SAE Aerospace
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AEROSPACE MATERIAL SPECIFICATION

SAE AMS2658 | REV. C

Issued 1980-04
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Superseding AMS2658B

Hardness and Conductivity Inspection of Wrought Aluminum Alloy Parts

RATIONALE

AMS2658C revises test locations (4.4) and hardness and conductivity values (Tables 1, 2) and is a Five Year Review and update of this specification.

1. SCOPE

1.1 Purpose

This specification establishes hardness and electrical conductivity acceptance criteria of finished or semi-finished parts of wrought aluminum alloys.

1.2 Application

This specification has been used typically for nondestructive testing of wrought aluminum alloy parts to aid in determining correctness of alloy, temper, and/or heat treatment, but usage is not limited to such applications.

2. APPLICABLE DOCUMENTS

The issue of the following documents in effect on the date of the purchase order forms a part of this specification to the extent specified herein. The supplier may work to a subsequent revision of a document unless a specific document issue is specified. When the referenced document has been cancelled and no superseding document has been specified, the last published issue of that document shall apply.

2.1 ASTM Publications

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

ASTM E 10	Brinell Hardness of Metallic Materials
ASTM E 18	Rockwell Hardness of Metallic Materials
ASTM E 1004	Electromagnetic (Eddy-Current) Measurements of Electrical Conductivity
ASTM G 34	Exfoliation Corrosion Susceptibility in 2xxx and 7xxx Series Aluminum Alloys (EXCO Test)

TO PLACE A DOCUMENT ORDER: **Tel: 877-606-7323 (inside USA and Canada)**
Tel: +1 724-776-4970 (outside USA)
Fax: 724-776-0790
Email: CustomerService@sae.org
http://www.sae.org

SAE values your input. To provide feedback on this Technical Report, please visit http://www.sae.org/technical/standards/AMS2658C

2.2 U.S. Government Publications

Available from the Document Automation and Production Service (DAPS), Building 4/D, 700 Robbins Avenue, Philadelphia, PA 19111-5094, Tel: 215-697-6257, http://assist.daps.dla.mil/quicksearch/.

MIL-STD-1537 Electrical Conductivity Test for Measurement of Heat Treatment of Aluminum Alloys, Eddy Current Method

3. TECHNICAL REQUIREMENTS

3.1 Equipment

The equipment used for hardness and electrical conductivity testing shall meet the requirements of ASTM E 10, ASTM E 18, ASTM E 1004, or MIL-STD-1537, as applicable.

3.1.1 Verification

The hardness test equipment when in use shall be checked against test blocks at least once per day to ensure accurate and repeatable results. The conductivity test equipment shall require a periodic standardization every hour of continuous operation. Equipment which does not provide accurate or repeatable results shall be corrected and recalibrated.

3.2 Procedure

3.2.1 Hardness

Shall be determined in accordance with ASTM E 10 for Brinell hardness and ASTM E 18 for Rockwell hardness.

3.2.2 Electrical Conductivity

Shall be determined in accordance with ASTM E 1004 or MIL-STD-1537.

3.3 Properties

Parts shall conform to the hardness and electrical conductivity values in Table 1 for bare alloys and Table 2 for clad alloys after heat treatment or annealing in accordance with the applicable specification. Alloys/tempers not contained herein shall be referred to the cognizant engineering organization.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for Inspection

The inspection source shall be responsible for the performance of all required tests. Purchaser reserves the right to perform any confirmatory testing deemed necessary to ensure that hardness and conductivity conform to specified requirements.

4.2 Classification of Tests

Not applicable.

4.3 Sampling and Testing

Shall be in accordance with the applicable heat treatment specification or as agreed upon by purchaser and processing vendor.

4.4 Test Locations

Shall be in accordance with the applicable drawing, specification or contract.

4.4.1 If test locations are not specified, the following shall be considered acceptable.

4.4.1.1 Conductivity testing shall be performed in accordance with the applicable heat treat document and at sufficient locations on the surface to ensure that the entire part meets the requirements of Tables 1 and 2. At a minimum the testing shall be performed as follows: A part with any dimension exceeding twelve inches shall be tested in more than one location. When more than one location is tested, each part shall be tested at a location near its center and at its dimensional extremes. Long, thin parts, such as extruded shapes or sheet metal parts shall be tested at both ends, and near the center. Parts shall be tested in both the nominally thinnest and thickest areas, when possible. Large sheets shall be tested in several locations in order to determine that the entire part meets the requirements of Tables 1 or 2.

