Part 29—Airworthiness Standards: Transport Category Rotorcraft

This change incorporates Amendment 29–33, Emergency Locator Transmitters, adopted June 10, 1994. The only section affected by this amendment is § 29.1415(d). Bold brackets appear around the revised material.

Page Control Chart

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Suggest filing this transmittal at the beginning of the FAR. It will provide a method for determining that all changes have been received as listed in the current edition of AC 00–44, Status of Federal Aviation Regulations, and a check for determining if the FAR contains the proper pages.

According to FAA Order 2100.14A, the definition of a small aircraft and aircraft parts manufacturer is one with 75 or fewer employees. There is only one rotorcraft manufacturer (out of 10) in the United States that meets this definition. FAA Order 2100.14A defines a substantial number of small entities as more than one-third of the group but not fewer than 11. With only one small manufacturer in the United States, there is not a significant economic impact on a substantial number of small entities.

B. Small Rotorcraft Operators.

The small operators affected by the final rule are commercial operators that are regulated under parts 91, 133, 135, and 137. The size standards criteria in FAA Order 2100.14A classify operators of aircraft for hire as small if they own, but not necessarily operate, nine or fewer aircraft. Estimates of the number of small operators in the United States and the average number of rotorcraft owned by small U.S. operators can be made based on membership data from the Helicopter Association International.

It is assumed for the purpose of this analysis that all small commercial operators in the United States will be affected by this final rule. This represents a worst-case scenario, since many part 27 helicopters are currently equipped with shoulder harnesses at all crew and passenger seats. The *World Aviation Directory,* Winter 1989, identified 214 firms as either helicopter scheduled air services or helicopter nonscheduled and specialty air services in the United States. At least 151 firms possessed 9 or fewer aircraft. Of the 32 firms who did not identify the number of aircraft that they possessed, it is estimated that 27 of them (84 percent) also possess 9 or fewer aircraft.

FAA Order 2100.14A defines cost thresholds for significant economic impacts for various entity types. The threshold for "operators of aircraft for hire-unscheduled" was $3,300 per year in December 1983 dollars or about $4,100 in second quarter 1990 dollars. The total annualized lifetime cost of complying with the final rule is estimated at about $75 per rotorcraft for operators of part 27 rotorcraft and $450 per rotorcraft with 12 seats ($1,670 per rotorcraft with 45 seats) for operators of part 29 rotorcraft.

The final rule would affect only newly manufactured rotorcraft). If, under a worst-case scenario, an operator of a part 27 rotorcraft purchased nine new rotorcraft manufactured under the final rule over a 10-year period, the total annualized cost due to the rule would be $675, which is less than the $4,100 threshold. A small commercial operator would exceed the annual cost threshold only if the operator replaced at least 9 part 29 rotorcraft with 12 seats (or 3 part 29 rotorcraft with 45 seats). This is very unlikely. Furthermore, even if this did occur among all operators with 8 or 9 part 29 rotorcraft with more than 12 seats, it would represent only 15 commercial operators or 8.4 percent of the 178 commercial operators. The rule, therefore, does not impact more than one-third of affected small entities. Thus, even in the worst case, the final rule would not substantially impact a significant number of small entities.

Federalism Implications

The regulations adopted herein will not have substantial direct effects on the States, on the relationship between the national government and the States, or on the distribution of power and responsibilities among the various levels of government. Therefore, in accordance with Executive Order 12612, it is determined that this final rule does not have sufficient federalism implications to warrant the preparation of a Federalism Assessment.

Conclusion

For these reasons, and based on the findings in the Regulatory Flexibility Determination and the International Trade impact Assessment, the FAA has determined that this regulation is not major under Executive Order 12291. In addition, the FAA certifies that these amendments do not have a significant economic impact, positive or negative, on a substantial number of small entities under the criteria of

Authority: 49 U.S.C. 1344, 1354(a), 1355, 1421, 1423, 1424, 1425, 1428, 1429, 1430; 49 U.S.C. 106(g).

Amendment 29–33

Emergency Locator Transmitters

Adopted: June 10, 1994 **Effective: June 21, 1994**

(59 FR 32050, June 21, 1994)

SUMMARY: This rule requires that newly installed emergency locator transmitters (ELT's) on U.S.-registered aircraft be of an improved design that meets the requirements of a revised Technical Standard Order (TSO) or later TSO's issued for ELT's. This rule is prompted by unsatisfactory performance experienced with automatic ELT's manufactured under the original TSO. Further, it addresses certain safety recommendations made by the National Transportation Safety Board (NTSB) and the search and rescue (SAR) community. The FAA is also adopting improved standards for survival ELT's. The rule is expected to have a dramatic effect on reducing activation failures and would increase the likelihood of locating airplanes after accidents. In addition, publication of this document coincides with notice of the FAA's withdrawal of manufacturing authority for ELT's produced under TSO–C91.

FOR FURTHER INFORMATION CONTACT: Phil Akers, Aircraft Engineering Division (AIR–120), Aircraft Certification Service, Federal Aviation Administration, 800 Independence Avenue, SW., Washington, DC 20591; telephone (202) 267–9571.

SUPPLEMENTARY INFORMATION:

Background

In 1971, responding to a congressional mandate for rulemaking (Public Law 91–596), the FAA adopted amendments to parts 25, 29, 91, 121, and 135 of the Federal Aviation Regulations (FAR) to require the installation and use of ELT's that meet the requirements of TSO–C91. The amendments require that certain U.S.-registered civil airplanes be equipped with automatic ELT's. An automatic ELT is a crash-activated electronic signaling device used to facilitate search and rescue efforts in locating downed aircraft. The ELT's crash sensor is commonly called a G-switch (an actuation device that operates on acceleration forces measured in G's; one G denotes the acceleration of the earth's gravity). In most installations, the ELT is attached to the aircraft structure as far aft as practicable in the fuselage in such a manner that damage to the device will be minimized in the event of impact.

Certain aircraft, such as turbojet-powered aircraft and aircraft engaged in scheduled air carrier operations, are excepted from this requirement because they are more readily located after an accident because they operate within the air traffic control system and their operators have filed instrument flight plans. For example, scheduled air carriers and turbojet-powered aircraft use the air traffic control system (ATC) and air carriers use instrument flight plans. This rule is applicable to those airplanes that are most difficult to locate after an accident. An ELT is particularly helpful in locating an airplane that is operated by a pilot who does not file a flight plan or operate within the air traffic control system.

Survival ELT's are manually operated or automatically actuated upon contact with water. Survival ELT's are required ditching equipment for transport category airplanes and rotorcraft, as provided by the operating rules. They are also required emergency equipment for extended overwater operations on aircraft used in air carrier, air taxi, and commercial operations.

That safety recommendation also urged that ELT's be subject to specific maintenance requirements.

In October 1990, the National Aeronautics and Space Administration (NASA) and the FAA completed a report entitled, "Current Emergency Locator Transmitter (ELT) Deficiencies and Potential Improvements Utilizing TSO–C91a ELT's", hereafter referred to as the FAA/NASA report. This report consolidates and analyzes most of the known data on ELT problems and quantifies the safety problem. General aviation accident and fatality data from the NTSB form the cornerstone of the report. The most significant conclusions derived from the report show: 23 to 58 lives are lost per year due to ELT failures; 15 percent of ELT failures are attributed to poor or no ELT maintenance; and after excluding lives lost attributed to maintenance-related ELT failures, 64 percent or 13 to 31 of the lives lost each year could be saved with a complete transition to TSO–C91a ELT's.

Based on the known unsatisfactory performance of the TSO–C91 ELT's during the 1970's and 1980's, the FAA issued Notice No. 90–11, (55 FR 12316, April 2, 1990). This notice proposed that ELT's approved under TSO–C91a (or later issued TSO's for ELT's) be required for all future installations. The NPRM further proposed that the manufacture of the TSO–C91 ELT's be simultaneously terminated with issuance of a final rule. The term "future installations" applies to newly manufactured airplanes, and to the replacement of existing ELT's as they become unusable or unserviceable. Additionally, the FAA solicited comments on the need for a fleet-wide ELT replacement program and specific maintenance requirements. These issues are addressed below.

Sources of Information Referenced Below:

NTSB Recommendations

1. NTSB safety recommendations A–78–5 through A–78–12, issued 1978;

2. NTSB safety recommendation A–87–104, issued 1987.

Reference Material

(1) The National Aeronautics and Space Administration (NASA) and the FAA, a report entitled, "Current Emergency Locator Transmitter (ELT) Deficiencies and Potential Improvements Utilizing TSO–C91a ELT's", (FAA/NASA report), October 1990.

(2) FAA Action Notice A 8150.3 (July 23, 1990).

Related Activity

(1) Publication of this document coincides with notice of the FAA's withdrawal of manufacturing authority for ELT's produced under TSO–C91.

(2) The Aviation Rulemaking Advisory Committee (ARAC) has been tasked to make recommendations concerning an ELT retrofit policy.

Discussion of Comments

The FAA received 51 written comments in response to Notice No. 90–11 from individuals, manufacturers, equipment users, associations, and government agencies. Twenty-two support the proposed rule or its intent while 20 express concern or nonsupport. Most of the nonsupport commenters, however, address the fleet-wide replacement of automatic ELT's rather than the proposal for new installations. Nine of the comments do not take a position for or against the proposals; however, they offer suggestions and advice.

