BOOK
ON
RATIONALISATION OF AVIATION METALLIC MATERIALS

VOLUME - II

BAR, PLATE, SHEET, TUBE AND WIRE





CEMILAC, DRDO
BANGALORE

HINDUSTAN AERONAUTICS LTD
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FOREWORD

Materials, in specific Aviation Metallic Materials, take a huge share among different class of materials in the military aircraft, aero engines, helicopters and missiles. Over the century, metallic materials development has evolved to the stage where we have a plenty of aero grade alloys of different country origins. Much time, with huge expenditure, has been devoted by many special alloy producers to the development of these alloys which provide higher mechanical properties and corrosion resistance often with low density for aircraft components. Most of the aero grade alloys of different country origins are essentially similar. These necessitate the best practices to be established in the materials Rationalisation.

There has been remarkable growth, over the last decade, in the civil and defence aerospace fields. Today, the aerospace sector has become a major potential area for manufacturing activities in India. The government's "Make in India" initiative has certainly gathered momentum with more and more Indian companies establishing themselves as trusted partners to global OEMs. The challenges that constrain the growth of the Indian aerospace industry include the lack of indigenous raw material sources, which meet global aerospace standards.

DRDO labs and Hindustan Aeronautics Limited (HAL) are involved in developing various platforms of indigenous designs and also those manufactured through "Transfer of Technology (ToT)" involving both 'fixed wing' and 'rotary wing'. A large variety of alloys in aluminum, steel, titanium and nickel is used in the manufacture, repair and overhaul of helicopter, aircraft and aero engines. Further, these material specifications originate from different countries and are in various shapes, forms and sizes.

In India, very few types of aluminum alloys, steel, nickel and titanium have been developed by DPSUs, ordnance factory and private sectors with limited size, Mill forms and quantity. In spite of the above, most of the materials required by DRDO labs, HAL and other organizations are sourced from abroad. Whenever a material is imported from abroad to a particular specification, minimum order quantity, cost, obsolescence superseded documents and delivery period are the key issues and at times this will delay the delivery of the end product which may further affect the programme.

To break all the aforementioned barriers, it is thought appropriate, as a first step, to have a consolidation of the different material specifications with information on their chemistry, heat treatment, forms and mechanical properties as a compilation of materials information of indigenous and imported materials in one place.

In this regard, CEMILAC with the support of various stakeholders like HAL, ADE, GTRE, NAL and ADA has brought out a book comprising of Bar, plate, sheet, tube & wire form materials. ***This document acts as a ready-reckoner for all the designers and production houses for the manufacturing of bar, plate, sheet, tube & wire towards the selection of materials.*** Apart from aiding DRDO labs and HAL in their indigenization mission, I foresee this book as an important information guide for the selection and usage of the materials at the government and policy maker's level towards indigenization of materials. In addition, this book will be a guide and opportunity for the private material manufacturing industry in India to indigenize the stated rationalised grade in each category towards Aatmanirbhar initiative of GoI without any firm order from users.

I compliment the entire team for their efforts in accomplishing this challenging and commendable task.

(APVS Prasad)
OS & Chief Executive (Airworthiness)

ABOUT THE BOOK

The 2nd volume of the “Compendium on the Rationalisation of Aviation Metallic Materials” is being published as a sequel to the first volume which covered Forging Stock and was published in 2019. This Compendium is a culmination of the painstaking efforts of the team comprising Engineers and Scientists from RCMA(F&F), HAL and DRDO Labs. In the current scenario wherein HAL and DRDO Labs need to provide life time support to legacy programs, sourcing of materials for such programs has become an uphill task because of the country specific nomenclature of material specifications as also the fragmented quantity requirements.

Central Materials and Processing Laboratory (CMPL) – F&F Division had collated material specifications of OEM, Open and Indigenous grades way back in the seventies and released 3 Volumes of “Metallic Material Data Books” covering ‘Light Alloys’, ‘Steel and Cast Irons’ and ‘Titanium and Nickel Base Alloys’ covering the entire spectrum of Metallic Materials. These data Books have also been revised over the years to incorporate additions / deletions. These volumes have been serving Designers, Manufacturers and Airworthiness Agencies as reference.

The need to have a ready reckoner for Forging Stock of Metallic Materials duly approved by the Airworthiness Agencies spurred HAL(F&F) and RCMA(F&F) to jointly pore through the different specifications, tabulate properties, arrive at equivalences and publish the first volume of “Compendium of Rationalisation of Aviation Metallic Materials” in 2019. This effort has now been supplemented by this Volume-II covering “Bar, Plate, Sheet, Tube and Wire”.

This compendium which is an authenticated compilation of equivalence of raw materials rationalised to the currently prevalent two to three specifications is sure to provide Designers, Design Liaison Engineers and Materials Management Personnel a ready solution to their quest for equal / alternate material specifications. I foresee this book to be extensively used for material selection, material Rationalisation as well as material substitution, keeping in mind the Airworthiness Agencies’ full support to this initiative. In this regard, I wish to place on record the strenuous persistent efforts of the Scientists & Engineers of HAL and DRDO Labs in reviewing the work done and approving the equivalences to enable effective usage of this compendium.

I foresee this compendium as an important source document to the Indian Defence and Aerospace Industries in their effort in indigenization of raw materials in the country apart from serving as an essential guide to all the stakeholders.

My hearty congratulations to the entire team.

(M S VENKATESH)
Executive Director, Foundry & Forge Division
HAL, (BC)

PREFACE

Aeronautical Industries and R and D labs, primarily Hindustan Aeronautics Limited (HAL) and DRDO, use different grades of metallic materials in aircraft as well as helicopter programmes. These materials are used in aero structures, landing gear, power plant etc. The metallic materials used are broadly classified as aluminum / titanium / nickel and steels. Further, these materials are also in various forms, such as bar, plate, sheet, tube & wire.

DRDO labs is involved in development of advanced technologies in the field of India's military aerospace programmes. HAL has been supporting India's military aerospace programmes by ab-initio projects and indigenized development of components for Western / Russian platform. For the same grade of material, there are several material specifications being of different country origin / OEMs such as DIN (German), AIR (French), BS (British), AMS (American), MSRR (Rolls-Royce), GOST (Russian), EMS (Honeywell), CCT (Turbomeca), etc. These specifications do undergo periodic revisions and many have become obsolete over time, having been replaced with newer material specifications. The current aerospace raw material market is largely driven by AMS specifications due to their versatility and adoption by leading global aerospace majors.

Over the period, procuring raw material of such diverse specifications is becoming difficult particularly when the quantities are not significant. Hence, the need was felt to bring out a compendium of rationalised material specification by grouping materials based on their near equivalency with respect to chemistry and mechanical properties to facilitate a steady flow of indigenization activity and also, ensure effective supply chain management. The compilation will be useful to the designers as well as manufacturing divisions as a ready-reckoner to select suitable equivalent specifications for overcoming material obsolescence and issues of small quantity requirements.

In this connection, a Task Force was constituted under the chairmanship of

Shri. Kamesh Goyal, Director (Aircraft), CEMILAC with representatives of RCMA (F&F), DRDO labs and various divisions of HAL as members with a brief to take up the grouping and Rationalisation of bar, plate, sheet, tube & wire of aluminum alloys, steels, nickel and titanium alloys.

The consolidation effort has been divided into two categories.

Volume I: Forging Stock in Aluminum Alloys, Steels, Nickel and Titanium Alloys. This was completed in May 2019.

Volume II: Bar, Plate, Sheet, Tube & Wire of Aluminum Alloys, Steels, Nickel and Titanium Alloys.

The scope of work involved:

a. Preparation of consolidated list of applicable metallic material grades in the form of bar, plate, sheet, tube & wire.

b. Grouping material specifications based on their equivalence and compile chemical composition, heat treatment, hardness and mechanical properties.

c. Identify obsolete material specifications and indicate the latest superseded material specification.

d. List out the rationalised material specifications for a particular material grade. The result of this effort has been this book, which would be used for determining near equivalent material specifications and substitute for obsolete raw material specifications.

(Kamesh Goyal, Sc 'G')
Director (Aircraft & HR) & Chairman of Committee

ACKNOWLEDGEMENT

The task of preparation of Compendium on "Rationalisation of Aviation Metallic Materials (Volume II), on short notice, would not have been possible without the active participation of the Members and encouragement from the Management of CEMILAC and HAL.

The team would like to express their sincere thanks to Dr. Kota Harinarayana, SERB Distinguished fellow, NAL, Mr. APVS Prasad, OS & Chief Executive (Airworthiness), CEMILAC, who has sown the seed and approved this source book. I sincerely express my gratitude to Shri DM Isack, Director (Helicopter) and Shri AR Raghunath, Director (TC&PI) for motivating the team towards bringing out this publication.

My wholehearted gratitude also goes to Mr. M S Venkatesh, Executive Director, HAL(F&F) and Mr. Anil Kumar, AGM (F&F), who was instrumental in driving the team and providing support and guidance for this vital compilation.

It would not be appropriate, if I do not appreciate the dedicated contribution of my RCMA (F&F) team, especially Member Secretary Dr. T Ram Prabhu, RCMA (F&F) and his team (M Veera Prasad, C Dinesh Babu & V Gowramma). I am also thankful to Mr. Anil Kumar, DGM (F&F) and his team (Anand G S) for their painstaking efforts in compiling the data to enable bringing out this edition of the compendium.

At this juncture, I would also like to thank the contribution made by Authors from various organizations for the book vol I and II.

Last but not the least, I must place on record the efforts of our colleagues from DRDO Labs, ADA, NAL, various Divisions of HAL who worked as a team in bringing out this Source Book.

(Dr. Shirish S Kale, Sc 'G')
Group Director (Materials)

CATEGORISATION OF AVIATION METALLIC MATERIALS

Volume I: Forging stock in Aluminum Alloys, Steels, Nickel and Titanium Alloys

Volume II: Bar, Plate, Sheet, Tube and Wire of Aluminum Alloys, Steels, Nickel and Titanium Alloys.


ARMY

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1.0 INTRODUCTION

1.1 AIM OF RATIONALISATION

DRDO Labs works on several pioneering projects such as LCA, AMCA, Rustom-II, SWIFT, Kaveri Dry Engine, STFE, Ghatak, Nirbhay, RPSA, TEDBF etc. HAL Divisions support legacy projects such as Kiran, Jaguar, Dornier, Garrett, Adour, Dart, Avro, HS-748, etc., As also recent projects such as ALH, LCH, LUH, LCA, HTT-40 and IJT. Several private companies have involved in indigenization of materials in different mill forms (bar, sheets, plates, tubes and wires) for our aircraft projects.

As DRDO and HAL divisions are involved in supporting various platforms, it handles a variety of material specifications of different origins. Many of the specifications are similar in chemical composition and due to different origins, separate specification names are evolved. Due to a variety of specifications and the requirement for a quantum of parts being less in quantity, DRDO and HAL face the issue of substantially high MOQ while procuring the raw materials. Further, over the past years, some of the specifications have become obsolete and are no longer available in the market.

Hence, the need was felt for the Rationalisation of Metallic Materials. It will help to narrow down many different specifications to a few equivalent specifications and will help in the easy procurability of materials. We have completed Rationalisation of Metallic Materials - Vol 1 for forging stocks. This book aims at rationalizing the metallic materials for mill forms such as bar, sheets, plates, tubes and wires.

1.2 APPROACH TO RATIONALISATION

The following approach has been adopted for rationalizing the material specifications:

- ❖ The list of material specifications used for manufacturing bars, plates, sheets, tubes and wires has been taken from the current product range across all the projects.
- ❖ This List has been segregated into four broad categories based on the Base Metal: Aluminum base, Iron base, Nickel base and Titanium base alloys.
- ❖ Further, these alloys have been arranged as per principal alloying elements and grouped under different sub-categories.
- ❖ AMS specifications and commonly available equivalent specifications are also added to the list to make it comprehensive.
- ❖ The Rationalised material has been chosen based on the near equivalent specification comparable with other grades in the same sub-group, ease of procurement and as far as possible avoiding the company-specific specification (e.g. MSRR-Rolls Royce, CCT-Turbomeca, etc.) by rationalizing to AMS specifications, and including Indigenized materials wherever available.
- ❖ After grouping, Rationalisation data has been branched into three headings sections as shown below:

1. First sheet is the summary sheet that contains the Identified specifications and rationalised specification

2. Second sheet contains the Chemical composition

3. Third sheet contains Heat treatment and Mechanical properties data

❖ Mechanical properties provided is for reference only. Actual values have to be checked form respective specification with current issue.

❖ Wherever, hardness values are specified in Material Specification as BHN, reported values shall be in HBW (Test to be done with Tungsten Carbide ball).

❖ Unless otherwise specified, Mechanical test properties are reported for Room Temperature.

1.3 CONDITIONS OF USAGE

The Rationalised material specifications provided in this compendium have to be used only if the following conditions are met:

❖ The bar, sheets, plates, tubes and wires for which rationalised material specification to be used shall have respective approved test Schedule or approved specifications.

❖ The properties of bars, plates, sheets, tubes and wires produced from Rationalised material shall meet the requirements specified in the respective Test Schedule or approved specifications.

❖ Material specifications other than specified in this book need to follow the Production Permit route as per the prescribed procedure.

❖ Higher issues of the material specification issued at later stage are acceptable in lieu of previous / lower issues based on comparison.

❖ Heat treatment cycle and Mechanical properties are only for reference purposes. Heat treatment to be followed and Mechanical properties are to be met as per respective Test Schedule.

❖ User has to ensure that heat treatment condition of use and supply condition are same, in case it is not, same material has to be heat treated to the condition of use before machining/ fabricating the component. Mechanical properties are to be met as per the respective Test Schedule.

1.4 RATIONALISATION OF ALLOYS

1.4.1 Table 1 provides the Number of Alloys Identified and Number of Alloys Rationalised.

Table 1: Summary of Alloys Rationalised

Sl No.	Type of Base Alloy	No. of Alloys Identified - Aluminum	No. of Alloys Identified - Steel	No. of Alloys Identified - Nickel	No. of Alloys Identified - Titanium	No. of Rationalised Alloys
1	**BAR**	**70**	**138**	**78**	**36**	**90**
2	**PLATE**	**22**	**-**	**-**	**31**	**13**
3	**SHEET**	**35**	**27**	**16**	**15**	**32**
4	**TUBE**	**19**	**24**	**9**	**-**	**18**
5	**WIRE**	**2**	**-**	**9**	**-**	**3**
	TOTAL	**148**	**189**	**112**	**82**	**156**

1.4.2 Table 2 provides the Designation, Mill Form and Number of Rationalised Alloy Grades with respect to Identified Alloy Grades

Table 2: Material Specifications and Their Rationalised Grades

ALUMINIUM ALLOYS						
2014 - BAR						
Sl. No.	**Material Specification**	**Grade**	**Rationalised Material Specification**	**Form**	**No. of Alloy Grades**	
					Identified	**Rationalised**
1	ASTM - B - 247	2014	HE15A ST \ BS LS 168 \ BS EN 2635	BAR	18	3
2	AIR 3350	A-U4 SG				
3	AMS-QQA-200/2	2014				
4	BS EN 573-3	EN AW-2014				
5	AIR 9051	A7-U4SG (2014 F)				
6	IS: 734	24345 (HF15 old)				
7	DIN 1747 3.1255	2014				
8	MIL-A-22771 / AMS-A-22771	2014				
9	HE15A ST (Iindigenized)	2014				
10	BS L 103 / BS L 76	2014				
11	BS L 168	2014				
12	BS EN 2635-U	AL – P 2014				
13	BS L65-T6	2014				
14	BS L87	2014				
15	DIN 1749 3.1255	2014				
16	HE 15 A ST	2014				
17	QQ- A-A225 / 4 QQ – A - 366	2014				
18	AMS 4124	2014				

Sl. No.	Material Specification	Grade	Rationalised Material Specification	Form	No. of Alloy Grades	
					Identified	Rationalised
2014 - SHEET						
1	BS L – 104 T6	2014	BS L 165 (T6) / BS L 167 (T6) / AMS 4029 (T6)	SHEET	10	3
2	BS L 164	2014 A				
3	BS L 108	2014 A				
4	BS L 90	2014 A				
5	IS 3436 TY II COND WP	2014 A				
6	BS L73, BS L165, BS L167	2014 A				
7	BS L72, DTD 610	2014 A				
8	QQ-A-250/3 QQ-A-255	2014				
9	BS EN 2087-U (2014A-T6)	2014 A				
10	AMS 4029	2014				
2014 - PLATE						
1	2014 T651	2014	AMS 4029 (T651)	PLATE	2	1
2	AMS 4029	2014				
2014 – TUBE						
1	BS L 63	2014	AMS 4153 (T6)	TUBE	4	1
2	BS L 105 BS L 62	2014				
3	AMS-QQA-200 / 2	2014				
4	AMS 4153	2014				
2014 – WIRE						
1	G-14938-78	D1P	AMS 4121 (T6)	WIRE	2	1
2	AMS 4121	2014				

Sl. no	Material Specification	Grade	Rationalised Material Specification	Form	No. of Alloy Grades	
					Identified	Rationalised
2024 - BAR						
1	AMS-QQ-A-200/3	2024	AMS QQ–A–225/6 / AMS-QQ-A-200/3 / AU4G1 AIR 9051 (T4)	BAR	7	3
2	AA 2024 AMS QQ–A–225/6	AA 2024				
3	BS EN 573-3	EN AW - 2024				
4	BS L-102 TB/T4	2024				
5	WL 3.1354	AA 2024				
6	AIR 9051	AU 4 G1				
7	G-4784-74	AK4 - 1				
2024 - PLATE						
1	2024 T351	2024	2024 AMS QQ–A–250/4	PLATE	4	1
2	2024 AMS QQ–A–250/4	2024				
3	WL 3.1354 (LN 9073)	2024				
4	AMS 4033	2024				
2024 - SHEET						
1	2024 AMS QQ–A–250/5	2024	2024 AMS QQ-A-250/5	SHEET	5	1
2	AMS 4037	2024				
3	WL 3.1364 - LN 9073	2024				
2024 - TUBE						
1	AMS WW – T –700/3	2024	AMS 4088 (T3)	TUBE	3	1
2	WL 3.1354 (Part-4) (LN 1795)	2024				
3	AMS 4088	2024				

Sl. no	Material Specification	Grade	Rationalised Material Specification	Form	No. of Alloy Grades	
					Identified	Rationalised
2017 - BAR						
1	AIR 9051	AU4G / AU4G1	AMS 4118 (T4) / AU4G1 AIR 9051 (T4)	BAR	3	2
2	BS EN 573-3	EN AW-2017A				
3	AMS 4118	2017				
2618 - BAR						
1	MSRR 8007	-	AMS 4132 (T61) / AU2G1 AIR 9051 (T6)	BAR	9	2
2	AIR 9051	AU2GN				
3	MSRR 8018 (Superseded by RRMS 34001/2)	2618-F				
4	DTD-731 (Obsolete)	-				
5	BS EN 573-3	EN AW-2618A				
6	DTD-5014 (Obsolete)	-				
7	MIL-A-22771/ AMS-A-22771	2618				
8	ASTM -B-247	2618				
9	AMS 4132	2618				

<table>
<tr><th rowspan="2">Sl. No.</th><th rowspan="2">Material Specification</th><th rowspan="2">Grade</th><th rowspan="2">Rationalised Material Specification</th><th rowspan="2">Form</th><th colspan="2">No. of Alloy Grades</th></tr>
<tr><th>Identified</th><th>Rationalised</th></tr>
<tr><td colspan="7">6061 - BAR</td></tr>
<tr><td>1</td><td>ASTM B247</td><td>6061</td><td rowspan="12">AMS 4127 (T6) / HE 20 A (T6) / AMS 4116 (T62)</td><td rowspan="12">BAR</td><td rowspan="12">12</td><td rowspan="12">3</td></tr>
<tr><td>2</td><td>BS EN 573-3</td><td>EN AW-6061</td></tr>
<tr><td>3</td><td>IS 734</td><td>65032 (HF20 Old)</td></tr>
<tr><td>4</td><td>MIL-A-22771/ AMS-A-22771</td><td>6061</td></tr>
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<tr><td>9</td><td>AMS 4116</td><td>6061</td></tr>
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<tr><td>11</td><td>AMS 4128</td><td>6061</td></tr>
<tr><td>12</td><td>WL 3.3214 (LN 1796 – LN 1798)</td><td>6061</td></tr>
<tr><td colspan="7">6061 – SHEET</td></tr>
<tr><td>1</td><td>IS 737 (GR 65032 WP) HS20A WP</td><td>Gr 65032</td><td rowspan="5">AMS 4026 (T6)</td><td rowspan="5">SHEET</td><td rowspan="5">5</td><td rowspan="5">1</td></tr>
<tr><td>2</td><td>AMS 4025</td><td>6061</td></tr>
<tr><td>3</td><td>AMS 4026</td><td>6061</td></tr>
<tr><td>4</td><td>AMS 4027</td><td>6061</td></tr>
<tr><td>5</td><td>WL 3.3214 LN 9073</td><td>6061</td></tr>
</table>

Sl. No.	Material Specification	Grade	Rationalised Material Specification	Form	No. of Alloy Grades	
					Identified	Rationalised
6061 - PLATE						
1	WL 3.3214 (LN 9073)	6061	AMS 4026 (T451)	PLATE	3	1
2	6061 AMS 4026	6061				
3	6061 AMS 4027	6061				
6061 – TUBE						
1	AMS-WW-T-700/6	6061	AMS 4083 (T62)	TUBE	9	1
2	AMS 4083	6061				
3	AMS-T-7081	6061				
4	BS L118	6061				
5	QQ-A-200/8	6061				
6	AMS 4079	6061				
7	AMS 4080	6061				
8	AMS 4081	6061				
9	AMS 4082	6061				
7049 – BAR						
1	ASTM B247	7049	AMS 4111 (T73)	BAR	3	1
2	AMS 4111	7049				
3	MIL-A-22771 / AMS-A-22771	7049				
7050 – BAR						
1	ASTM -B-247	7050	AMS 4333 (T7452)	BAR	3	1
2	AMS 4333	7050				
3	MIL-A-22771 / AMS-A-22771	7050				

Sl. No.	Material Specification	Grade	Rationalised Material Specification	Form	No. of Alloy Grades	
					Identified	Rationalised
7075 – BAR						
1	ASTM -B-247	7075	AMS QQ – A – 200/11 (T73)	BAR	6	1
2	BS EN 573-3	EN AW-7175				
3	MIL-A-22771/ AMS-A-22771	7075				
4	AMS -QQ-A-200/11	7075				
5	AIR 9051	AZ5GU				
6	WL 3.4364	7075				
7075 – PLATE						
1	WL 3.4364 - LN 9073	7075	7075 AMS QQ – A – 250/12 (T651/T351)	PLATE	4	1
2	7075 AMS QQ– A–250/12	7075				
3	TU1-90-161-90	V95PCH (B-95PCH)				
4	AMS 4078	7075				
7075 – SHEET						
1	WL 3.4364 - LN 9073 / (LN 9074)	7075	7075 AMS QQ – A – 250/12 (T6)	SHEET	4	1
2	7075 AMS QQ-A-250/12	7075				
3	OST1-90026-71 G-4784-95	V95PCH (B-95PCH)				
4	AMS 4045	7075				

Sl. No.	Material Specification	Grade	Rationalised Material Specification	Form	No. of Alloy Grades	
					Identified	Rationalised
5083 – BAR						
1	AIR 9051	AG4MC	BS EN 573-3 (H111)	BAR	3	1
2	BS EN 573-3	EN AW-5083				
3	ASTM B247	5083				
5083 – SHEET						
1	AG3	5083	QQ-A 250/6 (H111)	SHEET	2	1
2	AG4MC	5083				
	QQ-A-200/4 QQ-A-250/6	5083				
2219 – BAR						
1	ASTM B247	2219	AMS 4162 (T8511)	BAR	4	1
2	AMS 4143	2219				
3	MIL-A-22771/ AMS-A-22771	2219				
4	AMS 4162	2219				
2219 – PLATE						
1	AMS-QQ-A-250/30	2219	AMS 4599 (2219-T851)	PLATE	3	1
2	AMS 4599 (2219-T851)	2219				
3	AMS 4601 (2219-T351)	2219				
2219 – SHEET						
1	AMS-QQ-A-250/30	2219	AMS 4601 (2219-T31 / - T351)	SHEET	2	1
2	AMS 4601 (2219-T31/-T351)	2219				

Sl. No.	Material Specification	Grade	Rationalised Material Specification	Form	No. of Alloy Grades	
					Identified	Rationalised
2124 – PLATE						
1	2124 T851	2124	AMS 4101 (T851)	PLATE	4	1
2	AMS 4101	2124				
3	AMS-QQ-A-250/29	2124				
4	AIR 9048/91 620 (2214-T651)	2224				
5251 – TUBE						
1	BS 4L 56	5251	EN- AW -5251 / BS 4L 56	TUBE	3	2
2	EN- AW -5251	5251				
3	BS N4	5251				
3103 – SHEET						
1	BS 4L 59	3103	BS N3 / BS 4L 59	SHEET	5	2
2	BS L60	3103				
3	BS L61	3103				
4	DIN 1745 3.0515	3103				
5	BS N3	3103				
6082 – BAR						
1	BS L111	6082	BS L111 (T651/T6511)	BAR	2	1
2	IS 733 (Gr 64430 WP) HE 30A WP	Gr 64430				
6082 – SHEET						
1	BS L113	6082	BS L113 (T6)	SHEET	2	1
2	IS 737 (GR 64430 WP) HS 30A WP	Gr 64430				
7010 – PLATE						
1	AMS 4205	7010	AMS 4205 (T7451)	PLATE	2	1
2	BS EN 2684	Al-P 7010				

STEEL						
AISI 316 BAR						
Sl. No.	**Material Specification**	**Grade**	**Rationalised Material Specification**	**Form**	**No. of Alloy Grades**	
					Identified	**Rationalised**
1	AMS 5653	316L	AMS 5653	BAR	4	1
2	AMS 5648	316				
3	AMS 5649	316				
4	AMS-S-7720 / Mil-S-7720	316				
AISI 316 SHEET						
1	AMS 5507	316L	AMS 5507	SHEET	4	1
2	BS S 537	316				
3	MIL-S-5059 Type 316	316				
4	AMS 5524	316				
AISI 316 TUBE						
1	AMS 5584 Class 1	316L	AMS 5584 CLASS 1	TUBE	3	1
2	BS T 75	316L				
3	AMS 5573	316				
AISI 1074 SHEET						
1	BS S 513	-	AMS 5120	SHEET	2	1
2	AMS 5120	1074				
AISI 1095 SHEET						
1	MIL-S-7947	-	AMS 5122	SHEET	3	1
2	AMS 5121	1095				
3	AMS 5122	1095				

Sl. No.	Material Specification	Grade	Rationalised Material Specification	Form	No. of Alloy Grades	
					Identified	Rationalised
AISI 304 TUBE						
1	MIL-T-6845 Type 1	304	AMS 5564 Class 1	TUBE	4	1
2	AMS-T-6845 Type 1	304				
3	AMS 5566 Type 1	304				
4	AMS 5564 Class 1	304				
AISI 321 BAR						
1	AMS 5645	321	AMS 5645 / MDN 321 A	BAR	5	2
2	S 129	321				
3	MDN 321 A	321				
4	WL 1.4544.9 (LN 668)	321				
5	Z10CNT18-11 A (AIR 9160)	321				
AISI 321 SHEET						
1	BS S 526	321	BS S 526 / MDN 321 A	SHEET	7	2
2	MDN 321 A	321				
3	AMS 5510	321				
4	MIL-S-6721	321				
5	BS S 524	321				
6	WL 1.4544.9 (LN 9450)	321				
7	Z10CNT18-11 (AIR 9160)	321				

Sl. No.	Material Specification	Grade	Rationalised Material Specification	Form	No. of Alloy Grades	
					Identified	Rationalised
AISI 321 TUBE						
1	AMS 5570	321	AMS 5570 / Z10CNT18-11 (AIR 9160) / MDN 321A	TUBE	6	3
2	MDN 321 A	321				
3	BS T69	321				
4	AMS 5896 Type1	321				
5	Z10CNT18-11 AIR 9160	321				
6	WL 1.4544.9 (LN 9398)	321				
AISI 347 SHEET						
1	BS S 527	347	BS S 527 / AMS 5512 / MDN 347 A	SHEET	4	3
2	MDN 347 A	347				
3	AMS 5512	347				
4	MIL-S-6721 (Cb + Ta)	347				
AISI 347 TUBE						
1	BS 2T 68	347	BS 2T 68	TUBE	3	1
2	BS T66	347				
3	BS T72	347				

Sl. No.	Material Specification	Grade	Rationalised Material Specification	Form	No. of Alloy Grades	
					Identified	Rationalised
AISI 4130 BAR						
1	MIL-S-6758 (Obsolete Superceded by AMS-S-6758)	4130	AMS 6370 / MDN 6758 A / AMS-S-6348	BAR	10	3
2	AMS-S-6348	4130				
3	BS S142	-				
4	AMS 6370	4130				
5	G-4543-71	30KHMA				
6	MIL-S-6758 D4	4130				
7	AIR 9160 25CD4S	4130				
8	DIN 17200 1.7218	25CrMo4				
9	QQ-S-684	4130				
10	WL 1.7214 (LN 1017, LN 668)	4130				
AISI 4130 SHEET						
1	AMS 6345	4130	AMS 6345 / BS S 534	SHEET	7	2
2	MIL-S-18729	4130				
3	BS S 534	4130				
4	AIR 9160 25CD4S	4130				
5	DIN 17200 1.7218	25CrMo4				
6	BS S 535	4130				
7	WL 1.7214.5 (LN 9451)	4130				

Sl. No.	Material Specification	Grade	Rationalised Material Specification	Form	No. of Alloy Grades	
					Identified	Rationalised
AISI 4130 TUBE						
1	AMS-T-6736	4130	AMS 6361 / AMS 6362	TUBE	8	2
2	MIL-T-6736	4130				
3	AMS 6361	4130				
4	AMS 6362	4130				
5	BS T65	4130				
6	BS T60	4130				
7	BS T76	4130				
8	BS T77	4130				
15-5 PH BAR						
1	AMS 5659	15-5PH	AMS 5659	BAR	2	1
2	MDN 15-5PH	15-5PH				
17-4 PH BAR						
1	AMS 5643	17-4 PH	AMS 5622 / MDN 174A PH	BAR	3	2
2	AMS 5622	17-4 PH				
3	MDN 174A PH	17-4 PH				
MSRR 6596 BAR						
1	MSRR 6596 (Made from 6919)	-	MSRR 6596	BAR	3	1
2	BS S 150	-				
3	TU14-1-1161-75	15KH12N2 MB-FAB-SH AP 517				

Sl. No.	Material Specification	Grade	Rationalised Material Specification	Form	No. of Alloy Grades	
					Identified	Rationalised
52100 BAR						
1	BS 2S 136	52100	AMS 6440 / BS 2S 136	BAR	4	2
2	AMS 6440 (SAE 52100)	52100				
3	BS S 135	52100				
4	AIR 9160 - 100C6	100C6				
Z12CNDV12 BAR						
1	AIR 9160	Z12CNDV12	AMS 5719 / AIR 9160	BAR	9	2
2	MSRR 6503 (Made from MSRR 6916)	-				
3	RRMS 32007/1 (Made from RRMS 32007)	-				
4	CCT-00115	Z12CNDV12				
5	BS S151	-				
6	AMS 5719	-				
7	MSRR 6509	-				
8	CCT-00321	EZ12CNDV12				
9	MSRR 6510	-				
12NC12 BAR						
1	MSRR 6004	-	BS S 15	BAR	3	1
2	BS S 15	-				
3	AIR 9160	12NC12				
SAE 4340 BAR						
1	AMS 6414	SAE 4340	AMS 6414 / BS 5S 99 / MDN 99 A	BAR	6	3
2	MIL S 5000	E4340				
3	AMS 6415	SAE 4340				
4	BS 5S 99	4340				
5	MDN 99 A	4340				
6	BS S 98	4340				

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<tr><td>2</td><td>BSEM 545 (Replaced by MSRR 6051 and obsolete)</td><td>-</td></tr>
<tr><td>3</td><td>AIR 9160</td><td>16NCD13</td></tr>
<tr><td>4</td><td>MSRR 6051</td><td>-</td></tr>
<tr><td>5</td><td>BS S157</td><td>-</td></tr>
<tr><td>6</td><td>AMS 6549</td><td>-</td></tr>
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<tr><td colspan="7">16NCD17 BAR</td></tr>
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<tr><td>2</td><td>BS S 82</td><td>-</td></tr>
<tr><td>3</td><td>AIR 9160 16NCD17</td><td>-</td></tr>
<tr><td colspan="7">15CDV6 BAR</td></tr>
<tr><td>1</td><td>WL 1.7734</td><td>-</td><td rowspan="7">AIR-9160</td><td rowspan="7">BAR</td><td rowspan="7">7</td><td rowspan="7">1</td></tr>
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<tr><td>3</td><td>CCT LA 189</td><td>E15 CDV 6</td></tr>
<tr><td>4</td><td>AIR-9160</td><td>15 CDV 6 / E15 CDV 6</td></tr>
<tr><td>5</td><td>TU14-4-950-86</td><td>30 KHGSA</td></tr>
<tr><td>6</td><td>TU14-4-950-86</td><td>30KHGSA-SH</td></tr>
<tr><td>7</td><td>TU14-1-1885-76</td><td>30KHGSA-VD</td></tr>
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Sl. No.	Material Specification	Grade	Rationalised Material Specification	Form	No. of Alloy Grades	
					Identified	Rationalised
30CDV12 BAR						
1	BS 4S 106	-	30CDV12 AIR 9160	BAR	6	1
2	AIR 9160	30CD12				
3	MSRR 6001/ (MSRR 6001 SUPERSEDED TO RRMS 31018/1)	-				
4	CCT LA 239	30CD12				
5	MSRR 6002/ (MSRR 6002 SUPERSEDED TO RRMS 31018/2)	-				
6	RRMS 31018 (Forging stock specification)	RRMS 31018/1 RRMS 31018/2				
35CD4 BAR						
1	AIR-9160	35CD4	AMS 6348	BAR	3	1
2	AMS 6348	-				
3	CCT-00308	35CD4				
SAE 9310 BAR						
1	AMS 6260	SAE 9310	AMS 6265	BAR	3	1
2	AMS 6265	SAE 9310				
3	EMS 56280	SAE 9310				
SAE 51410 BAR						
1	AIR 9160	Z12CN13	AMS 5613	BAR	3	1
2	CCT LA 37	EN Z12CN13				
3	AMS 5613	SAE 51410				

Sl. No.	Material Specification	Grade	Rationalised Material Specification	Form	No. of Alloy Grades	
					Identified	Rationalised
SAE 51431 BAR						
1	WL 1.4044 (LN 176, LN 668, LN 1017)	431	AMS 5628 / MDN 431A / BS 7S 80	BAR	11	3
2	MSRR 6573	-				
3	AIR 9160	Z15CN17-03				
4	AMS 5628	SAE 51431				
5	DIN 17440	X22CrNi17 1.4057				
6	MIL-S-18732	431				
7	TU14-1-377-72	14KH17N2 1KH17N2				
8	BS 7S 80	431				
9	BS S137	-				
11	MDN 431A	431				
MDN 250 BAR						
1	MIL-S-46850	TY IV, Grade 250	AMS 6512 / MIL-S-46850 / MDN 250A	BAR	5	3
2	AMS 6512	-				
3	DTD 5212	-				
4	MLA 101	-				
5	MDN 250A (Indigenised)	-				
BS 95 BAR						
1	BS S 95	-	BS S 95	BAR	3	1
2	MSRR 6017	-				
3	MSRR 6036 (Obsolete) MSRR 6017 is ALTERNATE to MSRR 6036)	-				

Sl. No.	Material Specification	Grade	Rationalised Material Specification	Form	No. of Alloy Grades	
					Identified	Rationalised
BS 62 BAR						
1	AIR-9165	Z20 CDNb 11	AIR-9165	BAR	2	1
2	BS 62	-				
AMS 6264 BAR						
1	MSRR 6009	-	AMS 6264	BAR	5	1
2	MSRR 6010 / (MSRR 6010 SUPERSEDED TO RRMS 31014/1)	-				
3	RRMS 31014 / RRMS 31014 /1	-				
4	MSRR 6094	-				
5	AMS 6264	-				
Z30C13 BAR						
1	MSRR 6602	-	AMS 5655	BAR	3	1
2	AIR 9160	Z30C13				
3	AMS 5655	-				
MDN 132 BAR						
1	MSRR 6012 (Made from MSRR 6911)	-	BS S 132 / MDN 132 A (Indigenized)	BAR	5	2
2	MSRR 6011 (Made from MSRR 6910)	-				
3	MSRR 6100	-				
4	BS S 132	-				
5	MDN 132 A (Indigenized)	-				
A286 BAR						
1	AMS 5731	-	AMS 5737	BAR	4	1
2	AMS 5732	-				
3	AMS 5734	-				
4	AMS 5737	-				

Sl. No.	Material Specification	Grade	Rationalised Material Specification	Form	No. of Alloy Grades	
					Identified	Rationalised
BS S 99 BAR						
1	BS 5S 99	-	BS 5S 99 / MDN 99 A	BAR	6	2
2	BS S 98	-				
3	BS S154	-				
4	BS S 96 (Obsolete Replaced by S154)	-				
5	BS S 97	-				
6	MDN 99 A	-				
18-8 BAR						
1	AMS 5645	321	AMS 5645	BAR	7	1
2	X10CrNiTi189 1.4541 DIN 17440	321				
3	BS S129	-				
4	Z10CNT18-11 AIR 9160	321				
5	MSRR 6522					
6	G-5632-72 G-5949-75 TU14-1-378-72 G-8060-78 12KH18N10T KH18N10T	-				
7	WL 1.4544 (LN 668)	321				
18-9 BAR						
1	MDN 321A	-	AMS 5646	BAR	2	1
2	AMS 5646	SAE 30347				
ZFNL 9201 BAR						
1	ZFNL 9201	-	MDN 9201 A	BAR	2	1
2	MDN 9201 A (Indigenized)	-				

NICKEL

NIMONIC 263 BAR

Sl. No.	Material Specification	Grade	Rationalised Material Specification	Form	No. of Alloy Grades	
					Identified	Rationalised
1	MSRR 7035 [superseded by RRMS 33031, RRMS 33031/1, RRMS 33030/2, RRMS 33030/3, RRMS 33030/4]	-	AMS 5886 / BS 2HR 10 / SUPERNI 263 A	BAR	6	3
2	MSRR 7038 [superseded by RRMS 33045, RRMS 33045/1, RRMS 33045/2, RRMS 33045/3, RRMS 33045/4]	-				
3	BS 2HR 10	-				
4	AIR 9165	NCK20D				
5	AMS 5886	-				
6	SUPERNI 263 A (Indigenized)	-				

INCONEL 625 BAR

Sl. No.	Material Specification	Grade	Rationalised Material Specification	Form	Identified	Rationalised
1	AMS 5666	-	AMS 5666	BAR	4	1
2	CCT LA 398	NC22DNb				
3	ASTM B 564	UNS N06625				
4	BS EN 10095	NiCr22Mo9Nb Alloy no. 2.4856				

WASP ALLOY BAR

Sl. No.	Material Specification	Grade	Rationalised Material Specification	Form	Identified	Rationalised
1	MSRR 7192	-	AMS 5707 / EMS 55388	BAR	9	2
2	AIR 9165	NC20 K14				
3	AMS 5704	-				
4	AMS 5706	-				
5	AMS 5707	-				
6	AMS 5708	-				
7	AMS 5709	-				
8	NC20K14	-				
9	EMS 55388	-				

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<tr><td>1</td><td>AMS 5662</td><td>-</td><td rowspan="7">AMS 5662 / SUPERNI 718 A</td><td rowspan="7">BAR</td><td rowspan="7">7</td><td rowspan="7">2</td></tr>
<tr><td>2</td><td>AMS 5663</td><td>-</td></tr>
<tr><td>3</td><td>AMS 5664</td><td>-</td></tr>
<tr><td>4</td><td>AIR 9165</td><td>NC19FeNb</td></tr>
<tr><td>5</td><td>MSRR 7115</td><td>-</td></tr>
<tr><td>6</td><td>SuperNi 718 A (Indigenized)</td><td>-</td></tr>
<tr><td>7</td><td>TU14-1-3905-85</td><td>KHN45MVTYUBR EP718</td></tr>
<tr><td colspan="7">NIMONIC 75 BAR</td></tr>
<tr><td>1</td><td>RRMS 33030 & RRMS 33030/1 [supersedes MSRR 7004]</td><td>-</td><td rowspan="6">BS 2HR 5 / SuperNi 75 A</td><td rowspan="6">BAR</td><td rowspan="6">6</td><td rowspan="6">2</td></tr>
<tr><td>2</td><td>MSRR 7008 [superseded by RRMS 33030 & RRMS 33030/2]</td><td>-</td></tr>
<tr><td>3</td><td>BS 2HR 5</td><td>-</td></tr>
<tr><td>4</td><td>BS 3HR 504</td><td>-</td></tr>
<tr><td>5</td><td>AIR 9165</td><td>NC 20T</td></tr>
<tr><td>6</td><td>SuperNi 75 A / MDN 75 (Indigenized)</td><td>-</td></tr>
<tr><td colspan="7">INCONEL 718 PLUS BAR</td></tr>
<tr><td>1</td><td>MSRR 7202</td><td>Special grade Inco 718</td><td rowspan="3">MSRR 7202</td><td rowspan="3">BAR</td><td rowspan="3">3</td><td rowspan="3">1</td></tr>
<tr><td>2</td><td>EMS 55476 (supersedes EMS 55458)</td><td>Delta Processed (DP) 718</td></tr>
<tr><td>3</td><td>CCT 771</td><td>INCONEL 718 PQ</td></tr>
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Sl. No.	Material Specification	Grade	Rationalised Material Specification	Form	No. of Alloy Grades	
					Identified	Rationalised
NIMONIC 80A BAR						
1	MSRR 7009	-	BS 3 HR 1	BAR	7	1
2	MSRR 7010 (cancelled)	-				
3	MSRR 7011	-				
4	MSRR 7012	-				
5	BS 3 HR 1	-				
6	BS 4HR 601 (supersedes MSRR 7013)	-				
7	AIR 9165	NC 20 TA				
NIMONIC 90 BAR						
1	MSRR 7137	-	AIR 9165 / BS HR 2	BAR	6	2
2	MSRR 7135	-				
3	MSRR 7129	-				
4	MSRR 7016	-				
5	BS HR 2	-				
6	AIR 9165	NCK 20 TA				
NIMONIC 115 BAR						
1	MSRR 7023	-	BS HR 4 / SuperNi 115	BAR	5	2
2	MSRR 7022	-				
3	BS HR 4	-				
4	DTD 5017 (Obsolete)					
5	SuperNi115 (Indigenized)	-				
NIMONIC 105 BAR						
1	MSRR 7017	-	BS 2 HR 3	BAR	6	1
2	MSRR 7018	-				
3	MSRR 7134	-				
4	BS 2HR 3	-				
5	DTD 5007 (obsolete)	-				
6	AIR 9165	NK 20 CDA				

Sl. No.	Material Specification	Grade	Rationalised Material Specification	Form	No. of Alloy Grades	
					Identified	Rationalised
NC 22 FeD SHEET						
1	NC 22 FeD	-	NC 22 FeD / AMS 5536 / MIDAHNI ATGE	SHEET	4	3
2	BS HR 204	-				
3	AMS 5536	-				
4	MIDAHNI ATGE	-				
NIMONIC 90 WIRE						
1	BS HR 502	-	BS HR 502 / MIDHANI ATG S4	WIRE	9	2
2	BS HR 501	-				
3	BS HR 503	-				
4	BS HR 506	-				
5	MSRR 7014	-				
6	MSRR 7015	-				
7	BSEM 796	-				
8	BSEM 797	-				
9	MIDHANI ATG S4	-				
BS HR 202 SHEET						
1	BS HR 202	-	BAS HR 202 / MIDHANI ATG S4	SHEET	6	2
2	MSRR 7086	-				
3	MSRR 7087	-				
4	BACE355	-				
5	NCK20TA	-				
6	MIDHANI ATG S4	-				
BS HR 403 TUBE						
1	BS HR 403	-	BS HR 403 / MIDAHNI ATGR	TUBE	4	2
2	MSRR 7006	-				
3	KhN 78 T	-				
4	MIDAHNI ATGR	-				

Sl. No.	Material Specification	Grade	Rationalised Material Specification	Form	No. of Alloy Grades	
					Identified	Rationalised
BS HR 402 TUBE						
1	BS HR 402	-	BS HR 402	TUBE	2	1
2	MIDHANI ATG S4	-				
NIMONIC 75 SHEET						
1	BS HR 203	-	BS HR 203 / NC 20 T/ MIDAHNI ATGR	SHEET	6	3
2	MSRR 7104	-				
3	MSRR 7157	-				
4	NC 20 T	-				
5	KhN 78 T	-				
6	MIDAHNI ATGR	-				
AMS 5713 BAR						
1	AMS 5712	-	AMS 5713	BAR	2	1
2	AMS 5713	-				
MSRR 7037 TUBE						
1	MSRR 7037	-	MSRR 7037 / MIDAHNI ATG WO	TUBE	3	2
2	BS HR 404	-				
3	MIDAHNI ATG WO	-				

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(BSEM 572)</td><td>-</td></tr>
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MIDHANI ATG W0</td><td rowspan="7">BAR</td><td rowspan="7">7</td><td rowspan="7">2</td></tr>
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<tr><td>3</td><td>NIMONIC 263</td><td>-</td></tr>
<tr><td>4</td><td>BS HR 10</td><td>-</td></tr>
<tr><td>5</td><td>MSRR 7035</td><td>-</td></tr>
<tr><td>6</td><td>MSRR 7038</td><td>-</td></tr>
<tr><td>7</td><td>MIDHANI ATG W0</td><td>-</td></tr>
</table>

TITANIUM

TA6ZrD BAR

Sl. No.	Material Specification	Grade	Rationalised Material Specification	Form	No. of Alloy Grades	
					Identified	Rationalised
1	CCT 00202	-	TITAN 26 A	BAR	6	1
2	MSRR 8616	-				
3	BS TA 43 (withdrawn)	-				
4	BS TA 44 (withdrawn)	-				
5	GTM Ti-685 (Indigenized)	-				
6	TITAN 26 A (Indigenized)	-				

TA8DV BAR

Sl. No.	Material Specification	Grade	Rationalised Material Specification	Form	Identified	Rationalised
1	CCT LA 114	-	AMS 4972 / TITAN 22 A	BAR	6	2
2	AMS 4972	-				
3	AMS 4933	-				
4	AMS-T-9047 / MIL-T-9047 (8Al-1Mo-1V) (obsolete)-superseded by AMS 6910	-				
5	AMS 4973	-				
6	TITAN 22 A (Indigenized)	-				

Ti6242S BAR

Sl. No.	Material Specification	Grade	Rationalised Material Specification	Form	Identified	Rationalised
1	EMS 54929	-	EMS 54929	BAR	4	1
2	AMS 4976	-				
3	AMS 4975	-				
4	AMS-T-9047 / MIL-T-9047 [6Al-2Sn-4Zr-2Mo] (obsolete)-superseded by AMS 6905	-				

Sl. No.	Material Specification	Grade	Rationalised Material Specification	Form	No. of Alloy Grades	
					Identified	Rationalised
Ti6Al6V2Sn BAR						
1	AMS 4971	Ti 662	AMS 4971	BAR	5	1
2	AMS 4978	Ti 662				
3	AMS 4979	Ti 662				
4	AMS 4936	Ti 662				
5	AMS 4937	Ti 662				
Ti6Al4V PLATE / SHEET						
1	TA6V	Ti6Al4V	AMS 4911	PLATE / SHEET	8	1
2	BT6	Ti6Al4V				
3	AMS 4906	Ti6Al4V				
4	AMS 4911	Ti6Al4V				
5	AMS 4932	Ti6Al4V				
6	BS TA 10	Ti6Al4V				
7	BS TA 56	Ti6Al4V				
8	BS TA 59	Ti6Al4V				
Ti8Al1Mo1V(TA8DV) PLATE / SHEET						
1	AMS 4915	Ti8Al1Mo1V (TA8DV)	AMS 4916	SHEET \ PLATE	3	1
2	AMS 4916	Ti8Al1Mo1V (TA8DV)				
3	AMS-T-9046 A-4	Ti8Al1Mo1V				
Ti6Al2Sn4Zr2Mo0.1Si PLATE / SHEET						
1	AMS 4919	Ti6242	AMS 4919	SHEET \ PLATE	2	1
2	MIL-T-9046J AB-4	Ti6242				

Sl. No.	Material Specification	Grade	Rationalised Material Specification	Form	No. of Alloy Grades	
					Identified	Rationalised
Ti64 BAR						
1	MSRR 8614	-	AMS 4928 / TITAN 31 A	BAR	15	2
2	AMS 4928	-				
3	CCT 00166	TA6V.PQ				
4	GTM Ti-64 (Indigenized)	-				
5	AIR9183	TA6V				
6	CCT LA109	TA6V				
7	BS TA12 (Obsolete) - superseded by BS EN 3310	-				
8	BS TA13 (Obsolete) - superseded by BS EN 3312	-				
9	TITAN 31 A (Indigenized)	-				
10	AMS-T-9047 / MIL-T-9047 6Al-4V (obsolete) - superseded by AMS 6931	-				
11	ASTM B 348	Grade 5, UNS R56400				
12	ASTM B 381	Grade F5, UNS R56400				
13	WL 3.7164	-				
14	OST1 90013-81 / OST1 90173-75 / AMTY 451	BT6 / VT6				
15	OST1-90013-71 OST1-90024-94	VT6				

Sl. No.	Material Specification	Grade	Rationalised Material Specification	Form	No. of Alloy Grades	
					Identified	Rationalised
Ti64 PLATE						
1	MSRR 8614	-	AMS 4911 / TITAN 31 A	PLATE	16	2
2	AMS 4911	-				
3	CCT 00166	TA6V.PQ				
4	GTM Ti-64 (Indigenized)	-				
5	AIR9183	TA6V				
6	CCT LA109	TA6V				
7	BS TA10 (obsolete)-superseded by BS EN 3310	-				
8	BS TA13 (obsolete)-superseded by BS EN 3312	-				
9	TITAN 31A (Indigenized)	-				
10	AMS-T-9046 / MIL-T-9046 6Al-4V (obsolete)	-				
11	ASTM B 265	Grade 5, UNS R56400				
12	ASTM B 381	Grade F5, UNS R56400				
13	EMS 54930	-				
14	WL 3.7164	-				
15	OST1 90013-81 / OST1 90173-75 / AMTY 451	BT6 / VT6				
16	OST1-90013-71 OST1-90024-94	VT6				
Ti662 PLATE / SHEET						
1	AMS 4918	Ti662	AMS 4918	SHEET \ PLATE	2	1
2	MIL-T-9046J AB-3	Ti662				

2.0 LITERATURE

2.1 ALUMINIUM ALLOYS

Aluminum Alloys are used extensively because of the following benefits:

- Aluminium is a light metal and is about one third of the density of Steel, Copper and Brass.
- Aluminium has good corrosion resistance to common atmospheric and marine atmospheres. Its corrosion resistance and scratch resistance can be enhanced by anodizing.
- Aluminium has high reflectivity and can be used for decorative applications.
- Some Aluminum Alloys can match or even exceed the strength of common construction steel.
- Aluminium retains its toughness at very low temperatures, without becoming brittle (like carbon steel).
- Aluminium is a good conductor of heat and electricity. When measured using equal cross-sectional area, electrical grade aluminium has a conductivity that is approximately 62% of electrical grade annealed copper. However, when compared using equal weight, the conductivity of aluminium is 204% of copper.
- Aluminium can be readily worked and formed using a wide variety of forming processes including deep-drawing and roll forming.
- Aluminium can be readily recycled.

2.1.1 Classification of Aluminum Alloys

Classification of Aluminum alloys is established by the International Alloy Designation System (IADS), based on the classification developed by Aluminum Association of the United States. Each wrought aluminum alloy is designated by a four digit number.

The first digit indicates the alloy group according to the major alloying element:

1xxx Aluminum 99.0% minimum

2xxx Copper (1.9%-.6.8%)

3xxx Manganese (0.3%-1.5%)

4xxx Silicon (3.6%-13.5%)

5xxx Magnesium (0.5%-5.5%)

6xxx Magnesium and Silicon (Mg 0.4%-1.5%, Si 0.2%-1.7%)

7xxx Zinc, Magnesium and Copper (Zn 1%-8.2%-Mg 1-2.9%-1-2%Cu)

8xxx Others

The second digit indicates modification of the alloy or impurity limits.

- ❖ Original (basic) alloy is designated by "0" as the second digit. Numbers 1…9 indicate various alloy modifications with slight differences in the compositions.
- ❖ In the alloys of the 1xxx series the second digit indicates modifications in impurity limits: 0 means natural impurity limit, 1…9 indicate special control of one or more impurities or alloying element.

The last two digits identify aluminum alloy or indicate the alloy purity. In the alloys of the 1xxx series the last two digits indicate the level of purity of the alloy:

1070 or 1170 mean a minimum of 99.70 % of aluminum in the alloys

1050 or 1250 mean 99.50% of aluminum in the alloys

1100 or 1200 mean a minimum of 99.00 % of aluminum in the alloys.

In all other groups of aluminum alloys (2xxx through 8xxx) the last two digits signify different alloys in the group.

Foundry and Forge Division currently manufactures forgings in 2xxx, 6xxx, 5xxx and 7xxx series alloys and their properties are briefed below.

2.1.2 Heat-Treatable Alloys

Some alloys are strengthened by solution heat-treating and then quenching, or rapid cooling. Heat treating takes the solid, alloyed metal and heats it to a specific point. The alloy elements called the solute, are homogeneously distributed with the aluminum putting them in a solid solution. The metal is subsequently quenched or rapidly cooled, which freezes the solute atoms in place. The solute atoms consequently combine into a finely distributed precipitate. This occurs at room temperature which is called natural ageing or in a low temperature furnace operation which is called Artificial ageing.

2.1.2.1 2xxx Series

In the 2xxx series, copper is used as the principal alloying element and can be strengthened significantly through solution heat-treating. These alloys possess a good combination of high strength and toughness but do not have the levels of atmospheric corrosion resistance as many other aluminum alloys. Therefore, these alloys are usually painted or clad for such exposures. They are generally clad with a high-purity alloy or a 6xxx series alloy to greatly resist corrosion. Alloy 2014 is perhaps the most widely known Aircraft Alloy.

2.1.2.2 6xxx Series

The 6xxx series are versatile, heat treatable, highly formable, wieldable and have moderately high strength coupled with excellent corrosion resistance. Alloys in this series contain silicon and magnesium in order to form magnesium silicide within the alloy. Extrusion products from the 6xxx series are the first choice for architectural and structural applications. Alloy 6061 is the most widely used alloy in this series and is often used in truck and marine frames.

2.1.2.3 7xxx Series

Zinc is the primary alloying agent for this series, and when magnesium is added in a smaller amount, the result is a heat-treatable, very high strength alloy. Other elements such as copper and chromium may also be added in small quantities. The most commonly known alloys are 7050 and 7075, which are widely used in the aircraft industry.

2.1.3 Non Heat-Treatable Alloys

Non-heat treated alloys are strengthened through cold-working. Cold working occurs during rolling or forging methods and is the action of “working” the metal to make it stronger. For example, when rolling aluminum down to thinner gauges, increases the strength of the metal. Alloying elements like magnesium intensify this effect, resulting in even higher strength.

2.1.3.1 5xxx Series

Magnesium is one of the most effective and widely used alloying elements for Aluminum and is the primary alloying agent in the 5xxx series. Alloys in this series possess moderate to high strength characteristics, as well as good weld ability and resistance to corrosion in the marine environment. Because of this, Aluminum-Magnesium Alloy is widely used in building and construction, storage tanks, pressure vessels and marine applications. Examples of common alloy applications include: 2024 in Electronics, 5083 in Marine applications, anodized 5005 sheet for Architectural applications and 5182 makes the Aluminum beverage can lid.

2.1.4 Effect of Alloying Elements

Alloying elements when added to Aluminum alloys produce effects such as precipitation hardening (age hardening), solid solution hardening, dispersion strengthening, grain refining, modifying metallic and intermetallic phases, suppression of grain growth at elevated temperatures (e.g. during annealing), wear resistance and other tri-biological properties. The following provides some of the effects of alloying elements on Aluminum Alloys.

2.1.4.1 **Silicon - Si** (up to 17%)

- Improves cast ability of Aluminum Alloys due to a better fluidity and lower shrinkage of molten Aluminum-Silicon Alloys.
- Increases strength of the Alloys.
- Improves resistance to abrasive wear.
- Silicon in combination with Magnesium allows to strengthening the alloys by precipitation hardening heat treatment (Wrought Aluminum-Magnesium-Silicon Alloys (6xxx)).

2.1.4.2 **Copper - Cu** (up to 6.5%)

- Increases tensile strength, fatigue strength and hardness of the alloys due to the effect of solid solution hardening.
- Allows to strengthening the alloys by precipitation hardening heat treatment (Wrought Aluminum-Copper Alloys (2xxx)).
- Decreases the ductility of the Alloys.
- Decreases corrosion resistance.

2.1.4.3 **Magnesium - Mg** (up to 10%)

- Strengthens and hardens the Alloys by Solid solution hardening mechanism without considerable decrease of ductility (Wrought Aluminum-Magnesium Alloys (5xxx))
- In combination with Silicon or Zinc allows to strengthening the alloys by precipitation hardening heat treatment (Wrought Aluminum-Magnesium-Silicon Alloys (6xxx), Wrought Aluminum-Zinc-Magnesium Alloys (7xxx).

2.1.4.4 **Manganese -Mn** (up to 1.5%)

- Strengthens and hardens the Alloys (Wrought Aluminum-Manganese Alloys (3xxx)) by Solid solution hardening and dispersion hardening mechanisms.
- Improves low cycle fatigue resistance.
- Increases corrosion resistance.
- Improves ductility of Aluminum Alloys containing Iron and Silicon due to modification of Al_5FeSi intermetallic inclusions from platelet to cubic form $Al_{15}(MnFe)_3Si_2$.

2.1.4.5 **Zinc - Zn** (up to 8%)

- In combination with Magnesium or Magnesium-Copper allows to strengthening the Alloy by precipitation hardening heat treatment (Wrought Aluminum-Zinc-Magnesium Alloys (7xxx)).
- Increases susceptibility of the Alloys to Stress corrosion cracking.

2.1.4.6 **Chromium - Cr** (up to 0.3%)

- Suppresses the grain growth at elevated temperatures (e.g. during heat treatment).
- Improves ductility and toughness of Aluminum Alloys containing Iron and Silicon due to modification of Al_5FeSi intermetallic inclusions from platelet to cubic form (similar to the effect of Manganese).
- Reduces susceptibility of the Alloys to Stress corrosion cracking.

2.1.4.7 **Nickel - Ni** (up to 2%)

- Increases hardness and strength of Aluminum-Copper (Wrought Aluminum-Copper Alloys (2xxx) and Aluminum-Silicon (Wrought Aluminum-Silicon Alloy 4032) at elevated temperatures.
- Reduces the Coefficient of Thermal Expansion.

2.1.4.8 **Lithium - Li** (up to 2.6%)

- Increases strength by the precipitation hardening heat treatment.
- Increases Modulus of Elasticity.
- Reduces density.

2.1.4.9 **Titanium - Ti** (up to 0.35%)

- Refines primary aluminum grains (grains formed during the Solidification) due to the formation of fine nuclei of Al_3Ti. Titanium is commonly added to Aluminum Alloys together with Boron due to their synergistic grain refining effect.

2.1.4.10 **Boron - B** (up to 0.03%)

- Boron in combination with Titanium refines primary Aluminum grains (grains formed during the Solidification) due to the formation of fine nuclei TiB_2.

2.1.4.11 **Zirconium -Zr** (up to 0.3%); **Vanadium - V** (up to 0.2%)

- Inhibit recovery and recrystallization
- Increase the recrystallization temperature.

2.1.4.12 **Iron - Fe** (up to 1.1%)

- Increases strength due to formation of Al-Fe intermetallic.
- Decreases ductility. In most Aluminum Alloys, Iron is an undesirable impurity.

2.1.4.13 Sodium - Na (up to 0.015%); **Antimony - Sb** (up to 0.5%);

Calcium - Ca (up to 0.015%), **Strontium -Sr** (up to 0.05%)

- ❖ Increase ductility of Hypoeutectic and Eutectic Aluminum-Silicon Alloys (Wrought Aluminum-Silicon Alloys (4xxx)) by a modification of the Silicon phase from coarse platelet like particles to the fine fibrous structure.

2.1.4.14 Tin - Sn (up to 40%)

- ❖ Reduces co-efficient of friction of Aluminum Alloys (Aluminum).
- ❖ Increases compatibility of the Aluminum bearing Alloy.
- ❖ Improves conformability.
- ❖ Improves embed ability.

2.2 STEEL

Steel are those in which Iron is the prime constituent. These are produced in larger quantities than any other metal type. Ferrous Alloys are broadly classified into two major categories.

- ❖ Steels
- ❖ Cast Irons

2.2.1 Steels

Steels are Iron–Carbon Alloys that may contain appreciable concentrations of other alloying elements; there are thousands of Alloys that have different compositions and/or heat treatments. The mechanical properties are sensitive to the content of Carbon, which is normally less than 1.0% by weight. Some of the more common Steels are classified according to Carbon concentration—namely, Low, Medium and High Carbon types. Sub-classes also exist within each group according to the concentration of other alloying elements.

Plain carbon steels contain only residual concentrations of impurities in addition to Carbon and a little Manganese. For Alloy Steels, more alloying elements are intentionally added in specific concentrations.

2.2.1.1 Low-Carbon Steels

Low Carbon Steels generally contain less than about 0.25 wt.% C and are unresponsive to heat treatments intended to form marten site. Strengthening is accomplished by cold work. Microstructures consist of ferrite and pearlite constituents. As a consequence, these Alloys are relatively soft and weak but have outstanding ductility and toughness. In addition, they are Machin able as well as wieldable and of all the Steels, are the least expensive to produce.

Typical applications include automobile body components, structural shapes (I-beams, channel and angle iron) and sheets that are used in pipelines, buildings, bridges and tin cans. Another group of Low-carbon Alloys are high-strength, low-alloy (HSLA) steels. They contain other alloying elements such as Copper, Vanadium, Nickel and Molybdenum in combined concentrations as high as 10 wt.% and possess higher strengths than the plain low-carbon steels. Most may be strengthened by heat treatment, giving tensile strengths in excess of 480 MPa. In addition, they are ductile, formable and Machin able. In normal atmospheres, the HSLA steels are more resistant to corrosion than the plain carbon steels, which they have replaced in many applications where structural strength is critical (e.g., bridges, towers, support columns in high-rise buildings and pressure vessels).

2.2.1.2 Medium-Carbon Steels

The Medium-Carbon Steels have Carbon concentrations between about 0.25 and 0.60 wt.%. These Alloys may be heat treated by austenitizing, quenching and then tempering to improve their mechanical properties. They are most often utilized in tempered conditions, having microstructures of tempered marten site. The medium-carbon steels have low hardened abilities and can be successfully heat treated only in very thin sections and with very rapid quenching rates. Additions of Chromium, Nickel and Molybdenum improve the capacity of these Alloys to be heat treated, giving rise to a variety of strength–ductility combinations. These heat-treated Alloys are stronger than the Low-carbon steels but at the cost of ductility and toughness. Applications include railway wheels and tracks, gears, crankshafts and other machine parts and high-strength structural components calling for a combination of high strength, wear resistance and toughness.

2.2.1.3 High-Carbon Steels

The High-Carbon Steels, normally having Carbon contents between 0.60 and 1.4 wt. %, are the hardest, strongest and yet least ductile of the carbon steels. They are almost always used in a hardened and tempered condition and as such, are especially wear resistant and capable of holding a sharp cutting edge. The tool and die steels are High-carbon alloys, usually containing Chromium, Vanadium, Tungsten and Molybdenum. These Alloying elements combine with Carbon to form very hard and wear-resistant carbide compounds (e.g.: $Cr_{23}C_6$,

V_4C_3, and WC). These Steels are utilized as cutting tools and die for forming and shaping materials, as well as in knives, razors, hacksaw blades, springs and high-strength wire.

