

INCH-POUND

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SUPERSEDING
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19 July 1988

DEPARTMENT OF DEFENSE

TEST METHOD STANDARD

FOR

ELECTRICAL CONDUCTIVITY TEST FOR VERIFICATION OF

HEAT TREATMENT OF ALUMINUM ALLOYS

EDDY CURRENT METHOD



AMSC N/A

AREA NDTI

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FOREWORD

1. This test method standard is approved for use by all Departments and Agencies of the Department of Defense.
2. An electrical conductivity measurement of an aluminum alloy determines its conductivity in ohm centimeters or in percent of the International Annealed Copper Standard (IACS) by comparison with certified conductivity standards. For a properly identified aluminum alloy, electrical conductivity measurement is a nondestructive method for verifying heat treatment. The electrical conductivity test used in conjunction with hardness testing makes it feasible to verify proper heat treatment.
3. Electrical conductivity in production part testing is measured by the eddy current method. Direct reading type eddy current instruments indicate conductivity in percent IACS (%IACS) and indirect type eddy current instruments are normally scaled in microamperes. To calibrate either of these types of eddy current instruments, certified non-ferrous conductivity standards are required.
4. Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document shall be addressed to ASC/ENOI, 2530 Loop Road West, Wright-Patterson Air Force Base, Ohio 45433-7101 by using Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

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1 SCOPE

1.1 Scope.

This standard contains procedures for verifying aluminum alloy heat treatment by means of eddy current techniques, which measure electrical conductivity. Aluminum alloy heat treatment can be verified when electrical conductivity measurements are used in conjunction with hardness measurements.

2 APPLICABLE DOCUMENTS

2.1 General.

The documents listed in this section are specified in sections 3, 4, and 5 of this standard. This section does not include documents cited in other sections of this standard 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 documents cited in sections 3, 4, and 5 of this standard, whether or not they are listed.

2.2 Non-Government publications.

The following documents form a part of this document to the extent specified herein. Unless otherwise indicated, the issues of the documents which are DOD are those listed in the issue of the DoDISS cited in the solicitation. Unless otherwise specified, the issues of documents not listed in the DoDISS are the issues of the documents cited in the solicitation (see 6.2).

American Society for Testing and Materials (ASTM)

ASTM B193	Electrical Resistivity of Conductor Materials
ASTM E10	Brinell Hardness of Metallic Materials
ASTM E18	Rockwell Hardness and Rockwell Superficial Hardness of Metallic Materials

(Application for copies should be addressed to the ASTM, 1916 Race Street, Philadelphia, PA 19103.)

American National Standards Institute (ANSI)

ANSI/NCSL Z540-1	Calibration Laboratories and Measuring and Test Equipment
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(Application for copies should be addressed to the ANSI, 1819 L. Street NW, Washington DC 20036.)

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National Aerospace Standard (NAS)

AIA/NAS 410

Certification and Qualification of Nondestructive Test Personnel

(Application for copies of NAS should be addressed to the Aerospace Industries Association of America, 1250 I Street NW, Suite 1100, Washington DC 20005-3924)

International Standards (ISO)

ISO 10012-1

Quality Assurance for Measuring Equipment

(Application for copies should be addressed to the Aerospace Industries Association of America Inc., 1725 DeSales Ste N.W. Washington DC 20036)

2.3 Order of precedence.

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 DEFINITIONS**3.1 Volume resistivity.**

Volume resistivity, ρ , is the resistivity of a known volume of nonferrous metal expressed in ohm (centimeters)² per centimeter or simply ohm centimeters, where the area is of uniform cross-section A in sq cm and the resistance R in ohms is the value for a known length L in cm of the area A, or expressed in equation form

$$\rho = \frac{RA}{L} \text{ (ohm centimeters) @ } 20^{\circ}\text{C (68}^{\circ}\text{F)}$$

3.2 Conductivity.

The conductivity, σ , of a material is the reciprocal of volume resistivity or $1/\rho$. It is the relative value of conductivity of any nonferrous metal, to the arbitrary value set for commercially pure copper, and is usually expressed in percent International Annealed Copper Standard (percent IACS or %IACS), at 20°C by definition, where copper = 100 %IACS.

