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Part II

Department of Transportation

Federal Aviation Administration

Rotorcraft Regulatory Review Program; Amendment No. 1

DEPARTMENT OF TRANSPORTATION

Federal Aviation Administration

14 CFR Parts 1, 27, and 29

[Docket No. 21180; Amdts. 1-31, 27-19, and 29-21]

Rotorcraft Regulatory Review Program; Amendment No. 1

AGENCY: Federal Aviation Administration (FAA), DOT.

ACTION: Final rule.

SUMMARY: This rule adopts airworthiness standards for type certification of normal and transport category rotorcraft. It revises the applicability of Part 29 and incorporates standards for instrument flight rule (IFR) and icing certification in both Parts 27 and 29. This revision establishes a clear relationship between the number of passenger seats and the required performance level for transport category rotorcraft. For cargo configurations and configurations of less than 10 passengers, the rule relaxes requirements in the areas of height-velocity and maximum weight and will result in increased productivity for roles which are special and unique to rotorcraft. This change also adopts IFR standards for rotorcraft handling qualities and systems design with minor revisions from the current requirements which have been successfully administered for a number of years through IFR interim standards. The icing standards which are adopted by this change incorporate the same natural environment recognized in Part 25 transport airplane rules for many years, and provide considerable flexibility for demonstrating safe flight capability. This amendment affects only new civil rotorcraft models for which an application for a new type certificate is received after the adoption of the rule. The existing rotorcraft certification rules have not undergone a comprehensive reassessment in over 25 years. In the intervening period, significant improvements in rotorcraft capabilities have been made and rotorcraft usage has evolved somewhat differently than that originally envisioned. The Rotorcraft Regulatory Review Program was initiated at the request of industry. This amendment, which is the result of an extensive review of rotorcraft certification requirements by industry and Government, updates the existing rules to recognize these improvements, current uses, current technology, and future projections. The rule provides increased safety benefits to passengers traveling in rotorcraft. A thorough assessment of potential benefits and burdens has been made in accordance with Executive Order 12291. It has been judged that the benefits of this amendment, in providing an increased level of safety to passengers traveling in rotorcraft while at the same time recognizing and providing for the unique qualities and capabilities of rotorcraft, far outweigh the burdens.

EFFECTIVE DATE: March 2, 1983.

FOR FURTHER INFORMATION CONTACT: Tommie S. Plummer, Regulations Program Management (ASW-111), Aircraft Certification Division, Mailing address: P.O. Box 1689, Fort Worth, Texas 76101 and offic e location at 4400 Blue Mound Road, Fort Worth, Texas 76106, telephone (817) 624-4911, ext. 504.

SUPPLEMENTARY INFORMATION:

Discussion of Comments

Section 29.1 Applicability

All changes in applicability of the rule are contained in revised § 29.1. However, this change influences other portions of the current rule which may be summarized in the following three areas:

(1) Transport category rotorcraft certificated with 10 or more passenger seats must comply with the category A design requirements of Subparts C, D, E, and F of Part 29 and the category A final segment climb requirement of § 29.67(a)(2). (2) In Part 29, height-velocity (HV) is removed as an operating limitation for category B rotorcraft with nine or less passenger seats. HV information for these models must be placed in the performance section of the Rotorcraft Flight Manual. (3) In Part 29, the 20,000-pound weight limit for category B is removed for rotorcraft with less than 10 passenger seats.

This adopted applicability rule is the same as that in Notice 80-25 with the exception of relaxed requirements for 10 or more passenger rotorcraft having a maximum certificated weight of 20,000 pounds or less. The proposal in Notice 80-25 would have required rotorcraft with 10 or more passengers to be fully certificated to category A standards of design and performance. To attain full category A performance capability, future rotorcraft would have been required to incorporate additional power with resultant higher cost. The FAA, in Notice 80-25, estimates this cost at $12.5 million over the first three years of production for each new model in this range of weight and passenger seating. One commenter estimates a $1.35 billion impact on the total world economy over a 5-year production period for all affected models. Another commenter estimates a $1 billion impact for the world market in a similar 5-year period. While these economic analyses should have included only the impact on the U.S. economy, and the impacts were not calculated in a manner similar to that in which a new model would enter the market, the impact is nevertheless significant. Additional clarifying data were obtained from these commenters and were docketed to allow the FAA to more accurately assess the economic impact of this proposal. This additional information was of great benefit to the FAA. Discounting the previously mentioned features of the commenters' analyses and eliminating certain double counting of purchase price increases, the FAA estimates that the economic impact on the U.S. economy of providing full category A capability for 10 or more passenger configurations would be $1.18 billion over the first 10 years of production. This 10-year production period would begin approximately 5 years after adoption of the proposed rule.

While the concept of full category A protection for 10 or more passengers is a worthwhile goal which FAA hopes will be ultimately achieved, the safety benefits are difficult to quantify through existing accident statistics and, therefore, do not appear to clearly outweigh the cost as required by Executive Order 12291.

The significant cost impact in this portion of the proposed rule was alleviated by requiring only a portion of the category A performance requirements. The existing requirement in §29.67(a)(2) for category A final segment climb has been adopted instead of the full category A performance package. This change alleviates the large one-engine-inoperative (OEI) power requirements needed when an engine fails at low speed, yet the change retains category A performance capabilities throughout a large portion (climb, cruise, and descent) of the flight regime. It is realized that in many cases the traveling public associates twin-engine helicopters with the capability to continue flight when an engine fails. The performance requirement adopted in this rule will assure that capability for 10 or more passenger configurations in only a portion of the flight envelope; nevertheless, it is considered a significant increase in the minimum performance level for certification of civil rotorcraft. At the same time, it must be recognized that engine-out performance capability will not be assured during takeoff or landing at low-speed conditions from hover to near-best rate-of-climb speed. FAA is encouraged by the increases in power-to-weight which have resulted from technological changes over the last 15 years in transport category rotorcraft, and it is hoped that increased technology will ultimately lead to full category A performance capability for these transport category designs.

Six commenters made docket submittals on applicability. One commenter fully supports the proposed applicability change. This commenter states that a review of safety records found the fatal accident rate of transport helicopters to be significantly higher than that of comparable fixed-wing transport aircraft. The commenter states that "the attainment of a high level of airworthiness in fixed-wing transports has been, in part, achieved by means of high standards of reliability and the provision of redundancy in aeroplane design, and there is no reason why similar approaches to the design of helicopters should not be adopted * * *." FAA agrees with these comments and this "fail safe" concept for transport rotorcraft is partially addressed through the category A provisions of this rule. Other design aspects of this comment were outside the scope of Notice 80–25. These additional aspects will be considered in aircraft systems, powerplants, and structures areas for incorporation in future notices under this Rotorcraft Review Program.

A second commenter recommends a separate FAR part for utility helicopter certification rules and recommends incorporating standards similar to those proposed in Notice 80–25 for transport category B. This comment is considered outside of the scope of Notice 80–25. The second commenter also recommends retaining height-velocity as a limitation for category B, but having it mandatory only when carrying passengers. This comment is more properly an operating consideration and will be addressed in a later notice as part of this review.

A third commenter recommends that the category A design standards currently in Subparts D, E, and F of Part 29 be required for 10 or more passengers. This commenter argues that many multiengine helicopters recover "category A performance" in cruise conditions, and that certification to the "category A, technology" of Subparts D, E, and F offers a sufficient level of safety for transport category rotorcraft carrying more than nine passengers. The recommendations of this commenter regarding category A design standards have been considered and are adopted as a portion of the applicability rule.

The remaining three commenters oppose the category A requirement for 10 or more passengers on the basis that added safety benefits do not offset the large costs of full category A performance. One of these commenters strongly supports removing the category B, 20,000-pound weight limit, but feels that this group of rotorcraft should be allowed to carry large numbers of passengers. Another commenter proposes retaining the present 20,000-pound category B weight limit and requiring all multiengine rotorcraft to incorporate full category A design features. This commenter's proposal could have significant adverse impacts on future large helicopter designs similar to a recently certified configuration in the 50,000-pound weight class, which can show an increase in payload of approximately 12,000 pounds under category B performance standards for missions such as transporting oil drilling or exploratory equipment into inaccessible, confined areas. It would also unnecessarily restrict those small-scale applicants engaging in aircraft alteration who may wish to replace a large engine with two smaller engines and continue to certify a helicopter to category B performance standards. The commenter's proposal could be reasonably met by an original manufacturer, but does not treat the small-scale applicant equally because that applicant would not typically have the capability to fully redesign rotorcraft systems to category A standards. Single-engine category B rotorcraft are designed with suitable flight characteristics and sufficient rotor inertia to safely tolerate total power failure. For single-engine rotorcraft which are modified to incorporate a twin-pack or an additional engine, the remaining category A isolation features are not needed to assure freedom from total power failure because that condition has already been safely substantiated for the design. For FAA to require full category A design for this condition as its minimum safety standard would impose a crippling economic burden which is not warranted.

At the same time, however, these category B designs are not considered appropriate for transporting large numbers of passengers. In Notice 80–25, the manufacturers' and operators' responsibilities to protect large numbers of people were explained in some detail. Current certification rules differentiate between levels of design by rotorcraft weight only. It is necessary and appropriate for minimum safety standards to be clearly related to the number of persons affected. The philosophy behind this rule is that the higher the potential level of danger and the more people who fall within the endangered class, the higher the level of safety should be. The greater the number of passengers, the greater the potential loss of life in an accident; the greater the size and inertia of an aircraft, the greater the potential hazard to persons on the ground in the event of an accident. These two features, size and number of passengers, combine to determine the level of safety required by this rule.

Three commenters question the need for category A performance due to the lack of engine failure accident statistics in multiengine category B rotorcraft. One commenter states that the FAA does not recognize the safety record of large multiengine category B helicopters. FAA accident statistics show an impressively low number of accidents due to engine-related failures in multiengine category B rotorcraft. Approximately 30 percent of all rotorcraft accidents over the past several years have been related to engine failure. In multiengine rotorcraft, only about 10 percent of the accidents have been related to engine failure. This is due, in part, to the fact that at moderate weights and low-density altitudes, many current category B twin-engine rotorcraft have performance capabilities equivalent to category A standards throughout a significant portion of their operating envelope. Many engine failures have not become accident statistics due to this one-engine-inoperative performance capability. These FAA accident statistics serve even more clearly to highlight the need to prohibit future single-engine rotorcraft designs from carrying 10 or more passengers. During the period from 1966 to 1979, there were 44 accidents in twin-engine helicopters carrying 10 or more passengers. Of those accidents, 9 percent were related to engine failure. During that same period there were 81 accidents in single-engine rotorcraft carrying 10 or more passengers. Of those accidents, 33 percent were related to engine failure. The FAA determined that up to eight of these accidents may have been prevented through the multiengine, category A requirements of this rule. Upgrading the requirement for rotorcraft with 10 or more passenger seats to the multiengine category A configuration establishes an appropriate level of safety for civil certification.

There were no adverse comments submitted to the docket regarding category A design standards for 10 or more passenger rotorcraft. To the contrary, one commenter who opposes the economic aspects of the full category

A performance requirement states, "Without exception, new helicopters capable of carrying 10 or more passengers have gone to twin engines for both safety and reliability reasons." It is also true that all new twin-engine designs in that seating range have met category A standards of design. At the NASA-FAA Advanced Rotorcraft Technology Workshop in December 1980, the helicopter users expressed a strong desire to have full category A performance capability in future designs. These desires are summarized in SAE Technical Paper 810589, which states, in part:

Concerns relating to powerplants appeared to top the lists of all the users. A true one-engine-inoperative capability was referred to repeatedly and in a variety of ways. The operators were unanimous in their endorsement of twin engine helicopters, but less happy with available single engine performance. Ideally, an out-of-ground-effect hover capability with one-engine-inoperative was desired. In general, operators would like to see a non-emergency outcome for any single failure of any helicopter component.

This rule satisfies a portion of those industry needs and desires. Let us now consider the cost factors involved in adopting the category A climb requirement.

Figure A represents the approximate climb performance capabilities of existing twin-engine models capable of carrying 10 or more passengers. The ordinate, or vertical axis, is the change in power that would be required to comply with the added performance requirement of this rule at the weights originally certificated on existing twin-engine category B models. The abscissa, or horizontal axis, represents the year each model was initially certified for civil use. Where final flight test data were not available for one projected model, manufacturers' estimates were utilized. The necessary power increase is based on an average of two hot day ambient takeoff conditions: (1) Sea level 40°C (ISA + 25°C) and (2) 5,000 feet 30°C (ISA + 25°C). The data were generated through computations shown in Table I. Necessary horsepower increases were referenced to sea level standard conditions by averaging factors of .8 and .73, respectively. Data for these factors are shown in Table II. These cases include a major portion of the typical helicopter operating envelope but are in no way limiting. A similar trend results when other ambient conditions are used. A curve through the data in Figure A reflects a trend toward lighter components and more powerful engines in transport category rotorcraft. Assuming this trend continues, the added costs of complying with this minimum performance standard will cross the zero cost line in the mid-1980's. This corresponds to the time period during which the first new model could conceivably be impacted by this rule. It may, therefore, logically be concluded that the economic impact of the 10 or more passenger requirement incorporated for new models under this rule is approximately zero. The remaining aspects of the applicability rule change are relieving. FAA received no adverse comments on the removal of height-velocity as a limitation for under 10-passenger seat applications. This will provide additional flexibility to operators, with an unquantifiable potential revenue benefit. FAA, likewise, received no adverse comments on the removal of the 20,000-pound weight limit for category B. This provision could result in increased revenues for operators of new or requalified rotorcraft at the higher weights allowable for category B operations. It is estimated that industry revenue increases of from $5 million to $13 million per year could be achieved in the 1982 through 1989 time frame. Such revenue increases have a net present value of $43 million in 1982 dollars, using a discount rate of 10 percent. Therefore, the overall economic impact upon the helicopter industry of this rulemaking action is to provide moderate to major economic benefit.

