DEPARTMENT OF TRANSPORTATION

Federal Aviation Administration

14 CFR Part 25

[Docket No. 28617; Amendment No. 25–104]

RIN 2120–AF79

Revision of Hydraulic Systems Airworthiness Standards To Harmonize With European Airworthiness Standards for Transport Category Airplanes

AGENCY: Federal Aviation Administration (FAA), DOT.

ACTION: Final rule.

SUMMARY: This amendment revises the hydraulic systems design and test requirements of the airworthiness standards for transport category airplanes. The amendment adds appropriate existing Joint Aviation Requirements (JAR) standards to achieve harmonization; moves some of the existing regulatory text to a new advisory circular (AC) 25.1435–1; consolidates and/or separates certain subparagraphs for clarity; and revises airplane static proof pressure test requirements to allow a complete functional (dynamic) airplane test at the hydraulic system relief pressure. These revisions were developed in cooperation with the Joint Aviation Authorities (JAA) of Europe, Transport Canada, and the U.S. and European aviation industry through the Aviation Rulemaking Advisory Committee (ARAC). These changes benefit the public interest by standardizing certain requirements, concepts, and procedures contained in the airworthiness standards without reducing, but potentially enhancing, the current level of safety.

DATE: Effective June 15, 2001.

FOR FURTHER INFORMATION CONTACT: Mahinder K. Wahi, Propulsion/Mechanical Systems Branch, ANM–112, Transport Airplane Directorate, Aircraft Certification Service, FAA, 1601 Lind Avenue SW., Renton, WA 98055–4056; telephone (425) 227–2142; facsimile (425) 227–1320.

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Background

This amendment is based on notice of proposed rulemaking (NPRM) Notice No. 96–6, which was published in the **Federal Register** on July 3, 1996 (61 FR 35056). The related background leading to Notice No. 96–6 is as follows:

In 1988, the FAA, in cooperation with the JAA and other organizations representing the American and European aerospace industries, began a process to harmonize the airworthiness requirements of the United States and the airworthiness requirements of Europe, especially in the areas of Flight Test and Structures.

In 1992, the FAA harmonization effort was undertaken by the Aviation Rulemaking Advisory Committee (ARAC). A working group of industry and government hydraulic systems specialists of Europe, the United States, and Canada was chartered by notice in the **Federal Register** (57 FR 58843, December 12, 1992) to harmonize requirements and the associated test conditions for hydraulic systems, installed in transport category airplanes (§ 25.1435). The harmonization task was completed by the working group and recommendations were submitted to FAA by letter dated November 6, 1995. The FAA concurred with the recommendations and proposed them in Notice No. 96–6. A Notice of availability of proposed AC 25.1435–1 and request for comments was also published in the **Federal Register** on July 3, 1996 (61 FR 35062). In August 1996, the JAA issued its Notice of Proposed Amendment (NPA) 25F–273: ''Hydraulic Systems'' which included the proposed advisory material AMJ 25.1435. The amendments proposed in NPA 25F–273 and the advisory material proposed in AMJ 25.1435 were substantively the same as the amendments proposed in Notice No. 96–6 and the advisory material in proposed AC 25.1435–1.

As a result, although the FAA (and JAA) has received two sets of comments from the public, in response to the proposed rule and the proposed AC, the comments are interlinked and addressed jointly. Therefore, the FAA has considered both sets of comments in preparing the final rule contained herein and the new AC. The announcement of the FAA's issuance of the new AC will be published in the **Federal Register** once it is available to the public. Interested persons have been given an opportunity to participate in this rulemaking, and due consideration has been given to all matters presented. Comments received are discussed below.

Discussion of Comments

Eight commenters responded to the request for comments contained in Notice No. 96–6, the notice of availability of proposed AC 25.1435–1 and the corresponding JAA document NPA 25F–273 and AMJ 25.1435. Comments were received from foreign airplane manufacturers, foreign airworthiness authorities, and both foreign and domestic industry organizations. The majority of the commenters agree with the proposal and recommend its adoption. However, some commenters disagree with the proposal while providing alternative proposals that appear to merit further consideration by the ARAC. Therefore the FAA tasked the ARAC Hydraulic Systems Harmonization Working Group (HWG) by notice in the **Federal Register** (62 FR 38187, July 16, 1997) to consider the comments and provide recommendations for the disposition of the comments along with any recommendations for changes to the proposal. The disposition of the comments that follows is based on the agreement reached by the HWG. Several

of the comments address multiple issues and some of the issues were addressed by many commenters. As a result, the FAA responses to the comments are organized by individual comment under each proposal, *i.e.,* proposals 1 through 12.

Proposal 1, § 25.1435(a)(1). One commenter states that the structure of the punctuation in the first sentence appears to allow leakage under proof pressure, providing that such leakage does not prevent the element from performing its intended function. The proper intent should be to prohibit any leakage under proof pressure. The commenter suggests to revise the regulatory text of the first sentence as follows: ''(1) Withstand the proof pressure without leakage and without permanent deformation that would prevent it from performing its intended function, and withstand the ultimate pressure without rupture.'' The FAA agrees that some clarification of the rule text is necessary. The FAA does not however agree with the commenter's suggested text because under proof pressure, some external seal leakage is allowed as long as the element's ability to perform its intended function remains unaffected once the design operating pressure (DOP) is restored. Accordingly, the final rule text of the first sentence and the associated advisory circular text have been revised to read:

Rule text: ''(a) *Element design.* Each element of the hydraulic system must be designed to:

(1) Withstand the proof pressure without permanent deformation that would prevent it from performing its intended functions, and the ultimate pressure without rupture.''

