

भारत सरकार  
अंतरिक्ष विभाग (अं.वि.)  
द्रव नोदन प्रणाली केंद्र  
वलियमला, तिरुवनंतपुरम  
695547, केरला

GOVERNMENT OF INDIA  
DEPARTMENT OF SPACE (DOS)  
LIQUID PROPULSION SYSTEMS CENTRE  
VALIAMALA  
THIRUVANANTHAPURAM, 695547, KERALA

फोन नं Ph No, 0471-2567 726/813/317/319 / Fax 091-0472-2800712,0471-2567305 / ईमेल e-mail: head\_ps@lpsc.v.dos.gov.in

निविदा आमंत्रण  
INVITATION TO TENDER

मैसर्स  
M/s

000000

हमारी संदर्भ सं  
Our Ref. No.

TM07 2023-038447-01

निविदा अंतिम तिथि  
Tender Due at

14:00 hrs IST on 30/04/2024

महोदय

Dear Sirs,

कृपया निम्नलिखित मदों की आपूर्ति के लिए अनुलग्नक (फार्म सं. संलग्न ) में उल्लिखित निबंधन एवं शर्तों के अनुसार संलग्न निविदा प्रपत्र में वर्णनात्मक सूचीपत्र/पैम्फलेट/साहित्य सहित हमारी संदर्भ सं. एवं अंतिम तिथि (मोटे अक्षरों में) उपर लिखते हुए अपनी मुहरबंद निविदा प्रस्तुत करें।

Please submit your sealed quotation, in the Tender Form enclosed here along with the descriptive catalogues /pamphlets /literature, superscribed with Our Ref.No. and Due Date for the supply of the following items as per the terms & conditions mentioned in Annexure(Form No. DOSPM - FORM 22 )

क्र.सं. Sl. No.	विनिर्देशों सहित मद का विवरण Description of items with Specifications	इकाई Unit	मात्रा Quantity
1	Supply of seamless drawn AA 2219 T0 tubes: OD 32mm x WI 1mm x 3000-5000mm	Kg	170
2	Supply of seamless drawn AA 2219 T0 tubes: OD 48mm x WT 1mm x 3000-5000mm	Kg	130
3	Supply of seamless drawn AA 2219 T0 tubes: OD 45mm x WT 1.5mm x 3000-5000mm	Kg	180
4	Supply of seamless drawn AA 2219 T0 tubes: OD 135mm x WT 2.5mm x 3000-5000mm	Kg	600
5	Supply of seamless drawn AA 6061 T6 tubes: OD 60mm x WT 4mm x 4800mm	Kg	130
6	Supply of seamless drawn AA 6061 T6 tubes: OD 66mm x WT 3mm x 5000mm	Kg	400
7	Supply of seamless drawn AA 6061 T6 tubes: OD 166mm x WT 3mm x 3000mm	Kg	1040

सुपुर्दगी स्थल

Delivery At

LPSC VALIAMALA

प्रेषण की विधि

Mode of Despatch

BY AIR

शुल्क छूट

Duty Exemptions

ELIGIBLE FOR CUSTOMS DUTY CONCESSION

विशेष अनुदेश

Special Instructions

NIL

विशेष निबंधन

Specilic Terms

DOSPM - FORM 22

निविदाकारों को अनुदेश

Instructions to Tenderers

- (1) Technical Terms and Conditions as per Annexure 1, Specifications as per Annexure 2,3 & 4
- (2) Instructions to Two Part tender as per Annexure 5, General terms and Conditions as per Annexure 6
- (3) Compliance Statement as per Annexure 7, That shall be duly filled and sent along with the offer, without which your offer will not be considered.

*For and on behalf of the  
President of India  
The Purchaser.*

**Technical terms & conditions for AA2219 T0 tubes**

- Supply of aluminum alloy AA2219 T0 seamless tube shall meet the requirements as per **ASTM B 221M**.
- Supply condition: Tubes shall be supplied in seamless, extruded & drawn and annealed condition. Heat treatment/Annealing of the tubes shall be performed as per **AMS2772**.
- The supplier shall furnish the original mill test certificate for the tubes, failing which the material will not be accepted.
- Quantity tolerance is +/-10% of order quantity.
- Dimensional tolerance shall be as per ANSI H 35.2/ ANSI H 35.2M
- Hydrogen content at melt stage shall be measured and best efforts shall be made to achieve  $\leq 0.2\text{ml}/100\text{ gm}$  of metal.
- Inside & outside surface finish of tubing shall be conforming to best practice for high quality aircraft tubing.
- Non-destructive test: Each tube shall be 100% eddy current tested as per ASTM E 215.
- Tensile testing shall be carried out in longitudinal direction of the tubes as per ASTM B557M standard. Minimum three samples shall be tested per heat per heat treatment batch per size. For tubes supplied in O condition tensile properties shall be guaranteed in T0 AND T62 conditions.
- Original Mill Test certificate for the tubes shall be submitted prior to dispatch for our verification and acceptance. Test certificate shall include, Dimensional inspection, chemical composition, Mechanical Properties, Heat treatment & Eddy Current reports. The tubes shall be dispatched only after approval from LPSC.
- Lot: Each category of tube must be supplied from same lot of particular heat, having subjected to the same heat treatment condition.
- Marking: Material designation, heat number, supply condition & size shall be marked on tubes as per ASTM B 666 before dispatch.
- Packing: Tubing shall be prepared for shipment in accordance with ASTM B660 and in compliance with applicable rules and regulations pertaining to the handling, packaging, and transportation of the tubing to ensure carrier acceptance and safe delivery.
- The mill certificates shall be duly attested by TPI agencies like Bureau Veritas / Lloyds etc. Third party inspection charges to separately quoted by party.

**Technical terms & conditions for AA6061 T6 tubes**

- Aluminium alloys AA6061 seamless tube in T6 condition shall be supplied as per latest edition of **AMS 4082** and other requirement as detailed below.
- Supply condition: AA6061 seamless extruded & drawn tubes and heat treated to T6 condition.
- The supplier shall furnish the original mill test certificate for the tubes, failing which the material will not be accepted.
- Quantity tolerance is +/-10% of order quantity.
- Dimensional tolerance shall be as per ANSI H 35.2/ ANSI H 35.2M.
- Hydrogen content at melt stage shall be measured and best efforts shall be made to achieve  $\leq 0.2\text{ml}/100\text{ gm}$  of metal.
- Inside & outside surface finish of tubing shall be conforming to best practice for high quality aircraft tubing.
- Non destructive test: Each tube shall be 100% eddy current tested as per ASTM E215.
- Tensile testing shall be carried out in longitudinal direction of tube following the ASTM B557M standard. Minimum 3 samples shall be tested per heat treatment batch per size.
- Original Mill Test certificate for the tubes shall be submitted prior to dispatch for over verification and acceptance. Test certificate shall include Dimensional inspection, chemical composition, Mechanical properties, Heat treatment & Eddy Current report. The tubes shall be dispatched only after approval from LPSC.

- Lot: Each category of tubes must be supplied from same lot of particular heat, having subjected to the same heat treatment condition.
- Marking: Material designation, heat number, supply conditions & size shall be marked on tubes as per ASTM B 666 before dispatch.
- Packing: Tubing shall be prepared for shipment in accordance with ASTM B660 and in compliance with applicable rules and regulations pertaining to the handling, packaging, and transportation of the tubing to the tubing to ensure carrier acceptance and safe delivery.
- The mill certificates shall be dully attested by TPI agencies like Bureau Veritas / Lloyds etc. Third party inspection charges to be separately quoted by party.

*S. M. S. S.*  
*25/3*

संध्या आर एस / SANDHYA R S  
क्रय व भंडार अधिकारी / PURCHASE & STORES OFFICER  
द्रव नोदन प्रणाली केंद्र  
LIQUID PROPULSION SYSTEMS CENTRE  
इसरो, भारत सरकार, अंतरिक्ष विभाग  
ISRO, GOVT. OF INDIA, DEPT. OF SPACE  
वलियमला, तिरुवनंतपुरम  
VALIAMALA, THIRUVANANTHAPURAM-685 547



## 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](http://www.astm.org).

ASTM B 660 Packaging/Packing of Aluminum and Magnesium Products  
 ASTM B 666/B 666M Identification Marking of Aluminum Products

## 2.3 ANSI Publications

Available from American National Standards Institute, 25 West 43rd Street, New York, NY 10036, Tel: 212-642-4900, [www.ansi.org](http://www.ansi.org).

ANSI H35.2 Dimensional Tolerances for Aluminum Mill Products  
 ANSI H35.2M Dimensional Tolerances for Aluminum Mill Products (Metric)

## 3. TECHNICAL REQUIREMENTS

### 3.1 Composition

Shall conform to the percentages by weight shown in Table 1, determined in accordance with AMS2355.

TABLE 1 - COMPOSITION

Element	min	max
Silicon	0.40	0.8
Iron	--	0.7
Copper	0.15	0.40
Manganese	--	0.15
Magnesium	0.8	1.2
Chromium	0.04	0.35
Zinc	--	0.25
Titanium	--	0.15
Other Elements, each	--	0.05
Other Elements, total	--	0.15
Aluminum	remainder	

### 3.2 Condition

Solution and precipitation heat treated in accordance with AMS2772.

3.2.1 Tubing shall be supplied unground with an as-drawn surface finish, unless otherwise specified by purchaser.

### 3.3 Properties

Tubing shall conform to the following requirements, determined on the mill produced size in accordance with AMS2355:

#### 3.3.1 Tensile Properties

Shall be as shown in Table 2.

TABLE 2A - MINIMUM TENSILE PROPERTIES, INCH/POUND UNITS

Nominal Wall Thickness Inch	Tensile Strength ksi	Yield Strength at 0.2% Offset ksi	Elongation in 2 Inches or 4D % Cut Out Specimen	Elongation in 2 Inches or 4D % Full Section Specimen
0.025 to 0.049, incl	42.0	35.0	8	10
Over 0.049 to 0.259, incl	42.0	35.0	10	12
Over 0.259 to 0.500, incl	42.0	35.0	12	14

TABLE 2B - MINIMUM TENSILE PROPERTIES, SI UNITS

Nominal Wall Thickness Millimeters	Tensile Strength MPa, min	Yield Strength at 0.2% Offset MPa, min	Elongation in 50.8 mm or 4D % Cut Out Specimen	Elongation in 50.8 mm or 4D % Full Section Specimen
0.64 to 1.24, incl	290	241	8	10
Over 1.24 to 6.58, incl	290	241	10	12
Over 6.58 to 12.70, incl	290	241	12	14

### 3.4 Quality

Tubing, 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 tubing.

3.4.1 Detrimental imperfections include, but are not limited to, cracks, splits, seams, inclusions, or severe crosshatching (surface breaks) that cannot be removed by light hand sanding using 180 grit or finer sandpaper.

### 3.5 Tolerances

Shall conform to all applicable requirements of ANSI H35.2 or ANSI H 35.2M.

## 4. QUALITY ASSURANCE PROVISIONS

### 4.1 Responsibility for Inspection

The vendor of tubing shall supply all samples for vendor'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 tubing conforms to specified requirements.

### 4.2 Classification of Tests

All technical requirements are acceptance tests and, except for composition, shall be performed on each lot.

### 4.3 Sampling and Testing

Shall be in accordance with AMS2355.

#### 4.4 Reports

The vendor of tubing shall furnish with each shipment a report stating that the tubing conforms to the composition and tolerances (and NDT inspection, when required); and showing the numerical results of tests on each inspection lot to determine conformance to the other acceptance test requirements and periodic test requirements when performed. This report shall include the purchase order number, inspection lot number(s), AMS4082P, size, and quantity. The report shall also identify the producer, the product form, and the size of the mill product.

#### 4.5 Resampling and Retesting

Shall be in accordance with AMS2355.

### 5. PREPARATION FOR DELIVERY

#### 5.1 Identification

Shall be in accordance with ASTM B 666/B 666M.

#### 5.2 Packaging

5.2.1 When specified, tubing shall be coated, prior to shipment, with a light corrosion-inhibiting oil.

5.2.2 Tubing shall be prepared for shipment in accordance with ASTM B 660, Commercial Practice, and in compliance with applicable rules and regulations pertaining to the handling, packaging, and transportation of the tubing to ensure carrier acceptance and safe delivery.

### 6. ACKNOWLEDGMENT

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

### 7. REJECTIONS

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

### 8. NOTES

8.1 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 specification. An (R) symbol to the left of the document title indicates a complete revision of the specification, including technical revisions. Change bars and (R) are not used in original publications, nor in specifications that contain editorial changes only.

8.2 Terms used in AMS are clarified in ARP1917.

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

8.4 Purchase documents should specify not less than the following:

AMS4082P

Size of tubing required

Quantity of tubing required.

8.5 Federal WWT700/6, Temper T6, is listed for information only and shall not be construed as an acceptable alternate unless all requirements of this AMS are met.



Designation: B 241/B 241M – 02

Used in USNRC-RDT standards

## Standard Specification for Aluminum and Aluminum-Alloy Seamless Pipe and Seamless Extruded Tube<sup>1</sup>

This standard is issued under the fixed designation B 241/B 241M; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reappraisal. A superscript epsilon ( $\epsilon$ ) indicates an editorial change since the last revision or reappraisal.

*This standard has been approved for use by agencies of the Department of Defense.*

### 1. Scope \*

1.1 This specification<sup>2</sup> covers aluminum and aluminum-alloy seamless pipe in the alloys (Note 1) and tempers shown in Table 1 [Table 2] and extruded round seamless tube in the alloys and tempers shown in Table 3 [Table 4] intended for pressure applications. The standard sizes for seamless pipe are listed in Table 16.7 of ANSI H35.2 and H35.2M. Nonstandard alloys, tempers, and sizes of pipe are produced as seamless extruded tube.

Note 1—Throughout this specification, use of the term *alloy*, in the general sense, includes aluminum as well as aluminum alloy.

Note 2—For other seamless drawn tubes, see Specification B 210 or Specification B 483. For extruded tube see Specification B 221, and for structural pipe and tube see Specification B 429.

1.2 Alloy and temper designations are in accordance with ANSI H35.1 and H35.1M. The equivalent Unified Numbering System alloy designations are those of Table 5 preceded by A9, for example, A91100 for aluminum 1100 in accordance with Practice E 527.

1.3 For acceptance criteria for inclusion of new aluminum and aluminum alloys in this specification, see Annex A2.

1.4 The values stated in either inch-pound or SI units are to be regarded separately as standard. The SI units are shown either in brackets or in separate tables. The values stated in each system are not exact equivalents; therefore, each system must be used independently of the other. Combining values from the two systems will result in nonconformance with this specification.

### 2. Referenced Documents

2.1 The following documents of the issue in effect on date of material purchase form a part of this specification to the extent referenced herein:

#### 2.2 ASTM Standards:

- B 210 Specification for Aluminum and Aluminum-Alloy Drawn Seamless Tubes<sup>3</sup>
- B 221 Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes<sup>3</sup>
- B 429 Specification for Aluminum-Alloy Extruded Structural Pipe and Tube<sup>3</sup>
- B 483 Specification for Aluminum and Aluminum-Alloy Drawn Tubes for General Purpose Applications<sup>3</sup>
- B 557 Test Methods of Tension Testing Wrought and Cast Aluminum- and Magnesium-Alloy Products<sup>3</sup>
- B 557M Test Methods of Tension Testing Wrought and Cast Aluminum- and Magnesium-Alloy Products [Metric]<sup>3</sup>
- B 594 Practice for Ultrasonic Inspection of Aluminum-Alloy Wrought Products for Aerospace Applications<sup>3</sup>
- B 647 Test Method for Indentation Hardness of Aluminum Alloys by Means of a Webster Hardness Gage<sup>3</sup>
- B 648 Test Method for Indentation Hardness of Aluminum Alloys by Means of a Barcol Impressor<sup>3</sup>
- B 660 Practices for Packaging/Packing of Aluminum and Magnesium Products<sup>3</sup>
- B 666/B 666M Practice for Identification Marking of Aluminum and Magnesium Products<sup>3</sup>
- B 807 Practice for Extrusion Press Solution Heat Treatment of Aluminum Alloys<sup>3</sup>
- B 918 Practice for Heat Treatment of Wrought Aluminum Alloys<sup>3</sup>
- E 18 Test Methods for Rockwell Hardness and Rockwell Superficial Hardness of Metallic Materials<sup>4</sup>
- E 29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications<sup>5</sup>
- E 34 Test Methods for Chemical Analysis of Aluminum and Aluminum-Base Alloys<sup>6</sup>
- E 55 Practice for Sampling Wrought Nonferrous Metals and Alloys for Determination of Chemical Composition<sup>6</sup>
- E 227 Test Method for Optical Emission Spectrometric Analysis of Aluminum and Aluminum Alloys by the Point-to-Plane Technique<sup>6</sup>

<sup>1</sup> This specification is under the jurisdiction of ASTM Committee B07 on Light Metals and Alloys and is the direct responsibility of Subcommittee B07.03 on Aluminum Alloy Wrought Products.

Current edition approved Oct. 10, 2002. Published January 2003. Originally approved in 1949. Last previous edition approved in 2000 as B 241/B 241M-00.

<sup>2</sup> For ASME Boiler and Pressure Vessel Code applications see related Specification SB-241/SB-241M in Section II of that Code.

<sup>3</sup> Annual Book of ASTM Standards, Vol 02.02.

<sup>4</sup> Annual Book of ASTM Standards, Vol 03.01.

<sup>5</sup> Annual Book of ASTM Standards, Vol 14.02.

<sup>6</sup> Annual Book of ASTM Standards, Vol 03.05.

\*A Summary of Changes section appears at the end of this standard.



 B 241/B 241M – 02

TABLE 1 Tensile Property Limits for Pipe, Inch-Pound Units<sup>A,B</sup>

Alloy	Temper	Pipe Size, in	Tensile Strength, min, ksi	Yield Strength (0.2 % Offset), min, ksi	Elongation in
					2 in. or 4 in. Diameter, min % <sup>C,D</sup>
3003	H18	Under 1	27.0	24.0	4
	H112	1 and over	14.0	5.0	25
6061	T6 (Extruded)	Under 1	38.0	35.0	8
		1 and over	38.0	35.0	10 <sup>D</sup>
	T6 (Drawn)	Under 1	42.0	35.0	8 <sup>E</sup>
		1 and over	38.0	35.0	10 <sup>F</sup>
6063	T6	All	30.0	25.0	8
6351	T5	All	38.0	35.0	10 <sup>D</sup>
	T6	All	42.0	37.0	10 <sup>G</sup>

<sup>A</sup> The basis for establishment of tensile property limits is shown in Annex A1.

<sup>B</sup> For purposes of determining conformance with this specification, each value for tensile strength and yield strength shall be rounded to the nearest 0.1 ksi, and each value for elongation shall be rounded to the nearest 0.5 %, both in accordance with the rounding-off method of Practice E 29.

<sup>C</sup> Elongation of full-section and cut-out sheet-type specimens is measured in 2 in. of round specimens, in 4 × specimen diameter.

<sup>D</sup> For wall thicknesses less than 0.250 in., the minimum elongation is 8 %.

<sup>E</sup> For wall thickness 0.050 to 0.259 in., the minimum elongation is 10 %.

<sup>F</sup> For wall thickness 0.260 to 0.500 in., the minimum elongation is 12 %.

<sup>G</sup> For wall thickness less than 0.125 in., the minimum elongation is 8 %.

TABLE 2 Tensile Property Limits for Pipe [SI Units]<sup>A,B</sup>

Alloy <sup>C</sup>	Temper <sup>C</sup> (Product)	Pipe Size, Designation	Tensile Strength, min, MPa	Yield Strength (0.2 % Offset), min, MPa	Elongation, <sup>C</sup> min, %	
					in 50 mm	in 5 × Diameter (5.65 √A)
3003	H18	Under 1	185	165	4	...
	H112	1 and over	95	35	25	22
6061	T6 (Extruded)	Under 1	260	240	8	...
		1 and over	260	240	10 <sup>D</sup>	9
	T6 (Drawn)	Under 1	290	240	8 <sup>E</sup>	...
		1 and over	260	240	10 <sup>F</sup>	9
6063	T6	All	205	170	8	7
6351	T5	All	260	240	10 <sup>D</sup>	9
	T6	All	290	255	10 <sup>G</sup>	9

<sup>A</sup> The basis for establishment of mechanical property limits is shown in Annex A1.

<sup>B</sup> For purposes of determining conformance with this specification, each value for ultimate strength and yield strength shall be rounded to the nearest 1 MPa, and each value for elongation shall be rounded to the nearest 0.5 %, both in accordance with the rounding-off method of Practice E 29.

<sup>C</sup> Elongations in 50 mm apply for pipe tested in full-section and to sheet type specimens taken from pipes having a wall up to 12.50 mm thick. Elongations in 5D (5.65 √A), where D and A are diameter and cross-sectional area of the specimens respectively, apply to round test specimens machined from wall thicknesses over 6.30 mm.

<sup>D</sup> For wall thicknesses up through 6.30 mm the minimum elongation is 8 %.

<sup>E</sup> For wall thicknesses over 1.25 through 6.60 mm, the minimum elongation is 10 %.

<sup>F</sup> For wall thicknesses over 6.60 through 12.50 mm, the minimum elongation is 12 %.

<sup>G</sup> For wall thicknesses up through 3.20 mm the minimum elongation is 8 %.

