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Aircraft ground equipment — Design, test and maintenance for towbarless towing vehicles (TLTV) interfaced with nose-landing gear —

Part 2: Regional aircraft

Matériels au sol pour aéronefs — Conception, essais et entretien des tracteurs sans barre (TLTV) s'accouplant au train d'atterrissage avant

Partie 2: Aéronefs régionaux

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 20683-2 was prepared by Technical Committee ISO/TC 20, *Aircraft and space vehicles*, Subcommittee SC 9, *Air cargo and ground equipment*.

ISO 20683 consists of the following parts, under the general title *Aircraft ground equipment — Design, test and maintenance for towbarless towing vehicles (TLTV) interfaced with nose-landing gear*:

— *Part 1: Main line aircraft*

— *Part 2: Regional aircraft*

Introduction

This part of ISO 20683 specifies design, testing, maintenance and associated requirements to be applied to towbarless aircraft towing vehicles intended for use on regional civil transport aircraft in order to ensure their operation cannot result in damage to aircraft nose-landing gears, their steering systems, or associated aircraft structure.

Throughout this part of ISO 20683, the minimum essential criteria are identified by the use of the imperative or the key word “shall”. Recommended criteria are identified by the use of the key word “should” and, while not mandatory, are considered to be of primary importance in providing safe and serviceable towbarless tractors. Alternative solutions can be adopted only after careful consideration, extensive testing and thorough service evaluation have shown them to be equivalent.

Aircraft ground equipment — Design, test and maintenance for towbarless towing vehicles (TLTV) interfaced with nose-landing gear —

Part 2:
Regional aircraft

1 Scope

This part of ISO 20683 is applicable to towbarless aircraft towing vehicles (TLTVs) interfacing with the nose-landing gear of civil transport aircraft with a maximum ramp mass comprised between 10 000 kg and 50 000 kg (22 000 lb and 110 000 lb), commonly designated as “regional aircraft”. The requirements for main line transport aircraft with a higher maximum ramp mass are specified in ISO 20683-1, which is not applicable to TLTVs which were manufactured before its date of publication.

This part of ISO 20683 specifies general design requirements, testing and evaluation requirements, maintenance, calibration, documentation, records, tracing and accountability requirements in order to ensure that the loads induced by the tow vehicle not exceed the design loads of the nose gear or its steering system, or reduce the certified safe life limit of the nose gear, or induce a stability problem during aircraft push back and/or maintenance towing operations.

This part of ISO 20683 specifies requirements and procedures for towbarless tow vehicles (TLTVs) intended for aircraft push-back and gate relocation or maintenance towing only. It is not intended to allow for dispatch (operational) towing (3.7). Dispatch towing imposes greater loads on nose gears and aircraft structure due to the combination of speed and additional passenger, cargo, and fuel loads.

This part of ISO 20683 does not apply to towbarless towing vehicles interfacing with aircraft main landing gear.

NOTE TLTV designers should also take into account the requirements of documents referenced in Bibliography.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 6966-1, *Aircraft ground equipment — Basic requirements — Part 1: General design requirements*

ISO 6966-2, *Aircraft ground equipment — Basic requirements — Part 2: Safety requirements*

Federal Aviation Regulations (FAR) 14 CFR Part 25, *Airworthiness Standards: Transport category airplanes,* paragraphs 25.301, *Loads*, and 25.509*, Towing loads* [1)]

Joint Airworthiness Regulations (JAR) Part 25, *Airworthiness Standards: Transport category aeroplanes,* paragraphs 25.301, *Loads*, 25.509*, Towing loads,* 25X745(d*), Nose-wheel steering, and* ACJ (interpretative material) 25X745(d) [2)]

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
main line aircraft
civil passenger and/or freight transport aircraft with a maximum ramp mass over 50 000 kg (110 000 lb)

3.2
regional aircraft
civil passenger and/or freight transport aircraft with a maximum ramp mass between 10 000 kg (22 000 lb) and 50 000 kg (110 000 lb)

3.3
maximum ramp mass
MRW
maximum ramp weight
maximum mass allowable for an aircraft type when leaving its parking position either under its own power or towed, comprising maximum structural take-off mass (MTOW) and taxiing fuel allowance

3.4
push-back
moving a fully loaded aircraft [up to maximum ramp mass (MRW)] from the parking position to the taxiway

NOTE Movement includes pick-up, push back with turn, a stop, a short push or tow to align aircraft and nose wheels, and release. Engines might or might not be operating. Aircraft movement is similar to a conventional push back operation with a tow bar. Typical speed does not exceed 10 $km \cdot h^{-1}$ (6 mph).

