Downloaded from SAE International by Univ of Toronto, Tuesday, January 03, 2023

AEROSPACE MATERIAL SPECIFICATION

AMS4907™	REV. M
Issued 1965-09 Revised 2020-08 Superseding AMS4907L	

Titanium Alloy, Sheet, Strip, and Plate
6.0Al - 4.0V, Extra Low Interstitial
Annealed
(Composition similar to UNS R56401)

RATIONALE

AMS4907M results from a Five-Year Review and update of this specification that revises yttrium requirement (Table 1), updates unauthorized exceptions (3.5.1.1, 3.9, 8.6), and allows for lower temperature for notched/unnotched tensile ratio determination (3.5.3).

1. SCOPE

1.1 Form

This specification covers a titanium alloy in the form of sheet, strip, and plate on product 0.008 to 3.000 inches (0.20 to 76.20 mm), inclusive in thickness.

1.2 Application

These products have been used typically for parts requiring a combination of weldability, ductility, and good notch-toughness down to -423 °F (-253 °C), but usage is not limited to such applications.

1.3 Certain processing procedures and service conditions may cause these products to become subject to stress-corrosion cracking; ARP982 recommends practices to minimize such conditions.

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.

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

Copyright © 2020 SAE International

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system or transmitted, in any form or by any means, electronic, mechanical, photocopying, recording, or otherwise, without the prior written permission of SAE.

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/AMS4907M/

Downloaded from SAE International by Univ of Toronto, Tuesday, January 03, 2023

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.

AMS2242	Tolerances, Corrosion and Heat Resistant Steel, Iron Alloy, Titanium, and Titanium Alloy Sheet, Strip, and Plate
AMS2249	Chemical Check Analysis Limits, Titanium and Titanium Alloys
AMS2368	Sampling and Testing of Wrought Titanium Raw Material Except Forgings and Forging Stock
AMS2631	Ultrasonic Inspection, Titanium and Titanium Alloy Bar, Billet and Plate
AMS2750	Pyrometry
AMS2809	Identification, Titanium and Titanium Alloy Wrought Products
ARP982	Minimizing Stress-Corrosion Cracking in Wrought Titanium Alloy Products
ARP1917	Clarification of Terms Used in Aerospace Metals Specifications
AS1814	Terminology for Titanium Microstructures
AS4194	Sheet and Strip Surface Finish Nomenclature
AS6279	Standard Practice for Production, Distribution, and Procurement of Metal Stock

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 A480/A480M	General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip
ASTM E8/E8M	Tension Testing of Metallic Materials
ASTM E290	Bend Testing of Material for Ductility
ASTM E384	Microindentation Hardness of Materials
ASTM E539	Analysis of Titanium Alloys by X-Ray Fluorescence Spectrometry
ASTM E1409	Determination of Oxygen and Nitrogen in Titanium and Titanium Alloys by Inert Gas Fusion
ASTM E1447	Determination of Hydrogen in Titanium and Titanium Alloys by the Inert Gas Fusion Thermal Conductivity/Infrared Detection Method
ASTM E1941	Determination of Carbon in Refractory and Reactive Metals and Their Alloys by Combustion Analysis
ASTM E2371	Analysis of Titanium and Titanium Alloys by Direct Current Plasma and Inductively Coupled Atomic Emission Spectrometry
ASTM E2994	Analysis of Titanium and Titanium Alloys by Spark Atomic Emission Spectrometry and Glow Discharge Atomic Emission Spectrometry

Downloaded from SAE International by Univ of Toronto, Tuesday, January 03, 2023

3. TECHNICAL REQUIREMENTS

3.1 Composition

Shall conform to the percentages by weight shown in Table 1; carbon shall be determined in accordance with ASTM E1941, hydrogen in accordance with ASTM E1447, oxygen and nitrogen in accordance with ASTM E1409, and other elements in accordance with ASTM E539, ASTM E2371, or ASTM E2994. Other analytical methods may be used if acceptable to the purchaser.

Table 1 - Composition

Element	Min	Max	
Aluminum	5.50	6.50	
Vanadium	3.50	4.50	
Iron	--	0.25	
Oxygen	--	0.13	
Carbon	--	0.08	
Nitrogen	--	0.05	(500 ppm)
Hydrogen	--	0.0125	(125 ppm)
Yttrium (3.1.1)	--	0.005	(50 ppm)
Other Elements, each (3.1.1)	--	0.10	
Other Elements, total (3.1.1)	--	0.30	
Titanium	remainder		

3.1.1 Determination not required for routine acceptance.

3.1.2 Check Analysis

Composition variations shall meet the applicable requirements of AMS2249.

