely improbable, each hazardous failure condition is extremely remote, and each major failure condition was remote.

In light of comments received, the FAA revises proposed § 23.1315 (now § 23.2510) by withdrawing paragraph (a), merging paragraph (b) into the introductory sentence, and renaming paragraphs (b)(1), (b)(2) and (b)(3) as § 23.2510(a), (b) and (c), respectively. This section discusses these changes in more detail.

Garmin commented that proposed § 23.1315 should be located with the other general rules applicable to all systems and equipment.

The FAA agrees with Garmin's comment and is placing the regulation with the other general rules at the beginning of subpart F.

Textron commented the intent of proposed § 23.1315 is not as clearly written as CS 23.600 and 23.605 and an AC will be needed to determine the meaning of the proposed rule. The commenter recommended using the wording of CS 23.600 and 23.605. In contrast, The Associations preferred the FAA's proposed § 23.1315 to the EASA's A-NPA language, which they stated may unduly tie means of compliance to an objective-based rule. EASA suggested that proposed § 23.1315 show the inverse relationship between probability and severity in an illustration.

To clarify the intent of the rule, the FAA revises the proposed rule language to require each system and equipment to be designed and installed such that "there is a logical and acceptable inverse relationship between the average probability and the severity of failure condition." This change is consistent with the NPRM, which explained that proposed § 23.1315 (now § 23.2510) would require an engineering safety analysis to identify possible failures, interactions, and consequences, and require an inverse relationship between the probability of failures and the severity of consequences. The logical inverse relationship should be proportionate and flexible with respect to risk

levels. The FAA notes that if the FAA provided more detail and graphics in the rule, future interpretation of the rule may be more restrictive than intended. The FAA finds the additional information provided in EASA's A-NPA is more suitable for guidance similar to AC 23.1309-1E and is not adding this to the rule.

The Associations recommended the FAA add a new paragraph to proposed § 23.1315 that would allow the FAA to accept a higher failure probability for functionality that enhances the safety of the airplane beyond the required minimum functionality. The commenters noted such a provision would allow for safety-enhanced equipment to be treated in a less stringent manner that accounts for the significant benefits it could have. The commenters explained this would ensure the lowest cost of this equipment without sacrificing the safety-enhancing benefits. Garmin similarly noted that system safety analysis and design assurance are focused on system and equipment failures rather than the safety benefit such systems and equipment can provide. For example, TSO-C151, "Terrain Awareness and Warning System (TAWS)," equipment specifies a major failure classification, but no credit is given for the offsetting safety benefit provided for installation of TAWS with its corresponding reduction in Controlled Flight into Terrain (CFIT) accidents. Garmin asked the FAA to consider adopting a requirement that allows for design assurance certitude for systems that provide an increased safety benefit.

The FAA has determined adding a new requirement to proposed § 23.1315 (now § 23.2510) would create a special class of equipment in the rule, which is contrary to the FAA's intent. The objective of this rulemaking is to provide clear safety objectives without prescribing design solutions. The objective of proposed § 23.1315 is to require

each system and equipment to be designed and installed such that there is a logical and acceptable inverse relationship between the average probability and the severity of failure conditions. This applies to all equipment whether required or non-required, safety-enhancing or not. The rule does not specify a required numeric probability of failure. The rule is written to allow a proportionate and flexible numerical value to the probabilities regarding risk levels of the equipment and airplane. System safety assessment standards will be relied on to provide a suitable approach for the different risk levels, similar to what is currently found in AC 23.1309-1E for the various classes of airplanes. Section 23.2510 provides a proportionate and flexible structure for future technology implementation.

Garmin and the Associations recommended the FAA use the term "failure condition" rather than "failure" to ensure the rule addresses the broader impacts of failures, rather than just those that occur within the equipment that may have failed. Garmin explained that by using "failure condition," the rule would address combinations of failures in the system and equipment and other systems and equipment. ANAC stated the use of "failure" in paragraph (a) and use of "failure condition" in paragraph (b) may add confusion.

The FAA agrees with the commenters and revises proposed § 23.1315 (now § 23.2510) to use "failure condition" throughout the section.

Textron noted some simple systems were exempt from former § 23.1309. Textron asked if there was a list of systems exempt from proposed § 23.1315 (now § 23.2510), or if the FAA intended to apply the regulation to all systems. Textron specifically asked for confirmation that propulsion, fuel systems, fire protection systems, exits, landing gear,

flight navigation, powerplant instruments, system power generation, storage, and distribution and flight controls were exempt from proposed § 23.1315 (now § 23.2510), since they each have their own rules dealing with failures.

This final rule does not contain a list of systems exempt from proposed § 23.2510 (proposed as § 23.1315). Consistent with former § 23.1309, proposed § 23.1315 (now § 23.2510) applies generally to installed equipment and systems, except that § 23.2510 does not apply if another section of part 23 imposes requirements for specific equipment or systems. The FAA is not providing a list of systems exempt from the rule, as Textron requested, because such a list would be based on today's technology and would be overly prescriptive and inflexible over time. This would conflict with the goal of allowing coverage for future unforeseen technological advancements.

Textron asked the FAA to clarify the intent of the safety requirements in proposed § 23.1315. In particular, Textron noted that paragraph (a) simply stated "determine", while paragraph (b) stated "design and install" to achieve safety goals that have no connection with those stated in paragraph (a). Textron asked for clarification of the relationship between the two paragraphs, as well as the overall intent of the rule. Textron recommended using the language in CS 23.605(a), which would have required each equipment and system to be designed and installed so there is a logical and acceptable inverse relationship between the average probability and the severity of failure condition effects. ANAC similarly noted that no clear safety objective was stated in proposed § 23.1315(a); rather, an applicant needed only determine if conditions (1) and (2) were examined. Embraer suggested the FAA remove proposed § 23.1315(a) , asserting that the intent of proposed § 23.1315(b) would be sufficient to meet compliance.

EASA asserted the terminology in proposed § 23.1315(a) may be confusing. Phrases such as "continued safe flight and landing" and "significantly reduce the capacity of the airplane" or "the ability of the flightcrew to cope with adverse operating conditions," are not as clear as terms "catastrophic," " hazardous," and "major" in describing the failure condition.

In light of these comments, the FAA withdraws proposed paragraph (a). Proposed § 23.1315(a) could have been interpreted as an element of the means of compliance to paragraph (b) in that the determinations of the potential consequences of failures is necessary to establish whether the probability of their occurrence is acceptable. Additionally, the FAA adopts Textron's recommendation and revises the proposed rule language to require each system and equipment to be designed and installed so there is a logical and acceptable inverse relationship between the average probability and the severity of failure condition effects. To comply with § 23.2510(a), applicants must account for airplane systems and equipment, separately and in relation to other airplane systems and equipment.

Textron indicated that the terms used in proposed § 23.1315(b) were not defined in the regulations.

The FAA did not define the terms "catastrophic failure condition," "hazardous failure condition," and "major failure condition" in the regulations because the terms are better addressed in guidance. These terms are currently defined in AC 23.1309-1E. Furthermore, the rule language is consistent with the historical rule language of former § 23.1309.[51]

[51] See 55 FR 43306, October 26, 1990.

ANAC commented that proposed § 23.1315(b) implied specific classification and probability terms that may be considered prescriptive. The commenter noted that, as written, this may prevent an applicant from using a means of compliance that employs different hazard categories or terminology.

The FAA notes the terms used in proposed § 23.1315 (now § 23.2510) are already defined in guidance (i.e., AC 23.1309-1E) and originated from former § 23.1309, and should not prevent an applicant from using a means of compliance that employs different hazard categories or terminology. The FAA may accept a means of compliance standard that uses different hazard categories or terminology, if they align with the failure condition effects in paragraphs (a) through (c) so the requirements of proposed § 23.1315 (now § 23.2510) are met.

Rockwell Collins noted that former § 23.1309(c)(1) required each catastrophic failure condition to be extremely improbable and not result from a single failure. However, proposed § 23.1315(b)(1), which was intended to capture the safety intent of former § 23.1309, would have required only that each catastrophic failure condition be extremely improbable. It would not have prohibited single-point catastrophic failures. Rockwell Collins asked the FAA to retain the phrase "and not result from a single failure" in the regulation, because the commenter believed the FAA's intent was not to propose changes with regard to single-point catastrophic failures.

The FAA notes the ARC recommended the FAA require systems and equipment to be designed and installed so there is a logical acceptable inverse relationship between the average probability and the severity of failure condition effects whether the result of a single failure or multiple failures. With the advancement of technology and increased

integration of systems, it is virtually impossible to eliminate all theoretical potential single-points of failure. The rule will allow in some cases, as is true today with some portions of the airplane, to have the potential of single-point failures if the risk and probability of such failure is acceptable. The FAA adopts the rule language as proposed in § 23.1315(b)(1).

Noting that key pieces of FAA guidance are critical to design and certification, Kestrel asked whether AC 23.1309 would remain the primary guidance for SSA. If not, Kestrel asked what the recommended guidance would be.

Guidance for proposed § 23.1315 may consist of existing FAA guidance, such as AC 23.1309, future FAA-generated guidance, and FAA-accepted industry standards.

Textron noted the NPRM stated applicants who use the means of compliance described in the existing special conditions would be able to use data developed for compliance with proposed § 23.1315. Textron recommended the FAA revise the statement to clarify the FAA was referring to special conditions for part 25 airplanes.

The statement in the NPRM is correct. Applicants who use the means of compliance described in the existing special conditions for parts 23, 25, 27, or 29 may use data developed for compliance with § 23.2510.

f. Electrical and Electronic System Lightning Protection (proposed § 23.1320/now § 23.2515)

In the NPRM, proposed § 23.1320(a) would have required, for an airplane approved for IFR operations, that each electrical or electronic system that performs a function, the failure of which would prevent the continued safe flight and landing of the airplane, be designed and installed such that—

- The airplane system level function continues to perform during and after the time the airplane is exposed to lightning; and
- The system automatically recovers normal operation of that function in a timely manner after the airplane is exposed to lightning, unless the system's recovery conflicts with other operational or functional requirements of the system.

Proposed § 23.1320(b) would have required each electrical and electronic system that performed a function, the failure of which would reduce the capability of the airplane or the ability of the flightcrew to respond to an adverse operation condition, to be designed and installed such that the function recovers normal operation in a timely manner after the airplane is exposed to lightning.

Several commenters raised concerns with the term "system" in proposed § 23.1320(a)(1). BendixKing explained that the proposed phrase "airplane system level function" may lead to multiple interpretations of the regulation. BendixKing asked the FAA to delete "system" from the proposed rule language because the rule addresses failure at the airplane level. The Associations recommended the FAA require the function, rather than the airplane system level function, to comply with the requirement in paragraph (a)(1).

Garmin stated that there has been much discussion in the GAMA HIRF (High-Intensity Radiated Fields) ad-hoc meetings regarding the interpretation of the term "system." Garmin explained the rule language could be interpreted as requiring all redundant systems, which perform the same function, to meet the lightning requirements. Garmin explained that not all redundant systems should be required to meet the catastrophic requirements to prevent potentially catastrophic failure; proposed

§ 23.1320(a) should apply to the function level only. Garmin recommended alternative regulatory language would prevent catastrophic, major, or hazardous failure conditions at the airplane level.

The FAA agrees proposed § 23.1320(a)(1) (now § 23.2515(a)(1)) could have been misinterpreted due to the confusion surrounding the phrase "airplane system level function." The FAA intended to require the function at the airplane level to meet the requirements of paragraph (a)(1), consistent with proposed § 23.1325(a)(1) (now § 23.2520). Thus, the FAA intended proposed § 23.1320(a)(1) to require the function at the airplane level not to be adversely affected during and after the time the airplane is exposed to lightning. This means if multiple systems perform the same function, only one of those systems is required to provide the function under § 23.2515 (a)(1). Therefore, not all redundant systems are required to meet the requirements of § 23.2515 (a)(1). The FAA deletes the term "system" from the phrase "airplane system level function," as several commenters recommended to ensure the FAA's intent is clear. The FAA revises the rule language to make clear that the requirements of proposed § 23.1320(a)(1) (now § 23.2515(a)(1)) apply to the function at the airplane level.

Garmin noted that the proposed § 23.1320 rule language was essentially the same as former § 23.1306, which was overly burdensome for low-end part 23 airplanes. Garmin stated that proposed § 23.1320 is contrary to the goal of the part 23 reorganization and explained the objective should be to prevent catastrophic, hazardous, and major failure conditions for the airplane. Garmin suggested revising proposed § 23.1320 to be more general and to allow the ASTM standards to provide the necessary

means of compliance, which should consist of a tiered compliance approach for different airplane certification levels.

The FAA does not agree to make § 23.2515 more general. Section 23.2515 is intended to address catastrophic, hazardous, and major failure condition at the airplane level due to the effects of lightning on systems. Critical functions that would prevent continued safe flight and landing (catastrophic) should remain available to the crew throughout a lightning exposure. How to maintain the function, whether with redundant systems or non-susceptible systems, is a means of compliance and is not specified. Likewise, systems that perform a function, the failure of which would significantly reduce the capability of the airplane (hazardous), must recover normal operation of that function. A means of compliance is not specified and could include redundancy. The FAA has revised the rule to state more clearly that the concern for catastrophic failure conditions is at the airplane level. Furthermore, the rule already allows a tiered compliance approach based on the environment the airplane is likely to see.

Several commenters raised concerns with applying proposed § 23.1320 to airplanes approved for IFR operations. The Associations noted the FAA has recently approved required equipment for use in IFR airplanes, without the need for lightning testing based on the history of lightning strikes in the general aviation fleet. However, these commenters indicated the proposed rule would have prohibited airplanes with a low probability of lightning strikes from benefiting from such an approach. These commenters asked the FAA to revise the proposed rule language to ensure the rule does not apply to airplanes with a low probability of lightning strike.

Garmin noted that former § 23.1306 required both VFR and IFR airplanes to meet lightning requirements for systems with catastrophic failure conditions. However, while proposed § 23.1320 would have removed the requirement for VFR airplanes, the burden for industry is primarily IFR airplanes as there are very few VFR airplanes, if any, that have systems with catastrophic failure conditions. Garmin recommended revising the proposed rule language by removing the language that would have made proposed § 23.1320 applicable to airplanes approved for IFR operations.

EASA also asked the FAA to remove the language that would have made proposed § 23.1320 applicable to airplanes approved for IFR operations. EASA explained that this revision would permit credit for reliable systems that allow for avoidance of thunderstorms, as these systems would make exposure to lightning unlikely.

In light of these comments, the FAA recognizes the proposed rule language would not have adequately relieved the burden of former § 23.1306, which required all airplanes regardless of their design or operational limitations meet the same requirements for lightning regardless of the potential threat. As explained in the NPRM, the FAA intended to relieve this burden by applying the lightning requirements to airplanes with the greatest threat of lightning. The FAA proposed to meet this objective by making the rule applicable to airplanes approved for IFR operations. Because airplanes approved for IFR operations may also have a low probability of lightning exposure, the proposed rule language did not meet the FAA's objective. Accordingly, the FAA adds an exception to the rule language for applicants who can show that exposure to lightning is unlikely. This change from what was proposed is more consistent with the FAA's intent as it relieves an airplane approved for IFR operations from complying with § 23.2515 if it is shown the

airplane has a low probability of lighting exposure. The method of compliance is not specified in the rule and could be system, operational, or environment based.

Garmin and the Associations recommended the FAA revise proposed § 23.1320(b) to make the requirement only applicable to levels 3 and 4 airplanes approved for IFR operations.

The FAA disagrees. Section 23.2520(b) is a general safety objective with compliance tailored to the specific design intent. Exposure to lightning is an environmental threat not directly associated with airplane certification levels and therefore could apply to all airplanes. The intent is to set requirements appropriately to the design. Therefore, the FAA adds an exception to the rule language for applicants who can show that exposure to lightning is unlikely.

Daher, Textron, and the Associations suggested the FAA, in proposed § 23.1320(a)(1) (now § 23.2515(a)(1)), require the function to not be "adversely affected" during and after the time the airplane is exposed to lightning, but require the function to "continue to perform." Daher and Textron explained that requiring the function to not be "adversely affected" would be more consistent with the language of proposed § 23.1325 (now § 23.2520). The Associations asserted that this revision would permit equipment installations that may be affected by lightning, provided the loss of equipment does not result in catastrophic events. Textron further noted this revision would ensure harmony with EASA's proposed CS 23.620.

In response to these comments, the FAA revises the proposed rule language to require the function at the airplane level to not be "adversely affected" during and after the time the airplane is exposed to lighting. As explained in the NPRM, the FAA

intended proposed § 23.1320(a)(1) (now § 23.2515(a)(1)) to capture the safety intent of former § 23.1306. Former § 23.1306(a)(1) required the function to not be "adversely affected" during and after the time the airplane is exposed to lightning. Because the proposed language could be interpreted as an increase in burden, which would not meet the intent of former § 23.1306, the FAA is reverting back to the former rule language. It should be noted that "adversely affected" was not previously limited to catastrophic events as suggested by the commenters, but included hazardous and major failure conditions as well.

Textron questioned if crew action could be involved in the recovery of the function or must recovery be automatic. Textron asked the FAA to clarify whether proposed § 23.1320(a)(2) would permit crew action in recovery of the function. Garmin recommended the FAA not adopt proposed § 23.1320(a)(2).

Based on Textron's comment, the FAA clarifies paragraph (a)(2) by removing the term "automatic" from the proposed rule to allow either flightcrew action or automatic recovery. One of the goals of the proposal was to remove prescriptive design solution for the airworthiness standards and replace them with performance-based rules. Automatic reset of a system is a design solution, while the safety objective is the function be usable to the flightcrew in a timely manner such that the intermittent loss or malfunction does not have an adverse effect on the safety of the flight. Therefore, the recovery of the function may be automatic or manual. While Garmin recommended that the FAA not adopt proposed § 23.1320(b) (now § 23.2515(b)), the FAA believes the safety intent of former § 23.1306, which addressed catastrophic and hazardous failure condition due to the effects of lightning on systems, must be retained.

Transport Canada noted that proposed § 23.1320(a)(2) would benefit from inclusion of a specific safety objective. The commenter suggested revising the proposed rule language to require the system to automatically recover normal operation of the function in such time as to allow a safety objective to be achieved.

The FAA notes the safety objective of paragraph (a)(2) is "the timely recovery of the system's function." Additionally, the rule language existed in former § 23.1306(a)(2). Based on this, the FAA does not adopt the change proposed by Transport Canada in the final rule.

Textron requested the FAA insert "significantly" before "reduce" in proposed § 23.1320(b), because any reduction in capacity would trigger this rule.

The FAA agrees with Textron and revises the language in proposed § 23.1320(b) (now § 23.2515(b)) accordingly. This change is consistent with former § 23.1306, which used the phrase "significantly reduce." Also, this change is necessary because without the term "significantly", the language could be interpreted as imposing requirements on each electrical and electronic system that performs a function, the failure of which would reduce—no matter how minimal—the capability of the airplane or the ability of the flightcrew to respond to an adverse operating condition. This would increase the burden from former part 23, which was not the FAA's intent.

g. High-Intensity Radiated Fields (HIRF) Protection (proposed § 23.1325/now § 23.2520)

In the NPRM, proposed § 23.1325 (now § 23.2520) would have required electrical and electronic systems that perform a function whose failure would prevent the continued safe flight and landing of the airplane, to be designed and installed such that—the airplane system level function is not adversely affected during and after the time the

airplane is exposed to the HIRF environment. Proposed § 23.1325 would have also required these systems automatically recover normal operation of that function in a timely manner after the airplane is exposed to the HIRF environment, unless the system's recovery conflicts with other operational or functional requirements of the system.

For airplanes approved for IFR operations, proposed § 23.1325(b) would have required the applicant to design and install each electrical and electronic system that performs a function—the failure of which would reduce the capability of the airplane or the ability to the flightcrew to respond to an adverse operating condition—so the function recovers normal operation in a timely manner after the airplane is exposed to the HIRF environment.

Several commenters raised concerns about the term "system" in proposed § 23.1325(a)(1). Textron stated the phrase "airplane system level"[52] could be interpreted to mean that if multiple systems provide a redundant function, each system needs to work through the threat although only one is required. Textron asked the FAA to clarify if proposed § 23.1325(a)(1) was intended to require a means to provide the airplane level function for continued safe flight and landing. BendixKing similarly commented that the failure being addressed in proposed § 23.1325(a)(1) is at the airplane level, but the proposed phrase "airplane system level function" would lead to multiple interpretations of the regulation. Textron and BendixKing suggested deleting the term "system" from proposed § 23.1325(a)(1) to clarify the requirement applies to the airplane level.

[52] Safety requirements exist at the airplane, system, and item level. SAE International, ARP 475A Guidelines for Development of Civil Aircraft Systems, 4.1.3 Introduction to Hierarchical Safety Requirements Generated from Safety Analyses (2010).

Garmin noted there has been much discussion in the GAMA HIRF ad-hoc meetings regarding the definition of a "system." Garmin asked the FAA whether "system" means each individual redundant system or all redundant systems. Garmin explained that proposed § 23.1325(a)(2) could be interpreted to impose additional requirements to the extent that all redundant systems must meet the catastrophic failure requirements of paragraph (a). Garmin suggested that not all redundant systems should be required to meet the catastrophic requirements and proposed § 23.1325(a) should apply only to the function level. Garmin recommended alternative regulatory language that reflected its comments.

The FAA agrees that proposed § 23.1325(a)(1) (now § 23.2520(a)(1)) could be misinterpreted due to the confusion surrounding the phrase "airplane system level function." As explained in the NPRM, the FAA intended the proposed rule language to clarify the failure consequence of interest is at the airplane level. Thus, the FAA intended paragraph (a)(1) to require the function at the airplane level not to be adversely affected during and after the time the airplane is exposed to the HIRF environment. This means if multiple systems perform the same function, only one of those systems is required to provide the function under paragraph (a)(1). Therefore, in response to Garmin's comment, the FAA notes not all redundant systems are required to meet the requirements of paragraph (a)(1). To clearly reflect the intent of proposed § 23.1325(a)(1) (now § 23.2520(a)(1)), the FAA deletes the term "system" from the phrase "airplane system level function," as recommended by Textron and BendixKing, and revises the proposed rule language to clarify that the requirements of paragraph (a)(1) apply to the function at the airplane level.

Furthermore, in light of Garmin's comment, the FAA revises the proposed rule language in § 23.1325(a) (now § 23.2520(a)) to clarify that "each" electric and electronic system that performs a function—the failure of which would prevent the continued safe flight and landing of the airplane—must be designed and installed such that the requirements of § 23.2520(a)(1) and § 23.2520(a)(2) of this section are met.

Garmin recommended the FAA delete proposed § 23.1325(a)(2) and explained that proposed § 23.1325 (a)(2) is unnecessary because proposed § 23.1325 (a)(1) already prohibits systems from preventing safe flight and landing after a HIRF event. The commenter maintained paragraph (a)(1) would be sufficient to ensure a tiered means of compliance could be developed based on the criticality of the HIRF event. Garmin stated that proposed § 23.1325(a)(2) contains design information, which is contrary to the goal of the part 23 reorganization, and explained the objective should be to prevent catastrophic, hazardous, and major failure conditions for the airplane. Garmin suggested revising proposed § 23.1325 to be more general and allow the ASTM standards to provide the necessary means of compliance.

The FAA disagrees with the commenter's recommendation to delete proposed § 23.1325 (a)(2) and to make paragraph (a) more general. The FAA agrees with a tiered means of compliance approach for hazardous and major failure conditions, which are addressed in § 23.2520(b). However, for catastrophic failure conditions addressed in § 23.2520(a), the FAA finds it necessary to require each system that performs a function, the failure of which would prevent the continued safe flight and landing of the airplane, to be able to recover normal operation of the function. Paragraph § 23.2520 (a)(2) is not design specific; it captures the safety intent of former § 23.1308(a) at a high level,

allowing for means of compliance other than appendix J to part 23—“HIRF Environments and Equipment HIRF Test Levels”.

Textron asked the FAA to clarify whether proposed § 23.1325(a)(2) would permit flightcrew action in recovery of the function.

The FAA is removing the term “automatically” from the proposed rule language to clarify that flightcrew action is permitted in recovering the normal operation of the system’s function. The FAA intended proposed § 23.1325 to capture the safety intent of former § 23.1308, which required the system to “automatically” recover normal operation of the function in a timely manner. Automatic reset of a system is a design solution. The safety objective of former § 23.1308(a) is that the function be usable to the flightcrew in a timely manner such that the intermittent loss or malfunction does not have an adverse effect on the safety of the flight. The FAA finds that permitting the flightcrew to manually recover normal operation of the system’s function in a timely manner would maintain the level of safety found in former § 23.1308(a). Therefore, the recovery of the function may be automatic or manual under § 23.2520(a)(2).

The Associations commented that current policy and guidance may apply HIRF requirements differently to part 23 products than in other areas and suggested that the IFR discriminator in paragraph (b) may not be as valid as using airworthiness level. The commenters recommended the FAA restrict paragraph (b) to level 3 and 4 airplanes that are approved for IFR operations.

Mooney International (Mooney) questioned the intent of including IFR-related HIRF requirements in paragraph (b). Mooney contended that HIRF is related to

environments from ground-based transmission of RF energy from radars, radios, etc., which is unrelated to IFR environmental operations.

The FAA has considered the comments on inconsistent application of HIRF requirements, but notes the hazardous and major failure conditions of paragraph (b) should apply to airplanes certificated for IFR operations regardless of airworthiness level. The different types of operations an airplane may be certificated for are Day VFR, Night VFR, and IFR. Airplanes certified for only VFR operations are restricted from operating under IFR, which includes flight into IMC. IFR-certified airplanes, however, are not prohibited from flight into IMC. The severity of a HIRF event is greater in IMC. Therefore, the FAA finds it necessary to apply the hazardous and major failure conditions to all airplanes certified for IFR operations. Furthermore, while the FAA is not restricting the application of paragraph (b) to only level 3 and 4 airplanes, paragraph (b) allows for a tiered means of compliance approach based on airworthiness level and the associated risk. The FAA replaced the prescriptive requirements, which were further defined in former appendix J to part 23, with the wording "exposed to the HIRF environment." The intent is to allow for the exposure environment to match the risk associated with each airplane level. Therefore, the threat will be appropriately scaled to the airworthiness level as the data and risk supports.

Garmin suggested revising the proposed rule language of paragraph (b) to require each electrical and electronic system to be designed and installed, rather than requiring the applicant to design and install each system.

The FAA adopts Garmin's recommendation, which makes the language of paragraph (b) parallel the language of paragraph (a).

Embraer suggested the FAA adopt the same HIRF environments and test levels that are described in former appendix J to part 23, which were associated with former § 23.1308.

The FAA finds the prescriptive environments and test levels found in former appendix J to part 23 are more appropriately addressed as a means of compliance to proposed § 23.1325 (now § 23.2520). This allows the test levels to change as the environment changes without new regulatory action. Additionally, one prescriptive level for all airplanes does not allow for a tiered compliance approach, which was an objective of this rule.

h. System Power Generation, Storage, and Distribution (proposed § 23.1330/now § 23.2525)

In the NPRM, proposed § 23.1330 (now § 23.2525) would have required the power generation, storage, and distribution for any system be designed and installed to supply the power required for operation of connected loads during all likely operating conditions. Proposed § 23.1330 would have required the design installation ensure no single failure or malfunction would prevent the system from supplying the essential loads required for continued safe flight and landing. Finally, proposed § 23.1330 would have required the design and installation have enough capacity to supply essential loads, should the primary power source fail, (for at least 30 minutes for airplanes certificated with a maximum altitude of 25,000 feet or less and at least 60 minutes for airplanes certificated with a maximum altitude over 25,000 feet.

Textron requested the FAA make slight revisions to proposed § 23.1330(a) to harmonize the wording with CS 23.630. Specifically, Textron recommended requiring

the power generation, storage, and distribution for any system be designed and installed to supply the power required for operation of connected loads during all intended operating conditions rather than "all likely operating conditions" because it would provide a clear boundary for demonstration of compliance. In the alternative, Textron suggested removing proposed paragraph (a) because the requirement is already covered more broadly in proposed § 23.1300(a)(2).

The FAA agrees with Textron's recommendation to replace "likely" with "intended" to harmonize with EASA and make clear the boundary for demonstration of compliance. Therefore, the FAA did not consider Textron's alternative recommendation to remove paragraph (a). The FAA notes that proposed § 23.1330(a) (now § 23.2525) is not redundant with proposed § 23.1300(a)(2) (now § 23.2500). Section 23.2500 is a rule of general applicability and does not supersede more specific rules. It is appropriate for system power generation, storage, and distribution to be addressed by a specific rule.

Air Tractor noted that proposed § 23.1330(b) appears more restrictive than former § 23.1310 in regards to single-point failures. The commenter further noted this may require there be no single failure points between the power supply and the essential load bus.

The FAA did not intend for proposed § 23.1330(b) (now § 23.2525(b)) to be more restrictive than the requirements under former part 23. The FAA revises proposed § 23.1330(b) for clarity by adding "of any one power supply, distribution system, or other utilization system." This sets limits as to what needs to be considered when examining single-point failures.

Several commenters, including EASA, Kestrel, Daher, and the Associations raised concerns about the minimum flight times (i.e., 30 minutes and 60 minutes) set forth in proposed § 23.1330(c). The commenters generally focused on allowing the means of compliance to define the appropriate minimum flight times and basing the minimum flight times on airplane performance. Daher suggested that ASTM standards should provide minimum flight times for battery systems. The Associations raised concerns the requirement in proposed § 23.1330(c)(1) may be excessive for airplanes with a maximum ceiling much lower than 25,000 feet. The Associations requested the FAA provide a reasonable window of essential power required for these lower flying airplanes for which electrical power will be controlled in a very reliable but efficient manner due to the nature of their design. Similarly, BendixKing noted that 25,000 feet and 30 minutes capacity requirement to supply essential loads may be restrictive to newer "simple" airplanes, which operate only at 10,000 feet and require only 10-15 minutes. Garmin noted the wording of the proposed rule would require some new electrical-powered airplanes, which may have flight durations of less than 30 or 60 minutes, to carry the power supply regardless.

In response to numerous comments opposing the specific flights times outlined in proposed § 23.1330(c)(1) and (c)(2) (now § 23.2525(c)), the FAA agrees the language would have been overly prescriptive and incompatible with new technologies. The FAA revises proposed § 23.1330(c) to remove the specific time requirements and add the safety intent requiring enough capacity for the time needed to complete the functions required for continued safe flight and landing.

Kestrel questioned whether the language “design and installation have enough capacity to supply essential loads” permitted use of both the engine start battery and the emergency battery in combination to supply essential loads in the event of loss of the primary electrical power generating systems, without the need for an alternate means of compliance. The commenter noted this is typically addressed using an ELOS finding to former § 23.1353(h).

Kestrel also raised concerns about the possible misinterpretation of the phrase “if the primary source fails” in proposed § 23.1330(c). Kestrel said it was aware of at least one such instance, resulting in the issuance of an STC based on the understanding this meant failure of the primary generator and proper operation of the backup alternator. Kestrel asked FAA to revise the wording to prevent this possible misinterpretation.

Both of Kestrel’s comments relate to a specific design solution and method of compliance that should be addressed with the use of industry developed consensus standards or other accepted means of compliance. In the past, the engine start battery could be used to meet the required load capacity based on an ELOS finding (as pointed out be Kestrel). The requirements found in this ELOS finding to former § 23.1353(h) could be documented in a consensus standard as an acceptable means of compliance to the regulation. The same applies to the definition of the “primary source.” The intent is not to increase design requirements, but to make showing of compliance more flexible.