3.3 Percent IACS (International Annealed Copper Standard).

Percent IACS is the percent value of the conductivity of a material compared to the IACS standard value. The IACS standard is a commercially pure copper rod one meter long with a uniform cross-section of 1 mm² with resistance of 1/58 (0.017241) ohms at 20°C. The conductivity of this standard is considered to be 100 %IACS.

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3.4 Eddy current instrument.

An electrical measuring instrument that induces and responds to eddy currents in metals through a probe. These currents are induced by means of time-varying electromagnetic fields. Note: also called an eddy current meter.

3.5 Probe.

Many turns of fine wire usually wound on a ferrite or laminated iron core in such a way as to produce a varying electromagnetic field when energized by an alternating current, usually 60 KHz or above for conductivity measurements.

3.6 Nonferrous conductivity standards.

Either primary (reference), secondary (laboratory), or instrument conductivity standards which have the following characteristics:

a. Primary or Reference Nonferrous Conductivity Standards:

Uniformly dimensioned rectangular or round bars of homogeneous nonferrous metal finished to a surface finish which will permit dimensional and resistance measurements such that they can be certified for conductivity values within ± 0.2 %IACS or ± 0.5 percent of stated value, whichever is less at 20°C (68°F). These standards must be National Institute of Standards and Technology (NIST) traceable.

b. Secondary or Laboratory Nonferrous Conductivity Standards:

Blocks or coupons of nonferrous homogeneous metal of adequate thickness to prevent noticeable effects on the meter reading. The surface finish must be of sufficient quality so as to eliminate lift-off errors and of such an area as to preclude edge effect calibrated on alternating current by comparison with primary conductivity standards and certified within ± 0.35 %IACS or 1 percent of stated value, whichever is less at 20°C (68°F).

c. Instrument Nonferrous Conductivity Standards:

Similar or identical to the secondary or laboratory standards in 3.6b above except they are fastened securely to an eddy current instrument and certified within ± 0.85 %IACS at 20°C (68°F) when calibrated against secondary or laboratory standards using the eddy current instrument as tile transfer means.

3.7 Standard depth of penetration**3.7.1 English Units.**

$$\delta = \frac{26}{\sqrt{f\mu\sigma}} \quad \text{or} \quad \frac{26}{(f\mu\sigma)^{1/2}}$$

where δ = standard depth of penetration (inches)

f = operating frequency (Hertz)

μ = relative permeability (1.0 for nonmagnetic materials)

σ = conductivity in %IACS

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3.7.2 Metric Units.

$$\delta = 656.5 / \sqrt{f\mu\sigma} \quad \text{or} \quad 656.5 / (f\mu\sigma)^{1/2}$$

where δ = standard depth of penetration (millimeters)

f = operating frequency (Hertz)

μ = relative permeability (1.0 for nonmagnetic materials)

σ = conductivity in %IACS

3.8 Lift-off effect.

The change in eddy current meter indication when the spacing between the surface probe and the test object changes from an "in contact" position to a position away from the surface of the test object. The resulting gap between the probe and the object surface is filled with nonconductive air, coatings, or shims.

3.9 Direct reading eddy current instrument.

An analog or digital electronic instrument and probe which displays the conductivity of a nonferrous metal under test in percent IACS.

3.10 Indirect reading eddy current instrument.

An electronic instrument and probe with variable frequency and gain characteristics requiring graphic interpolation of pointer and scale indication for any probe frequency and gain combination to obtain values of conductivity of a nonferrous metal under test in percent IACS.

