How to Write Digital-Ready Standards

Leslie McKay, Director of Digital Product Development
SAE International

MISSION: *To advance mobility knowledge and solutions for the* ***benefit of humanity***

NEUTRAL FORUMS

Address society's mobility needs

RESOURCES

Engineering resources to advance mobility

EDUCATION

STEM programs and professional courses, building the workforce

COMMUNITY

Global community pulling from each other's collective wisdom

STANDARDS

Consensus-based standards that advance quality, safety and innovation

ROLES IN INDUSTRY: Professional Association, SDO, Publisher, STEM Educator, Professional Workforce Development, Knowledge & Networking Resource

SAE Community – Aerospace and Ground Vehicle

105+
Years

44,000+
Standards

11,000+
Participants

59+
Countries

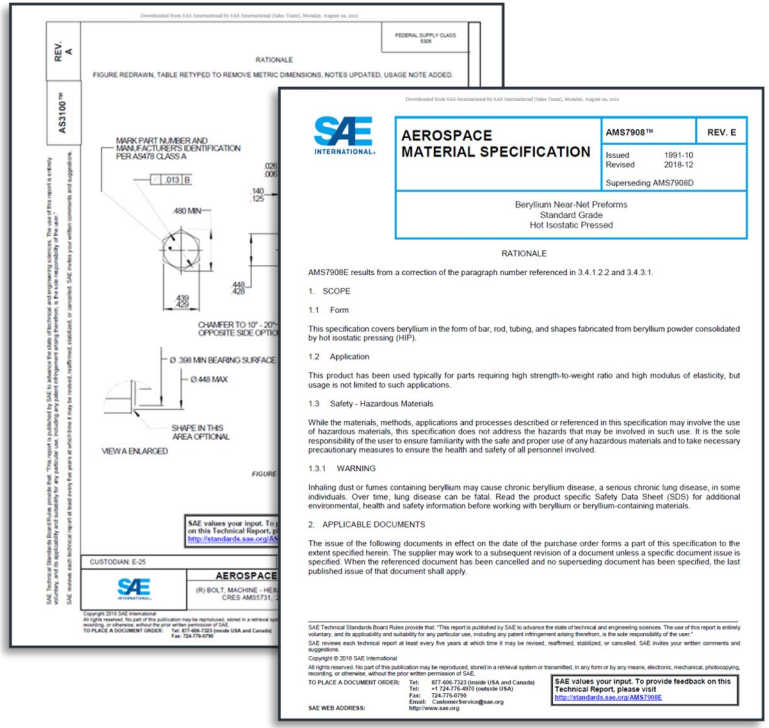
1,800+
Works in Progress

570+
Technical Committees

550+
Committees & steering groups

Rethinking How You Write Standards

- Going digital is changing how standards are written
- A document does not always translate well to a database of digital standards
- Sentence structure, table layouts, and variable naming can all be impacted
- Need to consider how digital standards are searched and retrieved—not how a document is read



REV. A

AS3100™

RATIONALE

FIGURE REDRAWN, TABLE RETYPED TO REMOVE METRIC DIMENSIONS, NOTES UPDATED, USAGE NOTE ADDED.

FEDERAL SUPPLY CLASS 5306

MARK PART NUMBER AND MANUFACTURER'S IDENTIFICATION PER AS478 CLASS A

.013 B

.480 MIN

.439 .429

.448 .428

CHAMFER TO .10" - .20" OPPOSITE SIDE OPTIO

Ø .398 MIN BEARING SURFACE

Ø .448 MAX

SHAPE IN THIS AREA OPTIONAL

VIEW A ENLARGED

FIGURE

SAE values your input. To p... on this Technical Report, p... http://standards.sae.org/AS...

CUSTODIAN: E-25

AEROSPACE

(R) BOLT, MACHINE - HEX... CRES AMS5731, ...

SAE INTERNATIONAL

AEROSPACE MATERIAL SPECIFICATION

AMS7908™ REV. E

Issued 1991-10
Revised 2018-12

Superseding AMS7908D

Beryllium Near-Net Preforms
Standard Grade
Hot Isostatic Pressed

RATIONALE

AMS7908E results from a correction of the paragraph number referenced in 3.4.1.2.2 and 3.4.3.1.

1. SCOPE

1.1 Form

This specification covers beryllium in the form of bar, rod, tubing, and shapes fabricated from beryllium powder consolidated by hot isostatic pressing (HIP).

1.2 Application

This product has been used typically for parts requiring high strength-to-weight ratio and high modulus of elasticity, but usage is not limited to such applications.

1.3 Safety - Hazardous Materials

While the materials, methods, applications and processes described or referenced in this specification may involve the use of hazardous materials, this specification does not address the hazards that may be involved in such use. It is the sole responsibility of the user to ensure familiarity with the safe and proper use of any hazardous materials and to take necessary precautionary measures to ensure the health and safety of all personnel involved.

1.3.1 WARNING

Inhaling dust or fumes containing beryllium may cause chronic beryllium disease, a serious chronic lung disease, in some individuals. Over time, lung disease can be fatal. Read the product specific Safety Data Sheet (SDS) for additional environmental, health and safety information before working with beryllium or beryllium-containing materials.

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.

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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.

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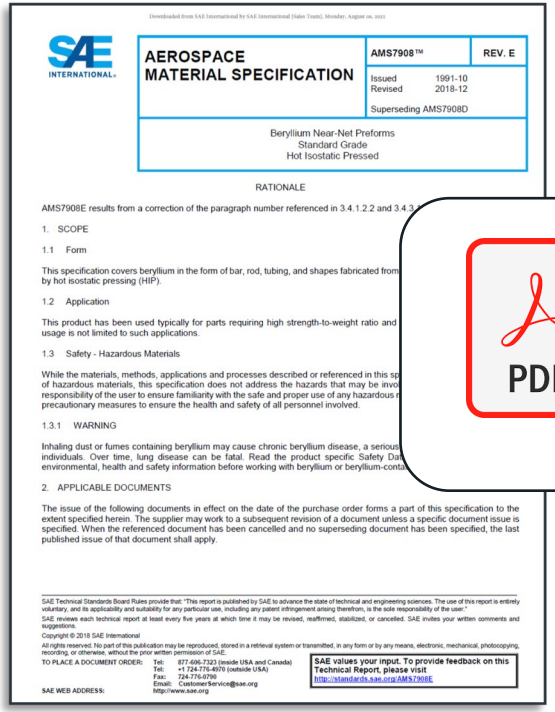
Digital-Ready Standards



AEROSPACE MATERIAL SPECIFICATION

AMS7908™ REV. E

Issued 1991-10
Revised 2018-12

Superseding AMS7908D

Beryllium Near-Net Preforms
Standard Grade
Hot Isostatic Pressed

RATIONALE

AMS7908E results from a correction of the paragraph number referenced in 3.4.1.2.2 and 3.4.3.1.

1. SCOPE

1.1 Form

This specification covers beryllium in the form of bar, rod, tubing, and shapes fabricated from
by hot isostatic pressing (HIP).

1.2 Application

This product has been used typically for parts requiring high strength-to-weight ratio and
usage is not limited to such applications.