Advisory circular text: The following text has been added to Paragraph 4a(1)(d), Ref. § 25.1435(a)(1), of the AC: ''At proof pressure, seal leakage not exceeding the allowed maximum in-service leak rate is permitted. Each element should be able to perform its intended function when the DOP is restored.'' For consistency, in Paragraph 4a(2), Ref. § 25.1435(a)(2), of the AC, the following text will be added: ''At limit load, seal leakage not exceeding the allowed maximum in-service rate is permitted.''

Another commenter recommends that consideration be given to address system ''return pressures'' in addition to the ''design, proof, and ultimate pressures'' in the table presented as part of § 25.1435(a)(1). The FAA did consider the return pressures but decided that since the factors specified in the table apply to both high/supply pressures and low/return pressures, it was unnecessary to specify two sets of factors.

A third commenter recommends that the advisory material should include guidance for determination of the DOP for elements in the low pressure side of the system. The FAA concurs and has added the following definition in the AC, Paragraph 4a(1)(b), Ref. § 25.1435(a)(1): ''The DOP for low pressure elements (*e.g.,* return, case-drain, suction, reservoirs) is the maximum pressure expected to occur during normal user system operating modes. Included are transient pressures that may occur during separate or simultaneous operation of user systems such as slats, flaps, landing gears, thrust reversers, flight controls, and power transfer units. Short term transient pressures, commonly referred to as pressure spikes, that may occur during the selection and operation of user systems (e.g., those pressure transients due to the opening and closing of selector/control valves) may be excluded, provided the fatigue effect of such transients is addressed in accordance with Paragraph 4a(4) of this AC.''

A fourth commenter proposes to replace the term DOP with the term ''nominal pressure'' claiming that this terminology was consistent with MIL-standards and the commenter's own country's practices where operating pressure of 3000 psi corresponds to the nominal pressure. The FAA notes that consideration was given by the working group to use the term ''nominal pressure'' but no agreement could be reached on its definition because the term ''nominal'' could involve tolerances, fluctuations, and other interpretations; the term ''DOP'' is more specific.

This commenter also proposes that the same safety factor be used for all elements, *i.e.,* not less than 1.5 for proof pressure and not less than 3.0 for burst pressure. The FAA does not agree. Existing U.S. and European industry standards/practices were used to arrive at these factors and to harmonize with current JAR 25, Appendix ''J'' (Appendix ''K'' effective May 27, 1994) requirements. The commenter's suggestion would simplify the requirements but does not reflect the acceptable industry standards.

For the above reasons, the proposed § 25.1435(a)(1) has been modified by deleting reference to ''without leakage'' and text added in the advisory circular regarding leakage and a definition of the DOP for elements in the low pressure side of the system.

Proposals 2 and 3, §§ 25.1435(a)(2), (3). One commenter states that in spite of the guidance material, there is still room for misunderstanding the meaning of structural loads in the context of hydraulic system elements. The commenter states that the intent is that the designer must consider those loads arising when the airplane responds to the relevant critical loading conditions of subpart C, in which case it would improve clarity to say so. Also, the strength analysis of hydraulic system elements must not stop at consideration of inertia, dynamic and aerodynamic loads, but must also include consideration of strains imposed by the deformation (bending, twist, etc.) of the structure to which the elements are attached. Furthermore, thermal stresses are likely to be important at the normal operating temperature of the hydraulic system. To address these factors, the commenter proposes the following amendment:

''§ 25.1435(a)(2)—Withstand, without deformation that would prevent it from performing its intended functions, the design operating pressure in combination with the loads and structural deflections arising from the critical limit loading conditions of subpart C. Where appropriate, thermal effects must also be taken into account.

§ 25.1435(a)(3)—Withstand, without rupture, the design operating pressure multiplied by a factor of 1.5, in combination with the ultimate loads and ultimate structural deflections arising from the critical loading conditions of subpart C. Where appropriate, thermal effects must also be taken into account.''

The commenter also suggests that the third sentence of Paragraph 4a(2) of the proposed AC be modified to read: ''The loading conditions to be considered include, but are not limited to flight and ground maneuvers, and gust and turbulence conditions. The loads arising in these conditions should be combined with the maximum hydraulic pressures, including dynamic transients, that could occur simultaneously. Where appropriate, thermal effects should also be accounted for in the strength justification.''

The FAA has considered these comments. The commenter's suggested amendments to §§ 25.1435(a)(2) and (a)(3) are inherent in the regulations as stated in the original document and do not have to be itemized in the rule. Therefore, it was determined that it would be more appropriate that the texts for §§ 25.1435(a)(2) and (a)(3) should remain as proposed in the NPRM but that the associated advisory material should be improved, as suggested by the commenter, to more adequately reflect the intent of the proposed requirements.