E 527 Practice for Numbering Metals and Alloys (UNS)<sup>7</sup>

E 607 Test Method for Atomic Emission Spectrometric Analysis of Aluminum and Aluminum Alloys by the Point-to-Plane Technique, Nitrogen Atmosphere<sup>6</sup>

E 716 Practices for Sampling Aluminum and Aluminum Alloys for Spectrochemical Analysis<sup>6</sup>

E 1004 Practice for Determining Electrical Conductivity Using the Electromagnetic (Eddy-Current) Method<sup>8</sup>

E 1251 Test Method for Optical Emission Spectrometric Analysis of Aluminum and Aluminum Alloys by the Argon Atmosphere, Point-to-Plane, Unipolar Self-Initiating Capacitor Discharge<sup>6</sup>

G 47 Test Method for Determining Susceptibility to Stress-Corrosion Cracking of 2xxx and 7xxx Aluminum Alloy Products<sup>9</sup>

2.3 ANSI Standards:

H35.1 Alloy and Temper Designation Systems for Aluminum<sup>3</sup>

H35.1(M) Alloy and Temper Designation Systems for Aluminum<sup>3</sup>

H35.2 Dimensional Tolerances for Aluminum Mill Products<sup>3</sup>

H35.2(M) Dimensional Tolerances for Aluminum Mill Products<sup>3</sup>

2.4 Federal Standard:

Fed. Std. No. 123 Marking for Shipment (Civil Agencies)<sup>10</sup>

2.5 Military Standard:

MIL-STD-129 Marking for Shipment and Storage<sup>10</sup>

2.6 AMS Specification:

AMS 2772 Heat Treatment of Aluminum Alloy Raw Materials<sup>11</sup>

<sup>7</sup> Annual Book of ASTM Standards, Vol 01.01.

<sup>8</sup> Annual Book of ASTM Standards, Vol 03.03.

<sup>9</sup> Annual Book of ASTM Standards, Vol 03.02.

<sup>10</sup> Available from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094. Attn: NPODS.

<sup>11</sup> Available from Society of Automotive Engineers (SAE), 400 Commonwealth Dr., Warrendale, PA 15096-0001.



## B 241/B 241M – 02

**TABLE 3 Tensile Property Limits for Extruded Tube, Inch-Pound Units<sup>A,B</sup>**

Temper	Specified Section or Wall Thickness, in.	Area, in <sup>2</sup>	Tensile Strength, ksi		Yield Strength (0.2 % Offset), ksi		Elongation in 2 in. or 4 × Diameter, min, % <sup>C</sup>
			Min	Max	Min	Max	
<b>Aluminum 1060</b>							
O	all	all	8.5	14.0	2.5		25
H112	all	all	8.5		2.5		25
F <sup>D</sup>	all	all					
<b>Aluminum 1100</b>							
O	all	all	11.0	15.5	3.0		25
H112	all	all	11.0		3.0		25
F <sup>D</sup>	all	all					
<b>Alloy 2014</b>							
O	all	all		30.0		18.0	12
T4	}	all	50.0		35.0		12
T4510 <sup>E</sup>							
T4511 <sup>E</sup>							
T42	all	all	50.0			29.0	12
T6	}	all	60.0			53.0	7
T6510 <sup>E</sup>							
T6511 <sup>E</sup>							
T6511 <sup>E</sup>							
		up thru 0.499				58.0	7
		0.500–0.749				60.0	7
		0.750 and over				58.0	6
		up thru 25					
		over 25 thru 32					
T62	up thru 0.749	all	60.0			53.0	7
	0.750 and over	up thru 25	60.0			53.0	7
		over 25 thru 32	60.0			53.0	6
F <sup>D</sup>	all	all					
<b>Alloy 2024</b>							
O	all	all		35.0		19.0	12
T3	}	all	57.0		42.0		10
T3510 <sup>E</sup>							
T3511 <sup>E</sup>							
T3511 <sup>E</sup>							
T3511 <sup>E</sup>							
		up thru 0.249				44.0	10
		0.250–0.749				46.0	10
		0.750–1.499				48.0	10
		1.500 and over				46.0	8
		up thru 25					
		over 25 thru 32					
T42	up thru 0.749	all	57.0			38.0	12
	0.750–1.499	all	57.0			38.0	10
	1.500 and over	up thru 25	57.0			38.0	10
		over 25 thru 32	57.0			38.0	8
T81	}	all	64.0		56.0		4
T8510 <sup>E</sup>							
T8511 <sup>E</sup>							
T8511 <sup>E</sup>							
F <sup>D</sup>		up thru 32	66.0			58.0	5
		all	66.0			58.0	5
		all					
<b>Alloy 2219</b>							
O	all	all		32.0		18.0	12
T31	}	all	42.0		26.0		14
T3510 <sup>E</sup>							
T3511 <sup>E</sup>		up thru 0.499					
		0.500–2.999				27.0	14
T62	up thru 0.999	up thru 25	54.0			36.0	6
	1.000 and over	up thru 25	54.0			36.0	6
T81	}	all	58.0		42.0		6
T8510 <sup>E</sup>							
T8511 <sup>E</sup>		up thru 2.999					
F <sup>D</sup>	all	all					
<b>Alloy 3003</b>							
O	all	all	14.0	19.0	5.0		25
H112	all	all	14.0		5.0		25
F <sup>D</sup>	all	all					
<b>Alclad Alloy 3003</b>							
O	all	all	13.0	18.0	4.5		25



B 241/B 241M - 02

TABLE 3 Continued

Temper	Specified Section or Wall Thickness, in.	Area, in <sup>2</sup>	Tensile Strength, ksi		Yield Strength (0.2 % Offset), ksi		Elongation in 2 in. or 4 × Diameter, min. % <sup>C</sup>
			Min	Max	Min	Max	
H112	all	all	13.0	22.0	4.5	11.0	25
F <sup>D</sup>	all	all	13.0	22.0	4.5	11.0	25
Alloy 5052							
O	all	all	25.0	35.0	10.0	14.0	14
F <sup>D</sup>	all	all	25.0	35.0	10.0	14.0	14
Alloy 5083							
O	all	up thru 32	39.0	51.0	16.0	24.0	14
H111	all	up thru 32	40.0	52.0	24.0	25.0	12
H112	all	up thru 32	39.0	51.0	16.0	24.0	12
F <sup>D</sup>	all	all	39.0	51.0	16.0	24.0	12
Alloy 5086							
O	all	up thru 32	35.0	46.0	14.0	20.0	14
H111	all	up thru 32	36.0	47.0	21.0	22.0	12
H112	all	up thru 32	35.0	46.0	14.0	20.0	12
F <sup>D</sup>	all	all	35.0	46.0	14.0	20.0	12
Alloy 5154							
O	all	up thru 32	31.0	41.0	12.0	18.0	14
H111	all	up thru 32	33.0	43.0	19.0	20.0	12
H112	all	up thru 32	31.0	41.0	12.0	18.0	12
F <sup>D</sup>	all	all	31.0	41.0	12.0	18.0	12
Alloy 5456							
O	all	up thru 32	41.0	53.0	19.0	25.0	14
H111	all	up thru 32	42.0	54.0	26.0	27.0	12
H112	all	up thru 32	41.0	53.0	19.0	25.0	12
F <sup>D</sup>	all	all	41.0	53.0	19.0	25.0	12
Alloy 6061							
O	all	all	22.0	22.0	16.0	16.0	16
T1	up thru 0.625	all	26.0	26.0	14.0	14.0	16
T4	} all	all	26.0	26.0	16.0	16.0	16
T4510 <sup>E</sup>							
T4511 <sup>E</sup>							
T42	all	all	26.0	26.0	12.0	12.0	16
T51	up thru 0.625	all	35.0	35.0	30.0	30.0	8
T6, T62	} up thru 0.249	all	38.0	38.0	35.0	35.0	8
T6510 <sup>E</sup>							
T6511 <sup>E</sup>							
F <sup>D</sup>	0.250 and over	all	38.0	38.0	35.0	35.0	10
F <sup>D</sup>	all	all	38.0	38.0	35.0	35.0	10
Alloy 6063							
O	all	all	19.0	19.0	14.0	14.0	18
T1 <sup>F</sup>	up thru 0.500	all	17.0	17.0	9.0	9.0	12
	0.501-1.000	all	16.0	16.0	8.0	8.0	12
T4, T42	up through 0.500	all	19.0	19.0	10.0	10.0	14
	0.501-1.000	all	18.0	18.0	9.0	9.0	14
T5	up thru 0.500	all	22.0	22.0	16.0	16.0	8
	0.501-1.000	all	21.0	21.0	15.0	15.0	8
T52	up thru 1.000	all	22.0	30.0	16.0	25.0	8
T6, T62	up thru 0.124	all	30.0	30.0	25.0	25.0	8
	0.125-1.000	all	30.0	30.0	25.0	25.0	10
F <sup>D</sup>	all	all	30.0	30.0	25.0	25.0	10
Alloy 6066							
O	all	all	29.0	29.0	18.0	18.0	16

 B 241/B 241M – 02

TABLE 3 Continued

Temper	Specified Section or Wall Thickness, in.	Area, in. <sup>2</sup>	Tensile Strength, ksi		Yield Strength (0.2 % Offset), ksi		Elongation in 2 in. or 4 × Diameter, min, % <sup>C</sup>		
			Min	Max	Min	Max			
T4, T4510 <sup>E</sup> T4511 <sup>E</sup>	all	all	40.0	...	25.0	...	14		
T42	all	all	40.0	...	24.0	...	14		
T6, T6510 <sup>E</sup> T6511 <sup>E</sup>	all	all	50.0	...	45.0	...	8		
T62	all	all	50.0	...	42.0	...	8		
Alloy 6162									
T5, T5510 <sup>E</sup> T5511 <sup>E</sup>	up thru 1.000	all	37.0	...	34.0	...	7		
T6, T6510 <sup>E</sup> T6511 <sup>E</sup>	up thru 0.249 0.250–0.499	all all	30.0 38.0	...	35.0 35.0	...	8 10		
Alloy 6351									
T4 T6	up thru 0.749 up thru 0.124 0.125–0.749	all	32.0 42.0 42.0	...	19.0 37.0 37.0	...	16 8 10		
Alloy 7075									
O	all	...	...	40.0	...	24.0	10		
T6, T62 T6510 <sup>E</sup> T6511 <sup>E</sup>	up through 0.249 0.250–0.499 0.500–1.499 1.500–2.999	all all all all	78.0 81.0 81.0 81.0	...	70.0 73.0 72.0 72.0	...	7 7 7 7		
T73 T73510 T73511		all up thru 25 up thru 25	0.062–0.249 0.250–1.499 1.500–2.999	68.0 70.0 69.0	...	58.0 61.0 59.0	...	7 8 8	
F <sup>D</sup>			all	...	...	...	...	...	
Alloy 7178									
O	all	up thru 32	...	40.0	...	24.0	10		
T6 T6510 <sup>E</sup> T6511 <sup>E</sup>	up through 0.061 0.062–0.249 0.250–1.499 1.500–2.499 2.500–2.999	all up thru 20 up thru 25 up thru 25 over 25 thru 32 up thru 32	82.0 84.0 87.0 86.0 84.0 82.0	...	76.0 76.0 78.0 77.0 75.0 71.0	...	5 5 5 5 5 5		
T62		all up thru 20 up thru 25 up thru 25 over 25 thru 32	up thru 0.061 0.062–0.249 0.250–1.499 1.500–2.499	79.0 82.0 86.0 86.0	...	73.0 74.0 77.0 77.0	...	5 5 5 5	
F <sup>D</sup>			all	...	...	...	...	...	
Alloy 7178									
T62			up thru 0.061 0.062–0.249 0.250–1.499 1.500–2.499	all up thru 20 up thru 25 up thru 25 over 25 thru 32	79.0 82.0 86.0 86.0	...	73.0 74.0 77.0 77.0	...	5 5 5 5
F <sup>D</sup>				all	...	...	...	...	...

<sup>A</sup>The basis for establishment of mechanical property limits is shown in Annex A1.

<sup>B</sup>To determine conformance to this specification, each value for ultimate strength and for yield strength shall be rounded to the nearest 0.1 ksi and each value for elongation to the nearest 0.5 %, both in accordance with the rounding-off-method of Practice E 29.

<sup>C</sup>Elongation of full-section and cut-out sheet-type specimens is measured in 2 in. of round specimens, in 4 × specimen diameter. See 9.1.1 for conditions under which measurements are not required.

<sup>D</sup>Tests for tensile properties in the F temper are not required.

<sup>E</sup>For stress relieved tempers (T3510, T3511, T4511, T5510, T5511, T6510, T6511, T73510, T73511, T8510, T8511), characteristics and properties other than those specified may differ somewhat from the corresponding characteristics and properties of material in the basic tempers.

<sup>F</sup>Formerly designated T42 temper. When properly aged (precipitation heat-treated) 6063-T1 extruded products are designated T5.



## B 241/B 241M - 02

**TABLE 4 Tensile Property Limits for Extruded Tube [SI Units]<sup>A,B</sup>**

Temper	Specified Section or Wall Thickness, mm		Area, mm <sup>2</sup>		Tensile Strength, MPa		Yield Strength (0.2 % offset), MPa		Elongation <sup>C</sup> %, min	
	over	through	over	through	min	max	min	max	in 50 mm	in 5 × diameter (5.65 √A)
<b>Aluminum 1060</b>										
O	all		all		60	95	15		25	22
H112	all		all		60		15		25	22
F <sup>D</sup>	all		all							
<b>Aluminum 1100</b>										
O	all		all		75	105	20		25	22
H112	all		all		75		20		25	22
F <sup>D</sup>	all		all							
<b>Alloy 2014</b>										
O	all		all			205		125	12	10
T4	}		all			345		240	12	10
T4510 <sup>E</sup>										
T4511 <sup>E</sup>										
T42 <sup>F</sup>	all		all			345		200	12	10
T6	}	12.50	all		16 000	415		365	7	6
T6510 <sup>E</sup>										
T6511 <sup>E</sup>										
		18.00			20 000	440		400		6
		18.00				470		415		6
		18.00	16 000			470		400		5
T62 <sup>F</sup>	}	18.00	all		16 000	415		365	7	6
		18.00			20 000	415		365		6
		18.00	16 000			415		365		5
F <sup>E</sup>	all		all							
<b>Alloy 2024</b>										
O	all		all			240		130	12	10
T3	}	6.30	all			395		290	10 <sup>H</sup>	9 <sup>H</sup>
T3510 <sup>E</sup>										
T3511 <sup>E</sup>										
		18.00			16 000	415		305		9
		35.00			20 000	450		315		9
		35.00				480		380 <sup>I</sup>		9
		35.00	16 000			470		330 <sup>J</sup>		7
T42 <sup>F</sup>	}	18.00	all			395		260	12	10
		35.00			16 000	395		260		9
		35.00			20 000	395		260		9
		35.00	16 000			395		260		7
T81	}	1.20	all			440		385	4	4
T8510 <sup>E</sup>										
T8511 <sup>E</sup>										
		6.30			20 000	455		400		4
		35.00				455		400		4
F <sup>D</sup>	all		all							
<b>Alloy 2219</b>										
O	all		all			220		125	12	10
T31	}	12.50			16 000	290		180	14	12
T3510 <sup>E</sup>										
T3511 <sup>E</sup>										
		80.00			16 000	310		185		12
T62 <sup>F</sup>	}	25.00			16 000	370		250	6	5
		25.00			20 000	370		250		5
T81	}				16 000	400		290	6	5
T8510 <sup>E</sup>										
T8511 <sup>E</sup>										
F <sup>E</sup>	all		all							
<b>Alloy 3003</b>										
O	all		all			95		35	25	22



B 241/B 241M - 02

TABLE 4 Continued

Temper	Specified Section or Wall Thickness mm		Area, mm <sup>2</sup>		Tensile Strength, MPa		Yield Strength (0.2 % offset), MPa		Elongation, <sup>c</sup> %, min	
	over	through	over	through	min	max	min	max	in 50 mm	in 5 × diameter (5.65 √A)
H112		1.60	all		95		35			
F <sup>D</sup>	1.60		all		95		35		25	22
	all		all							
Alclad Alloy 3003										
O	all		all		90	125	30		25	22
H112	all		all		90		30		25	22
F <sup>D</sup>	all		all							
Alloy 5052										
O	all		all		170	240	70			
F <sup>D</sup>	all		all							
Alloy 5083										
O	all			20 000	270	350	110		14	12
H111	all			20 000	275		165		12	10
H112	all			20 000	270		110		12	10
F <sup>D</sup>	all		all							
Alloy 5086										
O	all			20 000	240	315	95		14	12
H111	all			20 000	250		145		12	10
H112	all			20 000	240		95		12	10
F <sup>D</sup>	all		all							
Alloy 5454										
O	all			20 000	215	285	85		14	12
H111	all			20 000	230		130		12	10
H112	all			20 000	215		85		12	10
F <sup>D</sup>	all		all							
Alloy 5456										
O	all			20 000	285	365	130		14	12
H111	all			20 000	290		180		12	10
H112	all			20 000	285		130		12	10
F <sup>D</sup>	all		all							
Alloy 6061										
O	all		all			150		110	16	14
T1		16.00	all			180		95	16	14
T4			all			180		110	16	14
T4510 <sup>E</sup>	}		all							
T4511 <sup>E</sup>										
T42 <sup>F</sup>	all		all			180		85	16	14
T51		16.00	all			240		205	8	7
T6, T62 <sup>F</sup>	}	6.30	all			260		240	8	
T6510 <sup>E</sup>										
T6511 <sup>E</sup>										
F <sup>E</sup>	all		all							
Alloy 6063										
O	all		all				130		18	16
T1		12.50	all			115		60	12	10
		25.00	all			110		55	12	10
T4, T42 <sup>F</sup>		12.50	all			130		70	14	12
		25.00	all			125		60	12	12
T5		12.50	all			150		110	8	7
		25.00	all			145		105	8	7
T52		25.00	all			150		205	110	170
									8	7

 B 241/B 241M - 02

TABLE 4 Continued

Temper	Specified Section or Wall Thickness, mm		Area, mm <sup>2</sup>		Tensile Strength, MPa		Yield Strength (0.2 % offset), MPa		Elongation, <sup>c</sup> %, min	
	over	through	over	through	min	max	min	max	in 50 mm	in 5 × diameter (5.65 √A)
T6	3.20	3.20 25.00	all	all	205	205	170	170	8	9
F <sup>D</sup>	all		all							
Alloy 6066										
O	all		all		200		125		16	14
T4, T4510 <sup>E</sup> T4511 <sup>E</sup>	all		all		275		170		14	12
T42	all		all		275		165		14	12
T6, T6510 <sup>E</sup> T6511 <sup>E</sup>	all		all		345		310		8	7
T62	all		all		345		290		8	7
Alloy 6162										
T5, T5510 <sup>E</sup> T5511 <sup>E</sup>		25.00	all		255		235		7	6
T6, T6510 <sup>E</sup> T6511 <sup>E</sup>	6.30	6.30 12.50	all	all	260	260	240	240	8	9
Alloy 6351										
T4		19.00	all		220		130		16	14
T6	3.20	3.20 25.00	all	all	290	290	255	255	8	9
Alloy 7075										
O	all		all		275		165		10	9
1b, T62 <sup>F</sup> T62510 <sup>E</sup> T6511 <sup>E</sup>	6.30 6.30 12.50	6.30 12.50 70.00	all	all	540	560	485	505	7	6
T73 T3510 <sup>E</sup> T3511 <sup>E</sup>	1.60 6.30 35.00	6.30 35.00 70.00		13 000 16 000 18 000	470 485 475	400 420 405			7 8 7	
F <sup>D</sup>	all		all							
Alloy 7178										
O	all			20 000	275		165		10	9
T6 T6510 <sup>E</sup> T6511 <sup>E</sup>	1.60 6.30 35.00 35.00 60.00	1.60 6.30 35.00 60.00 80.00	all	13 000 16 000 16 000 20 000 20 000	565 580 600 595 565	525 525 540 530 515 490			5 5 4 4 4	
1b2 <sup>F</sup>	1.60 6.30 35.00 35.00 60.00	1.60 6.30 35.00 60.00 80.00	all	13 000 13 000 16 000 16 000 20 000	545 565 595 595 580 565	505 510 530 530 515 490			5 5 4 4 4	
F <sup>D</sup>	all	all								

<sup>A</sup>The basis for establishment of tensile property limits is shown in Annex A1.

<sup>B</sup>To determine conformance to this specification, each value for tensile strength and yield strength shall be rounded to the nearest 1 MPa and each value for elongation

to the nearest 0.5 %, both in accordance with the rounding off method of Practice E 29.

<sup>c</sup>Elongation in 50 mm apply for shapes tested in full section and for sheet-type specimens machined from material up through 12.5 mm in thickness having parallel surfaces. Elongations in  $5D(5.65\sqrt{A})$ , where  $D$  and  $A$  are diameter and cross-sectional area of the specimen respectively, apply to round test specimens machined from thicknesses over 6.30. See 9.1.1 for conditions under which measurements are not required.

<sup>d</sup>No mechanical properties are specified or guaranteed.

<sup>e</sup>For stress-relieved tempers (T3510, T3511, T4510, T4511, T5510, T5511, T6510, T6511, T73510, T73511, T76510, T76511, T8510, T8511), characteristics and properties other than those specified may differ somewhat from the corresponding characteristics and properties of material in the basic tempers.