1.3 Safety - Hazardous Materials

While the materials, methods, applications and processes described or referenced in this sp
of hazardous materials, this specification does not address the hazards that may be invo
responsibility of the user to ensure familiarity with the safe and proper use of any hazardous
precautionary measures to ensure the health and safety of all personnel involved.

1.3.1 WARNING

Inhaling dust or fumes containing beryllium may cause chronic beryllium disease, a serious
individuals. Over time, lung disease can be fatal. Read the product specific Safety Dat
environmental, health and safety information before working with beryllium or beryllium-conta

2. APPLICABLE DOCUMENTS

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SAE reviews each technical report at least every five years at which time it may be revised, reaffirmed, stabilized, or canceled. SAE invites your written comments and suggestions.

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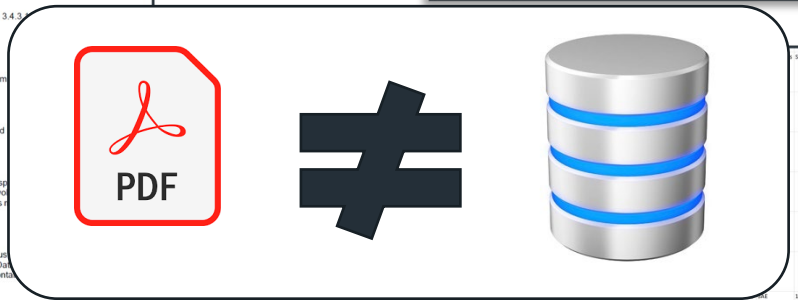
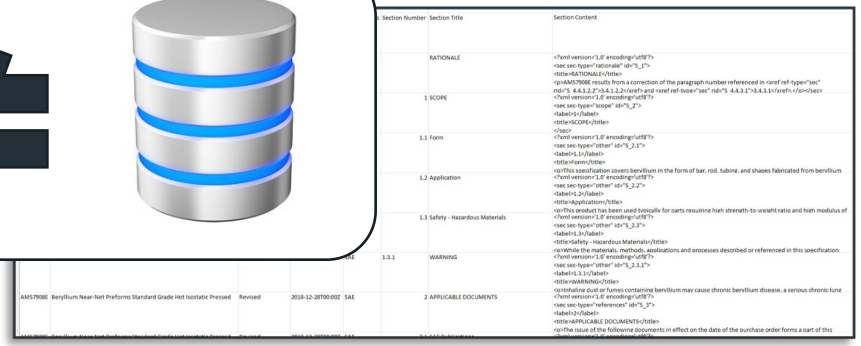


Standard	Title	Group Name	Element	Value (max)	Value (min)
AMS7908E	Beryllium Near-Net Preforms Standard Grade Hot Isostatic Pressed	T1 - Composition	Beryllium Oxide	1.5	
AMS7908E	Beryllium Near-Net Preforms Standard Grade Hot Isostatic Pressed	T1 - Composition	Carbon	0.15	
AMS7908E	Beryllium Near-Net Preforms Standard Grade Hot Isostatic Pressed	T1 - Composition	Iron	0.13	
AMS7908E	Beryllium Near-Net Preforms Standard Grade Hot Isostatic Pressed	T1 - Composition	Aluminum	0.1	
AMS7908E	Beryllium Near-Net Preforms Standard Grade Hot Isostatic Pressed	T1 - Composition	Magnesium	0.08	
AMS7908E	Beryllium Near-Net Preforms Standard Grade Hot Isostatic Pressed	T1 - Composition	Silicon	0.06	
AMS7908E	Beryllium Near-Net Preforms Standard Grade Hot Isostatic Pressed	T1 - Composition	Other Elements, each	0.04	
AMS7908E	Beryllium Near-Net Preforms Standard Grade Hot Isostatic Pressed	T1 - Composition	Beryllium		98.5



Primary Differences When Writing a Document vs. a Digital Standard

- Digital standards need to be searchable, across all unique separate values
  - Dimensions
  - Properties
  - Elemental composition
  - Etc.
- Inconsistency increases AI Model complexity, the need for manual review, and the need for external support tools, i.e., mapping tables

How to Think of Standards Differently
What We've Learned So Far

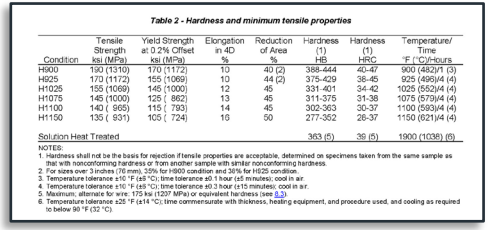


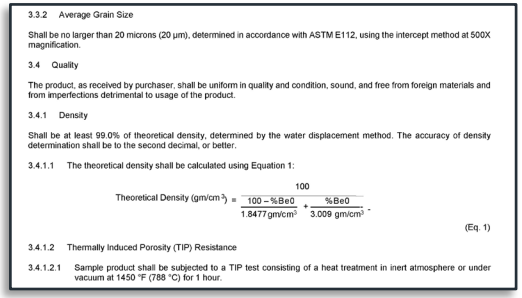
Table 2 - Hardness and minimum tensile properties

Condition	Tensile Strength ksi (MPa)	Yield Strength at 0.2% Offset ksi (MPa)	Elongation in 4D %	Reduction of Area %	Hardness (1) HB	Hardness (1) HRC	Temperature/ Time °F (°C)/Hours
H900	190 (1310)	170 (1172)	10	40 (2)	388-444	40-47	900 (482)/1 (3)
H925	170 (1172)	155 (1069)	10	44 (2)	375-429	38-45	925 (496)/4 (4)
H1025	155 (1069)	145 (1000)	12	45	331-401	34-42	1025 (552)/4 (4)
H1075	145 (1000)	125 (862)	13	45	311-375	31-38	1075 (579)/4 (4)
H1100	140 (965)	115 (793)	14	45	302-363	30-37	1100 (593)/4 (4)
H1150	135 (931)	105 (724)	16	50	277-352	26-37	1150 (621)/4 (4)
Solution Heat Treated					363 (5)	39 (5)	1900 (1038) (6)

NOTES:
1. Hardness shall not be the basis for rejection if tensile properties are acceptable, determined on specimens taken from the same sample as that with nonconforming hardness or from another sample with similar nonconforming hardness.
2. For sizes over 3 inches (76 mm), 33% for H900 condition and 36% for H925 condition.
3. Temperature tolerance ±10 °F (±5 °C); time tolerance ±0.1 hour (±5 minutes); cool in air.
4. Temperature tolerance ±10 °F (±5 °C); time tolerance ±0.3 hour (±15 minutes); cool in air.
5. Maximum; alternate for wire: 175 ksi (1207 MPa) or equivalent hardness (see 8.3).
6. Temperature tolerance ±25 °F (±14 °C); time commensurate with thickness, heating equipment, and procedure used, and cooling as required to below 90 °F (32 °C).

Table Structure

- How to best show properties in tables
- See good (and not-so-good) tables



3.3.2 Average Grain Size

Shall be no larger than 20 microns (20 µm), determined in accordance with ASTM E112, using the intercept method at 500X magnification.

