

AEROSPACE RECOMMENDED PRACTICE

SAE ARP5916

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Design Specification for Regional Aircraft Towbarless Tow Vehicle for Pushback and/or Maintenance Towing Operations

FOREWORD

This SAE Aerospace Recommended Practice (ARP) describes the design requirements, performance, and capability of a towbarless tow vehicle (TLTV), used for push-back and/or maintenance towing operations on the nose gear of regional type aircraft.

Throughout this document, the minimum essential criteria are identified by the use of the key-word "shall". Other 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 may be adopted only after thorough consideration and in-service evaluation have shown them to be equivalent.

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1. SCOPE:

The tow vehicle should be designed for towbarless push-back and/or maintenance towing of regional type aircraft as specified in 1.3.

The design will ensure that the unit will safely secure the aircraft nose landing gear within the coupling system for any operational mode.

The purpose of this towing procedure is to achieve a safer and faster operation than is possible with conventional towing equipment.

1.1 One-Man Operation:

A one-man towbarless tow vehicle operation is required with all functions to be performed by the operator. Good visibility is required for controlled and safe operations, during day and night conditions.

1.2 The TLTV has to be designed to carry out the following tasks:

- 1.2.1 Push-Back: Push-back shall be defined as the moving of a loaded airplane in a backward direction from a parking position to the taxiway. Movement typically includes push-back with a turn, stop and short tow forward to align the airplane. Aircraft engines may or may not be running.

And/Or

- 1.2.2 Maintenance Towing: Maintenance towing shall be defined as the movement of an airplane for maintenance/remote parking purposes (i.e., from the gate to a maintenance hangar or remote parking stand or vice versa). Airplane is typically unloaded.

1.3 Range of Aircraft:

The TLTV should be designed for use with regional type aircraft with maximum ramp weights ranging between 8600 kg (19,000 lb) and 50,000 kg (110,000 lb), as covered by FAR 25 and JAR 25.

Including but not limited to the following types of aircraft:

ATR 42/72
BAe 146 RJ 85/RJ 100
Canadair CRJ 200/700
De Havilland Dash 8
Dornier 328
Embraer 120/135/140/145/145XR/170/190
Fokker 50/70/100
Saab 340/2000
Shorts 340/360

This type of towbarless tractor may also be capable of handling larger civil transport aircraft, in which case it should also comply with the applicable requirements of ARP4852 Revision B and ARP4853 Revision B.

2. REFERENCES:

2.1 Applicable Documents:

The following publications form a part of this specification to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of other publications shall be the issue in effect on the date of the purchase order for such TLTV equipment. In the event of conflict between the text of this specification and references cited herein, the text of this specification takes precedence. Nothing in this specification, however, supersedes applicable laws and regulations unless a specific exemption has been obtained. The TLTV must fully comply with the most recent issue to the following documents, standards, specifications, and practices as applicable to airport ramp operations.

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2.1.1 SAE Publications: Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

ARP1247	General Requirements for Aerospace Ground Support Equipment Motorized and Non-motorized
AIR1328	Aircraft Support Equipment Stability Analysis
ARP1330	Welding of Structures for Ground Support Equipment
AIR1375	Minimum Safety Requirements for Special Purpose Airline Ground Support Equipment
AIR1838	Pictograms for Ground Support Equipment
ARP5911	Regional Aircraft Towbarless Tow Vehicle Test Requirements
ARP5284A	TLTV – Aircraft NLG Steering and Tractive Force Protection Systems or Alerting Devices – Inspection, Maintenance and Calibration Requirements
ARP5285A	Towbarless Towing Vehicle Operating Procedure

2.1.2 Applicable References:

SAE ARP5911 – Regional Aircraft Towbarless Tow Vehicle – Test Requirements

Applicable airframe manufacturers service letters referring to towbarless towing

Federal Occupational Safety and Health Standards (OSHA), subpart N

California Occupational Safety and Health Standards (CAL-OSHA)

CEN Standards (EN1915-1, EN1915-2, EN1915-3, EN 1915-4 and EN12312-7)

EU/EEC Machinery Directive

National traffic codes and regulations

Applicable mechanical engineering standards, recommended practices, and Health and Safety Rules

Application aviation regulatory agency rulings or interpretations (FAA, JAA or Country)

2.1.2 (Continued):

Standards and safety rules especially applicable to electrical installations

Local Airport Regulations

If local regulations add requirements, they have to be made known to seller and adhered to.

2.2 Terms and Definitions:

TLTV – Towbarless Towing Vehicle

NLG – Nose Landing Gear

3. GENERAL REQUIREMENTS:

This tow vehicle will basically be used for handling Regional type aircraft including (but not limited to) the aircraft listed in 1.3.

Overall design of the unit is to allow operations under climatic conditions as stated under 5.1.1 and 8.1.1 and safe operations during day and night conditions on airport aprons, runways, taxiways, and in hangars.