<sup>f</sup>Material in the T42 and T62 tempers is not available from the material producers.

### 3. Terminology

#### 3.1 Definitions:

3.1.1 *clad seamless pipe or clad seamless tube*—a composite pipe or tube product composed of a seamless aluminum alloy core having on either the inside or the outside surface a metallurgically bonded aluminum or aluminum-alloy coating that is anodic to the core, thus electrolytically protecting the core against corrosion.

3.1.2 *extruded seamless round tube*—an extruded hollow product having a round cross section and a uniform wall thickness, which does not contain any line junctures resulting from method of manufacture.

3.1.3 *producer*—the primary manufacturer of the material.

3.1.4 *seamless pipe*—extruded or drawn seamless tube having certain standardized sizes of outside diameter and wall thickness commonly designated by “Nominal Pipe Sizes” and American National Standards Institute (ANSI) Schedule Numbers.

3.1.5 *supplier*—jobber or distributor as distinct from producer.

#### 3.2 Definitions of Terms Specific to This Standard:

3.2.1 *capable of*—the test need not be performed by the producer of the material. However, should subsequent testing by the purchaser establish that the material does not meet these requirements, the material shall be subject to rejection.

### 4. Ordering Information

4.1 Orders for material to this specification shall include the following information:

4.1.1 This specification designation (which includes the number, the year, and the revision letter, if applicable),

NOTE 3—For inch-pound orders specify Specification B 241; for metric orders specify Specification B 241M. Do not mix units.

4.1.2 Quantity in pieces or pounds [kilograms],

4.1.3 Alloy (Section 7),

4.1.4 Temper (Section 9),

4.1.5 Pipe size and schedule number (Table 16.7 of ANSI H35.2 and H35.2M), or outside diameter and wall thickness (extruded tube), and

4.1.6 Length.

4.2 Additionally, orders for material to this specification shall include the following information when required by the purchaser:

4.2.1 Whether solution treatment at the press is unacceptable (8.2),

4.2.2 Whether heat treatment in accordance with Practice B 918 is required (8.3),

4.2.3 Whether pipe size under 1 shall be extruded only (5.1 and Table 1 or [Table 2], Footnote F),

4.2.4 Whether threaded ends are required (see 15.2),

4.2.5 Whether inspection or witness of inspection and tests by the purchaser’s representative is required prior to material shipment (Section 16),

4.2.6 Whether marking for identification is required (Section 19), and whether marking of lot number for alloys 2014 and 2024 in the T3- and T4-type tempers and alloy 6061 in the T6-type tempers is required (19.2),

4.2.7 Whether Practices B 660 applies and, if so, the levels of preservation, packaging, and packing required (19.3),

4.2.8 Whether certification of the material is required (Section 20),

4.2.9 Requirements for tensile property and dimensional tolerance for sizes not specifically covered (9.1.2 and 14.2), and

4.2.10 Whether ultrasonic inspection is required (Section 16, Table 6 [Table 7]).

### 5. Materials and Manufacture

5.1 The pipe and tube shall be produced from hollow extrusion ingot (cast in hollow form, or drilled, or pierced from solid ingot) and shall be extruded by use of the die and mandrel method. Pipe and tube may be subsequently cold drawn at the option of the producer.

### 6. Quality Assurance

6.1 *Responsibility for Inspection and Tests*—Unless otherwise specified in the contract or purchase order, the producer is responsible for the performance of all inspection and test requirements specified herein. The producer may use his own or any other suitable facilities for the performance of the inspection and test requirements specified herein, unless disapproved by the purchaser in the order or at the time of contract signing. The purchaser shall have the right to perform any of the inspections and tests set forth in this specification where such inspections and tests are deemed necessary to ensure that material conforms to prescribed requirements.

6.2 *Lot Definition*—An inspection lot shall be defined as follows:

6.2.1 For heat-treated tempers, an inspection lot shall consist of an identifiable quantity of material of the same mill form, alloy, temper, and nominal dimensions traceable to a heat-treat lot or lots, and subjected to inspection at one time.

6.2.2 For nonheat-treated tempers, an inspection lot shall consist of an identifiable quantity of material of the same mill form alloy, temper, and nominal dimensions subjected to inspection at one time.

### 7. Chemical Composition

7.1 *Limits*—The material shall conform to the chemical composition limits specified in Table 5. Conformance shall be determined by analyzing samples taken when the ingots are





B 241/B 241M - 02

TABLE 5 Chemical Composition Limits<sup>A, B, C</sup>

Alloy	Silicon	Iron	Copper	Manganese	Magnesium	Chromium	Zinc	Titanium	Other Elements <sup>D</sup>		Aluminum
									Each	Total <sup>E</sup>	
1060	0.25	0.35	0.05	0.03	0.03	...	0.05	0.03	0.03 <sup>F</sup>	...	99.60 min <sup>G</sup>
1100	0.95 Si + Fe	...	0.05-0.20	0.05	...	...	0.10	...	0.05	0.15	99.00 min <sup>G</sup>
2014	0.50-1.2	0.7	3.0-5.0	0.40-1.2	0.20-0.8	0.10	0.25	0.15 <sup>H</sup>	0.05	0.15	remainder
2024	0.50	0.50	3.8-4.9	0.30-0.9	1.2-1.8	0.10	0.25	0.15 <sup>H</sup>	0.05	0.15	remainder
2219	0.20	0.30	5.8-6.8	0.20-0.40	0.02	...	0.10	0.02-0.10	0.05 <sup>I</sup>	0.15 <sup>J</sup>	remainder
3003	0.6	0.7	0.05-0.20	1.0-1.5	...	...	0.10	...	0.05	0.15	remainder
Alclad 3003 <sup>K</sup>	...	...	...	...	...	...	...	...	...	...	...
5052	0.25	0.40	0.10	0.10	2.2-2.8	0.15-0.35	0.10	...	0.05	0.15	remainder
5083	0.40	0.40	0.10	0.40-1.0	4.0-4.9	0.05-0.25	0.25	0.15	0.05	0.15	remainder
5086	0.40	0.50	0.10	0.20-0.7	3.5-4.5	0.05-0.25	0.25	0.15	0.05	0.15	remainder
5454	0.25	0.40	0.10	0.50-1.0	2.4-3.0	0.05-0.20	0.25	0.20	0.05	0.15	remainder
5456	0.25	0.40	0.10	0.50-1.0	4.7-5.5	0.05-0.20	0.25	0.20	0.05	0.15	remainder
6061 <sup>L</sup>	0.40-0.8	0.7	0.15-0.40	0.15	0.8-1.2	0.04-0.35	0.25	0.15	0.05	0.15	remainder
6063	0.20-0.6	0.35	0.10	0.10	0.45-0.9	0.10	0.10	0.10	0.05	0.15	remainder
6066	0.9-1.8	0.50	0.7-1.2	0.6-1.1	0.8-1.4	0.40	0.25	0.20	0.05	0.15	remainder
6162	0.40-0.8	0.50	0.20	0.10	0.7-1.1	0.10	0.25	0.10	0.05	0.15	remainder
6351	0.7-1.3	0.50	0.10	0.40-0.8	0.40-0.8	...	0.20	0.20	0.05	0.15	remainder
7072 <sup>M</sup>	0.7 Si + Fe	...	0.10	0.10	0.10	...	0.8-1.3	...	0.05	0.15	remainder
7075	0.40	0.50	1.2-2.0	0.30	2.1-2.9	0.18-0.28	5.1-6.1	0.20 <sup>N</sup>	0.05	0.15	remainder
7178	0.40	0.50	1.6-2.4	0.30	2.4-3.1	0.18-0.28	6.3-7.3	0.20	0.05	0.15	remainder

<sup>A</sup> Limits are in weight [mass] percent maximum unless shown as a range or stated otherwise.

<sup>B</sup> Analysis shall be made for the elements for which limits are shown in this table.

<sup>C</sup> For purposes of determining conformance to these limits, an observed value or a calculated value obtained from analysis shall be rounded to the nearest unit in the last right-hand place of figures used in expressing the specified limit, in accordance with the rounding-off method of Practice E 29.

<sup>D</sup> *Others* includes listed elements for which no specific limit is shown as well as unlisted metallic elements. The producer may analyze samples for trace elements not specified in the specification. However, such analysis is not required and may not cover all metallic *Others* elements. Should any analysis by the producer or the purchaser establish that an *Others* element exceeds the limit of *Each* or that the aggregate of several *Others* elements exceeds the limit of *Total*, the material shall be considered nonconforming.

<sup>E</sup> *Other Elements*—Total shall be the sum of unspecified metallic elements 0.010 % or more, rounded to the second decimal before determining the sum.

<sup>F</sup> Vanadium 0.05 % maximum.

<sup>G</sup> The aluminum content shall be calculated by subtracting from 100.00 % the sum of all metallic elements present in amounts of 0.010 % or more each, rounded to the second decimal before determining the sum.

<sup>H</sup> A maximum limit of 0.20 % for zirconium + titanium is permitted upon agreement between the purchaser and producer.

<sup>I</sup> Vanadium 0.05-0.15 %; zirconium, 0.10-0.25 %. The total for other elements does not include vanadium and zirconium.

<sup>J</sup> Alloy 3003 clad with alloy 7072.

<sup>K</sup> Beginning in the 1965 issue, the requirements for alloy 6062 were combined with alloy 6061 by revision of the minimum chromium content of 6061 from 0.15 to 0.04.

This action cancelled alloy 6062.

<sup>L</sup> Cladding on alclad 3003.

<sup>M</sup> A maximum limit of 0.25 % for zirconium + titanium is permitted upon agreement between the purchaser and producer.

TABLE 6 Ultrasonic Discontinuity Limits<sup>A</sup> for Seamless Extruded Tube, Inch-Pound Units

Alloy	Wall Thickness, in.	Max Weight per Piece, lb	Max Width: Thickness Ratio	Discontinuity Class <sup>B</sup>
7075	0.500-1.499	600	10:1	B
7178	1.500 & over	600	10:1	A

<sup>A</sup> Discontinuities in excess of those listed in this table shall be allowed, subject to the approval of the procuring activity, if it is established that they will be removed by machining or that they are in noncritical areas.

<sup>B</sup> The discontinuity class limits are defined in Section 11, Discontinuity Class Limits, of Practice B 594.

TABLE 7 Ultrasonic Discontinuity Limits<sup>A</sup> for Seamless Extruded Tube, [SI Units]

Alloy	Wall Thickness, mm		Max Mass per Piece, kg	Max Width: Thickness Ratio	Discontinuity Class <sup>B</sup>
	Over	Through			
2024	12.50	...	300	10:1	B
7075	12.50	35.00	300	10:1	B
7178	35.00	...	300	10:1	A

<sup>A</sup> Discontinuities in excess of those listed in this table shall be allowed, subject to the approval of the procuring activity, if it is established that they will be removed by machining or that they are in noncritical areas.

<sup>B</sup> The discontinuity class limits are defined in Section 11, Discontinuity Class Limits, of Practice B 594.

poured, or analyzing samples taken from the finished or semifinished product. If the producer has determined the chemical composition of the material during the course of manufacture, he shall not be required to sample and analyze the finished product.

NOTE 4—It is standard practice in the United States aluminum industry to determine conformance to the chemical composition limits prior to further processing of ingots into wrought products. Due to the continuous nature of the process, it is not practical to keep a specific ingot analysis identified with a specific quantity of finished material.

7.2 Number of Samples—The number of samples taken for determination of chemical composition shall be as follows:

7.2.1 When samples are taken at the time the ingots are poured, at least one sample shall be taken for each group of ingots poured simultaneously from the same source of molten metal.

7.2.2 When samples are taken from the finished or semifinished product, a sample shall be taken to represent each 4000 lb [2000 kg], or fraction thereof, in the shipment, except that not more than one sample shall be required per piece.

7.3 Methods of Sampling—Samples for determination of chemical composition shall be taken in accordance with one of the following methods:

7.3.1 Samples for chemical analysis shall be taken from the material by drilling, sawing, milling, turning, or clipping a



representative piece or pieces to obtain a sample of not less than 75 g. Sampling shall be in accordance with Practice E 55.

7.3.2 Sampling for spectrochemical analysis shall be in accordance with Practices E 716. Samples for other methods of analysis shall be suitable for the form of material being analyzed and the type of analytical method used.

**Note 5**—It is difficult to obtain a reliable analysis of each of the components of clad materials using material in its finished state. A reasonably accurate determination of the core composition can be made if the cladding is substantially removed prior to analysis. The cladding composition is more difficult to determine because of the relatively thin layer and because of diffusion of core elements to the cladding. The correctness of cladding alloy used can usually be verified by a combination of metallographic examination and spectrochemical analysis of the surface at several widely separated points.

7.4 *Methods of Analysis*—The determination of chemical composition shall be made in accordance with suitable chemical (Test Methods E 34) or spectrochemical (Test Methods E 227, E 607, and E 1251) methods. Other methods may be used only when no published ASTM test method is available. In case of dispute, the methods of analysis shall be agreed upon between the producer and the purchaser.

## 8. Heat Treatment

8.1 Producer or supplier heat treatment for the production of T1 and T5-type tempers shall be in accordance with Practice B 807, and for the production of T3, T4, T6, T7, and T8-type tempers, except as noted in 8.2 or unless otherwise specified in 8.3, in accordance with AMS 2772.

8.2 Alloys 6061, 6063, and 6351 may be solution heat-treated and quenched at the extrusion press in accordance with Practice B 807 for the production of T4 and T6-type tempers, as applicable.

8.3 When specified, heat treatment for the production of T3, T4, T6, T7, and T8-type tempers shall be in accordance with Practice B 918.

## 9. Tensile Properties

9.1 *Limits*—The material shall conform to the tensile property requirements specified in Table 1 [Table 2] and Table 3 [Table 4] as applicable.

9.1.1 The elongation requirements shall not be applicable to the following:

9.1.1.1 Material of such dimensions that a standard test specimen cannot be taken in accordance with Test Methods B 557 [B 557M].

9.1.1.2 Tubes less than 0.062 in. [up through 1.60 mm] in wall thickness.

9.1.2 Tensile property limits for sizes not covered in Table 3 and [Table 4] shall be as agreed upon between the producer and purchaser and shall be so specified in the contract or purchase order.

### 9.2 *Number of Specimens:*

9.2.1 For material having a nominal weight of less than 1 lb/linear ft [up through 1.7 kg/linear m], one tension test specimen shall be taken for each 1000 lb [500 kg] or fraction thereof in the lot.

9.2.2 For material having a nominal weight of 1 lb or more/linear ft [over 1.7 kg/linear m], one tension test specimen shall be taken for each 1000 ft [300 m] or fraction thereof in the lot.

9.2.3 Other procedures for selecting samples may be employed if agreed upon by the producer and the purchaser.

9.3 *Test Methods*—The tension tests shall be made in accordance with Test Methods B 557 [B 557M].

## 10. Producer Conformation of Heat Treatment Response

10.1 The producer shall determine that heat treatable alloys supplied in the O or F tempers (within the size limits specified in Table 3 and [Table 4]) respond to heat treatment in accordance with the following:

10.1.1 Alloys 2014, 2024, 6061, and 6063 shall, after proper solution heat treatment and natural aging for not less than 4 days at room temperature, conform to the properties specified in Table 3 and [Table 4] for T42 temper material. The heat-treated samples may be tested prior to 4 days natural aging but if they fail to conform to the T42 temper properties, the tests may be repeated after completion of the 4 days natural aging without prejudice.

10.1.2 Alloys 2024, 2219, 6061, 6063, 7075, and 7178 shall, after proper solution heat treatment and precipitation heat treatment, conform to the properties specified in Table 3 and [Table 4] for T62 temper material.

10.2 *Number of Specimens*—The number of specimens from each lot of O and F temper material shall be as specified in 9.2.

10.3 *Quality Assurance Screening of Extrusion Press Heat Treated Pipe and Tube*—Pipe and tube heat-treated at the extrusion press shall conform to all the requirements of Section 9. In addition, hardness tests shall be performed on each extruded length or, with the approval of the purchaser, on samples selected in accordance with a mutually agreeable sampling plan. The minimum hardness control value shall be in accordance with Table 8 [Table 9] for pipe and with Table 10 [Table 11] for tube for the type of hardness tester used. The specific type of hardness tester shall be left to the discretion of the producer, but the test method shall be in accordance with Test Methods B 647, B 648, or E 18, as applicable.

10.3.1 Individual pieces within a lot that fail to conform to the minimum applicable hardness values may be accepted provided that samples from the two pieces exhibiting the lowest minimum hardness values are tension tested and found to conform to the requirements of Table 1 [Table 2] for pipe or Table 3 [Table 4] for tube.

**Note 6**—It may be necessary in the case of 6xxx—naturally aged tempers to allow for the elapse of four days subsequent to heat treatment for the material to attain its expected strength. Material in these tempers that has been tested for mechanical properties prior to an elapse of four days and fails may be retested after four days without prejudice.

## 11. Heat Treatment and Reheat Treatment Capability

11.1 As-received material in the O or F temper in alloys 2014, 2024, 6061, and 6063 (within the size limits specified in Table 3 [Table 4] and without the imposition of cold work) shall be capable of attaining the properties specified in Table 3

 B 241/B 241M – 02

**TABLE 8 Hardness Screening Values for Seamless Extruded Tube, Inch-Pound Units<sup>A</sup>**

Alloy and Temper	Specified Wall Thickness, in.	Hardness Number, min <sup>B,C</sup>		
		Webster	Barcol	Rockwell E
6061-T4 -T6	0.050 and over	...	64	...
	0.050 through 0.075	15	76	89
	0.076 through 0.499	15	76	89
6063-T1 -T4 -T5 -T6	0.500 through 1.000	15	76	...
	0.050 through 0.500	...	50	...
	0.050 through 0.500	...	60	...
6351-T6	0.050 through 0.500	...	65	...
	0.050 through 1.000	12	72	75
6351-T6	0.050 through 0.749	16	...	...

<sup>A</sup> See 10.3.

<sup>B</sup> Alternate minimum hardness values and hardness testing devices may be used provided agreement is reached between the purchaser and supplier or producer.

<sup>C</sup> The hardness values shown do not guarantee material will pass the applicable mechanical property requirements but are for informational purposes only. It is the responsibility of the user of this specification to establish the relationship between the hardness values and tensile properties.

**TABLE 9 Hardness Screening Values for Seamless Extruded Tube [SI Units]<sup>A</sup>**

Alloy and Temper	Specified Wall Thickness, mm	Hardness Number, Minimum <sup>B,C</sup>		
		Webster	Barcol	Rockwell E
6061-T4 -T6	1.25 and over	...	64	...
	1.25 through 1.50	15	76	89
	over 1.50 through 12.5	15	76	89
6063-T1 -T4 -T5 -T6	over 12.5 through 25.0	15	76	...
	1.25 through 12.5	...	50	...
	1.25 through 12.5	...	60	...
6351-T6	1.25 through 12.5	...	65	...
	1.25 through 25.0	12	72	75
6351-T6	1.25 through 19.00	16	...	...

<sup>A</sup> See Section 10.3.

<sup>B</sup> Alternate minimum hardness values and hardness testing devices may be used provided agreement is reached between the purchaser and supplier or producer.

<sup>C</sup> The hardness values shown do not guarantee material will pass the applicable mechanical property requirements but are for informational purposes only. It is the responsibility of the user of this specification to establish the relationship between the hardness values and tensile properties.

**TABLE 10 Hardness Screening Values for Seamless Pipe, Inch-Pound Units<sup>A</sup>**

Alloy and Temper	Pipe Size, in.	Wall Thickness, in.	Hardness Number, min <sup>B,C</sup>		
			Webster	Barcol	Rockwell E
6061-T6	less than 1 in. 1 in. and over	0.050 and over	16	...	...
		0.050 to 0.075	15	76	89
		0.076 to 0.499	15	76	89
		0.500 through 1.000	15	76	...
6063-T6	All	0.050 through 1.000	12	72	75
6351-T5	All	0.050 through 1.000	15	76	89
-T6	All	0.050 through 1.000	16	...	...

<sup>A</sup> See 10.3.

<sup>B</sup> Alternate minimum hardness values and hardness testing devices may be used provided agreement is reached between the purchaser and supplier or producer.

<sup>C</sup> The hardness values shown do not guarantee material will pass the applicable mechanical property requirements but are for informational purposes only. It is the responsibility of the user of this specification to establish the relationship between the hardness values and tensile properties.

**TABLE 11 Hardness Screening Values for Seamless Pipe [SI Units]<sup>A</sup>**

Alloy and Temper	Pipe Size Designation	Wall Thickness, mm	Hardness Number, Minimum <sup>B,C</sup>		
			Webster	Barcol	Rockwell E
6061-T6	Less than 1 1 and over	1.25 and over	16	...	...
		1.25 through 1.50	15	76	89
		over 1.50 through 12.5	15	76	89
		over 12.5 through 25.0	15	76	...
6063-T6	All	over 1.25 through 25.0	12	72	75
6351-T5	All	over 1.25 through 25.0	15	76	89
-T6	All	over 1.25 through 25.0	16	...	...

<sup>A</sup> See 10.3.

<sup>B</sup> Alternate minimum hardness values and hardness testing devices may be used provided agreement is reached between the purchaser and supplier or producer.