3.4 Quality

The product, as received by purchaser, shall be uniform in quality and condition, sound, and free from foreign materials and from imperfections detrimental to usage of the product.

3.4.1 Density

Shall be at least 99.0% of theoretical density, determined by the water displacement method. The accuracy of density determination shall be to the second decimal, or better.

3.4.1.1 The theoretical density shall be calculated using Equation 1:

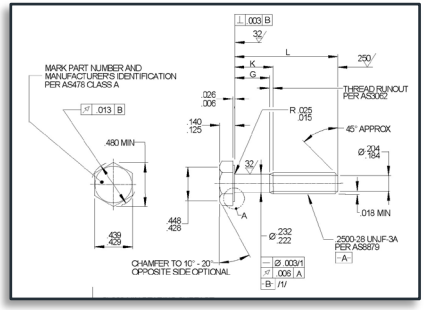
$$\text{Theoretical Density (gm/cm}^3\text{)} = \frac{100}{\frac{100 - \%Be0}{1.8477\ \text{gm/cm}^3} + \frac{\%Be0}{3.009\ \text{gm/cm}^3}} \quad \text{(Eq. 1)}$$

3.4.1.2 Thermally Induced Porosity (TIP) Resistance

3.4.1.2.1 Sample product shall be subjected to a TIP test consisting of a heat treatment in inert atmosphere or under vacuum at 1450 °F (788 °C) for 1 hour.

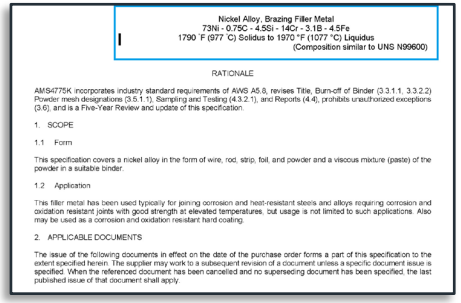
Content

- Property naming
- Value ranges
- Units
- Number formats



Drawings and Variables

- Dimensions
- Data
- Variable names
- Units
- Number formats



Nickel Alloy, Brazing Filler Metal
73Ni - 0.75C - 4.5Si - 14Cr - 3.1B - 4.5Fe
1790 °F (977 °C) Solidus to 1970 °F (1077 °C) Liquidus
(Composition similar to UNS N99600)

RATIONALE

AMS4775K incorporates industry standard requirements of AWS A5.8, revises Title, Burn-off of Binder (3.3.1.1, 3.3.2.2) Powder mesh designations (3.5.1.1), Sampling and Testing (4.3.2.1), and Reports (4.4), prohibits unauthorized exceptions (3.6), and is a Five-Year Review and update of this specification.

1. SCOPE

1.1 Form

This specification covers a nickel alloy in the form of wire, rod, strip, foil, and powder and a viscous mixture (paste) of the powder in a suitable binder.

1.2 Application

This filler metal has been used typically for joining corrosion and heat-resistant steels and alloys requiring corrosion and oxidation resistant joints with good strength at elevated temperatures, but usage is not limited to such applications. Also may be used as a corrosion and oxidation resistant hard coating.

2. APPLICABLE DOCUMENTS

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Document Structure

- Sentence structure
- Composition

Table Structure

Organizing Primary Data Elements in Tables

Table 5 - Minimum tensile properties

Property	Tangential	Axial
Tensile Strength	55.0 ksi (379 MPa)	55.0 ksi (379 MPa)
Yield Strength at 0.2% Offset	41.0 ksi (283 MPa)	41.0 ksi (283 MPa)
Elongation in 4D	6%	5%
in 5D	5%	4%

Table 5 Minimum Tensile Properties

Axis	Tensile Strength	Yield Strength at 0.2% Offset	Elongation in 4D	Elongation in 5D
Tangential	55.0 ksi (379 MPa)	41.0 ksi (283 MPa)	6%	5%
Axial	55.0 ksi (379 MPa)	41.0 ksi (283 MPa)	5%	4%

OR

Table 5a Minimum Tensile Properties Tangential

Property	Value
Tensile Strength	55.0 ksi (379 MPa)
Yield Strength at 0.2% Offset	41.0 ksi (283 MPa)
Elongation in 4D	6%
Elongation in 5D	5%

Table 5b Minimum Tensile Properties Axial

Property	Value
Tensile Strength	55.0 ksi (379 MPa)
Yield Strength at 0.2% Offset	41.0 ksi (283 MPa)
Elongation in 4D	5%
Elongation in 5D	4%

Avoid Combining Multiple Primary Data Elements in One Column

Table 3 - Maximum hardness requirement

Nominal Thickness Inch	Nominal Thickness Millimeters	Hardness
Up to 0.040, incl	Up to 1.02, incl	75 HR15N
Over 0.040 to 0.070, incl	Over 1.02 to 1.78, incl	64 HRA
Over 0.070 to 0.1874, incl	Over 1.78 to 4.760, incl	30 HRC

Table 3 Minimum Hardness Requirements

Nominal Thickness Inch	Nominal Thickness Millimeters	Hardness HR15N	Hardness HRA	Hardness HRC
Up to 0.040, incl	Up to 1.02, incl	75	N/A	N/A
Over 0.040 to 0.070, incl	Over 1.02 to 1.78, incl	N/A	64	N/A
Over 0.070 to 0.1874, incl	Over 1.78 to 4.760, incl	N/A	N/A	30

Reporting Primary Data Elements with Different Table Dimensions

TABLE 2 - TENSILE PROPERTIES

Property			Value
Yield Strength			
Center Stress, +15%			36.0 ksi
Working Range			10.5 ksi
Elongation, min			
Nominal Diameter Inch		Nominal Diameter Millimeter	
0.012 to 0.020, incl		0.30 to 0.50, incl	15%
0.025 to 0.040, incl		0.62 to 1.00, incl	20%

Table 2a Yield Strength

Property	Value
Yield Strength Center Stress, +15%	36.0 ksi
Yield Strength Working Range	10.5 ksi

Table 2b Elongation

Nominal Diameter Inch	Nominal Diameter Millimeter	Elongation, min
0.012 to 0.020, incl	0.30 to 0.50, incl	15%
0.025 to 0.040, incl	0.62 to 1.00, incl	20%

Simplify Tables, Even if that Requires Splitting into Multiple Tables

TABLE I. Chemical requirements (heat analysis) percent by weight

Type	Carbon	Manganese	Silicon	Phosphorus	Sulfur
				Maximum	Maximum
I, II	0.55 to 0.85	0.60 to 1.20 1/	0.10 to 0.35	0.040	0.050
II	.45 to .85 2/	.60 to 1.30 3/	.10 to .30	.040	.050
III	.55 to .85	.60 to 1.20	.10 to .35	.040	.050

1/ Manganese shall be between 0.80 and 1.20 percent for diameters 0.192 inch and larger, and it shall be between 0.60 and 0.90 percent for sizes smaller than 0.192 inch. Unless otherwise specified (see 6.2), choice of composition shall be at the manufacturer's option.

2/ Not varying more than 0.13 percent in any one lot.