The AC, Paragraph 4a(2), is therefore amended to read as follows:

''(2) (Ref. § 25.1435(a)(2)) Limit structural loads are defined in § 25.301(a). The loading conditions of Part 25, Subpart C to be considered include, but are not limited to flight and ground maneuvers, and gust and turbulence conditions. The loads arising in these conditions should be combined with the maximum hydraulic pressures, including transients, that could occur simultaneously. Where appropriate, thermal effects should also be accounted for in the strength justification. For hydraulic actuators equipped with hydraulic or mechanical locking features, such as flight control actuators and power steering actuators, the actuators and other loaded elements should be designed for the most severe combination of internal and external loads that may occur in use. For hydraulic actuators that are free to move with external loads, i.e., do not have locking features, the structural loads are the same as those produced by the hydraulic actuators. At limit load, seal leakage not exceeding the allowed maximum in-service leak rate is permitted.'' For consistency, the statement ''Where appropriate, thermal effects should be accounted for in the strength justification'' will also be added at the end of Paragraph 4a(3) of the AC.

The same commenter further adds ''The final sentence in Paragraph 4a(3) of the proposed AC specifically allows operational/functional failure under (when subjected to) ultimate load conditions. However, the use of the word ''under'' in this context could give rise to confusion as to whether operational/functional failure is allowed ''below'' ultimate load. If so, this would be inconsistent with the safety objectives set by the structural requirements that prohibit failure at any load level up to and including ultimate. If a hydraulic component is essential for continued safe flight then it must not be allowed to fail, or lose operational functionality, at or below, ultimate load conditions. For example, the hydraulic system powering an elevator would be critical for recovery from the design maneuvering condition, and must not be allowed to fail below the ultimate loads associated with this condition. To improve clarity and remove confusion, the wording should be changed to state positively that operational/functional failure is not allowed at any load level up to and including ultimate.'' The FAA agrees with the commenter that no structural failure (rupture) may occur up to ultimate load. However, the commenter seems to be suggesting that operational/functional failures should not be allowed up to ultimate loads. The FAA disagrees. Section 25.1435(a)(3) of the regulation requires that elements of the hydraulic system not rupture (structural failure) up to ultimate loads. Section 25.1435(a)(2) requires operational/functional integrity only up to limit load. Paragraphs 4a(2) and (3) of the AC properly capture this relationship and no change is necessary.

Another commenter suggests that time limits for proof and burst pressure tests be included in the regulation, not just in the AC. The FAA does not agree. The recommended time limits in the proposed AC, paragraph 4(a)(1)(e), are an industry standard and one method, but not the only method, of demonstrating compliance and therefore not appropriate for inclusion in the regulation. The commenter also states that the definitions of pressures and/or pressures and times given in the proposed AC do not appear to match the current JAA criteria and wondered whether they had been fully harmonized. The FAA notes that the proposed pressures and times have been fully harmonized although they may differ from the current JAA criteria (Appendix J to JAR 25). The regulatory agencies have agreed to use the criteria proposed in the AC.

A third commenter states that the proposed advisory material for § 25.1435(a)(3) was simply rephrasing of the regulation and not a means of compliance as expected; a more detailed clarification in the AC of the methods of implementing this requirement was desirable. The FAA notes that the first statement in the AC references regulations relevant to the requirement, however the remainder is advisory and gives details of the methods of pass/fail of a test of the requirement but allows flexibility for the applicant to propose any method acceptable to the FAA.

In light of the above discussion, §§ 25.1435(a)(2) and (a)(3) are adopted as proposed with clarifying text added in the AC to account for thermal effects in strength justification and to allow some leakage at limit load.

Proposal 4, § 25.1435(a)(4). One commenter states that in order to provide sufficient safeguard against the possibility of a premature failure in the operational life of an airplane, it will be necessary to consider the effects of material fatigue variability on life. Conventionally, this would be done through application of an appropriate scatter factor to the result of the fatigue analysis or fatigue test (See JAR ACJ 25.571(a)(3)). To ensure that the effects of variability are properly taken into account in the interpretation of the fatigue analysis and test data required by this paragraph, the commenter proposed the following:

''§ 25.1435(a)(4)—Withstand, without failure, the fatigue effects of repeated loads of variable magnitude expected during its service life, including pressure cycles, pressure transients, externally induced loads, structural deformations and, where appropriate, thermal effects. Appropriate safe-life scatter factors must be applied.''

The FAA understands the concerns expressed here, but does not agree with the linkage to § 25.571, which applies to safe-life components, e.g., landing gear, and not to hydraulic components. However, the intent of this comment is already addressed in AC Paragraph 4c(1), Ref. § 25.1435(c)(1).

The same commenter adds, ''The term ''cyclical loads'' in Paragraph 4a(4) of the proposed AC, is usually associated with a periodic force. It would be better to use the term ''load cycles.'' This paragraph would be an appropriate place to give guidance on the need to cover scatter in fatigue properties—JAR ACJ 25.571(a) has some relevant guidance material.'' The FAA agrees with the use of the term ''load cycles'' and the advisory text has been modified accordingly. The FAA does not agree that any advisory material is needed for scatter factors or the relevance to § 25.571, as discussed earlier.