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Figure A

POWER TREND, MULTI-ENGINE ROTOCRAFT

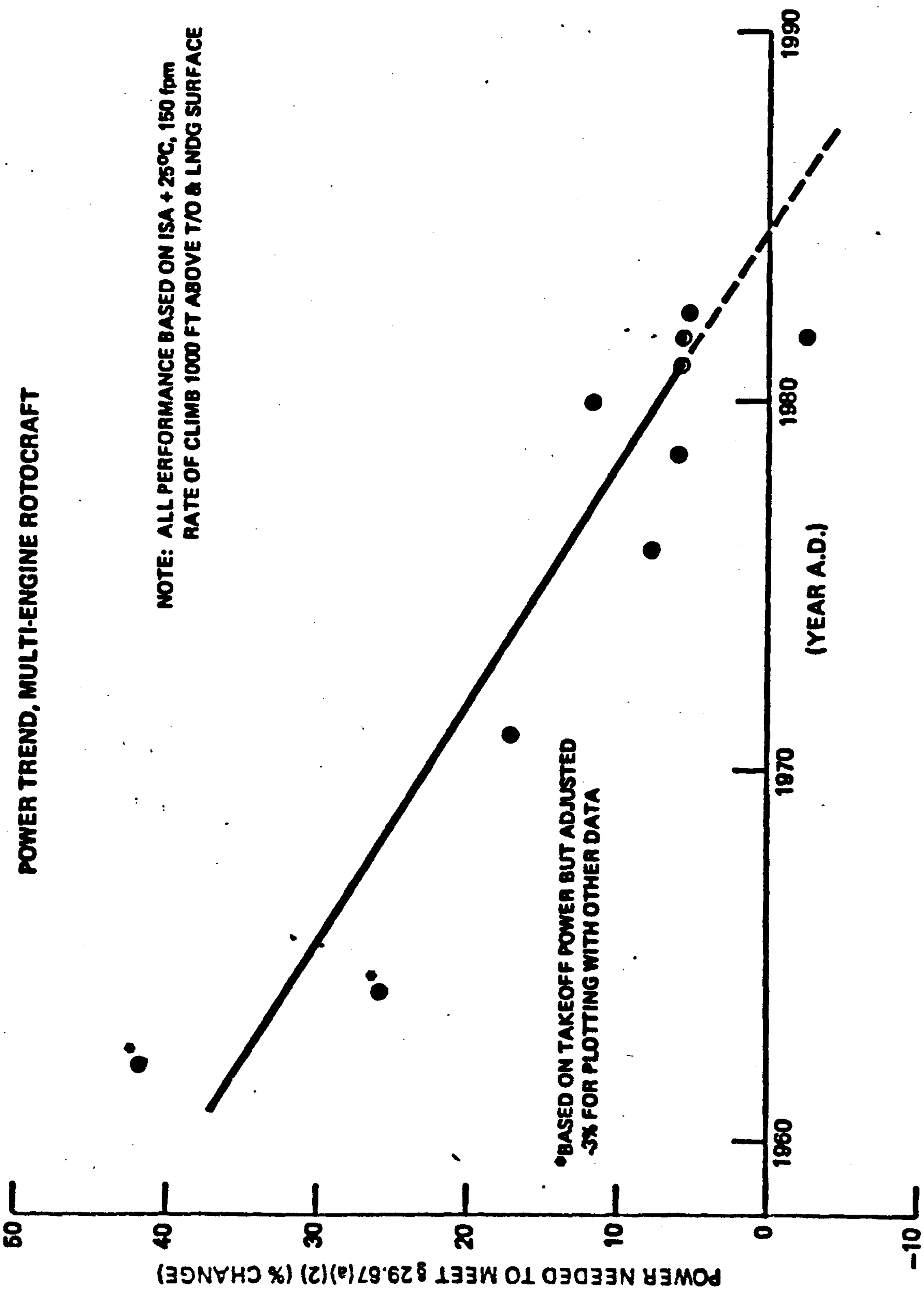

Table I

Analysis of Change in Power Required to Meet Category A Enroute Requirement of § 29.67(a)(2)

Two Ambient Conditions Analyzed (and averaged):
Takeoff and Landing WAT [Weight, Altitude, Temperature] Limit at:
(1) Sea Level: ISA + 25°C (40°C/104°F)
(2) 5,000 Feet Pressure Altitude: ISA + 25°C (30°C/86°F)

Helicopter Model	T/O & Landing Weight Limit (lbs) (1)	(2)	OEI Climb Rate 1,000' Above Surface (fpm) (1)	(2)	*Additional Horsepower (hp) Required to Meet § 29.67(a)(2) (1)	(2)	30 Minute Rating (horsepower)	**Percentage Increase in Horsepower Required (1)	(2)	Average Percentage Increase Required
A	19,000	17,750	−460	−620	390	460	1,250	39	50.4	44.7
B	18,330	16,810	−286	−306	269	258	1,250	28	29.5	28.75
C	11,200	10,450	−105	−219	96.2	129.8	900	13.9	20.6	17.25
D	16,300	16,180	150	−200	0	191	1,742	0	15.4	7.7
E	9,800	8,800	25	100	41	14.8	627	8.5	3.4	5.95
F	7,650	6,980	−80	−95	59	57.6	650	11.3	12.1	11.7
G	11,600	10,600	80	5	27.3	51.75	925	3.7	7.66	5.7
H	8,487	7,400	25	50	35.7	24.9	700	6.4	4.9	5.6
I	17,190	17,190	420	40	−156	63.7	2,078	−9.4	4.2	−2.6
J	17,500	16,550	90	−30	35.4	100	1,625	2.7	8.4	5.5 (estimated)

(*) Δ hp required = $\frac{\Delta R/C \times \text{Weight}}{29,700}$

(**) percentage increase = $\frac{\Delta \text{ hp}}{\text{SL Rated hp} \times \text{\% Available}}$

Table II

Percentage Rated Power Available at Climb Conditions of § 29.67(a)(2)

Engine Model	SL-STD 30 Min Rating	30 Min Rating (1,000'/38°C)	Percentage of S.L. Rating	30 Min Rating (6,000'/28°C)	Percentage of S.L. Rating
1	1,250	950	76	890	71
2	1,380	1,099	80	988	72
3	1,625	1,365	84	1,230	76
4	600	475	79	426	71
5	660	535	81	480	73
Average Percentage of Rated Power Available			80%		73%

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Two of the three commenters who oppose the 10 or more passenger rule argue that this rule discriminates against U.S. helicopters and gives foreign manufacturers a distinct advantage. This is not true for helicopters to be certificated and registered in the United States. To obtain an FAA type certificate, foreign designed and manufactured helicopters must meet the same or equivalent standards that must be met by helicopters designed and manufactured in the United States. Section 21.29 makes this point clear. Foreign airworthiness regulating agencies currently recognize Parts 27 and 29 of the Federal Aviation Regulations as the world's leading civil airworthiness standard. Moreover, these standards and their predecessor parts have been used for certification of all civil models which have major impact on the marketplace worldwide. These standards will continue to be recognized and used throughout the free world as long as they reflect appropriate, up-to-date safety standards that clearly prescribe an appropriate safety standard for current technology. If the remaining portion of these certification standards can be updated to reflect an appropriate minimum level of design, they will endure as a world standard, and there will be no gross benefit or competitive advantage to manufacturers, foreign or domestic.

Two commenters state that the proposed applicability revision to Part 27 is not needed because rotorcraft of 6,000 pounds or less are not projected to have more than nine passenger seats. The FAA agrees, and this portion of the proposal has been removed.

One commenter recommends incorporating the category A and category B definitions into the rules for standardization and clarity. The FAA agrees and the definitions are incorporated into Part 1 of the FAR as presented in the explanatory portion of Notice 80–25 without substantive change.

Two commenters contend that the 10 passenger safety comparison between rotorcraft and fixed-wing aircraft in Notice 80–25 is not valid because of the slower landing speeds and the lower rate of fatalities in engine-failure-related accidents for helicopters. This capability is recognized. The FAA, however, cannot condone low-speed crashes simply because they kill fewer people. The FAA is hopeful that increased technology and upgraded performance standards can jointly lead to elimination of engine-failure-caused accidents. Future rulemaking actions in the ongoing rotorcraft review will seek to improve safety in structural, systems, and pilot-related areas through similar upgrading and modernization of the standards with the intent that major accidents, both fatal and non-fatal, can be minimized. The period when helicopters will be routinely flying in IFR conditions with large numbers of passengers is at hand. Uncontrolled descent to the surface is not a viable alternative for these operations. A moderate performance capability for future designs which is consistent with these evolving operations is envisioned in this rule. Nevertheless, this rule recognizes significant differences between fixed-wing aircraft and rotorcraft performance levels, and adopts performance standards for engine failure in rotorcraft which are much lower than those for their fixed-wing counterparts.

A general concern over retroactive application of the proposed applicability rule was noted throughout the comments. The full category A requirement in Notice 80–25 for 10 or more passenger configurations is inappropriate for current multiengine designs under 20,000 pounds because those rotorcraft have been designed to achieve reasonable payload capabilities under category B operating conditions. As seen in Figure A, the implications of adopting only the "en route climb" requirements have steadily diminished in recent years. The FAA has determined that retroactive application would not provide a safety benefit commensurate with the cost. In regard to the specified docket comments, even though an applicant is free to seek and obtain certification to full category A performance capability for competitive advantage with existing models, full category A performance will not be required retroactively for existing models of 20,000 pounds or less.

Section 29.79 Limiting Height-Speed Envelope.

No comments were received on proposed § 29.79. The FAA noted, however, that the words, "covered by paragraph (a)(2)(i) of this section," in the proposed § 29.79(a)(2)(ii) are redundant and, therefore, are deleted. Accordingly, § 29.79 is adopted essentially as proposed.

Sections 27.141 and 29.141 General.

No comments were received concerning reference to control system failures proposed in §§ 27.141 and 29.141 and those sections are adopted as proposed.

Section 29.877 Ice Protection.

Notice 80–25 proposed deleting § 29.877 and establishing updated icing requirements in a new § 29.1419. One commenter suggests retaining § 29.877 along with additional certification guidance material. Section 29.877 inadvertently implies the possibility of limited icing certification. The FAA cannot endorse limited certification because of the inability of the crew to control the limiting conditions, the difficulty in forecasting the severity of icing, and the inability to relate the effects of reported icing among different types of aircraft. This would create the potential for unsafe conditions beyond the capability of the rotorcraft without viable escape alternatives. Although the commenter would like to retain § 29.877 and allow limited icing approvals, the limited icing concerns and objections raised in Notice 80–25 have not been satisfied. Accordingly, § 29.877 is removed and marked "reserved," and § 29.1419 is adopted. Specific comments pertaining to the content of § 29.1419 are addressed elsewhere in this document.

Section 29.1309 Equipment, Systems, and Installations.

One commenter recommends that § 29.1309 be revised to specify requirements relating to probability of failure in a manner similar to that required by § 25.1309 for transport category airplanes. This recommendation is beyond the scope of this rulemaking action, but will be addressed in a subsequent rotorcraft regulatory review notice.

Section 29.1321 Instrument Arrangement and Visibility.

Notice 80–25 proposed grouping and centering specific instruments and, for IFR-certified transport rotorcraft, arrangement and visibility requirements (basic "T" concept) comparable to those for transport category airplanes. One commenter recommends that the grouping and centering requirement be "consistent with the VFR and IFR approach and touchdown visibility needs of the particular helicopter." The commenter contends that exterior visibility requirements are different for rotorcraft than for airplanes, and implies that good exterior visibility and good instrument arrangement may be mutually exclusive. The requirement for grouping and centering of flight instruments has been in this section of the rules for many years and Notice 80–25 did nothing to change this aspect of the requirement. Successful certification of existing rotorcraft which have satisfactorily demonstrated compliance with instrument and visibility requirements has proven that flight instruments may be centered on the panel without compromising VFR capabilities. Instrument arrangement and visibility requirements for IFR flight are the same and are equally necessary for airplanes and rotorcraft. Existing rules require satisfactory exterior visibility for rotorcraft and airplanes. The FAA cannot accept the commenter's rationale and recommendation.

The commenter also recommends a change which would provide an exception to the instrument grouping, arrangement, and visibility requirements for centralized displays such as cathode-ray tubes. Specific equipment of this type is more properly addressed on an equivalent safety basis, rather than by attempting in the rule to identify this and other possible variations in equipment that may qualify as exceptions. Approvals by equivalent safety have proven satisfactory in past certifications and the FAA sees no reason why this cannot continue in the future.

Another commenter recommends a change which would have specified an exact size for the movable horizon display in the attitude indicator noted in § 29.1321(b)(1). The readability of a particular instrument depends on many factors in addition to physical size. Specifying a particular size would not, in itself, assure that the intent of the rule is met. It could, in some cases, be overly burdening. Other factors such as sensitivity, clarity of display, and physical distance from the crew may also be relevant. It would be preferable to allow applicants maximum flexibility in meeting the requirement without specifying size parameters which may not contribute significantly to the overall safety objective.

In view of this and the foregoing discussions, § 29.1321 is adopted as proposed.

Section 29.1517 Limiting Height-Speed Envelope; and Section 29.1587 Performance Information.

Under the proposed applicability requirement (§ 29.1) of Notice 80-25, category B rotorcraft could not be certificated with more than nine passenger seats, and height-velocity would be removed as a category B operating limitation, but retained in the flight manual as performance information. No comments were received objecting to the proposed deletion of height-velocity as an operating limitation for the less-than-10-passenger category B rotorcraft. However, because of economic reasons discussed in the applicability portion of this preamble, this rule permits the certification of a "category B rotorcraft" as defined in Part 1, with 10 or more passenger seats. Because of this difference and in keeping with the concept of protection for the maximum number of passengers, it is necessary to retain height-velocity as an operating limitation for category B rotorcraft with 10 or more passenger seats. This is accomplished in § 29.1(a)(2), which requires compliance with § 29.1517 for category B rotorcraft having 10 or more passenger seats. Section 29.1517 is therefore adopted as proposed. Height-velocity would still be removed as an operating limitation and retained as performance information for category B rotorcraft with less than 10 passenger seats.

The proposed wording for § 29.1587 would have required height-velocity data in the performance information section of category B rotorcraft flight manuals. In view of the revised applicability requirements, this is now pertinent only for category B rotorcraft with less than 10 passenger seats. Slightly different wording than that proposed for § 29.1587(b)(6) is therefore needed. Accordingly, the proposed § 29.1587(b)(6) is adopted with the addition of the words "except for rotorcraft incorporating this as an operating limitation."

Appendix B—Parts 27 and 29, Instrument Flight Rules Certification.

The adoption in Parts 27 and 29 of certification standards and operational limitations related to Instrument Flight Rule (IFR) approval of rotorcraft has no economic impact since there will be little change in current operating practices or procedures. Currently, an IFR interim standard, similar to that adopted in this rule, is applied for applicants seeking instrument flight approval. Adopting this rule, therefore, imposes no significant change from current requirements under which 25 instrument approvals and approximately 200 operating helicopters have shown a perfect safety record. IFR certification is not mandatory, so the applicant has the opportunity to evaluate whether the provisions of IFR capability in a given rotorcraft model will be sufficiently attractive in the market to improve revenues, profits, and market-share objectives. Moreover, many rotorcraft have been approved for IFR under earlier interim standards that are so similar to the proposed standards that this proposal does not materially alter any economic considerations. The formal adoption of the interim standards is considered to benefit manufacturers by providing a more stable design standard.

Eleven comments on the proposed IFR appendices were received. The majority of the comments propose editorial changes or word clarifications from that proposed in Notice 80-25. Commenters favor proceeding with adoption of helicopter IFR standards in a final rule, and there are no objections to incorporating certification standards in IFR appendices as proposed in the notice. The disposition of docketed comments is discussed in sequential order as they affect Appendix A (changed to Appendix B in the adopted rule) to Part 27. Changes may apply to both Parts 27 and 29 appendices although this may not be specifically noted in the discussion. Where only one part is affected, it is so noted. Numbering of the major paragraphs (I through IX) in this discussion refers to that in the final rule and as presented in the IFR appendix of Notice 80-25 for Part 27 rotorcraft. The numbering in the Part 29 IFR appendix of the notice is incorrect due to the inadvertent omission of the heading "II. Definitions."

During the formulation period of Notice 80-25, appendices entitled "Appendix A, Instructions for Continued Airworthiness," were adopted in Parts 27 and 29. It is therefore appropriate to retitle the IFR appendix "Appendix B, Airworthiness Criteria for Helicopter Instrument Flight" and to alter the corresponding reference in §§ 27.141(c) and 29.141(c).

Four commenters express concern regarding the disposition of Special Federal Aviation Regulations (SFAR) 29, and approval of rotorcraft currently operating under the SFAR "limited IFR" concept. One commenter expresses concern with the apparent lack of substantive distinction between the level of safety implied for IFR in Part 27 "Normal Category Rotorcraft" and Part 29 "Transport Category Rotorcraft" proposals. Further, this commenter feels that the equipment, systems, and installation requirements of the proposed notice drew excessively upon transport airplane criteria. This commenter proposes additional consideration of proven SFAR 29 standards into the Part 27 IFR criteria.

At the conference in New Orleans, industry representatives expressed a uniform desire to have identical standards for IFR in both normal and transport category rotorcraft. A desire for relaxed standards in Part 27 normal catgegory rotorcraft was not enumerated at the conference, nor at the August 1980 meeting in Washington, D.C. This commenter raises a valid question for consideration. "Should the IFR standards incorporate differences in level of safety between normal and transport category rotorcraft in a similar manner to other portions of these rules, and can the SFAR experience be utilized to help in formulating requirements for the Part 27 rule?"