3/ Not varying more than 0.30 percent in any one lot.

Table Ia Chemical Requirements (Heat Analysis) Percent by Weight for Type I, II

Element	Min	Max
Carbon	0.55	0.85
Manganese	0.60	1.20[1]
Silicon	0.10	0.35
Phosphorus	--	0.040
Sulfur	--	0.050

1 Manganese...

Table Ib Chemical Requirements (Heat Analysis) Percent by Weight for Type II

Element	Min	Max
Carbon	0.45	0.85[1]
Manganese	0.60	1.30[2]
Silicon	0.10	0.30
Phosphorus	--	0.040
Sulfur	--	0.050

1 Not varying more than 0.13% in any one lot.
2 Not varying more than 0.30 in any one lot.

Table Ic Chemical Requirements (Heat Analysis) Percent by Weight for Type III

Element	Min	Max
Carbon	0.55	0.85
Manganese	0.60	1.20
Silicon	0.10	0.30
Phosphorus	--	0.040
Sulfur	--	0.050

Explicitly Identify Null Cells in Tables

Table 1 - Composition core (2219)

Element	Min	Max
Silicon	--	0.20
Iron	--	0.30
Copper	[illegible]	6.8
Manganese	0.20	0.40
Magnesium	--	0.02
Zinc	--	0.10
Titanium	0.02	0.10
Vanadium	0.05	0.15
Zirconium	0.10	0.25
Other Elements, each	--	0.05
Other Elements, total	--	0.15
Aluminum	remainder	

- Use a unique way to identify null cells in tables
- Blank cells may “mean” the value equals the cell above it

Good Table Examples

TABLE 5B - Minimum Tensile Properties, SI Units

Nominal Thickness at Time of Heat Treatment Millimeters	Specimen Orientation	Tensile Strength MPa	Yield Strength at 0.2% Offset MPa	Elongation in 4D %
50 to 75, incl	Longitudinal	490	420	9
	Long Trans.	490	405	4
	Short Trans.	475	400	3
Over 75 to 100, incl	Longitudinal	475	405	8
	Long Trans.	475	395	3
	Short Trans.	460	385	2
Over 100 to 125, incl	Longitudinal	460	385	7
	Long Trans.	460	385	3
	Short Trans.	455	380	2

Table 1 - Composition core (2219)

Element	Min	Max
Silicon	--	0.20
Iron	--	0.30
Copper	5.8	6.8
Manganese	0.20	0.40
Magnesium	--	0.02
Zinc	--	0.10
Titanium	0.02	0.10
Vanadium	0.05	0.15
Zirconium	0.10	0.25
Other Elements, each	--	0.05
Other Elements, total	--	0.15
Aluminum	remainder	

TABLE 2 - Minimum Tensile Properties

Property	Value
Tensile Strength	72 ksi (495 MPa)
Yield Strength at 0.2% Offset	62 ksi (425 MPa)
Elongation in 4D	7%

Table 4 - Bending parameters

Nominal Thickness Inch	Nominal Thickness Millimeters	Bend Factor
0.020	0.51	8
Over 0.020 to 0.249, incl	Over 0.51 to 6.32, incl	12
Over 0.249 to 0.499, incl.	Over 6.32 to 12.67, incl.	16

TABLE 4A - Minimum Tensile Properties, Inch/Pound Units

Nominal Thickness at Time of Heat Treatment Inches	Tensile Strength ksi	Yield Strength at 0.2% Offset ksi	Elongation in 4D %
Up to 1, incl	71	61	3
Over 1 to 3, incl	70	60	3
Over 3 to 4, incl	70	60	2
Over 4 to 5, incl	68	58	2

TABLE 4B - Minimum Tensile Properties, SI Units

Nominal Thickness at Time of Heat Treatment Millimeters	Tensile Strength MPa	Yield Strength at 0.2% Offset MPa	Elongation in 4D %
Up to 1, incl	490	420	3
Over 1 to 3, incl	485	415	3
Over 3 to 4, incl	485	415	2
Over 4 to 5, incl	470	400	2

Table 2 - Composition, cladding (7072)

Element	Min	Max
Silicon & Iron	--	0.7
Copper	--	0.10
Manganese	--	0.10
Magnesium	--	0.10
Zinc	0.8	1.3
Other Elements, each	--	0.05
Other Elements, total	--	0.15
Aluminum	remainder	

Example of Challenging Table

Table 2 - Hardness and minimum tensile properties

Condition	Tensile Strength ksi (MPa)	Yield Strength at 0.2% Offset ksi (MPa)	Elongation in 4D %	Reduction of Area %	Hardness (1) HB	Hardness (1) HRC	Temperature/ Time °F (°C)/Hours
H900	190 (1310)	170 (1172)	10	40 (2)	388-444	40-47	900 (482)/1 (3)
H925	170 (1172)	155 (1069)	10	44 (2)	375-429	38-45	925 (496)/4 (4)
H1025	155 (1069)	145 (1000)	12	45	331-401	34-42	1025 (552)/4 (4)
H1075	145 (1000)	125 (862)	13	45	311-375	31-38	1075 (579)/4 (4)
H1100	140 (965)	115 (793)	14	45	302-363	30-37	1100 (593)/4 (4)
H1150	135 (931)	105 (724)	16	50	277-352	28-37	1150 (621)/4 (4)
Solution Heat Treated					363 (5)	39 (5)	1900 (1038) (6)

NOTES:
1. Hardness shall not be the basis for rejection if tensile properties are acceptable, determined on specimens taken from the same sample as that with nonconforming hardness or from another sample with similar nonconforming hardness.
2. For sizes over 3 inches (76 mm), 35% for H900 condition and 38% for H925 condition.
3. Temperature tolerance ±10 °F (±6 °C); time tolerance ±0.1 hour (±5 minutes); cool in air.
4. Temperature tolerance ±10 °F (±6 °C); time tolerance ±0.3 hour (±15 minutes); cool in air.
5. Maximum; alternate for wire: 175 ksi (1207 MPa) or equivalent hardness (see 8.3).
6. Temperature tolerance ±25 °F (±14 °C); time commensurate with thickness, heating equipment, and procedure used, and cooling as required to below 90 °F (32 °C).

