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DESIGN ALLOWABLES FOR

TITANIUM ALLOYS.

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North American Rockwell Corporation

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FOREWORD

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This report was prepared by North American Rockwell Corporation, Los Angeles Division, under USAF Contract No. AF 33(615)-3979. The contract was initiated under Project No. 7381, "Materials' Application". Task No. 738106, "Engineering and Design Data". The work was administered under the direction of the Air Force Materials Laboratory, Wright-Patterson Air Force, Ohio, by Mr. C. L. Harmsworth, Project Engineer.

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This technical report has been reviewed and is approved.

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ABSTRACT

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The purpose of this program was to develop design information on four titanium alloys for inclusion into Military Handbook-5. The alloys investigated were Ti-6Al-4V Condition STA, Ti-4Al-3Mo-1V Annealed Condition, Ti-13V-11Cr-3Al Annealed Condition, and Ti-6Al-6V-2Sn Annealed Condition and Condition STA.

The mechanical properties investigated were tensile, compression, shear, bearing, fracture toughness and fatigue. The general results obtained are presented in Section VII of this report and the data generated for Military Handbook-5 are presented in Section VIII.

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SECTION I

INTRODUCTION

1.1 PURPOSE OF THE PROGRAM

The program objective was to support the development of MIL-HDBK-5 data on titanium alloys by conducting a mechanical property design data program for four selected titanium alloys. The alloys evaluated are:

- 1. Ti-4A1-3Mo-1V Cond. A Sheet
- 2. Ti-13V-11Cr-3A1 Cond. A Sheet
- 3. Ti-6A1-4V Cond. STA Plate
- 4. Ti-6A1-6V-2Sn Cond. A and STA Plate

The mechanical property tests performed were tension, compression, bearing, shear, and thermal stability at temperatures from ambient to 800F in conjunction with fracture toughness and fatigue tests at room temperature. The data generated was compared with data obtained by means of a literature search.

1.2 BACKGROUND

MIL-HDBK-5 has long been accepted by the DOD and the FAA as the appropriate source of design allowables on structural materials. In order to establish and maintain an acceptable level of confidence in the handbook the MIL-HDBK-5 Supervisory Committee has imposed certain reliability criteria on the data and their analysis. These include a general requirement for at least ten heats or lots of each material condition from three or more (if possible) producers. A minimum total of 100 tests should go into the establishment of each allowable value. Consequently, the only properties that are genuinely established as "A" and "B" value (statistically reliable allowables) are Ftu and Fty at room temperature. The remaining properties such as compression, bearing, and shear, if they are included, are usually derived using ratioing techniques. Elevated temperature properties may also be derived. It is the purpose of this program to obtain these data on several titanium alloys using information from producers, users, data information centers and a test program. The alloys were selected as a result of a review of gaps in MIL Hdbk-5 data and based on requests for data received by the Department of Defense Information Centers.

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Section II

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TEST MATERIALS

Contained within this section are; (1) material procurement specification requirements, (2) vendor certifications (3) thermal processing history, (4) metallography (5) mechanical properties to be determined, and (6) test conditions for all the materials utilized in this investigation.

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2.1 Discussion:

The material data contained herein, identifies the source and provides the chemistry, heat treat condition, and material thickness for all the material used in the subject program. Each material is listed with the applicable vendor heat number, chemical composition, and the results of the supplier's tensile tests as obtained from the vendor certifications. All material utilized under this program sponsorship was procured to MIL-T-9046 requirements with all thermal processing adhering to the requirements of MIL-H-81200.

A brief summary of the materials, source and number of heats is listed below:

<u>Material</u>	Source	<u>Number of Heats</u>
Ti-4Al-3Mo-1V Cond. A	TMCA RMI	5 1
Ti-13V-11Cr-3Al Cond. ST Ti-6AL-4V Cond. STA	TMCA TMCA	· 5 5
Ti-6Al-6V-2Sn Cond. A and STA	RMI TMCA	3 15

In addition to the data obtained from the test program, data has also been incorporated from North American's Engineering and Quality Control Laboratories and test reports from the following vendors and users:

Titanium Metals Corporation of America NASA - Langley DMIC Data Sheets (Battelle Memorial Institute) The Boeing Company Reactive Metals, Incorporated

2.2 Material Certification

The following pages present the test material procurement specification requirements along with the vendor certifications sent with the test material. One heat of Ti 4Al-3Mo-1V Condition A was received without an attached certification Efforts to obtain this contification means and unsuccessful

tion. Efforts to obtain this certification proved unsuccessful.

Contrails

2.2.1 Material: Ti 4A1-3Mo-1V Cond A

(Specification requirements)

Sheet, Strip and Plate

Specification

on MIL-T-9046 Type III

Tensile Strength	125
-	
Yield Strength 0.2% Offset	115
Elongation %	10

· ·		.		SP	ECIFIC	ATION	CHEMICA	L LIMI	TS	<u> </u>			
C (Max.)	Fe (Max)	N	Al	v	Cr	Мо	н	Zr	Sn	Mn	02 (Max)	Ti	Total Other Elements (Max.)
0.08	0.30	0.05	5.5 6.75	3.5 4.5		-	0.015				0.20	Bal	0.40

MATERIAL:	TI 4A1-3Mo-1V Co	nd. A
VENDOR HEAT NUMBER:	G-1595 (TMCA	.)

NR/LAD IDENTIFICATION: Heat 1

CHEMICAL COMPOSITION:

CARBON	0.023	VANADIUM	1.1
IRON	0.09	MOLYBDENUM	3.3
NITROGEN	0.008	HYDROGEN	0.012
ALUMINUM	4.6	OXYGEN	0.10

Contrails

Vendor Test No.	Test Temp.	Mat'l. Cond.	Nom. Gage	Spec. Direct.	Ult. Tensile Strength Ksi	0.2% Yield Strength Ksi	ž Elong.
F-86 49	Room	Annealed	0.034	Long.	134.7	123.5	12.5
				Trans.	139.8	128.3	12.0

Contrails

.