4.4.1.2 Hardness testing shall be performed in accordance with the applicable heat treat document and at sufficient locations on the surface to ensure that the entire part meets the requirements of Tables 1 and 2. When tested at the thickest accessible section, one hardness test per part is normally adequate to determine part acceptability. When less than 100% hardness testing is performed, the sample tested shall include those parts within the lot tested with the highest and lowest conductivity values.

4.5 Reports

The inspection source shall furnish with each shipment a report showing the actual minimum and maximum values obtained. This report shall include the purchase order number, AMS2658C, heat treatment specification number, part number, and quantity.

5. PREPARATION FOR DELIVERY

Not applicable.

6. ACKNOWLEDGMENT

A vendor shall mention this specification number and its revision letter in all quotations and when acknowledging purchase orders.

7. REJECTIONS

Parts not inspected in accordance with this specification or not conforming to the specified hardness and conductivity requirements, or to modifications authorized by purchaser, will be subject to rejection.

7.1 Nonconforming Parts

Parts failing to meet the hardness or electrical conductivity acceptance values specified herein shall be either reprocessed in accordance with the limits of the applicable heat treatment specification or referred to the cognizant quality assurance organization for additional testing or evaluation.

8. NOTES

8.1 A change bar (|) located in the left margin is for the convenience of the user in locating areas where technical revisions, not editorial changes, have been made to the previous issue of this document. An (R) symbol to the left of the document title indicates a complete revision of the document, including technical revisions. Change bars and (R) are not used in original publications, nor in documents that contain editorial changes only are clarified in ARP1917 treated by the user during the fabrication process.

8.2 Terms used in AMS are clarified in ARP1917 and as follows:

8.2.1 Parts

Finished and semi-finished parts also include raw material stock heat treated by the user during the fabrication process.

8.3 Dimensions and properties in inch/pound units and the Fahrenheit temperatures are primary; dimensions and properties in SI units and the Celsius temperatures are shown as the approximate equivalents of the primary units and are presented only for information.

8.4 Purchase documents should specify not less than the following:

AMS2658C.

PREPARED BY AMS COMMITTEE "D" AND "AMEC"

TABLE 1 - BARE ALUMINUM ALLOY HARDNESS AND CONDUCTIVITY ACCEPTANCE VALUES

Alloy	Temper (1)	Hardness Brinell min (2)	Hardness Rockwell, min (3) B	Hardness Rockwell, min (3) E	Hardness Rockwell, min (3) H	Hardness Rockwell, min (3) 15T	Conductivity % (4)
1100	0	--	--	--	50 max	--	57.0 - 62.0
2004	T6	--	--	92	--	--	35.5 - 42.0
2014	0	--	22 max	70 max	95 max	--	43.5 - 51.5
	T3 (9)	100	65	95	--	82	31.5 - 35.0
	T4	100	65	95	--	82	31.5 - 35.0
	T6	125	78		--	86	35.0 - 41.5
2024	0	--	22 max	70 max	95 max	--	46.0 - 51.0
	T3 (9)	100	63	94	--	82	27.5 - 32.5
	T4	100	63	94	--	82	27.5 - 34.0
	T6	114	72	98	--	84	34.0 - 44.0
	T72	114	72	98	--	82	38.0 - 45.0
	T8	118	74	99	--	85	35.0 - 42.5
	T86 (9)	135	83		--	87.5	37.0 - 41.0
2124	T3	110	69	97	--	--	27.5 - 32.5
	T8	120	74	99	--	--	35.0 - 42.5
2219	0	--	22 max	70 max	95 max	--	44.0 - 49.0
	T3 (9)	95	60	92	--	79	26.0 - 31.0
	T31 (9)	96	60	--	--	--	26.0 - 34.0
	T37 (9)	100	62	93	--	81	27.0 - 31.0
	T4	100	58	90	--	78	28.0 - 32.0
	T6	110	62	93	--	81	32.0 - 36.0
	T8	115	71	98	--	83	31.0 - 35.0
	T87	125	75		--	84	31.0 - 35.0
3003	0	--	--	--	65 max	--	44.5 - 50.5
5052	0	--	--	70 max	95 max	--	34.0 - 37.0
6013	0	--	--	90 max	--	--	--
	T4	--	40	--	--	--	(5)
	T6	--	61	96	--	--	(5)
6061	0	40 max	--	--	75 max	--	(5)
	T4	50	--	60	--	64	(5)
	T6	80	47	85	--	78	(5)
6063	0	--	--	--	70 max	--	(5)
	T1 (9)	--	--	37	--	53	(5)
	T4	--	--	40	--	54	(5)
	T5 (9)	--	--	44	--	57	(5)
	T6	60	--	70	--	68	(5)
6066	0	--	--	40 max	--	--	42.0 - 47.0
	T4	--	--	85	--	76	34.0 - 41.0
	T6	100	65	95	--	82	38.0 - 50.0