Another commenter states that it is not understood how the current JAR 25.1435(a)(6) requirement—means of providing flexibility—comes into the new § 25.1435(a)(4) requirement. The FAA notes that it is not the new § 25.1435(a)(4) but rather the new § 25.1435(a)(5) that addresses the current JAR 25.1435(a)(6) requirement and NPRM Proposal 5 clearly stated that. The new § 25.1435(a)(5) addresses the environmental factors, including the vibrational & acceleration effects of the elemental installation as discussed in the associated advisory material. The commenter also suggested including in the advisory material, a recommendation for the scatter factor to be used when conducting the fatigue testing (for example 4.0 for non-critical parts, 6.0 for critical parts). The FAA notes that as stated in Paragraph 4c(1) of the AC, the manufacturer may select design factors identified in accepted manufacturing, national, military, or industry standards provided that it can be established that they are suitable for the intended application. It is not appropriate to give scatter factors since they are more suitable for safe life components, e.g., landing gear and not hydraulic system components.

This same commenter also wonders whether there should be an allowance for the fact that a component might be fitted on more than one airplane in its lifetime, and hence the fatigue cycles could well be considerably more than predicted for a part which is assumed to be on the airplane for its entire life; it would be very useful to have a consistent policy for this issue. The FAA notes that the requirements of §§ 25.671 and 25.1309 specify that the failure of no single element shall jeopardize the continued safe flight and landing of the airplane. Section 25.1435(a)(4) specifies the design requirements of the element and its failure consequences that should be understood and addressed by the designer. The existing requirements adequately cover the overall safety of an airplane at the time of certification and part 25 regulations are not intended to deal with parts tracking. Furthermore, reliability of hydraulic systems is based on redundancy of the design architecture rather than safe-life of components.

Yet another commenter suggests that Society of Automotive Engineers (SAE) document ARP 1383 ''Impulse Testing of Hydraulic Actuators, Valves, Pressure Containers, and Similar Fluid System Components'' be included as a reference in the AC. The FAA notes that ARP 4752 ''Aerospace-Design and Installation of Commercial Transport Aircraft Hydraulic Systems'' listed in the advisory circular in turn refers to ARP 1383. All of the relevant SAE documents are referenced in ARP 4752 and are too numerous to be individually listed in the AC.

For the reasons stated, § 25.1435(a)(4) is adopted as proposed.

Proposal 5, § 25.1435(a)(5). One commenter recommends that the advisory material state that thermal effects be particularly considered for accumulators which are isolated from the hydraulic system by non-return valves. The FAA notes that § 25.1435(a)(5) addresses the environmental factors that are to be considered when designing the element and that in the AC, temperature effects are specifically stated as one of the variables to be addressed. For the stated reasons, § 25.1435(a)(5) is adopted as proposed.

Proposal 6, § 25.1435(b)(1). One commenter expresses a concern that the requirements of (b)(1)(i) could be open for interpretation by different airworthiness authorities, particularly with respect to fluid level quantity indication. The commenter further states that there were occasions when the warning/indication philosophy that had been agreed to with one airworthiness authority had not been agreed to by other authorities and this therefore led to redesign and/or other additional costs. The FAA notes that the commenter's concern of eliminating differences in interpretations is the basic reason for harmonization effort. The intent of the harmonized rule is to specify what type of indication is required from the point of view of what the pilot can use, without specifying the design of the indication. Adoption of a harmonized rule and guidance material will enhance the likelihood of similar interpretations during the certification process. But neither the rule nor the guidance material can assure precision in interpretation and application absent detailed listings of acceptable methods for particular applications. Since the rule and guidance material are intended to establish performance based standards, useful for future applications and developments, as well as current certifications, it is impossible, and undesirable to provide the detail that would assure uniformity. The FAA has determined that the currently agreed upon language is as likely to produce uniform interpretations as any other language which can prudently be adopted.

Another commenter states that ''moving from prescriptive to general indication requirements is considered to be sensible, but to be truly meaningful, the requirement should be stated more objectively. Section 25.1435(b)(1)(ii) is close to being an objective requirement but § 25.1435(b)(1)(i) is not. In fact it is not apparent what indication might be required by § 25.1435(b)(1)(i) that would not be required by § 25.1435(b)(1)(ii).'' The FAA does not agree. Changing the existing requirement of JAR 25.1435(a)(2), which refers to the provision of indications of system pressure and fluid quantity, to § 25.1435(b)(1) which is less prescriptive in that it requires the provision of indications of only the appropriate parameters, establishes an objective statement of the requirement. The FAA has determined that, to ensure continued safe flight and landing, each hydraulic system that either (1) performs an essential function or (2) that requires corrective action by the flightcrew following a malfunction (irrespective of whether it performs an essential function), must be associated with the appropriate flight-crew indications. The associated AC clarifies that the ''appropriate indications'' are not limited other than that they should be appropriate. As discussed in the response to the preceding comment, the FAA believes the current language is as close to a performance based standard as is possible, while avoiding dictating design and allowing flexibility in future design development.

The second commenter also points out that ''in Paragraph 4b of the proposed AC, the statement 'These requirements are unique to hydraulic systems' is questioned.'' The FAA agrees with the commenter. Accordingly, the first sentence ''These requirements are unique to hydraulic systems, and may compliment § 25.1309'' has been deleted and the second sentence has been modified to read ''Design features that should be considered for elimination of undesirable conditions and effects are:''

The first commenter also points out that the NPRM cited this requirement as § 25.1435(a)(1) when it should have been § 25.1435(b)(1). The FAA concurs that the preamble of the proposed rule had a typographical error but not the proposed rule text.