4 GENERAL REQUIREMENTS**4.1 Equipment.****4.1.1 Instruments.**

Electrical conductivity of aluminum alloys shall be determined using either a direct or an indirect reading eddy current instrument. Whenever possible, direct reading instruments shall be used for conductivity measurements. Where indirect reading eddy current instruments are required for conductivity measurements, calibration curves are necessary to correlate instrument readings with percent IACS values, since indirect reading instruments typically have non-linear characteristics and read in microamperes (μA) or are read by relative signal position on an instrument display. Indirect reading eddy current instruments require at least three certified standards to verify the calibration curve being used. These standards must be within +/-10 percent IACS of the value being measured, with at least one above and one below the value to be measured.

4.1.2 Instrument sensitivity.

Direct and indirect reading instruments shall have sensitivity such that changes of at least 0.5 %IACS are clearly distinguishable over the conductivity range of the aluminum alloys under test.

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4.1.3 Instrument accuracy.

Direct and indirect reading instruments shall be capable of determining the conductivity of aluminum alloys as a percentage of the International Annealed Copper Standard (%IACS) with an accuracy of +1.0 %IACS or better through electrically non-conductive films and coatings at least 0.003 inch (0.076 mm) thick.

4.2 Standards**4.2.1 Laboratory conductivity standards.**

The contractor or calibrating facility shall maintain three or more certified aluminum alloy laboratory conductivity standards. One laboratory conductivity standard shall be between 25 and 32 %IACS, another between 32 and 38 %IACS and the third between 38 and 72 %IACS. Laboratory conductivity standards shall be certified by comparing eddy current measurement with primary conductivity standards. Using the comparison methods, the values of these standards shall be certified to be within ± 0.35 %IACS or ± 1 percent of their stated value whichever is less, at 20°C (68°F). Calibration shall be performed in accordance with ASTM B193 procedure in a system in accordance with ANSI Z540-1. Intervals shall be based on objective evidence that accuracy as the lesser of ± 0.35 %IACS or ± 1 percent of value is constantly maintained. Recalibration of laboratory conductivity standards shall not exceed 12 months.

4.2.2 Instrument conductivity standards.

At least two instrument conductivity standards are required. These standards are similar to the laboratory conductivity standard (see 4.2.1), with the exception that these standards shall always accompany the conductivity instrument. Also, these standards are calibrated by comparison with laboratory conductivity standards. Using the comparison method, instrument conductivity standards shall be certified to ± 0.85 %IACS accuracy. The high and low value instrument standards shall have a minimum difference of 10 %IACS. At least one standard shall cover the 25 to 32 %IACS range and one standard shall cover the 38 to 62 %IACS range. Calibration intervals shall be such that they coincide with the eddy current instrument recalibration cycle (see 4.3.2) or as supported by objective evidence that the required accuracy is consistently maintained.

4.3 Calibration and standardization.**4.3.1 Standardization.**

Instruments shall be standardized before using as required by following the manufacturer's instructions. Allow approximately 20 minutes warm-up time for all types except solid state which may take five minutes. Use the instrument conductivity standards to calibrate the eddy current instrument using the standards nearest to the conductivity range being measured and adjust as required.

4.3.1.1 Standardization frequency.

During continuous operation, calibration of the conductivity instrument shall be conducted at 15 minute intervals.

4.3.1.2 Lift-off effect.

Lift-off effect is determined by comparison of readings taken when placing the probe on a bare standard followed by placing a 0.003 inch (0.076 mm) thick nonconducting flat shim between

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the probe and the standard. The difference in the two readings shall not exceed 0.5 %IACS. If it does exceed 0.5 %IACS, return the instrument to the calibration facility for repair and recertification. This test shall be performed, immediately prior to use, or at a frequency based upon objective evidence that the required accuracy is consistently maintained. On indirect reading instruments, lift-off shall be checked immediately prior to use.

4.3.2 Laboratory calibration.

The eddy current instrument shall be returned to the calibration laboratory on a periodic schedule for a complete calibration and certification including scale tracking (if analog type), lift-off, drift and battery replacement (if required). Periodic recalibration of eddy current instruments used for conductivity testing shall be conducted every 120 days or at an interval based upon objective evidence that the required accuracy is consistently maintained. The calibration interval shall not exceed 12 months.