MATERIAL:		Ti-4AL-3Mo-1	V Cond.	A
VENDOR HEAT NUMBER	:	G-895	(TMCA)	
NR/LAD IDENTIFICAT	ION:	Heat 2		
CHEMICAL COMPOSITI	on:			
CARBON	0.023	V	NADIUM	1.1
IRON	0.09	м	DLYBDENUM	3.2
NITROGEN	0.014	H	DROGEN	0.008
ALUMINUM	4.5	0	CYGEN	0.11

Vendor Test No.	Test Temp.	Mat'l. Cond.	Nom. Gage	Spec. Direct.	Ult. Tensile Strength Ksi	0.25 Yield Strength Kai	£ Elong.
J -06 79	Room	Annealed	0.055	Long.	133.0	124.1	14.0
				Trans.	137.3	131.8	10.5

2.2.1 (continued)

MATERIAL:	T1-4A1-3M0-1V	Cond.	A

VENDOR HEAT NUMBER: G-2446

NR/LAD IDENTIFICATION: Heat 3

CHEMICAL COMPOSITION:

CARBON	0.022	VANADIUM	1.1
IRON	0.06	MOLYBDENUM	3.2
NITROGEN	0.007	HYDROGEN	0.009
ALUMINUM	4.3	OXYGEN	0.10

Contrails

Vendor Test No.	Test Temp.	Mat'l. Cond.	Nom. Gage	Spec. Direct.	Ult. Tensile Strength Ksi	0.2% Yield Strength Ksi	1 Elong.
J-067 8	Room	Annealed	0.063	Long.	131.9	123.8	15.5
				Trans.	136.5	130.8	12.0

Contrails

MATERIAL:	T1- 4A1-3Mo-	1V Cond. A				
VENDOR HEAT NUMBER:	G-1523	(TMCA)				
Heat 4 NR/LAD IDENTIFICATION:						
CHEMICAL COMPOSITIO	IN :					
CARBON	0.025	VANADIUM				
IRON	0.09	MOLYBDENUM				
	A A1A					

NITROGEN	0.010	HYDROGEN	0.012
ALUMINUM	4.4	OXYGEN	0.12

1.0

3.3

Vendor Test No.	Test Tesp.	Matil. Cond.	Non. Gage	Spec. Direct.	Ult. Tensile Strength Kai	0.2% Yield Strength Kai	I Elong.
F- 7737	Room	Annealed	0.051	Long.	134.8	118.0	13.5
			[Trans.	136.2	122.6	14.0
						•	

Contrails

MATERIAL:	Ti-4A1-3Mo-1V	Cond.	A
VENDOR HEAT NUMBER:	G-1401 (*	IMCA)	

NR/LAD IDENTIFICATION: Heat 5

CHEMICAL COMPOSITION:

CARBON	0.025	VANADIUM	1.2
IRON	0.09	MOLYBDENUM	3.3
NITROGEN	0.011	HYDROGEN	0.005
ALUMINUM	4.3	OXYGEN	0.12

HEAT TREAT CONDITION: Annealed Per MIL-H-81200

Vendor Test No.	Test Temp.	Mat'l. Cond.	Nom. Gage	Spec. Direct.	Ult. Tensile Strength Ksi	0.2% Yield Strength Ksi	f Elong.
F -7 786	Room	Annealed	0.067	L	131.0	121.8	11.5
				т	140.4	136.0	1 3.5

,

Contrails

MATERIAL:	T1-4A1-3Mo-1V Cond. A
VENDOR HEAT HUNDER:	321055 (RMI)

NR/LAD IDENTIFICATION: Heat 6

CHEMICAL COMPOSITION:

CARBON	0.015	VANADIUM	0.91
IRON	0.19	MOLYBDENUM	3.27
NITROGEN	0.004	HYDROGEN	62 PPM
ALUNINUM	3.80	OXYGEN	0.091

HEAT TREAT CONDITION: Annealed Fer MIL-H-81200

Vendor Test No.	Test Temp.	Mat'l. Cond.	Nom. Gege	Spec. Direct.	Ult. Tensile Strength Kei	0.2% Tield Strength Kei	f Elong.
-	RT	A	0.110	L	131.5	124.8	13.0
				T	138.8	136.0	14.0

Note: Above tests performed by North American Rockwell, Los Angeles Division

Contrails

2.2.2 Material: Ti 13V-11Cr-3Al Cond A or ST (Specification Requirements)

Specification MIL-T-9046 Type IV Sheet, Strip and Plate

SPECIFICATION MINIMUM PROPERTIES (KSI)					
	0.050 Gage	Other 0.050 Gage			
Tensile Strength	132	125			
Yield Strength 0.2% Offset	125	120 (Min)			
Elongation #	8.0	10.			

				SP	SPECIFICATION CHEMICAL LIMITS					Total			
C (Max)	Fe (Max)	N	Al	v	Cr	Мо	Ħ	Zr	Sn	Mn	O ₂ (Max)	Ti	Other Elements (Max.)
0.05	0.15 0.30	0.05	2.5 3.5	12.5 14.5	10 12		0.025		_		0.20	Bal.	0.40

Contrails

MATERIAL:	T1-13V-11Cr-3A1		
VENDOR HEAT NUMBER:	D- 7855	(TMCA)	

NR/LAD IDENTIFICATION: Heat 1

CHEMICAL COMPOSITION:

CARBON 0.017	VANADIUM	13.7
IRON 0.15	CHROMIUM	10.9
NITROGEN 0.030	HYDROGEN	0.010
ALUMINUM 3.1	OXYGEN	0.13
HEAT TREAT CONDITION:	Solution Treated	

Vendor Test No.	Test Temp.	Mat'l. Gond.	Nom. Gege	Spec. Direct.	Ult. Tensile Strength Kei	0.2% Yield Strength Kai	1 Elong.
F- 2102	Room	ST	0.040	Long.	136.8	128.4	18.0
				Trans	141.7	132.7	9.5
	Room	STA(1)		Long.	194.1	176.3	7.0
				Trans	208.5	192.7	4.5
				-	•		-

Lab Aged 24 Hours at 900°F

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2.2.2 (continued)

IAL: T1_13V-11Cr-3A1	
IAL: T1_13V-11Cr-3A1	

VENDOR HEAT NUMBER: D-7770 (TMCA)

NR/LAD IDENTIFICATION: Heat 2

CHEMICAL COMPOSITION:

CARBON	0.017	VANADIUM	13.6
IRON	0.16	CHROMIUM	10.8
NITROGEN	0.028	HYDROGEN	0.023
ALUMINUM	3.1	OXYGEN	0.12
HEAT TREAT CONDITION:	Soluti	lon Treated	