Nineteen of the commenters supporting the rule represent major segments of the aviation search and rescue community such as government agencies and associations. These commenters also agree on the unsatisfactory performance of current TSO–C91 ELT's.

- Fire damage;
- Impact damage;
- Antenna broken/disconnected;
- Water submersion;
- Unit not armed;
- Internal failure;
- Packing device still installed;
- Remote switch in off position; and
- ELT shielded by wreckage or terrain (although not an initial failure, this was listed as another reason for the ELT not functioning).

An ELT manufacturer states that the term "failure to activate" encompasses two groups of cases that should not be treated in the same manner. Group 1 situations are those in which the ELT does not operate after a crash because it has a mechanical defect or failure. Group 2 situations are those in which the ELT does not operate because the crash forces are insufficient to activate it. This commenter states that the Group 2 cases should not be classified as ELT failures because the ELT's did what they were supposed to do when they did not activate. The commenter asserts that any "failure" associated with the Group 2 cases is a shortcoming of the current TSO–C91 standard that established the crash sensor sensitivity specifications.

FAA Response: The FAA agrees with the manufacturer's comment about two causes of failure-to-activate and notes that the FAA/NASA report addresses these two situations. The FAA/NASA report documents well the failures of ELT's approved under TSO–C91. As discussed previously, the most significant conclusions from the report are that: (1) 23 to 58 lives are lost each year due to ELT failures; (2) many of these failures are caused by poor ELT maintenance; and (3) a 64 percent failure rate reduction can be expected with a complete transition to TSO–C91a ELT's. Attachment 1 of the FAA/NASA report entitled, "Validation of NASA ELT Reasons for Failure Analysis Report," verifies the NTSB data that provides the cornerstone of the FAA/NASA report. In addition, the new ELT TSO–C91a contains revised G-switch specifications designed to provide proper activation limits and to minimize mechanical defects. This new design is expected to reduce the number of false alarms and improve the failure-to-activate rate.

False Alarms—Automatic ELT's

Twenty commenters identified ELT false alarms as contributing to poor performance. Several commenters cite the FAA/NASA report, which documents the following causes of false alarms:

- G-switch (crash sensor);
- Corrosion;
- Incorrect installation of the ELT;
- Human failures or mishandling;
- Heat, water, or radiated interference;
- Accidental operation of the controls;
- Internal failure.

nance program. However, as stated in the FAA/NASA report, the FAA cannot quantify the benefits in lives to be saved. A reduction in the number of false alarms would result in the Air Force Rescue Coordination Center (AFRCC) spending less time analyzing the validity of thousands of signals that occur annually on the 121.5 Mhz frequency. Thus, it is reasonable to presume that if the pre-rescue preparation time were reduced, additional lives could be saved.

Replacement Time and Costs

Although the FAA did not propose the replacement of existing ELT's with models of newer design, in Notice No. 90–11, the agency solicited opinion from affected users regarding a proposed time frame for a near-term retrofit program. Twenty-one commenters address the time that should be permitted for mandatory replacement of existing ELT's with those approved under TSO–C91a. Seven commenters call for a "voluntary" replacement. In general, the SAR community proposes four years. Most commenters acknowledge that a mandatory timetable for replacement is necessary to realize the benefits of this second-generation ELT.

Twenty-six commenters express concern over the direct replacement cost of existing TSO–C91 ELT's with TSO–C91a ELT's.

FAA Response: The FAA does not agree with the recommendations concerning voluntary replacement. The FAA envisions this final rule addressing new installations to be the first step in the much-needed transition to the improved ELT's. Even though the FAA conducted an extensive education program in the 1980's through the FAA Back-to-Basics Program, seminars, advisory material, and pamphlets, the FAA estimates that fewer than five percent of potential users voluntarily installed the improved ELT's. Although a voluntary replacement program may be less costly, resolution of the failure to activate and false alarm problems would not be timely.

The Aviation Rulemaking Advisory Committee (ARAC) has been tasked to make recommendations concerning the retrofit of ELT's in the entire fleet. For a detailed description of this task, see the ARAC notice published at 58 FR 16574, March 29, 1993.

Automatic ELT Replacement

Integration of 406 Mhz ELT's

Nineteen commenters recommend using the 406 Mhz ELT because it has significant technical improvements over the 121.5/243 Mhz ELT equipment system. Commenters also noted that 406 Mhz ELT's are compatible with the Search and Rescue Satellite-Aided Tracking System (COSPAS–SARSAT). Several commenters submitted data indicating that the COSPAS/SARSAT system has proven to be an effective tool in detecting and locating both maritime and aeronautical distress incidents. The data further show that this satellite system had been credited with saving more than 1,700 lives since it was commissioned in 1982. In many of these distress cases, the satellite system was the only means of detecting the distress signal. The commenters assert that improvements in ELT equipment, both on the 121.5 Mhz and 406 Mhz frequencies, will increase the accuracy of location, reduce the time required to provide information to the Rescue Coordination Centers, reduce the effects of interference, reduce the number of false alerts on 121.5 Mhz, and improve satellite coverage of all areas in the United States.

Most commenters support use of an improved 121.5/243.0 Mhz ELT or the improved ELT that includes 406 Mhz capability. The NTSB further advocates a fleet-wide mandatory conversion to the 406 Mhz standard.

FAA Response: In October, 1992, the United States responded to an International Civil Aviation Organization (ICAO) letter requesting comments on ELT carriage requirements. The United States recommended the use of 406 Mhz ELT's.

characteristics of these batteries and has placed some initial guidance material in TSO–C126 to aid approving lithium batteries. Currently, RTCA Special Committee 168 is developing a standard for the various kinds of lithium batteries that could be used in aircraft. The FAA plans to use the RTCA standard as a basis for a future TSO.

The 121.5/243 Mhz ELT's approved under TSO–C91a are expected to be effective when used in conjunction with the U.S. National Airspace and SAR systems. Therefore, the FAA recommends, but does not require, carriage of 406 Mhz ELT's. Voluntary use of the 406 Mhz ELT's would provide a definite enhancement over the minimum requirements of the Federal Aviation Regulations. There may be even more life-saving benefits derived from the 406 Mhz ELT for those operations conducted over water and in remote areas; therefore, the FAA encourages installation of the 406 Mhz ELT although the 121.5/243 Mhz will continue to be used.

Costs of Automatic and Survival ELT's

Five commenters express concern over the additional cost of automatic TSO–C91a ELT's required for new installations. The General Aviation Manufacturers Association indicates that the estimated $75 installation cost in Notice No. 90–11 is inappropriate. It claims that a realistic estimate for parts and labor is $750.

With regard to survival ELT's, Dayton-Granger, Inc. and the DME Corporation currently estimate the cost of survival ELT's at approximately $900. Both companies plan to manufacture ELT's approved to the TSO–C91a standard. The Air Transport Association of America (ATA) states that its member airlines estimate the cost of the TSO–C91a survival ELT's to be $4,193 to $4,662 per aircraft. Additionally, it states that the new TSO standards are unnecessary because there are no problems with the current survival ELT's.

FAA Response: The FAA based its cost estimates on estimates provided by manufacturers of authorized equipment. ARNAV Systems, Inc., whose automatic ELT is now marketed by Artex Aircraft Supplies, Inc., obtained TSO–C91a approval for the model ELS–10 in October 1986 and for a lower cost model, the ELT–100, in March 1988. These automatic ELT's sell for approximately $900 and $350 respectively, and have beneficial design enhancements, such as built-in test equipment. Narco Avionics, Inc., obtained approval for its automatic model ELT–910 in June 1989, and is marketing it for approximately $400. Since the issuance of Notice No. 90–11, ACK Technologies, Inc., received approval for its automatic Model E–01 ELT in May 1990; the list price for this ELT is $279. According to this manufacturer, a selling price of less than $200 may be possible, once full production is underway. Several other ELT manufacturers have expressed an interest in producing low-cost TSO–C91a ELT's.

This rulemaking applies only to "new installations;" therefore, the FAA has attempted to minimize direct costs to operators while enhancing operators' safety. In Notice 90–11 the FAA estimated that automatic ELT's would cost an additional $150 to $400 per unit, and that survival ELT's would cost an additional $875 to $1,225 per unit. However, as a result of analyzing more recent data received from ELT manufacturers, the FAA has reduced its estimates of incremental costs. Automatic ELT's are estimated to cost an additional $50 to $200 per unit, and survival ELT's are estimated to cost an additional $250 to $750 per unit. Conversely, the FAA has increased its estimate of incremental installation costs for automatic ELT's from $75 to $150 per unit.

G-Switch

Eight commenters express concern about the design specifications of the TSO–C91a crash sensor, known as a G-switch. These eight commenters agree that the current TSO–C91 G-switch needs improvement because it is the primary cause of an ELT's failure to activate. Several commenters note that the FAA/NASA report estimates a 95 percent rate of effectiveness increase expected from using the TSO–C91a G-switch.

to use of size "D" batteries.

FAA Response: The FAA has found that most battery problems can be eliminated if aircraft owners ensure that the ELT and its battery receive a proper inspection as discussed in the next section, ELT Maintenance. The status of FAA requirements for lithium batteries was discussed previously.

ELT Maintenance

Consistent with tile FAA/NASA report, 19 commenters note lack of proper maintenance as a contributing cause of the current unsatisfactory performance of TSO–C91 ELT's. Most of the commenters agree that scheduled inspection of ELT's is necessary to reduce the number of false alarms and to ensure their proper working order. The NTSB, National Oceanic and Atmospheric Administration (NOAA), ACK Technology, Inc., and The National Association for Search and Rescue (NASAR) call for mandatory inspections.