<sup>C</sup> The hardness values shown do not guarantee material will pass the applicable mechanical property requirements but are for informational purposes only. It is the responsibility of the user of this specification to establish the relationship between the hardness values and tensile properties.



[Table 4] for T42 temper material, upon being properly solution heat-treated and natural aged for not less than 4 days at room temperature.

11.2 As-received material in the O or F temper in alloys 2014, 2219, 6061, 6063, 7075, and 7178 (within the size limits specified in Table 3 [Table 4] and without the imposition of cold work) shall be capable of attaining the properties specified in Table 3 [Table 4] for T62 tempers, upon being properly solution and precipitation heat-treated.

11.3 Material in alloys and tempers 2014-T4, T4510, T4511, T6, T6510, and T6511 and 2024-T3, T3510, T3511, T81, T8510, and T8511 shall be capable of attaining the properties specified in Table 3 [Table 4] for the T42 temper, upon being properly resolution heat-treated and natural aged for not less than 4 days at room temperature.

11.4 Material in alloys and tempers 2219-T31, T3510, T3511, T81, T8510, and T8511, 7075-T6, T6510 and T6511 and 7178-T6, T6510 and T6511 shall be capable of attaining the properties specified in Table 3 [Table 4] for T62 tempers, upon being properly resolution heat-treated and precipitation heat-treated.

11.5 Material in T31, T3510, T3511, T4, T4510, and T4511 tempers shall be capable of attaining the properties specified in Table 3 [Table 4] for the T81, T8510, T8511, T6, T6510, and T6511 tempers, respectively, upon being properly precipitation heat-treated.

**12. Stress-Corrosion Resistance**

12.1 Alloy 7075 extruded tube in the T73-type tempers shall be capable of exhibiting no evidence of stress-corrosion cracking when subjected to the test specified in 12.2.

12.1.1 For lot-acceptance purposes, resistance to stress-corrosion cracking for each lot shall be established by testing the previously selected tension-test samples to the criteria shown in Table 12 [Table 13].

12.1.2 For surveillance purposes, each month the producer shall perform at least one stress-corrosion test in accordance

with 12.2 on each of the T73-type tempers for each thickness range 0.750 in. [20.00 mm] and over listed in Table 3 [Table 4] produced that month. Each sample shall be taken from material considered acceptable in accordance with lot-acceptance criteria of Table 8 [Table 9]. A minimum of three adjacent replicate specimens shall be taken from each sample and tested. The producer shall maintain records of all lots so tested and make them available for examination at the producer's facility.

12.2 The stress-corrosion cracking test shall be performed on extruded tube with wall thickness 0.750 in. [20.00 mm] and over as follows:

12.2.1 The stress-corrosion test shall be made in accordance with Test Method G 47.

12.2.2 Specimens shall be stressed in tension in the short transverse direction with respect to the grain flow and held at constant strain. The stress level shall be 75 % of the specified minimum yield strength.

12.2.3 There shall be no visual evidence of stress-corrosion cracking in any specimen, except that the retest provisions of 17.2 shall apply.

**13. Cladding**

13.1 The aluminum alloy coating of clad tube shall comprise the inside surface (only) of the tube and its thickness shall be approximately 10 % of the total wall thickness of the tube.

13.2 When the thickness of the coating is to be determined on finished tube, transverse cross sections of at least three tubes from the lot shall be polished for examination with a metallogical microscope. Using a magnification of 100 ×, the coating thickness at four points, 90° apart, in each sample shall be measured and the average of all measurements shall be taken as the thickness. In the case of tube having a diameter larger than can properly be mounted for polishing and examination, the portions of the cross section polished for examination may consist of an arc about ½ in. [13 mm] in length.

**TABLE 12 Lot Acceptance Criteria for Resistance to Stress Corrosion, Inch-Pound Units**

Alloy and Temper	Lot Acceptance Criteria		
	Electrical Conductivity <sup>A</sup> , % IACS	Level of Tensile Properties	Lot Acceptance Status
7074-T73, T73510, and T73511	40.0 or greater	per specified requirements	acceptable
	38.0 thru 39.9	per specified requirements and yield strength does not exceed minimum by more than 11.0 ksi	acceptable
		per specified requirements but yield strength exceeds minimum 12.0 ksi or more	unacceptable <sup>B</sup>
	less than 38.0	any level	unacceptable <sup>B</sup>

<sup>A</sup> Sampling for electrical conductivity tests shall be the same as for tensile tests as specified in 9.2. Test specimens may be prepared by machining a flat, smooth surface of sufficient width for proper testing. For small sizes of tubes, a cut-out portion may be flattened and the conductivity determined on the surface. Chemical milling may be used on flat surface samples. The electrical conductivity shall be determined in accordance with Practice E 1004 in the following locations:

Wall Thickness, in.	Location
Up thru 0.100	surface of tensile sample
0.101 thru 0.500	subsurface after removal of approximately 10 % of thickness of tensile sample
0.501 thru 1.500	subsurface at approximately center of wall thickness on a plane parallel to the longitudinal center line of the material
Over 1.500	subsurface on tensile test sample surface which is closest to the center of the wall thickness and on a plane parallel to the extrusion surface

<sup>B</sup> When material is found to be unacceptable, it shall be reprocessed (additional precipitation heat treatment, or re-solution heat treatment, stress relieving, straightening and precipitation heat treatment, when applicable)

**TABLE 13 Lot Acceptance Criteria for Resistance to Stress Corrosion, [SI Units]**

Lot Acceptance Properties			
Alloy and Temper	Electrical Conductivity <sup>A</sup> , % IACS	Level of Mechanical Properties	Lot Acceptance Status
7075-T73 T73510, and T73511	40.0 or greater	per specified requirements	acceptable
	38.0 to 39.9	per specified requirements and yield strength does not exceed minimum by more than 82 MPa	acceptable
	38.0 to 39.9	per specified requirements but yield strength exceeds minimum by 83 MPa or more	unacceptable <sup>B</sup>
	less than 38.0	any level	unacceptable <sup>B</sup>

<sup>A</sup> Sampling for electrical conductivity tests shall be the same as for tensile tests as specified in 0.2. Test specimens may be prepared by matching a flat, smooth surface of sufficient width for proper testing. For small sizes of tubes, a cut-out portion may be flattened and the conductivity determined on the surface. Chemical milling may be used on flat surface samples. The electrical conductivity shall be determined in accordance with Practice E 1004 in the following locations:

Wall Thickness, mm		Location
Over	Through	
---	2.50	surface of tensile sample
2.50	12.50	subsurface after removal of approximately 10 % of thickness of tensile sample
12.50	40.00	subsurface at approximately center of wall thickness on a plane parallel to the longitudinal center line of the material parallel
40.00	---	subsurface on tensile test sample surface which is closest to the center of the wall thickness and on a plane parallel to the extrusion surface

<sup>B</sup> When material is found to be unacceptable, it shall be reprocessed (additional precipitation heat treatment or re-solution heat treatment, stress relieving, straightening, and precipitation heat treatment, when applicable)

#### 14. Dimensional Tolerances

14.1 Variations from the specified dimensions for the type of material ordered shall not exceed the permissible variations prescribed in the following tables of ANSI H35.2 [H35.2M]:

Table No.	Title
12.	Extruded Tube
12.1	Diameter, Round Tube
12.3	Wall Thickness, Round Tube
12.5	Length
12.7	Straightness, Tube in Straight Lengths
12.9	Squareness of Cut Ends
16.	Pipe
16.1	Outside Diameter
16.2	Wall Thickness
16.3	Weight
16.4	Length, Plain End Pipe
16.7	Diameters, Wall Thicknesses, Weights

14.2 Tolerances for tempers and sizes not included in ANSI H35.2 [H35.2M] shall be as agreed upon between producer and purchaser and shall be so specified in the contract or purchase order.

14.3 *Sampling for Inspection*—Examination for dimensional conformance shall be made to ensure conformance to the tolerance specified.

#### 15. General Quality

15.1 Unless otherwise specified, the material shall be supplied in the mill finish and shall be uniform as defined by the requirements of this specification and shall be commercially sound. Any requirement not so covered is subject to negotiation between producer and purchaser.

15.2 When so specified in the contract or order, both ends of each length of pipe, or extruded tube except pipe of alloy 3003, temper H112, shall be threaded using an American National Standard Taper Pipe Thread. The variation from standard, when tested with the standard working gage, shall not exceed  $\pm 1\frac{1}{2}$  turns. The threaded ends shall be free from burrs and suitably protected against damage in transit.

15.3 Each pipe and tube shall be examined to determine conformance to this specification with respect to general quality and identification marking. On approval of the purchaser however, the producer may use a system of statistical quality control for such examinations.

#### 16. Internal Quality

16.1 When specified by the purchaser at the time of placing the contract or order, each tube 0.500 in. or greater [over 12.50 mm] in thickness, in alloys 2024, 7075, and 7178 shall be tested ultrasonically in accordance with Practice B 594 to the discontinuity acceptance limits of Table 6 [Table 7].

#### 17. Source Inspection

17.1 If the purchaser desires that his representative inspect or witness the inspection and testing of the material prior to shipment, such agreement shall be made by the purchaser and producer as part of the purchase contract.

17.2 When such inspections or witness of inspection and testing is agreed upon, the producer shall afford the purchaser's representative all reasonable facilities to satisfy him that the material meets the requirements of this specification. Inspection and tests shall be conducted so there is no unnecessary interference with the producer's operations.

#### 18. Retest and Rejection

18.1 If any material fails to conform to all of the applicable requirements of this specification, the inspection lot shall be rejected.

18.2 When there is evidence that a failed specimen was not representative of the inspection lot and when no other sampling plan is provided or approved by the purchaser through the contract or purchase order, at least two additional specimens shall be selected to replace each test specimen that failed. All specimens so selected for retest shall meet the requirements of the specification or the lot shall be subject to rejection.



18.3 Material in which defects are discovered subsequent to inspection may be rejected.

18.4 If material is rejected by the purchaser, the producer or supplier is responsible only for replacement of material to the purchaser. As much as possible of the rejected material shall be returned to the producer or supplier.

### 19. Identification Marking of Product

19.1 When specified on the purchase order or contract all pipe and tube shall be marked in accordance with Practice B 666/B 666M.

19.2 In addition, alloys 2014, 2024, 2219, 7075, and 7178 in the T6-, T73-, and T8-type tempers and, when specified, alloys 2014 and 2024 in the T3- and T4-type tempers and alloy 6061 in the T4- and T6-type tempers shall also be marked with the lot number in at least one location on each piece.

19.3 The requirements specified in 19.1 and 19.2 are minimum marking systems that involve added information; larger characters and greater frequencies are acceptable under this specification.

### 20. Packaging and Package Marking

20.1 The material shall be packaged to provide adequate protection during normal handling and transportation and each package shall contain only one size, alloy, and temper of

material unless otherwise agreed upon. The type of packaging and gross weight of containers shall, unless otherwise agreed upon, be at the producer's discretion, provided that they are such as to ensure acceptance by common or other carriers for safe transportation at the lowest rate to the delivery point.

20.2 Each shipping container shall be marked with the purchase order number, material size, specification number, alloy and temper, gross and net weights, and the producer's name or trademark.

20.3 When specified in the contract or purchase order, material shall be preserved, packaged, and packed in accordance with the requirements of Practices B 660. The applicable levels shall be as specified in the contract or order. Marking for shipment of such material shall be in accordance with Fed. Std. No. 123 for civilian agencies and MIL-STD-129 for military agencies.

### 21. Certification

21.1 The supplier or producer shall, on request, furnish to the purchaser a certificate stating that the material has been sampled, tested, and inspected in accordance with this specification, and has met the requirements.

### 22. Keywords

22.1 aluminum alloy; seamless extruded tube; seamless pipe

## ANNEXES

### (Mandatory Information)

#### A1. BASIS FOR INCLUSION OF PROPERTY LIMITS

A1.1 Limits are established at a level at which a statistical evaluation of the data indicates that 99 % of the population obtained from all standard material meets the limit with 95 % confidence. For the products described, mechanical property limits for the respective size ranges are based on the analyses of at least 100 data from standard production material with no more than ten data from a given lot. All tests are performed in accordance with the appropriate ASTM test methods. For

informational purposes, refer to "Statistical Aspects of Mechanical Property Assurance" in the Related Material section of the *Annual Book of ASTM Standards*, Vol 02.02. Mechanical property limits in this metric issue were derived from the inch-pound system limits that were developed under the above principles. As test data on metric dimensioned specimens are accumulated, some refinement of limits, particularly for elongations measured in 5D, can be anticipated.

#### A2. ACCEPTANCE CRITERIA FOR INCLUSION OF NEW ALUMINUM AND ALUMINUM ALLOYS IN THIS SPECIFICATION

A2.1 Prior to acceptance for inclusion in this specification, the composition of wrought or cast aluminum or aluminum alloy shall be registered in accordance with ANSI H35.1 or H35.1(M). The Aluminum Association<sup>12</sup> holds the Secretariat of ANSI H35 Committee and administers the criteria and procedures for registration.

A2.2 If it is documented that the Aluminum Association could not or would not register a given composition, an

alternative procedure and the criteria for acceptance shall be as follows:

A2.2.1 The designation submitted for inclusion does not utilize the same designation system as described in ANSI H35.1 or H35.1(M). A designation not in conflict with other designation systems or a trade name is acceptable.

A2.2.2 The aluminum or aluminum alloy has been offered for sale in commercial quantities within the prior twelve months to at least three identifiable users.

A2.2.3 The complete chemical composition limits are submitted.

<sup>12</sup> The Aluminum Association, 900 19th Street, NW, Washington, DC 20006.

A2.2.4 The composition is, in the judgment of the responsible subcommittee, significantly different from that of any other aluminum or aluminum alloy already in the specification.

A2.2.5 For codification purposes, an alloying element is any element intentionally added for any purpose other than grain refinement and for which minimum and maximum limits are specified. Unalloyed aluminum contains a minimum of 99.00 % aluminum.

A2.2.6 Standard limits for alloying elements and impurities are expressed to the following decimal places:

Less than 0.001 %	0.000X
0.001 to but less than 0.01 %	0.00X
0.01 to but less than 0.10 %	
Unalloyed aluminum made by a refining process	0.0XX
Alloys and unalloyed aluminum not made by a refining process	0.0X
0.10 through 0.55 %	0.XX
(It is customary to express limits of 0.30 through 0.55 % as 0.X0 or 0.X5.)	

Over 0.55 %

0 X, X X,  
etc.

(except that combined Si + Fe limits for 99.00 % minimum aluminum must be expressed as 0 XX or 1 XX)

A2.2.7 Standard limits for alloying elements and impurities are expressed in the following sequence: Silicon; Iron; Copper; Manganese; Magnesium; Chromium; Nickel; Zinc (Note A2.1); Titanium; Other Elements, Each; Other Elements, Total; Aluminum (Note A2.2).

NOTE A2.1—Additional specified elements having limits are inserted in alphabetical order of their chemical symbols between zinc and titanium, or are specified in footnotes.

NOTE A2.2—Aluminum is specified as *minimum* for unalloyed aluminum and as a *remainder* for aluminum alloys.

### A3. PART OR IDENTIFYING NUMBERS (PINs) FOR USE BY THE DEPARTMENT OF DEFENSE

A3.1 Part numbers are essential to maintain the integrity of the Department of Defense cataloging system as multiple National Stock Numbers (NSN) exist for this product.

A3.2 Part numbers shall be formulated by selecting from the options in this specification as follows:

B241	-XXXX	-XXXX	-XX	-XX	-XX
Document Identifier	Alloy	Temper	Pipe size in 0.25 in. increments	Schedule size	Length in feet

A3.3 *Examples of Part Numbers:*

B429-6063-T6-03-40-20 indicates a Specification B 429 standard structural pipe in 6063 alloy and T6 temper that is 3/4-in. pipe size, ANSI schedule 40, with a 20-ft length.

B429-3003-H112-04-10-10 indicates a Specification B 429 standard structural pipe in 3003 alloy and H112 temper that is 1-in. pipe size, ANSI schedule 10, with a 10-ft length.

### SUMMARY OF CHANGES

This section identifies the principal changes to this standard that have been incorporated since the last issue.

- (1) Replaced Practice B 597 with Practice B 918 in 2.2, 4.2.2 and 8.3.
- (2) Replaced MIL-H-6088 with AMS 2772 in 2.6 and 8.1.

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Designation: B 221M – 02

METRIC

# Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes [Metric]<sup>1</sup>

This standard is issued under the fixed designation B 221M; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reappraisal. A superscript epsilon ( $\epsilon$ ) indicates an editorial change since the last revision or reappraisal.

*This standard has been approved for use by agencies of the Department of Defense.*

## 1. Scope \*

1.1 This specification covers aluminum and aluminum-alloy extruded bar, rod, wire, profile, and tube in the aluminum alloys (Note 1) and tempers shown in Table 2.

NOTE 1—Throughout this specification the use of the term *alloy* in the general sense includes aluminum as well as aluminum alloy.

NOTE 2—For rolled or cold-finished bars and rods refer to Specification B 211M, for drawn tube to Specification B 210M, for structural pipe and tube to Specification B 429M, and for seamless pipe and tube to Specification B 241/B 241M.

1.2 Alloy and temper designations are in accordance with ANSI H35.1M. The equivalent Unified Numbering System alloy designations are those of Table 1 preceded by A9, for example, A91100 for Aluminum 1100 in accordance with Practice E 527.

1.3 For acceptance criteria for inclusion of new aluminum and aluminum alloys in this specification, see Annex A2.

1.4 This specification is the metric counterpart of Specification B 221.

## 2. Referenced Documents

2.1 The following documents of the issue in effect on the date of material purchase form a part of this specification to the extent referenced herein:

### 2.2 ASTM Standards:

- B 210M Specification for Aluminum and Aluminum-Alloy Drawn Seamless Tubes [Metric]<sup>2</sup>
- B 211M Specification for Aluminum and Aluminum-Alloy Bar, Rod, and Wire [Metric]<sup>2</sup>
- B 241/B 241M Specification for Aluminum and Aluminum-Alloy Seamless Pipe and Seamless Extruded Tube [Metric]<sup>2</sup>
- B 429M Specification for Aluminum-Alloy Extruded Structural Pipe and Tube [Metric]<sup>2</sup>
- B 557M Test Methods of Tension Testing Wrought and Cast Aluminum- and Magnesium-Alloy Products [Metric]<sup>2</sup>
- B 594 Practice for Ultrasonic Inspection of Aluminum-Alloy Wrought Products for Aerospace Applications<sup>2</sup>
- B 660 Practices for Packaging/Packing of Aluminum and Magnesium Products<sup>2</sup>
- B 666/B 666M Practice for Identification Marking of Aluminum and Magnesium Products<sup>2</sup>
- B 807 Practice for Extrusion Press Solution Heat Treatment of Aluminum Alloys<sup>2</sup>
- B 918 Practice for Heat Treatment of Wrought Aluminum Alloys<sup>2</sup>
- E 29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications<sup>3</sup>
- E 34 Test Methods for Chemical Analysis of Aluminum and Aluminum-Base Alloys<sup>4</sup>
- E 55 Practice for Sampling Wrought Nonferrous Metals and Alloys for Determination of Chemical Composition<sup>4</sup>
- E 227 Test Method for Optical Emission Spectrometric Analysis of Aluminum and Aluminum Alloys by the Point-to-Plane Technique<sup>4</sup>
- E 527 Practice for Numbering Metals and Alloys (UNS)<sup>5</sup>
- E 607 Test Method for Atomic Emission Spectrometric Analysis of Aluminum and Aluminum Alloys by the Point-to-Plane Technique, Nitrogen Atmosphere<sup>4</sup>
- E 716 Practices for Sampling Aluminum and Aluminum Alloys for Spectrochemical Analysis<sup>4</sup>
- E 1004 Practice for Determining Electrical Conductivity Using the Electromagnetic (Eddy-Current) Method<sup>6</sup>
- E 1251 Test Method for Optical Emission Spectrometric Analysis of Aluminum and Aluminum Alloys by the Argon Atmosphere, Point-to-Plane, Unipolar Self-Initiating Capacitor Discharge<sup>4</sup>

<sup>1</sup> This specification is under the jurisdiction of ASTM Committee B07 on Light Metals and Alloys and is the direct responsibility of Subcommittee B07.03 on Aluminum Alloy Wrought Products.

Current edition approved Oct. 10, 2002. Published January 2002. Originally approved in 1979. Last previous edition approved in 2000 as B 221M-00.

<sup>2</sup> Annual Book of ASTM Standards, Vol 02.02.

<sup>3</sup> Annual Book of ASTM Standards, Vol 14.02.

<sup>4</sup> Annual Book of ASTM Standards, Vol 03.05.

<sup>5</sup> Annual Book of ASTM Standards, Vol 01.01.

<sup>6</sup> Annual Book of ASTM Standards, Vol 03.03.

\*A Summary of Changes section appears at the end of this standard.



