AEROSPACE STANDARD

AS5282™ REV. C

Issued 1998-03
Reaffirmed 2007-02
Revised 2023-02

Superseding AS5282B

Tool Steel Ring for Magnetic Particle Inspection

RATIONALE

AS5282C is the result of a limited scope ballot to clarify the reporting requirements (4.4).

1. SCOPE

1.1 Purpose

This SAE Aerospace Standard (AS) establishes requirements for the manufacture and certification of tool steel rings for magnetic particle inspection.

1.2 Application

These rings are used typically for determining the sensitivity of magnetic particles in accordance with AMS3040 through AMS3046 and to perform magnetic particle system performance checks. Evaluations of the rings are performed using full-wave rectified alternating current through a copper conductor bar.

2. 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 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.

AS7766 Terms Used in Aerospace Metals Specifications

SAE J438 Tool and Die Steels

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
SAE WEB ADDRESS: **http://www.sae.org**

For more information on this standard, visit
https://www.sae.org/standards/content/AS5282C/

2.2 ASTM Publications

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

ASTM E18	Rockwell Hardness of Metallic Materials
ASTM E140	Hardness Conversion Tables for Metals Relationship Among Brinell Hardness, Vickers Hardness, Rockwell Hardness, Superficial Hardness, Knoop Hardness, Scleroscope Hardness, and Leeb Hardness
ASTM E1444/E1444M	Magnetic Particle Testing

3. TECHNICAL REQUIREMENTS

3.1 Material

The ring shall be made from normalized hot rolled 5.5-inch (140-mm) minimum diameter tool steel bar stock, O1 series, conforming to SAE J438, or equivalent.

3.2 Configuration

The ring configuration dimensions, and surface finish shall be in accordance with Figure 1.

3.3 Normalizing

Each bar shall be normalized by heating to 1600 °F ± 100 °F (871 °C ± 56 °C), holding at heat for 60 min/in ± 5 min/in (2.4 min/mm ± 0.2 min/mm) of diameter and air cool to room temperature.

3.4 Annealing

Each ring shall be annealed by heating at 1400 to 1440 °F (760 to 782 °C), holding at heat for 3 hours minimum, cooling at a rate of not more than 50 °F ± 5 °F (28 °C ± 3 °C) per hour to 1200 °F (649 °C), and furnace or air cool to room temperature.

3.4.1 Surface oxidation, caused by annealing, shall be removed by dry blasting using either glass beads or aluminum oxide at 25 to 40 psi (172 to 276 kPa). Following dry blasting, protect part from rust by applying a coating of oil or grease.

3.5 Hardness

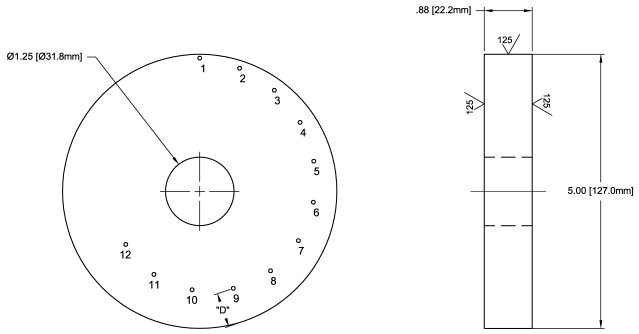
Hardness after annealing shall be 95 HRB maximum, or equivalent, as determined in accordance with ASTM E18.

4. QUALITY ASSURANCE PROVISIONS

4.1 Sensitivity Test

Each ring shall be magnetized using circular magnetization in accordance with ASTM E1444/E1444M applied by three-phase, full-wave, rectified alternating current through a 16 to 24-inch (406 to 610-mm) long and 1.0 to 1.1-inch (25.4 to 27.9-mm) diameter copper internal conductor bar.

4.1.1 The rings may be qualified by recording either the residual leakage field manually with a gauss meter, or automatically by using a magnetic sensor, amplifier, and oscilloscope.