4. DIMENSIONS:

The overall dimensions of the TLTV should be as compact as possible taking into account the dimensions and clearance requirements of the aircraft to be handled.

TLTVs must not preclude airplane emergency evacuation procedures.

5. PERFORMANCE:

- 5.1 Tractive force shall be variable depending on the aircraft type according to 4.4. The tractive forces must be sufficient to move A/C from standstill even under bad surface conditions and aircraft engines on idle speed on ramp gradients typically up to 2%.

The fore-aft load limiting device should be set as a function of the airplane to be towed. This value must not be exceeded during normal towing (including acceleration/braking).

5.1 (Continued):

Tractive and braking forces applied to the aircraft shall be limited by fail safe load limiting devices/systems. The load limiting device or system must be designed such that when the / a component in the system fails, or deteriorates over time, the TLTV will revert to a state where it cannot impart damaging loads into the aircrafts landing gear. This can be accomplished by some form of built in test monitoring function, or by some periodic maintenance activity targeting dormant failure modes.

The load limiting system should be subject to a failure modes and effects analysis to identify components whose failure requires some form of continuous or periodic monitoring to maintain the integrity of the system.

To ensure that the tow vehicle does not negatively impact the certified safe life of the airplane nose landing gear, the tow vehicle must be qualified according to the requirements specified by the Airframe Manufacturer.

5.2 Speed:

- a. An empty tow vehicle (without aircraft) should be capable of a minimum operational speed of at least 10 km/h (6 mph) or to meet customer's operational requirement.
- b. A loaded tow vehicle (with airplane) should be capable of a speed of at least 5 km/h (3 mph) for push-back operations and at least 12 km/h (8 mph) for maintenance towing operations or to meet customer's operational requirements but should not exceed airframe manufacturers' recommendation.

5.3 Acceleration:

Maximum speed shall be achieved as quickly as possible, but the acceleration forces must stay within the limits given by the airframe manufacturers, so that there is no negative influence on the structural integrity and safe life-limits of the NLGs.

5.4 Deceleration:

Tow vehicle acceleration and deceleration force values during towing operation must be in accordance with aircraft manufacturer's requirements and applicable regulatory requirements (FAR, JAR, etc.). Imposed force on the aircraft shall be limited by a protective fail safe device/system.

Braking Efficiency of TLTV: Tow vehicle calculated braking efficiency minimum 40% unladen without aircraft.

5.5 Nose Gear Towing Forces:

The tractive/brake force settings must not exceed the allowable loads specified by the airframe manufacturers for the aircraft model being towed.

6. GENERAL DESIGN AND CONSTRUCTION REQUIREMENTS:

6.1 Power Source:

Must be of adequate capacity for intended use and may be either:

1. Diesel
2. Alternative Fuels
3. Battery Electric
4. Fuel Cell
5. Hybrid
6. Dual Power

6.1.1 The power source shall be easily accessible for maintenance and inspection purposes.

6.1.2 Power source replacement must be possible within an acceptable time through the top or sides of the vehicle, using standard hoist/lifting equipment without the need for a maintenance pit.

6.2 Power Train/Drive Line:

6.2.1 Must be of adequate capacity for intended use and incorporate traction control, differential locks or other means to avoid a decrease in traction forces, skidding or wheel slippage.

6.2.2 The drive line may be:

1. 2 Wheel Drive
2. 4 Wheel Drive
3. Hydro-dynamic
4. Hydrostatic
5. Battery Electric
6. Hybrid

Gear shifting by hand shall not be required in the operational mode. In case of an automatic transmission (via a torque converter), gear change must be smooth.

6.2.3 It should be possible to tow the tow vehicle with a minimum speed of 5 km/h (3 mph) over a long distance.

6.3 Wheels, Tires, Axles:

6.3.1 Solid or pneumatic tires of adequate size and capacity with a tread pattern to suit all airport operations, should be fitted.

6.3.2 Wheel change shall be a simple operation using standard tools.

6.4 Brakes:

6.4.1 A braking system shall be installed complete with all necessary equipment to safely control the fully equipped and loaded tow vehicle under all operating conditions.

The brake mechanism shall be readily accessible for adjustments. The service brake should have two independent systems.

Deceleration forces, which should include regenerative or hydrostatic braking, shall stay within the limits given by the aircraft manufacturer.

6.4.2 The service brake shall operate on a sufficient number of wheels to ensure safe and stable braking under all operating conditions.

6.4.2.1 The parking brake shall engage on at least two wheels and shall hold the tow vehicle, coupled to an aircraft with the NLG interface carrying its maximum rated load, being in neutral at standstill on a 2% gradient. Emergency release for parking brake to be provided.