Textron requested the FAA limit the applicability of proposed § 23.1330(c) to electrical systems by changing the title proposed § 23.1330 to “Electrical system power generation, storage, and distribution.”

The FAA disagrees with Textron's proposal as the Part 23 ARC discussed this issue, with a consensus agreeing the rule should apply to current technologies such as batteries and new technologies that may apply in the future. The language proposed by the FAA would implement the ARC's recommendation, and the FAA makes no changes to that language in the final rule based on Textron's proposal.

i. External and Cockpit Lighting (proposed § 23.1335/now § 23.2530)

In the NPRM, proposed § 23.1335 (now § 23.2530) would have required an applicant to design and install all lights to prevent adverse effects on the performance of flightcrew duties. Proposed § 23.1335 would have required position and anti-collision lights, if installed, to have the intensities, flash rate, colors, fields of coverage, and other characteristics to provide sufficient time for another airplane to avoid a collision. Proposed § 23.1335 would have required position lights, if installed, to include a red light on the left side of the airplane, a green light on the right side of the airplane, spaced laterally as far apart as practicable, and a white light facing aft, located on an aft portion of the airplane or on the wing tips. Proposed § 23.1335 would have required that an applicant to design and install any taxi and landing lights, if required by operational rules, so they provide sufficient light for night operations. Finally, for seaplanes or amphibian airplanes, proposed § 23.1335 would have required riding lights to provide a white light visible in clear atmospheric conditions.

Textron commented on proposed § 23.1335(a), explaining it would have been difficult to design and install lights to "prevent adverse effects" on the performance of flightcrew duties in all cases. Therefore, Textron recommended the FAA require lights to

be installed to "minimize," rather than "prevent," the possibility they will adversely affect the satisfactory performance of the flightcrew's duties. [53]

The FAA agrees the term "prevent" would be difficult to comply with in all cases. The FAA also interprets the term "prevent" to be more restrictive than the former requirements, which used descriptive terms such as "no dangerous glare" in former § 23.1383(a) and "not seriously affected" in former § 23.1383(b). The term "minimize" more accurately reflects the former requirements of part 23. For these reasons, the FAA revises the proposed rule language to require the applicant to design and install all lights to minimize any adverse effects on the performance of flightcrew duties.

Kestrel commented that the proposed wording, "as far as space allows," in proposed § 23.1335(c) could be interpreted to mean that integrated wingtip navigation lights are no longer permitted, and the only way to meet the requirement is to install external navigation lights outboard of the wingtips. Kestrel recommended reverting to the language used in former § 23.1385, which stated that navigation lights should be "spaced laterally as far apart as practicable."

The FAA agrees with the commenter. The FAA intended proposed § 23.1335(c) (now § 23.2530(c)) to capture the safety intent of former § 23.1385(c) without an increase in burden for certification. Former § 23.1385(c) required the left and right position lights to consist of a red and a green light "spaced laterally as far apart as practicable." The FAA is reverting back to this language for the reasons identified by the commenter. Accordingly, § 23.2530(c) now requires any position lights, if required by

[53] This wording was proposed in the ARC final report for § 23.1383.

part 91, to include a red light on the left side of the airplane and a green light on the right side of the airplane, spaced laterally as far apart as practicable.

Kestrel and Air Tractor commented on proposed § 23.1335(d), which would have required the installation of taxi and landing lights. Kestrel asked the FAA to align proposed paragraph (d) with former § 23.1383, which did not require the installation of both taxi and landing lights, but instead required "sufficient light for each phase of night operations." Air Tractor suggested the FAA add rule language to paragraph (d) to make it applicable to taxi and landing lights, "if installed," because the regulations do not require night operations.

The FAA did not intend to require the design and installation of taxi and landing lights in proposed § 23.1335(d) (now § 23.2530(d)). As explained in the NPRM, the FAA intended proposed § 23.1335(d) to capture the safety intent of former § 23.1383, which required each taxi and landing light to be designed and installed so that it provided enough light for night operations. The FAA revises the proposed rule language to more clearly reflect its intent. Accordingly, § 23.2530(d) now requires any taxi and landing lights to be designed and installed so they provide sufficient light for night operations.

The Associations and ICON recommended the FAA not adopt proposed § 23.1335(e). The Associations noted that the requirement is already addressed in regulations concerning maritime vessels, and could create a conflict should those maritime regulations be changed. The Associations also noted that there is no safety benefit in duplicate coverage. ICON commented that the FAA proposed to add a requirement for a riding light on seaplanes. ICON stated that the operational requirement for a vehicle to display a white light on the water is not an FAA requirement and should

not be mandated as a vehicle design requirement by the FAA. ICON recommended the FAA let the agency controlling the body of water impose this operating rule on seaplanes. ICON further noted it should not be a design requirement because a pilot may choose to comply with the requirement by using a portable light rather than an installed device on an airplane.

The FAA considered the commenters recommendations but notes proposed § 23.1335(e) (now § 23.2530(e)) is not a new requirement. As explained in the NPRM, proposed § 23.1335(e) captures the safety intent of former § 23.1399. Former § 23.1399 required each riding (anchor) light required for a seaplane or amphibian, to be installed so it can show a white light for at least two miles at night under clear atmospheric conditions; and show the maximum unbroken light practicable when the airplane is moored or drifting on the water. Former § 23.1399 was adopted on February 1, 1965, as a recodification of CAR 3.704.[54] The FAA's intent was to remove the prescriptive requirements of former § 23.1399 to means of compliance and imposing the safety requirement as a performance-based standard in paragraph (e). Therefore, the FAA adopts paragraph (e) as proposed.

While the commenters did not cite a specific regulation concerning vessels, the FAA has determined the commenters are referring to Title 33 of the CFR (33 CFR), Navigation and Navigable Waters. 33 CFR part 83 contains rules applicable to all vessels upon the inland waters of the United States,[55] and defines a vessel as including every description of water craft— including seaplanes—used or capable of being used as a

[54] See 29 FR 17955 (1964).
[55] See 33 CFR 83.01.

means of transportation on the water.[56] Thus, while a seaplane is anchored or afloat upon the inland waters of the United States, it is subject to part 83. Although § 83.30 contains light requirements for anchored vessels, the FAA finds it necessary to require seaplanes to have a riding light that provides a white light visible in clear atmospheric conditions. The objective of § 83.30 is to ensure vessels see other vessels. The objective of § 23.2530(e) is to ensure seaplanes are able to see other seaplanes in the interest of safety, not to provide duplicate coverage. There is no apparent conflict between part 83 and § 23.2530(e), nor has there been a known conflict in the last fifty years. Furthermore, § 83.31 states that where it is impractical for a seaplane to exhibit lights and shapes of the characteristics or in the positions prescribed in subpart C of part 83, which contains § 83.30, that seaplane shall exhibit lights and shapes as closely similar in characteristics and position as possible.

Also, former § 23.1399(b) stated that externally-hung lights may be used. While the FAA removed this prescriptive requirement from the regulations, it may still be used as an acceptable means of compliance to § 23.2530(e).

Finally, Embraer suggested the FAA adopt guidance material and standards, such as ACs and Agency Process Recommendations, as reference to the certification project, provided these documents are compatible with the former part 23 requirements.

The FAA notes that current published guidance, previously accepted industry standards, and the prescriptive requirements found in former part 23 will remain acceptable means of compliance for this final rule. The FAA will continue to develop guidance as deemed necessary, but intends to use industry-developed standards if they

[56] See 33 CFR 83.03.

are found acceptable. The FAA is actively engaged with industry consensus groups developing suitable standards for this final rule.

j. Safety Equipment (proposed § 23.1400/now § 23.2535)

In the NPRM, proposed § 23.1400 (now § 23.2535) would have required safety and survival equipment, required by the operating rules of this chapter, to be reliable, readily accessible, easily identifiable, and clearly marked to identify its method of operation.

Air Tractor noted that the requirement for safety and survival equipment to be reliable may require some kind of testing or certification of fire extinguishers. The commenter questioned whether the current Underwriter's Laboratory (UL) rating of fire extinguishers would be sufficient.

The FAA finds the UL rating for fire extinguishers will be an acceptable means of compliance under § 23.2535, as it was an acceptable method of compliance under former § 23.1411. As explained in the NPRM, the FAA intended proposed § 23.1400 (now § 23.2535) to capture the safety intent of former § 23.1411. While the FAA removed the prescriptive language from former § 23.1411, it did not intend to change the current method of compliance for the required safety and survival equipment.

k. Flight In Icing Conditions (proposed § 23.1405/now § 23.2540)

In the NPRM, proposed § 23.1405 (now § 23.2540) would have required an applicant to demonstrate its ice protection system would provide for safe operation, if certification for flight in icing conditions is requested.[57] Proposed § 23.1405 would have required these airplanes to be protected from stalling when the autopilot is operating in a

[57] Part 23 Icing ARC recommendations, including recommendations on activation and operation of ice protection systems, would have been used as a means of compliance to proposed § 23.1405(a)(1).

vertical mode. Proposed § 23.1405 would have also required this demonstration be conducted in atmospheric icing conditions specified in part 1 of appendix C to part 25 of this chapter, and any additional icing conditions for which certification is requested.

In light of comments received, the FAA revises § 23.2540 to move proposed paragraphs (a) and (b) to the introductory paragraph, and renumber proposed paragraphs (a)(1) and (2) as new paragraphs (a) and (b). This section discusses these changes in more detail.

The NTSB stated that adopting proposed §§ 23.230 (now § 23.2165) and 23.1405 will likely result in Safety Recommendation A-96-54 being classified "Closed—Acceptable Action." The NTSB agreed with the FAA's statement in the NPRM that proposed § 23.1405 would address Safety Recommendations A-07-14 and-15.

The Associations suggested a better correlation between proposed §§ 23.230 and 23.1405 and added it may be appropriate to combine these sections.

In light of this comment, the FAA is restructuring proposed § 23.1405 to be consistent with § 23.2165. Proposed § 23.1405(a) and § 23.1405(b) were combined into the introductory sentence of § 23.2540 and modified to read similarly to § 23.2165. Accordingly, § 23.2540 now requires an applicant who requests certification for flight in icing conditions defined in part 1 of appendix C to part 25, or an applicant who requests certification for flight in these icing conditions and any additional atmospheric icing

conditions, to show compliance with paragraphs (a) and (b) in the icing conditions for which certification is requested. [58]

The FAA is not, however, combining proposed §§ 23.230 and 23.1405. The FAA agrees with the Part 23 Icing ARC's and the Part 23 ARC's recommendations to separate the performance and flight characteristics requirements for flight in icing conditions from the system requirements for flight in icing conditions.[59] The FAA notes § 23.2165 contains the requirement to safely avoid or exit icing conditions for which certification is not requested, whereas § 23.2540 does not contain such a requirement for systems. The FAA finds it appropriate to keep these sections separate as the distinction between the sections means that systems, such as the windshield or air data, do not have to be evaluated in icing conditions for which the airplane is not requesting certification.

Textron and Kestrel commented on ice crystal conditions. Textron noted that the proposed rule would not have defined ice crystal conditions and asked the FAA where the term would be defined. Kestrel asked if the requirements of TSO C16a, "Electrically Heated Pitot and Pitot-Static Tubes", would be an acceptable means of compliance to the ice crystal requirements of proposed § 23.1405.

The FAA notes the phrase "any additional atmospheric icing conditions" in proposed § 23.1405 includes "ice crystal conditions". However, the FAA is not defining "ice crystal conditions" in the final rule because it is more appropriately addressed in means of compliance.

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[58] See section III, B. Part 23, Airworthiness Standards, Subpart B of this preamble (explaining the clarifying change made to proposed § 23.230(a)).
[59] See docket number FAA-2015-1621.

The FAA finds TSO C16a will be an acceptable means of compliance when it is revised to include SAE airworthiness standard AS 5562, “Ice and Rain Minimum Qualification Standards for Pitot and Pitot-static Probes”. The FAA notes SAE AS 5562 is an acceptable means of compliance to the ice crystal requirements for pitot and static systems. The FAA points out, however, that SAE AS 5562 does not include ice crystal requirements for certain angle-of-attack instruments, such as sensors that utilize differential static pressure.

Kestrel questioned if the FAA would permit ice protection systems to be operational on an airplane not certified for Flight Into Known Ice (FIKI), as it does today via the guidelines established in Appendix 4 of AC 23.1419-2D for “non-hazard” systems. Kestrel noted that it was unclear whether the FAA intends to continue the use of the “non-hazard” classification because the NPRM does not explicitly mention “non-hazard” systems. Kestrel believed that operational ice protection systems on non-FIKI-certified airplane do not need a special “non-hazard” classification. Kestrel suggested ice protections systems could be considered supplemental systems, which are addressed by the installation and inadvertent operation requirements of proposed §§ 23.1300 and 23.1315.

Prior to this final rule, the FAA certified “non-hazard” systems in accordance with former §§ 23.1301 and 23.1309(a)(2), (b), (c), and (d). As explained in the NPRM, the FAA intended proposed §§ 23.1300(b) (now § 23.2500(b)), 23.1305 (now § 23.2505), and 23.1315 (now § 23.2510) to capture the safety intent of the applicable portions of former § 23.1301 and § 23.1309. Therefore, the FAA intends to certify these “non-hazard” systems in accordance with §§ 23.2500(b), 23.2505, and 23.2510.

The FAA received several comments on proposed § 23.1405(a)(2). Garmin stated that proposed § 23.1405(a)(2) should apply regardless of whether an airplane is certified for flight in icing conditions. Garmin recommended the FAA either move the proposed requirement to proposed § 23.215 (now § 23.2150) or delete it.

The FAA agrees that an airplane must be protected from stalling when the autopilot is operating, regardless of whether the airplane is certified for flight in icing conditions. However, proposed § 23.1405(a)(2) (now § 23.2540(b)) should not apply to airplanes where the applicant is not requesting certification for flight in icing conditions. The stall warning requirements of § 23.2150 will provide low-airspeed awareness, with or without the autopilot engaged, for new airplanes not certified for icing. The FAA finds § 23.2165(a) will provide stall warning for new airplanes where the applicant is requesting certification for flight in icing conditions. For new airplanes, the FAA acknowledges that a stall warning system that complies with §§ 23.2150 and 23.2165(a) will comply with § 23.2540(b). Section 23.2540(b) will also be added to the certification basis of certain STCs and amended TCs on icing certified airplanes, as discussed below in this section.

Textron and Rockwell Collins commented on the prescriptiveness of proposed § 23.1405(a)(2). Textron added that proposed § 23.1405(a)(2), which was in place only for changed product rule considerations, appeared to be a band-aid solution and not in line with higher-level goals for the new rules. Textron suggested the FAA delete proposed paragraph (a)(2).

The FAA finds that proposed § 23.1405(a)(2), with the exception of specifying "vertical mode," is performance-based and consistent with the higher-level goals of the

proposal, because the standard does not specify how to achieve protection from a stall. The FAA expects means of compliance to include the Icing ARC's recommendations. The FAA deletes the reference to "vertical mode" from § 23.2540(b) to make it less prescriptive, since it is expected the icing means of compliance will recognize that only vertical modes may result in airspeed loss. The FAA renumbers this section as part of the final rule. Proposed § 23.1405(a)(2) is now § 23.2540(b).

Additionally, in response to Textron's comment, proposed § 23.1405(a)(2) (now § 23.2540(b)) is intended to increase the safety of the existing fleet. While § 23.2540(a) and (b) apply to new airplanes, the FAA intends § 23.2540(b) to specifically target older airplanes adding an autopilot for the first time, modifying certain autopilots on airplanes with a negative service history in icing, or making significant changes that affect performance or flight characteristics and affect the autopilot. As stated in the NPRM, under the changed product rule, § 23.2540(b) will be added to the certification basis of these types of STCs and amended TCs for icing certified airplanes. This will result in a targeted increase in safety without requiring compliance to an entire later amendment, including § 23.2540(a). Compliance with § 23.2540(a) would require the applicant to address areas unaffected by an autopilot STC. The Part 23 Icing ARC Report (Icing ARC Report) provides examples of modifications in which new § 23.2540(b) will be applicable. Numerous icing accidents have shown that unrecognized airspeed loss can occur with autopilots in altitude hold or vertical speed modes. Means of compliance other than modifications to the airplanes' stall warning system may be acceptable under § 23.2540(b) for these STCs and amended TCs. The Task 9, "Determine if implementation of NTSB Safety Recommendation A-10-12 is feasible for part 23

airplanes for operations in icing conditions," discussion in the Icing ARC Report provides additional background.

Rockwell Collins stated that proposed § 23.1405(a)(2) could be interpreted as requiring the autopilot to protect the airplane from stalling.

To address the commenter's concern, the FAA revises the proposed rule language (now § 23.2540(b)) to clarify that the airplane design must provide protection from stalling when the autopilot is operating.

The NTSB disagreed that proposed § 23.1405(a)(2) would address Safety Recommendation A-10-12, which concerns low-airspeed alerting systems. The NTSB stated that this safety recommendation would be more appropriately addressed in proposed § 23.1500, "Flightcrew Interface."

The FAA notes, as explained in the NPRM, proposed § 23.1405(a)(2) was based on NTSB safety recommendation A-10-12. This implied proposed § 23.1405(a)(2) responded to recommendation A-10-12. The FAA acknowledges § 23.2540(b) is not the type of stall protection the NTSB recommended because it does not require the installation of low-airspeed alert systems. Instead, § 23.2540(b) addresses a different and more urgent safety problem by requiring airplanes with autopilots to provide an adequate stall warning in icing conditions. Furthermore, § 23.2540(b) is an airworthiness standard that establishes a minimum level of safety for all airplanes under part 23. If the FAA were to adopt a requirement in part 23 that required applicants to install a low-speed alert system in their airplanes, that requirement would apply to all airplanes. The FAA did not propose such a requirement because safety recommendation A-10-12 applies only to commercial airplanes under part 91 subpart K, and parts 121, and 135. To properly

respond to NTSB safety recommendation A-10-12, the FAA would have to change the operating rules, which is outside the scope of this rulemaking.

Embraer and Garmin both commented on the term "demonstration." Embraer recommended the FAA change "in atmospheric icing conditions" in proposed paragraph (b) to "considering atmospheric icing conditions". Embraer stated that its proposal aimed to make a broad statement, implying that there may be several means of addressing the icing conditions as shown in figures 1 through 6 of Appendix C to Part 25. The commenter asserted the original text in the NPRM might be understood as requiring only a flight test demonstration. Garmin commented on the importance of clarifying this term because the FAA Aircraft Certification Office has almost always insisted that "demonstration" means the applicant must perform it on an airplane.

In light of these comments, the FAA is using the phrase "must show" rather than "must demonstrate" in the introductory sentence of § 23.2540, which is consistent with the changes made to § 23.2165. This change is also consistent with the NPRM, which explained that demonstration, as a means of compliance, may include design and/or analysis and does not mean flight tests are required. However, for the foreseeable future, the FAA does expect means of compliance to include icing flight tests for applicants seeking icing certification for new TCs.

l. Pressurized System Elements (proposed § 23.1410/now § 23.2545)

In the NPRM, proposed § 23.1410(a), (c) and (d) (now § 23.2545) would have required the minimum burst pressure of—

- Hydraulic systems be at least 2.5 times the design operating pressure with the proof pressure at least 1.5 times the maximum operating pressure;

- Pressurization system elements be at least 2.0 times, and proof pressure be at least 1.5 times, the maximum normal operating pressure; and
- Pneumatic system elements be at least 3.0 times, and proof pressure be at least 1.5 times, the maximum normal operating pressure.

Proposed § 23.1410(e) would have required that other pressurized system elements to have pressure margins that take into account system design and operating conditions. Additionally, proposed § 23.1410(b) would have required engine driven accessories essential to safe operation to be distributed among multiple engines, on multiengine airplanes.

In light of comments received, the FAA withdraws proposed § 23.1410(a) through (e) and adopts new language for § 23.2545. This section discusses these changes in more detail.

Garmin commented that proposed § 23.1410 was still extremely prescriptive and suggested the FAA revise the rule to a higher safety objective, and burst and proof pressures should be in a consensus standard. Garmin proposed alternative, less prescriptive language. ANAC similarly stated that parts of proposed § 23.1410 were too prescriptive and suggested that it might be more appropriate to set the "minimum burst" and "proof pressure" values for the hydraulic, pressurization, and pneumatic systems using consensus standards. ANAC also proposed alternative language.

The FAA agrees with ANAC's recommendation to set the proof and burst factors for hydraulic, pneumatic and pressurization systems in consensus standards or means of compliance. This is consistent with the FAA's goal of moving from prescriptive regulations to performance-based regulations. The FAA did not use Garmin's suggested

language because it did not clearly state that the requirement was for “proof” and “burst” pressure, and would have applied to “pressurized system elements”. This may be more limited than using the phrase “pressurized system”. ANAC’s suggested language was also not used because it was not inclusive of all pressurized systems. Consensus standards or means of compliance can be used to document the appropriate proof and burst factors, the operating pressure to be factored, pass/fail criteria for tests, and other information included in former § 23.1435(a)(4), (b), § 23.1438, and AC 23-17C.

Textron noted it is unclear what the difference is between the terminology used to describe the system pressures upon which the factors in proposed § 23.1410(a), (c), (d), and (e) are applied (i.e., “design operation pressure,” “maximum operating pressure,” and “maximum normal operating pressure.”). ANAC made a similar observation, as it noted the phrase “maximum operating pressure” in proposed § 23.1410(a) and the phrase “maximum normal operating pressure” in proposed § 23.1410(b) and (c) might share the same interpretation. ANAC recommended a harmonization between these paragraphs in order to avoid misinterpretations for the consensus standards, while Textron suggested that using the ASTM to identify those differences would be more in keeping with the move from prescriptive to performance-based standards. ANAC also recommended merging proposed § 23.1410(a), (c), and (d).

The FAA agrees with merging proposed § 23.1410 (a), (c) and (d) because they are similar and related. In addition, the FAA has decided to merge proposed § 23.1410(e) with these requirements to address all systems containing fluids under pressure. Therefore, the FAA withdraws proposed paragraphs (a), (c), (d), and (e) and adopts new

language in § 23.2545 that requires pressurized systems to withstand appropriate proof and burst pressures.

ANAC, Textron, and an individual commenter addressed proposed § 23.1410(b). ANAC recommended the provision be deleted. In addition to being prescriptive, ANAC noted the provision is already addressed in proposed § 23.1315, which evaluates in a more systematic way the design and installation of a system or component according to their failure condition that is directly related to the airplane safe operation. Additionally, Textron said the provision is misplaced and should be moved to proposed subpart E, § 23.900 or § 23.910 (now § 23.2410). An individual commenter also recommended moving the provision to § 23.900.

Based on the comments, the FAA has decided that the safety intent of this requirement is adequately addressed in § 23.2510 and § 23.2410. Section 23.2510 requires equipment separation and redundancy based on the severity of equipment failures. Section 23.2410 requires powerplant failures, including engine driven accessory failures, to be considered and mitigated—effectively requiring safety critical engine driven accessories to be distributed on multiengine airplanes. Therefore, the FAA withdraws proposed § 23.1410(b) from the final rule; hence, there is no reason to place it elsewhere.

m. Equipment Containing High-Energy Rotors (§ 23.2550)

The requirements of former § 23.1461 were not fully incorporated into proposed § 23.755(a)(3), so the FAA creates a new § 23.2550 to correct this omission. The preamble section for § 23.2320 discusses this change in more detail.

8. Subpart G—Flightcrew Interface and Other Information

a. General Discussion

In the NPRM, the FAA proposed substantial changes to former subpart G based on its assessment that many of the regulations contained in this subpart contain prescriptive requirements that are more appropriate for inclusion as means of compliance to the new part 23 performance-based regulations. The FAA noted this approach would provide at least the same level of safety as current prescriptive requirements while providing greater flexibility for future designs. The FAA also expanded the scope of the subpart to address flightcrew interface requirements.

Zee agreed with the FAA's proposal to expand subpart G to address not only current operating limitations and information, but also flightcrew interface. Zee noted that, based on current technology, the FAA anticipates new airplanes will heavily rely on automation and systems that require new and novel pilot or flightcrew interface methods and procedures. The commenter noted further that more automated systems could dramatically reduce cockpit workload, which would be a great boon for the public who has shied away from personal aviation transportation due to increasing operational complexities of traditional airplanes.

EASA commented that information from various other subparts in proposed part 23 should be included in subpart G to provide requirements on how the information should be provided. EASA noted that proposed subpart G could include requirements for subjects such as flightcrew interface; function and installation, flight, navigation, powerplant instruments, cockpit controls, instrument markings, control markings and placards, airplane flight manual, and instructions for continued airworthiness. EASA also

noted these subjects were under consideration by EASA for inclusion as separate sections in a future proposal to revise CS 23.

The FAA finds its proposed actions respond to the concerns of Zee, EASA, and others within the industry to better address the issue of flightcrew interface. The FAA recognizes that flightcrew interface issues have become increasingly more important as a result of recent technological developments in flight, navigation, surveillance, and powerplant control systems. The FAA partially agrees with EASA's comment that information from various other subparts in proposed part 23 should be included in subpart G. However, the FAA finds the full extent of the material EASA proposes for inclusion would establish requirements that would be too prescriptive in nature and therefore not in accord with the overall objective of this rulemaking to replace the detailed prescriptive requirements with more general performance-based standards. The FAA does, however, acknowledge that certain sections of EASA A-NPA 2015-06 and NPA 2016-05 may better address those requirements where the FAA's proposed language may have been too general in nature and not sufficiently detailed to permit adequate means of compliance to be developed. In a number of instances, the FAA has adopted either the specific regulatory language used by EASA or similar equivalent language to better address those safety concerns and achieve greater harmonization. The specific instances where the FAA has adopted these revisions are discussed in the preamble to the sections in which those changes have been made.

The FAA notes that EASA proposed the inclusion of three sections in its revision of CS 23, subpart G, which added substantial detail to that subpart. The FAA did not include corresponding sections within its proposed subpart G. Proposed CS 23.2605,

“Installation and operation information”, and proposed CS 23.2610, “Flight, navigation, and powerplant instruments”, however, did correspond to proposed § 23.1305 and proposed § 23.1310, respectively, in subpart F of the NPRM. Proposed CS 23.2615, “Cockpit controls,” was also in EASA’s proposed subpart G, but did not have a corresponding section in the NPRM.

The FAA agrees that placing the requirements contained in these sections into subpart G is more appropriate than addressing those requirements in subpart F, as these requirements more directly relate to flightcrew interface issues. Accordingly, the FAA is relocating proposed § 23.1305 to subpart G, § 23.2605, “Installation and operation,” and proposed § 23.1310 to § 23.2615, “Flight, navigation, and powerplant instruments.” While adopting the general safety intent embodied in EASA’s proposed regulations, the FAA is not including the complete level of detail specified in those regulations because the FAA considers the additional information more appropriate as a means of compliance. While the FAA believes that cockpit controls should be addressed under subpart G, the FAA did not include a separate section in the final rule equivalent to proposed CS 23.2615 because the FAA has determined these requirements are more appropriate as a means of compliance to § 23.2600.

b. Flightcrew Interface (proposed § 23.1500/now § 23.2600)

In the NPRM, proposed § 23.1500 (now § 23.2600) would have required the pilot compartment and its equipment to allow each pilot to perform their duties, including taxi, takeoff, climb, cruise, descent approach and landing. The pilot compartment and its equipment would also have to allow a pilot to perform any maneuvers within the operating envelope of the airplane, without excessive concentration, skill, alertness, or

fatigue. Proposed § 23.1500 would have required an applicant to install flight, navigation, surveillance, and powerplant controls and displays so qualified flightcrew could monitor and perform all tasks associated with the intended functions of systems and equipment so as to make the possibility that a flightcrew error could result in a catastrophic event highly unlikely.

Textron noted that proposed § 23.1500 has "minimal wording" as compared to CS 23.460 and recommended the FAA harmonize proposed § 23.1500 with EASA's proposed provisions.

Textron also specifically recommended the FAA add the requirement in former § 23.671(b) for controls to be arranged and identified to provide convenience in operation and to prevent the possibility of confusion and subsequent inadvertent operation, to proposed § 23.1500.

The FAA has reviewed EASA A-NPA 2014-12 and NPA 2016-05 and finds the level of detail included in the crew interface requirements in both documents may be overly restrictive. The FAA finds § 23.2600 adequately address pilot compartment requirements and the requirements for the provision of necessary information and indications to the flightcrew. The FAA is not revising § 23.2600 as EASA recommended, because the FAA is concerned that adding the extensive level of detail that EASA is considering for inclusion in subpart G would neither enhance the FAA's ability to respond to the introduction of new technology nor foster future innovation. The FAA notes the adoption of the EASA's recommended requirements would only serve to create issues similar to those that the FAA is attempting to address with this significant revision of part 23 airworthiness standards. However, the FAA recognizes Textron's concerns and

agrees that cockpit controls should not only be convenient to operate, but also prevent the possibility of confusion and subsequent inadvertent operation. Nevertheless, the FAA finds the regulatory intent of former § 23.671 will be achieved because Textron's concerns will be addressed in any means of compliance developed and submitted for acceptance to demonstrate compliance with § 23.2600.

Air Tractor raised concerns that proposed § 23.1500(b) added a requirement that the flightcrew be able to monitor and perform "all" tasks associated with the intended functions of systems and equipment. Air Tractor recommended the FAA insert the term "required" after "all" to ensure the proposal would not require the performance and monitoring of non-required tasks. An individual commenter at the FAA's public meeting also shared concerns regarding use of the term "all" and asked if its use would preclude systems from monitoring tasks the flightcrew does not have to continuously monitor.

The FAA agrees that use of the term "all" is too encompassing in this section and could be misinterpreted to impose requirements that would exceed the safety intent of the rule. However, the FAA finds adding the term "required" would make the rule's requirements narrower than the FAA intended. The FAA notes that airplanes are currently equipped with systems and equipment that are not necessarily required, yet the flightcrew must be able have the ability to monitor and perform all tasks associated with the intended functions of those systems and equipment to operate the airplane safely. Accordingly, the FAA has determined that including the term "defined" in § 23.2600(b) will address both the concerns of Air Tractor and the FAA, and also allow for the installation of systems and equipment that can be used to monitor a function or parameter for the flightcrew. The FAA notes this term is currently used in § 25.1302(a), which

addresses flightcrew interface with systems and equipment installed in transport category airplanes. While the FAA recognizes that many of the requirements in § 25.1302 are inappropriate for the certification of airplanes under part 23, the FAA finds its use of the concept of "defined tasks" is appropriate for application to part 23 flightcrew interface requirements.

An individual commenter asserted that proposed § 23.1500(b) is "convoluted and subject to varying interpretations." The commenter noted that one such interpretation could be the flightcrew would not be required to monitor and perform tasks and prevent errors that go beyond the intended functions of the installed systems and equipment. Accordingly, the commenter asserted that if there is no equipment installed to prevent CFIT, such as TAWS, there would be no requirement for monitoring and performing tasks and preventing errors associated with terrain clearance. The commenter also stated the rule could be interpreted to mean the tasks, monitoring, and error prevention requirements are those associated with a particular flight phase and flight conditions. For example, the commenter noted that there must be equipment to prevent CFIT (e.g., TAWS or other), at least for IFR-certified airplanes, and it must meet the stated requirements. The commenter noted that many situations and types of equipment could be affected by the proposal and maintained that if these interpretations were accurate, there would be obvious cost, weight, practicability, and other implications that were not adequately addressed in the preamble or Regulatory Analysis.