HOLE	1	2	3	4	5	6	7	8	9	10	11	12
"D" Inches	0.07	0.14	0.21	0.28	0.35	0.42	0.49	0.56	0.63	0.70	0.77	0.84
"D" Millimeters	1.78	3.56	5.33	7.11	8.89	10.67	12.45	14.22	16.00	17.78	19.56	21.34

NOTES:
1. All hole diameters are 0.07 inch ± 0.005 inch [1.78 mm ± 0.13 mm].
2. Tolerance on the "D" distance is ±0.005 inch [±0.13 mm].
3. All other dimensions are ±0.03 inch [±0.8 mm].
4. Holes 10 through 12 are optional.

Figure 1 - O1 tool steel ring for use in magnetic particle system verification and testing of magnetic particles

4.2 Manual Leakage Field Measurement Method

Surface oil or grease shall be removed from each ring before magnetization. Each ring shall be magnetized at 1500 A, in accordance with 4.1. Remove the magnetized ring from the central conductor bar and place it in a fixture (Figure 2). Calibrate the gauss meter in accordance with the manufacturer's instructions. The gap between the gauss meter probe face and the ring surface shall be adjusted for a lift-off of 0.001 to 0.0015 inch (0.025 to 0.038 mm). The ring shall rotate smoothly on the fixture rollers without any wobble.

NOTE: If a series of rings are to be evaluated, magnetize and evaluate the rings in a uniform orientation to avoid a reverse in polarity of the leakage field.

4.2.1 Rotate the ring or rollers so that hole #1 is centered over the gauss meter probe. Slowly rotate the ring back and forth, past the sensing probe, and record the optimum gauss meter value. Repeat this process at each hole (#2 through #9).

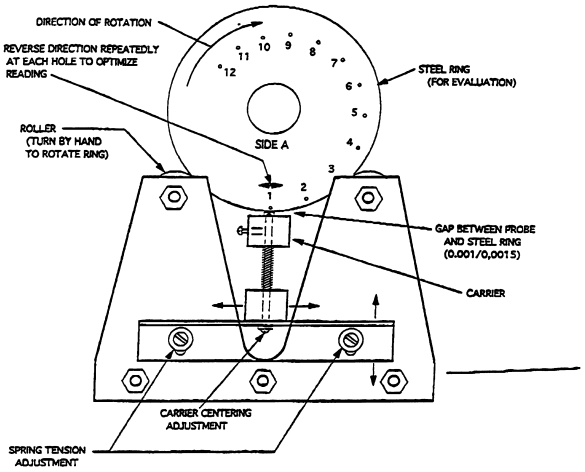


Figure 2 - Schematic of fixture for obtaining manual flux leakage readings

4.2.2 Graph the results with the hole numbers along the abscissa (horizontal) and gauss values along the ordinate (vertical). Join each value with a line to generate a smooth curve (Figure 3). For additional rings in a lot, repeat the steps in 4.2 through 4.2.2. Upon completion of the lot measurement, calculate the average gauss value at each hole for those rings which exhibit a smooth curve (Table 1, Rings 2-4) and plot the mean average curve (Figure 4).

Example: The mean average value for Rings 2-4, at hole #1, is 21 gauss and 10% of this value is 2.1 gauss. The upper and lower acceptance limit for Rings 2-4 are plotted at ±2.1 gauss from the mean average curve (Figure 4). Using a best fit curve, draw the mean curve for Ring 1 (Figure 4). The value for hole #1 (Ring 1) is 15 gauss and the upper and lower limits are 1.5 gauss. It is obvious that Ring 1 values do not generate a smooth curve and they fall outside the acceptance limits.