The FAA initiated SFAR 29 as a study to gather data and operating experience necessary to assess various issues affecting helicopter operations in the IFR environment. A limited number of approvals were granted on the basis of individual aircraft modifications, certain specified crewmembers, crew currency restriction, loading and flight envelope restrictions, and geographic limitations which were later removed. These approvals were not generally applicable to the civil helicopter pilot population or to the VFR helicopter fleet as a whole. Although the program began slowly, a moderate amount of IFR flight experience has been gained, particularly during the last two years of his study. During the intervening time period, the interim standard for IFR certification has undergone the final adjustment necessary to incorporate these standards into the rotorcraft certification rules. The explanatory information announcing the renewal of the SFAR on October 30, 1980, stated "it is the intent of the FAA to rescind this SFAR upon adoption of the new rotorcraft IFR certification standards in Parts 27 and 29 * * *." SFAR 29 has served its purpose, and FAA has no need to continue the study.

SFAR 29 has served well as an interim measure to permit joint airworthiness and operational certification of rotorcraft not originally type certificated for IFR operations to engage in IFR operations and, as originally intended, has lead to the adoption of permanent airworthiness certification standards incorporating the airworthiness features developed and the operational lessons learned under the SFAR. Nonetheless, although the SFAR's limited goal of permitting study of rotorcraft IFR operations has reached fruition in the shape of these amendments, a need remains to permit continued operations under SFAR 29 by operators who obtained approvals to operate thereunder prior to the effectiveness of these amendments. Significant amounts of money have already been expended to obtain SFAR 29 approvals, and while eligibility for new applications under the SFAR will expire, FAA considers that blanket termination of these operations would represent a significant economic burden to a number of small entities. For this reason, while future applicants for rotorcraft IFR certification must meet the airworthiness standards contained in these amendments, SFAR 29, as amended, will remain effective for operators holding approvals obtained prior to effectiveness of this amendment. SFAR 29, as amended, will be rescinded when the outstanding approvals granted thereunder have been surrendered, revoked, or otherwise terminated.

IFR flight hours for SFAR 29 operators have been gained since initial drafting of the Part 27 IFR appendix in March 1980, and the FAA has viewed these operations with continuing interest. Certain relaxatory changes in the IFR appendix for Part 27 rotorcraft are adopted in this amendment, partly as a result of the SFAR 29 experience. These changes are primarily in the area of required instruments and equipment. They are discussed below, along with other changes in response to industry comments.

I. *General.* No unfavorable comments were received on this paragraph.

II. *Definitions.* The term V_{MINI} is defined in both appendices as "instrument flight minimum speed. * * *" Some commenters feel this definition applies only to level flight, and further that an IFR approach could be legally flown at a speed below V_{MINI}. These commenters feel an additional term is needed to define minimum authorized approach speed.

The term V_{MINI} constitutes the minimum speed authorized for all instrument flight conditions and is not limited to the level flight condition. The level flight condition is not referred to anywhere in the definition of V_{MINI}. V_{MINI} is the lowest authorized airspeed for IFR climb, cruise, descent, and approach conditions, and it represents the minimum speed at which the helicopter complies with all IFR handling quality requirements, including those during approach. V_{MINI} is by definition "* * * instrument flight minimum speed * * *." It is, therefore, unnecessary to define an additional mimimum speed which is applicable only to approach conditions.

III. *Trim.* Commenters are highly supportive of the IFR trim requirement as worded in the notice. One commenter, however, feels that the wording requires a pilot adjustable control for directional trim. The wording of this requirement does not speak to a pilot adjustable trim control and such a requirement was not envisioned. Several configurations have been approved with no directional trim system as such, but through the use of balance weights and control system friction. Wording of this requirement would permit continued approval of those systems. Additional clarifying information will be provided through FAA handbook guidance.

IV. *Static Longitudinal Stability.* This section of the proposed Part 27 IFR standard contains differing requirements for single-and dual-pilot approvals. One commenter objects to varying standards by the number of crewmembers, primarily because pilot incapacitation in a two-pilot aircraft could result in an unacceptable workload for the remaining pilot. Two commenters object to varying standards by the number of crewmembers only in Appendix B to Part 27. They feel that two-pilot alleviation should be extended to Part 29. SFAR 29 experience has shown that safe operation can result from relaxed levels of stability and design for certain two-crewmember operations. Nevertheless, as stated in Notice 80-25, "It is inappropriate to permit less stringent handling qualities for transport category than for normal category, regardless of crew requirements." In answering these commenters' objections, it is necessary to point out that crew incapacitation is not a consideration in developing IFR flight criteria, and that it is important to retain the highest level of safety through the highest minimum standard for design in transport rules, regardless of the minimum number of crewmembers necessary to operate the aircraft. Therefore, the proposal which relaxes two-pilot requirements only in Part 27 is retained.

One commenter indicates a desire to use control position stability as a basis for static stability instead of control force stability for the two-pilot case. Another commenter proposes use of position stability unilaterally. Numerous studies have been conducted on the subject of static longitudinal control force stability. In addition to NASA and military studies on the subject, the FAA, in recent research and development programs with both the NASA Ames Simulator Facility and the Canadian National Research Council variable stability research helicopter, has conclusively substantiated the need for static longitudinal control force stability in helicopter instrument flight. These most recent results are documented in NASA/FAA Report FAA-RD-80-64 and in "An Evaluation of IFR Handling Qualities of Helicopters Using the NAE Airborne Simulator," April 1, 1981, presented at CASI Flight Test Symposium, Cold Lake, Alberta, Canada. It is, therefore, appropriate to retain this minimum level of safety for single-pilot operation throughout the IFR flight envelope. For a crew of two pilots, the positive static longitudinal control force stability requirement is retained only for conditions of cruise and approach. This will assure a minimum level of stability during a majority of a typical IFR mission and during the critical approach phase.

Another commenter points out that the 10 percent return-to-trim requirement could apply to two-pilot approvals as well as single-pilot approvals. It was not FAA's intent to require a 10 percent return-to-trim condition for a crew of two pilots in Part 27 helicopters and a satisfactory level of safety can be shown, based partly on the SFAR 29 experience. This feature is being clarified by incorporating the words "For single-pilot approvals," as a lead-in to the last sentence of paragraph IV(a) of Appendix B for Part 27 helicopters.

One commenter points out that if V_H were lower than V_{NEI}, demonstrations of static longitudinal stability in cruise would not include the speed range from 1.1 V_H to 1.1 V_{NEI}. FAA is aware of that fact. FAA and industry representatives, in drafting these requirements, continued a long-standing concept presently in VFR certification rules which removes from consideration speeds substantially exceeding V_H. For helicopters with V_H below V_{NE}, this concept assures stability in a reasonable range either side of the maximum attainable level flight speed. This level of stability has proven to be suitable as a minimum airworthiness standard for helicopter IFR flight in more than 20 engineering approvals for IFR flight over the past 8 years. The FAA can see no need to increase the severity of this requirement and it is adopted as proposed.

Three commenters note that lower helicopter IFR approach speeds are forthcoming, particularly for approaches to heliports or offshore facilities. Under guidelines of previous interim standards, an approach speed of 40 knots would require demonstration of stability down to 20 knots or to ½ of the approved airspeed value. A 20-knot approach speed presumably would require stability to a hover. The requirement, as currently worded, would be inappropriate for very low speed approaches and would be difficult to interpret for recommended speeds below 20 knots. Commenters suggest a factored or ratioed method to accommodate the anticipated lower approach speeds. Two commenters suggest 0.9 V_{APP} as a minimum demonstration speed, where V_{APP} is defined as the instrument flight minimum speed utilized in instrument flight approaches. The third commenter proposes 0.8 V_{APP}. A minimum recommended IFR approach speed for helicopters is typically 60 knots. FAA is not aware of any designs certified with minimum speeds greater than 70 knots. To retain approximately the same stability level as that provided in past versions of the IFR standard, a factor of 0.7 times the minimum recommended approach speed is appropriate. For a 60-knot minimum approach speed, this factored method will require static stability throughout a speed range 18 knots below the minimum approach speed compared to the current requirement of 20 knots. At the same time, this method will decrease the required stability range for lower approach speed conditions. For example, a 30-knot minimum approach speed would result in a positive stability demonstration down to 9 knots below that value. Since this rule contains essentially the same requirements as for current designs and provides significant and appropriate relaxation for low-speed approach conditions anticipated in the near future, it is being adopted without a further comment period.

V. *Static Lateral-Directional Stability.* One commenter objects to deleting the term "substantially proportional" from previous interim standards and substituting "proportional" in the directional stability requirement of Notice 80-25. This change was proposed for the purpose of removing subjective wording from the requirement when drafting the notice. This commenter interpreted the word "proportional" to mean in constant proportion. This was not intended by the FAA in its drafting of the notice. To prevent future difficulties in interpretation, the word "proportional" is being replaced by the phrase "in approximately constant proportion" to allow some curvature in the sideslip response to pedal position while retaining the "approximately constant proportion" necessary for good directional response.

Three commenters suggest that the wording "that at which full directional control is employed" is redundant because this condition also represented a "maximum sideslip angle appropriate to the type." Even though this wording has been carried forward in several versions of the IFR interim standard, FAA agrees that these words are redundant, adding nothing to the content of the rule. Accordingly, these words are deleted from the text as adopted.

One commenter states that the wording of the lateral-directional paragraphs is too subjective because the lack of quantitative parameters frequently causes large economic impact in the design of aircraft systems. The lateral-directional requirements of the IFR interim standards have changed little over the past 10 years. These requirements have been utilized successfully on approximately 25 IFR certification programs. Various research and development efforts, both inside and outside of FAA, have been conducted during this period, but none have successfully tied quantitative values for control force and deflection versus sideslip angle to specific levels which will assure a minimum safety standard for a wide range of helicopter models. It is conceivable that minimum safe values for control motion and force versus sideslip angle vary from model to model because of the wide variations in lateral-directional characteristics among rotorcraft. Therefore, the widest possible latitude has been allowed in establishing the minimum acceptable dihedral (roll due to sideslip) characteristic. To specify purely quantitative standards in this area would exclude a certain number of otherwise acceptable designs from IFR approval. For these reasons, quantitative force and deflection criteria for lateral-directional stability are not adopted in this rule.

Another commenter proposes adding dihedral requirements for sideslip angles which exceed 10°, but this is rejected for the same reasons. This same commenter points out an inconsistency in the use of the word "must" in Part 27 versus "shall" in Part 29 in the last line of paragraph V(b). No difference was intended and "must" is adopted for both.

VI. *Dynamic Stability.* One commenter feels that all dynamic stability criteria for Part 27 helicopters should be stated in qualitative terms because many existing helicopters cannot meet the proposed requirement and operator experience under SFAR 29 does not corroborate the need for a quantitative standard. Another commenter charges that the FAA had "* * * deviated from the objective-type rule concept in one very important area—the periodic response characteristics." The FAA assumes that this comment is meant to apply to the "aperiodic" requirement in proposed IV(a)(4) and (b)(3), because the requirements for damping of "periodic" motion in paragraph VI do not deviate from previous versions of the IFR interim standard. This assumption is supported by a commenter statement in another area of the submittal: "* * * the FAA did not establish a basis in its 'explanation' for the value selected for the quantitative aperiodic response nor was the value selected shown to be compatible with the comparable characteristics of helicopters now approved * * *."

Dynamic response characteristics represent an avenue of vehicle description which by their very nature are specific, quantifiable, and understandable in universal terms. Regardless of the type of vehicle, dynamic response must be controlled to assure satisfactory operation. It has long been recognized that quantitative standards for helicopter instrument flight are needed to assure fair and consistent administration of the requirement. The fact that some current designs approved for flight under visual flight rules (VFR) do not meet a proposed standard for instrument flight rules (IFR) is not justification for concluding that the standard is inadequate. Rotorcraft must be designed to minimum safety standards and those standards should reflect only those requirements necessary for safe flight. The standard, however, must not be formulated simply to comply with characteristics of current rotorcraft.

A large majority of SFAR 29 operators are approved for a minimum crew of two pilots and a majority of those helicopters are capable of meeting the periodic (oscillatory) damping requirements in paragraph VI(b). The few others were approved largely on the basis of pilot capability and these configurations should not be considered suitable for a national airworthiness standard appropriate for the civil pilot population as a whole. The periodic standards proposed in Notice 80-25 have been applied in over 20 civil certification programs and have been well established as a true "minimum" rather than a "highly desirable" design standard. It is interesting to note that some of these models have met the dynamic stability standards without stability augmentation. Because of this considerable experience and high level of confidence, the periodic portion of this requirement is adopted as proposed.

In helicopters, aperiodic modes are frequently manifest and are of equal importance in defining safe vehicle response. The FAA stated in its explanation to Notice 80-25 that, "pilot perception of aperiodic responses is similar to that for oscillatory responses which exceed a 20-second period and typically result in gradual rates of divergence over the first few seconds of aircraft motion. Although lower in attitude rate and acceleration level than the oscillatory modes, aperiodic requirements have been held to the same level of divergence as oscillations with a 20-second period due to their more insidious nature." This discussion applies well for axes in which both oscillatory and pure divergent modes exist. In pure roll dynamics, however, no oscillatory dynamic mode exists. Instead, an aperiodic spiral mode with low roll damping is typical and must be considered because it falls within the definition of an aperiodic response. As was recommended by the second commenter, FAA researched previously approved IFR models and determined that the most unstable aperiodic spiral divergence currently approved in a normal category rotorcraft had a time to double amplitude of 6 seconds. This level of instability was described as marginal in the FAA flight test report and appears appropriate for consideration as a minimum standard. No transport category helicopters have been certified without stability augmentation. The worst condition shown during testing with single stability augmentation system (SAS) failure, however, has shown an approximate 9-second time to double amplitude. These results indicate a need to limit the larger transport rotorcraft to a level of aperiodic response which is proportionally lower in divergence than is permitted for the lighter, more maneuverable normal category case. For this reason, the 9-second standard is adopted for transport category. For small rotorcraft with a minimum crew of two pilots, no minimum aperiodic criterion is adopted because it is assumed that one pilot will be at the controls and actively flying at all times. The military specification for flying qualities of piloted V/STOL aircraft, Mil-F-83300, defines a level 2 handling quality as one which is "* * * adequate to accomplish the mission Flight Phase, but some increase in pilot workload or degradation in mission effectiveness, or both, exists." For this condition, an allowable time to double amplitude for aperiodic response is 12 seconds. The adopted FAA standard is less stringent than the level 2 requirement. Mil-F-83300 defines a level 3 handling quality, in part, as one "* * * such that the aircraft can be controlled safely, but pilot workload is excessive or mission effectiveness is inadequate, or both." Allowable times to double amplitude for pitch and roll in level 3 are 5 and 4 seconds, respectively. The military standard tends to endorse the 6- and 9-second times to double amplitude previously approved by FAA for civil application. A current FAA research and development program is addressing aperiodic divergence. Initial results support the fixed levels of aperiodic divergence adopted here. This rule, therefore, is relaxed from that proposed in Notice 80-25 to a level of aperiodic instability which allows doubling in amplitude every 6 seconds for single-pilot, normal category rotorcraft and every 9 seconds for transport category rotorcraft. The adopted stability levels are based on existing models which have established an acceptable operating experience in service, previous handling qualities standards for fixed- and rotary-winged aircraft, docketed comments on this rulemaking action, and current FAA research efforts. Suitable methods for testing aperiodic levels of divergence will be included in a forthcoming procedures manual.

VII. *Stability Augmentation System (SAS).* Several commenters recommend that the pilot delay times for SAS failure should be provided. One recommends that maximum allowable helicopter attitudes and rates following SAS failure should also be specified. Stability systems are rapidly becoming more sophisticated and complex. The ability to specify a single minimum standard for attitudes, rates, and pilot time delays which would be suitable for all stability systems in all IFR rotorcraft models is doubtful. Disposition of this information as policy material has worked well in previous fixed-wing experience. In its explanation to Notice 80-25, FAA stated that "Pilot delay times for stability system malfunction testing are excluded from this amendment, as these criteria are more appropriately addressed in flight test guidance material." Guidance on these specific areas has been drafted for a transport helicopter certification guide which will be issued shortly. Draft copies are available from the FAA Helicopter Directorate, ASW-110, Box 1689, Ft. Worth, Texas 76101. No negative comments were received on incorporating this information as guidance material and this feature will remain unchanged in the adopted rule.

