

SAE The Engineering Society
For Advancing Mobility
Land Sea Air and Space

400 COMMONWEALTH DRIVE, WARRENDALE, PA 15096

AEROSPACE INFORMATION REPORT

AIR 1174

Issued: July 1970
Revised April 1987

REV
A

Supersedes AIR 1174

Submitted for recognition as an American National Standard

INDEX OF STARTING SYSTEM SPECIFICATIONS AND STANDARDS

1. SCOPE: This report lists military and industry specifications and standards which are used in aerospace engine starting and auxiliary power systems. Only those hardware standards which have been specifically designed for engine starting systems are listed. Revisions and amendments which are current for these specifications and standards are not listed.
 - 1.1 Listing Documents: The following documents which list specifications and standards are used as a basis for this report.
 - 1.1.1 Military Specifications and Standards: Department of Defense, Index of Specifications and Standards. This document is published annually with bi-monthly supplements.
 - 1.1.2 Society of Automotive Engineers, Inc. Documents: Index of Aerospace Standards, Recommended Practices and Information Reports. This document is published annually by SAE, Inc., 400 Commonwealth Drive, Warrendale, PA 15096.
2. ENGINE STARTING CHARACTERISTICS:
 - 2.1 Military Specifications:

Engines, Aircraft, Reciprocating, General Specification for	MIL-E-25109
Engines, Aircraft, Turbojet and Turbofan, General Specification for	MIL-E-5007
Engines, Aircraft, Turboshift and Turboprop, General Specification for	MIL-E-8593
Engines, Aircraft, Turbojet and Turbofan	MIL-E-87231

SAE Technical 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 reaffirmed, revised, or cancelled. SAE invites your written comments and suggestions.

2.2 Society of Automotive Engineers Documents:

Guide for Determining Engine Starter Drive Torque Requirements	AIR 781
Guide for Determining, Presenting and Substantiating Turbine Engine Starting and Motoring Characteristics	AIR 713A
Power Sources, Auxiliary, for Aerospace Applications	AIR 744A

3. ENGINE STARTING SYSTEM:3.1 Military Specifications:

Auxiliary Power Systems, Airborne	MIL-A-87229
-----------------------------------	-------------

3.2 Society of Automotive Engineers Documents:

Aircraft Accessory Drag Torque During Engine Starts	AIR 1087
A Means of Testing Turbojet Starter Performance	ARP 715
Final Report on Cold Starting of Reciprocating Aircraft Engines	AIR 13
Glossary, Aircraft Engine Starting Systems	ARP 906
Guide for Determining Engine Starter Drive Torque Requirements	ARP 781
Oil Dilution and Cold Starting of Aircraft Engines	AIR 6
Turbine Engine Starting System Design Requirements	ARP 949
Turbine Engine Starting and Motoring Characteristics Guide for Determining, Presenting, and Substantiating.	AIR 713A

3.3 Military Standards:

Drive Pad-Accessory, 10.000 BC Round, Design Standard for	MS3329
Flange Accessory, 5.000 BC Square, Design Standard for	MS3331
Flange Accessory, 10.000 BC Round, Design Standard for	MS3334
Gasket Type XI, Engine Accessory Drive (5.000 BC Square)	MS9135
Gasket-Engine Accessory Drive (8.000 BC Round)	MS9377
Adapter Installation - Type XII or XVI Drive Starter Jaw	MS33509
Drive Pad-Accessory, 5.000 BC Round, Design Standard for	MS3327 (AS)
Drive Pad-Accessory, 8.000 BC Round, Design Standard for	MS3328 (AS)
Drive Pad-Accessory, 5.000 BC Square, Design Standard for	MS3326 (AS)
Flange Accessory, 5.000 BC Round, Design Standard for	MS3332 (AS)
Flange Accessory, 8.000 BC Round, Design Standard for	MS3333 (AS)

3.3 (Continued):

Gasket-Type XII, XIV-A, XIV-B, XIV-E, XVII-A and XVII-B Engine Accessory Drive	MS9136
Gasket-Type XVI, XVII-C, -D, -E and -F Engine Accessory Drive (10.000 BC Round)	MS9139