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6.4.2.2 Applied parking brake shall be indicated in cab by a red warning lamp except in the case of a deadman parking brake.

6.4.3 Simultaneous action of the service brake and the parking brake must be rendered impossible by a safety device.

6.5 Steering:

6.5.1 Steering Modes:

Single Axle or Two wheel steering
Four wheel and crab steering (optional)

NOTE: In case of four wheel steering "front" always defines the direction the driver is facing.

6.5.2 Steering selection should only be possible while tow vehicle is stationary.

6.5.3 External Turning Radius: Should be as small as possible.

6.5.4 In case the tow vehicle has to be towed away, the steering has to be functional even with an engine/power source failure at a velocity of approximately 5 kph (3 mph) and for a minimum period of 30 minutes.

6.5.5 Nose Gear Oversteer Indication and/or Protection: The tractor shall be equipped with a fail-safe oversteer alerting/indication or protection system that:

- a. activates an in-cab (red) warning light and audible alarm to indicate the maximum safety limit has been reached, and
- b. requires a specific recordable action to complete the push-back/towing operation (in order to make it unmistakable to the tow vehicle driver than an inspection of the nose landing gear by an authorized person must be initiated).

In addition, it is desirable that the device activates an in-cab (amber) warning light and audible signal to indicate an operational limit has been reached. The oversteer indication system shall allow sufficient time for the tow vehicle operator to take appropriate action to avoid reaching a safety limit.

The system shall be automatically activated when the airplane is coupled to the tow vehicle.

6.5.5 (Continued):

The oversteer indication and/or protection system shall be designed to protect the range of aircraft that can be handled by the tow vehicle. Oversteer is defined as exceeding maximum allowable steering angle and/or torsional load.

An optional system may provide a structural fuse (or other reliable load limiting system) on the tow vehicle which will prevent the application of loads on the nose landing gear that exceed the airframe manufacturer's specified limit.

- 6.5.6 The oversteer indication and/or protection system should be set per allowable (not to be exceeded) values provided by the airframe manufacturers.

6.6 Electrical System (except electrical drive and electro-hydraulic systems):

- 6.6.1 The tow vehicle should have a reliable electrical system incorporating good quality components adequately rated for the intended use and environmental conditions.

- 6.6.2 The system shall operate with 24 V (or 12 V) DC system with battery capacity to suit electrical demand.

- 6.6.3 The following illumination is required:

- 6.6.3.1 Headlights at front.

- 6.6.3.2 Marker lights at front and rear.

- 6.6.3.3 A combination of lights for indicator lights, for direction flashers, braking and tail-light. Direction flashers should be visible from the side.

- 6.6.3.4 Warning beacons may be fitted according to airport regulations.

- 6.6.3.5 Lights may be provided to illuminate coupling area.

- 6.6.3.6 A main battery isolation switch is to be provided.

6.7 Tow Coupling (for recovery of tow vehicle):

- 6.7.1 A universal coupling may be provided on the centre line of the tow vehicle at the Front (driving station) end.

- 6.7.2 There may be a recovery coupling for emergencies on one side at the Rear (Pick-Up) end of the tow vehicle.

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6.8 Cab (if fitted)/Operator's Position (where applicable):

- 6.8.1 Provision must be made to have good visibility of the aircraft coupling area.
- 6.8.2 Driver's seat should be fully adjustable in height, seating position, and fore and aft position.
- 6.8.3 Cabin may have a roof window (glass with sun protection/tinted) and be located directly above the driver's seat.
- 6.8.4 The side windows may be designed as sliding windows. All windows may be furnished with electrical heating or equivalent to provide adequate demisting.
- 6.8.5 Front and rear windows should be installed at an appropriate angle to minimize reflection.
- 6.8.6 Ventilation and heating of the cabin may be provided. In cab air conditioning may be offered as an option.
- 6.8.7 The vehicle should have front and rear windshield wipers separately activated. Wiper interval switch should be standard. Washers should be available as standard.
- 6.8.8 Current applicable ergonomic guidelines are to be taken into consideration.
- 6.8.9 A mirror or similar system allowing observation of the nose landing gear during operation may be installed in the cabin.
- 6.8.10 Interior illumination of the cabin shall be 32 ft Candles minimum.
- 6.8.11 Two exterior rear view mirrors (wide angle) shall be provided to enable driver to observe area to the rear of the driving position. Electrical heating and adjustment may be an option.
- 6.8.12 Driver must have a good visibility from all seat/operating positions.

6.9 Logic Changeover of Vehicle Controls:

For each driving position may be provided.

- 6.9.1 All controls should be automatically defined by the direction the driver is facing.
- 6.9.2 The direction in which the operator is facing should always be regarded as the forward direction.