3.5
maintenance towing
movement of an aircraft for maintenance/remote parking purposes (e.g. from the parking position to a maintenance hangar)

NOTE The aircraft is typically unloaded with minimal fuel load [light gross weight (LGW)] with speeds up to 32 $km \cdot h^{-1}$ (20 mph).

3.6
gate relocation towing
movement of an aircraft from one parking position to an adjacent one or one in the same general area

NOTE The aircraft is typically unloaded with minimal fuel load [light gross weight (LGW)] with speeds intermediate between push back and maintenance towing.

1) FAR Part 25 constitutes the U.S.A. Government transport aircraft airworthiness Regulations, and can be obtained from: US Government Printing Office, Mail Stop SSOP, Washington DC 20402-9328, U.S.A.

2) JAR Part 25 constitutes the European Governments transport aircraft airworthiness Regulations, and can be obtained from: JAA Headquarters, Saturnusstraat 8-10, P.O. Box 3000, NL 2130 KA Hoofddorp, Netherlands.

3.7
dispatch towing
operational towing
towing a revenue aircraft [loaded with passengers, fuel, and cargo up to maximum ramp mass (MRW)], from the terminal gate/remote parking area, to a location near the active runway, or conversely

NOTE 1 The movement may cover several kilometres with speeds up to or over 32 $km \cdot h^{-1}$ (20 mph), with several starts, stops and turns. Replaces typical taxiing operations prior to takeoff or after landing.

NOTE 2 In the definitions of the towing modes, the frequency of operation has not been included. This should not be interpreted to mean that no limitations are present. For limitations on the frequency of push-back and maintenance operations, refer to the appropriate airframe manufacturer's documentation or consult directly with the airframe manufacturer.

3.8
towbarless towing vehicle
TLTV
towing vehicle acting without tow bar on an aircraft's nose-landing gear

3.9
nose-landing gear
NLG
aircraft nose-landing gear in a tricycle landing gear layout

3.10
light gross weight
LGW
reference aircraft mass for combined testing of the vehicle and aircraft, defined as the manufacturer's operating empty mass of the aircraft type concerned, plus fuel remaining in the tanks on landing (10 % to 20 % of total tanks capacity)

3.11
heavy gross weight
HGW
reference aircraft mass for combined testing of the vehicle and aircraft, defined as the manufacturer's operating empty mass of the aircraft concerned, plus at least 50 % of the maximum total fuel tanks capacity on the type, or its equivalent in mass (payload may be accounted if present, providing aircraft balance condition remains within limits)

3.12
maximum limits
limits (fore and aft tractive force, torsional, or angular) established by the airframe manufacturer as not-to-exceed values intended to preclude possible damage to nose-landing gear or structure

NOTE Maximum limits are established by airframe manufacturer's documentation and may be different for towbarless or towbar towing operations. All aircraft load limits are limit loads as defined in FAR/JAR paragraph 25.301 (a).

3.13
operational limits
limits (fore and aft tractive force, torsional, or angular) which are set at a lesser value than the maximum limits established by the airframe manufacturer

3.14
aircraft family
grouping of aircraft types or subtypes, defined by their manufacturer, for which the same maximum limits may be applied

NOTE A family usually encompasses all sub-types of a given type, but may also include other types. Testing for one (usually the lightest) model of the family results in towbarless towing approval for the whole family. See airframe manufacturers' towbarless towing evaluation documentation.

3.15
TLTV setting
grouping of aircraft types or sub-types, defined by the TLTV manufacturer, for which a single operational limits setting is used

NOTE A single TLTV setting usually encompasses aircraft types or sub-types, which may be produced by different airframe manufacturers, in a same defined MRW range.