3.2 Melting Practice

Alloy shall be multiple melted. The first melt shall be made by vacuum consumable electrode, nonconsumable electrode, electron beam cold hearth, or plasma arc cold hearth melting practice. The subsequent melt or melts shall be made using vacuum arc remelting (VAR) practice. Alloy additions are not permitted in the final melt cycle.

3.2.1 The atmosphere for nonconsumable electrode melting shall be vacuum or shall be argon and/or helium at an absolute pressure not higher than 1000 mm of mercury.

3.2.2 The electrode tip for nonconsumable electrode melting shall be water-cooled copper.

3.3 Condition

The product shall be supplied in the following condition:

3.3.1 Sheet and Strip

Hot rolled with or without subsequent cold reduction, annealed, descaled, and leveled, having a surface appearance comparable to a commercial corrosion-resistant steel No. 2D finish (see 8.2).

3.3.2 Plate

Hot rolled, annealed, descaled, and flattened, having a surface appearance comparable to a No. 1 finish (see 8.2). Plate product shall be produced using standard industry practices designed strictly for the production of plate stock to the procured thickness. Bar, billet, forgings, or forging stock shall not be supplied in lieu of plate.

Downloaded from SAE International by Univ of Toronto, Tuesday, January 03, 2023

3.4 Annealing

The product shall be annealed by heating to a temperature within the range 1300 to 1650 °F (704 to 899 °C), holding at the selected temperature within ±25 °F (±14 °C) for a time commensurate with product thickness and heating equipment and procedure used, and cooling at a rate which will produce product meeting the requirements of 3.5. Pyrometry shall be in accordance with AMS2750.

3.5 Properties

The as produced product shall conform to the following requirements and shall also meet the requirements of 3.5.1 and 3.5.2 after being heated in air to 1325 °F ± 25 °F (720 °C ± 14 °C), held at heat for 20 minutes ± 2 minutes, cooled at a rate equivalent to an air cool or slower, and descaled.

3.5.1 Tensile Properties

Shall be as specified in Table 2 on product 0.008 to 3.000 inches (0.20 to 76.20 mm), inclusive, in nominal thickness, determined in accordance with ASTM E8/E8M with the rate of strain set at 0.005 in/in/min (0.005 mm/mm/min) and maintained within a tolerance of ±0.002 in/in/min (0.002 mm/mm/min) through the 0.2% offset yield strain.

Table 2A - Minimum tensile properties, inch/pound units

Nominal Thickness Inches	Tensile Strength ksi	Yield Strength at 0.2% Offset ksi	Elongation in 2 Inches or 4D %
0.008 to 0.015, excl	130	120.0	6
0.015 to 0.025, excl	130	120.0	8
0.025 to 1.000, excl	130	120.0	10
1.000 to 3.000, incl	125	115.0	10

Table 2B - Minimum tensile properties, SI units

Nominal Thickness Millimeters	Tensile Strength MPa	Yield Strength at 0.2% Offset MPa	Elongation in 50.8 mm or 4D %
0.20 to 0.38, excl	896	827	6
0.38 to 0.64, excl	896	827	8
0.64 to 25.40, excl	896	827	10
25.40 to 76.20, incl	862	793	10

3.5.1.1 Mechanical property requirements for product outside the size range covered by 1.1 shall be agreed upon between purchaser and producer and reported per 4.4.2.

3.5.2 Bending

Product under 0.1875 inch (4.762 mm) in nominal thickness shall have a test sample prepared nominally 0.750 inch (19.06 mm) in width, with its axis of bending parallel to the direction of rolling. The sample shall be bend tested in conformance with the guided bend test defined in ASTM E290 through an angle of 105 degrees. The test fixture supports shall have a contact radius 0.010 inch (0.25 mm) minimum, and the plunger shall have a radius equal to the bend factor shown in Table 3 times the nominal thickness. Examination of the bent sample shall not show evidence of cracking when examined at 15 to 25X magnification.