4.4 Test article.**4.4.1 Surface.**

The areas to be tested shall be free of dirt, grease, oil or other contaminants. The surface finish of the areas to be tested shall be 150RHR (Roughness Height Rating) maximum, RMS (Root Mean Squared) 165 maximum or less than a maximum established by objective evidence, for the instrument in use, that the required accuracy is maintained. A nonconductive coating up to 0.003 inch (0.076 mm) thick is permissible on parts without determining a lift-off correction factor for eddy current readings. If the nonconductive coating thickness is greater than 0.003 inch (0.076 mm), the effects of the coating on instrument readings shall be determined. Effects of coating thickness shall be established by measuring the conductivity at individual locations before and after removal of the nonconductive coating or by simulating the coating thickness on bare metal by the use of plastic or paper shim stock (see 5.1.4). If the difference between the two readings from coated and uncoated aluminum is greater than 0.5 %IACS, further measurements and instrument recalibration shall be made to further verify the coating thickness and establish the magnitude of the difference in instrument readings. A lift-off correction factor shall be applied as determined from the difference in readings.

4.4.2 Edge effect.

To insure readings are not distorted from edge effect, the specimen area to which the eddy current instrument probe is applied shall be at least as large as the outside diameter of the test probe or per manufacturer's specifications. The coil shall be centered on all parts whose dimensions approach this limitation.

4.4.2.1 Curvature correction factor.

The limitations on the minimum radius of curvature of concave and convex surfaces on which conductivity measurements can be performed accurately shall be determined by user's tests or shall be in accordance with the instrument manufacturer's specifications. Round stock having a radius of less than the instrument manufacturer's specifications may be tested, provided a fixture is used to insure that the probe is placed in the same position on each piece and a curvature correction factor is used. An acceptable alternate method for round stock with a radius of less than four inches (100 mm) would be to move the probe slowly and gently across the surface at right angles to the length, read the maximum value indicated on the instrument and then apply the appropriate correction factor.

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4.4.3 Sample thickness.

Test articles for which electrical conductivity readings are made without a thickness correction factor shall meet or exceed the minimum thickness (see figure 1) for the %IACS range and frequency being used, except as shown (see 4.4.3.1) below. Note: The Effective Depth of Penetration (EDP) determined (see figure 1) are 2.66 times the Standard Depth of Penetration determined by equations (see 3.7.1 and 3.7.2).

4.4.3.1 Thin specimens.

Nonclad aluminum of the same heat treat condition but with a thickness as much as 40 percent below the minimum shown (see figure 1) or calculated EDP shall be tested as follows:

a. For each lot of material, three specimens identified as a, b, and c, shall be tested using stacked material specimens. Measurements of conductivity shall be made with the specimens stacked in the three arrangements shown below.

	ARRANGEMENT		
	(1)	(2)	(3)
Top specimen	a	b	c
Middle specimen	b	c	a
Bottom specimen	c	a	b

b. Unstacked specimens shall be placed on a nonconductive test surface at least 1/4 inch (6.35 mm) from any electrically conductive material and a measurement of the conductivity of each specimen made.

c. The average stacked and unstacked conductivity can be calculated.

$$\text{(Average "Stacked")} = 1/3 \text{ (Stacked (1) + Stacked (2) + Stacked (3))}$$

$$\text{(Average "Unstacked")} = 1/3 \text{ (Unstacked (a) + Unstacked (b) + Unstacked (c))}$$

d. The difference (Average Unstacked) - (Average Stacked) shall be the thickness correction factor to be added to the acceptance limits for the given material and shall be considered the acceptance criterion for measuring the balance of the lot in the unstacked condition in accordance with (b).

(1) If a conductivity measurement determined when specimens are stacked is outside the applicable acceptance range, the specimen in the top position in the measurement shall be rejected. A remeasured new specimen from the lot shall replace the rejected specimen and the stack shall be remeasured. In all measurements with stacked readings outside the acceptance range, the top specimen in the stack shall be rejected and a new specimen chosen as above.

