INCH-POUND

MIL-PRF-25478D
06 May 2013
SUPERSEDING
MIL-PRF-25478C
29 December 1997

PERFORMANCE SPECIFICATION

COOLERS, LUBRICATING OIL, AIRCRAFT, GENERAL SPECIFICATION FOR

This specification is approved for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This is general specification for aircraft engine lubricating oil coolers that provide oil temperature regulation for aircraft gas turbine engines using high temperature synthetic base lubricating oil, and aircraft piston engines, turbo propeller gear boxes, and helicopter transmission gear boxes using petroleum based oil.

1.2 Classification. Lubricating oil coolers (oil coolers) will be of the following types as specified in the acquisition document (see 6.2).

1.2.1 Type. The type of oil coolers are as follows:

Type IA - Petroleum base lubricating oil cooler for aircraft piston engines and turbo propeller gear boxes

Type IB - Petroleum base lubricating oil cooler for helicopters transmission gear boxes.

Type II - Synthetic base lubricating oil cooler for aircraft gas turbine engines.

Comments, suggestions, or questions on this document should be addressed to Oklahoma City Air Logistics Center/ENSDDA, 3001 Staff Drive, Tinker AFB, OK 73145 or emailed to tinker.dsp@tinker.af.mil. Since contact information can change, you may want to verify the currency of this address information using the ASSIST Online database at https://assist.dla.mil .

2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3, 4 or 5 of this specification. This section does not include documents cited in other sections of this specification or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements of the documents cited in sections 3, 4, or 5 of this specification, whether or not they are listed.

2.2 Government documents.

2.2.1 Specifications and standards. The following specifications and standards form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

DEPARTMENT OF DEFENSE SPECIFICATIONS

MIL-PRF-5636	- Valve, Lubricating Oil Cooler, Temperature Regulating With Surge Protection General Specification For

DEPARTMENT OF DEFENSE STANDARDS

MS33786	- Fitting Installation, Flared Tube and Hose, Swivel

(Copies of these documents are available online at https://assist.dla.mil/quicksearch/ or from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.)

2.3 Non-government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

AMERICAN SOCIETY FOR QUALITY (ASQ)

ANSI/ASQ-Z1.4	- Sampling Procedures and Tables for Inspection by Attributes

(ASQ documents may be obtained at http://asq.org or addressed to the American Society for Quality, P.O. Box 3005, Milwaukee, WI 53201-3005 or 600 North Plankinton Avenue Milwaukee, Wisconsin, 53203, USA)

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM B117 - Salt Spray (Fog) Apparatus, Operating

(ASTM documents may be obtained at http://www.astm.org/ or addressed to the American Society for Testing and Materials, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.)

AEROSPACE INDUSTRIES ASSOCIATION of AMERICA, INC. (AIA)

NASM33588 - Nut, Self-Locking, Aircraft, Reliability And Maintainability Usage Requirements For

(AIA/NAS documents may be obtained at www.aia-aerospace.org/ or from Aerospace Industries Association, 1000 Wilson Boulevard, Suite 1700, Arlington, VA 22209-3928.)

2.4 Order of precedence. Unless otherwise noted herein or in the contract, in the event of a conflict between the text of this document and the 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.

3. REQUIREMENTS

3.1 Associated specification sheets. The individual item requirements shall be as specified herein and in accordance with the applicable specification sheet cited in the acquisition document (see 6.2). In the event of any conflict between the requirements of this specification and the acquisition document, the latter shall govern.

3.2 First article. When specified (see 6.2), a sample shall be subjected to first article inspection in accordance with 4.2.

3.3 Recycled, recovered, or environmentally preferable materials. Recycled, recovered, or environmentally preferable materials should be used to the maximum extent possible, provided that the material meets or exceeds the operational and maintenance requirements, and promotes economically advantageous life cycle costs.