One commenter states that a SAS approval based primarily on statistical analysis would not be acceptable to FAA and VII(a) should reflect that philosophy. The basic premise behind the comment is invalid. Paragraph VII states, in part that, "the occurrence of any failure condition which would prevent continued safe flight and landing must be extremely improbable." While compliance with a portion of this requirement may be satisfied by conducting SAS hardover tests, many other failure conditions are not flight tested because they are shown to be extremely improbable through a combination of failure analyses, environmental tests, mock-up tests, or component service experience. In this regard, the appropriate hardover conditions are addressed in paragraph

VII(b), which specifically includes the eligibility of statistical methods.

Two commenters point out that a wording change from the interim standard had occurred in paragraph VII(a)(1) regarding the appropriate failure conditions to be considered. The IFR interim standard limited this requirement to failures "of the primary control system." The intent of this requirement is to assure that probable SAS failures in combination with probable conditions elsewhere in the control system do not combine to prohibit safe flight. This lack of specific reference to the control system in Notice 80-25 is noted and an appropriate revision is made. The requirement is further simplified and clarified by eliminating a redundant reference to "Combinations of Failures" which can be considered within the existing terminology of "Probable Failures."

One commenter states that the flight criteria following SAS failure in paragraph VII(a)(2) should not require continued compliance with all of the flight characteristics requirements of Parts 27 and 29 because, for like conditions in § 25.672(c), fixed-wing transport aircraft are required to comply only with controllability and maneuverability requirements of Part 25. This commenter states that, "Unless the FAA identifies inherent differences between helicopters and transport category airplanes relevant to continued flight following SAS failure and defines how those differences warrant the more stringent flight characteristics being proposed in the NPRM, the same criteria should apply."

Several SFAR 29 IFR interim standards, including the most recent dated December 15, 1978, required continued compliance with not only the flight characteristics portion but the entire Subpart B of Parts 27 and 29. This Subpart B requirement was relaxed to specify only the "Flight Characteristics" portion of Subpart B in Notice 80-25. There are significant differences in handling qualities requirements between helicopters and transport category airplanes and those differences are apparent in the basic rules for these two aircraft types. The differences, however, are more basic than the differences between helicopters and airplanes. The basic Part 25 transport airplane requirements for controllability and maneuverability are IFR requirements which provide suitable characteristics for IFR flight following a SAS failure. The flight characteristics requirements of Part 29 for rotorcraft are VFR requirements intended to provide suitable characteristics for VFR flight. For this reason, sections of Part 29 are not necessarily comparable to sections of Part 25 on a one-to-one basis as urged by the commenter and the requirements referenced in Part 29 are certainly not more stringent than those of Part 25. The less-stringent VFR handling qualities are permitted on the basis of a lower level of stability inherent to helicopters under SAS failure conditions. To further lower the standard would compromise a SAS failure criterion which has been used successfully in approximately 25 IFR approvals.

The commenter states that the full flight characteristics standard had not been met on one particular FAA approval and that the requirement should therefore be further relaxed. This FAA standard should not be structured based on exceptions. Rather, it should provide an appropriate minimum. To lower this standard because of a single case for which the standard did not apply is unwarranted and the wording of this section is adopted as proposed in the notice.

One organization recommends that credit toward meeting the single-pilot IFR stability requirements be given for installing an autopilot. The term "autopilot" has been subject to many definitions and interpretations in the helicopter community. It has been defined as anything from a SAS which would be eligible under paragraph VII, to a conventional autopilot which manipulates the primary flight controls and has no pilot "fly through" capability. The definitions also vary in reliability and complexity from a single-axis, wind-driven, wings-leveler device to a highly reliable, multipath, integrated system which would perform virtually all normal instrument flight maneuvers under probable failure conditions. To allow blanket credit for such a variation in capabilities cannot be permitted. If the system stabilizes the rotorcraft by allowing the pilot to "fly through" and perceive a stable, well-behaved vehicle, it qualifies as a SAS, clearly receives credit under paragraphs III through VII, and may be utilized for compliance with all handling qualities requirements. If a conventional autopilot does not provide "fly through" capability or allow the pilot to perceive a stable, well-behaved vehicle through his manipulation of the flight controls and the related feedback from those controls, then it tends to remove him from active involvement in flying and is eligible primarily as a workload reliever. Credit has been granted on that basis during previous certification programs. Since the commenter does not incude any justification to show why these provisions for "autopilot credit" should be changed, they will continue to be applied as before, and this portion of the rule is being adopted as proposed.

VIII. Equipment, Systems, and Installation. One commenter states that small helicopters should not have to comply with the Category A power supply requirement of § 29.1309(d) as indicated in the lead sentence of paragraph VIII. A category A electrical system requirement was never intended for small helicopters. Upon closer inspection of this paragraph, it is determined that the reference to § 29.1309 was not needed to define basic equipment and installation requirements and is removed. In its place a reference to § 29.1433 is added to the requirement for small helicopters to provide criteria for vacuum systems equivalent to that for electrical systems in § 29.1431. This change also helps clarify a later reference to "power supply" in paragraph VIII(b)(3) which was unclear to two commenters. The addition of a reference to § 29.1433 clearly indicates the eligibility of power sources other than electric for those flight instruments requiring a power supply. The addition of examples of sources used to power required flight instruments in paragraph VIII(b)(3) further aids in clarifying that requirement.

Two commenters feel that the required flight instruments should be clearly defined and listed as is done in § 25.1303. Upon review, it was found that § 25.1303 lists the same flight instruments as § 29.1303 plus a mach meter and speed warning which are currently only in Part 25. A further listing of the required flight instruments in the IFR appendix would be redundant with § 29.1303 and is, therefore, not incorporated.

One commenter feels that a vertical speed indicator should be required for IFR flight and four commenters want to delete the requirement for an instantaneous vertical speed indicator (IVSI), particularly for small rotorcraft. A fifth commenter recommends developing a performance standard for IVSI's.

A vertical speed indicator is specifically required in § 29.1303. As to the remaining comments concerning a vertical speed indicator, it is apparent that considerable confusion exists in the term "IVSI," and that neither industry nor government has defined the term sufficiently to clearly determine its meaning or its appropriate level of performance. Even though the IVSI requirement has been carried forward in renewed versions of the helicopter interim IFR standard, it is inappropriate for a final rule, lacking a defined standard of performance. For this reason, the proposed requirement for an IVSI in place of the standard vertical speed indicator is not adopted.

Two commenters suggest that the statement in VIII(a)(2) which prohibits the use of standby batteries for engine starting should be removed from the Part 27 requirement. These comments are based primarily on the high cost of existing self-contained standby attitude indicators and on satisfactory operating experience in some SFAR 29 configurations which use standby batteries to assist in engine starting. One of these commenters argues that this is a particular burden for small helicopters because of the high initial capital expenditure and the high percentage loss of payload. FAA has considered these comments in light of the SFAR 29 experience and the difference in intended level of safety for normal and transport categories. FAA agrees with the less stringent requirement suggested by these commenters for normal category. The requirement to exclude the standby batteries from engine starting is therefore removed from the normal category requirement.

One commenter indicates that the requirement for a magnetic gyro-stabilized direction indicator is excessively stringent for normal category rotorcraft. The commenter's opinion is based on SFAR 29 experience with a gyro-stabilized direction indicator set by reference to a magnetic direction indicator (often referred to as a whisky compass). FAA's experience in certifying direction indicators for IFR flight in helicopters reveals that a magnetic direction indicator, used in conjunction with a non-magnetic gyroscopic indicator, is suitable for flight in smooth air. For operation in moderate turbulence, however, the magnetic indicator is unsuitable. The effect is more degrading and much more severe in helicopters than for their fixed-wing counterparts. In Notice 80–25, FAA stated that "* * * the nonstabilized magnetic indicator, which is subject to many errors, is inadequate as the primary source of directional information, but it must remain as an emergency source. The standard directional gyro is also inadequate as the primary source of directional information because of drift and the requirement to set it by reference to some other precise reference. Therefore, a gyro-stabilized magnetic direction indicator would be required." Comments submitted have not addressed the degraded level of navigation performance associated with helicopters operated in turbulence without a magnetic gyro-stabilized indicator. Therefore, the requirement for a magnetic gyro-stabilized direction indicator proposed in Notice 80–25 is considered necessary to assure safe navigation capability and is adopted in the final rule.

One commenter states that the isolation features contained in paragraph VIII(b)(5) (that is, paragraph VIII(b)(6) of Notice 80–25) should not be required for normal category rotorcraft because these were basically transport airplane standards. The commenter feels essentially that independent sources are not necessary. These requirements are intended to assure that, for dual-pilot configurations, the first pilot station has a dedicated source for required flight instruments and that the required flightcrew operations are not compromised by the installation of additional equipment. Handling qualities criteria for normal category two-pilot operation are significantly relaxed from those required for single-pilot approval. Part of this relaxation includes a very limited longitudinal stability requirement and the lack of a return to trim requirement. This low initial level of stability makes it mandatory that accurate airspeed, altitude, and attitude information remain available to the required crew complement during both normal and reasonably anticipated failure conditions. This requirement is much more vital to a helicopter, which barely meets two-pilot helicopter instrument flight criteria, than it would be for small or transport airplane applications or for single-pilot IFR helicopters because all of those configurations have both a static longitudinal stability requirement throughout the flight envelope and a 10 percent return-to-trim requirement. These two requirements greatly aid aircraft control when airspeed indications are lost. Also, power changes in helicopters typically result in significantly greater longitudinal control changes than in fixed-wing airplanes. In the absence of at least one reliable airspeed and altitude indication, airspeed control in IFR helicopters can be quickly lost when performing even moderate power changes. For these reasons, it is necessary to adopt the proposed level of design for configurations requiring two pilots.

For configurations meeting the normal category single-pilot requirement, instruments for a second crew station (for training or at customer request) would not be "required instruments" and could be powered from existing sources which are used for other equipment.

One organization commments that by requiring calibration of the alternate static source in paragraph VIII(b)(5)(iv) (that is, paragraph VIII(b)(5)(ii) of Notice 80–25), this requirement would result in alternate source calibration cards in the cockpit. A calibration card, however, would only be required if the alternative source could not meet the 50-foot accuracy requirement of §§ 27.1325 and 29.1325.

One commenter states that §§ 27.1365 and 29.1365 allow circuit breakers or fuses to be used as protective devices, but in practice FAA has not permitted fuses on flight-critical items due to IFR pilot workload constraints. This commenter recommends a regulation to require circuit breaker protection for all required IFR systems. FAA has found both circuit breakers and fuses acceptable as protective devices for essential systems provided they can be located and identified to allow ready reset or replacement in flight. This requirement is found in §§ 27.1357 and 29.1357. FAA does not prohibit the use of fuses provided they are accessible and replaceable in flight and that sufficient spare fuses are available to the crew. We can find no justification for changing the requirements at this time.

One commenter suggests that autopilots and flight directors be included under the requirements of paragraph VIII(b)(5)(i) and that specific cockpit lighting requirements, switch positions, and annunciation be required for helicopter IFR. Neither flight directors nor autopilots are required for IFR certification in helicopters. They, therefore, do not come under the definition of "required flight instruments" (those listed in §29.1303) and are inappropriate for inclusion in this requirement. Cockpit lighting, switch position, and annunciator requirements are contained in general regulatory requirements and in more specific handbook criteria and policy guidance. Requirements in these areas are generally worded to allow innovation and variation in design. For a design requirement which has as its primary purpose establishing a minimum level of safety, incorporating specific requirements for these areas would not enhance safety or otherwise serve the needs of industry. The freedom to allow innovation in design should be retained and for this reason more specific requirements are not imposed.

Several commenters suggest clarifying the wording of paragraph VIII. Most of the wording was initially derived from similar requirements for other types of aircraft in other Federal Aviation Regulation parts. These comments have been reviewed and several changes are made to simplify and clarify wording, with no change in intent from Notice 80-25: (1) Examples of typical power supplies are included in paragraph VIII(b)(3) to indicate that the power supply indicator is not intended solely for electrical instruments; (2) Words are added in paragraph VIII(b)(4) to indicate that this requirement is only for multiple systems which perform like functions; (3) The words "the pilots" in paragraph VIII(b)(6)(ii) (of Notice 80-25) were changed to "a pilot" (in paragraph VIII(b)(5)(iii) of the rule) to more clearly indicate that information essential to safety of flight must remain available to at least one pilot following single or probable failures; (4) Wording is added to paragraph VIII(a)(2) in the rule (proposed paragraph VIII(a)(3)) to indicate one pilot's primary attitude indicator could satisfy the standby attitude indicator requirement for two-pilot configurations; (5) Paragraphs VIII(b) (5) and (6) of Notice 80-25 are reorganized, reworded, and simplified. The paragraph designator (6) is eliminated in the final rule. Concepts have been clarified, consolidated, and described by simpler wording throughout these paragraphs, and no change in meaning from Notice 80-25 is intended.

IX. Rotorcraft Flight Manual. One commenter proposes a requirement that new performance data must be presented either in the manufacturer's format or in a format created by the "STC facilities." It is unclear how such a requirement would improve safety. Any flight manual performance presentation which is clear and functional is acceptable to FAA regardless of format. The proposed change offered no rationale to show why other methods of presentation should not be allowed. Therefore, the proposal is not incorporated in this flight manual requirement.

Sections 27.1419 and 29.1419 Ice Protection.

The rule adopted in §§ 27.1419, 29.1419, and Appendix C to Part 29 establishes minimum safety standards for certification of rotorcraft for flight in icing conditions. Compliance with this rule is not required of all rotorcraft; it would be required only for those rotorcraft for which icing certification is requested. This rule simply requires that rotorcraft be capable of operating safely in icing conditions and defines the natural icing environment for certification. The defined icing environment is the same as that utilized and accepted for many years in icing certification of fixed-wing aircraft, except that inherent altitude limitations of helicopters are recognized.

Even though no U.S.-manufactured helicopters have been certified for flight in icing conditions, the need for icing certification criteria for helicopters has been recognized by industry and FAA. The helicopters industry, some time ago, requested that criteria be developed, and the FAA embarked on a program to accomplish this goal. FAA has developed icing special conditions for current rotorcraft programs and these requirements are substantively identical to those incorporated by this rule. Even if formal icing rules were not adopted, icing requirements similar to these would be applied as special conditions in those cases where icing certification is requested. There is, therefore, no economic impact in adopting this icing rule. Certification of rotorcraft in icing is a logical next step to the rapidly increasing usage and projections for increased future operation of rotorcraft in IFR conditions. A foreign-manufactured helicopter was recently approved by that foreign country for flight in icing conditions and developmental flight tests by several U.S. helicopter manufacturers have begun with the intent to obtain icing certification on new and existing models.

This icing rule is in accordance with the economic and regulatory guidelines of Executive Order 12291. As noted in Notice 80-25, the adoption of icing certification standards has no economic impact. Since certification for icing is not required of any rotorcraft, this rule merely offers an additional option for expanding rotorcraft utilization. The manufacturer and operator are not obligated to comply with these icing requirements and they have the option of deciding whether or not adoption of the capability to operate in icing offers an overall economic benefit for their particular application.

If flight in icing conditions is to be attempted, certified ice protection provisions offer positive safety benefits to people traveling in rotorcraft. Flight in icing conditions in any aircraft can entail risk due to increased structural loads and drag, and loss of lift, engine power, aircraft performance, stability, controllability, and forward visibility. Operating rotorcraft in icing can introduce additional risks due to the potential loss of autorotational capability with an iced main rotor and high vibrational stresses with an unbalanced rotor when asymmetrical ice shedding occurs. Certification with adequate ice protection provisions can eliminate these risks and, thereby, enhance safety for people traveling in rotorcraft in icing conditions.

In view of the need, economic viability, and positive safety benefits of rotorcraft icing certification, the FAA participated jointly with the U.S. Army in icing research flight tests involving various helicopters. In consideration of this experience and other pertinent icing data, a rotorcraft icing certification standard was proposed in Notice 80-25. Comments have been received, carefully considered, and are discussed as follows.