In the NPRM, the FAA stated that it proposed to expand subpart G to address not only current operating limitations and information, but also the concept of flightcrew interface. The FAA further noted that it was proposing to address the pilot interface

issues found in subparts D and F in proposed § 23.1500. Otherwise, subpart G retained the safety intent of the requirements in the former rules. This section does not impose additional equipment requirements, as suggested by the commenter's example, but it does require consideration of the flightcrew interface and human factors in the design and installation of equipment. The FAA notes the commenter's concern that the flightcrew would not be required to monitor and perform tasks, such as terrain avoidance, that are not directly addressed by installed systems and equipment.

Several commenters raised concerns regarding the use of the term "highly unlikely" in proposed § 23.1500(b) that addresses the ability of the system and equipment design to avoid the possibility that a flightcrew error could result in a catastrophic event. One individual commenter specifically noted that "highly unlikely" is a new and undefined term. The commenter recognized that prevention of errors undoubtedly would increase safety, but noted there is a limit to how much system and equipment design error prevention is justified and practicable in any airplane, not just those certificated under the provisions of part 23. This commenter also contended it would be difficult to comply with a stringent reading of "highly unlikely" and asserted a review of accident history would reveal this. Garmin, Air Tractor, and BendixKing submitted similar comments regarding the potential for this proposed requirement to increase the burden on applicants. Each of these commenters proposed alternative regulatory language addressing their concerns.

The Associations commented that the intent of this proposed requirement is to prevent likely flightcrew errors with flight, navigation, surveillance, and powerplant controls and displays and proposed language to meet this intent. Textron also noted the

proposed requirement failed to exclude skill related errors, errors as a result of malicious intent, recklessness, and actions taken under duress. Textron contended that system designs should not be responsible for all possible flightcrew errors, but only for reasonable errors. Textron recommended proposed alternative regulatory language addressing its concern.

Astronautics said the term “highly unlikely,” as it relates to “catastrophic,” would cause confusion in the context of failure condition categorization and likelihood of occurrence. The commenter suggested replacing the term “highly unlikely” with recognized terms that categorize failure hazards and probabilities. Astronautics also suggested recognizing a flightcrew error may have differing degrees of severity by revising the proposed rule to include consideration of the three different degrees of failure in proposed § 23.1315(b).

The FAA agrees with many of the commenters concerns regarding the use of the term “highly unlikely” in addressing the probability of preventing flightcrew errors resulting from system and equipment designs that could lead to catastrophic events. The FAA also recognizes the difficulty in assessing complex flightcrew interface issues associated with the approval of control and display designs. Prior to the adoption of this rule, the FAA utilized very prescriptive requirements with associated guidance material based on its need to address traditional controls, displays, and flight operations in the certification process. Although the FAA expects that this prescriptive language for the evaluation of traditional controls and displays will serve as a means of compliance with the new performance-based requirements, the FAA determines the new performance-based requirements will also allow for alternative approaches to meeting flightcrew

interface requirements for non-traditional airplanes, operations, and non-traditional controls and displays.

As the FAA noted in the NPRM preamble, the smart use of automation and phase-of-flight-based displays could reduce pilot workload and increase pilot awareness. Accordingly, the FAA finds new technology can help the pilot in numerous ways, all with the effect of reducing pilot workload, which should help reduce accidents based on pilot error. The FAA intended to remove many of the barriers to the introduction of new technology while still retaining a clear performance-based requirement to which an applicant could demonstrate compliance. The FAA recognizes the potential for misinterpretation of the requirements with this new approach; however, the FAA's intent is not to increase the requirements set forth in former regulations, unless specifically stated in the preamble. The FAA expects the use of performance-based requirements to address flightcrew interface issues will result in the accelerated development of industry standards that will be used to improve the manner in which pilots interface not only with information that has been traditionally provided to them but also with new information. Section 23.2600 is not intended to add any burden on the applicant and is expected to reduce time to market for new system and equipment designs, thereby, resulting in reduced costs.

As several commenters noted, the terms "highly unlikely" and "catastrophic" have specific meanings with respect to the certification of systems that typically are not used when addressing human interactions. Based on the commenters' recommendations, the FAA finds the best approach to adequately address flightcrew interface issues is to revise § 23.2600 using language similar to that contained in former § 23.1309(d), which

states that systems and controls must be designed to minimize crew errors which could create additional hazards. This avoids the problems associated with the use of language more appropriate for evaluation of system and equipment failures.

Shortly after the close of the comment period, EASA published NPA 2016-05, which proposed requirements to address an oversight in the NPRM regarding the pilot visibility requirements originally contained in subpart D. The FAA has adopted EASA's proposed language both in paragraphs (a) and (c) to correct this oversight in the FAA's proposal, to ensure that pilot compartment visibility requirements are addressed. Adopting these requirements serves to ensure that pilot view requirements, and particularly those requirements that could result from the loss of vision through a windshield panel in a level 4 airplane, are addressed. The FAA finds that these revisions impose no requirements in excess of those specified in the former § 23.775 and will maintain the level of safety set forth in part 23, through amendment 23-62, as originally intended in the proposal. As discussed in the context of proposed § 23.755, the requirement for level 4 airplanes that the flightcrew interface design must allow for continued safe flight and landing after the loss of vision through any one of the windshield panels has been moved to § 23.2600(c).

c. Installation and Operation (proposed § 23.1305/now § 23.2605)

In the NPRM, proposed § 23.1305 (now § 23.2605) would have required each item of installed equipment—

- To perform its intended function;
- Be installed according to limitations specified for that equipment; and

- The equipment be labeled, if applicable, due to the size, location, or lack of clarity as to its intended function, as to its identification, function, or operation limitations, or any combination of these factors.

Proposed § 23.1305 would have required a discernable means of providing system operating parameters required to operate the airplane, including warnings, cautions, and normal indications to the responsible crewmember. Proposed § 23.1305 would have also required information concerning an unsafe operating condition be provided in a clear and timely manner to the crewmember responsible for taking corrective action.

In light of comments received, the FAA revises proposed § 23.1305 by moving paragraphs (a)(2) through (c) to new § 23.2605. This section discusses these changes in more detail.

The function and installation rule language in proposed § 23.1305 was originally located in subpart F, Equipment. The logic behind the location of these requirements was that requirements for the display and control of a specific function would be in subpart G, while requirements for the hardware or software for the display or control are would be in subpart F. For this reason, proposed § 23.1305, "Function and installation," included specific paragraphs from the requirements of former §§ 23.1301, 23.1303, 23.1305, 23.1309, 23.1322, 23.1323, 23.1326, 23.1327, 23.1329, 23.1331, 23.1335, 23.1337, 23.1351, 23.1353, 23.1357, 23.1361, 23.1365, 23.1367, and 23.1416.

The Associations recommended the FAA delete proposed § 23.1305(a)(2) and (a)(3). The commenters also suggested the FAA delete proposed § 23.1305(b), as the flightcrew interface portion of the proposed rules already addressed the same subject

area. Furthermore, EASA recommended moving the flightcrew interface requirements from proposed § 23.1305(a)(2) through (c) to subpart G.

The FAA agrees with the commenters that the paragraphs in proposed § 23.1305 that address display and control for the flightcrew is better located in subpart G. Upon closer review, the FAA agrees with EASA's recommendation as it is consistent with the FAA's intent behind moving requirements from subpart F to subpart G. As proposed, subpart G did not have any sections that directly address these specific paragraphs. For that reason, the FAA adds new § 23.2605, "Installation and operation", which contains the language from proposed § 23.1305(a)(2) through (c).

d. Instrument Markings, Control Markings, and Placards (proposed § 23.1505/now § 23.2610)

In the NPRM, proposed § 23.1505 (new § 23.2610) would have required each airplane to display in a conspicuous manner any placard and instrument marking necessary for operation. Proposed § 23.2610 would also have required an applicant to clearly mark each cockpit control, other than primary flight controls, as to its function and method of operation and include instrument marking and placard information in the AFM.

Astronautics agreed that an applicant should ensure markings are adequate and meet the marking requirements specified in 14 CFR 45.11, "Marking of products." However, they asserted that the requirement for applicants to mark the controls and instruments themselves, as required by proposed § 23.1505(b), is "overly broad." The proposed requirement fails to account for existing markings such as those required by § 45.15, "Marking requirements for PMA articles, TSO articles, and critical parts."

Astronautics noted that some controls, such as knobs and push buttons, are typically integrated parts of TSO articles. The commenter believed that proposed § 23.1505 could be interpreted to require an applicant to add or replace markings on instruments already marked pursuant to a TSO authorization or PMA. Astronautics recommended the FAA revise proposed § 23.1505 to specify that an applicant is not required to alter markings already required under § 45.15.

The FAA agrees with Astronautics that the proposal is overly prescriptive as to how information regarding function and method of operation is to be provided. Accordingly, the FAA removes the requirement from proposed paragraph (b) specifically requiring an applicant to mark cockpit controls and instruments and revises the proposal to require the airplane design clearly indicate the function of each cockpit control (other than primary flight controls). This revision will permit an applicant to utilize markings made pursuant to a TSO authorization or PMA without imposing a repetitive and potentially conflicting requirement.

BendixKing requested the FAA delete the phrase "… and method of operation" from proposed § 23.1505(b). The commenter believed that the marking of cockpit controls should be limited to labeling the function of the control and that including its method of operation as a marking requirement is neither bounded nor appropriate.

The FAA agrees in part with BendixKing's comment. The FAA concurs that application of the proposed requirement to all cockpit controls (other than primary flight controls) is overbroad and could lead to an applicant including information on cockpit control markings that is excessive, unnecessary, and contrary to the agency's original intent. Accordingly, the FAA revises proposed paragraph (b) to eliminate the proposed

requirement that an applicant mark cockpit controls with their method of operation. However, cockpit controls (other than primary flight controls) would continue to be required to clearly indicate their function. As under the former regulations, information on the method of operation of equipment is provided in the airplane flight manual and equipment manuals, which is sufficient to satisfy the objective of the proposal.

Textron requested the FAA be more specific as to what placards (i.e., emergency, passenger safety, or operational placards) need to be included in the AFM pursuant to proposed § 23.1505(c).

The FAA recognizes that information may be provided to pilots and passengers using a variety of methods and considers it unnecessary to specifically prescribe those placards that must be included in the AFM. Additionally, a requirement to include specific placards would be counter to this rule's intent to remove prescriptive requirements from current regulatory text and replace those provisions with performance-based regulations. The FAA finds that variations in airplane designs and the methods of providing information to pilots and passengers may necessitate the need for various types of placard information that would be more appropriate for inclusion as a means of compliance to the regulatory requirements, thereby providing applicants with more flexibility in meeting the underlying safety intent of the rule.

e. Flight, Navigation, and Powerplant Instruments (proposed § 23.1310/now § 23.2615)

In the NPRM, proposed § 23.1310 (now § 23.2615) would have required installed systems to provide the flightcrew member who sets or monitors flight parameters for the flight, navigation, and powerplant information necessary to do so during each phase of flight. Proposed § 23.1310 would have required this information include parameters and

trends, as needed for normal, abnormal, and emergency operation, and limitations, unless an applicant showed the limitation would not be exceeded in all intended operations. Proposed § 23.1310 would have prohibited indication systems that integrate the display of flight or powerplant parameters to operate the airplane or are required by the operating rules of this chapter, from inhibiting the primary display of flight or powerplant parameters needed by any flightcrew member in any normal mode of operation. Proposed § 23.1310 would have required these indication systems be designed and installed so information essential for continued safe flight and landing would be available to the flightcrew in a timely manner after any single failure or probable combination of failures.

Several commenters raised concerns with proposed § 23.1310(a)(1), which would have required installed systems to provide the flightcrew member with parameters and trends, as needed. Air Tractor questioned whether round gauge instruments produce a trend and whether the FAA would use paragraph (a)(1) to mandate electric gauges. Similarly, Garmin contended that proposed § 23.1310(a)(1) could be interpreted as requiring more information than was formerly required. Garmin noted the pilot often determines the trend by monitoring a gauge, but the trend itself may not be displayed. Garmin asked the FAA to clarify whether it intended paragraph (a)(1) to require trend information to be displayed, or information to be presented in a manner that enables the pilot to monitor the parameter and determine trends. Genesys Aerosystems commented that requiring “trends” rather than addressing “trends” in guidance materials would lead to more trends being required than needed.

The FAA did not intend proposed § 23.1310(a)(1) to require electric gauges. Traditional analog indicators, such as airspeed indicators or altimeters, have been shown

to provide adequate trend indications and will still be acceptable. It may also be possible to have a system that automatically monitors the parameter of interest and warns the pilot of any trend that could lead to a failure. Paragraph (a)(1), however, does not allow a light that comes on at the same time that the failure occurs to replace analog indicators because such a light does not provide trend information prior to a failure. A warning light system that would comply must be sophisticated enough to read transients and trends, and give a useful warning to the pilot of a potential condition.

The FAA agrees the proposed rule language could have been misinterpreted as requiring more information than former part 23. The FAA intended proposed § 23.1310 to capture the safety intent of the former requirements, which was to provide flightcrew members the ability to obtain the information necessary to operate the airplane safely in flight, but not to exceed the safety intent of former part 23. Therefore, proposed § 23.1310(a)(1) was intended to require installed systems to provide adequate information to the flightcrew member to determine trends by monitoring a gauge or display. The FAA did not intend to expressly require an installed system to display the trend itself, because not all systems display trends. The FAA revises the proposed rule language to clarify its intent. Accordingly, § 23.2615(a)(1) now requires the information to be presented in a manner that enables the flightcrew member to monitor parameters and determine trends, as needed, to operate the airplane.

Former § 23.1311(a)(6) required electronic display indicators to incorporate, as appropriate, trend information to the parameter being displayed to the pilot. Section 23.2615(a)(1) is not meant to be an increase in burden from the former requirement and associated guidance regarding when trends are needed.

Kestrel raised concerns that although proposed § 23.1310 is less prescriptive, it did not minimally require the pilot to have available airspeed, altitude, direction, and attitude indicators as former § 23.1303 prescribed. The commenter asked if the FAA envisions a scenario where this information would not be required. Kestrel was also concerned that the phrase "as needed" would lead to diverging FAA interpretations of proposed § 23.1310(a)(1). The commenter asked the FAA to clarify its intent regarding the requirement to provide parameters and trends "as needed." If this was not a fixed set of parameters, Kestrel asked for details on how this list would be determined.

As explained in the NPRM, the former regulations that required airspeed, altimeter, and magnetic direction were redundant with the operating rules, specifically §§ 91.205 and 135.149. Furthermore, they required prescriptive design solutions that were assumed to achieve an acceptable level of safety. These prescriptive solutions precluded finding more effective or more economical paths to providing acceptable safety. One of the stated goals of the proposal was to facilitate the introduction of new technologies into small airplanes. Concepts already envisioned with fly-by-wire system may render the instruments that were required by former § 23.1303 irrelevant in the future. New § 23.2615 reflects the intent to allow new technologies in the future, while maintaining a minimum safety requirement by capturing the safety intent of the former regulations and by relying on the operating rules and accepted means of compliance to prescribe the details. This philosophy also applies to the comment on the phrase "as needed." The accepted means of compliance, which may include industry consensus standards, will define which parameters need trends.

Astronautics asked the FAA to insert a comma after “as needed” in paragraph (a)(1) to clarify that “as needed” is a parenthetical phrase. The FAA agrees and corrects the grammar in the revised rule language.

ANAC suggested the FAA not adopt proposed § 23.1310(a) because it is covered by proposed § 23.1305(b) and (c), which are broader in scope. In light of the performance-based context of the proposed rule, ANAC reasoned that defining specific requirements only for flight, navigation, and powerplant instruments was unnecessary. ANAC also recommended the FAA not adopt proposed § 23.1310(b), which appeared to apply to specific technologies (integrated systems). ANAC noted the intent of paragraph (b) was already addressed in proposed § 23.1305(b) and (c) (requiring timely information), and proposed § 23.1315 (now § 25.2510, requiring the capacity to maintain continued safety flight and landing after single or probable failures).

The FAA notes ANAC’s comment on proposed § 23.1310(a) and (b), but paragraphs (a) and (b) are not redundant. Sections 23.2505 and 23.2510 apply generally to installed equipment and systems. However, §§ 23.2505 and 23.2510 do not apply if another section of part 23 imposes requirements for specific installed equipment or systems. The FAA finds that flight, navigation, and powerplant instrumentation are significant enough to warrant their own requirements. Therefore, the FAA adopts § 23.1310 (now§ 23.2615(a) and (b)) as proposed.

ANAC also raised concerns that the phrase “normal, abnormal, and emergency operation” in paragraph (a) may be interpreted as a required classification of types of operations, meaning a system safety type analysis may be required for each indicator, classification of each condition, and three separate indications for each condition, which

it deemed overly prescriptive. As an alternative to deleting proposed § 23.1310(a)(1), ANAC recommended the FAA revise paragraph (a)(1) to require parameters and trends, as needed, "to operate the airplane."

The FAA agrees with ANAC and revises paragraph (a)(1) accordingly.

Genesys Aerosystems commented on proposed § 23.1310(b), which was formerly covered only in guidance material. Genesys Aerosystems contended that paragraph (b) is a bit prescriptive and including it in the regulation could stifle future innovation.

The FAA notes Genesys Aerosystems concern, but this requirement was previously covered under former § 23.1311. Section 23.2615(b) captures the safety intent of former § 23.1311, but removes the prescriptive requirements of former § 23.1311(a)(5), which mandated secondary instruments as the means to providing information to the flightcrew essential for continued safe flight and landing. This would allow future innovations in system architecture and design to provide the flight parameters necessary to maintain safe flight.

EASA recommended moving the pilot interface issues of proposed § 23.1310 to subpart G.

The FAA agrees with this recommendation because flightcrew interface issues are more appropriately addressed in subpart G, which contains requirements on flightcrew interface and other information. Therefore, the FAA moves the entire proposed § 23.1310 to subpart G as new § 23.2615.

f. Airplane Flight Manual (proposed § 23.1510/now § 23.2620)

In the NPRM, proposed § 23.1510 (now § 23.2620) would have required an applicant to furnish an AFM with each airplane that contained the operating limitations

and procedures, performance information, loading information, and any other information necessary for the operation of the airplane.[60]

Garmin noted that the purpose of the AFM is to provide the pilot with basic information required to safely fly the airplane and stated it appreciates and supports the FAA's proposal to remove the prescriptive detail about the AFM content from § 23.1510. However, Garmin did express concern about use of the phrases "[o]perating limits and procedures" in proposed § 23.1510(a) and "[a]ny other information necessary for the operation of the airplane" in proposed § 23.1510(d). Garmin noted the possibility for confusion arising from the ambiguity of the terms "operating" and "operation" in former §§ 23.1581(a)(2), 23.1581(a)(3), 23.1583(k), and 23.1585(j). For example, Garmin pointed out that many current FAA 20-series ACs specify that equipment operation limitations should be included in an AFM.[61] Garmin contended the AFM was never intended as a catch-all for equipment or airspace operating limitations and that equipment operating limitations are more appropriately included in the equipment's pilot guide or operating manual provided by the equipment manufacturer.

Garmin also suggested using the terms "operating" and "operation" in proposed § 23.1510(a) and (d) could be easily confused with operating rule limitations (e.g., § 91.225 for ADS-B Out) or system-wide operating limitations (e.g., the displayed age of

[60] The NPRM erroneously stated that proposed § 23.1510 was intended to consolidate current §§ 23.1505 through 23.1527. *See* 81 FR at 13495. However, § 23.1510 was actually intended to consolidate the AFM provisions in former §§ 23.1581 through 23.1589.

[61] As an example, the commenter noted that: AC 20-138D (including change 1 and 2) for positioning and navigation equipment includes 77 instances of "AFM," AC 20-165B for ADS-B Out equipment includes 8 instances of "AFM," AC 20-149B for non-required safety enhancing FIS-B equipment includes 7 instances of "A/RFM," and even AC 20-153B for aeronautical database LOAs includes 2 paragraphs requiring specific AFM content. The commenter noted that these counts do not include instances of "airplane flight manual" or other similar phrases.

FIS-B weather products), which are not necessary to safely fly the airplane and would be more appropriately captured in the Aeronautical Information Manual (AIM).

Therefore, Garmin recommended proposed § 23.1510(a) state: "Airplane operating limitations and procedures." The Associations recommended the same revision. Garmin also suggested revising the NPRM preamble to state that the AFM is not intended to be used as a catch-all for equipment operating limitations, or to be used for operating rule limitations or system-wide operating limitations, all of which are more appropriately included in guides and manuals.

The FAA agrees with Garmin in that the AFM was never intended as a catch-all for equipment or airspace operating limitations. The requirement for "operating limitations and procedures" in the proposed § 23.1510(a) was intended to capture information required to be included in the AFM by former §§ 23.1583 and 23.1585.

The FAA did not intend to expand § 23.2620(a) to encompass information that is not required to be included in the AFM by former §§ 23.1583 and 23.1585. To further clarify its intent, the FAA adopts the commenters' suggestion and amends § 23.2620(a)(1) to specify that this section requires "airplane" operating limitations and procedures.

Proposed § 23.1510(a)(4) would have required that "any other information necessary for the operation of the airplane" must be included in the AFM. The FAA agrees with the commenters' concern that the proposed language was too broad and could be interpreted as requiring information that has not traditionally been included in the AFM. The intent of this proposed provision was to retain the requirement of former § 23.1581(a)(2), which require the AFM to include other information that is necessary for

safe operation because of design, operating, or handling characteristics." Because the proposed language was unclear, the final rule will simply codify, without change, the language of former § 23.1581(a)(2) into § 23.2620(a)(4).

Garmin noted that while it was not specifically covered in the NPRM preamble, it appreciated that proposed § 23.2620 no longer appears to require FAA approval of certain information contained in the AFM as required by former § 23.1581(b). Garmin said this would eliminate delays associated with seeking an Aircraft Certification Office engineer's approval of AFM content for the TC or STC process, typically a one-time occurrence; or Flight Standards District Office inspector's approval of AFM content for post-certification installations, which occur frequently. Garmin explained that these approval delays translate into loss of revenue for the applicants. Garmin recommended the preamble specifically indicate there is no intent to require FAA approval of AFM content during certification or for post-certification installation.

NATCA asked the FAA to clarify the Airworthiness Limitations Sections (ALS), as well as portions of the AFM, requiring FAA approval. NATCA indicated this clarification was need as approval of ALS and AFM content are "inherently governmental functions." NATCA noted that all other sections of the continuing operating instructions, maintenance, and some flight manual sections are accepted.

The FAA notes the requirement for the AFM in former § 23.1581 required each portion of the AFM containing information required by the FAA must be approved by the FAA, segregated, identified, and clearly distinguished from each unapproved portion of the AFM. The former requirements also provided an exception for reciprocating-powered

airplanes that do not weigh more than 6,000 pounds if certain requirements were met. [62] It was not the FAA's intent to discontinue the former requirement to approve select AFM information. The approval process allows the FAA to review an AFM to ensure it satisfies the applicable requirements; this rule will generally retain the existing requirement that FAA-required information provided in the AFM must be approved by the FAA. For this reason, the FAA has added paragraph (b) to clarify that the FAA will retain our authority to approve specific AFM information.

E. Miscellaneous Amendments (§§ 21.9, 21.17, 21.24, 21.35, 21.50, 21.101, SFAR 23, Appendix E to Part 43, and 91.323)

1. Production of Replacement and Modification Articles (§ 21.9)

In the NPRM, the FAA proposed revising § 21.9 by adding a new paragraph (a)(7) to provide applicants with an alternative method to obtain FAA approval to produce replacement and modification articles that are reasonably likely to be installed on type certificated aircraft. The FAA also proposed revising paragraphs (b) and (c) to specify that these articles would be suitable for use in a type certificated product. Lastly, the FAA also proposed allowing an applicant to submit production information for a specific article, but would not require the producer of the article to apply for approval of the article's design or obtain approval of its quality system. Under the proposed changes, approval to produce a modification or replacement article under proposed § 21.9(a)(7) would not constitute a production approval as defined in § 21.1(b)(6). In the NPRM, the FAA indicated it would limit use of this procedure to articles whose improper operation

[62] *Id.* § 23.1581(b)(2). To qualify for this exception, the following requirements must be satisfied: (1) each part of the AFM containing the Limitations information must be limited to such information, and must be approved, identified, and clearly distinguished from each other part of the AFM; and (2) the remaining required information must be presented in its entirety in a manner acceptable to the FAA.

or failure would not cause a hazard. Additionally, the approval would be granted on a case-by-case basis, specific to the installation proposed, accounting for potential risk and considering the safety continuum.

The FAA specifically solicited comments regarding whether the proposed change would safely facilitate retrofit of low risk articles and whether there are alternative methods to address the perceived retrofit barrier.

All commenters expressed some level of support for the proposed changes to § 21.9. Several commenters asked the FAA to provide guidance to clarify how the proposed changes will work.

The FAA agrees with the commenters that additional details and clarification are needed to further define the process for obtaining approval under § 21.9(a)(7) and will provide the necessary policy and guidance material. Generally, the process for obtaining FAA approval under § 21.9(a)(7) is intended to be scalable in nature in that different degrees of substantiation may be required, depending on the complexity of the article for which approval is sought. For example, a non-required, low-risk article could be simple enough that a design approval and quality system might not be required; however, a more complex article might also require a § 21.8(d) design approval and some form of quality system. Examples of the requirements for more complex projects include FAA policy memorandum AIR100-14-110-PM01, “Approval of Non-Required Angle-of-Attack (AOA) Indicator Systems, and FAA policy statement PS-AIR-21.8-1602, Approval of Non-Required Safety Enhancing Equipment (NORSEE).” For simple articles, a reduction in scale could be negotiated with the FAA to provide an appropriate level of safety. Audits of the manufacturer’s facility would be at the discretion of the appropriate MIDO.

Typically, a MIDO audit would not be required unless there is evidence that indicates improper quality control issues that require a MIDO's involvement, as described in the FAA Policy Statement PS-AIR-21.8-1602.[63]

Astronautics Corporation commented that whether an article is "required" or "non-required" depends on the kind of operation the applicant requests for certification. Garmin also questioned why the qualifying articles have to be non-required and asked the FAA to consider expanding use of the proposed § 21.9(a)(7) process to include low-risk required articles when the applicant has an approved quality system. Garmin contended that low risk to the aircraft or its occupants should be sufficient criteria to allow application to both required and non-required equipment.

Astronautics Corporation is correct in its observation that the approval means for an article could potentially affect the "kinds of operation" authorized for an aircraft. The FAA's intent is not to bypass existing certification process for required equipment, but to provide an alternative process for non-required, low-risk articles. For example, a weather display approved under § 21.9(a)(7) may have extensive information available, but this information would be considered supplemental and could not be used to satisfy operational requirements. If the FAA determines that certain equipment is required for safety, then existing certification processes must be followed to ensure the required safety equipment is functioning properly.

Garmin also asked what would be needed for approval of the installation of articles produced under § 21.9(a)(7) and whether new FAA policy would be needed each time there is a new equipment standard proposed to allow its installation.

[63] Policy No. PS-AIR-21.8-1602 has been placed in docket number FAA-20150-1621.

Section 21.9(a)(7) concerns only the production of articles, not their installation. The required process for obtaining installation approval remains unchanged by this rule.

Garmin asserted that the term “low risk” is subjective and asked the FAA to clarify the intent of this term. Specifically, Garmin asked if a system with a minor failure condition would fall into the low-risk category.

The FAA intends the term “low risk,” for the purposes of § 21.9(a)(7), to apply to non-required articles with a hazard classification no greater than minor. In this context, a “minor” failure condition would result in only a slight reduction in functional capabilities or safety margins.

Air Tractor asked whether the changes to § 21.9 will apply equally to TC and STC holders and applicants for those certificates, which the commenter said it believed the changes should.

It is the FAA’s intent that an article approved under § 21.9(a)(7) can be subsequently approved for installation by a TC or STC holder based on the installation data provided by the TC or STC holder.

Additionally, the FAA has decided not to except articles approved under § 21.9(a)(7) from the prohibition on representing an article as suitable for installation on a type-certificated product found in § 21.9(b) and § 21.9(c); therefore, the FAA is not adopting the NPRM’s proposed changes to § 21.9(b) and § 21.9(c). The current § 21.9 creates an exception from this prohibition for articles produced under a TC or an FAA production approval because these articles have approved installation data that justify a representation of suitability. The proposed changes in the NPRM would have allowed articles that are not produced under a TC or production approval to be sold or represented

as suitable for installation on type-certificated products without approved installation data. A representation that an article is "suitable for installation" could be misinterpreted as "approved for installation." The FAA notes that approval under § 21.9(a)(7) does not constitute approval for installation of the article; however, a person may state that an article approved under § 21.9(a)(7) may be installed in a type-certificated aircraft provided it has been determined suitable for installation by an appropriately-rated mechanic using appropriate means.

2. Designation of Applicable Regulations (§ 21.17)

In the NPRM, the FAA proposed amending § 21.17(a) by removing the reference to § 23.2 because § 23.2 would be deleted by this rule.

NATCA commented that elimination of the reference to retroactive rules, former § 23.2, leaves holes in certification basis for the existing fleet of airplanes. This commenter noted that while § 23.2 is not listed as a basis for certification for many existing airplanes, the provision nevertheless applies due to the date of manufacture of some airplanes. NATCA also raised concerns it would be burdensome to revise Type Certificate Data Sheets (TCDS) to reflect the change; therefore, NATCA requested that this regulation address the addition of seatbelts as a retroactive, date of manufacture, requirement.

The FAA notes NATCA's concern; however, the provisions of current § 23.2 are duplicated in § 91.205 and therefore remain applicable based on date of manufacture. The revision of TCDS will be unnecessary because any reference to current § 23.2 in an existing TCDS will include reference to the applicable amendment and continue to be enforceable.

The NTSB commented that the FAA should retain § 23.2 because it is a regulatory mechanism to apply special retroactive requirements to newly-manufactured items after the item has been issued a TC.

The FAA notes the NTSB's comment, but this rule does not affect the FAA's ability to promulgate other special retroactive requirements using the normal rulemaking process.

The FAA removes § 23.2 and revises § 21.17(a) by removing the reference to § 23.2, as proposed.

Although the NPRM did not propose changes to § 21.17(b), which addresses the designation of applicable regulations to special classes of airplane, NATCA asked whether the FAA would continue to accept EASA's CS-VLA and CS 22 sailplanes and powered sailplanes, as special, stand-alone classes of airplanes, or whether the intent was to include these airplanes in part 23 as EASA proposed.

The FAA intends to continue to allow CS-VLA and CS 22 airplanes to be approved as special, stand-alone classes of airplanes while also allowing eligibility for certification in accordance with part 23 using accepted means of compliance.

3. Issuance of Type Certificate: Primary Category Aircraft (§ 21.24)

In the NPRM, the FAA proposed amending § 21.24 by revising paragraph (a)(1)(i) to modify the phrase "as defined by § 23.49" to include reference to amendment 23-62 (76 FR 75736, December 2, 2011), effective on January 31, 2012. The FAA explained that revision would be necessary to maintain a complete definition of stall speed in § 21.24, as the former § 23.49 is removed by this rule.

The Associations said it is unnecessary to amend § 21.24(a)(1)(i) as proposed. These commenters noted there are many references to items such as stall speed that do not need to reference a previous amendment regulation for the steps to determine stall speed. The commenters contended it would be sufficient to include the intent in the preamble discussion.

The FAA agrees the reference to § 23.49, amendment 23-62, in § 21.24 is unnecessary. V_{SO} is defined in § 1.2. The conditions and techniques for determining stall speed have been consistent for decades. Furthermore, AC 23-8C has a thorough discussion on how to do stall testing. Rather than referencing a regulation from a previous amendment, the FAA is revising § 21.24 to refer to V_{SO} stall speed as determined under part 23.