3.4 Society of Automotive Engineers Standards:

Power Take-Off Pad Requirements, Gas Turbine Engine Flange - Accessory, 2.653 BC Square, Design Standard for	ARP 748 AS 960A
Splines Involute; Wear Limit Definition of Drives and Flange Standards, Aircraft Engine and Accessory	ARP 1200 AIR 1160A
Breech Drive Pad, OAD Assembly	AS 1259
Carburetor Flange, Aircraft, 2-bolt, Single-Barrel No. 3 & 4	AS 62
Coupling Clamp, Groove V-Band 6.400, 9.400, 11.400 Flange OD	AS 976
Disconnect Systems, Accessory Drive Shaft Drive 3/4, Generator-10" BC-Female Pilot Drive Tachometer Type I	AIR 853 AS 535 AS 54
Drive Studded, Accessory, 10.000 BC Round, Design Standard for	AS 967A
Drive Studded, Accessory, 2.653 BC Square, Design Standard for	AS 959B
Drive Studded, Accessory, 5.000 BC Square, Design Standard for	AS 961B
Drive Accessory, 10.000 BC Round, QAD, Design Standard for	AS 971A
Flange Accessory, 10.000 BC Round, Design Standard for	AS 968B
Flange Accessory-Slotted Mounting Holes	AS 474
Gasket Copper, Tube Connection, Plain	AS 3332
Flange Accessory, 5.000 BC Square, Design Standard for	AS 962A
Drive Accessory, 5.000 BC Round, QAD, Design Standard for	AS 969A
Drive Accessory, 8.000 BC Round, QAD, Design Standard for	AS 970A
Drive Studded, Accessory, 5.000 BC Round, Design Standard for	AS 963A
Drive Studded, Accessory, 8.000 BC Round, Design Standard for	AS 965A
Flange Accessory, 5.000 BC Round, Design Standard for	AS 964B
Flange Accessory, 8.000 BC Round, Design Standard for	AS 966B
Spline Details, Accessory Drives and Flanges	AS 972
Adapter 10.000 Bolt Circle to 4.125 Pilot Diameter QAD	AS 528

4. CARTRIDGE/PNEUMATIC STARTING SYSTEM:4.1 Society of Automotive Engineers Documents:4.2 System Components:4.2.1 Starter:4.2.1.1 Military Specifications:

Starter, Engine, Cartridge/Pneumatic, Shaft Drive, General Specification for	MIL-S-27266
---	-------------

4.2.2 Energy Control:4.2.2.1 Military Specifications:

Valve, Starter Control, Pneumatic, Aircraft Engine General Specifications for	MIL-V-38398
Valve, Starter Control, Aircraft Engine, General Specification for	MIL-V-81995

4.2.3 Connections:4.2.3.1 Ducting:4.2.3.1.1 Military Specifications:

Bleed Air Systems, General Specification for Coupling Half, Quick Disconnect, Pneumatic	MIL-B-81365 MIL-C-25531
Starter, External, Low Pressure Duct, Pneumatic Start, Flexible	MIL-D-22706
Environmental Control, Airborne	MIL-E-87145
Pneumatic Power Systems, High Pressure	MIL-P-87210

4.2.3.1.2 Society of Automotive Engineers Documents:

High Temperature Pneumatic Duct Systems for Aircraft	ARP 699
--	---------

4.2.3.1.3 Military Standards:

Fitting, Pneumatic Starter Duct-Flanged (Male)	MS17833
Fitting, Pneumatic Starter Duct-Flanged (Female)	MS17835
Connector, Pneumatic Starter Duct, Double Ended	MS17836
Adapter, Pneumatic Starter, Duct Nipple and Flange (Male)	MS17834
Nipple, Pneumatic Starting, 3 Inch I.D., Outline Dimensions of	MS33740

4.2.3.2 Electrical:4.2.3.2.1 Military Specifications:

Connectors, Electrical, Circular, Threaded AN type, General Specification For	MIL-C-5015
Connectors, Electric, (Circular, Environment Resisting), Receptacles and Plugs, General Specification For	MIL-C-83723
Slash Sheets for Series III Threaded Coupling Connectors	MIL-C-83723/82 thru MIL-C-87323/85 MIL-C-83723/88 thru
Connectors, Electrical, Circular, Miniature, High Density, Quick Disconnect, Threaded Coupling, Series III	MIL-C-82723/90 MIL-C-83723/95 thru
Connectors, Series III, Slash Sheets	MIL-C-83723/98 thru MIL-C-38999
Contracts, Electrical Connector, General Specification For	MIL-C-38999/20 thru
Connector, Accessories, Electrical, General Specification For	MIL-C-38999/27 MIL-C-39029
Installing and Removal Tools, Connector Electrical Contact, General Specification For	MIL-C-85049
Crimping Tools, Terminal, Hand or Power Actuated, Wire Termination, and Tool Kits, General Specification For	MIL-I-81969 MIL-C-22520