FAA Response: The FAA agrees with these comments concerning ELT maintenance and with NTSB recommendation, A–87–104, that recommended replacing TSO–C91 ELT's with TSO–C91a ELT's. The FAA/NASA report also concludes that an inspection and maintenance program for ELT's is necessary. As discussed in the background section of this preamble, an estimated 15 percent of ELT failures have been maintenance related.

The FAA already provides for mandatory ELT inspections in the regulations and in TSO's. Meeting the inspection requirements is a responsibility shared among the manufacturer, the inspector, and the aircraft owner or operator. Maintenance of ELT's is a major issue; accordingly, this section will digress from discussion of the comments to emphasize these requirements. This is necessary so that users understand the FAA's requirements concerning ELT maintenance.

ELT Maintenance Requirements—An Explanation

Subpart E of part 91 provides inspection and maintenance requirements for the continued airworthiness of the aircraft and all of its components. Also, § 91.207, of subpart C, requires that each ELT be in an operable condition and provides specific requirements for battery replacement. Technical Standard Order C91a requires that instructions for periodic maintenance, which are necessary for the ELT's continued airworthiness, be provided with each unit manufactured under the TSO. These instructions must contain specific information to ensure that appropriately rated persons will be able to inspect and maintain ELT's in an airworthy condition to meet the needs of the flying public and the SAR community. Manufacturers of the earlier (TSO–C91) ELT's, however, were not required to submit periodic maintenance instructions to the FAA with their TSO approval applications. Therefore, the content and usefulness of instructions provided with TSO–C91 ELT's may vary, depending on the approach used by each manufacturer.

Section 43.13(a) requires persons performing inspections and other maintenance to use the manufacturers' instructions or other instructions acceptable to the FAA Administrator. The aircraft owner or operator is responsible for ensuring that the ELT is included in these inspections and is maintained accordingly. To provide guidance on improving ELT maintenance, Action Notice A 8310.1, recommending a specific supplemental inspection procedure for ELT's, was issued to all FAA field personnel in September 1988. This information was also included in the February 1989 issue of Advisory Circular 43–16, General Aviation Airworthiness Alerts, and reissued in Action Notice A 8150.3 on July 23, 1990. This Action Notice applies to ELT's authorized under both TSO–C91 and TSO–C91a.

To summarize the notice, the inspection procedure can be accomplished by making a close examination of the ELT, its battery pack, and antenna. The signal emissions and G-switch must also be checked.

If the ELT's antenna is radiating a signal, it can be heard on any frequency through a low-cost AM radio held about six inches from the ELT's antenna. The aircraft's VHF receiver or a check with an airport control tower may also be used to verify the ELT signal on the 121.5 Mhz frequency. An

the adequacy of the G-switch or the power output of the antenna, they do provide an acceptable level of confidence that the ELT is functioning properly.

In response to NTSB recommendation A–87–104, the findings of the FAA/NASA report, and the comments to this rulemaking, the FAA is clarifying what must be done for an ELT to be considered in "operable condition" as found in § 91.207(a)(1) by adding a new paragraph (d). Although paragraph (d) is new, it is written in accordance with current regulations and guidance, as discussed earlier under, "ELT Maintenance Requirements—An Explanation". Specifically, the new regulation § 91.207(a)(1)(d), describes how to inspect an ELT under part 43, appendix D, paragraph (i), and requires that it be accomplished within 12 calendar months after the last inspection. The appendix D requirements are non-specific in nature because they apply to all components of the radio group, which includes the ELT's. The 12-month requirement accommodates those airplanes maintained under either an annual or a progressive inspection program and could be accomplished under the provisions of any other program approved by the Administrator under § 91.409. The FAA has determined that this clarification is not an additional requirement that would entail additional rulemaking and an economic evaluation. The FAA has determined that this additional information should be included in part 91 to reinforce to airplane owners and inspectors what the FAA expects when an ELT is inspected.

"Approved" as Opposed to "TSO-Approved"

Three commenters express concern over the meaning of the word "approved" in the proposed language of the ELT rules. One commenter indicates that this rulemaking procedure may "establish a precedent for future mass terminations of TSO authorizations, without going through the rulemaking process." Another commenter requests that the FAA refer to a particular TSO number instead of using the generic language, "approved TSO."

FAA Response: The FAA intends to clarify the certification process with regard to the regulations and TSO's. Since the effective date of Amendment 21–50 to part 21 (September 9, 1980), the FAA's TSO revision program has been eliminating TSO's from the rulemaking process and eliminating references to specific TSO's from the regulations. The TSO revision makes it possible for the public to use the most up-to-date TSO or other standards that are found acceptable during the certification of a particular piece of equipment. When specific TSO standards are designated in a regulation, other TSO's or standards are automatically excluded. As stated in Notice No. 90–11, "This rule replaces specific references to TSO–C91 in the FAR with 'an approved ELT that is in operable condition'," and withdraws all TSO–C91 authorizations issued to ELT manufacturers. In effect, this would allow TSO–C91a, or any subsequent TSO's issued for ELT's, to be used as a basis for compliance with the FAR. Using the language "approved" is consistent with the FAA's responsibility to eliminate dated references to regulations.

Whenever a material, part, process, or appliance is required to be "approved," it must be approved under the Federal Aviation Regulations. The approval can be obtained in one of the following ways: (1) under a Parts Manufacturer Approval; (2) in conjunction with type certification procedures for a product, including approvals granted by a supplemental type certificate; (3) under a Technical Standard Order authorization; or (4) in any other manner approved by the Administrator.

Of these approval methods, TSO's contain minimum performance and quality control standards for specified articles (material, part, process, or appliance). The standards for each TSO are those the Administrator finds necessary to ensure that the article concerned will operate satisfactorily. Compliance with a TSO is only one method of obtaining an approval and its use is not mandatory; therefore, the standards contained in the TSO are not mandatory but are a way of obtaining approval for a particular article.

Miscellaneous Comments

An ELT manufacturer requests that the word "transmitter" be added to § 91.207(c)(2) for consistency with the rest of the section.

technology on the horizon. The rule is in agreement with the ICAO requirements, including recent changes pertaining to ELT's. The FAA is a strong supporter of the search and rescue satellite system (COSPAS/SARSAT). In addition, the ELT program, as outlined in this rulemaking, takes into account national and international issues and these considerations were integrated into the justification for this rule.

Three commenters request field testing of TSO–C91a ELT's to confirm their potential costs and benefits before their use is mandated. Four commenters call for additional research on ELT's. For example, the General Aviation Manufacturers Association (GAMA) requests further research on TSO–C91a G-switches and battery technology.

FAA Response: The FAA agrees with the intent of these comments on the need for appropriate research and field testing. Transport Canada, the Canadian counterpart of the United States Department of Transportation, is currently field testing 130 ARNAV ELT's. Useable results may not be available until late 1993. The FAA is working with Transport Canada on its ELT improvement program and with other government as well as non-government organizations on maximizing ELT knowledge. However, in view of the Canadian study and numerous studies documented in the FAA/NASA report, including an FAA ELT maintenance survey on repair stations, the FAA has determined that there is no need for research on new issues before regulatory action is taken. Additional research would only delay the installation of improved ELT's without any clear expectation of improvement over the TSO–C91a specification.

One commenter encourages the FAA to expand its ELT educational effort to install more reliable ELT's. NASA suggests that all pilots be required to monitor the 121.5 Mhz frequency as part of the shutdown procedure in aircraft that do not have a cockpit monitor.

FAA Response: The FAA agrees with the intent of both of these comments. Working with organizations such as the Aircraft Owners and Pilots Association, the FAA has been actively promoting the public's awareness of potential problems with ELT's. A pamphlet entitled, "Attention to ELT's: Insurance To Life" has been distributed to all active U.S. pilots. This pamphlet addresses the ELT false alarm problem and recommends that a pilot-in-command monitor the 121.5 Mhz frequency prior to engine shutdown. This information contained in the pamphlet and ELT inspection procedures are discussed at pilot safety seminars and have been incorporated in the FAA Back-To-Basics program.

The NASA report suggested that the pilot be required to check the 121.5 Mhz frequency before leaving the airplane.

One commenter requests that tow planes be excepted from the requirements because they often are operated under harsh conditions that could trigger false alarms.

FAA Response: The FAA agrees and the final rule does not change the ELT requirements for tow planes. Those airplanes that are currently excepted may continue operations without an ELT.

The ATA concludes, given the operating procedures of transport category aircraft, that benefits to the travelling public from automatic ELT's would be very limited. A complete replacement of its members' fleets by 1995 would cost $14 million.

FAA Response: Survival ELT's, rather than automatic ELT's, are required in transport category aircraft. Currently, automatic ELT's are not required on transport category aircraft.

One commenter suggests that a fine be used as a penalty for an ELT false alarm resulting from the pilot's failure to maintain the ELT.

FAA Response: The suggestion is beyond the scope of this rulemaking.

Another commenter suggests that insurance considerations should be the driving force to motivate aircraft owners to install ELT's, rather than the FAA mandating ELT's.