Table 3 - Bend factor

Nominal Thickness Inches	Nominal Thickness Millimeters	Bend Factor
Up to 0.070, incl	Up to 1.78, incl	4.5
Over 0.070 to 0.1875, excl	Over 1.78 to 4.762, excl	5

Downloaded from SAE International by Univ of Toronto, Tuesday, January 03, 2023

3.5.3 Notched/Unnotched Tensile Ratio

Tensile specimens shown in Figures 1 and 2, tested at -423 °F (-253 °C) or lower, shall have a notched/unnotched tensile ratio of not less than 0.75. Testing shall be performed with the specimen held in liquid hydrogen or other appropriate cooling media for a time commensurate with the size of the specimen necessary to equalize at test temperature ±10 °F (±6 °C) prior to testing.

3.5.4 Microstructure

Shall be that structure resulting from alpha-beta processing. Microstructure shall conform to 3.5.4.1, 3.5.4.2, 3.5.4.3, or 3.5.4.4. A microstructure showing a continuous network of alpha in prior beta grain boundaries is not acceptable.

3.5.4.1 Lamellar alpha with some equiaxed alpha in a transformed beta matrix.

3.5.4.2 Equiaxed alpha in a transformed beta matrix.

3.5.4.3 Equiaxed alpha and elongated alpha in a transformed beta matrix.

3.5.4.4 Partially broken and distorted grain boundary alpha with plate-like alpha.

3.5.5 Surface Contamination

The product shall be free of any oxygen-rich layer, such as alpha case, or other surface contamination, determined as in 3.5.5.1, 3.5.5.2, 3.5.5.3, or other method acceptable to purchaser.

3.5.5.1 The bend test of 3.5.2.

3.5.5.2 Examination of a metallographic cross-section at 400X minimum.

3.5.5.3 Hardness differential; a surface hardness more than 40 points higher than the subsurface hardness, determined in accordance with ASTM E384 on the Knoop scale using a 200 g load, being evidence of unacceptable surface contamination.

3.6 Quality

The product, as received by purchaser, shall be uniform in quality and condition, sound, and free from “oil cans” (see 8.3.1) of depth in excess of the flatness tolerance, ripples, and foreign materials and from imperfections detrimental to usage of the product.

3.6.1 Plate 0.500 inch (12.70 mm) and over in nominal thickness shall meet Class A1 requirements when ultrasonically inspected in accordance with AMS2631.

3.7 Tolerances

Shall be as follows:

3.7.1 Thickness, Width, Length, and Straightness

All applicable requirements of AMS2242.

3.7.2 Flatness

Flatness tolerance for product 36 inches (914 mm) and under in width shall be 5% if nominal thickness is less than 0.025 inch (0.64 mm) and 3% if nominal thickness is 0.025 to 0.1875 inch (0.64 to 4.762 mm), exclusive. Flatness tolerance for product under 0.1875 inch (4.762 mm) in nominal thickness and over 36 inches (914 mm) wide and for product 0.1875 inch (4.762 mm) and over in nominal thickness in all widths shall be agreed upon by purchaser and producer.

Downloaded from SAE International by Univ of Toronto, Tuesday, January 03, 2023

3.7.2.1 Flatness shall be determined from the expression 100H/L, where “H” is the distance from the straight edge to the product at the point of greatest separation and “L” is the distance between contact points of a straight edge laid in any direction on the product.

3.7.2.2 Flatness tolerances do not apply to coiled products.

3.7.2.3 Special flatness may be specified for plate, in which case the special flatness tolerances of AMS2242 apply.

3.8 Production, distribution, and procurement of metal stock shall comply with AS6279.

3.9 Exceptions

Any exceptions shall be authorized by purchaser and reported as in 4.4.2.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for Inspection

The producer of the product shall supply all samples for producer’s tests and shall be responsible for the performance of all required tests. Purchaser reserves the right to sample and to perform any confirmatory testing deemed necessary to ensure that the product conforms to specified requirements.

4.2 Classification of Tests

4.2.1 Acceptance Tests

Composition (3.1), condition (3.3), tensile properties (3.5.1), bending (3.5.2), microstructure (3.5.4), surface contamination (3.5.5), quality (3.6), and tolerances (3.7) are acceptance tests and shall be performed on each heat or lot as applicable.