3.16
drag load
towforce
total force from the tow vehicle on the nose gear tires in the **X axis** (3.17)

3.17
X axis
fore and aft axis of the tow vehicle, parallel to the ground

3.18
oversteer
exceedence of maximum torsional load or angular limits where potential damage to the nose-landing gear structure or steering system could take place

NOTE These limits are defined in the appropriate airframe manufacturer's documentation. Torsional load limits typically occur after exceeding angular limits, but may occur before the angular limit is reached (e.g. nose gear hydraulic system bypass failure).

3.19
snubbing
sudden relief and reapplication of acceleration/deceleration loads while TLTV and aircraft are in motion

3.20
jerking
sudden application of push/pull forces from a complete stop

4 Design requirements

4.1 General

4.1.1 Towbarless tow vehicles (TLTVs) shall comply with the applicable general requirements of ISO 6966-1 and safety requirements of ISO 6966-2.

4.1.2 Airframe manufacturers should provide information for each aircraft type which allows TLTV manufacturers or airlines to self-test or evaluate the towbarless tow vehicles themselves. Refer to the airframe manufacturer's documentation for evaluation requirements and detailed testing procedures, that may be different from or additional to those contained in this part of ISO 20683.

4.1.3 TLTV manufacturers should prepare and provide customers or regulatory agencies, as required, with a certificate of compliance or equivalent documentation, as evidence that successful testing and evaluation of a specific tow vehicle/aircraft type combination have been completed in accordance with this part of ISO 20683 and/or the applicable airframe manufacturer's documentation. This certification shall allow use of the vehicle on specifically designated aircraft model types. The certificate should be established under an appropriate quality control program meeting the requirements of ISO 9001 [2] or equivalent pertinent industry standard.

4.1.4 Towbarless towing vehicles shall, either by intrinsic design or through appropriate load-limiting devices, ensure that the following maximum limits are not exceeded.

4.2 Towing loads

4.2.1 The push-and-pull towing forces induced by the TLTV onto the aircraft's nose-landing gear as a result of either accelerating or braking shall be verified as specified in Clauses 5 and/or 6 hereafter, and shall not at any time exceed the maximum values specified by the aircraft manufacturer.

4.2.2 Depending on the range of aircraft types with which the TLTV is compatible, preset towing load values may be used for a number of aircraft types or sub-types in a given MRW range. In this case, each TLTV setting shall comply with the maximum limits specified by the manufacturer(s) of the designated aircraft types, sub-types, or family(s) thereof as defined by the aircraft manufacturers, and each TLTV setting shall be subjected to a separate verification.

4.3 Oversteering protection

4.3.1 The maximum angular or torsional load limits stated by the aircraft's manufacturer in the event of oversteering shall not at any time be exceeded. See aircraft manufacturer's TLTV assessment criteria document.

4.3.2 This may be achieved either by oversteer protection built into the TLTV, or by an oversteer alerting system being provided.

4.3.3 Oversteer protection may be achieved either by intrinsic design precluding the possibility of either limit being reached or exceeded, or by a fail-safe oversteer protection system ensuring they shall not be exceeded. Oversteer alerting shall consist in an appropriate fail-safe warning system installed on the TLTV, providing the driver with unmistakable indication that one of the maximum limits was reached.

4.3.4 No testing of the TLTV oversteer protection or alerting systems shall be performed on an in-service aircraft, in order to preclude any possible damage to the NLG structure or steering system. Such testing should be accomplished with a suitable ground-testing device representative of the specific aircraft model for which the TLTV is intended, or through appropriate numeric simulation demonstration.

NOTE JAA requirements: For aircraft are registered or operated under European JAR Regulations, ACJ 25X745(d), *Nose-wheel steering (interpretative material)*, paragraph 4, *Alternate acceptable means of compliance*, requires the TLTV manufacturers to provide a Declaration of Compliance (see 4.1.3) of their unit's oversteer protection or oversteer alerting system(s) with the present part of ISO 20683 and the criteria published by the manufacturer of each aircraft type for which it is intended, and the aircraft manufacturers to list in their appropriate documentation the TLTV models that were specifically accepted for each aircraft type based on this Declaration of Compliance.