Impact of the Rule

Summary of the Amendments

In summary, effective six months after publication of this Final Rule, the FAA is withdrawing TSO–C91 authorizations for automatic ELT's; therefore, the TSO–C91 model ELT's may not be manufactured after that date. Current production of unsold TSO–C91 ELT's for general aviation airplanes is sufficiently small so that accumulation of inventories is unlikely. This inventory is expected to be depleted by the time this rule becomes effective. The preamble to Notice No. 90–11 specifically stated that the FAA proposed to require installation of an improved ELT that meets the requirements of a revised TSO, and to terminate approval to use ELT's authorized under the original TSO–C91. Although the notice stated that the new equipment would be required for future installations, language to that effect did not appear in the proposed amendment. To carry out this intent, § 91.207(a)(1) and (a)(2) are revised to state that ELT's meeting the applicable requirements of TSO–C91 may no longer be installed.

Another change is being made to paragraph (a)(2) of § 91.207 to correct an error that inadvertently occurred when former § 91.52 was revised and renumbered as § 91.207 during the recodification of part 91 in 1990. Former paragraph (b)(4) of § 91.52 (the predecessor to paragraph (a)(2) of § 91.207) contained a reference to three preceding paragraphs. That is, paragraph (a)(1)(i) was included in the subject reference. The reference also should have included paragraphs (a)(1)(ii) and (a)(1)(iii). This correction is effected by replacing the reference to "(a)(1)(i)" with "(a)(1)", which subsumes all of the provisions of paragraph (a)(1) into the reference.

With regard to survival ELT's, the TSO authorization withdrawal will become effective two years after publication of this final rule. The FAA is allowing additional time for the manufacturers of survival ELT's to begin producing, and for operators to begin installing, TSO–C91a ELT's. For new installations, the new requirements include satellite compatibility, crash survivability, and certain environmental specifications (temperature, water resistance, etc.) that will provide definite improvement at reasonable costs.

Finally, a change is made to §§ 121.339, 121.353, 125.209, and 135.167 to correct inadvertent errors that were made when the applicable parts were codified in 1971 and 1980. These sections refer to survival ELT's and specifically describe the timely replacement of transmitter batteries. Currently, these sections state that the transmitter batteries must be replaced when the transmitter has been in use for more than one hour *and* when 50 percent of its useful life has expired (according to the specific expiration date). The FAA has always intended and enforced these regulations concerning survival ELT's to prescribe a change of transmitter batteries when either the battery has been in use for more than one hour *or,* when 50 percent of its useful life has expired. This correction is consistent with § 91.207 regarding automatic ELT's.

Technical Standard Order

Published simultaneously with this rule, the FAA, pursuant to § 21.621 of the Federal Aviation Regulations, is withdrawing each TSO authorization to the extent that it authorizes the holder to identify or mark ELT's with TSO–C91, effective six months after the publication of this rule for automatic ELT's, and effective two years after publication of this rule for survival ELT's.

Regulatory Evaluation Summary

Proposed changes to Federal regulations must undergo several economic analyses. First, Executive Order 12866 directs that each Federal agency shall propose or adopt a regulation only upon a reasoned determination that the benefits of the intended regulation justify its costs. Second, the Regulatory Flexibility Act of 1980 requires agencies to analyze the economic effect of regulatory changes on small entities. Third, the Office of Management and Budget directs agencies to assess the effects of regulatory changes on international trade. In conducting these analyses, the FAA has determined that this rule: 1) will generate benefits that justify its costs and is not a significant regulatory action as defined in the Executive

the first 20 years of the rule (1995–2014), the costs of automatic ELT's will total $19.3 million (or $10.2 million in 1993 dollars at 1994 discounted present value).

Costs—Survival ELT's

Recent efficiencies in production techniques have reduced the costs from those estimated in the NPRM. As a result, the incremental acquisition cost of survival ELT's is estimated to total $500 per unit. The FAA estimates that, during the 1996–2015 evaluation period, 3,081 new survival ELT's will be installed, costing $1.5 million (or $0.8 million, discounted).

Benefits—Automatic ELT's

Based on the findings of the FAA/NASA report (cited earlier), significant improvements in ELT effectiveness will reduce the time required to locate downed airplanes and, concomitantly, improve the chances of saving seriously injured crash survivors. Additional benefits will be realized from reducing false alarms.

The report's most significant conclusions are that: 23 to 58 lives are lost per year due to ELT's failure-to-operate; 12 to 18 percent of these are attributed to poor or no maintenance; and, with 100 percent TSO–C91a installations, a 64 percent failure rate reduction can be expected. In addition, a 75 percent reduction in false alarms is likely with all new units in place (although not directly specified in the report, this evaluation estimates that 25 percent of false alarms, in contrast to the 12 to 18 percent of ELT failures-to-operate, are attributable to poor or no maintenance).

Consequently, using the midpoints of the range of lives lost (41) and the range attributed to maintenance failures (15 percent), 22 or more lives could be saved annually if all TSO–C91 ELT's were replaced with TSO–C91a ELT's ($41 \times (1-.15) \times .64$), decreasing to approximately 18 annually as general aviation activity decreases during the 20-year evaluation period. Since ELT replacements will take place gradually over time, avoided fatalities will not reach their full potential for several years after the period. Nevertheless, 81 fatalities are expected to be avoided during the 20-year period following promulgation of the rule, valued at $209 million ($86.4 million discounted).

The additional benefits expected from reduced false alarms are calculated as follows. False alarms are estimated to cost approximately $4.3 million annually (based on a $3.5 million estimate for 1987 by the Air Force Rescue Coordination Center, adjusted to 1993 dollars). Excluding the 25 percent of false alarms attributable to maintenance-related problems, the expected reduction in false alarm costs totals $2.4 million annually ($4.3 million $\times$ .75 $\times$ (1–.25)). Taking into account the gradual, increasing percentage of the fleet equipped with new ELT's over the 1995–2014 evaluation period, these benefits are projected to total $8.9 million ($3.7 million discounted).

Benefits—Survival ELT's

There is no direct evidence of lives lost as a result of delays in reaching survivors because of defective survival ELT's; however, such occurrences are possible. Historical data indicate that an average of 61 preventable drownings occur per 10-year period in parts 121 and 135 operations. Over the course of the 1996–2015 evaluation period, only one life needs to be saved in order for the benefits of new survival ELT's to exceed the $0.8 million in discounted costs.

Comparison of Cost and Benefits

Costs and benefits summarized below are for the evaluation period 1995–2015 in terms of 1993 dollars at 1994 discounted present value. Automatic ELT's are estimated to have incremental costs totalling $10.2 million and benefits of $90.1 million, yielding a benefit-to-cost ratio of 8.8 to 1. Incremental costs of survival ELT's are estimated to total $0.8 million, requiring the avoidance of only one fatality in order to be cost-beneficial.

uled operators. A substantial number of small entities is a number which is not less than eleven and which is more than one-third of the small entities subject to the rule.

The only type of entity with the potential to sustain a significant economic impact as a result of this rule is an unscheduled operator. Such an operator would have to purchase at least ten ELT's in a year in order to exceed the $4,700 threshold. The rule will not have a significant economic impact on a substantial number of small unscheduled operators because most such operators own five or fewer airplanes each, and it is unlikely that at least 11 of them representing more than one-third of the total will purchase ten new ELT's in any given year.

International Trade Impact Statement

The rule will have little or no impact on trade for either U.S. firms doing business in foreign countries or foreign firms doing business in the United States. Foreign air carriers are prohibited from operating between points within the United States. Therefore, they will not gain any competitive advantage over U.S. carriers. In international operations, foreign air carriers are not expected to realize any cost advantage over U.S. carriers because the differential in costs between the existing and new ELT rule will not be significant enough to have an adverse impact on the international operations of U.S. carriers. Further, general aviation operations conducted in the United States are not in any direct competition with foreign enterprises. For these reasons, the FAA does not expect that the rule will result in any international trade impact.

Federalism Implications

The regulations herein will not have substantial direct effects on the States, on the relationship between the national government and the States, or on the distribution of power and responsibilities among the various levels of government. Therefore, in accordance with Executive Order 12612, it is determined that this final rule does not(hive sufficient feleralism implications to warrant the prmparation of a Federalism Assessment.

Conclusion

The FAA has determined that the potential benefits of the regulation outweigh its potential costs and that it is not a significant regulatory action under Executive Order 12866. In addition, this rule will not have a significant economic impact, positive or negative, on a substantial number of small entities under the criteria of the Regulatory Flexibility Act. This rule is considered significant under DOT Regulatory Policies and Procedures (44 FR 11034; February 26, 1979) because it concerns a matter of substantial public interest. A regulatory evaluation of the rule, including a Regulatory Flexibility Determination and an International Trade Impact Analysis, has been placed in the docket. A copy may be obtained by contacting the person identified under "FOR FURTHER INFORMATION CONTACT."

The Amendments

In consideration of the foregoing, the Federal Aviation Administration amends 14 CFR parts 25, 29, 91, 121, 125, and 135 effective June 21, 1994.

The authority citation for part 29 is revised to read as follows:

Authority: 49 U.S.C. 1344, 1354(a), 1355, 1421, 1423, 1424, 1425, 1428, 1429, 1430; 49 U.S.C. 106(g).

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§ 29.1301 Function and installation.

Each item of installed equipment must—

(a) Be of a kind and design appropriate to its intended function;

(b) Be labeled as to its identification, function, or operating limitations, or any applicable combination of these factors;

(c) Be installed according to limitations specified for that equipment; and

(d) Function properly when installed.