3.4 Workmanship. The oil cooler, including all parts and equipment, shall be constructed in accordance with commonly accepted industrial workmanship standards.

3.5 Materials. All materials shall be corrosion resistant or suitably treated to resist corrosion due to electrolytic decomposition from hydraulic fluids, fuels, fungus, salt fog, and any other condition that may be encountered during operational use or storage. The use of toxic chemicals, hazardous substances, or ozone depleting chemicals shall be avoided, whenever feasible.

3.5.1 Compatibility. All materials shall be compatible with the lubricating oil and preservative compounds specified in the acquisition document (see 6.2). No copper or magnesium shall be used.

3.6 Component parts. Unless otherwise specified in the acquisition document (see 6.2), the oil cooler shall consist of the core assembly, oil inlet and outlet ports, a drain device, a temperature control device, a surge protection device, and a bypass warm-up passage. The temperature control device, a surge protection device, and a bypass warm-up passage can be combined into one device as described in MIL-PRF-5636.

3.6.1 Castings. f metal is chosen and a casting process is used, then the casting shall be clean, free from blow-holes, porosity, cracks, and other defects.

3.6.2 Temperature control device. The oil cooler shall incorporate a temperature control device which, in conjunction with a bypass warm-up passage, controls the temperature of the oil at the oil cooler outlet to the value specified in the acquisition document (see 6.2). The temperature control device shall be a removable part of the oil cooler assembly.

3.6.3 Surge protection device. The surge protection device shall be used on the bypass warm-up passage outlet and shall be a removable part of the oil cooler assembly. The surge protection device shall open at the minimum differential pressure relief setting and shall limit the maximum differential pressure as specified in the acquisition document (see 6.2).

3.7 Interfaces.

3.7.1 Fittings. The oil inlet and outlet ports shall permit connection of fittings conforming to MS33786.

3.7.2 Dimensions and weight. The overall dimensions and weight shall be as specified in the acquisition document (see 6.2).

3.7.3 Locking thread parts. Threaded parts shall be secured to prevent loss during operation. Self-locking nuts, shall be in accordance with NASM33588. Staking and the use of lockwashers shall not be permitted.

3.8 Performance.

3.8.1 Static pressure. There shall be no leakage or permanent distortion of the oil cooler when subjected to hydrostatic pressure as specified in the acquisition document (see 6.2).

3.8.2 Bypass warm-up passage pressure drop without air flow. Unless otherwise specified in the acquisition document (see 6.2), the oil pressure drop through the bypass warm-up passage shall not exceed 8 psi.

3.8.3 Pressure drop with air flow. The pressure drop across the oil cooler shall not exceed 30 psi for Type IA and Type IB oil coolers with temperature regulation; 25 psi for Type IA and Type IB oil coolers without temperature regulation; and 20 psi, unless otherwise specified in the acquisition document (see 6.2), for Type II oil coolers with or without temperature regulation.

3.8.4 Pressure drop without air flow. The pressure drop across the oil cooler with no air flow shall not exceed the maximum allowable pressure for the engine oil scavenging pump system as specified in the acquisition document (see 6.2).

3.8.5 Pressure resistance. The oil cooler shall withstand an oil pressure drop of 80 psi with an oil temperature of less than 100°F and the bypass warm-up passage closed.

3.8.6 Pressure cycles. The oil cooler shall withstand 50,000 air pressure cycles applied to the oil inlet with the oil outlet closed. An air pressure cycle is from 3 $\pm$3 psi to 60 $\pm$1 psi and back to 3 $\pm$3 psi in 4.5 $\pm$0.5 seconds.

3.8.7 Ratings.

3.8.7.1 Rated oil flow. Rated oil flow shall meet the requirement specified in the acquisition document (see 6.2).

3.8.7.2 Rated air flow. Rated air flow shall meet requirement specified in the acquisition document (see 6.2).

3.8.7.3 Oil heat rejection. At rated oil flow, rated air flow, and the air inlet temperature specified in the acquisition document (see 6.2), the total heat rejection (British Thermal Units per minute) from the oil cooler shall be equal to or greater than total heat rejection specified in the acquisition document (see 6.2).