4.2.3.2.2 Military Standards:

Connectors, Receptacle, Electrical, Wall Mounting Rear Release, Crimp Contact, AN Type	MS3450
Connectors, Receptacle, Electrical, Cable Connecting, Rear Release, Crimp Contact, AN Type	MS3451
Connectors, Receptacle, Electrical, Box Mounting, Rear Release, Crimp Contact, AN Type	MS3452
Connectors, Receptacle, Electrical, Jam Nut Mounting, Rear Release, Crimp Contact, AN Type	MS3454
Connectors, Plug, Electrical, Self-locking Coupling Nut, Rear Release, Crimp Contact, AN Type	MS3459

4.3 Power Source:4.3.1 Military Specifications:

Cartridge, Engine Starter MXU-4A/A	MIL-C-27505
Power Units, Aircraft Auxiliary, Gas-Turbine-Type, General Specification For	MIL-P-8686
Auxiliary Power Systems, Airborne	MIL-A-87229
Power Unit, Aircraft, Auxiliary, Gas Turbine, General Specification For	MIL-P-85573

4.3.2 Society of Automotive Engineers Documents:

Pneumatic Power Supplies for Starting Aircraft	AIR 944
Summary of Transportation, Handling and Storage Requirements for Starter Cartridges, Jet Engine, MXU-4/A and MXU-129/A	ARP 956

5. ELECTRIC STARTING SYSTEM:5.1 Military Specifications:

Electric Equipment, Aircraft, Selection and Installation Of	MIL-E-7080
Generators, 30-Volt, Direct Current, Aircraft Engine Driven, and Starter-Generators, General Specification for	MIL-G-006162
Electrical Power Systems, Aircraft	MIL-E-87219

5.2 Society of Automotive Engineers Documents:5.3 Military Standards:

Criteria, Jet Electrical Starting System, DC Aircraft Electrical Power Characteristics	MS17794 MIL-STD-704
---	------------------------

5.4 System Components:5.4.1 Starter:5.4.1.1 Military Specifications:

Starter, Electric, Constant Current DC	MIL-S-7780
Starter, Engine, Electrical, Direct Cranking Aircraft, 28 Volts DC	MIL-S-6150
Starter-Generator, Engine, STU-6A	MIL-S-26547

5.4.1.2 Society of Automotive Engineers Documents:

Generators/Starter-Generators, Engine Driven DC, and Associated Voltage Regulators, Minimum Performance Standards for	AS 8020
D-C Starter-Generator, Engine, General Specifica- tion for	ARP 892

5.4.1.3 Military Standards:

Starter-Aircraft, Direct Cranking, 28V DC AN4116

5.4.2 Connections:5.4.2.1 Electrical:5.4.2.1.1 Military Specifications:

Cable Assemblies and Attachable Plugs, MIL-C-7974
External Power, Aircraft

5.5 Power Source:5.5.1 Military Specifications:

Battery and Cell, Storage, Aircraft, MIL-B-8565
General Specification For
Batteries, Storage, Aircraft, Nickel-Cadmium, MIL-B-26220
General Specification for
Battery, Storage, Aircraft, Type MA-2-1 MIL-B-26026
Batteries and Cells, Storage, Nickel-Cadmium, MIL-B-81757
Aircraft, General Specification For
Batteries, Storage, Lead Acid, General MIL-B-83769
Specification for

5.5.2 Society of Automotive Engineers Documents

Electromagnetic Compatibility (Emc) System Design AIR 1221
Checklist
Electromagnetic Compatibility on Gas Engines for AIR 1423
Aircraft Propulsion
Electromagnetic Interference (EMI) Measurement ARP 1267
Impulse Generators; Standard Calibration
Requirements and Techniques
Methods of Achieving Electromagnetic Compatibility AIR 1425
of Gas Turbine Engine Accessories for Self-
Propelled Vehicles
Nickel Cadmium Vented Rechargeable Aircraft AS 8033
Batteries (non-sealed maintainable type)