The Associations also asked the FAA to include electric propulsion in the primary category aircraft once the FAA determines acceptable standards by inserting the phrase "or with electric propulsion systems" after the phrase "naturally aspired engine."

The commenters' request to include electric propulsion systems in the primary category is beyond the scope of this rulemaking. Therefore, the FAA defers the request for consideration in future part 21 rulemaking activity.

NATCA argued the establishment of Primary Category Aircraft in current § 21.24 has been an almost useless addition to part 21, resulting in problems without providing any benefit. As an example, NATCA referenced without elaboration the Seabird Seeker.[64] NATCA also noted that very few airplanes have been certified under existing § 21.24, except perhaps those seeking to obtain EASA approval for CS-LSA (Light Sport

[64] It appears the Seabird Seeker is a light utility airplane built by Seabird Aviation Australia that was prohibited from being sold in the United States until receiving part 23 TC in 2015.

Aeroplanes). The commenter said the proposed changes to part 23 support the use of industry specifications as a certification basis within part 23, thereby eliminating the need to retain procedural regulations for Primary Category Aircraft. NATCA recommended FAA focus on harmonizing the standards for Very Light Aircraft and Light Sport Aircraft with bilateral partners, particularly EASA. The commenter observed that United States manufacturers are at a disadvantage to obtain CS-LSA approval in Europe.

NATCA maintained that these types of airplanes are meant to be included in the part 23 rewrite and therefore recommended the FAA remove new type certification under § 21.24 once the part 23 revisions becomes final. Specifically, NATCA recommended the FAA rewrite §§ 21.24 and 21.184 to eliminate Primary Category certifications, or keep with an effective date to account for existing fleet, and create procedural requirements in part 21 and maybe part 23 to recognize something equivalent to EASA's CS-LSA.

The FAA considered NATCA's proposal to remove § 21.24, in effect, eliminating primary category certification. Although Very Light Aircraft and Light Sport Aircraft could be certified under the new part 23, eliminating § 21.24 is beyond the scope of this rulemaking because it would also remove a means of certification for certain rotorcraft that qualify for the primary category. These rotorcraft will not be able to take advantage of the new part 23 because it applies only to the certification of airplanes. Additionally, § 21.24 and the new part 23 do not conflict; they are alternative paths for certification.

Additionally, proposed § 21.24(i) abbreviated "January" as "Jan". This rule replaces "Jan" with "January".

4. Flight Tests (§ 21.35)

The NPRM proposed amending § 21.35(b)(2) to delete reference to reciprocating engines and expanding the exempted airplanes to include all low-speed part 23 airplanes 6,000 pounds or less. This proposed change would align the requirements for function and reliability testing with the proposed changes in part 23 that do not distinguish between propulsion types. This change would allow the FAA flexibility to address new propulsion types.

All commenters objected to the use of a 6,000-pound weight limit as a threshold for exemption from testing in proposed § 21.35(b)(2). Each commenter noted that the stated intent of the part 23 revision is, in part, to move away from weight and propulsion type classifications. Each commenter also requested the FAA remove the 6,000-pound weight limit.

Air Tractor proposed eliminating the need for function and reliability testing entirely and suggested the market will sort out function and reliability issues by means of natural economic controls.

The Associations suggested the FAA use a parameter other than maximum weight as a discriminator. Recognizing that the 6,000-pound weight limit appears to be based on the airplane's complexity and considering the acceptable level of risk, these commenters suggested using a low-speed airplane, which is a measure of complexity, and airworthiness level 2 or less, which are newly accepted measures of risk, to provide the same level of safety. The commenters noted this discriminator would also better align with the part 23 design rules. Therefore, the Associations recommended replacing the

phrase “of 6,000 pound or less maximum weight” with “meeting part 23 airworthiness level 1 or 2.”

The FAA disagrees with Air Tractor’s proposal to eliminate all Function and Reliability (F&R) testing, because elimination of F&R testing for high-speed, complex airplanes, carrying larger numbers of passengers is not in keeping with the FAA’s statutory mandate to prescribe minimum standards in the interest of safety for the design and performance of airplanes.

The FAA agrees with Textron and the Associations to remove the 6,000-pound discriminator in favor of values based on complexity and risk. Accordingly, the FAA has decided to replace the exception from F&R testing for airplanes weighing 6,000 pounds and below with an exception for airplanes with performance level of low-speed and certification level of 2 or less. The 6,000-pound discriminator was based on the FAA’s assumptions regarding the complexity and risk associated with airplanes of that weight. However, as the commenters point out, their recommended parameters reflect the same assumptions regarding complexity and risk. Although this change may provide an exception for airplanes of up to 19,000 pounds, these airplanes would still be within the allowable risk and complexity parameters.

5. Instructions for Continued Airworthiness and Manufacturer's Maintenance Manuals Having Airworthiness Limitations Sections (§ 21.50)

In the NPRM, proposed § 21.50(b) would have replaced the reference § 23.1529 with § 23.1515 to align with the proposed part 23 numbering convention.

The FAA has decided not to renumber § 23.1529, which requires applicants for a TC or a change to a TC under part 23 to prepare Instructions for Continued

Airworthiness; therefore, this section retains the reference to § 23.1529 in this rule. However, the FAA will keep the proposed addition of the phrase "for Continued Airworthiness" in the second sentence of § 21.50 to clarify that the second sentence in paragraph (b) refers to Instructions for Continued Airworthiness.

6. Designation of Applicable Regulations (§ 21.101)

The NPRM proposed amending § 21.101(b) to remove reference to § 23.2 because § 23.2 was proposed to be removed from part 23 and the requirements of former § 23.2 are addressed in the operating rules. The NPRM, in order to align § 21.101 with the proposed part 23 certification levels, proposed amending § 21.101(c) to include simple airplanes, level 1, low-speed airplanes, and level 2, low-speed airplanes. The NPRM did not propose to revise § 21.101 to address airplanes certified under former part 23, amendment 23–62, or prior amendments. Section 21.101 will continue to allow for compliance with the certification requirements at amendment 23–62 or earlier when compliance to the latest amendment of part 23 is determined by the FAA to be impractical.

The Associations said the FAA should remove the phrase "to a simple" from the first sentence of § 21.101(c), regardless of the later utilization of the term as these aircraft are completely encompassed by low-speed, level 1 airplanes. The FAA agrees and revises the rule language to remove "to a simple" from § 21.101(c).

Textron commented that the purpose of the part 23 rewrite is to move away from prescriptive classifications like weight and propulsion type, and therefore asked FAA to remove the 6,000-pound weight-based division in proposed § 21.101(c). Textron also noted the FAA provided no justifications for retaining the 6,000-pound weight-based

division. Textron also suggested adding the word “airplane” after “simple” and after “level 1 low speed” for clarity.

The FAA considered Textron’s comment. However, the 6,000-pound weight division cannot be removed because it continues to apply to legacy airplanes and modifications to those airplanes. A legacy airplane would only be identified by a certification level if it was re-certified to be fully compliant with the new rule. Therefore, the proposed wording is intended to capture both legacy airplanes and newly type certified airplanes. The FAA agrees that adding the word “airplane” after “level 1 low speed” in paragraph (c) will improve the sentence’s clarity.

NATCA observed that there do not appear to be FAA directives or guidance on how to apply the part 23 rewrite to existing airplanes. As an example, NATCA asked how this rewrite would apply to a Piper Seneca V, an amendment 23-6 airplane. The commenter contended the FAA already struggles with the existing regulations and guidance. NATCA also asked how the proposed changes will be implemented on existing TC and STC products and how the certification basis will be captured. NATCA asked FAA to issue new directives, orders, and ACs specifically addressing application of part 23, relative to the Changed Product Rule, to prevent a situation in which each ACO (and applicant) comes up with their own creative interpretation of the regulation.

The FAA has developed internal training and guidance material to assist FAA employees. Specific to the application of the Changed Product Rule (§ 21.101), there should be minimal variation from existing procedures and guidance material. The certification basis for changed products will be captured by section and amendment in

accordance with existing procedures, and section-specific certification levels identified for those amendments issued concurrent with, or subsequent to, this rulemaking.

7. Special Federal Regulation 23 (SFAR No. 23)

This final rule removes SFAR No. 23 as unnecessary because an applicant may no longer certify an airplane to SFAR No. 23. SFAR No. 23 was first superseded by SFAR 41 and then by commuter category in part 23, amendment 23-34. The FAA's intent to remove SFAR No. 23 was reflected in the amendatory language in the NPRM.

8. Altimeter System Test and Inspection (Appendix E to Part 43)

In the NPRM, the FAA proposed to revise paragraph (a)(2) of appendix E to part 43 by removing the reference to § 23.1325,[65] which would cease to exist in the proposed rule, and by requiring each person performing the altimeter system tests and inspections required by § 91.411 to perform a proof test to demonstrate the integrity of the static pressure system in a manner acceptable to the Administrator. This proposed change would have affected owners and operators of part 23 certificated airplanes in controlled airspace under IFR, who must comply with § 91.411.

Kestrel noted that existing appendix E to part 43 references § 23.1325 for leakage tolerances; however, the proposed rule would not have included § 23.1325 and the specified tolerances. Kestrel asked if the FAA plans to address the specified tolerances in guidance, or if it will permit the varying tolerances between similar airplane.

The FAA agrees and will address the leakage tolerances in guidance. As explained in the NPRM, the FAA is revising AC 43-6, Altitude Reporting Equipment and

[65] In the NPRM, the FAA proposed to capture the safety intent of § 23.1325 in proposed §§ 23.1300, 23.1310, and 23.1315.

Transponder System Maintenance and Inspection Practices, to include a static pressure system proof test acceptable to the Administrator. The revised AC will incorporate the same static leakage standards that were formerly prescribed in § 23.1325. However, as ACs are not the only means of compliance, it is possible that someone could ultimately propose an alternative means that the FAA could find acceptable, which would lead to a difference between similar airplane. But no such methods have been proposed to date.

9. Increased Maximum Certification Weights for Certain Airplanes Operated in Alaska (§ 91.323)

The NPRM proposed amendments to §§ 91.205, 91.313, 91.323, and 91.531. The only section that received comments was § 91.323, Increased maximum certification weights for certain airplanes operated in Alaska.

The FAA proposed to amend § 91.323 by removing the reference to § 23.337 because the FAA proposed revising and consolidating § 23.337 with other structural requirements. The FAA proposed adding the relevant prescriptive requirement of § 23.337 to § 91.323(b)(3).

Air Tractor noted that the weight in § 91.323(b)(3) has been changed to reflect a maneuvering load factor that is now independent of the load factor in part 23, but matches the previous § 23.337 definition. The commenter contended that there is now an increased likelihood that the load factor considered under this new rule will not match the load factors that were used in the original certification of the design, because it is possible that some consensus standard will impose some other creative interpretation. The commenter suggested that safety would be better preserved if § 91.323 were required to reference the load factors that were used in the original certification.

Air Tractor's concern is based on an incorrect interpretation of the FAA's proposed amendment to § 91.323. Section 91.323 applies only to aircraft that have been type certificated under Airworthiness Bulletin 7A or under normal category of part 4a of the former Civil Air Regulations (CAR). The FAA's proposed amendment to § 91.323 would not permit any additional aircraft to be operated in accordance with § 91.323. It would only preserve the approval of increased maximum certification weights for airplanes that were designed and built to a higher design requirement than CAR 3 and 14 CFR part 23. Approving an increase in the maximum certificated weight of an airplane pursuant to § 91.323, based on the equation from former § 23.337(a)(1), allows operation at the same weights had the airplane been certificated in accordance with CAR 3.

10. Additional Emergency Equipment (§ 121.310)

In the NPRM, the FAA proposed to amend § 121.310(b)(2)(iii) by updating the reference to § 23.811(b). Current § 121.130(b)(2)(iii) references § 23.811(b) of part 23, amendment 23-62. Because the FAA is replacing part 23, amendment 23-62 with new part 23, the FAA proposed to update the reference to § 23.811(b) by specifying that each passenger emergency exit marking and each locating sign must be manufactured to meet the requirements of § 23.811(b) of this chapter in effect on June 16, 1994. However, upon further reflection, the FAA has decided not to reference a section that will no longer exist in the CFR on August 30, 2017. Instead, the FAA is incorporating the requirements of § 23.811(b) in § 121.310(b)(2)(iii). Accordingly, § 121.310(b)(2)(iii) now requires, for a nontransport category turbopropeller powered airplane type certificated after December 31, 1964, that each passenger emergency exit marking and each locating sign be manufactured to have white letters 1 inch high on a red background 2 inches high, be

self-illuminated or independently, internally electrically illuminated, and have a minimum brightness of at least 160 microlamberts. The color may be reversed if the passenger compartment illumination is essentially the same.

11. Additional Airworthiness Requirements (§ 135.169)

In the NPRM, the FAA proposed to allow a small airplane in the normal category, in § 135.169(b)(8), to operate within the rules governing commuter and on demand operations. Proposed § 135.169(b)(8) would have required the new normal category airplane to use a means of compliance accepted by the Administrator equivalent to the airworthiness standards applicable to the certification of airplanes in the commuter category found in part 23, amendment 23-62.

Upon further reflection, the FAA has decided not to reference part 23, amendment 23-62 in § 135.169(b)(8) because part 23, amendment 23-62 will not exist in the CFR when new normal category airplanes are being type certificated under new part 23. The FAA intended proposed § 135.169(b)(8) to ensure a continued higher level of safety for commercial operations by requiring a new normal category airplane under part 23 to use a means of compliance equivalent to the airworthiness standards that applied to airplanes certified in the commuter category. As explained in the NPRM, this final rule sunsets the commuter category for newly type certificated airplanes and creates a new normal category, certification level 4 airplane as equivalent to the commenter category by applying it to 10-19 passengers. In order to retain the FAA's intent while omitting the reference to part 23 at amendment 23-62, the FAA is revising the proposed rule language to clarify that § 135.169(b)(8) applies to a normal category airplane equivalent to the commuter category. Accordingly, § 135.169(b)(8) now allows consideration of a small

airplane that is type certificated in the normal category, as a multi-engine certification level 4 airplane, to operate within the rules governing commuter and on demand operations.

Because new part 23 maintains the level of safety associated with current part 23, except for areas addressing loss of control and icing where a higher level of safety is established, the FAA expects that any multi-engine, level 4 airplane approved for commercial operations with 10 or more passengers will meet, at a minimum, the performance required for airplanes type certificated in the commuter category.

IV. Regulatory Notices and Analyses

A. Regulatory Evaluation Summary

Changes to Federal regulations must undergo several economic analyses. First, Executive Order 12866 and Executive Order 13563 direct that each Federal agency shall propose or adopt a regulation only upon a reasoned determination that the benefits of the intended regulation justify its costs. Second, the Regulatory Flexibility Act of 1980 (Public Law 96-354) requires agencies to analyze the economic impact of regulatory changes on small entities. Third, the Trade Agreements Act (Public Law 96-39) prohibits agencies from setting standards that create unnecessary obstacles to the foreign commerce of the United States. In developing U.S. standards, this Trade Act requires agencies to consider international standards and, where appropriate, that they be the basis of U.S. standards. Fourth, the Unfunded Mandates Reform Act of 1995 (Public Law 104-4) requires agencies to prepare a written assessment of the costs, benefits, and other effects of proposed or final rules that include a Federal mandate likely to result in the expenditure by State, local, or tribal governments, in the aggregate, or by the private

sector, of $100 million or more annually (adjusted for inflation with base year of 1995). This portion of the preamble summarizes the FAA's analysis of the economic impacts of this final rule. We suggest readers seeking greater detail read the full regulatory evaluation, a copy of which we have placed in the docket for this rulemaking.

In conducting these analyses, FAA has determined that this final rule: (1) has benefits that justify its costs, (2) is not an economically "significant regulatory action" as defined in section 3(f) of Executive Order 12866, (3) is not "significant" as defined in DOT's Regulatory Policies and Procedures; (4) has a significant positive economic impact on small entities; (5) will not create unnecessary obstacles to the foreign commerce of the United States; and (6) will not impose an unfunded mandate on state, local, or tribal governments, or on the private sector by exceeding the threshold identified above. These analyses are summarized below.

1. Total Benefits and Costs of this Rule

The following table shows the estimated benefits and costs of the final rule. Another way to consider the expected net benefit to the society is if the rule saves only one human life by improving stall characteristics and stall warnings, this alone would result in benefits which substantially outweigh the costs.

Estimated Benefits and Costs

(2015 $ Millions)

	Stall & Spin + Other Costs	**Safety Benefits + Cost Savings = Total Benefits**
Total	$0.8 + $3.1 = $3.9	$17.9+ $9.9 = $27.8
Present value at 7%	$0.8 + $3.1 = $3.9	$6.1 + $4.9 = $11.0
Present value at 3%	$0.8 + $3.1 = $3.9	$11.1 + $7.1 = $18.3

***These numbers are subject to rounding error.**

2. Who is Potentially Affected by this Rule?

The proposal will affect U.S. manufacturers and operators of new part 23 type certificated airplanes.

3. Assumptions:

The benefit and cost analysis for the regulatory evaluation is based on the following factors/assumptions:

- The analysis is conducted in constant dollars with 2015 as the base year.
- The final rule will be effective in 2017.
- The primary analysis period for costs and benefits extends for 20 years, from 2017 through 2036. This period was selected because annual costs and benefits will have reached a steady state by 2036.
- Future part 23 type certifications and deliveries are estimated from historical part 23 type certifications and deliveries.
- Costs for the new part 23 type certifications forecasted in the "Fleet Discussion" section will all occur in year 1 of the analysis interval.
- Airplane deliveries from the forecasted part 23 type certificates will start in year 5 of the analysis interval. Therefore, accident reduction benefits will begin five years after the rule is in effect.
- The FAA uses a three and seven percent discount rate for the benefits and costs as prescribed by OMB in Circular A-4.
- The baseline for estimating the costs and benefits of the rule will be part 23, through the current amendment level.

- Based on FAA Small Airplane Directorate expert judgment, the FAA estimates 335 FAA part 23 certification engineers will require additional training as a result of this final rule. The FAA assumes that the same number of industry part 23 certification engineers will also require additional training as a result of this final rule.
- The FAA estimates this rulemaking will add 16 hours of training to FAA and industry part 23 certification engineers.
- Since this training program will be on-line, we estimate no travel costs for the engineers.
- FAA pay-band tables and the Bureau of Labor Statistics (BLS) determines the hourly wages used to estimate the costs to the FAA and applicants.
- Using the U.S. Department of Transportation guidance, the wage multiplier for employee benefits is 1.17.

4. Benefits of this Rule

The major safety benefit of this rule is to add stall characteristics and stall warnings that will result in airplane designs that are more resistant to inadvertently departing controlled flight. The largest number of accidents for small airplanes is a stall or departure based loss of control (LOC) in flight. This rule will have cost savings by streamlining the certification process and encouraging new and innovative technology. Streamlining the certification process will reduce the issuance of special conditions, exemptions, and equivalent level of safety findings.

5. Costs of this Rule

The final rules major costs are the engineer training costs and the certification database creation costs. Additional costs will also accrue from the controllability and stall sections that will increase scope over current requirements and manual upgrade costs.

In the following table, we summarize the total estimated compliance costs by category. The FAA notes that since we assumed that all costs occurred in Year 1 of the analysis interval, the 2015-dollar costs equal the present value costs.

Total Cost Summary by Category (in 2015 Present Value Dollars)

Type of Cost	Total Costs in Present Value at 7 percent
§23.2150(c) Controllability	$277,318
§23.2150(b) Stall characteristics, stall warning, and spins	$500,595
Engineer Training Costs	$1,167,379
Certification Database Costs	$1,295,290
Manual Upgrade Costs	$700,833
Total Costs	**$3,941,414**

***These numbers are subject to rounding error.**

B. Final Regulatory Flexibility Determination

The Regulatory Flexibility Act of 1980 (Public Law 96-354) (RFA) establishes "as a principle of regulatory issuance that agencies shall endeavor, consistent with the objectives of the rule and of applicable statutes, to fit regulatory and informational

requirements to the scale of the businesses, organizations, and governmental jurisdictions subject to regulation. To achieve this principle, agencies are required to solicit and consider flexible regulatory proposals and to explain the rationale for their actions to assure that such proposals are given serious consideration." The RFA covers a wide-range of small entities, including small businesses, not-for-profit organizations, and small governmental jurisdictions.

Agencies must perform a review to determine whether a rule will have a significant economic impact on a substantial number of small entities. If the agency determines that it will, the agency must prepare a regulatory flexibility analysis as described.

The FAA believes that this final rule could have a significant positive economic impact on a substantial number of entities because we believe this rule could enable the creation of new part 23 type certificates and new manufacturers. The FAA has been working with U.S. and foreign small aircraft manufacturers since 2007 to review the life cycle of part 23 airplanes and determine what needed improvement.

The purpose of this analysis is to provide the reasoning underlying the FAA determination.

Section 604(a) of the Act specifies the content of a FRFA.

Each FRFA must contain:

- a statement of the need for, and objectives of, the rule;
- a statement of the significant issues raised by the public comments in response to the initial regulatory flexibility analysis, a statement of the assessment of the

agency of such issues, and a statement of any changes made in the proposed rule as a result of such comments;

- the response of the agency to any comments filed by the Chief Counsel for Advocacy of the Small Business Administration in response to the proposed rule, and a detailed statement of any change made to the proposed rule in the final rule as a result of the comments;
- a description of and an estimate of the number of small entities to which the rule will apply or an explanation of why no such estimate is available;
- a description of the projected reporting, recordkeeping and other compliance requirements of the rule, including an estimate of the classes of small entities which will be subject to the requirement and the type of professional skills necessary for preparation of the report or record; and
- a description of the steps the agency has taken to minimize the significant economic impact on small entities consistent with the stated objectives of applicable statutes, including a statement of the factual, policy, and legal reasons for selecting the alternative adopted in the final rule and why each one of the other significant alternatives to the rule considered by the agency which affect the impact on small entities was rejected.

1. Reasons Why the Rule Is Needed

The FAA promulgates this action to amend the airworthiness standards for new part 23 type certificated airplanes to reflect the current needs of the small airplane industry, accommodate future trends, address emerging technologies, and enable the creation of new part 23 manufacturers and new type certificated airplanes. The rule's

changes to part 23 are necessary to eliminate the current workload of exemptions, special conditions, and equivalent levels of safety findings necessary to certificate new part 23 airplanes. These part 23 changes will also promote safety by enacting new regulations for controllability and stall standards and promote the introduction of new technologies in part 23 airplanes.

2. Significant issues raised by the public comments in response to the initial regulatory flexibility analysis

With regard to assessing the impact on small, numerous firms were left out of the FAA's analysis. Analysis concerning the impact on small firms ultimately included data from only 5 firms, one of which has not been in operation for 8 years, and another that no longer exists, but is struggling to set up business under new ownership. It would seem that the FAA should have knowledge of every company that still has active manufacturing activities (active production certificates), and that the data that was included was exceptionally non-representative of the overall industry. Further, by eliminating from consideration all firms that are not US-owned a distorted view of the true impact on the general aviation industry in our country is presented.

FAA Response: Under the Small Business Regulatory Flexibility Act, for each initial regulatory flexibility analysis, agencies are required to provide a description of and, where feasible, an estimate of the number of small entities to which the proposed rule would apply. Many, if not most, small entities do not provide public data such as publically available employment data in order to determine if a business is small under the SBA guidelines, or publically available revenue data, in order to determine if a business is disproportionately burdened by the proposed or final rulemaking. The FAA

does not have the means or authority to require small entities to report their employment or revenue data and therefore we do not have knowledge of every company that still has active manufacturing activities. The small business entities that the FAA analyzed provided data on their employment and revenue either through the U.S. DOT Form 41 rules, SEC rules, or through news releases the companies made public.

The FAA conducted research and found that all five businesses' we examined at the time of our analysis were small and either actively manufacturing aircraft or they were under new ownership and had publically announced they were in the process of working towards setting up an aircraft manufacturing line. The FAA notes the rule also reduces the certification time for small part 23 parts manufacturers. The FAA conclusion that the proposed rule may have a significant positive impact on small entities extends well beyond our sample.

Further, FAA regulations apply to US-owned business and to any foreign owned business that manufactures a product in the U.S. or markets their products/services in the U.S. Foreign owned business' voluntarily complies with the rules and regulations promulgated by the FAA. Thus the FAA expects that the final rule would impact a substantial number of small entities.

The comment regarding numerous firms being left out of the FAA's small business analysis was from a company who certificates most of their aircraft with a restricted category special air worthiness certificate. A restricted category special airworthiness certificate is issued to operate aircraft that have been type certificated in the restricted category. Operation of restricted category aircraft is limited to special purposes identified in the applicable type design. Restricted category aircraft manufacturers do not follow

part 23 in its entirety, rather they follow parts of part 21, part 21 subpart H, part 45, section 91.313, part 91 subpart D, section 91.715, and part 375 and can choose whatever other certification bases requirements, based on FAA approval, to certificate their aircraft for the aircraft's special operations. Therefore, since restricted category aircraft manufacturers do not comply part 23 in its entirety for their type certifications, these manufacturers are not included in our analysis.

In addition, many part suppliers may benefit from this performance-based rule through an expected quicker approval process. The objective of this rule is to allow industry more flexibility and lower cost methods to certify future part 23 airplanes at a sufficiently lower certification cost which can be driven by industry innovation and more small entities will have additional opportunities that do not exist today.

3. FAA response to any comments filed by the Chief Counsel for Advocacy of the Small Business Administration in response to the proposed rule

The Chief Counsel for Advocacy did not file comments for the proposed rule.

4. A description of and an estimate of the number of small entities to which the rule will apply or an explanation of why no such estimate is available

For the initial regulatory flexibility analysis (IRFA), the FAA conducted a review to determine whether a rule will have a significant economic impact on a substantial number of small entities. The IRFA concluded that the proposed rule could have a significant economic impact on a substantial number of entities because we believe this rule could enable the creation of new part 23 type certificates and new manufacturers.

The FAA is unable to estimate the total number of small entities to which the rule will apply because many, if not most, small part 23 aircraft manufacturing entities do not

provide public data such as publically available employment data in order to determine if a business is small under the SBA guidelines, and publically available revenue data, in order to determine if a business is disproportionately burdened by the final rulemaking. The FAA also believes that the final rule will enable new part 23 aircraft manufacturing industries, while maintaining a safe operating environment. In addition, many part suppliers may benefit from this performance-based rule through an expected quicker approval process.

5. A description of the projected reporting, recordkeeping and other compliance requirements of the rule, including an estimate of the classes of small entities which will be subject to the requirement and the type of professional skills necessary for preparation of the report or record

The final rule will reduce the number of special conditions, equivalent level of safety (ELOS), and exemptions and therefore will reduce paperwork and processing time for both the FAA and industry. The rule would also maintain the fundamental safety requirements from the current part 23 regulations but allow more flexibility in airplane designs, faster adoption of safety enhancing technology, and reduce the regulatory cost burden. To estimate savings driven by this change, the FAA counted the special conditions, ELOS, and exemption applications submitted to the FAA for part 23 aircraft between 2012 and 2014 and divided the number by two years for an average of 37 applications per year. The Aviation Rulemaking Committee (ARC) report offered a similar average of 37 applications per year. Additionally, the FAA counted the number of pages per application to obtain an average number of pages per application. For special conditions, there were approximately 21 pages, 16 pages for an exemption, and 15 pages

per ELOS application. The FAA assumes that the applicant and each FAA office that reviews the application spend 8 hours on research, coordination, and review per page. The ARC also noted “an ELOS finding or exemption can take the FAA between 4 to12 months to develop and approve. The applicant spends roughly the same amount of time as the FAA in proposing what they need and responding to FAA questions for SC, exemption, or ELOS. As explained in number four above, the FAA is unable to estimate the total number of small entities to which the rule will apply. The completion of these reports will not require professional skills beyond basic literacy and aviation skills required to work for a part 23 aircraft manufacturer.

6. A description of the steps the agency has taken to minimize the significant economic impact on small entities consistent with the stated objectives of applicable statutes, including a statement of the factual, policy, and legal reasons for selecting the alternative adopted in the final rule and why each one of the other significant alternatives to the rule considered by the agency which affect the impact on small entities was rejected

The Federal Aviation Administration (FAA) is revising the airworthiness standards for normal, utility, acrobatic, and commuter category part 23 airplanes and believes this action will provide a set of requirements that will allow more flexibility in part 23 airplane designs and faster adoption of safety enhancing technology while maintaining a higher level of safety. The current issue with part 23 is the prescriptive regulatory framework does not readily allow the adoption of new and innovative technology. This rulemaking will solve this issue by putting in place a performance-based

regulatory structure that will result in the FAA accepting new means of compliance based upon industry consensus standards.

This rulemaking project will comply with the Congressional mandated Small Airplane Revitalization Act of 2013, which requires the FAA to issue a final rule that revises the certification requirements for small airplanes by creating a regulatory regime that will improve safety and decrease certification costs. This action will increase the FAA's ability to address future technology and be relieving for all part 23 manufacturers regardless of their size and number of employees.

For the initial regulatory flexibility analysis, the FAA analyzed two alternatives and solicited and received no comments on the alternative analysis. The two alternatives the FAA analyzed follows.

Alternative 1

The FAA will continue to issue special conditions, exemptions, and equivalent level of safety findings to certificate part 23 airplanes. As this approach will not follow congressional direction, we choose not to continue with the status quo.

Alternative 2

The FAA will continue to enforce the current regulations that affect stall and controllability. The FAA rejected this alternative because the accident rate for part 23 airplanes identified a safety issue that had to be addressed.

Thus, this rule's benefits small entities by allowing new designs and parts with lower certifications costs.

C. International Trade Impact Assessment

The Trade Agreements Act of 1979 (Public Law 96-39), as amended by the Uruguay Round Agreements Act (Public Law 103-465), prohibits Federal agencies from establishing standards or engaging in related activities that create unnecessary obstacles to the foreign commerce of the United States. Pursuant to these Acts, the establishment of standards is not considered an unnecessary obstacle to the foreign commerce of the United States, so long as the standard has a legitimate domestic objective, such as the protection of safety, and does not operate in a manner that excludes imports that meet this objective. The statute also requires consideration of international standards and, where appropriate, that they be the basis for U.S. standards. The FAA has assessed the potential effect of this final rule and determined that the standards are necessary for aviation safety and will not create unnecessary obstacles to the foreign commerce of the United States.

D. Unfunded Mandates Assessment

Title II of the Unfunded Mandates Reform Act of 1995 (Public Law 104-4) requires each Federal agency to prepare a written statement assessing the effects of any Federal mandate in a proposed or final agency rule that may result in an expenditure of $100 million or more (in 1995 dollars) in any one year by State, local, and tribal governments, in the aggregate, or by the private sector; such a mandate is deemed to be a "significant regulatory action." The FAA currently uses an inflation-adjusted value of $155.0 million in lieu of $100 million. This final rule does not contain such a mandate; therefore, the requirements of Title II of the Act do not apply.

E. Paperwork Reduction Act

The Paperwork Reduction Act of 1995 (44 U.S.C. 3507(d)) requires that the FAA consider the impact of paperwork and other information collection burdens imposed on the public. The information requirements for aircraft certification are covered by existing OMB No. 2120-0018. Burdens associated with special conditions, ELOS, and exemptions are not quantified in this collection because the need to seek relief under one of these options is dependent on each applicant and is difficult to quantify. It is expected that this rulemaking will reduce the number of special conditions, ELOS, and exemptions filed, thus reducing paperwork and processing time for both the FAA and industry. It would also maintain the fundamental safety requirements from the current part 23 regulations but allow more flexibility in airplane designs, faster adoption of safety enhancing technology, and reduce the regulatory cost burden.