4.2.1.1 Ultrasonic quality (3.6.1) of each plate, when required.

4.2.2 Periodic Tests

The following requirements are periodic tests and shall be performed at a frequency selected by the producer unless frequency of testing is specified by purchaser:

4.2.2.1 Notch/unnotched tensile ratio (3.5.3) of the product.

4.2.2.2 Tensile (3.5.1) and bending (3.5.2) properties of product after reheating to 1325 °F ± 25 °F (720 °C ± 14 °C).

4.3 Sampling and Testing

Shall be in accordance with AMS2368 and the following; a lot shall be all product of the same nominal size from the same heat processed at the same time:

4.3.1 For Acceptance Tests

4.3.1.1 Composition

One sample from each heat, except that for hydrogen determinations one sample from each lot obtained after thermal and chemical processing is completed.

4.3.1.2 Tensile Property, Bending, Microstructure, and Surface Contamination Requirements

One or more samples from each lot for each requirement.

Downloaded from SAE International by Univ of Toronto, Tuesday, January 03, 2023

4.3.1.2.1 Specimens for tensile and notch-tensile tests from widths 9 inches (229 mm) and over shall be taken with the axis of the specimen perpendicular to the direction of rolling; for widths under 9 inches (229 mm), specimens shall be taken with the axis parallel to the direction of rolling. Specimens from product under 2 inches (50.8 mm) in width shall be agreed upon by purchaser and producer.

4.3.1.2.2 For U-channel bend tests, specimen width shall be not less than ten times the nominal thickness, but not less than 1 inch (25 mm). For free bend tests, minimum specimen width shall, when possible, be not less than ten times the nominal thickness; maximum width need not be greater than 1 inch (25 mm).

4.3.2 For Periodic Tests

As selected by the producer to ensure conformance, unless specified by purchaser.

4.4 Reports

4.4.1 The producer shall furnish with each shipment a report showing producer identity, country where the metal was melted (i.e., final melt in the case of metal processed by multiple melting operations), results of tests for composition of each heat and for the hydrogen content, tensile and bending properties, and surface contamination of each lot, ultrasonic inspection of each plate (when required), and when performed, results of tests to determine conformance to the periodic test requirements and stating that the product conforms to the other technical requirements. This report shall include the purchase order number, heat and lot number, AMS4907M, specific annealing treatment used, product form, size, and quantity.

4.4.2 When material produced to this specification is beyond the sizes allowed in the scope or tables, or other exceptions authorized by purchaser are taken to the technical requirements listed in Section 3 (see 5.1.1), the report shall contain a statement “This material is certified as AMS4907M(EXC) because of the following exceptions:” and the specific exceptions shall be listed.

4.5 Resampling and Retesting

Shall be in accordance with AMS2368.

5. PREPARATION FOR DELIVERY

5.1 Identification

Shall be in accordance with AMS2809. When technical exceptions are taken (see 4.4.2), the material shall be marked with AMS4907M(EXC).

5.2 Packaging

The product shall be prepared for shipment in accordance with commercial practice and in compliance with applicable rules and regulations pertaining to the handling, packaging, and transportation of the product to ensure carrier acceptance and safe delivery.

6. ACKNOWLEDGMENT

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

7. REJECTIONS

Product not conforming to this specification, or to modifications authorized by purchaser, will be subject to rejection.

Downloaded from SAE International by Univ of Toronto, Tuesday, January 03, 2023

8. NOTES

8.1 Revision Indicator

A change bar (I) 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.

8.2 Commercial corrosion-resistant steel finishes are defined in ASTM A480/A480M and AS4194.

8.3 Terms used in AMS are clarified in ARP1917 and defined as follows:

8.3.1 Oil Can

“Oil can” is defined as an excess of material in a localized area of a sheet which causes the sheet to buckle in that area. When the sheet is placed on a flat surface and hand pressure applied to the buckle, the buckle will spring through to the opposite surface or spring up in another area of the sheet.

