This AC section is hereby effective and replaces the existing section AC 29 MG 5 dated 9/30/99, as well as the updates in Change 1 dated 2/12/03. This revised MG will be incorporated in a future change or revision to AC 29-2C. The vertical lines in the margin indicate the revised parts.

CHAPTER 3
AIRWORTHINESS STANDARDS
TRANSPORT CATEGORY ROTORCRAFT

MISCELLANEOUS GUIDANCE (MG)

AC 29 MG 5. AGRICULTURAL DISPENSING EQUIPMENT INSTALLATION.

NOTE: This paragraph has been extensively revised and expanded to clarify the restricted category certification of agricultural dispensing equipment installations on rotorcraft.

a. Explanation. In the early development of the rotorcraft, one of its primary usages was agricultural operation. The FAA recognized that the existing requirements, which were designed primarily to establish an appropriate level of safety for passenger-carrying aircraft, imposed an unnecessary economic burden and were unduly restrictive for the manufacture and operation of aircraft used in agricultural operations in rural, sparsely settled areas. To resolve this, the FAA developed a special document that established new standards for agricultural dispensing equipment and other special purpose operations. This document, Restricted Category CAM 8, became effective October 11, 1950.

(1) During the re-codification of the CAM's and CAR's in 1965, CAR 8 ceased to exist as a regulatory basis and selected portions addressing certification were incorporated into 14 Code of Federal Regulations (CFR), part 21. While the specific standards in CAR 8 were not changed substantively when adopted into part 21, the less restrictive philosophy of CAM 8 and the policy material that was stated in the preamble to CAM 8 was not clearly written.

(2) Advisory material published in 1965 and revised in 1975, summarized the information contained in the advisory portions of CAM 8. Unfortunately, this document specified that CAM 8 was to be used only in conjunction with certain airworthiness standards for restricted category certification of small agricultural airplanes.

(3) A survey of restricted category rotorcraft projects related to agricultural modifications indicates that the CAM 8 philosophy was interpreted to allow the use of AC 43.13-2A structural criteria for most STCs issued for rotorcraft through the early 1980's. Since then, more restrictive guidance based on CAR 7 and part 29 requirements has been applied by some ACO's to several STC applications. Since the more restrictive guidance imposed a significant economic burden on the industry, the HAI requested a meeting with the FAA during the 1990 annual convention in Dallas. As

a result of the meeting, an Action Notice to clarify the interpretation of § 21.25(a)(1) for restricted category aircraft has been issued.

(4) The following advisory material is a result of a reassessment of past and present policy.

b. Procedures. The certification basis for agricultural dispensing aircraft equipment installations in the restricted category is § 21.25 as interpreted by Order 8110.56. The accountable Directorate guidance for the substantiation requirements for rotorcraft is as follows:

(1) The list of airworthiness standards below is appropriate for most agricultural dispensing equipment installations and is intended to address the key compliance areas for those installations. However, it is not intended to be all inclusive for every type of agricultural dispensing equipment installation, such as those possessing novel or unusual design features.

Compliance List of 14 CFR, Part 29 Airworthiness Standards for Agricultural Dispensing Aircraft Equipment Installations

Airworthiness Standard	Rule Section
Center of Gravity	§ 29.27 (Provided an expanded envelope is necessary)
Performance (Takeoff)	§ 29.51
Performance (Landing)	§ 29.75
Controllability and Maneuverability	§ 29.143
Static Longitudinal Stability	§ 29.173
Static Directional Stability	§ 29.177
Taxiing Condition	§ 29.235
Excessive Vibration	§ 29.251
Limit Maneuvering Load Factor	§ 29.337
Static structural strength at the equipment attachment using emergency landing loads	§ 29.561
Fatigue (apply forward airspeed restriction to prevent increasing mast bending and oscillatory loading on dynamic components)	§ 29.571
Design and Construction (material strength properties, protection of materials from environmental conditions, use of aerospace grade hardware, etc.)	part 29, Subpart D
Pilot Compartment Areas	§ 29.771 thru 29.779
External Loads	§ 29.865
Equipment Installations	§ 29.1309
Electrical Equipment and Installations	§ 29.1351
Circuit Protection Devices	§ 29.1357

Airspeed Limitations	§ 29.1503
*Instruction for Continued Airworthiness	§ 29.1529
Rotorcraft Flight Manual	§ 29.1581
Operating Limitations	§ 29.1583
Operating Procedures	§ 29.1585

*Requires acceptance by the cognizant Flight Standards District Office

Note: Some rotorcraft manufacturers have qualified certain locations on the underside of their aircraft for mounting external equipment. The manufacturers will typically specify external equipment weight and dimensional limitations at those locations. The applicant should contact the manufacturer to see if this information is available as it could be used to reduce the applicant's certification effort.

(2) The critical structural loading conditions for substantiating the installation of agricultural dispensing equipment can be developed by using the associated occupant protection load factors provided in Figure AC 29.MG-1. These load factors are prescribed to prevent dispensing equipment from causing injuries to occupants in the event of an emergency landing. To ensure this, adequate margins of safety should be used in the structural design consideration of dispensing equipment and dispensing equipment installations.

FIGURE AC 29.MG 5-1
ACCEPTABLE ULTIMATE LOAD FACTOR FOR
AGRICULTURAL DISPENSING EQUIPMENT DESIGN

	UP	DOWN	SIDE	FORWARD	AFT
Tanks & Equipment Mounted In Or Near The Fuselage	1.5g	4.0g	2.0g	4.0g Note 1	- - - -
Spray Booms	1.5g	2.5g	- - - -	Note 1	2.5g Note 2

Note 1: An ultimate load factor of 2 G's is acceptable for externally side or under fuselage mounted tank and forward mounted spray booms where failure in a minor crash landing will not create a hazard to occupants or prevent an occupant's exit from the rotorcraft.

Note 2: The aft loads for spray booms may be developed by the applicant based on the 111 percent of V_{NE} for which certification is requested or the load factors of Figure AC 29.MG 5-1, whichever is greater.

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(3) The applicant may elect to substantiate their product by either static or dynamic testing, by analysis, or any combination thereof.

(4) Lower load factors may be used only when justified by manufacturer's data, rational analysis, actual rotorcraft flight data and ground load demonstrations, or any combination of these approaches.

(5) Tank pressure testing, while not mandated, is recommended for safety reasons. An acceptable procedure is included in paragraph c.(4) under "Acceptable Means of Compliance."

(6) Dispensing equipment installation attach points that are an integral part of the rotorcraft and have been certified to the appropriate airworthiness standards, need no further substantiation. This applies provided a load analysis indicates the dispensing system does not impose loads at the attach points which exceed those approved as part of the rotorcraft certification.

(7) A 5-inch ground clearance for skid gear equipped, newly manufactured rotorcraft has typically been used when installing dispensing equipment, such as belly mounted supply tanks/hoppers or when installing dual side mounted supply tanks/hoppers. This applies provided the rotorcraft design incorporates cross tubes or other skid gear reinforcing structure below the fuselage and the cross tubes have not experienced in-service permanent elastic deformation. For rotorcraft equipped with wheels and/or landing gear struts, the maximum system deflections should be considered when determining the 5 inches of acceptable static ground clearance. A 3-inch ground clearance has been found acceptable and may be approved for skid gear equipped rotorcraft to account for the in-service permanent elastic deformation allowed for skid gear members (i.e., cross tube deflections allowed per the maintenance manual). Cable supported systems (e.g., cargo hook installations) or dispensing systems utilizing flexible ducts, such as water snorkels, have been approved even though portions of the systems contact the surface during a normal landing. A determination should be made that these systems do not interfere with the safe landing of the rotorcraft.

(8) A number of rotorcraft are approved for external cargo operations that allow a gross weight higher than the approved internal gross weight limit. This difference is usually due to the allowable weight limit restriction of the landing gear. (The gear is not approved for the higher weight.) Those types of dispensing equipment, which can be loaded in flight to a weight that exceeds the allowable limit of the landing gear, should incorporate a reliable means that rapidly reduces the total aircraft gross weight to within allowable landing gear limits. In most cases, this will involve jettison of the disposable load. The time interval for this operation should be demonstrated, and should not exceed a recommended 3 seconds from a level flight condition.

(9) A flight check or demonstration of the agricultural dispensing equipment installation is normally conducted. This flight check should also qualitatively determine that no hazardous deflection or resonance in the rotorcraft or dispensing system exists. For FAA flight operations approval, this flight check must be conducted under the requirements of § 133.41.

(10) Recent service history has shown that external equipment and external fixture modifications that generate high drag loads in forward flight can affect main rotor mast bending loads. In lieu of a mast bending survey, a pre and post modification flight test may be conducted at identical weights, center-of-gravity (CG), power, and density altitude to compare a critical control position parameter (typically longitudinal cyclic stick position) at pre and post modification V_{NE} airspeeds.

(i) If required, the post modification V_{NE} should be reduced so that the post modification longitudinal cyclic stick position is slightly aft of (or less than) the pre-modification stick position. This alternative procedure assumes that the static longitudinal stability of the helicopter has not been altered by the modification. For helicopters with neutral static stability, a more comprehensive investigation may be required.

(ii) In some cases, a control position parameter other than longitudinal stick position may be critical. For example, a heavy external device mounted to the side of the helicopter that gives a lateral CG close to the limit and an asymmetric yaw component would require pre and post modification lateral cyclic stick and pedal position measurements. Operating limitations other than V_{NE} may need to be established, or reduced from pre-modification limitations, to ensure pre modification mast bending is not exceeded.

(11) For rotorcraft certificated in dual categories, the inspection requirements of § 21.187(b) must be observed when converting from restricted to transport category.

c. Acceptable Means of Compliance.

(1) Analysis Method. Static structural analysis may be used provided a methodology is applied that has been shown to be reliable for analyzing the type of structure. Structural substantiation of tanks that are designed to contain liquid materials may be accomplished by pressure testing. For tanks or hoppers designed to contain dry material (e.g., dust or fertilizer), static load tests may be used to verify structural integrity. The tank/hopper, mounting hardware, and support structure should all be substantiated to the load conditions specified and should consider the effects of internal fluid pressures, when applicable, in Figure AC 29.MG 5-1.

(2) Static Tests. Static tests of tank/hoppers, mounting hardware, and support structure for each critical load condition may be accomplished using conventional techniques; such as, dead weight loading, whiffletree systems, and hydraulic rams. If tests of the tank and its mounting hardware are conducted using a test fixture

representing the rotorcraft, the rotorcraft support structure may be substantiated independently by means of test or analysis, or both. Static test loads should be applied in combination with associated internal fluid pressure loadings. The ultimate loads specified in Figure AC 29.MG 5-1 should be sustained for at least 3 seconds without failure.

(3) Dynamic Tests

(i) If the applicant elects to test to the loading conditions in Figure AC 29.MG 5-1, the maneuvering and gust loadings will be considered to be adequately substantiated. For each condition, the critical volume and density of fluid should be used.

(ii) The tank and mounting hardware should support ultimate loads without permanent elastic deformation failure, respectively. The rotorcraft support structure may be included in the dynamic tests, or it may be substantiated separately via static test or analysis, or both, for each condition specified in Figure AC 29.MG 5-1.

(4) Pressure Testing. Internal pressure loads may be applied using the water standpipe technique. Standpipe water height should be accurately computed for each critical spray tank static test loading. Pressure testing of spray tanks is not absolutely essential but is recommended for safety reasons. This testing will also determine whether the joints and connections are tight and will not leak in addition to determining any weak spots in the construction. Where spraying is done with highly volatile and flammable liquids, or where the tank has a return line, such as in an engine oil tank where the fluid is pumped back into the tank, it is recommended that the tank be tested for a pressure of 5 pounds per square inch. For other liquids, and where no fluid return line is used, testing to 3 ½ pounds per square inch should be satisfactory. There are many ways of pressure testing a tank, however, it is believed that the simplest and easiest method is to fill the tank with water and use a standpipe filled with water. A 1 1/8-inch pipe can be connected to the venting tube or one adapted to the filler opening. In either case, the height of the pipe would be the same. For a 3 ½ PSI test of the tank, the height of the water in the pipe would only need to be 8 feet and for a 5 PSI test only an 11 ½ -foot height of water will be needed. (See Figure AC 29.MG 5-2 below.)

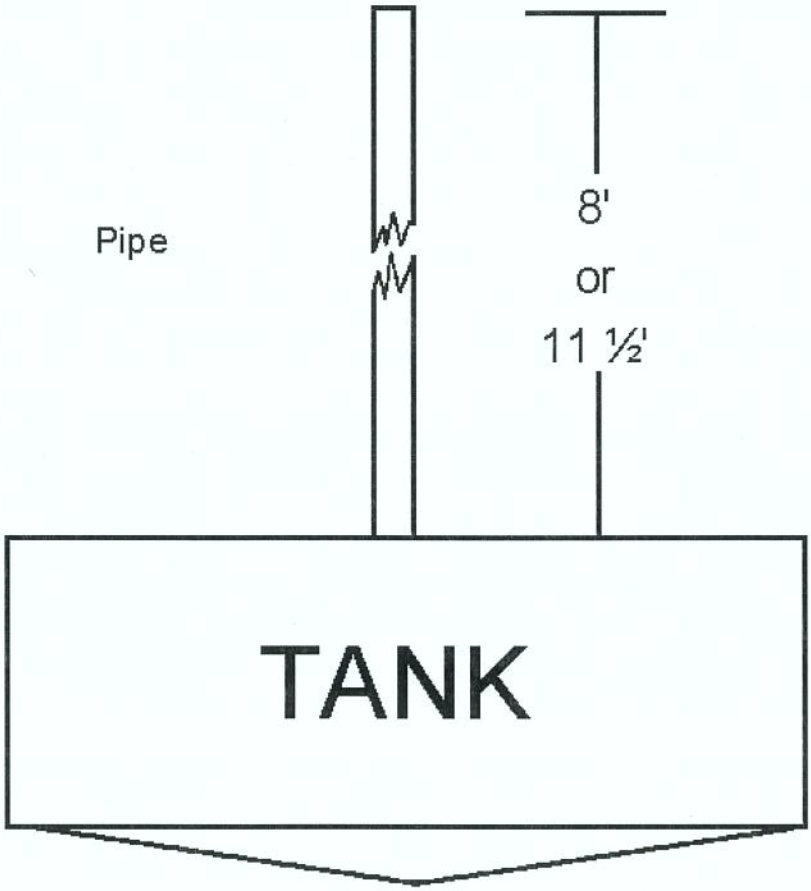

Figure AC 29.MG 5-2 Sketch of Tank Pressure Test