TABLE 1 Chemical Composition Limits<sup>A,B,C</sup>

Alloy	Silicon	Iron	Copper	Manga- nese	Magne- sium	Chro- mium	Zinc	Vanadium	Titanium	Other Elements <sup>D</sup>		Alumi- num	
										Each	Total <sup>E,F</sup>		
1060	0.25	0.35	0.05	0.03	0.03	...	0.05	0.05	...	0.03	0.03	99.60 min <sup>F</sup>	
1100	0.95 Si + Fe		0.05-0.20	0.05	...	...	0.10	...	...	0.05	0.15	99.00 min <sup>F</sup>	
2014	0.50-1.2	0.7	3.9-5.0	0.40-1.2	0.20-0.8	0.10	0.25	...	...	0.15	0.05	0.15	remainder
2024	0.50	0.50	3.8-4.9	0.30-0.9	1.2-1.8	0.10	0.25	...	...	0.15	0.05	0.15	remainder
2219	0.20	0.30	5.8-6.8	0.30-0.40	0.02	...	0.10	0.05-0.15	0.10-0.25 Zr	0.02-0.10	0.05	0.15	remainder
3003	0.6	0.7	0.05-0.20	1.0-1.5	...	...	0.10	...	...	...	0.05	0.15	remainder
Alclad 3003			3003 clad with 7072 alloy										
3004	0.30	0.7	0.25	1.0-1.5	0.8-1.3	...	0.25	...	...	...	0.05	0.15	remainder
3102	0.40	0.7	0.10	0.05-0.40	...	...	0.30	...	...	0.10	0.05	0.15	remainder
5052	0.25	0.40	0.10	0.10	2.2-2.8	0.15-0.35	0.10	...	...	...	0.05	0.15	remainder
5083	0.40	0.40	0.10	0.40-1.0	4.0-4.9	0.05-0.25	0.25	...	...	0.15	0.05	0.15	remainder
5086	0.40	0.50	0.10	0.20-0.7	3.5-4.5	0.05-0.25	0.25	...	...	0.15	0.05	0.15	remainder
5154	0.25	0.40	0.10	0.10	3.1-3.9	0.15-0.35	0.20	...	...	0.20	0.05	0.15	remainder
5454	0.25	0.40	0.10	0.50-1.0	2.4-3.0	0.05-0.20	0.25	...	...	0.20	0.05	0.15	remainder
5456	0.25	0.40	0.10	0.50-1.0	4.7-5.5	0.05-0.20	0.25	...	...	0.20	0.05	0.15	remainder
6005	0.6-0.9	0.35	0.10	0.10	0.40-0.6	0.10	0.10	...	...	0.10	0.05	0.15	remainder
6005A	0.50-0.9	0.35	0.30	0.50 <sup>G</sup>	0.40-0.7	0.30 <sup>G</sup>	0.20	...	...	0.10	0.05	0.15	remainder
6060	0.30-0.6	0.10-0.30	0.10	0.10	0.35-0.6	0.05	0.15	...	...	0.10	0.05	0.15	remainder
6081	0.40-0.8	0.7	0.15-0.40	0.15	0.8-1.2	0.04-0.35	0.25	...	...	0.15	0.05	0.15	remainder
6063	0.20-0.6	0.35	0.10	0.10	0.45-0.9	0.10	0.10	...	...	0.10	0.05	0.15	remainder
6066	0.9-1.8	0.50	0.7-1.2	0.6-1.1	0.8-1.4	0.40	0.25	...	...	0.20	0.05	0.15	remainder
6070	1.0-1.7	0.50	0.15-0.40	0.40-1.0	0.50-1.2	0.10	0.25	...	...	0.15	0.05	0.15	remainder
6105	0.6-1.0	0.35	0.10	0.10	0.45-0.8	0.10	0.10	...	...	0.10	0.05	0.15	remainder
6162	0.40-0.8	0.50	0.20	0.10	0.7-1.1	0.10	0.25	...	...	0.10	0.05	0.15	remainder
6262	0.40-0.8	0.7	0.15-0.40	0.15	0.8-1.2	0.04-0.14	0.25	...	...	0.15	0.05	0.15	remainder
6351	0.7-1.3	0.50	0.10	0.40-0.8	0.40-0.8	...	0.20	...	...	0.20	0.05	0.15	remainder
6463	0.20-0.6	0.15	0.20	0.05	0.45-0.9	...	0.05	...	...	...	0.05	0.15	remainder
7005	0.35	0.40	0.10	0.20-0.7	1.0-1.8	0.06-0.20	4.0-5.0	...	0.08-0.20 Zr	0.01-0.06	0.05	0.15	remainder
7072 <sup>I</sup>	0.7 Si + Fe		0.10	0.10	0.10	...	0.8-1.3	...	...	...	0.05	0.15	remainder
7075	0.40	0.50	1.2-2.0	0.30	2.1-2.9	0.18-0.28	5.1-6.1	...	...	0.20	0.05	0.15	remainder
7116	0.15	0.30	0.50-1.1	0.05	0.8-1.4	...	4.2-5.2	0.05	0.03Ga	0.05	0.05	0.15	remainder
7129	0.15	0.30	0.50-0.9	0.10	1.3-2.0	0.10	4.2-5.2	0.05	0.03Ga	0.05	0.05	0.15	remainder
7178	0.40	0.50	1.6-2.4	0.30	2.4-3.1	0.18-0.28	6.3-7.3	...	...	0.20	0.05	0.15	remainder

<sup>A</sup> Limits are in mass percent maximum unless shown as a range, or stated otherwise.

<sup>B</sup> Analysis shall be made for the elements for which limits are shown in this table.

<sup>C</sup> For the purpose of determining conformance to these limits, an observed value or a calculated value obtained from analysis shall be rounded to the nearest unit in the last right-hand place of the figures used in expressing the specified limits, in accordance with the rounding-off method of Practice E 29.

<sup>D</sup> Others includes listed elements for which no specific limit is shown as well as unlisted metallic elements. The producer may analyze samples for trace elements not specified in the specification. However, such analysis is not required and may not cover all metallic Others elements. Should any analysis by the producer or the purchaser establish that an Others element exceeds the limit of Each or that the aggregate of several Others elements exceeds the limit of Total, the material shall be considered nonconforming.

<sup>E</sup> Other elements—Total shall be the sum of unspecified metallic elements 0.010 % or more, rounded to the second decimal before determining the sum.

<sup>F</sup> The aluminum content shall be calculated by subtracting from 100.00 % the sum of all metallic elements present in amounts of 0.010 % or more each, rounded to the second decimal before determining the sum.

<sup>G</sup> Manganese plus chromium shall total 0.12-0.50.

<sup>H</sup> Bismuth and lead shall be 0.40-0.7 % each.

<sup>I</sup> Composition of cladding alloy applied during the course of manufacture. Samples from finished tube shall not be required to conform to these limits.

G 47 Test Method for Determining Susceptibility to Stress-Corrosion Cracking of 2xxx and 7xxx Aluminum Alloy Products<sup>7</sup>

Method of Test for Exfoliation Corrosion Susceptibility in 7xxx Series Copper-Containing Aluminum Alloys (EXCO Test) (G34-72)<sup>8</sup>

2.3 ANSI Standards:

H35.1(M) Alloy and Temper Designation Systems for Aluminum<sup>2</sup>

H35.2(M) Dimensional Tolerances for Aluminum Mill Products<sup>2</sup>

2.4 ISO Standards:<sup>9</sup>

ISO 209-1 Wrought Aluminum and Aluminum Alloys—Chemical Composition and Forms of Product

ISO 2107 Aluminum, Magnesium and their Alloys—Temper Designation

ISO 6362-2 Wrought Aluminum and Aluminum Alloy Extruded Rod/Bar, Tube, and Profile—Mechanical Properties

2.5 Federal Standard:

Fed. Std. No. 123 Marking for Shipment (Civil Agencies)<sup>10</sup>

2.6 Military Standard:

MIL-STD-129 Marking for Shipment and Storage<sup>10</sup>

2.7 AMS Specification:

<sup>7</sup> Annual Book of ASTM Standards, Vol 03.02.

<sup>8</sup> The applicable edition in the use of this specification is G 34-72, which is available in the gray pages of the Annual Book of ASTM Standards, Vol 02.02.

<sup>9</sup> Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036.

<sup>10</sup> Available from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094, Attn: NPODS.

AMS 2772 Heat Treatment of Aluminum Alloy Raw Materials<sup>1)</sup>

### 3. Terminology

#### 3.1 Definitions:

3.1.1 *extruded bar*—an extruded solid section, long in relation to its cross-sectional dimensions, having asymmetrical cross section that is square or rectangular with sharp or rounded corners or edges, or is a regular hexagon or octagon, and whose width or greatest distance between parallel faces is over 10 mm.

3.1.2 *extruded rod*—an extruded round section, long in relation to its diameter, whose diameter is over 10 mm.

3.1.3 *extruded profile*—a hollow or solid extruded section, long in relation to its cross-sectional dimensions, whose cross section is other than that of wire, rod, bar, or tube.

3.1.4 *extruded tube*—an extruded hollow section, long in relation to its cross-sectional dimensions, which is symmetrical and is round, square, rectangular, hexagonal, octagonal, or

elliptical with sharp or rounded corners, and has a uniform wall thickness except as affected by corner radii.

3.1.5 *alclad tube*—tube having on the inside surface a metallurgically bonded aluminum or aluminum-alloy coating that is anodic to the core alloy to which it is bonded, thus electrolytically protecting the core alloy against corrosion.

3.1.6 *wire*—a solid section long in relation to its cross-sectional dimensions, having a cross section that is round, hexagonal, or octagonal and whose diameter, width, or greatest distance between parallel faces is up through 10 mm, or having a symmetrical cross section that is square or rectangular (excluding flattened wire) with sharp or rounded corners or edges.

3.1.7 *producer*—the primary manufacturer of a material.

3.1.8 *supplier*—includes only the category of jobbers and distributors as distinct from producer.

#### 3.2 Definitions of Terms Specific to This Standard:

3.2.1 *capable of*—The term *capable of* as used in this specification means that the test need not be performed by the producer of the material. However, should subsequent testing by the purchaser establish that the material does not meet these requirements, the material shall be subject to rejection.

<sup>1)</sup> Available from Society of Automotive Engineers (SAE), 400 Commonwealth Dr., Warrendale, PA 15096-0001.

ASTM B 221M - 02

TABLE 2 Tensile Property Limits<sup>A,B</sup>

Temper	Specified Section or Wall Thickness, mm		Area, mm <sup>2</sup>		Tensile Strength, MPa		Yield Strength (0.2% offset), MPa		Elongation, <sup>C</sup> %, min	
	over	incl	over	incl	min	max	min	max	in 50 mm	in 5 × Diameter (5.65 √A)
Aluminum 1060										
O	all		all		60	95	15		25	22
H112	all		all		60		15		25	22
F <sup>D</sup>	all		all							
Aluminum 1100										
O	all		all		75	105	20		25	22
H112	all		all		75		20		25	22
F <sup>D</sup>	all		all							
Alloy 2014										
O	all		all			205		125	12	10
I4	all		all		345		240		12	10
T4510 <sup>E</sup>	}		all							
T4511 <sup>E</sup>										
I42 <sup>F</sup>										
T6	}	12.50	all						7	6
T6510 <sup>E</sup>										
T6511 <sup>E</sup>										
T62 <sup>F</sup>										
		18.00		16 000	440		400			6
		18.00		20 000	470		415			6
		18.00	16 000		470		400			5
		18.00	all		415		365		7	6
		18.00		16 000	415		365			6
		18.00	16 000	20 000	415		365			5
F <sup>D</sup>	all		all							
Alloy 2024										
O	all		all			240		130	12	10
T3	}	6.30	all						12 <sup>G</sup>	10 <sup>G</sup>
T3510 <sup>E</sup>										
T3511 <sup>E</sup>										
		18.00	all		415		305			
		35.00	all		450		315			9
		35.00		16 000	485		360 <sup>H</sup>			9
		35.00		20 000	470		330 <sup>I</sup>			7
T42 <sup>F</sup>	}	18.00	all						12	10
		35.00	all		395		260			9
		35.00		16 000	395		260			9
		35.00	16 000	20 000	395		260			7
T81	}	6.30	all						4	4
T8510 <sup>E</sup>										
T8511 <sup>E</sup>										
F <sup>D</sup>	all		all		20 000	455	400			4
	all		all							
Alloy 2219										
O	all		all			220		125	12	10
T31	}	12.50			16 000	290		180	14	12
T3510 <sup>E</sup>										
T62 <sup>F</sup>										
		25.00			16 000	370		250	6	5
		25.00			20 000	370		250		5
T81	}	80.00			16 000	400		290	6	5
T8510 <sup>E</sup>										
T8511 <sup>E</sup>										
F <sup>D</sup>	all		all							
Alloy 3003										
O	all		all		95	130	35		25	22
H112	all		all		90		30		25	22
F <sup>D</sup>	all		all							
Alciad Alloy 3003										
O	all	all	all		90	125	30		25	
H112	all				90		30 <sup>J</sup>		25	
Alloy 3004										
O	all		all		160	200	60			
F <sup>D</sup>	all		all							

 **B 221M – 02**

**TABLE 2** *Continued*

Temper	Specified Section or Wall Thickness, mm		Area, mm <sup>2</sup>		Tensile Strength, MPa		Yield Strength (0.2 % offset), MPa		Elongation, % <sup>c</sup> , min	
	over	incl	over	incl	min	max	min	max	in 50 mm	in 5 × Diameter (5.65 √A)
<b>Alloy 3102</b>										
H112 <sup>K</sup>	0.70	1.30	all		75	125	30		25	
<b>Alloy 5052</b>										
O	all		all		170	240	70			
<b>Alloy 5083</b>										
O		130.00 <sup>L</sup>		20 000	270	350	110		14	12
H111		130.00 <sup>L</sup>		20 000	275		165		12	10
H112		130.00 <sup>L</sup>		20 000	270		110		12	10
F <sup>D</sup>	all		all							
<b>Alloy 5086</b>										
O		130.00 <sup>L</sup>		20 000	240	315	95		14	12
H111		130.00 <sup>L</sup>		20 000	250		145		12	10
H112		130.00 <sup>L</sup>		20 000	240		95		12	10
F <sup>D</sup>	all		all							
<b>Alloy 5154</b>										
O	all		all		205	285	75			
H112	all		all		205		75			
<b>Alloy 5454</b>										
O		130.00 <sup>L</sup>		20 000	215	285	85		14	12
H111		130.00 <sup>L</sup>		20 000	230		130		12	10
H112		130.00 <sup>L</sup>		20 000	215		85		12	10
F <sup>D</sup>	all		all							
<b>Alloy 5456</b>										
O		130.00 <sup>L</sup>		20 000	285	365	130		14	12
H111		130.00 <sup>L</sup>		20 000	290		180		12	10
H112		130.00 <sup>L</sup>		20 000	285		130		12	10
F <sup>D</sup>	all		all							
<b>Alloy 6005</b>										
T1		12.50	all		170		105		16	14
T5		3.20	all		260		240		8	
	3.20	25.00	all		260		240		10	9
<b>Alloy 6005A</b>										
T1		6.30	all		170		100		15	
T5		6.30	all		260		215		7	
	6.30	25.00	all		260		215		9	8
<b>Alloy 6060</b>										
T51		3.20	all		150		110		8	
<b>Alloy 6061</b>										
O	all		all			150		110	16	14
T1		16.00	all		180		95		16	14
T4			all		180		110		16	14
T4510 <sup>E</sup>	}	all	all							
T4511 <sup>E</sup>										
T42 <sup>F</sup>	all		all		180		85		16	14
T51		16.00	all		240		205		8	7
T6, T62 <sup>F</sup>	}	6.30	all		260		240		8	
T6510 <sup>E</sup>										
T6511 <sup>E</sup>	}	6.30	all		260		240		10	9
F <sup>D</sup>										
<b>Alloy 6063</b>										
O	all		all			130			18	16
T1		12.50	all		115		60		12	10
		25.00	all		110		55			10
T4, T42 <sup>F</sup>		12.50	all		130		70		14	12
		25.00	all		125		60			12
T5		12.50	all		150		110		8	7
		25.00	all		145		105			7

 B 221M - 02

TABLE 2 Continued

Temper	Specified Section or Wall Thickness, mm		Area, mm <sup>2</sup>		Tensile Strength, MPa		Yield Strength (0.2% offset), MPa		Elongation, <sup>C</sup> %, min	
	over	incl	over	incl	min	max	min	max	in 50 mm	in 5 × Diameter (5.65 √A)
T52		25.00	all		150	205	110	170	8	7
T6, T62 <sup>K</sup>		3.20	all		205		170		8	
	3.20	25.00	all		205		170		10	9
Alloy 6066										
O	all		all			200		125	16	14
T4			all		275		170		14	12
T4510 <sup>E</sup>	}	all	all							
T4511 <sup>E</sup>										
T42 <sup>F</sup>	all		all		275		165		14	12
T6	}	all	all		345		310		8	7
T6510 <sup>E</sup>										
T6511 <sup>E</sup>										
T62 <sup>F</sup>	all		all		345		290		8	7
Alloy 6070										
T6, T62		80.00		20.000	330		310		6	5
Alloy 6105										
T1		12.5	all		170		105		16	14
T5		3.20	all		250		240		8	
	3.20	25.00	all		250		240		10	9
Alloy 6162										
T5, T5510 <sup>E</sup> , T5511 <sup>E</sup>	}	25.00	all		255		235		7	6
T6, T6510 <sup>E</sup> , T6511 <sup>E</sup>										
	6.30	12.50	all		260		240		8	9
			all		260		240		10	9
Alloy 6262										
T6, T6510 <sup>E</sup> , T6511 <sup>E</sup>	}	all	all		260		240		10	9
Alloy 6351										
T1		12.50		13.000	180		90		15	13
T11		19.00	all		180		110		16	14
T4		19.00	all		220		130		16	14
T5		6.30	all		260		240		8	
	6.30	25.00	all		260		240		10	9
T51	3.20	25.00	all		250		230		10	7
T54		12.50	all		205		140		10	9
T6		3.20	all		290		255		8	
	3.20	18.00	all		290		255		10	9
Alloy 6463										
T1		12.50		13.000	115		60		12	10
T5		12.50		13.000	150		110		8	7
T6, T62 <sup>F</sup>		3.20		13.000	205		170		8	
	3.20	12.50		13.000	205		170		10	9
Alloy 7005										
T53	3.20	25.00		16.000	345		305		10	9
Alloy 7116										
T5	3.20	12.50	all		330		290		8	7
Alloy 7129										
T5, T6		12.50	all		380		340		9	8
Alloy 7075										
O	all		all			275		165	10	9

TABLE 2 Continued

Temper	Specified Section or Wall Thickness, mm		Area, mm <sup>2</sup>		Tensile Strength, MPa		Yield Strength (0.2 % offset), MPa		Elongation, <sup>a</sup> %, min	
	over	incl	over	incl	min	max	min	max	in 50 mm	in 5 × Diameter (5.65 √A)
T6		6.30	all		540		485		7	
T62 <sup>F</sup>	6.30	12.50	all		560		505		7	6
T6510 <sup>E</sup>	12.50	70.00	all		560		495			6
T6511 <sup>E</sup>	70.00	110.00		13 000	560		490			6
	70.00	110.00 <sup>d</sup>	13 000	20 000	540		485			5
	110.00	130.00 <sup>d</sup>		20 000	540		470			5
T73	1.60	6.30		13 000	470		400		7	
T3510 <sup>E</sup>	6.30	35.00		16 000	485		420		8	7
T3511 <sup>E</sup>	35.00	70.00		18 000	475		405			7
	70.00	110.00 <sup>d</sup>		13 000	470		395			6
	70.00	110.00 <sup>d</sup>	13 000	20 000	450		380			6
		1.25	all		500		435		7	
T76	1.25	3.20	all		510		440		7	
T76510 <sup>E</sup>	3.20	6.30		13 000	510		440		7	
T76511 <sup>E</sup>	6.30	12.50		13 000	515		450		7	6
	12.50	25.00		13 000	515		450			6
	25.00	50.00		13 000	515		450		7	6
	50.00	75.00		13 000	510		440		7	6
	75.00	100.00		13 000	510		435		7	6
F <sup>D</sup>	all		all							
Alloy 7178										
O	all			20 000		275		165	10	9
		1.60		13 000	565		525			
T6	1.60	6.30		13 000	580		525		5	
T6510 <sup>E</sup>	6.30	35.00		16 000	600		540		5	4
T6511 <sup>E</sup>	35.00	60.00	16 000	16 000	595		530			4
	35.00	60.00		20 000	580		515			4
	60.00	80.00		20 000	565		490			4
		1.60		13 000	545		505			
		6.30		13 000	565		510		5	
T62 <sup>F</sup>	6.30	35.00		16 000	595		530		5	4
	35.00	60.00		16 000	595		530			4
	35.00	60.00	16 000	20 000	580		515			4
	60.00	80.00		20 000	565		490			4
T76	3.20	6.30		13 000	525		455		7	
T76510 <sup>E</sup>	6.30	12.50		13 000	530		460		7	6
T76511 <sup>E</sup>	12.50	25.00		13 000	530		460			6
F <sup>D</sup>	all		all							

<sup>a</sup>The basis for establishment of tensile property limits is shown in Annex A1.

<sup>b</sup>To determine conformance to this specification, each value shall be rounded to the nearest 1 MPa for strength and the nearest 0.5 % for elongation, in accordance with the rounding-off method of Practice E 29.

<sup>c</sup>Elongations in 50 mm apply for shapes tested in full section and for sheet-type specimens machined from material up through 12.5 mm in thickness having parallel surfaces. Elongations in 5 × diameter (5.65 √A), where D and A are diameter and cross-sectional area of the specimen respectively, apply to round test specimens machined from thicknesses over 6.30. See 8.1.1 and 8.1.2 for conditions under which measurements are not required.