To estimate savings driven by this change, the FAA counted the special conditions, ELOS, and exemption applications submitted to the FAA for part 23 aircraft between 2012 and 2014 and divided the number by three years for an average of 37 applications per year.[66] Additionally, the FAA counted the number of pages per application to obtain an average number of pages per application. For special conditions, there were approximately 21 pages, 16 pages for an exemption, and 15 pages per ELOS application. The FAA assumes that the applicant and each FAA office that reviews the application spend 8 hours on research, coordination, and review per page. The ARC also noted "an ELOS finding or exemption can take the FAA between 4 to12 months to develop and approve. The applicant spends roughly the same amount of time as the FAA

[66] https://my.faa.gov/org/linebusiness/avs/offices/air/tools/cert.html

in proposing what they need and responding to FAA questions for SC, exemption, or ELOS."[67]

The number of applications is multiplied by the number of pages and by the hourly wage for the applicant and different FAA offices to account for the cost to the FAA and the applicant. The following table shows annual hours and cost by special condition, exemption, and ELOS.

	Annual Total	
	Man Hours	**Cost**
Savings from Special Conditions (SC)	8,826	$553,962
Savings from Exemptions	1,620	$101,596
Savings from Equivalent Level of Safety (ELOS)	5,268	$330,691

Using these yearly cost estimates in the table above, over 20 years $6.6 million in man-hours will be spent on applying for and processing special conditions, exemptions, and ELOS. However under the rule, the need to demonstrate compliance through special conditions, exemptions, or ELOS will largely be eliminated. Instead new products will simply need to demonstrate compliance by following consensus standards acceptable to the Administrator, or by submitting their own proposed means of compliance using the process outlined in AC 23.10.[68] As a conservative estimate, the FAA estimates that

[67] Ibid., 54.
[68] See Section VI. Discussion of the Regulatory Amendments of the preamble for a discussion of how this might be accomplished.

special conditions, exemptions, and ELOS will be reduced by half for a savings to the FAA and applicant of roughly $3.3 million ($1.6 million present value). The total cost and hour savings by year is shown in the table below.

	FAA SAD		FAA ACO		Applicant		Total	
	Man-hours	Savings	Man-hours	Savings	Man-hours	Savings	Man-hours	Savings
Total	34,920	$2,613,227	34,920	$1,789,953	34,920	$2,171,813	104,760	$6,574,993
0.5*Total	17,460	$1,306,613	17,460	$904,977	17,460	$1,085,907	52,380	$3,287,497

These numbers are subject to rounding error.

In addition to this savings, there would also be additional paperwork burden associated with § 23.2150(c). This rulemaking will not require a new control number, but does need an update to the control number that currently covers part 23. A PRA questionnaire has been updated with new requirements from this rule, and submitted to our PRA officer. This provision could result in a change to a limitation or a performance number in the flight manual, which will require an update to the training courseware or flight manual. Industry ARC members believe that this change could cost from $100,119 to $150,179 in 2015 dollars. Therefore, the FAA uses $125,149 (($100,119 + $150,179)/2) as an average cost for this change. This will be a one-time cost per new type certification.

There will also be additional paperwork associated with this requirement that is not part of the costs discussed above. The FAA estimates the paperwork costs for these provisions by multiplying the number of hours the FAA estimates for each page of paperwork, by the number of pages for the training courseware, or flight manual, by the hourly rate of the person responsible for the update. The FAA estimates that this section will add a total of four pages to the training courseware and flight manual. The FAA also

estimates that it will take a part 23 certification engineer eight hours to complete the one page required for each new type certification. The eight hours to complete a page includes the research, coordination, and review each document requires. Therefore, the FAA estimates the total paperwork costs for § 23.2150(c) will be about $1,990 in 2015 dollars. The FAA assumes that this section will add costs to only one of the new part 23 turbojet airplane type certificates estimated in the Fleet Discussion section of the regulatory evaluation. The following table shows the total paperwork costs for the changes to § 23.2150(c).

Airplane Type	Hours	Changes to Flight Manual	Paper Work	Total
Turbojet	2,044	$125,149	$1,990	$127,139

Conversations with the industry ARC members indicate that there may need to be some changes to the engineering manuals to describe how the accepted means of compliance must be related to the regulations. Depending on the complexity of each company's manual, industry estimates that these changes could run from about $50,060 up to $200,238 in 2015 dollars. This will be a one-time cost per new type certification.

As we received no comments to the paperwork analysis in the NPRM, we use the same assumptions in the final rule regarding manual complexity. The manufacturers of the two new part 23 reciprocating engine airplane type certifications, discussed in the Fleet Discussion section of the regulatory evaluation, will spend $50,060 to make the changes to the engineering manual. We also assume that the one new part 23 turboprop airplane certification and the two new part 23 turbojet airplane certifications, discussed in

the Fleet Discussion section of the regulatory evaluation, will use the more complex and costly approach of $200,238.

The FAA notes that either the simple approach or the more complex approach to updating the manuals could also either take place in-house or could be contracted out to a consultant. The following table shows the total paperwork costs for the changes to the engineering manuals in 2015 dollars.

Airplane Type	Number of Estimated New Type Certificates	Simple Approach	Complex Approach	Hours	Total
Recip	2	$50,060	$0	1,610	$100,119
Turboprop	1	$0	$200,238	3,219	$200,238
Turbojet	2	$0	$200,238	6,439	$400,476
Total				**11,268**	**$700,833**

These numbers are subject to rounding error.

F. International Compatibility and Cooperation

In keeping with U.S. obligations under the Convention on International Civil Aviation, it is FAA policy to conform to International Civil Aviation Organization (ICAO) Standards and Recommended Practices to the maximum extent practicable. The FAA has reviewed the corresponding ICAO Standards and Recommended Practices and has identified the following differences with these proposed regulations. The ICAO Standards for small airplanes use weight and propulsion to differentiate between some requirements. The proposed regulations use certification levels and performance to differentiate between some requirements. Furthermore, part 23 will still allow the

certification of airplanes up to 19,000 pounds. If this proposal is adopted, the FAA intends to file these differences with ICAO. Executive Order (EO) 13609, Promoting International Regulatory Cooperation, (77 FR 26413, May 4, 2012) promotes international regulatory cooperation to meet shared challenges involving health, safety, labor, security, environmental, and other issues and reduce, eliminate, or prevent unnecessary differences in regulatory requirements. The FAA has analyzed this action under the policy and agency responsibilities of Executive Order 13609, Promoting International Regulatory Cooperation. The agency has determined that this action would eliminate differences between U.S. aviation standards and those of other CAAs by aligning the revised part 23 standards with the new CS 23 standards that are being developed concurrently by EASA. Several other CAAs are participating in this effort and intend to either adopt the new part 23 or CS 23 regulations or revise their airworthiness standards to align with these new regulations.

The Part 23 ARC included participants from several foreign CAAs and international members from almost every GA manufacturer of both airplanes and avionics. It also included several Light-Sport Aircraft manufacturers who are interested in certificating their products using the airworthiness standards contained in part 23. The rulemaking and means of compliance are international efforts. Authorities from Europe, Canada, Brazil, China, and New Zealand all are working to produce similar rules. These rules, while not identical, are intended to allow the use of the same set of industry developed means of compliance. Industry has told that FAA that it is very costly to address the differences that some contrived means of compliance imposes. If there is substantial agreement between the major CAAs to use the same industry means of

compliance, then U.S. manufactures expect a significant saving for exporting their products.

Furthermore, this project is a harmonization project between the FAA and EASA.

EASA has worked a parallel rulemaking program for CS 23. The FAA provided comments to the EASA A-NPA. EASA and other authorities will have an opportunity to comment on this NPRM when it is published. These efforts will allow the FAA, EASA and other authorities to work toward a harmonized set of regulations when the final rules are published.

G. Environmental Analysis

FAA Order 1050.1F identifies FAA actions that are categorically excluded from preparation of an environmental assessment or environmental impact statement under the National Environmental Policy Act in the absence of extraordinary circumstances. The FAA has determined this rulemaking action qualifies for the categorical exclusion identified in paragraph 5-6.6 and involves no extraordinary circumstances.

H. Regulations Affecting Intrastate Aviation in Alaska

Section 1205 of the FAA Reauthorization Act of 1996 (110 Stat. 3213) requires the Administrator, when modifying 14 CFR regulations in a manner affecting intrastate aviation in Alaska, to consider the extent to which Alaska is not served by transportation modes other than aviation, and to establish appropriate regulatory distinctions. Because this rule would apply to GA airworthiness standards, it could, if adopted, affect intrastate aviation in Alaska. The FAA, therefore, specifically requests comments on whether there is justification for applying the proposed rule differently in intrastate operations in Alaska.

V. Executive Order Determination

A. Executive Order 13132, Federalism

The FAA has analyzed this rule under the principles and criteria of Executive Order 13132, Federalism. The agency has determined that this action would not have a substantial direct effect on the States, or the relationship between the Federal Government and the States, or on the distribution of power and responsibilities among the various levels of government, and, therefore, would not have Federalism implications.

B. Executive Order 13211, Regulations that Significantly Affect Energy Supply, Distribution, or Use

The FAA analyzed this rule under Executive Order 13211, Actions Concerning Regulations that Significantly Affect Energy Supply, Distribution, or Use (May 18, 2001). The agency has determined that it would not be a "significant energy" action under the executive order and would not be likely to have a significant adverse effect on the supply, distribution, or use of energy.

VI. How to Obtain Additional Information

A. Rulemaking Documents

An electronic copy of rulemaking documents may be obtained from the Internet by—

1. Searching the Federal eRulemaking Portal (http://www.regulations.gov) for Docket FAA-2015-1621;
2. Visiting the FAA's Regulations and Policies web page at http://www.faa.gov/regulations_policies/; or

3. Accessing the Government Printing Office's web page at http://www.gpo.gov/fdsys/.

Copies may also be obtained by sending a request to the Federal Aviation Administration, Office of Rulemaking, ARM-1, 800 Independence Avenue SW., Washington, DC 20591, or by calling (202) 267-9680.

B. Comments Submitted to the Docket

Comments received may be viewed by going to http://www.regulations.gov and following the online instructions to search the docket number (FAA-2015-1621) for this action. Anyone is able to search the electronic form of all comments received into any of the FAA's dockets by the name of the individual submitting the comment (or signing the comment, if submitted on behalf of an association, business, labor union, etc.).

C. Small Business Regulatory Enforcement Fairness Act

The Small Business Regulatory Enforcement Fairness Act (SBREFA) of 1996 requires FAA to comply with small entity requests for information or advice about compliance with statutes and regulations within its jurisdiction. A small entity with questions regarding this document, may contact its local FAA official, or the person listed under the FOR FURTHER INFORMATION CONTACT heading at the beginning of the preamble. To find out more about SBREFA on the Internet, visit http://www.faa.gov/regulations_policies/rulemaking/sbre_act/.

Appendix 1 to the Preamble—Former to New Regulations Cross-Reference Table

The below cross-reference table is intended to permit easy access from former to new regulations. The preamble is organized topical, section-by-section, former to new regulations. This table should assist the reader in following the section discussions contained in the preamble. If the intent of a former regulation was incorporated into multiple new regulations, only the most pertinent new regulations were listed.

Former Section	Former Title	New Section	New Title
Subpart A—General			
23.1	Applicability	23.2000	Applicability
23.2	Special retroactive requirements	23.2	Interim Airworthiness Requirements
23.3	Airplane categories	23.2005	Certification of normal category airplanes
--	--	23.2010	Accepted means of compliance
Subpart B—Flight			
23.21	Proof of compliance	23.2100	Weight and center of gravity
23.23	Load distribution limits	23.2100	Weight and center of gravity
23.25	Weight limits	23.2100	Weight and center of gravity

23.29	Empty weight and corresponding center of gravity	23.2100	Weight and center of gravity
23.31	Removable ballast	23.2100	Weight and center of gravity
23.33	Propeller speed and pitch limits	23.2400	Powerplant installation
23.45	Performance - General	23.2105	Performance data
23.49	Stalling speed	23.2110	Stall Speed
23.51	Takeoff speeds	23.2115	Takeoff performance
23.53	Takeoff performance	23.2115	Takeoff performance
23.55	Accelerate-stop distance	23.2115	Takeoff performance
23.57	Takeoff path	23.2115	Takeoff performance
23.59	Takeoff distance and takeoff run	23.2115	Takeoff performance
23.61	Takeoff flight path	23.2115	Takeoff performance
23.63	Climb: General	23.2120	Climb requirements
23.65	Climb: All engines operating	23.2120	Climb requirements
23.66	Takeoff climb: one engine inoperative	23.2125	Climb information

23.67	Climb: One engine inoperative	23.2120	Climb requirements
23.69	Enroute climb/descent	23.2125	Climb information
23.71	Glide: single engine airplanes	23.2125	Climb information
23.73	Reference landing approach speed	23.2130	Landing
23.75	Landing distance	23.2130	Landing
23.77	Balked landing	23.2120	Climb requirements
23.141	Flight Characteristics - General	23.2135	Controllability
23.143	Controllability and Maneuverability - General	23.2135	Controllability
23.145	Longitudinal control	23.2135	Controllability
23.147	Directional and lateral control	23.2135	Controllability
23.149	Minimum control speed	23.2135	Controllability
23.151	Acrobatic maneuvers	23.2135	Controllability
23.153	Control during landings	23.2135	Controllability
23.155	Elevator control force in maneuvers	23.2135	Controllability

23.157	Rate of roll	23.2135	Controllability
23.161	Trim	23.2140	Trim
23.171	Stability – General	23.2145	Stability
23.173	Static longitudinal stability	23.2145	Stability
23.175	Demonstration of static longitudinal stability	23.2145	Stability
23.177	Static directional and lateral stability	23.2145	Stability
23.179	Instrument stick force measurements	23.2145	Stability
23.181	Dynamic stability	23.2145	Stability
23.201	Wings level stall	23.2150	Stall characteristics, stall warning, and spins
23.203	Turning Flight and accelerated turning stalls	23.2150	Stall characteristics, stall warning, and spins
23.207	Stall Warning	23.2150	Stall characteristics, stall warning, and spins
23.221	Spinning	23.2150	Stall characteristics, stall warning, and spins
23.231	Longitudinal stability and control	23.2155	Ground and water handling characteristics

23.233	Directional stability and control	23.2155	Ground and water handling characteristics
23.235	Operation on unpaved surfaces	23.2155	Ground and water handling characteristics
23.237	Operation on water	23.2155	Ground and water handling characteristics
23.239	Spray characteristics	23.2155	Ground and water handling characteristics
23.251	Vibration and buffeting	23.2160	Vibration, buffeting, and high-speed characteristics
23.253	High-speed characteristics	23.2160	Vibration, buffeting, and high-speed characteristics
23.255	Out of trim characteristics	23.2160	Vibration, buffeting, and high-speed characteristics
--	--	23.2165	Performance and flight characteristics requirements for flight in icing conditions

Subpart C – Structure

23.301	Loads	23.2210, 23.2230	Structural design loads, Limit and ultimate loads
(a)	--	23.2230	Limit and ultimate loads
(b)	--	23.2210	Structural design loads

(c)	--	23.2210	Structural design loads
(d)	--	23.2210	Structural design loads
23.302	Canard or tandem wing configurations	23.2210	Structural design loads
23.303	Factors of safety	23.2230	Limit and ultimate loads
23.305	Strength and deformation	23.2235	Structural strength
--	--	23.2205	Interaction of systems and structures
23.307	Proof of structure	23.2235	Structure strength
23.321	Flight Loads - General	23.2210	Structural design loads
(a)	--	23.2210	Structural design loads
(b)	--	23.2200	Structural design envelope
(c)	--	23.2200	Structural design envelope
23.331	Symmetrical flight conditions	23.2210	Structural design loads
23.333	Flight envelope	23.2200	Structural design envelope
(a)	--	23.2200	Structural design envelope
(b)	--	23.2200	Structural design envelope
(c)	--	23.2215	Flight load conditions

(d)	--	23.2200	Structural design envelope
23.335	Design airspeeds	23.2200	Structural design envelope
23.337	Limit maneuvering load factors	23.2200	Flight load conditions
(a)	--	23.2200	Structural design envelope
(b)	--	23.2200	Structural design envelope
(c)	--	Means of Compliance	--
23.341	Gust load factors	23.2215	Flight load conditions
23.343	Design fuel loads	23.2200	Structural design envelope
(a)	--	23.2200	Structural design envelope
(b)	--	23.2200	Structural design envelope
(c)	--	Means of Compliance	--
23.345	High lift devices	23.2225	Component loading conditions
23.347	Unsymmetrical flight loads	23.2215	Flight load conditions
23.349	Rolling conditions	23.2215	Flight load conditions
23.351	Yawing conditions	23. 215	Flight load conditions
23.361	Engine torque	23.2225	Component loading conditions

23.363	Side load on engine mount	23.2225	Component loading conditions
23.365	Pressurized cabin loads	23.2225	Flight load conditions
(e)	--	23.2240	Structural durability
23.367	Unsymmetrical loads due to engine failure	23.2215	Flight load conditions
23.369	Rear lift truss	Means of Compliance	--
23.371	Gyroscopic and aerodynamic loads	23.2225	Component loading conditions
23.373	Speed control devices	23.2225	Component loading conditions
23.391	Control surface loads	23.2225	Component loading conditions
23.393	Loads parallel to hinge line	23.2225	Component loading conditions
23.395	Control system loads	23.2225	Component loading conditions
23.397	Limit control forces and torques	23.2225	Component loading conditions
23.399	Dual control system	23.2225	Component loading conditions
23.405	Secondary control system	23.2225	Component loading conditions
23.407	Trim tab effects	23.2225	Component loading conditions
23.409	Tabs	23.2225	Component loading conditions
23.415	Ground gust conditions	23.2225	Component loading conditions

23.421	Balancing loads	Means of Compliance	--
23.423	Maneuvering loads	23.2215	Flight load conditions
23.425	Gust loads	23.2215	Flight load conditions
23.427	Unsymmetrical loads due to engine failure	23.2215	Flight load conditions
23.441	Maneuvering loads	23.2215	Flight load conditions
23.443	Gust loads	23.2215	Flight load conditions
23.445	Outboard fins or winglets	Means of Compliance	--
23.455	Ailerons	23.2225	Component loading conditions
23.459	Special devices	23.2225	Component loading conditions
23.471	Ground Loads - General	23.2220	Ground and water load conditions
23.473	Ground load conditions and assumptions	23.2220	Ground and water load conditions
23.477	Landing gear arrangement	23.2220	Ground and water load conditions
23.479	level landing conditions	23.2220	Ground and water load conditions
23.481	Tail down landing	23.2220	Ground and water load

	conditions		conditions
23.483	One-wheel landing conditions	23.2220	Ground and water load conditions
23.485	Side load conditions	23.2220	Ground and water load conditions
23.493	Braked roll conditions	23.2220	Ground and water load conditions
23.497	Supplementary conditions for tail wheels	23.2220	Ground and water load conditions
23.499	Supplementary conditions for nose wheels	23.2220	Ground and water load conditions
23.505	Supplementary conditions for skiplanes	23.2220	Ground and water load conditions
23.507	Jacking loads	23.2220	Ground and water load conditions
23.509	Towing loads	23.2220	Ground and water load conditions
23.511	Ground load: unsymmetrical loads on multiple-wheel units	23.2220	Ground and water load conditions
23.521	Water load conditions	23.2220	Ground and water load conditions

23.523	Design weights and center of gravity positions	23.2220	Ground and water load conditions
23.525	Application of loads	23.2220	Ground and water load conditions
23.527	Hull and main float load factors	23.2220	Ground and water load conditions
23.529	Hull and main float landing conditions	23.2220	Ground and water load conditions
23.531	Hull and main float takeoff conditions	23.2220	Ground and water load conditions
23.533	Hull and main float bottom pressures	23.2220	Ground and water load conditions
23.535	Auxiliary float loads	23.2220	Ground and water load conditions
23.537	Seawing loads	23.2220	Ground and water load conditions
23.561	Emergency Landing Conditions - General	23.2270	Emergency conditions
23.562	Emergency landing dynamic conditions	23.2270	Emergency conditions
23.571	Metallic pressurized cabin structures	23.2240	Structural durability
23.572	Metallic wing, empennage,	23.2240	Structural durability

	and associated structures		
23.573	Damage tolerance and fatigue evaluation of structure	23.2240	Structural durability
23.574	Metallic damage tolerance and fatigue evaluation of commuter category airplanes	23.2240	Structural durability
23.575	Inspections and other procedures	23.2240	Structural durability

Subpart D - Design and Construction

23.601	General	23.2250	Design and construction principles
23.603	Materials and workmanship	23.2250, 23.2260	Design and construction principles, Materials and processes
23.605	Fabrication methods	23.2260	Materials and processes
23.607	Fasteners	23.2250, 23.2255	Design and construction principles, Protection of structure
23.609	Protection of Structure	23.2255	Protection of structure
23.611	Accessibility	23.2255	Protection of structure

23.613	Material strength properties and design values	23.2260	Materials and processes
23.619	Special factors	23.2265	Special factors of safety
23.621	Casting factors	23.2265	Special factors of safety
23.623	Bearing factors	23.2265	Special factors of safety
23.625	Fitting factors	23.2265	Special factors of safety
23.627	Fatigue strength	23.2240	Structural durability
23.629	Flutter	23.2245	Aeroelasticity
23.641	Proof of strength	Means of Compliance	--
23.651	Proof of strength	Means of Compliance	--
23.655	Installation	23.2300(a)(2)	Flight control systems
23.657	Hinges	23.2265	Special factors of safety
23.659	Mass balance	23.2215, 23.2335	Flight load conditions, Structural strength
23.671	Control systems - General		
(a)	--	23.2300(a)(1) & 23.2600(a)	Flight control systems & Flightcrew interface
(b)	--	23.2600,	Flightcrew interface,

		23.2605	Installation and operation
23.672	Stability augmentation and automatic and power-operated systems		
(a)	--	23.2605(c)	Installation and operation
(b)	--	23.2300(a)(2)	Flight control systems
(c)	--	23.2510, 23.2300(a)(2)	Installation and operation, Flight control systems
23.673	Primary flight controls	--	Definition
23.675	Stops	23.2300(a)(2)	Flight control systems
23.677	Trim systems		
(a)	--	23.2300(b) & 23.2600	Flight control systems & Flightcrew interface
(b)	--	23.2300(a)(2)	Flight control systems
(c)	--	23.2245	Aeroelasticity
(d)	--	23.2515	Equipment, systems and installations
23.679	Control system locks		
(a), (b)	--	23.2605(c)	Installation and operation

(c)	--	23.2300(a)(2)	Flight control systems
23.681	Limit load static tests		
(a)	--	23.2225(b), 23.2235	Component loading conditions, Structural strength
(b)	--	23.2265	Special factors of safety
23.683	Operation tests	23.2250(d), 23.2300(a)(2)	Design and construction principles, Flight control systems
23.685	Control system details	23.2300(a)(2)	Flight control systems
23.687	Spring devices	23.2245, 23.2250 & 23.2300(a)(2)	Aeroelasticity. Structural design & Flight control systems
23.689	Cable systems	23.2250(c)	Design and construction principles
(a)(3)	--	23.2255(c)	Protection of structure
23.691	Artificial stall barrier system		
(a), (b)	--	23.2250	Design and construction principles
(c)	--	23.2605(c)	Installation and operation
(d), (e), (f)	--	23.2300(a)(2)	Flight control systems

(g)	--	23.2510	Equipment, systems, and installations
23.693	Joints	23.2265	Special factors of safety
23.697	Wing flap controls	23.2300(a)	Flight control systems
23.699	Wing flap position indicator	23.2600(b)	Flightcrew interface
23.701	Flap interconnection	23.2300(a)(2), 23.2510	Flight control systems & Equipment, systems, and installations
23.703	Takeoff warning system	23.2605(c)	Installation and operation
23.721	General	23.2305(a)(2), 23.2430(a)(6)	Landing gear systems, Fuel systems
23.723	Shock absorption tests	23.2235, 23.2250(c)	Structural strength, Design and construction principles
23.725	Limit drop tests	23.2235	Structural strength
23.726	Ground load dynamic tests	23.2235	Structural strength
23.727	Reserve energy absorption drop tests	23.2235, 23.2250(c)	Structural strength, Design and construction principles
23.729	Landing gear extension and retraction system		
(a)	--	23.2235	Structural strength
(b)	--	23.2305(c)(1)	Landing gear systems

(c)	--	23.2305(c)(2)	Landing gear systems
(d)	--	23.2505	Function and installation
(e)	--	23.2600	Flightcrew interface
(f)	--	23.2605(c)	Installation and operation
(g)	--	23.2305(a)(2)	--
23.731	Wheels	23.2220, 23.2250(c)	Ground and water load conditions, Design and construction principles
23.733	Tires		
(a)	--	23.2250(c)	Design and construction principles
(b)	--	23.2610	Instrument markings, control markings, and placards
(c)	--	23.2250(c)	Design and construction principles
23.735	Brakes		
(a), (b), (c), (e)	--	23.2305(b)	Landing gear systems
(b)	--	23.2250(c)	Design and construction principles
(d)	--	23.2510	Equipment, systems, and

			installations
23.737	Skis	23.2235	Structural strength
23.745	Nose/Tail wheel steering	23.2305 & 23.2600(a)	Landing gear systems & Flightcrew interface
23.751	Main float buoyancy	23.2310	Buoyancy for seaplanes and amphibians
23.753	Main float design	23.2220	Ground and water load conditions
23.755	Hulls	23.2310	Buoyancy for seaplanes and amphibians
23.757	Auxiliary floats	23.2310	Buoyancy for seaplanes and amphibians
23.771	Pilot compartment		
(a)	--	23.2600	Flightcrew interface
(b)	--	23.2320(a)(1)	Occupant physical environment
(c)	--	23.2320(a)(2)	Occupant physical environment
23.773	Pilot compartment view	23.2600(a)	Flightcrew interface
23.775	Windshields and windows		
(a),	--	23.2320(a)(3)	Occupant physical environment
(b), (c), (d)	--	23.2250	Design and construction

			principles
(e)	--	23.2600(a)	Flightcrew interface.
(f)	--	23.2540	Flight in icing conditions
(g)	--	23.2510	Equipment, systems and installations
(h)(1)	--	23.2320(b)	Occupant physical environment
(h)(2)	--	23.2600(c)	Flightcrew interface.
23.777	Cockpit controls	23.2600, 23.2610	Flightcrew interface, Instrument markings, control markings and placards
23.779	Motion and effect of cockpit controls	23.2600	Flightcrew interface
23.781	Cockpit control knob shape	23.2600	Flightcrew interface
23.783	Doors		
(a), (b), (c)(2), (c)(3), (c)(4), (c)(5), (c)(6), (d), (f), (g)	--	23.2315(a)	Means of egress and emergency exits

(b)	--	23.2250	Design and construction principles.
(c)(1), (e)	--	23.2250(e)	Design and construction principles
(e)(3)	--	23.2605(c)	Installation and operation
23.785	Seats, berths, litters, safety belts, and shoulder harnesses	23.2265 and 23.2270	Special factors of safety, Emergency conditions
23.787	Baggage and cargo compartments	23.2270(e) & 23.2315(a)	Emergency conditions & Means of egress and emergency exits
23.791	Passenger information signs	23.2320(a)(1)	Occupant physical environment
23.803	Emergency evacuation	23.2315(a)	Means of egress and emergency exits
23.805	Flightcrew emergency exits	23.2315(a)	Means of egress and emergency exits
23.807	Emergency exits		
(a), (b)(1), (b)(2), (b)(3), (b)(4), (d)(1),	--	23.2315(a)	Means of egress and emergency exits

(d)(3), (d)(4), (c), (e)			
(b)(5), (b)(6)	--	23.2315(b)	Means of egress and emergency exits
(d)(2)	--	23.2250(e)	Design and construction principles
23.811	Emergency exit marking	23.2315(a)	Means of egress and emergency exits
23.812	Emergency lighting	23.2315(a)	Means of egress and emergency exits
23.813	Emergency exit access	23.2315(a)	Means of egress and emergency exits
23.815	Width of aisle	23.2315(a)	Means of egress and emergency exits
23.831	Ventilation		
(a), (b), (c)	--	23.2320(c)	Occupant physical environment
(c)	--	23.2600(a)	Flightcrew interface
(d)	--	23.2510	Equipment, systems and installations
23.841	Pressurized cabins		

(a), (b)(4), (d)(1)	--	23.2320(c)	Occupant physical environment
(b)(1), (b)(2), (b)(8), (c), (d)(2), (d)(3)	--	23.2320(d)	Occupant physical environment
(b)(3),	--	23.2320(c), (d)	Occupant physical environment
(b)(5), (b)(6), (d)(4), (d)(5)	--	23.2605	Installation and operation
(b)(7)	--	23.2610	Instrument markings, control markings, and placards
(b)(8), (c), (d)(2), (d)(3)	--	23.2510	Equipment, systems and installations
(d)(5)	--	23.2505	Function and installation
23.843	Pressurization tests		
(a)	--	23.2225(c), 23.2236	Component loading conditions, Structural strength

(b)	--	23.2320 & 23.2505	Occupant physical environment & Function and installation
23.851	Fire extinguishers		
(a) and (b)	--	23.2325	Fire protection
(c)	--	Means Of Compliance	--
23.853	Passenger and crew compartment interiors		
(a), (d)(3)(i), (d)(3)(iii), (d)(3)(iv), (e), (f)	--	23.2325	Fire protection
(b)(c) and (d)(1)(2)	--	Means Of Compliance	--
23.855	Cargo and baggage compartment fire protection	23.2325	Fire protection
23.856	Thermal/acoustic insulation materials	23.2325	Fire protection
23.859	Combustion heater fire protection		
(a)	--	23.2325(h)	Fire protection

(b) thru (i)	--	23.2250(c)	Design and construction principles
23.863	Flammable fluid fire protection	23.2325(g)	Fire protection
23.865	Fire protection of flight controls, engine mounts, and other flight structure	23.23330	Fire protection in designated fire zones and adjacent areas
23.867	Electrical bonding and protection against lightning and static electricity	23.2335	Lightning protection
23.871	Leveling means	Means Of Compliance	--
Subpart E – Powerplant			
23.901(a) and (f)	Installation	23.2400(a)	Powerplant Installation
(b), (c), and (d)(2)	--	23.2400(c)	Powerplant Installation
(d)(1) and (e)	--	23.2400(e)	Powerplant Installation
23.903(a)(1)	Engines	23.2400(b)	Powerplant Installation
(a)(2)	--	23.2400(c)	Powerplant Installation
(b)	--	23.2400(c),	Powerplant installation,

		23.2410(a), (b) and 23.2425(a)	Powerplant installation hazard assessment; Powerplant operational characteristics
(c)	--	23.2410(a) and (c)	Powerplant installation hazard assessment
(d) thru (g)	--	23.00(d), 23.2410(a) and 23.2425(b)	Powerplant installation, Powerplant installation hazards assessment, Powerplant operational characteristics
23.904	Automatic power reserve system	23.2405	Automatic power or thrust control systems
23.905(a)	Propellers	23.2400(b)	Powerplant installation
(b)	--	23.2400(e)	Powerplant installation
(c)	--	23.2425(b)	Powerplant operational characteristics
(d), (e) and (f)	--	23.2400(c)	Powerplant installation
(g)	--	23.2400(c), (e)	Powerplant installation
(h)	--	23.2400(c)(3)	Powerplant installation
23.907	Propeller vibration and fatigue	23.2400(c)(4), (e)	Powerplant installation

