



AEROSPACE RECOMMENDED PRACTICE

ARP1558™

Issued 2014-10
Reaffirmed 2019-03

Interface Protection - Ground Equipment to Aircraft

RATIONALE

This ARP, superseding former AIR 1558A originally published in 1978, specifies both passive devices and current state of the art active detection systems that should be incorporated or considered in GSE design in order to ensure aircraft protection against fuselage damage resulting from GSE interface. The change of document status from AIR to ARP is intended to take into account research findings on composite fuselage aircraft protection.

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1. SCOPE

1.1 Purpose

This SAE Aerospace Recommended Practice (ARP) discusses damage to aircraft fuselages caused by ground equipment contact at servicing and recommends methods to be incorporated or considered in ground equipment design for protection against that damage.

1.2 Field of Application

This ARP is applicable to ground support equipment directly interfacing with aircraft fuselages, in order to provide fuselage protection and prevent or minimize the risk of damaging impacts by means of:

- a. passive contact protection devices;
- b. active aircraft detection and alerting systems;
- c. combination of both.

This ARP is not applicable to protection against damage to aircraft connections, which is covered in the documents specifying those connections.

2. REFERENCES

2.1 Applicable Documents

The following publications form a part of this document 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. In the event of conflict between the text of this document and references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

2.1.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or 724-776-4970 (outside USA), www.sae.org.

ARP1247 Aircraft Ground Support Equipment - General Requirements

ARP5910 Ramp Markings

2.1.2 ANSI Publications

Available from American National Standards Institute, 25 West 43rd Street, 4th Floor, New York, NY 10036, Tel: 212-642-4900, www.ansi.org.

ANSI Z136.1 Safe Use of Lasers

2.1.3 ASTM Publications

Available from ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959, Tel: 610-832-9585, www.astm.org.

ASTM D412 Test Methods for Vulcanized Rubber and Thermoplastic Rubber and Thermoplastic Elastomers

2.1.4 ISO/IEC International Standards

Available from American National Standards Institute, 25 West 43rd Street, 4th Floor, New York, NY 10036, Tel: 212-642-4900, www.ansi.org.

ISO 6966-2	Aircraft ground equipment - Basic requirements - Part 2: Safety requirements
ISO 11532	Aircraft ground equipment - Graphical symbols
IEC 60825-1	Safety of laser products - Part 1: Equipment classification and requirements
IEC 60947-5-2	Low-voltage switch gear and control gear - Part 5-2: Control circuit devices and switching elements - Proximity switches

2.1.5 Other Documents

"Engineering Uses of Rubber," A.T. McPherson & A. Klemm, Reinhold, New York, Publisher, 1956

"Awareness and Reporting of Significant Impact Incidents Involving Composite Airframe Structures" - FAA White Paper, 2009

Available from UCSD, hyonny@ucsd.edu.

"Wide Area Ground Support Equipment Blunt Impact Damage to Composite Aircraft Structure" - Hyonny Kim, Professor Department of Structural Engineering, University of California San Diego (FAA funded), 2013

2.2 Definitions

ACTIVE: System capable of emitting in defined circumstances a signal which can be used to activate either a safety function or a warning or both (see **PASSIVE**).

APPROACH SPEED: Maximum speed allowed for a vehicle within the aircraft parking stand's Equipment Restraint Area (see ARP5910), identified by the "turtle" symbol (ISO 11532 symbol N° 52).

BUMPER

FENDER

PADDING: Device made of semi-soft material, fixed as a passive protection on the edges of ground support equipment which directly interface with aircraft fuselage.

DOCKING SPEED: Average speed of a vehicle during the last 20 inches (500 mm) of travel before contact with the aircraft.

DUROMETER: Measurement of compressibility of rubber. The lower the durometer number, the more flexible/compressible.

ELONGATION RATING: Maximum elongation/distortion measured in percent by pulling a fender until failure.

PASSIVE: Non-powered device, without a possibility to emit a signal (see **ACTIVE**).

TEAR STRENGTH: Tearing point measured in pounds per linear inch or SI equivalent (Newton/linear unit).

TENSILE STRENGTH: Ability to puncture rubber measured in pounds per square inch or SI equivalent (Pascal) (refer to ASTM D412).

SHORE: Unit of durometer measurement.

3. GENERAL

3.1 Aluminum Alloy Aircraft Fuselages

Most ground equipment damage to aircraft with conventional aluminum alloy fuselages is described as skin punctures, dents, and abrasions in the fuselage areas adjacent to and below passenger, cargo, and galley doors. Damage is typically detected at aircraft pre-flight inspection. These loading and servicing areas are served by various types of servicing equipment. Most of these are equipped with rubber cylinders and/or other protective padding, positioned on the equipment at points normally in contact with, or in proximity to, the aircraft skin during servicing. Widely differing methods of installation and varying materials of these devices exist. Some of these, when incorrectly used, have contributed directly to aircraft damage.

3.2 Composite Aircraft Fuselages

With the advent of composite fuselage aircraft, damage patterns have radically changed: significant to major - depending on kinetic energy of impact - damage to the inner structure can occur without leaving outside visible traces that can be detected at aircraft pre-flight inspection. See 2013 UCSD "Blunt Impact Damage" study for illustration and measured magnitudes, and 2009 FAA White Paper "Awareness and Reporting of Significant Impact Incidents Involving Composite Airframe Structures" for background.

3.3 Operation

It is necessary to examine the approach of vehicles and equipment to the aircraft fuselage. Some servicing positions are at points on the aircraft where the fuselage tapers. This tapering may cause the driver and signalman to misjudge the interface with the airplane. The contacting surface may then be jammed against the fuselage. Also, some positions may not permit the vehicle contact surfaces to be brought parallel to the fuselage. Care must be taken to keep fender contacting surfaces sufficiently away from the fuselage to prevent over-compression if the aircraft settles.

3.4 Docking Speed

Vehicle speed at contact with aircraft skin is the fundamental parameter of any subsequent damage. Since damage resulting from impact is proportional to kinetic energy, it can be expected to vary according to the square of speed, very far from a linear relationship. No protection device or system whatsoever can be expected to fully protect aircraft fuselage against all impacts regardless of their speed. Accordingly:

- 3.4.1 Ground equipment operators should be trained to systematically control vehicle docking speed and braking so as to bring the vehicle to a stop with its nearest point 2 to 5 inches (50 to 120 mm) away from the fuselage. The upper limit, usually not dictated by aircraft servicing, is required for staff safety in order to avoid the risk of feet being trapped. The equipment's passive contact protection devices remain necessary to cover the unavoidable cases when this safety gap is missed and actual aircraft contact occurs.
- 3.4.2 In order to minimize kinetic energy in the event of coming to contact, speed should be reduced appropriately when maneuvering near the aircraft. In accordance with ISO 6966-2, a controlled "inching" docking speed not exceeding 8 inches per second (0.2 m/s) should be initiated at approximately 20 inches (500 mm) prior to contact with the aircraft.
- 3.4.3 The "inching" speed specified in 3.4.2 may be initiated either:
 - a. By the operator. In this case, the relevant control shall be identified on the control panel by the "snail" graphic symbol (ISO 6966-2 Annex C) - not to be mistaken for the higher equipment approach speed control identified by the "turtle" symbol (ISO 11532 symbol N° 52).

NOTE: This can be impractical where vehicle traveling is ensured by an automotive automatic transmission: in this case, all efforts should be brought to select or adjust the transmission to allow the vehicle not exceeding the required speed, or other measures, e.g., per (b), should be taken.

or