4.2.3 Any ring which exhibits gauss values which fall outside the limits shall be rejected (see Figure 4).

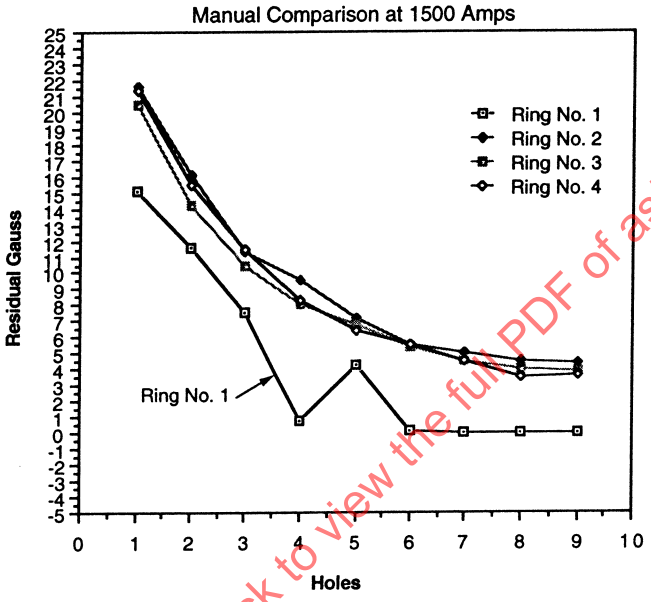


Figure 3 - Flux leakage comparison at 1500 A

Table 1 - Flux leakage results (gauss)

Holes	Ring No. 1	Ring No. 2	Ring No. 3	Ring No. 4	Avg. 2-4
1	15.1	21.6	20.5	21.3	21.1
2	11.6	16.1	14.2	15.4	15.2
3	7.6	11.3	10.4	11.4	11.0
4	0.8	9.5	8	8.3	8.6
5	4.3	7.2	6.8	6.4	6.8
6	0.2	5.6	5.4	5.6	5.5
7	0	5.1	4.5	4.5	4.7
8	0	4.5	4.1	3.5	4.0
9	0	4.4	3.9	3.6	4.0

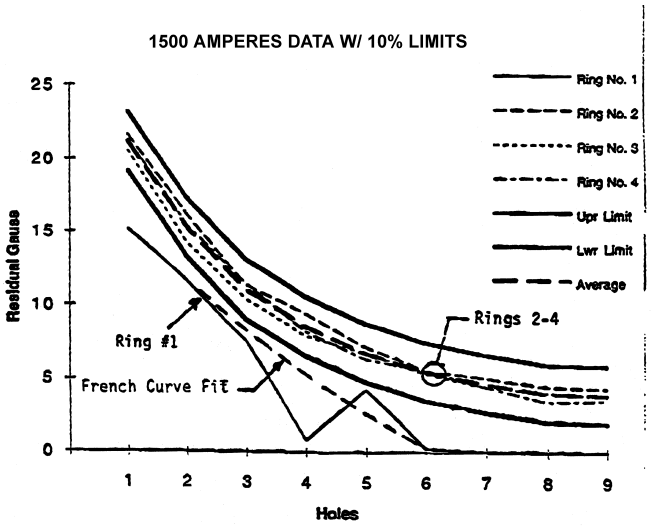


Figure 4 - Residual flux leakage (gauss) results with acceptance criteria

4.3 Automated Leakage Field Measurement Method

Surface oil or grease shall be removed from each ring before magnetization. Each ring shall be magnetized at 1500 A, in accordance with 4.1. Calibrate the magnetic sensor in accordance with the manufacturer's instructions and insert it in a fixture similar to Figure 5. The gap between the sensor face and the ring surface shall be 0.001 to 0.0015 inch (0.025 to 0.038 mm).

4.3.1 The automated system in Figure 5 utilizes a turntable which has a central hole through which is inserted a central conductor. Clamps and cables may be attached to the internal conductor and magnetizing source if it is desired to magnetize the ring in-place or the rings may be magnetized on an internal conductor separate from the auto fixture. A motorized drive system shall be provided to rotate the ring past the magnetic sensor. The system shall rotate freely without any wobble. In addition to the rotating fixture, the system requires a power supply, magnetic sensor, amplifier, and oscilloscope (see Figure 6).

4.3.2 The rings shall be magnetized and evaluated in a uniform orientation to avoid a reverse in polarity of the leakage field.