<sup>d</sup>No mechanical properties are specified or guaranteed.

<sup>e</sup>For stress-relieved tempers (T3510, T3511, T4510, T4511, T5510, T5511, T6510, T6511, T73510, T73511, T76510, T76511, T8510, T8511), characteristics and properties offer than those specified may differ somewhat from the corresponding characteristics and properties of material in the basic tempers.

<sup>f</sup>Material in the T42 and T62 tempers is not available from the material producers.

<sup>g</sup>Minimum elongation for tube, 10 % in 50 mm and 9 % in 5 × diameter.

<sup>h</sup>Minimum yield strength for tube, 330 MPa.

<sup>i</sup>Minimum yield strength for tube 315 MPa.

<sup>j</sup>Yield strength is not applicable to tube.

<sup>k</sup>Only in tube form.

<sup>l</sup>Properties not applicable to extruded tube over 70 mm wall thickness.

#### 4. Ordering Information

4.1 Orders for material to this specification shall include the following information:

- 4.1.1 This specification designation (which includes the number, the year, and the revision letter, if applicable),
- 4.1.2 Quantity in pieces or kilograms,
- 4.1.3 Alloy (Section 7 and Table 1),

4.1.4 Temper (Section 8 and Table 2),

4.1.5 Nominal cross-sectional dimensions as follows:

- 4.1.5.1 For rod and round wire—diameter,
- 4.1.5.2 For square-cornered bar and wire—depth and width,
- 4.1.5.3 For sharp-cornered hexagonal or octagonal bar and wire—distance across flats,

4.1.5.4 For round tube—outside or inside diameter and wall thickness.

4.1.5.5 For square or sharp-cornered tube other than round—distance across flats and wall thickness.

4.1.5.6 For round-cornered bar, profile, tube other than round, square, rectangular, hexagonal, or octagonal with sharp corners—drawing required, and

4.1.6 Length.

4.2 Additionally, orders for material to this specification shall include the following information when required by the purchaser:

4.2.1 Whether heat treatment in accordance with Practice B 918 is required (9.2),

4.2.2 Whether ultrasonic inspection is required (Section 17, Table 3),

4.2.3 Whether inspection or witness of inspection and tests by the purchaser's representative is required prior to material shipment (Section 18),

4.2.4 Whether certification is required (Section 22),

4.2.5 Whether marking for identification is required (Section 20), and whether marking of lot number for alloys 2014 and 2024 in the T3- and T4-type tempers and alloy 6061 in the T6-type temper is required (20.2).

4.2.6 Whether Practices B 660 applies and, if so, the levels of preservation, packaging, and packing required (Section 21.3), and

4.2.7 Requirements for tensile property and dimensional tolerance for sizes not specifically covered (8.1.3 and 15.1.1).

**5. Materials and Manufacture**

5.1 The products covered by this specification shall be produced by the hot extrusion method or by similar methods at the option of the producer, provided that the resulting products comply with the requirements in this specification.

**6. Quality Assurance**

6.1 *Responsibility for Inspection and Tests*—Unless otherwise specified in the contract or purchase order, the producer is responsible for the performance of all inspection and test requirements specified herein. The producer may use his own or any other suitable facilities for the performance of the inspection and test requirements specified herein, unless dis-

approved by the purchaser in the order or at the time of contract signing. The purchaser shall have the right to perform any of the inspections and tests set forth in this specification where such inspections are deemed necessary to ensure that material conforms to prescribed requirements.

6.2 *Lot Definition*—An inspection lot shall be defined as follows:

6.2.1 For heat-treated tempers, an inspection lot shall consist of an identifiable quantity of material of the same mill form, alloy, temper, and nominal dimensions traceable to a heat-treat lot or lots, and subjected to inspection at one time.

6.2.2 For nonheat-treated tempers, an inspection lot shall consist of an identifiable quantity of material of the same mill form, alloy, temper, and nominal dimensions subjected to inspection at one time.

**7. Chemical Composition**

7.1 *Limits*—The material shall conform to the chemical composition limits in Table 1. Conformance shall be determined by analyzing samples taken when the ingots are poured, or samples taken from the finished or semifinished product. If the chemical composition has been determined during the course of manufacture, analysis of the finished product shall not be required.

NOTE 3—It is standard practice in the United States aluminum industry to determine conformance to the chemical composition limits prior to further processing of ingots into wrought products. Due to the continuous nature of the process, it is not practical to keep a specific ingot analysis identified with a specific quantity of finished material.

7.2 *Number of Samples:*

7.2.1 The number of samples taken for determination of chemical composition shall be as follows:

7.2.1.1 When samples are taken at the time the ingots are poured, at least one sample shall be taken for each group of ingots poured simultaneously from the same source of molten metal:

7.2.1.2 When samples are taken from the finished or semifinished product, a sample shall be taken to represent each 2000 kg, or fraction thereof, in the lot, except that not more than one sample shall be required per piece.

7.3 *Methods of Sampling:*

7.3.1 Samples for determination of chemical composition shall be taken in accordance with one of the following methods:

7.3.1.1 Samples for chemical analysis shall be taken from the material by drilling, sawing, milling, turning, or clipping a representative piece or pieces to obtain prepared sample of not less than 75 g. Sampling shall be in accordance with Practice E 55.

7.3.1.2 Sampling for spectrochemical analysis shall be in accordance with Practices E 716. Samples for other methods of analysis shall be suitable for the form of material being analyzed and the type of analytical method used.

NOTE 4—It is difficult to obtain a reliable analysis of each of the components of clad materials using material in its finished state. A reasonably accurate determination of the core composition can be made if the cladding is substantially removed prior to analysis. The cladding composition is more difficult to determine because of the relatively thin layer and because of diffusion of core elements to the cladding. The

**TABLE 3 Ultrasonic Discontinuity Limits for Extruded Bar and Profiles<sup>A</sup>**

Alloy	Thickness, <sup>B</sup> mm		Mass max per Piece, kg	Max Width, Thickness Ratio	Discontinuity Class <sup>C</sup>
	over	incl			
2014	12.50	...	300	10:1	B
2024					
2219					
7075	12.50	35.00	300	10:1	B
7178					

<sup>A</sup>Discontinuities in excess of those listed in this table shall be allowed, subject to the approval of the procuring activity, if it is established that they will be removed by machining or that they are in noncritical areas.

<sup>B</sup>The thickness of any element of a "profile" shall be deemed to be the smallest dimension of that element and the discontinuity class applicable to that particular thickness shall apply to that element of the profile.

<sup>C</sup>The discontinuity class limits are defined in Section 11 of Practice B 594.

correctness of cladding alloy used can usually be verified by a combination of metallographic examination and spectrochemical analysis of the surface at several widely separated points.

**7.4 Methods of Analysis**—The determination of chemical composition shall be made in accordance with suitable chemical (Test Methods E 34) or spectrochemical (Test Methods E 227, E 607, and E 1251) methods. Other methods may be used only when no published ASTM test method is available. In case of dispute, the methods of analysis shall be agreed upon between the producer and purchaser.

## 8. Tensile Properties of Material from the Producer

**8.1 Limits**—The material shall conform to the tensile property requirements specified in Table 2.

**8.1.1** The elongation requirements shall not be applicable to the following:

**8.1.1.1** Material of such dimensions that a standard test specimen cannot be taken in accordance with Test Methods B 557M, and of such profile that it cannot be satisfactorily tested in full section.

**8.1.1.2** Material up through 1.60 mm in thickness.

**8.1.1.3** Wire up through 3.20 mm in diameter.

**8.1.2** The measurement for yield strength is not required for wire up through 3.20 mm in diameter.

**8.1.3** Tensile property limits for sizes not covered in Table 2 shall be as agreed upon between the producer and purchaser and shall be so specified in the contract or purchase order.

**8.2 Number of Specimens:**

**8.2.1** For material having a nominal mass up through 1.7 kg/linear m, one tension test specimen shall be taken for each 500 kg or fraction thereof in the lot.

**8.2.2** For material having a nominal mass over 1.7 kg/linear m, one tension test specimen shall be taken for each 300 m or fraction thereof in the lot.

**8.2.3** Other procedures for selecting samples may be employed if agreed upon between the producer or supplier and the purchaser.

**8.3** Geometry of test specimens and the location in the product from which they are taken shall be as specified in Test Methods B 557M.

**8.4 Test Methods**—The tension tests shall be made in accordance with Test Methods B 557M.

**8.5 Retests**—When there is evidence that the test specimen is defective or is not representative of the lot of material, retesting may be performed in accordance with Section 8 and 9 of Test Methods B 557M.

## 9. Heat Treatment

**9.1** Producer and supplier heat treatment for the production of T1 and T5-type tempers shall be in accordance with Practice B 807 and for the production of T3, T4, T6, T7, and T8-type tempers, except as noted in 9.3 or otherwise specified in 9.2, shall be in accordance with AMS 2772.

**9.2** When specified, heat treatment for the production of T3, T4, T6, T7, and T8-type tempers shall be in accordance with Practice B 918.

**9.3** Alloys 6061, 6063, 6162, 6463, and 6351 may be solution heat-treated and quenched at the extrusion press in accordance with Practice B 807 for the production of T4 and T6-type tempers, as applicable.

## 10. Producer Confirmation of Heat-Treat Response

**10.1** In addition to the requirements of Section 8, material in alloys 2014, 2024, and 6061 produced in the O or F temper (within the size limits specified in Table 2) shall, after proper solution heat treatment and natural aging for not less than 4 days at room temperature, conform to the properties specified in Table 2 for T42 temper material. The heat-treated samples may be tested prior to 4 days natural aging but if they fail to conform to the T42 temper properties, the test may be repeated after completion of 4 days natural aging without prejudice.

**10.2** Alloys 2219, 7075, and 7178 material produced in the O or F temper (within the size limits specified in Table 2) shall, after proper solution heat treatment and precipitation heat treatment, conform to the properties specified in Table 2 for T62 temper material.

**10.3 Number of Specimens**—The number of specimens from each lot of O temper material and F temper material to be tested to verify conformance with 10.1 and 10.2 shall be as specified in 8.2.

## 11. Heat Treatment and Reheat-Treatment Capability

**11.1** As-received material in the O or F temper in alloys 2014, 2024, and 6061 (within the size limitations specified in Table 2 and without the imposition of cold work) shall be capable of conforming to the properties specified in Table 2 for T42 temper, upon being properly solution heat-treated and naturally aged for not less than 4 days at room temperature.

**11.2** As-received material in the O and F tempers in alloys 2219, 7075, and 7178 (within the size limitations specified in Table 2 and without the imposition of cold work) shall be capable of conforming to the properties specified in Table 2 for the T62 temper, upon being properly solution and precipitation heat-treated.

**11.3** Material in alloys and tempers 2014-T4, T4510, T4511, T6, T6510, and T6511, and 2024-T3, T3510, T3511, T81, T8510, and T8511 shall be capable of conforming to the properties specified in Table 2 for the T42 temper, upon being properly resolution heat-treated and naturally aged for not less than 4 days at room temperature.

NOTE 5—6061-T4, T6, T4510, T4511, T6510, and T6511 are deleted from 11.3 because experience has shown the reheat-treated material tends to develop large recrystallized grains and may fail to develop the tensile properties shown in Table 2.

**11.4** Alloy 2219 in the T31, T3510, T3511, T81, T8510, and T8511 tempers, and alloys 7075 and 7178 in the T6, T651, T6510, and T6511 tempers shall be capable of conforming to the properties specified in Table 2 for the T62 temper, upon being properly resolution heat-treated and precipitation heat-treated.

**11.5** Material in T3/T31, T3510, T3511, T4, T4510, and T4511 tempers shall be capable of conforming, upon being properly precipitation heat-treated, to the properties specified in Table 2 for the T81, T8510, T8511, T6, T6510, and T6511 tempers, respectively.



12. Stress-Corrosion Resistance

12.1 Alloy 7075 in the T73 and T76-type tempers and alloy 7178 in the T76-type tempers shall be capable of exhibiting no evidence of stress-corrosion cracking when subjected to the test specified in 12.2.

12.1.1 For lot-acceptance purposes, resistance to stress-corrosion cracking for each lot of material shall be established by testing the previously selected tension-test samples to the criteria shown in Table 4.

12.1.2 For surveillance purposes, each month the producer shall perform at least one test for stress corrosion resistance in accordance with 12.2 on each applicable alloy/temper for each thickness range 20.00 and over produced that month. Each sample shall be taken from material considered acceptable in accordance with the lot-acceptance criteria of Table 4. A minimum of three adjacent replicate specimens shall be taken from each sample and tested. The producer shall maintain records of all lots so tested and make them available for examination at the producer's facility.

12.2 The stress-corrosion cracking test shall be performed on material 20.00 mm and over in thickness as follows:

12.2.1 Specimens shall be stressed in tension in the short transverse direction with respect to grain flow and held at constant strain. The stress level shall be 75 % of the specified minimum yield strength for T73-type tempers and 170 MPa for T76-type tempers.

12.2.2 The stress-corrosion test shall be made in accordance with Test Method G 47.

12.2.3 There shall be no visual evidence of stress-corrosion cracking in any specimen, except that the retest provisions of 19.2 shall apply.

13. Exfoliation-Corrosion Resistance

13.1 Alloys 7075 and 7178 in the T76, T76510, and T76511 tempers shall be capable of exhibiting no evidence of exfoliation corrosion equivalent to or in excess of that illustrated by Category B in Fig. 2 of Test for Exfoliation Corrosion Susceptibility in 7xxx Series Copper Containing Aluminum Alloys (EXCO Test) (G 34-72) when tested in accordance with 13.1.1.

13.1.1 For surveillance purposes, each month at least one exfoliation-corrosion test shall be performed for each size range of extrusions produced during that month. The test shall be in accordance with Test for Exfoliation Corrosion Susceptibility in 7xxx Series Copper Containing Aluminum Alloys (EXCO Test) (G 34-72) on material considered acceptable in accordance with lot-acceptance criteria of Table 4. Specimens shall be selected at random and shall be, if possible, a minimum of 50 by 100 mm with the 100-mm dimension in a plane parallel to the direction of extrusion. The test location shall be in accordance with that specified in Table 4. The producer shall maintain records of all surveillance test results and make them available for examination at the producer's facility.

13.2 For lot-acceptance purposes, resistance to exfoliation corrosion for each lot of material in the alloys and tempers listed in 13.1 shall be established by testing the previously selected tension-test samples to the criteria shown in Table 4.

14. Cladding

14.1 The aluminum-alloy cladding on clad tube shall comprise the inside surface (only) of the tube and its thickness shall be approximately 10 % of the total wall thickness.

TABLE 4 Lot Acceptance Criteria for Resistance to Stress Corrosion and Exfoliation Corrosion

Alloy and Temper	Lot Acceptance Criteria		Lot Acceptance Status
	Electrical Conductivity, <sup>A</sup> % IACS	Level of Mechanical Properties	
7075-T73	40.0 or greater	per specified requirements	acceptable
T73510 and T73511	38.0 through 39.9	per specified requirements and yield strength does not exceed minimum by more than 82 MPa	acceptable
	38.0 through 39.9	per specified requirements but yield strength exceeds minimum by more than 82 MPa	unacceptable <sup>B</sup>
	less than 38.0	any level	unacceptable <sup>B</sup>
7075-T76, T76510, and T76511	38.0 or greater	per specified requirements	acceptable
	36.0 through 37.9	per specified requirements	unacceptable <sup>B</sup>
	less than 36.0	any level	unacceptable <sup>B</sup>
7178-T76, T76510, and T76511	38.0 or greater	per specified requirements	acceptable
	35.0 through 37.9	per specified requirements	unacceptable <sup>B</sup>
	less than 35.0	any level	unacceptable <sup>B</sup>

<sup>A</sup> Sampling for electrical conductivity tests shall be the same as for tensile tests as specified in 8.2. Test specimens may be prepared by machining a flat, smooth surface of sufficient width for proper testing. For small sizes of tubes, a cut-out portion may be flattened and the conductivity determined on the surface. Chemical milling may be used on flat surface samples. The electrical conductivity shall be determined in accordance with Practice E 1004 in the following locations:

<sup>B</sup> When material is found to be unacceptable, it shall be reprocessed (additional precipitation heat treatment or re-solution heat treatment, stress relieving, straightening, and precipitation heat treatment, when applicable).

Section Thickness, mm		Location
over	through	
...	2.50	surface of tension sample
2.50	12.50	subsurface after removal of approximately 10 % of the thickness
12.50	40.00	subsurface at approximate center of section thickness, on a plane parallel to the longitudinal center line of the material
40.00	...	subsurface on tension-test specimen surface that is closest to the center of the section thickness and on a plane parallel to the extrusion surface

14.2 When the cladding thickness is to be determined on finished tube, transverse cross sections of at least three tubes from the lot shall be polished for examination with a metallographic microscope. Using a 100× magnification, the cladding thickness at four points 90° apart in each sample shall be measured and the average of the 12 measurements shall be taken as the thickness. For a tube having a diameter larger than can be properly mounted for polishing and examination, the portions of the cross section polished for examination may consist of an arc about 12 mm in length.

## 15. Dimensional Tolerances

15.1 *Dimensions*—Variations from the specified dimensions for the type of material ordered shall not exceed the permissible variations prescribed in the tables of ANSI H35.2M (see Table 5).

15.1.1 Dimensional tolerances for sizes not covered in ANSI H35.2M shall be as agreed upon between the producer and purchaser and shall be so specified in the contract or purchase order.

15.2 *Sampling for Inspection*—Examination for dimensional conformance shall be made to ensure conformance to the tolerance specified.

## 16. General Quality

16.1 Unless otherwise specified the extruded bar, rod, wire, profile, and tube shall be supplied in the mill finish and shall be uniform as defined by the requirements of this specification and shall be commercially sound. Any requirement not so covered is subject to negotiation between the producer and purchaser.

16.2 Each bar, rod, wire, profile, or tube shall be examined to determine conformance to this specification with respect to general quality and identification marking. On approval of the purchaser, however, the producer or the supplier may use a system of statistical quality control for such examination.

## 17. Internal Quality

17.1 When specified by the purchaser at the time of placing the contract or order, each bar or profile over 12.50 mm in thickness or smallest dimension, in alloys 2014, 2024, 2219, 7075, and 7178 shall be tested ultrasonically in accordance with Practice B 594 to the discontinuity acceptance limits of Table 3.

## 18. Source Inspection

18.1 If the purchaser desires that his representative inspect or witness the inspection and testing of the material prior to shipment, such agreement shall be made by the purchaser and the producer or supplier as part of the purchase contract.

18.2 When such inspection or witness of inspection and testing is agreed upon, the producer or supplier shall afford the purchaser's representative all reasonable facilities to satisfy him that the material meets the requirements of this specification. Inspection and tests shall be conducted so there is no unnecessary interference with the producer's or supplier's operations.

## 19. Retest and Rejection

19.1 If any material fails to conform to all of the applicable requirements of this specification, it shall be cause for rejection of the inspection lot.

19.2 When there is evidence that a failed specimen was not representative of the inspection lot and when no other sampling plan is provided or approved by the purchaser through the contract or purchase order, at least two additional specimens shall be selected to replace each test specimen that failed. All specimens so selected for retest shall meet the requirements of the specification or the lot shall be subject to rejection.

19.3 Material in which defects are discovered subsequent to inspection may be rejected.

19.4 If material is rejected by the purchaser, the seller is responsible only for replacement of the material to the purchaser. As much as possible of the rejected material shall be returned to the seller by the purchaser.

## 20. Identification Marking of Product

20.1 When specified in the contract or purchase order, all material shall be marked in accordance with Practice B 666/ B 666M.

20.2 In addition, alloys 2014, 2024, 2219, 7075, and 7178 in the T6-, T73-, T76-, and T8-type tempers and, when specified, alloys 2014, 2024, and 6061 in the T3- and T4-type tempers and alloy 6061 in the T6-type tempers shall also be marked with the lot number in at least one location on each piece.

20.3 The requirements specified in 20.1 and 20.2 are the minimum; marking systems that involve added information, larger characters, and greater frequencies are acceptable under this specification, and shall be agreed upon by the producer and purchaser.

TABLE 5 Tables of ANSI H35.2M

Table No.	Title
10.1	Cross-Sectional Dimensions: Wire, Rod, Bar & Profiles Except for Profiles in T3510, T4510, T6510, T73510, T76510 and T8510 Tempers
10.2	Length: Wire, Rod, Bar and Profiles
10.3	Straightness: Rod, Bar and Profiles
10.4	Twist: Bar and Profiles
10.5	Flatness: Flat Surfaces
10.6	Flatness: Flat Surfaces, Hollow Profiles Except for O, T3510, T4510, T6510, T73510, T76510 and T8510 Tempers
10.7	Surface Roughness: Wire, Rod, Bar and Profiles
10.8	Contour (Curved Surfaces): Profiles Except for O, T3510, T4510, T6510, T73510, T76510 and T8510 Tempers
10.9	Squareness of Cut Ends: Wire, Rod, Bar and Profiles
10.10	Corner and Fillet Radii: Bar and Profiles
10.11	Angularity: Bar and Profiles Except for O, T3510, T4510, T6510, T73510, T76510, and T8510 Tempers
12.1	Diameter Round Tube Except for T3510, T4510, T6510, T73510, T76510 and T8510 Tempers
12.2	Width and Depth: Square, Rectangular, Hexagonal, Octagonal Tube Except for T3510, T4510, T6510, T73510, T76510 and T8510 Tempers
12.3	Wall Thickness: Round Tube
12.4	Wall Thickness: Other Than Round Tube
12.5	Length Extruded Tube
12.6	Twist: Other Than Round Tube
12.7	Straightness: Tube in Straight Lengths
12.8	Flatness: Flat Surfaces
12.9	Squareness of Cut Ends: Extruded Tube
12.10	Corner and Fillet Radii: Tube Other Than Round
12.11	Angularity: Tube Other Than Round
12.12	Surface Roughness: Extruded Tube
12.13	Dents: Extruded Tube



21. Packaging and Package Marking

21.1 The material shall be packaged to provide adequate protection during normal handling and transportation and each package shall contain only one size, alloy, and temper of material unless otherwise agreed upon. The type of packing and gross mass of containers shall, unless otherwise agreed upon, be at the producer or supplier's discretion, provided they are such as to ensure acceptance by common or other carriers for safe transportation at the lowest rate to the delivery point.