§ 29.1303 Flight and navigation instruments.

The following are required flight and navigational instruments:

(a) An airspeed indicator. For Category A rotorcraft with V_{NE} less than a speed at which unmistakable pilot cues provide overspeed warning, a maximum allowable airspeed indicator must be provided. If maximum allowable airspeed varies with weight, altitude, temperature, or r.p.m., the indicator must show that variation.

(b) A sensitive altimeter.

(c) A magnetic direction indicator.

(d) A clock displaying hours, minutes, and seconds with a sweep-second pointer or digital presentation.

(e) A free-air temperature indicator.

(f) A non-tumbling gyroscopic bank and pitch indicator.

(g) A gyroscopic rate-of-turn indicator combined with an integral slip-skid indicator (turn-and-bank indicator) except only a slip-skid indicator is required on rotorcraft with a third attitude instrument system that—

(1) Is useable through flight attitudes of ±80 degrees of pitch and ±120 degrees of roll;

(2) Is powered from a source independent of the electrical generating system;

(3) Continues reliable operation for a minimum of 30 minutes after total failure of the electrical generating system;

(5) Is operative without selection after total failure of the electrical generating system;

(6) Is located on the instrument panel in a position acceptable to the Administrator that will make it plainly visible to and useable by any pilot at his station; and

(7) Is appropriately lighted during all phases of operation.

(h) A gyroscopic direction indicator.

(i) A rate-of-climb (vertical speed) indicator.

(j) For Category A rotorcraft, a speed warning device when V_{NE} is less than the speed at which unmistakable overspeed warning is provided by other pilot cues. The speed warning device must give effective aural warning (differing distinctively from aural warnings used for other purposes) to the pilots whenever the indicated speed exceeds V_{NE} plus 3 knots and must operate satisfactorily throughout the approved range of altitudes and temperatures.

[(Amdt. 29–12, Eff. 2/1/77); (Amdt. 29–14, Eff. 9/1/77); (Amdt. 29–24, Eff. 12/6/84)]

§ 29.1305 Powerplant instruments.

The following are required powerplant instruments:

(a) For each rotorcraft—

(1) A carburetor air temperature indicator for each reciprocating engine;

(2) A cylinder head temperature indicator for each air-cooled reciprocating engine, and a coolant temperature indicator for each liquid-cooled reciprocating engine;

(3) A fuel quantity indicator for each fuel tank;

(4) A low fuel warning device for each fuel tank which feeds an engine. This device must—

(i) Provide a warning to the crew when approximately 10 minutes of usable fuel remains in the tank; and

(ii) Be independent of the normal fuel quantity indicating system.

(5) A manifold pressure indicator, for each reciprocating engine of the altitude type;

rotor drive gearbox, including gearboxes necessary for rotor phasing;

(10) A gas temperature indicator for each turbine engine;

(11) A gas producer rotor tachometer for each turbine engine;

(12) A tachometer for each engine that, if combined with the applicable instrument required by paragraph (a)(13) of this section, indicates rotor r.p.m. during autorotation.

(13) At least one tachometer to indicate, as applicable—

(i) The r.p.m. of single main rotor;

(ii) The common r.p.m. of any main rotors whose speeds cannot vary appreciably with respect to each other; and

(iii) The r.p.m. of each main rotor whose speed can vary appreciably with respect to that of another main rotor;

(14) A free power turbine tachometer for each turbine engine;

(15) A means, for each turbine engine, to indicate power for that engine;

(16) For each turbine engine, an indicator to indicate the functioning of the powerplant ice protection system;

(17) An indicator for the filter required by § 29.997 to indicate the occurrence of contamination of the filter to the degree established in compliance with § 29.955;

(18) For each turbine engine, a warning means for the oil strainer or filter required by § 29.1019, if it has no bypass, to warn the pilot of the occurrence of contamination of the strainer or filter before it reaches the capacity established in accordance with § 29.1019(a)(2);

(19) An indicator to indicate the functioning of any selectable or controllable heater used to prevent ice clogging of fuel system components;

(20) An individual fuel pressure indicator for each engine, unless the fuel system which supplies that engine does not employ any pumps, filters, or other components subject to degradation, and an indicator, warning or caution device, or other means to advise the flightcrew that limits are being exceeded, if exceeding these limits can be hazardous, for—

(i) Gas temperature;

(ii) Oil pressure; and

(iii) Rotor speed.

(b) For category A rotorcraft—

(1) An individual oil pressure indicator for each engine, and either an independent warning device for each engine or a master warning device for the engines with means for isolating the individual warning circuit from the master warning device;

(2) An independent fuel pressure warning device for each engine or a master warning device for all engines with provision for isolating the individual warning device from the master warning device; and

(3) Fire warning indicators.

(c) For category B rotorcraft—

(1) An individual oil pressure indicator for each engine; and

2) Fire warning indicators, when fire detection is required.

[(Amdt. 29–3, Eff. 2/25/68); (Amdt. 29–10, Eff. 10/31/74); (Amdt. 29–26, Eff. 10/3/88)]

§ 29.1307 Miscellaneous equipment.

The following is required miscellaneous equipment:

(a) An approved seat for each occupant.

(b) A master switch arrangement for electrical circuits other than ignition.

(c) Hand fire extinguishers.

(d) A windshield wiper or equivalent device for each pilot station.

(e) A two-way radio communication system.

[(Amdt. 29–12, Eff. 2/1/77)]

systems, must be designed so that:

(1) For Category B rotorcraft, the equipment, systems, and installations must be designed to prevent hazards to the rotorcraft if they malfunction or fail; or

(2) For Category A rotorcraft—

(i) The occurrence of any failure condition which would prevent the continued safe flight and landing of the rotorcraft is extremely improbable; and

(ii) The occurrence of any other failure conditions which would reduce the capability of the rotorcraft or the ability of the crew to cope with adverse operating conditions is improbable.

(c) Warning information must be provided to alert the crew to unsafe system operating conditions and to enable them to take appropriate corrective action. Systems, controls, and associated monitoring and warning means must be designed to minimize crew errors which could create additional hazards.

(d) Compliance with the requirements of paragraph (b)(2) of this section must be shown by analysis and, where necessary, by appropriate ground, flight, or simulator tests. The analysis must consider—

(1) Possible modes of failure, including malfunctions and damage from external sources;

(2) The probability of multiple failures and undetected failures;

(3) The resulting effects on the rotorcraft and occupants, considering the stage of flight and operating conditions; and

(4) The crew warning cues, corrective action required, and the capability of detecting faults.

(e) For Category A rotorcraft, each installation whose functioning is required by this subchapter and which requires a power supply is an "essential load" on the power supply. The power sources and the system must be able to supply the following power loads in probable operating combinations and for probable durations:

(1) Loads connected to the system with the system functioning normally.

be assumed to be reduced under a monitoring procedure consistent with safety in the kinds of operations authorized. Loads not required for controlled flight need not be considered for the two-engine-inoperative condition on rotorcraft with three or more engines.

(g) In showing compliance with paragraphs (a) and (b) of this section with regard to the electrical system and to equipment design and installation, critical environmental conditions must be considered. For electrical generation, distribution, and utilization equipment required by or used in complying with this subchapter, except equipment covered by Technical Standard Orders containing environmental test procedures, the ability to provide continuous, safe service under foreseeable environmental conditions may be shown by environmental tests, design analysis, or reference to previous comparable service experience on other aircraft.

(h) In showing compliance with paragraphs (a) and (b) of this section, the effects of lightning strikes on the rotorcraft must be considered in accordance with § 29.610.

[(Amdt. 29–14, Eff. 9/1/77); (Amdt. 29–24, Eff. 12/6/84)]

INSTRUMENTS INSTALLATION

§ 29.1321 Arrangement and visibility.

(a) Each flight, navigation, and powerplant instrument for use by any pilot must be easily visible to him from his station with the minimum practicable deviation from his normal position and line of vision when he is looking forward along the flight path.

(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

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.

(c) Other required powerplant instruments must be closely grouped on the instrument panel.

(d) Identical powerplant instruments for the engines must be located so as to prevent any confusion as to which engine each instrument relates.

(e) Each powerplant instrument vital to safe operation must be plainly visible to appropriate crewmembers.

(f) Instrument panel vibration may not damage, or impair the readability or accuracy of, any instrument.

(g) If a visual indicator is provided to indicate malfunction of an instrument, it must be effective under all probable cockpit lighting conditions.

[(Amdt. 29–14, Eff. 9/1/77); (Amdt. 29–21, Eff. 3/2/83)]

§ 29.1322 Warning, caution, and advisory lights.

If warning, caution or advisory lights are installed in the cockpit they must, unless otherwise approved by the Administrator, be—

(a) Red, for warning lights (lights indicating a hazard which may require immediate corrective action);

(b) Amber, for caution lights (lights indicating the possible need for future corrective action);

(c) Green, for safe operation lights; and

(d) Any other color, including white, for lights not described in paragraphs (a) through (c) of this section, provided the color differs sufficiently from the colors prescribed in paragraphs (a) through (c) of this section to avoid possible confusion.

[(Amdt. 29–3, Eff. 2/25/68); (Amdt. 29–12, Eff. 2/1/77)]

system error excluding airspeed instrument error. This calibration must be determined—

(1) In level flight at speeds of 20 knots and greater, and over an appropriate range of speeds for flight conditions of climb and autorotation; and

(2) During takeoff, with repeatable and readable indications that ensure—

(i) Consistent realization of the field lengths specified in the Rotorcraft Flight Manual; and

(ii) Avoidance of the critical areas of the limiting height-speed envelope established under § 29.79.