4.4 Vehicle classification

The TLTV model shall be classified according to its intended use, and tested or evaluated accordingly, as either:

a) Category I: pushback only,

b) Category II: maintenance towing only, or

c) Category III: both pushback and maintenance.

4.5 Placarding

Limitations and warnings imposed by all conditions shall be placarded in a location readily visible to the tow vehicle driver, including but not necessarily limited to:

a) classification category as defined in 4.4;

b) types of aircraft for which the TLTV is qualified (by TLTV setting if applicable);

c) maximum allowable speed;

d) maximum allowable towing angle.

5 Testing requirements

5.1 General

5.1.1 The following tests shall be performed to provide verification that the loads induced by the TLTV do not exceed the allowable maximum limits, and the operation of the unit in an operational push-back environment does not result in events potentially jeopardizing aircraft safety.

5.1.2 Dynamic numeric simulation may be used instead of part of the specified tests, unless prohibited by airframe manufacturer's documentation, and providing it guarantees at least equivalent results reliability (see Clause 6 hereafter). See 4.3.4 above for testing of oversteering protection features.

5.2 Static load tests

5.2.1 Static load tests shall be performed in accordance with 5.2.2 to 5.2.4 to verify inadvertent application of TLTV power, while the aircraft is braked or chocked, will not result in exceeding the NLG maximum loads.

5.2.2 In order to preclude any possible damage to the NLG structure, such testing may be accomplished with a suitable ground-testing device representative of the specific aircraft model(s) for which the TLTV is intended.

5.2.3 Each test shall consist of the following sequence.

a) Ensure the device representative of the aircraft is fully braked.

b) Progressively apply full power of the TLTV, either push or pull.

c) Maintain maximum power for 5 s; record the force exerted by the TLTV onto the device during this sequence

5.2.4 Two tests shall be performed in each direction. On completion of the tests, print and examine the load recordings. The maximum towing loads for the aircraft type as specified in 4.2 shall not be exceeded at any point of the tests.

5.3 Dynamic load tests

5.3.1 Tests shall be performed in accordance with 5.3.2 to 5.3.6 to verify the maximum push-and-pull towing forces induced by the TLTV onto the aircraft's nose-landing gear as a result of either accelerating or braking.

5.3.2 In order to avoid the difficulties and costs of using an instrumented aircraft, the towing vehicle shall be instrumented to record the towing loads. Installation of strain gauges or equivalent load measuring sensors shall be at the locations most appropriate for accurate and unbiased readings, specified by the TLTV manufacturer. Data should be recorded analogically or, if numerically, at a minimum sampling rate of 50 Hz (50 times per second).

5.3.3 Prior to performing the aircraft test, the strain gauges or equivalent measuring sensors on the TLTV shall be calibrated to known tow load inputs, using a calibration method specified by the TLTV manufacturer, in order to obtain measurements linearity and repeatability. A calibration report should be established.

5.3.4 Each test shall consist in one sequence of:

a) aircraft NLG pick-up;

b) push back using maximum available power of the TLTV to accelerate from a dead stop until reaching maximum speed, or approximately 8 $km \cdot h^{-1}$ (5 mph), or the maximum speed specified by the airframe manufacturer, whichever is less;

c) maintenance towing using maximum available power of the TLTV to accelerate from a dead stop until reaching maximum speed, or the maximum speed specified by the airframe manufacturer, whichever is less;

d) maintaining the above speed stabilized for a straight line distance of no less than 30 m (100 ft);

e) applying TLTV maximum available braking until the aircraft comes to a complete stop;

f) aircraft NLG release, using the TLTV and the aircraft type concerned. Avoid snubbing and jerking during braking and acceleration. Aircraft brakes shall not be used throughout the test. Record the push-and-pull loads on the NLG throughout the sequence, and note the mass and centre of gravity condition of the aircraft at each test for reference.

5.3.5 Perform the tests successively in the push-and-pull directions. The minimum number of tests to be performed shall be three in each direction, to be performed by at least two different drivers.