TABLE 1 - BARE ALUMINUM ALLOY HARDNESS AND CONDUCTIVITY ACCEPTANCE VALUES (CONT.)

Alloy	Temper (1)	Hardness Brinell min (2)	Hardness Rockwell, min (3) B	Hardness Rockwell, min (3) E	Hardness Rockwell, min (3) H	Hardness Rockwell, min (3) 15T	Conductivity % (4)
7049	0	--	22 max	70 max	95 max	--	44.0 - 50.0
	T73	135	81		--	85	38.0 - 44.0
	T76	140	84		--	87	38.0 - 44.0
7050	0	--	22 max	70 max	95 max	--	44.0 - 50.0
	T73	135	81		--	85	41.0 - 44.0
	T74	135	82		--	86	40.0 - 44.0 (6)
	T76	140	84		--	87	39.0 - 44.0
7075	0	--	22 max	70 max	95 max	--	44.0 - 48.0
	T6	135	84		--	87	30.5 - 36.0
	T73	125	78		--	85	38.0 - 43.0
	T76	130	82		--	86	38.0 - 42.0
7149	0	--	22 max	70 max	95 max	--	44.0 - 50.0
	T73	135	81		--	85	38.0 - 44.0
	T76	140	84		--	87	38.0 - 44.0
7150	0	--	22 max	70 max	95 max	--	44.0 - 50.0
	T61 (9)	145	87		--	--	29.0 - 33.5
	T73	135	81		--	85	41.0 - 44.0
	T74	135	82		--	86	40.0 - 44.0 (6)
	T76	140	84		--	87	39.0 - 44.0
	T77 (9)	145	87		--	87	37.0 - 39.0
7175	0	--	--	--	95 max	--	44.0 - 48.0
	T6	135	84		--	87	30.5 - 36.0
	T73	125	78		--	85	38.0 - 43.0
	T74	135	82		--	--	38.0 - 42.0
	T76	130	82		--	86	38.0 - 42.0
7178	0	--	--	--	95 max	--	43.0 - 47.0
	T6	145	87		--	88	29.0 - 34.0
	T76	140	84		--	87	38.0 - 42.0
7475	T73	--	78		--	--	38.0 - 44.5
	T76	--	82		--	--	38.0 - 42.0 (8)
	T6	--	84	--	--	--	30.0 - 35.0