(c) For Category A rotorcraft—

(1) The indication must allow consistent definition of the critical decision point; and

(2) The system error, excluding the airspeed instrument calibration error, may not exceed—

(i) Three percent or 5 knots, whichever is greater, in level flight at speeds above 80 percent of takeoff safety speed; and

(ii) Ten knots in climb at speeds from 10 knots below takeoff safety speed to 10 knots above V_Y.

(d) For Category B rotorcraft, the system error, excluding the airspeed instrument calibration error, may not exceed 3 percent or 5 knots, whichever is greater, in level flight at speeds above 80 percent of the climb out speed attained at 50 feet when complying with § 29.63.

(e) Each system must be arranged, so far as practicable, to prevent malfunction or serious error due to the entry of moisture, dirt, or other substances.

(f) Each system must have a heated pilot tube or an equivalent means of preventing malfunction due to icing.

[(Amdt. 29–3, Eff. 2/25/68); (Amdt. 29–24, Eff. 12/6/84)]

and located in such manner that the correlation between air pressure in the static pressure system and true ambient atmospheric static pressure is not altered when the rotorcraft encounters icing conditions. An anti-icing means or an alternate source of static pressure may be used in showing compliance with this requirement. If the reading of the altimeter, when on the alternate static pressure system, differs from the reading of the altimeter when on the primary static system by more than 50 feet, a correction card must be provided for the alternate static system.

(d) Except for the vent into the atmosphere, each system must be airtight.

(e) Each pressure altimeter must be approved and calibrated to indicate pressure altitude in a standard atmosphere with a minimum practicable calibration error when the corresponding static pressures are applied.

(f) Each system must be designed and installed so that an error in indicated pressure altitude, at sea level, with a standard atmosphere, excluding instrument calibration error, does not result in an error of more than ± 30 feet per 100 knots speed. However, the error need not be less than ± 30 feet.

(g) Except as provided in paragraph (h) of this section, if the static pressure system incorporates both a primary and an alternate static pressure source, the means for selecting one or the other source must be designed so that—

(1) When either source is selected, the other is blocked off; and

(2) Both sources cannot be blocked off simultaneously.

(h) For unpressurized rotorcraft, paragraph (g)(1) of this section does not apply if it can be demonstrated that the static pressure system calibration, when either static pressure source is selected, is not changed by the other static pressure source being open or blocked.

[(Amdt. 29–3, Eff. 2/25/68); (Amdt. 29–14, Eff. 9/1/77); (Amdt. 29–24, Eff. 12/6/84)]

§ 29.1329 Automatic pilot system.

(a) Each automatic pilot system must be designed so that the automatic pilot can—

(1) Be sufficiently overpowered by one pilot to allow control of the rotorcraft; and

(2) Be readily and positively disengaged by each pilot to prevent it from interfering with the control of the rotorcraft.

(b) Unless there is automatic synchronization, each system must have a means to readily indicate to the pilot the alignment of the actuating device in relation to the control system it operates.

(c) Each manually operated control for the system's operation must be readily accessible to the pilots.

(d) The system must be designed and adjusted so that, within the range of adjustment available to the pilot, it cannot produce hazardous loads on the rotorcraft, or create hazardous deviations in the flight path, under any flight condition appropriate to its use, either during normal operation or in the event of a malfunction, assuming that corrective action begins within a reasonable period of time.

(e) If the automatic pilot integrates signals from auxiliary controls or furnishes signals for operation of other equipment, there must be positive interlocks and sequencing of engagement to prevent improper operation.

[(Amdt. 29–24, Eff. 12/6/84)]

§ 29.1331 Instruments using a power supply.

For category A rotorcraft—

(a) Each required flight instrument using a power supply must have—

(1) Two independent sources of power;

(2) A means of selecting either power source; and

(3) A visual means integral with each instrument to indicate when the power adequate to sustain proper instrument performance is not being supplied. The power must be measured at or near the point where it enters the instrument. For electrical instruments, the power is consid-

§ 29.1333 Instrument systems.

For systems that operate the required flight instruments which are located at each pilot's station, the following apply:

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

(b) 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 flight instruments remains available to a pilot, without additional crewmember action, after any single failure or combination of failures that are not shown to be extremely improbable.

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

[(Amdt. 29–24, Eff. 12/6/84)]

§ 29.1335 Flight director systems.

If a flight director system is installed, means must be provided to indicate to the flight crew its current mode of operation. Selector switch position is not acceptable as a means of indication.

[(Amdt. 29–14, Eff. 9/1/77)]

§ 29.1337 Powerplant instruments.

(a) *Instruments and instrument lines.*

(1) Each powerplant and auxiliary power unit instrument line must meet the requirements of §§ 29.993 and 29.1183.

(2) Each line carrying flammable fluids under pressure must—

(i) Have restricting orifices or other safety devices at the source of pressure to prevent the escape of excessive fluid if the line fails; and

each tank during flight. In addition—

(1) Each fuel quantity indicator must be calibrated to read "zero" during level flight when the quantity of fuel remaining in the tank is equal to the unusable fuel supply determined under § 29.959;

(2) When two or more tanks are closely interconnected by a gravity feed system and vented, and when it is impossible to feed from each tank separately, at least one fuel quantity indicator must be installed;

(3) Tanks with interconnected outlets and airspaces may be treated as one tank and need not have separate indicators; and

(4) Each exposed sight gauge used as a fuel quantity indicator must be protected against damage.

(c) *Fuel flowmeter system.* If a fuel flowmeter system is installed, each metering component must have a means for bypassing the fuel supply if malfunction of that component severely restricts fuel flow.

(d) *Oil quantity indicator.* There must be a stick gauge or equivalent means to indicate the quantity of oil—

(1) In each tank, and

(2) In each transmission gearbox.

(e) Rotor drive system transmissions and gearboxes utilizing ferromagnetic materials must be equipped with chip detectors designed to indicate the presence of ferromagnetic particles resulting from damage or excessive wear within the transmission or gearbox. Each chip detector must—

(1) Be designed to provide a signal to the indicator required by § 29.1305(a)(22); and

(2) Be provided with a means to allow crewmembers to check, in flight, the function of each detector electrical circuit and signal.

[(Amdt. 29–13, Eff. 5/2/77); (Amdt. 29–26, Eff. 10/3/88)]

sis; and

(2) Meet the requirements of § 29.1309.

(b) *Generating system.* The generating system includes electrical power sources, main power busses, transmission cables, and associated control, regulation, and protective devices. It must be designed to that—

(1) Power sources function properly when independent and when connected in combination;

(2) No failure or malfunction of any power source can create a hazard or impair the ability of remaining sources to supply essential loads;

(3) The system voltage and frequency (as applicable) at the terminals of essential load equipment can be maintained within the limits for which the equipment is designed, during any probable operating condition;

(4) System transients due to switching, fault clearing, or other causes do not make essential loads inoperative, and do not cause a smoke or fire hazard;

(5) There are means accessible in flight to appropriate crewmembers for the individual and collective disconnection of the electrical power sources from the main bus; and

(6) There are means to indicate to appropriate crewmembers the generating system quantities essential for the safe operation of the system, such as the voltage and current supplied by each generator.

(c) *External power.* If provisions are made for connecting external power to the rotorcraft, and that external power can be electrically connected to equipment other than that used for engine starting, means must be provided to ensure that no external power supply having a reverse polarity, or a reverse phase sequence, can supply power to the rotorcraft's electrical system.

(d) *Operation without normal electrical power.* It must be shown by analysis, tests, or both, that the rotorcraft can be operated safely in VFR conditions, for a period of not less than five minutes, with the normal electrical power (electrical power sources excluding the battery) inoperative, with critical type fuel (from the standpoint of flameout

(5) The electrical wire and cable insulation and other materials, of the parts turned on are self-extinguishing when tested in accordance with § 25.1359(d) in effect on September 1, 1977.

[(Amdt. 29–14, Eff. 9/1/77)]

§ 29.1353 Electrical equipment and installations.

(a) Electrical equipment, controls, and wiring must be installed so that operation of any one unit or system of units will not adversely affect the simultaneous operation of any other electrical unit or system essential to safe operation.

(b) Cables must be grouped, routed, and spaced so that damage to essential circuits will be minimized if there are faults in heavy current-carrying cables.

(c) Storage batteries must be designed and installed as follows:

(1) Safe cell temperatures and pressures must be maintained during any probable charging and discharging condition. No uncontrolled increase in cell temperature may result when the battery is recharged (after previous complete discharge)—

(i) At maximum regulated voltage or power;

(ii) During a flight of maximum duration; and

(iii) Under the most adverse cooling condition likely in service.

(2) Compliance with paragraph (a)(1) of this section must be shown by test unless experience with similar batteries and installations has shown that maintaining safe cell temperatures and pressures presents no problem.

(3) No explosive or toxic gases emitted by any battery in normal operation, or as the result of any probable malfunction in the charging system or battery installation, may accumulate in hazardous quantities within the rotorcraft.

(4) No corrosive fluids or gases that may escape from the battery may damage surrounding structures or adjacent essential equipment.