2.2.1.4 Stainless Steels

Stainless Steel is highly resistant to corrosion (rusting) in a variety of environments, especially the ambient atmosphere. Their predominant alloying element is Chromium; a concentration of at least 11 wt.% Cr is required for corrosion resistance. Corrosion resistance may also be enhanced by Nickel and Molybdenum additions. Stainless Steels are divided into three classes based on the predominant phase constituent of the Microstructure— Martensitic, Ferritic or Austenitic. A wide range of mechanical properties combined with excellent corrosion resistance makes stainless steel very versatile in its applicability.

Martensitic stainless steels are capable of being heat treated in such a way that the marten site is the prime micro-constituent. Additions of alloying elements in significant concentrations produce dramatic alterations in the Iron–Iron carbide phase diagram.

For Austenitic stainless steels, the austenite (or γ) phase field is extended to room temperature. Ferritic stainless steels are composed of the Ferrite (BCC) phase. Austenitic and Ferritic stainless steels are hardened and strengthened by cold work because they are not heated treatable. The austenitic stainless steels are the most corrosion resistant because of the high Chromium contents and also the Nickel additions and they are produced in the largest quantities. Both Martensitic and Ferritic stainless steel is magnetic but the Austenitic stainless is not.

Some stainless steels are frequently used at elevated temperatures and in severe environments because they resist oxidation and maintain their mechanical integrity under such conditions. The upper temperature limit in oxidizing atmospheres is about 1000°C. Equipment employing these steels includes gas turbines, high-temperature steam boilers, heat-treating furnaces, aircraft, missiles and nuclear power generating units.

2.2.2 Effects of Alloying Elements

Specific effects of the addition of such elements are outlined below:

2.2.2.1 Carbon - C:

- The most important constituent of Steel.
- It raises tensile strength, hardness and resistance to wear and abrasion.
- It lowers ductility, toughness and machinability.

2.2.2.2 Chromium - Cr:

- Increases tensile strength, hardness, hardenability, toughness
- Increases resistance to wear and abrasion, resistance to corrosion and scaling at elevated temperatures.

2.2.2.3 Cobalt - Co:

- Increases strength and hardness
- permits higher quenching temperatures
- increases the red hardness of high speed steel.
- It also intensifies the individual effects of other major elements in more complex steels.
-

2.2.2.4 Columbium - Cb:

- Used as stabilizing elements in Stainless steel.
- High affinity for carbon and forms carbides, which are uniformly dispersed throughout the steel. Thus, localized precipitation of carbides at grain boundaries is prevented.

2.2.2.5 Copper - Cu:

- In significant amounts are detrimental to hot-working steels.
- Copper negatively affects forge welding but does not seriously affect arc or oxyacetylene welding.
- Copper can be detrimental to surface quality.
- Copper is beneficial to atmospheric corrosion resistance when present in amounts exceeding 0.20%. Weathering steels are sold having greater than 0.20% Copper.

2.2.2.6 Manganese - Mn:

- A deoxidizer and degasifier and reacts with sulfur to improve forge ability.
- It increases tensile strength, hardness, hardenability and resistance to wear.
- It decreases the tendency toward scaling and distortion.
- It increases the rate of carbon penetration in carburizing.

2.2.2.7 Molybdenum - Mo:

- Increases strength, hardness, hardenability, and toughness, as well as creep resistance and strength at elevated temperatures.
- It improves machinability and resistance to corrosion and intensifies the effects of other alloying elements.
- In hot-work steels and high speed steels, it increases red-hardness properties.

2.2.2.8 Nickel - Ni:

- ❖ Increases strength and hardness without sacrificing ductility and toughness.
- ❖ It also increases resistance to corrosion and scaling at elevated temperatures when introduced in suitable quantities in high-chromium (stainless) steels.

2.2.2.9 Phosphorus - P:

- ❖ Increases strength and hardness and improves machinability.
- ❖ Adds marked brittleness or cold-shortness to steel.

2.2.2.10 Silicon - Si:

- ❖ A deoxidizer and degasifier.
- ❖ It increases tensile and yield strength, hardness, forge ability and magnetic permeability.

2.2.2.11 Sulphur - S:

- ❖ Improves machinability in free-cutting steels, but without sufficient Manganese, it produces brittleness at red heat.
- ❖ It decreases weld ability, impacts toughness and ductility.

2.2.2.12 Tantalum - Ta:

- ❖ Used as stabilizing elements in stainless steel.
- ❖ It has a high affinity for carbon and forms carbides, which are uniformly dispersed throughout the steel. Thus, localized precipitation of carbides at grain boundaries is prevented.

2.2.2.13 Titanium - Ti:

- ❖ Used as stabilizing elements in Stainless steel.
- ❖ It has a high affinity for carbon and forms carbides, which are uniformly dispersed throughout the steel. Thus, localized precipitation of carbides at grain boundaries is prevented.

2.2.2.14 Tungsten - W:

- ❖ Increases strength, wear resistance, hardness and toughness.
- ❖ Tungsten steels have superior hot-working and greater cutting efficiency at elevated temperatures.

2.2.2.15 Vanadium - V:

- Increases strength, hardness, wear resistance and resistance to shock impact.
- It retards grain growth, permitting higher quenching temperatures.
- It also enhances the red-hardness properties of high-speed metal cutting tools.

2.3 NICKEL ALLOYS

Nickel is a versatile element and alloys well with most Metals. Complete solid solubility exists between Nickel and Copper. Wide solubility ranges of Iron, Chromium with Nickel can make many alloy combinations possible. The Face-centered cubic structure of the Nickel matrix (γ) can be strengthened by solid-solution hardening, carbide precipitation or precipitation hardening.

2.3.1 Solid-Solution Hardening

Cobalt, Iron, Chromium, Molybdenum, Tungsten, Vanadium, Titanium and Aluminum are all Solid-solution hardeners in Nickel. The elements differ with Nickel in atomic diameter from 1 to 13%. Lattice expansion related to atomic diameter oversize can be related to the hardening observed. Above 0.6 *T*m (melting temperature), which is the range of high-temperature creep, strengthening is diffusion dependent and large slow diffusing elements such as Molybdenum and Tungsten are the most effective hardeners.

2.3.2 Carbide Strengthening

Nickel is not a carbide former. Carbon reacts with other elements such as Cr, TI, Mo, V and W alloyed with Nickel to form carbides that can be either a bane or a blessing to the designer of alloys.

The carbides most frequently found in Nickel-base alloys are MC, M_6C, M_7C_3, and $M_{23}C_6$ (where M is the Metallic carbide-forming element or elements).

M_6C carbides are also blocky; formed in grain boundaries. They can be used to control grain size or precipitated in a Widmannstetter pattern throughout the grain. These carbides can impair ductility and rupture life.

M_7C_3 carbides (predominately Cr_7C_3) form intergranularly and are beneficial if precipitated as discrete particles. They can cause embrittlement if they agglomerate, forming continuous grain-boundary films. This condition will occur over an extended period of time at high temperatures.

$M_{23}C_6$ carbides show a propensity for grain-boundary precipitation.

The $M_{23}C_6$ carbides are influential in determining the mechanical properties of Nickel-base alloys. Discrete grain-boundary particles enhance rupture properties. Long time exposure at 760 to 980 °C (1400 to 1800 °F) will cause precipitation of angular intragranular carbides as well as particles along with twin bands and twin with ends.

2.3.3 Precipitation Hardening

The precipitation of γ', Ni3(Al, Ti) in a high-nickel matrix provides significant strengthening to the material. This unique intermetallic phase has a Face-centered cubic structure similar to that of the matrix and a lattice constant having 1% or less mismatch in the lattice constant with the γ matrix. This close matching allows low surface energy and longtime stability. Precipitation of the γ' from the supersaturated matrix yields an increase in strength with increasing precipitation temperature, up to the over aging or coarsening temperature. The Strengthening of alloys by γ' precipitation is a function of γ' particle size. The hardness of the alloy increases with particle size growth, which is a function of temperature and time. The volume percent of γ' precipitated is also important because high-temperature strength increases with the amount of the phase present. The amount of gamma prime formed is a function of the hardener content of the Alloy. Aluminium, Titanium, Niobium and Tantalum are strong γ' formers. Effective strengthening by γ' decreases above about 0.6 Tm as the particles coarsen. To retard coarsening, the alloy designer can add elements to increase the volume percent of γ' or add high-partitioning, slow-diffusing elements such as Niobium or Tantalum to form the desired precipitate.

2.3.4 Applications of Nickel Alloys

Nickel and Nickel Alloys are used for a wide variety of applications the majority of which involve corrosion resistance and/or heat resistance. Some of these include:

- Aircraft Gas Turbines: Disks, combustion chambers, bolts, casings, shafts, exhaust systems, cases, blades, vanes, burner cans, afterburners, thrust reversers.
- Steam Turbine Power Plants: Bolts, blades
- Reciprocating Engines: Turbochargers, exhaust valves, hot plugs, valve seat inserts
- Metal Processing: Hot-work tools and dies
- Medical Applications: Dentistry uses, prosthetic devices
- Space Vehicles: Aerodynamically heated skins, Rocket engine parts
- Heat-treating Equipment: Trays, fixtures, conveyor belts, baskets, fans, furnace mufflers
- Nuclear Power Systems: Control rod drive mechanisms, valve stems, springs, ducting
- Chemical and Petrochemical Industries: Bolts, fans, valves, reaction vessels, piping, pumps
- Pollution Control Equipment: Scrubbers, flue gas desulfurization equipment (liners, fans, ducting)
- Metals Processing Mills: Ovens, afterburners, exhaust fans

- Coal Gasification and Liquefaction Systems: Heat exchangers, piping
- Pulp and Paper Mills: Tubing, doctor blades, bleaching circuit equipment, scrubbers

2.4 TITANIUM ALLOYS

The rapid growth of the Titanium industry is testimony to the metal's high specific strength and corrosion resistance. With a density of about 55% that of Steel, Titanium Alloys are widely used for highly loaded aerospace components that operate at low to moderately elevated temperatures, including both Airframe and Jet-engine components. In spite of high temperature reactivity, the corrosion resistance of Titanium Alloys at normal temperatures is unusually high. They are virtually immune to air, marine and a variety of industrial environments. They are commonly utilized in airplane structures, space vehicles, surgical implants and in the petroleum and chemical industries. At room temperature, Titanium has a Hexagonal close-packed (hcp) crystal structure, which is referred to as the "alpha" phase. This structure transforms to a body-centered cubic (bcc) crystal structure, called the "beta" phase, at 882°C (l621°F). It is common to separate the alloys into three categories, referring to the phases normally present. The alloy categories generally are called:

- Alpha
- Alpha-beta (alpha-plus-beta)
- Beta

2.4.1 Alpha Alloys

Alpha Alloys contain elements such as Aluminum and Tin. These α-stabilizing elements work by either inhibiting change in the phase transformation temperature or by causing it to increase. Alpha Alloys generally have creep resistance superior to β Alloy, and are preferred for high-temperature applications. The absence of a ductile-to-brittle transition, a feature of β alloys makes α Alloys suitable for cryogenic applications. Alpha Alloys are characterized by satisfactory strength, toughness, and weld ability, but poorer forge ability than β Alloys. This latter characteristic results in a greater tendency for forging defects. Smaller reductions and frequent reheating can minimize these problems. Unlike β alloys, alpha alloys cannot be strengthened by heat treatment. Most often they are used in the annealed or recrystallized condition to eliminate residual stresses caused by working.

2.4.2 Alpha - Beta alloys

Alpha plus beta Alloys have compositions that support a mixture of α and β phases and may contain between 10 and 50% β phase at room temperature. Alloys in alpha-beta systems contain one or more alpha stabilizers (e.g., Aluminum) or alpha-soluble elements plus one or more beta stabilizers (e.g. Vanadium, Molybdenum) in larger amounts than in near-alpha alloys. The most common α + β alloy is Ti-6Al-4V. This particular alloy is relatively difficult to form even in the annealed condition, whereas, α + β alloys generally have good formability. The properties of these Alloys can be controlled through heat treatment, which is used to adjust the amounts and types of β phase present. Solution treatment followed by aging at 480 to 650°C (900 to 1200°F) precipitates α, resulting in a fine mixture of α and β in a matrix of retained or transformed β phase.

2.4.3 Beta Alloys

Beta Alloys contain transition elements such as Vanadium, Niobium and Molybdenum, which tend to decrease the temperature of the α to β phase transition and thus promote the development of the bcc β phase. They have excellent forge ability over a wider range of forging temperatures than α alloys, and β alloy sheet is cold formable in the solution treated condition. Beta Alloys have excellent hardenability and respond readily to heat treatment. A common thermal treatment involves solution treatment followed by aging at temperatures of 450 to 650°C (850 to 1200°F). This treatment results in the formation of finely dispersed α particles in the retained β.

2.4.4 Basic Principles of Heat Treatment

It is desirable to examine the general principles that are involved even though they relate mainly to the α/β and β groups. This is possible by considering the effects of alloys content on the β to α transformation in a typical binary β-isomorph us system, as shown in Fig

It is also included is a schematic diagram that depicts trends in tensile strength with respect to alloy content resulting from different heat-treatment procedures.

From the Fig. for the heat treatment of β-isomorph us titanium alloys quenched from the β-phase field, a more complex relationship exists between strength and composition which is dependent upon the transformation of β to the martensitic form of the α-phase, designated α’. For low concentrations of solute, some strengthening occurs as a result of this transformation, but the effect is much less than that traditionally found for martensitic reactions in ferrous materials. Moreover, little change occurs when martensitic α’ is tempered or aged. The maximum strength obtainable from this β to α’ transformation occurs at a composition for which the martensite finish (M_f) temperature corresponds to room temperature.

Increasing the solute content above this level results in a progressive increase in the amount of metastable β that is retained on quenching from the β or α+β phase fields, and there is a gradual decrease in strength of quenched alloys to a minimum value at composition at which the martensite start (M_s) temperature occurs at room temperature, i.e. 100% metastable β. On the other hand, these compositions provide the maximum response to strengthening if the quenched alloys are aged to decompose the retained β.

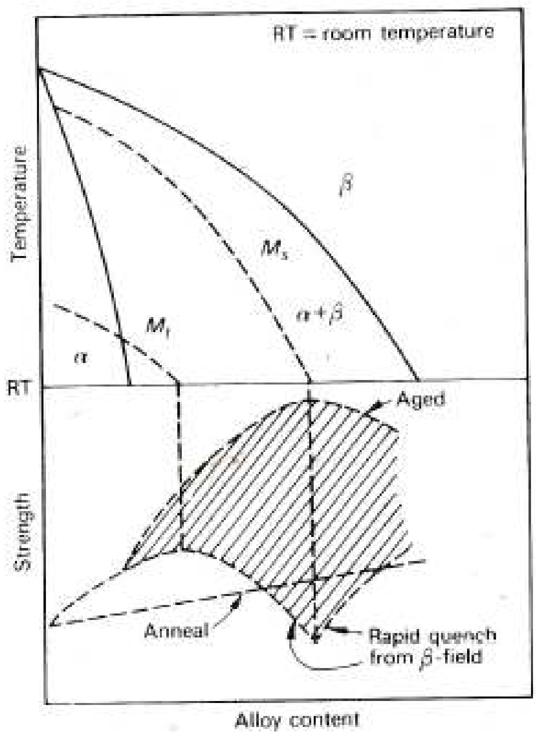


Fig 1. Typical Phase diagram of TI ALLOYS


ARMY

3.0 TERMINOLOGIES AND ABBREVIATIONS

The following are the notations used in this book:

A	:	Annealed
AC	:	Air cool
AMS	:	Aerospace Material Specification
ASTM	:	American Society for Testing of Material
BS	:	British Standard
BWQ	:	Boiling Water Quench
El	:	Elongation
FAC	:	Forced Air Cool
GTM	:	Gas Turbine Material Specification
H	:	Hardened
HB	:	Unit of hardness, Brinell Hardness Number
HBW	:	Brinell hardness, Tungsten Ball
H&T	:	Hardened and Tempered
HV	:	Vickers hardness
HWQ	:	Hot Water Quench
J	:	Joules
Max	:	Maximum
Min	:	Minimum
MSRR	:	Material Specification Rolls Royce
N	:	Normalized
O	:	Annealed
Ppm	:	Parts per million
P.S.	:	Proof stress
RA	:	Reduction in Area
RB	:	Unit of hardness, Rockwell B scale
RC	:	Unit of hardness, Rockwell C scale
RRMS	:	Rolls Royce Material Specification
RT	:	Room Temperature
Sol	:	Solutionised
Soln & Ppt	:	Solutionised and Precipitation Treated
Soln + Age	:	Solutionised and Aged
T	:	Tempered
T1	:	Cooled from an elevated temperature shaping process and naturally aged

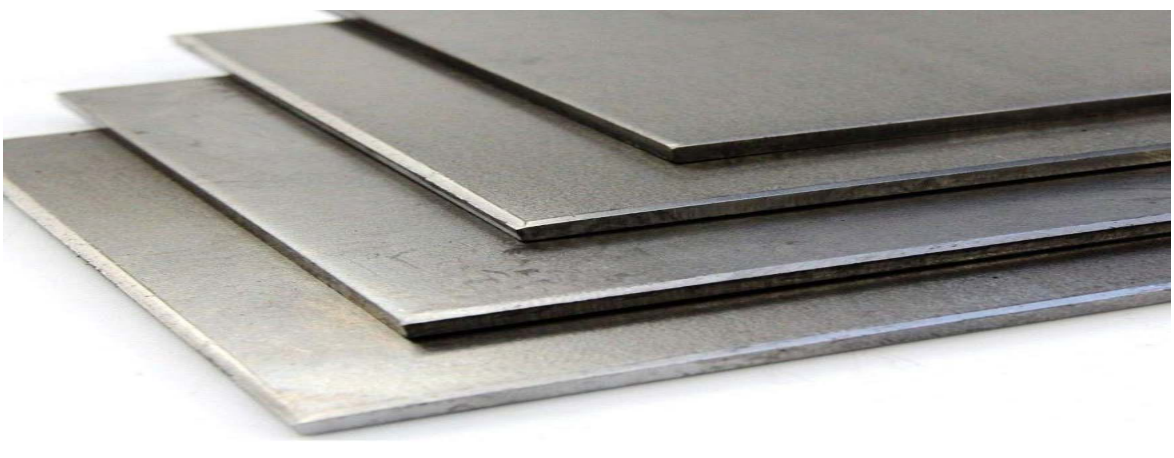
T2	:	Cooled from an elevated temperature shaping process, cold worked and naturally aged
T3	:	Solution heat-treated, cold worked and naturally aged.
T4	:	Solution heat-treated and naturally aged to a substantially stable condition
T5	:	Cooled from an elevated temperature shaping process and then artificially aged
T6	:	Solution heat-treated and then artificially aged
T7	:	Solution heat-treated and overaged / stabilized
T61	:	Solution heat treated and then artificially aged in under aging conditions to improve formability
T651	:	Solution heat treated, stress relieved by controlled stretching and then artificially aged
T6510	:	Solution heat treated, stress relieved by controlled stretching and then artificially aged. The products receive no further straightening after stretching
T6511	:	Same as T6510, except minor straightening is allowed after stretching to comply with standard tolerances
T652	:	Solution heat treated, stress relieved by compressing to produce a permanent set of 1-5% and then artificially aged
T73	:	Solution heat treated and stabilized condition to develop required mechanical properties and high resistance to stress corrosion cracking
UTS	:	Ultimate Tensile Strength
VHN	:	Vickers Hardness Number
W	:	Solution treated and naturally aged
WP	:	Solution heat treated and Precipitation treated
WQ	:	Water Quench
Wt%	:	Weight in percentage

BAR

Bar has cylinder or square or rectangular cross section. Bars are used as forging feedstock or used to fabricate the parts through machining. It is typically produced by hot or cold forging or rolling or extrusion or drawing.

PLATE

Plates are the rectangular cross sectional shape which has the thickness of 6mm or more and specified by length, width and thickness. It is typically produced by hot or cold rolling.



SHEET

Sheets are the rectangular cross sectional shape which has the thickness less than 6 mm and specified by length, width and thickness. It is typically produced by hot or cold rolling.

TUBE

Tubes are hollow circular cross sectional shape specified by inner and outer diameter and wall thickness. It is typically produced by tube drawing, hot or cold extrusion.

WIRE

Wires are circular cross sectional shape specified by diameter and length. It is typically produced by wire drawing.

Indigenized Materials	Materials approved by CEMILAC.
Obsolete specifications	These specifications are old and not used in current designs. Hence procurement of material to this specification is difficult.
Superseded Specifications	These specifications are replaced by another specification by issuing agencies.
Withdrawn Specifications	These specifications are made inactive by respective issuing agencies.

4.0
PART 1
ALUMINUM ALLOYS

Data Sheet for Rationalisation of Aviation Metallic Materials - Aluminium Alloys

General Grade of Material	2014	Type of Material	Al -Cu-Si	Number of Specifications Identified	18
Rationalisation for Use	BAR				

Sl No	Specification	Grade	Form	Origin	Chemical composition (Wt%) (wherever limit not mentioned consider as max)														
					Al	Cu	Zn	Si	Mg	Fe	Mn	Cr	Zr	Ti	Ti+Zr	Ni	Pb	Others (Max)	Each (Max)
1	ASTM -B-247	2014	BAR	AMERICAN	Rem	3.9-5.0	0.25	0.5-1.2	0.2-0.8	0.7	0.40-1.2	0.1	-	0.15	-	-	-	0.15	0.05
2	AIR 3350	A-U4 SG	BAR	FRENCH	Rem	4.4	-	0.8	0.3	0.5	0.8	-	-	0.2	-	-	-	-	-
3	AMS-QQA-200/2	2014	BAR	AMERICAN	Rem	3.9-5.0	0.25	0.50-1.2	0.2-0.8	0.7	0.40-1.2	0.1	-	0.15	-	-	-	0.15	0.05
4	BS EN 573-3	EN AW-2014	BAR	BRITISH	Rem	3.9-5.0	0.25	0.50-1.2	0.2-0.8	0.7	0.40-1.2	0.1	-	0.15	-	-	-	0.15	0.05
5	AIR 9051	A7-U4SG (2014F)	BAR	FRENCH	Rem	3.9-5.0	0.25	0.50-1.2	0.20-0.8	0.35	0.40-1.2	0.1	-	0.15	0.2	-	-	0.15	0.05
6	IS: 734	24345 (HF15 Old)	BAR	INDIAN	Rem	3.8-2.0	0.25	0.5-1.2	0.20-0.8	0.7	0.3-1.2	0.1	-	0.3	-	-	-	-	-
7	DIN 1747 3.1255	2014A	BAR	GERMAN	Rem	3.9 - 5.0	0.25	0.50-1.2	0.20-0.8	0.7	0.40-1.2	0.1	-	0.15	-	-	-	0.15	0.05
8	MIL-A-22771 / AMS-A-22771	2014	BAR	AMERICAN	Rem	3.9 - 5.0	0.25	0.50-1.2	0.20-0.8	0.7	0.40-1.2	0.1	-	0.15	-	-	-	0.15	0.05
9	HE15A (Indeginsed)	2014A	BAR	INDIAN	Rem	3.9 - 5.0	0.25	0.5-0.9	0.2-0.8	0.5	0.40-1.2	0.1	-	0.15	0.2	0.1	-	0.15	0.05
10	BS L103 BS L76	2014A	BAR	BRITISH	Rem	3.9 - 5.0	0.25	0.5-0.9	0.2-0.8	0.5	0.4-1.2	0.1	-	-	0.2	0.2	0.05	-	0.05
11	BS L168	2014A	BAR	BRITISH	Rem	3.9-5.0	0.25	0.5-0.9	0.2-0.8	0.5	0.40-1.2	0.1	-	0.15	0.2	0.1	-	0.15	0.05
12	BS EN 2635-U	Al-P2014	BAR	BRITISH	Rem	3.9-5.0	0.25	0.5-0.9	0.2-0.8	0.5	0.40-1.2	0.1	-	0.15	0.2	0.1	-	0.15	0.05
13	BS L65-T6	2014A	BAR	BRITISH	Rem	3.9-5.0	0.25	0.5-0.9	0.2-0.8	0.5	0.40-1.2	0.1	-	0.15	0.2	0.1	-	0.15	0.05
14	BS L87	2014A	BAR	BRITISH	Rem	3.9-5.0	0.25	0.5-0.9	0.2-0.8	0.5	0.4-1.2	0.1	-	-	0.2	0.2	0.05	-	-
15	DIN 1749 3.1255	2014	BAR	AMERICAN	Rem	3.9-5.0	0.25	0.5-1.2	0.2-0.8	0.7	0.4-1.2	0.1	-	0.15	0.2	-	-	0.15	0.05
16	HE15A ST	2014A	BAR	INDIAN	Rem	3.9-5.0	0.25	0.5-0.9	0.2-0.8	0.5	0.40-1.2	0.1	-	0.15	0.2	0.1	-	0.15	0.05
17	QQ-A-225/4 QQ-A-366	2014	BAR	AMERICAN	Rem	3.9-5.0	0.25	0.5-1.2	0.2-0.8	0.7	0.40-1.2	0.1	-	0.15	0.2	-	-	0.15	0.05
18	AMS 4121	2014	BAR	AMERICAN	Rem	3.9-5.0	0.25	0.5-1.2	0.2-0.8	0.7	0.40-1.2	0.1	-	0.15	0.2	-	-	0.15	0.05

Sl No	Specification	Grade	Size range (mm)	-	Heat treatment	Condition	Mechanical properties (Minimum)			
							UTS (MPa)	0.2% P.S. (MPa)	% EL (5D)	Hardness (BHN)
Heat Treatment Condition : T6										
1	ASTM -B-247	2014	-	BAR	Sol : 502°C / HWQ Age : 177°C / 8-9Hr /AC (As per AMS 2770)	T6	450	385	6	125
2	AIR 3350	A-U4 SG	-	BAR	Sol : 505°C / WQ Age : 170°C / 10Hr /AC	T6	470	412	7	120
3	BS EN 573-3	EN AW-2014	-	BAR	Sol : 502°C /HWQ Age : 177°C / 9 Hr /AC (HT As per AMS 2772)	T6	460	415	7	140
4	AIR 9051	A7-U4SG (2014F)	-	BAR	Sol : 502°C / WQ Age : 160°C / 16Hr /AC	T6	450	380	8	-
5	IS: 734	24345 (HF15 Old)	-	BAR	Sol : 502°C /HWQ Age : 177°C / 9 Hr /AC (HT As per AMS 2772)	WP/T6	445	385	6	-
6	DIN 1747 3.1255	2014A	-	BAR	Sol : 500±5 °C / WQ Age : 165-177°C / 10 Hr /AC	T6	430	385	6	155
7	MIL-A-22771 / AMS-A-22771	2014	-	BAR	Sol : 517 °C / WQ Age : 171°C / 10 Hr /AC (As per MIL-H-6088)	T6	447	378	6	125
8	BS L103 BS L76	2014A	All	BAR	Sol : 500±5 °C / WQ Age : RT / 2 Days MIN /AC	T4	370	225	14	-
9	DIN 1749 3.1255	2014A	All	BAR	Sol : 500±5 °C / WQ Age : 165-177°C / 10 Hr /AC	T6	430	385	6	155
10	BS L65-T6	2014A	≤2.5 2.5-10 10-25 25-75 75-100 100-150 150-200	BAR	Sol : 500±5 °C / WQ Age : 170-180°C / 5-12 Hr /AC	T6	415 435 460 490 480 465 435	370 385 415 440 435 420 390	7 7 7 7 7 7 7	-
11	BS L87	2014A	14-36	BAR	Sol : 500±5 °C / WQ Age : 165-185°C / 8-18 Hr /AC	T6	430	390	5	-
12	AMS 4121	2014	203 dia	BAR	Sol : 496-507 °C / WQ Age : 171-182°C / 10 Hr /AC	T6	448	379	8	-
13	HE15A ST	2014A	All	BAR	Sol : 500±5 °C / WQ Contol streching after solutionizing Age : 170-180°C / 5-12 Hr /AC	ST	465	420	7	-

Heat Treatment Condition : T651/ T6511										
14	HE15A (Indeginsed)	2014A		BAR	As per TA No.724	T6511	465	420	7	134
15	BS L168	2014A	≤2.5 2.5-10 10-25 25-75 75-100 100-150 150-200	BAR	Sol : 500±5 °C / WQ Contol streching after solutionizing Age : 170-180°C / 5-12 Hr /AC	T651 / T6511	415 435 460 490 480 465 435	370 385 415 440 435 420 390	7 7 7 7 7 7 7	-
16	BS EN 2635-U	Al-P2014	≤2.5 2.5-10 10-25 25-75 75-100 100-150 150-201	BAR	Sol : 500±5 °C / WQ Contol streching after solutionizing Age : 170-180°C / 5-12 Hr /AC	T6511	415 435 460 490 480 465 436	370 385 415 440 435 420 391	7 7 7 7 7 7 8	-
17	AMS-QQ-A-200/2	2014	≤12.7 12.7-19 >19 & ≤16130 mm2 >19 & 16130-20646	BAR	Sol : 500±5 °C / WQ Contol streching after solutionizing Age : 155-165°C / 18 Hr /AC	T6511	413 440 468 468	365 400 413 400	7 7 7 6	-
18	QQ-A-225/4 QQ-A-366	2014	<3.1 3.1-203	BAR	Sol : 500±5 °C / WQ Contol streching after solutionizing Age : 155-165°C / 18 Hr /AC	T651	445 445	380	8	-
Fatigue Data in T6 condition **(Extracted from MMPDS, Minimum Values assumed 10% less than mean Value)**										
Test Condition : R= -1, Wave Form: Sine, Load Direction : Axial, Temperature : Room Temperature, Frequency: 1100 to 3600 cpm, Specimen type : Unnotched										
1. Stress: 278 MPa, No of cycles : 1,00,000 (min)						2. Stress: 173 MPa, No of cycles : 10,00,000 (min)				

Data Sheet for Rationalisation of Aviation Metallic Materials - Aluminium Alloys

General Grade of Material			2014	Type of Material	Al -Cu-Si	Number of Specifications Identified	18
Rationalisation for Use			BAR				
Identified Specifications			Rationalised to	Form	Number of Specifications Identified	Number of Specifications Rationalised	Remarks
Sl No	Specification	Grade	Specification				
1	ASTM -B-247	2014	BS L168 / BS EN 2635 / HE15A ST	BAR	18	3	-
2	AIR 3350	A-U4 SG					
3	AMS-QQA-200/2	2014					
4	BS EN 573-3	EN AW-2014					
5	AIR 9051	A7-U4SG (2014F)					
6	IS: 734	24345 (HF15 Old)					
7	DIN 1747 3.1255	2014					
8	MIL-A-22771 / AMS-A-22771	2014					
9	HE15A (Indeginsed)	2014					
10	BS L103 BS L76	2014					
11	BS L168	2014					
12	BS EN 2635-U	Al-P2014					
13	BS L65-T6	2014					
14	BS L87	2014					
15	DIN 1749 3.1255	2014					
16	HE15A ST	2014					
17	QQ-A-225/4 QQ-A-366	2014					
18	AMS 4121	2014					

Data Sheet for Rationalisation of Aviation Metallic Materials - Aluminium Alloys																			
General Grade of Material				2014	Type of Material		Al -Cu-Si		Number of Specifications Identified					10					
Rationalisation for Use				SHEET															
Sl No	Specification	Grade	Form	Origin	Chemical composition (Wt%) (wherever limit not mentioned consider as max)														
					Al	Cu	Zn	Si	Mg	Fe	Mn	Cr	Zr	Ti	Ti+Zr	Ni	Pb	Others (max)	Each (max)
1	BS L-104 T6	2014	SHEET	BRITISH	Rem	3.9-5.0	0.25	0.5-0.90	0.2-0.8	0.5	0.4-1.2	0.1	-	0.15-0.20		0.1	-	-	-
2	BS L164	2014	SHEET	BRITISH	Rem	3.9-5.0	0.25	0.5-0.9	0.2-0.8	0.5	0.4-1.2	0.1	-	0.15	0.2	0.1	-	0.05	0.15
3	BS L108	2014	SHEET	BRITISH	Rem	3.9-5.0	0.2	0.5-0.9	0.2-0.8	0.5	0.4-1.2	0.1	-	--	0.2	0.1	-	0.05	--
4	BS L90	2014	SHEET	BRITISH	Rem	3.9-5.0	0.2	0.5-0.9	0.2-0.8	0.5	0.4-1.2	0.1	-	--	0.2	0.2	-	0.05	--
5	IS 3436 TY III COND WP	2014	SHEET	INDIAN	Rem	3.9-5.0	0.2	0.5-0.9	0.2-0.8	0.5	0.4-1.2	0.1	-	--	0.2	0.2	-	0.05	--
6	BS L73 BS L165 BS L167	2014	SHEET	BRITISH	Rem	3.9-5.0	0.2	0.5-0.9	0.2-0.8	0.5	0.4-1.2	0.1	-	--	0.2	0.2	-	0.05	--
7	BS L72 DTD 610	2014	SHEET	BRITISH	Rem	3.9-5.0	0.25	0.5-0.9	0.2-0.8	0.5	0.4-1.2	0.1	-	0.15	0.2	0.1	-	0.05	0.15
8	QQ-A-250/3 QQ-A-255	2014	SHEET	AMERICAN	Rem	3.9-5.0	0.25	0.5-1.2	0.2-0.8	1	0.4-1.2	0.1	-	0.15	--	--	-	0.05	0.15
9	BS EN 2087-U (2014A-T6)	2014	SHEET	BRITISH	Rem	3.9-5.0	0.2	0.5-0.9	0.2-0.8	0.5	0.4-1.2	0.1	-	--	0.2	0.2	-	0.05	--
10	AMS 4029	2014	SHEET	AMERICAN	Rem	3.9-5.0	0.25	0.5-0.9	0.2-0.8	0.5	0.4-1.2	0.1	-	0.15	0.2	0.1	-	0.05	0.15

Sl No	Specification	Grade	Size range (mm)	Form	Heat treatment	Condition	Mechanical properties (Minimum)			
							UTS (MPa)	0.2% P.S. (MPa)	% EL (5D)	Hardness (BHN)
Heat Treatment Condition : T4/T651										
1	BS L-104 T6	2014	0.4-0.8	Sheet	As per AMS 2770	T4	430	370	6	-
			0.8-1.6				440	380	6	-
			1.6-6.0				440	390	6	-
2	BS L164	2014	0.4-1.6 1.6-6.0		Sol : 500±5 °C / Hr* / WQ Age : RT / 5 Days MIN	T4	385 390	240 245	14 14	-
3	BS L108	2014	0.4-6.0		Sol : 500±5 °C / Hr* / WQ Age : RT / 4 Days MIN	T42	385	240	14	-
4	BS L90	2014	0.4-0.8 0.8-6.0		Sol : 500±5 °C / Hr* / WQ Age : 175°C / 10 1/2 Hr /AC	T6	415 420	350 370	7 8	-
5	IS 3436 TY III COND WP	2014	0.4-0.8 0.8-6.0		Sol : 500±5 °C / Hr* / WQ Age : 175°C / 10 1/2 Hr /AC	T6	415 420	350 360	7 8	-
6	BS L73 BS L165 BS L167	2014	0.4-0.8 0.8-1.6 1.6-6.0		Sol : 500±5 °C / Hr* / WQ Age : 175°C / 10 1/2 Hr /AC	T6	415 420 420	345-350 345-350 355-370	7 8 9	-
7	BS L72(Sheet)	2014	0.4-0.8 0.8-6.0		Sol : 500±5 °C / Hr */ WQ Age : RT / 4 Days MIN	T4	370 375	235 235	13 14	-
8	QQ-A-250/3 QQ-A-255	2014	0.5-1.0 1.0-6.3		Sol : 500±5 °C / Hr* / WQ Age : 160°C / 18 Hr / AC	T6	435 455	395 400	6 7	-
9	BS EN 2087-U (2014A-T6)	2014	0.4-0.8 0.8-1.6 1.6-6.0		Sol : 500±5 °C / Hr* / WQ Age : 160°C / 18 Hr / AC	T6	415 420 420	345-350 345-350 355-370	7 8 9	-
10	AMS 4029	2014	0.4-0.8 0.8-1.6 1.6-6.0		HT ss per AMS 2770	T651	435	390	7	-
Fatigue Data in T6 condition (Extracted from MMPDS, Minimum Values assumed 10% less than mean Value)										
Test Condition : R= -1, Wave Form: Sine, Load Direction : Axial, Temperature : Room Temperature, Frequency: 1100 to 3600 cpm, Specimen type : Unnotched										
1. Stress: 278 MPa, No of cycles : 1,00,000 (min)							2. Stress: 173 MPa, No of cycles : 10,00,000 (min)			

Data Sheet for Rationalisation of Aviation Metallic Materials - Aluminium Alloys

General Grade of Material	2014	Type of Material	Al -Cu-Si	Number of Specifications Identified	10
Rationalisation for Use	SHEET				

Sl No	Identified Specifications: Specification	Identified Specifications: Grade	Rationalised to: Specification	Form	Number of Specifications Identified	Number of Specifications Rationalised	Remarks
1	BS L-104 T6	2014	BS L 165 (T6) \ BS L 167 (T6) \ AMS 4029 (T6)	SHEET	10	3	-
2	BS L164	2014					
3	BS L108	2014					
4	BS L90	2014					
5	IS 3436 TY III COND WP	2014					
6	BS L73 BS L165 (CLAD SHEET) BS L167 (CLAD SHEET)	2014					
7	BS L72 DTD 610	2014					
8	QQ-A-250/3 QQ-A-255	2014					
9	BS EN 2087-U (2014A-T6)	2014					
10	AMS 4029	2014					

Data Sheet for Rationalisation of Aviation Metallic Materials - Aluminium Alloys

General Grade of Material	2014	Type of Material	Al -Cu-Si	Number of Specifications Identified	2
Rationalisation for Use	PLATE				

Sl No	Specification	Grade	Form	Origin	Chemical composition (Wt%) (wherever limit not mentioned consider as max)														
					Al	Cu	Zn	Si	Mg	Fe	Mn	Cr	Zr	Ti	Ti+Zr	Ni	Pb	Others (Max)	Each (Max)
1	2014 T651	2014	Plate	-	Rem	3.8-5.0	0.25	-	0.2-0.8	0.7	0.5-1.2	0.1	-	0.015	-	-	-	-	-
2	AMS 4029	2014	Plate	AMERICAN	Rem	3.8-5.0	0.25	-	0.2-0.8	0.7	0.5-1.2	0.1	-	0.1	0.2	-	-	0.15	0.05

Sl No	Specification	Grade	Size range (mm)	Form	Heat treatment	Condition	Mechanical properties (Minimum)			
							UTS (MPa)	0.2% P.S. (MPa)	% EL (5D)	Hardness (BHN)
1	2014 T651 (PLATES)	2014	0- 25.4 50.8 -76.2 20 , 30, 70 and 80 thickness	PLATE	-	T651	448.1	379.2	8	-
2	AMS 4029	2014	20-75 75-150 150-200	PLATE	As per AMS 2770	T651	435 465 480	390 420 435	7	-

Fatigue Data in T6 condition (Extracted from MMPDS, Minimum Values assumed 10% less than mean Value)	
Test Condition : R= -1, Wave Form: Sine, Load Direction : Axial, Temperature : Room Temperature, Frequency: 1100 to 3600 cpm, Specimen type : Unnotched	
1. Stress: 278 MPa, No of cycles : 1,00,000 (min)	2. Stress: 173 MPa, No of cycles : 10,00,000 (min)

Data Sheet for Rationalisation of Aviation Metallic Materials - Aluminium Alloys							
General Grade of Material			2014	Type of Material	Al -Cu-Si	Number of Specifications Identified	2
Rationalisation for Use			PLATE				
Identified Specifications			Rationalised to	Form	Number of Specifications Identified	Number of Specifications Rationalised	Remarks
Sl No	Specification	Grade	Specification				
1	2014 T651	2014	AMS 4029 (T651)	PLATE	2	1	-
2	AMS 4029	2014					

Data Sheet for Rationalisation of Aviation Metallic Materials - Aluminium Alloys

General Grade of Material	2014	Type of Material	Al -Cu-Si	Number of Specifications Identified	4
Rationalisation for Use	TUBE				

Sl No	Specification	Grade	Form	Origin	Chemical composition (Wt%) (wherever limit not mentioned consider as max)														
					Al	Cu	Zn	Si	Mg	Fe	Mn	Cr	Zr	Ti	Ti+Zr	Ni	Pb	Others (Max)	Each (Max)
1	BS L63	2014	TUBE	BRITISH	Rem	3.9-5.0	0.2	0.5-0.9	0.2-0.8	0.5	0.40-1.2	0.1	-	-	0.2	0.2	Sn: 0.05	-	-
2	BS L105 BS L62	2014	TUBE	BRITISH	Rem	3.9-5.0	0.2	0.5-0.9	0.2-0.8	0.5	0.40-1.2	0.1	-	-	0.2	0.2	0.05	-	-
3	AMS-QQA-200/2	2014	TUBE	AMERICAN	Rem	3.9-5.0	0.25	0.5-1.2	0.2-0.8	0.7	0.40-1.2	0.1	-	0.15	-	-	-	0.15	0.05
4	AMS 4153	2014	Extrusion (Tubes)	AMERICAN	Rem	3.9-5.0	0.25	0.5-1.2	0.2-0.8	0.7	0.40-1.2	0.1	-	0.15	-	-	-	0.15	0.05

Sl No	Specification	Grade	Size range (mm)	Form	Heat treatment	Condition	Mechanical properties (Minimum)			
							UTS (MPa)	0.2% P.S. (MPa)	% EL (5D)	Hardness (BHN)
1	BS L63	2014	-	TUBE	Sol : 500±5 °C / WQ Age : 160-190°C / 3-18 Hr /AC	T6	415	325	7	-
2	BS L105 BS L62	2014	≤10		Sol : 500±5 °C / WQ Age : RT / 2 Hr MIN /AC	T4	385	245	-	-
3	AMS-QQA-200/2	2014	≤12.7 12.7-19 >19		Sol : 500±5 °C / WQ Age : 160-190°C / 3-18 Hr /AC	T6	413 440 468	365 400 413	7 7 7	-
4	AMS 4153	2014	<20		As per AMS 2770	T6	480	435	7	-

Fatigue Data in T6 condition (Extracted from MMPDS, Minimum Values assumed 10% less than mean Value)	
Test Condition : R= -1, Wave Form: Sine, Load Direction : Axial, Temperature : Room Temperature, Frequency: 1100 to 3600 cpm, Specimen type : Unnotched	
1. Stress: 278 MPa, No of cycles : 1,00,000 (min)	2. Stress: 173 MPa, No of cycles : 10,00,000 (min)

Data Sheet for Rationalisation of Aviation Metallic Materials - Aluminium Alloys

General Grade of Material	2014	Type of Material	Al -Cu-Si	Number of Specifications Identified	4
Rationalisation for Use	TUBE				

Identified Specifications			Rationalised to	Form	Number of Specifications Identified	Number of Specifications Rationalised	Remarks
Sl No	Specification	Grade	Specification				
1	BS L63	2014	AMS 4153 (T6)	TUBE	4	1	-
2	BS L105 BS L62	2014					
3	AMS-QQA-200/2	2014					
4	AMS 4153	2014					

Data Sheet for Rationalisation of Aviation Metallic Materials - Aluminium Alloys

General Grade of Material	2014	Type of Material	Al -Cu-Si	Number of Specifications Identified	2
Rationalisation for Use	WIRE				

Sl No	Specification	Grade	Form	Origin	Chemical composition (Wt%) (wherever limit not mentioned consider as max)														
					Al	Cu	Zn	Si	Mg	Fe	Mn	Cr	Zr	Ti	Ti+Zr	Ni	Pb	Others (Max)	Each (Max)
1	G-14938-78 (Wire)	D1 P	WIRE	RUSSIAN	Rem	3.8 - 4.5	0.1	0.5	0.4-0.8	0.5	0.4- 0.8	-	-	0.1	-	-	-	-	0.05
2	AMS 4121	2014	WIRE	AMERICAN	Rem	3.8 - 4.5	0.1	0.5	0.4-0.8	0.5	0.4- 0.8	-	-	0.15	0.2	-	-	-	0.05

Sl No	Specification	Grade	Size range (mm)	Heat treatment	Condition	Mechanical properties (Minimum)				
						UTS (MPa)	0.2% P.S. (MPa)	% EL (5D)	Hardness (BHN)	Shear Stregth Kg/mm²
1	G-14938-78 (Wire)	D1 P	Dia From 1.4-7.5	Sol & Nat Aged (T)	D1P	480	435	7	125	24
2	AMS 4121	2014	Dia From 1.4-7.5	Sol & Nat Aged (T)	T6	480	435	7	125	-

Fatigue Data in T6 condition
(Extracted from MMPDS, Minimum Values assumed 10% less than mean Value)

Test Condition : R= -1, Wave Form: Sine, Load Direction : Axial, Temperature : Room Temperature, Frequency: 1100 to 3600 cpm, Specimen type : Unnotched

1. Stress: 278 MPa, No of cycles : 1,00,000 (min)	2. Stress: 173 MPa, No of cycles : 10,00,000 (min)

Data Sheet for Rationalisation of Aviation Metallic Materials - Aluminium Alloys

General Grade of Material	2014	Type of Material	Al -Cu-Si	Number of Specifications Identified	2
Rationalisation for Use	WIRE				

Identified Specifications			Rationalised to	Form	Number of Specifications Identified	Number of Specifications Rationalised	Remarks
Sl No	Specification	Grade	Specification				
1	G-14938-78 (Wire)	D1 P	AMS 4121 (T6)	WIRE	2	1	-
2	AMS 4121	2014					

Data Sheet for Rationalisation of Aviation Metallic Materials - Aluminium Alloys

General Grade of Material	2024	Type of Material	Al -Cu-Mg-Mn	Number of Specifications Identified	8
Rationalisation for Use	BAR				

Sl No	Specification	Grade	Form	Origin	Chemical composition (Wt%) (wherever limit not mentioned consider as max)												
					Al	Cu	Zn	Si	Mg	Ti+Zr	Ni	Ti	Fe	Mn	Cr	Others (Max)	Each (Max)
1	AMS 4152	2024	BAR	AMERICAN	Rem	3.8-4.9	0.25	0.5	1.2-1.8	0.2	-	0.15	0.5	0.3-0.9	0.1	0.15	0.05
2	AA 2024 T3 / T3511 AMS QQ–A–200 / 3	2024	BAR	AMERICAN	Rem	3.8-4.9	0.25	0.5	1.2-1.8	-	-	0.15	0.5	0.3-0.9	0.1	0.15	0.05
3	AA 2024 AMS QQ–A–225/6	2024	BAR	AMERICAN	Rem	3.8-4.9	0.25		1.2-1.8	-	-	0.15		0.3-0.9	0.1	0.15	0.05
4	BS EN 573-3	EN AW-2024	BAR	BRITISH	Rem	3.8-4.9	0.25	0.5	1.2-1.8	-	-	0.15	0.5	0.3-0.9	0.1	0.15	0.05
5	BS L-102 TB/T4	2024	BAR	BRITISH	Rem	3.9-5.0	0.2	0.5-0.90	0.2-0.8	0.2	-	-	0.5	0.4-1.2	0.1	-	-
6	WL 3.1354	2024	BAR	GERMAN	Rem	3.8-4.9	0.25		1.2-1.8	0.2	-	0.15		0.3-0.9	0.1	0.15	0.05
7	AIR 9051	AU4G1	BAR	FRENCH	Rem	3.8-4.9	0.25	0.5	1.2-1.8	0.25	-	-	0.5	0.3-0.9	0.1	0.15	0.05
8	G-4784-74	D16	BAR	RUSSIAN	Rem	3.8-4.9	0.3	0.5	1.2-1.8	-	0.1	0.1	0.5	0.3-0.9	-	-	0.05

Sl No	Specification	Thickness (mm)	Grade	Form	Heat treatment	Condition	Mechanical properties (Minimum)			
							UTS (MPa)	0.2% P.S. (MPa)	% EL (5D)	Hardness (BHN)
1	AMS 4152		2024	BAR	Sol : 493°C / HWQ (As per MIL-H-6088)	T3	450	315	10	100
2	AA 2024 T3/T3511 AMS QQ-A-200/3		2024	BAR	Sol : 493°C / HWQ (As per MIL-H-6088)	T3	468	330	8	-
3	AA 2024 T351 AMS QQ–A–225/6	12.7- 165.1	2024	BAR	Sol : 485-498°C / WQ, 1.5-3% Stretched, Straightened after stretching Age : RT / 48 Hr	T351	428	310	10	-
	AA 2024 T42 AMS QQ–A–225/6	≤ 165.1			Sol : 485-498°C / WQ, Age : RT / 48 Hr	T42	414	276	10	-
	AA 2024 T62 AMS QQ–A–225/6	≤ 165.1			Sol : 485-498°C / WQ, Age : 190 °C/ 16-18 Hr /AC	T62	414	317	5	-
4	BS EN 573-3		EN AW-2024	BAR	Sol : 495°C / WQ NaturAl Age : 4 Days (Min)	T4	440	300	8	120
5	BS L-102TB/T4	≤ 10	2024	BAR	-	T4	370	235	-	-
		10-20					400	260	-	-
		20-75					410	270	-	-
		75-150					400	260	-	-
6	WL 3.1354 T3511 LN 1796-LN 1798	≤ 75	2024	BAR	Sol : 495°C / WQ, 1.5-3% Stretched, Straightened after stretching Age : RT / 48 Hr	T3511	440	315	12	110
					Sol : 495°C / WQ, Age : RT / 48 Hr	T42	430	275	14	110
	WL 3.1354 T62 (Finished Part)				Sol : 495°C / WQ, Age : 190 °C/ 16-18 Hr /AC	T62	415	320	5	120
7	AIR 9051	-	AU4G1	BAR	Sol : 495°C / WQ NaturAl Age : 4 Days (Min)	T4	450	290	9	-
8	G-4784-74	Dia 8-100	D16	BAR	Sol : 495°C -505°C Cool in water 20-40 °C NaturAl ageing: 4 days in room temp	T4	402	265	10 - 12	105
Fatigue Data in T4 condition (Extracted from MMPDS, Minimum Values assumed 10% less than mean Value)										
Test Condition : R= -1, Wave Form: Sine, Load Direction : Axial, Temperature : Room Temperature, Frequency: 1800 to 3600 cpm, Specimen type : Unnotched										
1. Stress: 235 MPa, No of cycles : 1,00,000 (min)										
2. Stress: 180 MPa, No of cycles : 10,00,000 (min)										

Data Sheet for Rationalisation of Aviation Metallic Materials - Aluminium Alloys

General Grade of Material	2024	Type of Material	Al -Cu-Mg-Mn	Number of Specifications Identified	8
Rationalisation for Use	BAR				

Identified Specifications			Rationalised to	Form	Number of Specifications Identified	Number of Specifications Rationalised	Remarks
Sl No	Specification	Grade	Specification				
1	AMS 4152	2024	AMS QQ-A-200/3 / AMS QQ–A–225/6 / AIR 9051 (AU4G1) (T4)	BAR	8	3	-
2	AA 2024 T3/T3511 AMS QQ-A-200/3	2024					
3	AA 2024 AMS QQ–A–225/6	2024					
4	BS EN 573-3	EN AW-2024					
5	BS L-102 TB/T4	2024					
6	WL 3.1354	2024					
7	AIR 9051	AU4G1					
8	G-4784-74	D16					

Data Sheet for Rationalisation of Aviation Metallic Materials - Aluminium Alloys																	
General Grade of Material				2024	Type of Material			Al -Cu-Mg-Mn		Number of Specifications Identified					4		
Rationalisation for Use				PLATE													
Sl No	Specification	Grade	Form	Origin	Chemical composition (Wt%) (wherever limit not mentioned consider as max)												
					Al	Cu	Zn	Si	Mg	Ti+Zr	Ni	Ti	Fe	Mn	Cr	Others (Max)	Each (Max)
1	2024 T351	2024	PLATES	-	Rem	3.8-4.9		0.5	1.2-1.8	-	-	0.15	0.3	0.3-0.9	0.1	-	-
2	AA 2024 AMS QQ–A–250/4	2024	PLATES	AMERICAN	Rem	3.8-4.9	0.25	0.5	1.2-1.8	-	-	0.15	0.5	0.3-0.9	0.1	0.15	0.05
3	WL 3.1354 (LN 9073)	2024	PLATES	GERMAN	Rem	3.8-4.9	0.25	0.5	1.2-1.8	0.2	-	0.15	0.5	0.3-0.9	0.1	0.15	0.05
4	AMS 4033	2024	PLATES	AMERICAN	Rem	3.8-4.9	0.25	0.5	1.2-1.8	-	-	0.15	0.5	0.3-0.9	0.1	0.15	0.05

Sl No	Specification	Thickness (mm)	Grade	Form	Heat treatment	Condition	Mechanical properties (Minimum)			
							UTS (MPa)	0.2%	% EL (5D)	Hardness
1	2024 T351	25.4 – 50.8	2024	PLATES	-	T4	420	250	20	120 min
2	AA 2024 T351 AMS QQ–A–250/4	6.35-12.67 12.7-25.4 25.4-38.1 38.1-50.8 50.8-76.2 76.2-101.6	2024	PLATES	Sol : 485-498 °C / WQ, 1% Cold Formed, Age : RT / 48 Hr	T351	441 434 427 427 414 393	290 290 290 290 290 283	12 8 7 6 4 4	-
	AA 2024 T42 AMS QQ–A–250/4	6.35-12.67 12.7-25.4 25.4-38.1 38.1-50.8 50.8-76.2	2024	PLATES	Sol : 485-498 °C / WQ, Age : RT / 48 Hr	T42	428 421 414 414 400	262 262 262 262 262	12 8 7 6 4	-
	AA 2024 T62 AMS QQ–A–250/4	6.35-12.67 12.7-76.2	2024	PLATES	Sol : 495°C / WQ, Age : 185-195°C / 9-16 Hr	T62	441 434	345 345	5 5	-
3	WL 3.1354 T351 (LN 9073)	6-12 12-25 25-38 38-50 50-75 75-100 100-140	2024	PLATES	Sol : 495°C / WQ, 1.5-3% Stretched, Age : RT / 48 Hr	T351	440 430 430 430 430 420 380	290 290 310 310 310 310 300	12 12 12 12 10 10 8	110
	WL 3.1354 T62 (Finished Part)	6-12 12-25	2024	PLATES	Sol : 495°C / WQ, Age : 190°C / 16-18 Hr	T62	440 435	345 345	5 5	120
4	AMS 4033	6.35-12.67 12.7-25.4 25.4-38.1 38.1-50.8 50.8-76.2 76.2-101.6	2024	PLATES	Sol : 485-498 °C / WQ, 1% Cold Formed, Age : RT / 48 Hr	T351	441 434 427 427 414 393	290 290 290 290 290 283	12 8 7 6 4 4	-

Fatigue Data in T4 condition
(Extracted from MMPDS, Minimum Values assumed 10% less than mean Value)

Test Condition : R= -1, Wave Form: Sine, Load Direction : Axial, Temperature : Room Temperature, Frequency: 1800 to 3600 cpm, Specimen type : Unnotched

1. Stress: 235 MPa, No of cycles : 1,00,000 (min)

2. Stress: 180 MPa, No of cycles : 10,00,000 (min)

Data Sheet for Rationalisation of Aviation Metallic Materials - Aluminium Alloys							
General Grade of Material			2024	Type of Material	Al -Cu-Mg-Mn	Number of Specifications Identified	4
Rationalisation for Use			PLATE				
Identified Specifications			Rationalised to	Form	Number of Specifications Identified	Number of Specifications Rationalised	Remarks
Sl No	Specification	Grade	Specification				
1	2024 T351	2024	AMS QQ–A–250/4	PLATE	4	1	-
2	AA 2024 AMS QQ–A–250/4	2024					
3	WL 3.1354 (LN 9073)	2024					
4	AMS 4033	2024					

Data Sheet for Rationalisation of Aviation Metallic Materials - Aluminium Alloys

General Grade of Material				2024	Type of Material			Al -Cu-Mg-Mn		Number of Specifications Identified					3		
Rationalisation for Use				SHEET	Chemical composition (Wt%) (wherever limit not mentioned consider as max)												
Sl No	Specification	Grade	Form	Origin	Al	Cu	Zn	Si	Mg	Ti+Zr	Ni	Ti	Fe	Mn	Cr	Others (Max)	Each (Max)
1	AA 2024 AMS QQ–A–250/4	2024	SHEET	AMERICAN	Rem	3.8-4.9	0.25	0.5	1.2-1.8	-	-	0.15	0.5	0.3-0.9	0.1	0.15	0.05
2	WL 3.1354 (LN 9073 / LN 9074)	2024	SHEET	GERMAN	Rem	3.8-4.9	0.25	0.5	1.2-1.8	0.2	-	0.15	0.5	0.3-0.9	0.1	0.15	0.05
3	AMS 4037	2024	SHEET	AMERICAN	Rem	3.8-4.9	0.25	0.5	1.2-1.8	-	-	0.15	0.5	0.3-0.9	0.1	0.15	0.05

Sl No	Specification	Thickness (mm)	Grade	Form	Heat treatment	Condition	Mechanical properties (Minimum)			
							UTS (MPa)	0.2% P.S. (MPa)	% EL (5D)	Hardness (BHN)
1	AA 2024 T3 AMS QQ–A–250/4	0.203-0.228 0.254-0.508 0.533-3.25 3.27-6.32	2024	SHEET	Sol : 485-498 °C / WQ, 1% Cold Formed, Age : RT / 48 Hr	T3	434 434 434 441	290 290 290 290	10 12 15 15	-
	AA 2024 T62 AMS QQ–A–250/4	0.254-6.0	2024	SHEET	Sol : 495°C / WQ, Age : 185-195°C / 9-16 Hr	T62	441	345	5	-
2	WL 3.1354 T3/T351 (LN 9073/LN 9074)	0.4-6.0	2024	SHEET	Sol : 495°C / WQ, 1.5-3% Stretched, Age : RT / 48 Hr	T3/T351	440	290	14	110
	WL 3.1354 T62 (Finished Part)	0.4-6.0	2024	SHEET	Sol : 495°C / WQ, Age : 190°C / 16-18 Hr	T62	440	345	5	120
3	AMS 4037	0.203-0.228 0.254-0.508 0.533-1.57 1.6-3.2 3.27 - 6.32	2024	SHEET	Sol : 495°C / WQ, Age : RT / 48 Hr	T3/T351	400 406 406 420 420	269 269 269 276 276	10 12 15 15 15	110
Fatigue Data in T4 condition (Extracted from MMPDS, Minimum Values assumed 10% less than mean Value)										
Test Condition : R= -1, Wave Form: Sine, Load Direction : Axial, Temperature : Room Temperature, Frequency: 1800 to 3600 cpm, Specimen type : Unnotched										
1. Stress: 235 MPa, No of cycles : 1,00,000 (min)										
2. Stress: 180 MPa, No of cycles : 10,00,000 (min)										

Data Sheet for Rationalisation of Aviation Metallic Materials - Aluminium Alloys								
General Grade of Material			2024	Type of Material	Al -Cu-Mg-Mn	Number of Specifications Identified		3
Rationalisation for Use			SHEET					
Identified Specifications			Rationalised to	Form	Number of Specifications Identified	Number of Specifications Rationalised	Remarks	
Sl No	Specification	Grade	Specification					
1	AA 2024 AMS QQ–A–250/4	2024	AMS QQ–A–250/5	SHEET	3	1	-	
2	WL 3.1354 (LN 9073 / LN 9074)	2024						
3	AMS 4037	2024						

Data Sheet for Rationalisation of Aviation Metallic Materials - Aluminium Alloys																		
General Grade of Material			2024	Type of Material		Al -Cu-Mg-Mn		Number of Specifications Identified								3		
Rationalisation for Use			TUBE															
Sl No	Specification	Grade	Form	Origin	Chemical composition (Wt%) (wherever limit not mentioned consider as max)													
					Al	Cu	Zn	Si	Mg	Ti+Zr	Ni	Ti	Fe	Mn	Cr	Others (Max)	Each (Max)	
1	AMS WW – T – 700/3	2024	TUBE	AMERICAN	Rem	3.8-4.9	0.25	0.5	1.2-1.8	-	-	0.15	0.5	0.3-0.9	0.1	0.15	0.05	
2	WL 3.1354 (Part-4) (LN 1795)	2024	TUBE	GERMAN	Rem	3.8-4.9	0.25	0.5	1.2-1.8	0.2	-	0.15	0.5	0.3-0.9	0.1	0.15	0.05	
3	AMS 4088	2024	TUBE	AMERICAN	Rem	3.8-4.9	0.25	0.5	1.2-1.8	-	-	0.15	0.5	0.3-0.9	0.1	0.15	0.05	

Sl No	Specification	Thickness (mm)	Grade	Form	Heat treatment	Condition	Mechanical properties (Minimum)			
							UTS (MPa)	0.2% P.S. (MPa)	% EL (5D)	Hardness (BHN)
1	AA 2024 T3 AMS WW – T – 700/3	0.46–0.61 0.61-1.24 1.24-6.58 6.58-12.7	2024	TUBE	Sol : 485-498°C / WQ, 1% Cold Formed Age : RT / 48 Hr	T3	441 441 441 441	290 290 290 290	10 12 14 16	-
		0.46–0.61 0.61-1.24 1.24-6.58 6.58-12.7	2024		Sol : 485-498°C / WQ, Age : RT / 48 Hr	T42	427 427 427 427	262 262 262 262	10 12 14 16	-
2	WL 3.1354 T3 (Part-4) (LN 1795)	0.5 – 12.5	2024	TUBE	Sol : 495°C / WQ, Stretched Age : RT / 48 Hr	T3	440	290	12	120
	WL 3.1354 T351 (LN 1795)	0.5 – 12.5	2024	TUBE	Sol : 495°C / WQ, 1.5-3% Stretched, Age : RT / 48 Hr	T351	440	290	12	120
	WL 3.1354 T42 (LN 1795)	0.5 – 12.5	2024	TUBE	Sol : 495°C / WQ, Age : RT / 48 Hr	T42	440	270	12	110
3	AMS 4088	0.46-0.61 0.61-1.24 1.24- 6.58 6.58 -12.7	2024	TUBE	Sol : 485-498°C / WQ, 1% Cold Formed Age : RT / 48 Hr	T3	441 441 441 441	290 290 290 290	10 12 14 16	-

Fatigue Data in T4 condition
(Extracted from MMPDS, Minimum Values assumed 10% less than mean Value)

Test Condition : R= -1, Wave Form: Sine, Load Direction : Axial, Temperature : Room Temperature, Frequency: 1800 to 3600 cpm, Specimen type : Unnotched

1. Stress: 235 MPa, No of cycles : 1,00,000 (min)
2. Stress: 180 MPa, No of cycles : 10,00,000 (min)

Data Sheet for Rationalisation of Aviation Metallic Materials - Aluminium Alloys								
General Grade of Material			2024	Type of Material	Al -Cu-Mg-Mn	Number of Specifications Identified		3
Rationalisation for Use			TUBE					
Identified Specifications			Rationalised to		Form	Number of Specifications Identified	Number of Specifications Rationalised	Remarks
Sl No	Specification	Grade	Specification					
1	AMS WW – T – 700/3	2024	AMS 4088 (T3)		TUBE	3	1	-
2	WL 3.1354 (Part-4) (LN 1795)	2024						
3	AMS 4088	2024						

Data Sheet for Rationalisation of Aviation Metallic Materials - Aluminium Alloys

General Grade of Material	2017	Type of Material	Al -Cu-Mn-Mg-Si	Number of Specifications Identified	3
Rationalisation for Use	BAR				

Sl No	Specification	Grade	Form	Origin	Chemical composition (Wt%) (wherever limit not mentioned consider as max)											
					Al	Cu	Zn	Si	Mg	Ti+Zr	Ti	Fe	Mn	Cr	Others (Max)	Each (Max)
1	AIR 9051	AU4G /AU4G1	BAR	FRENCH	Rem	3.5-4.5	0.25	0.25-0.8	0.5-1.0	0.25	0.2	0.5	0.3-0.8	-	0.15	0.05
2	BS EN 573-3	EN AW-2017A	BAR	EU	Rem	3.5-4.5	0.25	0.2-0.8	0.4-1.0	0.25	-	0.7	0.4-1.0	0.1	0.15	0.05
3	AMS 4118	2017	BAR	AMERICAN	Rem	3.5-4.5	0.25	0.2-0.8	0.4-0.8	-	0.15	0.7	0.4-1.0	0.1	0.15	0.05