6.10 The tow vehicle should be equipped with the following controls as a minimum requirement:

- a. Throttle
- b. Service brake
- c. Flashers/dimming switch
- d. Emergency stop button
- e. Direction selection (vehicle travel)
- f. Parking brake
- g. Tractive force settings (if variable)

6.11 The tow vehicle should be equipped with the following instruments/indicators as a minimum requirement:

- a. Hazard warning
- b. Parking brake set

6.12 The tow vehicle should be equipped with the following switches and indication/control lamps as a minimum requirement:

- a. Ignition switch with anti-restart
- b. Start/stop device for engine/power source
- c. Amber warning beacons
- d. Light switches
- e. Dim switch
- f. Other illumination (working lamps)
- g. Position lights
- h. Windshield wipers and washers in front and rear (if cab fitted)
- i. Heating/ventilation (if cab fitted)

6.12 (Continued):

- j. Controls for coupling/pick-up system
- k. Switch to select type of aircraft (if required)
- l. Heating for windows in front and rear (optional)
- m. Heating for mirrors (optional)
- n. Electrical adjustment for mirrors (optional)
- o. Dimmer for panel illumination
- p. Testing device for all alarm circuits/lamps
- q. Steering angle indication (optional)

6.13 Monitoring and Alarm Circuits/Lights:

6.13.1 The following instruments/indicators should be fitted in the operation panel in the cab or at the operator's station:

- a. Hourmeter
- b. Battery charging control light
- c. Power source monitors
- d. Fuel gauge
- e. Indication: "Vehicle ready for operation (second/simultaneous verification of aircraft relevant settings)
- f. Speedometer
- g. High beam (headlight) on (blue signal)
- h. Heater on
- i. Hazard flashers

6.13.2 The following maybe be optional and mounted in a panel for engineering purposes:

Monitors indicating:

1. Preliminary heating
2. Hydraulic oil
3. Hydraulic oil temperature
4. Maintenance required for hydraulic filter
5. Emergency steering in operation
6. Emergency stop is activated
7. Hourmeter

All operating instruments and alarm signals shall be labeled on the panel.

6.14 Miscellaneous:

Quick check points or gauge/s for hydraulic oil pressure shall be installed.

Jacking points for wheel change and general maintenance shall be provided on the chassis.

Size of fuel tanks or battery capacity shall allow for one day's operation or sized to suit customer's requirements.

6.15 Coupling System:

The tow vehicle should be designed for coupling to the aircraft's nose landing gear.

6.15.1 The nose wheel coupling and holding system should be capable of capturing the types of aircraft defined in 1.3 with consideration to including telescoping of the nose landing gear strut and turn geometry of non-vertical nose landing gear designs.

6.15.2 The nose wheel tires must only be captured at the tire tread surface.

The surface contact area between pick-up device and aircraft's tire surface should be sufficient to preclude unacceptable aircraft tire loading (refer to tire or airframe manufacturers for tire loadings/bearing pressures).

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- 6.15.3 While in the fully engaged position, the nose gear wheels must remain captive in the pick-up mechanism under all dynamic conditions. The nose gear wheels must be restrained in the upward direction above the axle to prevent escape.
- 6.15.4 When an aircraft is braked by wheel chocks or the parking brake (or connected to passenger stairs, boarding bridges or other GSE), it may not be moved in horizontal direction during coupling or release.
- 6.15.5 In fully coupled position the coupling system must lock automatically so that in case of hydraulic failure the nose landing gear is not involuntarily releasable.
- 6.15.6 In case of failure of the coupling system, and/or clamp device, it shall be possible to release the nose landing gear via an emergency system/s.
- 6.15.7 The TLTV's coupling system (if adjustable) should be able to identify the type or class of aircraft that has been picked up, which it has been approved to handle. If the wrong type of aircraft has been programmed by the operator (or in case of incorrect pre-selection of aircraft type) the tow vehicle should be inhibited or fail safe.
- 6.16 Design and Construction Engineering Practice:
- 6.16.1 The equipment design and accessory installations shall be such that no interference with any aircraft structure may occur and shall permit accessibility for use, maintenance, and service. All components and assemblies shall be free of hazardous protrusions, sharp edges, pinch points, cracks, or other elements, which might cause injury to personnel or equipment. All oil, hydraulic, and tubing lines and electric wiring shall be located in protective positions, properly clipped to the frame or body structure and shall have protective loom or grommets at each point where they pass through structural members, except where a through-frame connector is necessary.
- 6.16.2 All components and assemblies must be manufactured to tolerances allowing easy replacement and/or new installation. High grade shop practice utilizing the latest machining, welding and metal working practices are to be used throughout. All welding must have good penetration and be clean and free from slag upon completion.
- 6.16.3 The tow vehicle should be constructed so that no parts can work loose in service. It shall be built to withstand the strains, jars, vibrations, the maximum rim pull obtainable under most favorable conditions, and other dynamic conditions incident to the service intended.