Most of the comments submitted on the proposed icing rules, along with the FAA reponses, apply to both the proposed §§ 27.1419 and 29.1419, although this may not be specifically noted in the comments. Where a comment applies to only one specific section, it is so noted.

It was correctly noted by one commenter that an Appendix A had been added to Parts 27 and 29 in the last year. Appendix A, Airworthiness Criteria for Helicopter Instrument Flight, and Appendix B, Icing Certification, as proposed in Notice 80-25, therefore become Appendix B and Appendix C, respectively, in the final rule.

Several commenters suggest changes that would allow limited or partial icing certification, that is, approval of an icing flight envelope which limits the range of natural icing parameters (liquid water content, droplet size, and outside air temperature) in which the rotorcraft can operate, or approvals with an ice protection system which provide only partial capability to operate in natural icing conditions. It is recognized that a specific rotorcraft may not have the capability to operate at the higher altitudes specified in Appendix C. Altitude, unlike other icing parameters (liquid water content, droplet size, and temperature), can be controlled by the flightcrew and therefore may be considered as a limiting condition in icing certification provided an operationally practical altitude envelope is available. It is not the intent of the FAA to require certification to icing parameters which cannot be encountered within the altitude capability of the rotorcraft. However, the concerns and objections to limited icing certification were stated in Notice 80-25. These are based on minimum safety considerations. Although several commenters recommend permitting limited certification, neither the FAA nor the commenters could provide a means of satisfying these concerns and objections. Therefore, the commenters' suggestion to permit limited or partial icing conditions per se is not adopted at this time. However, limiting a helicopter's altitude will result in changes to associated parameters such as liquid water content and temperature. A pilot would not directly control liquid water content or temperature, but at lower altitudes, the most severe combinations would not be encountered. A suitable icing envelope relating the changes in these parameters will be included in a forthcoming procedures manual.

One commenter recommends that Appendix C, which defines the icing environment for certification, be adopted as an "interim rule" for a fixed period of time, pending verification of the raw data and statistical procedures used to construct the curves. The criteria of Appendix C were developed by NACA (now NASA) and have been used successfully by FAA for over 25 years for certification of fixed-wing aircraft in icing conditions. Special consideration for the limited altitude capability of most rotorcraft is incorporated in the rotorcraft icing rule. However, in response to requests from industry, the FAA is sponsoring a reassessment of the criteria in Appendix C. Initial results of that review do not substantiate a change. In view of this and the long history of successful application, it is inappropriate to apply Appendix C on an interim basis at this time. Should the final results of the reassessment indicate a change is appropriate, such a change would be considered at that time. This effectively accomplishes the intent of the commenter's recommendation without being committed to the effort and expense of further rulemaking at a specified future point when final results may not be available and a change may or may not be warranted. Accordingly, Appendix C is being incorporated in the rule as proposed.

Two commenters recommend that the proposed rule be revised to permit extrapolation, due to the great expense and low probability of encountering extreme conditions during natural icing tests. Considerable analysis to show compliance with extreme conditions has been successfully used in icing certification of fixed-wing aircraft. It may be considered by the certification authority for rotorcraft icing approvals, depending on the similarity of results obtained by flight tests in natural ice with results obtained by analysis. In general, the rules contain minimum safety criteria. Specific means of compliance are not usually specified, in order to allow applicants maximum flexibility in methods of showing compliance. The subject of extrapolation is more appropriately addressed in policy and guidance material and is, therefore, not addressed in these rules.

One commenter recommends a series of changes to Parts 91 and 135 dealing with operation of rotorcraft in icing. It is acknowledged that the operational rules should allow for operation of icing-certified rotorcraft in icing conditions. Notice 80-25 and this amendment deal primarily with certification criteria, and it is planned to address operational proposals in a subsequent notice as described in the background information to Notice 80-25. The commenter's recommendations relative to operation of rotorcraft in icing, therefore, are deferred until issuance of the operations notice.

One commenter states that the wording, "the rotorcraft must demonstrate", in §§ 27.1419(b) and 29.1419(b) gives the impression that the rotorcraft is capable of conducting a demonstration all by itself. The wording is clarified to eliminate this interpretation. This paragraph will begin with the words, "It must be demonstrated that * * *." Although this wording does not appear in comparable sections of Parts 23 and 25, this requirement for demonstration is included in the rotorcraft rules to make it clear that the applicable requirements must be shown by actual demonstration. The commenter also points out that the term "flight envelope" in airplane certification rules refers to the maneuvering and gust envelope. Accordingly, the first sentence of §§ 27.1419(b) and 29.1419(b) is clarified to specify that the icing capability of the rotorcraft must be demonstrated and that this applies within the altitude envelope of the rotorcraft. As noted previously, this altitude envelope must be operationally practical.

Two commenters recommend changes to §§ 27.773, 29.773, 27.1093, 29.1093, 27.1323, 29.1323, 27.1325 and 29.1325 of the certification rules dealing with ice protection. The recommended changes would make these sections compatible with the icing certification requirements of §§ 27.1419 and 29.1419. The icing criteria referenced in §§ 27.1419 and 29.1419 are appropriate for IFR pitot-static system protection, but would be an excessively stringent design criterion for VFR approval under §§ 27.1323, 29.1323, 27.1325, and 29.1325. The compatibility of §§ 27.773, 29.773, 27.1093, and 29.1093 will be addressed in subsequent notices.

One commenter expresses the opinion that the wording of proposed §§ 27.1419(a) and 29.1419(a) could restrict a manufacturer from installing any anti-icing equipment on a helicopter unless complete ice protection certification is obtained for the helicopter. Identical wording as contained in the present fixed wing rules does not restrict manufacturers from installing such equipment. Installing equipment on a "no-hazard" basis has been allowed, even if the installation did not result in an operational approval. Also, the wording proposed by the commenter impinges on operational considerations, while this rule deals with certification requirements. This comment, however, raises a valid issue and wording in §§ 27.1419(a) and 29.1419(a) is changed to more accurately reflect that these requirements apply to rotorcraft for which full certification in icing conditions is desired.

One commenter states that §§ 27.1419(c) and 29.1419(c) imply that "complete" flight testing is required in measured natural atmospheric icing conditions in addition to testing by one or more other methods. The commenter expresses the opinion that this requirement is unreasonable. The rules clearly allow compliance by a variety of methods, provided they include flight tests in measured natural conditions to validate results obtained elsewhere. There is no inference of "complete" flight testing in measured natural conditions in this rule. If complete flight testing were prescribed, there would be no benefit or need to include other methods. The amount of flight testing required in measured natural conditions versus other methods will depend to a large extent on the substantiating data provided by the applicant in each particular certification program. The icing certification rules prescribe minimum safety criteria and permit reasonable flexibility in meeting these requirements. The FAA is aware of the time and expense involved in attaining icing certification. Substantial research and developmental effort and funding have been invested by the FAA over the past several years to reduce the time and cost associated with icing certification, and considerable progress has been made toward this goal. This commenter also proposes revising §§ 27.1419(c) and 29.1419(c) to permit certification by one or more methods, including flight tests in natural conditions. This proposal is unacceptable as it would permit icing certification without flight testing in natural conditions. At our current level of technology, some flight tests in natural conditions are an essential, minimum safety requirement and are necessary to validate results from other methods. In view of the foregoing considerations, the FAA disagrees that this requirement is unreasonable and this proposal is adopted without substantive change.

It is noted by one commenter that the proposed wording of §§ 27.1419(d) and 29.1419(d) is redundant in that rotors are included in the definition of airframe in Part 1. The FAA concurs and the words "and rotor systems" are deleted in the final rule.

Another commenter indicates that Subpart E presently contains all the icing requirements for the engine installation, and that the wording of the proposed §§ 27.1419(d) and 29.1419(d), which state "certain additional provisions of Subpart E of this part may be applicable", is subject to misinterpretation. The FAA concurs, and the revised wording suggested by the commenter is adopted. It is noted for clarification, however, that the revised wording does not preclude testing the engine installation for actual flight icing conditions that may present a hazard to engine operation, such as ingestion of ice shed from the rotorcraft.

One commenter recommends that the proposed § 27.1419 be written so that, if a small helicopter were to be approved in IFR or icing conditions, the total rotorcraft would be certificated under Part 29 as a transport category rotorcraft. Small helicopters have been successfully certified and operated in IFR conditions. Updated IFR certification rules for Part 27 rotorcraft are adopted as Appendix B of that part. The icing certification rules for Parts 27 and 29 rotorcraft are identical. However, to require small helicopters to comply with Part 29 transport category rules could impose rules which may be inappropriate and unnecessarily burdensome for small rotorcraft. Compliance with the IFR and icing rules of Part 27 would provide an adequate level of safety for small rotorcraft. Accordingly, proposed § 27.1419 is adopted without substantive change.

Economic Summary

The FAA conducted an evaluation of the economic impact of these regulatory changes. A copy of the evaluation has been placed in the docket. The findings of this evaluation are summarized below.

Applicability—Category A Performance Requirements

This change would require new design rotorcraft with 10 or more passenger seats to be multiengine and have category A performance in parts of the flight regime.

The FAA concludes that this change will impose no additional costs on the private sector for the following reasons:

1. Industry sources state there has not been a demand for new design single-engine rotorcraft configured to carry 10 or more passengers and none is expected in the future. Therefore, manufacturers have elected to develop only twin-engine designs for helicopters configured for 10 or more passengers. This rule formalizes current industry practice without restricting either operators or manufacturers since single-engine helicopters are being and will continue to be produced under current type certificates and modifications. Therefore, there will be no economic burden on either manufacturers or operators and passengers will realize additional safety benefits.

2. This change will require an increase in installed power from what is generally available in current models, but any helicopter type certificated under this change would be likely to have the necessary installed power whether or not the change is enacted. No helicopter could be type certificated under this changed rule before 1985, and Figure A shows that, because of the general industry trend toward increased installed power, new model helicopters will meet the requirement before a new helicopter could be type certificated under the change.

The FAA concludes that this rule change will have safety benefits which are difficult to quantify. A review of the available rotorcraft accident data shows that if category A performance had been available, it may have prevented nine past accidents. However, since the change applies only to new model rotorcraft, it would not prevent similar accidents of present model rotorcraft in the future.

Applicability—Other Changes

The removal of height-velocity as a limitation for under-10-passenger-seat applications will provide additional flexibility to helicopter operators at no cost. This change will increase the productivity of rotorcraft in such applications, but the value of that productivity increase is unquantifiable. In some cases, to comply with the current rule, operators have to reduce productivity of a flight by reducing payload or decreasing fuel. This change eliminates the need for such adjustment.

Removal of the 20,000-pound weight limit for category B could result in increased revenues for operators if current rotorcraft models are requalified at higher weights. FAA estimates the value of the revenue increases at $5 million to $13 million per year from 1982 through 1989 for a total of $62.7 million with a net present value of $43.0 million. New large helicopters will also have the benefit of this increased weight capability.

IFR Certification Standards (Parts 27 and 29)

The instrument flight rules (IFR) certification standards will impose no new costs on helicopter operators and manufacturers. IFR certification is currently administered through "Interim Standards" which contain similar requirements to those in this amendment. Moreover, the rule change permits helicopter modifiers and operators to obtain approvals for IFR operation, and approvals under the rule change will reduce the regulatory burden because they will be broader in scope than current SFAR 29 approvals, will be sought less frequently, and will include no recurrent requalification features. This rule change will also permit manufacturers of small helicopters to obtain IFR certification at a slightly lower cost than under the current "Interim Standard" due to relaxation of requirements in some areas. There is, therefore, only a small, unquantified economic benefit in adopting this rule.

Since this rule change essentially formalizes the regulatory mechanism for obtaining IFR certification, it is not expected to result in any quantifiable safety benefits.

Icing Certification Standards (Parts 27 and 29)

The icing certification standards in this amendment provide regulatory guidance on how to obtain an additional level of operational capability. A helicopter operator, therefore, will weigh this increased operations capability against increased production costs that will be factored into the purchase price of the aircraft. In the past, the FAA has developed special conditions to certify rotorcraft for icing conditions. Issuing special conditions is a time-consuming process. Proposed special conditions are published in the Federal Register, comments are analyzed, and then a final document is issued and published.

These amendments incorporate standards currently contained in special conditions into the FAR icing certification rules. If this icing rule were not adopted, those special conditions would continue to be administered for icing approval. Therefore, this rule will have only a positive economic impact for manufacturers, operators, and the FAA. A manufacturer will incur the costs of obtaining icing approval only if it has determined that marketing benefits outweigh production costs and it wishes to have its helicopters certificated for operation in icing conditions. Both manufacturers and operators are likely to find icing certification advantageous from both a marketing and utilization standpoint because it would allow full use of the IFR capabilities of the rotorcraft.

Icing certification will allow increased utilization and will have an unquantifiable safety benefit. It will reduce the risk of accidents during flight in icing conditions. Because of increasing rotorcraft operations, exposure to these conditions may increase greatly in the future.

SUMMARY OF BENEFITS AND COSTS

[Millions of 1983 dollars]

	Benefits	Costs	Benefits/cost ratio
10 or more passengers, category A	Improved Safety	Negligible	Not applicable.
Remove height-velocity limitations	Increased productivity; Unquantifiable Revenue Benefit.	Negligible	Not applicable.
Remove 20,000 lb. limitation	$62.7 (7 years) (or $43.0 present value)	Negligible	Not applicable.
IFR certification	Reduced regulatory burden, Small, unquantifiable economic benefit.	Negligible	Not applicable.
Icing certification	Increased utilization resulting in increased operator revenues.	Negligible [1]	Not applicable.

[1] Cost negligible since icing certification is not mandatory. However, manufacturers' costs of icing certification will be offset by increased sales to operators wishing to utilize rotorcraft in icing conditions.

Regulatory Flexibility Determination

A final regulatory flexibility analysis of this amendment is not necessary since Notice 80-25 was issued before January 1, 1981. However, the overall impact of the amendments should not be adverse for small entities.

List of Subjects

14 CFR Part 1

Airmen, Flights, Balloons, Parachutes, Aircraft pilots, Pilots, Transportation, Agreements, Kites, Air safety, Safety, Aviation safety, Air transportation, Air carriers, Aircraft, Airports, Airplanes, Helicopters, Rotorcraft, Heliports.

14 CFR Parts 27 and 29

Air transportation; Aircraft, Aviation safety, Safety, Tires.

Adoption of the Amendment

Accordingly, Parts 1, 27, and 29 of the Federal Aviation Regulations (14 CFR Parts 1, 27, and 29) are amended as follows, effective March 2, 1983.

PART 1—DEFINITIONS AND ABBREVIATIONS

1. By amending § 1.1 by adding the following definitions after the definitions of "Category:"

§ 1.1 General definitions.

* * * * *

"Category A," with respect to transport category rotorcraft, means multiengine rotorcraft designed with engine and system isolation features specified in Part 29 and utilizing scheduled takeoff and landing operations under a critical engine failure concept which assures adequate designated surface area and adequate performance capability for continued safe flight in the event of engine failure.

"Category B," with respect to transport category rotorcraft, means single-engine or multiengine rotorcraft which do not fully meet all Category A standards. Category B rotorcraft have no guaranteed stay-up ability in the event of engine failure and unscheduled landing is assumed.

* * * * *

PART 27—AIRWORTHINESS STANDARDS: NORMAL CATEGORY ROTORCRAFT

2. By removing the word "and" at the end of § 27.141(b)(1); by adding a new § 27.141(b)(3); and by adding a sentence to the end of § 27.141(c) to read as follows:

§ 27.141 General.

* * * * *

(b) * * *

(3) Sudden, complete control system failures specified in § 27.695 of this part; and

* * * * *

(c) * * * Requirements for helicopter instrument flight are contained in Appendix B of this part.

3. By adding a new § 27.1419 to read as follows:

§ 27.1419 Ice protection.

(a) To obtain certification for flight into icing conditions, compliance with this section must be shown.

(b) It must be demonstrated that the rotorcraft can be safely operated in the continuous maximun and intermittent. maximum icing conditions determined under Appendix C of Part 29 of this chapter within the rotorcraft altitude envelope. An analysis must be performed to establish, on the basis of the rotorcraft's operational needs, the adequacy of the ice protection system for the various components of the rotorcraft.