TABLE 2 - CLAD ALUMINUM ALLOY SHEET HARDNESS AND CONDUCTIVITY ACCEPTANCE VALUES

Alloy	Temper	Nominal Thickness (7) Inch (mm)			Hardness Rockwell Minimum (3) B	Hardness Rockwell Minimum (3) E	Hardness Rockwell Minimum (3) H	Hardness Rockwell Minimum (3) 15T	Conductivity % (4)
2014	0		All		22 max	70 max	95 max	--	43.5 - 51.5
	T6	Up to	0.062	(1.57), incl	76		--	85	35.5 - 44.0
		Over	0.062	(1.57)	75		--	--	35.5 - 44.0
2024	0		All		22 max	70 max	95 max	--	46.0 - 51.0
	T3 (9)	Up to	0.062	(1.57), incl	57	91	--	79	28.5 - 35.0
		Over	0.062	(1.57)	60	93	--	--	28.5 - 35.0
	T4	Up to	0.062	(1.57), incl	57	91	--	79	28.5 - 35.0
		Over	0.062	(1.57)	60	93	--	--	28.5 - 35.0
	T6	Up to	0.062	(1.57), incl	60	93	--	82	35.0 - 45.0
		Over	0.062	(1.57)	62	94	--	--	35.0 - 45.0
	T72	Up to	0.062	(1.57), incl	52	91	--	80	39.0 - 45.0
		Over	0.062	(1.57)	52	93	--	80	39.0 - 45.0
	T8		All		65	97	--	82	35.0 - 45.0
	T86 (9)		All		83		--	87	36.0 - 42.0
2219	0		All		22 max	70 max	95 max	--	44.0 - 49.0
	T6	Up to	0.062	(1.57), incl	61	92	--	80	32.0 - 37.0
		Over	0.062	(1.57)	60	91	--	--	32.0 - 37.0
	T8	Up to	0.062	(1.57), incl	64	96	--	82	31.0 - 37.0
		Over	0.062	(1.57)	63	95	--	--	31.0 - 37.0
6061	0		All		--	--	75 max	--	(5)
	T6		All		--	84	--	74	--
7075	0		All		22 max	70 max	95 max	--	44.0 - 48.0
	T6	Up to	0.032	(0.81), incl	78			86	30.5 - 36.0
		Over	0.032	to 0.062, incl	76		--	--	30.5 - 36.0
		(Over	0.81	to 1.57, incl					
		Over	0.062	(1.57)	75		--	--	30.5 - 36.0
	T76	Up to	0.032	(0.81), incl	76			84	38.0 - 42.0
		Over	0.032	to 0.062, incl	75		--	--	38.0 - 42.0
		(Over	0.81	to 1.57, incl)					
		Over	0.062	(1.57)	74		--	--	38.0 - 42.0
7178	0		All		--	--	95 max	--	43.0 - 47.0
	T6	Up to	0.032	(0.81), incl	79			86	29.0 - 34.0
		Over	0.032	to 0.062, incl	78		--	--	29.0 - 37.0
		(Over	0.81	to 1.57, incl)					
		Over	0.062	(1.57)	76		--	--	29.0 - 37.0
7475	T76				74		85		37.0 - 43.0

NOTES TO TABLES 1 AND 2

(1) Only the basic temper, TX, TXX, is shown. Hardness and conductivity values also apply to the stress relieved TX51, TX52, TX54, TX510, or TX511 conditions and the user heat treated T42 and T62 conditions.

(2) HB, 500 kg load, 10 mm ball.

(3) Hardness values for the annealed (O) condition are maximum; all other hardness values are minimum. The HR15T values are for parts up to 0.032 inch (0.81 mm), incl, in nominal thickness.

(4) % International Annealed Copper Standard (IACS).

(5) The following conductivity values are provided for reference only:

Alloy temper Conductivity (% IACS)

6013 T4 37.0-39.0	6063 O 57.0 - 65.0
6013 T6 40.0-43.0	6063 T1 48.0 - 58.0
6061 O 42.0 - 50.0	6063 T4 48.0 - 58.0
6061 T4 35.5 - 43.0	6063 T5 50.0 - 60.0
6061 T6 40.0 - 50.0	6063 T6 50.0 - 60.0
6066 O 42.0 - 47.0	
6066T4 34.0 - 41.0	
6066 T6 38.0 - 50.0	

(6) Alloys 7050-T74 and 7150-T74: Lower conductivities of 38.0% to 39.9% are acceptable provided the hardness of the part is not higher than as shown in Table 3.

(7) Values are for sheet with cladding intact. Clad sheet over 0.091 inch (2.31 mm) in nominal thickness can result in incorrect hardness and conductivity values from the cladding thickness. When permitted by the purchaser, removal of the cladding in local areas may be performed to obtain valid hardness and conductivity values.

(8) Alloy 7475-T76: Conductivity values of 36.0 to 37.9% IACS are acceptable for bare material and 35.0-36.9 for clad material, if the material conforms to exfoliation tests in accordance with ASTM G 34.

(9) Generally considered as a mill or purchaser generated temper. Hardness and conductivity values are provided as references.

TABLE 3 - LIMITATIONS OF THICKNESS/HARDNESS

Material Thickness Inches					Material Thickness Millimeters					Hardness Maximum
	Up	to	0.50,	incl		Up	to	12.7,	incl	88 HRB
Over	0.50	to	2.00,	incl	Over	12.7	to	50.8,	incl	86 HRB
Over	2.00				Over	50.8				84 HRB