(2) Any lot of parts or material thicker than 0.6 EDP (see figure 1) and with a thickness correction factor between 0 and 2.5 %IACS may be tested without stacking. Parts or material with a thickness correction factor greater than 2.5 %IACS shall be stacked before testing.

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(3) If the thickness correction factor as determined above in (2) is greater than 5 %IACS, stacking may lead to erroneous results. For correct results a higher eddy current instrument frequency shall be used.

e. Example #1: Suppose a lot of bare 0.040 inch (1.02 mm) 7075-T6 material is to be tested with a 60 kHz instrument and the acceptance range for this material is 30.0 to 34.5 %IACS (see figure 1), at 60 kHz and 32 %IACS, the minimum thickness is 0.050 inch (1.27 mm). Since $EDP = 0.050 \times 0.6 = 0.030$ inch (0.76 mm), the 0.040 inch (1.02 mm) thick material shall be tested when stacked (see 4.4.3).

f. Example #2: Suppose three samples taken from the lot and tested while stacked, give readings of 34.0, 34.5 and 34.%IACS. All readings are in the acceptable 30.0 - 34.5 %IACS range. The average change in conductivity between the "unstacked" and "stacked" readings is +2 %IACS. This is within the acceptable +2.5 %IACS range (see 4.4.3.1). The new acceptance range for this lot of 0.040-inch (1.02-mm) thick 7075-T6 material, unstacked, is then equal to 30.0 +2 to 34.5 +2 %IACS or 32.0 to 36.5 %IACS. The remaining specimens with "Unstacked" conductivity outside the 32.0 to 36.5 %IACS range are rejected.

4.4.4 Clad Specimens.

Electrical conductivity measurement of clad specimens shall be permitted only when correlation has been established between the conductivity readings and the acceptable range of heat-treat response for the clad specimens. Correlation shall take into account the possible range of cladding allowed by the applicable material specification and limitations of the instrument operating frequency and specimen thickness. All procedures for conductivity measurements of clad aluminum alloys must be supported by documented evidence of correlation with heat treat response and hardness measurements over the allowable range of cladding thickness and shall be subject to review by the procuring agency.

4.4.5 Alclad specimens.

Alclad materials shall be inspected at 50 to 75 kHz. When testing alclad parts thicker than 0.091 inch (2.3 mm) the cladding shall be partially removed on at least one part per inspection lot by spot facing. If the value obtained in the spot-faced area is acceptable, a second reading shall be taken on the alclad surface of the same part. The difference in conductivity between the two readings shall be used as a cladding correction factor when inspecting the remaining parts in the lot. In case of doubtful or marginal values, a second part from the same lot shall be spot-faced, and the average difference shall be used for the cladding correction factor. The above procedure shall be performed on each lot of material or parts.