21.2 Each shipping container shall be marked with the purchase order number, material size, specification number, alloy and temper, gross and net masses, and the producer's name or trademark.

21.3 When specified in the contract or purchase order, material shall be preserved, packaged, and packed in accordance with the requirements of Practices B 660. The applicable level shall be as specified in the contract or order. Marking for shipment of such material shall be in accordance with Fed. Std. No. 123 for civil agencies and MIL-S11D-129 for Military agencies.

22. Certification

22. Certification

22.1 The producer or supplier shall, on request, furnish to the purchaser a certificate stating that each lot has been sampled, tested, and inspected in accordance with this specification and has met the requirements.

23. Keywords

23.1 aluminum alloy; extruded bars; extruded rods; extruded profiles; extruded tubes; extruded wire

ANNEXES

(Mandatory Information)

A1. BASIS FOR INCLUSION OF PROPERTY LIMITS

A1.1 Limits are established at a level at which a statistical evaluation of the data indicates that 99 % of the population obtained from all standard material meets the limit with 95 % confidence. For the products described, mechanical property limits for the respective size ranges are based on the analyses of at least 100 data from standard production material with no more than ten data from a given lot. All tests are performed in accordance with the appropriate ASTM test methods. For informational purposes, refer to "Statistical Aspects of Mechanical Property Assurance" in the Related Material section of the Annual Book of ASTM Standards, Vol 02.02. Mechanical property limits in this metric issue were derived from the inch-pound system limits that were developed under the above principles. As test data on metric dimensioned specimens are accumulated, some refinement of limits, particularly for elongations measured in 5D, can be anticipated.

A2. ACCEPTANCE CRITERIA FOR INCLUSION OF NEW ALUMINUM AND ALUMINUM ALLOYS IN THIS SPECIFICATION

A2. ACCEPTANCE CRITERIA FOR INCLUSION OF NEW ALUMINUM AND ALUMINUM ALLOYS IN THIS SPECIFICATION

A2.1 Prior to acceptance for inclusion in this specification, the composition of wrought or cast aluminum or aluminum alloy shall be registered in accordance with ANSI H35.1(M). The Aluminum Association<sup>12</sup> holds the Secretariat of ANSI H35 Committee<sup>12</sup> and administers the criteria and procedures for registration.

A2.2.3 The complete chemical composition limits are submitted.

A2.2 If it is documented that the Aluminum Association could not or would not register a given composition, an alternative procedure and the criteria for acceptance shall be as follows:

A2.2.4 The composition is, in the judgment of the responsible subcommittee, significantly different from that of any other aluminum or aluminum alloy already in the specification.

A2.2.1 The designation submitted for inclusion does not utilize the same designation system as described in ANSI H35.1(M). A designation not in conflict with other designation systems or a trade name is acceptable.

A2.2.5 For codification purposes, an alloying element is any element intentionally added for any purpose other than grain refinement and for which minimum and maximum limits are specified. Unalloyed aluminum contains a minimum of 99.00 % aluminum.

A2.2.2 The aluminum or aluminum alloy has been offered for sale in commercial quantities within the prior twelve months to at least three identifiable users.

A2.2.6 Standard limits for alloying elements and impurities are expressed to the following decimal places:

Less than 0.001 %	0.000X
0.001 to but less than 0.01 %	0.00X
0.01 to but less than 0.10 %	
Unalloyed aluminum made by a refining process	0.0XX
Alloys and unalloyed aluminum not made by a refining process	0.0X
0.10 through 0.55 %	0.XX
(It is customary to express limits of 0.30 through 0.55 % as 0.X0 or 0.X5.)	
Over 0.55 %	0.X, X.X, etc.
(except that combined Si + Fe limits for 99.00 % minimum aluminum must be expressed as 0.XX or 1.XX)	

<sup>12</sup> The Aluminum Association, 900 19th St., NW, Washington, DC 20006.

 B 221M – 02

A2.2.7 Standard limits for alloying elements and impurities are expressed in the following sequence: Silicon; Iron; Copper; Manganese; Magnesium; Chromium; Nickel; Zinc (Note A2.1); Titanium; Other Elements, Each; Other Elements, Total; Aluminum (Note A2.2).

Note A2.1—Additional specified elements having limits are inserted in alphabetical order of their chemical symbols between zinc and titanium, or are specified in footnotes.

Note A2.2—Aluminum is specified as *minimum* for unalloyed aluminum and as a *remainder* for aluminum alloys.

**APPENDIX**

**(Nonmandatory Information)**

**X1. ISO EQUIVALENTS OF ANSI ALLOYS AND TEMPERS**

X1.1 International Organization for Standardization (ISO) equivalents of the ANSI alloys and tempers given in Table X1.1 and Table X1.2 are included in ISO 209-1: 1989, Part 1, Chemical Composition and ISO 2107-1983. Mechanical property limits shown in Part 2, Mechanical Properties, of ISO 6362-2: 1990 are similar to B221M but not necessarily identical.

**TABLE X1.1 ISO Equivalents of Alloys in B 221M**

Alloys			
ANSI	ISO	ANSI	ISO
1060	Al 99.6	6005	Al SiMg
1100	Al 99.0 Cu	6005A	Al SiMg (A)
2014	Al Cu4SiMg	6060	Al MgSi
2024	Al Cu4Mg1	6061	Al Mg1SiCu
2219	Al Cu6Mn	6263	Al Mg0.7Si
3003	Al Mn1Cu	6262	Al Mg1SiPb
3004	Al Mn1Mg1	6351	Al Si1Mg0.5Mn
5052	Al Mg2.5	7005	Al Zn4.5Mg1.5Mn
5083	Al Mg4.5Mn0.7	7075	Al Zn5.5MgCu
5086	Al Mg4	7178	Al Zn7MgCu
5154	Al Mg3.5		
5454	Al Mg3Mn		
5456	Al Mg5Mn1		

**TABLE X1.2 ISO Equivalents of Tempers in B 221M**

Tempers	
ANSI	ISO
F	F
O	O
H112	M
T1	TA
T3	TD
T4	TB
T5	TE
T6	TF
T7	TM
T8	TH

**SUMMARY OF CHANGES**

This section identifies the principal changes to this standard that have been incorporated since the last issue.

- (1) Replaced Practice B 597 with Practice B 918 in 2.2, 4.2.1 and 9.2.
- (2) Replaced MIL-H-6088 with AMS 2772 in 2.7 and 9.1.



## B 221M – 02

*ASTM International takes no position respecting the validity of any patent rights asserted in connection with any item mentioned in this standard. Users of this standard are expressly advised that determination of the validity of any such patent rights, and the risk of infringement of such rights, are entirely their own responsibility.*

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INSTRUCTIONS FOR TWO PART TENDERS

1. We invite your offer duly signed, in **TWO** parts as follows:-

(a) **PART- I : TECHNICAL & COMMERCIAL** (Other than Price)

(b) **PART -II : PRICE BID**

1.1 **PART-I : TECHNICAL & COMMERCIAL**

1.1.1 **TECHNICAL:** The detailed Technical Specification and Commercial Terms such as delivery date, taxes, duties payable, place of delivery, payment term, validity, guarantee etc and scope of supply shall be covered in this part. Please enclose a copy of the details indicated in price quotation (**WITHOUT PRICES OR BY MASKING THE PRICE**) mainly to know the items/ specifications for which you have indicated prices in price bid. **This part should not contain prices. If Part - I contains price of any nature, the offer will be rejected summarily.** The Technical and commercial part of the offer should be kept in a sealed envelope superscribing the following details.

QUOTATION AGAINST TENDER NO TM07 2023038447 01  
DUE ON 30.04.2024 at 14.00 hrs IST  
OPENING ON 30.04.2024 at 14.30 hrs IST  
FOR SUPPLY OF SEAMLESS DRAWN AA2219 AND AA6061 TUBES  
PART I - TECHNICAL & COMMERCIAL

The cover should indicate" **SENDER'S**" address.

1.2. **PART -II : PRICE BID**

1.2.1. This part shall contain **PRICE** details only.

1.2.2. The price for the item should be indicated item wise in this part. All the items/ specifications mentioned in the Technical Part should come here and prices indicated against each. The break-up for each item of supply or services should be indicated.

1.2.3. Whenever options are quoted, the same should also be indicated with quantity and unit rate separately. The prices are to be mentioned both in figures and in words. This part should also be kept in a sealed cover superscribing as follows:-

QUOTATION AGAINST TENDER NO TM07 2023038447 01  
DUE ON 30.04.2024 at 14.00 hrs IST  
FOR SUPPLY OF SEAMLESS DRAWN AA2219 AND AA6061 TUBES  
PART II - PRICE BID

THE TWO SEALED COVERS PREPARED AS ABOVE SHOULD BE KEPT IN ANOTHER ENVELOPE, SEALED AND SUPERSCRIBED AS UNDER:-

"Quotation against Tender No. TM07 2023038447 01 Due on 30.04.2024, 14.00 hrs IST  
FOR SEAMLESS DRAWN AA2219 AND AA6061 TUBES containing TWO SEPARATE COVERS  
PART-1 & PART -II and addressed to:

SR.PURCHASE & STORES OFFICER  
Liquid Propulsion Systems Centre  
Valiamala (PO)  
Thriuvananthapuram- 695 547.

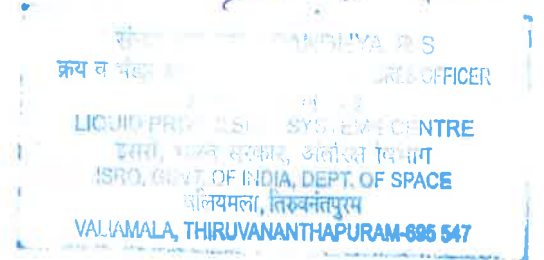
The cover should indicate "SENDER'S " address

For any clarification you may contact us at following phone/Fax Nos.

Telephone : 0471 2567726/0471 2567727  
Fax : 0472 2800712/0471 2567305

Your offer should reach us on or before the due date and time i.e. 30<sup>th</sup>, April 2024 at 14.00 hrs IST. *Offers received after the due date and time will not be considered.*

*Offers received through fax or email will not be considered.*



**General Terms and Conditions:****1) Instruction to Foreign Suppliers:-**

- a) Payment term shall be **SIGHT DRAFT / 80%** by irrevocable Letter of Credit and balance 20% by wire transfer after receipt & acceptance of the ordered item. Please confirm acceptance in your offer. If you insist for L/C, and all bank charges shall be to your account. Confirm acceptance.
- b) We are eligible for Customs Duty Concession vide Notification No. 050/2017 539 A-CUSTOMS DTD. 30.06.2017 and necessary Customs Duty Exemption Certificate will be provided on request.
- c) Please specify whether any export clearance is required in case of an order on you.
- d) Warranty/Guarantee applicable for the item shall be mentioned in your offer.
- e) Special Certification for packing Material : as per Plant Quarantine (Regulation of Control into India) Order 2003, Articles packed with packing material of plant origin viz., hay, straw, wood shavings, wood chips, saw dust, wood waste, wooden pallets, Dunn age Mats, wooden packages, coir pith, pear or sphagnum moss etc., will be allowed entry by Customs only with a Phytosanitary Certificate. In case if a Purchase Order, if you propose to us any of the above material for packing such a certificate issued by your local Plant Quarantine Authority shall be furnished.
- f) Confirm whether any Export License is required and for which End User Certificate is to be provided by us, in case of an Order on you. (Enclose format for EUC, if applicable)
- g) Either Indian Agent on behalf of the foreign principles or the foreign principal directly can quote against this order, but not both. In either case an Indian *agent* cannot represent more than one principal against the same tender.
- h) High Sea Sales**

In case any bidder is submitting their offer on High Sea Sale (HSS) basis, the Indian Trader shall submit the following documents **mandatorily** along with the offer. It will be the responsibility of the Party to clear the items from Customs and deliver to us on FOR LPSC, Valiamala basis

- The Import Export Code of the Indian Trader.
- Bank Authorisation Code of the Indian Trader.
- GSTIN of the Indian Trader.

**2) Delivery Terms:**

FOR : LPSC, VALIAMALA

In case of Foreign vendors : Ex-works (place)/ FOB (port of despatch)

**3) Payment Term**

- (a) 100% payment shall be made through RTGS within 30 days of receipt and acceptance of the item at our site.
- (b) In case of Foreign orders, Payment term shall be **SIGHT DRAFT / 80% BY IRREVOCABLE LETTER OF CREDIT AND BALANCE 20% BY WIRE TRANSFER AFTER RECEIPT & ACCEPTANCE OF THE ORDERED ITEM.**



**4) Warranty**

Warranty for the offered item shall be from the date of installation/acceptance of the item at our site for a minimum period of one year or as specified in the tender document.

5) Please specify IGST percentage, if any, in your offer.

**6) Liquidated Damages:**

If the ordered items are not supplied within the delivery schedule, LD shall be levied from your bill @ 0.5% per week for the undelivered items subject to a maximum of 10% of the order value for the delayed period.

**7) Performance Bank Guarantee**

Vendor has to submit a PBG from a Nationalised / Scheduled Bank (from a bank of international repute in case of foreign vendors) for 3% of the order value towards the performance of the system at the time of supply valid till the completion of warranty period plus 60 days as per the format provided by the Department.

OR

3% OF THE ORDER VALUE SHALL BE WITH HELD TILL THE COMPLETION OF WARRANTY PERIOD PLUS 60 DAYS.

**8) Security Deposit(only for order value above INR 5 Lakh)**

Vendor has to furnish a Bank Guarantee for 3% of the order value(from a bank of international repute in case of foreign vendors)within 10 days of receipt of Order towards the faithful execution of the order valid till the completion of the scope of work as per order plus sixty days. (This will be returned to you immediately on execution of the order satisfactorily as per order terms. In case of non-performance / poor performance, the amount will be forfeited).

**9) Resolution of Disputes**

Any dispute, disagreement or question arising out of or relating to or in consequence of the contract or to its fulfillment, or the validity of enforcement thereof which cannot be settled mutually, or the settlement of which is not herein specifically provided for, shall within 30 (thirty) days from the date either party informs the other in writing that such dispute or disagreement exists be referred to arbitration by the sole arbitrator. The Arbitrator shall be appointed "As per the Indian Arbitration and Conciliation Act 1996" and proceedings will be conducted in Kerala. The Arbitration proceedings shall be conducted in accordance with and subject to the Arbitration and Conciliation Act 1996 (Act 26 of 1996) as amended from time to time and the decision of the Arbitrator shall be final and binding on the parties thereto. Each party shall bear its own cost of preparing and presenting its case. The cost of Arbitration including the fees and expenses of the Arbitrator shall be shared equally by the parties unless the award provides otherwise. Subject to provisions of this clause, the courts at Kerala shall have exclusive jurisdiction. Performance under this Contract shall, however continue during Arbitration proceeding and no payment due or payable by the parties hereto shall be withheld unless any such payment is/ or forms a part of the subject matter of the Arbitration proceedings.


**10) Offer Validity**

(a) The validity of the offers should be 90 days (in case of single part tender) from the date of opening of the tenders.

(b) The validity of the offers should be 120 days (in case two part tender) from the date of opening of the tenders.

Note :- Tenders having shorter offer validity will not be considered for evaluation.

11)We only accept offers which are signed by hand. Offers received through fax or email will not be considered.

  
संघा आचार्य / SANDHYA R S  
क्रय व भंडार अधिकारी / PURCHASE & STORES OFFICER  
द्रव नोदन प्रणाली केंद्र  
LIQUID PROPULSION SYSTEMS CENTRE  
इसरो, भारत सरकार, अंतरिक्ष विभाग  
ISRO, GOVT. OF INDIA, DEPT. OF SPACE  
वलियमला, तिरुवनंतपुरम  
VALIAMALA, THIRUVANANTHAPURAM-695 547

## COMPLIANCE STATEMENT FOR COMMERCIAL TERMS

Sl. No. (1)	Description (Commercial terms & conditions) (2)	Compliance to Col. (2) [YES/NO] (3)	Remarks (4)
1.	P & F charges, if any, (If mentioned as EXTRA OR INCLUDED in your quote, please mention the percentage in Remarks Column)..		
2.	Whether applicable GST percentage mentioned in offer (If mentioned as EXTRA OR INCLUDED in your quote, please mention the percentage in Remarks Column).		
3.	ISRO is eligible for Customs Duty Concessionvide Notification No.NO. 050/2017 539 A-CUSTOMS DTD. 30.06.2017  [We will provide Customs Duty Concession Certificate for bought out items being imported for manufacturing the ordered Items (List of items to be imported with quantities to be enclosed along with offer) OR for Orders placed on Foreign Vendors OR for High Sea Sale orders ORvendors from SEZ]		
4.	<ul style="list-style-type: none"> <li>• Installation Charges, if any,</li> <li>• Third Party Inspection (TPI) charges if any, as per tender.</li> </ul> (If mentioned as EXTRA OR INCLUDED in your quote, please mention the percentage in Remarks Column).		
5.	<b>Delivery Term :-</b> <ul style="list-style-type: none"> <li>• FOR : LPSC, VALAIAMALA</li> <li>• In case of Foreign orders, FOB or FCA</li> </ul>		
6.	Freight charges, if any. (If mentioned as EXTRA OR INCLUDED in your quote, please mention the percentage in Remarks Column).		
7.	Delivery Period  (If any specific delivery period is mentioned in the tender, please comply the same. If not agreed, please mention your delivery period in remarks column OR if already mentioned in your quote please mention as "already furnished in the quote")		
8.	<b>Payment Term :-</b> (a) 100% payment shall be made through RTGS within 30 days of receipt and acceptance of the item at our site. (b) In case of Foreign orders, Payment term shall be SIGHT DRAFT / 80% BY IRREVOCABLE LETTER OF CREDIT AND BALANCE 20% BY WIRE TRANSFER AFTER RECEIPT & ACCEPTANCE OF THE ORDERED ITEM.		
9.	<b>Liquidated Damages (LD) :-</b> If the ordered items are not supplied within the delivery schedule, LD shall be levied from your bill @ 0.5% per week for the undelivered items subject to a maximum of 10% of the order value for the delayed period.		

Sl. No. (1)	Description (Commercial terms & conditions) (2)	Compliance to Col. (2) [YES/NO] (3)	Remarks (4)
10.	<b>Warranty :-</b> Warranty for the offered item shall be from the date of installation/acceptance of the item at our site for a minimum period of one year or as specified in the tender document.		
11.	<b>Security Deposit (SD) :- (only for order value above Rs.5 Lakh)</b> You have to furnish a Bank Guarantee for 3% of the order value within 10 days of receipt of Order towards the faithful execution of the order valid till the completion of the scope of work as per order plus sixty days. (This will be returned to you immediately on execution of the order satisfactorily as per order terms. In case of non-performance / poor performance, the amount will be forfeited)		
12.	<b>Performance Bank Guarantee (PBG) :-</b> You have to submit a PBG from a Nationalised / Scheduled Bank for 3% of the order value towards the performance of the system at the time of supply valid till the completion of warranty period plus 60 days as per the format provided by the Department.  OR  3% OF THE ORDER VALUE SHALL BE WITH HELD TILL THE COMPLETION OF WARRANTY PERIOD PLUS 60 DAYS.		
13.	In case, if parties are unable to provide two separate BGs, i.e., one for SD and one for PBG, they can submit a combined BG for SD & PBG within 10 days of receipt of order for 3% of order value valid till the completion of total contractual obligation (i.e., supply period + warranty period + 60 days) as per the format provided by the Department.		
14.	<b>Insurance :-</b> Being a Govt. Of India Dept., Insurance is not required at our cost. Please ensure the safe delivery of the ordered item with proper AIR / SEA / ROAD worthy packing		
15.	<b>Validity of Offer :-</b>  (a) The validity of the offers should be 90 days (in case of single part tender) from the date of opening of the tenders. (b) The validity of the offers should be 120 days (in case two part tender) from the date of opening of the tenders.  <b>Note :-Tenders having shorter offer validity will not be considered for evaluation.</b>		

Sl. No. (1)	Description (Commercial terms & conditions) (2)	Compliance to Col. (2) [YES/NO] (3)	Remarks (4)
16.	<p>In case of foreign orders,</p> <p>(a) Please specify whether any Export clearance is required. If it is required please provide End User Certificate format along with offer.</p> <p>(b) Please specify whether any Agency Commission is involved or not. If 'YES' mention the percentage of Agency Commission. [Agency Commission shall be claimed by the Indian Agent through an Invoice. The Agency Commission shall be paid to the Indian Agent in Indian Rupees worked out on the basis of Telegraphic Transfer buying rate of exchange prevailing on the date of placement of the Purchase order/Contract and within 30 days from the date of satisfactory acceptance of the item at our site. Distributors are not eligible for Agency Commission]</p>		
17.	<p><b>Special conditions against Indian Agents submitting quotations in Foreign Currency.</b></p> <p>(a) Foreign Principal's proforma invoice indicating the commission payable to the Indian Agent and nature of after sales service to be rendered by the Indian Agent.</p> <p>(b) Copy of Agency agreement with the Foreign Principal, precise relationship between them and their mutual interest in the business.</p>		

GOVERNMENT OF INDIA  
DEPARTMENT OF SPACE  
**LIQUID PROPULSION SYSTEM CENTRE**  
PURCHASE DIVISION  
VALIAMALA P.O. THIRUVANANTHAPURAM

Tender No : TM07 2023038447 01  
Due on : 30.04.2024  
Ref. No : .....  
Date : .....