(5) Each nickel cadmium battery installation capable of being used to start an engine or auxil-

of the battery automatically so as to prevent battery overheating;

(ii) A battery temperature sensing and over-temperature warning system with a means for disconnecting the battery from its charging source in the event of an over-temperature condition; or

(iii) A battery failure sensing and warning system with a means for disconnecting the battery from its charging source in the event of battery failure.

[(Amdt. 29–14, Eff. 9/1/77); (Amdt. 29–15, Eff. 3/1/78)]

§ 29.1355 Distribution system.

(a) The distribution system includes the distribution busses, their associated feeders, and each control and protective device.

(b) If two independent sources of electrical power for particular equipment or systems are required by this chapter, in the event of the failure of one power source for such equipment or system, another power source (including its separate feeder) must be provided automatically or be manually selectable to maintain equipment or system operation.

[(Amdt. 29–14, Eff. 9/1/77); (Amdt. 29–24, Eff. 12/6/84)]

§ 29.1357 Circuit protective devices.

(a) Automatic protective devices must be used to minimize distress to the electrical system and hazard to the rotorcraft in the event of wiring faults or serious malfunction of the system or connected equipment.

(b) The protective and control devices in the generating system must be designed to de-energize and disconnect faulty power sources and power transmission equipment from their associated buses with sufficient rapidity to provide protection from hazardous overvoltage and other malfunctioning.

(c) Each resettable circuit protective device must be designed so that, when an overload or circuit

each circuit in an essential load system (such as each position light circuit in a system) is not required.

(f) If fuses are used, there must be spare fuses for use in flight equal to at least 50 percent of the number of fuses of each rating required for complete circuit protection.

(g) Automatic reset circuit breakers may be used as integral protectors for electrical equipment provided there is circuit protection for the cable supplying power to the equipment.

[(Amdt. 29–24, Eff. 12/6/84)]

§ 29.1359 Electrical system fire and smoke protection.

(a) Components of the electrical system must meet the applicable fire and smoke protection provisions of §§ 29.831 and 29.863.

(b) Electrical cables, terminals, and equipment, in designated fire zones, and that are used in emergency procedures, must be at least fire resistant.

§ 29.1363 Electrical system tests.

(a) When laboratory tests of the electrical system are conducted—

(1) The tests must be performed on a mock-up using the same generating equipment used in the rotorcraft;

(2) The equipment must simulate the electrical characteristics of the distribution wiring and connected loads to the extent necessary for valid test results; and

(3) Laboratory generator drives must simulate the prime movers on the rotorcraft with respect to their reaction to generator loading, including loading due to faults.

(b) For each flight condition that cannot be simulated adequately in the laboratory or by ground tests on the rotorcraft, flight tests must be made.

pilot's eyes; and

(2) No objectionable reflections are visible to the pilot.

§ 29.1383 Landing lights.

(a) Each required landing or hovering light must be approved.

(b) Each landing light must be installed so that—

(1) No objectionable glare is visible to the pilot;

(2) The pilot is not adversely affected by halation; and

(3) It provides enough light for night operation, including hovering and landing.

(c) At least one separate switch must be provided, as applicable—

(1) For each separately installed landing light; and

(2) For each group of landing lights installed at a common location.

§ 29.1385 Position light system installation.

(a) *General.* Each part of each position light system must meet the applicable requirements of this section and each system as a whole must meet the requirements of §§ 29.1387 through 29.1397.

(b) *Forward position lights.* Forward position lights must consist of a red and a green light spaced laterally as far apart as practicable and installed forward on the rotorcraft so that, with the rotorcraft in the normal flying position, the red light is on the left side, and the green light is on the right side. Each light must be approved.

(c) *Rear position light.* The rear position light must be a white light mounted as far aft as practicable, and must be approved.

(d) *Circuit.* The two forward position lights and the rear position light must make a single circuit.

(e) *Light covers and color filters.* Each light cover or color filter must be at least flame resistant and may not change color or shape or lose any appreciable light transmission during normal use.

(c) Dihedral angle *R* (right) is formed by two intersecting vertical planes, the first parallel to the longitudinal axis of the rotorcraft, and the other at 110 degrees to the right of the first, as viewed when looking forward along the longitudinal axis.

(d) Dihedral angle *A* (aft) is formed by two intersecting vertical planes making angles of 70 degrees to the right and to the left, respectively, to a vertical plane passing through the longitudinal axis, as viewed when looking aft along the longitudinal axis.

(e) If the rear position light, when mounted as far aft as practicable in accordance with § 29.1385(c), cannot show unbroken light within dihedral angle *A* (as defined in paragraph (d) of this section), a solid angle or angles of obstructed visibility totaling not more than 0.04 steradians is allowable within that dihedral angle, if such solid angle is within a cone whose apex is at the rear position light and whose elements make an angle of 30° with a vertical line passing through the rear position light.

[(Amdt. 29–9, Eff. 11/5/71)]

§ 29.1389 Position light distribution and intensities.

(a) *General.* The intensities prescribed in this section must be provided by new equipment with light covers and color filters in place. Intensities must be determined with the light source operating at a steady value equal to the average luminous output of the source at the normal operating voltage of the rotorcraft. The light distribution and intensity of each position light must meet the requirements of paragraph (b) of this section.

(b) *Forward and rear position lights.* The light distribution and intensities of forward and rear position lights must be expressed in terms of minimum intensities in the horizontal plane, minimum intensities in any vertical plane, and maximum intensities in overlapping beams, within dihedral angles, *L*, *R*, and *A*, and must meet the following requirements:

where I is the minimum intensity prescribed in § 29.1391 for the corresponding angles in the horizontal plane.

(3) *Intensities in overlaps between adjacent signals.* No intensity in any overlap between adjacent signals may exceed the values in § 29.1395, except that higher intensities in overlaps may be used with the use of main beam intensities substantially greater than the minima specified in §§ 29.1391 and 29.1393 if the overlap intensities in relation to the main beam intensities do not adversely affect signal clarity.

§ 29.1391 Minimum intensities in the horizontal plane of forward and rear position lights.

Each position light intensity must equal or exceed the applicable values in the following table:

Dihedral angle (light included)	*Angle from right or left or longitudinal axis, measured from dead ahead*	*Intensity (candles)*
L and *R* (forward red and green).	0° to 10°	40
	10° to 20°	30
	20° to 110°	5
A (rear white)	110° to 180°	20

§ 29.1393 Minimum intensities in any vertical plane of forward and rear position lights.

Each position light intensity must equal or exceed the applicable values in the following table:

Angle above or below the horizontal plane:	*Intensity*
0°	1.00*I*
0° to 5°	0.90*I*
5° to 10°	0.80*I*
10° to 15°	0.70*I*
15° to 20°	0.50*I*
20° to 30°	0.30*I*
30° to 40°	0.10*I*
40° to 90°	0.05*I*

Green in dihedral angle *L*	10	1
Red in dihedral angle *R*	10	1
Green in dihedral angle *A*	5	1
Red in dihedral angle *A*	5	1
Rear white in dihedral angle *L*	5	1
Rear white in dihedral angle *R*	5	1

Where—

(a) Area A includes all directions in the adjacent dihedral angle that pass through the light source and intersect the common boundary plane at more than 10° but less than 20°; and

(b) Area B includes all directions in the adjacent dihedral angle that pass through the light source and intersect the common boundary plane at more than 20°.

§ 29.1397 Color specifications.

Each position light color must have the applicable International Commission on Illumination chromaticity coordinates as follows:

(a) *Aviation red*—

"y" is not greater than 0.335; and

"z" is not greater than 0.002.

(b) *Aviation green*—

"x" is not greater than $0.440-0.320y$;

"x" is not greater than $y-0.170$; and

"y" is not less than $0.390-0.170x$.

(c) *Aviation white*—

"x" is not less than 0.300 and not greater than 0.540;

"y" is not less than "$x-0.040$" or "$y_c-0.010$," whichever is the smaller; and

"y" is not greater than "$x+0.020$" nor "$0.636-0.400x$";

Where "y_0" is the "y" coordinate of the Planckian radiator for the value of "x" considered.

[(Amdt. 29–7, Eff. 8/11/71)]

§ 29.1399 Riding light.

(a) Each riding light required for water operation must be installed so that it can—

(1) Show a white light for at least two miles at night under clear atmospheric conditions; and

(2) Show a maximum practicable unbroken light with the rotorcraft on the water.

the conspicuity of the position lights; and

(2) Meets the requirements of paragraphs (b) through (f) of this section.

(b) *Field of coverage.* The system must consist of enough lights to illuminate the vital areas around the rotorcraft, considering the physical configuration and flight characteristics of the rotorcraft. The field of coverage must extend in each direction within at least 30° above and 30° below the horizontal plane of the rotorcraft, except that there may be solid angles of obstructed visibility totaling not more than 0.5 steradians.

(c) *Flashing characteristics.* The arrangement of the system, that is, the number of light sources, beam width, speed of rotation, and other characteristics, must give an effective flash frequency of not less than 40, nor more than 100, cycles per minute. The effective flash frequency is the frequency at which the rotorcraft's complete anticollision light system is observed from a distance, and applies to each sector of light including any overlaps that exist when the system consists of more than one light source. In overlaps, flash frequencies may exceed 100, but not 180 cycles per minute.

(d) *Color.* Each anticollision light must be aviation red and must meet the applicable requirements of § 29.1397.

