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NATIONAL TRANSPORTATION SAFETY BOARD

Washington, D.C.

Amendment FAR 25-13
Hydraulic System for Transport Category Airplanes
Effective July 27, 1967

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Hydraulic System for Transport Category Airplanes

Adopted: June 21, 1967 **Effective: July 27, 1967**

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The purpose of this amendment to **§ 25.1435** of the Federal Aviation Regulations is to prescribe more comprehensive design and test requirements for transport category airplane hydraulic systems.

This amendment is based on a notice of proposed rulemaking (Notice No. 65-33) published in the Federal Register on November 5, 1985, (30 FR 14015).

Numerous comments were received in response to Notice 65-33. The more pertinent of these comments, together with the changes in the proposal resulting therefrom are discussed hereinafter.

One comment recommended that, in order to be consistent with normal design practices, each element of the hydraulic system should withstand, without rupture, the ultimate pressure loads (design operating pressure loads multiplied by a factor of safety of 1.5) in combination with ultimate structural loads that can reasonably occur simultaneously. The proposal would have required consideration of design operating pressure loads in combination with ultimate structural loads in all cases, with no regard as to whether the two would ever occur simultaneously in service. The FAA agrees with this comment since the establishment of ultimate pressure is in accord with other provisions in the regulation, and the application of ultimate pressure loads and ultimate structural loads only when the combination can reasonably occur to cause rupture, is more rational aid less burdensome than the proposal.

A number of comments objected to the use of the terms "main" and "primary" in describing the hydraulic power systems in proposed § 25.1435(a) (2), (3) and (4). The FAA agrees that the words "primary" and "main" can be confusing and that the proposal should be clarified in this regard. However, the FAA does not agree with the comment that the rule should require pressure indication in each "standby system"). In this connection, the proposal has been changed to make it clear that pressure indication is necessary only in continuously operating systems.

Numerous comments suggested that the pressure indication means should be gages, or warning lights, or both. However, the FAA does not consider that it is necessary to specify the means. While either a gage or a light would be satisfactory, the applicant should be allowed to show that some other means is also adequate.

There was a comment to the effect that fluid quantity indication should be mandatory for each system having a reservoir. On the other hand, another comment stated that a minimum airworthiness standard should not require any fluid quantity indication, and that the pressure indication was sufficient. The FAA does not agree with either of these comments. A fluid quantity indication means could not be justified for certain

emergency standby systems which have small reservoirs. However, based on service experience, the FAA considers that there is ample justification for the proposed fluid quantity indication requirement. In the light of these comments the proposed requirement concerning the fluid quantity indication means has been changed to make it clear that a means must be provided at a flight crewmember station to indicate the quantity of fluid in each continuously operating system. The FAA agrees with a final comment that there is no reasonable correlation between quantity indication and four separate ways of serving any fundamental function as suggested in proposed § 25.1435(a)(3) and the proposed exception to the fluid indication requirement has been deleted.

There were a large number of comments objecting to the requirement for a fluid temperature indication as set forth in **§ 25.1435(a)(4)**. After further consideration in the light of the comments received, the FAA has concluded that there is no present need for the proposed temperature indication requirement and the proposal has been deleted accordingly.

While concurring with the proposed requirement of § 25.1435(a)(5), one commentator suggested a limit of 125 percent of design operating pressure for the hydraulic system generally, and plus or minus 10 percent pump ripple pressures. Another comment said that the standard should require that power supplied (pumps) and operation of actuators must not produce surges or frequencies which are destructive to any part of the system. Finally, it was recommended that the requirement should minimize surge pressure effect in all components in the hydraulic system. The FAA agrees with these comments but considers that the regulations as proposed will accomplish the stated objective. The FAA also sees merit in establishing specific overpressure limits as suggested. However, it is not in a position at this time to specify the limit values and further study will be required before a proposal in this matter can be made.

In response to a comment with respect to the proposed requirements in § 25.1435(a)(6) that each hydraulic element must be protected from abrasion, corrosion, and mechanical damage, the FAA agrees that such a requirement is too restrictive and should be changed to take into consideration damage which must be expected during normal service life. Furthermore, the FAA agrees that the requirement concerning harmful or hazardous concentrations of hydraulic fluid or vapor should be revised to apply only during flight. However, the FAA does not agree with a request that the terms "harmful" and "hazardous" be defined. The FAA considers that since each individual application must be evaluated to determine whether there is a harmful or hazardous condition present and since such an evaluation depends on, among other things, the fluid used, system pressure, and emergency procedures available to the crew, a definition that would be uniformly applicable is not possible.