- Data ranges shown in a single cell
- Notes in same format as different units
- Multiple values in some cells (Temp/Time)
- Solution Heat Treated Row is unclear

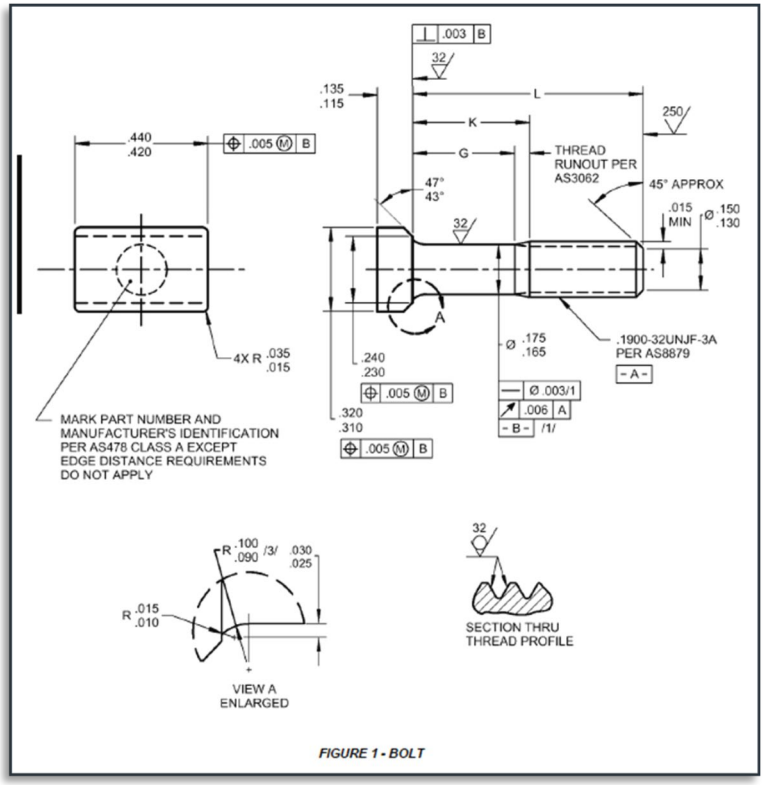
Takeaways

- Keep tables simple—strive to have one data element per cell
- Think about how you are organizing data in rows and columns
- Simplifying and better organizing tables may require some data to be repeated
- It may be best to split more complex tables into two or more

Drawing and Variables

Using Consistent Variable Names for Dimensions

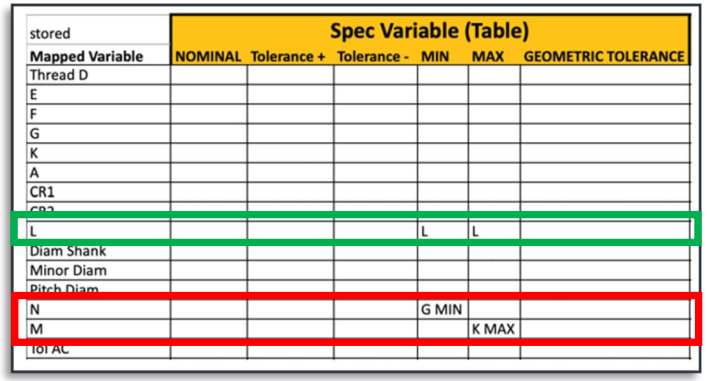
- Digital standards must be searchable in different ways than PDFs
- Users who want to find a standard part may want to search by various dimensions to find the right size
  - Any dimension that a user wants to search must have a variable name (preferably a consistent one!)
- If standard variables are not used, manual mapping tables need to be created and managed



Working Towards Consistent Variables

- Where possible, work to make variables consistent across a common Type and Subtype
- In addition, work to make variables consistent from standard to standard

Type	Subtype	Variables
Nut	Self-locking, Spline Drive	D B Nominal Size K Max …
Nut	Plain Hexagon, Drilled and Undrilled	AF K R …
Nut	Castellated Hexagon	E Min D Nominal Thread Size AF …



stored	Spec Variable (Table)					
Mapped Variable	NOMINAL	Tolerance +	Tolerance -	MIN	MAX	GEOMETRIC TOLERANCE
Thread D						
E						
F						
G						
K						
A						
CR1						
CR2						
L				L	L	
Diam Shank						
Minor Diam						
Pitch Diam						
N				G MIN		
M					K MAX	
Tol AC						

Data Stored Outside of Standards

- Some data, such has fixed dimensions of parts, are sometimes stored in separate document
- When the standard itself does not include the relevant data, it can complicate the digitization process.
- Some values do not have a variable name (e.g., common for fixed values)

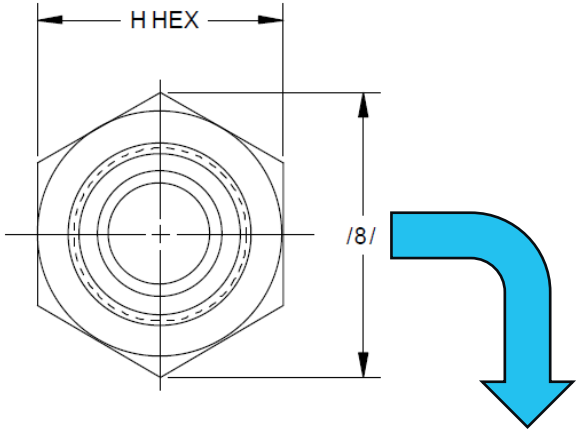
What does this mean?

- Increases amount of manual extraction
- Requires manual variable naming
- Increases need for manually managed mapping tables
- Reduces value of drawing itself when fixed measurements are not identified

Display all relevant variables/measurements in drawings or in tables in the standard

stored	Spec Numerical Fixed Size						
Mapped Variable	NOMINAL	Tolerance +	Tolerance -	MIN	MAX	GEOMETRIC TOLERANCE	Units
Thread D	.1900-32 UNJF-3A						in
E				.420	.440		in
F				.310	.320		in
G				.230	.240		in
K				.115	.135		in
A				.025	.030		in
CR1				.010	.015		in
CR2				.090	.100		in
L							in
Diam Shank				.165	.175		in
Minor Diam				.130	.150		in
Pitch Diam				.015			in
N							in
M							in
Tol AC						.005	in
Tol AD						.003	in
Tol AG						.005	in

Non-Dimensional Information in Drawings



/8/ THE HEX CORNERS MAY BE ROUNDED PER ARP1942.

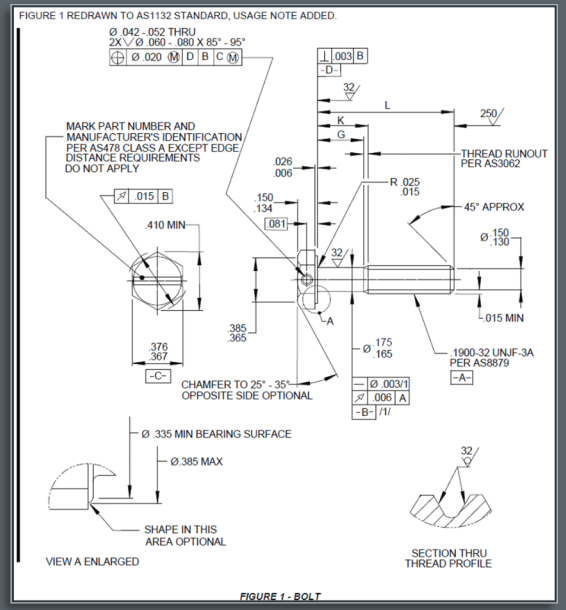
- /8/ looks like dimension, but this is actually a note
- Relevant metadata often buried in list of notes for parts standards
- Best practice is to identify types of information in notes, rather than a random list

Takeaways

- Use standard variables within a Type and Subtype of a part to reduce manual management and support cross-standard searching
- Where possible, have all relevant data in a standard and avoid separate documents
- Clearly identify the different types of information in the Notes section

Content

Properties, Elements, Units and Such



3.4.3.2.1 Individual Indications

Shall not exceed 0.050 inch (1.27 mm) in major dimension.