8.4 Terminology relating to titanium microstructures is presented in AS1814.

8.5 Dimensions and properties in inch/pound units and 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.

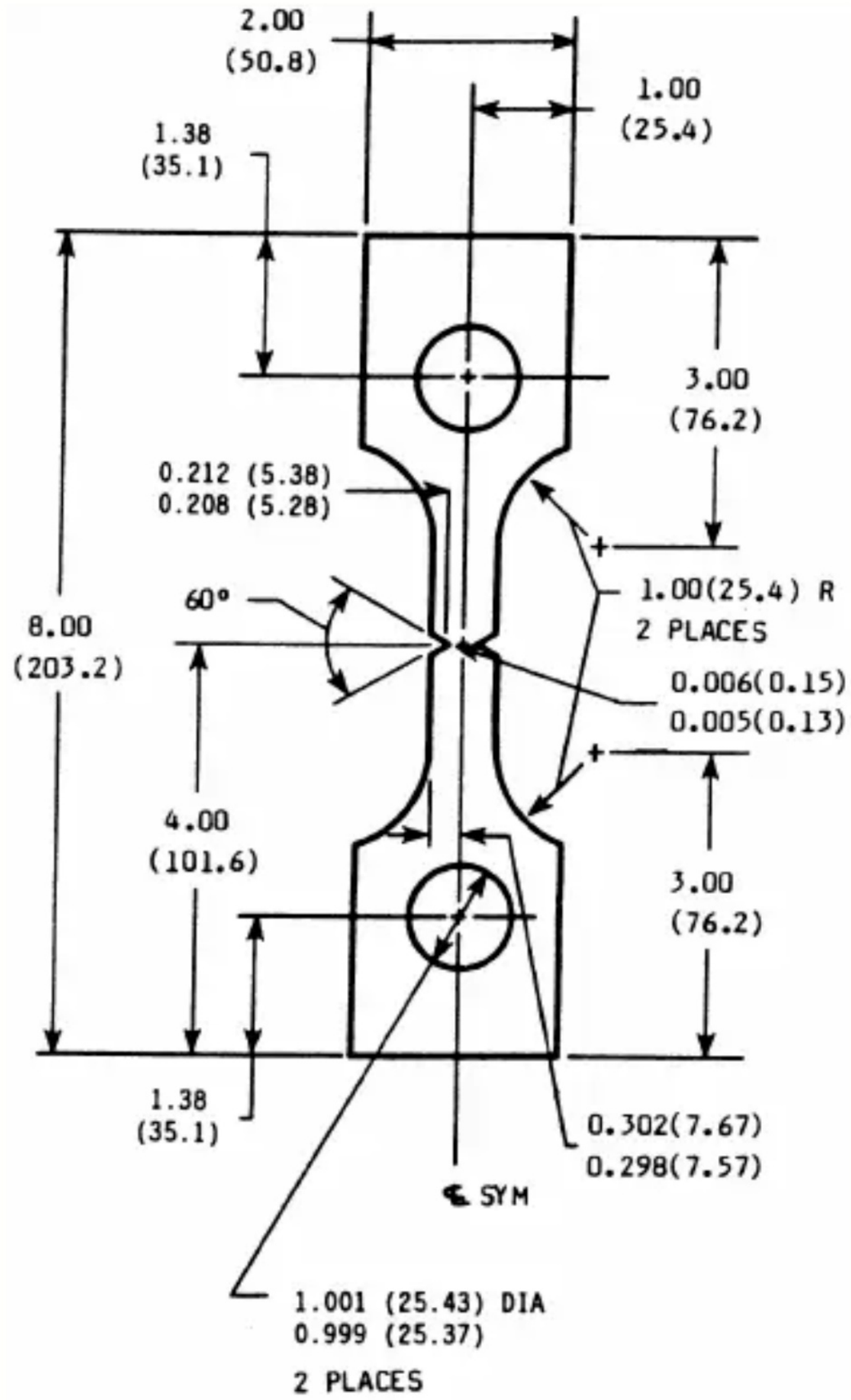
8.6 It is the purchaser’s obligation to ensure that product they procure or resell as AMS4907M has any exceptions approved by their subsequent purchaser.

8.7 Purchase documents should specify not less than the following:

AMS4907M
Product form and size of product desired
Quantity of product desired

8.8 Unless otherwise specified, the material producer shall work to the revision of this specification (AMS4907) in effect on the date of order placement. Unless otherwise specified, material manufactured and certified to the immediately previous revision of this specification (AMS4907) may be procured and used until inventory is depleted.