(e) *Light intensity.* The minimum light intensities in any vertical plane, measured with the red filter (if used) and expressed in terms of "effective" intensities, must meet the requirements of paragraph (f) of this section. The following relation must be assumed:

$$Ie = \frac{\int_{t_1}^{t_2} I(t)dt}{0.2 + (t_2 - t_1)}$$

Where—

I_e = effective intensity (candles).

$I(t)$ = instantaneous intensity as a function of time.

$t_2 - t_1$ = flash time interval (seconds).

Normally, the maximum value of effective intensity is obtained when t_2 and t_1 are chosen so that the

0° to 5°	150
5° to 10°	90
10° to 20°	30
20° to 30°	15

[(Amdt. 29–7, Eff. 8/11/71); (Amdt. 29–11, Eff. 2/5/76)]

SAFETY EQUIPMENT

§ 29.1411 General.

(a) *Accessibility.* Required safety equipment to be used by the crew in an emergency, such as automatic liferaft releases, must be readily accessible.

(b) *Stowage provisions.* Stowage provisions for required emergency equipment must be furnished and must—

(1) Be arranged so that the equipment is directly accessible and its location is obvious; and

(2) Protect the safety equipment from inadvertent damage.

(c) *Emergency exit descent device.* The stowage provisions for the emergency exit descent device required by § 29.809(f) must be at the exits for which they are intended.

(d) *Liferafts.* Liferafts must be stowed near exits through which the rafts can be launched during an unplanned ditching. Rafts automatically or remotely released outside the rotorcraft must be attached to the rotorcraft by the static line prescribed in § 29.1415.

(e) *Long-range signaling device.* The stowage provisions for the long-range signaling device required by § 29.1415 must be near an exit available during an unplanned ditching.

(f) *Life preservers.* Each life preserver must be within easy reach of each occupant while seated.

§ 29.1413 Safety belts: Passenger warning device.

(a) If there are means to indicate to the passengers when safety belts should be fastened, they

required by any operating rule of this chapter must meet the requirements of this section.

(b) Each liferaft and each life preserver must be approved. In addition—

(1) Provide not less than two rafts, of an approximately equal rated capacity and buoyancy to accommodate the occupants of the rotorcraft; and

(2) Each raft must have a trailing line, and must have a static line designed to hold the raft near the rotorcraft but to release it if the rotorcraft becomes totally submerged.

(c) Approved survival equipment must be attached to each liferaft.

(d) [There must be an approved survival type emergency locator transmitter for use in one life raft.]

(Amdt. 29–8, Eff. 10/21/71); (Amdt. 29–19, Eff. 9/9/80); (Amdt. 29–30, Eff. 4/5/90); [(Amdt. 29–33, Eff. 6/21/94)]

§ 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:

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.

[(Amdt. 29–21, Eff. 3/2/83)]

MISCELLANEOUS EQUIPMENT

§ 29.1431 Electronic equipment.

(a) Radio communication and navigation installations must be free from hazards in themselves, in their method of operation, and in their effects on other components, under any critical environmental conditions.

(b) Radio communication and navigation equipment, controls, and wiring must be installed so that operation of any one unit or system of units will not adversely affect the simultaneous operation of any other radio or electronic unit, or system of units, required by this chapter.

§ 29.1433 Vacuum systems.

(a) There must be means, in addition to the normal pressure relief, to automatically relieve the pressure in the discharge lines from the vacuum air pump when the delivery temperature of the air becomes unsafe.

(b) Each vacuum air system line and fitting on the discharge side of the pump that might contain flammable vapors or fluids must meet the requirements of § 29.1183 if they are in a designated fire zone.

(c) Other vacuum air system components in designated fire zones must be at least fire resistant.

be designed to withstand pressures sufficiently greater than those prescribed in paragraph (b) of this section to show that the system will not rupture under service conditions.

(3) There must be means to indicate the pressure in each main hydraulic power system.

(4) There must be means to ensure that no pressure in any part of the system will exceed a safe limit above the maximum operating pressure of the system, and to prevent excessive pressures resulting from any fluid volumetric change in lines likely to remain closed long enough for such a change to take place. The possibility of detrimental transient (surge) pressures during operation must be considered.

(5) Each hydraulic line, fitting, and component must be installed and supported to prevent excessive vibration and to withstand inertia loads. Each element of the installation must be protected from abrasion, corrosion, and mechanical damage.

(6) Means for providing flexibility must be used to connect points, in a hydraulic fluid line, between which relative motion or differential vibration exists.

(b) *Tests.* Each element of the system must be tested to a proof pressure of 1.5 times the maximum pressure to which that element will be subjected in normal operation, without failure, malfunction, or detrimental deformation, of any part of the system.

(c) *Fire protection.* Each hydraulic system using flammable hydraulic fluid must meet the applicable requirements of §§ 29.861, 29.1183, 29.1185, and 29.1189.

§ 29.1439 Protective breathing equipment.

(a) If one or more cargo or baggage compartments are to be accessible in flight, protective breathing equipment must be available for an appropriate crewmember.

(b) For protective breathing equipment required by paragraph (a) of this section or by any operating rule of this chapter—

(1) Each equipment must supply protective oxygen of 10 minutes duration per crewmember at a pressure altitude of 8,000 feet with a respiratory minute volume of 30 liters per minute BTPD.

§ 29.1457 Cockpit voice recorders.

(a) Each cockpit voice recorder required by the operating rules of this chapter must be approved, and must be installed so that it will record the following:

(1) Voice communications transmitted from or received in the rotorcraft by radio.

(2) Voice communications of flight crewmembers on the flight deck.

(3) Voice communications of flight crewmembers on the flight deck, using the rotorcraft's interphone system.

(4) Voice or audio signals identifying navigation or approach aids introduced into a headset or speaker.

(5) Voice communications of flight crewmembers using the passenger loudspeaker system, if there is such a system, and if the fourth channel is available in accordance with the requirements of paragraph (c)(4)(ii) of this section.

(b) The recording requirements of paragraph (a)(2) of this section may be met—

(1) By installing a cockpit-mounted area microphone, located in the best position for recording voice communications originating at the first and second pilot stations and voice communications of other crewmembers on the flight deck when directed to those stations; or

(2) By installing a continually energized or voice-actuated lip microphone at the first and second pilot stations.

The microphone specified in this paragraph must be so located and, if necessary, the preamplifiers and filters of the recorder must be so adjusted or supplemented, that the recorded communications are intelligible when recorded under flight cockpit noise conditions and played back. The level of intelligibility must be approved by the Administrator.

(2) For the second channel, from each microphone, headset, or speaker used at the second pilot station.

(3) For the third channel, from the cockpit-mounted area microphone, or the continually energized or voice-actuated lip microphones at the first and second pilot stations.

(4) For the fourth channel, from—

(i) Each microphone, headset, or speaker used at the stations for the third and fourth crewmembers; or

(ii) If the stations specified in paragraph (c)(4)(i) of this section are not required or if the signal at such a station is picked up by another channel, each microphone on the flight deck that is used with the passenger loudspeaker system if its signals are not picked up by another channel.

(iii) Each microphone on the flight deck that is used with the rotorcraft's loudspeaker system if its signals are not picked up by another channel.

(d) Each cockpit voice recorder must be installed so that—

(1) It receives its electric power from the bus that provides the maximum reliability for operation of the cockpit voice recorder without jeopardizing service to essential or emergency loads;

(2) There is an automatic means to simultaneously stop the recorder and prevent each erasure feature from functioning, within 10 minutes after crash impact; and

(3) There is an aural or visual means for preflight checking of the recorder for proper operation.

(e) The record container must be located and mounted to minimize the probability of rupture of the container as a result of crash impact and consequent heat damage to the record from fire.

(f) If the cockpit voice recorder has a bulk erasure device, the installation must be designed to minimize the probability of inadvertent operation and actuation of the device during crash impact.

directional data obtained from sources that meet the accuracy requirement of §§ 29.1323, 29.1325, and 29.1327 of this part, as applicable;

(2) The vertical acceleration sensor is rigidly attached, and located longitudinally within the approved center gravity limits of the rotorcraft;

(3) It receives its electrical power from the bus that provides the maximum reliability for operation of the flight recorder without jeopardizing service to essential or emergency loads;

(4) There is an aural or visual means for preflight checking of the recorder for proper recording of data in the storage medium; and

(5) Except for recorders powered solely by the engine-driven electrical generator system, there is an automatic means to simultaneously stop a recorder that has a data erasure feature and prevent each erasure feature from functioning, within 10 minutes after any crash impact.

(b) Each nonejectable recorder container must be located and mounted so as to minimize the probability of container rupture resulting from crash impact and subsequent damage to the record from fire.

(c) A correlation must be established between the flight recorder readings of airspeed, altitude, and heading and the corresponding readings (taking into account correction factors) of the first pilot's instruments. This correlation must cover the airspeed range over which the aircraft is to be operated, the range of altitude to which the aircraft is limited, and 360 degrees of heading. Correlation may be established on the ground as appropriate.

(d) Each recorder container must—

(1) Be either bright orange or bright yellow;

(2) Have a reflective tape affixed to its external surface to facilitate its location under water; and

(3) Have a underwater locating device, when required by the operating rules of this chapter, on or adjacent to the container which is secured in such a manner that it is not likely to be separated during crash impact.

[(Amdt. 29–25, Eff. 10/11/88)]

tail damage caused by the failure of high energy rotor blades; and

(2) Equipment control devices, systems, and instrumentation must reasonably ensure that no flight.

[(Amdt. 29–3, Eff. 2/25/68)]