4.3.3 After magnetizing the ring, start the rotation and set the oscilloscope gain to 10 mV/cm and adjust the oscilloscope horizontal adjustment so that the peak reading from each of the nine holes is uniformly spaced on the CRT trace (see Figure 7). Photograph or record the trace from each ring in the batch. Select the ring which gave the most uniform response from the nine holes and the one with the highest amplitude from hole #1. Draw a best-fit curve through both the positive and negative peaks (Figure 7). Measure the total amplitude of hole #1 and calculate 5% of that value. Using the hole #1 5% value, draw duplicate lines above and below the positive and negative median lines (Figure 7).

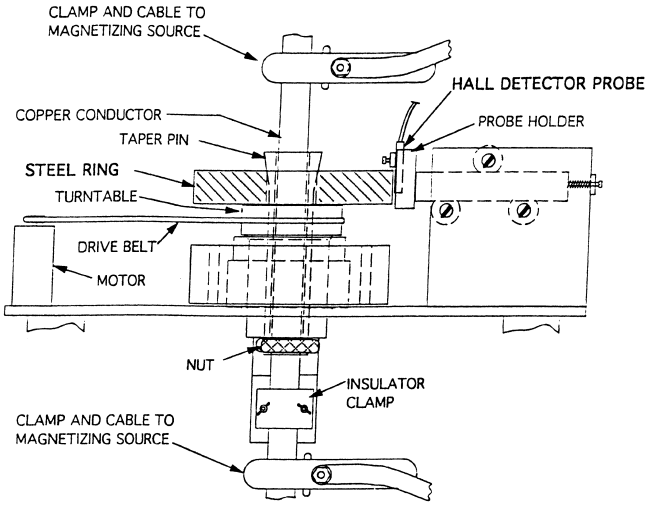


Figure 5 - Steel ring evaluation fixture

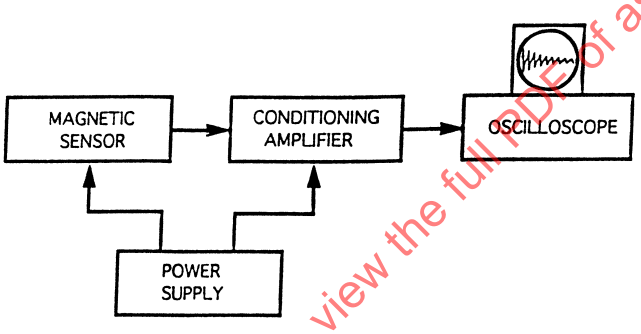
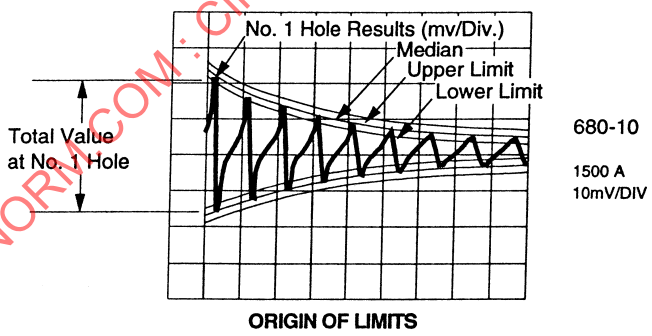


Figure 6 - Schematic of automated testing system



1. Draw a median line along top of positive signals.
2. Draw a duplicate line above median at 5% of total value.
3. Draw a duplicate line below median at 5% of total value.
4. Repeat Steps 1, 2 and 3 for negative signals.

The limit band widths now represent +or- 10% of the positive or negative half of the results.

Figure 7 - Automated leakage field results at 1500 A with limits

4.3.4 Figure 8 shows the automated residual flux leakage results for four rings. Figures 8A and 8B results are acceptable. Figures 8C and 8D are unacceptable. Rings not yielding a uniform response and which fall outside the acceptance criteria shall be rejected.

4.3.5 Upon completion of all testing, each ring shall be demagnetized to a maximum level of 2 gauss, as measured at hole #1.