23.909(a)	Turbocharger systems	23.2400(e) and 23.2425(a)	Powerplant installation, Powerplant operational characteristics
(b)	--	23.2410(a)	Powerplant installation hazards assessment
(c)	--	23.2400(c)(3) and 23.2410(a)	Powerplant installation, Powerplant installation hazards assessment
(d)	--	23.2400(c)	Powerplant installation
(e)	--	23.2400(e), 23.2420 and 23.2620	Powerplant installation Powerplant operational characteristics, Airplane flight manual
23.925	Propeller clearance	23.2400(c)(2)	Powerplant installation
23.929	Engine installation ice protection	23.2415(b)	Powerplant ice protection
23.933	Reversing systems	23.2420	Reversing systems
23.934	Turbojet and turbofan engine thrust reverser systems tests	23.2400(c), (e) and 23.2425(a)	Powerplant installation, Powerplant operational characteristics
23.937	Turbopropeller-drag limiting systems	23.10(a)	Powerplant installation hazard assessment

23.939	Powerplant operating characteristics	23.2400(c)(4), (e) and 23.2425(a)	Powerplant installation, Powerplant operational characteristics
23.943	Negative acceleration	23.2400(c)(1), (c)(3) and 23.2425(a)	Powerplant installation, Powerplant operational characteristics
23.951 (a), (b) and (c)	Fuel System - General	23. 2400(c)(1), (3) and 23.2430(a)(3)	Powerplant installation, Fuel systems
(d)	--	--	Intent covered under Part 34
23.953	Fuel system independence	23.2410(a), (c), 23.2430(a)(1) and 23.2440(d)	Powerplant installation hazards assessment, Fuel systems, Powerplant fire protection
23.954	Fuel system lightning protection	23.2430(a)(2)	Fuel systems
23.955	Fuel flow	23.2400(c)(1), (3), 23.2410(a) and 23.2430(a)(3),	Powerplant installation, Powerplant installation hazard assessment, Fuel systems

		(4)	
23.957(a)	Flow between interconnected tanks	23.2430(a)(2), (b)(3)	Fuel systems
(b)	--	23.2400(c)(1), (3), 23.2430(b)(3)	Powerplant installation, Fuel systems--
23.959	Unusable fuel supply	23.2430(a)(4) and 23.2410(a)	Fuel systems and Powerplant installation hazard assessment
23.961	Fuel system hot weather operation	23.2430(a)(3)	Fuel systems
23.963(a)	Fuel tank: general	23.2430(a)(1)	Fuel systems
(b) and (c)	--	23.2400(c)	Powerplant installation
(d)	--	23.2430(b)(4)	Fuel systems
(e)	--	23.2430(a)(4)	Fuel systems
23.965	Fuel tank tests	23.2430(b)(1)	Fuel systems
23.967	Fuel tank installation		
(a)	--	23.2400(c) and 23.2430(a), (b)	Powerplant installation, Fuel systems

(b)	--	23.2400(d)	Fuel systems
(c) and (d)	--	23.2430(b)(2)	Fuel systems
(e)	--	23.2430(a)(6)	Fuel systems
23.969	Fuel tank expansion space	23.2430(b)(3)	Fuel systems
23.971	Fuel tank sump	23.2430(a)(7)	Fuel systems
23.973	Fuel tank filler connection	23.2430(c)	Fuel systems
23.975	Fuel tank vents and carburetor vapor vents	23.2400(c)(1), (3), 23.2415 and 23.2430(a)(3), (b)(3)	Powerplant installation, Powerplant ice protection, Fuel systems
23.977	Fuel tank outlet	23.2430(a)(7)	Fuel systems
23.979	Pressure fueling systems	23.2400(c) and 23.2430(c)	Powerplant installation, Fuel systems
23.991(a), (b) and (d)	Fuel pumps	23.2410(a) and 23.2430(a)(1), (3)	Powerplant installation hazard assessment, Fuel systems
(a), (b), (c)	--	23.2430(a)(1), (3) and	Fuel systems

		23.2410(a)	
(c)	--	23.2605	Installation and operation
23.993	Fuel system lines and fittings	23.2430(a)(6)	Fuel systems
23.994	Fuel system components	23.2430(a)(6)	Fuel systems
23.995	Fuel valves and controls	23.2440(d)	Powerplant fire protection
23.997(a)	Fuel strainer or filter	23.2400(c)(3)	Fuel systems
(b)	--	23.2430(a)(7)	Fuel systems
(c)	--	23.2400(c)(1)	Powerplant installation
(d)	--	23.2400(e) and 23.2430(a)(7)	Powerplant installation, Fuel systems
(e)	--	23.2430(a)(3)	Fuel systems
23.999	Fuel system drains	23.2400(c)(3), 23.2430(a)(5)	Powerplant installation, Fuel systems
23.1001(a) thru (f)	Fuel jettisoning system	23.2400(c)(1), (3) and 23.2430(b)(5)	Powerplant installation, Fuel systems
(g)	--	23.2610	Instrument markings, controls markings, and placards

(h)	--	23.2410(a)	Powerplant installation hazard assessment
23.1011	General	23.2400(c), (e) and 23.2410(a)	Powerplant installation and Powerplant installation hazard assessment
23.1013	Oil tanks	23.2400(c)	Powerplant installation
23.1015	Oil tank tests	23.2400(c)	Powerplant installation
23.1017	Oil lines and fittings	23.2400(c)	Powerplant installation
23.1019	Oil strainer or filter	23.2400(c), (e) and 23.2600(b)	Powerplant installation
23.1021	Oil system drains	23.2400(c)	Powerplant installation
23.1023	Oil radiators	23.2400(c)	Powerplant installation
23.1027	Propeller feathering system	23.2400(c) and 23.2410(a)	Powerplant installation and Hazard assessment
23.1041	Cooling – General	23.2400(c) and (e)	Powerplant installation
23.1043	Cooling tests	23.2400(c), (e)	Powerplant installation
23.1045	Cooling test procedures for turbine engine powered	23.2400(c), (e)	Powerplant installation

	airplanes		
23.1047	Cooling test procedures for reciprocating engine powered airplanes	23.2400(c), (e)	Powerplant installation
23.1061	Installation	23.2400(c)	Powerplant installation
23.1063	Coolant tank tests	23.2400(c)	Powerplant installation
23.1091	Air induction system	23.2435(a)	Powerplant induction and exhaust systems
23.1093	Induction system icing protection	23.2415(a)	Powerplant ice protection
23.1095	Carburetor deicing fluid flow rate	23.2415(a)	Powerplant ice protection
23.1097	Carburetor deicing fluid system capacity	23.2400(c) and 23.2415(a)	Powerplant installation and Powerplant ice protection
23.1099	Carburetor deicing fluid system detail design	23.2400(c) and 23.2415(a)	Powerplant installation and Powerplant ice protection
23.1101(a)	Induction air preheater design	23.2400(c), 23.2435(b)	Powerplant installation and Powerplant induction and exhaust systems

(b) and (c)	--	23.2400(c)	Powerplant installation
23.1103(a) thru (d)	Induction system ducts	23.2400(c) and 23.2435(a)	Powerplant installation and Powerplant induction and exhaust systems
(e) and (f)	--	23.2400(c) and 23.2440(c)	Powerplant installation and Powerplant fire protection
23.1105	Induction system screens	23.2400(c) and 23.2415(a)	Powerplant installation and Powerplant ice protection
23.1107	Induction system filters	23.2400(c)	Powerplant installation
23.1109	Turbocharger bleed air system	23.2400(c)(1), (3) and 23.2410(a)	Powerplant installation and Powerplant installation hazard assessment
23.1111(a) and (c)	Turbine engine bleed air system	23.2400(c)(3)	Powerplant installation
(b)	--	23.2400(c) and 23.2435(a)	Powerplant installation and Powerplant induction and exhaust systems
23.1121	Exhaust System - General	23.2400(c), (d) and 23.2435(b)	Powerplant installation and Powerplant induction and exhaust systems

23.1123	Exhaust system	23.2435(b)	Powerplant induction and exhaust systems
23.1125	Exhaust heat exchangers	23.2400(c) and 23.2435(b)	Powerplant installation and Powerplant induction and exhaust systems
23.1141(a)	Powerplant controls: general	23.2600	Flightcrew interface
(b), (c) and (d)	--	23.2400(c) and 23.2500	Powerplant installation and Airplane level systems requirements
(e)	--	23.2410(a)	Powerplant installation hazard assessment
(f)	--	23.2440(c)(2)	Powerplant fire protection
(g)	--	23.2600 and 23.2615	Flightcrew interface and Flight, Navigation and Powerplant Instruments
23.1142	Auxiliary power unit controls	23.2425(b), 23.2600, 23.2605 and 23.2615	Powerplant operational characteristics, Flightcrew interface, Installation and operation, and Flight, Navigation and Powerplant Instruments
23.1143(a)	Engine controls	23.2600	Flightcrew interface

thru (f)			
(g)	--	23.2410(a)	Powerplant installation hazard assessment
23.1145	Ignition switches	23.2425(a) and 23.2600	Powerplant operational characteristics and Flightcrew interface
23.1147	Mixture controls	23.2410(a) and 23.2600	Powerplant installation hazard assessment and Flightcrew interface
23.1149	Propeller speed and pitch controls	23.2600	Flightcrew interface
23.1153	Propeller feathering controls	23.2600	Flightcrew interface
23.1155	Turbine engine reverse thrust and propeller pitch settings below the flight regime	23.2600	Flightcrew interface
23.1157	Carburetor air temperature controls	23.2600	Flightcrew interface
23.1163	Powerplant accessories	23.2400(c), (e) and 23.2410(a)	Powerplant installation and Powerplant installation hazard assessment
23.1165	Engine ignition systems	23.2400(c),	Powerplant installation,

		23.2425(b) and 23.2605	Powerplant operational characteristics, and Installation and operation
23.1181	Designated fire zones: regions included	23.2440(a)	Powerplant fire protection
23.1182	Nacelle areas behind firewalls	23.2440(c)	Powerplant fire protection
23.1183	Lines, fittings, and components	23.2440(c)	Powerplant fire protection
23.1189	Shutoff means	23.2440(d)	Powerplant fire protection
23.1191	Firewalls	23.2440(a), (b) and (c)	Powerplant fire protection
23.1192	Engine accessory compartment diaphragm	23.2440(a) and (b)	Powerplant fire protection
23.1193	Cowling and nacelle	23.2400(c), 23.2440(a) and (b)	Powerplant installation, Powerplant fire protection
23.1195	Fire extinguishing systems	23.2440(f)	Powerplant fire protection
23.1197	Fire extinguishing agents	23.2400(d) and 23.2440(f)	Powerplant fire protection
23.1199	Extinguishing agent	23.2400(c)	Powerplant installation

	containers		
23.1201	Fire extinguishing system materials	23.2400(c), 23.2440(c) and 23.2500	Powerplant installation, Powerplant fire protection, and Airplane systems level requirements
23.1203(a)	Fire detector system	23.2440(e)	Powerplant fire protection
(a)	--	23.2440(e)	Powerplant fire protection
(b) and (c)	--	23.2400(c)	Powerplant installation
(d)	--	23.2600	Flight crew interface
(e)	--	23.2440(c) and 23.2500	Powerplant fire protection and Airplane systems level requirements
Subpart F – Equipment			
23.1301	Function and installation	--	--
(a)	--	23.2250(a), 23.2500(a),23.2505	Design and construction principles, Airplane level systems requirements, Function and installation
(b)	--	23.2605	Installation and operation
(c)	--	23.2505	Function and installation

23.1303	Flight and navigation instruments	23.2500, 23.2615, 23.2 and 23.2525	Airplane level systems requirements; Flight, navigation, and powerplant instruments; Function and installation; System power generation, storage, and distribution
23.1305	Powerplant instruments	23.2500, 23.2615and 23.2605	Airplane level systems requirements; Flight, navigation, and powerplant instruments; Installation and operation
23.1306	Electrical and electronic system lightning protection	23.2515	Electrical and electronic system lightning protection
23.1307	Miscellaneous equipment	23.2500 and 23.2610	Airplane level systems requirements; Flight, navigation, and powerplant instruments
23.1308	High-Intensity Radiated Fields (HIRF) protection	23.2520	High-intensity Radiated Fields (HIRF) protection
23.1309	Equipment, systems, and installations	23.2510	Equipment, systems, and installations
(a)(1)	--	23.2500(a)	Airplane level systems

			requirements
(a)(2)	--	23.2500(b)	Airplane level systems requirements
(b)	--	--	--Deleted--
(c)	--	23.2510	Equipment, systems, and installations
(d)	--	23.2605	Installation and operation
23.1310	Power source capacity and distribution	23.2525	System power generation, storage, and distribution
23.1311	Electronic display instrument systems	23.2500 and 23.2615	Airplane level systems requirements; Flight, navigation, and powerplant instruments
23.1321	Arrangement and visibility	23.2500 and 23.2610	Airplane level systems requirements; Flight, navigation, and powerplant instruments
23.1322	Warning, caution, and advisory lights	23.2605	Flight, navigation, and powerplant instruments
23.1323	Airspeed indicating system	23.2250, 23.2500, 23.2505,	Design and construction principles; Airplane level systems requirements;

		23.2615, and 23.2510	Function and installation; Flight, navigation, and powerplant instruments; and Equipment, systems, and installations
(d)	--	23.2250, 23.2540(a)	Design and construction principles, Flight in icing conditions
23.1325	Static pressure system	23.2500, 23.2615, and 23.2510	Airplane level systems requirements; Flight, navigation, and powerplant instruments; and Equipment, systems, and installations
(a), (b), (c), (d), (e)	--	23.2250	Design and construction principles
(b)(3) and (g)	--	23.2540(a)	Flight in icing conditions
23.1326	Pitot heat indication systems	23.2605	Installation and operation
23.1327	Magnetic direction indicator	23.2500, 23.2505 and 23.2615	Airplane level systems requirements; Function and installation; Flight, navigation, and

			powerplant instruments
23.1329	Automatic pilot system	23.2500, 23.2505, 232510, and 23.2605	Airplane level systems requirements; Function and installation; Equipment, systems, and installations; Installation and operation
(a)	--	23.2500 and 23.2510	Airplane level systems requirements; Equipment, systems, and installations
(b)	--	23.2300and 23.2600	Flight control systems; Flightcrew interface
(c)	--	23.2605	Installation and operation
(d)	--	23.2300 and 23.2600	Flight control systems; Flightcrew interface
(e), (f), (g)	--	23.2500 and 23.2510	Airplane level systems requirements; Equipment, systems, and installations
(h)	--	23.2605	Installation and operation
23.1331	Instruments using a power		

	source		
(a)	--	23.2605	Installation and operation
(b) and (c)	--	23.2510 and 23.2525	Equipment, systems, and installations; System power generation, storage, and distribution
23.1335	Flight director systems	23.2500, 23.2505, 23.2510, 23.2600, and 23.2605	Airplane level systems; Function and installation; Equipment systems and installations; Flightcrew interface; and Installation and operation
23.1337	Powerplant instruments installation		
(a)	--	23.2325	Fire protection
--	--	23.2430	Fuel systems
(b)	--	23.2605	Installation and operation
--	--	23.2610	Flight, navigation, and powerplant instruments
--	--	23.2510	Equipment, systems, and installations

(c)	--	23.2510	Equipment, systems, and installations
(d)	--	23.2605	Installation and operation
--	--	23.2615	Flight, navigation, and powerplant instruments
23.1351	Electrical Systems - General		
(a)	--	23.2525	System power generation, storage, and distribution
(b)	--	23.2500 23.2525	Airplane level systems requirements: System power generation, storage, and distribution
(c)	--	23.2525 23.2605	System power generation, storage, and distribution; Installation and operation
(d)	--	23.2605	Installation and operation
(e)	--	23.2500 23.2325	Airplane level systems requirements: Fire protection
(f),(g)	--	23.2500	Airplane level systems requirements

23.1353	Storage battery design and installation	23.2525	System power generation, storage, and distribution
23.1357	Circuit protective devices	23.2500, 23.2505, 23.2510,and 23.2525	Airplane level systems requirements; Function and installation; Equipment, systems, and installations; and System power generation, storage, and distribution
23.1359	Electrical system fire protection		
(a)	--	23.2330 23.2325	Fire protection in designated fire zones; Fire protection
(b)	--	23.2330	Fire protection in designated fire zones
(c)	--	23.2325	Fire protection
23.1361	Master switch arrangement	23.2500 and 23.2505	Airplane level systems requirements; Function and installation
23.1365	Electrical cables and equipment	23.2505	Function and installation
(b)	--	23.2330	Fire protection in designated fire zones

23.1367	Switches		
(a) and (b)	--	23.2505	Function and installation
(c) and (d)	--	23.2600	Flightcrew interface
23.1381	Instrument lights		
(a) and (b)	--	23.2600	Flightcrew interface
(c)	--	23.2500	Airplane level systems requirements
23.1383(a), (b), (c)	Taxi and landing lights	23.2530	External and cockpit lighting
(d)	Taxi and landing lights	23.2325	Fire protection
23.1385(a), (b), (c)	Position light system installation	23.2530	External and cockpit lighting
(d)	Position light system installation	23.2325	Fire protection
23.1387	Position light system dihedral angles	23.2530	External and cockpit lighting
23.1389	Position light distribution and intensities	23.2530	External and cockpit lighting
23.1391	Minimum intensities in the horizontal plane of position lights	23.2530	External and cockpit lighting

23.1393	Minimum intensities in any vertical plane of position lights	23.2530	External and cockpit lighting
23.1395	Maximum intensities in overlapping beams of position lights	23.2530	External and cockpit lighting
23.1397	Color specifications	23.2530	External and cockpit lighting
23.1399	Riding light	23.2530	External and cockpit lighting
23.1401	Anticollision light system		
(a), (a)(1)	--	23.2530	External and cockpit lighting
(a)(2)	--	Means Of Compliance	--
(b) thru (f)	--	23.2530	External and cockpit lighting
23.1411	Safety Equipment-General		
(a), (b)(1)	--	23.2535	Safety equipment
(b)(2)	--	23.2270	Emergency conditions
23.1415	Ditching equipment	23.2535	Safety equipment
(a), (c), (d)	--	23.2535	Safety equipment
(b)	--	Means Of Compliance	--

23.1416	Pneumatic de-icer boot system	23.2500	Airplane level systems requirements.
	--	23.2505	Function and installation.
(c)	--	23.2605(b)	Installation and operation
23.1419	Ice protection	23.2165(a)(1)	Performance and flight characteristics requirements for flight in icing conditions
	--	23.2540(a)	Flight in icing conditions
(d)	--	23.2600(a)	Flightcrew interface
23.1431	Electronic equipment	23.2510	Equipment, systems and installations
23.1435	Hydraulic systems		
(a)(1)	--	23.2235	Structural strength
(a)(2)	--	23.2600	Flightcrew interface
(a)(3)(c)	--	23.2250	Design and construction principles
(a)(4), (b)	--	23.2545	Pressurized system elements
(c)	--	23.2440(c)	Powerplant fire protection
23.1437	Accessories for multiengine airplanes	23.2410 & 23.2515	Powerplant installation hazard assessment and Equipment,

			systems and installations
23.1438	Pressurization and pneumatic systems	23.2545	Pressurized system elements
23.1441	Oxygen equipment and supply	23.2320(e)	Occupant physical environment
(c)	--	23.2605(b)	Installation and operation
23.1443	Minimum mass flow of supplemental oxygen	23.2320(e)	Occupant physical environment
23.1445	Oxygen distribution system	23.2320(e)	Occupant physical environment
(a), (b)	--	23.2250(c)	Design and construction principles
23.1447	Equipment standards for oxygen dispensing units	23.2320(e)	Occupant physical environment
23.1449	Means for determining use of oxygen	23.2320(e)	Occupant physical environment
23.1450	Chemical oxygen generators		
(a)(b)	--	23.2320(e)	Occupant physical environment
(c)	--	23.2610	Instrument markings, control markings, and placards.
23.1451	Fire protection for oxygen	23.2320(e)	Occupant physical environment

	equipment		
23.1453	Protection of oxygen equipment from rupture	23.2320(e) & 23.2545	Occupant physical environment & Pressurized system elements
23.1457	Cockpit voice recorders	23.1457	No Change
23.1459	Flight recorders	23.1459	No Change
23.1461	Equipment containing high-energy rotors	23.2550	Equipment containing high-energy rotors

Subpart G - Operating Limitations and Information

23.1501	General	23.2610	Instrument, control markings, and placards.
23.1505	Airspeed limitations	23.2610	Instrument markings, control markings, and placards.
23.1507	Operating maneuvering speed	23.2610	Instrument markings, control markings, and placards.
23.1511	Flap extended speed	23.2610	Instrument markings, control markings, and placards.
23.1513	Minimum control speed	23.2610	Instrument markings, control markings, and placards.
23.1519	Weight and center of gravity	23.2610	Instrument markings, control markings, and placards.
23.1521	Powerplant limitations	23.2610	Instrument markings, control markings, and placards.

23.1522	Auxiliary power unit limitations	23.2610	Instrument markings, control markings, and placards.
23.1523	Minimum flight crew	23.2610	Instrument markings, control markings, and placards.
23.1524	Maximum passenger seating configuration	23.2610	Instrument markings, control markings, and placards.
23.1525	Kinds of operation	23.2610	Airplane level system requirements.
--	--	23.2610	Instrument markings, control markings, and placards
23.1527	Maximum operating altitude	23.2610	Instrument markings, control markings, and placards.
23.1529	Instructions for continued airworthiness	23.1529	Instructions for continued airworthiness.
23.1541	Marking and Placards - General	23.2610	Instrument markings, control markings, and placards.
23.1543	Instrument marking: general	23.2610	Instrument markings, control markings, and placards.
23.1545	Airspeed indicator	23.2610	Instrument markings, control markings, and placards.
23.1547	Magnetic direction indicator	23.2610	Instrument markings, control markings, and placards.
23.1549	Powerplant and auxiliary	23.2610	Instrument markings, control

	power unit instruments		markings, and placards.
23.1551	Oil quantity indicator	23.2610	Instrument markings, control markings, and placards.
23.1553	Fuel quantity indicator	23.2610	Instrument markings, control markings, and placards.
23.1555	Control markings	23.2610	Instrument markings, control markings, and placards.
23.1557	Miscellaneous marking and placards	23.2610	Instrument markings, control markings, and placards.
23.1559	Operating limitations placard	23.2610	Instrument markings, control markings, and placards.
23.1561	Safety equipment	23.2610	Instrument markings, control markings, and placards.
23.1563	Airspeed placards	23.2610	Instrument markings, control markings, and placards.
23.1567	Flight maneuver placard	23.2610	Instrument markings, control markings, and placards.
23.1581	Airplane Flight Manual and Approved Manual Material - General	23.2620	Airplane flight manual.
23.1583	Operating limitations	23.2620	Airplane flight manual.
23.1585	Operating procedures	23.2620	Airplane flight manual.

23.1587	Performance information	23.2620	Airplane flight manual.
23.1589	Loading information	23.2620	Airplane flight manual.
Appendix A	Simplified Design Load Criteria	Means Of Compliance	--
Appendix B	[Reserved]	--	--
Appendix C	Basic Landing Conditions	Means Of Compliance	--
Appendix D	Wheel Spin-Up and Spring-Back Loads	Means Of Compliance	--
Appendix E	[Reserved]	--	--
Appendix F	Test Procedure	Means Of Compliance	--
Appendix G	Instructions for Continued Airworthiness	Appendix A	Instructions for Continued Airworthiness
Appendix H	Installation of An Automatic Power Reserve (APR) System	Means Of Compliance	--
Appendix I	Seaplane Loads	Means Of Compliance	--
Appendix J	HIRF Environments and Equipment HIRF Test Levels	Means Of Compliance	--

Appendix 2 to the Preamble—Abbreviations and Acronyms Frequently Used In This Document

AC	Advisory Circular
AD	Airworthiness Directive
AFM	Airplane Flight Manual
A-NPA	Advance Notice of Proposed Amendment
ARC	Aviation Rulemaking Committee
ASTM	ASTM International
FCAA	Foreign Civil Aviation Authority
CAR 3	Civil Aviation Regulations, Part 3
Cf	Confer (to identify a source or a usage citation for a word or phrase)
CPS	Certification Process Study
CS	Certification Specification
CS-VLA	Certification Specification-Very Light Aeroplanes
DER	Designated Engineering Representative
EASA	European Aviation Safety Agency
ELOS	Equivalent Level of Safety
FR	Federal Register
GA	General Aviation
HIRF	High-Intensity Radiated Field

IFR	Instrument Flight Rules
IMC	Instrument Meteorological Conditions
KCAS	Knots Calibrated Airspeeds
LOC	Loss of Control
NATCA	National Air Traffic Controllers Association
NPA	Notice of Proposed Amendment
NPRM	Notice of Proposed Rulemaking
NTSB	National Transportation Safety Board
OMB	Office of Management and Budget
SAE	SAE International
SARA	Small Airplane Revitalization Act of 2013
SLD	Supercooled Large Droplet
STC	Supplemental Type Certificate
TC	Type Certificate
TCDS	Type Certificate Data Sheet
V_A	Design Maneuvering Speed
V_C	Design Cruising Speed
V_D	Design Dive Speed
V_{MC}	Minimum Control Speed
V_{MO}/M_{MO}	Maximum Operating Limit Speed
V_{NO}	Maximum Structural Cruising Speed
VFR	Visual Flight Rules
V_{SO}	Stalling speed or the minimum steady flight speed in the landing

configuration

List of Subjects

14 CFR Part 21

Aircraft, Aviation safety, Recording and recordkeeping requirements.

14 CFR Part 23

Aircraft, Aviation Safety, Signs and symbols.

14 CFR Part 35

Aircraft, Aviation safety

14 CFR Part 43

Aircraft, Aviation safety, Reporting and recordkeeping requirements.

14 CFR Part 91

Air traffic control, Aircraft, Airmen, Airports, Aviation safety, Reporting and recordkeeping requirements.

14 CFR Part 121

Aircraft, Airmen, Aviation safety, Reporting and recordkeeping requirements

14 CFR Part 135

Aircraft, Airmen, Aviation safety, Reporting and recordkeeping requirements

The Amendment

In consideration of the foregoing, the Federal Aviation Administration amends chapter I of title 14, Code of Federal Regulations as follows:

PART 21—CERTIFICATION PROCEDURES FOR PRODUCTS AND ARTICLES

1. The authority citation for part 21 is revised to read as follows:

Authority: 42 U.S.C. 7572; 49 U.S.C. 106(f), 106(g), 40105, 40113, 44701-44702, 44704, 44707, 44709, 44711, 44713, 44715, 45303.

2. In § 21.9, revise paragraphs (a)(5), (a)(6), and add paragraph (a)(7) to read as follows:

§ 21.9 Replacement and modification articles.

(a) * * *

(5) Produced by an owner or operator for maintaining or altering that owner or operator's product;

(6) Fabricated by an appropriately rated certificate holder with a quality system, and consumed in the repair or alteration of a product or article in accordance with part 43 of this chapter; or

(7) Produced in any other manner approved by the FAA.

* * * * *

3. In § 21.17, revise paragraph (a) introductory text to read as follows:

§ 21.17 Designation of applicable regulations.

(a) Except as provided in §§ 25.2, 27.2, 29.2, and in parts 26, 34, and 36 of this subchapter, an applicant for a type certificate must show that the aircraft, aircraft engine, or propeller concerned meets—

* * * * *

4. In § 21.24, revise paragraph (a)(1)(i) to read as follows:

§ 21.24 Issuance of type certificate: primary category aircraft.

(a) * * *

(1) * * *

(i) Is unpowered; is an airplane powered by a single, naturally aspirated engine with a 61-knot or less V_{so} stall speed as determined under part 23 of this chapter; or is a rotorcraft with a 6-pound per square foot main rotor disc loading limitation, under sea level standard day conditions;

*** * * * ***

5. In § 21.35, revise paragraph (b)(2) to read as follows:

§ 21.35 Flight tests.

*** * * * ***

(b) * * *

(2) For aircraft to be certificated under this subchapter, except gliders and low-speed, certification level 1 or 2 airplanes, as defined in part 23 of this chapter, to determine whether there is reasonable assurance that the aircraft, its components, and its equipment are reliable and function properly.

*** * * * ***

6. In § 21.50, revise paragraph (b) to read as follows:

§ 21.50 Instructions for continued airworthiness and manufacturer's maintenance manuals having airworthiness limitations sections.

*** * * * ***

(b) The holder of a design approval, including either a type certificate or supplemental type certificate for an aircraft, aircraft engine, or propeller for which application was made after January 28, 1981, must furnish at least one set of complete Instructions for Continued Airworthiness to the owner of each type aircraft, aircraft engine, or propeller upon its delivery, or upon issuance of the first standard airworthiness certificate for the affected aircraft, whichever occurs later. The Instructions for Continued Airworthiness must be prepared in accordance with

§§ 23.1529, 25.1529, 25.1729, 27.1529, 29.1529, 31.82, 33.4, 35.4, or part 26 of this subchapter, or as specified in the applicable airworthiness criteria for special classes of aircraft defined in § 21.17(b), as applicable. If the holder of a design approval chooses to designate parts as commercial, it must include in the Instructions for Continued Airworthiness a list of commercial parts submitted in accordance with the provisions of paragraph (c) of this section. Thereafter, the holder of a design approval must make those instructions available to any other person required by this chapter to comply with any of the terms of those instructions. In addition, changes to the Instructions for Continued Airworthiness shall be made available to any person required by this chapter to comply with any of those instructions.

* * * * *

7. In § 21.101 revise paragraphs (b) introductory text, and (c) to read as follows:

§ 21.101 Designation of applicable regulations.

* * * * *

(b) Except as provided in paragraph (g) of this section, if paragraphs (b)(1), (2), or (3) of this section apply, an applicant may show that the change and areas affected by the change comply with an earlier amendment of a regulation required by paragraph (a) of this section, and of any other regulation the FAA finds is directly related. However, the earlier amended regulation may not precede either the corresponding regulation included by reference in the type certificate, or any regulation in §§ 25.2, 27.2, or 29.2 of this chapter that is related to the change. The applicant may show compliance with an earlier amendment of a regulation for any of the following:

* * * * *

(c) An applicant for a change to an aircraft (other than a rotorcraft) of 6,000 pounds or less maximum weight, to a non-turbine rotorcraft of 3,000 pounds or less maximum weight, to a level 1 low-speed airplane, or to a level 2 low-speed airplane may show that the change and areas affected by the change comply with the regulations included in the type certificate. However, if the FAA finds that the change is significant in an area, the FAA may designate compliance with an amendment to the regulation incorporated by reference in the type certificate that applies to the change and any regulation that the FAA finds is directly related, unless the FAA also finds that compliance with that amendment or regulation would not contribute materially to the level of safety of the product or would be impractical.

*** * * * ***

8. Revise part 23 to read as follows:

PART 23—AIRWORTHINESS STANDARDS: NORMAL CATEGORY AIRPLANES

Sec.

23.1457 Cockpit voice recorders.

23.1459 Flight data recorders.

23.1529 Instructions for continued airworthiness.

Subpart A—General

23.2000 Applicability and definitions.

23.2005 Certification of normal category airplanes.

23.2010 Accepted means of compliance.

Subpart B—Flight

PERFORMANCE

23.2100 Weight and center of gravity.

23.2105 Performance data.

23.2110 Stall speed.

23.2115 Takeoff performance.

23.2120 Climb requirements.

23.2125 Climb information.

23.2130 Landing.

FLIGHT CHARACTERISTICS

23.2135 Controllability.

23.2140 Trim.

23.2145 Stability.

23.2150 Stall characteristics, stall warning, and spins.

23.2155 Ground and water handling characteristics.

23.2160 Vibration, buffeting, and high-speed characteristics.

23.2165 Performance and flight characteristics requirements for flight in icing conditions.

Subpart C—Structures

23.2200 Structural design envelope.

23.2205 Interaction of systems and structures.

STRUCTURAL LOADS

23.2210 Structural design loads.

23.2215 Flight load conditions.

23.2220 Ground and water load conditions.

23.2225 Component loading conditions.

23.2230 Limit and ultimate loads.

STRUCTURAL PERFORMANCE

23.2235 Structural strength.

23.2240 Structural durability.

23.2245 Aeroelasticity.

DESIGN

23.2250 Design and construction principles.

23.2255 Protection of structure.

23.2260 Materials and processes.

23.2265 Special factors of safety.

STRUCTURAL OCCUPANT PROTECTION.