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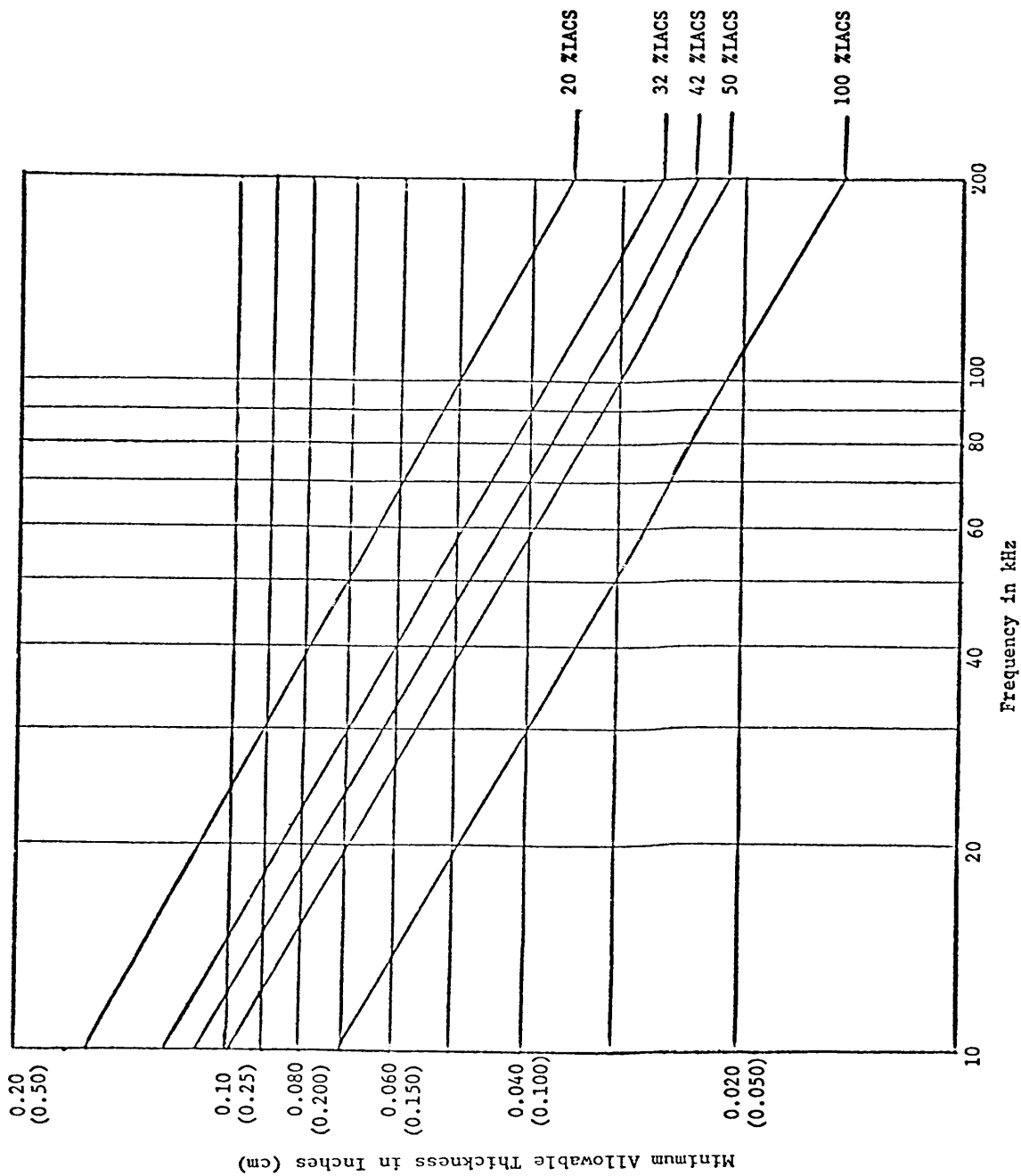


Figure 1. Effective Depth of Penetration as a Function of Conductivity and Operating Frequency.

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4.5 Personnel qualification.**4.5.1 Direct reading instruments.**

Personnel performing tests using direct reading instruments shall receive sufficient instruction for proper performance of the test and utilization of the equipment. Proper performance includes the capability to demonstrate operation and standardization of the equipment in accordance with the requirements of this standard.

4.5.2 Indirect reading instruments.

Personnel performing conductivity tests using indirect reading eddy current instruments shall be qualified to level II requirements in accordance with AIA/NAS 410.

5 DETAIL REQUIREMENTS**5.1 Procedure.****5.1.1 Hardness tests.**

Measure the hardness of the first part in the lot to be tested to determine if the parts are in proper heat-treated condition or the as quenched condition. Perform Rockwell hardness in accordance with either ASTM E10 or ASTM E18.

