



AEROSPACE SPECIFICATION

AS6858™

Issued

2017-03

Installation of Fuel Cell Systems in Large Civil Aircraft

RATIONALE

This document defines the technical guidelines for the safe development, testing, integration, validation and certification of proton exchange membrane fuel cell systems, including fuel storage, fuel distribution and the integration of electrical systems into the aircraft.

TABLE OF CONTENTS

1.	SCOPE.....	4
2.	REFERENCES.....	4
2.1	Applicable Documents	4
2.1.1	SAE Publications.....	4
2.1.2	EASA Publications	5
2.1.3	EUROCAE Publications	6
2.1.4	FAA Publications	6
2.1.5	RTCA Publications	7
2.1.6	ANSI Standards	7
2.1.7	IEC Publications.....	7
2.1.8	ISO Publications.....	7
2.1.9	Military Standards	7
2.1.10	Other Publications.....	8
2.2	Abbreviations and Definitions	8
2.2.1	Abbreviations	8
2.2.2	Definitions	9
3.	GENERAL	11
3.1	Operating Modes.....	11
4.	FCS INTEGRATION WITH THE AIRCRAFT	13
4.1	General Considerations	13
4.2	Medevac.....	13
4.2.1	Functional Description / Operation.....	13
4.2.2	Architecture Principles	14
4.2.3	Aircraft Interfaces	14
4.2.4	Installation Considerations.....	14
4.2.5	System Safety Approach.....	14
4.3	Galley	14
4.3.1	Functional Description / Operation.....	14
4.3.2	Architecture Principles	15
4.3.3	Aircraft Interfaces	16
4.3.4	Installation Considerations.....	16
4.3.5	System Safety Approach.....	16

SAE Technical Standards Board Rules provide that: "This report is published by SAE to advance the state of technical and engineering sciences. The use of this report is entirely voluntary, and its applicability and suitability for any particular use, including any patent infringement arising therefrom, is the sole responsibility of the user."

SAE reviews each technical report at least every five years at which time it may be revised, reaffirmed, stabilized, or cancelled. SAE invites your written comments and suggestions.

Copyright © 2017 SAE International

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system or transmitted, in any form or by any means, electronic, mechanical, photocopying, recording, or otherwise, without the prior written permission of SAE.

TO PLACE A DOCUMENT ORDER: Tel: 877-606-7323 (inside USA and Canada)
Tel: +1 724 776 4970 (outside USA)

SAE values your input. To provide feedback
on this Technical Report, please visit

SAE WEB ADDRESS:

This is a preview. Click here to purchase the full publication.

58

4.4	Emergency Power	16
4.4.1	Functional Description / Operation	16
4.4.2	Architecture Principles	17
4.4.3	Aircraft Interfaces	17
4.4.4	Installation Considerations	17
4.4.5	System Safety Approach	17
5.	SAFETY	17
5.1	Particular Risks Analyses	18
5.1.1	Trajectory based PRA's	19
5.1.2	Sustained Engine Imbalance	19
5.1.3	Nose Wheel Imbalance	19
5.1.4	Fuel Tank Safety	19
5.1.5	Bleed Air Duct Rupture	20
5.1.6	AFT Pressure Bulkhead Rupture	20
5.1.7	Crashworthiness	20
5.1.8	Tail Strike	20
5.1.9	Survivability of Systems	20
6.	PROOF AND BURST	20
7.	MATERIAL COMPATIBILITY	21
8.	AFFECTED CERTIFICATION REQUIREMENTS	21
9.	ENVIRONMENTAL	21
10.	GASEOUS H2 STORAGE AND DISTRIBUTION	22
10.1	Fuel Quality	22
10.2	Intrinsic Risks	22
10.3	Pressure Vessels	22
10.4	Hydrogen Storage and Supply System	22
10.5	Protective Devices	23
10.6	Leakage Management	23
10.7	Separation / Segregation	23
10.8	Marking/Placards	23
10.9	Fueling/Defueling	23
11.	OXIDANT SUPPLY AND DISTRIBUTION	23
11.1	Sources	23
11.2	Installation	24
11.2.1	Ambient Air	24
11.2.2	Cabin Air	25
11.2.3	Air taken from Bleed Air System	25
11.2.4	Pressurized Oxygen	25
11.3	Ducting Containing High Oxygen Concentration	25
11.4	Pressure Vessel	25
11.5	Oxygen/Air Quality	26
11.6	Intrinsic Risks	26
11.7	Ventilation	26
11.8	Protective Devices	26
11.9	Maintenance / Servicing	26
12.	FUEL CELL MODULE CONSIDERATIONS	26
12.1	Scope	26
12.2	Installation Considerations	27
12.3	Operating Emissions and Abnormal H2 Leakage	28
12.4	Intrinsic Risks	28
12.5	Protective Devices	29