Contrails

Vendor Test No.	Test Temp.	Mat'l. Gond.	Non. Gere	Spec. Direct.	Ult. Tensile Strength Kei	0.25 Yield Strength Kai	S Elong.
F-1951	Room	ST	0.038	Long.	134.4	129.0	18.5
				Trans.	140.9	136.8	14.0
	Room	_{ST} (1)		Long.	193.5	175.2	6.0
				Trans.	205.0	188.9	5.0
				-	•		-

(1) Lab Aged 24 Hrs. at 900°F

Contrails

2.2.2 (continued)

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MATERIAL:	T	1-13V-110	r-3Al	
VENDOR HEAT NUMBER:		D-7107	(TMCA)	
NR/LAD IDENTIFICATI	(CN :	Heat 3		
CHEMICAL COMPOSITIO	层:			
CARBON	0.028	· •	VANADIUM	13.5
IRON	0.16	I	CHROMIUM	10.8
NITROGEN	.022	1	HYDROGEN	0.004
ALUMINUM	3.0	(OXYCEN	0.14
HEAT TREAT CONDITIO	N: So	lution Tr	reated	

Vendor Test No.	Test Temp.	Mat'l. Cond.	Non. Gage	Spec. Direct.	Ult. Tensile Strength Ksi	0.2% Yield Strength Ksi	≰ Elong.
T-0342	Room	ST	0.035	Long.	136.9	133.7	21.0
				Trans.	140.3	135.7	17.0
		_{STA} (1)		Long.	193.2	175.9	9.5
				Trans.	200.1	184.1	7.0
				-	•		-

(1) Lab Aged 2^{14} Hrs. at $900^{\circ}F$

Contrails

MATERIAL:	RIAL: T1_13V-11Cr-	
VENDOR HEAT NUMBER:	D-7639	(TMCA)

NR/LAD IDENTIFICATION: Heat 4

CHEMICAL COMPOSITION:

CARBON	0.023	VANADIUM	13.7
IRON	0.17	CHROMIUM	10.6
NITROGEN	0.025	HYDROGEN	0.015
ALUMINUM	3.1	OXYCEN	0.12
HEAT TREAT CONDITION	Solution	[reated	

Vendor Test No.	Test Temp.	Matil. Cond.	Nom. Gago	Spec. Direct.	Ult. Tensile Strength Ksi	0.2% Yield Strength Kei	S Elong.
c-9887	Room	ST	0.038	Long.	139.7	135.1	16.0
				Trans.	144.6	139.2	13.0
		STA(1)		Long.	197.9	179.1	7.5
				Trans.	208.9	191.4	5.5
							-

(1) Lab Aged 24 Hrs. at 900°F

(continued) 2.2.2

.

MATERIAL:	Ti	_13V-11Cr	-3A1	
VENDOR HEAT NUMBER:		D-7110	(TMCA)	
NR/LAD IDENTIFICATIO	N :	Heat 5		
CHEMICAL COMPOSITION	1			
CARBON	0.027		VANADIUM	13.7
IRON	0.16		CHROMITUM	10.8
NITROGEN	0.026		HYDROGEN	0.003
ALUMINUM	3.0		OXYGEN	0.12
HEAT TREAT CONDITION	:	Solution	Treated	

Contrails

Vendor Test No.	Test Temp.	Matil. Gond.	Nom. Gere	Spec. Direct.	Ult. Tensile Strength Ksi	0.25 Yield Strength Kai	≰ Elong.
T-0294	Room	st	0.037	Long.	133.6	130.7	22.5
				Trans.	1 38.1	135.9	17.5
		STA(1)		Long.	180.1	164.1	9.0
				Trans.	179.8	165.7	6.5
							-

(1) Lab Aged 24 Hrs. at 900°F

Contrails

2.2.3 Material: Ti 6Al-4V Cond STA (Specification Requirements) Specification MIL-T-9046 Sheet, Strip, and Plate Type III Comp C

SPECIFICATION MINIMUM PROPERTIES (KSI)								
	≥1/4" to 1/2"	•≥1/2" to 3/4"	3/4" to 1"	l" to 1-1/2"				
Tensile Strength (Min)	160	160	150	145				
Yield Strength (Min) 0.2% Offset	145	145	140	135				
Elongation %	8	8	6	6				

	SPECIFICATION CHEMICAL LIMITS												
C (Max)	Fe (Max)	N	Al	v	Cr	Мо	H	Zr	Sn	Mn	0 ₂ (Max)	Ti	Total Other Elements (Max)
0.08	0.30	0.05	5•5 6•75	3.5 4.5		—	0.015	_	-		0.20	Bal.	0.40

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Contrails

MATERIAL:	Ti- 6A1-4V		
VENDOR HEAT MUMBER:	HT G	4956 (TMC	N)
NR/LAD IDENTIFICATION:	Heat]	L	
CHEMICAL COMPOSITION:			
CARBON	0.025	VANADIUM	4.1
IRON	0.10	HYDROGEN	0.009
NITROGEN	0.010	OXYGEN	0.10
ALUMINUM	6.0		
HEAT TREAT CONDITION:	Solution Tre Type 3 Comp		l to MIL-T-9046E

	Vendor Test No.	Test Temp.	Mat'l. Cond.	Nom. Gaga	Spec. Direct.	Ult. Tensile Strength Ksi	0.2% Yield Strength Kei	S Elong.
	J-318 3	RT	STA	0.250	L	166.6	153.0	8.5
					Т	183.2	171.8	8.0
						1		
•								

.

MATERIAL:	T1-6A1-4V

VENDOR HEAT NUMBER: HT G-4796 (TMCA)

NR/LAD IDENTIFICATION: Heat 2

CHEMICAL COMPOSITION:

CARBON	0.026	VANADIUM	4.2
IRON	0.15	HYDROGEN	0.005
NITROGEN	0.015	OXYGEN	0.14
ALUMINUM	6.4		

Contrails

HEAT TREAT CONDITION: Solution Treated and Aged to MIL-T-9046E Type 3 Comp C 1700°F 1/4 Hr - W.Q. Aged 4 hours - 1000°F A.C.

Vendor Test No.	Test Temp.	Mat'l. Gond.	Nom. Gage	Spec. Direct.	Ült. Tensile Strength Ksi	0.2% Yield Strength Kei	S Elong.
J- 4376	RT	STA	0.250	L	176.0	164.0	9.0
				T	180.2	174.3	10.5

Contrails

2.2.3 (continued)

MATERIAL:	T1- 6AL-4V	,	
VENDOR HEAT NUMBER:	HT X-	53788 (RMI)
NR/LAD IDENTIFICATI	CON: Heat 6		
CHEMICAL COMPOSITIO	DN :		
CARBON	0.03	VANADIUM	4.2
IRON	0.16	HYDROGEN	72 ppm
NITROGEN	0.011	OXYGEN	0.107
ALUMINUM	6.1		

HEAT TREAT CONDITION: Prod. Solution Treated 1725°F for 10 minutes W. Q. Aged 1000°F for 4 Hrs. and Air Cooled

Venior Test No.	Test Temp.	Matil. Cond.	Nom. Gege	Spec. Direct.	Ult. Tensile Strength Ksi	0.2% Yield Strength Ksi	≴ Elong.
	RT	STA	0.250	L	168.0	156.0	8.0
				т	168.0	151.0	8.0

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Contrails

MATERIAL: T1-6A1-4V

VENDOR HEAT NUMBER HT G-6539 (TMCA)

NR/LAD IDENTIFICATION: Heat 1

CHEMICAL COMPOSITION:

CARBON	0.024	VANADIUM	4.2
IRON	0.16	HYDROGEN	0.005
NITROGEN	0.008	OXYGEN	0.19
ALUMINUM	6.2		

HEAT TREAT CONDITION: So

Solution Treated and Aged to MIL-T-9046E Type 3 Comp C

Vendor Test No.	Test Temp.	Mat'l. Cond.	Nom. Gage	Spec. Direct.	Ult. Tensile Strength Ksi	0.2% Yield Strength Kei	5 Elong.	¢, Red. Area
J-3855	RT	STA	0.500	L T	171.1 168.1	158.1 155.2	19.0 16.5	41.2 42.6

Contrails

- - -

MATERIA	L:		T1-	6A1	-4V	
VENDOR	HEAT	NUMBER		HT	G- 7278	(TMCA)

NR/LAD IDENTIFICATION: Heat 2

CHEMICAL COMPOSITION:

CARBON	0.025	VARADIUM	4.2
IRON	0.17	HYDROGEN	0.005
NITROGEN	0.009	OXYGEN	0.20
ALUMINUM	6.4		

HEAT TREAT CONDITION: Solution Treated and Aged to MIL-T-9046E Type 3 Comp C

Vendor Test No.	Test Temp.	Mat'l. Cond.	Nom. Gage	Spec. Direct.	Ult. Tensile Strength Ksi	0.2% Yield Strength Kei	ž Elong.	∜ Red. A rea
J-5801	RT	STA	0.500	L	175.5	163.3	15.0	39.5
				Т	182.2	172.4	14.0	36.8
						1		

VENDOR HEAT NUMBER HT 302634 (RMI)

NR/LAD IDENTIFICATION: Heat 7

CHEMICAL COMPOSITION:

CARBON	0.02	VANADIUM	4.3
IRON	0.12	HYDROGEN	42 ppm
NITROGEN	0.013	OXYGEN	0.168
ALUMINUM	6.4		

Contrails

HEAT TREAT CONDITION:

Prod. Solution Treated 1725°F for 10 minutes W.Q. Lab Aged 1000°F for 4 Hours Air Cooled.

Vendor Test No.	Test Temp.	Mat'l. Cond.	Nom. Gaga	Spec. Direct.	Ult. Tensile Strength Ksi	0.2% Yield Strength Kai	S Elong.
	RT	STA	0.475	L	170.0	153.0	7.0
				т	173.0	162.0	9.0

MATERIAL:	T1-6A1-4V	
VENDOR HEAT MIMBER	HT G- 7021	(TMCA)

NR/LAD IDENTIFICATION: Heat 2

CHEMICAL COMPOSITION:

CARBON	0.022	VANADIUM	4.2
IRON	0.18	HIDROGEN	0.004
NITROGEN	0.12	OXYGEN	0.17
ALUMINUM	6.3		

Contrails

HEAT TREAT CONDITION: Solution Treated and Aged to MIL-T-9046E Type 3 Comp C 1675°F, 15 Min. - W.Q. Age 4 Hours 1000°F A.C.

Vendor Test No.	Test Temp.	Mat'l. Cond.	Nom. Gage	Spec. Direct.	Ult. Tensile Strength Ksi	0.2% Yield Strength Kei	S Elong.
J-4821	RT	STA	1.000	L.	168.5	155.0	14.5
				т	176.8	165.9	17.0

.

MATERIAL: T1-6A1-4V

VENDOR HEAT IDMBER HT 293504 (RMI).

NR/LAD IDENTIFICATION: Heat 6

CHEMICAL COMPOSITION:

CARBON	0.03	VANADIUM	4.4
IRON	0.08	HYDROGEN	30 ppm
NITROGEN	0.010	OXYGEN	0.160
ALUMINUM	6.4		

Contrails

HEAT TREAT CONDITION:

Vendor Test No.	Test Temp.	Mat'l. Cond.	Nom. Gage	Spec. Direct.	Vit. Tensile Strength Ksi	0.2% Yield Strength Kei	S Elong.
	RT	STA	1.025	L T	150.0/ 161.0 145.0/ 161.0	143.0/ 148.0 143.0/ 148.0	12.0/ 14.0 11.0/ 15.0

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Contrails

2.2.4 Material: Ti 6A1-6V-2Sn Cond A and STA (Specification Requirements)

Specification MIL-T-9046 Type III Comp E Sheet, Strip and Plate

SPECIFICATION MINIMUM PROPERTIES (KSI)								
	Annealed	STA						
		To 1-1/2" Thick	1-1/2" to 2" Thick					
Tensile Strength (Min)	155	170	160					
Yield Strength (Min) 0.2% Offset	145	160	150					
Elongation % (Long)10 Frans) 8	8	6					

SPECIFICATION CHEMICAL LIMITS													
C (Max)	Fe (Max)	N	Al	V	Cr	Мо	H	Zr	Sn	Mn	0 ₂ (Max)	Ti	Total Other Elements (Max)
0.05	0.35	0.05	5.0	5.0			0.015		1.5		0.20	Bal	0.30
	1.00		6.0	6.0		1			2.5				

i.