Sl No	Specification	Grade	Form	Heat treatment	Condition	Mechanical properties (Minimum)			
						UTS (MPa)	0.2% P.S. (MPa)	% EL (5D)	Hardness (BHN)
1	AIR 9051	AU4G /AU4G1	BAR	Sol : 500°C / WQ NaturAl Age : 4 Days (Min)	T4	400	260	13	-
2	BS EN 573-3	EN AW-2017A	BAR	Sol : 502°C / WQ NaturAl Age : 4 Days (Min) (As per MIL-H-6088)	T4	400	270	10	105
3	AMS 4118	2017	BAR	Sol : 502°C / WQ NaturAl Age : 4 Days (Min) (As per MIL-H-6088)	T4	380	220	12	90

Data Sheet for Rationalisation of Aviation Metallic Materials - Aluminium Alloys

General Grade of Material			2017	Type of Material	Al -Cu-Mn-Mg-Si	Number of Specifications Identified	3
Rationalisation for Use			BAR				
Identified Specifications			**Rationalised to**	**Form**	**Number of Specifications Identified**	**Number of Specifications Rationalised**	**Remarks**
Sl No	**Specification**	**Grade**	**Specification**				
1	AIR 9051	AU4G /AU4G1	AMS 4118 (T4) / AIR 9051 (AU4GI) (T4)	BAR	3	2	-
2	BS EN 573-3	EN AW-2017A					
3	AMS 4118	2017					

Data Sheet for Rationalisation of Aviation Metallic Materials - Aluminium Alloys

General Grade of Material	2618	Type of Material	Al -Cu-Mg	Number of Specifications Identified	9
Rationalisation for Use	BAR				

Sl No	Specification	Grade	Form	Origin	Chemical composition (Wt%) (wherever limit not mentioned consider as max)												
					Al	Cu	Zn	Si	Mg	Ni	Fe	Ti	Mn	Pb	Ti+Zr	Others (Max)	Each (Max)
1	MSRR 8007	-	BAR	BRITISH	Rem	2.1-2.7	0.1	0.25	1.35-1.65	1.0-1.4	0.9-1.2	0.1	0.2	0.05	-	-	-
2	AIR 9051	AU2GN	BAR	FRENCH	Rem	1.8-2.7	0.15	0.25	1.2-1.8	0.8-1.4	0.9-1.4	0.2	0.2	-	0.25	0.15	0.05
3	MSRR 8018 (Superceeded by RRMS 34001/2)	2618-F	BAR	BRITISH	Rem	1.8-2.7	0.15	0.15-0.25	1.2-1.8	0.8-1.1	0.9-1.4	0.2	0.25	-	0.25	0.15	0.05
4	DTD-731 (Obselete)	-	BAR	BRITISH	Rem	1.8-2.7	0.1	0.25	1.2-1.8	0.8-1.4	0.9-1.4	-	0.2	0.05	0.2	-	-
5	BS EN 573-3	EN AW-2618A	BAR	EU	Rem	1.8-2.7	0.15	0.15-0.25	1.2-1.8	0.8-1.4	0.9-1.4	0.2	0.25	-	0.25	0.15	0.05
6	DTD-5014 (Obselete)	-	BAR	BRITISH	Rem	1.8-2.7	0.1	0.25	1.2-1.8	0.8-1.4	0.9-1.4	0.2	0.2	0.05	0.25	Sn:0.05	-
7	MIL-A-22771/ AMS-A-22771	2618	BAR	AMERICAN	Rem	1.9-2.7	0.1	0.1-0.25	1.3-1.8	0.9-1.2	0.9-1.3	0.04-0.1	-	0.05	-	Sn:0.05	-
8	ASTM -B-247	2618	BAR	AMERICAN	Rem	1.9-2.7	0.1	0.1-0.25	1.3-1.8	0.9-1.2	0.9-1.3	0.04-0.1	-	-	-	0.15	0.05
9	AMS 4132	2618	BAR	AMERICAN	Rem	1.9-2.7	0.1	0.1-0.25	1.3-1.8	0.9-1.2	0.9-1.3	0.04-0.1	-	-	-	0.15	0.05

Sl No	Specification	Grade	Form	Heat treatment	Condition	Mechanical properties (Minimum)			
						UTS (MPa)	0.2% P.S. (MPa)	% EL (5D)	Hardness (BHN)
Heat Treatment Condition : T6									
1	MSRR 8007	-	BAR	Sol : 525°C / WQ Age : 195°C / 16-20Hr /AC	T6	400	330	6	125-150
2	AIR 9051	AU2GN	BAR	Sol : 530°C / WQ Age : 200°C / 22Hr /AC	T6	410	340	6	-
3	MSRR 8018 (Superceeded by RRMS 34001/2)	2618-F	BAR	Sol : 530°C / BWQ Age : 200°C / 20 Hr /AC	T6	430	340	5	125-150
4	DTD-731 (Obselete)	-	BAR	Sol : 530°C / BWQ Age : 200°C / 20-24 Hr /AC	T6	430	340	5	-
5	BS EN 573-3	EN AW-2618A	BAR	Sol : 530°C / BWQ Age : 200°C / 20 Hr /AC (HT As per MIL-H-6088)	T6	420	360	5	145
6	DTD-5014 (Obselete)	-	BAR	Sol : 530°C / WQ Age : 200°C / 16-24Hr /AC	T6	430	310	6	130
Heat Treatment Condition : T61									
7	MIL-A-22771/ AMS-A-22771	2618	BAR	Sol : 530°C / BWQ Age : 200°C / 20 Hr /AC (HT As per MIL-H-6088)	T61	400	310	4	115
8	ASTM -B-247	2618	BAR	Sol : 530°C / BWQ Age : 200°C / 20 Hr /AC (HT As per MIL-H-6088)	T61	400	310	4	115
9	AMS 4132	2618	BAR	Sol : 530°C / BWQ Age : 200°C / 20 Hr /AC (HT As per MIL-H-6088)	T61	448	368	8	120

Data Sheet for Rationalisation of Aviation Metallic Materials - Aluminium Alloys

General Grade of Material	2618	Type of Material	Al -Cu-Mg	Number of Specifications Identified	9
Rationalisation for Use	BAR				

Identified Specifications			Rationalised to	Form	Number of Specifications Identified	Number of Specifications Rationalised	Remarks
SI No	Specification	Grade	Specification				
1	MSRR 8007	-	AMS 4132 (T61) / AIR 9051 (AU2GN) (T6)	BAR	9	2	-
2	AIR 9051	AU2GN					
3	MSRR 8018 (Superceeded by RRMS 34001/2)	2618-F					
4	DTD-731 (Obselete)	-					
5	BS EN 573-3	EN AW-2618A					
6	DTD-5014 (Obselete)	-					
7	MIL-A-22771/ AMS-A-22771	2618					
8	ASTM -B-247	2618					
9	AMS 4132	2618					

Data Sheet for Rationalisation of Aviation Metallic Materials - Aluminium Alloys

General Grade of Material	6061	Type of Material	Al -Mg-Si-Cu	Number of Specifications Identified	12

Rationalisation for Use: BAR

Sl No	Specification	Grade	Origin	Chemical composition (Wt%) (wherever limit not mentioned consider as max)												
				Al	Cu	Zn	Ni	Si	Mg	Fe	Mn	Cr	Ti	Ti+Zr	Others (Max)	Each (Max)
1	ASTM B247	6061	AMERICAN	Rem	0.15-0.4	0.25	-	0.4-0.8	0.8-1.2	0.7	0.15	0.04-0.35	0.15	-	0.15	0.05
2	BS EN 573-3	EN AW-6061	EU	Rem	0.15-0.4	0.25	-	0.4-0.8	0.8-1.2	0.7	0.15	0.04-0.35	0.15	-	0.15	0.05
3	IS 734	65032 (HF20 Old)	INDIAN	Rem	0.15-0.4	0.2	-	0.4-0.8	0.7-1.2	0.7	0.2-0.8	0.15-0.35	0.2	-	Either Mn or Cr shAll be present	
4	MIL-A-22771/ AMS-A-22771	6061	AMERICAN	Rem	0.15-0.4	0.25	-	0.4-0.8	0.8-1.2	0.7	0.15	0.04-0.35	0.15	-	0.15	0.05
5	AMS 4127	6061	AMERICAN	Rem	0.15-0.4	0.25	-	0.4-0.8	0.8-1.2	0.7	0.15	0.04-0.35	0.15	-	0.15	0.05
6	HE20A (Indegenised)	6061	INDIAN	Rem	0.15-0.4	0.2	-	0.4-0.8	0.7-1.2	0.7	0.2-0.8	0.1-0.35	-	0.2	Ni: 0.1 Sn: 0.05	-
7	IS 733 (Gr 65032 WP) HE 20A WP	Gr 65032	INDIAN	Rem	0.15-0.4	0.2	-	0.4-0.8	0.7-1.2	0.7	0.2-0.8	0.15-0.35	0.2	-	-	-
8	AMS 4115	6061	AMERICAN	Rem	0.15-0.4	0.25	-	0.4-0.8	0.8-1.2	0.7	0.15	0.04-0.35	0.15	-	0.15	0.05
9	AMS 4116	6061	AMERICAN	Rem	0.15-0.4	0.25	-	0.4-0.8	0.8-1.2	0.7	0.15	0.04-0.35	0.15	-	0.15	0.05
10	AMS 4117	6061	AMERICAN	Rem	0.15-0.4	0.25	-	0.4-0.8	0.8-1.2	0.7	0.15	0.04-0.35	0.15	-	0.15	0.05
11	AMS 4128	6061	AMERICAN	Rem	0.15-0.4	0.25	-	0.4-0.8	0.8-1.2	0.7	0.15	0.04-0.35	0.15	-	0.15	0.05
12	WL 3.3214 (LN 1796 – LN 1798)	AA6061	GERMAN	Rem	0.15-0.4	0.25	-	04-0.8	0.8-1.2	0.7	0.15	0.04-0.35	0.15	-	0.15	0.05

Sl No	Specification	Grade	Heat treatment	Condition	Mechanical properties (Minimum)				
					Size Range (WT) mm	UTS (MPa)	0.2% P.S. (MPa)	% EL (5D)	Hardness (BHN)
1	ASTM B247	6061	Sol : 529°C / HWQ Age : 177°C / 8-10Hr /AC (HT As per AMS-2770)	T6	-	260	240	7	80
2	BS EN 573-3	EN AW-6061	Sol : 529°C / WQ Age : 177°C / 8-10Hr /AC (HT As per AMS-2770)	T6	-	260	240	6	95
3	IS 734	65032 (HF20 Old)	Sol : 529°C / WQ Age : 177°C / 8-10Hr /AC (HT As per AMS-2770)	T6	-	280	235	7	-
4	MIL-A-22771/ AMS-A-22771	6061	Sol : 547°C / WQ Age : 177°C / 8Hr /AC (HT As per MIL-H-6088)	T61	-	262	241	7	80
5	AMS 4127	6061	Sol : 547°C / WQ Age : 176°C / 8Hr /AC (HT As per MIL-H-6088)	T6	-	260	240	9	80
6	HE20A (Indegenised)	6061	As per type record	T6	-	280	235	7	93-100
7	IS 733 (Gr 65032 WP) HE 20A WP	Gr 65032	Not Available with spec	T6	<150 150-200	280 - 245	235 - 200	7- 6	-
8	AMS 4115	6061	Sol : 529°C / WQ Age : 177°C / 8-10Hr /AC	T6	-	290	241	10	80
9	AMS 4116	6061	Sol : 515-579°C / WQ Age : 177°C / 8-10Hr /AC	T62	<203 dia	290	241	10	80
10	AMS 4117	6061	Sol : 515-579°C / WQ Age : 177°C / 8-10Hr /AC	T6	-	290	241	10	80
11	AMS 4128	6061	Sol : 515-579°C / WQ Age : 177°C / 8-10Hr /AC	T6	-	290	241	10	80
12	WL 3.3214 T4 (LN 1796 – LN 1798)	6061	Sol : 525°C / WQ, Straightened Age : 96Hr / RT	T4	≤ 2000	210	100	18	60
	WL 3.3214 T6 (LN 1796 – LN 1798)	6061	Sol : 525°C / WQ, Straightened Age : 8-16 Hr / 165°C	T6	≤ 2000	290	245	9	90

Fatigue Data in T6 condition
(Extracted from MMPDS, Minimum Values assumed 10% less than mean Value)

Test Condition : R= -1, Wave Form: Sine, Load Direction : Axial, Temperature : Room Temperature, Frequency: 1100 to 3600 cpm, Specimen type: Unnotched

1. Stress: 155 MPa, No of cycles : 1,00,000 (min)	2. Stress: 120 MPa, No of cycles : 10,00,000 (min)

<table>
<tr><th colspan="9">Data Sheet for Rationalisation of Aviation Metallic Materials - Aluminium Alloys</th></tr>
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<tr><td colspan="3">Rationalisation for Use</td><td colspan="6">BAR</td></tr>
<tr><td colspan="3">Identified Specifications</td><td>Rationalised to</td><td rowspan="2">Form</td><td rowspan="2">Number of Specifications Identified</td><td rowspan="2">Number of Specifications Rationalised</td><td rowspan="2" colspan="2">Remarks</td></tr>
<tr><td>Sl No</td><td>Specification</td><td>Grade</td><td>Specification</td></tr>
<tr><td>1</td><td>ASTM B247</td><td>6061</td><td rowspan="12">AMS 4127 (T6) /
HE20A (T6) /
AMS 4116 (T62)</td><td rowspan="12">BAR</td><td rowspan="12">12</td><td rowspan="12">3</td><td rowspan="12" colspan="2">-</td></tr>
<tr><td>2</td><td>BS EN 573-3</td><td>EN AW-6061</td></tr>
<tr><td>3</td><td>IS 734</td><td>65032
(HF20 Old)</td></tr>
<tr><td>4</td><td>MIL-A-22771/
AMS-A-22771</td><td>6061</td></tr>
<tr><td>5</td><td>AMS 4127</td><td>6061</td></tr>
<tr><td>6</td><td>HE20A
(Indegenised)</td><td>6061</td></tr>
<tr><td>7</td><td>IS 733 (Gr 65032 WP)
HE 20A WP</td><td>Gr 65032</td></tr>
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<tr><td>9</td><td>AMS 4116</td><td>6061</td></tr>
<tr><td>10</td><td>AMS 4117</td><td>6061</td></tr>
<tr><td>11</td><td>AMS 4128</td><td>6061</td></tr>
<tr><td>12</td><td>WL 3.3214
(LN 1796 – LN 1798)</td><td>AA6061</td></tr>
</table>

Data Sheet for Rationalisation of Aviation Metallic Materials - Aluminium Alloys

General Grade of Material	6061	Type of Material	Al -Mg-Si-Cu	Number of Specifications Identified	5
Rationalisation for Use	SHEET				

Sl No	Specification	Grade	Origin	Chemical composition (Wt%) (wherever limit not mentioned consider as max)													
				Al	Cu	Zn	Ni	Si	Mg	Fe	Mn	Cr	Ti	Ti+Zr	Others (Max)	Each (Max)	Form
1	IS 737 (GR 65032 WP) HS20A WP	Gr 65032	INDIAN	Rem	0.15-0.4	0.2	-	0.4-0.8	0.7-1.2	0.7	0.2-0.8	0.1	0.2	-	-	-	6061
2	AMS 4025	6061	AMERICAN	Rem	0.15-0.4	0.25	-	0.4-0.8	0.8-1.2	0.7	0.15	0.04-0.35	0.15	-	0.15	0.05	6061
3	AMS 4026	6061	AMERICAN	Rem	0.15-0.4	0.25	-	0.4-0.8	0.8-1.2	0.7	0.15	0.04-0.35	0.15	-	0.15	0.05	6061
4	AMS 4027	6061	AMERICAN	Rem	0.15-0.4	0.25	-	0.4-0.8	0.8-1.2	0.7	0.15	0.04-0.35	0.15	-	0.15	0.05	6061
5	WL 3.3214 LN 9073	6061	GERMAN	Rem	0.15-0.4	0.25	-	0.4-0.8	0.8-1.2	0.7	0.15	0.04-0.35	0.15	-	0.15	0.05	6061

Sl No	Specification	Grade	Heat treatment	Condition	Mechanical properties (Minimum)				
					Size Range (WT) mm	UTS (MPa)	0.2% P.S. (MPa)	% EL (5D)	Hardness (BHN)
1	IS 737 (GR 65032 WP) HS20A WP	Gr 65032	Not Available with spec	T6	0.15-0.18 0.18-0.23 0.23-0.51 0.51-6.3	280	235	5-6	-
2	AMS 4025	6061	Sol : 529°C / WQ Age : 177°C / 8-10Hr /AC	T62	0.15-0.18 0.18-0.23 0.23-0.51 0.51-6.3	290	241	4 6 8 10	-
3	AMS 4026	6061	Sol : 529°C / WQ Age : 177°C / 8-10Hr /AC	T6	0.15-0.18 0.18-0.23 0.23-0.51 0.51-6.3	290	241	4 6 8 10	-
4	AMS 4027	6061	Sol : 529°C / WQ Age : 177°C / 8-10Hr /AC	T6	0.15-0.18 0.18-0.23 0.23-0.51 0.51-6.3	290	241	4 6 8 10	-
5	WL 3.3214 T4 LN 9073	6061	Sol : 525°C / WQ Straightened Age : 96Hr /RT	T4	≤ 0.5 0.5-3.2 3.2-6	210	110	14 16 16	60
	WL 3.3214 T42 (Finished Part)	6061	Sol : 525°C / WQ Age : 96Hr /RT	T42	≤ 0.5 0.5-6	210	100	14 16	60
	WL 3.3214 T6 LN 9073	6061	Sol : 525°C / WQ Straightened Age : 165°C / 8-16 Hr /AC	T6	≤ 0.5 0.5-3.2 3.2-6	290	240	8 10 10	90
	WL 3.3214 T62 (Finished Part)	6061	Sol : 525°C / WQ Age : 165°C / 8-10Hr /AC	T62	≤ 0.5 0.5-6	290	240	8 10	90

Fatigue Data in T6 condition
(Extracted from MMPDS, Minimum Values assumed 10% less than mean Value)

Test Condition : R= -1, Wave Form: Sine, Load Direction : Axial, Temperature : Room Temperature, Frequency: 1100 to 3600 cpm, Specimen type: Unnotched

1. Stress: 155 MPa, No of cycles : 1,00,000 (min)	2. Stress: 120 MPa, No of cycles : 10,00,000 (min)

Data Sheet for Rationalisation of Aviation Metallic Materials - Aluminium Alloys							
General Grade of Material		6061	Type of Material	Al -Mg-Si-Cu	Number of Specifications Identified		5
Rationalisation for Use		SHEET					
Identified Specifications			Rationalised to	Form	Number of Specifications Identified	Number of Specifications Rationalised	Remarks
Sl No	Specification	Grade	Specification				
1	IS 737 (GR 65032 WP) HS20A WP	Gr 65032	AMS 4026 (T6)	SHEET	5	1	-
2	AMS 4025	6061					
3	AMS 4026	6061					
4	AMS 4027	6061					
5	WL 3.3214 LN 9073	6061					

Data Sheet for Rationalisation of Aviation Metallic Materials - Aluminium Alloys

General Grade of Material	6061	Type of Material	Al -Mg-Si-Cu	Number of Specifications Identified	3
Rationalisation for Use	PLATE				

Sl No	Specification	Grade	Origin	Chemical composition (Wt%) (wherever limit not mentioned consider as max)												
				Al	Cu	Zn	Ni	Si	Mg	Fe	Mn	Cr	Ti	Ti+Zr	Others (Max)	Each (Max)
1	WL 3.3214 (LN 9073)	6061	GERMAN	Rem	0.15-0.4	0.25	-	04-0.8	0.8-1.2	0.7	0.15	0.04-0.35	0.15	-	0.15	0.05
2	AA 6061 AMS 4026	6061	AMERICAN	Rem	0.15-0.4	0.25	-	04-0.8	0.8-1.2	0.7	0.15	0.04-0.35	0.15	-	0.15	0.05
3	AA 6061 AMS 4027	6061	AMERICAN	Rem	0.15-0.4	0.25	-	04-0.8	0.8-1.2	0.7	0.15	0.04-0.35	0.15	-	0.15	0.05

Sl No	Specification	Grade	Heat treatment	Condition	Mechanical properties (Minimum)				
					Size Range (WT) mm	UTS (MPa)	0.2% P.S. (MPa)	% EL (5D)	Hardness (BHN)
1	WL 3.3214 T451 (LN 9073)	6061	Sol : 525°C / WQ, 1-3% Stretched Age : 96Hr / RT	T451	6-25 25-80	210 210	100 100	18 16	60
	WL 3.3214 T651 (LN 9073)	6061	Sol : 525°C / WQ, 1-3% Stretched Age : 8-16 Hr / 165°C	T651	6-25 25-50 50– 100	290 290 290	240 240 240	9 8 6	90
2	AMS 4026	6061	Sol : 525°C / WQ, 1-3% Stretched Age : 96Hr / RT	T451	6.32 –12.7 12.7- 25.4 25.4- 76.2	207 207 207	110 110 110	18 18 16	-
3	AMS 4027	6061	Sol : 525°C / WQ, 1-3% Stretched Age : 8-16 Hr / 165°C	T651	6 –12.67 12.67-25.4 25.4-50.8 50.8-101.6 101.6-152.4	290 290 290 290 276	241 241 241 241 241	10 9 8 6 6	-

Fatigue Data in T6 condition
(Extracted from MMPDS, Minimum Values assumed 10% less than mean Value)

Test Condition : R= -1, Wave Form: Sine, Load Direction : Axial, Temperature : Room Temperature, Frequency: 1100 to 3600 cpm, Specimen type: Unnotched

1. Stress: 155 MPa, No of cycles : 1,00,000 (min)	2. Stress: 120 MPa, No of cycles : 10,00,000 (min)

Data Sheet for Rationalisation of Aviation Metallic Materials - Aluminium Alloys

General Grade of Material			6061	Type of Material		Al -Mg-Si-Cu	Number of Specifications Identified	3
Rationalisation for Use			PLATE					
Identified Specifications			Rationalised to	Form		Number of Specifications Identified	Number of Specifications Rationalised	Remarks
Sl No	Specification	Grade	Specification					
1	WL 3.3214 (LN 9073)	6061	AMS 4026 (T451)	PLATE		3	1	-
2	AA 6061 AMS 4026	6061						
3	AA 6061 AMS 4027	6061						

Data Sheet for Rationalisation of Aviation Metallic Materials - Aluminium Alloys

General Grade of Material	6061	Type of Material	Al -Mg-Si-Cu	Number of Specifications Identified	9
Rationalisation for Use	TUBE				

Sl No	Specification	Grade	Origin	Chemical composition (Wt%) (wherever limit not mentioned consider as max)												
				Al	Cu	Zn	Ni	Si	Mg	Fe	Mn	Cr	Ti	Ti+Zr	Others (Max)	Each (Max)
1	AMS-WW-T-700/6 WW-T-700/6	6061	AMERICAN	Rem	0.15-0.40	0.25	-	0.4-0.8	0.8-1.2	0.7	0.15	0.04-0.35	-	-	0.15	0.05
2	AMS 4083	6061	AMERICAN	Rem	0.15-0.40	0.25	-	0.4-0.8	0.8-1.2	0.7	0.15	0.04-0.35	0.15	-	0.15	0.05
3	AMS-T-7081	6061	AMERICAN	Rem	0.15-0.40	0.25	-	0.4-0.8	0.8-1.2	0.7	0.15	0.04-0.35	0.15	-	0.15	0.05
4	BS L118	6061	BRITISH	Rem	0.15-0.40	0.25	-	0.4-0.8	0.8-1.2	0.7	0.15	0.04-0.35	0.15	-	0.15	0.05
5	QQ-A-200/8	6061	AMERICAN	Rem	0.15-0.40	0.25	-	0.4-0.8	0.8-1.2	0.7	0.15	0.04-0.35	0.15	-	0.15	0.05
6	AMS 4079	6061	AMERICAN	Rem	0.15-0.40	0.25	-	0.4-0.8	0.8-1.2	0.7	0.15	0.04-0.35	0.15	-	0.15	0.05
7	AMS 4080	6061	AMERICAN	Rem	0.15-0.40	0.25	-	0.4-0.8	0.8-1.2	0.7	0.15	0.04-0.35	0.15	-	0.15	0.05
8	AMS 4081	6061	AMERICAN	Rem	0.15-0.40	0.25	-	0.4-0.8	0.8-1.2	0.7	0.15	0.04-0.35	0.15	-	0.15	0.05
9	AMS 4082	6061	AMERICAN	Rem	0.15-0.40	0.25	-	0.4-0.8	0.8-1.2	0.7	0.15	0.04-0.35	0.15	-	0.15	0.05

Sl No	Specification	Grade	Heat treatment	Condition	Mechanical properties (Minimum)				
					Size Range (WT) mm	UTS (MPa)	0.2% P.S. (MPa)	% EL (5D)	Hardness (BHN)
1	AMS-WW-T-700/6	6061	Sol : 515-520°C/ WQ Age : 165-175°C / 8Hr	T6	0.61-1.25 1.25-6.50 6.50-12.5	289 289 289	241 241 241	10 12 14	-
2	AMS 4083	6061	Sol : 515-579°C/ WQ Age : 154-165°C / 18Hr	T6	0.61-1.25 1.25-6.50 6.50-12.5	291 291 291	240 240 240	10 12 14	-
3	AMS-T-7081	6061	Sol : 515-520°C/ WQ Age : 165-175°C / 8Hr	T6	0.61-1.25 1.25-6.50 6.50-12.5	289 289 289	240 240 240	10 12 14	-
4	BS L118	6061	Sol : 510-540°C/ WQ Age : 165-195°C / 3-12Hr /AC	T6	<1.0 1-5 5-10	290 290 290	240 240 240	10 12 14	-
5	QQ-A-200/8	6061	Sol : 515-520°C/ WQ Age : 165-175°C / 8Hr	T6	≤6.3 >6.3	261 261	241 241	8 10	-
6	AMS 4079	6061	Sol : 529°C/ WQ Age : 177°C / 8-10Hr	T62	0.61-1.25 1.25-6.50 6.50-12.5	290 290 290	240 240 240	10 12 14	-
7	AMS 4080	6061	Sol : 529°C/ WQ Age : 177°C / 8-10Hr	T6	0.61-1.25 1.25-6.50 6.50-12.5	290 290 290	241 241 241	10 12 14	-
8	AMS 4081	6061	Sol : 515-599°C/ WQ Age : 177°C / 8-10Hr	T62	0.61-1.25 1.25-6.50 6.50-12.5	290 290 290	240 240 240	10 12 14	-
9	AMS 4082	6061	Sol : 515-579°C/ WQ Age : 154-165°C / 18Hr	T6	0.61-1.25 1.25-6.50 6.50-12.5	290 290 290	241 241 241	10 12 14	-
Fatigue Data in T6 condition (Extracted from MMPDS, Minimum Values assumed 10% less than mean Value)									
Test Condition : R= -1, Wave Form: Sine, Load Direction : Axial, Temperature : Room Temperature, Frequency: 1100 to 3600 cpm, Specimen type: Unnotched									
1. Stress: 155 MPa, No of cycles : 1,00,000 (min)					2. Stress: 120 MPa, No of cycles : 10,00,000 (min)				

Data Sheet for Rationalisation of Aviation Metallic Materials - Aluminium Alloys

General Grade of Material	6061	Type of Material	Al -Mg-Si-Cu	Number of Specifications Identified	9
Rationalisation for Use	TUBE				

Identified Specifications			Rationalised to	Form	Number of Specifications Identified	Number of Specifications Rationalised	Remarks
Sl.no	Specification	Grade	Specification				
1	AMS-WW-T-700/6	6061	AMS 4083 (T62)	TUBE	9	1	-
2	AMS 4083	6061					
3	AMS-T-7081	6061					
4	BS L118	6061					
5	QQ-A-200/8	6061					
6	AMS 4079	6061					
7	AMS 4080	6061					
8	AMS 4081	6061					
9	AMS 4082	6061					

Data Sheet for Rationalisation of Aviation Metallic Materials - Aluminium Alloys

General Grade of Material	7049	Type of Material	Al-Zn-Mg-Cu-Cr	Number of Specifications Identified	3
Rationalisation for Use	BAR				

Sl No	Specification	Grade	Form	Origin	Chemical composition (Wt%) (wherever limit not mentioned consider as max)										
					Al	Cu	Zn	Si	Mg	Ti	Fe	Mn	Cr	Others (Max)	Each (Max)
1	ASTM B247	7049	BAR	AMERICAN	Rem	1.2-1.9	7.2-8.2	0.25	2.0-2.9	0.1	0.35	0.2	0.1-0.22	0.15	0.05
2	AMS 4111	7049	BAR	AMERICAN	Rem	1.2-1.9	7.2-8.2	0.25	2.0-2.9	0.1	0.35	0.2	0.1-0.22	0.15	0.05
3	MIL-A-22771/ AMS-A-22771	7049	BAR	AMERICAN	Rem	1.2-1.9	7.2-8.2	0.25	2.0-2.9	0.1	0.35	0.2	0.1-0.22	0.15	0.05

Sl No	Specification	Grade	Form	Heat treatment	Condition	Mechanical properties (Minimum)			
						UTS (MPa)	0.2% P.S. (MPa)	% EL (5D)	Hardness (BHN)
1	ASTM B247	7049	BAR	Sol : 468°C / HWQ Age 1 : 121°C / 23-25 Hr /AC Age 2 : 166°C / 13-14 Hr /AC (HT As per AMS-2770)	T73	490	420	7	135
2	AMS 4111	7049	BAR	Sol : 468°C / HWQ Age 1 : 121°C / 23-25 Hr /AC Age 2 : 166°C / 13-14 Hr /AC (HT As per AMS-2770)	T73	442	379	7	140
3	MIL-A-22771/ AMS-A-22771	7049	BAR	Sol : 467°C / HWQ Age 1 : 121°C / 24 Hr /AC Age 2 : 163°C / 10-16 Hr /AC (HT As per MIL-H-6088)	T73	489	420	7	135

Fatigue Data in T6 condition (Extracted from MMPDS, Minimum Values assumed 10% less than mean Value)	
Test Condition : R= 0.10, Wave Form: Sine, Load Direction : Axial, Temperature : Room Temperature, Frequency: 1800 cpm, Specimen type: Unnotched	
1. Stress: 297 MPa, No of cycles : 1,00,000 (min)	2. Stress: 241 MPa, No of cycles : 10,00,000 (min)

Data Sheet for Rationalisation of Aviation Metallic Materials - Aluminium Alloys

General Grade of Material			7049	Type of Material	Al-Zn-Mg-Cu-Cr	Number of Specifications Identified	3
Rationalisation for Use			BAR				
Identified Specifications			Rationalised to	Form	Number of Specifications Identified	Number of Specifications Rationalised	Remarks
SI No	Specification	Grade	Specification				
1	ASTM B247	7049	AMS 4111 (T73)	BAR	3	1	-
2	AMS 4111	7049					
3	MIL-A-22771/ AMS-A-22771	7049					

Data Sheet for Rationalisation of Aviation Metallic Materials - Aluminium Alloys

General Grade of Material	7050	Type of Material	Al -Zn-Mg	Number of Specifications Identified	3
Rationalisation for Use :	BAR				

Sl No	Specification	Grade	Form	Origin	Chemical composition (Wt%) (wherever limit not mentioned consider as max)											
					Al	Cu	Zn	Si	Mg	Zr	Ti	Fe	Mn	Cr	Others (Max)	Each (Max)
1	ASTM -B-247	7050	BAR	AMERICAN	Rem	2.0-2.6	5.7-6.7	0.12	1.9-2.6	0.08-0.15	0.06	0.15	0.1	0.04	0.15	0.05
2	AMS 4333	7050	BAR	AMERICAN	Rem	2.0-2.6	5.7-6.7	0.12	1.9-2.6	0.08-0.15	0.06	0.15	0.1	0.04	0.15	0.05
3	MIL-A-22771/ AMS-A-22771	7050	BAR	AMERICAN	Rem	2.0-2.6	5.7-6.7	0.12	1.9-2.6	0.08-0.15	0.06	0.15	0.1	0.04	0.15	0.05

Sl No	Specification	Grade	Form	Heat treatment	Condition	Mechanical properties (Minimum)			
						UTS (MPa)	0.2% P.S. (MPa)	% EL (5D)	Hardness (BHN)
1	ASTM -B-247	7050	BAR	Sol : 477°C / WQ Age1 : 121°C / 3-6 Hr /AC Age2 : 177°C / 6-8 Hr /AC (As per AMS 2770)	T74	490	420	7	135
2	AMS 4333	7050	BAR	Sol : 477°C / WQ Age1 : 121°C / 3-6 Hr /AC Age2 : 177°C / 6-8 Hr /AC (As per MIL-H-6088)	T7452	488	406	8	135
3	MIL-A-22771/ AMS-A-22771	7050	BAR	Sol : 477°C / WQ Age1 : 121°C / 3-6 Hr /AC Age2 : 177°C / 6-12 Hr /AC (As per MIL-H-6088)	T74	489	420	7	135

Fatigue Data in T6 condition (Extracted from MMPDS, Minimum Values assumed 10% less than mean Value)	
Test Condition : R= 0.10, Wave Form: Sine, Load Direction : Axial, Temperature : Room Temperature, Frequency: 800 cpm, Specimen type: Unnotched	
1. Stress: 180 MPa, No of cycles : 1,00,000 (min)	2. Stress: 120 MPa, No of cycles : 10,00,000 (min)

Data Sheet for Rationalisation of Aviation Metallic Materials - Aluminium Alloys

General Grade of Material			7050	Type of Material	Al -Zn-Mg	Number of Specifications Identified		3
Rationalisation for Use			BAR					
Identified Specifications			**Rationalised to**	**Form**	**Number of Specifications Identified**	**Number of Specifications Rationalised**	**Remarks**	
Sl No	**Specification**	**Grade**	**Specification**					
1	ASTM -B-247	7050	AMS 4333 (T7452)	BAR	3	1	-	
2	AMS 4333	7050						
3	MIL-A-22771/ AMS-A-22771	7050						

Data Sheet for Rationalisation of Aviation Metallic Materials - Aluminium Alloys

General Grade of Material	7075	Type of Material	Al -Zn-Mg	Number of Specifications Identified	6
Rationalisation for Use	BAR				

Sl No	Specification	Grade	Origin	Chemical composition (Wt%) (wherever limit not mentioned consider as max)												
				Al	Cu	Ni	Zn	Si	Mg	Ti	Fe	Mn	Cr	Ti+Zr	Others (Max)	Each (Max)
1	ASTM -B-247	7075	AMERICAN	Rem	1.2-2.0	-	5.1-6.1	0.4	2.1-2.9	0.2	0.5	0.3	0.18-0.28	-	0.15	0.05
2	BS EN 573-3	EN AW-7175	EU	Rem	1.2-2.0	-	5.1-6.1	0.15	2.1-2.9	0.1	0.2	0.1	0.18-0.28	-	0.15	0.05
3	MIL-A-22771/ AMS-A-22771	7075	AMERICAN	Rem	1.2-2.0	-	5.1-6.1	0.4	2.1-2.9	0.2	0.5	0.1	0.18-0.28	-	0.15	0.05
4	AMS -QQ-A-200/11	7075	AMERICAN	Rem	1.2-2.0	-	5.1-6.1	0.4	2.1-2.9	0.2	0.5	0.3	0.18-0.28	-	0.15	0.05
6	AIR 9051	AZ5GU	FRENCH	Rem	1.2-2.0	-	5.1-6.1	0.4	2.1-2.9	0.2	0.5	0.3	0.18-0.35	-	0.15	0.05
8	WL 3.4364 (Part-3)	7075	GERMAN	Rem	1.2-2.0	-	5.1-6.1	0.4	2.1-2.9	0.2	0.5	0.3	0.18-0.28	-	0.15	0.05

Sl No	Specification	Grade	Heat treatment	SIZE	Condition	Mechanical properties (Minimum)			
				RANGE MM		UTS (MPa)	0.2% P.S. (MPa)	% El (5D)	Hardness (HBW/BHN)
Heat Treatment Condition : T73									
1	ASTM -B-247	7075	Sol : 466°C / HWQ Age1 : 107°C / 6-7Hr /AC Age 2: 177°C /8-10Hr /AC (As per AMS 2770)	-	T73	455	385	7	125
2	BS EN 573-3	EN AW-7175	Sol : 466°C / HWQ Age1 : 107°C / 6-7Hr /AC Age 2: 177°C /8-10Hr /AC (As per AMS 2770)	-	T73	475	405	7	135
3	MIL-A-22771/ AMS-A-22771	7075	Sol : 465°C / HWQ Age1 : 107°C / 6-8Hr /AC Age 2: 177°C /8-10Hr /AC (As per MIL-H-6088)	-	T73	455	385	7	130
4	AMS -QQ-A-200/11	7075	Sol : 480°C / HWQ Age1 : 107°C / 6-8Hr /AC Age 2: 177°C /6-8Hr /AC (As per AMS 2772)	-	T73	379	448	7	-
5	WL 3.4364-DIN 65033	7075	Sol : 470°C / WQ Age : 105°C / 6-8 Hr + 165°C / 24-30 Hr / AC	-	T73	455	385	7	135
T6									
6	ASTM -B-247	7075	Sol : 466°C / HWQ Age : 120°C / 23-25Hr /AC (As per AMS 2770)	-	T6	510	435	7	135
7	AIR 9051	AZ5GU	Sol : 465°C / WQ Age : 120°C / 24Hr /AC	-	T6	530	450	8	-
8	BS EN 573-3	EN AW-7075	Sol : 466°C / HWQ Age : 120°C / 23-25Hr /AC (As per AMS 2770)	-	T6	560	500	7	150
9	MIL-A-22771/ AMS-A-22771	7075	Sol : 465°C / HWQ Age : 121°C / 24Hr /AC (As per MIL-H-6088)	-	T6	510	434	7	135
10	WL 3.4364 T6 (Part-2) (LN 1799 & LN 1770)	7075	Sol : 470°C / WQ Straightened Age : 120°C/12-16 Hr + 170°C/4-5 Hr / AC	2000-8000 8000-16000 16000-21000	T6	550 550 540	490 490 480	7 7 6	140
11	AA 7075 T6 AMS QQ – A –200/11	7075	Sol : 460-475°C / WQ Age : 115-125°C/ 24Hr	6.32 6.35-12.67 12.7-76.17 76.2-114	T6	538 558 558 558	482 503 496 490	7 7 7 7	-

Heat Treatment Condition : T74									
12	ASTM -B-247	7175	Sol : 480°C / HWQ Age1 : 107°C / 6-8Hr /AC Age 2: 177°C /6-8Hr /AC (As per AMS 2772)	-	T74	525	455	7	-
13	MIL-A-22771/ AMS-A-22771	7175	Sol : 480°C / HWQ Age1 : 107°C / 6-8Hr /AC Age 2: 177°C /6-8Hr /AC (As per AMS 2772)	-	T74	524	455	7	135
Heat Treatment Condition : T62 / 651 / 7351 / 75311									
14	WL 3.4364 T7351 (LN 1796 – LN 1798)	7075	Sol : 470°C/ WQ , 1.5-3 % Stretched, Age : 105°C / 6-8 Hr + 165°C / 24-30 Hr/AC	2000 2000-8000	T7351	480 480	420 410	7 7	130
15	AA 7075 T73511 AMS QQ – A –200/11	7075	Sol : 460-475°C / WQ 1-3% Stretched Age : 100-110°C / 6-8 Hr + 160-170°C / 24-30 Hr	1.57-6.32 6.35-12.67 12.7-75.96 76.2-114	T73511	469 482 476 469	400 421 407 393	7 8 8 7	-
Fatigue Data in T6 condition (Extracted from MMPDS, Minimum Values assumed 10% less than mean Value)									
Test Condition : R= -1, Wave Form: Sine, Load Direction : Axial, Temperature : Room Temperature, Frequency: 1100 to 3600 cpm, Specimen type: Unnotched									
1. Stress: 247 MPa, No of cycles : 1,00,000 (min)						2. Stress: 192 MPa, No of cycles : 10,00,000 (min)			

Data Sheet for Rationalisation of Aviation Metallic Materials - Aluminium Alloys

General Grade of Material			**7075**	**Type of Material**	**Al -Zn-Mg**	**Number of Specifications Identified**	**6**
Rationalisation for Use			**BAR**				
Identified Specifications			**Rationalised to**	**Form**	**Number of Specifications Identified**	**Number of Specifications Rationalised**	**Remarks**
Sl No	**Specification**	**Grade**	**Specification**				
1	ASTM -B-247	7075	AMS QQ – A –200/11	BAR	6	1	-
2	BS EN 573-3	EN AW-7175					
3	MIL-A-22771/ AMS-A-22771	7075					
4	AMS -QQ-A-200/11	7075					
5	AIR 9051	AZ5GU					
6	WL 3.4364 (Part-3)	7075					

Data Sheet for Rationalisation of Aviation Metallic Materials - Aluminium Alloys															
General Grade of Material			7075	Type of Material			Al -Zn-Mg		Number of Specifications Identified					4	
Rationalisation for Use			PLATE												
Sl No	Specification	Grade	Origin	Chemical composition (Wt%) (wherever limit not mentioned consider as max)											
				Al	Cu	Ni	Zn	Si	Mg	Ti	Fe	Mn	Cr	Ti+Zr	Others (Max)	Each (Max)
1	WL 3.4364 - LN 9073	7075	GERMAN	Rem	1.2-2.0	-	5.1-6.1	0.4	2.1-2.9	0.2	0.5	0.3	0.18-0.28	-	0.15	0.05
2	AA 7075 AMS QQ – A –250/12	7075	AMERICAN	Rem	1.2-2.0	-	5.1-6.1	0.4	2.1-2.9	0.2	0.5	0.3	0.18-0.28	-	0.15	0.05
3	TU1-90-161-90	V95PCH (B-95PCH)	RUSSIAN	Rem	1.4-2	0.1	5 - 6.5	0.1	1.8-2.8	0.06	0.15-0.25	0.2-0.6	0.1-0.25	-	-	0.05
4	AMS 4078	7075	AMERICAN	Rem	1.2-2.0	-	5.1-6.1	0.5	2.1-2.9	0.2	0.5	0.30	0.18-0.28	-	0.15	0.5

Sl No	Specification	Grade	Heat treatment	SIZE RANGE	Condition	Mechanical properties (Minimum)			
						UTS (MPa)	0.2% P.S. (MPa)	% El (5D)	Hardness (HBW/BHN)
1	WL 3.4364 T6 (LN 9073) (Plate)	7075	Sol : 470°C / WQ, Cold Worked Age : 120°C/12-16Hr + 170°C/4-5 Hr / AC	-	T6	530 530 530 500 480 480	450 450 450 430 410 390	8 5 5 2 2 2	140
Heat Treatment Condition : T62 / 651 / 7351 /									
1	WL 3.4364 T651 (LN 9073) PL	7075	Sol : 470°C / WQ,1.5-3 % Stretched Age : 120°C/12-16Hr + 170°C/4-5 Hr / AC	6-10 10-25 25-40 40-60 60-80 80-100	T651	530 530 530 520 490 470	470 470 470 455 430 410	8 6 6 5 5 4	-
	WL 3.4364 T7351 (LN 9073) PL	7075	Sol : 470°C / WQ, Age : 105°C/6-8 Hr + 165°C/25-30 Hr / AC	6-10 10-25 25-40 40-60 60-80 80-100	T7351	480 470 460 440 420	390 390 370 350 340	7 6 6 6 6	-
2	AA 7075 T651 AMS QQ – A –250/12 PL	7075	Sol : 470°C / WQ, 1.5-3 % Stretched Age : 120°C/12-16Hr + 170°C/4-5 Hr / AC	6.35–12.67 12.7-25.4 25.4-50.8 50.8- 63.5 63.5-76.2 76.2-88.9 88.9- 101.6	T651	538 538 531 524 496 490 462	461 469 461 441 421 400 372	9 7 6 5 5 5 3	-
	AA 7075 T7351 AMS QQ – A –250/12 PL	7075	Sol : 470°C / WQ, Age : 105°C/6-8 Hr + 165°C/25-30 Hr / AC	6.35–12.67 12.7-25.4 25.4-50.8 50.8- 63.5 63.5-76.2 76.2-88.9 88.9- 101.6	T7351	476 476 455 441 434 421	393 393 359 338 338 331	7 6 6 6 6 6	-
3	Tu1-92-161-90 (Plate)	D16CHT	Sol. Treated & Nat. Aged (HT Regime as above)	Thickness 11 -25	-	432	294	8	-
4	AMS 4078	7075	Aper AMS 2770	6.35-25.4 25.4-50.8 50.8-63.5 63.5-76.2 76.2-88.9 88.9-101.6	T7351	476 476 455 441 434 421	393 393 359 338 338 331	7 6 6 6 6 6	-

Fatigue Data in T6 condition (Extracted from MMPDS, Minimum Values assumed 10% less than mean Value)	
Test Condition : R= -1, Wave Form: Sine, Load Direction : Axial, Temperature : Room Temperature, Frequency: 1100 to 3600 cpm, Specimen type: Unnotched	
1. Stress: 247 MPa, No of cycles : 1,00,000 (min)	2. Stress: 192 MPa, No of cycles : 10,00,000 (min)

Data Sheet for Rationalisation of Aviation Metallic Materials - Aluminium Alloys

General Grade of Material			7075	Type of Material	Al -Zn-Mg	Number of Specifications Identified		4
Rationalisation for Use			PLATE					
Identified Specifications			Rationalised to	Form		Number of Specifications Identified	Number of Specifications Rationalised	Remarks
Sl No	Specification	Grade	Specification					
1	WL 3.4364 - LN 9073	7075	AMS QQ – A –250/12 (T651 / T7351)	PLATE		4	1	-
2	AA 7075 AMS QQ – A –250/12	7075						
3	TU1-90-161-90	V95PCH (B-95PCH)						
4	AMS 4078	7075						

Data Sheet for Rationalisation of Aviation Metallic Materials - Aluminium Alloys

General Grade of Material	7075	Type of Material	Al -Zn-Mg	Number of Specifications Identified	4
Rationalisation for Use	SHEET				

Sl No	Specification	Grade	Origin	Chemical composition (Wt%) (wherever limit not mentioned consider as max)												
				Al	Cu	Ni	Zn	Si	Mg	Ti	Fe	Mn	Cr	Ti+Zr	Others (Max)	Each (Max)
1	WL 3.4364 - LN 9073 / (LN 9074)	7075	GERMAN	Rem	1.2-2.0	-	5.1-6.1	0.4	2.1-2.9	0.2	0.5	0.3	0.18-0.28	-	0.15	0.05
2	AA 7075 AMS QQ – A –250/12	7075	AMERICAN	Rem	1.2-2.0	-	5.1-6.1	0.4	2.1-2.9	0.2	0.5	0.3	0.18-0.28	-	0.15	0.05
3	OST1-90026-71 G-4784-95	V95PCH (B-95PCH)	RUSSIAN	Rem	1.4-2	0.1	5 - 6.5	0.1	1.8-2.8	-	0.15-0.25	0.2-0.6	0.1-0.25	-	-	0.05
4	AMS 4045	7075	AMERICAN	Rem	1.2-2.0	-	5.1-6.1	0.4	2.1-2.9	0.2	0.5	0.3	0.18-0.28	-	0.15	0.05

Sl No	Specification	Grade	Heat treatment	SIZE	Condition	Mechanical properties (Minimum)			
				Range mm		UTS (MPa)	0.2% P.S. (MPa)	% El (5D)	Hardness (HBW/BHN)
1	WL 3.4364 T6 (LN 9073/LN 9074)	7075	Sol : 470°C / WQ Straightened Age : 120°C/12-16 Hr+170°C/ 4-5 Hr / AC	3.2 - 6	T6	530	450	8	-
	WL 3.4364 T62 (LN 9073/LN 9074)	7075	Sol : 470°C / WQ Preage 3 Days / RT Age : 120°C/12-16 Hr+ 170°C/ 4-5 Hr / AC	3.2 - 6	T62	530	450	8	140
2	AA 7075 T6 AMS QQ – A –250/12	7075	Sol : 460-475°C / WQ Age : 115-125°C / 24 Hr / AC	0.203 -0.279 0.304-0.990 1.01-3.17 3.2-6.32	T6	511 524 538 538	434 462 469 476	5 7 8 8	-
	AA 7075 T62 AMS QQ – A –200/11	7075	Sol : 460-475°C / WQ 90-100°C/ 4Hr Age : 155-165°C/ 8Hr	0.203 -0.279 0.304-0.990 1.01-3.17 3.2-6.32	T62	538 558 558 558	482 503 496 490	7 7 7 7	-
3	OST1-90026-71	V95PCH	Annealed (M)	0.5 to 10.5	A	441	245	10	-
4	AMS 4045 T6	7075	Sol : 460-475°C / WQ Strech , 48hr natureAl age	0.2- 0.28 0.28-0.99 0.99-3.18 3.18-4.75 4.75-6.32 6.32-12.67 12.67-25.4 25.4-50.8 50.8-63.5 63.5-76.2 76.2-88.9 88.9-101.6	-	510 524 538 545 552 538 538 531 524 496 490 462	434 462 469 476 476 462 469 462 441 421 400 372	-	-

Fatigue Data in T6 condition
(Extracted from MMPDS, Minimum Values assumed 10% less than mean Value)

Test Condition : R= -1, Wave Form: Sine, Load Direction : Axial, Temperature : Room Temperature, Frequency: 1100 to 3600 cpm, Specimen type: Unnotched

1. Stress: 247 MPa, No of cycles : 1,00,000 (min)	2. Stress: 192 MPa, No of cycles : 10,00,000 (min)

Data Sheet for Rationalisation of Aviation Metallic Materials - Aluminium Alloys							
General Grade of Material			7075	Type of Material / Al -Zn-Mg		Number of Specifications Identified	4
Rationalisation for Use			SHEET				
Identified Specifications			Rationalised to	Form	Number of Specifications Identified	Number of Specifications Rationalised	Remarks
Sl No	Specification	Grade	Specification				
1	WL 3.4364 - LN 9073 / (LN 9074)	7075	AMS QQ – A –250/12 (T6)	SHEET	4	1	-
2	AA 7075 AMS QQ – A –250/12	7075					
3	OST1-90026-71 G-4784-95	V95PCH (B-95PCH)					
4	AMS 4045	7075					

Data Sheet for Rationalisation of Aviation Metallic Materials - Aluminium Alloys

General Grade of Material	5083	Type of Material	Al -Mg	Number of Specifications Identified	3
Rationalisation for Use	BAR				

Sl No	Specification	Grade	Form	Origin	Chemical composition (Wt%) (wherever limit not mentioned consider as max)										
					Al	Cu	Zn	Si	Mg	Cr	Ti	Fe	Mn	Others (Max)	Each (Max)
1	AIR 9051	AG4MC	BAR	FRENCH	Rem	0.1	0.25	0.4	3.5-4.5	0.05-0.25	0.15	0.5	0.2-0.7	0.15	0.05
2	BS EN 573-3	EN AW-5083	BAR	EU	Rem	0.1	0.25	0.4	4.0-4.9	0.05-0.25	0.15	0.4	0.4-1.0	0.15	0.05
3	ASTM B247	5083	BAR	AMERICAN	Rem	0.1	0.25	0.4	4.0-4.9	0.05-0.25	0.15	0.4	0.4-1.0	0.15	0.05

Sl No	Specification	Grade	Form	Heat treatment	Condition	Mechanical properties (Minimum)			
						UTS (MPa)	0.2% P.S. (MPa)	% EL (5D)	Hardness (BHN)
Heat Treatment Condition : Anneal									
1	AIR 9051	AG4MC	BAR	Anneal : 360°C	Anneal	240	95	16	-
Heat Treatment Condition : H111									
2	BS EN 573-3	EN AW-5083	BAR	H111	-	270	110	10	70
3	ASTM B247	5083	BAR	H111		290	150	14	-

Data Sheet for Rationalisation of Aviation Metallic Materials - Aluminium Alloys

General Grade of Material	5083	Type of Material	Al -Mg	Number of Specifications Identified	3
Rationalisation for Use	BAR				

Identified Specifications			Rationalised to	Form	Number of Specifications Identified	Number of Specifications Rationalised	Remarks
Sl No	Specification	Grade	Specification				
1	AIR 9051	AG4MC	BS EN 573-3 (H111)	BAR	3	1	-
2	BS EN 573-3	EN AW-5083					
3	ASTM B247	5083					

Data Sheet for Rationalisation of Aviation Metallic Materials - Aluminium Alloys

General Grade of Material	5083	Type of Material	Al -Mg	Number of Specifications Identified	2
Rationalisation for Use	SHEET				

Sl No	Specification	Grade	Form	Chemical composition (Wt%) (wherever limit not mentioned consider as max)										
				Al	Cu	Zn	Si	Mg	Cr	Ti	Fe	Mn	Others (Max)	Each (Max)
1	AG3	5083	SHEET	Rem	0.1	0.1	0.3	2.2-3.8	0.35	-	0.4	0.05-0.60	-	-
2	AG4MC	5083	SHEET	Rem	0.1	0.25	0.4	3.5-4.5	0.05-0.25	0.15	0.5	0.2-0.70	-	-

Sl No	Specification	Grade	Form	Heat treatment	Condition	Mechanical properties (Minimum)			
						UTS (MPa)	0.2% P.S. (MPa)	% EL (5D)	Hardness (BHN)
1	AG3	5083	SHEET	-	H111	180	80	18	-
2	AG4MC	5083	SHEET	-	H111	240-290	100	18	-
	QQ-A-200/4 QQ-A-250/	5083	SHEET	-	H111	240-290	100	18	-

Data Sheet for Rationalisation of Aviation Metallic Materials - Aluminium Alloys

General Grade of Material	5083	Type of Material	Al -Mg	Number of Specifications Identified	2
Rationalisation for Use	SHEET				

Identified Specifications			Rationalised to	Form	Number of Specifications Identified	Number of Specifications Rationalised	Remarks
Sl No	Specification	Grade	Specification				
1	AG3	5083	QQ-A 250/6 (H111)	SHEET	2	1	-
2	AG4MC	5083					
	QQ-A-200/4 QQ-A-250/6	5083					

Data Sheet for Rationalisation of Aviation Metallic Materials - Aluminium Alloys

General Grade of Material	2219	Type of Material	Al -Cu	Number of Specifications Identified	4
Rationalisation for Use	BAR				

Sl No	Specification	Grade	Form	Origin	Chemical composition (Wt%) (wherever limit not mentioned consider as max)												
					Al	Cu	Zn	Si	Mg	Zr	V	Cr	Fe	Mn	Ti	Others (Max)	Each (Max)
1	ASTM B247	2219	BAR	AMERICAN	Rem	5.8-6.8	0.1	0.2	0.02	0.1-0.25	-	-	0.3	0.2-0.4	0.02-0.1	0.15	0.05
2	AMS 4143	2219	BAR	AMERICAN	Rem	5.8-6.8	0.1	0.2	0.02	0.1-0.25	0.05-0.15	-	0.3	0.2-0.4	0.02-0.1	0.15	0.05
3	MIL-A-22771/ AMS-A-22771	2219	BAR	AMERICAN	Rem	5.8-6.8	0.1	0.2	0.02	0.1-0.25	0.05-0.15	-	0.3	0.2-0.4	0.02-0.1	0.15	0.05
4	AMS 4162	2219	BAR	AMERICAN	Rem	5.8-6.8	0.1	0.2	0.02	0.1-0.25	0.05-0.15	-	0.3	0.2-0.4	0.02-0.1	0.15	0.05

Sl No	Specification	Grade	Form	Heat treatment	Condition	Mechanical properties (Minimum)				
						Size range mm	UTS (MPa)	0.2% P.S. (MPa)	% EL (5D)	Hardness (BHN)
1	ASTM B247	2219	BAR	Sol : 535°C / HWQ Age : 191°C / 26Hr /AC (As per AMS 2772)	T6	-	400	260	8	100
2	AMS 4143	2219	BAR	Sol : 535°C / WQ Age : 190°C / 26Hr /AC (As per MIL-H-6088)	T6	-	400	260	7	115
3	MIL-A-22771/ AMS-A-22771	2219	BAR	Sol : 535°C / HWQ Age : 190°C / 26Hr /AC (As per MIL-H-6088)	T6	-	400	261	8	100
4	AMS 4162	2219	BAR	Sol : 535°C / HWQ Age : 190°C / 18Hr /AC (As per MIL-H-6088)	T8511	-	400	290	6	122

Fatigue Data in T851 condition
(Extracted from MMPDS, Minimum Values assumed 10% less than mean Value)

Test Condition : R= -1, Wave Form: Sine, Load Direction : Axial, Temperature : Room Temperature, Frequency: 7000 to 8000 cpm, Specimen type: Notched (Kt=2.0)

1. Stress: 111 MPa, No of cycles : 1,00,000 (min)	2. Stress: 86 MPa, No of cycles : 10,00,000 (min)

Data Sheet for Rationalisation of Aviation Metallic Materials - Aluminium Alloys							
General Grade of Material			2219	Type of Material	Al -Cu	Number of Specifications Identified	4
Rationalisation for Use			BAR				
Identified Specifications			Rationalised to	Form	Number of Specifications Identified	Number of Specifications Rationalised	Remarks
Sl No	Specification	Grade	Specification				
1	ASTM B247	2219	AMS 4162 (T8511)	BAR	4	1	-
2	AMS 4143	2219					
3	MIL-A-22771/ AMS-A-22771	2219					
4	AMS 4162	2219					

Data Sheet for Rationalisation of Aviation Metallic Materials - Aluminium Alloys

General Grade of Material	2219	Type of Material	Al -Cu	Number of Specifications Identified	3
Rationalisation for Use	PLATE				

Sl No	Specification	Grade	Form	Origin	Chemical composition (Wt%) (wherever limit not mentioned consider as max)												
					Al	Cu	Zn	Si	Mg	Zr	V	Cr	Fe	Mn	Ti	Others (Max)	Each (Max)
1	AMS-QQ-A-250/30	2219	PLATE	AMERICAN	Rem	5.8-6.8	0.1	0.2	0.02	0.1-0.25	0.05-0.15	0.1	0.3	0.2-0.4	0.02-0.10	0.15	0.05
2	AMS 4599 (2219-T851)	2219	PLATE	AMERICAN	Rem	6.3	0.1	0.2	0.02	0.18	0.1	0.1	0.3	0.3	0.06	0.15	0.05
3	AMS 4601 (2219-T351)	2219	PLATE	AMERICAN	Rem	5.8-6.8	0.1	0.2	0.02	0.1-0.25	0.05-0.15	0.1	0.3	0.2-0.4	0.02-0.10	0.15	0.05

Sl No	Specification	Grade	Form	Heat treatment	Condition	Mechanical properties (Minimum)				
						Size range mm	UTS (MPa)	0.2% P.S. (MPa)	% EL (5D)	Hardness (BHN)
1	AMS-QQ-A-250/30	2219	PLATE	Sol : 530-540°C/ WQ Cold work after solutionizing Age : 171-182°C / 18Hr /AC	T351	-	180	91	15	-
2	AMS 4599 (2219-T851)	2219	PLATE	Sol : 530-540°C/ WQ Cold work after solutionizing Age : 171-182°C / 18Hr /AC	T851	0.250–1.000 1.001–2.000 2.001–3.000 3.001–4.000 4.001–5.000 5.001–6.000	62.0 62.0 62.0 60.0 59.0 57.0	46.0 46.0 45.0 44.0 43.0 42.0	8 7 6 5 5 4	-
3	AMS 4601 (2219-T351)	2219	PLATE	Sol : 530-540°C/ WQ Age : 171-182°C / 18Hr /AC	T351	0.250–2.000 2.001–3.000 3.001–4.000 4.001–5.000 5.001–6.000	46.0 44.0 42.0 40.0 39.0	28.0 28.0 27.0 26.0 25.0	10 10 9 9 8	-

Fatigue Data in T851 condition
(Extracted from MMPDS, Minimum Values assumed 10% less than mean Value)

Test Condition : R= -1, Wave Form: Sine, Load Direction : Axial, Temperature : Room Temperature, Frequency: 7000 to 8000 cpm, Specimen type: Notched (Kt=2.0)

1. Stress: 111 MPa, No of cycles : 1,00,000 (min)	2. Stress: 86 MPa, No of cycles : 10,00,000 (min)

Data Sheet for Rationalisation of Aviation Metallic Materials - Aluminium Alloys

General Grade of Material	2219	Type of Material	Al -Cu	Number of Specifications Identified	3
Rationalisation for Use	PLATE				

Identified Specifications			Rationalised to	Form	Number of Specifications Identified	Number of Specifications Rationalised	Remarks
Sl No	Specification	Grade	Specification				
1	AMS-QQ-A-250/30	2219	AMS 4599 (2219-T351)	PLATE	3	1	-
2	AMS 4599 (2219-T851)	2219					
3	AMS 4601 (2219-T351)	2219					

Data Sheet for Rationalisation of Aviation Metallic Materials - Aluminium Alloys

General Grade of Material	2219	Type of Material	Al -Cu	Number of Specifications Identified	2
Rationalisation for Use	SHEET				

Sl No	Specification	Grade	Form	Origin	Chemical composition (Wt%) (wherever limit not mentioned consider as max)												
					Al	Cu	Zn	Si	Mg	Zr	V	Cr	Fe	Mn	Ti	Others (Max)	Each (Max)
1	AMS-QQ-A-250/30	2219	SHEET	AMERICAN	Rem	5.8-6.8	0.1	0.2	0.02	0.1-0.25	0.05-0.15	0.1	0.3	0.2-0.4	0.02-0.10	0.15	0.05
2	AMS 4601 (2219-T31/-T351)	2219	SHEET	AMERICAN	Rem	5.8-6.8	0.1	0.2	0.02	0.1-0.25	0.05-0.15	-	0.3	0.2-0.4	0.02-0.10	0.15	0.05

Sl No	Specification	Grade	Form	Heat treatment	Condition	Mechanical properties (Minimum)				
						Size range mm	UTS (MPa)	0.2% P.S. (MPa)	% EL (5D)	Hardness (BHN)
1	AMS-QQ-A-250/30	2219	SHEET	Sol : 530-540°C/ WQ Cold work after solutionizing Age : 171-182°C / 18Hr /AC	T81	0.5-1.02 1.02-6.32	427 427	317 317	6 7	-
2	AMS 4601 (2219-T31/-T351)	2219	SHEET	Sol : 530-540°C/ WQ Age : 171-182°C / 18Hr /AC	T62	0.5-1.0 1.0-6.25	372 372	248 248	6 7	-

Fatigue Data in T851 condition
(Extracted from MMPDS, Minimum Values assumed 10% less than mean Value)

Test Condition : R= -1, Wave Form: Sine, Load Direction : Axial, Temperature : Room Temperature, Frequency: 7000 to 8000 cpm, Specimen type: Notched (Kt=2.0)

1. Stress: 111 MPa, No of cycles : 1,00,000 (min)	2. Stress: 86 MPa, No of cycles : 10,00,000 (min)

Data Sheet for Rationalisation of Aviation Metallic Materials - Aluminium Alloys

General Grade of Material	2219	Type of Material	Al -Cu	Number of Specifications Identified	2
Rationalisation for Use	SHEET				

Identified Specifications			Rationalised to	Form	Number of Specifications Identified	Number of Specifications Rationalised	Remarks
Sl No	Specification	Grade	Specification				
1	AMS-QQ-A-250/30	2219	AMS 4601	SHEET	2	1	-
2	AMS 4601 (2219-T31/-T351)	2219					

Data Sheet for Rationalisation of Aviation Metallic Materials - Aluminium Alloys

General Grade of Material	2124	Type of Material	Al -Cu-Si	Number of Specifications Identified	4
Rationalisation for Use	PLATE				

Sl No	Specification	Grade	Form	Origin	Chemical composition (Wt%) (wherever limit not mentioned consider as max)													
					Al	Cu	Zn	Si	Mg	Fe	Mn	Cr	Ti	Ti+Zr	Ni	Pb	Others (Max)	Each (Max)
1	2124 T851	2124	PLATE	-	Rem	3.8-4.9	0.25	0.2	0.2-0.8	0.3	0.3-0.9	0.1	0.15	-	-	-	-	-
2	AMS 4101	2124	PLATE	AMERICAN	Rem	3.8-4.9	0.25	0.2	1.2-1.8	0.3	0.3-0.9	0.1	0.15	-	-	-	0.15	0.05
3	AMS-QQ-A-250/29	2124	PLATE	AMERICAN	Rem	3.8-4.9	0.25	0.2	1.2-1.8	0.3	0.3-0.9	0.1	0.15	0.2	-	-	0.15	0.05
4	AIR 9048/91 620 (2214-T651)	2214	PLATE	FRENCH	Rem	3.9-5	0.25	0.2	0.2-0.8	0.3	0.4-1.2	0.1	0.15	0.2	-	-	-	-

Sl No	Specification	Grade	Size range (mm)	Heat treatment	Condition	Mechanical properties (Minimum)			
						UTS (MPa)	0.2% P.S. (MPa)	% EL (5D)	Hardness (BHN)
1	2124 T851	2124	25.4-38.1, 38.1-50.8	-	T851	455	393	6	-
			50.8-76.2		T851	448.1	393	6	-
			101.6-127.0		T851	441.2	379.2	5	-
			127.0-152.4		T851	434.3	372.3	5	-
2	AMS 4101	2124	38-51 51-76 76-102 102-127 127-152	Sol : 488-499°C / WQ Control Strech and cold work Age : 185-196°C / 12Hr /AC	T851	455 448 448 441 434	393 393 386 379 372	6 6 5 5 5	-
3	AMS-QQ-A-250/29	2124	38-51 51-76 76-102 102-127 127-152	Sol : 488-499°C / WQ Control Strech and cold work Age : 185-196°C / 12Hr /AC	T851	455 448 448 441 434	393 393 386 379 372	6 6 5 5 5	-
4	AIR 9048/91 620 (2214-T651)	2214	6-10 10-25 25-40 40-60 60-80 80-100 100-120 120-140	Sol : 500-510°C / WQ Control Stretching 1-3% Age : 157-163°C / 18-22 Hr /AC	T651	460 460 460 450 450 430 430 420	410 410 400 390 390 370 360 350	8 6 5 5 5 4 4 4	-
Test Condition : R= -1, Wave Form: Sine, Load Direction : Axial, Temperature : Room Temperature, Frequency: 1100 to 3600 cpm, Specimen type : Unnotched									
1. Stress: 278 MPa, No of cycles : 1,00,000 (min)						2. Stress: 173 MPa, No of cycles : 10,00,000 (min)			

Data Sheet for Rationalisation of Aviation Metallic Materials - Aluminium Alloys

General Grade of Material	2124	Type of Material	Al -Cu-Si	Number of Specifications Identified	4
Rationalisation for Use	PLATE				

Identified Specifications			Rationalised to	Form	Number of Specifications Identified	Number of Specifications Rationalised	Remarks
Sl No	Specification	Grade	Specification				
1	2124 T851	2124	AMS 4101 (T851)	PLATE	4	1	-
2	AMS 4101	2124					
3	AMS-QQ-A-250/29	2124					
4	AIR 9048/91 620 (2214-T651)	2214					

Data Sheet for Rationalisation of Aviation Metallic Materials - Aluminium Alloys																	
General Grade of Material			5251	Type of Material			Al-Mg-Mn		Number of Specifications Identified						3		
Rationalisation for Use			Tube														
Sl No	Specification	Grade	Origin	Chemical composition (Wt%) (wherever limit not mentioned consider as max)													
				Al	Cu	Zn	Si	Mg	Ti+Zr	Ni	Fe	Mn	Cr	Ti	Pb	Others (Max)	Each (Max)
1	BS 4L56	5251	BRITISH	Rem	0.15	0.15	0.4	1.7-2.4	-	0.2	0.5	0.1-0.5	0.15	0.15	-	0.15	0.05
2	EN- AW -5251	5251	EU	Rem	0.15	0.15	0.4	1.7-2.4	-	0.2	0.5	0.1-0.5	0.15	0.15	-	0.15	0.05
3	BS N4	5251	BRITISH	Rem	0.15	0.15	0.4	1.7-2.4	-	0.2	0.5	0.1-0.5	0.15	0.15	-	0.15	0.05

Sl No	Specification	Grade	Heat treatment	Condition	Mechanical properties (Minimum)				
					SIZE (mm)	UTS (MPa)	0.2% Proof (MPa)	% E	Hardness (HBW/BHN)
1	BS 4L56	5251	-	-	≤12t	160-200	60	18	-
2	EN- AW -5251	5251	-	-	≤12t	160-200	60	18	-
3	BS N4	5251	-	-	≤12t	180-280	60	19	-

Data Sheet for Rationalisation of Aviation Metallic Materials - Aluminium Alloys

General Grade of Material	5251	Type of Material	Al-Mg-Mn	Number of Specifications Identified	3
Rationalisation for Use	TUBE				

Identified Specifications			Rationalised to	Form	Number of Specifications Identified	Number of Specifications Rationalised	Remarks
Sl No	Specification	Grade	Specification				
1	BS 4L56	5251	EN- AW -5251 \ BS 4L 56	TUBE	3	2	-
2	EN- AW -5251	5251					
3	BS N4	5251					

Data Sheet for Rationalisation of Aviation Metallic Materials - Aluminium Alloys

General Grade of Material	3103	Type of Material	Al -Cu-Si	Number of Specifications Identified	5
Rationalisation for Use	SHEET				

Sl No	Specification	Grade	Origin	Chemical composition (Wt%) (wherever limit not mentioned consider as max)													
				Al	Cu	Zn	Si	Mg	Ti+Zr	Ni	Fe	Mn	Cr	Ti	Pb	Others (Max)	Each (Max)
1	BS 4L59	3103	BRITISH	Rem	0.1	0.2	0.6	0.2	0.1	0.2	0.7	0.9-1.5	0.1	-	-	0.15	0.05
2	BS L60	3103	BRITISH	Rem	0.1	0.2	0.6	0.3	0.1	0.2	0.7	0.9-1.5	0.1	-	-	0.15	0.05
3	BS L61	3103	BRITISH	Rem	0.1	0.2	0.6	0.3	0.1	0.2	0.7	0.9-1.5	0.1	-	-	0.15	0.05
4	DIN 1745 3.0515	3103	GERMAN	Rem	0.1	0.2	0.5	0.3	-	-	0.6	0.9-1.4	0.05	0.1	-	0.15	0.05
5	BS N3	3103	BRITISH	Rem	0.1	0.2	0.6	0.2	0.1	0.2	0.7	0.9-1.5	0.1	-	-	0.15	0.05

Sl No	Specification	Grade	Heat treatment	Condition	Mechanical properties (Minimum)					
					SIZE RANGE (mm)	UTS (MPa)	0.2% Proof (MPa)	% E	Hardness (HBW/BHN)	-
1	BS 4L59	3103	-	H16	0.4-0.8 0.8-1.3 1.3-6.0	160-195 160-195 160-195	-	2 3 4	-	-
2	BS L60	3103	-	H12	<0.8 0.8-1.3 1.3-2.6 2.6-6.0	120-145 120-145 120-145 120-145	-	5 6 7 9	-	-
3	BS L61	3103	-	0 (Annealed)	<0.8 0.8-1.3 1.3-3.0 3.0-6.0	90-130 90-130 90-130 90-130	-	20 23 24 25	-	-
4	DIN 1745 3.0515	3103	-	0 H14 H18	0.2-6.0 0.2-6.0 0.2-6.0	100 125 155	40 90 125	24 7 4	25 35 40	-
5	BS N3	3103	-	0 H14 H16	0.4-0.8 0.8-1.3 1.3-6.0	90-130 120-145 160-195	-	20 5 2	-	-

Data Sheet for Rationalisation of Aviation Metallic Materials - Aluminium Alloys

General Grade of Material	3103	Type of Material	Al -Cu-Si	Number of Specifications Identified	5
Rationalisation for Use	SHEET				

Identified Specifications			Rationalised to	MaterialType	Number of Specifications Identified	Number of Specifications Rationalised	Remarks
Sl No	Specification	Grade	Specification				
1	BS 4L59	3103	BS N3 / BS 4L 59	Sheet	5	2	-
2	BS L60	3103					
3	BS L61	3103					
4	DIN 1745 3.0515	3103					
5	BS N3	3103					

Data Sheet for Rationalisation of Aviation Metallic Materials - Aluminium Alloys

General Grade of Material	6082	Type of Material	Al -Cu-Si	Number of Specifications Identified	2
Rationalisation for Use	BAR				

Sl No	Specification	Grade	Origin	Chemical composition (Wt%) (wherever limit not mentioned consider as max)													
				Al	Cu	Zn	Si	Mg	Ti+Zr	Ni	Fe	Mn	Cr	Ti	Pb	Others (Max)	Each (Max)
1	BS L111	6082	BRITISH	Rem	0.1	0.2	0.7-1.3	0.5-1.2	-	0.1	0.5	0.4-1.0	0.25	0.2	0.005	-	Sn: 0.005
2	IS 733 (Gr 64430 WP) HE 30A WP	Gr 64430	INDIAN	Rem	0.1	0.1	0.6-1.3	0.4-1.2	-	-	0.6	0.4-1.0	0.25	0.2	-	-	-

Sl No	Specification	Grade	Section thickness (50 mm) Heat treatment	Condition	Mechanical properties (Minimum)				
					SIZE RANGE (mm)	UTS (MPa)	0.2% Proof (MPa)	% E	Hardness (HBW/BHN)
1	BS L111	6082	Sol : 510 - 540 °C/ WQ Age : 165-195°C / 3-12 Hr	T651/T6511	<20 20-150 150-200	295 310 280	255 270 240	8 8 5	-
2	IS 733 (Gr 64430 WP) HE 30A WP	Gr 64430	Not Available with spec	T6	<5 5-75 75-150 150-200	295 310 295 280	255 270 270 240	7 7 7 6	-

Data Sheet for Rationalisation of Aviation Metallic Materials - Aluminium Alloys

General Grade of Material	6082	Type of Material	Al -Cu-Si	Number of Specifications Identified	2
Rationalisation for Use	BAR				

Identified Specifications			Rationalised to	Form	Number of Specifications Identified	Number of Specifications Rationalised	Remarks
Sl No	Specification	Grade	Specification				
1	BS L111	6082	BS L111 (T651/T6511)	BAR	2	1	–
2	IS 733 (Gr 64430 WP) HE 30A WP	Gr 64430					

Data Sheet for Rationalisation of Aviation Metallic Materials - Aluminium Alloys

General Grade of Material	6082	Type of Material	Al -Cu-Si	Number of Specifications Identified	2
Rationalisation for Use	SHEET				

Sl No	Specification	Grade	Origin	Chemical composition (Wt%) (wherever limit not mentioned consider as max)													
				Al	Cu	Zn	Si	Mg	Ti+Zr	Ni	Fe	Mn	Cr	Ti	Pb	Others (Max)	Each (Max)
1	BS L113	6082	BRITISH	Rem	0.1	0.2	0.7-1.3	0.5-1.2	-	0.1	0.5	0.4-1.0	0.25	0.2	0.05		Sn: 0.05
2	IS 737 (GR 64430 WP) HS 30A WP	Gr 64430	INDIAN	Rem	0.1	0.1	0.6-1.3	0.4-1.2	-	-	0.6	0.4-1.0	0.25	0.2	-	-	-

Sl No	Specification	Grade	Section thickness (50mm) Heat treatment	Condition	Mechanical properties (Minimum)				
					SIZE RANGE (mm)	UTS (MPa)	0.2% Proof (MPa)	% E	Hardness (HBW/BHN)
1	BS L113	6082	Sol : 510 - 540 °C/ WQ Age : 165-195°C / 3-12 Hr	T6	0.2-3.0 3.0-6.0	295 295	255 240	8 8	-
2	IS 737 (GR 64430 WP) HS 30A WP	Gr 64430	-	T6	0.5-2.6 2.6-6.3	295 295	250 250	5 6	-

Data Sheet for Rationalisation of Aviation Metallic Materials - Aluminium Alloys

General Grade of Material	6082	Type of Material	Al -Cu-Si	Number of Specifications Identified	2
Rationalisation for Use	SHEET				

Identified Specifications			Rationalised to	Form	Number of Specifications Identified	Number of Specifications Rationalised	Remarks
Sl No	Specification	Grade	Specification				
1	BS L113	6082	BS L113 (T6)	Sheet	2	1	–
2	IS 737 (GR 64430 WP) HS 30A WP	Gr 64430					

Data Sheet for Rationalisation of Aviation Metallic Materials - Aluminium Alloys

General Grade of Material	7010	Type of Material	Al -Cu-Si	Number of Specifications Identified	2
Rationalisation for Use	PLATE				

Sl No	Specification	Grade	Origin	Chemical composition (Wt%) (wherever limit not mentioned consider as max)													
				Al	Cu	Zn	Si	Mg	Zr	Ni	Fe	Mn	Cr	Ti	Pb	Others (Max)	Each (Max)
1	AMS 4205	7010	AMERICAN	Rem	1.5-2.0	5.7-6.7	0.12	2.1-2.6	0.1-0.16	0.05	0.15	0.1	0.05	0.06	-	0.15	0.05
2	BS EN 2684	Al-P 7010	BRITISH	Rem	1.5-2.0	5.7-6.7	0.12	2.1-2.6	0.1-0.16	0.05	0.15	0.1	0.05	0.06	-	0.15	0.05

Sl No	Specification	Grade	Section thickness (50 mm) Heat treatment	Condition	Mechanical properties (Minimum)					
					SIZE RANGE (mm)	UTS (MPa)	0.2% Proof (MPa)	% E	Hardness (HBW/BHN)	
1	AMS 4205	7010	-	T7451	<50.8 50.8-63.5 63.5-76.2 76.2-101.6 101.6-127 127-139.7	524 517 503 496 496 490	455 448 441 441 434 427	8 8 7 7 7 6	-	-
2	BS EN 2684	Al-P 7010	470 °C ≤ θ ≤ 485 °C a / WQ θ ≤ 40 °C + 1,5 % ≤ controlled stretched ≤ 3 % + 115 °C ≤ θ ≤ 125 °C / 4 h ≤ t ≤ 24 h + 165 °C ≤ θ ≤ 175 °C / 6 h ≤ t ≤ 15 h	T7451	6-12.5 12.5-25 25-40 40-60 60-80 80-100 100-120 120-140	525 525 515 515 505 500 495 490	450 450 450 445 440 435 430 430	8 8 7 7 6 6 6 5	-	-

Data Sheet for Rationalisation of Aviation Metallic Materials - Aluminium Alloys							
General Grade of Material			7010	Type of Material	Al -Cu-Si	Number of Specifications Identified	2
Rationalisation for Use			PLATE				
Identified Specifications			Rationalised to	Form	Number of Specifications Identified	Number of Specifications Rationalised	Remarks
Sl No	Specification	Grade	Specification				
1	AMS 4205	7010	AMS 4205 (T7451)	PLATE	2	1	–
2	BS EN 2684	Al-P 7010					

5.0
PART 2
STEEL

Data Sheet for Rationalisation of Aviation Metallic Materials - Steel

General Grade of Material	AISI 316	Type of Material	Stainless Steel	Number of Specifications Identified	4
Rationalisation for Use	BAR				

Sl No	Specification	Grade	Origin	Chemical composition (Wt%) (wherever limit not mentioned consider as max)												
				C	Mn	Si	S	P	Ni	Cr	Mo	V	Cu	Fe	Others: Each	Others: Total
1	AMS 5653	316L	AMERICAN	0.03	1.25-2.0	1.0	0.03	0.04	10.0-14.0	16.0-18.0	2.0-3.0	-	1.0	Rem	-	-
2	AMS 5648	316	AMERICAN	0.08	1.25-2.0	1.0	0.03	0.04	10.0-14.0	16.0-18.0	2.0-3.0	-	1.0	Rem	-	-
3	AMS 5649	316	AMERICAN	0.08	1.25-2.0	1.0	0.03	0.04	10.0-14.0	16.0-18.0	2.0-3.0	-	1.0	Rem	-	-
4	AMS-S-7720 / Mil-S-7720	316	AMERICAN	0.08	1.25-2.0	1.0	0.03	0.04	10.0-14.0	16.0-18.0	2.0-3.0	-	1.0	Rem	-	-

Sl No	Specification	Grade	Heat treatment	Condition	Mechanical properties (Minimum)				
					Size (mm)	UTS (MPa)	0.2% Proof (MPa)	% EL	Hardness (HBW/BHN)
1	AMS 5653	316L	Solution Heat Treated	ST	<50.8 >50.8	-	-	-	140-255 255 max
2	AMS 5648	316	Solution Heat Treated	ST	<50.8 >50.8	-	-	-	140-255 255 max
3	AMS 5649	316L	Solution Heat Treated	ST	<50.8 >50.8	-	-	-	140-255 255 max
4	AMS-S-7720 / Mil-S-7720	316	Solution Heat Treated	ST	<50.8 >50.8	-	-	-	140-255 255 max

<table>
<tr><th colspan="9">Data Sheet for Rationalisation of Aviation Metallic Materials - Steel</th></tr>
<tr><td colspan="3">General Grade of Material</td><td>AISI 316</td><td>Type of Material</td><td>Stainless Steel</td><td colspan="2">Number of Specifications Identified</td><td>4</td></tr>
<tr><td colspan="3">Rationalisation for Use</td><td colspan="6">BAR</td></tr>
<tr><td colspan="3">Identified Specifications</td><td colspan="2">Rationalised to</td><td rowspan="2">Form</td><td rowspan="2">Number of Specifications Identified</td><td rowspan="2">Number of Specifications Rationalised</td><td rowspan="2">Remarks</td></tr>
<tr><td>Sl No</td><td>Specification</td><td>Grade</td><td colspan="2">Specification</td></tr>
<tr><td>1</td><td>AMS 5653</td><td>316L</td><td colspan="2" rowspan="4">AMS 5653</td><td rowspan="4">Bar</td><td rowspan="4">4</td><td rowspan="4">1</td><td rowspan="4">-</td></tr>
<tr><td>2</td><td>AMS 5648</td><td>316</td></tr>
<tr><td>3</td><td>AMS 5649</td><td>316</td></tr>
<tr><td>4</td><td>AMS-S-7720 / Mil-S-7720</td><td>316</td></tr>
</table>

Data Sheet for Rationalisation of Aviation Metallic Materials - Steel

General Grade of Material	AISI 316	Type of Material	Stainless Steel	Number of Specifications Identified	4
Rationalisation for Use	SHEET				

Sl No	Specification	Grade	Origin	Chemical composition (Wt%) (wherever limit not mentioned consider as max)												
				C	Mn	Si	S	P	Ni	Cr	Mo	V	Cu	Fe	Others: Each	Others: Total
1	AMS 5507	316L	AMERICAN	0.03	2	1	0.03	0.04	10.0-14	16-18	2.0-3.0	-	0.75	Rem	-	-
2	BS S 537	316L	BRITISH	0.03	0.5-2.0	0.2-1.0	0.025	0.035	11.0-14.0	16.5-18.5	2.25-3.0	-	-	Rem	-	-
3	MIL-S-5059 Type 316	316	AMERICAN	0.08	2	1	0.03	0.04	10.0-14.0	16.0-18.0	1.75 min	-	0.5	Rem	-	-
4	AMS 5524	316	AMERICAN	0.08	2	1	0.03	0.04	10.0-14.0	16-18	2.0-3.0	-	0.75	Rem	-	-

Sl No	Specification	Grade	Heat treatment	Condition	Mechanical properties (Minimum)				
					Size (mm)	UTS (MPa)	0.2% Proof (MPa)	% EL	Hardness (HBW/BHN)
1	AMS 5507	316L	Solution Heat Treated	CR & ST	<0.62 >0.62	689 max 689 max	-	40 45	-
2	BS S 537	316L	Annealed	A	<1.5 1.5-3.0 >3.0	500-700 500-700 500-700	190 190 190	30 35 40	170 HBW max
3	MIL-S-5059 Type 316	316	Strain Hardened	1/4H	<1.27 1.27-4.8	860 860	620 620	10 10	-
4	AMS 5524	316	Solution Heat Treated	CR & ST	<0.64 >0.64	517 517	207 207	40 45	95HRB max

Data Sheet for Rationalisation of Aviation Metallic Materials - Steel							
General Grade of Material			AISI 316	Type of Material	Stainless Steel	Number of Specifications Identified	4
Rationalisation for Use			SHEET				
Identified Specifications			Rationalised to	Form	Number of Specifications Identified	Number of Specifications Rationalised	Remarks
Sl No	Specification	Grade	Specification				
1	AMS 5507	316L	AMS 5507	SHEET	4	1	-
2	BS S 537	316L					
3	MIL-S-5059 Type 316	316					
4	AMS 5524	316					
Note : 316L can be used in all application where 316 called. However proper heat treatment and processing to be selected							

Data Sheet for Rationalisation of Aviation Metallic Materials - Steel

General Grade of Material	AISI 316	Type of Material	Stainless Steel	Number of Specifications Identified	3
Rationalisation for Use	TUBE				

Sl No	Specification	Grade	Origin	Chemical composition (Wt%) (wherever limit not mentioned consider as max)												
				C	Mn	Si	S	P	Ni	Cr	Mo	V	Cu	Fe	Others: Each	Others: Total
1	AMS 5584 Class 1	316L	AMERICAN	0.03	2	1	0.03	0.04	10.0-14.0	16.0-18.0	2.0-3.0	-	0.75	Rem	-	-
2	BS T 75	316L	BRITISH	0.03	0.5-2.0	0.2-1.0	0.025	0.35	11.0-14.0	16.5-18.5	2.25-3.0	-	-	Rem	-	-
3	AMS 5573	316	AMERICAN	0.08	1.25-2.0	1	0.03	0.04	10.0-14.0	16.0-18.0	2.0-3.0	-	0.75	Rem	-	-

Sl No	Specification	Grade	Heat treatment	Condition	Mechanical properties (Minimum)				
					Size (mm)	UTS (MPa)	0.2% Proof (MPa)	% EL	Hardness (HBW/BHN)
1	AMS 5584 Class 1	316L	Solution Heat Treated	ST	-	724-965	517-689	20 Tu	-
2	BS T 75	316L	Solution Heat Treated	ST	<0.7 >0.7	500-700 500-700	190 190	40 45	-
3	AMS 5573	316	Solution Heat Treated	ST	**<4.78 OD** WT<0.41 WT>0.41 **4.8-12.7 OD** WT<0.25 WT>0.25 **>12.7 OD** WT<0.25 WT>0.25	 793 (max) 689 (max) 758 (max) 689 (max) 689 (max) 689 (max)	-	 35 40 37 Tu 40 Tu 32 Tu 35 Tu	-

Data Sheet for Rationalisation of Aviation Metallic Materials - Steel								
General Grade of Material			AISI 316	Type of Material	Stainless Steel	Number of Specifications Identified		3
Rationalisation for Use			TUBE					
Identified Specifications			Rationalised to	Form	Number of Specifications Identified	Number of Specifications Rationalised	Remarks	
Sl No	Specification	Grade	Specification					
1	AMS 5584 Class 1	316L	AMS 5584 Class 1	TUBE	3	1	-	
2	BS T 75	316L						
3	AMS 5573	316						

Data Sheet for Rationalisation of Aviation Metallic Materials - Steel

General Grade of Material	AISI 1074	Type of Material	Spring Steel	Number of Specifications Identified	2
Rationalisation for Use	SHEET				

Sl No	Specification	Grade	Origin	Chemical composition (Wt%) (wherever limit not mentioned consider as max)												
				C	Mn	Si	S	P	Ni	Cr	Mo	V	Cu	Fe	Others: Each	Others: Total
1	BS S 513	-	BRITISH	0.7-0.9	0.35-0.9	0.1-0.35	0.04	0.04	-	-	-	-	-	Rem	-	-
2	AMS 5120	1074	AMERICAN	0.68-0.8	0.5-0.8	0.1-0.3	0.05	0.04	-	-	-	-	-	Rem	-	-

Sl No	Specification	Grade	Heat treatment	Condition	Mechanical properties (Minimum)				
					Size (mm)	UTS (MPa)	0.2% Proof (MPa)	% EL	Hardness (HBW/BHN)
1	BS S 513	-	Harden at 860 deg.C Temper suitably	HT	-	-	-	-	HV 400-500
2	AMS 5120	1074	-	CR & A	-	-	-	-	85 HRB (max)

Data Sheet for Rationalisation of Aviation Metallic Materials - Steel

General Grade of Material	AISI 1074	Type of Material	Spring Steel	Number of Specifications Identified	2
Rationalisation for Use	**SHEET**				

Sl No	Identified Specifications		Rationalised to	Form	Number of Specifications Identified	Number of Specifications Rationalised	Remarks
	Specification	Grade	Specification				
1	BS S 513	-	AMS 5120	SHEET	2	1	-
2	AMS 5120	1074					

Data Sheet for Rationalisation of Aviation Metallic Materials - Steel

General Grade of Material	AISI 1095	Type of Material	Spring Steel	Number of Specifications Identified	3
Rationalisation for Use	SHEET				

Sl No	Specification	Grade	Origin	Chemical composition (Wt%) (wherever limit not mentioned consider as max)												
				C	Mn	Si	S	P	Ni	Cr	Mo	V	Cu	Fe	Others: Each	Others: Total
1	MIL-S-7947	-	AMERICAN	0.9-1.03	0.3-0.5	-	0.05	0.04	-	-	-	-	-	Rem	-	-
2	AMS 5121	1095	AMERICAN	0.9-1.04	0.3-0.5	0.15-0.35	0.05	0.04	-	-	-	-	-	Rem	-	-
3	AMS 5122	1095	AMERICAN	0.9-1.04	0.3-0.5	0.15-0.35	0.05	0.04	-	-	-	-	-	Rem	-	-

Sl No	Specification	Grade	Heat treatment	Condition	Mechanical properties (Minimum)				
					Size (mm)	UTS (MPa)	0.2% Proof (MPa)	% EL	Hardness (HBW/BHN)
1	MIL-S-7947	-	-	CR & HT	-	-	-	-	47-52 HRC HV 443-512
2	AMS 5121	1095	-	CR & A	-	-	-	-	85 HRB (max)
3	AMS 5122	1095	-	CF & HT	-	-	-	-	47-52 HRC

Data Sheet for Rationalisation of Aviation Metallic Materials - Steel								
General Grade of Material			AISI 1095	Type of Material	Spring Steel	Number of Specifications Identified		3
Rationalisation for Use			SHEET					
Identified Specifications			Rationalised to	Form	Number of Specifications Identified	Number of Specifications Rationalised	Remarks	
Sl No	Specification	Grade	Specification					
1	MIL-S-7947	-	AMS 5122	SHEET	3	1	-	
2	AMS 5121	1095						
3	AMS 5122	1095						

Data Sheet for Rationalisation of Aviation Metallic Materials - Steel

General Grade of Material	AISI 304	Type of Material	Stainless Steel	Number of Specifications Identified	4
Rationalisation for Use	TUBE				

Sl No	Specification	Grade	Origin	Chemical composition (Wt%) (wherever limit not mentioned consider as max)												
				C	Mn	Si	S	P	Ni	Cr	Mo	V	Cu	Fe	Others: Each	Others: Total
1	MIL-T-6845 Type 1	304	AMERICAN	0.08	2.0	1.0	0.03	0.04	8-10.5	18-20	0.75	-	0.75	Rem	-	-
2	AMS-T-6845 Type 1	304	AMERICAN	0.08	2.0	1.0	0.03	0.04	8-10.5	18-20	0.75	-	0.75	Rem	-	-
3	AMS 5566 Type 1	304	AMERICAN	0.08	2.0	0.75	0.03	0.04	8.0-12	18-20	0.75	-	0.75	Rem	-	-
4	AMS 5564 Class 1	304	AMERICAN	0.08	2.0	1.0	0.03	0.04	8.0-12	18-20	0.75	-	0.75	Rem	-	-

Sl No	Specification	Grade	Heat treatment	Condition	Mechanical properties (Minimum)				
					Size (mm)	UTS (MPa)	0.2% Proof (MPa)	% EL	Hardness (HBW/BHN)
1	MIL-T-6845 Type 1	304	-	CD	Nominal OD 6.35, for all wall thickness	724-965	517-758	20	-
2	AMS-T-6845 Type 1	304	-	CD	Nominal OD 6.35, for all wall thickness	724-965	517-758	20	-
3	AMS 5566 Type 1	304	-	CD	**<3.0 OD**, all WT **3.0-4.75 OD** WT<0.4 WT>0.4 **>4.75 OD**, all WT	655-896 655-896 655-896 724-965	 414-621 414-621 515-760	- 20 25 20	-
4	AMS 5564 Class 1	304	-	CD	**<3.0 OD**, all WT **3.0-4.75 OD** WT<0.4 WT>0.4 **>4.75 OD**, all WT	655-896 655-896 655-896 724-965	 414-621 414-621 515-758	- 20 25 20	-

Data Sheet for Rationalisation of Aviation Metallic Materials - Steel

General Grade of Material			AISI 304	Type of Material	Stainless Steel	Number of Specifications Identified	4
Rationalisation for Use			TUBE				
Identified Specifications			Rationalised to	Form	Number of Specifications Identified	Number of Specifications Rationalised	Remarks
Sl No	Specification	Grade	Specification				
1	MIL-T-6845 Type 1	304	AMS 5564 Class 1	TUBE	4	1	-
2	AMS-T-6845 Type 1	304					
3	AMS 5566 Type 1	304					
4	AMS 5564 Class 1	304					

Data Sheet for Rationalisation of Aviation Metallic Materials - Steel

General Grade of Material	AISI 321	Type of Material	Stainless Steel	Number of Specifications Identified	5
Rationalisation for Use	BAR				

Sl No	Specification	Grade	Origin	Chemical composition (Wt%) (wherever limit not mentioned consider as max)												
				C	Mn	Si	S	P	Ni	Cr	Mo	Cu	N	Fe	Others: Each	Others: Total
1	AMS 5645	321	AMERICAN	0.08	2	1	0.03	0.04	8.0-12.0	17.0-19.0	0.75	0.75	0.1	Rem	Ti: 5(C+N)-0.7	-
2	BS S 129	321	BRITISH	0.08	0.5-2.0	0.2-1.0	0.025	0.035	8.0-11.0	17.0-19.0	-	-	-	Rem	Ti: 5(C)-0.8	-
3	MDN 321A	321	INDIAN	0.12	0.5-2.0	0.2-0.8	0.025	0.035	9.0-11.0	17.0-19.0	-	-	-	Rem	TI: 5x(C-0.02) - 0.8	-
4	WL 1.4544 (LN 668)	321	GERMAN	0.08	2	1	0.025	0.035	9.0 - 11.5	17.0-19.0	-	-	-	Rem	Ti 5x%C 0.6	-
5	Z10CNT18-11 (AIR 9160)	321	FRENCH	0.12	2	1	0.025	0.035	10.0 - 13.0	17.0-19.0	-	-	-	Rem	Ti 5x%C 0.8	-

Sl No	Specification	Grade	Heat treatment	Condition	Mechanical properties (Minimum)				
					Size (mm)	UTS (MPa)	0.2% Proof (MPa)	% EL	Hardness (HBW/BHN)
1	AMS 5645	321	Solution Heat Treated	ST	-	517	206.8	30	-
2	BS S 129	321	Annealed	Annealed	-	540	210	35	-
3	MDN 321A	321	Annealed	Annealed	-	539	196	40	-
4	WL 1.4544.9 (LN 668)	321	Anneal at 1020-1070 °C / WQ or AC	Annealed	5 - 26	500-750	205	40	130-190 Hv
5	Z10CNT18-11 A (AIR 9160)	321	Anneal at 1050-1100 °C / WQ or AC	Annealed	50	490-690	210	37	-

Data Sheet for Rationalisation of Aviation Metallic Materials - Steel

General Grade of Material	AISI 321	Type of Material	Stainless Steel	Number of Specifications Identified	5
Rationalisation for Use	BAR				

Identified Specifications			Rationalised to	Form	Number of Specifications Identified	Number of Specifications Rationalised	Remarks
SI No	Specification	Grade	Specification				
1	AMS 5645	321	AMS 5645 MDN 321 A	BAR	5	2	-
2	BS S 129	321					
3	MDN 321 A	321					
4	WL 1.4544.9 (LN 668)	321					
5	Z10CNT18-11 A (AIR 9160)	321					

Data Sheet for Rationalisation of Aviation Metallic Materials - Steel

General Grade of Material			AISI 321	Type of Material			Stainless Steel		Number of Specifications Identified					7		
Rationalisation for Use			SHEET													
Sl No	Specification	Grade	Origin	Chemical composition (Wt%) (wherever limit not mentioned consider as max)												
				C	Mn	Si	S	P	Ni	Cr	Mo	V	Cu	Fe	Others: Each	Others: Total
1	BS S 526	321	BRITISH	0.08	0.5-2.0	0.2-1.0	0.025	0.035	9.0-11.0	17.0-19.0	1.0	-	-	Rem	Ti 5(C) -0.7	-
2	MDN 321A	321	INDIAN	0.12	0.5-2.0	0.2-0.8	0.025	0.035	9.0-11.0	17.0-19.0	0.75	-	0.75	Rem	Ti 5(C-0.02) -0.8	-
3	AMS 5510	321	AMERICAN	0.08	2.0	0.4-1.0	0.03	0.04	9.0-12.0	17.0-19.0	0.75	-	0.75	Rem	Ti 5(C+N) -0.7	N 0.1
4	MIL-S-6721	321	AMERICAN	0.08	2.0	1.0	0.03	0.04	8.0-11.0	17.0-19.0	-	-	0.5	Rem	Ti 6(C) -0.75	-
5	BS S 524	321	BRITISH	0.08	0.5-2.0	0.2-1.0	0.025	0.035	9.0-11.0	17.0-19.0	-	-	-	Rem	Ti 5C -0.7	-
6	WL 1.4544 (LN 9450)	321	GERMAN	0.08	2	1	0.025	0.035	9 - 11.5	17.0 - 19.0	-	-	-	Rem	Ti 5x%C 0.6	-
7	Z6CNT18-10	321	FRENCH	0.08	2	1	0.03	0.04	9 -12	17.0 - 19.0	-	-	-	Rem	Ti 5x%C 0.7	-

Sl No	Specification	Grade	Heat treatment	Condition	Mechanical properties (Minimum)				
					Size (mm)	UTS (MPa)	0.2% Proof (MPa)	% EL	Hardness (HBW/BHN)
1	BS S 526	321	Annealed	A	<1.5 1.5-3.0 >3.0	540 540 540	210 210 210	30 35 40	179 max
2	MDN 321A	321	Annealed	A	-	530	206	40	-
3	AMS 5510	321	Solution Heat treated	CR & ST	0.05-0.08 0.08-0.1 >0.1	483-758 483-724 483-689	172 172 172	20 30 40	-
4	MIL-S-6721	321	Annealed	A	-	689	-	40	-
5	BS S 524	321	Cold Rolled & Tempered	CR & T	<1.5 1.5-3.0 >3.0	800-1100 800-1100 800-1100	640 640 640	11 13 15	-
6	WL 1.4544.9 (LN 9450)	321	Anneal at 1020-1070 °C / WQ or AC	A	0.4-6	500-750	205	40	-
7	Z6CNT18-10	321	Anneal at 1050-1100 °C / WQ or AC	A	≤ 3 3 - 6	500-700	220	40	-

Data Sheet for Rationalisation of Aviation Metallic Materials - Steel

General Grade of Material	AISI 321	Type of Material	Stainless Steel	Number of Specifications Identified	7
Rationalisation for Use	SHEET				

Sl No	Identified Specifications: Specification	Identified Specifications: Grade	Rationalised to: Specification	Form	Number of Specifications Identified	Number of Specifications Rationalised	Remarks
1	BS S5 26	321	BS S5 26 / MDN 321A	Sheet	7	2	-
2	MDN 321A	321					
3	AMS 5510	321					
4	MIL-S-6721	321					
5	BS S 524	321					
6	WL 1.4544.9 (LN 9450)	321					
7	Z10CNT18-10	321					

Data Sheet for Rationalisation of Aviation Metallic Materials - Steel

General Grade of Material			AISI 321	Type of Material			Stainless Steel		Number of Specifications Identified						6	
Rationalisation for Use			TUBE													
Sl No	Specification	Grade	Origin	Chemical composition (Wt%) (wherever limit not mentioned consider as max)												
				C	Mn	Si	S	P	Ni	Cr	Mo	Cu	N	Fe	Others: Each	Others: Total
1	AMS 5570	321	AMERICAN	0.08	2	0.25-1.0	0.03	0.04	9.0-13.0	17-19	0.75	0.75	0.1	Rem	Ti 5x(C+N)-0.7	-
2	MDN 321A	321	INDIAN	0.12	0.5-2.0	0.2-0.8	0.025	0.035	9.0-11.0	17-19	-	-	-	Rem	Ti 5x(C-0.02)-0.8	-
3	BS T69	321	BRITISH	0.08	0.5-2.0	0.2-1.0	0.025	0.035	9.0-12.0	17.0-19.0	-	-	-	Rem	Ti 5x(C)-0.7	-
4	AMS 5896 Type1	321	AMERICAN	0.08	2	1	0.03	0.04	9.0-12.0	17.0-20.0	0.75	0.75	0.1	Rem	Ti 5x(C+N)-0.75	-
5	Z10CNT18-11 AIR 9160	321	FRENCH	0.12	2	1	0.025	0.035	10.0-13.0	17.0-19.0	-	-	-	Rem	Ti 5x(C)-0.8	-
6	WL 1.4544.9 (LN 9398)	321	GERMAN	0.08	2	1	0.025	0.035	9.0--11.5	17.0-19.0	-	-	-	Rem	Ti 5x%C 0.6	-

Sl No	Specification	Grade	Heat treatment	Condition	Mechanical properties (Minimum)				
					Size (mm)	UTS (MPa)	0.2% Proof (MPa)	% EL	Hardness (HBW/BHN)
1	AMS 5570	321	Solution Heat Treated	ST	**<4.7 OD** WT<0.4 WT>0.4 **4.7-12.5 OD** WT<0.25 WT>0.25 **>12.5 OD** WT<0.25 WT>0.25	 827 (max) 724 (max) 793 (max) 724 (max) 827 (max) 724 (max)	-	Tu 33 35 35 35 30 35	-
2	MDN 321A	321	Cold Drawn	CD	>6 OD	724-965	517-758	20	-
3	BS T69	321	Temper at 550 degC max	CD&T	-	800-1100	700	-	-
4	AMS 5896 Type1	321	Solution Heat Treated & Cold Drawn	ST, CD & Passivated	-	724-965	517-758	20 Tu	-
5	Z10CNT18-11 AIR 9160	321	Anneal at 1050-1100 degC Quench in Water	A CW	-	490-690 800	220 700	40 10	-
6	WL 1.4544.9 (LN 9398)	321	Anneal at 1020-1070 °C / WQ or AC	A	5-50 DIA 0.5-6 THK	500-750	205	40	-

Data Sheet for Rationalisation of Aviation Metallic Materials - Steel

General Grade of Material			AISI 321	Type of Material	Stainless Steel	Number of Specifications Identified	6
Rationalisation for Use			TUBE				
Identified Specifications			Rationalised to	Form	Number of Specifications Identified	Number of Specifications Rationalised	Remarks
Sl No	Specification	Grade	Specification				
1	AMS 5570	321	AMS 5570 / Z10CNT18-11 (AIR 9160) / MDN 321A	TUBE	6	3	-
2	MDN 321A	321					
3	BS T69	321					
4	AMS 5896 Type1	321					
5	Z10CNT18-11 AIR 9160	321					
6	WL 1.4544.9 (LN 9398)	321					

Data Sheet for Rationalisation of Aviation Metallic Materials - Steel

General Grade of Material	AISI 347	Type of Material	Stainless Steel	Number of Specifications Identified	4
Rationalisation for Use	SHEET				

Sl No	Specification	Grade	Origin	Chemical composition (Wt%) (wherever limit not mentioned consider as max)												
				C	Mn	Si	S	P	Ni	Cr	Mo	V	Cu	Fe	Others: Each	Others: Total
1	BS S 527	347	BRITISH	0.08	0.5-2.0	0.2-1.0	0.025	0.035	9.0-11.0	17.0-19.0	1	-	-	Rem	Nb 10xC - 1.0	-
2	MDN 347A	347	INDIAN	0.08	0.5-2.0	0.2-1.0	0.025	0.035	9.0-11.0	17.0-19.0	1	-	0.5	Rem	Nb 10xC - 1.0 Al 0.05	-
3	AMS 5512	347	AMERICAN	0.08	2	1	0.03	0.04	9.0-12.0	17.0-19.0	0.75	-	0.75	Rem	Cb 10xC - 1.1	-
4	MIL-S-6721 Type 347 (Cb + Ta)	347	AMERICAN	0.08	2	1	0.03	0.04	9.0-13.0	17.0-19.0	-	-	0.5	Rem	Cb+Ta 10xC - 1.25	-

Sl No	Specification	Grade	Heat treatment	Condition	Mechanical properties (Minimum)				
					Size (mm)	UTS (MPa)	0.2% Proof (MPa)	% EL	Hardness (HBW/BHN)
1	BS S 527	347	Annealed	A	<1.5 1.5-3.0 >3.0	540 540 540	210 210 210	30 35 40	-
2	MDN 347A	347	Annealed	A	-	540	210	40	-
3	AMS 5512	347	Cold Rolled & Solution Heat Treated	CR+ST	0.051-0.076 0.076-0.102 >0.102	483-793 483-758 483-724	172 172 172	20 30 40	-
4	MIL-S-6721 (Cb + Ta)	347	Annealed	A	-	690 max	-	40	-

<table>
<tr><th colspan="10">Data Sheet for Rationalisation of Aviation Metallic Materials - Steel</th></tr>
<tr><td colspan="3">General Grade of Material</td><td>AISI 347</td><td>Type of Material</td><td>Stainless Steel</td><td colspan="2">Number of Specifications Identified</td><td colspan="2">4</td></tr>
<tr><td colspan="3">Rationalisation for Use</td><td colspan="7">SHEET</td></tr>
<tr><td colspan="3">Identified Specifications</td><td colspan="2">Rationalised to</td><td rowspan="2">Form</td><td rowspan="2">Number of Specifications Identified</td><td rowspan="2">Number of Specifications Rationalised</td><td rowspan="2" colspan="2">Remarks</td></tr>
<tr><td>Sl No</td><td>Specification</td><td>Grade</td><td colspan="2">Specification</td></tr>
<tr><td>1</td><td>BS S 527</td><td>347</td><td rowspan="4" colspan="2">BS S 527 /
AMS 5512 /
MDN 347A</td><td rowspan="4">SHEET</td><td rowspan="4">4</td><td rowspan="4">3</td><td rowspan="4" colspan="2">-</td></tr>
<tr><td>2</td><td>MDN 347A</td><td>347</td></tr>
<tr><td>3</td><td>AMS 5512</td><td>347</td></tr>
<tr><td>4</td><td>MIL-S-6721 (Cb + Ta)</td><td>347</td></tr>
</table>

Data Sheet for Rationalisation of Aviation Metallic Materials - Steel

General Grade of Material	AISI 347	Type of Material	Stainless Steel	Number of Specifications Identified	3
Rationalisation for Use	TUBE				

Sl No	Specification	Grade	Origin	Chemical composition (Wt%) (wherever limit not mentioned consider as max)												
				C	Mn	Si	S	P	Ni	Cr	Mo	Cu	Nb	Fe	Others: Each	Others: Total
1	BS 2T 68	347	BRITISH	0.08	0.5-2.0	0.2-1.0	0.025	0.035	9.0-12.0	17.0-19.0	-	-	10xC-1.0	Rem	-	-
2	BS T66	347	BRITISH	0.08	0.5-2.0	0.2-1.0	0.025	0.035	9.0-11.0	17.0-19.0	-	-	10xC-1.0	Rem	-	-
3	BS T72	347	BRITISH	0.08	0.5-2.0	0.2-1.0	0.025	0.035	9.0-12.0	17.0-19.0	-	0.5	10xC-1.0	Rem	-	-

Sl No	Specification	Grade	Heat treatment	Condition	Mechanical properties (Minimum)				
					Size (mm)	UTS (MPa)	0.2% Proof (MPa)	% EL	Hardness (HBW/BHN)
1	BS 2T 68	347	Cold Rolled & Tempered (Temper at 550 deg.C max)	CD&T	-	800-1100	700	-	229-375
2	BS T66	347	Annealed	A	-	550	210	-	-
3	BS T72	347	Solution Heat treated (Heat to 1000-1100 deg.C Cool suitably)	ST	<0.70 >0.70	550-700 550-700	210-340 210-340	40 45	-

Data Sheet for Rationalisation of Aviation Metallic Materials - Steel

General Grade of Material	AISI 347	Type of Material	Stainless Steel	Number of Specifications Identified	3
Rationalisation for Use	TUBE				

Identified Specifications			Rationalised to	Form	Number of Specifications Identified	Number of Specifications Rationalised	Remarks
Sl No	Specification	Grade	Specification				
1	BS 2T 68	347	BS 2T 68	TUBE	3	1	-
2	BS T66	347					
3	BS T72	347					

Data Sheet for Rationalisation of Aviation Metallic Materials - Steel

General Grade of Material			AISI 4130	Type of Material		Cr-Mo Steel		Number of Specifications Identified					10		
Rationalisation for Use			BAR												
Sl No	Specification	Grade	Origin	Chemical composition (Wt%) (wherever limit not mentioned consider as max)											
				C	Mn	Si	S	P	Ni	Cr	Mo	Cu	Fe	Others: Each	Other Total
1	MIL-S-6758 (obsolete. Superceded by AMS-S-6758)	4130	AMERICAN	0.28-0.33	0.4-0.6	0.2-0.35	0.025	0.025	0.25	0.8-1.1	0.15-0.25	-	Rem	-	-
2	AMS-S-6348	4130	AMERICAN	0.28-0.33	0.4-0.6	0.15-0.35	0.025	0.025	0.25	0.8-1.1	0.15-0.25	0.35	Rem	-	-
3	BS S142	-	BRITISH	0.22-0.29	0.5-0.8	0.15-0.35	0.015	0.02	0.3	0.9-1.2	0.15-0.25	-	Rem	-	-
4	AMS 6370	4130	AMERICAN	0.28-0.33	0.4-0.6	0.15-0.35	0.025	0.025	0.25	0.8-1.1	0.15-0.25	0.35	Rem	-	-
5	G-4543-71	30KHMA	RUSSIAN	0.26-0.33	0.4-0.7	0.17-0.37	0.025	0.025	0.3	0.8-1.1	-	0.3	Rem	-	-
6	MDN 6758A	4130	INDIAN	0.28-0.33	0.4-0.6	0.15-0.34	0.025	0.025	0.25	0.8-1.1	0.15-0.25	0.35	Rem	-	-
7	AIR 9160 25CD4S	4130	FRENCH	0.22-0.29	0.5-0.8	0.1-0.25	0.015	0.02	0.3	0.8-1.2	0.15-0.25	-	Rem	-	-
8	DIN 17200 1.7218	25CrMo4	GERMAN	0.22-0.29	0.5-0.8	0.15-0.4	0.035	0.035	-	0.9-1.2	0.15-0.3	-	Rem	-	-
9	QQ-S-684	4130	AMERICAN	0.25-0.35	0.4-0.6	-	0.05	0.04	-	0.8-1.1	0.15-0.25	-	Rem	-	-
10	WL 1.7214.4 (LN 1017, LN 668)	4130	GERMAN	0.22-0.29	0.50-0.80	0.15-0.35	0.015	0.02	0.3	0.9-1.2	0.15-0.25	-	Rem	-	-

Sl No	Specification	Grade	Heat treatment	Condition	Mechanical properties (Minimum)				
					Size (mm)	UTS (MPa)	0.2% P.S. (MPa)	% EL (5D)	Hardness (BHN)
1	MIL-S-6758 (obsolete. Superceded by AMS-S-6758)	4130	Harden at 845-885°.C Quench in Oil/Water Temper to achieve the properties	HT	-	861	689	17	-
2	AMS-S-6348	4130	Harden at 845-885°.C Quench in Oil/Water Temper to achieve the properties	HT	-	861	689	17	-
3	BS S142	-	HARDEN: 830-880° C, OIL QUENCH/ WATER QUENCH TEMPER : > 520° C, AIR COOL	H&T	-	900-1100	700	12	269-331
4	AMS 6370	4130	Harden at 845-885°.C Quench in Oil/Water Temper to achieve the properties Heat treatment and mechanical properties are from established data	HT	-	861	689	17	-
5	G-4543-71	30KHMA	HARDEN: 880° C, OIL QUENCH TEMPER : 540° C, OIL QUENCH / WATER QUENCH	H&T	-	837	736	12	-
6	MDN 6758A	4130	Harden at 845-885 deg.C Quench in Oil/Water Temper at 550 deg.C	HT	-	861	689	17	-
7	AIR 9160 25CD4S	4130	Harden at 830-880 deg.C Quench in Oil/Water Temper at a) 520 deg.C b) 550 deg.C c) 580 deg.C	HT	≤16 16-40 40-100 100-150	880-1080 880-1080 780-930 640-830	740 690 590 470	12 (a) 12 (a) 14 (b) 15 ©	-
8	DIN 17200 1.7218	25CrMo4	Harden at 850-880 deg.C Quench in Oil or Harden at 840-870 deg.C Quench in Water Temper at 540-680 deg.C	HT	≤16 16-40 40-100 100-140	885-1080 785-930 685-835 635-785	685 590 460 410	12 14 15 16	-
9	QQ-S-684	4130	Harden at 845-885 deg.C Quench in Oil Temper at 560 deg.C	HT	-	860	690	16	-
10	WL 1.7214.4 (LN 1017, LN 668)	4130	Harden 850-880 °C / AC Temper 620-680 °C / AC	0.4	5-250	650-850	480	15	197-255
			Harden 850-880 °C / AC Temper 520-580 °C / AC	0.5	5-40	900-1100	700	12	269-331
Fatigue Data in H&T condition (Extracted from Book: Aerospace Materials by Balram Gupta, Minimum values are taken for 25CD4S)									
Test Condition : R= -1, Wave form: Sine, Rotating beam benging, Temperature : Room Temperature, Specimen type : Unnotched									
Stress: 295 MPa, No of cycles : 10.2 X 106 (min)									

Data Sheet for Rationalisation of Aviation Metallic Materials - Steel

General Grade of Material			AISI 4130	Type of Material	Cr-Mo Steel	Number of Specifications Identified		10
Rationalisation for Use			BAR					
Identified Specifications			Rationalised to	Form		Number of Specifications Identified	Number of Specifications Rationalised	Remarks
Sl No	Specification	Grade	Specification					
1	MIL-S-6758 (obsolete. Superceded by AMS-S-6758)	4130	AMS 6370 / MDN 6758A / AMS-S-6348	BAR		10	3	-
2	AMS-S-6348	4130						
3	BS S142	-						
4	AMS 6370	4130						
5	G-4543-71	30KHMA						
6	MDN 6758A	4130						
7	AIR 9160 25CD4S	4130						
8	DIN 17200 1.7218	25CrMo4						
9	QQ-S-684	4130						
10	WL 1.7214.4 (LN 1017, LN 668)	4130						

Data Sheet for Rationalisation of Aviation Metallic Materials - Steel															
General Grade of Material			AISI 4130	Type of Material			Cr-Mo Steel	Number of Specifications Identified						7	
Rationalisation for Use			SHEET												
Sl No	Specification	Grade	Origin	Chemical composition (Wt%) (wherever limit not mentioned consider as max)											
				C	Mn	Si	S	P	Ni	Cr	Mo	Cu	Fe	Others: Each	Other Total
1	MIL-S-18729	4130 Sheet	AMERICAN	0.28-0.33	0.4-0.6	0.15-0.35	0.025	0.025	0.25	0.8-1.1	0.15-0.25	-	Rem	-	-
2	BS S 534	4130 Sheet	BRITISH	0.22-0.29	0.5-0.8	0.15-0.35	0.015	0.02	0.3	0.9-1.2	0.15-0.25	-	Rem	-	-
3	AIR 9160 25CD4S	4130 Sheet	FRENCH	0.22-0.29	0.4-0.8	0.1-0.25	0.015	0.02	0.3	0.8-1.2	0.15-0.3	-	Rem	-	-
4	DIN 17200 1.7218	25CrMo4 Sheet	GERMAN	0.22-0.29	0.5-0.8	0.15-0.4	0.035	0.035	-	0.9-1.2	0.15-0.3	-	Rem	-	-
5	BS S 535	4130Sheet	BRITISH	0.22-0.29	0.5-0.8	0.15-0.35	0.015	0.02	0.3	0.9-1.2	0.15-0.25	-	Rem	-	-
6	AMS 6345	4130 Sheet	AMERICAN	0.28-0.33	0.4-0.6	0.15-0.35	0.025	0.025	0.25	0.8-1.1	0.15-0.25	0.35	Rem	-	-
7	WL 1.7214 (LN 9451)	4130 Sheet	GERMAN	0.22-0.29	0.50-0.80	0.15-0.35	0.015	0.02	0.3	0.9-1.2	0.15-0.25	-	Rem	-	-

Sl No	Specification	Grade	Heat treatment	Condition	Mechanical properties (Minimum)				Hardness (BHN)
					Size (mm)	UTS (MPa)	0.2% P.S. (MPa)	% EL (5D)	
1	AMS 6345	4130	Harden at 871˚C ±6 Quench in oil Temper at not less than 482 to not less than 30 min	N	<1.575 1.575-3.175 3.175-4.75 4.75-6.325 6.325-19.025 19.025-38.1	655 655 655 621 621 621	517 517 517 483 483 483	8 10 12 15 16 18	-
2	MIL-S-18729	4130	-	A	≤ 6.32	750	-	-	-
3	BS S 534	4130	Harden at 870˚C Quench in oil Temper at 520˚C	HT'	<1.5 1.5-3.0 >3.0	880-1080 880-1080 880-1080	690 690 690	8 9 10	255-321 HB
4	AIR 9160 25CD4S	4130	Normalize at 860-880˚C	N	0.5-12.0 >12.0	670-870 670-870	490 470	13 13	197-258 HB
			Harden 830-880 °C + OQ Temper 520-580 °C + AC	HT	0.5-6	880-1080	690	10	264-321
5	DIN 17200 1.7218	25CrMo4	Harden at 860˚C Quench in oil Temper at 540-680˚C	HT	-	880-1080	690	12	-
6	BS S 535	4130	Harden at 870˚C Quench in oil Temper at 350˚C	HT	<1.5 1.5-3.0 >3.0	1150-1300 1150-1300 1150-1300	1000 1000 1000	4 5 6	341-388 HB
7	WL 1.7214.3 (LN 9451)	-	Anneal at 700 °C / FC	A	0.5-6	590	-		-
			Harden 850-880 °C / AC Temper 620-680 °C / AC	HT	0.5-6	670-870	500	6--13	-
			Harden 850-880 °C / AC Temper 520-580 °C / AC	HT	0.5-6	900-1100	700	6--10	-
Stress: 295 MPa, No of cycles : 10.2 X 106 (min)									

Data Sheet for Rationalisation of Aviation Metallic Materials - Steel

General Grade of Material	AISI 4130	Type of Material	Cr-Mo Steel	Number of Specifications Identified	7
Rationalisation for Use	SHEET				

Identified Specifications			Rationalised to	Form	Number of Specifications Identified	Number of Specifications Rationalised	Remarks
Sl No	Specification	Grade	Specification				
1	AMS 6345	4130	AMS 6345 / BS S 534	SHEET	7	2	-
2	MIL-S-18729	4130					
3	BS S 534	4130					
4	AIR 9160 25CD4S	4130					
5	DIN 17200 1.7218	25CrMo4					
6	BS S 535	4130					
7	WL 1.7214.5 (LN 9451)	4130					

Data Sheet for Rationalisation of Aviation Metallic Materials - Steel

General Grade of Material			AISI 4130	Type of Material			Cr-Mo Steel	Number of Specifications Identified						8	
Rationalisation for Use			TUBE												
Sl No	Specification	Grade	Origin	Chemical composition (Wt%) (wherever limit not mentioned consider as max)											
				C	Mn	Si	S	P	Ni	Cr	Mo	Cu	Fe	Others: Each	Other Total
1	AMS-T-6736	4130	AMERICAN	0.27-0.33	0.4-0.6	0.2-0.35	0.025	0.025	-	0.8-1.1	0.15-0.25	-	Rem	-	-
2	MIL-T-6736	4130	AMERICAN	0.27-0.33	0.4-0.6	0.2-0.35	0.025	0.025	-	0.8-1.1	0.15-0.25	-	Rem	-	-
3	AMS 6361	4130	AMERICAN	0.27-0.33	0.4-0.6	0.2-0.35	0.025	0.025	0.25	0.8-1.1	0.15-0.25	0.35	Rem	-	-
4	AMS 6362	4130	AMERICAN	0.27-0.33	0.4-0.6	0.2-0.35	0.025	0.025	0.25	0.8-1.1	0.15-0.25	0.35	Rem	-	-
5	BS T65	4130	BRITISH	0.22-0.29	0.5-0.8	0.15-0.35	0.015	0.02	0.3	0.9-1.2	0.15-0.25	-	Rem	-	-
6	BS T60	4130	BRITISH	0.22-0.29	0.5-0.8	0.15-0.35	0.015	0.02	0.3	0.9-1.2	0.15-0.25	-	Rem	-	-
7	BS T76	4130	BRITISH	0.22-0.29	0.5-0.8	0.15-0.35	0.015	0.02	0.3	0.9-1.2	0.15-0.25	-	Rem	-	-
8	BS T77	4130	BRITISH	0.22-0.29	0.5-0.8	0.15-0.35	0.015	0.02	0.3	0.9-1.2	0.15-0.25	-	Rem	-	-

Sl No	Specification	Grade	Heat treatment	Condition	Mechanical properties (Minimum)			
					UTS (MPa)	0.2% P.S. (MPa)	% EL (5D)	Hardness (BHN)
1	AMS-T-6736	4130	Harden at 840-885 deg.C Quench in Oil/Water Temper at 565 deg.C Temper at 495 deg.C Temper at 455 deg.C	HT125 HT150 HT180	861 1033 1240	689 930 1135	12 10 8	-
2	MIL-T-6736	4130	Harden at 840-885 deg.C Quench in Oil/Water Temper at 565 deg.C Temper at 495 deg.C Temper at 455 deg.C	HT125 HT150 HT180	861 1033 1240	689 930 1135	12 10 8	-
3	AMS 6361	4130	Harden at 840-885 deg.C Quench in Oil/Water Temper at 565 deg.C	HT125	861	689	12	-
4	AMS 6362	4130	Harden at 840-885 deg.C Quench in Oil/Water Temper at 455 deg.C	HT150	1033	930	10	-
5	BS T65	4130	Harden at 870-910 deg.C Quench in Oil Temper at 520 deg.C	HT	880-1080	700	-	-
6	BS T60	4130	Harden at 870-910 deg.C Quench in Oil Temper at 520 deg.C	HT	1150-1350	1050	6	-
7	BS T76	4130	Harden at 870-910 deg.C Quench in Oil/water Temper at 675 deg.C	HT	770-970	700	-	-
8	BS T77	4130	Harden at 870-910 deg.C Quench in Oil/water Temper at 520 deg.C	HT	900-1100	700	10	-
Fatigue Data in H&T condition (Extracted from Book: Aerospace Materials by Balram Gupta, Minimum values are taken for 25CD4S)								
Test Condition : R= -1, Wave form: Sine, Rotating beam benging, Temperature : Room Temperature, Specimen type : Unnotched								
Stress: 295 MPa, No of cycles : 10.2 X 106 (min)								

Data Sheet for Rationalisation of Aviation Metallic Materials - Steel

General Grade of Material			AISI 4130	Type of Material	Cr-Mo Steel	Number of Specifications Identified	8
Rationalisation for Use			TUBE				
Identified Specifications			Rationalised to	Form	Number of Specifications Identified	Number of Specifications Rationalised	Remarks
Sl No	Specification	Grade	Specification				
1	AMS-T-6736	4130	AMS 6361 / AMS 6362	TUBE	8	2	-
2	MIL-T-6736						
3	AMS 6361						
4	AMS 6362						
5	BS T65						
6	BS T60						
7	BS T76						
8	BS T77						

Data Sheet for Rationalisation of Aviation Metallic Materials - Steel

General Grade of Material	15-5 PH	Type of Material	PH Steel	Number of Specifications Identified	2
Rationalisation for Use	BAR				

SI No	Specification	Grade	Origin	Chemical composition (Wt%) (wherever limit not mentioned consider as max)												
				C	Mn	Si	S	P	Ni	Cr	Mo	V	Cu	Fe	Others: Each	Others: Total
1	AMS 5659	15-5PH	AMERICAN	0.07	1.0	1.0	0.015	0.03	3.5-5.5	14.0-15.5	0.5	-	2.5-4.5	Rem	Cb 5xC - 0.45	-
2	MDN 15-5PH	15-5PH	INDIAN	0.07	1.0	1.0	0.015	0.03	3.5-5.0	14.0-15.5	0.5	-	2.5-4.5	Rem	Cb 5xC - 0.45 Ta 0.05	-

SI No	Specification	Grade	Heat treatment	Condition	Mechanical properties (Minimum)				
					Size (mm)	UTS (MPa)	0.2% Proof (MPa)	% EL	Hardness (HBW/BHN)
1	AMS 5659	15-5PH	Solution Treat at 1040±15 deg.C for 30-60mts, Cool below 30deg.C PPT 1) 480±5 deg.C for 1hr 2) 495±5 deg.C for 4hr 3)552±5 deg.C for 4hr 4)578±5 deg.C for 4hr 5)593±5 deg.C for 4hr 6)621±5 deg.C for 4hr	H900 H925 H1025 H1075 H1100 H1150	Marerial Type	1310 1172 1069 1000 965 931	1172 1069 1000 862 793 724	10 10 12 13 14 16	-
2	MDN 15-5PH	15-5PH	Solution Treat at 1040±15 deg.C for 30-60mts, Cool below 30deg.C PPT 1) 550±5 deg.C for 4hr 2) 620±5 deg.C for 4hr	H1025 H1150	-	1069 931	1000 724	12 16	-

Data Sheet for Rationalisation of Aviation Metallic Materials - Steel								
General Grade of Material			15-5 PH	Type of Material	PH Steel	Number of Specifications Identified		2
Rationalisation for Use			BAR					
Identified Specifications			Rationalised to	Form	Number of Specifications Identified	Number of Specifications Rationalised		Remarks
SI No	Specification	Grade	Specification					
1	AMS 5659	15-5PH	AMS 5659	BAR	2	1		-
2	MDN 15-5PH	15-5PH						

Data Sheet for Rationalisation of Aviation Metallic Materials - Steel

General Grade of Material	17-4 PH	Type of Material	PH Steel	Number of Specifications Identified	3
Rationalisation for Use	BAR				

Sl No	Specification	Grade	Origin	Chemical composition (Wt%) (wherever limit not mentioned consider as max)												
				C	Mn	Si	S	P	Ni	Cr	Mo	V	Cu	Fe	Others: Each	Others: Total
1	AMS 5643	17-4 PH	AMERICAN	0.07	1	1	0.03	0.04	3.0-5.0	15.0-17.5	0.5	-	3.0-5.0	Rem	Cb 5xC-0.45	-
2	AMS 5622	17-4 PH	AMERICAN	0.07	1	1	0.015	0.025	3.0-5.0	15.0-17.5	0.5	-	3.0-5.0	Rem	Cb 5xC-0.45	-
3	MDN 174A PH	17-4 PH	INDIAN	0.07	1	1	0.025	0.025	3.0-5.0	15.0-17.0	0.5	-	3.0-5.0	Rem	Cb+Ta 5xC-0.45	-

Sl No	Specification	Grade	Heat treatment	Condition	Mechanical properties (Minimum)				
					Size (mm)	UTS (MPa)	0.2% Proof (MPa)	% EL	Hardness (HBW/BHN)
1	AMS 5643	17-4 PH	Solution Treat at 1040±15 deg.C for 30-60mts, Cool below 30deg.C PPT 1) 480±5 deg.C for 1hr 2) 495±5 deg.C for 4hr 3)552±5 deg.C for 4hr 4)578±5 deg.C for 4hr 5)593±5 deg.C for 4hr 6)621±5 deg.C for 4hr	H900 H925 H1025 H1075 H1100 H1150	-	1310 1172 1069 1000 965 931	1172 1069 1000 862 793 724	10 10 12 13 14 16	-
2	AMS 5622	17-4 PH	Solution Treat at 1040±15 deg.C for 30-60mts, Cool below 30deg.C PPT 1) 480±5 deg.C for 1hr 2) 495±5 deg.C for 4hr 3)552±5 deg.C for 4hr 4)578±5 deg.C for 4hr 5)593±5 deg.C for 4hr 6)621±5 deg.C for 4hr	H900 H925 H1025 H1075 H1100 H1150	-	1310 1170 1069 1000 966 931	1172 1069 1000 862 793 724	10 10 12 13 14 16	-
3	MDN 174A PH	17-4 PH	Solution Treat at 1040±15 deg.C for 30-60mts, Cool below 30deg.C PPT 1) 550±5 deg.C for 4hr 2) 620±5 deg.C for 4hr	H1025 H1150	-	1069 931	1000 724	12 16	-

Data Sheet for Rationalisation of Aviation Metallic Materials - Steel							
General Grade of Material			17-4 PH	Type of Material	PH Steel	Number of Specifications Identified	3
Rationalisation for Use			BAR				
Identified Specifications			Rationalised to	Form	Number of Specifications Identified	Number of Specifications Rationalised	Remarks
Sl No	Specification	Grade	Specification				
1	AMS 5643	17-4 PH	AMS 5622 \ MDN 174A PH	BAR	3	2	-
2	AMS 5622	17-4 PH					
3	MDN 174A PH	17-4 PH					

Data Sheet for Rationalisation of Aviation Metallic Materials - Steel

General Grade of Material	MSRR 6596	Type of Material	Ni-Cr-Mo Steel	Number of Specifications Identified	3
Rationalisation for Use	BAR				

Sl No	Specification	Grade	Origin	Chemical composition (Wt%) (wherever limit not mentioned consider as max)												
				C	Mn	Si	S	P	Ni	Cr	Mo	V	N	Nb	Others Each	Fe
1	MSRR 6596 (Made from 6919)	-	BRITISH	0.08-0.16	0.3-1.2	0.15-0.6	0.025	0.03	0.6-1.2	9.8-11.2	0.4-0.8	0.1-0.25	0.03-0.075	0.15-0.45	Co 0.85	Rem
2	BS S 150	-	BRITISH	0.08-0.16	0.3-1.2	0.15-0.6	0.025	0.03	0.6-1.2	9.8-11.2	0.4-0.8	0.1-0.25	0.03-0.075	0.15-0.45	-	Rem
3	TU14-1-1161-75	15KH12N2MB-FAB-SH AP 517	RUSSIAN	0.13-0.18	0.5	0.5	0.015	0.03	1.7-2.1	11.0-12.5	1.35-1.65	0.16-0.32	0.02-0.08	0.2-0.35	W 0.65-1.05	Rem

Sl No	Specification	Grade	Heat treatment	Condition	UTS (MPa)	0.2% P.S. (MPa)	% EL (5D)	Hardness (BHN)
1	MSRR 6596 (Made from 6919)	-	HARDEN: 1150 °C, AIR COOL / OIL QUENCH TEMPER : 650 -720°C , AIR COOL	H & T	930-1080	800	10	286-321
2	BS S 150	-	HARDEN: 1150 °C, AIR COOL / OIL QUENCH TEMPER : 650 -700°C , AIR COOL	H & T	930-1080	780	10	285-331
3	TU14-1-1161-75	15KH12N2MB-FAB-SH AP 517	HARDEN: 1120 °C, OIL QUENCH TEMPER : 670 -720°C , AIR COOL	H & T	1030	934	-	-

Endurance Limit : 50% of UTS

Ref: Mechanical Properties of Engineering Materials by Wole Soboyeio and Machine Design Data by ADEKO

Data Sheet for Rationalisation of Aviation Metallic Materials - Steel								
General Grade of Material			MSRR 6596	Type of Material	Ni-Cr-Mo Steel	Number of Specifications Identified		3
Rationalisation for Use			BAR					
Identified Specifications			Rationalised to	Form	Number of Specifications Identified	Number of Specifications Rationalised	Remarks	
Sl No	Specification	Grade	Specification					
1	MSRR 6596 (Made from 6919)	-	MSRR 6596	BAR	3	1	-	
2	BS S 150	-						
3	TU14-1-1161-75	15KH12N2MB-FAB-SH AP 517						

Data Sheet for Rationalisation of Aviation Metallic Materials - Steel

General Grade of Material	52100	Type of Material	High Carbon - Cr Steel	Number of Specifications Identified	4
Rationalisation for Use	BAR				

Sl No	Specification	Grade	Origin	Chemical composition (Wt%) (wherever limit not mentioned consider as max)												
				C	Mn	Si	S	P	Ni	Cr	Mo	V	Cu	Fe	Others: Each	Others: Total
1	BS 2S 136	52100	BRITISH	0.9-1.1	0.25-0.55	0.15-0.40	0.01	0.015	0.4	1.3-1.6	0.1	0.3	0.25	Rem	-	-
2	AMS 6440 (SAE 52100)	52100	AMERICAN	0.93-1.05	0.25-0.45	0.15-0.35	0.015	0.025	0.25	1.35-1.6	0.1	0.3	0.3	Rem	Al 0.05	O - 0.0015
3	BS S 135	52100	BRITISH	0.9-1.1	0.25-0.55	0.15-0.40	0.025	0.03	0.4	1.3-1.6	0.1	0.3	0.25	Rem	-	-
4	AIR 9160 100C6	100C6	FRENCH	0.95-1.1	0.2-0.4	0.15-0.35	0.02	0.03	0.4	1.35-1.6	0.1	0.3	-	Rem	-	-

Sl No	Specification	Grade	Heat treatment	Condition	Mechanical properties (Minimum)				
					Size (mm)	UTS (MPa)	0.2% Proof (MPa)	% EL	Hardness (HBW/BHN)
1	BS 2S 136	52100	Harden at 820-860 deg.C Quench in oil. Temper at 160-170 deg.C for 1hr Cool in air	HT	-	-	-	-	HV 770 or HRC 62
2	AMS 6440 (SAE 52100)	52100	--	HT	-	-	-	-	≥ HRC 63
3	BS S 135	52100	Harden at 820-860 deg.C Quench in oil. Temper at 160-170 deg.C for 1hr Cool in air	HT	-	-	-	-	HV 770 or HRC 62
4	AIR 9160 100C6	100C6	Harden at 825-850 deg.C Quench in oil. Temper at 150-190 deg.C for 1hr Cool in air	HT	-	-	-	-	HRC 61

Data Sheet for Rationalisation of Aviation Metallic Materials - Steel							
General Grade of Material		52100	Type of Material	High Carbon - Cr Steel	Number of Specifications Identified		4
Rationalisation for Use		BAR					
Identified Specifications			Rationalised to	Form	Number of Specifications Identified	Number of Specifications Rationalised	Remarks
Sl No	Specification	Grade	Specification				
1	BS 2S 136	52100	AMS 6440 / BS 2S 136	BAR	4	2	-
2	AMS 6440 (SAE 52100)	52100					
3	BS S 135	52100					
4	AIR 9160 100C6	100C6					

Data Sheet for Rationalisation of Aviation Metallic Materials - Steel

General Grade of Material	Z12CNDV12	Type of Material	Ni-Cr-Mo Steel	Number of Specifications Identified	9
Rationalisation for Use	BAR				

Sl No	Specification	Grade	Origin	Chemical composition (Wt%) (wherever limit not mentioned consider as max)												
				C	Mn	Si	S	P	Ni	Cr	Mo	Cu	V	N	Others Each	Fe
1	AIR 9160	Z12CNDV12	FRENCH	0.08-0.12	0.5-0.9	0.35	0.025	0.035	2.0-3.0	11.0-12.5	1.5-2.0	-	0.25-0.4	0.02-0.04	-	Rem
2	MSRR 6503 (Made from MSRR 6916)	-	BRITISH	0.08-0.13	0.5-0.9	0.35	0.025	0.03	2.0-3.0	11.0-12.5	1.5-2.0	-	-	-	0.35	Rem
3	RRMS 32007/1 (Made from RRMS 32007)	-	BRITISH	0.08-0.13	0.5-0.9	0.35	0.025	0.03	2.0-3.0	11.0-12.5	1.5-2.0	-	-	-	0.35	Rem
4	CCT-00115	Z12CNDV12	FRENCH	0.08-0.13	0.5-0.9	0.35	0.025	0.03	2.0-3.0	11.0-12.5	1.5-2.0	0.5	0.25-0.4	0.02-0.04	-	Rem
5	BS S151	-	BRITISH	0.08-0.13	0.5-0.9	0.35	0.025	0.03	2.0-3.0	11.0-12.5	1.5-2.0	-	0.25-0.4	0.02-0.04	-	Rem
6	AMS 5719	-	AMERICAN	0.08-0.15	0.5-0.9	0.35	0.025	0.025	2.0-3.0	11.0-12.5	1.5-2.0	0.5	0.25-0.4	0.01-0.05	-	Rem
7	MSRR 6509	-	BRITISH	0.08-0.13	0.5-0.9	0.35	0.025	0.025	2.0-3.0	11.0-12.5	1.5-2.0	0.35	-	-	-	Rem
8	CCT-00321	EZ12CNDV12	FRENCH	0.08-0.13	0.5-0.9	0.35	0.025	0.025	2.0-3.0	11.0-12.5	1.5-2.0	0.5	0.25-0.4	0.02-0.04	-	Rem
9	MSRR 6510	-	BRITISH	0.08-0.13	0.5-0.9	0.35	0.025	0.025	2.0-3.0	11.0-12.5	1.5-2.0	-	0.25-0.4	0.015-0.04	-	Rem

Sl No	Specification	Grade	Heat treatment	Condition	Mechanical properties (Minimum)				
					UTS (MPa)	0.2% P.S. (MPa)	% EL (5D)	Impact (J)	Hardness (BHN)
1	AIR 9160	Z12CNDV12	HARDEN: 1050 °C, OIL QUENCH TEMPER: >640°C, AIRCOOL	H&T	930-1130	780	6	60	286
2	MSRR 6503 (Made from MSRR 6916)	-	HARDEN AT 1050°C, AIR COOL / OIL QUENCH TEMPER-1: 650°C, AIR COOL TEMPER-2 : 630°C, AIR COOL	H&T	930-1130	760	14	60	286-331
3	RRMS 32007/1 (Made from RRMS 32007)	-	HARDEN AT 1050°C, AIR COOL / OIL QUENCH TEMPER-1: 650°C, AIR COOL TEMPER-2 : 630°C, AIR COOL	H&T	930-1130	760	14	60	286-331
4	CCT-00115	Z12CNDV12	HARDEN: 1020-1050 °C, AIRCOOL/ OIL QUENCH TEMPER: 650°C, AIRCOOL	H&T	930-1130	760	14	50	-
5	BS S151	-	HARDEN: 1050 °C, AIRCOOL TEMPER: 650°C, AIRCOOL	H&T	930-1130	760	14	61 45 (ft lbf)	286-331
6	AMS 5719	-	HARDEN AT 1050DEG C, QUENCH IN OIL TEMPER-1 AT 560 TO 580DEG C, AIR COOL TEMPER-2 AT 540-560DEG C, AIR COOL	H&T	1070	895	12	-	341 to 375
7	MSRR 6509	-	HARDEN: 1050 °C, AIRCOOL/ OIL QUENCH TEMPER: 560-590°C, AIRCOOL	H&T	1080-1310	900	9	40	321-388
8	CCT-00321	EZ12CNDV12	HARDEN: 1020-1050 °C, AIRCOOL/ OIL QUENCH TEMPER 1: 560°C, AIRCOOL TEMPER 2: 560°C, AIRCOOL	H&T	1080-1240	900	8	-	320-365
9	MSRR 6510	-	HARDEN: 1050 °C, AIRCOOL/ OIL QUENCH TEMPER: 300-370°C, AIRCOOL	H&T	1206-1470	950	9	40	374-429
Endurance Limit : 50% of UTS Ref: Mechanical Properties of Engineering Materials by Wole Soboyeio and Machine Design Data by ADEKO									

Data Sheet for Rationalisation of Aviation Metallic Materials - Steel

General Grade of Material	Z12CNDV12	Type of Material	Ni-Cr-Mo Steel	Number of Specifications Identified	9
Rationalisation for Use	BAR				

Identified Specifications			Rationalised to	Form	Number of Specifications Identified	Number of Specifications Rationalised	Remarks
Sl No	Specification	Grade	Specification				
1	AIR 9160	Z12CNDV12	AMS 5719 / AIR 9160	BAR	9	2	-
2	MSRR 6503 (Made from MSRR 6916)	-					
3	RRMS 32007/1 (Made from RRMS 32007)	-					
4	CCT-00115	Z12CNDV12					
5	BS S151	-					
6	AMS 5719	-					
7	MSRR 6509	-					
8	CCT-00321	EZ12CNDV12					
9	MSRR 6510	-					

Data Sheet for Rationalisation of Aviation Metallic Materials - Steel

General Grade of Material	12NC12	Type of Material	3% Ni Case carburising steel	Number of Specifications Identified	3
Rationalisation for Use	BAR				

Sl No	Specification	Grade	Origin	Chemical composition (Wt%) (wherever limit not mentioned consider as max)									
				C	Mn	Si	S	P	Ni	Cr	Fe	Other min:	Other max:
1	MSRR 6004	-	BRITISH	0.1-0.15	0.35-0.6	0.1-0.35	0.02	0.025	2.75-3.25	0.9	Rem	-	-
2	BS S15	-	BRITISH	0.1-0.15	0.35-0.6	0.1-0.35	0.02	0.025	2.75-3.25	0.3	Rem	-	-
3	AIR 9160	12NC12	FRENCH	0.1-0.16	0.35-0.65	0.1-0.4	0.02	0.025	2.75-3.25	0.6-0.9	Rem	-	-

Sl No	Specification	Grade	Heat treatment	Condition	Mechanical properties (Minimum)				
					UTS (MPa)	0.2% Proof (MPa)	% EL (5D)	Impact (J)	Hardness (BHN)
1	MSRR 6004	-	HARDEN: 760-780° C, OIL QUENCH TEMPER 2 : 120-140° C, AIR COOL	H & T	770- 1235	400	12	47.5 35 (ft lbf)	225-365
2	BS S15	-	HARDEN: 760-780 ° C, WATER QUENCH TEMPER 2 : 120-140° C, AIR COOL	H & T	775	-	12	65 47.5 (ft lbf)	-
3	AIR 9160	12NC12	HARDEN: 810-830° C, OIL QUENCH TEMPER 2 : 140-190° C, AIR COOL	H & T	830	630	11	35 7 daJ/cm2	-

Fatigue Data in H&T condition
(Extracted from Book: Aerospace Materials by Balram Gupta, Minimum values are taken for 12NC12)

Test Condition : R= -1, Wave form: Sine, Rotating beam benging, Temperature : Room Temperature, Specimen type : Unnotched

Stress: 432 MPa, No of cycles : 10 X 10^6 (min)

Data Sheet for Rationalisation of Aviation Metallic Materials - Steel

General Grade of Material			12NC12	Type of Material	3% Ni Case carburising steel	Number of Specifications Identified		3
Rationalisation for Use			BAR					
Identified Specifications			Rationalised to	Form		Number of Specifications Identified	Number of Specifications Rationalised	Remarks
Sl No	Specification	Grade	Specification					
1	MSRR 6004	-	BS S15	BAR		3	1	-
2	BS S15	-						
3	AIR 9160	12NC12						

Data Sheet for Rationalisation of Aviation Metallic Materials - Steel														
General Grade of Material			SAE 4340	Type of Material			Ni-Cr-Mo Steel		Number of Specifications Identified					6
Rationalisation for Use			BAR											
Sl No	Specification	Grade	Origin	Chemical composition (Wt%) (wherever limit not mentioned consider as max)										
				C	Mn	Si	S	P	Ni	Cr	Mo	Cu	Al	Fe
1	AMS 6414	SAE 4340	AMERICAN	0.38-0.43	0.6-0.9	0.15-0.35	0.01	0.01	1.65-2.0	0.7-0.9	0.2-0.3	0.35	-	Rem
2	MIL S 5000	E4340	AMERICAN	0.38-0.43	0.65-0.85	0.15-0.35	0.025	0.025	1.65-2.0	0.7-0.9	0.2-0.3	0.35	-	Rem
3	AMS 6415	SAE 4340	AMERICAN	0.38-0.43	0.6-0.9	0.15-0.35	0.01	0.01	1.65-2.0	0.7-0.9	0.2-0.3	0.35	-	Rem
4	BS 5S 99	4340	BRITISH	0.36-0.44	0.45-0.7	0.1-0.35	0.015	0.025	2.3-2.8	0.5-0.8	0.45-0.65	-	0.015-0.05	Rem
5	MDN 99A	4340	INDIAN	0.36-0.44	0.45-0.7	0.1-0.35	0.015	0.025	2.3-2.8	0.5-0.8	0.45-0.65	-	0.015-0.05	Rem
6	BS S 98	4340	BRITISH	0.36-0.44	0.45-0.7	0.1-0.35	0.02	0.025	2.3-2.8	0.5-0.8	0.45-0.65	-	0.015-0.05	Rem

Sl No	Specification	Grade	Heat treatment	Condition	Mechanical properties (Minimum)			
					UTS (MPa)	0.2% P.S. (MPa)	% EL (5D)	Hardness (BHN)
1	AMS 6414	SAE 4340	NORMALISE:899° C., AIR COOL. HARDEN : 816° C, OIL QUENCH TEMPER 1: 246° C,AIR COOL TEMPER 2: 246° C, AIR COOL	H&T	1793	1496	10	-
2	MIL S 5000	E4340	HARDEN: 795 -840° C, OIL QUENCH TEMPER ACCORDING TO ACHIEVE VALUES	H&T	1034	896	14	-
3	AMS 6415	SAE 4340	NORMALISE:899° C., AIR COOL. HARDEN : 816° C, OIL QUENCH TEMPER 1: 246° C,AIR COOL TEMPER 2: 246° C, AIR COOL Heat treatment and mechanical properties are from established data	H&T	1793	1496	10	-
4	BS 5S 99	4340	Harden at 820-850 deg.C Quench in Oil/Water Temper at 500-600 deg.C	H&T	1230-1420	1080	10	-
5	MDN 99A	4340	Harden at 820-850 deg.C Quench in Oil/Water Temper at 500-600 deg.C	H&T	1230-1420	1080	10	-
6	BS S 98	4340	Harden at 820-850 deg.C Quench in Oil/Water Temper at 500-660 deg.C	H&T	1157-1314	1000	10	-

Fatigue Data in H&T condition
(Extracted from MMPDS, Minimum values assumed 10% less than mean value)

Test Condition : R= -1, Wave form: Sine, Load Direction : Axial, Temperature : Room Temperature, Frequency: 2000 to 2500 cpm, Specimen type : Unnotched

1. Stress: 360 MPa, No of cycles : 1,00,000 (min)	2. Stress: 340 MPa, No of cycles : 10,00,000 (min)

Data Sheet for Rationalisation of Aviation Metallic Materials - Steel							
General Grade of Material			SAE 4340	Type of Material	Ni-Cr-Mo Steel	Number of Specifications Identified	6
Rationalisation for Use			BAR				
Identified Specifications			Rationalised to	Form	Number of Specifications Identified	Number of Specifications Rationalised	Remarks
Sl No	Specification	Grade	Specification				
1	AMS 6414	SAE 4340	AMS 6414 / BS 5S 99 / MDN 99A	BAR	6	3	-
2	MIL S 5000	E4340					
3	AMS 6415	SAE 4340					
4	BS 5S 99	4340					
5	MDN 99A	4340					
6	BS S 98	4340					

Data Sheet for Rationalisation of Aviation Metallic Materials - Steel

General Grade of Material			16NCD13	Type of Material			Ni-Cr-Mo Steel		Number of Specifications Identified				9
Rationalisation for Use			BAR										
Sl No	Specification	Grade	Origin	Chemical composition (Wt%) (wherever limit not mentioned consider as max)									
				C	Mn	Si	S	P	Ni	Cr	Mo	Cu	Fe
1	MSRR 6061	-	BRITISH	0.12-0.17	0.3-0.6	0.15-0.4	0.02	0.02	3.0-3.5	0.8-1.1	0.2-0.3	-	Rem
2	BSEM 545 (Replaced by MSRR 6051 and obsolete)	-	BRITISH	0.12-0.17	0.3-0.6	0.15-0.4	0.02	0.025	3.0-3.5	0.8-1.1	0.2-0.3	-	Rem
3	AIR 9160	16NCD13	FRENCH	0.12-0.17	0.3-0.6	0.15-0.4	0.02	0.025	3.0-3.5	0.8-1.1	0.20-0.3	-	Rem
4	MSRR 6051	-	BRITISH	0.12-0.17	0.3-0.6	0.15-0.4	0.02	0.02	3.0-3.5	0.8-1.1	0.2-0.3	-	Rem
5	BS S157	-	BRITISH	0.12-0.17	0.3-0.6	0.15-0.4	0.02	0.025	3.0-3.5	0.8-1.1	0.2-0.3	-	Rem
6	AMS 6549	-	AMERICAN	0.12-0.17	0.3-0.6	0.15-0.4	0.005	0.015	3.0-3.5	0.8-1.1	0.22-0.32	0.35	Rem
7	CCT-00264	16NCD13	FRENCH	0.12-0.17	0.3-0.6	0.15-0.4	0.02	0.025	3.0-3.5	0.8-1.1	0.2-0.3	0.35	Rem
8	CCT-00140	E16NCD13	FRENCH	0.12-0.17	0.3-0.6	0.15-0.4	0.01	0.015	3.0-3.5	0.8-1.1	0.2-0.3	0.35	Rem
9	E16NCD13 (Indigenised)	-	INDIAN	0.16C-3.25Ni-1Cr-0.25Mo-Bal Fe as per CEMILAC/2011/GDP dated 01.08.2007 (Rationalisation of Metallic Materials)									

Sl No	Specification	Grade	Heat treatment	Condition	Mechanical properties (Minimum)				
					UTS (MPa)	0.2% Proof (MPa)	% EL (5D)	Impact (J)	Hardness (BHN)
1	MSRR 6061	-	HARDEN : 750-780° C, OIL QUENCH TEMPER: 125° C, AIRCOOL	H & T	1080-1400	780	11	40	321-401
2	BSEM 545 (Replaced by MSRR 6051 and obsolete)	-	HARDEN: 825° C, OIL QUENCH TEMPER : 180° C, AIR COOL	H & T	1180-1380	930	8	34 25 (ft lbf)	345-420
3	AIR 9160	16NCD13	HARDEN: 825° C, OIL QUENCH TEMPER : 190° C, AIR COOL	H&T	1180-1380	980	8	30 6 (daj/cm2)	340-410
4	MSRR 6051	-	HARDEN: 825° C, OIL QUENCH TEMPER : 180° C, AIR COOL	H & T	1180-1380	930	8	34 25 (ft lbf)	345-420
5	BS S157	-	HARDEN: 825° C, OIL QUENCH (Tempering temperature can be varied as per requirement) TEMPER : 180° C, AIR COOL	H & T	1180-1380	930	8	34 25 (ft lbf)	-
6	AMS 6549	-	HARDEN: 825° C, OIL QUENCH TEMPER : 190° C, AIR COOL	H & T	1180-1430	980	8	40 8 (daj/cm2)	-
7	CCT-00264	16NCD13	HARDEN: 825° C, OIL QUENCH TEMPER : 190° C, AIR COOL	H & T	1180-1380	980	8	40 8 (daj/cm2)	-
8	CCT-00140	E16NCD13	HARDEN: 825° C, OIL QUENCH TEMPER : 190° C, AIR COOL	H & T	1180-1430	980	8	40 8 (daj/cm2)	-
9	E16NCD13 (Indigenised)	-	Refer CEMILAC/2011/GDP dated 01.08.2007 (Rationalisation of Metallic Materials)						
Endurance Limit : 50% of UTS Ref: Mechanical Properties of Engineering Materials by Wole Soboyeio and Machine Design Data by ADEKO									

Data Sheet for Rationalisation of Aviation Metallic Materials - Steel							
General Grade of Material			16NCD13	Type of Material	Ni-Cr-Mo Steel	Number of Specifications Identified	9
Rationalisation for Use			BAR				
Identified Specifications			Rationalised to	Form	Number of Specifications Identified	Number of Specifications Rationalised	Remarks
Sl No	Specification	Grade	Specification				
1	MSRR 6061	-	AMS 6549 / E16NCD13 (Indigenised)	BAR	9	2	-
2	BSEM 545 (Replaced by MSRR 6051 and obsolete)	-					
3	AIR 9160	16NCD13					
4	MSRR 6051	-					
5	BS S157	-					
6	AMS 6549	-					
7	CCT-00264	16NCD13					
8	CCT-00140	E16NCD13					
9	E16NCD13 (Indigenised)	-					

Data Sheet for Rationalisation of Aviation Metallic Materials - Steel

General Grade of Material	16NCD17	Type of Material	Case Hardening Steel	Number of Specifications Identified	3
Rationalisation for Use	BAR				

Sl No	Specification	Grade	Origin	Chemical composition (Wt%) (wherever limit not mentioned consider as max)												
				C	Mn	Si	S	P	Ni	Cr	Mo	V	Cu	Fe	Others: Each	Others: Total
1	BS S 156	-	BRITISH	0.14-0.18	0.25-0.55	0.1-0.35	0.012	0.015	3.8-4.3	1.0-1.4	0.2-0.3	-	-	Rem	-	-
2	BS S82	-	BRITISH	0.14-0.18	0.25-0.55	0.15-0.40	0.02	0.025	3.8-4.3	1.0-1.4	0.2-0.3	-	-	Rem	-	-
3	AIR 9160 16NCD17	-	FRENCH	0.14-0.18	0.35-0.45	0.1-0.3	0.02	0.025	4.0-4.5	1.0-1.3	0.15-0.35	-	-	Rem	-	-

Sl No	Specification	Grade	Heat treatment	Condition	Mechanical properties (Minimum)				
					Size (mm)	UTS (MPa)	0.2% Proof (MPa)	% EL	Hardness (HBW/BHN)
1	BS S 156	-	Blank Carburize at 888-930 deg.C Harden at 815-835 deg.C Quench in oil. Sub-zero at -60 to -80deg.C Temper at 190 deg.C	HT	-	1320-1520	1030	11	-
2	BS S82	-	Blank Carburize at 888-930 deg.C Cool in air/OQ Harden at 815-835 deg.C Quench in oil. OQ at -60 to -80deg.C Temper at 190±5 deg.C Cool in air	HT	-	1320-1520	1030	8	-
3	AIR 9160 16NCD17	-	-	HT	≤16 16-30 30-63	1310 1270 1180	1030 880 830	8 8 8	-

Data Sheet for Rationalisation of Aviation Metallic Materials - Steel

General Grade of Material	16NCD17	Type of Material	Case Hardening Steel	Number of Specifications Identified	3
Rationalisation for Use	BAR				

Identified Specifications			Rationalised to	Form	Number of Specifications Identified	Number of Specifications Rationalised	Remarks
Sl No	Specification	Grade	Specification				
1	BS S 156	-	BS S 156	BAR	3	1	-
2	BS S82	-					
3	AIR 9160 16NCD17	-					

Data Sheet for Rationalisation of Aviation Metallic Materials - Steel													
General Grade of Material			15CDV6	Type of Material		Cr-Mo Steel		Number of Specifications Identified					7
Rationalisation for Use			BAR										
Sl No	Specification	Grade	Origin	Chemical composition (Wt%) (wherever limit not mentioned consider as max)									
				C	Mn	Si	S	P	Cr	Mo	V	Others	Fe
1	WL 1.7734	-	GERMAN	0.12-0.18	0.8-1.1	0.2	0.015	0.02	1.25-1.5	0.8-1.0	0.20-.30	-	Rem
2	CCT-00067	15CDV6	FRENCH	0.12-0.18	0.8-1.1	0.2	0.015	0.02	1.25-1.5	0.8-1.0	020-.30	-	Rem
3	CCT LA 189	E15CDV6	FRENCH	0.12-0.18	0.8-1.1	0.2	0.01	0.015	1.25-1.5	0.8-1.0	020-.30	Cu 0.35 Sn 0.03	Rem
4	AIR-9160	15CDV6/ E15CDV6	FRENCH	0.12-0.18	0.8-1.1	0.2	0.015	0.02	1.25-1.5	0.8-1.0	0.20-.30	-	Rem
5	TU14-4-950-86	30KHGSA	RUSSIAN	0.28-0.34	0.8-1.1	0.9-1.2	0.025	0.025	0.8-1.1	0.015-0.25	-	Cu 0.25	Rem
6	TU14-4-950-86	30KHGSA-SH	RUSSIAN	0.28-0.34	0.8-1.1	0.9-1.2	0.015	0.015	0.8-1.1	-	-	Cu 0.25	Rem
7	TU14-1-1885-76	30KHGSA-VD	RUSSIAN	0.28-0.34	0.8-1.1	0.8-1.1	0.015	0.015	0.8-1.1	-	-	Cu 0.2	Rem

Sl No	Specification	Grade	Heat treatment	Condition	Mechanical properties (Minimum)				
					UTS (MPa)	0.2% P.S. (MPa)	% EL (5D)	Impact (J)	Hardness (BHN)
1	WL 1.7734.4 (LN 1017, LN 668)	-	Harden at 960-990 °C + OQ Temper at 720-740 °C + AC	H&T	700	550	12	60	205 HV
	WL 1.7734.5 (LN 1017, LN 668)	-	Harden at 960-990 °C + OQ Temper at 620-660 °C + AC	H&T	980-1180	790	11	-	293-352
	WL 1.7734.6 (LN 1017, LN 668)	-	Harden at 960-990 °C + OQ Temper at 620-640 °C + AC	H&T	1080-1250	930	10	-	321-363
2	CCT-00067	15CDV6	HEAT TO 975° C OIL QUENCH. TEMPER AT 650° C COOL IN AIR.	H&T	980-1180	780	12	60	33 (HRB)
3	CCT LA 189	E15CDV6	HEAT TO 975° C OIL QUENCH. TEMPER AT 650° C COOL IN AIR.	H&T	980-1180	780	12	60	287-342
4	AIR-9160	15CDV6/ E15CDV6	HEAT TO 975 ° C , AIR COOL TEMPER AT 620-650° C COOL IN AIR.	H&T	1080-1280	930	10	-	33 (HRB)
5	TU14-4-950-86	30KHGSA	HARDEN TO 880° C, OIL QUENCH TEMPER AT 510 -570° C, OIL QUENCH	H&T	1078	-	10	-	-
6	TU14-4-950-86	30KHGSA-SH	HARDEN TO 880° C, OIL QUENCH TEMPER AT 510 -570° C, AIR COOL	H&T	1078	833	10	-	311-363
7	TU14-1-1885-76	30KHGSA-VD	HARDEN TO 880° C, OIL QUENCH TEMPER AT 510 -570° C, OIL QUENCH	H&T	1078	882	10	-	-
Fatigue Data in H&T condition (Extracted from Book: Aerospace Materials by Balram Gupta, Minimum values are taken for 15CDV6)									
Test Condition : R= -1, Wave form: Sine, Rotating beam benging, Temperature : Room Temperature, Specimen type : Unnotched									
Stress: 372 MPa, No of cycles : 10.3 X 10^6 (min)									

Data Sheet for Rationalisation of Aviation Metallic Materials - Steel							
General Grade of Material			15CDV6 / Type of Material	Cr-Mo Steel	Number of Specifications Identified		7
Rationalisation for Use			BAR				
Identified Specifications			Rationalised to	Form	Number of Specifications Identified	Number of Specifications Rationalised	Remarks
Sl No	Specification	Grade	Specification				
1	WL 1.7734	-	15CDV6 / E15CDV6 (AIR-9160)	BAR	7	1	-
2	CCT-00067	15CDV6					
3	CCT LA 189	E15CDV6					
4	AIR-9160	15CDV6/ E15CDV6					
5	TU14-4-950-86	30KHGSA					
6	TU14-4-950-86	30KHGSA-SH					
7	TU14-1-1885-76	30KHGSA-VD					

Data Sheet for Rationalisation of Aviation Metallic Materials - Steel													
General Grade of Material			30CD12	Type of Material			Nitriding Steel	Number of Specifications Identified					6
Rationalisation for Use			BAR										
Sl No	Specification	Grade	Origin	Chemical composition (Wt%) (wherever limit not mentioned consider as max)									
				C	Mn	Si	S	P	Ni	Cr	Mo	Others: Each	Fe
1	BS 4S 106	-	BRITISH	0.2-0.28	0.4-0.7	0.1-0.35	0.02	0.02	0.3	3.0-3.5	0.5-0.7	Sn 0.03	Rem
2	AIR 9160	30CD12	FRENCH	0.28-0.35	0.4-0.7	0.1-0.4	0.02	0.025	0.3	2.8-3.3	0.3-0.5	-	Rem
3	MSRR 6001/ (MSRR 6001 SUPERSEDED TO RRMS 31018/1)	-	BRITISH	0.2-0.28	0.4-0.7	0.1-0.35	0.02	0.02	0.3	3.0-3.5	0.5-0.7	Sn 0.03 P+S+Sn 0.04	Rem
4	CCT LA 239	30CD12	FRENCH	0.28-0.35	0.4-0.7	0.1-0.4	0.02	0.025	0.3	2.8-3.3	0.3-0.5	-	Rem
5	MSRR 6002/ (MSRR 6002 SUPERSEDED TO RRMS 31018/2)	-	BRITISH	0.2-0.28	0.4-0.7	0.1-0.35	0.02	0.02	0.3	3.0-3.5	0.5-0.7	Sn 0.03 P+S+Sn 0.04	Rem
6	RRMS 31018 (Forging stock specification)	RRMS 31018/1 RRMS 31018/2	BRITISH	0.2-0.28	0.4-0.7	0.1-0.35	0.02	0.02	0.3	3.0-3.5	0.5-0.7	Sn 0.03 P+S+Sn 0.04	Rem

Sl No	Specification	Grade	Heat treatment	Condition	Mechanical properties (Minimum)			
					UTS (MPa)	0.2% P.S. (MPa)	% EL (5D)	Hardness (BHN)
1	BS 4S 106	-	Harden at 890-910°.C Quench in oil Temper at 570°.C AC	H&T	930-1080	740	13	-
2	AIR 9160	30CD12	Harden at 890-910 °C / OQ Temper at 625 °C	H&T	930-1080	780	14	-
			Harden at 890-910 °C / OQ Temper at 580 °C	H&T	1080-1270	880	11	-
3	MSRR 6001/ (MSRR 6001 SUPERSEDED TO RRMS 31018/1)	-	HARDEN : 900° C, OIL QUENCH TEMPER: 580- 630° C, AIR COOL/ WATER QUENCH	H&T	910-1130	760	13	269-341
4	CCT LA 239	30CD12	HARDEN : 900° C, OIL QUENCH TEMPER : 600° C, AIR COOL	H&T	930 - 1080	780	14	269-317
5	MSRR 6002/ (MSRR 6002 SUPERSEDED TO RRMS 31018/2)	-	HARDEN : 900° C, OIL QUENCH TEMPER: 550 - 600° C, AIR COOL/ WATER QUENCH	H&T	1090-1300	980	11	352-388
6	RRMS 31018 (Forging stock specification)	RRMS 31018/1 RRMS 31018/2	HARDEN : 900° C, OIL QUENCH RRMS 31018/1: TEMPER: 580 - 630° C, AIR COOL/ WATER QUENCH RRMS 31018/2 : TEMPER: 550 - 600° C, AIR COOL/ WATER QUENCH	H&T	910-1130 1090-1300	760 980	13 11	269-341 352-388
Fatigue Data in H&T condition (Extracted from Book: Aerospace Materials by Balram Gupta, Minimum values are taken for 30CD12)								
Test Condition : R= -1, Wave form: Sine, Rotating beam benging, Temperature : Room Temperature, Specimen type : Unnotched								
Stress: 440 MPa, No of cycles : 10.1 X 10^6 (min)								

Data Sheet for Rationalisation of Aviation Metallic Materials - Steel

General Grade of Material			30CD12	Type of Material	Nitriding Steel	Number of Specifications Identified	6
Rationalisation for Use			BAR				
Identified Specifications			Rationalised to	Form	Number of Specifications Identified	Number of Specifications Rationalised	Remarks
Sl No	Specification	Grade	Specification				
1	BS 4S 106	-	30CD12 AIR 9160	BAR	6	1	-
2	AIR 9160	30CD12					
3	MSRR 6001/ (MSRR 6001 SUPERSEDED TO RRMS 31018/1)	-					
4	CCT LA 239	30CD12					
5	MSRR 6002/ (MSRR 6002 SUPERSEDED TO RRMS 31018/2)	-					
6	RRMS 31018 (Forging stock specification)	RRMS 31018/1 RRMS 31018/2					

Data Sheet for Rationalisation of Aviation Metallic Materials - Steel

General Grade of Material	35CD4	Type of Material	Ni-Cr-Mo Steel	Number of Specifications Identified	3
Rationalisation for Use	BAR				

Sl No	Specification	Grade	Origin	Chemical composition (Wt%) (wherever limit not mentioned consider as max)									
				C	Mn	Si	S	P	Ni	Cr	Mo	Cu	Fe
1	AIR-9160	35CD4	FRENCH	0.3-0.37	0.5-0.8	0.15-0.4	0.02	0.025	0.4	0.9-1.2	0.15-0.3	-	Rem
2	AMS 6348	-	AMERICAN	0.28-0.33	0.4-0.6	0.15-0.35	0.025	0.025	0.25	0.8-1.1	0.15-0.25	0.35	Rem
3	CCT-00308	35CD4	FRENCH	0.3-0.37	0.5-0.8	0.15-0.4	0.02	0.025	0.4	0.9-1.2	0.15-0.3	-	Rem

Sl No	Specification	Grade	Heat treatment	Condition	Mechanical properties (Minimum)				
					UTS (MPa)	0.2% P.S.(MPa)	% EL (5D)	Impact (J)	Hardness (BHN)
1	AIR-9160	35CD4	HARDEN: 840-860° C, OIL QUENCH TEMPER: 580° C, AIR COOL	H&T	880-1080	740	12	30 6 daj/cm^2	267-324
2	AMS 6348	-	HARDEN: 840-860° C, OIL QUENCH TEMPER: 580° C, AIR COOL Heat treatment and mechanical properties are from established data	H&T	880-1080	740	12	30 6 daj/cm^2	267-324
3	CCT-00308	35CD4	HARDEN: 850° C, OIL QUENCH TEMPER: 550° C, OIL QUENCH	H&T	1080-1280	930	10	25 5 daj/cm^2	-

Endurance Limit : 50% of UTS

Ref: Mechanical Properties of Engineering Materials by Wole Soboyeio and Machine Design Data by ADEKO

Data Sheet for Rationalisation of Aviation Metallic Materials - Steel

General Grade of Material	35CD4	Type of Material	Ni-Cr-Mo Steel	Number of Specifications Identified	3
Rationalisation for Use	BAR				

Identified Specifications			Rationalised to	Form	Number of Specifications Identified	Number of Specifications Rationalised	Remarks
Sl No	Specification	Grade	Specification				
1	AIR-9160	35CD4	AMS 6348	BAR	3	1	-
2	AMS 6348	-					
3	CCT-00308	35CD4					

Data Sheet for Rationalisation of Aviation Metallic Materials - Steel

General Grade of Material	SAE 9310	Type of Material	Ni-Cr-Mo Steel	Number of Specifications Identified	3
Rationalisation for Use	BAR				

Sl No	Specification	Grade	Origin	Chemical composition (Wt%) (wherever limit not mentioned consider as max)										
				C	Mn	Si	S	P	Ni	Cr	Mo	Cu	Others	Fe
1	AMS 6260	SAE 9310	AMERICAN	0.07-0.13	0.4-0.7	0.15-0.35	0.025	0.025	3.0-3.5	1.0-1.4	0.08-0.15	0.35	B 0.001	Rem
2	AMS 6265	SAE 9310	AMERICAN	0.07-0.13	0.4-0.7	0.15-0.35	0.015	0.015	3.0-3.5	1.0-1.4	0.08-0.15	0.35	B 0.001	Rem
3	EMS 56280	SAE 9310	EUROPEAN	0.07-0.13	0.4-0.7	0.15-0.35	0.015	0.015	3.0-3.5	1.0-1.4	0.08-0.15	0.35	Al 0.02-0.1	Rem

Sl No	Specification	Grade	Heat treatment	Condition	Mechanical properties (Minimum)			
					UTS (MPa)	0.2% P.S (MPa)	% EL (5D)	Hardness (BHN)
1	AMS 6260	SAE 9310	Harden: 815° C/WQ Temper to customer requirement (Mechanical values are for tempering at 150C)	H&T	1030	-	-	33-43 (Rc)
2	AMS 6265	SAE 9310	Harden: 815° C/WQ Temper to customer requirement (Mechanical values are for tempering at 150C)	H&T	1030	-	-	33-43 (Rc)
3	EMS 56280	SAE 9310	Harden: 815° C/WQ Temper to customer requirement (Mechanical values are for tempering at 150C)	H&T	1030	-	-	33-43 (Rc)

Endurance Limit : 50% of UTS

Ref: Mechanical Properties of Engineering Materials by Wole Soboyeio and Machine Design Data by ADEKO

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<tr><td>Sl No</td><td>Specification</td><td>Grade</td><td>Specification</td></tr>
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<tr><td>3</td><td>EMS 56280</td><td>SAE 9310</td></tr>
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Data Sheet for Rationalisation of Aviation Metallic Materials - Steel

General Grade of Material	SAE 51410	Type of Material	Cr-Mo Steel	Number of Specifications Identified	3
Rationalisation for Use	BAR				

Sl No	Specification	Grade	Origin	Chemical composition (Wt%) (wherever limit not mentioned consider as max)									
				C	Mn	Si	S	P	Ni	Mo	Cr	Others	Fe
1	AIR 9160	Z12CN13	FRENCH	0.12-0.15	0.3-0.6	0.8	0.025	0.035	0.3-0.8	-	11.5-13.0	-	Rem
2	CCT LA 37	EN Z12CN13	FRENCH	0.10-0.15	0.3-0.8	0.8	0.025	0.035	0.3-0.8	-	11.5-13.0	-	Rem
3	AMS 5613	SAE 51410	AMERICAN	0.12-0.15	1.0	1.0	0.03	0.04	0.8	0.5	11.5-13.5	Al 0.05 N 0.08 Cu 0.5 Sn 0.05	Rem

Sl No	Specification	Grade	Heat treatment	Condition	Mechanical properties (Minimum)				
					UTS (MPa)	0.2% P.S. (MPa)	% EL (5D)	Impact (J)	Hardness (BHN)
1	AIR 9160	Z12CN13	HARDEN: 980 -1000° C, WATER QUENCH TEMPER: > 640° C, AIR COOL	H&T	590-790	410	-	40 8 daJ/cm2	174-235
2	CCT LA 37	EN Z12CN13	HARDEN: 980 -1000° C, WATER QUENCH TEMPER: > 640° C, AIR COOL Heat treatment and mechanical properties are from established data	H&T	590-790	410	-	40 8 daJ/cm2	174-235
3	AMS 5613	SAE 51410	ANNEAL : 954° C, AIR COOL	A	800 (Max)	-	-	-	241 (Max)

Endurance Limit : 50% of UTS

Ref: Mechanical Properties of Engineering Materials by Wole Soboyeio and Machine Design Data by ADEKO

Data Sheet for Rationalisation of Aviation Metallic Materials - Steel

General Grade of Material	SAE 51410	Type of Material	Cr-Mo Steel	Number of Specifications Identified	3
Rationalisation for Use	BAR				

Identified Specifications			Rationalised to	Form	Number of Specifications Identified	Number of Specifications Rationalised	Remarks
Sl No	Specification	Grade	Specification				
1	AIR 9160	Z12CN13	AMS 5613	BAR	3	1	-
2	CCT LA 37	EN Z12CN13					
3	AMS 5613	SAE 51410					

Data Sheet for Rationalisation of Aviation Metallic Materials - Steel

General Grade of Material			SAE 51431	Type of Material			Stainless Steel	Number of Specifications Identified						11		
Rationalisation for Use			BAR													
Sl No	Specification	Grade	Origin	Chemical composition (Wt%) (wherever limit not mentioned consider as max)												
				C	Mn	Si	S	P	Ni	Cr	Mo	Cu	Others Each max	Fe	V	W
1	WL 1.4044 (LN 176, LN 668, LN 1017)	431	GERMAN	0.12-0.20	1.0	1.0	0.025	0.035	2.0-3.0	15.0-18.0	-	-	-	Rem	-	-
2	MSRR 6573	-	BRITISH	0.12-0.2	1.0	1.0	0.025	0.03	2.0-3.0	15.0-18.0	0.3	0.3	Sn 0.02 Co 0.05 Nb 0.05 Sn 0.02 Ti 0.05 V 0.2 W 0.05	Rem	-	-
3	AIR 9160	Z15CN17-03	FRENCH	0.12-0.2	1.0	1.0	0.025	0.035	2.0-3.0	15.0-18.0	-	-	-	Rem	-	-
4	AMS 5628	SAE 51431	AMERICAN	0.12-0.17	0.3-0.8	0.2-0.6	0.03	0.04	2.0-3.0	15.5-16.5	0.25	0.5	N 0.1	Rem	-	-
5	DIN 17440	X22CrNi17 1.4057	GERMAN	0.15-0.23	1.0	1.0	0.03	0.045	1.5-2.5	16.0-18.0	-	-	-	Rem	-	-
6	MIL-S-18732	431	AMERICAN	0.12-0.17	0.3-0.8	0.2-0.6	0.03	0.04	1.5-2.5	15.5-17.0	-	-	-	Rem	-	-
7	TU14-1-377-72	14KH17N2 1KH17N2	RUSSIAN	0.11-0.17	0.3-0.8	0.8	0.025	0.025	1.5-2.5	16-18	-	-	-	Rem	-	-
8	BS 7S 80	431	BRITISH	0.12-0.20	1	1	0.025	0.03	2.0-3.0	15.0-18.0	0.3	0.3	Sn 0.02 Co 0.05	Rem	0.2	0.05
9	BS S137	-	BRITISH	0.12-0.20	1.5	1	0.015-0.3	0.03	2.0-3.0	15.0-18.0	0.6	-	-	Rem	-	-
10	MIL-S-18732	431	AMERICAN	0.12-0.17	0.3-0.8	0.2-0.6	0.03	0.04	1.5-2.5	15.5-17.0	-	-	-	Rem	-	-
11	MDN 431A	431	INDIAN	0.12-0.2	1	1	0.01	0.015	2.0-3.0	15.0-18.0	0.3	0.3	-	Rem	0.2	-

Sl No	Specification	Grade	Heat treatment	Condition	Mechanical properties (Minimum)			
					UTS (MPa)	0.2% P.S. (MPa)	% EL (5D)	Hardness (BHN)
1	WL 1.4044 (LN 176, LN 668, LN 1017)	431	Harden at 1000-1020°.C Quench in oil Temper at 640-660° C OQ/WQ Re-Temper at 620-640°.C	H&T	880-1080	690	12	255-321
2	MSRR 6573	-	HARDEN: 1000-1020°.C, OIL QUENCH TEMPER 1: 640-660°.C, OIL QUENCH/ WATER QUENCH TEMPER 2: 620-640°.C, OIL QUENCH/ WATER QUENCH	H&T	880-1080	690	12	255-321
3	AIR 9160	Z15CN17-03	HARDEN: 1000-1030° C, OIL QUENCH TEMPER : 300-380° C, AIR COOL	H&T	1350	1050	10	388
4	AMS 5628	SAE 51431	Harden at 1024°.C Quench in oil Temper at 288° C.	H&T	1379	1034	10	-
5	DIN 17440	X22CrNi17 1.4057	HARDEN: 1000-1050° C, OIL QUENCH TEMPER: 630 -720° C, AIR COOL	H&T	800-950	600	9	225-275
6	MIL-S-18732	431	HARDEN: 1000-1020°.C, OIL QUENCH TEMPER 1: 640-660°.C, OIL QUENCH/ WATER QUENCH TEMPER 2: 620-640°.C, OIL QUENCH/ WATER QUENCH	H&T	880-1080	690	12	255-321
7	TU14-1-377-72	14KH17N2 1KH17N2	HARDEN: 1010-1030°.C, OIL QUENCH TEMPER : 670-690°.C, AIR COOL	H&T	834	687	16	269-302
8	BS 7S 80	431	Harden at 1000-1020deg.C Quench in oil Temper at 650±10 deg.C OQ/WQ Re-Temper at 630+10 deg.C	HT	880-1080	690	12	255-321
9	BS S137	-	Harden at 1000-1020deg.C Quench in oil Temper at 650+10 deg.C AC Re-Temper at 600+10 deg.C	HT	880-1080	685	11	255-321
10	MIL-S-18732	431	Harden at 1010-1050deg.C Quench in oil Temper at 371 deg.C Harden at 982-1040deg.C Quench in oil Temper at 593 deg.C	HT 175 HT115	1207 793	930 620	13 13	-
11	MDN 431A	431	-	HT	880-1080	690	12	-
Endurance Limit : 50% of UTS Ref: Mechanical Properties of Engineering Materials by Wole Soboyeio and Machine Design Data by ADEKO								

Data Sheet for Rationalisation of Aviation Metallic Materials - Steel

General Grade of Material	SAE 51431	Type of Material	Stainless Steel	Number of Specifications Identified	11
Rationalisation for Use	BAR				

Identified Specifications			Rationalised to	Form	Number of Specifications Identified	Number of Specifications Rationalised	Remarks
Sl No	Specification	Grade	Specification				
1	WL 1.4044 (LN 176, LN 668, LN 1017)	431	AMS 5628 / MDN 431A / BS 7S 80	BAR	11	3	-
2	MSRR 6573	-					
3	AIR 9160	Z15CN17-03					
4	AMS 5628	SAE 51431					
5	DIN 17440	X22CrNi171.4057					
6	MIL-S-18732	431					
7	TU14-1-377-72	14KH17N2 1KH17N2					
8	BS 7S 80	431					
9	BS S137	-					
10	MIL-S-18732	431					
11	MDN 431A	431					

Data Sheet for Rationalisation of Aviation Metallic Materials - Steel

General Grade of Material	Maraging steel 250	Type of Material	MARAGING STEEL	Number of Specifications Identified	5
Rationalisation for Use	BAR				

Sl No	Specification	Grade	Origin	Chemical composition (Wt%) (wherever limit not mentioned consider as max)												
				C	Mn	Si	S	P	Ni	Zr	Mo	Al	Co	Ti	Others Each max	Fe
1	MIL-S-46850	TY IV, Grade 250	AMERICAN	0.03	0.1	0.1	0.01	0.01	17.0-19.0	0.02	4.6-5.2	0.05-0.15	7.0-8.5	0.3-0.5	B 0.03 Ca 0.05	Rem
2	AMS 6512	-	AMERICAN	0.03	0.1	0.1	0.01	0.01	17.0-19.0	0.02	4.6-5.2	0.05-0.15	7.0-8.5	0.3-0.5	B 0.003 Cu 0.5 Cr 0.5 Ca 0.05	Rem
3	DTD 5212	-	BRITISH	0.015	0.1	0.1	0.01	0.01	17.0-19.0	0.025	4.6-5.2	0.05-0.15	7.0-8.5	0.3-0.6	Cr 0.25	Rem
4	MLA 101	-	EUROPEAN	0.02	0.1	0.1	0.01	0.01	17.0-19.0	0.025	4.6-5.2	0.05-0.15	7.0-8.5	0.3-0.6	Cr 0.25 B 0.03 Zr 0.02 Ca 0.05	Rem
5	MDN 250A (Indigenised)	-	INDIAN	0.03	0.1	0.1	0.01	0.01	17.0-19.0	0.02	4.6-5.2	0.05-0.15	7.0-8.5	0.3-0.5	B 0.003 Ca 0.05	Rem

Sl No	Specification	Grade	Heat treatment	Condition	Mechanical properties (Minimum)			
					UTS (MPa)	0.2% P.S. (MPa)	% EL (5D)	Hardness (BHN)
1	MIL-S-46850	TY IV, Grade 250	Marage at 482±5 deg.C for 3-6 hrs cool in air	SOL & AGED	-	1654	3	48 HRC
2	AMS 6512	-	Marage at 480±5 deg.C for 6 hrs cool in air	SOL & AGED	1689 - 1758	1655 - 1724	5 -6	48 HRC
3	DTD 5212	-	SOLUTIONISING : 820° C, AIR COOL AGING : 485°.C, 3 HRS, AIR COOL	SOL & AGED	1800-2000	1700	8	520-620 HV
4	MLA 101	-	SOLUTIONISING : 820° C, AIR COOL AGING : 485°.C, 3 HRS, AIR COOL	SOL & AGED	1517	1448	8	520 HV
5	MDN 250A (Indigenised)	-	Marage at 480±5 deg.C for 3 hrs cool in air	SOL & AGED	-	1655	6	HRC 48
Fatigue Data in H&T condition (Extracted from Book: Aerospace Materials by Balram Gupta, Minimum values are taken for MDN 250A)								
Test Condition : R= -1, Wave form: Sine, Rotating beam benging, Temperature : Room Temperature, Specimen type : Unnotched								
Stress: 680 MPa, No of cycles : 10 X 10^6 (min)								

Data Sheet for Rationalisation of Aviation Metallic Materials - Steel							
General Grade of Material			Maraging steel 250	Type of Material	MARAGING STEEL	Number of Specifications Identified	5
Rationalisation for Use			BAR				
Identified Specifications			Rationalised to	Form	Number of Specifications Identified	Number of Specifications Rationalised	Remarks
Sl No	Specification	Grade	Specification				
1	MIL-S-46850	TY IV, Grade 250	AMS 6512 / MIL-S-46850 / MDN 250A	BAR	5	3	-
2	AMS 6512	-					
3	DTD 5212	-					
4	MLA 101	-					
5	MDN 250A (Indigenised)	-					

Data Sheet for Rationalisation of Aviation Metallic Materials - Steel

General Grade of Material	NCM	Type of Material	Ni-Cr-Mo Steel	Number of Specifications Identified	3
Rationalisation for Use	BAR				

Sl No	Specification	Grade	Origin	Chemical composition (Wt%) (wherever limit not mentioned consider as max)								
				C	Mn	Si	S	P	Ni	Cr	Mo	Fe
1	BS S95	-	BRITISH	0.36-0.44	0.45-0.7	0.15-0.35	0.02	0.025	1.3-1.7	1.1-1.4	0.2-0.35	Rem
2	MSRR 6017	-	BRITISH	0.36-0.44	0.45-0.7	0.15-0.35	0.02	0.025	1.3-1.7	1.1-1.4	0.2-0.35	Rem
3	MSRR 6036 (obsolete) MSRR 6017 IS ALTERNATE TO MSRR 6036)	-	BRITISH	0.36-0.44	0.45-0.7	0.15-0.35	0.02	0.025	1.3-1.7	1.1-1.4	0.2-0.35	Rem

Sl No	Specification	Grade	Heat treatment	Condition	Mechanical properties (Minimum)				
					UTS (MPa)	0.2% P.S. (MPa)	% EL (5D)	Impact (J)	Hardness (BHN)
1	BS S95	-	HARDEN: 830-850° C, OIL QUENCH TEMPER: 580 ° C., AIR COOL	H&T	786 -965	607	12	45 40 (ft lbf)	255-321
2	MSRR 6017	-	HARDEN: 830-850° C, OIL QUENCH TEMPER: 630-660 ° C., AIR COOL	H&T	850-930	700	16	54	248-286
3	MSRR 6036 (obsolete) MSRR 6017 IS ALTERNATE TO MSRR 6036)	-	HARDEN: 830-850° C, OIL QUENCH TEMPER: 570- 610 ° C., AIR COOL	H&T	1000-1160	900	13	41	301-341

Endurance Limit : 50% of UTS

Ref: Mechanical Properties of Engineering Materials by Wole Soboyeio and Machine Design Data by ADEKO

Data Sheet for Rationalisation of Aviation Metallic Materials - Steel

General Grade of Material			NCM	Type of Material	Ni-Cr-Mo Steel	Number of Specifications Identified	3
Rationalisation for Use			BAR				
Identified Specifications			Rationalised to	Form	Number of Specifications Identified	Number of Specifications Rationalised	Remarks
Sl No	Specification	Grade	Specification				
1	BS S95	-	BS S95	BAR	3	1	-
2	MSRR 6017	-					
3	MSRR 6036 (obsolete) MSRR 6017 IS ALTERNATE TO MSRR 6036)	-					

Data Sheet for Rationalisation of Aviation Metallic Materials - Steel

General Grade of Material	Cr-Mo Steel	Type of Material	Cr-Mo Steel	Number of Specifications Identified	2
Rationalisation for Use	BAR				

Sl No	Specification	Grade	Origin	Chemical composition (Wt%) (wherever limit not mentioned consider as max)									
				C	Mn	Si	S	P	Ni	Mo	Cr	Others	Fe
1	AIR-9165	Z20CDNb11	FRENCH	0.15-0.24	1.0	0.8	0.025	0.03	1.0	0.5-1.0	10.0-13.0	V 0.1-0.7 Nb 0.1-0.5	Rem
2	BS S 62	-	BRITISH	0.18-0.25	1.0	0.8	0.025	0.03	1.0	-	12.0-14.0	-	Rem

Sl No	Specification	Grade	Heat treatment	Condition	Mechanical properties (Minimum)				
					UTS (MPa)	0.2% Proof (MPa)	% EL (5D)	Impact (J)	Hardness (BHN)
1	AIR-9165	Z20CDNb11	HARDEN: 1100 -1150° C, OIL QUENCH TEMPER: 660° C, AIR COOL	H&T	930-1080	780	10	30	277-325
2	BS S 62	-	HARDEN: 950-1020° C, OIL QUENCH/ AIR COOL TEMPER: 650-750° ,AIR COOL	H&T	620-758	441 (0.1%)	15	27.1 20 (ft lbf)	201-255

<table>
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<tr><td colspan="3">General Grade of Material</td><td>Cr-Mo Steel | Type of Material</td><td>Cr-Mo Steel</td><td colspan="2">Number of Specifications Identified</td><td>2</td></tr>
<tr><td colspan="3">Rationalisation for Use</td><td colspan="5">BAR</td></tr>
<tr><td colspan="3">Identified Specifications</td><td>Rationalised to</td><td rowspan="2">Form</td><td rowspan="2">Number of Specifications Identified</td><td rowspan="2">Number of Specifications Rationalised</td><td rowspan="2">Remarks</td></tr>
<tr><td>Sl No</td><td>Specification</td><td>Grade</td><td>Specification</td></tr>
<tr><td>1</td><td>AIR-9165</td><td>Z20CDNb11</td><td rowspan="2">Z20CDNb11
(AIR-9165)</td><td rowspan="2">BAR</td><td rowspan="2">2</td><td rowspan="2">1</td><td rowspan="2">-</td></tr>
<tr><td>2</td><td>BS S 62</td><td>-</td></tr>
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Data Sheet for Rationalisation of Aviation Metallic Materials - Steel

General Grade of Material	NCM Steel	Type of Material	Ni-Cr-Mo Steel	Number of Specifications Identified	5
Rationalisation for Use	BAR				

Sl No	Specification	Grade	Origin	Chemical composition (Wt%) (wherever limit not mentioned consider as max)								
				C	Mn	Si	S	P	Ni	Cr	Mo	Fe
1	MSRR 6009	-	BRITISH	0.14-0.18	0.25-0.55	0.15-0.4	0.015	0.015	3.8-4.3	1.0-1.4	0.2-0.3	Rem
2	MSRR 6010/ (MSRR 6010 SUPERSEDED TO RRMS 31014/1)	-	BRITISH	0.14-0.18	0.25-0.55	0.1-0.35	0.012	0.15	3.8-4.3	1.0-1.4	0.2-0.3	Rem
3	RRMS 31014/ RRMS 31014/1	-	BRITISH	0.14-0.18	0.25-0.55	0.1-0.35	0.012	0.15	3.8-4.3	1.0-1.4	0.2-0.3	Rem
4	MSRR 6094	-	BRITISH	0.14-0.18	0.25-0.55	0.1-0.35	0.012	0.15	3.8-4.3	1.0-1.4	0.2-0.3	Rem
5	AMS 6264	-	AMERICAN	0.14-0.2	0.4-0.7	0.15-0.35	0.025	0.025 Cu: 0.35	3-3.5	1.0-1.4	0.08-0.15	Rem

Sl No	Specification	Grade	Heat treatment	Condition	Mechanical properties (Minimum)				
					UTS (MPa)	0.2% Proof (MPa)	% EL (5D)	Impact (J)	Hardness (BHN)
1	MSRR 6009	-	HARDEN: 820° C, OIL QUENCH TEMPER : 190° C, AIR COOL	H&T	1320-1520	1030	8	33	388-444
2	MSRR 6010/ (MSRR 6010 SUPERSEDED TO RRMS 31014/1)	-	HARDEN: 820° C, OIL QUENCH TEMPER : 190° C, AIR COOL	H&T	1320-1520	1030	11	33	388-444
3	RRMS 31014/ RRMS 31014/1	-	HARDEN: 820-850° C, OIL QUENCH TEMPER : 190° C, AIR COOL	H&T	1320-1480	1030	11	40	388-444
4	MSRR 6094	-	HARDEN: 820° C, OIL QUENCH TEMPER : 190° C, AIR COOL	H&T	1320-1520	1030	11	33	388-444
5	AMS 6264	-	NORMALISE: 925° C, AIR COOL	N	862 (Max)	-	-	-	229 (Max)

Endurance Limit : 50% of UTS

Ref: Mechanical Properties of Engineering Materials by Wole Soboyeio and Machine Design Data by ADEKO

Data Sheet for Rationalisation of Aviation Metallic Materials - Steel							
General Grade of Material			NCM Steel	Type of Material	Ni-Cr-Mo Steel	Number of Specifications Identified	5
Rationalisation for Use			BAR				
Identified Specifications			Rationalised to	Form	Number of Specifications Identified	Number of Specifications Rationalised	Remarks
SI No	Specification	Grade	Specification				
1	MSRR 6009	-	AMS 6264	BAR	5	1	-
2	MSRR 6010/ (MSRR 6010 SUPERSEDED TO RRMS 31014/1)	-					
3	RRMS 31014/ RRMS 31014/1	-					
4	MSRR 6094	-					
5	AMS 6264	-					

Data Sheet for Rationalisation of Aviation Metallic Materials - Steel

General Grade of Material	Z30C13	Type of Material	Ni-Cr-Mo Steel	Number of Specifications Identified	3
Rationalisation for Use	BAR				

Sl No	Specification	Grade	Origin	Chemical composition (Wt%) (wherever limit not mentioned consider as max)										
				C	Mn	Si	S	P	Ni	Cr	Mo	V	Other	Fe
1	MSRR 6602	-	BRITISH	0.22-0.32	0.5	0.5	0.025	0.03	1.0	12.0-14.5	-	-	-	Rem
2	AIR 9160	Z30C13	FRENCH	0.25-0.32	1.0	0.8	0.025	0.035	1.0	12.0-14.0	-	-	-	Rem
3	AMS 5655	-	AMERICAN	0.2-0.25	1.0	0.2-0.6	0.03	0.04	0.5-1.0	11-13.5	0.75-1.25	0.17-0.3	Cu 0.5 W 0.75-1.25	Rem

Sl No	Specification	Grade	Heat treatment	Condition	Mechanical properties (Minimum)			
					UTS (MPa)	0.2% P.S (MPa)	% EL (5D)	Hardness (BHN)
1	MSRR 6602	-	HARDEN: 940- 980° C., QUENCH IN OIL TEMPER: 550-650° C , WATER QUENCH	H&T	930-1080	750	8	286-321
2	AIR 9160	Z30C13	HARDEN: 980-1000° C, OIL QUENCH/ AIR COOL TEMPER: >580° C, AIR COOL	H&T	880-1080	690	10	262-326
3	AMS 5655	-	HARDEN:1052° C, OIL QUENCH TEMPER: HEAT TO 593° C COOL TO 538DEG C THEN, AIR COOL	H&T	965	793	13	293-341

Endurance Limit : 50% of UTS

Ref: Mechanical Properties of Engineering Materials by Wole Soboyeio and Machine Design Data by ADEKO

Data Sheet for Rationalisation of Aviation Metallic Materials - Steel							
General Grade of Material			Z30C13	Type of Material	Ni-Cr-Mo Steel	Number of Specifications Identified	3
Rationalisation for Use			BAR				
Identified Specifications			Rationalised to	Form	Number of Specifications Identified	Number of Specifications Rationalised	Remarks
Sl No	Specification	Grade	Specification				
1	MSRR 6602	-	AMS 5655	BAR	3	1	-
2	AIR 9160	Z30C13					
3	AMS 5655	-					

Data Sheet for Rationalisation of Aviation Metallic Materials - Steel															
General Grade of Material			MDN 132A	Type of Material		Cr-Mo-V Steel		Number of Specifications Identified						5	
Rationalisation for Use			BAR												
Sl No	Specification	Grade	Origin	Chemical composition (Wt%) (wherever limit not mentioned consider as max)											
				C	Mn	Si	S	P	Ni	Cr	Mo	Sn	V	Others: Each	Fe
1	MSRR 6012 (Made from MSRR 6911)	-	BRITISH	0.35-0.43	0.4-0.7	0.1-0.35	0.01	0.015	0.3	3.0-3.5	0.8-1.1	0.025	0.15-0.25	P+Sn 0.025	Rem
2	MSRR 6011 (Made from MSRR 6910)	-	BRITISH	0.35-0.43	0.4-0.7	0.1-0.35	0.02	0.02	0.3	3.0-3.5	0.8-1.1	0.025	0.15-0.25	P+Sn 0.025	Rem
3	MSRR 6100	-	BRITISH	0.35-0.43	0.4-0.7	0.1-0.35	0.01	0.015	0.3	3.0-3.5	0.8-1.1	0.025	0.15-0.25	P+Sn 0.025	Rem
4	BS S 132	-	BRITISH	0.35-0.43	0.4-0.7	0.1-0.35	0.02	0.02	0.3	3.0-3.5	0.8-1.1	0.03	0.15-0.25	-	Rem
5	MDN 132A (Indigenised)	-	INDIAN	0.4C-0.5Mn-3Cr-0.9Mo-Bal Fe as per CEMILAC/2011/GDP dated 01.08.2007 (Rationalisation of Metallic Materials)											

Sl No	Specification	Grade	Heat treatment	Condition	Mechanical properties (Minimum)				
					UTS (MPa)	0.2% P.S. (MPa)	% EL (5D)	Impact (J)	Hardness (BHN)
1	MSRR 6012 (Made from MSRR 6911)	-	HARDEN AT 930-950° C, OIL QUENCH TEMPER AT 590-620° C., AIR COOL	H&T	1240-1390	1030	10	-	363-401
2	MSRR 6011 (Made from MSRR 6910)	-	HARDEN AT 930-950° C, OIL QUENCH TEMPER AT 580-610° C., AIR COOL	H&T	1320-1470	1130	8	-	388-429
3	MSRR 6100	-	HARDEN AT 930-950° C, OIL QUENCH TEMPER AT 580-610° C., AIR COOL	H&T	1320-1470	1130	8	-	388-429
4	BS S 132	-	HARDEN AT 950° C, OIL QUENCH TEMPER AT 600° C., AIR COOL	H&T	1320-1470	1130	8	27.1 20 ft lbf	388-429
5	MDN 132A (Indigenised)	-	Refer CEMILAC/2011/GDP dated 01.08.2007 (Rationalisation of Metallic Materials)						
Fatigue Data in H&T condition (Extracted from Book: Aerospace Materials by Balram Gupta, Minimum values are taken for MDN 132A)									
Test Condition : R= -1, Wave form: Sine, Rotating beam benging, Temperature : Room Temperature, Specimen type : Unnotched									
Stress: 552 MPa, No of cycles : 30 X 10^6 (min)									

Data Sheet for Rationalisation of Aviation Metallic Materials - Steel

General Grade of Material			MDN 132A	Type of Material	Cr-Mo-V Steel	Number of Specifications Identified	5
Rationalisation for Use			BAR				
Identified Specifications			Rationalised to	Form	Number of Specifications Identified	Number of Specifications Rationalised	Remarks
Sl No	Specification	Grade	Specification				
1	MSRR 6012 (Made from MSRR 6911)	-	BS S132 / MDN 132A (Indigenised)	BAR	5	2	-
2	MSRR 6011 (Made from MSRR 6910)	-					
3	MSRR 6100	-					
4	BS S 132	-					
5	MDN 132A (Indigenised)	-					

Data Sheet for Rationalisation of Aviation Metallic Materials - Steel																
General Grade of Material			A286	Type of Material			15 Cr- 25 Ni		Number of Specifications Identified					4		
Rationalisation for Use			BAR													
Sl No	Specification	Grade	Origin	Chemical composition (Wt%) (wherever limit not mentioned consider as max)												
				C	Mn	Si	S	P	Ni	Cr	Mo	V	Co	Ti	Others Each	Fe
1	AMS 5731	-	AMERICAN	0.08	2.0	1.0	0.025	0.025	24.0-27.0	13.5-16.0	1.0-1.5	0.1-0.5	1.0	1.9-2.35	B 0.003-0.01 Cu 0.5 Al 0.35	Rem
2	AMS 5732	-	AMERICAN	0.08	2.0	1.0	0.025	0.025	24.0-27.0	13.5-16.0	1.0-1.5	0.1-0.5	1.0	1.9-2.35	B 0.003-0.01 Cu 0.5 Al 0.35	Rem
3	AMS 5734	-	AMERICAN	0.08	2.0	1.0	0.025	0.025	24.0-27.0	13.5-16.0	1.0-1.5	0.1-0.5	1.0	1.9-2.35	B 0.003-0.01 Cu 0.5 Al 0.35	Rem
4	AMS 5737	-	AMERICAN	0.08	2.0	1.0	0.025	0.025	24.0-27.0	13.5-16.0	1.0-1.5	0.1-0.5	1.0	1.9-2.35	B 0.003-0.01 Cu 0.5 Al 0.35	Rem

Sl No	Specification	Grade	Heat treatment	Condition	Mechanical properties (Minimum)			
					UTS (MPa)	0.2% P.S. (MPa)	% EL (5D)	Hardness (BHN)
1	AMS 5731	-	Solution Treat at 980°.C Water/Oil Quench Ppt at 720°.C for 16hrs min Air cool	ST+PPT	895	585	15	248-341
2	AMS 5732	-	Solution Treat at 982±14°.C Water/Oil Quench Ppt at 704-760°.C for 16hrs min Air cool	ST+PPT	896	586	15	248-341
3	AMS 5734	-	Solution Treat at 899±14°.C Water/Oil Quench Ppt at 718±8°.C for 16hrs min Air cool	ST+PPT	965	655	12	277-363
4	AMS 5737	-	Solution Treat at 899°.C Water/Oil Quench Ppt at 704-760°.C for 16hrs min Air cool	ST+PPT	965	655	12	277-363

Endurance Limit : 50% of UTS

Ref: Mechanical Properties of Engineering Materials by Wole Soboyeio and Machine Design Data by ADEKO

Data Sheet for Rationalisation of Aviation Metallic Materials - Steel

General Grade of Material	A286	Type of Material	15 Cr- 25 Ni	Number of Specifications Identified	4
Rationalisation for Use	BAR				

Identified Specifications			Rationalised to	Form	Number of Specifications Identified	Number of Specifications Rationalised	Remarks
Sl No	Specification	Grade	Specification				
1	AMS 5731	-	AMS 5737	BAR	4	1	-
2	AMS 5732	-					
3	AMS 5734	-					
4	AMS 5737	-					

Data Sheet for Rationalisation of Aviation Metallic Materials - Steel

General Grade of Material	2.5%Ni-Cr-Mo	Type of Material	Ni-Cr-Mo Steel	Number of Specifications Identified	6
Rationalisation for Use	BAR				

Sl No	Specification	Grade	Origin	Chemical composition (Wt%) (wherever limit not mentioned consider as max)										
				C	Mn	Si	S	P	Ni	Cr	Mo	Al	Others	Fe
1	BS 5S 99	-	BRITISH	0.36-0.44	0.45-0.7	0.1-0.35	0.015	0.025	2.3-2.8	0.5-0.8	0.45-0.65	0.015-0.06	-	Rem
2	BS S 98	-	BRITISH	0.36-0.44	0.45-0.7	0.1-0.35	0.02	0.025	2.3-2.8	0.5-0.8	0.45-0.65	-	-	Rem
3	BS S154	-	BRITISH	0.27-0.35	0.45-0.7	0.15-0.35	0.015	0.025	2.3-2.8	0.5-0.8	0.45-0.65	Al 0.015-0.05	-	Rem
4	BS S96 (obsolete. Replaced by S154)	-	BRITISH	0.27-0.35	0.45-0.7	0.1-0.35	0.02	0.025	2.3-2.8	0.5-0.8	0.45-0.65	-	-	Rem
5	BS S97	-	BRITISH	0.27-0.35	0.45-0.7	0.1-.035	0.02	0.025	2.3-2.8	0.5-0.8	0.45-0.65	-	-	Rem
6	MDN 99 A	-	INDIAN	0.4C-0.7Cr-0.5Mo-2.5Ni-Bal Fe as per CEMILAC/2011/GDP dated 01.08.2007 (Rationalisation of Metallic Materials)										

Sl No	Specification	Grade	Heat treatment	Condition	Mechanical properties (Minimum)				
					UTS (MPa)	0.2% Proof (MPa)	% EL (5D)	Impact (J)	Hardness (BHN)
1	BS 5S 99	-	Harden : 820-850°.C Quench in Oil Temper at 500-600°.C	H&T	1230-1420	1080	10	25	363-415
2	BS S 98	-	Harden at 820-850°.C Quench in Oil Temper at 500-660°.C	H&T	1034-1172	896	10	25	341-388
3	BS S154	-	HARDEN: 850° C, OIL QUENCH TEMPER:600° C, AIR COOL	H&T	880-1080	690	12	40	255-321
4	BS S96 (obsolete. Replaced by S154)	-	HARDEN: 850° C, OIL QUENCH TEMPER:600° C, AIR COOL	H&T	880-1080	690	12	40	255-321
5	BS S97	-	HEAT AT 820-850° C, OIL QUENCH TEMPER: 560-660° C, AIR COOL	H&T	896-1034	758	12	35	293-341
6	MDN 99 A	-	Refer CEMILAC/2011/GDP dated 01.08.2007 (Rationalisation of Metallic Materials)						
Fatigue Data in H&T condition (Extracted from Book: Aerospace Materials by Balram Gupta, Minimum values are taken for BS S154)									
Test Condition : R= -1, Wave form: Sine, Rotating beam benging, Temperature : Room Temperature, Specimen type : Unnotched									
Stress: 431 MPa, No of cycles : 10 X 10^6 (min)									

Data Sheet for Rationalisation of Aviation Metallic Materials - Steel							
General Grade of Material			2.5%Ni-Cr-Mo	Type of Material	Ni-Cr-Mo Steel	Number of Specifications Identified	6
Rationalisation for Use			BAR				
Identified Specifications			Rationalised to	Form	Number of Specifications Identified	Number of Specifications Rationalised	Remarks
Sl No	Specification	Grade	Specification				
1	BS 5S 99	-	BS 5S 99 / MDN 99 A	BAR	6	2	-
2	BS S 98	-					
3	BS S154	-					
4	BS S96 (obsolete. Replaced by S154)	-					
5	BS S97	-					
6	MDN 99 A	-					

Data Sheet for Rationalisation of Aviation Metallic Materials - Steel

General Grade of Material	18/8 P.H	Type of Material	Stainless Steel	Number of Specifications Identified	7
Rationalisation for Use	BAR				

Sl No	Specification	Grade	Origin	Chemical composition (Wt%) (wherever limit not mentioned consider as max)											
				C	Mn	Si	S	P	Ni	Cr	Mo	Ti	Cu	Others Each	Fe
1	AMS 5645	321	AMERICAN	0.08	2.0	1.0	0.03	0.04	8.0-12.0	17.0-19.0	0.75	5(C+N)-0.7	0.75	N 0.1	Rem
2	X10CrNiTi189 1.4541 DIN 17440	321	GERMAN	0.1	2.0	1.0	0.03	0.045	9.0-11.5	17.0-19.0	-	5C - 0.8	-	-	Rem
3	BS S129		BRITISH	0.08	0.5-2.0	0.2-1.0	0.025	0.035	8.0-11.0	17.0-19.0	0.7	5C - 0.8	-	-	Rem
4	Z10CNT18-11 AIR 9160	321	FRENCH	0.12	2.0	1.0	0.025	0.035	10.0-13.0	17.0-19.0	-	5C - 0.8	-	-	Rem
5	MSRR 6522	-	BRITISH	0.08	0.5-2.0	0.2-1.0	0.025	0.035	7.0-11.0	17.0-19.0	1.0	5C - 0.8	0.5	Al 0.05 Nb 10C - 1.1	Rem
6	G-5632-72 G-5949-75 TU14-1-378-72 G-8060-78 12KH18N10T KH18N10T	-	RUSSIAN	0.12	2	0.8	0.02	0.035	9.0-11.0	17.0-19.0	-	(C-0.02) - 0.7	-	-	Rem
7	WL 1.4544 (LN 668)	321	GERMAN	0.08	2	1	0.025	0.035	9.0--11.5	17.0-19.0	-	-	-	Ti 5x%C 0.6	Rem

Sl No	Specification	Grade	Heat treatment	Condition	SIZE (mm)	Mechanical properties (Minimum)				
						UTS (MPa)	0.2% P.S. (MPa)	% EL (5D)	Impact (J)	Hardness (BHN)
1	AMS 5645	321	1000-1100° C, OIL QUENCH / WATER QUENCH / AIR COOL	-	50	615 (Max)	-	-	-	187 (Max)
2	X10CrNiTi189 1.4541 DIN 17440	321	-	-		500-750	205	35	115 85 (ft lbf)	130-190
3	BS S129	-	1000-1100° C, OIL QUENCH / WATER QUENCH / AIR COOL	-		540 (Max)	210	35	-	183 (Max)
4	Z10CNT18-11 AIR 9160	321	Heat at 1050-1100 °C / WQ or AC	-		490-690	210	37	50 10 (daJ/cm2)	-
5	MSRR 6522	-	Heat at 1050-1080° C, OIL QUENCH / WATER QUENCH / AIR COOL	-		540 (Max)	210	35	-	140-220
6	G-5632-72 G-5949-75 TU14-1-378-72 G-8060-78 12KH18N10T KH18N10T	321	Heat at 1050-1100° C, OIL QUENCH / WATER QUENCH / AIR COOL	-		510 (Max)	196	40	-	-
7	WL 1.4544.9 (LN 668)	321	Heat at 1020-1070 °C / WQ or AC	-	5 - 26	500-750	205	40	-	130-190 Hv

Endurance Limit : 50% of UTS

Ref: Mechanical Properties of Engineering Materials by Wole Soboyeio and Machine Design Data by ADEKO

Data Sheet for Rationalisation of Aviation Metallic Materials - Steel							
General Grade of Material			**18/8 P.H**	**Type of Material**	**Stainless Steel**	**Number of Specifications Identified**	**7**
Rationalisation for Use			**BAR**				
Identified Specifications			**Rationalised to**	**Form**	**Number of Specifications Identified**	**Number of Specifications Rationalised**	**Remarks**
Sl No	**Specification**	**Grade**	**Specification**				
1	AMS 5645	321	AMS 5645	BAR	7	1	-
2	X10CrNiTi189 1.4541 DIN 17440	321					
3	BS S129	-					
4	Z10CNT18-11 AIR 9160	321					
5	MSRR 6522	-					
6	G-5632-72 G-5949-75 TU14-1-378-72 G-8060-78 12KH18N10T KH18N10T	-					
7	WL 1.4544 (LN 668)	321					

Data Sheet for Rationalisation of Aviation Metallic Materials - Steel

General Grade of Material	18/9	Type of Material	Stainless Steel	Number of Specifications Identified	2
Rationalisation for Use	BAR				

Sl No	Specification	Grade	Origin	Chemical composition (Wt%) (wherever limit not mentioned consider as max)								
				C	Mn	Si	S	P	Ni	Cr	Others Each	Fe
1	MDN 321A	-	INDIAN	18Cr-10Ni-Ti-Bal Fe as per CEMILAC/2011/GDP dated 01.08.2007 (Rationalisation of Metallic Materials)								
2	AMS 5646	SAE 30347	AMERICAN	0.12	2.0	1.0	0.025	0.035	10.0-13.0	17.0-19.0	Ti: 5C - 0.8	Rem

Sl No	Specification	Grade	Heat treatment	Condition	Mechanical properties (Minimum)			
					UTS (MPa)	0.2% P.S. (MPa)	% EL (5D)	Hardness (BHN)
1	MDN 321A	-	Refer CEMILAC/2011/GDP dated 01.08.2007 (Rationalisation of Metallic Materials)					
2	AMS 5646	SAE 30347	AUSTENISE: 1000-1100° C, OIL QUENCH / WATER QUENCH / AIR COOL	A	490-690	210	37	-

Endurance Limit : 50% of UTS

Ref: Mechanical Properties of Engineering Materials by Wole Soboyeio and Machine Design Data by ADEKO

Data Sheet for Rationalisation of Aviation Metallic Materials - Steel							
General Grade of Material			18/9	Type of Material	Stainless Steel	Number of Specifications Identified	2
Rationalisation for Use			BAR				
Identified Specifications			Rationalised to	Form	Number of Specifications Identified	Number of Specifications Rationalised	Remarks
Sl No	Specification	Grade	Specification				
1	MDN 321A	-	AMS 5646	BAR	2	1	-
2	AMS 5646	SAE 30347					

Data Sheet for Rationalisation of Aviation Metallic Materials - Steel

General Grade of Material	Cr-Mo Steel	Type of Material	Cr-Mo Steel	Number of Specifications Identified	2
Rationalisation for Use	BAR				

Sl No	Specification	Grade	Origin	Chemical composition (Wt%) (wherever limit not mentioned consider as max)									
				C	Mn	Si	S	P	Ni	Mo	Cr	Others	Fe
1	ZFNL 9201	-	GERMAN	0.15-0.19	0.4-0.6	0.35	0.015	0.015	1.4-1.7	0.1	1.4-1.7	Cu 0.2 Al 0.045	Rem
2	MDN 9201A (Indigenised)	-	INDIAN	0.15-0.19	0.4-0.6	0.35	0.005	0.015	1.4-1.7	0.1	1.4-1.7	Cu 0.2 Al 0.045	Rem

Sl No	Specification	Grade	Heat treatment	Condition	Mechanical properties (Minimum)			
					UTS (MPa)	0.2% P.S. (MPa)	% EL (5D)	Hardness (BHN)
1	ZFNL 9201	-	HARDEN: 840° C, OIL QUENCH TEMPER: 150° C, AIR COOL	H&T	1100-1500	750	7	320
2	MDN 9201A (Indigenised)	-	HARDEN: 840° C, OIL QUENCH TEMPER: 150° C, AIR COOL	H&T	1100-1500	750	7	327

Fatigue Data in H&T condition
(Extracted from DTS- MDN 9201A, Minimum values are taken for MDN 9201A)

Test Condition : R= -1, Wave form: Sine, Rotating beam benging, Temperature : Room Temperature, Specimen type : Unnotched

Stress: 525 MPa, No of cycles : 1 X 10^7 (min)

Data Sheet for Rationalisation of Aviation Metallic Materials - Steel							
General Grade of Material			Cr-Mo Steel	Type of Material	Cr-Mo Steel	Number of Specifications Identified	2
Rationalisation for Use			BAR				
Identified Specifications			Rationalised to	Form	Number of Specifications Identified	Number of Specifications Rationalised	Remarks
Sl No	Specification	Grade	Specification				
1	ZFNL 9201	-	MDN 9201A	BAR	2	1	-
2	MDN 9201A (Indigenised)	-					

6.0
PART 3
NICKEL ALLOYS

Data Sheet for Rationalisation of Aviation Metallic Materials - Nickel Alloy

General Grade of Material			NIMONIC 263	Type of Material			Ni-Cr-Co-Mo		Number of Specifications Identified							6
Rationalisation for Use			Bar													
Sl. No.	Specification	Grade	Origin	Chemical composition (Wt%) (wherever limit not mentioned consider as max)												
				Ni	Co	Fe	C	Si	Mn	Mo	Ti	Cr	Al	Others (each)		Others (total)
1	MSRR 7035 [superseded by RRMS 33031, RRMS 33031/1, RRMS 33030/2, RRMS 33030/3, RRMS 33030/4]	-	BRITISH	Rem	18.5-21.0	0.8	0.04-0.08	0.4	0.6	5.6-6.1	1.9-2.4	19-21	0.3-0.6, Al+Ti = 2.4-2.9	S=0.007 Zr= 0.04 Bi= 0.0001	Cu=0.20 B = 0.005	Ag= 0.0005 Pb= 0.002	-
2	MSRR 7038 [superseded by RRMS 33045, RRMS 33045/1, RRMS 33045/2, RRMS 33045/3, RRMS 33045/4]	-	BRITISH	Rem	18.5-21.0	0.8	0.04-0.08	0.4	0.6	5.6-6.1	1.9-2.4	19-21	0.3-0.6, Al+Ti = 2.4-2.9	S=0.007 Zr= 0.04 Bi= 0.0001	Cu=0.20 B = 0.005	Ag= 0.0005 Pb= 0.002	-
3	BS 2HR 10	-	BRITISH	Rem	19.0-21.0	0.7	0.04-0.08	0.4	0.6	5.6-6.1	1.9-2.4	19-21	0.3-0.6, Al+Ti = 2.4-2.8	S=0.007 Zr= 0.04 Bi= 0.0001	Cu=0.20 B = 0.005	Ag= 0.0005 Pb= 0.002	-
4	AIR 9165	NCK 20D	FRENCH	Rem	19.0-21.0	0.7	0.04-0.08	0.1-0.4	0.2-0.6	5.6-6.1	1.9-2.4	19-21	0.3-0.6, Al+Ti = 2.4-2.8	S=0.007 P= 0.015	Cu=0.20 Bi= 0.0001	Ag= 0.0005 Pb= 0.002	-
5	AMS 5886	-	AMERICAN	Rem	19.0-21.0	0.7	0.04-0.08	0.4	0.6	5.6-6.1	1.9-2.4	19-21	0.3-0.6	Al+Ti = 2.4-2.8	S=0.007 P= 0.015	Cu=0.20 B = 0.005	-
6	SUPERNI 263A (Indiginized)	-	INDIAN	Rem	18.5-21.0	0.8	0.04-0.08	0.4	0.6	5.6-6.1	1.9-2.4	19-21	0.3-0.6	Al+Ti = 2.4-2.9 Bi=1 ppm Ag = 5 ppm	S=0.007 Pb= 0.002	Cu=0.20 B = 0.005	-

Sl. No.	Specification	Grade	Heat treatment	Condition	Mechanical properties (Minimum)					
					UTS (MPa)	0.2% Proof (MPa)	% EL (5D)	% RA	Others	Remarks
1	MSRR 7035 [superseded by RRMS 33031, RRMS 33031/1, RRMS 33030/2, RRMS 33030/3, RRMS 33030/4]	-	-	Solutionize + Ppt	-	-	-	-	-	-
2	MSRR 7038 [superseded by RRMS 33045, RRMS 33045/1, RRMS 33045/2, RRMS 33045/3, RRMS 33045/4]	-	**Solutionize**: 1150 (±10)°C / 1 hour / AC or WQ **Ppt**: 800°C (±10°C) / 8 hrs / AC	Solutionize + Ppt	540 (at 780°C)	400 (at 780°C)	15 (at 780°C) or 16 (at 780°C for 4D) - for Bars/Section OR 12% (at 780°C) or 13% (at 780°C for 4D) - for Flash welded rings/finished parts	-	**Creep test: Temperature= 780oC, Stress= 120 MPa, Duration=50 hours, Total Plastic Strain: £0.1% max.**	For Flash welded cold-rolled rings-**Weld diffuse**: 1150°C / 1 hour / AC or WQ before Solutionizing and Ppt.
3	BS 2HR 10	-	**Solutionize**: 1150 (±10)°C / 30 minutes for ≤8 mm, 1.5-2.5 hours for >8 mm / WQ **Ppt**: 800°C (±10°C) / 8 hrs / AC	Solutionize + Ppt	540 (at 780°C)	400 (at 780°C)	12 (at 780°C)	-	**Creep test: Temperature= 780oC, Stress= 120 MPa, Duration= 50 hours, Total Plastic Strain: £0.1% max. [£0.15% max. for cold drawn and finally heat-treated bar]**	-
4	AIR 9165	NCK 20D	**Solutionize**: 1100-1150°C / WQ + **Ppt**: 790-810°C / 8 hrs / AC	Solutionize + Ppt	540 (at 780°C)	400 (at 780°C)	12 (at 780°C)	-	**Hardness: 230 BHN(min.), Creep test: Temperature= 780oC, Stress= 120 MPa, Duration= 50 hours, Total Plastic Strain: £0.1% max.**	-
5	AMS 5886	-	**Solutionize**: 1038-1163°C (±14°C)/ AC or faster **Ppt**: 802°C (±8°C) / 8 hrs / AC	Solutionize + Ppt	541 (at 780°C)	403 (at 780°C)	12 [@4D] (at 780°C)	-	**Creep test: Temperature= 779oC, Stress= 120 MPa, Duration= 50 hours, Total Plastic Strain: £0.1% max.**	-

6	SUPERNI 263A (Indiginized)	-	**Solutionize**: 1150°C (±10°C) / 0.5 hr for ≤ 8 mm ϕ OR 1.5-2.5 hrs for >8 mm ϕ / WQ or OQ or AC **Ppt**: 800°C (±5°C) / 8 hrs / AC	Solutionize + Ppt	1000 (±10%) [at RT]	580 (±10%) (at RT)	40 (±10%) (at RT)	-	**Hardness**: ≥ 275 HV	Creep and stress rupture test, samples shall be heat-treated as follows- **Solutionize**: 1150°C / 2 hr / WQ + **Ppt**: 800°C / 8 hrs / AC
								-	**Creep test: Temperature= 780oC, Stress= 120 MPa, Duration= 50 hours, Total Plastic Strain: £0.1% max.**	
								-	**Creep test: Temperature= 700oC, Stress= 417 MPa, Duration= 100 hours, Total Plastic Strain: £0.2% max.**	
					540 (at 780°C)	400 (at 780°C)	12 (at 780°C)	-	**Stress rupture test: Temperature= 600oC, Stress= 618 MPa, Time to rupture ≥100 hours**	
								-	**Stress rupture test: Temperature= 700oC, Stress= 448 MPa, Time to rupture ≥100 hours**	
								-	**Stress rupture test: Temperature= 800oC, Stress= 216 MPa, Time to rupture ≥100 hours**	

Data Sheet for Rationalisation of Aviation Metallic Materials - Nickel Alloy

General Grade of Material	NIMONIC 263	Type of Material	Ni-Cr-Co-Mo	Number of Specifications Identified	6
Rationalisation for Use	Bar				

Identified Specifications			Rationalised to	Form	Number of Specifications Identified	Number of Specifications Rationalised	Remarks
Sl. No.	Specification	Grade	Specification				
1	MSRR 7035 [superseded by RRMS 33031, RRMS 33031/1, RRMS 33030/2, RRMS 33030/3, RRMS 33030/4]	-	AMS 5886 / BS 2HR10 / SUPERNI 263A	Bar	6	3	-
2	MSRR 7038 [superseded by RRMS 33045, RRMS 33045/1, RRMS 33045/2, RRMS 33045/3, RRMS 33045/4]	-					
3	BS 2HR 10	-					
4	AIR 9165	NCK20D					
5	AMS 5886	-					
6	SUPERNI 263A (Indiginized)	-					

Data Sheet for Rationalisation of Aviation Metallic Materials - Nickel Alloy

General Grade of Material	INCONEL 625	Type of Material	Ni-Cr-Mo-Nb	Number of Specifications Identified	4
Rationalisation for Use	Bar				

Sl. No.	Specification	Grade	Origin	Chemical composition (Wt%) (wherever limit not mentioned consider as max)													
				Ni	Co	Fe	C	Si	Mn	Mo	Ti	Cr	Al	Others (each)			Others (total)
1	AMS 5666	-	AMERICAN	Rem	1.0	5.0	0.1	0.5	0.5	8.0-10.0	0.4	20.0-23.0	0.4	S=0.015 P=0.015	Ta=0.05, Cu=0.015	Nb= 3.15-4.15	-
2	CCT LA 398	NC22DNb	FRENCH	Rem	1.0	5.0	0.1	0.5	0.5	8.0-10.0	0.4	20.0-23.0	0.4	S=0.015	P=0.015	Nb+Ta= 3.15-4.15	-
3	ASTM B 564	UNS N06625	AMERICAN	58 min.	-	5.0	0.1	0.5	0.5	8.0-10.0	0.4	20.0-23.0	0.4	S=0.015	P=0.015	Nb+Ta= 3.15-4.15	-
4	BS EN 10095	NiCr22Mo9Nb Alloy no. 2.4856	BRITISH	58 min.	1.0	5.0	0.03-0.10	0.5	0.5	8.0-10.0	0.4	20.0-23.0	0.4	S=0.015 Cu = 0.50	P=0.020	Nb+Ta= 3.15-4.15	-

Sl. No.	Specification	Grade	Heat treatment	Condition	Mechanical properties (Minimum)					
					UTS (MPa)	0.2% Proof (MPa)	% EL (5D)	% RA	Hardness (BHN)	Remarks
1	AMS 5666	-	-	-	827	414	30 (@4D)	-	287 (max)	-
2	CCT LA 398	NC22DNb	**Solution treat:** 1160°C (± 10°C) / WQ	Solution treat	700	280	40 (@5D / 50mm)	-	250 (max)	-
3	ASTM B 564	UNS N06625	-	-	827	414	30 (@4D or 50 mm)	-	-	-
4	BS EN 10095	NiCr22Mo9Nb Alloy no. 2.4856	**Anneal:** 950-1000°C / WQ or AC rapidly	-	820-1050	415	30	-	240 (max)	-

Data Sheet for Rationalisation of Aviation Metallic Materials - Nickel Alloy

General Grade of Material	INCONEL 625	Type of Material	Ni-Cr-Mo-Nb	Number of Specifications Identified	4
Rationalisation for Use	Bar				

Identified Specifications			Rationalised to	Form	Number of Specifications Identified	Number of Specifications Rationalised	Remarks
Sl. No.	Specification	Grade	Specification				
1	AMS 5666	-	AMS 5666	BAR	4	1	-
2	CCT LA 398	NC22DNb					
3	ASTM B 564	UNS N06625					
4	BS EN 10095	NiCr22Mo9Nb Alloy no. 2.4856					

Data Sheet for Rationalisation of Aviation Metallic Materials - Nickel Alloy																
General Grade of Material			WASPALOY	Type of Material			Ni-Cr-Co-Mo		Number of Specifications Identified					9		
Rationalisation for Use			Bar													
Sl. No.	Specification	Grade	Origin	Chemical composition (Wt%) (wherever limit not mentioned consider as max)												
				Ni	Co	Fe	C	Si	Mn	Mo	Ti	Cr	Al	Others (each)		Others (total)
1	MSRR 7192	-	BRITISH	Rem	12.0-15.0	2.0	0.02-0.10	0.15	0.10	3.5-5.0	2.8-3.3	18-21	1.2-1.6	S=80 ppm Zr= 0.02-0.08 Bi= 1 ppm	Cu=0.1 B = 30-100 ppm	Ag= 5 ppm P= 0.015 Pb= 10 ppm	-
2	AIR 9165	NC 20 K14	FRENCH	Rem	12.0-15.0	2.0	0.03-0.10	0.15	0.10	3.5-5.0	2.75-3.25	18-21	1.2-1.6	S=0.015 Zr= 0.02-0.08	Cu=0.1 B = 0.003 -0.01	P= 0.015	-
3	AMS 5704	-	AMERICAN	Rem	12.0-15.0	2.0	0.02-0.10	0.15	0.10	3.5-5.0	2.75-3.25	18-21	1.2-1.6	S= 0.015 Zr= 0.02-0.08 Bi= 0.3 ppm	Cu=0.1 B = 0.003-0.010 Se= 3 ppm	Ag= 5 ppm P= 0.015 Pb= 5 ppm	-
4	AMS 5706	-	AMERICAN	Rem	12.0-15.0	2.0	0.02-0.10	0.15	0.10	3.5-5.0	2.75-3.25	18-21	1.2-1.6	S= 0.015 , Zr= 0.02-0.08 Bi= 0.3 ppm	Cu=0.1 B = 0.003-0.010 Se= 3 ppm	P= 0.015 Pb= 5 ppm	-

5	AMS 5707	-	AMERICAN	Rem	12.0-15.0	2.0	0.02-0.10	0.15 .	0.10	3.5-5.0	2.75-3.25	18-21	1.2-1.6	S= 0.015 Zr= 0.02-0.08 Bi= 0.3 ppm .	Cu=0.1 B = 0.003-0.010 Se= 3 ppm .	P= 0.015 Pb= 5 ppm	-
6	AMS 5708	-	AMERICAN	Rem	12.0-15.0	2.0	0.02-0.1	0.15	0.10	3.5-5.0	2.75-3.25	18.0-21.0	1.20-1.60	S=0.015 ppm P=0.015 B=0.003-0.01 ppm	Cu=0.1 Bi-0.3 ppm Zr-0.02-0.08 Se-3 ppm	Pb=5 ppm	-
7	AMS 5709	-	AMERICAN	Rem	12.0-15.0	2.0	0.02-0.1	0.15	0.10	3.5-5.0	2.75-3.25	18.0-21.0	1.20-1.60	S=0.015ppm P=0.015 B=0.003-0.01 ppm	Cu=0.1 Bi=0.3 ppm Zr=0.02-0.08 Se=3 ppm	Pb=5 ppm	-
8	NC20K14	-	FRENCH	Rem	12.0-15.0	2.0	0.03-0.10	0.25	0.10	3.5-5.0	2.75-3.25	18.0-21.0	1.20-1.60	-	S=0.03ppm B=0.003-0.01 ppm Zr=0.02-0.15	-	-
9	EMS 55388	-	AMERICAN	Rem	12.0-15.0	2.0 .	0.02-0.08	0.15 .	0.10	3.5-5.0	2.75-3.25	18-21	1.2-1.6	S= 0.015 Zr= 0.02-0.08 Al +Ti= 4.1-4.45	Cu=0.1 B = 0.003-0.010 N=175 ppm	P= 0.015 Other (each) = 0.15	-

Sl. No.	Specification	Grade	Section thickness 50mm Heat treatment	Condition	Mechanical properties (Minimum)					
					UTS (MPa)	0.2% Proof (MPa)	% EL (5D)	% RA	Others	Remarks
1	MSRR 7192	-	**Solution treat** : 995-1035°C / 4 hrs / OQ or WQ **Ppt**: 850°C / 4 hrs / AC + 760 °C / 16 hrs / AC	Solution treat + Ppt	1080 (at 535°C)	770 (at 535°C)	12 (at 535°C)	18 (at 535°C)	**Stress rupture test: Temperature= 730oC, Stress= 550 MPa, Time to rupture ≥ 23 hours. %E= ≥5% [@5D] or ≥6% [@4D]**	**Stress relieving** (for bars and forgings after machining): 1000°C/ 2-4 hrs / OQ [Hardness £ 280 HB]
2	AIR 9165	NC 20 K14	**Solution treat** :1020°C / AC **Ppt**: 845°C / 4 hrs / AC + 760 °C / 16 hrs / AC	Solution treat + Ppt	1080 (at 535°C)	770 (at 535°C)	12 (at 535°C)	18 (at 535°C)	**Hardness: 321-403 BHN** **Creep test: Temperature= 800oC, Stress= 100 MPa, Duration = 100 hours, Plastic strain = 0.2% max.** **Stress rupture test: Temperature= 730oC, Stress= 530 MPa, Time to rupture ≥ 30 hours. %E= ≥5%**	-
3	AMS 5704	-	**Solutionize** : 996-1038°C (±14°C) / 4 hrs ± 15 minutes / OQ or WQ + **Stabilize:** 843°C (±8°C) / 4 hrs ± 30 minutes / AC **Ppt**: 760°C (±8°C) / 16 ± 1 hr / AC	Solutionize + Stabilize + Ppt	1207 (at RT)	827 (at RT)	15 (at RT) [@4D]	18 (at RT)	**Hardness:341-401 BHN, Stress rupture test: Temperature= 732oC, Stress= ≥550 MPa, Time to rupture ≥ 23 hours, %E= ≥5% [@4D]**	-
					1069 (at 538°C)	724 (at 538°C)	15 (at 538°C) [@4D]	18 (at 538°C)	**Stress rupture test: Temperature= 816oC, Stress= ≥293 MPa, Time to rupture ≥ 23 hours, %E= ≥5% [@4D]**	
4	AMS 5706	-	**Solutionize** : 996-1038°C (±14°C) / AC or faster + **Stabilize:** 843°C (±8°C) / 4 hrs ± 15 minutes / AC **Ppt**: 760°C (±8°C) / 16 ± 1 hr / AC	Solutionize + Stabilize + Ppt	1103	758	15 [@4D]	18	**Hardness:321-437 BHN** **Stress rupture test: Temperature= 732oC, Stress= ≥517 MPa, Time to rupture ≥ 23 hours, %E= ≥8% [@4D]**	-

5	AMS 5707	-	**Solutionize** : 996-1038°C (±14°C) / 4 hrs ± 30 minutes / AC + **Stabilize**: 843°C (±8°C) / 4 hrs ± 30 minutes / AC **Ppt**: 760°C (±8°C) / 16 ± 1 hr / AC	Solutionize + Stabilize + Ppt	1103	758	15 [@4D]	18	**Hardness= 321-437 BHN** **Stress rupture test: Temperature= 732oC, Stress= ≥517 MPa, Time to rupture ≥ 23 hours, %E ≥ 8 [@4D]**	-
									Stress rupture test: Temperature= 816oC, Stress= ≥276 MPa, Time to rupture ≥ 23 hours, %E ≥ 5 [@4D]	
6	AMS 5708	-	Solutionise at 1080 ±15deg C for 4hrs, A/C Stablise at 845±10 deg C for 4 hrs. A/C. PPT at 760±10 deg C for for 16 hrs. A/C	Soln Treat + Ppt	-	-	-	-	**Stress rupture test: Temperature= 815oC, Stress= 330 MPa, Time to rupture ≥ 23 hours, %E ≥ 5 [@4D]**	-
7	AMS 5709	-	Solutionise at 1080 ±15deg C for 4hrs, A/C Stablise at 845±10 deg C for 4 hrs. A/C. PPT at 760±10 deg C for for 16 hrs. A/C	Soln Treat + Ppt	-	-	-	-	**Stress rupture test: Temperature= 815oC, Stress= 328 MPa, Time to rupture ≥ 23 hours, %E ≥ 5 [@4D]**	-
8	NC20K14	-	Anneal at 1020 deg C, Cool in air, Solutionise at 1080 deg C, AC, Age at 845 deg C dor 24 hrs, Cool in air and 760 C for 16 hrs. Cool in air	A HT	1080	770	12	-	Size = AT 535	-
9	EMS 55388	-	**Solution treat** : 1024-1079°C (±14°C) {for Condition A} OR 996-1038°C (±14°C) {for Condition B} / 4 hr / OQ or WQ or Polymer quench **Stabilize**: 843°C (±8°C) / 4 hrs / AC **Ppt**: 760°C (±8°C) / 16 hr / AC [For more details on heat treatment, refer EMS 55388 and HT 5088]	Solutionize + Stabilize + Ppt	1103 [at RT]-for Condition A	758 [at RT]-for Condition A	12% [@4D] [at RT]-for Condition A	15 [at RT]-for Condition A	**Stress rupture test (smooth): For Condition A: Temperature= 816oC, Stress= ≥328 MPa, Time to rupture ≥ 23 hours, %E ≥ 5 [@4D]**	**Condition A** : Material requiring max. stress rupture properties. **Condition B**: Material requiring max. tenslie properties.
					1207 [at RT]-for Condition B	827 [at RT]-for Condition B	12% [@4D] [at RT]-for Condition B	15 [at RT]-for Condition B	**Stress rupture test (smooth & notched): For Condition A: Temperature= 732oC, Stress= 552 MPa, Time to rupture ≥ 23 hours, %E ≥ 5 [@4D]**	
					1103 [at 538°C] -for Condition B	758 [at 538°C] -for Condition B	12% [@4D] [at 538°C] -for Condition B	15 [at 538°C] -for Condition B	**Stress rupture test (smooth & notched): For Condition B: Temperature= 732oC, Stress= 517 MPa, Time to rupture ≥ 23 hours, %E ≥ 5 [@4D]**	

Data Sheet for Rationalisation of Aviation Metallic Materials - Nickel Alloy

General Grade of Material			WASPALOY	Type of Material	Ni-Cr-Co-Mo	Number of Specifications Identified	9
Rationalisation for Use			Bar				
Identified Specifications			Rationalised to	Form	Number of Specifications Identified	Number of Specifications Rationalised	Remarks
Sl. No.	Specification	Grade	Specification				
1	MSRR 7192	-	AMS 5707 / EMS 55388	Bar	9	2	-
2	AIR 9165	NC20 K14					
3	AMS 5704	-					
4	AMS 5706	-					
5	AMS 5707	-					
6	AMS 5708	-					
7	AMS 5709	-					
8	NC20K14	-					
9	EMS 55388	-					

Data Sheet for Rationalisation of Aviation Metallic Materials - Nickel Alloy

General Grade of Material			**INCONEL 718**	**Type of Material**			**Ni-Fe-Cr-Nb**			**Number of Specifications Identified**						**7**
Rationalisation for Use			**Bar**													
Sl. No.	**Specification**	**Grade**	**Origin**	**Chemical composition (Wt%) (wherever limit not mentioned consider as max)**												
				Ni	**Co**	**Fe**	**C**	**Si**	**Mn**	**Mo**	**Ti**	**Cr**	**Al**	**Others (each)**		**Others (total)**
1	AMS 5662	-	AMERICAN	50-55	1.0	Rem	0.08	0.35	0.35	2.8-3.3	0.65-1.15	17-21	0.2-0.8	S=0.015 B= 0.006 Se=3 ppm Bi=0.3 ppm	P = 0.015 Cu=0.3 Ta = 0.05 Pb= 5 ppm	Nb=4.75-5.5	-
2	AMS 5663	-	AMERICAN	50-55	1.0	Rem	0.08	0.35	0.3	2.8-3.3	0.65-1.15	17-21	0.2-0.8	S=0.015 B= 0.006 Se=3 ppm Bi=0.3 ppm	P = 0.015 Cu=0.3 Pb= 5 ppm	Nb=4.75-5.5	-
3	AMS 5664	-	AMERICAN	50-55	1.0	Rem	0.08	0.35	0.35	2.8-3.3	0.65-1.15	17-21	0.2-0.8	S=0.015 B= 0.006	P = 0.015 Cu=0.3	Nb=4.75-5.5	-
4	AIR 9165	NC19FeNb	FRENCH	Rem	1.0	17-20	0.03-0.10	0.35	0.35	2.8-3.3	0.65-1.15	17-21	0.4-0.8	P = 0.015 S=0.015	Cu=0.1 B = 0.006	Nb+Ta = 5.00-5.50	-
5	MSRR 7115	-	BRITISH	50-55	1.0	Rem	0.02-0.08	0.35	0.35	2.8-3.3	0.7-1.15	17-21	0.3-0.7	P = 0.015 S=0.015, B= 20-60 ppm Bi =1 ppm	Cu=0.2 Pb=10 ppm Ag= 5 ppm	Nb+Ta = 4.75-5.50	-
6	SuperNi 718A (Indigenized)	-	INDIAN	50-55	1.0	Rem	0.02-0.08	0.35	0.35	2.8-3.3	0.75-1.15	17-21	0.3-0.7	P = 0.015 S=0.015 B= 60 ppm Bi = 0.5ppm Mg= 0.01 Sn= 50 ppm	Cu=0.3 Pb= 5 ppm Ag= 10 ppm H= 5 ppm	O=100 ppm Nb / Nb+Ta = 4.75-5.50 N = 140 ppm Ca=0.01	-
7	TU14-1-3905-85	KHN45MVTYUBR EP718	RUSSIAN	43-47	-	Rem	0.1	0.3	0.6	4-5.2	1.9-2.4	14-16	0.9-1.4	Nb=0.8-1.5 B=0.008 W=2.5-3.5 Ce=0.1 Zr=0.02	S=0.01	P= 0.015	-

Sl. No.	Specification	Grade	Heat treatment	Condition	Mechanical properties (Minimum)					
					UTS (MPa)	0.2% Proof (MPa)	% EL (5D)	% RA	Others	Remarks
1	AMS 5662	-	**Solution treat** 941-1010°C (±14°C) / AC or faster **Ppt**: 718°C (±8°C) / ≥ 8 hours / Cool at the rate of 56°C (±8°C) per hour upto 621°C (±8°C) / hold at 621°C (±8°C) for ≥ 8 hours / AC	Solution treat + Ppt	1276 (at RT)	1034 (at RT)	12 (@4D) (at RT)	15 (at RT)	331 BHN (min.)	During Ppt, instead of cooling at the rate of 56°C (±8°C) per hour, FC at any rate provided the time at 621°C (±8°C) is adjusted to give a total ppt time of 18 hours (min.)
					1000 (at 649°C)	862 (at 649°C)	12 (@4D) (at 649°C)	15 (at 649°C)	**Stress rupture test: Temperature= 649oC, Stress ≥ 689 MPa, Time to rupture ≥ 23 hours, %E(@4D)≥ 4**	
							12 (@4D)	15	**Stress ruture test-for forgings: Temperature: 650oC, Stress: 760 MPa, Time to rupture ≥ 25 hours, %E ≥ 5**	
2	AMS 5663	-	**Solution treat** 941-1010°C (±14°C) / AC or faster **Ppt**: 718-760°C (±8°C) / 8 hours / Cool at the rate of 56°C (±8°C) per hour upto 621-649°C (±8°C) / hold at 621°C (±8°C) for 8 hours / AC	Solution treat + Ppt	1276 (at RT)	1034 (at RT)	12 (@4D) (at RT)	15 (at RT)	331 BHN (min.)	During Ppt, instead of cooling at the rate of 56°C (±8°C) per hour, FC at any rate provided the time at 621-649°C (±8°C) is adjusted to give a total ppt time of 18 hours (min.)
					1000 (at 649°C)	862 (at 649°C)	12 (@4D) (at 649°C)	15 (at 649°C)	**Stress rupture test: Temperature = 649oC, Stress ≥ 689 MPa, Time to rupture ≥ 23 hours, %E(@4D) ≥ 4**	
3	AMS 5664	-	**Solution treat** 1066°C (±14°C) / AC or faster **Ppt**: 760°C (±8°C) / 10 hours ± 30 minutes / FC to 649°C (±8°C) / hold at 649°C (±8°C) until total ppt time of 20 hours / cool suitably	Solution treat + Ppt	1241	1034	10 for bars, 12 for forgings and flash welded rings (@4D)	12 for bars, 15 for forgings and flash welded rings	341 BHN (min.)	-
4	AIR 9165	NC19FeNb	**Solution treat** 955°C / 1 hr / AC **Ppt**: 720°C / 8 hours / Slowly cool at the rate of 50°C per hour upto 620°C / hold at 620°C for 8 hours / AC	Solution treat + Ppt	1240 (at RT)	1030 (at RT)	12 (at RT)	15 (at RT)	329 BHN (min.)	-
					1000 (at 650°C)	860 (at 650°C)	12 (at 650°C)	15% (at 650°C)	**Stress rupture test: Temperature= 650oC, Stress = 680 MPa, Time to rupture ≥ 30 hours, %E ≥ 5**	
5	MSRR 7115	-	**Solution treat** 950-980°C / 1 hr / AC or WQ or OQ **Ppt**: 720°C / 8 hours / FC at the rate of 45-65°C per hour upto 620°C / hold at 620°C for 8 hours / AC	Solution treat + Ppt	1270 (at RT)	1030 (at RT)	10	15	331 BHN (min.) or 361 HV (min.)	During Ppt, instead of cooling at the rate of 45-65°C per hour, FC at any rate provided the time at 620°C is adjusted to give a total ppt time of 18 hours (min.)
					1000 (at 650°C)	860 (at 650°C)	10 (at 650°C)	15 (at 650°C)	**Stress rupture test: Temperature= 650oC, Stress = 695 MPa, Time to rupture ≥ 23 hours, %E ≥ 5**	
6	SuperNi 718A (Indigenized)	-	**Solution treat** 925-1010°C (±14°C) / 1 hr / AC or faster **Ppt**: 720-760°C(±8°C) / 8 hours / cool at the rate of 45-65°C per hour upto 620-650°C / hold at selected temperature (±8°C) for 8 hours / AC	Solution treat + Ppt	1275 (at RT)	1030 (at RT)	12 (@4D or 50 mm) [at RT]	15	331 BHN (min.)	-
					1000 (at 650°C)	860 (at 650°C)	12 (@ 4D or 50 mm) [at 650°C]	15 (at 650°C)	**Stress rupture test (combined smooth and notched): Temperature= 650oC, Stress = 690 MPa, Time to rupture ≥ 23 hours**	
									Creep test: Temperature= 650oC, Stress = 550 MPa, Duration = 100 hours, Plastic strain £ 0.1%	
7	TU14-1-3905-85	KHN45MVTYUBR EP718	**Solution treat** 1000-1130°C (±14°C) / 2-3 hr / Oil Quench **Age**: 560 -730°C(±8°C) / 16 hours, Air cool	Solution treat + Age	1128 (at RT)	687 (at RT)	12 (@ 5D) [at RT]	14	Stress rupture test : Temperature= 600oC, Stress = 785 MPa, Time to rupture ≥ 60 hours	-

Data Sheet for Rationalisation of Aviation Metallic Materials - Nickel Alloy							
General Grade of Material			**INCONEL 718**	**Type of Material**	**Ni-Fe-Cr-Nb**	**Number of Specifications Identified**	**7**
Rationalisation for Use			**Bar**				
Identified Specifications			**Rationalised to**	**Form**	**Number of Specifications Identified**	**Number of Specifications Rationalised**	**Remarks**
Sl. No.	**Specification**	**Grade**	**Specification**				
1	AMS 5662	-	AMS 5662 / SUPERNI 718A	Bar	7	2	-
2	AMS 5663	-					
3	AMS 5664	-					
4	AIR 9165	NC19FeNb					
5	MSRR 7115	-					
6	SuperNi 718A (Indigenized)	-					
7	TU14-1-3905-85	KHN45MVTYUBR EP718					

Data Sheet for Rationalisation of Aviation Metallic Materials - Nickel Alloy

General Grade of Material	NIMONIC 75	Type of Material	Ni-Cr-Co-Fe	Number of Specifications Identified	6
Rationalisation for Use	Bar				

Sl. No.	Specification	Grade	Origin	Chemical composition (Wt%) (wherever limit not mentioned consider as max)													
				Ni	Co	Fe	C	Si	Mn	Mo	Ti	Cr	Al	Others (each)			Others (total)
1	RRMS 33030 & RRMS 33030/1 [supersedes MSRR 7004]	-	BRITISH	Rem	5.0	5.0	0.08-0.15	1.0	1.0	-	0.2-0.6	18-21	-	S=0.02	Cu=0.50	Pb= 0.0050	-
2	MSRR 7008 [superseded by RRMS 33030 & RRMS 33030/2]	-	BRITISH	Rem	5.0	5.0	0.08-0.15	1.0	1.0	-	0.2-0.6	18-21	-	S=0.02	Cu=0.50	Pb= 0.0050	-
3	BS 2HR 5	-	BRITISH	Rem	5.0	5.0	0.08-0.15	1.0	1.0	-	0.2-0.6	18-21	-	S=0.02	Cu=0.50	Pb= 0.0050	-
4	BS 3HR 504	-	BRITISH	Rem	5.0	5.0	0.08-0.15	1.0	1.0	-	0.2-0.6	18-21	-	S=0.02	Cu=0.50	Pb= 0.0050	-
5	AIR 9165	NC 20T	FRENCH	Rem	5.0	5.0	0.08-0.15	1.0	1.0	-	0.2-0.6	18-21	-	S=0.015, P=0.015	Cu=0.50	Pb= 0.02	-
6	SuperNi 75A / MDN 75 (Indigenized)	-	INDIAN	Rem	5.0	1.0	0.08-0.12	0.8	0.7	-	0.2-0.4	19-21	0.15	S=0.01, P=0.015	Cu=0.07	Pb= 0.005	-

Sl. No.	Specification	Grade	Heat treatment	Condition	Mechanical properties (Minimum)					
					UTS (MPa)	0.2% Proof (MPa)	% EL (5D)	% RA	Hardness (BHN)	Remarks
1	RRMS 33030 & RRMS 33030/1 [supersedes MSRR 7004]	-	**Anneal:** 1050°C / AC or WQ	Annealed	650	230	30 (@ 5D)	-	230 (max)	For £ 8 mm f cold worked bar in annealed & straightened condition, hardness shall be 260 BHN max. or 270 HV max.
2	MSRR 7008 [superseded by RRMS 33030 & RRMS 33030/2]	-	**Solution treat:** 1050°C / ≥ 30 minutes / AC or WQ	Solution treat	620	230	30 (27 for flash welded rings)	-	-	For Flash welded and cold rolled rings- Weld diffuse at 1050°C / ≥ 30 minutes / AC + Cold roll + Solution treat at 1050°C / 1 hr / AC
3	BS 2HR 5	-	**Anneal**: 1000-1100°C / AC	Annealed	650	230	30	-	230 BHN (max). or 235 HV (max)	-
4	BS 3HR 504	-	**Anneal**: 1050°C (±10°C) / AC or WQ or cool suitably in controlled atmosphere	Annealed	620	232	30	-	230 BHN (max) or 240 HV (max)	-
5	AIR 9165	NC 20T	**Anneal**: 1000-1050°C / AC	Annealed	640	240	30	-	230 (max)	-
6	SuperNi 75A / MDN 75 (Indigenized)	-	**Anneal**: 1000°C (±10°C) / 1-4 hours / AC	Annealed	637	216	35 (@5D)	50	230 BHN (max) or 235 HV (max) **Stress rupture test: Temperature= 700oC, Stress = 103 MPa, Time to rupture ≥ 100 hours** **Creep test: Temperature= 700oC, Stress = 39 MPa, Duration = 100 hours, Plastic strain £ 0.2%**	-

Data Sheet for Rationalisation of Aviation Metallic Materials - Nickel Alloy

General Grade of Material			NIMONIC 75	Type of Material	Ni-Cr-Co-Fe	Number of Specifications Identified		6
Rationalisation for Use			Bar					
Identified Specifications			Rationalised to	Form	Number of Specifications Identified	Number of Specifications Rationalised	Remarks	
Sl. No.	Specification	Grade	Specification					
1	RRMS 33030 & RRMS 33030/1 [supersedes MSRR 7004]	-	BS 2HR 5 / SUPERNI 75A	Bar	6	2	-	
2	MSRR 7008 [superseded by RRMS 33030 & RRMS 33030/2]	-						
3	BS 2HR 5	-						
4	BS 3HR 504	-						
5	AIR 9165	NC 20T						
6	SUPERNI 75A / MDN 75 (Indigenized)	-						

Data Sheet for Rationalisation of Aviation Metallic Materials - Nickel Alloy

General Grade of Material	IN718 PLUS	Type of Material	Ni-Cr-Fe	Number of Specifications Identified	3
Rationalisation for Use	BAR				

Sl No	Specification	Grade	Origin	Chemical composition (Wt%) (wherever limit not mentioned consider as max)													
				Ni	Co	Fe	C	Si	Mn	Mo	Ti	Cr	Al	Cu	Others: Each		Others: Total
1	MSRR 7202	IN718 PLUS	BRITISH	50-55	1.0	Rem	0.02-0.045	0.2	0.20	2.8-3.3	0.75-1.1	17.0-21.0	0.30-0.70	0.2	S=80 ppm P=0.015 Ta=0.5 B=20-60 ppm Pb=0.0005	Bi=1 ppm Mg=100 ppm Nb+Ta=5.1-5.50 Pb=10 ppm Ca=0.01	-
2	CCT 771	INCONEL 718 PQ	FRENCH	Rem	1.0	15-21	0.01-0.08	0.35	0.35	2.8-3.4	0.75-1.2	17.0-21.1	0.3-0.7	0.3	S=13 ppm P=0.015 Ta=0.5 B=0.006 ppm Pb=0.0005 Bi=0.3 ppm Mg=100 ppm Nb+Ta=5.1-5.50	Pb=10 ppm Ca=50 PPM Ag=5 ppm Sn=50 ppm Se=3 ppm O=50 ppm N=100 ppm	-
3	EMS 55476 (supersedes EMS 55458)	Delta Processed (DP) 718	AMERICAN	50-55	1.0	Rem	0.03	0.35	0.35	2.8-3.3	0.65-1.15	17-21	0.2-0.8	0.3	S=0.015, B= 0.006, Mg=0.003, N=0.01	P = 0.015, Nb+Ta = 4.75-5.5	Others (each) = 0.1

Sl No	Specification	Grade	Heat treatment	Condition	Mechanical properties (Minimum)						
					Size (mm)	UTS (MPa)	0.2% Proof (MPa)	% EL (5D)	% RA	Others	Hardness (HBW/BHN)
1	MSRR 7202	IN718 PLUS	Solution Treat at 950-980Cel/1h/WQ or OQ PPT-720 Cel/8h, Furnace Cool-45-65Cel/h to 620 Cel PPT- 620 Cel/8h/AC	Soln Treat + Ppt	-	1345	1140	10	-	-	-
2	CCT 771	INCONEL 718 PQ	Solution Treat at 950-980Cel/1h/WQ or OQ PPT-720 Cel/8h, Furnace Cool-45-65Cel/h to 620 Cel PPT- 620 Cel/8h/AC	Soln Treat + Ppt	<150 mm	1450	1240	12	-	-	-
3	EMS 55476 (supersedes EMS 55458)	Delta Processed (DP) 718	Heat treat in accordance with HT5071 except that solution temperature shall be in the range of 954-996°C	Solution treat + Ppt	-	1345 (at RT)	1103 (at RT)	12 [@4D] (at RT)	15 (at RT)	**Stress rupture test: Temperature = 649oC, Stress= 758 MPa, Time to rupture ≥ 25 hours, %E (@4D) ≥ 5**	-
					-	1083 (at 649°C)	931 (at 649°C)	12 [@4D] (at 649°C)	15 (at 649°C)		

Data Sheet for Rationalisation of Aviation Metallic Materials - Nickel Alloy							
General Grade of Material			IN718 PLUS	Type of Material	Ni-Cr-Fe	Number of Specifications Identified	3
Rationalisation for Use			BAR				
Identified Specifications			Rationalised to	Form	Number of Specifications Identified	Number of Specifications Rationalised	Remarks
Sl No	Specification	Grade	Specification				
1	MSRR 7202	IN718 PLUS	MSRR 7202	BAR	3	1	-
2	CCT 771	INCONEL 718 PQ					
3	EMS 55476 (supersedes EMS 55458)	Delta Processed (DP) 718					

Data Sheet for Rationalisation of Aviation Metallic Materials - Nickel Alloy

General Grade of Material	NIMONIC 80A	Type of Material	Ni-Cr-Co-Ti-Al	Number of Specifications Identified	7
Rationalisation for Use	Bar				

Sl. No.	Specification	Grade	Origin	Chemical composition (Wt%) (wherever limit not mentioned consider as max)										Others (each)			Others (total)
				Ni	Co	Fe	C	Si	Mn	Mo	Ti	Cr	Al				
1	MSRR 7009	-	BRITISH	Rem	2.0	1.5	0.04-0.10	0.8	0.40	-	1.8-2.7	18-21	1.0-1.8	S=0.015 Bi= 0.0001	Cu=0.20 B = 0.008	Ag= 0.0005 Pb= 0.001	-
2	MSRR 7010 (Cancelled|	-	BRITISH	Rem	2.0	1.5	0.04-0.10	0.8	0.40	-	1.8-2.7	18-21	1.0-1.8	S=0.015 Bi= 0.0001	Cu=0.20	Ag= 0.0005	-
3	MSRR 7011	-	BRITISH	Rem	2.0	1.5	0.04-0.10	0.8	0.40	-	1.8-2.7	18-21	1.0-1.8	S=0.015 Bi= 0.0001	Cu=0.20 B = 0.008	Ag= 0.0005 Pb= 0.002	-
4	MSRR 7012	-	BRITISH	Rem	2.0	1.5	0.04-0.10	0.8	0.40	-	1.8-2.7	18-21	1.0-1.8	S=0.015 Bi= 0.0001	Cu=0.20 , B = 0.008	Ag= 0.0005 Pb= 0.002	-
5	BS 3HR1	-	BRITISH	Rem	2.0	1.5	0.04-0.10	1	1.0	-	1.8-2.7	18-21	1.0-1.8	S=0.015 Bi= 0.0001	Cu=0.20 B = 0.008	Ag= 0.0005 Pb= 0.002	-
6	BS 4HR 601 (supersedes MSRR 7013)	-	BRITISH	Rem	2.0	1.5	0.04-0.10	1	1.0	-	1.8-2.7	18-21	1.0-1.8	S=0.015 Bi= 0.0001	Cu=0.20 B = 0.008	Ag= 0.0005 Pb= 0.002	-
7	AIR 9165	NC20TA	FRENCH	Rem	2.0	1.5	0.04-0.10	1	1.0	-	1.8-2.7	18-21	1.0-1.8	S=0.015 Bi= 0.0001	Cu=0.20 B = 0.008	Ag= 0.0005 Pb= 0.001 P = 0.015	-

Sl. No.	Specification	Grade	Heat treatment	Condition	Mechanical properties (Minimum)					
					UTS (MPa)	0.2% Proof (MPa)	% EL (5D)	% RA	Others	Remarks
1	MSRR 7009	-	**Solutionize**: 1080°C / ≥ 8 hrs / AC **Ppt**: 700°C / ≥ 16 hrs / AC	Solutionize + Ppt	-	-	-	-	**Stress rupture test: Temperature= 750oC, Stress= 340 MPa, Time to rupture ≥ 23 hours**	-
2	MSRR 7010 (cancelled)	-	**Solutionize**: 1080°C (±10°C) / 8 hrs / AC **Ppt**: 700°C (±5°C) / 16 hrs / AC	Solutionize + Ppt	-	-	-	-	**Stress rupture test: Temperature= 750oC, Stress= 340 MPa, Time to rupture ≥ 30 hours**	-
3	MSRR 7011	-	**Solutionize**: 1080°C (±10°C) / 8 hrs / AC or WQ [OQ for bars > 40 mm ϕ] **Ppt**: 700°C (±10°C) / 16 hrs / AC OR 750°C (±10°C) / 4 hrs / AC	Solutionize + Ppt	1000	600	20	-	**Hardness = 265 BHN (miin.) or 285 HV (min.). Stress rupture test: Temperature= 750oC, Stress= 340 MPa, Time to rupture ≥ 30 hours**	During solutionizing, soaking time for bars ≤3 mm is 1 hr; >3-6 mm is 2 hours; >6-12.5 mm is 4 hours; and >12.5 mm is 8 hours.
4	MSRR 7012	-	**Soften:** 1050-1080°C / WQ **Solutionize**: 1050-1080°C / 2 hrs / WQ **Ppt**: 750°C / 4 hrs / AC	Solutionize + Ppt	1000	620	20	-	**Hardness = 265 BHN (miin.) or 285 HV (min.). Stress rupture test: Temperature= 750oC, Stress= 340 MPa, Time to rupture ≥ 30 hours**	For Flash welded cold-rolled rings, **Weld diffuse:** 1120°C / 1 hr / AC or WQ before Solution treatment and Ppt
5	BS 3HR1	-	**Soften:** 1080°C (±10°C) / ≤ 30 minutes / WQ, **Solutionize**: 1080°C (±10°C) / 8 hrs / AC or OQ or WQ **Ppt**: 700°C (±10°C) / 16 hrs / AC	Solutionize + Ppt	1000	600	20	-	Hardness = 285 BHN (miin.) or 310 HV (min.). Stress rupture test: Temperature= 750oC, Stress= 340 MPa, Time to rupture ≥ 30 hours	During solutionizing, for Bars & extruded sections for machining (viz. HR1A) as well as for Forgings (HR1D), soaking time is ≥ 1 hour for ≤3 mm; ≥ 2 hours for >3-6 mm; and ≥ 4 hours for > 6-12.5 mm
6	BS 4HR 601 (supersedes MSRR 7013)	-	**Solutionize:** 1080°C (±10°C) / 15-30 minutes for ≤15 mm & 30-60 minutes for 15-30 mm / AC or faster **Ppt**: 750°C (±10°C) / 4 hrs / AC	Solutionize + Ppt	1000	620	20	-	**Stress rupture test: Temperature= 750oC, Stress= 340 MPa, Time to rupture ≥ 30 hours**	-
7	AIR 9165	NC 20 TA	**Anneal:** 1050-1080°C / AC **Ppt**: 700°C / 16 hrs / AC	Solutionize + Ppt	1000	620	20	-	Hardness = 280 BHN (miin.), **Stress rupture test: Temperature= 750oC, Stress= 305 MPa, Time to rupture ≥ 75 hours** **Stress rupture test: Temperature= 815oC, Stress= 240 MPa, Time to rupture ≥ 30 hours, %E ≥ 3.5**	-

Data Sheet for Rationalisation of Aviation Metallic Materials - Nickel Alloy

General Grade of Material			NIMONIC 80A	Type of Material	Ni-Cr-Co-Ti-Al	Number of Specifications Identified	7
Rationalisation for Use			Bar				
Identified Specifications			Rationalised to	Form	Number of Specifications Identified	Number of Specifications Rationalised	Remarks
Sl. No.	Specification	Grade	Specification				
1	MSRR 7009	-	BS 3 HR1	Bar	7	1	-
2	MSRR 7010 (cancelled)	-					
3	MSRR 7011	-					
4	MSRR 7012	-					
5	BS 3HR1	-					
6	BS 4HR 601 (supersedes MSRR 7013)	-					
7	AIR 9165	NC 20 TA					

Data Sheet for Rationalisation of Aviation Metallic Materials - Nickel Alloy																	
General Grade of Material			NIMONIC 90	Type of Material			Ni-Cr-Co-Ti-Al	Number of Specifications Identified					6				
Rationalisation for Use			Bar														
Sl. No.	Specification	Grade	Origin	Chemical composition (Wt%) (wherever limit not mentioned consider as max)													
				Ni	Co	Fe	C	Si	Mn	Mo	Ti	Cr	Al	Others (each)			Others (total)
1	MSRR 7137	-	BRITISH	Rem	15-21	1.5	0.13	1.0	1.0	-	2.0-3.0	18-21	1.0-2.0	S=0.015 Zr= 0.15 Bi= 0.0001	Cu=0.20 B = 0.02	Ag= 0.0005 Pb= 0.001	-
2	MSRR 7135	-	BRITISH	Rem	15-21	1.5	0.13	0.8	0.4	-	2.0-3.0	18-21	1.0-2.0	S=0.015 Zr= 0.15 Bi= 0.0001	Cu=0.20 B = 0.02	Ag= 0.0005 Pb= 0.002	-
3	MSRR 7129	-	BRITISH	Rem	15-21	1.5	0.13	0.8	0.4	-	2.0-3.0	18-21	1.0-2.0	S=0.015 Zr= 0.15 Bi= 0.0001	Cu=0.20 B = 0.02	Ag= 0.0005 Pb= 0.001	-
4	MSRR 7016	-	BRITISH	Rem	15-21	1.5	0.13	0.8	0.4	-	2.0-3.0	18-21	1.0-2.0	S=0.015 Zr= 0.15 Bi= 0.0001	Cu=0.20 B = 0.02	Ag= 0.0005 Pb= 0.002	-
5	BS HR 2	-	BRITISH	Rem	15-21	1.5	0.13	1	1.0	-	2.0-3.0	18-21	1.0-2.0	S=0.015 Zr= 0.15 Bi= 0.0001	Cu=0.20 B = 0.02	Ag= 0.0005 Pb= 0.002	-
6	AIR 9165	NCK 20 TA	FRENCH	Rem	15-21	1	0.13	1	1.0	-	2.0-3.0	18-21	1.0-2.0	S=0.015 P= 0.015	Cu=0.20 B = 0.02	Pb= 0.02	-

Sl. No.	Specification	Grade	Heat treatment	Condition	Mechanical properties (Minimum)					
					UTS (MPa)	0.2% Proof (MPa)	% EL (5D)	% RA	Others	Remarks
1	MSRR 7137	-	**Stress relieve:** 1080°C (±10°C) / 30 minutes / AC (if required). **Solutionize**: 1080°C (±10°C) / 8 hrs / AC (for bars) and AC or OQ or WQ (for forgings) **Ppt**: 700°C (±10°C) for 16 hrs OR 750°C (±10°C) for 4 hrs / AC	Solutionize + Ppt	1080	695	20	-	**Stress rupture test: Temperature= 870 ° C, Stress= 140 MPa, Time to rupture ≥ 30 hours**	During solutionizing, soaking time for bars ≤ 3 mm is 1 hr, >3-6 mm is 2 hours and >6-12.5 mm is 4 hours
2	MSRR 7135	-	**Soften (anneal):** 1050-1080°C / WQ. **Solutionize**: 1050-1080°C / 8 hrs / AC **Ppt**: 700°C for 16 hrs OR 750°C for 4 hrs / AC	Solutionize + Ppt	1080	620	18	-	**Stress rupture test: Temperature= 870oC, Stress= 140 MPa, Time to rupture ≥ 30 hours**	-
3	MSRR 7129	-	**Solutionize**:1080°C / 8 hrs / AC **Ppt**: 700°C / ≥ 16 hrs / AC	Solutionize + Ppt	-	-	-	-	**Stress rupture test: Temperature= 870oC, Stress= 140 MPa, Time to rupture ≥ 56 hours**	-
4	MSRR 7016	-	**Solutionize**: 1080°C / AC or WQ **Ppt**: 750°C / 4 hrs / AC	Solutionize + Ppt	820 (at 650°C)	590 (at 650°C)	8 (at 650°C)	-	**Hardness: 295-370 HV (for forgings); 295-330 HV (for bars). Stress rupture test: Temperature= 870oC, Stress= 140 MPa, Time to rupture ≥ 30 hours**	During solutionizing, soaking time for ≤ 3 mm is 1 hr, >3-6 mm is 2 hours; >6-12.5 mm is 4 hours; and >12.5-25 mm is 8 hrs
5	BS HR 2	-	**Solutionize**: 1080°C (±10°C) / 8 hrs / AC or OQ or WQ **Ppt**: 700°C (±10°C) / 16 hrs / AC	Solutionize + Ppt	1080	695	20	-	Hardness: 293 BHN (min.) or 310 HV (min.). Stress rupture test: Temperature= 870oC, Stress= 140 MPa, Time to rupture ≥ 30 hours	During solutionizing, for Bars & extruded sections for machining (viz. HR2A) as well as for Forgings (HR2D), soaking time is 1 hour for ≤3 mm; 2 hours for >3-6 mm; and 4 hours for > 6-12.5 mm
6	AIR 9165	NCK 20 TA	**Solutionize**: 1050-1080°C / 8 hrs / AC **Ppt**: 710°C / 16 hrs / AC	Solutionize + Ppt	1080	690	20	-	290 BHN (min.) **Stress rupture test: Temperature= 700 °C, Stress= 590 MPa, Time to rupture ≥ 30 hours, %E ≥ 5 [for forgings)** **Stress rupture test: Temperature= 815°C, Stress= 290 MPa, Time to rupture ≥ 30 hours, %E ≥ 7**	-

Data Sheet for Rationalisation of Aviation Metallic Materials - Nickel Alloy

General Grade of Material			NIMONIC 90	Type of Material	Ni-Cr-Co-Ti-Al	Number of Specifications Identified		6
Rationalisation for Use			Bar					
Identified Specifications			Rationalised to		Form	Number of Specifications Identified	Number of Specifications Rationalised	Remarks
Sl. No.	Specification	Grade	Specification	Grade				
1	MSRR 7137	-	AIR 9165 / BS HR 2	NCK 20 TA	BAR	6	2	-
2	MSRR 7135	-						
3	MSRR 7129	-						
4	MSRR 7016	-						
5	BS HR 2	-						
6	AIR 9165	NCK 20 TA						

Data Sheet for Rationalisation of Aviation Metallic Materials - Nickel Alloy

General Grade of Material	NIMONIC 90	Type of Material	Ni-Cr-Co-Ti-Al Alloy	Number of Specifications Identified	9
Rationalisation for Use	WIRE				

Sl No	Specification / Grade	Origin	Chemical composition (Wt%) (wherever limit not mentioned consider as max)												
			NI	Co	Fe	C	Si	Mn	Mo	Ti	Cr	Al	S	Cu	Others
1	BS HR 502	BRITISH	Rem	15-21	1.5	0.13	1.0	1.0	-	2.0-3.0	18-21	1.0-2.0	0.015	0.2	Ag=0.0005 B=0.02 Pb=0.001 Bi=0.0001 Zr=0.15
2	BS HR 501	BRITISH	Rem	15-21	2	0.13	1.0	1.0	-	2.0-3.0	18-21	1.0-2.0	0.015	0.2	Ag=0.0005 B=0.02 Pb=0.001 Bi=0.0001 Zr=0.15
3	BS HR 503	BRITISH	Rem	15-21	1.5	0.13	1.0	1.0	-	2.0-3.0	18-21	1.0-2.0	0.015	0.2	Ag=0.0005 B=0.02 Pb=0.001 Bi=0.0001 Zr=0.15
4	BS HR 506	BRITISH	Rem	15-21	1.5	0.13	1.0	1.0	-	2.0-3.0	18-21	1.0-2.0	0.015	0.2	Ag=0.0005 B=0.02 Pb=0.002 Bi=0.0001 Zr=0.15
5	MSRR 7014	BRITISH	Rem	15-21	1.5	0.13	1.0	1.0	-	2.0-3.0	18-21	1.0-2.0	0.015	0.2	Ag=0.0005 B=0.02 Pb=0.001 Bi=0.0001 Zr=0.15
6	MSRR 7015	BRITISH	Rem	15-21	1.5	0.13	0.80	0.40	-	2.0-3.0	18-21	1.0-2.0	0.015	0.2	Ag=0.0005 B=0.02 Pb=0.001 Bi=0.0001 Zr=0.15

7	BSEM 796	BRITISH	Rem	15-21	1.5	0.13	0.80	0.40	-	2.0-3.0	18-21	1.0-2.0	0.015	0.2	Ag=0.0005 B=0.02 Pb-0.001 Bi=0.0001 Zr=0.15
8	BSEM 797	BRITISH	Rem	15-21	1.5	0.13	0.80	0.40	0.49	2.0-3.0	18-21	1.0-2.0	0.015	0.2	Ag=0.0005 B=0.02 Pb=0.001 Bi=0.0001 Zr=0.15
9	MIDHANI ATG S4	INDIAN	Rem	19	1.0 max	0.08	-	-	-	2.5	19	1.5	-	-	-

Sl No	Specification / Grade	Heat treatment	Condition	Mechanical properties (Minimum)				
				Size (mm) / Stress Rupture	UTS (MPa)	0.2% Proof (MPa)	% EL (5D)	Hardness (HBW/BHN)
1	BS HR 502	Solutionise at 1050-1100ºC in protective environment and quench in water. Ppt at 750± 10ºC for 4 hrs and air cool for 16 hrs and cool in air.	Soln.	0.44-0.99 >0.99 Stress Rupture Test Temp : 870°C Stress : 140 MPa Time to rupture : 30 hours	1080 1080	. 620	15 15	-
2	BS HR501	Ppt at 600 ±10ºC for 16 hrs. Cool in air or 650 ±10 ºC for 4 hrs. Cool in air. Solutionise at 1080 ±10 ºC. Air cool for 8 hrs. Cool in air. Ppt at 700 ±10 ºC for 16 hrs. Cool in air	Ppt	0.44-1.0 1.0-5.0 5.0-8.0 Stress Rupture Test Temp : 870°C Stress : 140 MPa Time to rupture : 30 hours	1540 1390 1310	- 1160 1000	- - 10	-
3	BS HR 503	Ppt at 600 ±10 ºC for 16 hrs. Cool in air	CD	0.44-2.0	1390 max	-	-	-
			Ppt	0.44-1.0 1.0-2.0	1390 1390	1160	-	-

4	BS HR 506	Soften at 1100-1050ºC	Soft treat(Tensile properties are not available for Soft Condition)	-	-	-	-	-
5	MSRR 7014	Ppt at 600 ±10 ºC for 16 hrs. Cool in air or 650 ±10 ºC for 4 hrs. Cool in air. Solutionise at 1080 ±10 ºC. Air cool for 8 hrs. Cool in air. Ppt at 700± 10 ºC for 16 hrs. Cool in air	Ppt	0.44-1.0 1.0-5.0 5.0-8.0 Stress Rupture Test Temp : 870°C Stress : 140 MPa Time to rupture : 30 hours	1540 1390 1310	- 1160 1000	- - 10	-
6	MSRR 7015	Solutionise at 1080± 10ºC and cool in air. Ppt at 750± 10ºC for 4 hrs. Cool in air	Soln.	0.44-0.99 >0.99 Stress Rupture Test Temp : 870°C Stress : 140 MPa Time to rupture : 30 hours	1080 1080	620	15 15	-
7	BSEM 796	Ppt at 600 ±10 ºC for 16 hrs. Cool in air or 650 ±10 ºC for 4 hrs. Cool in air. Solutionise at 1080 ±10 ºC. Air cool for 8 hrs. Cool in air. Ppt at 700 ±10º C for 16 hrs. Cool in air	Ppt	0.44-1.0 1.0-5.0 5.0-8.0 Stress Rupture Test Temp : 870°C Stress : 140 MPa Time to rupture : 30 hours	1540 1390 1310	.. 1160 1000	 10	-
8	BSEM 797	Solutionise at 1080± 10ºC and cool in air. Ppt at 750± 10ºC for 4 hrs. Cool in air	Soln.	0.44-0.99 >0.99 Stress Rupture Test	1080 1080	.. 620	15 15	-
9	MIDHANI ATG S4	-	-	Stress Rupture Test Temp : 650°C Stress : 550 MPa Time to rupture : 100 hours	1235 at RT	795 at RT	33	-

Data Sheet for Rationalisation of Aviation Metallic Materials - Nickel Alloy

General Grade of Material		NIMONIC 90	Type of Material	Ni-Cr-Co-Ti-Al Alloy	Number of Specifications Identified	9
Rationalisation for Use		WIRE				
Identified Specifications		Rationalised to	Form	Number of Specifications Identified	Number of Specifications Rationalised	Remarks
Sl No	Specification / Grade	Specification				
1	BS HR 502	HR 502 / MIDHANI ATG S4	WIRE	9	2	-
2	BS HR 501					
3	BS HR 503					
4	BS HR 506					
5	MSRR 7014					
6	MSRR 7015					
7	BSEM 796					
8	BSEM 797					
9	MIDHANI ATG S4					

Data Sheet for Rationalisation of Aviation Metallic Materials - Nickel Alloy

General Grade of Material	NIMONIC 115 [for turbine blade blanks]	Type of Material	Ni-Co-Cr-Al-Mo-Ti	Number of Specifications Identified	5
Rationalisation for Use	Bar				

Sl. No.	Specification / Grade	Origin	Chemical composition (Wt%) (wherever limit not mentioned consider as max)													
			Ni	Co	Fe	C	Si	Mn	Mo	Ti	Cr	Al	Others (each)			Others (total)
1	MSRR 7023	BRITISH	Rem	13-17	0.8	0.12-0.20	0.25	0.20	3.0-5.0	3.5-4.5	14.0-16.0	4.5-5.5	S=0.01 Bi= 0.0001 Zr=0.08	Cu=0.20 B = 0.010-0.025	Ag= 0.0005 Pb= 0.0005	Electron Vacany No. (Nv) £ 2.8 for remelting stock
2	MSRR 7022	BRITISH	Rem	13-17	0.8	0.12-0.20	0.25	0.20	3.0-5.0	3.5-4.5	14.0-16.0	4.5-5.5	S=0.01 Bi= 0.0001 Zr=0.08	Cu=0.20 B = 0.010-0.025	Ag= 0.0005 Pb= 0.0005	Electron Vacany No. (Nv) £ 2.8
3	BS HR 4	BRITISH	Rem	13-15.5	1.0	0.12-0.20	1.0	1.0	3.0-5.0	3.5-4.5	14.0-16.0	4.5-5.5	S=0.015 Bi= 0.0001 Zr=0.15	Cu=0.20 B = 0.010-0.025	Ag= 0.0005 Pb= 0.0015	Note 1
4	DTD 5017 (Obsolete)	BRITISH	Rem	13-15.5	1.0	0.2	1.0	1.0	3.0-5.0	3.5-4.5	14.0-16.0	4.5-5.5	S=0.015 Zr=0.15	Cu=0.20 B = 0.010-0.025	Pb= 0.005	-
5	SuperNi 115 (Indigenized)	INDIAN	Rem	13-17	0.8	0.12-0.20	0.25	0.20	3.0-5.0	3.5-4.5	14.0-16.0	4.5-5.5	S=0.010 Bi= 0.0001 Zr=0.08	Cu=0.20 B = 0.010-0.025	Ag= 0.0005 Pb= 0.0005	Electron Vacany No. (Nv) £ 2.8

Note 1: Electron vacancy no. (Nv) limits to be agreed between the manufacturer and purchaser so as to limit sigma phase formation

Sl. No.	Specification	Grade	Heat treatment	Condition	Mechanical properties (Minimum)					
					UTS (MPa)	0.2% Proof (MPa)	% EL (5D)	% RA	Others	Remarks
1	MSRR 7023	-	**Solution treat** : 1190°C / 1.5 hrs / FC to 1000°C at rate of 2-3°C per munute (limit 1-5°C per minute) / AC+ **Stress relieve** : 1030°C / 1.5 hrs in protective atmosphere	Solution treated + stress relieved	-	-	-	-	**Stress rupture test: Temperature= 850oC, Stress= 350 MPa, Time to rupture ≥ 40 hours** **Stress rupture test: Temperature= 980oC, Stress= 115 MPa, Time to rupture ≥ 60 hours**	-
2	MSRR 7022	-	**Solution treat** : 1190°C / 1.5 hrs / FC to 1000°C at rate of 2-3°C per munute (limit 1-5°C per minute)/ AC	Solution treated	-	-	-	-	**Stress rupture test: Temperature= 850oC, Stress= 350 MPa, Time to rupture ≥ 40 hours** **Stress rupture test: Temperature= 980oC, Stress= 115 MPa, Time to rupture ≥ 60 hours**	**Stress relieve**: 1030°C / 1.5 hrs in protective atmosphere for blade forgings or finished part.
3	BS HR 4	-	**Solution treat** : 1190°C (±10°C) / 1.5 hrs / FC to 1000°C at rate of 2-3°C per munute (limit 1-5°C per minute) / AC	Solution treated	-	-	-	-	**Stress rupture test: Temperature= 980oC, Stress= 116 MPa, Time to rupture ≥ 60 hours**	-
4	DTD 5017 (Obsolete)	-	-	-	-	-	-	-	**Hardness: 320 BHN (min.) or 335 HV (min.), Stress rupture test: Temperature= 980oC, Stress= 116 MPa, Time to rupture ≥ 50 hours**	-
5	SuperNi 115 (Indigenized)	-	**Solution treat** : 1190°C (±10°C) / 1.5-2.5 hrs / FC to 1000°C at rate of 2-3°C per munute (limit 1-5°C per minute) / AC	Solution treated	-	-	-	-	**Stress rupture test: Temperature= 850oC, Stress= 350 MPa, Time to rupture ≥ 40 hours** **Stress rupture test: Temperature= 980oC, Stress= 115 MPa, Time to rupture ≥ 60 hours**	-

Data Sheet for Rationalisation of Aviation Metallic Materials - Nickel Alloy

General Grade of Material		NIMONIC 115 [for turbine blade blanks]	Type of Material	Ni-Co-Cr-Al-Mo-Ti	Number of Specifications Identified	5
Rationalisation for Use		**Bar**				
Identified Specifications		**Rationalised to**	**Form**	**Number of Specifications Identified**	**Number of Specifications Rationalised**	**Remarks**
Sl. No.	**Specification / Grade**	**Specification**				
1	MSRR 7023	BS HR 4 / SuperNi 115	Bar	5	2	-
2	MSRR 7022					
3	BS HR 4					
4	DTD 5017 (Obsolete)					
5	SuperNi 115 (Indigenized)					

Data Sheet for Rationalisation of Metallic Materials - Nickel Alloy

General Grade of Material	NIMONIC 105	Type of Material	Ni-Co-Cr-Mo-Al-Ti	Number of Specifications Identified	6
Rationalisation for Use	Bar				

Sl. No.	Specification	Grade	Origin	Chemical composition (Wt%) (wherever limit not mentioned consider as max)										Others (each)			Others (total)
				Ni	Co	Fe	C	Si	Mn	Mo	Ti	Cr	Al				
1	MSRR 7017	-	BRITISH	Rem	18-22	1.0	0.12-0.17	0.25	0.40	4.5-5.5	1.18-1.50	14.0-15.7	4.5-4.9	S=0.010 Bi= 0.0001 Zr=0.07-0.15	Cu=0.20 B = 0.003-0.010	Ag= 0.0005 Pb= 0.0005	-
2	MSRR 7018	-	BRITISH	Rem	18-22	1.0	0.12-0.17	0.25	0.40	4.5-5.5	1.18-1.50	14.0-15.7	4.5-4.9	S=0.010 Bi= 0.0001 Zr=0.07-0.15	Cu=0.20 B = 0.003-0.010	Ag= 0.0005 Pb= 0.0005	-
3	MSRR 7134	-	BRITISH	Rem	18-22	1.0	0.12-0.17	0.25	0.40	4.5-5.5	1.18-1.50	14.0-15.7	4.5-4.9	S=0.010 Bi= 0.0001 Zr=0.07-0.15	Cu=0.20 B = 0.003-0.010	Ag= 0.0005 Pb= 0.001	-
4	BS 2HR 3	-	BRITISH	Rem	18-22	1.0	0.12-0.17	1	1.0	4.5-5.5	0.90-1.50	14.0-15.7	4.5-4.9	S=0.015 Bi= 0.0001 Zr=0.15	Cu=0.20 B = 0.003-0.010	Ag= 0.0005 Pb= 0.0015	-
5	DTD 5007 (obsolete)	-	BRITISH	Rem	18-22	2.0	0.2	1	1.0	4.5-5.5	0.90-1.50	14.0-15.7	4.5-4.9	S=0.015 Zr=0.15	Cu=0.20 B = 0.015	Pb= 0.005	-
6	AIR 9165	NK 20 CDA	FRENCH	Rem	18-22	1.0	0.12-0.17	1	1.0	4.5-5.5	0.90-1.50	14.0-15.7	4.5-4.9	S=0.015 P=0.015	Cu=0.20 B = 0.003-0.010	Zr=0.15	-

Sl. No.	Specification	Grade	Heat treatment	Condition	Mechanical properties (Minimum)					
					UTS (MPa)	0.2% Proof (MPa)	% EL (5D)	% RA	Others	Remarks
1	MSRR 7017	-	**Solutionize**: 1150°C / 4 hrs / AC **Ppt**: 1030°C / 16 hrs / AC + 700 °C / ≥16 hrs / AC	Solutionize + Ppt	-	-	-	-	**Stress rupture test: Temperature= 950°C, Stress= 110 MPa, Time to rupture ≥ 30 hours** **Stress rupture test: Temperature= 815°C, Stress= 360 MPa, Time to rupture ≥ 30 hours**	-
2	MSRR 7018	-	**Solutionize**: 1150°C / 4 hrs / AC **Ppt**: 1030°C / 16 hrs / AC + 700 °C / 16 hrs / AC	Solutionize + Ppt	-	-	-	-	**Stress rupture test: Temperature= 815°C, Stress= 360 MPa, Time to rupture ≥ 30 hours**	-
3	MSRR 7134	-	**Soften:** 1100°C / £30 minutes / Cool rapidly **Weld diffuse**: 1150°C / 4 hrs / AC **Ppt**: 1030°C / 16 hrs / AC **Ppt**: 700°C / 16 hrs / AC	Soften + Weld diffuse + Ppt	925 [at 700°C]	650 [at 700°C]	10 [at 700°C]	-	**Stress rupture test: Temperature= 815°C, Stress= 330 MPa, Time to rupture ≥ 25 hours**	-
4	BS 2HR 3	-	**Solutionize**: 1150°C (±10°C) / 4 hrs / AC **Heat at** 1050°C (±10°C) / 16 hrs / AC **Ppt:** 850°C (±10°C) / 16 hrs / AC	Solutionize + Ppt	-	-	-	-	Hardness = 331 BHN (miin.) **Stress rupture test: Temperature= 815°C, Stress= 360 MPa, Time to rupture ≥ 30 hours** **Stress rupture test: Temperature= 950°C, Stress= 108 MPa, Time to rupture ≥ 30 hours**	-
5	DTD 5007 (obsolete)	-	**Stage 1**: Heat to 1150°C (±10°C) / 2-4 hrs / AC + **Stage 2:** Heat to 1050-1100°C / 8-16 hrs / AC + **Stage 3:** Heat to 850°C (±10°C) / 8-16 hrs / AC	Heat-treated	-	-	-	-	Hardness = 300 BHN (min.) or 315 HV (min.) **Stress rupture test: Temperature= 950°C, Stress= 108 MPa, Time to rupture ≥ 28 hours**	-
6	AIR 9165	NK 20 CDA	**Solutionize**: 1150°C / 4 hrs / AC + **Heat at** 1030-1080°C / 8 hrs / AC + **Ppt:** 700-850°C / 16 hrs / AC	Solutionize + Ppt	-	-	-	-	Hardness = 350 BHN (min.) **Stress rupture test: Temperature= 950°C, Stress= 108 MPa, Time to rupture ≥ 30 hours, %E= ≥2** **Stress rupture test: Temperature= 815°C, Stress= 300 MPa, Time to rupture ≥ 75 hours, %E= ≥2**	-

Data Sheet for Rationalisation of Aviation Metallic Materials - Nickel Alloy							
General Grade of Material			NIMONIC 105	Type of Material	Ni-Co-Cr-Mo-Al-Ti	Number of Specifications Identified	6
Rationalisation for Use			Bar				
Identified Specifications			Rationalised to	Form	Number of Specifications Identified	Number of Specifications Rationalised	Remarks
Sl. No.	Specification	Grade	Specification				
1	MSRR 7017	-	BS 2HR 3	Bar	6	1	-
2	MSRR 7018	-					
3	MSRR 7134	-					
4	BS 2HR 3	-					
5	DTD 5007 (obsolete)	-					
6	AIR 9165	NK 20 CDA					

Data Sheet for Rationalisation of Aviation Metallic Materials - Nickel Alloy

General Grade of Material		NC22FeD	Type of Material			Ni-Cr-Fe-Mo		Number of Specifications Identified						4	
Rationalisation for Use		SHEET													
SI No	Specification / Grade	Origin	Chemical composition (Wt%) (wherever limit not mentioned consider as max)												
			NI	Co	Fe	C	Si	Mn	Mo	Ti	Cr	Al	S	Cu	Others
1	NC 22FeD	FRENCH	Rem	0.5-2.0	17-20	0.05-0.15	1.0	1.0	8-10	-	20.5-23	-	0.015	-	P-0.015 W-0.2-1.0
2	BS HR 204	BRITISH	Rem	0.5-2.5	17-20	0.05-0.15	1.0	1.0	8-10	-	20.5-23	-	0.015	-	P-0.04 W-0.2-1.0 B-0.01 Pb-0.005
3	AMS 5536	AMERICAN	Rem	0.5-2.5	17-20	0.05-0.15	1.0	1.0	8-10	0.15	20.5-23	-	0.030	0.50	P-0.04 W-0.2-1.0 B-0.01
4	MIDAHNI ATGE	INDIAN	Rem	1.5	18.5	0.1	-	-	9	-	22	-	-	-	W-0.6

Sl No	Specification /Grade	Heat treatment	Condition	Mechanical properties (Minimum)				
				Size (mm) / Stress Rupture	UTS (MPa)	0.2% Proof (MPa)	% EL (5D)	Hardness (HBW/BHN)
1	NC 22FeD	Solutionise (a) 1160-1180ºC and (b) at 1060ºC. Cool in air	Soln.	.. <1.5 >1.5 Stress Rupture Test Temp(°C) : (a) 815, (b)815, Stress(MPa) : (a)105 (b) 100 Time to rupture (hrs) : (a)30 (b) 30	690-880 770-970 770-970	270 350 350	30 25 25	262 max 292 max 292 max
2	BS HR 204	30 mts mase suitably. Cool suitably	O and Descaled	<0.5 0.5-5.0 >5.0 Stress Rupture Test (a) size (mm) 0.3-0.5, (b) size (mm) >0.5 Temp (°C) : (a)815 (b)815 Stress (MPa) : (a)105 (b) 100 Time to rupture (hrs) : (a)30 (b) 30	720 720 690	- 310 275	- 35 35	255 max
3	AMS 5536	Solution treated at 1170±10ºC. Rapid cool	HR/CR and solution	Upto 0.25 0.25-0.508 0.0508-4.75 4.75-50 >50 Stress Rupture Test size (mm) 0.25-0.5, size (mm) >0.5 Temp (°C) : (a) 815 (b)815 Stress (MPa) : (a)110 (b) 110 Time to rupture(hrs) : (a)15 (b) 25	725 725 725 690 655	- 29 35 35 35	-	-

4	MIDAHNI ATGE	-	-	Stress Rupture Test Temp(°C) : 650,700, 800, 900 Stress(MPa)) : 294,215,103,55 Time to rupture(hrs) : 100,100,100,100	795 at RT	363 at RT	43	-

Data Sheet for Rationalisation of Aviation Metallic Materials - Nickel Alloy

General Grade of Material	NC22FeD	Type of Material	Ni-Cr-Fe-Mo	Number of Specifications Identified	4
Rationalisation for Use	SHEET				

Identified Specifications		Rationalised to	Form	Number of Specifications Identified	Number of Specifications Rationalised	Remarks
Sl No	Specification / Grade	Specification				
1	NC 22FeD	NC22FeD / AMS 5536 / MIDAHNI ATGE	Sheet	4	3	-
2	BS HR 204					
3	AMS 5536					
4	MIDAHNI ATGE					

Data Sheet for Rationalisation of Aviation Metallic Materials - Nickel Alloy

General Grade of Material		BS HR 202	Type of Material		Ni-Cr-Co Alloy	Number of Specifications Identified							6
Rationalisation for Use		SHEET											
Sl No	Specification / Grade	Origin	Chemical composition (Wt%) (wherever limit not mentioned consider as max)										
			NI	Co	Fe	C	Si	Mn	Mo	Ti	Cr	Al	S	Cu	Others
1	BS HR 202	BRITISH	Rem	15-21	1.5	0.13	1.0	1.0	-	2.0-3.0	18.0-21	1.0-2.0	0.15	0.2	Ag =0.0005 B =0.02 Pb =0.002 Bi =0.0001 Zr = 0.15
2	MSRR 7086	BRITISH	Rem	15-21	1.5	0.13	0.8	0.4	-	2.0-3.0	18.0-21	1.0-2.0	0.15	0.2	Ag =0.0005 B =0.02 Bi =0.0001 Zr = 0.15
3	MSRR 7087	BRITISH	Rem	15-21	1.5	0.13	1.0	1.0	-	2.0-3.0	18.0-21	1.0-2.0	0.15	0.2	Ag =0.0005 B =0.008 Pb =0.001 Bi =0.0001
4	BACE355	BRITISH	Rem	15-21	1.5	0.13	1.5	1.0	-	2.0-2.7	18.0-21	1.0-1.65	0.05	-	Pb =0.005
5	NCK20TA	FRENCH	Rem	15-21	1.0	0.12	1.0	1.0	-	2.0-3.0	18-21	1.0-2.0	0.015	0.2	Pb =0.02 B = 0.02 P =0.015
6	MIDHANI ATG S4	INDIAN	Rem	19	1.0	0.08	-	-	-	2.5	19	1.5	-	-	-

Sl No	Specification / Grade	Heat treatment	Condition	Mechanical properties (Minimum)				
				Size (mm) / Stress Rupture	UTS (MPa)	0.2% Proof (MPa)	% EL (5D)	Hardness (HBW/BHN)
1	BS HR 202	Soften at 1100- 1150ºC for 1-10 mts. Cool suitably. PPt at 750±10ºC for 4 hours. Cool in air	HT	0.25- 0.35 0.3- 0.45 >0.45	1080 1080 1080	695 695 695	10 20 25	HV 280
		Soln. at 1080 10ºC for 8 hours. Cool in air. Ppt at 700±10 ºC for 16 hours. Cool in air	Soln and ppt	Stress Rupture Test Temp : 870°C Stress : 140 MPa Time to rupture(hrs) : 30 minimum	-	-	-	-
2	MSRR 7086	Ppt ata 700-725 ºC for 4 hours. Cool in air	CR and HT	1390-1620	1030	-	-	-
3	MSRR 7087	Solution at 1080 ºC > 5 mts. Oil quench. Soften at 1100- 1150ºC for 1-10 mts. Cool suitably. PPt at 750±10ºC for 4 hours. Cool in air	HT	0.25- 0.35 0.3- 0.45 >0.45	1080 1080 1080	695 695 695	10 20 25	HV 280
		Soln. at 1080 10ºC for 8 hours. Cool in air. Ppt at 700±10 deg C for 16 hours. Cool in air	Soln and ppt	Stress Rupture Test Temp : 870°C Stress : 140 MPa Time to rupture(hrs) : 30 minimum	-	-	-	-
4	BACE355	-	Soln. and Aged	Stress Rupture Test Temp : 870°C Stress : 140 MPa Time to rupture (hrs): 30 minimum	1080	-	20	HV 300
5	NCK20TA	1) Solutionize Solutionize at Solutionize at 1080ºC for 8 hours Cool in air.	Soln	Stress Rupture Test Temp : 815°C Stress : 290 MPa Time to rupture : 30 hours	-	-	-	311 max.
		2) Solutionize & Aged: Precipitate at 710ºC for 16 hours Cool in air	Solutin & Aged		1080	690	20	290
6	MIDHANI ATG S4	-		Stress Rupture Test Temp : 650°C Stress : 550 MPa Time to rupture : 100 hours	1235 at RT	795 at RT	33	-

Data Sheet for Rationalisation of Aviation Metallic Materials - Nickel Alloy

General Grade of Material	BS HR 202	Type of Material	Ni-Cr-Co Alloy	Number of Specifications Identified	6

Rationalisation for Use	SHEET

Identified Specifications		Rationalised to	Form	Number of Specifications Identified	Number of Specifications Rationalised	Remarks
Sl No	Specification / Grade	Specification				
1	BS HR 202	BS HR 202 / MIDHANI ATG S4	Sheet	6	2	-
2	MSRR 7086					
3	MSRR 7087					
4	BACE355					
5	NCK20TA					
6	MIDHANI ATG S4					

Data Sheet for Rationalisation of Aviation Metallic Materials - Nickel Alloy

General Grade of Material	BS HR 403	Type of Material	Ni-Cr-Co-Fe Alloy	Number of Specifications Identified	4
Rationalisation for Use	TUBE				

Sl No	Specification / Grade	Origin	Chemical composition (Wt%) (wherever limit not mentioned consider as max)											
			Ni	Co	Fe	C	Si	Mn	Mo	Ti	Cr	Al	S	Cu	Others
1	BS HR 403	BRITISH	Rem	5.0	5.0	0.08-0.15	1.0	1.0	-	0.20-0.60	18-21	-	0.02	0.50	Pb =0.005
2	MSRR 7006	BRITISH	Rem	5.0	5.0	0.08-0.15	1.0	1.0	-	0.20-0.60	18-21	-	0.02	0.50	Pb =0.005
3	KhN 78 T	RUSSIAN	Rem	-	1.0	0.12	0.8	0.7	-	0.15-0.35	19-22	-	0.01	0.07	P =0.015
4	MIDAHNI ATGR	INDIAN	Rem	5.0	5.0	0.1	-	-	-	0.4	19.5	-	-	-	-

Sl No	Specification / Grade	Heat treatment	Condition	Mechanical properties (Minimum)				
				Size (mm) / Stress Rupture	UTS (MPa)	0.2% Proof (MPa)	% EL (5D)	Hardness (HBW/BHN)
1	BS HR 403	Soften at 1000-1050ºC Cool in a suitable medium	CW and softened	<0.5 >0.5	690-830 690-830	.. 300	.. 30	HV 230
2	MSRR 7006	Heat at 1000-1050ºC Cool in air or in controlled atmosphere	CR and Descaled or Bright annealed	<0.5 >0.5	690-830 690-830	.. 300	.. 30	HV 230
3	KhN 78 T	Harden at 980 -1020ºC Water /Air Quench	Harden	-	833	-	25	-
4	MIDAHNI ATGR	-	-	Stress Rupture Test Temp : 700°C Stress : 127 MPa Time to rupture : 100 hours	805 at RT	343 at RT	44	-

Data Sheet for Rationalisation of Aviation Metallic Materials - Nickel Alloy

General Grade of Material	BS HR 403	Type of Material	Ni-Cr-Co-Fe Alloy	Number of Specifications Identified	4
Rationalisation for Use	TUBE				

Identified Specifications		Rationalised to	Form	Number of Specifications Identified	Number of Specifications Rationalised	Remarks
Sl No	Specification / Grade	Specification				
1	BS HR 403	BS HR 403 / MIDAHNI ATGR	Tube	4	2	-
2	MSRR 7006					
3	KhN 78 T					
4	MIDAHNI ATGR					

Data Sheet for Rationalisation of Aviation Metallic Materials - Nickel Alloy

General Grade of Material	BS HR 402	Type of Material	Ni-Cr-Co-Ti-Al	Number of Specifications Identified	2
Rationalisation for Use	Tube				

Sl No	Specification / Grade	Origin	Chemical composition (Wt%) (wherever limit not mentioned consider as max)												
			NI	Co	Fe	C	Si	Mn	Mo	Ti	Cr	Al	S	Cu	Others
1	BS HR 402	BRITISH	Rem	15-21	1.5	0.13	1.0	1.0	-	2.0-3.0	18-21	1.0-2.0	0.015	0.2	Bi = 0.0001 B =0.020 Ag =0.0005 Pb =0.0020 Zr =0.15
2	MIDHANI ATG S4	INDIAN	Rem	19	1	0.08	-	-	-	2.5	19	1.5	-	-	-

Sl No	Specification / Grade	Heat treatment	Condition	Mechanical properties (Minimum)				
				Size (mm) / Stress Rupture	UTS (MPa)	0.2% Proof (MPa)	% EL (5D)	Hardness
1	BS HR 402	Ppt at 750±10ºC for 4 hrs. Cool in air	Ppt	<0.5 WT 0.5-1.0 WT >1.0 WT	1080 1080 1080	.. 690 690	.. 15 20	HV 280
2	MIDHANI ATG S4	-	-	Stress Rupture Test Temp (°C) : 650, 700, 800 Stress(MPa) : 550,450, 275 Time to rupture (hrs) : 100,100,100	1235	795	33	-

Data Sheet for Rationalisation of Aviation Metallic Materials - Nickel Alloy

General Grade of Material	BS HR 402	Type of Material	Ni-Cr-Co-Ti-Al	Number of Specifications Identified	2
Rationalisation for Use	Tube				

Sl No	Identified Specifications	Rationalised to	Form	Number of Specifications Identified	Number of Specifications Rationalised	Remarks
	Specification / Grade	Specification				
1	BS HR 402	BS HR 402	Tube	2	1	-
2	MIDHANI ATG S4					

Data Sheet for Rationalisation of Aviation Metallic Materials - Nickel Alloy

General Grade of Material	NIMONIC 75	Type of Material	Ni-Cr-Co-Fe Alloy	Number of Specifications Identified	6
Rationalisation for Use	SHEET				

Sl No	Specification / Grade	Origin	Chemical composition (Wt%) (wherever limit not mentioned consider as max)												
			NI	Co	Fe	C	Si	Mn	Mo	Ti	Cr	Al	S	Cu	Others
1	BS HR 203	BRITISH	Rem	5.0	5.0	0.08-0.15	1.0	1.0	-	0.20-0.60	18-21	-	0.02	0.50	Pb=0.005
2	MSRR 7104	BRITISH	Rem	5.0	5.0	0.08-0.15	1.0	1.0	-	0.20-0.60	18-21	-	0.02	0.50	Pb=0.005
3	MSRR 7157	BRITISH	Rem	-	5.0	0.08-0.15	1.0	1.0	-	0.20-0.60	18-21	-	-	0.50	-
4	NC20T	FRENCH	Rem	5.0	5.0	0.08-0.15	1.0	1.0	-	0.20-0.60	18-21	-	0.015	0.50	P=0.015 Pb =0.02
5	KhN 78 T	RUSSIAN	Rem	-	1.0	0.12	0.8	0.7	-	0.15-0.35	19-22	-	0.01	0.07	P=0.015
6	MIDAHNI ATGR	INDIAN	Rem	5.0	5.0	0.1	-	-	-	0.4	19.5	-	-	-	-

Sl No	Specification / Grade	Heat treatment	Condition	Mechanical properties (Minimum)				
				Size (mm) / Stress Rupture	UTS (MPa)	0.2% Proof (MPa)	% EL (5D)	Hardness (HBW/BHN)
1	BS HR 203	Heat at 1000-1050ºC Cool in air or in controlled atmosphere	CR and (O) Descaled or Bright annealed	0.25-0.05	650	260	25	HV 230 max
				0.05-3.00	760	310	30	HV 230 max
2	MSRR 7104	Heat at 1000-1050ºC Cool in air or in controlled atmosphere	HR and Descaled	>3.00	620	230	30	230 max.
3	MSRR 7157	Anneal at 900-1050ºC Cool in air	CR, CR and O	-	795	400 (0.1 % Proof)	33	181-219
4	NC20T	Anneal at 1050ºC Cool in air		-	640	240	30	230 max.
5	KhN 78 T	Harden at 980 - 1020ºC Water /Air Quench	Harden	-	833	-	25	-
6	MIDAHNI ATGR	-	-	Stress Rupture Test Temp : 700°C Stress : 127 MPa Time to rupture : 100 hours	805 at RT	343 at RT	44	-

Data Sheet for Rationalisation of Aviation Metallic Materials - Nickel Alloy

General Grade of Material		NIMONIC 75	Type of Material	Ni-Cr-Ti Alloy	Number of Specifications Identified	6
Rationalisation for Use		SHEET				
Identified Specifications		Rationalised to	Form	Number of Specifications Identified	Number of Specifications Rationalised	Remarks
Sl No	Specification / Grade	Specification				
1	BS HR 203	BS HR 203 / NC 20 T / MIDAHNI ATGR	SHEET	6	3	-
2	MSRR 7104					
3	MSRR 7157					
4	NC 20 T					
5	KhN 78 T					
6	MIDAHNI ATGR					

Data Sheet for Rationalisation of Aviation Metallic Materials - Nickel Alloy

General Grade of Material		AMS 5713	Type of Material			Ni-Cr-Co-Mo-Fe Alloy	Number of Specifications Identified					2		
Rationalisation for Use		BAR												
Sl No	Specification / Grade	Origin	Chemical composition (Wt%) (wherever limit not mentioned consider as max)											
			Ni	Co	Fe	C	Si	Mn	Mo	Ti	Cr	Al	Others		
1	AMS 5712	AMERICAN	Rem	10 - 12	5	0.12	0.5	0.1	9 - 10.5	3 - 3.3	18- 20	1.4 - 1.8	S=0.015 B=0.003 - .01	Pb=5 ppm	Bi=3 ppm Se=3 ppm
2	AMS 5713	AMERICAN	Rem	10 - 12	5	0.12	0.5	0.1	9 - 10.5	3- 3.3	18- 20	1.4 - 1.8	S=0.015 B=0.003- 0.01	Pb=5 ppm	Bi =3 ppm Se =3 ppm

Sl No	Specification / Grade	Heat treatment	Condition	Mechanical properties (Minimum)				
				Temperature	UTS (MPa)	0.2% Proof (MPa)	% EL (5D)	Hardness (HBW)
1	AMS 5712	Solutionise at 1079± 14 deg C suitably cool Ppt at 760± 8 deg C for 16 hrs air cool	Soln ppt	RT at 760 deg C	931 - 1172	724 - 896	8 - 10	363 (max)
2	AMS 5713	Solutionise at 1079± 14 deg C suitably cool Ppt at 760± 8 deg C for 16 hrs air cool	Soln ppt	RT at 760 deg C	931 - 1172	724 - 896	8 - 10	363 (max)

<table>
<tr><th colspan="8">Data Sheet for Rationalisation of Aviation Metallic Materials - Nickel Alloy</th></tr>
<tr><td colspan="2">General Grade of Material</td><td>AMS 5713</td><td>Type of Material</td><td>Ni-Cr-Co-Mo-Fe Alloy</td><td colspan="2">Number of Specifications Identified</td><td>2</td></tr>
<tr><td colspan="2">Rationalisation for Use</td><td colspan="6">BAR</td></tr>
<tr><td colspan="2">Identified Specifications</td><td>Rationalised to</td><td rowspan="2">Form</td><td rowspan="2" colspan="2">Number of Specifications Identified</td><td rowspan="2">Number of Specifications Rationalised</td><td rowspan="2">Remarks</td></tr>
<tr><td>Sl No</td><td>Specification / Grade</td><td>Specification</td></tr>
<tr><td>1</td><td>AMS 5712</td><td rowspan="2">AMS 5713</td><td rowspan="2">BAR</td><td rowspan="2" colspan="2">2</td><td rowspan="2">1</td><td rowspan="2">-</td></tr>
<tr><td>2</td><td>AMS 5713</td></tr>
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Data Sheet for Rationalisation of Aviation Metallic Materials - Nickel Alloy

General Grade of Material		BS HR 601	Type of Material			Ni-Cr-Co-Ti-Al Alloy		Number of Specifications Identified							10
Rationalisation for Use		BAR	Shape					BAR							
Sl No	Specification / Grade	Origin	Chemical composition (Wt%) (wherever limit not mentioned consider as max)												
			NI	Co	Fe	C	Si	Mn	Mo	Ti	Cr	Al	S	Cu	Others
1	BS HR 601	BRITISH	Rem	2.0	1.5	0.04-0.10	1.0	1.0	-	1.8-2.7	18-21	1.0-1.8	0.015	0.2	Ag =0.0005 B =0.008 Pb =0.002 Bi =0.0001
2	BS HR 1	BRITISH	Rem	2.0	1.5	0.04-0.10	1.0	1.0	-	1.8-2.7	18-21	1.0-1.8	0.015	0.2	Ag =0.0005 B =0.008 Pb =0.002 Bi =0.0001
3	MSRR 7009 (BSEM 552)	BRITISH	Rem	2.0	1.5	0.04-0.10	0.8	0.4	-	1.8-2.7	18-21	1.0-1.8	0.015	0.2	Ag =0.0005 B =0.008 Pb =0.001 Bi =0.0001
4	MSRR 7010	BRITISH	Rem	2.0	1.5	0.04-0.10	0.8	0.4	-	1.8-2.7	18-21	1.0-1.8	0.015	0.2	Ag =0.0005 Bi =0.0001
5	MSRR 7011	BRITISH	Rem	2.0	1.5	0.04-0.10	0.8	0.4	-	1.8-2.7	18-21	1.0-1.8	0.015	0.2	Ag =0.0005 B =0.008 Pb =0.002 Bi =0.0001
6	MSRR 7012 (BSEM 572)	BRITISH	Rem	2.0	1.5	0.04-0.10	0.8	0.4	-	1.8-2.7	18-21	1.0-1.8	0.015	0.2	Ag =0.0005 B =0.008 Pb =0.002 Bi =0.0001
7	MSRR 7013	BRITISH	Rem	2.0	1.5	0.04-0.10	1.0	1.0	-	1.8-2.7	18-21	1.0-1.8	0.015	0.2	Ag =0.0005 B =0.008 Pb =0.002 Bi =0.0001
8	BSEM 556	BRITISH	Rem	2.0	5.0	0.10	1.0	1.0	-	1.8-2.7	18-21	0.5-1.8	0.05	-	Pb =0.005
9	NIMONIC 80A	BRITISH	Rem	2.0	5.0	0.10	1.0	1.0	-	1.8-2.7	18-21	0.5-1.8	0.05	-	Pb=0.008
10	MIDHANI ATG S4	INDIAN	Rem	1.9	1.0	0.08	-	-	-	2.5	19	1.5	-	-	-

Sl No	Specification / Grade	Heat treatment	Condition	Mechanical properties (Minimum)				
				Stress Rupture	UTS (MPa)	0.2% Proof (MPa)	% EL (5D)	Hardness (HBW/BHN)
1	BS HR 601	Heat at 1080 deg.C Cool in air/Quench in water for 15-30 mts for 15mm and 30-60 mts for 15-30mm. Ppt at 750 deg Cfor 4 hrs. Cool in air	HT	Stress Rupture Test Temp : 750°C Stress : 340 MPa Time to rupture : 30 hours	1000	620	20	-
2	BS HR 1	Soften at 1080±10 deg.C for 30 mts max. Quench in water. Solutionise at 1080±10 deg.C for 8 hrs.Cool in air/Quench in water or oil Soaking 3.mm - 1 hrs 3-6mm - 2 hrs,6-12mm - 4 hr ppt at 700±10 deg C for 16 hrs. Cool in water or 700 ±10 deg C for 4 hrs. Cool in air	O	Stress Rupture Test Temp : 750°C Stress : 340 MPa Time to rupture : 30 hours	-	-	-	250 max
			HT		1000	600	20	285 max
3	MSRR 7009 (BSEM 552)	Solutionise at 1080 deg C for 8 hrs. Cool in air. Ppt at 700 deg C for 16 hrs. Cool in air	Soln + Ppt	Stress Rupture Test Temp : 750°C Stress : 340 MPa Time to rupture : 32 hours	-	-	-	-
4	MSRR 7010	Solutionise at 1080±10 deg C for 8 hrs. Cool in air. Ppt at 700 ± 5 deg C for 16 hrs. Cool in air	Soln + Ppt	Stress Rupture Test Temp : 750°C Stress : 340 MPa Time to rupture : 30 hours	-	-	-	-
5	MSRR 7011	Solutionise at 1080±10 deg C for 8 hrs. Cool in air/Quench in water or oil. Soaking for 3 mm - 1 hrs, 3-6mm 2 hrs, 6-12mm 4 hrs, for above 12.5mm 8 hrs. Ppt at 700±10 deg C for 16 hrs. Cool in air or 750±10 deg C or 4hrs.Cool in air	Soln + Ppt	Stress Rupture Test Temp : 750°C Stress : 340 MPa Time to rupture : 30 hours	1000	600	20	265

6	MSRR 7012 (BSEM 572)	soften at 1050-1080 deg C Quench in water Solutionise at 1050-1080 deg C for 2 hrs. Quench in water. Ppt at 750 deg C for 4 hrs Cool in air.	HT	Stress Rupture Test Temp : 750°C Stress : 340 MPa Time to rupture : 30 hours	1000	620	20	265
7	MSRR 7013	Heat at 1080 deg.C Cool in air/Quench in water for 15-30 mts for 15mm and 30-60 mts for 15-30mm. Ppt at 750 deg Cfor 4 hrs. Cool in air	HT	Stress Rupture Test Temp : 750°C Stress : 340 MPa Time to rupture : 30 hours	1000	620	20	-
8	BSEM 556	Solutionise at 1080 deg C, Cool in air, Ppt at 700 deg C for 16 hrs. Cool in air.Ppt at 950 deg C for 5 mts Cool in air Ppt at 800 deg C for 2 hrs Cool in air	HT	Stress Rupture Test Temp : 750°C Stress : 325 MPa Time to rupture : 23 hours	1000	600 (0.1 % PS)	20	350
9	NIMONIC 80A	Solutionise at 1080 deg C for 6 hrs, Cool in air, Ppt ar 700 deg C for 16 hrs. Cool in air	HT	Stress Rupture Test Temp : 750°C Stress : 325 MPa Time to rupture : 23 hours	1060	600 (0.1 % PS)	35	238-311
10	MIDHANI ATG S4	-	-	Stress Rupture Test Temp : 650°C Stress : 550 MPa Time to rupture : 100 hours	1235 at RT	795 at RT	33	-

Data Sheet for Rationalisation of Aviation Metallic Materials - Nickel Alloy

General Grade of Material		BS HR 601	Type of Material	Ni-Cr-Co-Ti-Al Alloy	Number of Specifications Identified	10
Rationalisation for Use		BAR				
Identified Specifications		Rationalised to	Form	Number of Specifications Identified	Number of Specifications Rationalised	Remarks
Sl No	Specification / Grade	Specification				
1	BS HR 601	BS HR 601 / BS HR 1 / MIDHANI ATG S4	BAR	10	3	-
2	BS HR 1					
3	MSRR 7009 (BSEM 552)					
4	MSRR 7010					
5	MSRR 7011					
6	MSRR 7012 (BSEM 572)					
7	MSRR 7013					
8	BSEM 556					
9	NIMONIC 80A					
10	MIDHANI ATG S4					

Data Sheet for Rationalisation of Aviation Metallic Materials = Nickel Alloy

General Grade of Material	MSRR 7037	Type of Material	Ni =Cr =Co =Mo =Ti Alloy	Number of Specifications Identified	3
Rationalisation for Use	TUBE				

Sl No	Specification / Grade	Origin	Chemical composition (Wt%) (wherever limit not mentioned consider as max)												
			NI	Co	Fe	C	Si	Mn	Mo	Ti	Cr	Al	S	Cu	Others
1	MSRR 7037	BRITISH	Rem	19 -21	0.7	0.04 -0.08	0.40	0.60	5.6 -6.1	1.9 -2.4	19 -21	0.3 -0.6	0.007	0.2	Pb =0.02 B =0.005 Bi =0.0001 Ag = 0.0005 Al+Ti = 2.4-2.8
2	BS HR 404	BRITISH	Rem	19 -21	0.7	0.04 -0.08	0.40	0.60	5.6 -6.1	1.9 -2.4	19 -21	0.3 -0.6	0.007	0.2	Pb =0.02 B =0.005 Bi =0.0001 Ag = 0.0005 Al+Ti = 2.4 - 2.8
3	MIDAHNI ATG WO	INDIAN	Rem	20	2.0	0.06	-	-	4.0	3.0	20	-	-	-	-

SI No	Specification / Grade	Heat treatment	Condition	Mechanical properties (Minimum)				
				Size (mm) / Stress Rupture	UTS (MPa)	0.2% Proof (MPa)	% EL (5D)	Hardness (HBW/BHN)
1	MSRR 7037	Hesst to 800±5ºC for 8 hours. Cool in air	ppt	<0.50 WT >0.5 WT	540 540	.. 400	.. 9	
		Solutionise at 1150 ±10ºC afor 1/2 = 2 1/2 hrs. Quench in water. PPt at 800± 5 deg C for 8 hrs. Cool in air	solu. Treated	< 1.0 WT >1.0 WT	-	-	-	HV 230 max
2	BS HR 404	Hesst to 800±5ºCfor 8 hours. Cool in air	ppt	<0.50 WT >0.5 WT	540 540	. 400	. 9	=
		Solutionise at 1150 ±10ºC afor 1/2 = 2 1/2 hrs. Quench in water. PPt at 800± 5 ºC for 8 hrs. Cool in air	solu. Treated	< 1.0 WT >1.0 WT	-	-	-	HV 230 max
3	MIDAHNI ATG WO	-	=	Stress Rupture Test Temp(°C) : 650, 700 ,800 Stress(MPa) : 540, 450, 216 Time to rupture (hrs) : 100,100 100	1000 at RT	588 at RT	45	-

Data Sheet for Rationalisation of Aviation Metallic Materials = Nickel Alloy						
General Grade of Material		MSRR 7037	Type of Material	Ni =Cr =Co =Mo =Ti Alloy	Number of Specifications Identified	3
Rationalisation for Use		TUBE				
Identified Specifications		Rationalised to	Form	Number of Specifications Identified	Number of Specifications Rationalised	Remarks
SI No	Specification / Grade	Specification				
1	MSRR 7037	MSRR 7037 / MIDAHNI ATG WO	Tube	3	2	-
2	BS HR 404					
3	MIDAHNI ATG WO					

Data Sheet for Rationalisation of Aviation Metallic Materials - Nickel Alloy

General Grade of Material	MAR-M-247	Type of Material	Ni-Co-W-Cr-Al Alloy	Number of Specifications Identified	2
Rationalisation for Use					

Sl No	Specification / Grade		Origin	Chemical composition (Wt%) (wherever limit not mentioned consider as max)												
				NI	Co	W	Cr	Al	Ta	Hf	Ti	Mn	C	Zr	B	Others
1	MAR-M-247	MAR-M-247	AMERICAN	Rem	10	10	8.25	5.5	3	1.5	1	0.7	0.15	0.05	0.015	-
2	CM 247LC	CM 247LC	AMERICAN	Rem	9.0-9.5	9.3-9.7	8.0-8.5	5.4-5.7	3.1-3.3	1.4-1.6	0.6-0.9	0.01	0.07-0.08	0.007-0.02	0.01-0.02	-

Sl No	Specification / Grade		Heat treatment	Condition	Mechanical properties (Minimum)				
					Stress Rupture	UTS (MPa)	0.2% Proof (MPa)	% EL (5D)	Hardness (HBW/BHN)
1	MAR-M-247	MAR-M-247	Solutionize at 1230° C for 2 hrs, Argon quench, Ageing at 982° C for 5 hrs and 871 ° C for 20 hrs	Soln+ Ageing	Stress Rupture Test Temp : 760°C Stress : 672 MPa Time to rupture : 131 hours	965	827	7	30-40 HRc
2	CM 247LC	CM 247LC	Solutionize at 1230±10° C for 2 hrs Ageing at 870±8° C for 20 hrs	Soln+ Ageing	Stress Rupture Test Temp : 760°C Stress : 585 MPa Time to rupture : 40 hours	980	820	5 (%RA : 9)	-

Data Sheet for Rationalisation of Aviation Metallic Materials - Nickel Alloy

General Grade of Material		MAR-M-247	Type of Material	Ni-Co-W-Cr-Al Alloy	Number of Specifications Identified		2
Rationalisation for Use							
Identified Specifications		Rationalised to			Number of Specifications Identified	Number of Specifications Rationalised	Remarks
Sl No	Specification / Grade	Specification					
1	MAR-M-247	MAR-M-247			2	1	-
2	CM 247LC						

Data Sheet for Rationalisation of Aviation Metallic Materials - Nickel Alloy

General Grade of Material	NIMONIC 263	Type of Material	Ni-Cr-Co-Mo Alloy	Number of Specifications Identified	7
Rationalisation for Use	BAR	Shape		BAR	

Sl No	Specification / Grade	Origin	Chemical composition (Wt%) (wherever limit not mentioned consider as max)												
			Ni	Co	Fe	C	Si	Mn	Mo	Ti	Cr	Al	Cu	Others: Each	Others: Total
1	NCK 20D	FRENCH	Rem	19.0-21.0	0.7	0.04-0.08	0.1-0.4	0.2-0.6	5.60-6.10	1.90-2.40	19.0-21.0	0.3-0.6	0.2	S =0.007 P =0.015 Pb =0.002 Ti+Al =2.40 - 2.80 Bi =0.0001 Ag =0.005	-
2	AMS 5886	AMERICAN	Rem	19.0-21.0	0.7	0.04-0.08	0.4	0.60	5.60-6.10	1.90-2.40	19.0-21.0	0.3-0.6	0.2	S =0.007 P =0.015 Ti+Al =2.40 - 2.80 B =0.005	-
3	NIMONIC 263	AMERICAN	Rem	20	0.75	0.03	0.25	0.40	5.9	2.15	20	0.45	0.2	S =0.007 B =0.001 Zr =0.02	-
4	BS HR 10	BRITISH	Rem	19.0-21.0	0.7	0.04-0.08	0.4	0.60	5.60-6.10	1.90-2.40	19.0-21.0	0.3-0.6	0.2	S =0.007 Ti+Al =2.40 - 2.80 Bi =0.0001 Ag =0.005 Pb =0.002	-
5	MSRR 7035	BRITISH	Rem	19.0-21.0	0.7	0.04-0.08	0.4	0.60	5.60-6.10	1.90-2.40	19.0-21.0	0.3-0.6	0.2	S =0.007 Ti+Al =2.40 - 2.80 Bi =0.0001 Ag =0.005 Pb =0.002	-
6	MSRR 7038	BRITISH	Rem	19.0-21.0	0.7	0.04-0.08	0.4	0.60	5.60-6.10	1.90-2.40	19.0-21.0	0.3-0.6	0.2	S =0.007 Ti+Al =2.40 - 2.80 Bi =0.0001 Ag =0.005 Pb =0.002	-
7	MIDHANI ATG W0	INDIAN	Rem	20	-	0.06	-	-	5.9	2.15	20	0.45		-	-

Sl No	Specification / Grade	Heat treatment	Condition	Mechanical properties (Minimum)				
				Temperature	UTS (MPa)	0.2% Proof (MPa)	% EL (5D)	Hardness (HBW/BHN)
1	NCK 20D	Solutionise at 1100-1150 deg C. Cool ir Water. PPt at 790-810 deg C for 8 hrs. Cool in air	Soln Treat Ppt	AT 780 deg C	540	400	12	-
2	AMS 5886	Heat to 1130-1160 deg C for 1/2-21/2 hrs WQ/OQ. PPT at 800±8 deg C for 8 hr A/C	Soln Treat + Ppt	AT 780 deg C	540	405	12	-
3	NIMONIC 263	Solutionise at 1150deg C for 2 hrs. Coo in Water. PPt at 800 deg C for 8 hrs. Cool in air	HT	-	1000	590 (0.1 % Proof)	12	-
4	BS HR 10	Solutionise at 1150deg C for 2 hrs. Coo in Water. PPt at 800 deg C for 8 hrs. Cool in air	Soln	AT 780 deg C	540	400	12	-
5	MSRR 7035	Heat to 1130-1160 deg C for 1/2-21/2 hrs WQ/OQ. PPT at 800±8 deg C for 8 hr A/C	Soln	AT 780 deg C	540	400	12	-
6	MSRR 7038	Heat to 1130-1160 deg C for 1/2-21/2 hrs WQ/OQ. PPT at 800±8 deg C for 8 hr A/C	Soln Treat + Ppt	AT 780 deg C	540	400	12	-
7	MIDHANI ATG W0	-	-	-	1000	588	45	-

Data Sheet for Rationalisation of Aviation Metallic Materials - Nickel Alloy

General Grade of Material		NIMONIC 263	Type of Material	Ni-Cr-Co-Mo Alloy	Number of Specifications Identified		7
Rationalisation for Use		BAR					
Identified Specifications		Rationalised to	Form		Number of Specifications Identified	Number of Specifications Rationalised	Remarks
Sl No	Specification / Grade	Specification					
1	NCK 20D	AMS 5886 / MIDHANI ATG W0	BAR		7	2	-
2	AMS 5886						
3	NIMONIC 263						
4	BS HR 10						
5	MSRR 7035						
6	MSRR 7038						
7	MIDHANI ATG W0						

7.0
PART 4
TITANIUM ALLOYS

Data Sheet for Rationalisation of Aviation Metallic Materials - Titanium Alloy

General Grade of Material	TA6ZrD	Type of Material	Ti-Al-Zr Alloy	Number of Specifications Identified	6
Rationalisation for Use	Bar				

Sl. No.	Specification / Grade	Origin	Chemical composition (Wt%) (wherever limit not mentioned consider as max)													
			Fe	H	Al	Cu	Mn	Sn	Zr	Mo	Si	V	Ti	Others (each)		Others (total)
1	CCT 00202	FRENCH	0.05	60 ppm	5.7-6.3	-	-	-	4.5-6.0	0.25-0.75	0.15-0.35 (for ingots/ forging stock), 0.15-0.40 (for forgings)	-	Rem	O=0.09-0.19 N= 0.03 C= 0.08	Y=10 ppm B = 50 ppm	0.2
2	MSRR 8616	BRITISH	0.2	0.006 (for forging stock) 0.013 (for forgings)	5.7-6.3	-	-	-	4.5-6.0	0.25-0.75	0.10-0.40	-	Rem	O=0.19 N=0.05	C=0.08 Y=0.005	-
3	BS TA 43 (withdrawn)	BRITISH	0.2	0.006	5.7-6.3	-	-	-	4.0-6.0	0.25-0.75	0.10-0.40	-	Rem	C=0.08 O=0.19	N=0.05	-
4	BS TA 44 (withdrawn)	BRITISH	0.2	0.01	5.7-6.3	-	-	-	4.0-6.0	0.25-0.75	0.10-0.40	-	Rem	C=0.08 O=0.25	N=0.05	-
5	GTM Ti-685 (Indigenized)	INDIAN	0.2	60 ppm for forging stock, 100 ppm for forging	5.7-6.3	-	-	-	4.5-6.0	0.25-0.75	0.1-0.4	-	Rem	C=0.08 O=0.09-0.19	N=0.05	0.4
6	TITAN 26A (Indigenized)	INDIAN	0.05	60 ppm [100 ppm for forging]	5.7-6.3	-	-	-	4.5-6.0	0.25-0.75	0.15-0.35	-	Rem	C=0.08 O=0.09-0.19	N=0.03 Y = 0.001	0.2

Sl. No.	Specification / Grade	Heat treatment	Condition	Mechanical properties (Minimum)					
				UTS (MPa)	0.2% Proof (MPa)	% EL (5D)	% RA	OTHERS	Remarks
1	CCT 00202	**Solution treat**: 1050°C / ≥30 minutes / OQ or equivalent **Ppt**: 550°C / 24 hr / AC	Solutionize + Ppt	990 (at RT)	850 (at RT)	6 (at RT) [@ 50 mm]	15 [at RT]	**Notched / Plain tensile strength ≥** 1.3 (at RT)	**All properties are refered to bar stck in Longitudinal direction**
				620 (at 520°C)	480 (at 520°C)	9 (at 520°C) [@ 50 mm]	20 [at 520°C]	**Creep test: Temperature= 520oC, Stress= 300 MPa, Duration ≥ 100 hours, Plastic strain = 0.1% max.**	
								Low Cycle Fatigue (LCF) = 41.5 to 800 MPa / 2 Hz / Sinusoidal/ ≥16000 cycles (at RT)	
2	MSRR 8616	**Solution treat**: 1050°C / ≥30 minutes / OQ **Age**: 550°C / 24 hr / AC. **Stress relieve:** 950-1000°C / 3 hrs max. / AC	Solutionize + Age	990-1140 (at RT)	850 (at RT)	6 (at RT)	15 [at RT]	-	-
				620-780 (at 520°C)	480 (at 520°C)	9 (at 520°C)	20 [at 520°C]		
3	BS TA 43 (withdrawn)	**Solution treat**: 1050°C / 30 minutes per 25 mm / OQ **Age**: 550±5°C / 24 hr / AC. **Stress relieve:** 900-1000°C / 3 hrs max. / AC	Solutionize + Age	990-1140 (at RT)	850 (at RT)	6 (at RT)	15 [at RT]	**Creep test: Temperature= 520oC, Stress= 300 MPa, Duration ≥ 100 hours, Plastic strain = 0.1% max.**	-
				620-780 (at 520°C)	480 (at 520°C)	9 (at 520°C)	20 [at 520°C]		
4	BS TA 44 (withdrawn)	**Solution treat**: 1050°C / 30 minutes per 25 mm / OQ **Age**: 550±5°C / 24 hr / AC. **Stress relieve:** 900-1000°C / 3 hrs max. / AC	Solutionize + Age	990-1140 (at RT)	850 (at RT)	6 (at RT)	15 [at RT]	-	-
				620-780 (at 520°C)	480 (at 520°C)	9 (at 520°C)	20 [at 520°C]		
5	GTM Ti-685 (Indigenized)	**Solution treat**: 1050°C / 30 minutes -1 hr / OQ **Age**: 550°C / 24 hr / AC.	Solutionize + Age	990 (at RT)	850 (at RT)	6 (at RT) [@5D]	15 [at RT]	**Notched / Plain tensile strength ≥** 1.35 (at RT)	Creep test (only for forgings): Temperature= 450oC, Stress= 450 MPa, Duration = 100 hours, Plastic strain = 0.1% max.
				620 (at 520°C)	480 (at 520°C)	9 (at 520°C) [@5D]	20 [at 520°C]	**Creep test: Temperature= 520oC, Stress= 310 MPa, Duration = 100 hours, Plastic strain = 0.1% max.**	
								Post Creep tensile test: UTS≥ 990 MPa, 0.2% YS≥ 850 MPa, %E(5D) ≥6, %RA ≥10	

6	TITAN 26A (Indigenized)	**Solution treat**: 1050 ± 10°C / ≥ 30 per 25 mm ruling thickness / OQ **Age**: 550 ± 5°C / 24 hr	Solutionize + Age	990 (at RT)	850 (at RT)	6 (at RT) [@5D]	15 [at RT]	**Notched / Plain tensile strength ≥** 1.35 (at RT) **Low Cycle Fatigue (LCF) = 0.1P-P (R=0.1; 0.2% PS =850 MPa) / Sinusoidal / ≥ 1 X 104 cycles (at RT)** **Rotating beam fatigue testing (R=-1): 440 MPa, 1 X 107 cycles (at RT)**	**All properties are refered to bar stcck in L direction**
				620 (at 520°C)	480 (at 520°C)	9 (at 520°C) [@5D]	20 [at 520°C]	**Creep test: Temperature= 520oC, Stress= 310 MPa, Duration = 100 hours, Plastic strain = 0.15% max.** **Post Creep tensile test: UTS≥ 990 MPa, 0.2% PS≥ 850 MPa, %E(5D) ≥6, %RA ≥10**	

Data Sheet for Rationalisation of Aviation Metallic Materials - Titanium Alloy

General Grade of Material	**TA6ZrD**	**Type of Material**	**Ti-Al-Zr Alloy**	**Number of Specifications Identified**	**6**
Rationalisation for Use	**BAR**				

Identified Specifications		Rationalised to	Form	Number of Specifications Identified	Number of Specifications Rationalised	Remarks
Sl. No.	**Specification / Grade**	**Specification**				
1	CCT 00202	TITAN 26A	Bar	6	1	-
2	MSRR 8616					
3	BS TA 43 (withdrawn)					
4	BS TA 44 (withdrawn)					
5	GTM Ti-685 (Indigenized)					
6	TITAN 26A (Indigenized)					

Data Sheet for Rationalisation of Aviation Metallic Materials - Titanium Alloy

General Grade of Material	TA8DV	Type of Material	Ti-Al-Mo-V	Number of Specifications Identified	6
Rationalisation for Use	Bar				

Sl. No.	Specification / Grade	Origin	Chemical composition (Wt%) (wherever limit not mentioned consider as max)													
			Fe	H	Al	Cu	Mn	Sn	Zr	Mo	Si	V	Ti	Others (each)		Others (total)
1	CCT LA 114	FRENCH	0.3	0.015	7.35-8.35	0.1	-	0.2	-	0.75-1.25	0.1	0.75-1.25	Rem	O=0.20 N= 0.05 C= 0.08	Y=50 ppm B = 10 ppm	-
2	AMS 4972	AMERICAN	0.3	0.015	7.35-8.35	-	-	-	-	0.75-1.25	-	0.75-1.25	Rem	O=0.12 N= 0.05 C= 0.08	Y=50 ppm	0.4
3	AMS 4933	AMERICAN	0.3	0.015	7.35-8.35	-	-	-	-	0.75-1.25	-	0.75-1.25	Rem	O=0.12 N= 0.05 C= 0.08	Y=50 ppm	0.4
4	AMS-T-9047 / MIL-T-9047 (8Al-1Mo-1V) [obsolete] -superseded by AMS 6910	AMERICAN	0.3	0.015	7.35-8.35	-	-	-	-	0.75-1.25	-	0.75-1.25	Rem	O=0.15 N= 0.05 C= 0.08	Y=50 ppm	0.4
5	AMS 4973	AMERICAN	0.3	0.015	7.35-8.35	-	-	-	-	0.75-1.25	-	0.75-1.25	Rem	O=0.12 N= 0.05 C= 0.08	Y=50 ppm	0.4
6	TITAN 22A (Indigenized)	INDIAN	0.3	0.015	7.35-8.35	-	-	-	-	0.75-1.25	-	0.75-1.25	Rem	O=0.20 N= 0.05 C= 0.08 Ni =0.08	Ni+Cu=0.10 Y=50 ppm Mn+Cr = 0.15 B= 0.005	0.3

Sl. No.	Specification / Grade	Heat treatment	Condition	Mechanical properties (Minimum)					
				UTS (MPa)	0.2% Proof (MPa)	% EL (5D)	% RA	Others	Remarks
1	CCT LA 114	**Solution anneal** : 1000°C /1 hr / OQ Age: 580°C / 8 hrs / AC	Solution anneal + Age	900 (at RT)	820 (at RT)	10 (at RT) [@ 5D]	20 [at RT]	**Notched / Plain tensile strength** ≥ 1.3 (at RT)	-
				620 (at 425°C)	480 (at 425°C)	10 (at 425°C) [@ 5D]	25 [at 425°C]	**Creep test: Temperature= 455oC, Stress= 275 MPa, Duration ≥23 hours, Plastic strain = 0.15% max.**	-
2	AMS 4972	**Solution treat** : 899-927°C (±14°C) OR 982-1010°C / 1 hr ± 5 minutes / AC or faster **Stabilize** : 566-593°C (± 8°C) / ≥ 8 hr / AC	Solution treat + Stabilize	896 (at RT)	827 (at RT)	10 (at RT) [@ 4D]	20 [at RT]	-	-
				621 (at 427°C)	483 (at 427°C)	10 (at 427°C) [@ 4D]	25 [at 427°C]		
3	AMS 4933	**Solution treat** : 982-1010°C / 1 hr ± 6 minutes / AC or faster **Stabilize** : 566-621°C (± 14°C) / ≥ 8 hr / AC	Solution treat + Stabilize	896 (at RT)	827 (at RT)	10 (at RT) [@ 4D]	20 [at RT]	-	-
				621 (at 427°C)	483 (at 427°C)	10 (at 427°C) [@ 4D]	25 [at 427°C]		
4	AMS-T-9047 / MIL-T-9047 (8Al-1Mo-1V) [obsolete] -superseded by AMS 6910	**Solution treat** : 899-1010°C (±14°C) / AC or faster **Stabilize** : 595°C (± 14°C) / ≥ 8 hr / AC	Duplex annealed	896	827	10 [@ 4D or 50.8 mm]	20	-	-
5	AMS 4973	**Solution treat** : 899-927°C or 982-1010°C (±10°C) / 1 hr / AC **Stabilize** : 566-593°C (± 10°C) / ≥ 8 hr / AC	Solution treat + Stabilize	896 (at RT)	827 (at RT)	10 (at RT) [@ 4D]	20 [at RT]	-	-
				621 (at 427°C)	483 (at 427°C)	10 (at 427°C) [@ 4D]	25 [at 427°C]	-	-
6	TITAN 22A (Indigenized)	**Solution treat** : 900-925°C or 980-1010°C (±10°C)/ 1 hr / AC **Stabilize** : 565-595°C (±10°C) / ≥ 8 hr / AC	Solution treat + Stabilize	896 (at RT)	827 (at RT)	10 (at RT)	20 [at RT]	**Notched / Plain tensile strength** ≥ 1.3 (at RT)	-
				621 (at 425°C)	483 (at 425°C)	10 (at 425°C)	25 [at 425°C]	**Notched Stress rupture (at RT): Stress= 1034 MPa, Time to rupture ≥ 5 hours**	-

<table>
<tr><th colspan="7">Data Sheet for Rationalisation of Aviation Metallic Materials - Titanium Alloy</th></tr>
<tr><th colspan="2">General Grade of Material</th><th>TA8DV</th><th>Type of Material</th><th>Ti-Al-Mo-V</th><th>Number of Specifications Identified</th><th>6</th></tr>
<tr><th colspan="2">Rationalisation for Use</th><th colspan="5">Bar</th></tr>
<tr><th colspan="2">Identified Specifications</th><th>Rationalised to</th><th rowspan="2">Form</th><th rowspan="2">Number of Specifications Identified</th><th rowspan="2">Number of Specifications Rationalised</th><th rowspan="2">Remarks</th></tr>
<tr><th>Sl. No.</th><th>Specification / Grade</th><th>Specification</th></tr>
<tr><td>1</td><td>CCT LA 114</td><td rowspan="6">AMS 4972 / TITAN 22A</td><td rowspan="6">Bar</td><td rowspan="6">6</td><td rowspan="6">2</td><td rowspan="6">-</td></tr>
<tr><td>2</td><td>AMS 4972</td></tr>
<tr><td>3</td><td>AMS 4933</td></tr>
<tr><td>4</td><td>AMS-T-9047 / MIL-T-9047 (8Al-1Mo-1V) [obsolete] -superseded by AMS 6910</td></tr>
<tr><td>5</td><td>AMS 4973</td></tr>
<tr><td>6</td><td>TITAN 22A (Indigenized)</td></tr>
</table>

Data Sheet for Rationalisation of Aviation Metallic Materials - Titanium Alloy															
General Grade of Material		Ti-6-2-4-2 / Ti6242S	Type of Material			Ti-Al-Sn-Zr-Mo Alloy		Number of Specifications Identified					4		
Rationalisation for Use		Bar													
Sl. No.	Specification / grade	Origin	Chemical composition (Wt%) (wherever limit not mentioned consider as max)												
			Fe	H	Al	Cu	Mn	Sn	Zr	Mo	Si	V	Ti	Others (each)		Others (total)
1	EMS 54929	AMERICAN	0.08	0.0125 [0.015 for forgings]	5.7-6.3	0.02	-	1.75-2.25	3.5-4.5	1.85-2.15	0.07-0.14 Si/Fe ≥ 1.4	-	Rem	O=0.10-0.15 N= 0.02 C= 0.04 Ni=50 ppm Cr =0.01	Y=50 ppm B = 30 ppm	0.4
2	AMS 4929	AMERICAN	0.1	0.0125 [0.015 for forgings]	5.5-6.5	-	-	1.80-2.20	3.6-4.40	1.80-2.20	0.06-0.10	-	Rem	O=0.15 N= 0.05 C= 0.05	Y=50 ppm	0.3
3	AMS 4975	AMERICAN	0.1	0.0125 [0.015 for rings]	5.5-6.5	-	-	1.80-2.20	3.6-4.40	1.80-2.20	0.06-0.10	-	Rem	O=0.15 N= 0.05 C= 0.05	Y=50 ppm	0.3
4	AMS-T-9047 / MIL-T-9047 [6Al-2Sn-4Zr-2Mo] (obsolete)- superseded by AMS 6905	AMERICAN	0.25	0.0125	5.5-6.5	-	-	1.80-2.20	3.6-4.40	1.80-2.20	0.13	-	Rem	O=0.15 N= 0.04 C= 0.05	Y=50 ppm	0.3

Sl. No.	Specification / grade	Heat treatment	Condition	Mechanical properties (Minimum)					
				UTS (MPa)	0.2% Proof (MPa)	% EL (5D)	% RA	OTHERS	Remarks
1	EMS 54929	**Solution treat**: sufficiently close to b transus temp /1-2 hr / AC or faster **Ppt**: 593°C (±14°C) / 8 hrs / AC	Solution treat + Ppt	896 (at RT)	827 (at RT)	10 (at RT) [@ 4D]	25 [at RT]	**Creep test: Temperature= 510oC, Stress= 448 MPa, Duration ≥ 100 hours, Plastic strain = 1.0% max.**	-
				620 (at 482°C)	483 (at 482°C)	15 (at 482°C) [@ 4D]	30 [at 482°C]		
2	AMS 4976	**Solution treat**: 14-28°C (±8°C) below b transus temp /1 hr ± 5 minutes / AC or faster **Ppt**: 593°C (±8°C) / 8 hr ±15 minutes / AC	Solution treat + Ppt	896 (at RT)	827 (at RT)	10 (at RT) [@ 4D]	25 [at RT]	**Creep test: Temperature= 510oC, Stress= 241 MPa, Duration ≥ 35 hours, Plastic strain = 0.1% max.**	-
				621 (at 482°C)	483 (at 482°C)	15 (at 482°C) [@ 4D]	30 [at 482°C]		
3	AMS 4975	**Solution treat**: 14-28°C (±8°C) below b transus temp /1 hr ± 5 minutes / AC or faster **Ppt**: 593°C (±8°C) / 8 hr ±15 minutes / AC	Solution treat + Ppt	896 (at RT)	827 (at RT)	10 (at RT) [@ 4D]	25 [at RT]	**Creep test: Temperature= 510oC, Stress= 241 MPa, Duration ≥ 35 hours, Plastic strain = 0.1% max.**	-
				621 (at 482°C)	483 (at 482°C)	15 (at 482°C) [@ 4D]	35 [at 482°C]		
4	AMS-T-9047 / MIL-T-9047 [6Al-2Sn-4Zr-2Mo] (obsolete)- superseded by AMS 6905	**Solution treat**: 14-28°C (±8°C) below b transus temp / AC or faster **Stabliize**: 595°C (±14°C) / 8 hrs min. / AC	Solution treat + Stabilize (Duplex anneal)	896	827	10 [@ 4D or 50.8 mm]	25	-	-

Data Sheet for Rationalisation of Aviation Metallic Materials - Titanium Alloy						
General Grade of Material	**Ti-6-2-4-2/ Ti6242S**	**Type of Material**	**Ti-Al-Sn-Zr-Mo Alloy**	**Number of Specifications Identified**		**4**
Rationalisation for Use		**Bar**				
Identified Specifications		**Rationalised to**	**Form**	**Number of Specifications Identified**	**Number of Specifications Rationalised**	**Remarks**
Sl. No.	**Specification / grade**	**Specification**				
1	EMS 54929	EMS 54929	Bar	4	1	-
2	AMS 4976					
3	AMS 4975					
4	AMS-T-9047 / MIL-T-9047 [6Al-2Sn-4Zr-2Mo] (obsolete)- superseded by AMS 6905					

Data Sheet for Rationalisation of Aviation Metallic Materials - Titanium Alloy																
General Grade of Material			Ti6Al6V2Sn	Type of Material			Ti-Al-V-Sn Alloy	Number of Specifications Identified							5	
Rationalisation for Use			BAR													
Sl No	Specification	Grade	Origin	Chemical composition (Wt%) (wherever limit not mentioned consider as max)												
				Fe	H	Al	Cu	Mn	Sn	Zr	Mo	Si	V	Ti	Others: Each	Others: Total
1	AMS 4971	Ti662	AMERICAN	0.35-1	0.015	5-6	0.35-1	-	1.5-2.5	-	-	-	5-6 Yt 0.005	Rem	O= 0.20 N=0.04 C =0.05 E=0.10	-
2	AMS 4978	Ti662	AMERICAN	0.35-1	0.015	5-6	0.35-1	-	1.5-2.5	-	-	-	5-6 Yt 0.005	Rem	O= 0.20 N=0.04 C =0.05 E=0.11	-
3	AMS 4979	Ti662	AMERICAN	0.35-1	0.015	5-6	0.35-1	-	1.5-2.5	-	-	-	5-6 Yt 0.005	Rem	O= 0.20 N=0.04 C =0.05 E=0.12	-
4	AMS 4936	Ti662	AMERICAN	0.35-1	0.015	5-6	0.35-1	-	1.5-2.5	-	-	-	5-6 Yt 0.005	Rem	O= 0.20 N=0.04 C =0.05 E=0.13	-
5	AMS 4937	Ti662	AMERICAN	0.35-1	0.015	5-6	0.35-1	-	1.5-2.5	-	-	-	5-6 Yt 0.005	Rem	O= 0.20 N=0.04 C =0.05 E=0.14	-

Sl No	Specification	Grade	Heat treatment	Condition	Mechanical properties (Minimum)					
					Size (mm)	UTS (MPa)	0.2%	% EL (5D)		Hardness
1	AMS 4971	Ti662	Anneal at 705 ± 15 deg.C for 2 hrs. Cool ; Soln treat at 900 ± 15 deg.C for 1 hr Quench in agitated water. Ppt at 540 ± 8 deg.C for 4 hrs Air cool.	O ST+Ppt	Diameter (or Distance between parallel sides <25 25-50 50-75* 75-100**	1205 1205 1170 1170 * 1140 * 1070 * 1140 ** 1105** 1070** 1035**	1105 1105 1170 1105 * 1070 * 1000 * 1070 ** 1035** 1000** 965**	L 8 8 8 8* 8* 8* 8** 8** 8** 8**	T 6 6 6 6* 6* 6* 6** 6** 6** 6**	-
2	AMS 4978	Ti662	-	O	Dia <50.8 50.8-101.6	1034 1000	965 931	L 10 10	T 8 8	-
3	AMS 4979	Ti662	Soln treat at 855-900 deg.C for 1 hr WQ. (agitated) Ppt at 540 ± 15 deg.C for 4 hrs.Air cool.	ST +Ppt	<25 25-50 50-75 75-100	1205 1170 1070 1035	1105 1070 1000 975	L 10 10 10 10	T 8 8 8 8	-
4	AMS 4936	Ti662	Heat to 705-816 dec.C for 2 hrs & cool in water. Stress relieve at 565 deg.C max. * Soln at 900 ± 14 deg.C for 1 hr. Quench in agitated oil or water Ppt at 565± 8 for 4 hrs. Air cool **	O ST+Ppt	<38.1 * 38.1-76.2 * 76.2-101.6 * <50.8 ** 50.8-100 **	1034 * 1000 * 965 * 1034 ** 1000 **	965-1138 * 930-1103 * 895-1069 * 965-1138** 930-1103 **	L 10 * 10 * 10 * 10** 10**	T 8 * 8 * 8 * 8** 8**	-
5	AMS 4937	Ti662	-	Anneal and stress relieve. Soln Ppt	*<76.2 *76.2-101.6 *<62.5 *62.5-100	1000 965 1035 1008	931-1103 896-1069 965-1138 930-1103	L 10 * 10 * 10 * 15**	T 8 * 8 * 8 * 15**	-

<table>
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<tr><th colspan="3">General Grade of Material</th><th>Ti6Al6V2Sn</th><th>Type of Material</th><th>Ti-Al-V-Sn Alloy</th><th>Number of Specifications Identified</th><th>5</th></tr>
<tr><th colspan="3">Rationalisation for Use</th><th colspan="5">BAR</th></tr>
<tr><th colspan="3">Identified Specifications</th><th>Rationalised to</th><th rowspan="2">Form</th><th rowspan="2">Number of Specifications Identified</th><th rowspan="2">Number of Specifications Rationalised</th><th rowspan="2">Remarks</th></tr>
<tr><th>Sl No</th><th>Specification</th><th>Grade</th><th>Specification</th></tr>
<tr><td>1</td><td>AMS 4971</td><td>Ti662</td><td rowspan="5">AMS 4971</td><td rowspan="5">BAR</td><td rowspan="5">5</td><td rowspan="5">1</td><td rowspan="5">-</td></tr>
<tr><td>2</td><td>AMS 4978</td><td>Ti662</td></tr>
<tr><td>3</td><td>AMS 4979</td><td>Ti662</td></tr>
<tr><td>4</td><td>AMS 4936</td><td>Ti662</td></tr>
<tr><td>5</td><td>AMS 4937</td><td>Ti662</td></tr>
</table>

Data Sheet for Rationalisation of Aviation Metallic Materials - Titanium Alloy																
General Grade of Material			Ti64	Type of Material			Ti-Al-V		Number of Specifications Identified					15		
Rationalisation for Use			Bar													
Sl. No.	Specification	Grade	Origin	Chemical composition (Wt%) (wherever limit not mentioned consider as max)												
				Fe	H	Al	Cu	Mn	Sn	Zr	Mo	Si	V	Ti	Others (each)		Others (total)
1	MSRR 8614	-	BRITISH	0.3	125 ppm for bar and section for machining, 100 ppm for forging stock and 150 ppmfor forging	5.5-6.75	-	-	-	-	-	-	3.5-4.5	Rem	O=0.14-0.23 N= 0.03 C = 0.08	Y=50 ppm	-
2	AMS 4928	-	AMERICAN	0.3	125 ppm [150 ppmfor forgings]	5.5-6.75	-	-	-	-	-	-	3.5-4.5	Rem	O=0.20 N=0.05 C=0.08	Y=50 ppm	0.4
3	CCT 00166	TA6V.PQ	FRENCH	0.3	100 ppm [150 ppmfor forgings]	5.5-6.75	0.1	0.1	Sn: 0.1, Sn+Mo+Cu+ Mn+Zr=0.20%	0.1	0.1	-	3.5-4.5	Rem	O=0.22 N=0.05 C=0.08 B=10 ppm	Y=50 ppm	0.2
4	GTM Ti-64 (Indigenized)	-	INDIAN	0.3	100 ppm	6.2-6.75	0.1	0.1	0.1	0.1	0.1	-	3.5-4.5	Rem	N= 0.03 Y=0.001 O=0.16-0.20	C=0.08 B=10 ppm Others (each) = 0.1	0.2
5	AIR9183	TA6V	FRENCH	0.25	125 ppm ,	5.5-7.0	-	-	-	-	-	-	3.5-4.5	Rem	C=0.08 O=0.20	N=0.07	-
6	CCT LA109	TA6V	FRENCH	0.3	0.010 [0.015 for forgings]	5.5-6.75	-	-	-	-	-	-	3.5-4.5	Rem	C=0.08 O=0.12-0.20.	N=0.05 Y=0.005	-
7	BS TA12 (Obsolete) - superseded by BS EN 3310	-	BRITISH	0.3	0.01	5.5-6.75	-	-	-	-	-	-	3.5-4.5	Rem	O + 2N =0.25 C=0.08	N=0.03 Y=0.005 Others (each) = 0.1	0.4

8	BS TA13 (Obsolete) - superseded by BS EN 3312	-	BRITISH	0.3	0.0125	5.5-6.75	-	-	-	-	-	-	3.5-4.5	Rem	O + 2N =0.25 C=0.08	N=0.03 Y=0.005	0.4
9	TITAN 31A (Indigenized)	-	INDIAN	0.3	0.008	5.5-6.75	0.1	0.1	0.1	0.1	0.1	Sn + Mo + Cu + Mn + Zr = 0.2	3.5-4.5	Rem	C=0.08 O=0.15-0.20 B = 0.005	N=0.05 Y=0.005	0.2
10	AMS-T-9047 / MIL-T-9047 6Al-4V (obsolete) - superseded by AMS 6931	-	AMERICAN	0.3	0.0125	5.5-6.75	-	-	-	-	-	-	3.5-4.5	Rem	C=0.08 O=0.20	N=0.05 Y=0.005	0.4
11	ASTM B 348	Grade 5, UNS R56400	AMERICAN	0.4	0.015	5.5-6.75	-	-	-	-	-	-	3.5-4.5	Rem	C=0.08 O=0.20	N=0.05	0.4
12	ASTM B 381	Grade F5, UNS R56400	AMERICAN	0.4	0.015	5.5-6.75	-	-	-	-	-	-	3.5-4.5	Rem	C=0.08 O=0.20	N=0.05	0.4
13	WL 3.7164	-	GERMAN	0.3	0.015	5.5-6.5	-	-	-	-	-	-	3.5-4.5	Rem	O =0.20 C=0.08	N=0.05	-
14	OST1 90013-81 / OST1 90173-75 / AMTY 451	BT6 / VT6	RUSSIAN	0.3	0.015	5.5-6.8	-	-	-	0.3	-	0.1	3.5-5.3	Rem	O =0.20 C=0.10	N=0.05	0.3
15	OST1-90013-71 OST1-90024-94	VT6	RUSSIAN	0.3	0.015	5.5 - 7 5.3 - 6.8	0.1 DO	- -	- -	- -	- -	0.15	4.2 - 6 3.5 - 5.3	Rem	O = 0.2 N = 0.05	-	-

Sl. No.	Specification	Grade	Heat treatment	Condition	Mechanical properties (Minimum)					
					UTS (MPa)	0.2% Proof (MPa)	% EL (5D)	% RA	OTHERS	Remarks
1	MSRR 8614	-	**Anneal**: 700-705°C / 1 hr min. / AC	Anneal	930-1160	830	8 [@5.650A]	25	-	For Large Forgings, a homogenization treatment of 960°C/ 1 hr min./WQ may be used prior to annealing
2	AMS 4928	-	**Solutionize** : 28-83°C below β transus (±14°C)/AC or faster **Anneal**:704-788°C (±14°C) / 1 hr min. / cool suitably	Solutionize and anneal	896	827	10	25	-	%RA in ST direction is waived-off for flash welded rings made from extrusions
3	CCT 00166	TA6V.PQ,	**For Bars & Forging Stock** :- **Homogenize:** 955°C (±7°C) / 1 hr / WQ **Anneal**: 700°C (±10°C) / 2 hr / AC; **For Forgings** :- **Homogenize** : 950-970°C / WQ **Anneal**: 700°C (±10°C) / 2 hr / AC	Homogenize + Anneal	930 (at RT)	830 (at RT)	10 for bars and forging stock; 9 for forgings (at RT) {%E in 5D/50mm}	25 (at RT)	**Notched / Plain tensile strength** ≥ 1.3 (at RT)	-
									Fracture toughness KIC ≥ 50 MPaÖm (at RT)	
					650 (at 300°C)	530 (at 300°C)	9 (at 300°C) {%E in 5D/50mm}	35 (at 300°C)	**Low Cycle Fatigue (LCF) = 41.5 to 830 MPa / 1-2 Hz / Sinusoidal/ ≥16000 cycles (at RT)**	
4	GTM Ti-64 (Indigenized)	-	**Solutionize** : 950-975°C (±10°C) / 1-2 hrs / quench in agitated water. **Anneal**:700 (±5°C) / 30 minutes to 2 hours/AC. **Stress relieve**:700 (±5°C) / 30 minutes to 2 hours/AC	Solutionize + anneal + stress relief	930 (at RT)	830 (at RT)	10 (for 4D) ; 9 (for 5D) {at RT}	25 (at RT)	**Hardness:** 300-380 BHN	-
									Notched / Plain tensile strength ≥ 1.3 (at RT)	
									Fracture toughness KIC≈KQ ≥ 50 MPaÖm (at RT)	
					650 (at 300°C)	530 (at 300°C)	10 (for 4D) ; 9 (for 5D) {at 300°C}	35 (at 300°C)	**Notched Stress rupture (at RT): Stress= 1172 MPa, Time to rupture ≥ 5 hours**	
									Creep test: Temperature= 300oC, Stress= 500 MPa, Duration = 100 hours, Plastic strain = 0.1% max.	
									Low Cycle Fatigue (LCF) = 41.5 to 830 MPa / 1.5 Hz / Sinusoidal/ ≥10000 cycles (at RT)	

For AMS Specifications, %E is in 50.8 mm or 4D.										
5	AIR9183	TA6V	**Anneal** at 730°C (±10°C) / 1 hr / AC	Anneal	830-1130	820	10	25	**Stress rupture test (at RT): Stress= 1160 MPa, Time to rupture ≥ 5 hours**	-
6	CCT LA109	TA6V	**Anneal** at 730°C (±10°C) / 1 hr / AC	Anneal	880-1130 (at RT)	820 (at RT)	8 for bars, 10 for forgings {at RT} [@5D]	20 for bars, 25 for forgings (at RT)	**Hardness**: 300-380 BHN	HT tensile is for bars only
					640 (at 300°C)	530 (at 300°C)	9 (for 5D) {at 300°C}	35 (at 300°C)	**Notched / Plain tensile strength** ≥ 1.3 (at RT)	
7	BS TA12 (Obsolete) - superseded by BS EN 3310	-	**Anneal** at 690-840°C / ≥30 minutes/AC or cool in inert atmosphere	Anneal	900-1160	830	10	25	-	-
8	BS TA13 (Obsolete) - superseded by BS EN 3312	-	**Anneal** at 690-840°C / ≥30 minutes/AC or cool in inert atmosphere	Anneal	900-1160	830	10	25	-	-
9	TITAN 31A (Indigenized)	-	**Solutionize** : 950-970°C (±10°C) / 1-2 hrs / quench in agitated water + **Anneal**:700°C (±10°C) / ≥2 hours / AC.	Solution + Anneal	930 (at RT)	830 (at RT)	9 (@ 5D) {at RT}	25 (at RT)	**Notched / Plain tensile strength** ≥ 1.3 (at RT)	-
									Fracture toughness KIC≈KQ ≥ 50 MPaÖm (at RT)	
									Notched Stress rupture (at RT): Stress= 1276 MPa, Time to rupture ≥ 5 hours	*Notched Stress rupture test and Creep test shall be performed in Solution and Precipitation treated condition* [Solutionize: 950°C (±10°C) / 1-2 hrs / quench in agitated water + Ppt:530-540°C (±10°C) / 4-8 hours / AC]
					650 (at 300°C)	530 (at 300°C)	9 (for 5D) {at 300°C}	35 (at 300°C)	**Stress rupture (at 300oC): Stress= 700 MPa, Time to rupture ≥ 100 hours**	
									Creep test: Temperature= 300oC, Stress= 580 MPa, Duration = 100 hours, Plastic strain = 0.2% max.	
									Low Cycle Fatigue (LCF) = 41.5 to 830 MPa / 1-2 Hz / Sinusoidal/ ≥10000 cycles (at RT)	-
									High Cycle Fatigue (HCF)-Rotating Beam = 430 MPa / R= -1 / 3x07 cycles (at RT)	

10	AMS-T-9047 / MIL-T-9047 6Al-4V (obsolete) - superseded by AMS 6931	-	**Anneal**: 704-788°C (±14°C) / AC		Anneal	896	827	10	25	-	-
11	ASTM B 348	Grade 5, UNS R56400	-		Anneal	895	828	10 (@ 4D)	25	-	-
12	ASTM B 381	Grade F5, UNS R56400	-		Anneal	895	828	10 (@ 4D)	25	-	-
13	WL 3.7164.1	-	**Anneal**: 700-840°C / AC or FC		Anneal	900	830	8	20-25	-	**Shear strength = 550-580 MPa** **Fracture toughness K_{IC}:** LT = 1770 $Nmm^{-3/2}$, TL = 1892 $Nmm^{-3/2}$
14	OST1 90013-81 / OST1 90173-75/ AMTY 451	BT6 / VT6	-		Anneal	902-1049	-	10	30	-	**Stress rupture (at 400oC): Stress= 590 MPa, Time to rupture ≥ 100 hours**
15	OST1-9013-71 AMTY451-67 OST1.9024-94 (Bar)	VT6	Anneal: H= 800°C, Air Cool Sol Treat & Aged Harden T=950±10°C Water Quench.	Dia upto 25	Anneal	931-1098	-	10	30	4	-
				Above 25		902-1050	-	10	30	4	
				All dim		1078	-	6	20	2.5	
				From 1.0-2.0	Anneal	882-1078	-	8	40	-	
				Above 2.0-10.5		-	-	-	30	-	
For AMS Specifications, %EL is in 50.8 mm or 4D.											

Data Sheet for Rationalisation of Aviation Metallic Materials - Titanium Alloy

General Grade of Material	Ti64	Type of Material	Ti-Al-V	Number of Specifications Identified	15
Rationalisation for Use	Bar				

Identified Specifications			Rationalised to	Form	Number of Specifications Identified	Number of Specifications Rationalised	Remarks
Sl. No.	Specification	Grade	Specification				
1	MSRR 8614	-	AMS 4928 / TITAN 31A	BAR	15	2	-
2	AMS 4928	-					
3	CCT 00166	TA6V.PQ					
4	GTM Ti-64 (Indigenized)	-					
5	AIR9183	TA6V					
6	CCT LA109	TA6V					
7	BS TA12 (Obsolete) - superseded by BS EN 3310	-					
8	BS TA13 (Obsolete) - superseded by BS EN 3312	-					
9	TITAN 31A (Indigenized)	-					
10	AMS-T-9047 / MIL-T-9047 6Al-4V (obsolete) - superseded by AMS 6931	-					
11	ASTM B 348	Grade 5, UNS R56400					
12	ASTM B 381	Grade F5, UNS R56400					
13	WL 3.7164	-					
14	OST1 90013-81 / OST1 90173-75 / AMTY 451	BT6 / VT6					
15	OST1-90013-71 OST1-90024-94	VT6					

Data Sheet for Rationalisation of Aviation Metallic Materials - Titanium Alloy

General Grade of Material	Ti6Al4V	Type of Material	Ti-Al-V alloy	Number Specifications Identified	8
Rationalisation for Use	PLATE / SHEET				

Sl No	Specification	Grade	Origin	Chemical composition (Wt%) (wherever limit not mentioned consider as max)												
				Fe	H	Al	Cu	Mn	Sn	Zr	Mo	Si	V	Ti	Others: Each	Others: Total
1	TA6V	Ti6Al4V	FRENCH	0.3	0.015	5.5-6.75	-	-	-	-	-	-	3.5-4.5	Rem	C=0.08 O=0.20 N=0.05	-
2	BT6	Ti6Al4V	RUSSIAN	0.3	0.015	5.5-6.75	-	-	-	-	-	-	3.5-4.5	Rem	O=0.20 C=0.08 N=0.05	-
3	AMS 4906	Ti6Al4V	AMERICAN	0.3	0.015	5.5-6.75	-	-	-	-	-	-	3.5-4.5	Rem	O=0.20 N=0.05 C=0.08	-
4	AMS 4911	Ti6Al4V	AMERICAN	0.3	0.015	5.5-6.75	-	-	-	-	-	-	3.5-4.5	Rem	O=0.20 N=0.05 C=0.08 Each 0.1	-
5	AMS 4932	Ti6Al4V	AMERICAN	0.3	0.015	5.5-6.75	-	-	-	-	-	-	3.5-4.5 Yt 0.005	Rem	O=0.20 N=0.05 C=0.08	-
6	BS TA 10	Ti6Al4V	BRITISH	0.3	0.015	5.5-6.75	-	-	-	-	-	-	3.5-4.5	Rem	O+N=0.25	-
7	BS TA 56	Ti6Al4V	BRITISH	0.3	0.015	5.5-6.75	-	-	-	-	-	-	3.5-4.5	Rem	O+N=0.25	-
8	BS TA 59	Ti6Al4V	BRITISH	0.3	0.015	5.5-6.75	-	-	-	-	-	-	3.5-4.5	Rem	O+N=0.25 O=0.2	-

Sl No	Specification	Grade	Heat treatment	Condition	Mechanical properties (Minimum)				
					Size (mm)	UTS (MPa)	0.2% Proof (MPa)	% EL (5D)	Hardness (HBW/BHN)
1	TA6V	Ti6Al4V	Anneal at 730± 10 deg.C for 1 hr.	O	-	890	820	8	-
2	BT6	Ti6Al4V	-	O	-	890	820	8	-
3	AMS 4906	Ti6Al4V	-	HR & Cold Reduction & O	<0.2 0.2-0.63 0.63-1.5	- 965 965	- 870 870	8 10	-
4	AMS 4911	Ti6Al4V	Heat at 705-900 deg.C. Cool suitably.	Hot Rolled & Anneal	<0.2 0.2-0.62 0.62-1.6 1.6-4.75 4.75-100	925 925 925 925 895	870 870 870 870 825	- 6 8 10 10	-
5	AMS 4932	Ti6Al4V	Heat at 705-900 deg.C. Cool suitably.	HR	-	924	869	5	-
6	BS TA 10	Ti6Al4V	Anneal at 700-900 deg.C Cool in air.	O	-	960-1270	900	8	-
7	BS TA 56	Ti6Al4V	Anneal at 700-900 deg.C Cool in air/Furnace cool.	O	5-10 10-25 25-100	895-1150 895-1150 895-1150	825 825 825	8	-
8	BS TA 59	Ti6Al4V	Anneal at 700-900 deg.C for 20 mts. Cool in air.	O	-	920-1180	870	8	-

Data Sheet for Rationalisation of Aviation Metallic Materials - Titanium Alloy

General Grade of Material			Ti6Al4V	Type of Material	Ti-Al-V alloy	Number Specifications Identified	8
Rationalisation for Use			PLATE / SHEET				
Identified Specifications			Rationalised to	Form	Number of Specifications Identified	Number of Specifications Rationalised	Remarks
Sl No	Specification	Grade	Specification				
1	TA6V	Ti6Al4V	AMS 4911	PLATE / SHEET	8	1	-
2	BT6	Ti6Al4V					
3	AMS 4906	Ti6Al4V					
4	AMS 4911	Ti6Al4V					
5	AMS 4932	Ti6Al4V					
6	BS TA 10	Ti6Al4V					
7	BS TA 56	Ti6Al4V					
8	BS TA 59	Ti6Al4V					

Data Sheet for Rationalisation of Metallic Materials - Titanium Alloy

General Grade of Material	Ti662	Type of Material	Ti-Al-V-Sn Alloy	Numbe of Specifications Identified	2
Rationalisation for Use	PLATE / SHEET				

Sl No	Specification	Grade	Origin	Chemical composition (Wt%) (wherever limit not mentioned consider as max)												
				Fe	H	Al	Cu	Mn	Sn	Zr	Mo	Si	V	Ti	Others: Each	Others: Total
1	AMS 4918	Ti662	AMERICAN	0.35-1	0.015	5-6	0.35-1	1	1.5-2.5	-	-	-	5.75-6.25	Rem	P=0.20 N =0.04 C =0.05 E =0.10	-
2	MIL-T-9046J AB-3	Ti662	AMERICAN	0.35-1	0.015	5-6	0.35-1	1	1.5-2.5	-	-	-	5-6	Rem	O=0.2	0.3

Sl No	Specification	Grade	Heat treatment	Condition	Mechanical properties (Minimum)				
					Size (mm)	UTS (MPa)	0.2% Proof (MPa)	% EL (5D)	Hardness (HBW/BHN)
1	AMS 4918	Ti662	Heat to 705-815 deg.C for 20 mts/25mm (10 mts minimum)	HR & O	<0.62 0.62-4.75 4.75-50 50-100	1070 1035 1035 1000	1000 1000 965 930	8 10 10 10	-
2	MIL-T-9046J AB-3	Ti662	Heat to 705-815 deg.C followed by air cool	O	<20	1138	1034	10	-

Data Sheet for Rationalisation of Aviation Metallic Materials - Titanium Alloy								
General Grade of Material			Ti662	Type of Material	Ti-Al-V-Sn Alloy	Number of Specifications Identified		2
Rationalisation for Use			PLATE / SHEET					
Identified Specifications			Rationalised to	Form	Number of Specifications Identified	Number of Specifications Rationalised		Remarks
Sl No	Specification	Grade	Specification					
1	AMS 4918	Ti662	AMS 4918	PLATE / SHEET	2	1		-
2	MIL-T-9046J AB-3	Ti662						

Data Sheet for Rationalisation of Aviation Metallic Materials - Titanium Alloy

General Grade of Material	Ti8Al1Mo1V(TA8DV)	Type of Material	Ti-Al-Mo-V alloy	Number of Specifications Identified	3
Rationalisation for Use	PLATE / SHEET				

Sl No	Specification	Grade	Origin	Chemical composition (Wt%) (wherever limit not mentioned consider as max)												
				Fe	H	Al	Cu	Mn	Sn	Zr	Mo	Si	V	Ti	Others: Each	Others: Total
1	AMS 4915	Ti8Al1Mo1V(TA8DV)	AMERICAN	0.3	0.015	7.35-8.35	-	-	-	-	0.75-1.25	-	0.75-1.25 Yt 0.005	Rem	O=0.12 N=0.05 C=0.08	-
2	AMS 4916	Ti8Al1Mo1V(TA8DV)	AMERICAN	0.3	0.015	7.35-8.35	-	-	-	-	0.75-1.25	-	0.75-1.25 Yt 0.005	Rem	O=0.12 N=0.05 C=0.09	-
3	AMS-T-9046 A-4	Ti8Al1Mo1V	AMERICAN	0.3	0.015	7.35-8.35	-	-	-	-	0.75-1.25	-	0.75-1.25 Yt 0.005	Rem	O=0.12 N=0.05 C=0.10	-

Sl No	Specification	Grade	Heat treatment	Condition	Mechanical properties (Minimum)				
					Size (mm)	UTS (MPa)	0.2% Proof (MPa)	% EL (5D)	Hardness (HBW/BHN)
1	AMS 4915	Ti8Al1Mo1V(TA8DV)	Anneal at 760-790 ± 15 deg.C for 1-8 hrS. Cool at 55 deg.C/hr upto 480 deg.C & cool to room temperature	HR & O	0.2-0.35 0.35-0.6 0.6-12.5 12.5-25 25-62.5 62.5-100	1000 1000 1000 965 895 825	930 930 930 895 825 760	6 8 10 10 10 8	-
2	AMS 4916	Ti8Al1Mo1V(TA8DV)	-	HR & Cold Reduction & O	0.2-0.35 0.35-0.6 0.6-4.75 4.75-25 25-50 50-100	930 930 930 895 865 825	825 825 825 825 795 760	6 8 10 10 10 8	-
3	AMS-T-9046 A-4	Ti8Al1Mo1V	Anneal at 760-790 ± 15 deg.C followed by air cool	HR & O	0.2-0.35 0.35-0.6 0.6-12.5 12.5-25 25-62.5 62.5-100	1000 1000 1000 965 895 825	930 930 930 895 825 760	6 8 10 10 10 8	-

Data Sheet for Rationalisation of Aviation Metallic Materials - Titanium Alloy

General Grade of Material			Ti8Al1Mo1V(TA8DV)	Type of Material	Ti-Al-Mo-V alloy	Number of Specifications Identified	3
Rationalisation for Use			PLATE / SHEET				
Identified Specifications			Rationalised to	Form	Number of Specifications Identified	Number of Specifications Rationalised	Remarks
Sl No	Specification	Grade	Specification				
1	AMS 4915	Ti8Al1Mo1V(TA8DV)	AMS 4916	PLATE / SHEET	3	1	-
2	AMS 4916	Ti8Al1Mo1V(TA8DV)					
3	AMS-T-9046 A-4	Ti8Al1Mo1V					

Data Sheet for Rationalisation of Aviation Metallic Materials - Titanium Alloy

General Grade of Material	Ti 6Al 2Sn 4Zr 2Mo	Type of Material	Ti-Al-Sn-Zr-Mo Alloy	Number Specifications Identified	2
Rationalisation for Use	PLATE / SHEET				

Sl No	Specification	Grade	Origin	Chemical composition (Wt%)												
				Fe	H	Al	Cu	Mn	Sn	Zr	Mo	Si	V	Ti	Others: Each	Others: Total
1	AMS 4919	Ti 6242	AMERICAN	0.25	0.015	5.5-6.5	-	-	1.8-2.2	3.6-4.4	1.8-2.2	0.06 - 0.10 Yt0.005	-	Rem	O=0.12 N=0.05 C=0.05	-
2	MIL-T-9046J AB-4	Ti 6242	AMERICAN	0.25	0.012	5.5 - 6.7	-	-	1.8-2.2	3.6-4.4	1.8-2.2	0.06 - 0.10 Yt0.005	3.5 - 4.5	Rem	O=0.2 N=0.05 C=0.08	-

Sl No	Specification	Grade	Heat treatment	Condition	Mechanical properties (Minimum)				
					Size (mm)	UTS (MPa)	0.2% Proof (MPa)	% EL (5D)	Hardness (HBW/BHN)
1	AMS 4919	Ti6242	Heat to 899± 14 deg.C for 30 mts. Cool in air. Reheat to 788± 14 deg.C for 15 mts. Cool in air.25mm	HR & O ** At 482 deg.C	0.64-1.57 1.57-25.4 25.4-76.2 0.64-15.7 1.57-50.8 50.8-76.2	931 931 896 655** 655** 621**	862 862 827 517** 517** 483**	8 10 10 7** 10** 10**	-
2	MIL-T-9046J AB-4	Ti6242	Heat to 899± 14 deg.C for 30 mts. Cool in air. Reheat to 788± 14 deg.C for 15 mts. Cool in air.25mm	Duplex annealed Room temp	0.635 - 1.52	931	862	8	-
					1.52 - 25.4	931	862	10	-
					25.4 - 76.2	896	827	10	-

Data Sheet for Rationalisation of Aviation Metallic Materials - Titanium Alloy								
General Grade of Material			Ti6Al2Sn4Zr2Mo	Type of Material	Ti-Al-Sn-Zr-Mo Alloy	Number Specifications Identified		2
Rationalisation for Use			PLATE / SHEET					
Identified Specifications			Rationalised to	Form		Number of Specifications Identified	Number of Specifications Rationalised	Remarks
Sl No	Specification	Grade	Specification					
1	AMS 4919	Ti6242	AMS 4919	PLATE / SHEET		2	1	-
2	MIL-T-9046J AB-4	Ti6242						

Data Sheet for Rationalisation of Aviation Metallic Materials - Titanium Alloy

General Grade of Material			Ti64	Type of Material			Ti-Al-V	Number of Specifications Identified							16		
Rationalisation for Use			Plate														
Sl. No.	Specification	Grade	Origin	Chemical composition (Wt%) (wherever limit not mentioned consider as max)													
				Fe	H	Al	Cu	Mn	Sn	Zr	Mo	Si	V	Ti	Others (each)		Others (total)
1	MSRR 8614	-	BRITISH	0.3	125 ppm for bar and section for machining, 100 ppm for forging stock and 150 ppmfor forging	5.5-6.75	-	-	-	-	-	-	3.5-4.5	Rem	O=0.14-0.23 N= 0.03 C = 0.08	Y=50 ppm	-
2	AMS 4911	-	AMERICAN	0.3	125 ppm [150 ppmfor forgings]	5.5-6.75	-	-	-	-	-	-	3.5-4.5	Rem	O=0.20 N=0.05 C=0.08	Y=50 ppm Others (each)= 0.10	0.4
3	CCT 00166	TA6V.PQ	FRENCH	0.3	100 ppm [150 ppmfor forgings]	5.5-6.75	0.1	0.1	Sn: 0.1, Sn+Mo+Cu+ Mn+Zr=0.20%	0.1	0.1	-	3.5-4.5	Rem	O=0.22 N=0.05 C=0.08 B=10 ppm	Y=50 ppm Others (each)= 0.10	0.2
4	GTM Ti-64 (Indigenized)	-	INDIAN	0.3	100 ppm	6.2-6.75	0.1	0.1	0.1	0.1	0.1	-	3.5-4.5	Rem	N= 0.03 Y=0.001 O=0.16-0.20	C=0.08 B=10 ppm	0.2
5	AIR9183	TA6V	FRENCH	0.25	125 ppm ,	5.5-7.0	-	-	-	-	-	-	3.5-4.5	Rem	C=0.08 O=0.20	N=0.07	-
6	CCT LA109	TA6V	FRENCH	0.3	0.010 [0.015 for forgings]	5.5-6.75	-	-	-	-	-	-	3.5-4.5	Rem	C=0.08 O=0.12-0.20	N=0.05 Y=0.005	-
7	BS TA10 (Obsolete) - superseded by BS EN 3310	-	BRITISH	0.3	0.01	5.5-6.75	-	-	-	-	-	-	3.5-4.5	Rem	O + 2N =0.25 C=0.08	N=0.03 Y=0.005	0.4
8	BS TA13 (Obsolete) - superseded by BS EN 3312	-	BRITISH	0.3	0.0125	5.5-6.75	-	-	-	-	-	-	3.5-4.5	Rem	O + 2N =0.25 C=0.08	N=0.03 Y=0.005	0.4

9	TITAN 31A (Indigenized)	-	INDIAN	0.3	0.008	5.5-6.75	0.1	0.1	0.1	0.1	0.1	Sn + Mo + Cu + Mn + Zr = 0.2	3.5-4.5	Rem	C=0.08 O=0.15-0.20 B = 0.005	N=0.05 Y=0.005	0.2
10	AMS-T-904/ MIL-T-9046 6Al-4V (obsolete) - superseded by AMS 6931	-	AMERICAN	0.3	0.0125	5.5-6.75	-	-	-	-	-	-	3.5-4.5	Rem	C=0.08 O=0.20	N=0.05 Y=0.005	0.4
11	ASTM B 265	Grade 5, UNS R56400	AMERICAN	0.4	0.015	5.5-6.75	-	-	-	-	-	-	3.5-4.5	Rem	C=0.08 O=0.20	N=0.05	0.4
12	ASTM B 381	Grade F5, UNS R56400	AMERICAN	0.4	0.015	5.5-6.75	-	-	-	-	-	-	3.5-4.5	Rem	C=0.08 O=0.20	N=0.05	0.4
13	EMS 54930	-	AMERICAN	0.1-0.25	0.0125 [0.015 for forgings]	5.75-6.75	-	-	-	-	-	-	3.5-4.5	Rem	C=0.05 O=0.14-0.20 O+2N=0.22	Y=50 ppm N=0.02	0.4
14	WL 3.7164	-	GERMAN	0.3	0.015	5.5-6.5	-	-	-	-	-	-	3.5-4.5	Rem	O =0.20 C=0.08	N=0.05	-
15	OST1 90013-81	BT6 / VT6	RUSSIAN	0.3	0.015	5.5-6.8	-	-	-	0.3	-	0.1	3.5-5.3	Rem	O =0.20 C=0.10	N=0.05	0.3
16	OST1-90013-71 OST1-90024-94 (Plate)	VT6	RUSSIAN	0.3	0.015	5.5 - 7 5.3 - 6.8	0.1	- -	- -	- -	- -	0.15	4.2 - 6 3.5 - 5.3	Rem	O = 0.2 N = 0.05	-	-

Sl. No.	Specification	Grade	Heat treatment	Condition	Mechanical properties (Minimum)					
					UTS (MPa)	0.2% Proof (MPa)	% EL (5D)	% RA	OTHERS	Remarks
1	MSRR 8614	-	**Anneal**: 700-705°C / 1 hr min. / AC	Anneal	930-1160	830	8 [@5.65ÖA]	25	-	For Large Forgings, a homogenization treatment of 960°C/ 1 hr min./WQ may be used prior to annealing
2	AMS 4911	-	**Solutionize**: 28-83°C below b transus (±14°C)/AC or faster **Anneal**:704-788°C (±14°C) / 1 hr min. / cool suitably	Solutionize and anneal	896	827	10	25	-	%RA in ST direction is waived-off for flash welded rings made from extrusions
3	CCT 00166	TA6V.PQ,	<u>**For Bars & Forging Stock**</u> :- **Homogenize:** 955°C (±7°C) / 1 hr / WQ **Anneal**: 700°C (±10°C) / 2 hr / AC; <u>**For Forgings**</u>:- **Homogenize** : 950-970°C / WQ **Anneal**: 700°C (±10°C) / 2 hr / AC	Homogenize + Anneal	930 (at RT)	830 (at RT)	10 for bars and forging stock; 9 for forgings (at RT) { E in 5D/50mm}	25 (at RT)	**Notched / Plain tensile strength** ≥ 1.3 (at RT)	-
									Fracture toughness KIC ≥ 50 MPaÖm (at RT)	
					650 (at 300°C)	530 (at 300°C)	9 (at 300°C) { E in 5D/50mm}	35 (at 300°C)	**Low Cycle Fatigue (LCF) = 41.5 to 830 MPa / 1-2 Hz / Sinusoidal/ ≥16000 cycles (at RT)**	
4	GTM Ti-64 (Indigenized)	-	**Solutionize**: 950-975°C (±10°C) / 1-2 hrs / quench in agitated water. **Anneal**:700 (±5°C) / 30 minutes to 2 hours/AC. **Stress relieve**:700 (±5°C) / 30 minutes to 2 hours/AC	Solutionize + anneal + stress relief	930 (at RT)	830 (at RT)	10 (for 4D) ; 9 (for 5D) {at RT}	25 (at RT)	**Hardness:** 300-380 BHN	-
									Notched / Plain tensile strength ≥ 1.3 (at RT)	
									Fracture toughness KIC≈KQ ≥ 50 MPaÖm (at RT)	
					650 (at 300°C)	530 (at 300°C)	10 (for 4D) ; 9 (for 5D) {at 300°C}	35 (at 300°C)	<u>**Notched Stress rupture (at RT): Stress= 1172 MPa, Time to rupture ≥ 5 hours**</u>	
									<u>**Creep test: Temperature= 300oC, Stress= 500 MPa, Duration = 100 hours, Plastic strain = 0.1% max.**</u>	
									Low Cycle Fatigue (LCF) = 41.5 to 830 MPa / 1.5 Hz / Sinusoidal/ ≥10000 cycles (at RT)	

For AMS Specifications, %E is in 50.8 mm or 4D.										
5	AIR9183	TA6V	**Anneal** at 730°C (±10°C) / 1 hr / AC	Anneal	830-1130	820	10	25	**Stress rupture test (at RT): Stress= 1160 MPa, Time to rupture ≥ 5 hours**	-
6	CCT LA109	TA6V	**Anneal** at 730°C (±10°C) / 1 hr / AC	Anneal	880-1130 (at RT)	820 (at RT)	8 for bars, 10 for forgings {at RT} [@5D]	20 for bars, 25 for forgings (at RT)	**Hardness**: 300-380 BHN	HT tensile is for bars only
					640 (at 300°C)	530 (at 300°C)	9 (for 5D) {at 300°C}	35 (at 300°C)	**Notched / Plain tensile strength** ≥ 1.3 (at RT)	
7	BS TA10 (Obsolete) - superseded by BS EN 3310	-	**Anneal** at 690-840°C / ≥30 minutes/AC or cool in inert atmosphere	Anneal	900-1160	830	10	25	-	-
8	BS TA13 (Obsolete) - superseded by BS EN 3312	-	Anneal at 690-840°C / ≥30 minutes/AC or cool in inert atmosphere	Anneal	900-1160	830	10	25	-	-
9	TITAN 31A (Indigenized)	-	**Solutionize** : 950-970°C (±10°C) / 1-2 hrs / quench in agitated water + **Anneal**:700°C (±10°C) / ≥2 hours / AC.	Solution + Anneal	930 (at RT)	830 (at RT)	9 (@ 5D) {at RT}	25 (at RT)	**Notched / Plain tensile strength** ≥ 1.3 (at RT)	-
									Fracture toughness KIC≈KQ ≥ 50 MPaÖm (at RT)	
									Notched Stress rupture (at RT): Stress= 1276 MPa, Time to rupture ≥ 5 hours	*Notched Stress rupture test and Creep test shall be performed in Solution and Precipitation treated condition* [Solutionize: 950°C (±10°C) / 1-2 hrs / quench in agitated water + Ppt:530-540°C (±10°C) / 4-8 hours / AC]
					650 (at 300°C)	530 (at 300°C)	9 (for 5D) {at 300°C}	35 (at 300°C)	**Stress rupture (at 300oC): Stress= 700 MPa, Time to rupture ≥ 100 hours**	
									Creep test: Temperature= 300oC, Stress= 580 MPa, Duration = 100 hours, Plastic strain = 0.2% max.	
									Low Cycle Fatigue (LCF) = 41.5 to 830 MPa / 1-2 Hz / Sinusoidal/ ≥10000 cycles (at RT)	-
									High Cycle Fatigue (HCF)- Rotating Beam = 430 MPa / R= -1 / 3x07 cycles (at RT)	

10	AMS-T-9046 / MIL-T-9046 6Al-4V (obsolete) -	-	**Anneal**: 704-788°C (±14°C) / AC		Anneal	896	827	10	25	-	-
11	ASTM B 265	Grade 5, UNS R56400	-		Anneal	895	828	10 (@ 4D)	25	-	-
12	ASTM B 381	Grade F5, UNS R56400	-		Anneal	895	828	10 (@ 4D)	25	-	-
13	EMS 54930	-	**Mill Anneal** as per AMS 4928		Anneal	896 (at RT)	827 (at RT)	10 (@ 4D) (at RT)	20 (at RT)	-	-
						724 (at 204°C)	593 (at 204°C)	15 (at 204°C) (@ 4D)	40 (at 204°C)	-	
14	WL 3.7164.1	-	**Anneal**: 700-840°C / AC or FC		Anneal	900	830	8	20-25	-	**Shear strength = 550-580 MPa**
										-	**Fracture toughness K_{IC}:** LT = 1770 $Nmm^{-3/2}$, TL = 1892 $Nmm^{-3/2}$
15	OST1 90013-81 / OST1 90173-75/ AMTY 451	BT6 / VT6	-		Anneal	902-1049	-	10	30	-	**Stress rupture (at 400oC): Stress= 590 MPa, Time to rupture ≥ 100 hours**
16	OST1-90218-76 (Steet)	VT6	Annealed	From 1.0-2.0	Anneal	883-1078	-	-	-	-	-
For AMS Specifications, %E is in 50.8 mm or 4D.											

Data Sheet for Rationalisation of Aviation Metallic Materials - Titanium Alloy

General Grade of Material	Ti64	Type of Material	Ti-Al-V	Number of Specifications Identified	16
Rationalisation for Use	PLATE				

Identified Specifications			Rationalised to	Form	Number of Specifications Identified	Number of Specifications Rationalised	Remarks
Sl. No.	Specification	Grade	Specification				
1	MSRR 8614	-	AMS 4911 / TITAN 31A	PLATE	16	2	-
2	AMS 4911	-					
3	CCT 00166	TA6V.PQ					
4	GTM Ti-64 (Indigenized)	-					
5	AIR9183	TA6V					
6	CCT LA109	TA6V					
7	BS TA10 (Obsolete) - superseded by BS EN 3310	-					
8	BS TA13 (Obsolete) - superseded by BS EN 3312	-					
9	TITAN 31A (Indigenized)	-					
10	AMS-T-9046/ MIL-T-9046 6Al-4V (obsolete)	-					
11	ASTM B 265	Grade 5, UNS R56400					
12	ASTM B 381	Grade F5, UNS R56400					
13	EMS 54930	-					
14	WL 3.7164	-					
15	OST1 90013-81 / OST1 90173-75 / AMTY 451	BT6 / VT6					
16	OST1-90013-71 OST1-90024-94	VT6					

8.0 REFERENCES OF PREVIOUSLY RATIONALISED MATERIALS

In the past, similar exercise has been taken up by various agencies along with RCMA/ CEMILAC. Some of the known references of Rationalisation of materials are as follows:

- Compendium of Alternate / Equivalent Material for Tejas Aircraft (LCA MK1 – Air Force Version Fighter & Trainer)" - Ref No. HAL/ARDC/LCA/MTL/005 Issue 'B' dated 05.12.2016.
- Rationalisation of Metallic Materials of Russian Military Aircraft and Aero-Engines-Ref No: RCMA(Nsk)/07/01 dated 27.09.2007.
- Rationalisation of MIDANI Metallic Materials - Annexure-1

  Ref. No.: CEMILAC/2011/GDP dated 01.08.2007
- Ordnance Factory, Ambajhari - Rationalisation of Aluminum Alloys - Annexure-2. Ref. No. CEMILAC/2011/GDP dated 30.10.2006
- Compendium on Rationalisation of Aviation Metallic Materials Volume-1

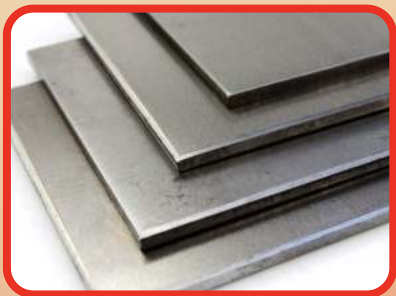
  Ref. No. CEMILAC/2011/GDP dated May-2019

ENGLISH EQUIVALENT OF RUSSIAN LETTERS

U.S.S.R.	Pronounced as	ENGLISH	U.S.S.R.	Pronounced as	ENGLISH
A	a	A	0	o	0
Б	beh	B	П	peh	P
B	veh	V	P	err	R
Г	geh	G	C	ess	S
Д	day	D	T	teh	T
E	Ye	Ye	Y	OOO	U
Ё	Yo	Yo	ф	ef	F
Ж	zheh	Jh	X	khah	Kh
З	zeh	Z	μ	tsch	Tse
и	ee	Ee	ч	cheh	ch
й	y	Y	щ	shah	Sh
K	kah	K	ш	shchah	Sch
Л	eL	L	э	e	E
M	em	M	Ю	u	Yu
H	en	N	Я	ya	Ya


ARMY

BAR



PLATE

SHEET

TUBE

WIRE