**TENDER FORM**

From :

.....  
.....  
.....

To: The Purchase & Stores Officer,  
Liquid Propulsion Systems Centre  
Valiamala P.O.  
Thiruvananthapuram – 695 547

Dear Sir,

I/We hereby offer to supply the stores detailed below at the price hereunder quoted and agree to hold this offer open till.....I/We shall be bound to supply the stores hereby offered upon the issue of the Purchase Order communicating the acceptance there of on or before the expiry of the last mentioned date. You are at liberty to accept any one or more of the items of stores tendered for or any portion of any one or more of the items of such stores. I/We notwithstanding that the offer in this tender has not been accepted in whole, shall be bound to supply to you such items and such portion or portions of one or more of the items as may be specified in the said Purchase Order communicating the acceptance:

Sl. No.	Description	Quantity	Unit	Rate Rs.	Delivery Date
---------	-------------	----------	------	----------	---------------

.....  
.....

NOTE: All the rates should be given both in figures and words.

Place at which delivery will be made: .....

Date by which the ordered items will be supplied:.....

2.I/We have understood the items of the tender annexed to the invitation to tender and have thoroughly examined the specification/drawing and / or pattern quoted or referred to herein and /are fully aware of the nature of the stores required and my/our offer is to supply the stores strictly in accordance with the requirements subject to the terms and conditions stipulated in the enquiry and contained in the purchase order communicating the acceptance of this tender either in whole or in part.

Signature of Tenderer  
Date.....  
(Seal)

## INSTRUCTIONS TO TENDERERS

1. The Tenderers should submit quotations in duplicate in a sealed envelope, superscribing the Tender No. and due date of opening and complete in all respects with technical specifications, including pamphlets and catalogues.
2. A Proforma Invoice may also be given which should contain the following information:
  - a) The FOB/FCA value, the C & F value for import by Sea freight / Air freight up to and for air parcel post up to ..... should be separately indicated.
  - b) Agency Commission: The amount of commission included in the price and payable to the Indian Agent of the Contractor shall be paid directly to the Indian Agent by the Purchaser in equivalent Indian Rupees on the basis of an Invoice for him applying T.T. buying rate of exchange ruling on the date of placement of the Purchase Order and which shall not be subject to any further exchange variations. This payment will be released to the Indian Agent immediately after Customs clearance of the goods in India.
  - c) The Contractor shall invoice only for the net amount payable to him, after deducting the amount of Agency Commission included in the invoice which will be paid to the Indian Agent directly by the Purchaser. However, the Contractor's invoice should separately reflect the amount of commission payable to his Indian Agent.
  - d) The earliest delivery period and country of origin of the Stores.
  - e) Banker's name, address, telephone/fax Nos. & e-Mail ID of the Contractor.
  - f) The approximate net and gross weight and dimensions of packages/cases.
  - g) Recommended spares for satisfactory operation for a minimum period of one year.
  - h) Details of any technical service, if required for erection, assembly, commissioning and demonstration.
3. The FOB/FCA and C & F prices quoted should be inclusive of all taxes, levies, duties arising in the tenderer's country.
4. The offer should be valid for a minimum period of 120 days from the due date of opening of the tender.
5. Samples, if called for, should be sent free of all charges.
6. Late and delayed tenders will not be considered. Quotations by cable must be followed by detailed offers.
7. Offers made by Indian Agents on behalf of their Principals, should be supported by the proforma invoice of their Principals.
8. The details of Import Licence will be furnished in the Purchase Order.
9. The authority of person signing the tender, if called for, shall be produced.
10. Instructions / Operation Manual containing all assembly details including wiring diagrams should be sent wherever necessary in duplicate. All documents / correspondence should be in English language only.
11. The Purchaser reserves the right to accept or reject the lowest or any offer in whole or part without assigning any reason.
12. It is expressly agreed that the acceptance of the Stores Contracted for is subject to final approval in writing by the Purchaser.
13.
  - a) Part shipment is not allowed unless specifically agreed to by us.
  - b) As far as possible stores should be despatched by Indian Flag Vessels / Air India through any Agency nominated by us.
14. Inspection / Test Certificate should be provided for the goods after testing it thoroughly at the Contractor's works. If any inspection by Lloyds or any other testing agency is considered necessary, it shall be arranged by Contractors.
15. Where erection or assembly or commissioning is a part of the Contract, it should be done immediately on notification. The Contractor shall be responsible for any loss/damage sustained due to delay in fulfilling this responsibility.
16. For items having shelf life, those with maximum shelf life should be supplied if order is placed

### I. TERMS AND CONDITIONS

1. DEFINITIONS:
  - a. The term 'Purchaser' shall mean the President of India or his successors or assignees.
  - b. The term 'Contractor' shall mean, the person, firm or company with whom or with which the order for the supply of stores is placed and shall be deemed to include the Contractor's Successors, representatives, heirs, executors and administrators unless excluded by the Contract.
  - c. The term 'Purchase Order' shall mean the communication signed on behalf of the Purchaser by an officer duly authorized intimating the acceptance on behalf of the Purchaser on the terms and conditions mentioned or referred to in the said communication accepting the Tender or offer of the Contractor for supply of stores of plant, machinery or equipment of part thereof.
  - d. The term 'Stores' shall mean what the Contractor agrees to supply under the Contract as specified in the Purchase Order.

2. PRICES:  
Tenders offering firm prices will be preferred. Where a price variation clause is insisted upon by a tenderer, quotations with a reasonable ceiling should be submitted. Such offers should invariably be supported by the base price taken into account at the time of tendering and also the formula for any such variations.
3. TERMS OF PAYMENT:  
3.1. Being a Department of the Government of India, the normal terms of payment are by Sight Draft. However other terms of payment like establishment of Letter of Credit may be considered by the Purchaser on such terms and conditions as may be agreed upon.  
3.2. The Sight Draft / Letter of Credit will be operative on presentation of the under mentioned documents:  
a) Original Bill of Lading / Airway Bill  
b) Commercially certified invoices describing the stores delivered, quantity, unit rate and their total value, in triplicate. The invoice should indicate the discounts, if any, and Agency Commission separately.  
c) Packing List showing individual dimensions and weight of packages.  
d) Country of Origin Certificate in duplicate. e) Test Certificate.  
e) Declaration by the Seller that the contents in each case are not less than those entered in the invoices and the quality of the Stores are guaranteed as per the specifications asked for by the Purchaser.  
f) Warrantee and guarantee Certificate/s vide Clause 20 herein below
4. IMPORTANT LICENCE:  
Reference to Import License No. & date and Contract number & date shall be prominently indicated in all the documents vide para 3.2
5. DEMURRAGE:  
Supplier shall bear demurrage charges, if any, incurred by the purchaser due to delayed presentation of shipping documents as prescribed in para 3.2 to the bankers within a reasonable time (say within 10-12 days) from the date of bill of lading for sea consignments and within 3-4 days from the date of Air Way Bill for air consignments.
6. ADDRESS OF INDIAN AGENTS:  
.....  
.....
7. GUARANTEED TIME DELIVERY:  
The time for and the date of delivery stipulated in the Purchase Order shall be deemed to be the essence of the Contract. Delivery must be completed within the date specified therein.
8. INSPECTION AND ACCEPTANCE TEST:  
8.1. The Purchaser's representatives shall also be entitled at all reasonable times during manufacture to inspect, examine and test on the Contractor's premises the material and workmanship of all stores to be supplied under this Contract and if part of the said stores is being manufactured on other premises, the Contractor shall obtain for the purchaser's representative permission to inspect, examine and test as if the equipment were being manufactured on the Contractor's premises. Such inspection, examination and testing shall not release the Contractor from the obligations under this Contract.  
8.2. For tests on the premises of the Contractor or of any of his sub-Contractors, the Contractor shall provide free of cost assistance, labour, material, electricity, fuel and instruments as may be required or as may be reasonably needed by the purchaser's representative to carry out the tests efficiently.  
8.3. When the stores have passed the specified test, the purchaser's representative shall furnish a certificate to the effect in writing to the Contractor. The Contractor shall provide copies of the test/s certificates to the purchaser as may be required.
9. MODE OF DESPATCH:  
Generally, stores should be despatched through Indian Flagged Vessel / Air India or through any other Agency nominated by the purchaser. A copy of the invoice and packing list should invariably be kept inside each of the packages.
10. PORT OF ENTRY:  
Thiruvananthapuram/Chennai/Mumbai/Hyderabad/Bangalore/
11. CONSIGNEE:  
Purchase & Stores Officer, Stores, (Valiamala, Thiruvananthapuram)

12. SHIPPING MARKS.

The mark on the shipping documents such as invoice, bill of lading and on the packages should be as follow:

PURCHASE ORDER NO. ....

DATED .....

GOVERNMENT OF INDIA  
DEPARTMENT OF SPACE  
LIQUID PROPULSION SYSTEM CENTRE  
DESTINATION: THIRUVANANTHAPURAM / MADRAS / BANGALORE  
PORT OF ENTRY: THIRUVANANTHAPURAM / MADRAS / BANGALORE

13. INSURANCE OF THE STORES:

The necessity or otherwise of insurance will be as indicated in the Purchase Order.

14. CONTRACTOR'S DEFAULT LIABILITY:

4.1. The purchaser may upon written notice of default to the Contractor terminate the Contract in whole or in part in circumstances detailed hereunder:

- a) If in the judgment of the Purchaser the Contractor fails to make delivery of Stores within the time specified in the Contract/agreement or within the period for which extension has been granted by the Purchaser to the Contractor.
- b) If in the judgment of the Purchaser the Contractor fails to comply with any of the other provisions of this Contract.

15. In the event the Purchaser terminates the Contract in whole or in part as provided in Clause 14 the Purchaser reserves the right to Purchase, upon such terms and in such a manner as he may deem appropriate, stores similar to that terminated and the Contractor shall be liable to the Purchaser for any additional costs for such similar stores and/or for liquidated damages for delay as defined in Clause 19 until such reasonable time as may be required for the final supply of stores.

15.1. If this Contract is terminated as provided in Clause 14 the Purchaser in addition to any other rights provided in this Article, may require the Contractor to transfer title and deliver to the Purchaser under any of the following clauses in the manner and as directed by the Purchaser:

- a) Any completed stores.
- b) Such partially completed stores, drawing, information and Contract rights (hereinafter called manufacturing material) as the Contractor has specifically produced or acquired for the performance of the Contract as terminated. The Purchaser shall pay to the Contractor the Contract price for completed stores delivered to and accepted, by the purchaser and for manufacturing material delivered and accepted.

15.2. In the event the Purchaser does not terminate the Contract as provided in Clause 14, the Contractor shall continue the performance of the Contract in which case he shall be liable to the purchaser for liquidated damages for delays set out in Clause 19 until the stores are accepted.

16. REPLACEMENT:

If the stores or any portion thereof is damaged or lost during transit, the Purchaser shall give notice to the Contractor setting forth particulars of such stores damaged or lost during transit. The replacement of such stores shall be effected by the Contractor within a reasonable time to avoid unnecessary delay in the intended usage of the Stores. In case the purchaser agrees, the price towards replacement items shall be paid by the purchaser on the basis of original price quoted in the tender or as reasonably worked out from the tender.

17. REJECTION :

In the event that any of the stores supplied by the Contractor is found defective in material or workmanship or otherwise not in conformity with the requirements of the Contract specifications, the purchaser shall either reject the stores or request the Contractor, in writing, to rectify the same. The Contractor, on receipt of such notification, shall either rectify or replace the defective stores free of cost to the purchaser. If the Contractor fails to do so, the purchaser may at his option either –

- a) replace or rectify such defective stores and recover the extra cost so involved from the Contractor, or
- b) terminate the Contract for default as provided under clause 14 above, or
- c) Acquire the defective stores at a reduced price considered equitable under the circumstances. The provision of this article shall not prejudice the Purchaser's rights under clause 19.



18. EXTENSION OF TIME:

If the completion of supply of stores is delayed due to reason of *force majeure* such as acts of god, acts of public enemy, acts of Government, fires, floods, epidemics, quarantine restriction, strikes, freight embargoes, etc., the Contractor shall give notice within 15 days to the purchaser in writing of his claim for an extension of time. The purchaser on receipt of such notice after verification, if necessary, may agree to extend the Contract delivery date as may be reasonable but without prejudice to other terms and conditions of the Contract.

19. DELAY IN COMPLETION / LIQUIDATED DAMAGES:

If the Contractor fails to deliver the stores within the time specified in the Contract or any extension thereof, the purchaser shall recover from the Contractor as liquidated damages a sum of one-half of one percent (0.5 percent) of the Contract price of the undelivered stores for each calendar week of delay. The total liquidated damages shall not exceed ten percent (10 percent) of the Contract price of the unit or units so delayed. Stores will be deemed to have been delivered only when all their component parts are also delivered. If certain components are not delivered in time, the stores will be considered as delayed until such time as the missing parts are delivered.

20. GUARANTEE & REPLACEMENT:

- a) The Contractor shall guarantee that the stores supplied shall comply fully with the specifications laid down for material, workmanship and performance.
- b) For a period of twelve months after the acceptance of the stores, if any defects are discovered therein or any defects therein are found to have developed under proper use arising from faulty materials, design or workmanship, the Contractor shall remedy such defects at his own cost provided he is called upon to do so within a period of 14 months from the date of acceptance thereof by the Purchaser who shall state in writing in what respect the stores or any parts thereof are faulty.
- c) If in the opinion of the purchaser it becomes necessary to replace or renew any defective stores, such replacements or renewals shall be made by the Contractor free of all costs to the purchaser provided the notice informing the Contractor of the defect is given by the purchaser in this regard within the said period of 14 months from the date of acceptance thereof.
- d) Should the Contractor fail to rectify the defects, the purchaser shall have the right to reject or repair or replace at the cost of the Contractor the whole or any portion of the defective stores.
- e) The decision of the Purchaser, notwithstanding any prior approval or acceptance or inspection thereof on behalf of the purchaser, as to whether or not the stores supplied by the Contractor are defective or any defects has developed within the said period of 12 months or as to whether the nature of the defects requires renewal or replacement shall be final, conclusive and binding on the Contractor.
- f) To fulfill guarantee conditions outlined in Clause 20 (a) to (e) above, the Contractor shall, at the option of the purchaser, furnish a Bank Guarantee (as prescribed by the purchaser - Bank Guarantee format enclosed) from a Bank approved by the purchaser for an amount equivalent to 10% of the value of the Contract along with first shipment documents. On the performance and completion of the Contract in all respects, the Bank Guarantee will be returned to the Contractor without any interest.
- g) All the replacement stores shall also be guaranteed for a period of 12 months from the date of arrival of stores at purchaser's site.
- h) Even while the 12 months guarantee applies to all stores, in case where a greater period is called for by our specifications, then such a specification shall apply, and in such cases, the period of 14 months referred to in Clause 20 (b) and (c) shall be asked for guarantee period plus two months.

21. REQUIREMENT OF ADDITIONAL NUMBERS OF THE STORES/SPARE PARTS ORDERED:

The Contractor shall also undertake the supply of additional number of items covered by the order as considered necessary by the purchaser at a later date, the actual price to be paid shall be mutually agreed to after negotiations.

22. PACKING:

- a) The Contractor wherever applicable shall pack and crate all stores for sea / air shipment as applicable in a manner suitable for export to a tropical humid climate, in accordance with internationally accepted export practices and in such a manner so as to protect it from damage and deterioration in transit by road, rail or sea for space qualified stores. The Contractors shall be held responsible for all damages due to improper packing.
- b) The Contractor shall ensure that each box / unit of shipment is legible and properly marked for correct identification. The failure to comply with this requirement shall make the Contractor liable for additional expenses involved.
- c) The Contractor shall notify the purchaser of the date of shipment from the port of embarkation as well

- as the expected date of arrival of such shipment at the designated port of arrival.
- d) The Contractor shall give complete shipment information concerning the weight, size, content of each packages, etc.
  - e) Transshipment of equipment shall not be permitted except with the written permission of the purchaser.
  - f) Apart from the despatch documents negotiated through Bank, the following documents shall also be airmailed to the purchaser within 7 days from the date of shipment by sea and within 3 days in case of air-consignments:
    - Commercial Bill of Lading / Air Way Bill / Post parcel Receipt. (Two non-negotiable copies)
    - Invoice (3 copies)
    - Packing List (3 copies)
    - Test Certificate (3 copies)
    - Certificate of Origin.
- The Contractor shall also ensure that one copy of the packing list is enclosed in each case
23. **ARBITRATION:**  
If at any time any question, dispute or difference whatsoever shall arise between the purchaser and the Contractor upon or in connection with this Contract, either party may forthwith give to the other notice in writing of the existence of such question, dispute or difference and the same shall be referred to the adjudication of two arbitrators, one to be nominated by purchaser, other by a Contractor and in the event of any difference of opinion, the arbitrators will refer the matter to the umpire. The arbitration shall be conducted in accordance with the rules and procedure for arbitration of the International Chamber of Commerce at Paris. The expenses of the arbitrators and umpire shall be paid as may be determined by them. However, the venue of such arbitration should be in India.
24. **LANGUAGE AND MEASURES:**  
All documents pertaining to the Contract including specification, schedule, notice, correspondence, operating and maintenance instructions, drawings or any other writings shall be written in English language. The metric system of measurement shall be used exclusively in the Contract.
25. **INDEMNITY:**  
The Contractor shall warrant and be deemed to have warranted that all Stores supplied against this Contract are free and clean of infringement of any patent, copyright or trade mark and shall at all times indemnify the purchaser against all claims which may be made in respect of stores for infringement of any right protected by Patent, Registration of design or Trade Mark, and shall take all risk of accident or damage which may cause a failure of the supply from whatever cause arising and the entire responsibility for the sufficiency of all the means used by him for the fulfillment of the Contract.
26. **COUNTER TERMS AND CONDITIONS OF SUPPLIERS:**  
Where counter terms and conditions/printed or cyclostyled conditions have been offered by the supplier, the same shall not be deemed to have been accepted by the purchaser unless specific written acceptance thereof is obtained.
27. **SECURITY INTEREST:**  
On each item to be delivered under this Contract, including an item of work in progress in respect of which payments have been made in accordance with the terms of the Contract, purchaser shall have a security interest in such items which shall be deemed to be released only at the time when the applicable deliverable item is finally accepted and delivered to the purchaser in accordance with the terms of the Contract. Such security interest of the purchaser shall constitute a prior charge as against any other charge or interest created in respect of such items by any entity.
28. **BANK CHARGES:**  
While the purchaser shall bear the bank charge payable to his Bankers (State Bank of India), the Contractor shall bear the Bank charges payable to his Bankers including the cheques towards advising amendment commissions.
29. **TRAINING:**  
The Contractor shall, if required by the purchaser, provide facilities for the practical training of Purchaser's engineering / technical personnel from India and for their active association on the manufacturing processes throughout the manufacturing period of the Contract / stores, number of such personnel to be mutually agreed upon.
30. **APPLICABLE LAW:**  
The Contract shall be interpreted, construed and governed by the laws of India.
31. **PERFORMANCE BANK GUARANTEE:**  
Towards the performance of the software during the warranty period you shall submit a Performance Bank Guarantee equivalent to 10% of the order value to cover the warranty period. This PBG shall be interest free and the same shall

be returned to you on successful completion of all contractual obligations. The said PBG shall have a further claim period of 6 months.

32. LIQUIDATED DAMAGES:

The delivery period mentioned is the essence of this order. If you fail to deliver the ordered items satisfactorily within the time specified or any extension thereof, Liquidated Damage @ 0.5% ( zero point five percent ) of the undelivered items of each calendar weeks of delay shall be recovered from your bill. However, total Liquidated Damage shall not exceed 10% ( ten percent ) of the order value.

33. SECURITY DEPOSIT:

Security @ 10 % of the value of the order shall be deposited within 10 days from the date of receipt of order in the form of Bank Guarantee or Fixed Deposit from any of the Scheduled Bank executed on non - judicial stamp paper of Rs 200/- towards the performance of the contract and shall be valid for a period of 60 days beyond the date of completion of the Purchase Order/Contract. This will be returned by LPSC immediately on execution of the Order satisfactorily as per Order terms. Failing which the amount will be forfeited / adjusted.