5.5.3 Military Standards

Battery, Aircraft Storage Nickel-Cadmium 24-Volt, MS24496
11 Ampere Hour, 27 Deg C (80 Deg F)
Battery, Aircraft Storage, Nickel-Cadmium 24-Volt, MS24497
22 Ampere Hour, 27 Deg C (80 Deg F)
Battery, Aircraft Storage, Nickel-Cadmium 24-Volt, MS24498
34 Ampere Hour, 27 Deg C (80 Deg F)
Battery Installation AND10441
Batteries, Storage, Aircraft, Dimensions For MS18093
Battery, Storage, Aircraft, Installation of MS25193

5.5.4 Connections:5.5.4.1 Military Specifications:

Cable Assemblies and Attachable Plugs, External Power, Aircraft	MIL-C-7974
---	------------

6. GAS TURBINE STARTING SYSTEM (Jet Fuel Starter):6.1 Military Specifications:

Starter Auxiliary Power Unit, Aircraft Engine, Gas Turbine Type, Detailed Specification for Auxiliary Power Systems, Airborne	MIL-S-85419
	MIL-A-87229

7. HYDRAULIC STARTING SYSTEM:7.1 Military Specifications:

Hydraulic Systems Aircraft, Type I and II, Design and Installation Requirements For Starter, Aircraft Engine, Hydraulic General Specification for Hydraulic Power Systems	MIL-H-5440
	MIL-S-22999
	MIL-H-87227

7.2 Society of Automotive Engineers Documents:

Aerospace Hydraulic and Pneumatic Specifications and Standards	AIR 737
Determination of Hydraulic Pressure Drop	ARP 24
Hydraulic Fluid Characteristics	AIR 81
Nomenclature, Aircraft Hydraulic and Pneumatic Systems	ARP 243
Fluid System Characteristics Affecting Hydraulic Pump Operation	ARP 819
Fluid Properties	AIR 1116

7.3 System Components:

Hydraulic System Components, Aircraft and Missiles, General Specification For	MIL-H-8775
---	------------

7.3.1 Starter:7.3.1.1 Military Specifications:

Starter, Aircraft Engine, Hydraulic	MIL-S-22999
-------------------------------------	-------------

7.3.1.2 Society of Automotive Engineers Documents:

Aircraft Hydraulic Starters	AS 714A
Aircraft Hydraulic Starter/Pumps	AS 838
Hydraulic Energy Limited Starting Systems	AIR 1466

7.4 Power Source:7.4.1 Military Specifications:

Filter and Filter Elements, Fluid Pressure, Hydraulic Line, 15 Micron Absolute and 5 Micron Absolute, Type II Systems, General Specifications For	MIL-F-8815
Accumulators, Aircraft Hydropneumatic Pressure	MIL-A-5498
Accumulators, Hydraulic, Cylindrical 3,000 PSI, Aircraft, Type II Systems	MIL-A-8897
Pump, Hydraulic Ram, Hand Driven	MIL-P-5515
Motors Aircraft, Hydraulic, Constant Displacement, General Specification For	MIL-H-7997
Pumps, Hydraulic, Variable Delivery, General Specification For	MIL-P-19692

7.4.2 Society of Automotive Engineers Documents:

Hose Assemblies, Metal, Medium Pressure, High Temperature	ARP 1424
Hose Assemblies: Aircraft and Missile, High Temperature (400 F), High Pressure (3000 psi)	ARP 604D
Hose Characteristics and Selection Chart	AIR 797C
Tubing Installations, Recommended Practice for the Design of, for Aerospace Fluid Power Systems	ARP 994

7.4.3 Military Standards:

Accumulator, Cylindrical, 3,000 PSI	MS28700
Accumulator, Hydraulic, Cylindrical, 3,000 PSI, Aircraft, Type II Systems	MS28797
Pump-Hydraulic Hand	AN620T
Pump-Hydraulic Hand, Type 3000	AN6248

8. MECHANICAL STARTING SYSTEM:8.1 System Components:8.1.1 Starter:9. PNEUMATIC STARTING SYSTEM:9.1 Society of Automotive Engineers Documents:

Safety Criteria for Pneumatic Starting Systems	AIR 1639
Gas Energy Limited Starting Systems	AIR 1467

9.2 System Components:9.2.1 Starter: