

**SPECIFICATION FOR ALUMINIUM ALLOY AA2014 DC CAST BILLETS/EXTRUDED
BILLETS & SLABS.**

1.0 SCOPE

This specification covers Aluminum Alloy AA2014 DC cast billets/extruded billets & slabs used for further conversion for Gaganyaan.

2.0 APPLICABLE DOCUMENTS

2.1 The following standards form a part of this specification to the extent specified herein. The latest documents in effect on the date of material purchase shall be applicable.

2.2 ASTM Standards;

- ASTM E3 - Preparation of Metallographic Specimens.
- ASTM E34 - Chemical Analysis of Aluminum and Aluminum alloys.
- ASTM E 607 - Optical Emission Spectrometric Analysis of Aluminum and Aluminum Alloys by the point to plane technique (inert atmosphere)
- ASTM E 340 - Macro-etching of Metals and Alloys.
- ASTM E 407 - Micro-etching of Metals and Alloys.

2.3 Aerospace material specifications.

- AMS 2630 - Ultrasonic Inspection of Products over 0.5" (12.7 mm) thick.
- AMS 2772 - Heat treatment of aluminum alloy Raw Materials
- AMS 2750 - Pyrometry

3.0 Process of Manufacture

- 3.1 The word billet/slab shall mean the direct chill cast product of one furnace melt or part of the melt.
- 3.2 Not more than one heat shall be used to make one billet/slab.
- 3.3 Melting to be done in gas fired furnaces and adequate furnace degassing is to be done. Pouring temperature shall not exceed 705 °C to contain hydrogen within limits. The transfer of molten metal to the launders has to be done without turbulence and the launder length to be kept as minimum as possible. Inline grain refining rods to be added at controlled rate and the molten metal shall be processed thro' degassing and filtering systems. CFF filters of 40 PPI minimum are preferred. Casting to be done with uniform control of temperature and cooling water flow rate. Billets/slabs shall be made by the directly chilled casting process.

- 3.4 Process of manufacturing should ensure that hydrogen shall not be more than 0.15 ml/ 100 gm of molten metal prior to pouring and measurements to be taken at both start and finish of each drop.

4.0 RAW MATERIAL CONTROL & RECYCLING

- 4.1 Raw material, master alloys, degassers, modifiers and such other elemental additions if any shall be free from harmful materials that could remain in the final product as unwanted inclusions of high or low density.
- 4.2 The identical alloy previously melted maybe recycled. Amount and details of re-cycled scrap addition has to be reported and controlled to maintain chemical composition within limits. The recycled scrap shall be from the stock property segregated, identified and from the foundry's own production. It shall be free from oil, grease, dirt and moisture.

5.0 CHEMICAL COMPOSITION

- 5.1 Chemistry shall conform to the following percentages by weight, determined in accordance with ASTM E 34 or E 607 or any other method mutually agreed.

Element	% by weight	
	Minimum	Maximum
Copper	4.0	5.00
Silicon	0.5	0.9
Manganese	0.4	1.2
Magnesium	0.2	0.8
Iron	-	0.3
Zinc	-	0.25
Titanium	-	0.15
Chromium	-	0.1
Sodium	-	0.0005
Calcium	-	0.001
Potassium	-	0.001
Other impurities, each	-	0.05

Other impurities, total	-	0.15
Hydrogen	-	0.15 ml/100 gm of molten metal
Aluminium	-	Remainder

5.2 Sampling plan for chemical analysis: Conformance to chemical composition shall be determined by the producer by analyzing samples taken at the time the billets/slabs are cast from the furnace melt and at the product stage from billet/slab after the casting.

5.2.1 Number of samples: When samples are taken at the time of pouring, at least two samples representing start and finish for each batch of billets/slabs cast simultaneously from the same source of molten metal shall be identified. Product samples representing top & bottom of billets/slabs shall be tested from logs identified as per the sketch shown in 8.2. Complete melt analysis records shall be available at the producer's plant to the purchaser.

5.2.2 The chemical composition of each element at different locations of billet/slab shall not vary by more than 10 %.

6.0 **HOMOGENISATION CYCLE:**

DC cast Billets/Slabs shall be homogenized as given below or by any other cycle mutually agreed between the supplier and purchaser.

Billet Dia (mm)	Soak Temperature (°C)	Soak Time (Hrs.)
Up to 300	490 ± 5	24
300 - 400		30
400 - 500		36
500 - 600		42
600 - 820		48

The cycle is indicative and the same shall be optimized to achieve the desired microstructure. Homogenisation to be carried out only in a furnace calibrated as per AMS 2772/2750 or mutually agreed plan. Extruded billets shall be realized from DC cast & homogenized billets and may be delivered in 'F' temper.

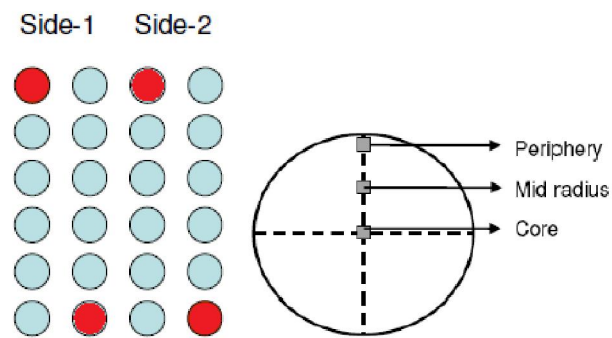
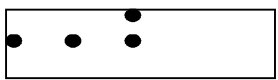
7.0 **MACRO - ETCH TEST:**

- 7.1 Macro - etch test samples shall be taken from location representing both top and bottom of the billet/slab after adequate removal of metal to eliminate any harmful defects. The test shall be carried out on the entire section of the stock. Macro etch samples shall be drawn from billets / slabs representing each row.
- 7.2 Macro - etch test shall be carried out in accordance with ASTM E – 340 after sufficient discard. Macrostructure shall be free from columnar grain, macro-segregation, discontinuities and voids such as seams, laps, porosity, cracks, cold shuts etc.
- 7.3 Sampling plan:

Cast Billets	Extruded Billets	Slabs
One log to be identified from each row, for both Top & Bottom, and entire cross section	Each log, both sides	Each slab, for Top & Bottom

8.0 **MICROSTRUCTURE EXAMINATION:**

- 8.1 Microstructure examination shall be carried out on samples drawn as per 7.1. It shall be free from coring, inter metallic inclusions, incipient melting, inter dendritic porosity, micro porosity, etc.
- 8.2 Sampling plan:

Cast Billets	Extruded Billets	Slabs
<p>One log from each row/side, Both Top & Bottom, randomly chosen. (Eg. shown below)</p> <p>Side-1 Side-2</p> 	<p>One sample per batch (Same heat, homogenised and extruded together) at front and back.</p>	<p>One slab each from both sides. Top & Bottom analysis at 4 locations (centre, mid-radius, periphery and centre edge) as shown below</p> 

8.3 Grain size & Cell size shall be uniform and average grain size shall be as follows:

Billet Dia (mm)	Cell size (μm)	Grain size (μm)
Up to 400	70	250
400-600	70	300
>600	70	350

8.4 Size of maximum permissible non-metallic inclusion shall be 10 μm and the distance between two such inclusions shall be more than 4 times the size of the inclusion.

9.0 **ULTRASONIC INSPECTION:**

9.1 All the billets/slabs shall be ultrasonically inspected for 100% of its volume by normal beam scanning as per AMS 2630.

9.2 The billets/slabs shall conform to class A (Single defect dia 2.0 mm FBH and multiple / linear defects dia 1.2 mm FBH). In addition to the above, the back wall drop shall not be more than 50% of the FSH when the back wall echo is set to 100 % of the full screen height.

9.3 All NDE tests shall be carried by qualified ISNT Level-2 personnel or personnel approved by VSSC.

10.0 **DIMENSIONAL TOLERANCE**

The dimensional tolerance shall be ± 5 mm on the diameter / thickness.

11.0 **SUPPLY CONDITION**

DC cast billets/slabs shall be supplied in homogenized & proof machined condition in case of billets and scalped in case of slabs. Extruded billets may be delivered in 'F' temper.

12.0 **IDENTIFICATION MARKING:**

The products shall be punched / engraved with the following information:

- ❖ Name of manufacturer
- ❖ Specification and grade number
- ❖ Size
- ❖ Heat no., batch no.
- ❖ Material code no.
- ❖ Any other identification no.

13.0 PRESERVATION AND PACKAGING:

- 13.1 All aluminium billets & slabs shall be cleaned thoroughly by non-corrosive solvent like acetone to remove any loose particles, oil, grease, dirt or corrosion.
- 13.2 Aluminium alloy billets & slabs shall be packed with proper wooden supports and tied with steel straps to avoid damage during transit and handling.

14.0 RESAMPLING AND RETESTING:

- 14.1 If any Macro test specimen shows any defects, Billets/Slabs may be further discarded and resampling may be carried out till acceptable results. In such cases, acceptance of shorter lengths of billets/slabs shall be as per VSSC approval.

15.0 INSPECTION:

The manufacturer shall afford the purchaser's inspector all reasonable facilities necessary to satisfy him that the material is being produced and furnished with this specification. All tests and inspection shall be made at the place of manufacturer unless otherwise agreed to.

16.0 CERTIFICATES AND REPORTS:

Manufacturer shall furnish the following certificates and test reports:

- 16.1 Chemical Analysis - both launder & product
- 16.2 Homogenisation Report
- 16.3 Metallurgical Analysis
- 16.4 Macro etch test
- 16.5 Ultrasonic inspection including the statement "Ultrasonically inspected in accordance with AMS standard 2630".
- 16.6 Dimensional inspection report.

17.0 REJECTION:

- 17.1 Any rejection based on tests made in accordance with this specification shall be reported to the manufacturer within 60 days from the receipt of material by purchaser at his site.
- 17.2 Material that shows rejectable discontinuities prior to or subsequent to acceptance by the purchaser shall be subjected to rejection and manufacturer shall be notified for replacement.