3.8.8 Direction of air flow. Unless otherwise specified (see 6.2), the oil cooler shall meet performance requirements with the air flow in either direction.

3.9 Environmental conditions.

3.9.1 Fluid resistance. The oil cooler shall withstand oil temperatures of -65° to 350°F without leakage or permanent distortion.

3.9.2 Vibration. There shall be no leakage or permanent distortion of the oil cooler when subjected to vibration. The vibration shall be maintained at an amplitude such that an acceleration of 10g is imposed upon the oil cooler.

3.10 Maintainability. A drain device shall be provided on the oil cooler which shall permit complete drainage of the oil cooler when installed in the aircraft.

3.11 Identification. The oil cooler shall be permanently and legibly marked with the following (see 6.2).

a. Nomenclature
b. Serial number
c. National stock number
d. Contract number
e. Manufacturer's CAGE code
f. Manufacturer's part number
g. Date of manufacture

3.11.1 Synthetic rubber parts. If used, synthetic rubber parts, except parts without suitable surface area, shall be marked with the cure date.

3.12 Interchangeability. All parts having the same manufacturer's part number shall be functionally and dimensionally interchangeable.

3.13 Cleaning. The oil cooler shall be free of acids, alkaloids, halides, or other foreign materials.

4. VERIFICATION

4.1 Classification of inspections. The inspection requirements specified herein are classified as follows:

a. First article inspection (see 4.2).
b. Conformance inspection (see 4.3).

4.2 First article inspection. When required (see 6.2), first article inspection shall be performed on two complete oil coolers and shall include the tests indicated in 4.6.

4.3 Conformance inspection. Conformance inspection shall include the tests indicated in 4.3.1 and 4.3.2.

4.3.1 Individual tests. Each oil cooler shall be subjected to the following tests:

a. Examination of [product (see 4.6.1)
b. Cleaning (see 4.6.2)
c. Static pressure test (see 4.6.3)

4.3.2 Sampling tests. A sample of oil coolers shall be selected in accordance with ASQC-Z1.4, and shall be subjected to the following tests at the inspection level (normal, tightened, or reduced) specified in the acquisition document (see 6.2). (In the oil pressure drop without air flow test, only one measurement, with oil at a temperature of 145^{o} $+2^{o}$F, shall be made):

a. Pressure drop without air flow (see 4.6.5).
b. Pressure cycles (see 4.6.8 and 6.4)

4.4 Test conditions. Unless otherwise specified (see 6.2), all inspections shall be performed in accordance with the following test conditions.

4.4.1 Ducting. The cooling air inlet and outlet ducts on the test bench shall be equivalent in size and shape to that of the aircraft installation on which the oil cooler is to be used. Dimensions shall be as specified in the acquisition document (see 6.2).

4.4.2 Oil. The oil used for all tests shall be specified in the acquisition document (see 6.2).

4.4.3 Tolerances. Unless otherwise specified, the variables specified at fixed values are permitted to deviate from specified conditions: $\pm 2^{o}$F for all temperatures, $\pm$2% for rated oil flow, and $\pm$2% of rated air flow for any air flow. The calculated heat added to the air ('air temperature rise' x 'air flow' x 'specific heat of air') shall be within 5% of calculated heat transferred from the oil ('oil temperature drop' x 'oil flow' x 'specific heat of oil'). Heat balance discrepancies of more than 5%, for all heat rejection runs other than 'Oil pressure drop with air flow' are unacceptable.

4.5 Requirements cross-reference matrix. Table I provides a cross-reference matrix of the section 3 requirement tested or verified in paragraphs below.