13.	BALANCE OF PLANT CONSIDERATIONS	29
13.1	Scope	29
13.2	Hydrogen Path	30
13.3	Oxidant Path	30
13.4	Shrouding and Ventilation	30
13.4.1	Piping and Tubing	30
13.4.2	Housings and Compartments	31
13.4.3	Ventilation	31
13.5	Power Provision	31
13.5.1	Start-up Battery	31
13.5.2	Balance of Plant Converter	32
13.6	Water Drainage	32
14.	THERMAL MANAGEMENT CONSIDERATIONS	32
14.1	Heat Rejection	32
14.2	Contamination	32
14.2.1	Air Cooled	32
14.2.2	Liquid Cooled (Hydrogen, Oxygen and Ions)	33
14.3	Properties (Electrical, Physical, Chemical)	33
14.3.1	Air Cooled	33
14.3.2	Liquid Cooled	33
14.4	Intrinsic Risks - General	33
14.5	Protective Devices	34
15.	CONTROLLER / SYSTEM INTERFACE CONSIDERATIONS.....	34
16.	SENSORS.....	34
17.	ELECTRICAL POWER CONDITIONING.....	34
18.	POWER STORAGE	34
19.	ELECTRICAL POWER INTERFACE	35
20.	MAINTENANCE	35
21.	NOTES.....	35
21.1	Revision Indicator.....	35
FIGURE 1	FUNCTIONAL DIAGRAM OF GENERIC PEM FUEL CELL SYSTEM.....	11
FIGURE 2	OPERATIONAL MODE DIAGRAM FOR GENERIC FUEL CELL SYSTEM	13
FIGURE 3	EXAMPLE PAYLOAD POWERED BY A FUEL CELL SYSTEM	14
FIGURE 4	EXAMPLE GALLEY APPLICATION.	15
FIGURE 5	EXAMPLE EMERGENCY POWER APPLICATION	17
FIGURE 6	EXAMPLE HYDROGEN SUPPLY AND DISTRIBUTION SYSTEM.....	22
FIGURE 7	EXAMPLE HYDROGEN SUPPLY AND DISTRIBUTION SYSTEM.....	24
FIGURE 8	FUEL CELL MODULE INTERFACES.....	27
FIGURE 9	EXAMPLE BALANCE OF PLANT.....	29
TABLE 1	PROOF AND BURST.....	21

1. SCOPE

This is a joint SAE/EUROCAE development. This document will be released as both an SAE Aerospace Specification (AS) and a EUROCAE Minimum Aviation System Performance Standard (MASPS).

This document defines the technical requirements for the safe integration of gaseous hydrogen fueled Proton Exchange Membrane (PEM) Fuel Cell Systems (FCS) within the aircraft.

Most of the technical concepts and approaches covered by this document represent current industry "best practice". Others require specific approval from the procuring activity before use. This requirement for approval is not intended to prohibit their use; but rather to ensure that the prime contractor has fully investigated their capability to perform reliably and to be sufficiently durable under the required conditions and that the prime contractor can present substantiating evidence for approval before the design is committed to.

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 +1 724-776-4970 (outside USA), www.sae.org.

AIR64C	Electrical and Electronic Equipment Cooling in Commercial Transports
AIR825/13	Guide for Evaluating Combustion Hazards in Aircraft Oxygen Systems
AS861B	Minimum General Standards for Oxygen Systems
AIR1059	Oxygen Cylinder Quality, Serviceability, Maintenance Transfilling and Marking
AIR1168	Aircraft Fuel Weight Penalty Due to Air Conditioning
AIR1277	Cooling of Military Avionic Equipment
ARP1532A	Aircraft Oxygen System Lines, Fabrication, Test and Installation
ARP1870	Aerospace Systems Electrical Bonding and Grounding for Electromagnetic Compatibility and Safety
AIR1957	Heat Sinks for Airborne Vehicles
ARP4418	Procedure for Sampling and Measurement of Engine and APU Generated Containments in Bleed Air Supplies from Aircraft Engines
ARP4754	Guidelines for Development of Civil Aircraft and Systems
ARP4761	Guidelines and Methods for Conducting the Safety Assessment Process on Civil Airborne Systems and Equipment
ARP5021A	Oxygen Cylinder Installation Guide
AIR6464	EUROCAE/SAE WG80/AE-7AFC Hydrogen Fuel Cells Aircraft Fuel Cell Safety Guidelines