For the stated reasons, § 25.1435(b)(1) is adopted as proposed with clarifying changes made in the AC text including deleting reference to § 25.1309.

Proposals 7, 8, and 9, §§ 25.1435(b)(2), (3), and (4). No comments were received. Sections 25.1435(b)(2), (3), and (4) are therefore adopted as proposed.

Proposal 10, § 25.1435(b)(5). One commenter states that the means to identify the hydraulic fluid may not always be practical—particularly for small components such as in line non-return valves. The FAA notes that the intent of the requirement is not that every component be so identified but rather that suitable placarding be provided as practical so that servicing of the hydraulic system(s) is done with the specified fluid. As pointed out by another commenter, typical/acceptable marking locations for the hydraulic fluid used are hydraulic actuators, refill points, reservoirs, and applicable servicing documents. The second commenter recommends specifying these typical locations in the AC. The FAA concurs and appropriate wording has been included in Paragraph 4b(5), Ref. § 25.1435(b)(5), of the AC.

A third commenter suggests that FAA consider clarifying the language in proposed § 25.1435(b)(5) to address the situation of fluid mixtures. The FAA infers that the commenter is referring to Paragraph 4b(5) of the AC which states: ''If more than one approved fluid is specified, the term suitable hydraulic fluid is intended to include acceptable mixtures.'' The FAA notes that acceptable fluids and/or mixtures are those listed in the airplane

manufacturer's maintenance manuals as approved for that airplane model. These maintenance manual provisions, coupled with the proposed AC language, seem to provide adequate clarity. For the stated reasons, § 25.1435(b)(5) is adopted as proposed.

Proposal 11, § 25.1435(c). One commenter states that as written, this section continues the practice of including some means of compliance within the main code rather than in the advisory material. The commenter believes § 25.1309(d) currently contains the same anomaly, but understands that the decision has been taken in the § 25.1309 Working Group to rectify this by moving § 25.1309(d) into the advisory material. The commenter recommends that the same thing could be done here. The FAA partially accepts this comment, and is amending the opening paragraph by deleting the words ''To demonstrate compliance with § 25.1435 and support compliance with § 25.1309.'' The paragraph would commence ''Tests must be conducted . . . .'' and would otherwise remain unchanged from the original proposal. Except for qualifying statements that bring immediate clarification to the primary regulatory statements, the remainder of the paragraph is considered regulatory and not advisory. Section 25.1435(c) has been revised accordingly.

Proposal 11, §§ 25.1435(c)(1) and (c)(2). One commenter states ''Although it is considered that an endurance test of a complete airplane hydraulic system is a very useful test, there are circumstances where a full endurance test is an expensive exercise with no benefit to the integrity and safety of the airplane. Particular examples of this are: (1) the airplane hydraulic system is substantially based on an existing, well proven in-service airplane, and (2) the number and/or nature of services which are powered hydraulically are such that the loss of the system has no significant effect on the airworthiness of the airplane.''

The FAA concurs with the commenter in that testing may not always be necessary and notes that the proposed requirement test criteria already include the provision ''except that analysis may be used in place of or to supplement testing, where the analysis is shown to be reliable and appropriate.'' The type and extent of testing guidance covered in AC adequately address commenter's concern. In addition, full system testing is not required; subsystem or element testing is allowed. The commenter further states:

''It should be noted that American engineers quite often think of endurance as fatigue testing. It is therefore recommended that 'pressure impulse' be added after fatigue in this section.'' The FAA notes that Paragraph 4c(1) of the AC adequately defines these terms (for all engineers) and the associated testing. For the stated reasons, §§ 25.1435(c)(1), and (c)(2) are adopted as proposed.

Proposal 12, § 25.1435(c)(3). One commenter states: ''It is proposed that this requirement be dispensed with. This is because (1) in the course of an airplane production run, the hydraulic system can undergo many modifications (including the introduction of a cargo door system) which affect the system installation. Yet, it is the norm that this is a once only test which is conducted on an early production airplane during the certification test program, and (2) each airplane should be inspected with respect to clearances with the hydraulic system unpressurized and then pressurized. It is doubtful whether there will be any significant movement of the piping, hoses, components, etc. as a result of increasing the pressure by 25%.''

The FAA notes that this test is conducted only once per installation. However, the FAA requires that any significant modification(s) such as introduction of a cargo door system, a ram air turbine (RAT), or a tail-skid system be assessed along with any associated/affected system(s) to meet this requirement. There are several recent examples of such modifications that will require additional testing. Such testing may also be supplemented by analysis if appropriate.

Regarding the commenter's statement (2) about insignificant movement of the piping etc., when pressurized at 25% above nominal, the FAA concurs and notes that both the proposed and the final rule states that instead a full range-of-motion, testing be conducted at just below the system relief pressure setting. The commenter goes on to state ''There are some reservations with the new test proposal, as follows:

(1) The requirement to check clearances may not be easily achieved for those parts of the system which are actuated, for example, landing gear, flight controls.

(2) As the system is pressurized to a higher value, there may be concerns about safety, particularly as the services may operate quicker.

(3) The validity of the test results could be queried as the flight control actuators are unloaded.''

The FAA notes that: (1) Paragraph 4c(3) of the AC adequately addresses this concern by stating: ''it may be permissible that certain components of the system need not be tested if it can be shown that they do not constitute a significant part of the system with respect to the evaluation of adequate clearances or detrimental effects.''

(2) The system(s) relief valve(s) protect against over-pressurization. Standard safety precautions on the factory floor while the testing is being conducted must be practiced. There are no appreciable differences from full functional test(s) conducted by the manufacturer.

(3) The intent is not to check/verify structural deflections or motion of surfaces for flight controls. Loading is not anticipated to cause surface deflections.

Lastly, the commenter states: ''With respect to the low pressure side of the hydraulic system, it is proposed that the tests be conducted with a dummy return filter element installed, thereby forcing all the fluid through the return filter bypass. This meets the same criteria as for increasing the system pressure to 125%, that is increasing the pressure levels to that which could conceivably occur in service.''

The FAA notes that the commenter's scenario may be applicable to some of the hydraulic system architectures (layouts), but not all. It is the FAA's policy to allow flexibility for the applicant to propose a method of compliance which is acceptable to the cognizant certification office. Specifying the proposed dummy filter installation may be misinterpreted by an applicant as too restrictive. The commenter's suggested method is one means but not the only means of demonstrating compliance.

In light of the discussion above and the explanations already provided in the AC, § 25.1435(c)(3) is adopted as proposed.

General: One commenter states: ''It is considered that the harmonization of the § /JAR 25.1435 has produced a good set of airworthiness requirements. However, there is still a concern that there are areas within the new requirements, which could be subject to interpretation by airworthiness surveyors. It is recommended that the FAA/JAA review the advisory material and ensure that there are no areas where misinterpretation can occur. The reason for this comment is not to direct concern at the professionalism of the JAA and FAA, but rather there is a concern that other national authorities could read in additional requirements where none were intended.'' The HWG together reviewed and developed these regulations and the associated advisory material. Both the regulations and the advisory material are fully harmonized. A considerable amount of time was

spent discussing the very issues and concerns raised by the commenter to arrive at the final rule and the AC. As discussed previously in addressing the comment on Proposal 6, the FAA believes that these rules are as likely to produce uniform interpretations as any other language which can be prudently adopted.

Another commenter points out that the word ''must'' in Paragraphs 4a(1), a(2), and a(4) of the AC, and the word ''shall'' in Paragraph 4a(3) of the AC should be replaced by ''should.'' The FAA agrees and the text in the AC has been revised. The commenter adds that in Paragraph 4a(1), third paragraph, reference to ''structural loads'' should be replaced by ''external loads.'' The FAA does not agree since reference to structural loads is appropriate as used in §§ 25.301 and 25.1435(a)(1).

With the exception of the changes noted in §§ 25.1435(a)(1) and (c) this final rule is adopted as proposed in Notice 96–6.

Paperwork Reduction Act

In accordance with the Paperwork Reduction Act of 1995 (44 U.S.C, 3507(d)), there are no requirements for information collection associated with this amendment.

International Compatibility

In keeping with U.S. obligations under the Convention on International Civil Aviation, it is FAA policy to comply with International Civil Aviation Organization (ICAO) Standards and Recommended Practices to the maximum extent practicable. The FAA has reviewed the corresponding ICAO Standards and Recommended Practices and has identified no differences with these regulations.

Executive Order 12866 and DOT Regulatory Policies and Procedures

Executive Order 12866, Regulatory Planning and Review, directs the FAA to assess both the costs and benefits of a regulatory change. We are not allowed to propose or adopt a regulation unless we make a reasoned determination that the benefits of the intended regulation justify its costs. Our assessment of this proposal indicates that its economic impact is minimal. Since its costs and benefits do not make it a ''significant regulatory action'' as defined in the Order, we have not prepared a ''regulatory impact analysis.'' Similarly, we have not prepared a ''regulatory evaluation,'' which is the written cost/benefit analysis ordinarily required for all rulemaking proposals under the DOT Regulatory and Policies and Procedures. We do not need to do the latter analysis where the economic impact of a proposal is minimal.

Economic Evaluation, Regulatory Flexibility Determination, International Trade Impact Assessment, and Unfunded Mandates Assessment

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 impact of regulatory changes on small entities. Third, the Trade Agreements Act (19 U.S.C. section 2531–2533) prohibits agencies from setting standards that create unnecessary obstacles to the foreign commerce of the United States. In developing U.S. standards, this Trade Act also requires the consideration of international standards and, where appropriate, that they be the basis of U.S. standards. And fourth, the Unfunded Mandates Reform Act of 1995 requires agencies to prepare a written assessment of the costs, benefits and other effects of proposed or final rules that include a Federal mandate likely to result in the expenditure by State, local or tribal governments, in the aggregate, or by the private sector, of $100 million or more (adjusted annually for inflation) in any one year.

In conducting these analyses, the FAA has determined this rule: (1) has benefits which do justify its costs, is not a ''significant regulatory action'' as defined in the Executive Order and is ''not significant'' as defined in DOT's Regulatory Policies and Procedures; (2) will not have a significant impact on a substantial number of small entities; (3) reduces barriers to international trade; and (4) does not impose an unfunded mandate on state, local, or tribal governments, or on the private sector of 100 million or more in any one year. These analyses, available in the docket, are summarized below.

Economic Evaluation

Manufacturers contacted by the FAA (in its preparation of the economic evaluation for the NPRM), estimated that three of the revisions to § 25.1435 (corresponding to proposals 1, 4, and 12) would impose additional costs—revision 1 (regarding design load factors for proof and ultimate pressure conditions), 4 (regarding induced loads, pressure transients, and fatigue), and 12 (regarding functional testing of the complete hydraulic system). However, based on new information from the same manufacturers related to their experiences with recent type certifications, the FAA has determined that none of the provisions will impose incremental costs. The rule changes codify current industry practice and or conform § 25.1435 to corresponding sections of the JAR. Adoption of the rule changes increases harmonization and commonality between American and European airworthiness standards. Harmonizing airworthiness standards reduces manufacturers' certification costs for testing, report preparation, certification-related travel abroad, etc. One manufacturer of part 25 large airplanes estimates that such cost savings could range between $65,000 and $650,000 per type certification (pertaining to hydraulic systems' requirements as discussed in this rulemaking). Since this estimate has such a wide range and represents only one manufacturer, the FAA used the midpoint of approximately $360,000 for a conservative estimate of harmonization cost savings for a part 25 large airplane type certification. A manufacturer of part 25 small airplanes estimates such savings at $65,000 per type certification. The FAA believes these industry-provided numbers are reasonable estimates of potential harmonization cost savings. Potential safety benefits resulting from specification of minimum accepted standards will supplement these cost savings. Thus, with the described benefits and no associated incremental costs, the FAA finds the rule cost-beneficial. (Note: All estimates in this analysis are expressed in 1999 dollars).

Regulatory Flexibility Determination

The Regulatory Flexibility Act of 1980 (the Act) establishes ''as a principle of regulatory issuance that agencies shall endeavor, consistent with the objective of the rule and of applicable statutes, to fit regulatory and informational requirements to the scale of the business, organizations, and governmental jurisdictions subject to regulation.'' To achieve that principle, the Act requires agencies to solicit and consider flexible regulatory proposals and to explain the rationale for their actions. The Act covers a wide range of small entities, including small businesses, not-for-profit organizations, and small governmental jurisdictions.

Agencies must perform a review to determine whether a proposed or final rule will have a ''significant economic impact on a substantial number of small entities.'' If the determination is that it will, the agency must prepare a regulatory flexibility analysis as described in the Act.

However, if an agency determines that a proposed or final rule is not expected to have a significant impact on a substantial number of small entities, section 605(b) of the Act provides that the head of the agency may so certify and a regulatory flexibility analysis is not required. The certification must include a statement providing the factual basis for this determination, and the reasoning should be clear.

The rule will affect manufacturers of transport category airplanes produced under future new airplane type certifications. For manufacturers, a small entity is one with 1,500 or fewer employees. Since no part 25 airplane manufacturer has 1,500 or fewer employees, and, in addition, the rule imposes no incremental costs, the FAA certifies that the rule will not have a significant economic impact on a substantial number of small manufacturers.

International Trade Impact Assessment

The Trade Agreement Act of 1979 prohibits Federal agencies from engaging in any standards or related activities that create unnecessary obstacles to the foreign commerce of the United States. Legitimate domestic objectives, such as safety, are not considered unnecessary obstacles. The statute also requires consideration of international standards and where appropriate, that they be the basis for U.S. standards. In addition, consistent with the Administration's belief in the general superiority and desirability of free trade, it is the policy of the Administration to remove or diminish to the extent feasible, barriers to international trade, including both barriers affecting the export of American goods and services to foreign countries and barriers affecting the import of foreign goods and services into the United States.

In accordance with the above statute and policy, the FAA has assessed the potential effect of this final rule and has determined that it will impose the same costs on domestic and international entities and thus has a neutral trade impact.

Unfunded Mandates Reform Act

The Unfunded Mandates Reform Act of 1995 (the Act), enacted as Pub. L. 104–4 on March 22, 1995, is intended, among other things, to curb the practice of imposing unfunded Federal mandates on State, local, and tribal governments. Title II of the Act requires each Federal agency to the extent permitted by law, to prepare a written statement assessing the effects of any Federal mandate in a proposed or final agency rule that may result in a $100 million or more expenditure (adjusted annually for inflation) in any one year by State, local, and tribal governments, in the aggregate, or by the private sector; such a mandate is deemed to be a significant regulatory action.

This final rule does not contain such a mandate. Therefore, the requirements of Title II of the Unfunded Mandates Reform Act of 1995 do not apply.

Executive Order 13132, Federalism

The FAA has analyzed this final rule under the principles and criteria of Executive Order 13132, Federalism. We determined that this action will not have a substantial direct effect on the States, or the relationship between the national Government and the States, or on the distribution of power and responsibilities among the various levels of government. Therefore, we determined that this final rule does not have federalism implications.

Regulations Affecting Intrastate Aviation in Alaska

Section 1205 of the FAA Reauthorization Act of 1996 (110 Stat. 3213) requires the Administrator, when modifying regulations in Title 14 of the CFR in a manner affecting intrastate aviation in Alaska, to consider the extent to which Alaska is not served by transportation modes other than aviation, and to establish such regulatory distinctions as he or she considers appropriate. Because this final rule applies to the certification of future designs of transport category airplanes and their subsequent operation, it could affect intrastate aviation in Alaska. The Administrator has considered the extent to which Alaska is not served by transportation modes other than aviation, and how the final rule could have been applied differently to intrastate operations in Alaska. However, the Administrator has determined that airplanes operated solely in Alaska would present the same safety concerns as all other affected airplanes; therefore, it would be inappropriate to establish a regulatory distinction for the intrastate operation of affected airplanes in Alaska.

Environmental Analysis

Federal Aviation Administration Order 1050.1D defines FAA actions that may be categorically excluded from preparation of a National Environmental Policy Act (NEPA) environmental impact statement. In accordance with FAA Order 1050.1D, appendix 4, paragraph 4(j), this amendment qualifies for a categorical exclusion.

Energy Impact

The energy impact of the amendment has been assessed in accordance with the Energy Policy and Conservation Act (EPCA) Pub. L. 94–163, as amended (42 U.S.C. 6362) and FAA Order 1053.1. It has been determined that the final rule is not a major regulatory action under the provisions of the EPCA.

List of Subjects in 14 CFR Part 25

Aircraft, Aviation safety, Reporting and recordkeeping requirements.

The Amendment

In consideration of the foregoing, the Federal Aviation Administration amends part 25 of Title 14, Code of Federal Regulations as follows:

PART 25—AIRWORTHINESS STANDARDS—TRANSPORT CATEGORY AIRPLANES

1. The authority citation for part 25 continues to read as follows:

Authority: 49 U.S.C. 106(g), 40113, 44701, 44702 and 44704.

2. Section 25.1435 is amended by revising paragraphs (a), (b), and (c) to read as follows:

§ 25.1435 Hydraulic systems.

(a) *Element design.* Each element of the hydraulic system must be designed to:

(1) Withstand the proof pressure without permanent deformation that would prevent it from performing its intended functions, and the ultimate pressure without rupture. The proof and ultimate pressures are defined in terms of the design operating pressure (DOP) as follows:

Element	Proof (xDOP)	Ultimate (xDOP)
1. Tubes and fittings.	1.5	3.0
2. Pressure vessels containing gas:		
High pressure (e.g., accumulators)	3.0	4.0
Low pressure (e.g., reservoirs)	1.5	3.0
3. Hoses	2.0	4.0
4. All other elements	1.5	2.0

(2) Withstand, without deformation that would prevent it from performing its intended function, the design operating pressure in combination with limit structural loads that may be imposed;

(3) Withstand, without rupture, the design operating pressure multiplied by

a factor of 1.5 in combination with ultimate structural load that can reasonably occur simultaneously;

(4) Withstand the fatigue effects of all cyclic pressures, including transients, and associated externally induced loads, taking into account the consequences of element failure; and

(5) Perform as intended under all environmental conditions for which the airplane is certificated.

(b) *System design.* Each hydraulic system must:

(1) Have means located at a flightcrew station to indicate appropriate system parameters, if

(i) It performs a function necessary for continued safe flight and landing; or

(ii) In the event of hydraulic system malfunction, corrective action by the crew to ensure continued safe flight and landing is necessary;

(2) Have means to ensure that system pressures, including transient pressures and pressures from fluid volumetric changes in elements that are likely to remain closed long enough for such changes to occur, are within the design capabilities of each element, such that they meet the requirements defined in § 25.1435(a)(1) through (a)(5);

(3) Have means to minimize the release of harmful or hazardous concentrations of hydraulic fluid or vapors into the crew and passenger compartments during flight;

(4) Meet the applicable requirements of §§ 25.863, 25.1183, 25.1185, and 25.1189 if a flammable hydraulic fluid is used; and

(5) Be designed to use any suitable hydraulic fluid specified by the airplane manufacturer, which must be identified by appropriate markings as required by § 25.1541.

(c) *Tests.* Tests must be conducted on the hydraulic system(s), and/or subsystem(s) and elements, except that analysis may be used in place of or to supplement testing, where the analysis is shown to be reliable and appropriate. All internal and external influences must be taken into account to an extent necessary to evaluate their effects, and to assure reliable system and element functioning and integration. Failure or unacceptable deficiency of an element or system must be corrected and be sufficiently retested, where necessary.

(1) The system(s), subsystem(s), or element(s) must be subjected to performance, fatigue, and endurance tests representative of airplane ground and flight operations.

(2) The complete system must be tested to determine proper functional performance and relation to the other systems, including simulation of relevant failure conditions, and to support or validate element design.

(3) The complete hydraulic system(s) must be functionally tested on the airplane in normal operation over the range of motion of all associated user systems. The test must be conducted at the system relief pressure or 1.25 times the DOP if a system pressure relief device is not part of the system design. Clearances between hydraulic system elements and other systems or structural elements must remain adequate and there must be no detrimental effects.

Issued in Renton, Washington, on May 9, 2001.

Donald L. Riggin,

Acting Manager, Transport Airplane Directorate, Aircraft Certification Service, ANM–100.

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