



AEROSPACE INFORMATION REPORT

AIR7988™

Issued

2021-12

Impact of Alkali Metal-Based Runway De-Icing Fluids on Aircraft Electrical Systems

RATIONALE

Raise awareness of the degrading effects that alkali metal-based runway deicers have on in-service aircraft electrical wiring interconnection system (EWIS) components and review testing and approaches to mitigate failures.

1. SCOPE

The SAE Aerospace Information Report (AIR) focuses on the impact of alkali metal-based runway deicers (potassium acetate, potassium formate, and sodium acetate, and sodium formate) have on in-service aircraft EWIS components.

1.1 Purpose

The purpose of this AIR is to raise awareness of the degrading effects that alkali metal based deicers have on in-service aircraft EWIS components, and review testing and approaches to mitigate failures.

2. 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 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), www.sae.org.

AMS1431	Solid Runway Deicing/Anti-Icing Product
AMS1435	Liquid Runway Deicing/Anti-Icing Product
AMS1424/2	Deicing/Anti-Icing Fluid, Aircraft, SAE Type I Non-Glycol Based
AMS1428/2	Fluid, Aircraft Deicing/Anti-Icing, Non-Newtonian (Pseudoplastic), SAE Types II, III, and IV Non-Glycol Based
AIR5567	Test Method for Catalytic Carbon Brake Disk Oxidation
AIR6130	Cadmium Plate Cyclic Corrosion Test

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<https://www.sae.org/standards/content/AIR7988>

Documents

Document Sharing Hub

AS4373 Test Methods for Insulated Electric Wire

AS22759 Wire, Electrical, Fluoropolymer-Insulated, Copper or Copper Alloy

2.2 IEC Publications

Available from IEC Central Office, 3, rue de Varembe, P.O. Box 131, CH-1211 Geneva 20, Switzerland, Tel: +41 22 919 02 11, www.iec.ch.

EIA-364-10 Connector Immersion Test

2.3 U.S. Government Publications

Copies of these documents are available online at <https://quicksearch.dla.mil>.

AC 150/5200-30D Airport Field Condition Assessments and Winter Operations Safety

EPA-HQ-OW-2004-0038 FRL-9667-6, Effluent Limitations Guidelines and New Source Performance Standards for the Airport Deicing Category; Final Rule

MIL-PRF-81309 Performance Specification: Corrosion Preventive Compounds, Water Displacing, Ultra-Thin Film

MIL-STD-2223 Military Standard: Test Methods For Insulated Electric Wire

2.4 Other Publications

- [1] FAA Airworthiness Directive 737 Aircraft, August 2005
- [2] FAA Airworthiness Directive 737-900ER, July 2021
- [3] Transportation Research Board Airport Deicing Report, 2008
- [4] Continental Airlines Aircraft and Airfield Deicing and Stormwater Conference, 2008
- [5] AFRL Aircraft and Runway Taxiway Deicer (Includes Wiring Report), June 2004
- [6] AFRL Report Runway Deicer Aircraft Materials Compatibility Study, 1998
- [7] AFRL Evaluation of Aircraft and Runway Deicers, July 2012
- [8] AE-8C1 Presentation on Runway Deicer Corrosion Task Team Summary, October 2020

3. BACKGROUND AND HISTORY

Airfield pavement and airport runway deicing, and anti-icing are essential activities to maintain safe winter operations per FAA Advisory Circular (AC) 150/5200-30D (Chapter 2). Airfield pavement deicers have traditionally been based on urea or glycol compounds. Beginning in the mid-1990s, as part of worldwide environmental legislation (refer to EPA-HQ-OW-2004-0038) aircraft runway deicers based on urea and glycol were mandated to be replaced by environmentally friendly deicers. In response to this mandate, runway deicer suppliers developed environmentally friendly deicers using alkali metal compounds. Alkali metal based AMS1431 and AMS1435 airfield pavement deicers have caused EWIS component failures in wiring, connectors, avionic panels, switches, and relays (see Figure 1) [1, 2, 3, 4]. Alkali metal based airfield pavement deicers are comprised of ionic organic salts which can accelerate corrosion processes and create conductive paths between normally electrically isolated circuits [7]. Alkali metal compounds used in runway deicers include potassium acetate, potassium formate, sodium acetate, and sodium formate.

Analysis and examination of failed in-service electrical components by the U.S. Air Force and aircraft original equipment manufacturers (OEMs) have determined AMS1431 and AMS1435 alkali metal based runway deicers (potassium acetate and potassium formate in particular) are substantial contributors to in-service electrical component failures located in areas exposed to runway fluids (see Figure 1) [1, 2, 3, 4]. Alkali metal based runway deicers are qualified to several standards: AMS1431, AMS1435, AMS1424/2, and AMS1428/2. The FAA has issued Airworthiness Directives (ADs) as the result of in-service reports of significant corrosion on electrical connectors in aircraft with open wheel wells [1, 2, 3, 4]. The ADs state the cause of severe corrosion on main landing gear electrical connectors is due to aircraft taking off and landing on runways treated with alkali metal based deicers. Over the years, multiple ADs have been issued to prevent corrosion and subsequent moisture ingress into the electrical connectors, which could result in electrical shorting and consequent incorrect functioning of critical airplane systems essential to safe flight and landing operations. The most recent AD was published by the FAA in July 2021 [2] for all Model 737-900ER series airplanes. It will require periodic inspections for connector corrosion as a result of exposure to deicers that contain potassium acetate and potassium formate; both alkali metal based runway deicers qualified to AMS standards.

4. FIELD FAILURES

Several in-service electrical system failures have been attributed to exposure to potassium and sodium based runway de-icing fluids. Some of the in-service events have resulted in mission aborts, flight diversions, electrical fires, and unscheduled maintenance [1, 2, 4, 7]. The following are examples of some systems and components that have been affected by exposure to these alkali metal based airfield pavement deicers, as well as some of the specific types of failures and issues that have occurred [7]:

- Electrical system(s) affected by deicer compounds are landing gear systems, electronic countermeasure pods, and electrical systems located in wing flaps and leading edges.
- Types of failures and issues that have occurred are connector corrosion, and shorting, and in some cases arcing in wire bundles, electrical connectors, and switches.
- Some of the EWIS components that have been affected are connectors, switches, wiring, and relays (see Figure 1).



Figure 1A - Corroded aircraft connectors that had ionic contamination attributed to deicers

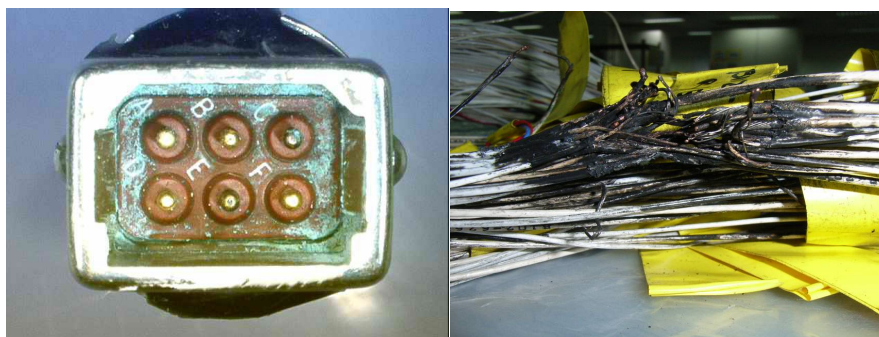


Figure 1B - Aircraft shorted switch and arced wires attributed to conductive deicers

Figure 1 - Examples of EWIS component corrosion resulting from exposure to alkali metal based runway deicing fluids [3, 7]