Dimension	Millimeters	Tolerance, Millimeters plus	Tolerance, Millimeters minus
Diameter, Width, or Thickness	Up to 76, incl	0.41	0.00
Diameter, Width, or Thickness	Over 76 to 508, incl	1.57	0.00
Diameter, Width, or Thickness	Over 508	6.35	0.00
Length	Up to 508, incl	3.18	0.00
Length	Over 508	6.35	0.00

Naming of Properties, Elements, Units and Such

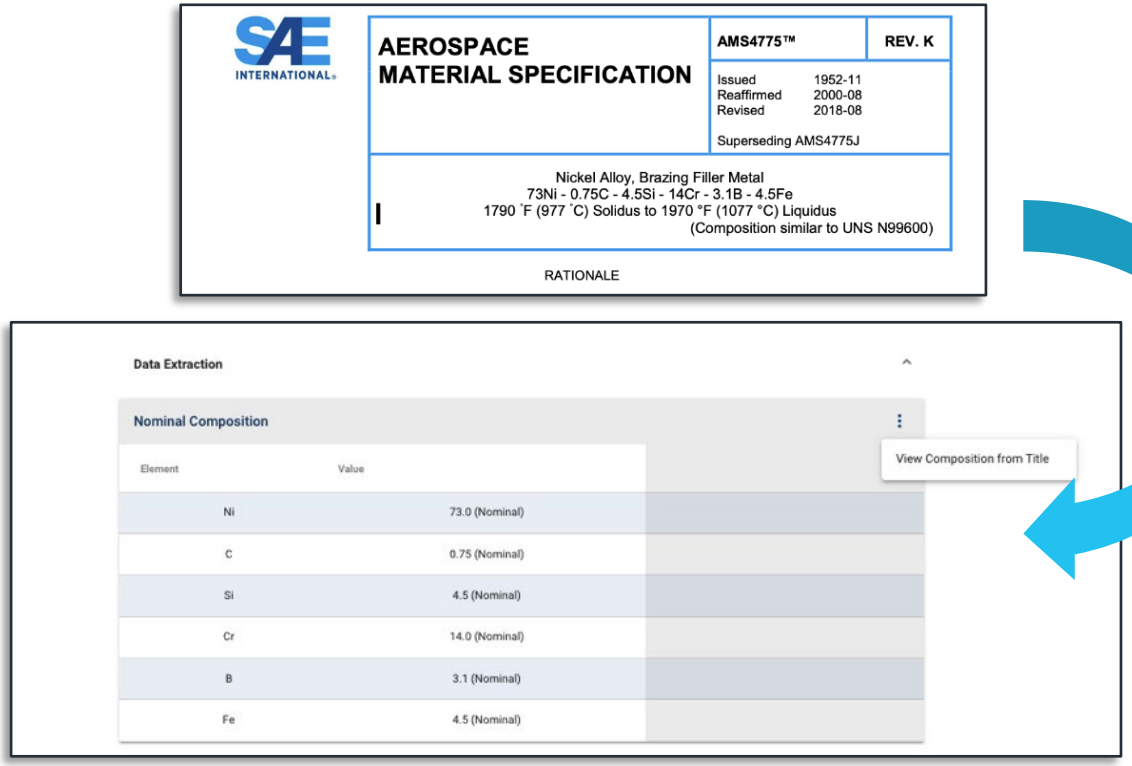
- It is important to understand that users will search for digital standards based on various properties or elements
- Naming properties consistently will help work toward more standard naming conventions.
- When inconsistent names are used, you must use a mapping table to enforce consistency:

property_key	property_name	doc_alias
arborDiameter	Arbor Diameter	arbor diameter millimeters
arborDiameter	Arbor Diameter	arbor diameter

element_name	element_key	doc_alias
Actinium (Ac)	actinium	actinium
Actinium (Ac)	actinium	ac
Aluminum (Al)	aluminum	aluminum
Aluminum (Al)	aluminum	al

- Inconsistency results in a lot of manual extraction/review from drawings and document text.

Composition



- Composition breakdown is critical information in materials specifications
- Be sure to include a Composition table for materials, even if Composition is specified in the Standard Title
- Having the model create this table adds complexity

Data Ranges

Model trained so value is included, if not otherwise specified
- Value is >= 0.018 and <= 0.050

TABLE 3 - BENDING FACTOR

Nominal Thickness Inch	Nominal Thickness Millimeters	Bend Factor
0.018 to 0.050	0.46 to 1.27, incl	1
0.051 to 0.250	1.28 to 6.35, incl	2

Model trained so that "and over" means >= and "Under" means <
- Value is >= 0.1875
- Value is < 0.006

TABLE 2A - TENSILE PROPERTIES, INCH/POUND UNITS

Nominal Thickness Inches	Tensile Strength ksi, max	Yield Strength at 0.2% Offset ksi, max	Elongation in 2 Inches or 4D %, min
Up to 0.1875, excl	130	80.0	30
0.1875 and over	140	90.0	30

Table 3 - Tensile properties

Nominal Thickness Inch	Tensile Strength ksi, Max	Yield Strength at 0.2% Offset ksi, Max	Elongation in 2 Inches %, Min
Under 0.006	150	85	Report
0.006 to 0.015, incl	150	85	25

Model trained so that ", incl" or ", excl" specify whether the range includes the number or not

Table 3 - Maximum hardness requirement

Nominal Thickness Inch	Nominal Thickness Millimeters	Hardness
Up to 0.040, incl	Up to 1.02, incl	75 HR15N
Over 0.040 to 0.070, incl	Over 1.02 to 1.78, incl	64 HRA
Over 0.070 to 0.1874, incl	Over 1.78 to 4.760, incl	30 HRC

TABLE 2A - TENSILE PROPERTIES, INCH/POUND UNITS

Nominal Thickness Inches	Tensile Strength ksi, max	Yield Strength at 0.2% Offset ksi, max	Elongation in 2 Inches or 4D %, min
Up to 0.1875, excl	130	80.0	30
0.1875 and over	140	90.0	30

Regardless of method used, it is best to be consistent so models do not have to account for multiple variations.

Units

Tensile Strength, min	180,000 psi (1240 MPa)
Yield Strength at 0.2% Offset, min	150,000 psi (1035 MPa)
Elongation in 4D, min	6%
Reduction of Area, min	15%

Nominal Thickness Inch	Tensile Strength ksi, max	Yield Strength at 0.2% Offset ksi, max
Under 0.006	180	150
0.006 to 0.015, incl	180	150

Table 3 - Precipitation hardening conditions

Condition	Temperature	Time
H900	900 °F ± 10 °F (482 °C ± 6 °C)	60 minutes ± 5 minutes
H925	925 °F ± 10 °F (496 °C ± 6 °C)	4 hours ± 0.25 hour
H1025	1025 °F ± 10 °F (552 °C ± 6 °C)	4 hours ± 0.25 hour
H1075	1075 °F ± 10 °F (579 °C ± 6 °C)	4 hours ± 0.25 hour
H1100	1100 °F ± 10 °F (593 °C ± 6 °C)	4 hours ± 0.25 hour
H1150	1150 °F ± 10 °F (621 °C ± 6 °C)	4 hours ± 0.25 hour

When digitized, users will be searching for data based on properties.