TABLE I. Requirements cross-reference matrix

Requirement	Verification	Requirement	Verification
3.2	4.2	3.8.4	4.6.5
3.4	4.6.1	3.8.5	4.6.6
3.5	4.6.1, 4.6.11	3.8.6	4.6.8
3.5.1	4.6.1, 4.6.9	3.8.7.1	4.6.4, 4.6.5
3.6	4.6.1	3.8.7.2	4.6.4
3.6.1	4.6.1	3.8.7.3	4.6.4
3.6.2	4.6.1, 4.6.4, 4.6.5, 4.6.10	3.8.8	4.6.4
3.6.3	4.6.1, 4.6.4, 4.6.5, 4.6.10	3.9.1	4.6.9
3.7.1	4.6.1	3.9.2	4.6.7
3.7.2	4.6.1	3.10	4.6.1
3.7.3	4.6.1	3.11	4.6.1
3.8.1	4.6.3	3.11.1	4.6.1
3.8.2	4.6.5	3.13	4.6.1, 4.6.2
3.8.3	4.6.4		

4.6 Tests.

4.6.1 Examination of product. The oil cooler shall be examined for compliance with requirements for materials, weight, identification, compatibility, components, castings, temperature control and surge protection devices, fittings locking threaded parts, maintainability, dimensions, workmanship, and presence of foreign materials.

4.6.2 Cleaning. Cleanliness of the oil cooler shall be demonstrated by industrially accepted test methods which detect the presence of acids, alkaloids, or halides.

4.6.3 Static pressure test. The oil cooler shall be subjected to a hydrostatic pressure, as specified in the acquisition document (see 6.2), for one minute and checked for leakage or permanent distortion. There shall be no leakage.

4.6.4 Oil pressure drop with air flow. The oil cooler shall be chilled at the temperature and for the duration specified in Table II while filled with oil. The rated air flow, at the temperature of rated air flow as specified in Table II, shall be applied to the oil cooler air inlet throughout the chilling and testing period. After chilling the oil cooler as specified, the flow of oil to the oil inlet shall be initiated at one-half of the value of rated oil flow as specified in Table II. The initial temperature of oil applied to the oil inlet shall be equivalent to chill temperature. AT the end of three minutes, the rated oil flow shall be established and the oil inlet and oil outlet temperatures shall be as specified in Table II. The oil pressure drop across the oil cooler shall not exceed the value specified Table II. When subjected to these conditions, the oil cooler shall meet the total heat rejection specified in the acquisition document (see 6.2) with rated air flow in either direction.

TABLE II. Pressure drop data

	Type IA with temperature regulation	Type IA without temperature regulation	Type IB with temperature regulation	Type IB without temperature regulation	Type II with/without temperature regulation
Chill Temperature	-30° ±2°F	(see note 1)	-30° ±2°F	(see note 1)	-65° ±2°F
Chill Duration	24 hours	24 hours	24 hours	24 hours	72 hours
Rated Air Flow	(see note 3)	(see note 3)	(see note 2)	(see note 2)	(see note 2)
Temperature of rated air flow	-30° ±2°F	100° ±2°F	-30° ±2°F	100° ±2°F	-65° ±2°F
Rated Oil Flow	(see note 4)	(see note 4)	(see note 4)	(see note 4)	(see note 4)
Temperature at oil inlet	225° ±2°F	225° ±2°F	225° ±2°F	225° ±2°F	325° ±5°F
Maximum temperature at oil outlet	185°F	185°F	185°F	185°F	285°F
Maximum pressure drop	30 psi	25 psi	30 psi	25 psi	(see note 5)

Notes: 1. Chilling not required, Stabilize at ambient temperature for 24 hours.
2. Rated air flow shall be provided by the acquisition document (see 6.2).
3. Double the rated air flow as provided by the acquisition document (see 6.2).
4. Rated oil flow shall be provided by the acquisition document (see 6.2).
5. Unless otherwise specified in the acquisition document (see 6.2), the pressure drop across the oil cooler shall not exceed 20 psi.