4.4 Reports

A certification shall be supplied to the purchaser for each ring which meets the specified requirements. The certification shall include the material type (3.1), the annealing certification (3.4), the serial number of each ring (5.1), its corresponding hardness (3.5), and statements which certify that each ring conforms to the requirements of Figure 1. A leakage field plot, similar to Figure 4 for manual measurement or Figure 7 for automated measurement, shall also be provided to the purchaser.

4.5 Certification/Recertification

Existing rings, made prior to the release of this document, are acceptable for use provided they meet the requirements of Table 2, when tested in accordance with 4.1. Rings not meeting the requirements of Table 2 may be reannealed in accordance with 3.4 and testing in accordance with this document. New rings shall be certified in accordance with the requirements of this document. Rings which meet the requirements of this document shall be identified in accordance with 5.1.

5. PREPARATION FOR DELIVERY

5.1 Identification

Each ring shall be identified by electroetching or vibroetching at the location shown in Figure 1; the manufacturer's name, serial number, and AS5282. Each ring shall have a separate serial number (S/N).

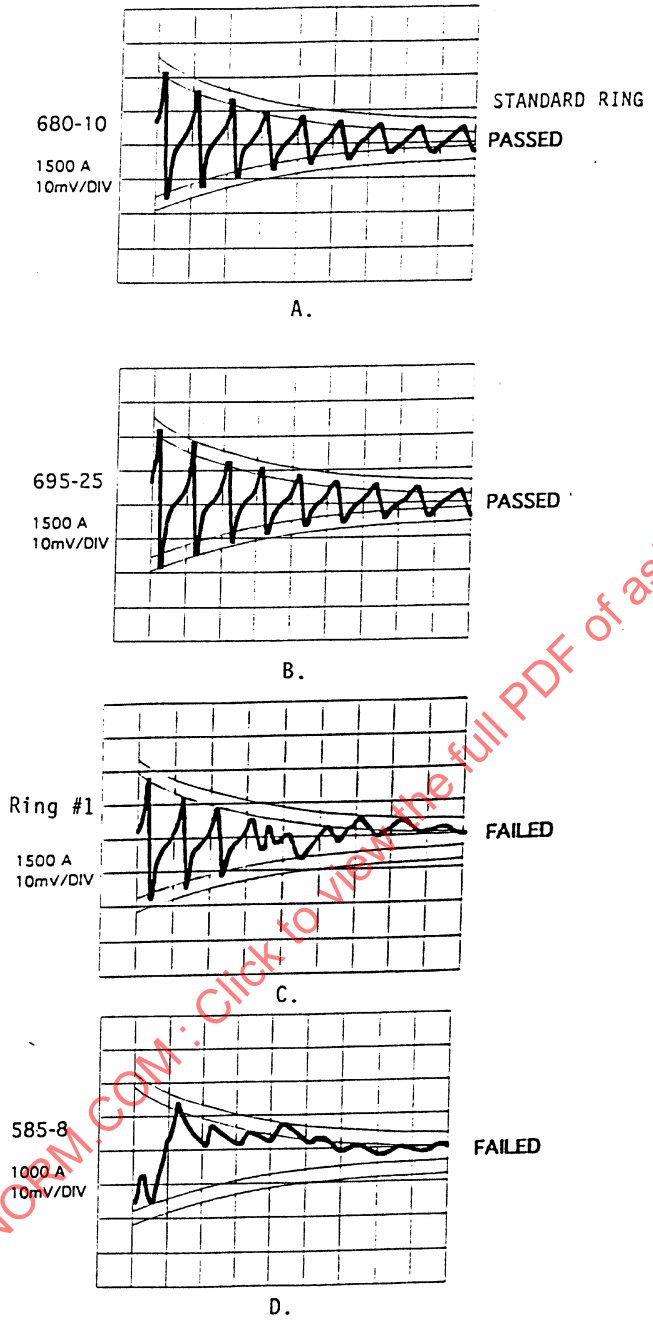


Figure 8 - Automated residual flux leakage results