Consistent units reduce model complexity with conversions:

- psi vs. ksi
- Minutes vs. hours
- Determine whether it is best to standardize with smaller or larger units

Units and Number Format Internationalization

- Establish a convention for measurements and keep it consistent across standards

4. DIMENSIONS AND TOLERANCES, EXCEPT FOR THREADS, ARE IN MILLIMETRES, INCH CONVERSIONS ARE IN PARENTHESES. ALL DIMENSIONS APPLY AFTER COATING UNLESS OTHERWISE SPECIFIED.

- Enforce consistency in number formats (always use “,” or decimal)

Remainders and Formulas in Tables

- Users cannot search on “remainder”
- Users cannot search on “10xC”
- Best to have numeric value for all elements when possible
- Models can calculate this, but it adds unnecessary complexity and manual oversight
- Also, consider decimal precision—keep consistent where possible

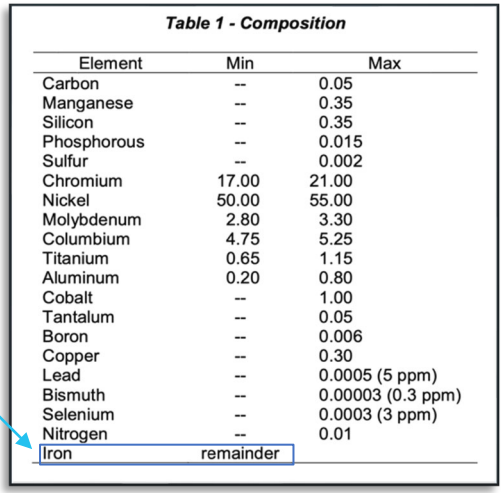


Table 1 - Composition

Element	Min	Max
Carbon	--	0.05
Manganese	--	0.35
Silicon	--	0.35
Phosphorous	--	0.015
Sulfur	--	0.002
Chromium	17.00	21.00
Nickel	50.00	55.00
Molybdenum	2.80	3.30
Columbium	4.75	5.25
Titanium	0.65	1.15
Aluminum	0.20	0.80
Cobalt	--	1.00
Tantalum	--	0.05
Boron	--	0.006
Copper	--	0.30
Lead	--	0.0005 (5 ppm)
Bismuth	--	0.00003 (0.3 ppm)
Selenium	--	0.0003 (3 ppm)
Nitrogen	--	0.01
Iron	remainder	

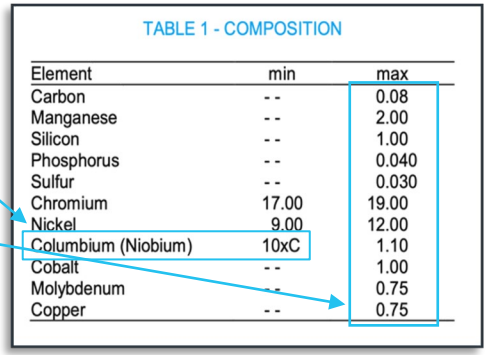


TABLE 1 - COMPOSITION

Element	min	max
Carbon	- -	0.08
Manganese	- -	2.00
Silicon	- -	1.00
Phosphorus	- -	0.040
Sulfur	- -	0.030
Chromium	17.00	19.00
Nickel	9.00	12.00
Columbium (Niobium)	10xC	1.10
Cobalt	- -	1.00
Molybdenum	- -	0.75
Copper	- -	0.75

Fractions vs. Decimals

- Use decimals over fractions, where possible
- Avoid scientific notations
- Different number formats, just like inconsistent units, adds unnecessary complexity to model and increases manual extraction/review

Table 4 - Tubing sizes for 1.3 minimum contractile strain ratio

Nominal OD Inch	Nominal OD Millimeters	Maximum Wall Thickness Inch	Maximum Wall Thickness Millimeters
3/16	4.8	0.020	0.51
1/4	6.4	0.022	0.56
3/8	9.5	0.032	0.81
1/2	12.7	0.043	1.09
5/8	15.9	0.054	1.37
3/4	19.0	0.065	1.65
7/8	22.2	0.077	1.96
1	25.4	0.088	2.24

Table 5 - Tubing sizes for 1.5 minimum contractile strain ratio

Nominal OD Inch	Nominal OD Millimeters	Maximum Wall Thickness Inch	Maximum Wall Thickness Millimeters
1-1/4	31.8	0.087	2.21
1-1/2	38.1	0.090	2.29

Takeaways

- Consistency, consistency, consistency
  - Simpler models
  - Less manual extraction
  - Less manual verification
  - Less management of mapping tables
  - More thorough search functionality
- Include composition tables for all material specifications
- Avoid requiring model to calculate values (e.g., remainder)
- Avoid using fractions or scientific notations

Properties

Elements

Units

Number Formats

Data Ranges

Decimal Precision

Document Structure

Sentence Structure

3.3.3.1 Tensile Properties in the T62 Temper

Shall be as shown in Table 4.

3.4.2.1 Radiographic indications (voids or inclusions) shall conform to the following requirements:

3.4.2.1.1 Maximum Dimension of Any Indication

Any dimension of any indication, measured in the plane of the radiograph, shall not exceed 0.050 inch (1.27 mm).

3.4.2.1.2 Maximum Average Dimension of Any Indication

The average dimension of any indication shall be the arithmetic average of the maximum and minimum dimensions, measured in the plane of the radiograph, and shall not exceed 0.030 inch (0.76 mm).

3.3.3.1 Tensile Properties

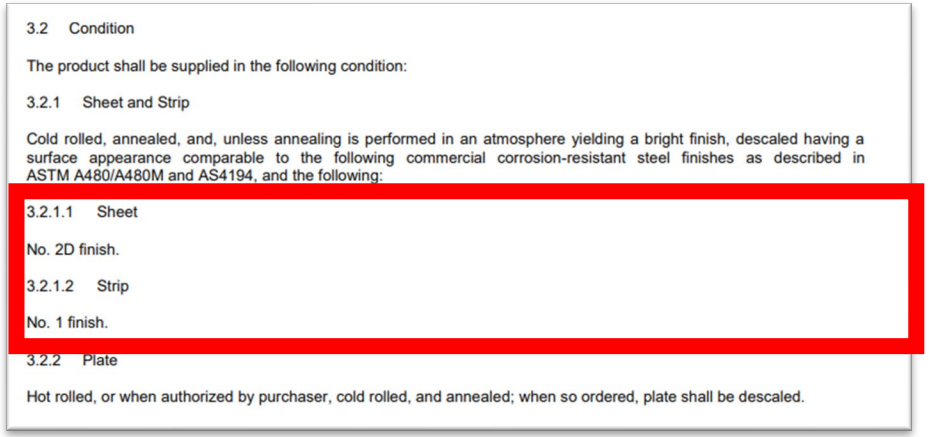
Tensile properties in the T62 Temper shall be as shown in Table 4.