(c) In addition to the analysis and physical evaluation prescribed in paragraph (b) of this section, the effectiveness of the ice protection system and its components must be shown by flight tests of the rotorcraft or its components in measured natural atmospheric icing conditions and by one or more of the following tests as found necessary to determine the adequacy of the ice protection system:

(1) Laboratory dry air or simulated icing tests, or a combination of both, of the components or models of the components.

(2) Flight dry air tests of the ice protection system as a whole, or its individual components.

(3) Flight tests of the rotorcraft or its components in measured simulated icing conditions.

(d) The ice protection provisions of this section are considered to be applicable primarily to the airframe. Powerplant installation requirements are contained in Subpart E of this part.

(e) A means must be indentified or provided for determining the formation of ice on critical parts of the rotorcraft. Unless otherwise restricted, the means must be available for nighttime as well as daytime operation. The rotorcraft flight manual must describe the means of determining ice formation and must contain information necessary for safe operation of the rotorcraft in icing conditions.

4. By adding an Appendix B to Part 27 to read as follows:

Appendix B.—Airworthiness Criteria for Helicopter Instrument Flight

I. *General.* A normal category helicopter may not be type certificated for operation under the instrument flight rules (IFR) of this chapter unless it meets the design and installation requirements contained in this appendix.

II. *Definitions.* (a) V_{YI} means instrument climb speed, utilized instead of V_Y for compliance with the climb requirements for instrument flight.

(b) V_{NEI} means instrument flight never exceed speed, utilized instead of V_{NE} for compliance with maximum limit speed requirements for instrument flight.

(c) V_{MINI} means instrument flight minimum speed, utilized in complying with minimum limit speed requirements for instrument flight.

III. *Trim.* It must be possible to trim the cyclic, collective, and directional control forces to zero at all approved IFR airspeeds, power settings, and configurations appropriate to the type.

IV. *Static longitudinal stability.* (a) *General.* The helicopter must possess positive static longitudinal control force stability at critical combinations of weight and center of gravity at the conditions specified in paragraph IV (b) or (c) of this appendix, as appropriate. The stick force must vary with speed so that any substantial speed change results in a stick force clearly perceptible to the pilot. For single-pilot approval, the airspeed must return to within 10 percent of the trim speed when the control force is slowly released for each trim condition specified in paragraph IV(b) of the this appendix.

(b) *For single-pilot approval:*

(1) *Climb.* Stability must be shown in climb throughout the speed range 20 knots either side of trim with—

(i) The helicopter trimmed at V_{YI};

(ii) Landing gear retracted (if retractable); and

(iii) Power required for limit climb rate (at least 1,000 fpm) at V_{YI} or maximum continuous power, whichever is less.

(2) *Cruise.* Stability must be shown throughout the speed range from 0.7 to 1.1 V_H or V_{NEI}, whichever is lower, not to exceed ±20 knots from trim with—

(i) The helicopter trimmed and power adjusted for level flight at 0.9 V_H or 0.9 V_{NEI}, whichever is lower; and

(ii) Landing gear retracted (if retractable).

(3) *Slow cruise.* Stability must be shown throughout the speed range from 0.9 V_{MINI} to 1.3 V_{MINI} or 20 knots above trim speed, whichever is greater, with—

(i) the helicopter trimmed and power adjusted for level flight at 1.1 V_{MINI}; and

(ii) Landing gear retracted (if retractable).

(4) *Descent.* Stability must be shown throughout the speed range 20 knots either side of trim with—

(i) The helicopter trimmed at 0.8 V_H or 0.8 V_{NEI} (or 0.8 V_{LE} for the landing gear extended case), whichever is lower;

(ii) Power required for 1,000 fpm descent at trim speed; and

(iii) Landing gear extended and retracted, if applicable.

(5) *Approach.* Stability must be shown throughout the speed range from 0.7 times the minimum recommended approach speed to 20 knots above the maximum recommended approach speed with—

(i) The helicopter trimmed at the recommended approach speed or speeds;

(ii) Landing gear extended and retracted, if applicable; and

(iii) Power required to maintain a 3° glide path and power required to maintain the steepest approach gradient for which approval is requested.

(c) Helicopters approved for a minimum crew of two pilots must comply with the provisions of paragraphs IV(b)(2) and IV(b)(5) of this appendix.

V. *Static lateral-directional stability.* (a) Static directional stability must be positive throughout the approved ranges of airspeed, power, and vertical speed. In straight, steady sideslips up to ±10° from trim, directional control position must increase in approximately constant proportion to angle of sideslip. At greater angles up to the maximum sideslip angle appropriate to the type, increased directional control position must produce increased angle of sideslip.

(b) During sideslips up to ±10° from trim throughout the approved ranges of airspeed, power, and vertical speed, there must be no negative dihedral stability perceptible to the pilot through lateral control motion or force. Longitudinal cyclic movement with sideslip must not be excessive.

VI. *Dynamic stability.* (a) For single-pilot approval—

(1) Any oscillation having a period of less than 5 seconds must damp to ½ amplitude in not more than one cycle.

(2) Any oscillation having a period of 5 seconds or more but less than 10 seconds must damp to ½ amplitude in not more than two cycles.

(3) Any oscillation having a period of 10 seconds or more but less than 20 seconds must be damped.

(4) Any oscillation having a period of 20 seconds or more may not achieve double amplitude in less than 20 seconds.

(5) Any aperiodic response may not achieve double amplitude in less than 6 seconds.

(b) For helicopters approved with a minimum crew of two pilots—

(1) Any oscillation having a period of less than 5 seconds must damp to ½ amplitude in not more than two cycles.

(2) Any oscillation having a period of 5 seconds or more but less than 10 seconds must be damped.

(3) Any oscillation having a period of 10 seconds or more may not achieve double amplitude in less than 10 seconds.

VII. *Stability augmentation system (SAS).* (a) If a SAS is used, the reliability of the SAS must be related to the effects of its failure. The occurrence of any failure condition which would prevent continued safe flight and landing must be extremely improbable. For any failure condition of the SAS which is not shown to be extremely improbable—

(1) The helicopter must be safely controllable and capable of prolonged instrument flight without undue pilot effort. Additional unrelated probable failures affecting the control system must be considered; and

(2) The flight characteristics requirements in Subpart B of Part 27 must be met throughout a practical flight envelope.

(b) The SAS must be designed so that it cannot create a hazardous deviation in flight path or produce hazardous loads on the helicopter during normal operation or in the event of malfunction or failure, assuming corrective action begins within an appropriate period of time. Where multiple systems are installed, subsequent malfunction conditions must be considered in sequence unless their occurrence is shown to be improbable.

VIII. *Equipment, systems, and installation.* The basic equipment and installation must comply with §§ 29.1303, 29.1431, and 29.1433 through Amendment 29-14, with the following exceptions and additions:

(a) *Flight and Navigation Instruments.* (1) A magnetic gyro-stablized direction indicator instead of a gyroscopic direction indicator required by § 29.1303(h); and

(2) A standby attitude indicator which meets the requirements of §§ 29.1303(g) (1) through (7) instead of a rate-of-turn indicator required by § 29.1303(g). For two-pilot configurations, one pilot's primary indicator may be designated for this purpose. If standby batteries are provided, they may be charged from the aircraft electrical system if adequate isolation is incorporated.

(b) *Miscellaneous requirements.* (1) Instrument systems and other systems essential for IFR flight that could be adversely affected by icing must be adequately protected when exposed to the continuous and intermittent maximum icing conditions defined in Appendix C of Part 29 of this chapter, whether or not the rotorcraft is certificated for operation in icing conditions.

(2) There must be means in the generating system to automatically de-energize and disconnect from the main bus any power source developing hazardous overvoltage.

(3) Each required flight instrument using a power supply (electric, vacuum, etc.) must have a visual means integral with the instrument to indicate the adequacy of the power being supplied.

(4) When multiple systems performing like functions are required, each system must be grouped, routed, and spaced so that physical separation between systems is provided to ensure that a single malfunction will not adversely affect more than one system.

(5) For systems that operate the required flight instruments at each pilot's station—

(i) Only the required flight instruments for the first pilot may be connected to that operating system;

(ii) Additional instruments, systems, or equipment may not be connected to an operating system for a second pilot unless provisions are made to ensure the continued normal functioning of the required instruments in the event of any malfunction of the additional instruments, systems, or equipment which is not shown to be extremely improbable;

(iii) The equipment, systems, and installations must be designed so that one display of the information essential to the safety of flight which is provided by the instruments will remain available to a pilot, without additional crewmember action, after any single failure or combination of failures that is not shown to be extremely improbable; and

(iv) For single-pilot configurations, instruments which require a static source must be provided with a means of selecting an alternate source and that source must be calibrated.

IX. *Rotorcraft Flight Manual.* A Rotorcraft Flight Manual or Rotorcraft Flight Manual IFR Supplement must be provided and must contain—

(a) *Limitations.* The approved IFR flight envelope, the IFR flightcrew composition, the revised kinds of operation, and the steepest

IFR precision approach gradient for which the helicopter is approved;

(b) *Procedures.* Required information for proper operation of IFR systems and the recommended procedures in the event of stability augmentation or electrical system failures; and

(c) *Performance.* If V_{YI} differs from V_Y, climb performance at V_{YI} and with maximum continuous power throughout the ranges of weight, altitude, and temperature for which approval is requested.

PART 29—AIRWORTHINESS STANDARDS: TRANSPORT CATEGORY ROTORCRAFT

5. By revising § 29.1 to read as follows:

§ 29.1 Applicability.

(a) This Part prescribes airworthiness standards for the issue of type certificates, and changes to those certificates, for transport category rotorcraft.

(b) Transport category rotorcraft must be certificated in accordance with either the Category A or Category B requirements of this Part. A multiengine rotorcraft may be type certificated as both Category A and Category B with appropriate and different operating limitations for each category.

(c) Rotorcraft with a maximum weight greater than 20,000 pounds and 10 or more passenger seats must be type certificated as Category A rotorcraft.

(d) Rotorcraft with a maximum weight greater than 20,000 pounds and nine or less passenger seats may be type certificated as Category B rotorcraft provided the Category A requirements of Subparts C, D, E, and F of this Part are met.

(e) Rotorcraft with a maximum weight of 20,000 pounds or less but with 10 or more passenger seats may be type certificated as Category B rotorcraft provided the Category A requirements of §§ 29.67(a)(2), 29.79, 29.1517, and of Subparts C, D, E, and F of this Part are met.

(f) Rotorcraft with a maximum weight of 20,000 pounds or less and nine or less passenger seats may be type certificated as Category B rotorcraft.

(g) Each person who applies under Part 21 for a certificate or change described in paragraphs (a) through (f) of this section must show compliance with the applicable requirements of this Part.

6. By revising § 29.79(a) to read as follows:

§ 29.79 Limiting height-speed envelope.

(a) If there is any combination of height and forward speed (including hover) under which a safe landing cannot be made under the applicable power failure condition in paragraph (b) of this section, a limiting height-speed envelope must be established for—

(1) *Category A.* Combinations of weight, pressure altitude, and ambient temperature for which takeoff and landing are approved; and

(2) *Category B.*

(i) Altitude, from standard sea level conditions to the maximum altitude for which takeoff and landing are approved; and

(ii) Weight, from the maximum weight (at sea level) to the highest weight approved for takeoff and landing at each altitude. For helicopters, this weight need not exceed the highest weight allowing hovering out-of-ground-effect at each altitude.

* * * * *

7. By amending § 29.141 by removing the word "and" at the end of § 29.141(b)(1), adding a new § 29.141(b)(3), and adding a sentence to the end of § 29.141(c) to read as follows:

§ 29.141 General.

* * * * *

(b) * * *

(3) Sudden, complete control system failures specified in § 29.695 of this part; and

(c) * * * Requirements for helicopter instrument flight are contained in Appendix B of this Part.

§ 29.877 [Reserved]

8. By removing § 29.877 and marking it "Reserved."

9. By revising § 29.1321(b) to read as follows:

§ 29.1321 Arrangement and visibility.

* * * * *

(b) Each instrument necessary for safe operation, including the airspeed indicator, gyroscopic direction indicator, gyroscopic bank-and-pitch indicator, slip-skid indicator, altimeter, rate-of-climb indicator, rotor tachometers, and the indicator most representative of engine power, must be grouped and centered as nearly as practicable about the vertical plane of the pilot's forward vision. In addition, for rotorcraft approved for IFR flight—

(1) The instrument that most effectively indicates attitude must be on the panel in the top center position;

(2) The instrument that most effectively indicates direction of flight must be adjacent to and directly below the attitude instrument;

(3) The instrument that most effectively indicates airspeed must be adjacent to and to the left of the attitude instrument; and

(4) The instrument that most effectively indicates altitude or is most frequently utilized in control of altitude must be adjacent to and to the right of the attitude instrument.

* * * * *

10. By adding a new § 29.1419 to read as follows:

§ 29.1419 Ice protection.

(a) To obtain certification for flight into icing conditions, compliance with this section must be shown.

(b) It must be demonstrated that the rotorcraft can be safely operated in the continuous maximum and intermittent maximum icing conditions determined under Appendix C of this part within the rotorcraft altitude envelope. An analysis must be performed to establish, on the basis of the rotorcraft's operational needs, the adequacy of the ice protection system for the various components of the rotorcraft.

(c) In addition to the analysis and physical evaluation prescribed in paragraph (b) of this section, the effectiveness of the ice protection system and its components must be shown by flight tests of the rotorcraft or its components in measured natural atmospheric icing conditions and by one or more of the following tests as found necessary to determine the adequacy of the ice protection system:

(1) Laboratory dry air or simulated icing tests, or a combination of both, of the components or models of the components.

(2) Flight dry air tests of the ice protection system as a whole, or its individual components.

(3) Flight tests of the rotorcraft or its components in measured simulated icing conditions.

(d) The ice protection provisions of this section are considered to be applicable primarily to the airframe. Powerplant installation requirements are contained in Subpart E of this part.

(e) A means must be identified or provided for determining the formation of ice on critical parts of the rotorcraft. Unless otherwise restricted, the means must be available for nighttime as well as daytime operation. The rotorcraft flight manual must describe the means of determining ice formation and must contain information necessary for safe operation of the rotorcraft in icing conditions.

11. By revising § 29.1517 to read as follows:

§ 29.1517 Limiting height-speed envelope.

For Category A rotorcraft, if a range of heights exists at any speed, including zero, within which it is not possible to make a safe landing following power failure, the range of heights and its variation with forward speed must be established, together with any other pertinent information, such as the kind of landing surface.

12. By amending § 29.1587 by removing the word "and" at the end of paragraph (b)(5); by redesignating (b)(6) as (b)(7), and by adding a new (b)(6) to read as follows:

§ 29.1587 Performance information.

* * * * *

(b) * * *

(6) The height-speed envelope except for rotorcraft incorporating this as an operating limitation; and

* * * * *

13. By adding an Appendix B to Part 29 to read as follows:

Appendix B.—Airworthiness Criteria for Helicopter Instrument Flight

I. *General.* A transport category helicopter may not be type certificated for operation under the instrument flight rules (IFR) of this chapter unless it meets the design and installation requirements contained in this appendix.

II. *Definitions.* (a) V_{YI} means instrument climb speed, utilized instead of V_Y for compliance with the climb requirements for instrument flight.

(b) V_{NEI} means instrument flight never exceed speed, utilized instead of V_{NE} for compliance with maximum limit speed requirements for instrument flight.

(c) V_{MINI} means instrument flight minimum speed, utilized in complying with minimum limit speed requirements for instrument flight.

III. *Trim.* It must be possible to trim the cyclic, collective, and directional control forces to zero at all approved IFR airspeeds, power settings, and configurations appropriate to the type.