23.2270 Emergency conditions.

Subpart D—Design and Construction

23.2300 Flight control systems.

23.2305 Landing gear systems.

23.2310 Buoyancy for seaplanes and amphibians.

OCCUPANT SYSTEM DESIGN PROTECTION

23.2315 Means of egress and emergency exits.

23.2320 Occupant physical environment.

FIRE AND HIGH ENERGY PROTECTION

23.2325 Fire protection.

23.2330 Fire protection in designated fire zones and adjacent areas.

23.2335 Lightning protection.

Subpart E—Powerplant

23.2400 Powerplant installation.

23.2405 Automatic power or thrust control systems.

23.2410 Powerplant installation hazard assessment.

23.2415 Powerplant ice protection.

23.2420 Reversing systems.

23.2425 Powerplant operational characteristics.

23.2430 Fuel system.

23.2435 Powerplant induction and exhaust systems.

23.2440 Powerplant fire protection.

Subpart F—Equipment

23.2500 Airplane level systems requirements.

23.2505 Function and installation.

23.2510 Equipment, systems, and installations.

23.2515 Electrical and electronic system lightning protection.

23.2520 High-intensity Radiated Fields (HIRF) protection.

23.2525 System power generation, storage, and distribution.

23.2530 External and cockpit lighting.

23.2535 Safety equipment.

23.2540 Flight in icing conditions.

23.2545 Pressurized system elements.

23.2550 Equipment containing high-energy rotors.

Subpart G—Flightcrew Interface and Other Information

23.2600 Flightcrew interface.

23.2605 Installation and operation.

23.2610 Instrument markings, control markings, and placards.

23.2615 Flight, navigation, and powerplant instruments.

23.2620 Airplane flight manual.

APPENDIX A TO PART 23—INSTRUCTIONS FOR CONTINUED AIRWORTHINESS

Authority: 49 U.S.C. 106(f), 106(g), 40113, 44701-44702, 44704, Pub. L. 113-53, 127 Stat. 584 (49 U.S.C. 44704) note.

§ 23.1457 Cockpit voice recorders.

(a) Each cockpit voice recorder required by the operating rules of this chapter must be approved and must be installed so that it will record the following:

(1) Voice communications transmitted from or received in the airplane by radio.

(2) Voice communications of flightcrew members on the flight deck.

(3) Voice communications of flightcrew members on the flight deck, using the airplane's interphone system.

(4) Voice or audio signals identifying navigation or approach aids introduced into a headset or speaker.

(5) Voice communications of flightcrew members using the passenger loudspeaker system, if there is such a system and if the fourth channel is available in accordance with the requirements of paragraph (c)(4)(ii) of this section.

(6) If datalink communication equipment is installed, all datalink communications, using an approved data message set. Datalink messages must be recorded as the output signal from the communications unit that translates the signal into usable data.

(b) The recording requirements of paragraph (a)(2) of this section must be met by installing a cockpit-mounted area microphone, located in the best position for recording voice communications originating at the first and second pilot stations and voice communications of other crewmembers on the flight deck when directed to those stations. The microphone must be so located and, if necessary, the preamplifiers and filters of the recorder must be so adjusted or supplemented, so that the intelligibility of the recorded communications is as high as practicable when recorded under flight cockpit noise conditions and played back. Repeated aural or visual playback of the record may be used in evaluating intelligibility.

(c) Each cockpit voice recorder must be installed so that the part of the communication or audio signals specified in paragraph (a) of this section obtained from each of the following sources is recorded on a separate channel:

(1) For the first channel, from each boom, mask, or handheld microphone, headset, or speaker used at the first pilot station.

(2) For the second channel from each boom, mask, or handheld microphone, headset, or speaker used at the second pilot station.

(3) For the third channel—from the cockpit-mounted area microphone.

(4) For the fourth channel from:

(i) Each boom, mask, or handheld microphone, headset, or speaker used at the station for the third and fourth crewmembers.

(ii) If the stations specified in paragraph (c)(4)(i) of this section are not required or if the signal at such a station is picked up by another channel, each microphone on the flight deck that is used with the passenger loudspeaker system, if its signals are not picked up by another channel.

(5) And that as far as is practicable all sounds received by the microphone listed in paragraphs (c)(1), (2), and (4) of this section must be recorded without interruption irrespective of the position of the interphone-transmitter key switch. The design shall ensure that sidetone for the flightcrew is produced only when the interphone, public address system, or radio transmitters are in use.

(d) Each cockpit voice recorder must be installed so that:

(1)(i) It receives its electrical power from the bus that provides the maximum reliability for operation of the cockpit voice recorder without jeopardizing service to essential or emergency loads.

(ii) It remains powered for as long as possible without jeopardizing emergency operation of the airplane.

(2) There is an automatic means to simultaneously stop the recorder and prevent each erasure feature from functioning, within 10 minutes after crash impact.

(3) There is an aural or visual means for preflight checking of the recorder for proper operation.

(4) Any single electrical failure external to the recorder does not disable both the cockpit voice recorder and the flight data recorder.

(5) It has an independent power source—

(i) That provides 10 ±1 minutes of electrical power to operate both the cockpit voice recorder and cockpit-mounted area microphone;

(ii) That is located as close as practicable to the cockpit voice recorder; and

(iii) To which the cockpit voice recorder and cockpit-mounted area microphone are switched automatically in the event that all other power to the cockpit voice recorder is interrupted either by normal shutdown or by any other loss of power to the electrical power bus.

(6) It is in a separate container from the flight data recorder when both are required. If used to comply with only the cockpit voice recorder requirements, a combination unit may be installed.

(e) The recorder container must be located and mounted to minimize the probability of rupture of the container as a result of crash impact and consequent heat damage to the recorder from fire.

(1) Except as provided in paragraph (e)(2) of this section, the recorder container must be located as far aft as practicable, but need not be outside of the pressurized compartment, and may not be located where aft-mounted engines may crush the container during impact.

(2) If two separate combination digital flight data recorder and cockpit voice recorder units are installed instead of one cockpit voice recorder and one digital flight data recorder, the combination unit that is installed to comply with the cockpit voice recorder requirements may be located near the cockpit.

(f) If the cockpit voice recorder has a bulk erasure device, the installation must be designed to minimize the probability of inadvertent operation and actuation of the device during crash impact.

(g) Each recorder container must—

(1) Be either bright orange or bright yellow;

(2) Have reflective tape affixed to its external surface to facilitate its location under water; and

(3) Have an underwater locating device, when required by the operating rules of this chapter, on or adjacent to the container, which is secured in such manner that they are not likely to be separated during crash impact.

§ 23.1459 Flight data recorders.

(a) Each flight recorder required by the operating rules of this chapter must be installed so that—

(1) It is supplied with airspeed, altitude, and directional data obtained from sources that meet the aircraft level system requirements and the functionality specified in § 23.2500;

(2) The vertical acceleration sensor is rigidly attached, and located longitudinally either within the approved center of gravity limits of the airplane, or at a distance forward or aft of these limits that does not exceed 25 percent of the airplane's mean aerodynamic chord;

(3)(i) It receives its electrical power from the bus that provides the maximum reliability for operation of the flight data recorder without jeopardizing service to essential or emergency loads;

(ii) It remains powered for as long as possible without jeopardizing emergency operation of the airplane;

(4) There is an aural or visual means for preflight checking of the recorder for proper recording of data in the storage medium;

(5) Except for recorders powered solely by the engine-driven electrical generator system, there is an automatic means to simultaneously stop a recorder that has a data erasure feature and prevent each erasure feature from functioning, within 10 minutes after crash impact;

(6) Any single electrical failure external to the recorder does not disable both the cockpit voice recorder and the flight data recorder; and

(7) It is in a separate container from the cockpit voice recorder when both are required. If used to comply with only the flight data recorder requirements, a combination unit may be installed. If a combination unit is installed as a cockpit voice recorder to comply with § 23.1457(e)(2), a combination unit must be used to comply with this flight data recorder requirement.

(b) Each non-ejectable record container must be located and mounted so as to minimize the probability of container rupture resulting from crash impact and subsequent damage to the record from fire. In meeting this requirement, the record container must be located as far aft as practicable, but need not be aft of the pressurized compartment, and may not be where aft-mounted engines may crush the container upon impact.

(c) A correlation must be established between the flight recorder readings of airspeed, altitude, and heading and the corresponding readings (taking into account correction factors) of the first pilot's instruments. The correlation must cover the airspeed range over which the airplane is to be operated, the range of altitude to which the airplane is limited, and 360 degrees of heading. Correlation may be established on the ground as appropriate.

(d) Each recorder container must—

(1) Be either bright orange or bright yellow;

(2) Have reflective tape affixed to its external surface to facilitate its location under water; and

(3) Have an underwater locating device, when required by the operating rules of this chapter, on or adjacent to the container, which is secured in such a manner that they are not likely to be separated during crash impact.

(e) Any novel or unique design or operational characteristics of the aircraft shall be evaluated to determine if any dedicated parameters must be recorded on flight recorders in addition to or in place of existing requirements.

§ 23.1529 Instructions for continued airworthiness.

The applicant must prepare Instructions for Continued Airworthiness, in accordance with appendix A of this part, that are acceptable to the Administrator. The instructions may be incomplete at type certification if a program exists to ensure their completion prior to delivery of the first airplane or issuance of a standard certificate of airworthiness, whichever occurs later.

Subpart A—General

§ 23.2000 Applicability and definitions.

(a) This part prescribes airworthiness standards for the issuance of type certificates, and changes to those certificates, for airplanes in the normal category.

(b) For the purposes of this part, the following definition applies:

Continued safe flight and landing means an airplane is capable of continued controlled flight and landing, possibly using emergency procedures, without requiring exceptional pilot skill or strength. Upon landing, some airplane damage may occur as a result of a failure condition.

§ 23.2005 Certification of normal category airplanes.

(a) Certification in the normal category applies to airplanes with a passenger-seating configuration of 19 or less and a maximum certificated takeoff weight of 19,000 pounds or less.

(b) Airplane certification levels are:

(1) Level 1 – for airplanes with a maximum seating configuration of 0 to 1 passengers.

(2) Level 2 – for airplanes with a maximum seating configuration of 2 to 6 passengers.

(3) Level 3 – for airplanes with a maximum seating configuration of 7 to 9 passengers.

(4) Level 4 – for airplanes with a maximum seating configuration of 10 to 19 passengers.

(c) Airplane performance levels are:

(1) Low speed – for airplanes with a V_{NO} and $V_{MO} \leq 250$ Knots Calibrated Airspeed (KCAS) and a $M_{MO} \leq 0.6$.

(2) High speed – for airplanes with a V_{NO} or $V_{MO} > 250$ KCAS or a $M_{MO} > 0.6$.

(d) Airplanes not certified for aerobatics may be used to perform any maneuver incident to normal flying, including—

(1) Stalls (except whip stalls); and

(2) Lazy eights, chandelles, and steep turns, in which the angle of bank is not more than 60 degrees.

(e) Airplanes certified for aerobatics may be used to perform maneuvers without limitations, other than those limitations established under subpart G of this part.

§ 23.2010 Accepted means of compliance.

(a) An applicant must comply with this part using a means of compliance, which may include consensus standards, accepted by the Administrator.

(b) An applicant requesting acceptance of a means of compliance must provide the means of compliance to the FAA in a form and manner acceptable to the Administrator.

Subpart B—Flight

PERFORMANCE

§ 23.2100 Weight and center of gravity.

(a) The applicant must determine limits for weights and centers of gravity that provide for the safe operation of the airplane.

(b) The applicant must comply with each requirement of this subpart at critical combinations of weight and center of gravity within the airplane's range of loading conditions using tolerances acceptable to the Administrator.

(c) The condition of the airplane at the time of determining its empty weight and center of gravity must be well defined and easily repeatable.

§ 23.2105 Performance data.

(a) Unless otherwise prescribed, an airplane must meet the performance requirements of this subpart in—

(1) Still air and standard atmospheric conditions at sea level for all airplanes; and

(2) Ambient atmospheric conditions within the operating envelope for levels 1 and 2 high-speed and levels 3 and 4 airplanes.

(b) Unless otherwise prescribed, the applicant must develop the performance data required by this subpart for the following conditions:

(1) Airport altitudes from sea level to 10,000 feet (3,048 meters); and

(2) Temperatures above and below standard day temperature that are within the range of operating limitations, if those temperatures could have a negative effect on performance.

(c) The procedures used for determining takeoff and landing distances must be executable consistently by pilots of average skill in atmospheric conditions expected to be encountered in service.

(d) Performance data determined in accordance with paragraph (b) of this section must account for losses due to atmospheric conditions, cooling needs, and other demands on power sources.

§ 23.2110 Stall speed.

The applicant must determine the airplane stall speed or the minimum steady flight speed for each flight configuration used in normal operations, including takeoff, climb, cruise, descent, approach, and landing. The stall speed or minimum steady flight speed determination must account for the most adverse conditions for each flight configuration with power set at—

(a) Idle or zero thrust for propulsion systems that are used primarily for thrust; and

(b) A nominal thrust for propulsion systems that are used for thrust, flight control, and/or high-lift systems.

§ 23.2115 Takeoff performance.

(a) The applicant must determine airplane takeoff performance accounting for—

(1) Stall speed safety margins;

(2) Minimum control speeds; and

(3) Climb gradients.

(b) For single engine airplanes and levels 1, 2, and 3 low-speed multiengine airplanes, takeoff performance includes the determination of ground roll and initial climb distance to 50 feet (15 meters) above the takeoff surface.

(c) For levels 1, 2, and 3 high-speed multiengine airplanes, and level 4 multiengine airplanes, takeoff performance includes a determination the following distances after a sudden critical loss of thrust—

(1) An aborted takeoff at critical speed;

(2) Ground roll and initial climb to 35 feet (11 meters) above the takeoff surface; and

(3) Net takeoff flight path.

§ 23.2120 Climb requirements.

The design must comply with the following minimum climb performance out of ground effect:

(a) With all engines operating and in the initial climb configuration—

(1) For levels 1 and 2 low-speed airplanes, a climb gradient of 8.3 percent for landplanes and 6.7 percent for seaplanes and amphibians; and

(2) For levels 1 and 2 high-speed airplanes, all level 3 airplanes, and level 4 single-engines a climb gradient after takeoff of 4 percent.

(b) After a critical loss of thrust on multiengine airplanes—

(1) For levels 1 and 2 low-speed airplanes that do not meet single-engine crashworthiness requirements, a climb gradient of 1.5 percent at a pressure altitude of 5,000 feet (1,524 meters) in the cruise configuration(s);

(2) For levels 1 and 2 high-speed airplanes, and level 3 low-speed airplanes, a 1 percent climb gradient at 400 feet (122 meters) above the takeoff surface with the landing gear retracted and flaps in the takeoff configuration(s); and

(3) For level 3 high-speed airplanes and all level 4 airplanes, a 2 percent climb gradient at 400 feet (122 meters) above the takeoff surface with the landing gear retracted and flaps in the approach configuration(s).

(c) For a balked landing, a climb gradient of 3 percent without creating undue pilot workload with the landing gear extended and flaps in the landing configuration(s).

§ 23.2125 Climb information.

(a) The applicant must determine climb performance at each weight, altitude, and ambient temperature within the operating limitations—

(1) For all single-engine airplanes;

(2) For levels 1 and 2 high-speed multiengine airplanes and level 3 multiengine airplanes, following a critical loss of thrust on takeoff in the initial climb configuration; and

(3) For all multiengine airplanes, during the enroute phase of flight with all engines operating and after a critical loss of thrust in the cruise configuration.

(b) The applicant must determine the glide performance for single-engine airplanes after a complete loss of thrust.

§ 23.2130 Landing.

The applicant must determine the following, for standard temperatures at critical combinations of weight and altitude within the operational limits:

(a) The distance, starting from a height of 50 feet (15 meters) above the landing surface, required to land and come to a stop.

(b) The approach and landing speeds, configurations, and procedures, which allow a pilot of average skill to land within the published landing distance consistently and without causing

damage or injury, and which allow for a safe transition to the balked landing conditions of this part accounting for:

(1) Stall speed safety margin; and

(2) Minimum control speeds.

FLIGHT CHARACTERISTICS

§ 23.2135 Controllability.

(a) The airplane must be controllable and maneuverable, without requiring exceptional piloting skill, alertness, or strength, within the operating envelope—

(1) At all loading conditions for which certification is requested;

(2) During all phases of flight;

(3) With likely reversible flight control or propulsion system failure; and

(4) During configuration changes.

(b) The airplane must be able to complete a landing without causing substantial damage or serious injury using the steepest approved approach gradient procedures and providing a reasonable margin below V_{ref} or above approach angle of attack.

(c) V_{MC} is the calibrated airspeed at which, following the sudden critical loss of thrust, it is possible to maintain control of the airplane. For multiengine airplanes, the applicant must determine $V_{MC,}$ if applicable, for the most critical configurations used in takeoff and landing operations.

(d) If the applicant requests certification of an airplane for aerobatics, the applicant must demonstrate those aerobatic maneuvers for which certification is requested and determine entry speeds.

§ 23.2140 Trim.

(a) The airplane must maintain lateral and directional trim without further force upon, or movement of, the primary flight controls or corresponding trim controls by the pilot, or the flight control system, under the following conditions:

(1) For levels 1, 2, and 3 airplanes in cruise.

(2) For level 4 airplanes in normal operations.

(b) The airplane must maintain longitudinal trim without further force upon, or movement of, the primary flight controls or corresponding trim controls by the pilot, or the flight control system, under the following conditions:

(1) Climb.

(2) Level flight.

(3) Descent.

(4) Approach.

(c) Residual control forces must not fatigue or distract the pilot during normal operations of the airplane and likely abnormal or emergency operations, including a critical loss of thrust on multiengine airplanes.

§ 23.2145 Stability.

(a) Airplanes not certified for aerobatics must—

(1) Have static longitudinal, lateral, and directional stability in normal operations;

(2) Have dynamic short period and Dutch roll stability in normal operations; and

(3) Provide stable control force feedback throughout the operating envelope.

(b) No airplane may exhibit any divergent longitudinal stability characteristic so unstable as to increase the pilot's workload or otherwise endanger the airplane and its occupants.

§ 23.2150 Stall characteristics, stall warning, and spins.

(a) The airplane must have controllable stall characteristics in straight flight, turning flight, and accelerated turning flight with a clear and distinctive stall warning that provides sufficient margin to prevent inadvertent stalling.

(b) Single-engine airplanes, not certified for aerobatics, must not have a tendency to inadvertently depart controlled flight.

(c) Levels 1 and 2 multiengine airplanes, not certified for aerobatics, must not have a tendency to inadvertently depart controlled flight from thrust asymmetry after a critical loss of thrust.

(d) Airplanes certified for aerobatics that include spins must have controllable stall characteristics and the ability to recover within one and one-half additional turns after initiation of the first control action from any point in a spin, not exceeding six turns or any greater number of turns for which certification is requested, while remaining within the operating limitations of the airplane.

(e) Spin characteristics in airplanes certified for aerobatics that includes spins must recover without exceeding limitations and may not result in unrecoverable spins—

(1) With any typical use of the flight or engine power controls; or

(2) Due to pilot disorientation or incapacitation.

§ 23.2155 Ground and water handling characteristics.

For airplanes intended for operation on land or water, the airplane must have controllable longitudinal and directional handling characteristics during taxi, takeoff, and landing operations.

§ 23.2160 Vibration, buffeting, and high-speed characteristics.

(a) Vibration and buffeting, for operations up to V_D/M_D, must not interfere with the control of the airplane or cause excessive fatigue to the flightcrew. Stall warning buffet within these limits is allowable.

(b) For high-speed airplanes and all airplanes with a maximum operating altitude greater than 25,000 feet (7,620 meters) pressure altitude, there must be no perceptible buffeting in cruise configuration at 1g and at any speed up to V_{MO}/M_{MO}, except stall buffeting.

(c) For high-speed airplanes, the applicant must determine the positive maneuvering load factors at which the onset of perceptible buffet occurs in the cruise configuration within the operational envelope. Likely inadvertent excursions beyond this boundary must not result in structural damage.

(d) High-speed airplanes must have recovery characteristics that do not result in structural damage or loss of control, beginning at any likely speed up to V_{MO}/M_{MO}, following—

(1) An inadvertent speed increase; and

(2) A high-speed trim upset for airplanes where dynamic pressure can impair the longitudinal trim system operation.

§ 23.2165 Performance and flight characteristics requirements for flight in icing conditions.

(a) An applicant who requests certification for flight in icing conditions defined in part 1 of appendix C to part 25 of this chapter, or an applicant who requests certification for flight in these icing conditions and any additional atmospheric icing conditions, must show the following in the icing conditions for which certification is requested under normal operation of the ice protection system(s):

(1) Compliance with each requirement of this subpart, except those applicable to spins and any that must be demonstrated at speeds in excess of—

(i) 250 knots CAS;

(ii) V_{MO}/M_{MO} or V_{NE}; or

(iii) A speed at which the applicant demonstrates the airframe will be free of ice accretion.

(2) The means by which stall warning is provided to the pilot for flight in icing conditions and non-icing conditions is the same.

(b) If an applicant requests certification for flight in icing conditions, the applicant must provide a means to detect any icing conditions for which certification is not requested and show the airplane's ability to avoid or exit those conditions.

(c) The applicant must develop an operating limitation to prohibit intentional flight, including takeoff and landing, into icing conditions for which the airplane is not certified to operate.

Subpart C—Structures

§ 23.2200 Structural design envelope.

The applicant must determine the structural design envelope, which describes the range and limits of airplane design and operational parameters for which the applicant will show compliance with the requirements of this subpart. The applicant must account for all airplane design and operational parameters that affect structural loads, strength, durability, and aeroelasticity, including:

(a) Structural design airspeeds, landing descent speeds, and any other airspeed limitation at which the applicant must show compliance to the requirements of this subpart. The structural design airspeeds must—

(1) Be sufficiently greater than the stalling speed of the airplane to safeguard against loss of control in turbulent air; and

(2) Provide sufficient margin for the establishment of practical operational limiting airspeeds.

(b) Design maneuvering load factors not less than those, which service history shows, may occur within the structural design envelope.

(c) Inertial properties including weight, center of gravity, and mass moments of inertia, accounting for—

(1) Each critical weight from the airplane empty weight to the maximum weight; and

(2) The weight and distribution of occupants, payload, and fuel.

(d) Characteristics of airplane control systems, including range of motion and tolerances for control surfaces, high lift devices, or other moveable surfaces.

(e) Each critical altitude up to the maximum altitude.

§ 23.2205 Interaction of systems and structures.

For airplanes equipped with systems that modify structural performance, alleviate the impact of this subpart's requirements, or provide a means of compliance with this subpart, the applicant must account for the influence and failure of these systems when showing compliance with the requirements of this subpart.

STRUCTURAL LOADS

§ 23.2210 Structural design loads.

(a) The applicant must:

(1) Determine the applicable structural design loads resulting from likely externally or internally applied pressures, forces, or moments that may occur in flight, ground and water operations, ground and water handling, and while the airplane is parked or moored.

(2) Determine the loads required by paragraph (a)(1) of this section at all critical combinations of parameters, on and within the boundaries of the structural design envelope.

(b) The magnitude and distribution of the applicable structural design loads required by this section must be based on physical principles.

§ 23.2215 Flight load conditions.

The applicant must determine the structural design loads resulting from the following flight conditions:

(a) Atmospheric gusts where the magnitude and gradient of these gusts are based on measured gust statistics.

(b) Symmetric and asymmetric maneuvers.

(c) Asymmetric thrust resulting from the failure of a powerplant unit.

§ 23.2220 Ground and water load conditions.

The applicant must determine the structural design loads resulting from taxi, takeoff, landing, and handling conditions on the applicable surface in normal and adverse attitudes and configurations.

§ 23.2225 Component loading conditions.

The applicant must determine the structural design loads acting on:

(a) Each engine mount and its supporting structure such that both are designed to withstand loads resulting from—

(1) Powerplant operation combined with flight gust and maneuver loads; and

(2) For non-reciprocating powerplants, sudden powerplant stoppage.

(b) Each flight control and high-lift surface, their associated system and supporting structure resulting from—

(1) The inertia of each surface and mass balance attachment;

(2) Flight gusts and maneuvers;

(3) Pilot or automated system inputs;

(4) System induced conditions, including jamming and friction; and

(5) Taxi, takeoff, and landing operations on the applicable surface, including downwind taxi and gusts occurring on the applicable surface.

(c) A pressurized cabin resulting from the pressurization differential—

(1) From zero up to the maximum relief pressure combined with gust and maneuver loads;

(2) From zero up to the maximum relief pressure combined with ground and water loads if the airplane may land with the cabin pressurized; and

(3) At the maximum relief pressure multiplied by 1.33, omitting all other loads.

§ 23.2230 Limit and ultimate loads.

The applicant must determine—

(a) The limit loads, which are equal to the structural design loads unless otherwise specified elsewhere in this part; and

(b) The ultimate loads, which are equal to the limit loads multiplied by a 1.5 factor of safety unless otherwise specified elsewhere in this part.

STRUCTURAL PERFORMANCE

§ 23.2235 Structural strength.

The structure must support:

(a) Limit loads without—

(1) Interference with the safe operation of the airplane; and

(2) Detrimental permanent deformation.

(b) Ultimate loads.

§ 23.2240 Structural durability.

(a) The applicant must develop and implement inspections or other procedures to prevent structural failures due to foreseeable causes of strength degradation, which could result in serious or fatal injuries, or extended periods of operation with reduced safety margins. Each of the inspections or other procedures developed under this section must be included in the Airworthiness Limitations Section of the Instructions for Continued Airworthiness required by § 23.1529.

(b) For Level 4 airplanes, the procedures developed for compliance with paragraph (a) of this section must be capable of detecting structural damage before the damage could result in structural failure.

(c) For pressurized airplanes:

(1) The airplane must be capable of continued safe flight and landing following a sudden release of cabin pressure, including sudden releases caused by door and window failures.

(2) For airplanes with maximum operating altitude greater than 41,000 feet, the procedures developed for compliance with paragraph (a) of this section must be capable of detecting damage to the pressurized cabin structure before the damage could result in rapid decompression that would result in serious or fatal injuries.

(d) The airplane must be designed to minimize hazards to the airplane due to structural damage caused by high-energy fragments from an uncontained engine or rotating machinery failure.

§ 23.2245 Aeroelasticity.

(a) The airplane must be free from flutter, control reversal, and divergence—

(1) At all speeds within and sufficiently beyond the structural design envelope;

(2) For any configuration and condition of operation;

(3) Accounting for critical degrees of freedom; and

(4) Accounting for any critical failures or malfunctions.

(b) The applicant must establish tolerances for all quantities that affect flutter.

DESIGN

§ 23.2250 Design and construction principles.

(a) The applicant must design each part, article, and assembly for the expected operating conditions of the airplane.

(b) Design data must adequately define the part, article, or assembly configuration, its design features, and any materials and processes used.

(c) The applicant must determine the suitability of each design detail and part having an important bearing on safety in operations.

(d) The control system must be free from jamming, excessive friction, and excessive deflection when the airplane is subjected to expected limit airloads.

(e) Doors, canopies, and exits must be protected against inadvertent opening in flight, unless shown to create no hazard when opened in flight.

§ 23.2255 Protection of structure.

(a) The applicant must protect each part of the airplane, including small parts such as fasteners, against deterioration or loss of strength due to any cause likely to occur in the expected operational environment.

(b) Each part of the airplane must have adequate provisions for ventilation and drainage.

(c) For each part that requires maintenance, preventive maintenance, or servicing, the applicant must incorporate a means into the aircraft design to allow such actions to be accomplished.

§ 23.2260 Materials and processes.

(a) The applicant must determine the suitability and durability of materials used for parts, articles, and assemblies, accounting for the effects of likely environmental conditions expected in service, the failure of which could prevent continued safe flight and landing.

(b) The methods and processes of fabrication and assembly used must produce consistently sound structures. If a fabrication process requires close control to reach this objective, the applicant must perform the process under an approved process specification.

(c) Except as provided in paragraphs (f) and (g) of this section, the applicant must select design values that ensure material strength with probabilities that account for the criticality of the structural element. Design values must account for the probability of structural failure due to material variability.

(d) If material strength properties are required, a determination of those properties must be based on sufficient tests of material meeting specifications to establish design values on a statistical basis.

(e) If thermal effects are significant on a critical component or structure under normal operating conditions, the applicant must determine those effects on allowable stresses used for design.

(f) Design values, greater than the minimums specified by this section, may be used, where only guaranteed minimum values are normally allowed, if a specimen of each individual item is tested before use to determine that the actual strength properties of that particular item will equal or exceed those used in the design.

(g) An applicant may use other material design values if approved by the Administrator.

§ 23.2265 Special factors of safety.

(a) The applicant must determine a special factor of safety for each critical design value for each part, article, or assembly for which that critical design value is uncertain, and for each part, article, or assembly that is—

(1) Likely to deteriorate in service before normal replacement; or

(2) Subject to appreciable variability because of uncertainties in manufacturing processes or inspection methods.

(b) The applicant must determine a special factor of safety using quality controls and specifications that account for each—

(1) Type of application;

(2) Inspection method;

(3) Structural test requirement;

(4) Sampling percentage; and

(5) Process and material control.

(c) The applicant must multiply the highest pertinent special factor of safety in the design for each part of the structure by each limit and ultimate load, or ultimate load only, if there is no corresponding limit load, such as occurs with emergency condition loading.

STRUCTURAL OCCUPANT PROTECTION

§ 23.2270 Emergency conditions.

(a) The airplane, even when damaged in an emergency landing, must protect each occupant against injury that would preclude egress when—

(1) Properly using safety equipment and features provided for in the design;

(2) The occupant experiences ultimate static inertia loads likely to occur in an emergency landing; and

(3) Items of mass, including engines or auxiliary power units (APUs), within or aft of the cabin, that could injure an occupant, experience ultimate static inertia loads likely to occur in an emergency landing.

(b) The emergency landing conditions specified in paragraph (a)(1) and (a)(2) of this section, must—

(1) Include dynamic conditions that are likely to occur in an emergency landing; and

(2) Not generate loads experienced by the occupants, which exceed established human injury criteria for human tolerance due to restraint or contact with objects in the airplane.

(c) The airplane must provide protection for all occupants, accounting for likely flight, ground, and emergency landing conditions.

(d) Each occupant protection system must perform its intended function and not create a hazard that could cause a secondary injury to an occupant. The occupant protection system must not prevent occupant egress or interfere with the operation of the airplane when not in use.

(e) Each baggage and cargo compartment must—

(1) Be designed for its maximum weight of contents and for the critical load distributions at the maximum load factors corresponding to the flight and ground load conditions determined under this part;

(2) Have a means to prevent the contents of the compartment from becoming a hazard by impacting occupants or shifting; and

(3) Protect any controls, wiring, lines, equipment, or accessories whose damage or failure would affect safe operations.

Subpart D—Design and Construction

§ 23.2300 Flight control systems.

(a) The applicant must design airplane flight control systems to:

(1) Operate easily, smoothly, and positively enough to allow proper performance of their functions.