4.6.5 Pressure drop without air flow. The oil pressure drop without air flow test shall be conducted at rated oil flow, as specified in the acquisition document (see 6.2). Unless otherwise specified in the acquisition document (see 6.2), Type IA and Type IB oil coolers shall be tested at oil inlet temperatures of 145°, 180°, 210°, and 240° ± 2°F. Type II oil coolers shall be tested at oil inlet temperatures of 145°, 205°, 265° ± 2°F, and 325° ± 5°F. The oil pressure drop across the oil cooler shall be compatible with the maximum allowable pressure for the engine oil scavenging pump system as specified in the acquisition document (see 6.2). Unless otherwise specified in the acquisition document (see 6.2), the oil pressure drop through the bypass warm-up passage shall not exceed 8 psi.

4.6.6 Pressure resistance. With an oil temperature of less than 100°F and the bypass warm-up passage closed, the flow of oil through the oil cooler shall be adjusted so that an oil pressure drop of 80 psi occurs from the oil inlet of the cooler to the oil outlet of the cooler. The oil outlet pressure shall be maintained at 10 psi maximum. There shall be no leakage or distortion.

4.6.7 Vibration test. The oil cooler shall be installed in a test system with the oil temperature at 225° ± 2°F, the rated oil flow as specified in the acquisition document (see 6.2), and the oil inlet pressure at the lowest operating pressure. The oil cooler shall be vibrated along each of three mutually perpendicular axes through a frequency survey of 25 to 150 Hertz (Hz) in order to determine the existence of resonant frequencies. If a resonant frequency is found, the oil cooler shall be vibrated at that frequency. If more than one resonant frequency is observed, the test frequency should be at the most severe resonant frequency. If no resonance is observed, the oil cooler shall be vibrated at 150 Hz. The test shall be conducted for 35 hours for each of the three mutually perpendicular axes, or if using a two-directional vibrator, for 50 hours with the oil cooler in the horizontal position and 50 hours in the vertical position. The vibration to the oil cooler shall be maintained at a 10g acceleration. There shall be no leakage, permanent distortion, or failure of the mounting structure integral to the oil cooler. At the completion of the test, the oil cooler shall satisfy the requirements of the static pressure test in 4.6.3.

4.6.8 Pressure cycles. The oil cooler shall be completely submerged in oil at 275° ± 5°F for Type IA and Type IB oil coolers, and at 350° ± 10°F for Type II oil coolers. An air pressure cycle (3 ± 3 psi to 60 ± 1 psi and back to 3 ± 3 psi) shall be applied to the oil inlet with a cycle time of 4.5 ± 0.5 seconds with the oil outlet closed. The oil cooler shall be subjected to 50,000 cycles without leakage or permanent distortion. At the completion of the test, the oil cooler shall satisfy the requirements of the static pressure test in 4.6.3.

4.6.9 Fluid resistance and material compatibility test.

4.6.9.1 High temperature test. The oil specified in the acquisition document (see 6.2) shall be circulated through the oil cooler for 96 hours at a temperature of 275° ± 5°F for Type IA and Type IB oil coolers, and 24 hours at a temperature of 350° ± 10°F for Type II oil coolers. Following this the oil cooler shall be subjected to the static pressure test in 4.6.3, except that the test pressures shall be 1 psi, 50 psi, and 100 psi. The pressure shall be held for 30 seconds during each test. The high temperature test shall be repeated 7 times. There shall be no leakage.

4.6.9.2 Low temperature test. Following the high temperature test, the oil cooler shall be soaked for 72 hours at -65° ± 5°F while filled with the oil specified in the acquisition document (see 6.2). The oil cooler shall be subjected to the static pressure test in 4.6.3 at -65° ± 5°F except that the pressures shall be 1 psi, 50 psi, and 100 psi alternately for at least 10 times. The pressure shall be held for 30 seconds during each test. There shall be no leakage.