IV. *Static longitudinal stability.* (a) *General.* The helicopter must possess positive static longitudinal control force stability at critical combinations of weight and center of gravity at the conditions specified in paragraphs IV (b) through (f) of this appendix. The stick force must vary with speed so that any substantial speed change results in a stick force clearly perceptible to the pilot. The airspeed must return to within 10 percent of the trim speed when the control force is slowly released for each trim condition specified in paragraphs IV (b) through (f) of this appendix.

(b) *Climb.* Stability must be shown in climb thoughout the speed range 20 knots either side of trim with—

(1) The helicopter trimmed at V_{YI};

(2) Landing gear retracted (if retractable); and

(3) Power required for limit climb rate (at least 1,000 fpm) at V_{YI} or maximum continuous power, whichever is less.

(c) *Cruise.* Stability must be shown throughout the speed range from 0.7 to 1.1 V_H or V_{NEI}, whichever is lower, not to exceed ±20 knots from trim with—

(1) The helicopter trimmed and power adjusted for level flight at 0.9 V_H or 0.9 V_{NEI}, whichever is lower; and

(2) Landing gear retracted (if retractable).

(d) *Slow cruise.* Stability must be shown throughout the speed range from 0.9 V_{MINI} to 1.3 V_{MINI} or 20 knots above trim speed, whichever is greater, with—

(1) The helicopter trimmed and power adjusted for level flight at 1.1 V_{MINI}; and

(2) Landing gear retracted (if retractable).

(e) *Descent.* Stability must be shown throughout the speed range 20 knots either side of trim with—

(1) The helicopter trimmed at 0.8 V_H or 0.8 V_{NEI} (or 0.8 V_{LE} for the landing gear extended case), whichever is lower;

(2) Power required for 1,000 fpm descent at trim speed; and

(3) Landing gear extended and retracted, if applicable.

(f) *Approach.* Stability must be shown throughout the speed range from 0.7 times the minimum recommended approach speed to 20 knots above the maximum recommended approach speed with—

(1) The helicopter trimmed at the recommended approach speed or speeds;

(2) Landing gear extended and retracted, if applicable; and

(3) Power required to maintain a 3° glide path and power required to maintain the steepest approach gradient for which approval is requested.

V. *Static lateral-directional stability.* (a) Static directional stability must be positive throughout the approved ranges of airspeed, power, and vertical speed. In straight, steady sideslips up to ±10° from trim, directional control position must increase in approximately constant proportion to angle of sideslip. At greater angles up to the maximum sideslip angle appropriate to the type, increased directional control position must produce increased angle of sideslip.

(b) During sideslips up to ±10° from trim throughout the approved ranges of airspeed, power, and vertical speed there must be no negative dihedral stability perceptible to the pilot through lateral control motion or force. Longitudinal cycle movement with sideslip must not be excessive.

VI. *Dynamic stability.* (a) Any oscillation having a period of less than 5 seconds must damp to 1/2 amplitude in not more than one cycle.

(b) Any oscillation having a period of 5 seconds or more but less than 10 seconds must damp to 1/2 amplitude in not more than two cycles.

(c) Any oscillation having a period of 10 seconds or more but less than 20 seconds must be damped.

(d) Any oscillation having a period of 20 seconds or more may not achieve double amplitude in less than 20 seconds.

(e) Any aperiodic response may not achieve double amplitude in less than 9 seconds.

VII. *Stability augmentation system (SAS).* (a) If a SAS is used, the reliability of the SAS must be related to the effects of its failure. The occurrence of any failure condition which would prevent continued safe flight and landing must be extremely improbable. For any failure condition of the SAS which is not shown to be extremely improbable—

(1) The helicopter must be safely controllable and capable of prolonged instrument flight without undue pilot effort. Additional unrelated probable failures affecting the control system must be considered; and

(2) The flight characteristics requirements in Subpart B of Part 29 must be met throughout a practical flight envelope.

(b) The SAS must be designed so that it cannot create a hazardous deviation in flight path or produce hazardous loads on the helicopter during normal operation or in the event of malfunction or failure, assuming corrective action begins within an appropriate period of time. Where multiple systems are installed, subsequent malfunction conditions must be considered in sequence unless their occurrence is shown to be improbable.

VIII. *Equipment, systems, and installation.* The basic equipment and installation must comply with Subpart F of Part 29 through Amendment 29–14, with the following exceptions and additions:

(a) *Flight and navigation instruments.* (1) A magnetic gyro-stabilized direction indicator instead of the gyroscopic direction indicator required by § 29.1303(h); and

(2) A standby attitude indicator which meets the requirements of §§ 29.1303(g) (1) through (7), instead of a rate-of-turn indicator required by § 29.1303(g). If standby batteries are provided, they may be charged from the aircraft electrical system if adequate isolation is incorporated. The system must be designed so that the standby batteries may not be used for engine starting.

(b) *Miscellaneous requirements.* (1) Instrument systems and other systems essential for IFR flight that could be adversely affected by icing must be provided with adequate ice protection whether or not the rotorcraft is certificated for operation in icing conditions.

(2) There must be means in the generating system to automatically de-energize and disconnect from the main bus any power source developing hazardous overvoltage.

(3) Each required flight instrument using a power supply (electric, vacuum, etc.) must have a visual means integral with the instrument to indicate the adequacy of the power being supplied.

(4) When multiple systems performing like functions are required, each system must be grouped, routed, and spaced so that physical separation between systems is provided to ensure that a single malfunction will not adversely affect more than one system.

(5) For systems that operate the required flight instruments at each pilot's station—

(i) Only the required flight instruments for the first pilot may be connected to that operating system;

(ii) Additional instruments, systems, or equipment may not be connected to an operating system for a second pilot unless provisions are made to ensure the continued normal functioning of the required instruments in the event of any malfunction of the additional instruments, systems, or equipment which is not shown to be extremely improbable;

(iii) The equipment, systems, and installations must be designed so that one display of the information essential to the safety of flight which is provided by the instruments will remain available to a pilot, without additional crew-member action, after any single failure or combination of failures that is not shown to be extremely improbable; and

(iv) For single-pilot configurations, instruments which require a static source must be provided with a means of selecting an alternate source and that source must be calibrated.

IX. *Rotorcraft Flight Manual.* A Rotorcraft Flight Manual or Rotorcraft Flight Manual IFR Supplement must be provided and must contain—

(a) *Limitations.* The approved IFR flight envelope, the IFR flightcrew composition, the revised kinds of operation, and the steepest IFR precision approach gradient for which the helicopter is approved;

(b) *Procedures.* Required information for proper operation of IFR systems and the recommended procedures in the event of stability augmentation or electrical system failures; and

(c) *Performance.* If V_{YI} differs from V_Y, climb performance at V_{YI} and with maximum continuous power throughout the ranges of weight, altitude, and temperature for which approval is requested.

14. By adding an Appendix C to Part 29 to read as follows:

Appendix C

(a) *Continuous maximum icing.* The maximum continuous intensity of atmospheric icing conditions (continuous maximum icing) is defined by the variables of the cloud liquid water content, the mean effective diameter of the cloud droplets, the ambient air temperature, and the interrelationship of these three variables as shown in Figure 1 of this appendix. The limiting icing envelope in terms of altitude and temperature is given in Figure 2 of this appendix. The interrelationship of cloud liquid water content with drop diameter and altitude is determined from Figures 1 and 2. The cloud liquid water content for continuous maximum icing conditions of a horizontal extent, other than 17.4 nautical miles, is determined by the value of liquid water content of Figure 1, multiplied by the appropriate factor from Figure 3 of this appendix.

(b) *Intermittent maximum icing.* The intermittent maximum intensity of atmospheric icing conditions (intermittent maximum icing) is defined by the variables of the cloud liquid water content, the mean effective diameter of the cloud droplets, the ambient air temperature, and the interrelationship of these three variables as shown in Figure 4 of this appendix. The limiting icing envelope in terms of altitude and temperature is given in Figure 5 of this appendix. The interrelationship of cloud liquid water content with drop diameter and altitude is determined from Figures 4 and 5. The cloud liquid water content for intermittent maximum icing conditions of a horizontal extent, other than 2.6 nautical miles, is determined by the value of cloud liquid water content of Figure 4 multiplied by the appropriate factor in Figure 6 of this appendix.

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APPENDIX C

FIGURE 1

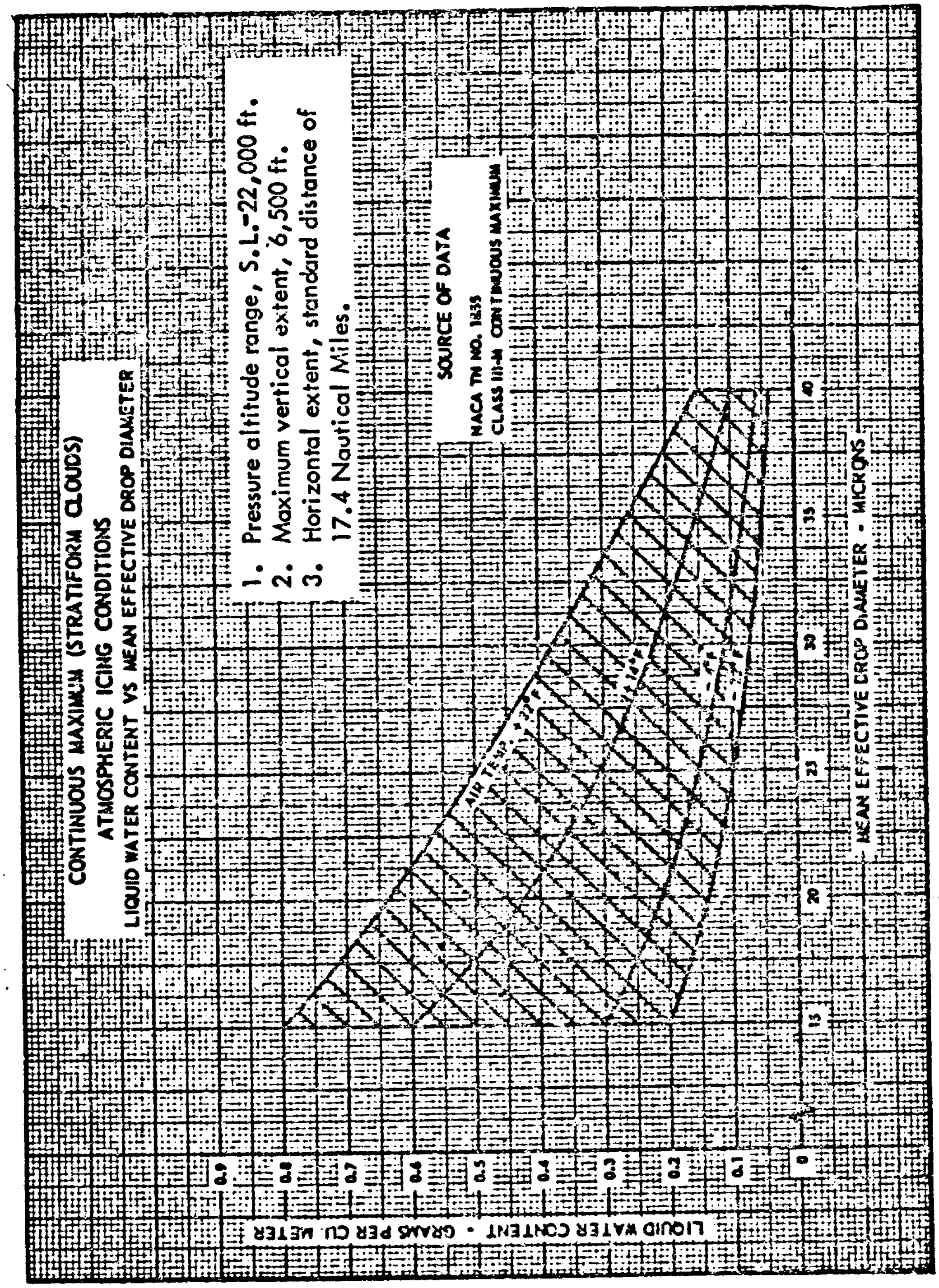

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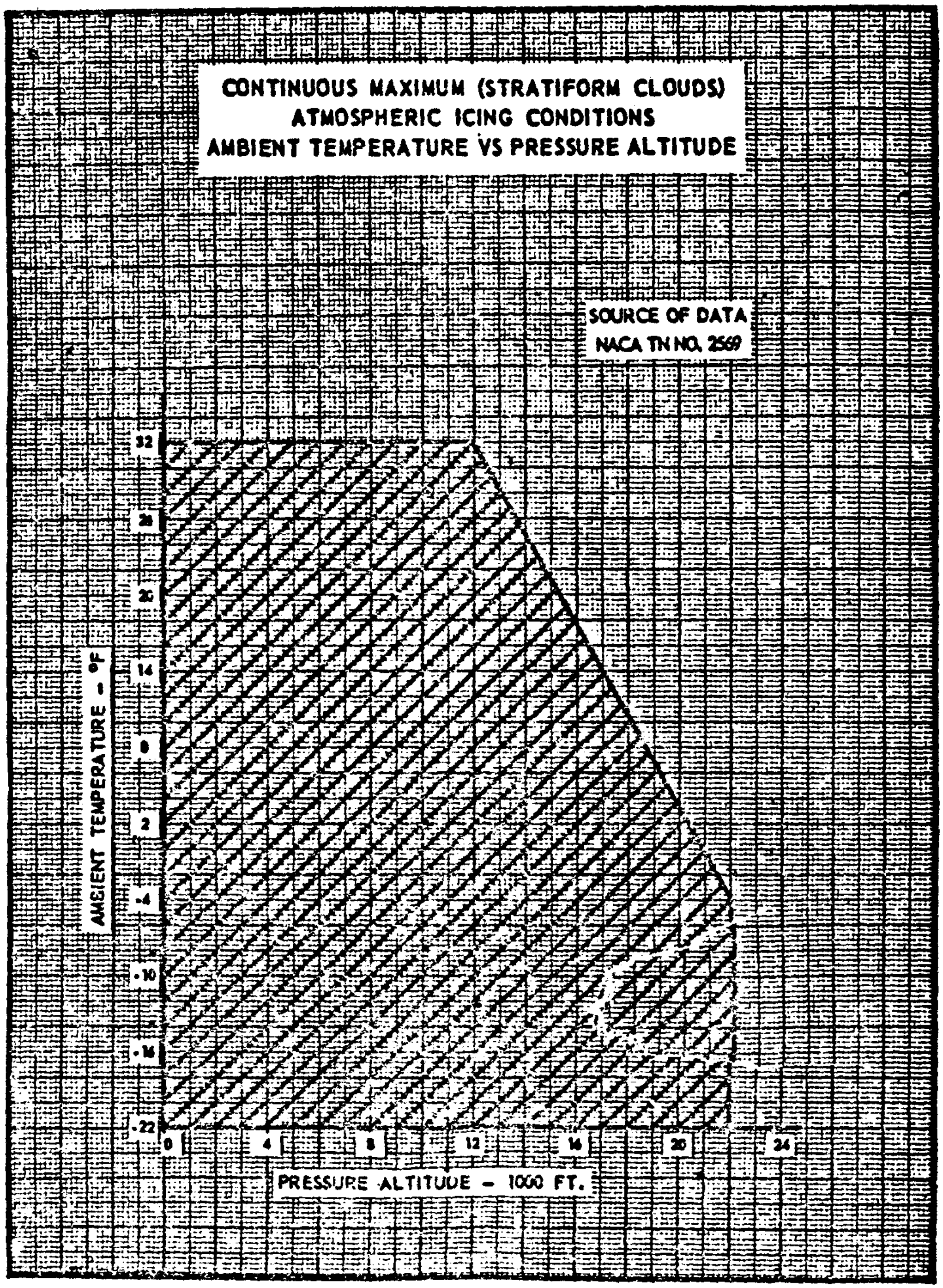
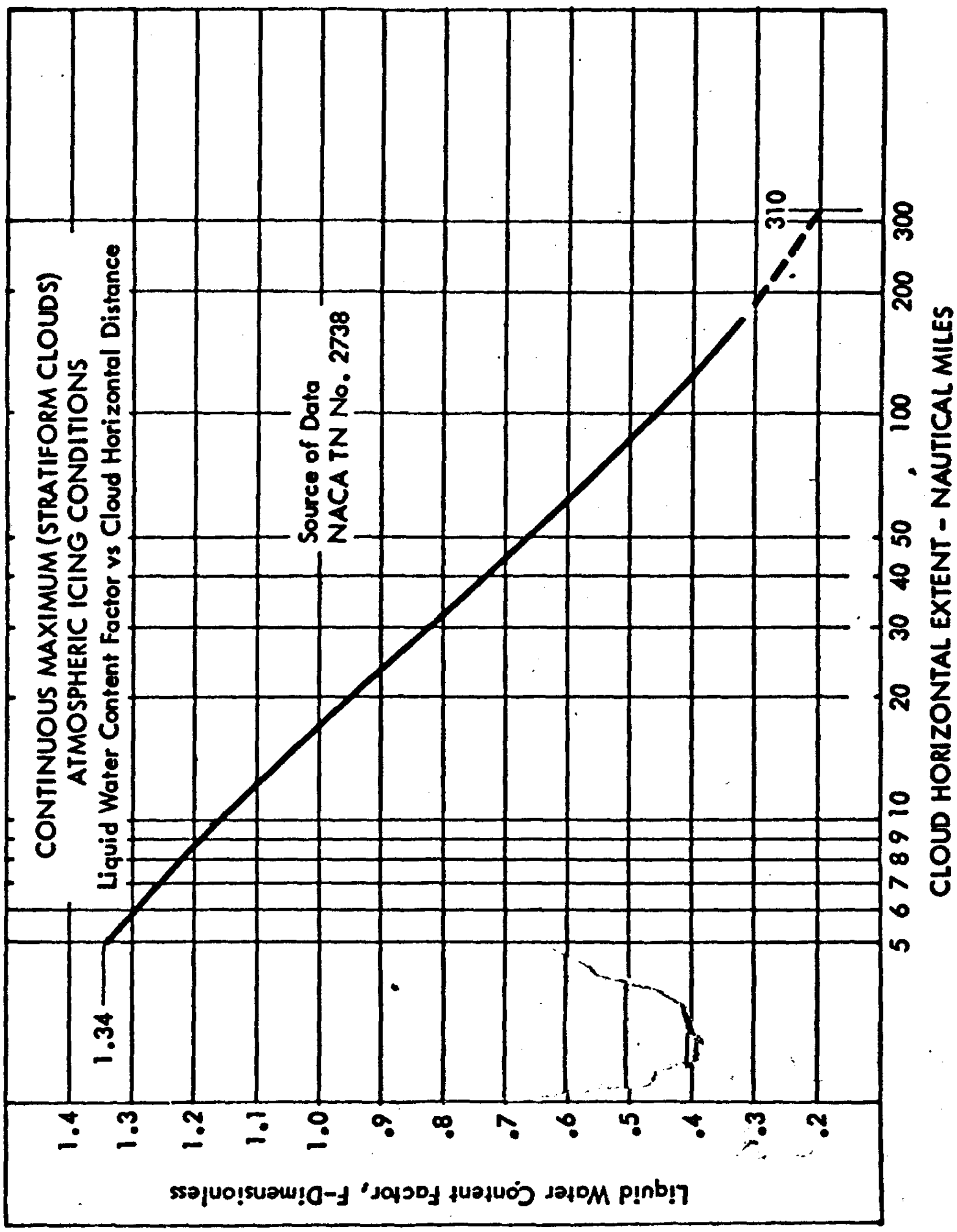
FIGURE 2