3.4.2.1 Radiographic Indications (voids or inclusions)

Any dimension of any indication, measured in the plane of the radiograph, shall not exceed 0.050 inch (1.27 mm).

The average dimension of any indication shall be the arithmetic average of the maximum and minimum dimensions measured in the plane of the radiograph, and shall not exceed 0.030 inch (0.76 mm).

Example: Corrosion Heat-Resistant Alloy



3.2 Condition

The product shall be supplied in the following condition:

3.2.1 Sheet and Strip

Cold rolled, annealed, and, unless annealing is performed in an atmosphere yielding a bright finish, descaled having a surface appearance comparable to the following commercial corrosion-resistant steel finishes as described in ASTM A480/A480M and AS4194, and the following:

3.2.1.1 Sheet

No. 2D finish.

3.2.1.2 Strip

No. 1 finish.

3.2.2 Plate

Hot rolled, or when authorized by purchaser, cold rolled, and annealed; when so ordered, plate shall be descaled.

The product shall be supplied in the following condition:

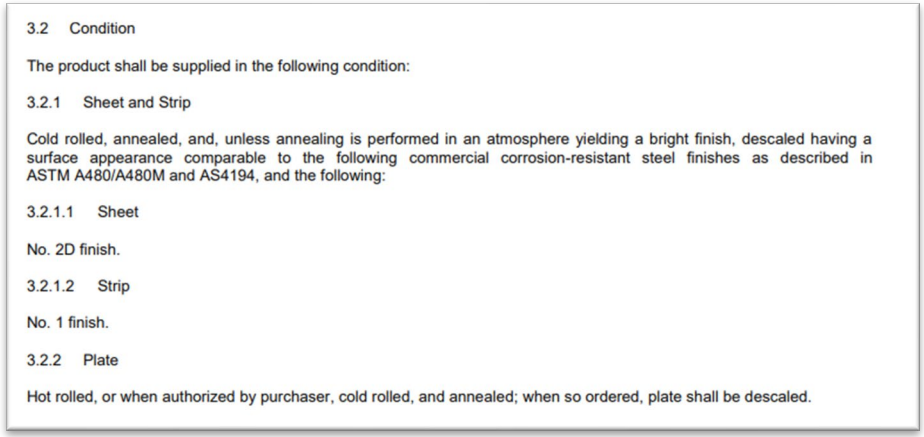
Cold rolled, annealed, and, unless annealing is performed in an atmosphere yielding a bright finish, descaled having a surface appearance comparable to the following commercial corrosion-resistant steel finishes as described in ASTM A480/A480M and AS4194, and the following:

Hot rolled, or when authorized by purchaser, cold rolled, and annealed; when so ordered, plate shall be descaled.

Incomplete requirements

Missing requirements

Complete Sentences Directly Impacts Machine-Readability



3.2 Condition

The product shall be supplied in the following condition:

3.2.1 Sheet and Strip

Cold rolled, annealed, and, unless annealing is performed in an atmosphere yielding a bright finish, descaled having a surface appearance comparable to the following commercial corrosion-resistant steel finishes as described in ASTM A480/A480M and AS4194, and the following:

3.2.1.1 Sheet

No. 2D finish.

3.2.1.2 Strip

No. 1 finish.

3.2.2 Plate

Hot rolled, or when authorized by purchaser, cold rolled, and annealed; when so ordered, plate shall be descaled.

Requirements for Sheet
Requirements for Strip
Requirements for Plate

The product shall be supplied in:
- Sheet
- Strip
- Plate

Sheet and Strip shall be Cold rolled, annealed, and, unless annealing is performed in an atmosphere yielding a bright finish, descaled having a surface appearance comparable to the following commercial corrosion-resistant steel finishes as described in ASTM A480/A480M and AS4194, and the following:

Sheet shall be No. 2 D Finish

Strip shall be No. 1 Finish

Plate shall be hot rolled, or when authorized by purchaser, cold rolled, and annealed; when so ordered, plate shall be descaled.

Table/Figure References

3.3.2 Hardness: Shall be as follows, or equivalent:

Nominal Diameter or Distance Between Parallel Sides		
Inches	Millimetres	Hardness, Brinell
Up to 1.000, incl	Up to 25.40, incl	255 - 331
Over 1.000 to 1.063, incl	Over 25.40 to 27.00, incl	248 - 331

3.3.2 Hardness

Hardness shall be as specified in Table 1.

Table 1 Nominal Diameter or Distance Between Parallel Sides

Inches	Millimetres	Hardness, Brinell
Up to 1.000, incl	Up to 25.40, incl	255 - 331
Over 1.000 to 1.063, incl	Over 25.40 to 27.00, incl	248 - 331

Part Number Logic

- Some standards have a standard logic used to generate part numbers
- Requires readers and the model to refer to tables and notes to built a part number
- **Recommendations:**
  - Refer to a common type of reference (e.g., a table) to build part number
  - Specify the part number logic for each standard in the document (e.g., beginning of notes section)
  - Ensure that standards can effectively grouped or classified by their part number logic
  - Logic can be built into the model to generate the appropriate part numbers

PART NUMBER BREAKDOWN

AS70001	4	16	L	H	Y
Basic Pt No.	Diameter Code (Table-1)	Grip Code (Table-3 & -4)	Finish Code (6)	Specific Code (Table-5)	Oversize Code (Table-6)

Example of Standard Bolt AS70001-8-20LH

Example of Oversize Bolt AS70001-20-30LHY

6. Protective Finish :

Code **L**	Aluminium Coat per EN 4473 Type II & Non-enduring Cetyl Alcohol Lubricant per SAE AS87132 or prEN 6117.
Code **M**	IVD Coat per EN 6118 & Non-enduring Cetyl Alcohol Lubricant per SAE AS87132 or prEN 6117.
Code **N**	Passivate per AMS2700 Method 1, Type 8 & Dry Film Lubricant without graphite as per SAE AS1701 Class 6.
Code **P**	Passivate per AMS2700 Method 1, Type 8 & & Non-enduring Cetyl Alcohol Lubricant per SAE AS87132 or prEN 6117.

Note 6 could easily be a table

Takeaways

Use complete sentences

- All relevant information in sentence, even if that requires repeating text in a section title
- Remember that each paragraph will be treated as a separate entity

Do not embed requirements in section titles

- Requirements should be in discrete paragraphs

Use explicit table or figure references (e.g., Table 1, Figure 5)

For cases where part numbers are built from a common reference

- Refer to a common type of reference (e.g., a table) to build part number
- Specify the part number logic for each standard in the document (e.g., beginning of notes section)
- Ensure that standards can effectively grouped or classified by their part number logic so that model can auto-generate part numbers

Summary

Summary

Stop thinking about standards as documents and more like they are a database

- The standard needs to stand on its own
- The components need to stand on their own

Digital standards need to be searchable, across standards

Consistency = Simpler AI models
Simpler AI models = Less manual extraction/review and fewer support tools = LESS COST

Some options to enforce consistency:

- Central templates or style guides
- Central editorial review
- Checking software

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Questions?