(2) Protect against likely hazards.

(b) The applicant must design trim systems, if installed, to:

(1) Protect against inadvertent, incorrect, or abrupt trim operation.

(2) Provide a means to indicate—

(i) The direction of trim control movement relative to airplane motion;

(ii) The trim position with respect to the trim range;

(iii) The neutral position for lateral and directional trim; and

(iv) The range for takeoff for all applicant requested center of gravity ranges and configurations.

§ 23.2305 Landing gear systems.

(a) The landing gear must be designed to—

(1) Provide stable support and control to the airplane during surface operation; and

(2) Account for likely system failures and likely operation environments (including anticipated limitation exceedances and emergency procedures).

(b) All airplanes must have a reliable means of stopping the airplane with sufficient kinetic energy absorption to account for landing. Airplanes that are required to demonstrate aborted takeoff capability must account for this additional kinetic energy.

(c) For airplanes that have a system that actuates the landing gear, there is—

(1) A positive means to keep the landing gear in the landing position; and

(2) An alternative means available to bring the landing gear in the landing position when a non-deployed system position would be a hazard.

§ 23.2310 Buoyancy for seaplanes and amphibians.

Airplanes intended for operations on water, must—

(a) Provide buoyancy of 80 percent in excess of the buoyancy required to support the maximum weight of the airplane in fresh water; and

(b) Have sufficient margin so the airplane will stay afloat at rest in calm water without capsizing in case of a likely float or hull flooding.

OCCUPANT SYSTEM DESIGN PROTECTION

§ 23.2315 Means of egress and emergency exits.

(a) With the cabin configured for takeoff or landing, the airplane is designed to:

(1) Facilitate rapid and safe evacuation of the airplane in conditions likely to occur following an emergency landing, excluding ditching for level 1, level 2 and single engine level 3 airplanes.

(2) Have means of egress (openings, exits or emergency exits), that can be readily located and opened from the inside and outside. The means of opening must be simple and obvious and marked inside and outside the airplane.

(3) Have easy access to emergency exits when present.

(b) Airplanes approved for aerobatics must have a means to egress the airplane in flight.

§ 23.2320 Occupant physical environment.

(a) The applicant must design the airplane to—

(1) Allow clear communication between the flightcrew and passengers;

(2) Protect the pilot and flight controls from propellers; and

(3) Protect the occupants from serious injury due to damage to windshields, windows, and canopies.

(b) For level 4 airplanes, each windshield and its supporting structure directly in front of the pilot must withstand, without penetration, the impact equivalent to a two-pound bird when the velocity of the airplane is equal to the airplane's maximum approach flap speed.

(c) The airplane must provide each occupant with air at a breathable pressure, free of hazardous concentrations of gases, vapors, and smoke during normal operations and likely failures.

(d) If a pressurization system is installed in the airplane, it must be designed to protect against—

(1) Decompression to an unsafe level; and

(2) Excessive differential pressure.

(e) If an oxygen system is installed in the airplane, it must—

(1) Effectively provide oxygen to each user to prevent the effects of hypoxia; and

(2) Be free from hazards in itself, in its method of operation, and its effect upon other components.

FIRE AND HIGH ENERGY PROTECTION

§ 23.2325 Fire protection.

(a) The following materials must be self-extinguishing—

(1) Insulation on electrical wire and electrical cable;

(2) For levels 1, 2, and 3 airplanes, materials in the baggage and cargo compartments inaccessible in flight; and

(3) For level 4 airplanes, materials in the cockpit, cabin, baggage, and cargo compartments.

(b) The following materials must be flame resistant—

(1) For levels 1, 2 and 3 airplanes, materials in each compartment accessible in flight; and

(2) Any equipment associated with any electrical cable installation and that would overheat in the event of circuit overload or fault.

(c) Thermal/acoustic materials in the fuselage, if installed, must not be a flame propagation hazard.

(d) Sources of heat within each baggage and cargo compartment that are capable of igniting adjacent objects must be shielded and insulated to prevent such ignition.

(e) For level 4 airplanes, each baggage and cargo compartment must—

(1) Be located where a fire would be visible to the pilots, or equipped with a fire detection system and warning system; and

(2) Be accessible for the manual extinguishing of a fire, have a built-in fire extinguishing system, or be constructed and sealed to contain any fire within the compartment.

(f) There must be a means to extinguish any fire in the cabin such that—

(1) The pilot, while seated, can easily access the fire extinguishing means; and

(2) For levels 3 and 4 airplanes, passengers have a fire extinguishing means available within the passenger compartment.

(g) Each area where flammable fluids or vapors might escape by leakage of a fluid system must—

(1) Be defined; and

(2) Have a means to minimize the probability of fluid and vapor ignition, and the resultant hazard, if ignition occurs.

(h) Combustion heater installations must be protected from uncontained fire.

§ 23.2330 Fire protection in designated fire zones and adjacent areas.

(a) Flight controls, engine mounts, and other flight structures within or adjacent to designated fire zones must be capable of withstanding the effects of a fire.

(b) Engines in a designated fire zone must remain attached to the airplane in the event of a fire.

(c) In designated fire zones, terminals, equipment, and electrical cables used during emergency procedures must be fire-resistant.

§ 23.2335 Lightning protection.

The airplane must be protected against catastrophic effects from lightning.

Subpart E—Powerplant

§ 23.2400 Powerplant installation.

(a) For the purpose of this subpart, the airplane powerplant installation must include each component necessary for propulsion, which affects propulsion safety, or provides auxiliary power to the airplane.

(b) Each airplane engine and propeller must be type certificated, except for engines and propellers installed on level 1 low-speed airplanes, which may be approved under the airplane type certificate in accordance with a standard accepted by the FAA that contains airworthiness criteria the Administrator has found appropriate and applicable to the specific design and intended use of the engine or propeller and provides a level of safety acceptable to the FAA.

(c) The applicant must construct and arrange each powerplant installation to account for—

(1) Likely operating conditions, including foreign object threats;

(2) Sufficient clearance of moving parts to other airplane parts and their surroundings;

(3) Likely hazards in operation including hazards to ground personnel; and

(4) Vibration and fatigue.

(d) Hazardous accumulations of fluids, vapors, or gases must be isolated from the airplane and personnel compartments, and be safely contained or discharged.

(e) Powerplant components must comply with their component limitations and installation instructions or be shown not to create a hazard.

§ 23.2405 Automatic power or thrust control systems.

(a) An automatic power or thrust control system intended for in-flight use must be designed so no unsafe condition will result during normal operation of the system.

(b) Any single failure or likely combination of failures of an automatic power or thrust control system must not prevent continued safe flight and landing of the airplane.

(c) Inadvertent operation of an automatic power or thrust control system by the flightcrew must be prevented, or if not prevented, must not result in an unsafe condition.

(d) Unless the failure of an automatic power or thrust control system is extremely remote, the system must—

(1) Provide a means for the flightcrew to verify the system is in an operating condition;

(2) Provide a means for the flightcrew to override the automatic function; and

(3) Prevent inadvertent deactivation of the system.

§ 23.2410 Powerplant installation hazard assessment.

The applicant must assess each powerplant separately and in relation to other airplane systems and installations to show that any hazard resulting from the likely failure of any powerplant system, component, or accessory will not—

(a) Prevent continued safe flight and landing or, if continued safe flight and landing cannot be ensured, the hazard has been minimized;

(b) Cause serious injury that may be avoided; and

(c) Require immediate action by any crewmember for continued operation of any remaining powerplant system.

§ 23.2415 Powerplant ice protection.

(a) The airplane design, including the induction and inlet system, must prevent foreseeable accumulation of ice or snow that adversely affects powerplant operation.

(b) The powerplant installation design must prevent any accumulation of ice or snow that adversely affects powerplant operation, in those icing conditions for which certification is requested.

§ 23.2420 Reversing systems.

Each reversing system must be designed so that—

(a) No unsafe condition will result during normal operation of the system; and

(b) The airplane is capable of continued safe flight and landing after any single failure, likely combination of failures, or malfunction of the reversing system.

§ 23.2425 Powerplant operational characteristics.

(a) The installed powerplant must operate without any hazardous characteristics during normal and emergency operation within the range of operating limitations for the airplane and the engine.

(b) The pilot must have the capability to stop the powerplant in flight and restart the powerplant within an established operational envelope.

§ 23.2430 Fuel systems.

(a) Each fuel system must—

(1) Be designed and arranged to provide independence between multiple fuel storage and supply systems so that failure of any one component in one system will not result in loss of fuel storage or supply of another system;

(2) Be designed and arranged to prevent ignition of the fuel within the system by direct lightning strikes or swept lightning strokes to areas where such occurrences are highly probable, or by corona or streamering at fuel vent outlets;

(3) Provide the fuel necessary to ensure each powerplant and auxiliary power unit functions properly in all likely operating conditions;

(4) Provide the flightcrew with a means to determine the total useable fuel available and provide uninterrupted supply of that fuel when the system is correctly operated, accounting for likely fuel fluctuations;

(5) Provide a means to safely remove or isolate the fuel stored in the system from the airplane;

(6) Be designed to retain fuel under all likely operating conditions and minimize hazards to the occupants during any survivable emergency landing. For level 4 airplanes, failure due to overload of the landing system must be taken into account; and

(7) Prevent hazardous contamination of the fuel supplied to each powerplant and auxiliary power unit.

(b) Each fuel storage system must—

(1) Withstand the loads under likely operating conditions without failure;

(2) Be isolated from personnel compartments and protected from hazards due to unintended temperature influences;

(3) Be designed to prevent significant loss of stored fuel from any vent system due to fuel transfer between fuel storage or supply systems, or under likely operating conditions;

(4) Provide fuel for at least one-half hour of operation at maximum continuous power or thrust; and

(5) Be capable of jettisoning fuel safely if required for landing.

(c) Each fuel storage refilling or recharging system must be designed to—

(1) Prevent improper refilling or recharging;

(2) Prevent contamination of the fuel stored during likely operating conditions; and

(3) Prevent the occurrence of any hazard to the airplane or to persons during refilling or recharging.

§ 23.2435 Powerplant induction and exhaust systems.

(a) The air induction system for each powerplant or auxiliary power unit and their accessories must—

(1) Supply the air required by that powerplant or auxiliary power unit and its accessories under likely operating conditions;

(2) Be designed to prevent likely hazards in the event of fire or backfire;

(3) Minimize the ingestion of foreign matter; and

(4) Provide an alternate intake if blockage of the primary intake is likely.

(b) The exhaust system, including exhaust heat exchangers for each powerplant or auxiliary power unit, must—

(1) Provide a means to safely discharge potential harmful material; and

(2) Be designed to prevent likely hazards from heat, corrosion, or blockage.

§ 23.2440 Powerplant fire protection.

(a) A powerplant, auxiliary power unit, or combustion heater that includes a flammable fluid and an ignition source for that fluid must be installed in a designated fire zone.

(b) Each designated fire zone must provide a means to isolate and mitigate hazards to the airplane in the event of fire or overheat within the zone.

(c) Each component, line, fitting, and control subject to fire conditions must—

(1) Be designed and located to prevent hazards resulting from a fire, including any located adjacent to a designated fire zone that may be affected by fire within that zone;

(2) Be fire resistant if carrying flammable fluids, gas, or air or required to operate in event of a fire; and

(3) Be fireproof or enclosed by a fire proof shield if storing concentrated flammable fluids.

(d) The applicant must provide a means to prevent hazardous quantities of flammable fluids from flowing into, within or through each designated fire zone. This means must—

(1) Not restrict flow or limit operation of any remaining powerplant or auxiliary power unit, or equipment necessary for safety;

(2) Prevent inadvertent operation; and

(3) Be located outside the fire zone unless an equal degree of safety is provided with a means inside the fire zone.

(e) A means to ensure the prompt detection of fire must be provided for each designated fire zone—

(1) On a multiengine airplane where detection will mitigate likely hazards to the airplane; or

(2) That contains a fire extinguisher.

(f) A means to extinguish fire within a fire zone, except a combustion heater fire zone, must be provided for—

(1) Any fire zone located outside the pilot’s view;

(2) Any fire zone embedded within the fuselage, which must also include a redundant means to extinguish fire; and

(3) Any fire zone on a level 4 airplane.

Subpart F—Equipment

§ 23.2500 Airplane level systems requirements.

This section applies generally to installed equipment and systems unless a section of this part imposes requirements for a specific piece of equipment, system, or systems.

(a) The equipment and systems required for an airplane to operate safely in the kinds of operations for which certification is requested (Day VFR, Night VFR, IFR) must be designed and installed to—

(1) Meet the level of safety applicable to the certification and performance level of the airplane; and

(2) Perform their intended function throughout the operating and environmental limits for which the airplane is certificated.

(b) The systems and equipment not covered by paragraph (a), considered separately and in relation to other systems, must be designed and installed so their operation does not have an adverse effect on the airplane or its occupants.

§ 23.2505 Function and installation.

When installed, each item of equipment must function as intended.

§ 23.2510 Equipment, systems, and installations.

For any airplane system or equipment whose failure or abnormal operation has not been specifically addressed by another requirement in this part, the applicant must design and install

each system and equipment, such that there is a logical and acceptable inverse relationship between the average probability and the severity of failure conditions to the extent that:

(a) Each catastrophic failure condition is extremely improbable;

(b) Each hazardous failure condition is extremely remote; and

(c) Each major failure condition is remote.

§ 23.2515 Electrical and electronic system lightning protection.

An airplane approved for IFR operations must meet the following requirements, unless an applicant shows that exposure to lightning is unlikely:

(a) Each electrical or electronic system that performs a function, the failure of which would prevent the continued safe flight and landing of the airplane, must be designed and installed such that—

(1) The function at the airplane level is not adversely affected during and after the time the airplane is exposed to lightning; and

(2) The system recovers normal operation of that function in a timely manner after the airplane is exposed to lightning unless the system's recovery conflicts with other operational or functional requirements of the system.

(b) Each electrical and electronic system that performs a function, the failure of which would significantly reduce the capability of the airplane or the ability of the flightcrew to respond to an adverse operating condition, must be designed and installed such that the system recovers normal operation of that function in a timely manner after the airplane is exposed to lightning.

§ 23.2520 High-intensity Radiated Fields (HIRF) protection.

(a) Each electrical and electronic systems that perform a function, the failure of which would prevent the continued safe flight and landing of the airplane, must be designed and installed such that—

(1) The function at the airplane level is not adversely affected during and after the time the airplane is exposed to the HIRF environment; and

(2) The system recovers normal operation of that function in a timely manner after the airplane is exposed to the HIRF environment, unless the system's recovery conflicts with other operational or functional requirements of the system.

(b) For airplanes approved for IFR operations, each electrical and electronic system that performs a function, the failure of which would significantly reduce the capability of the airplane or the ability of the flightcrew to respond to an adverse operating condition, must be designed and installed such that the system recovers normal operation of that function in a timely manner after the airplane is exposed to the HIRF environment.

§ 23.2525 System power generation, storage, and distribution.

The power generation, storage, and distribution for any system must be designed and installed to—

(a) Supply the power required for operation of connected loads during all intended operating conditions;

(b) Ensure no single failure or malfunction of any one power supply, distribution system, or other utilization system will prevent the system from supplying the essential loads required for continued safe flight and landing; and

(c) Have enough capacity, if the primary source fails, to supply essential loads, including non-continuous essential loads for the time needed to complete the function required for continued safe flight and landing.

§ 23.2530 External and cockpit lighting.

(a) The applicant must design and install all lights to minimize any adverse effects on the performance of flightcrew duties.

(b) Any position and anti-collision lights, if required by part 91 of this chapter, must have the intensities, flash rate, colors, fields of coverage, and other characteristics to provide sufficient time for another aircraft to avoid a collision.

(c) Any position lights, if required by part 91 of this chapter, must include a red light on the left side of the airplane, a green light on the right side of the airplane, spaced laterally as far apart as practicable, and a white light facing aft, located on an aft portion of the airplane or on the wing tips.

(d) Any taxi and landing lights must be designed and installed so they provide sufficient light for night operations.

(e) For seaplanes or amphibian airplanes, riding lights must provide a white light visible in clear atmospheric conditions.

§ 23.2535 Safety equipment.

Safety and survival equipment, required by the operating rules of this chapter, must be reliable, readily accessible, easily identifiable, and clearly marked to identify its method of operation.

§ 23.2540 Flight in icing conditions.

An applicant who requests certification for flight in icing conditions defined in part 1 of appendix C to part 25 of this chapter, or an applicant who requests certification for flight in these icing conditions and any additional atmospheric icing conditions, must show the following in the icing conditions for which certification is requested:

(a) The ice protection system provides for safe operation.

(b) The airplane design must provide protection from stalling when the autopilot is operating.

§ 23.2545 Pressurized systems elements.

Pressurized systems must withstand appropriate proof and burst pressures.

§ 23.2550 Equipment containing high-energy rotors.

Equipment containing high-energy rotors must be designed or installed to protect the occupants and airplane from uncontained fragments.

Subpart G—Flightcrew Interface and Other Information

§ 23.2600 Flightcrew interface.

(a) The pilot compartment, its equipment, and its arrangement to include pilot view, must allow each pilot to perform his or her duties, including taxi, takeoff, climb, cruise, descent, approach, landing, and perform any maneuvers within the operating envelope of the airplane, without excessive concentration, skill, alertness, or fatigue.

(b) The applicant must install flight, navigation, surveillance, and powerplant controls and displays so qualified flightcrew can monitor and perform defined tasks associated with the intended functions of systems and equipment. The system and equipment design must minimize flightcrew errors, which could result in additional hazards.

(c) For level 4 airplanes, the flightcrew interface design must allow for continued safe flight and landing after the loss of vision through any one of the windshield panels.

§ 23.2605 Installation and operation.

(a) Each item of installed equipment related to the flightcrew interface must be labelled, if applicable, as to it identification, function, or operating limitations, or any combination of these factors.

(b) There must be a discernible means of providing system operating parameters required to operate the airplane, including warnings, cautions, and normal indications to the responsible crewmember.

(c) Information concerning an unsafe system operating condition must be provided in a timely manner to the crewmember responsible for taking corrective action. The information must be clear enough to avoid likely crewmember errors.

§ 23.2610 Instrument markings, control markings, and placards.

(a) Each airplane must display in a conspicuous manner any placard and instrument marking necessary for operation.

(b) The design must clearly indicate the function of each cockpit control, other than primary flight controls.

(c) The applicant must include instrument marking and placard information in the Airplane Flight Manual.

§ 23.2615 Flight, navigation, and powerplant instruments.

(a) Installed systems must provide the flightcrew member who sets or monitors parameters for the flight, navigation, and powerplant, the information necessary to do so during each phase of flight. This information must—

(1) Be presented in a manner that the crewmember can monitor the parameter and determine trends, as needed, to operate the airplane; and

(2) Include limitations, unless the limitation cannot be exceeded in all intended operations.

(b) Indication systems that integrate the display of flight or powerplant parameters to operate the airplane or are required by the operating rules of this chapter must—

(1) Not inhibit the primary display of flight or powerplant parameters needed by any flightcrew member in any normal mode of operation; and

(2) In combination with other systems, be designed and installed so information essential for continued safe flight and landing will be available to the flightcrew in a timely manner after any single failure or probable combination of failures.

§ 23.2620 Airplane flight manual.

The applicant must provide an Airplane Flight Manual that must be delivered with each airplane.

(a) The Airplane Flight Manual must contain the following information—

(1) Airplane operating limitations;

(2) Airplane operating procedures;

(3) Performance information;

(4) Loading information; and

(5) Other information that is necessary for safe operation because of design, operating, or handling characteristics.

(b) The following sections of the Airplane Flight Manual must be approved by the FAA in a manner specified by the administrator—

(1) For low-speed, level 1 and 2 airplanes, those portions of the Airplane Flight Manual containing the information specified in paragraph (a)(1) of this section; and

(2) For high-speed level 1 and 2 airplanes and all level 3 and 4 airplanes, those portions of the Airplane Flight Manual containing the information specified in paragraphs (a)(1) thru (a)(4) of this section.

APPENDIX A TO PART 23—INSTRUCTIONS FOR CONTINUED AIRWORTHINESS

A23.1 General.

(a) This appendix specifies requirements for the preparation of Instructions for Continued Airworthiness as required by this part.

(b) The Instructions for Continued Airworthiness for each airplane must include the Instructions for Continued Airworthiness for each engine and propeller (hereinafter designated "products"), for each appliance required by this chapter, and any required information relating to the interface of those appliances and products with the airplane. If Instructions for Continued Airworthiness are not supplied by the manufacturer of an appliance or product installed in the airplane, the Instructions for Continued Airworthiness for the airplane must include the information essential to the continued airworthiness of the airplane.

(c) The applicant must submit to the FAA a program to show how changes to the Instructions for Continued Airworthiness made by the applicant or by the manufacturers of products and appliances installed in the airplane will be distributed.

A23.2 Format.

(a) The Instructions for Continued Airworthiness must be in the form of a manual or manuals as appropriate for the quantity of data to be provided.

(b) The format of the manual or manuals must provide for a practical arrangement.

A23.3 Content.

The contents of the manual or manuals must be prepared in the English language. The Instructions for Continued Airworthiness must contain the following manuals or sections and information:

(a) Airplane maintenance manual or section.

(1) Introduction information that includes an explanation of the airplane's features and data to the extent necessary for maintenance or preventive maintenance.

(2) A description of the airplane and its systems and installations including its engines, propellers, and appliances.

(3) Basic control and operation information describing how the airplane components and systems are controlled and how they operate, including any special procedures and limitations that apply.

(4) Servicing information that covers details regarding servicing points, capacities of tanks, reservoirs, types of fluids to be used, pressures applicable to the various systems, location of access panels for inspection and servicing, locations of lubrication points, lubricants to be used, equipment required for servicing, tow instructions and limitations, mooring, jacking, and leveling information.

(b) Maintenance Instructions.

(1) Scheduling information for each part of the airplane and its engines, auxiliary power units, propellers, accessories, instruments, and equipment that provides the recommended periods at which they should be cleaned, inspected, adjusted, tested, and lubricated, and the degree of inspection, the applicable wear tolerances, and work recommended at these periods. However, the applicant may refer to an accessory, instrument, or equipment manufacturer as the

source of this information if the applicant shows that the item has an exceptionally high degree of complexity requiring specialized maintenance techniques, test equipment, or expertise. The recommended overhaul periods and necessary cross reference to the Airworthiness Limitations section of the manual must also be included. In addition, the applicant must include an inspection program that includes the frequency and extent of the inspections necessary to provide for the continued airworthiness of the airplane.

(2) Troubleshooting information describing probable malfunctions, how to recognize those malfunctions, and the remedial action for those malfunctions.

(3) Information describing the order and method of removing and replacing products and parts with any necessary precautions to be taken.

(4) Other general procedural instructions including procedures for system testing during ground running, symmetry checks, weighing and determining the center of gravity, lifting and shoring, and storage limitations.

(c) Diagrams of structural access plates and information needed to gain access for inspections when access plates are not provided.

(d) Details for the application of special inspection techniques including radiographic and ultrasonic testing where such processes are specified by the applicant.

(e) Information needed to apply protective treatments to the structure after inspection.

(f) All data relative to structural fasteners such as identification, discard recommendations, and torque values.

(g) A list of special tools needed.

(h) In addition, for level 4 airplanes, the following information must be furnished—

(1) Electrical loads applicable to the various systems;

(2) Methods of balancing control surfaces;

(3) Identification of primary and secondary structures; and

(4) Special repair methods applicable to the airplane.

A23.4 Airworthiness limitations section.

The Instructions for Continued Airworthiness must contain a section titled Airworthiness Limitations that is segregated and clearly distinguishable from the rest of the document. This section must set forth each mandatory replacement time, structural inspection interval, and related structural inspection procedure required for type certification. If the Instructions for Continued Airworthiness consist of multiple documents, the section required by this paragraph must be included in the principal manual. This section must contain a legible statement in a prominent location that reads "The Airworthiness Limitations section is FAA approved and specifies maintenance required under §§ 43.16 and 91.403 of Title 14 of the Code of Federal Regulations unless an alternative program has been FAA approved."

PART 35—AIRWORTHINESS STANDARDS: PROPELLERS

9. The authority citation for part 35 is revised to read as follows:

Authority: 49 U.S.C. 106(f), 106(g), 40113, 44701-44702, 44704.

10. In § 35.1, revise paragraph (c) to read as follows:

§ 35.1 Applicability.

*** * * * ***

(c) An applicant is eligible for a propeller type certificate and changes to those certificates after demonstrating compliance with subparts A, B, and C of this part. However, the propeller may not be installed on an airplane unless the applicant has shown compliance with

either § 23.2400(c) or § 25.907 of this chapter, as applicable, or compliance is not required for installation on that airplane.

*** * * * ***

11. In § 35.37, revise paragraph (c)(1) to read as follows:

§ 35.37 Fatigue limits and evaluation.

*** * * * ***

(c) * * *

(1) The intended airplane by complying with § 23.2400(c) or § 25.907 of this chapter, as applicable; or

*** * * * ***

PART 43—MAINTENANCE, PREVENTIVE MAINTENANCE, REBUILDING, AND ALTERATION

12. The authority citation for part 43 is revised to read as follows:

Authority: 42 U.S.C. 7572; 49 U.S.C. 106(f), 106(g), 40105, 40113, 44701-44702, 44704, 44707, 44709, 44711, 44713, 44715, 45303.

13. In part 43, appendix E, revise the introductory text and paragraph (a)(2) to read as follows:

Appendix E to Part 43—Altimeter System Test and Inspection

Each person performing the altimeter system tests and inspections required by § 91.411 of this chapter must comply with the following:

(a) * * *

(2) Perform a proof test to demonstrate the integrity of the static pressure system in a manner acceptable to the Administrator. For airplanes certificated under part 25 of this chapter, determine that leakage is within the tolerances established by § 25.1325.

*** * * * ***

PART 91—GENERAL OPERATING AND FLIGHT RULES

14. The authority citation for part 91 continues to read as follows:

Authority: 49 U.S.C. 106(f), 106(g), 1155, 40101, 40103, 40105, 40113, 40120, 44101, 44111, 44701, 44704, 44709, 44711, 44712, 44715, 44716, 44717, 44722, 46306, 46315, 46316, 46504, 46506-46507, 47122, 47508, 47528-47531, 47534, articles 12 and 29 of the Convention on International Civil Aviation (61 Stat. 1180), (126 Stat. 11).

15. In § 91.205, revise paragraphs (b)(13) and (b)(14), and remove and reserve paragraph (b)(16) to read as follows:

§ 91.205 Powered civil aircraft with standard category U.S. airworthiness certificates: Instrument and equipment requirements.

*** * * * ***

(b) * * *

(13) An approved safety belt with an approved metal-to-metal latching device**,** or other approved restraint system for each occupant 2 years of age or older.

(14) For small civil airplanes manufactured after July 18, 1978, an approved shoulder harness or restraint system for each front seat. For small civil airplanes manufactured after December 12, 1986, an approved shoulder harness or restraint system for all seats. Shoulder harnesses installed at flightcrew stations must permit the flightcrew member, when seated and

with the safety belt and shoulder harness fastened, to perform all functions necessary for flight operations. For purposes of this paragraph—

(i) The date of manufacture of an airplane is the date the inspection acceptance records reflect that the airplane is complete and meets the FAA-approved type design data; and

(ii) A front seat is a seat located at a flightcrew member station or any seat located alongside such a seat.

*** * * * ***

(16) [Reserved]

* * * * *

16. In § 91.313, revise paragraph (g) introductory text to read as follows:

§ 91.313 Restricted category civil aircraft: Operating limitations.

*** * * * ***

(g) No person may operate a small restricted-category civil airplane manufactured after July 18, 1978, unless an approved shoulder harness or restraint system is installed for each front seat. The shoulder harness or restraint system installation at each flightcrew station must permit the flightcrew member, when seated and with the safety belt and shoulder harness fastened or the restraint system engaged, to perform all functions necessary for flight operation. For purposes of this paragraph—

* * * * *

17. In § 91.323, revise paragraph (b)(3) to read as follows:

§ 91.323 Increased maximum certificated weights for certain airplanes operated in Alaska.

*** * * * ***

(b) * * *

(3) The weight at which the airplane meets the positive maneuvering load factor *n, where* n=2.1+(24,000/(W+10,000)) and W=design maximum takeoff weight, except that n need not be more than 3.8; or

*** * * * ***

18. In § 91.531, revise paragraphs (a)(1) and (a)(3) to read as follows:

§ 91.531 Second in command requirements.

(a) * * *

(1) A large airplane or normal category level 4 airplane, except that a person may operate an airplane certificated under SFAR 41 without a pilot who is designated as second in command if that airplane is certificated for operation with one pilot.

*** * * * ***

(3) A commuter category airplane or normal category level 3 airplane, except that a person may operate those airplanes notwithstanding paragraph (a)(1) of this section, that have a passenger seating configuration, excluding pilot seats, of nine or less without a pilot who is designated as second in command if that airplane is type certificated for operations with one pilot.

*** * * * ***

PART 121—OPERATING REQUIREMENTS: DOMESTIC, FLAG, AND SUPPLEMENTAL OPERATIONS

19. The authority citation for part 121 continues to read as follows:

Authority: 49 U.S.C. 106(f), 106(g), 40103, 40113, 40119, 41706, 42301 preceding note added by Pub. L. 112-95, Sec. 412, 126 Stat. 89, 44101, 44701-44702, 44705, 44709-44711,

44713, 44716-44717, 44722, 44729, 44732; 46105; Pub. L. 111-216, 124 Stat. 2348 (49 U.S.C. 44701 note); Pub. L. 112-95, 126 Stat. 62 (49 U.S.C. 44732 note).

20. In § 121.310, revise paragraph (b)(2)(iii) to read as follows:

§ 121.310 Additional emergency equipment.

*** * * * ***

(b) * * *

(2) * * *

(iii) For a nontransport category turbopropeller powered airplane type certificated after December 31, 1964, each passenger emergency exit marking and each locating sign must be manufactured to have white letters 1 inch high on a red background 2 inches high, be self-illuminated or independently, internally electrically illuminated, and have a minimum brightness of at least 160 microlamberts. The color may be reversed if the passenger compartment illumination is essentially the same. On these airplanes, no sign may continue to be used if its luminescence (brightness) decreases to below 100 microlamberts.

*** * * * ***

PART 135—OPERATING REQUIREMENTS: COMMUTER AND ON DEMAND OPERATIONS AND RULES GOVERNING PERSONS ON BOARD SUCH AIRCRAFT

21. The authority citation for part 135 continues to read as follows:

Authority: 49 U.S.C. 106(f), 106(g), 41706, 40113, 44701-44702, 44705, 44709, 44711-44713, 44715-44717, 44722, 44730, 45101-45105; Pub. L. 112-95, 126 Stat. 58 (49 U.S.C. 44730).

22. In § 135.169, revise paragraphs (b) introductory text, (b)(6), and (b)(7), and add paragraph (b)(8) to read as follows:

§ 135.169 Additional airworthiness requirements.

* * * * *

(b) No person may operate a small airplane that has a passenger-seating configuration, excluding pilot seats, of 10 seats or more unless it is type certificated—

* * * * *

(6) In the normal category and complies with section 1.(b) of Special Federal Aviation Regulation No. 41;

(7) In the commuter category; or

(8) In the normal category, as a multi-engine certification level 4 airplane as defined in part 23 of this chapter.

* * * * *

Issued under authority provided by 49 U.S.C. 106(f), 44701(a), 44703 and Pub. L. 113-53 (127 Stat. 584; 49 U.S.C. 44704 note) in Washington, DC, on December 12, 2016.

Michael P. Huerta,

Administrator.

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