MATERIAL: T1-6A1-6V-2Sn						
VENDOR HEAT NUMBER:	HT G-	3104 (TMCA)				
NR/LAD IDENTIFICATION:	Heat	1.				
CHEMICAL COMPOSITION:						
CARBON	0.011	HYDROGEN	0.006			
IRON	0.73	TIN	2.1			
NITROGEN	0.016	COPPER	0.61			
ALUMINUM	5.6	OXYGEN	0.16			
VANADIUM	5.7					
HEAT TREAT CONDITION:	Annealed -	Anneal Temp.				
	1300F P/M 2	5 F				

Contrails

Vendor Test No.	Test Temp.	Mat'l. Cond.	Nom. Gage	Spec. Direct.	Ult. Tensile Strength Ksi	0.2 % Yield Strength Kgi	Z Elong.
J-0411	Ro o m	Annealed	0.340	L	155.0	148.4	15.0
				т	166.8	161.5	18.0

Approved for Public Release

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MATERIAL: T1-6A1-6V-28n						
VENDOR HEAT NUMBER:	HT	G- 3212	(TMCA)			
NR/LAD IDENTIFICATION:	Heat	2				
CHEMICAL COMPOSITION:						
CARBON	0.024	HYDRO	GEN 0.007			
IRON	0.70	TIN	2.0			
NITROGEN	0.014	COPPE	R 0.66			
ALUMINUM	5.4	OXYGE	N 0.13			
VANADIUM	5.4					
HEAT TREAT CONDITION:	Annealed -	Anneal Tem	р.			

Contrails

Vendor Test No.	Test Temp.	Mat'l. Cond.	Nom. Gage	Spec. Direct.	Ult. Tensile Strength Ksi	0.2 % Tield Strength Kai	f Elong.
J-0414	Room	Annealed	0.320	L T	156.1 160.3	151.1 156.3	15.0 16.5

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MATERIAL:	T1-6A1-6V-2Sn	
VENDOR HEAT NUMBER:	HT G-3211	(TMCA)

NR/LAD IDENTIFICATION: Heat 3

CHEMICAL COMPOSITION:

HEAT TREAT CONDITION:	Annealed - An	neal Temp.	
VANADIUM	5.5		
ALUMINUM	5.6	OXYGEN	0.15
NITROGEN	0.010	COPPER	0.67
IRON	0.71	TIN	2.0
CARBON	0.023	HYDROGEN	0.006

Contrails

Vendor Test No.	Test Temp.	Mat'l. Cond.	Nom. Gage	Spec. Direct.	Ult. Tensile Strength Ksi	0.2 % Yield Strength Kei	≰ Elong.
J-041 3	Room	Annealed	0.320	L	157.6	152.7	15.5
				т	155.7	149.9	15.0

MATERIAL:			T1-6A1		
VENDOR	HEAT	NUMBER:	HT	G-881	(TMCA)

NR/LAD IDENTIFICATION: Heat 4

CHEMICAL COMPOSITION:

CARBON	0.025	HYDROGEN	0.004
IRON	0.66	TIN	2.0
NITROGEN	0.012	COPPER	0.69
ALUMINUM	5.5	OXYGEN	0.16
VANADIUM	5.5		

Contrails

HEAT TREAT CONDITION: Annealed - Anneal Temp.

Vendor Test No.	Test Temp.	Mat'l. Cond.	Nom. Gage	Spec. Direct.	Vlt. Tensile Strength Ksi	0.2 \$ Tield Strength Kei	≰ Elong.
J-0 412	Room	Annealed	0.315	L T	157.4 1 60 .5	151.3 155.4	15.0 18.0
			1				

.

MATERIAL: Ti- 6A1-6V-2Sn

VENDOR HEAT NUMBER: HT G 1537 (TMCA)

NR/LAD IDENTIFICATION: Heat 5

CHEMICAL COMPOSITION:

CARBON	0.025	HYDROGEN	0.004
IRON	0.74	TIN	2.0
NITROGEN	0.013	COPPER	0.76
ALUMINUM	5.5	OXYGEN	0.17
VANADIUM	5.6		

Contrails

HEAT TREAT CONDITION: Annealed - Anneal Temp.

Vendor Test No.	Test Temp.	Mat'l. Cond.	Nom. Gege	Spec. Direct.	Ult. Tensile Strength Ksi	0.2 % Tield Strength Ksi	⊈ Elong.
J-041 5	Room	Annealed	0.310	L	159.8	154.7	14.0
				т	163.1	158.1	15.3
						•	

MATERIAL: T1-6A1-6V-2Sn

VENDOR HEAT NUMBER: HT G-393 (TMCA)

NR/LAD IDENTIFICATION: Heat 1

CHEMICAL COMPOSITION:

HEAT TREAT CONDITION:	Annealed	- Anneal Temp.	
VANADIUM	5.3		·
ALUMINUM	5.5	OXYGEN	0.12
NITROGEN	0.009	COPPER	0.64
IRON	0.75	TIN	1.9
CARBON	0.022	HYDROGEN	0.004

Contrails

Vendor Test No.	Test Tesp.	Mat'l. Cond.	Nom. Gage	Spec. Direct.	Ult. Tensile Strength Ksi	0.2 % Yield Strength Kei	f Elong.	% Red. Area
J-041 6	Room	Annealed	0.630	L	155.6	150.0	18.0	38.2
				T	155.4	151.4	16.5	35.7

MATERIAL: T1_6A1_6V-2Sn

VENDOR HEAT NUMBER: HT G-2443 (TMCA)

NR/LAD IDENTIFICATION: Heat 2

CHEMICAL COMPOSITION:

CARBON	0.023	HYDROGEN	0.004
IRON	0.67	TIN	2.1
NITROGEN	0.013	COPPER	0.66
ALUMINUM	5•3	OXYGEN	0.16
VANADIUM	5.7		

Contrails

HEAT TREAT CONDITION: Annealed - Anneal Temp.