5.3.6 On completion of the tests, print and examine the load recordings. The maximum towing loads for the aircraft type as specified in 4.2 shall not be exceeded at any point of the tests. Record the aircraft's mass and centre of gravity condition in the test reports.

5.4 Operational tests

5.4.1 Operational push-back tests shall be performed in order to verify operation of the TLTV in an operational push-back environment does not result in events potentially jeopardizing aircraft safety.

5.4.2 These tests may be accomplished on in-service scheduled flights, or as dedicated trials consisting of NLG pick-up, an aft push, with turn, a short tow forward to align the nose gear parallel to the taxiway, and NLG release.

5.4.3 Perform push-back tests taking into account the possibilities of aircraft engines being on, at idle or off. The minimum number of tests to be performed shall be five for each condition, by at least three different drivers, each of them accomplishing tests in both engine conditions if applicable. Tests with idle engines may also be replaced by adding their known idle thrust to the towing loads recorded during the tests without engines. In this case, a total of five push-back tests only are necessary.

Establish test reports and record any observations as well as the recorded towing loads. Record the aircraft's mass and centre of gravity condition in the test reports.

5.4.4 Verify aircraft lateral and vertical (NLG strut extension) stability in operational maintenance towing tests throughout the tests.

5.4.5 Throughout the duration of these tests, there shall be no evidence of abnormal behaviour of the aircraft or the TLTV, or risk of interference between them, or potential hazard to the aircraft's or its steering system's structural integrity. The maximum towing loads for the aircraft type as specified in 4.2 shall not be exceeded at any point of the tests.

5.5 Aircraft braking

The aircraft brakes shall not be used while the aircraft is being towed by a TLTV, except in an emergency.

Aircraft braking while the aircraft is under tow may result in loads exceeding the aircraft's design loads and can result in structural damage and/or NLG collapse. For these reasons, it is recommended that airlines take appropriate operational steps to preclude aircraft braking during normal towbarless towing. The airline's or airframe manufacturer's maintenance manual and operational procedures shall be followed.

6 Computer modelling

6.1 General

6.1.1 Dynamic numeric simulation (computer modelling) through an appropriate computer model including the relevant parameters of both the tractor and aircraft may be used instead of the tests specified in Clause 5 above, under the requirements given in 6.1.2 to 6.1.6.

6.1.2 The computer model shall be based on stated and recognized mechanical engineering methods and equations, be validated in accordance with 6.2, and be approved for this purpose by the manufacturer(s) of the aircraft type(s)/sub-type(s) for which the TLTV is to be approved.

6.1.3 It shall integrate all dynamic effects, including transient ones.

6.1.4 It shall provide continuous data or, if non continuous, a sampling rate at least twice the minimum rate stated in 5.3.2 above for tests recording purpose.

6.1.5 It shall provide at least equivalent overall results dependability.

6.1.6 Computer modelling results shall be printed, handled and filed in the same manner as the specified testing records.

6.2 Validation

6.2.1 Each computer model or variant thereof (except variation limited to parameters) should be validated by comparing its results with at least the following tests:

a) one static load test as specified in 5.2;

b) one dynamic load test as specified in 5.3.

6.2.2 Where the tests are used to validate a numeric analysis computer model, they need not necessarily be performed for the worst case. If validated, the analysis shall then be used to assess the critical loads induced on the NLG.

6.2.3 Validation testing required in 6.2.1 should be performed for each TLTV maximum towing force setting, as defined in 4.2.2 above, by either of:

a) actual testing as specified in 6.2.1 on at least one aircraft type;

b) previous actual testing evidence demonstrating correlations;

c) appropriate testing on a suitable ground device,

or combination thereof, as mutually agreed by the TLTV manufacturer and the manufacturer(s) of the aircraft type(s) to be towed.

7 Quality control

7.1 The TLTV's aircraft NLG tractive force and oversteering protection or alerting systems which, in the event of failure or malfunction, might not preclude potential damage to the aircraft's nose-landing gear or its steering system shall be designed, then inspected, maintained, tested and calibrated to the TLTV manufacturer's standard throughout the service life of the TLTV so as to ensure their effectiveness for all the aircraft types the TLTV is designed to handle.