APPENDIX C

FIGURE 3



APPENDIX C

FIGURE 4

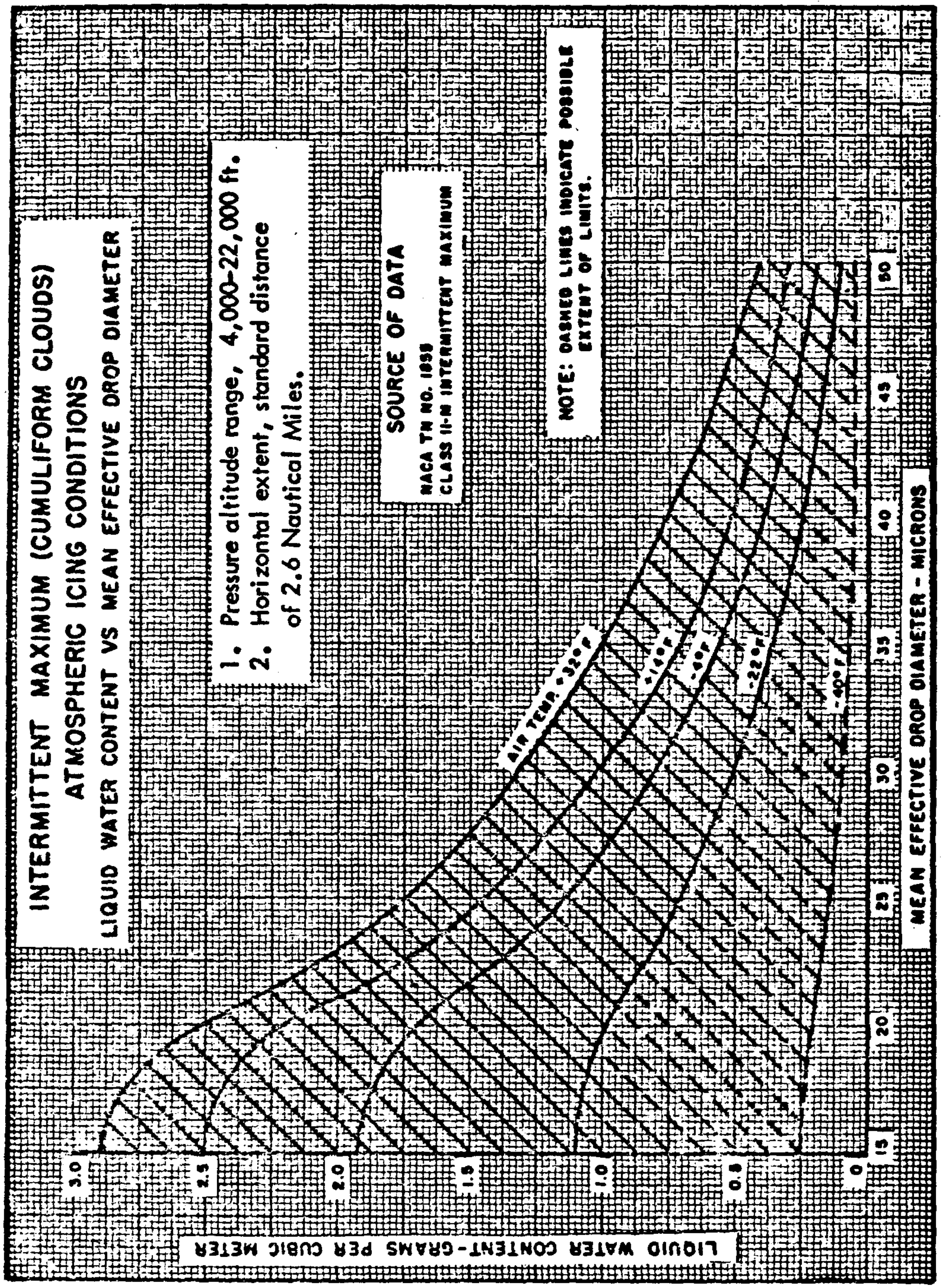


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FIGURE 5

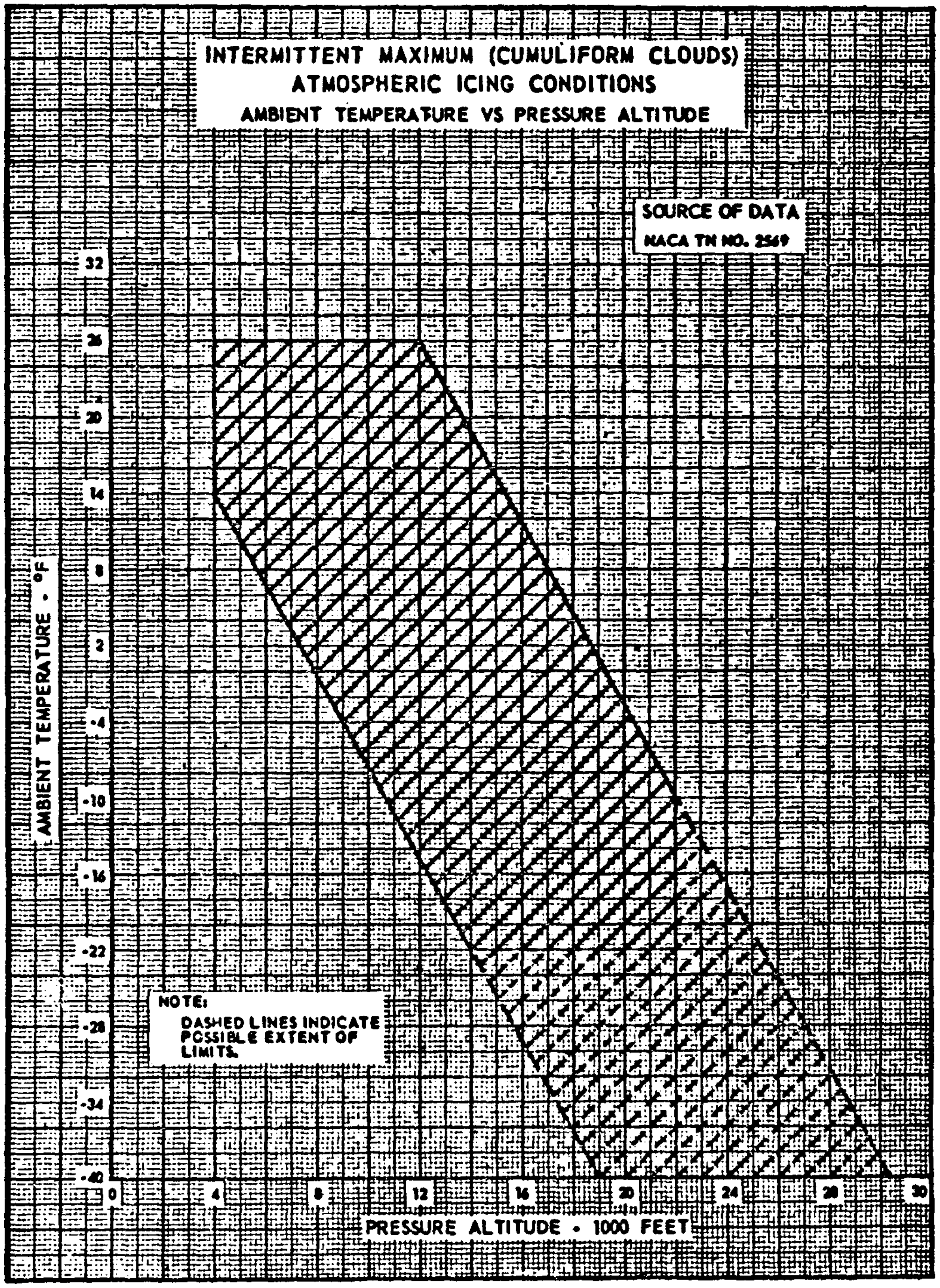

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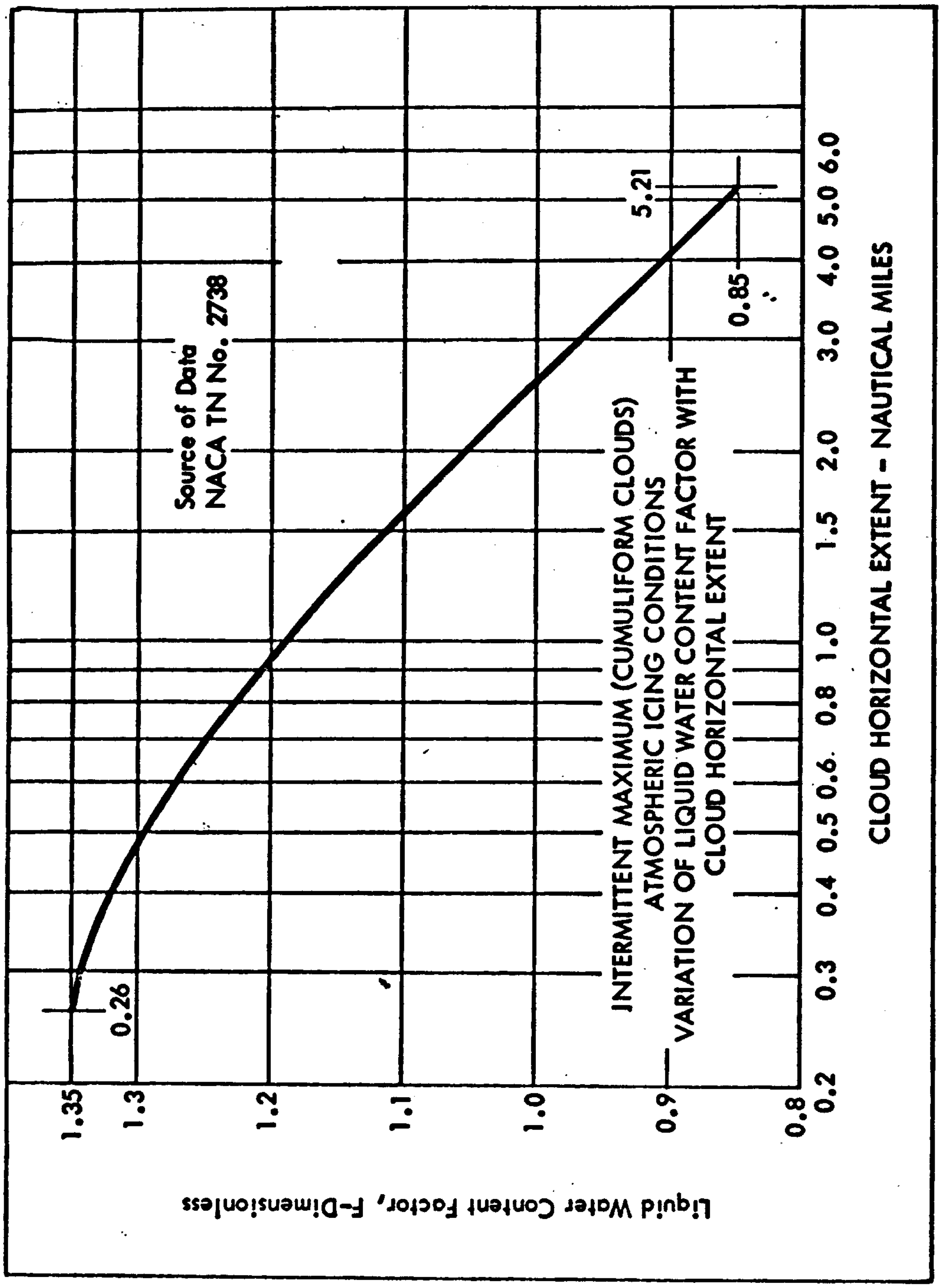
FIGURE 6



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(Sec. 313(a), 601, 603, and 604 Federal Aviation Act of 1958 (49 U.S.C. 1354(a), 1421, 1423, and 1424); sec. 6(c) Department of Transportation Act (49 U.S.C. 1655(c))

Note.—The FAA has determined that the benefits of this amendment, in providing an increased level of safety to passengers traveling in rotorcraft while at the same time recognizing and providing for the unique qualities and capabilities of rotorcraft, far outweigh the burdens and that this amendment: (1) Involves a regulation which is not a major rule under Executive Order 12291; and (2) is not a significant rule under the Department of Transportation Regulatory Policies and Procedures (44 FR 11034; February 26, 1979). A final regulatory evaluation prepared for this action is contained in the regulatory docket. A copy of it may be obtained by contacting the person identified under the caption "**FOR FURTHER INFORMATION CONTACT.**"

Issued in Washington, D.C., on January 6, 1983.

J. Lynn Helms,

Administrator.

[FR Doc. 83-2510 Filed 1-30-83; 8:45 am]

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