Vendor Test No.	Test Temp.	Mat'l. Cond.	Nom. Gage	Spec. Direct.	Ult. Tensile Strength Ksi	0.2 % Yield Strength Kei	f Elong.
J-0 420	Room	Annealed	0.610	L	159.6	156.9	16.0
				т	162.0	158.4	18.0

MATERIAL: T1-6A1-6V-2Sn VENDOR HEAT NUMBER: HT G-1971 (TMCA)

NR/LAD IDENTIFICATION: Heat 3

CHEMICAL COMPOSITION:

CARBON	0.023	HYDROGEN	0.006
IRON	0.68	TIN	2.1
NITROGEN	0.012	COPPER	0.70
ALUMINUM	5.3	OXYGEN	0.17
VANADIUM	5.4		

Contrails

HEAT TREAT CONDITION: Annealed - Anneal Temp.

Vendor Test No.	Test Tesp.	Mat'l. Cond.	Nom. Gage	Spec. Direct.	Ult. Tensile Strength Kei	0.2 \$ Yield Strength Kei	£ Elong.
J-417	Room	Annealed	0.610	L T	161.0 162.4	158.2 157.4	17.0 17.0

Contrails

MATERIAL: Ti-6A1-6V-2Sn

VENDOR HEAT NUMBER: HT G-2504

NR/LAD IDENTIFICATION: Heat 4

CHEMICAL COMPOSITION:

CARBON	0.023	HYDROGEN	0.004
IRON	0.66	TIN	2.1
NITROGEN	0.011	COPPER	0.66
ALUMINUM	5.6	OXYGEN	0.16
VANADIUM	5.4		
HEAT TREAT CONDITION:	Annealed	- Anneal Temp.	

Vendor Test No.	Test Temp.	Mat'l. Cond.	Nom. Gage	Spec. Direct.	Ult. Tensile Strength Ksi	0.2 % Yield Strength Kgi	f Elong.
J-041 8	Room	Annealed	0.610	L	162.1	158.9	16.5
				Т	161.1	160.1	19.5
				-			

Contrails

MATERIAL:	T1-6A1-6V-2Sn	
VENDOR HEAT NUMBER:	HT G-3106	(TMCA)

NR/LAD IDENTIFICATION: Heat 5

CHENCICAL COMPOSITION:

CARBON	0.016	HYDROGEN	0.005
IRON	0.77	TIN	2.0
NITROGE	N 0.019	COPPER	0.59
ALUMINU	M 5.6	OXYGEN	0.15
VANADIUN	4 5.8		

HEAT TREAT CONDITION: Annealed - Anneal Temp.

Vendor Test No.	Test Temp.	Mat'l. Cond.	Nom. Gage	Spec. Direct.	Ult. Tensile Strength Kai	0.2 % Tield Strength Kei	£ Elong.
J-0419	Room	Annealed	0.615	L	159.0	155.6	17.0
				т	158.8	156.3	18.0
	مەربىيە ئارلىيە ئارلىيە 1997-يىلى						

MATERIAL:	T1-6A1-6V-2Sn	
VENDOR HEAT NUMBER:	HT G-3023	(IMCA)

NR/LAD IDENTIFICATION: Heat 1

CHEMICAL COMPOSITION:

HEAT TREAT CONDITION:	Annealed - As	nneal Temp.	
VANADIUM	5.6		
ALUMINUM	5.5	OXYGEN	0.15
NITROGEN	0.012	COPPER	0.63
IRON	0.67	TIN	2.0
CARBON	0.023	HIDROGEN	0.004

Contrails

Vendor Test No.	Test Temp.	Matil. Cond.	Nom. Gage	Spec. Direct.	Ult. Tensile Strength Kai	0.2 % Yield Strength Kii	1 Elong.
J-0 430	Room	Annealed	1.570	L	155.9	145.5	20.0
				т	155.4	145.3	18.5

2.2.4 (continued)

MATERIAL:	Ti-6A1-6V-25n
VENDOR HEAT NUMBER:	HT G-3214

NR/LAD IDENTIFICATION: Heat 2

CHEMICAL COMPOSITION:

CARBON	0.023	HIDROGEN	0.004
IRON	0.69	TIN	2.0
NITROGEN	0.011	COPPER	0.65
ALUMINUM	5.4	OXYGEN	0.17
VANADIUM	5.5		

Contrails

HEAT TREAT CONDITION: Annealed - Anneal Temp.

Test Temp.	Mat'l. Cond.	Nom. Gego	Spec. Direct.	Dlt. Tensile Strength Ksi	0.2 % Yield Strength Ksi	I Elong.
Foom	Annealed	1.510	L T	155.4 156.0	149.4 149.8	18.0 17.5
	Temp.	Tamp. Cond.	Temp. Cond. Gage	Temp.Cond.GageDirect.RoomAnnealed1.510L	Test Temp.Mat'l. Cond.Nom. GageSpec. Direct.Tensile Strength KsiRoomAnnealed1.510L155.4	Test Temp.Mat'l. Cond.Nom. GageSpec. Direct.Tensile Strength KsiYield Strength HeiRoomAnnealed1.510L155.4149.4

MATERIAL:	Ti-6A1-6V-2Sn
VENDOR HEAT NUMBER:	HT G-2070

NR/LAD IDENTIFICATION: Heat 3

CHEMICAL COMPOSITION:

CARBON	0.023	HYDROGEN	0.007
IRON	0.73	TIN	5.0
NITROGEN	0.009	COPPER	0.73
ALUMINUM	5.6	OXYGEN	0.15
VANADIUM	5.6		

Contrails

HEAT TREAT CONDITION: Annealed - Anneal Temp.

1300F P/M 25F

Vendor Test No.	Test Temp.	Mat'l. Cond.	Nom. Gage	Spec. Direct.	Ult. Tensile Strength Kai	0.2 % Yield Strength Kei	f Elong.
J-0 427	Room	Annealed	1.570	L	155.4	149.2	19.0
				т	161.5	151.8	18.5

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1

MATERIAL:	T1-6A 1-6V- 2Sn		
VENDOR HEAT NUMBER:	HT G-1971	(TMCA)	
NR/LAD IDENTIFICATION:	Heat 4		
CHEMICAL COMPOSITION:			
CARBON	0.023	HYDROGEN	0.004
IRON	0.68	TIN	2.1
NITROGEN	0.012	COPPER	0.70
ALUMINUM	5.3	OXYGEN	0.17
VANADIUM	5.4		
HEAT TREAT CONDITION:	Annealed - Annea	al Temp.	