4.6.10 Temperature control and surge protection device test. The requirements of the temperature control and surge protection devices shall be demonstrated using the test methods of MIL-PRF-5636.

4.6.11 Salt fog. The oil cooler shall be subjected to the salt fog test in ASTM B117 for 50 hours. The oil cooler shall then be subjected to the individual tests in 4.3.1.

5. PACKAGING

5.1 Packaging. For acquisition purposes, the packaging requirements shall be as specified in the contract or order (see 6.2). When packaging of materiel is to be performed by DoD or in-house contractor personnel, these personnel need to contact the responsible packaging activity to ascertain packaging requirements. Packaging requirements are maintained by the Inventory Control Point's packaging activities within the Military Service or Defense Agency, or within the military service's system commands. Packaging data retrieval is available from the managing Military Department's or Defense Agency's automated packaging files, CD-ROM products, or by contacting the responsible packaging activity.

6. NOTES

(This section contains information of a general or explanatory nature that may be helpful, but is not mandatory.)

6.1 Intended use. Oil coolers covered by this specification are intended for use in aircraft piston and jet engine lubricating oil, turbo-propeller gear box oil, and helicopter transmission gear box oil systems.

6.2 Acquisition requirements. Acquisition documents should specify the following:

a. Title, number, and date of this specification.
b. Type designation (see 1.2).
c. Associated specifications or specification sheets (see 3.1).
d. When first article is required (see 3.2 and 4.2).
e. Lubricating oil (petroleum or synthetic base) to be used for testing and preservative compounds (see 3.5.1, 4.4.2, 4.6.9.1, and 4.6.9.2).
f. If component parts differ from that specified (see 3.6).
g. Oil temperature at oil cooler outlet (see 3.6.3).
h. Pressure relief setting (see 3.6.3).
i. Overall dimensions and weight (see 3.7.2).
j. Whether the hydrostatic pressure requirement is 100 ± 10 psi, 200 ± 10 psi or 400 ± 20 psi (see 3.8.1 and 4.6.3).
k. If the oil pressure drop through the bypass warm-up passage is other than 8 psi (see 3.8.2 and 4.6.5).
l. If the pressure drop across the oil cooler is other than 20 psi (see 3.8.3 and table II).
m. Oil scavenging pump system maximum pressure (see 3.8.4 and 4.6.5).
n. Rated oil flow requirement (see 3.8.7.1, 4.6.5, and 4.6.7).
o. Rated air flow requirement (see 3.8.7.2).
p. Air inlet temperature requirement (see 3.8.7.3).
q. Total heat rejection requirement (see 3.8.7.3, and 4.6.4).
r. If the direction of air flow is different than specified (see 3.8.8).
s. Item identification (see 3.11 items a, c, and d).
t. Sampling inspection level (normal, tightened, or reduced) (see 4.3.2).

u. If the test conditions are other than as specified in section 4 (see 4.4).
v. Test bench duct dimensional requirement (see 4.4.1).
w. Oil inlet temperature for test (see 4.6.5).
x. Packaging requirements (see 5.1).
y. Data required.

6.3 Guidance for sampling inspection. Samples subjected to the pressure cycles test were marked to show that the item was overstressed and were not used to fulfill contractual requirements.

6.4 Subject term (key word) listing.

Gas turbine engines
High temperature oil
Petroleum base oil
Piston engines
Synthetic base oil

6.5 Changes from previous issue. Marginal notations are not used in this revision to identify changes with respect to the previous issue due to the extent of the changes.

Custodians:
Air Force - 71

Preparing Activity:
Air Force - 71

(Project 2935-2009-002)

Review Activities:
DLA - GS

NOTE: The activities listed above were interested in this document as of the date of this document. Since organizations and responsibilities can change, you should verify the currency of the information above using the ASSIST database at https://assist.dla.mil/.