One of the comments recommended that the proposed § 25.1435(a)(6) be further amended to require that routing of hydraulic lines in exposed areas be designed to afford maximum protection from foreign object damage such as objects thrown by the wheels. In this regard, however, we believe that since the regulation requires that each hydraulic element must be installed to present excessive vibration, abrasion, corrosion, and mechanical damage, it is sufficiently broad to cover all physical damage

regardless of cause. It is considered, therefore, that further amendment as suggested would merely emphasize a specific source of damage already included within the objectively stated rule.

In response to numerous objections to the burst test pressure requirements in proposed § 25.1435(b)(1), the FAA has determined that the proposal should be deleted). In consideration of other provisions of the regulation, the FAA agrees that the proposed burst test pressures could result in a substantial weight and cost penalty with no certainty of improvement in reliability.

In commenting on § 25.1435(b)(2), several persons suggested that the rule should be amended to make it clear that it applies to type certification only. However, the FAA does not believe that such a revision is necessary since the applicability provision of Part 25 specifically states that the standards set forth therein are the airworthiness standards for the issue of and changes to type certification. Another comment stated that this rule should apply only to installed tubing. However, the FAA intends that the requirement be applied to the complete system installed in an airplane and not just to tubing and the current rule was revised in the proposal to make this clear. However, in response to comments, the FAA does agree that the proposed regulation should be changed to make it clear that during the static tests there must be adequate clearance between structural members and hydraulic system components and that following the tests there must be no permanent detrimental deformation. The rule has been amended accordingly and renumbered as **§ 25.1435(b)(1)**.

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The current fire protection requirements for hydraulic systems set forth in **§ 25.1435(c)** merely require compliance with other sections of Part 25. In Notice 65-33, the FAA expressly determined that paragraph (c) should be amended to include the substance of the referenced sections and to delete all reference to the word "flammable." However, comments received concerning the fire protection requirements have persuaded the FAA to retain paragraph (c) in its present form. Thus, paragraph (c) remains applicable only to hydraulic systems using flammable fluids. The following is a discussion of the comments received with respect to the proposed requirements insofar as they relate to the requirements of the final rule.

With respect to the requirements concerning fire protection set forth in proposed § 25.1435(c)(1), a comment suggested that the requirements should require detection as well as control of any fire resulting from the ignition of hydraulic fluids. In addition, a suggestion was made that the rule should require the use of fire resistant fluids. Control of a fire does not necessarily require detection. In some cases, control is inherent in the design through fireproof construction or the sealing off of ventilation. In other cases, however, control of a fire may entail detection. The requirement for control of a fire is intended to assure that all the steps necessary to control the fire in the particular case are provided, including detection where needed. Furthermore, the FAA does not believe that a requirement for fire resistant hydraulic fluids is necessary. The substantial service experience available for hydraulic fluids indicates that oil-base hydraulic fluids are safe when adequate

fire protection is also provided.

Concerning the requirements of proposed § 25.1435(c)(2), a suggestion was made that the location of the hydraulic fluid reservoir should not be permitted in any designated fire zone, The FAA does not agree with this suggestion. There has been no adverse service experience with flammable fluid reservoirs to indicate that a requirement prohibiting the installation of a hydraulic fluid reservoir in a designated fire zone is necessary.

A comment concerning the requirement in proposed § 25.1435(c)(3) that at least a ½-inch clearance must be provided between tank or reservoir and firewalls or shrouds, suggested that the requirement should be more general and should be tied to the ambient temperature or to the heat transmitting characteristics of the firewall or shroud. The FAA, however, does not believe it necessary to change this requirement. The requirement specifies that there must be at least a ½-inch clearance and this does not preclude requiring a larger clearance if type certification evaluation indicates that additional clearance is necessary. In this connection, the functional tests, endurance tests, and analyses required under amended **§ 25.1435(b)(2)** may justify imposition of a greater clearance.

Concerning the proposed requirements of § 25.1435(c)(5), certain comments indicated that the shutoff means required should be a shutoff valve while another comment stated that a shutoff means is not needed where tests prove the fluid transportation system and equipment is fire-resistant equivalent to the aircraft structure. The FAA, however, does not believe that the rule should specifically require a shutoff valve but should permit the use of any means to prevent hydraulic fluid from entering a designated fire zone. Moreover, the FAA must also reject the recommendation to allow elimination of the shutoff means on a showing that the fluid transportation system is fire-resistant, equivalent to the aircraft structure, The FAA does not consider that, in the event of fire, the unrestricted flow of flammable fluid within a designed fire zone, even though transported in a fire-resistant system, provides the same level of safety as preventing such flow by a shutoff means.

Comments received objecting to the proposed new § 25.1435(c)(6) indicated that the requirement should reference the remaining parts of the system, rather than only the parts of the system associated with other designated fire zones. The FAA agrees with this comment, and, by retaining the present paragraph (c) which contains the appropriate references, has incorporated it into the regulations.

With respect to the proposed requirement of § 25.1435(c)(9), a comment stated that it should require that the amount of plumbing between a shutoff valve and the fire zone be kept to a minimum. The FAA does not agree with this comment, There was no data submitted in support of this recommendation and in the FAA's opinion, keeping the plumbing between the shutoff valve and the fire zone to an undefined "minimum" would not, in all cases, prevent hazardous quantities of fluid from draining into that fire zone. Therefore, the FAA does not consider that a requirement along the lines suggested by this comment is necessary in the interest of safety.

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A comment concerning the requirements of proposed § 25.1435(c)(11) noted that the flexible hose assembly must be approved and asked by whom the hose is to be approved. Other comments suggested the need to define "fire resistant" and pointed out that the rule should make it clear that insofar as the fire resistant requirement is concerned, the word "line" includes flexible hose assemblies. By "approved" flexible hose assembly, the FAA means any assembly approved in a manner specified in **§ 21.305** of the FARs. Moreover, since the term "fire resistant" is already defined in **Part 1** of the FARs and since that definition applies to the term as used in this regulation, there is no need for a definition in this rule. Finally, it should be pointed out that the fire protection requirements have

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not been adopted in the form proposed. In this final amendment, the fire protection requirements are the same as presently set forth in the regulations. In this connection, the regulation, as presently drafted, includes flexible hose assemblies under the general heading of lines and fittings and such assemblies have been consistently treated as lines and fittings under that requirement. Therefore, the FAA does not believe that clarification or the requirement is necessary.

In response to numerous objections to proposed § 25.1435(d), Reliability, the FAA has deleted requirements relating to environmental testing of the assembled system and set forth the remaining portions of proposed paragraph (d) in a new paragraph (b)(2). In this connection, the FAA agrees that the proposed environmental testing of the assembled system is not necessary in order to achieve a reasonable and effective testing program for improving hydraulic system reliability, and the final rule has been changed accordingly. Moreover, the FAA determined that the specific requirements continued in proposed paragraphs (d)(2) and (d)(3), which stated endurance testing requirements were unnecessarily detailed. The endurance testing requirements have been revised to specify a more objective standard and as set forth in the new paragraph (b)(2) requires that endurance tests must simulate the repeated complete flights that could be expected to occur in service. In addition, based on numerous comments, the proposal has been relaxed to the extent that cyclic loads during the tests need not take into account the effects of vibration and variations in temperature. Finally, as pointed out by the comments, elements which have failed during testing may need only to be modified and not redesigned and the rule has been changed accordingly.

A comment recommended that filters be required at strategic points in the system so that contaminants from a failed component will not travel through the system. The FAA does not agree with the recommendation. Extra filters add to the weight and complexity of hydraulic systems and could, therefore, conceivably reduce the overall reliability of the system. Removal of contaminants following a component failure is accomplished by proper maintenance procedures which vary with hydraulic system design.

The comment presents no justification for such a requirement and the FAA is not aware of any unsatisfactory service experience in this area. Therefore, the FAA does not believe that such a requirement is necessary in the interest of safety.

In response to a recommendation that the standard require all

components to be designed so that they cannot be installed incorrectly it should be noted that such a requirement would impose an unwarranted design burden on the manufacturers since, in all cases, subsequent installation of the components is required to be made by trained personnel.

A comment was received suggesting that the rule should include a requirement that the normal system be provided with a reserve fluid supply. However, the FAA is aware that hydraulic failures, when they occur, are such that loss of fluid is rapid. The introduction of more fluid into the system would be of no value since the new fluid would be lost before pressure could be restored in the system.

Interested persons have been afforded an opportunity to participate in the making of this amendment, and due consideration has been given to all matter presented.

This amendment is made under the authority of Sections 313(a), 601, and 603 of the Federal Aviation Act of 1958 (49 US.C. 1354(a), 1421, and 1423).

In consideration of the foregoing, **§ 25.1435** of Part 25 of the Federal Aviation Regulations is amended, effective July 27, 1967.