Contrails

Vendor Test No.	Test Temp.	Mat'l. Cond.	Nom. Gage	Spec. Direct.	Ult. Tensile Strength Ksi	0.2 \$ Yield Strength Ksi	% Elong.
J-0431	Room	Annealed	1.50	L	155.2	149.6	15.5
				Ŧ	155.6	147.7	18.5

.

MATERIAL: T1-6A1-6V-2Sn

VENDOR HEAT NUMBER: HT G-3024 (TMCA)

NR/LAD IDENTIFICATION: Heat 5

CHEMICAL COMPOSITION:

VANADIUM	5.6			
ALUMINUM	5.6	OXYGEN	0.15	
NITROGEN	0.015	COPPER	0.62	
IRON	0.69	TIN	2.0	
CARBON	0.023	HYDROGEN	0.004	

Contrails

HEAT TREAT CONDITION: Annealed - Anneal Temp.

1300F P/M 25F

Vendor Test No.	Test Temp.	Mat'l. Cond.	Nom. Gage	Spec. Direct.	Ult. Tensile Strength Ksi	0.2 \$ Yield Strength Kei	f Elong.
J-0429	Room	Annealed	1.60	L T	156.4 160.1	151.0 153.4	17.5 18.5
				1	100.1	193.4	10.9

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2.3 THERMAL PROCESSING OF MATERIALS

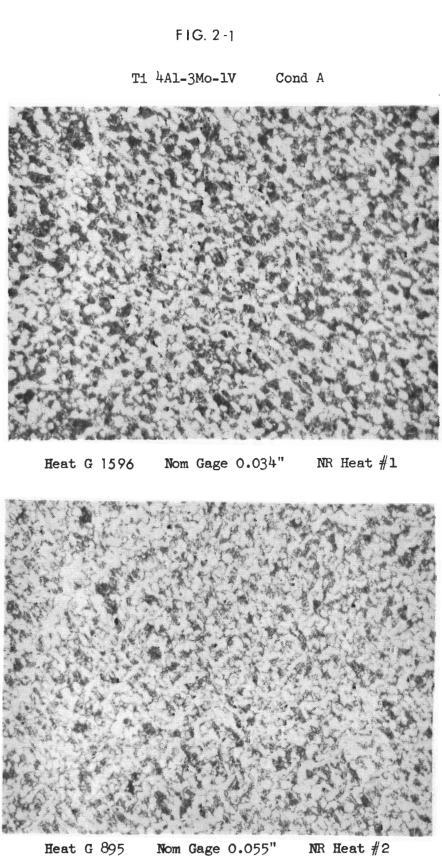
All test materials with the exception of the Ti-6Al-6V-2Sn condition STA, had all the required thermal processing done by the mill prior to receival by NR/LAD. The Ti-6Al-6V-2Sn material which was received in the annealed condition was heat treated to the STA condition by NR/LAD. The thermal processing of all test material both at the mill or at NR/LAD conformed to the requirements of MIL-H-81200.

Crutrails

2.4 MICROSTRUCTURAL EXAMINATION OF TEST MATERIALS

A microstructural examination of all test material was performed by NR/LAD. The photomicrographs in conjunction with a brief analysis of the structures observed and their relationship to the resulting mechanical properties are presented in the following section.

2.4.1 Ti-4A1-3Mo-1V, Cond. A: Photomicrographs typical of microstructures of six heats of Ti-4Al-3Mo-1V, Cond. A, program sheet material ranging in gages from 0.034" to 0.110" are shown in Figures 2-1 through 2-3. NR heat numbers 1 through 5 depict uniform, equi-axed microstructures consisting of islands of primary alpha phase surrounded by a matrix of transformed and retained beta. NR heat #3 shows some slight banding of the alpha phase which is not expected to have any unusual effect in terms of mechanical properties. NR heat #6, Figure 2-3 supplied by a different producer, exhibits a finer, more directional grain structure indicating the probability of a lower final rolling temperature in this instance. This particular photomicrograph displays a very faint trace of a prior beta grain boundary suggesting total rolling reduction may have been less than desired; however, mechanical properties tests indicate comparable mechanical properties with tensile ductility at room temperature perhaps slightly better than the other heats of Ti-4Al-3Mo-1V. In general, the microstructures of all six heats are quite uniform, the above mentioned differences being subtle, and, as would be expected, mechanical properties tests substantiate this microstructural uniformity.