5.1.2 Conductivity tests.

Maintain the temperature of the test probe, the standards and the test material within 3°C (5.4°F) of each other. Operate the electrical conductivity instrument in accordance with this standard and the manufacturer's recommendations. When tests are being made, the probe must be firmly pressed against the surface of the material or part. The condition of the part or material being tested shall meet the requirements (see 4.4). Readings of unsatisfactory or questionable conductivity must always be verified by a recheck of the instrument calibration standards and then a hardness measurement must be performed on the material before making a disposition.

5.1.2.1 Acceptable mechanical properties.

Acceptable hardness or conductivity, or both, of aluminum alloy materials does not guarantee acceptable mechanical properties. Inspection shall be based upon evidence of specified heat treatment or cold working on the accompanying fabrication outline or written certification, as well as on acceptable hardness and conductivity readings.

5.1.3 Correction factors for conductivity readings on round stock.

A suggested procedure for establishing a curvature correction factor for round stock (see 4.4.2.1) is by using flat stock of the same material and temper as the round stock to be tested or material having conductivity within 5 %IACS of the stock to be tested. Measure the conductivity of the flat stock with an eddy current instrument (reading "a"). Then machine the flat stock to a radius within the tolerance of the radius on the round stock to be tested. Again measure the conductivity (reading "b") using a fixture to hold the probe in the same position as is to be used on the round stock to be tested. The correction factor to be added to the readings on the round

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stock is reading "a" minus reading "b". Repeat for 3 specimens and take the average.

CAUTIONS: (a) Prior to machining curved surfaces on flat stock, establish that the conductivity of the flat stock does not vary appreciably throughout the depths to be exposed. (b) Do not over heat the part during machining since this will appreciably change the conductivity.

5.1.4 Lift-off correction factors.

a. Establish lift-off correction factors for material or parts having a nonconductive coating exceeding 0.003 inch (0.76 mm) as follows:

b. Obtain plastic shim stock or paper of the same thickness as the nonconductive layer on the parts to be tested. Where paint thickness is not known, it will be necessary to remove or measure the paint thickness, for example, nonuniform coatings.

c. Place the shim or paper on a bare specimen of the same nominal conductivity ($\pm 5\%$ IACS) as the parts to be tested.

d. Note the difference in readings of conductivity between tests run when the probe is placed directly on the surface of the bare specimen and when the probe is placed on the paper or plastic shim stock on top of the specimen. Use this difference as the lift-off correction factor for readings on the parts to be tested.

5.1.5 Operating precautions.

a. When necessary to rub or slide probe tip against a surface, do it gently to save wear on the probe surface.

b. Do not bang probe tip against surface being measured.

c. A firm consistent probe pressure is desirable.

d. Clean the surface of the material to be measured, if required.

e. Keep the probe tip clean by wiping often with a clean lint-free cloth or a suitable commercial wiper.

5.2 Conductivity requirements.

The conductivity measurements for acceptance of heat-treated aluminum alloys shall be within the conductivity range for the specific alloy and type of heat treatment condition defined by the applicable contracting agency materials specifications.

6 NOTES**6.1 Intended use.**

Hardness must be known for the conductivity test to be meaningful in measuring heat treatment. Figure 2 shows a typical variation of hardness and conductivity of an aluminum alloy with heat treat condition. Note that both hardness and conductivity values are required to define a given heat treat condition.

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6.2 Issue of DoDISS.

When this standard is used in acquisition, the applicable issue of the DoDISS must be cited in the solicitation (see 2.2).

6.3 Subject term (key word) listings.

- a. Alcad specimens
- b. Conductivity
- c. Nonferrous conductivity
- d. Percent International Annealed Copper Standard (%IACS)
- e. Volume

6.4 Report of results.

Results must be reported in a manner acceptable to both the contractor and the procuring agency.