Downloaded from SAE International by Univ of Toronto, Tuesday, January 03, 2023



Notes:

1. ALL DIMENSIONS IN INCHES (MILLIMETERS)

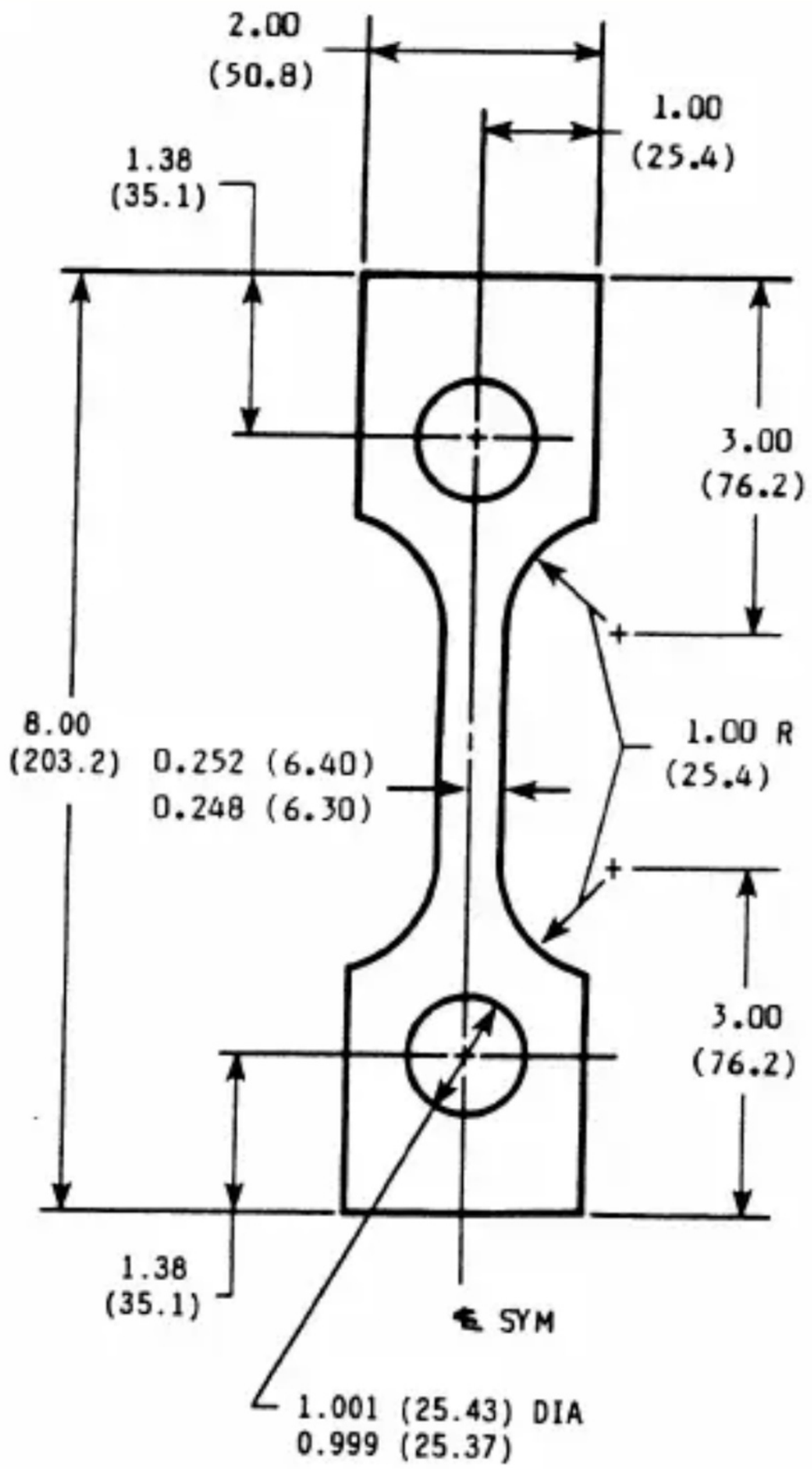
2. TOLERANCES: DIMENSIONS ±0.01 (±0.3) UNLESS NOTED

3. ANGLES: ±0° 15'

Notched kt ≈ 6.3

Figure 1 - Notched tensile specimen

Downloaded from SAE International by Univ of Toronto, Tuesday, January 03, 2023



Notes:

1. ALL DIMENSIONS IN INCHES (MILLIMETERS)

2. TOLERANCES: DIMENSIONS