6.5 Changes from previous issues.

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

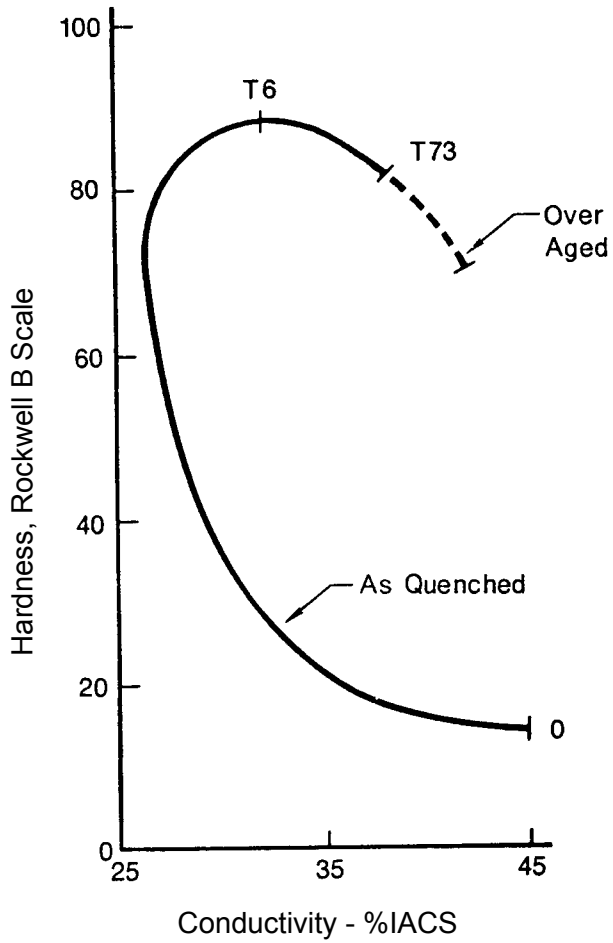
Custodian:
Air Force - 11
Navy – AS
Army – MR

Preparing activity:
Air Force - 11

Reviewers:
Air Force – 84, 99

Project No. NDTI-0281

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NOTE: Two different hardness conditions can provide the same conductivity reading in %IACS. Use hardness to verify condition.

NOTE: Figure 2 is a typical curve for information purposes only and shall not be used for acceptance or rejection.

Figure 2. Hardness vs. Conductivity for 7075 Aluminum Alloy.

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

INSTRUCTIONS

1. The preparing activity must complete blocks 1, 2, 3, and 8. In block 1, both the document number and revision letter shall be given.
2. The submitter of this form must complete blocks 4, 5, 6, and 7.
3. The preparing activity must provide a reply within 30 days from receipt of the form.
NOTE: This form may not be used to request copies of documents, nor to request waivers, or clarification of requirements on current contracts. Comments submitted on this form do not constitute or imply authorization to waive any portion of the referenced document(s) or to amend contractual requirements.

I RECOMMEND A CHANGE:

1. DOCUMENT NUMBER
MIL-STD-1537C

2. DOCUMENT DATE (YYMMDD)
2002/06/25

3. DOCUMENT TITLE

ELECTRICAL CONDUCTIVITY TEST FOR VERIFICATION OF HEAT TREATMENT OF ALUMINUM ALLOYS, EDDY CURRENT METHOD

4. NATURE OF CHANGE (Identify paragraph number and include proposed rewrite, if possible. Attach extra sheets as needed.)

5. REASON FOR RECOMMENDATION

6. SUBMITTER

a. NAME (Last, Middle Initial)

b. ORGANIZATION

c. ADDRESS (include Zip Code)

d. TELEPHONE (Include Area Code
(1) Commercial

e. DATE SUBMITTED
(YYMMDD)

(2) DSN
(If applicable)

8. PREPARING ACTIVITY

a. NAME

ASC/ENOI (AF-11)

b. TELEPHONE (Include Area Code

(1) Commercial
(513)255-6281

(2) DSN
785-6281

c. ADDRESS (Include Zip Code)

ASC/ENOI BLDG 560
2530 LOOP ROAD W
WRIGHT-PATTERSON AFB OH 45433-7101

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8725 John J. Kingman Road, Suite 2533
Fort Belvoir, VA 22060-6221
Telephone (703) 757-6888 DSN 427-6888