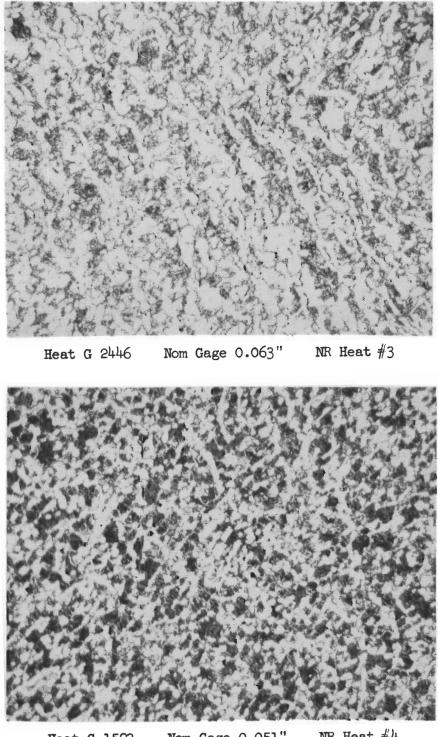
Contrails

Nom Gage 0.055" 500X

Contrails

FIG. 2-2

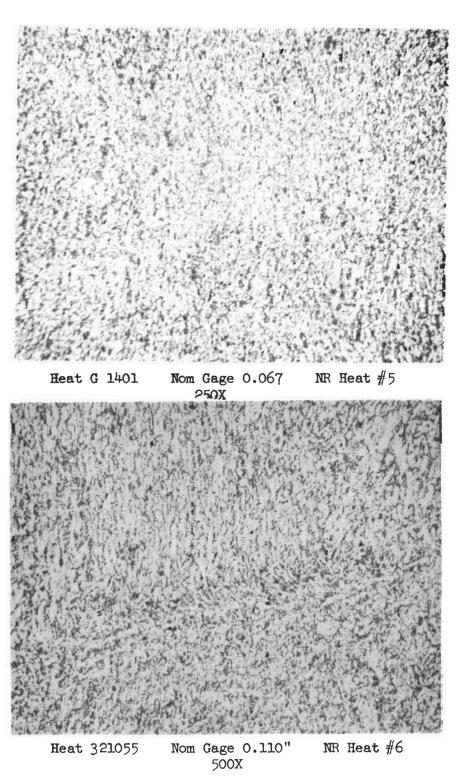
Ti 4A1-3Mo-1V Cond A



Heat G 1523 Nom Gage 0.051" NR Heat #4 500X

Contrails

FIG.2-3



Ti 4A1-3Mo-1V Cond A

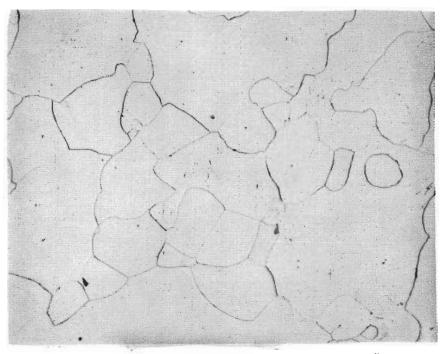
24.2 Hi-13V-11Cr-3A1, Cond. A (ST): Typical microstructures from five heats of alloy Ti-13V-11Cr-3Al sheet in the annealed or solution treated condition are shown in Figures2-4 through 2-6. The photomicrographs depict structures considered normal for the material and illustrate the essentially singlephase, beta microstructure characteristic of the alloy as solution treated. Microstructural variations among the five heats are slight, NR heat numbers 3 and 5 exhibiting somewhat smaller grain size than the others. Mechanical properties of the heats are uniform and similar with NR heat numbers 3 and 5 tending to exhibit properties slightly higher than the average. This is not considered extremely significant since NR heat #4 with comparatively large grain size also exhibits higher than the average properties. Again, microstructural and properties variations are subtle.

Contrails

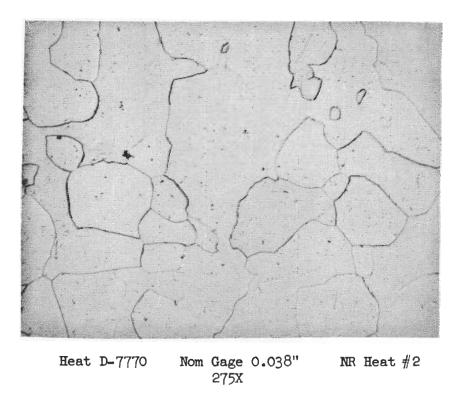
Contrails

FIG. 2-4





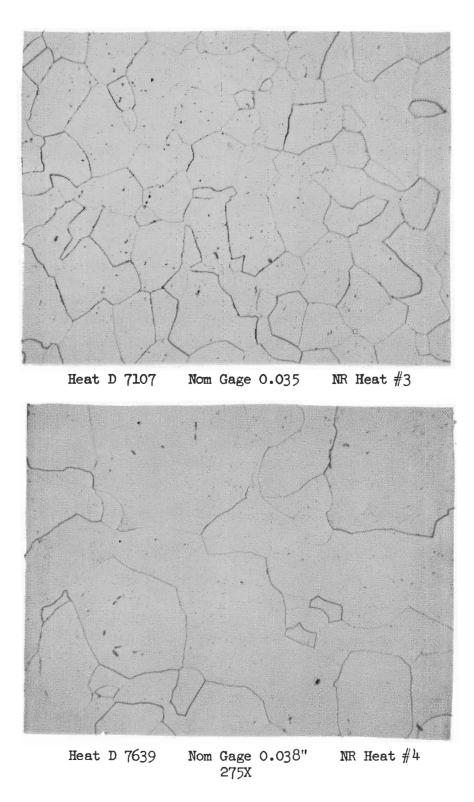
Heat D-7855 Nom Gage 0.040" NR Heat #1



Contrails

FIG. 2-5

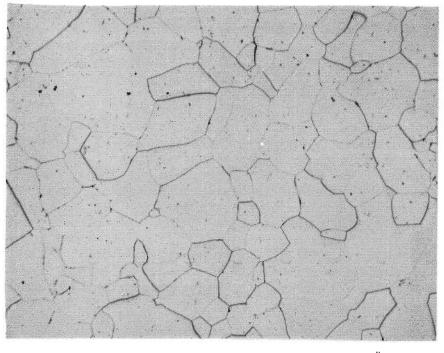
Ti 13V-11Cr-3Al Cond A or ST



Contrails



Ti 13V-11Cr-3Al Cond A or ST



Heat D 7110 Nom Gage 0.037 NR Heat #5

24.3 <u>Ti-6Al-4V</u>, <u>Cond. STA</u>: Microstructures representing eight heats of Ti-6Al-4V, Cond. STA plate are shown in Figures 2-7 through 2-10. In contrast to the other program materials, a wide variation in microstructures from heat to heat was obtained and considerable variation in mechanical properties as a function of gage, supplier, heat, and testing direction also noted.

Contrails

With respect to the nominal 0.250-inch gage material, three different microstructures were obtained from the three heats of material represented. The first, G4956, Figure 2-7 shows a transus-type structure, i.e., free from primary alpha with acicular alpha, and possible alpha prime, resulting from quenching from high in the alpha-beta field. Some banding is also noted and mechanical properties are considered satisfactory for heat-treated material. The second, heat G4796, represents material though stated to be heat treated is, to the contrary, believed to be annealed. It is suggested the material was thoroughly worked during rolling at relatively low final rolling temperatures resulting in a mixture of equiaxed alpha and intergranular beta. It might be argued that the photomicrograph represents material quenched from low in the alpha-beta phase, approximately 1500°F or lower; however, properties obtained show a spread between ultimate and yield strength much more indicative of annealed material than that associated with quenched and aged retained beta. In addition, the level of mechanical properties obtained would be quite low for material at 0.15% oxygen, solution treated at 1700°F and aged at 1000°F. The third, heat X53788, represents material finished from above the beta transus temperature and quenched from high in the alpha beta field. The microstructure is uniform, fine-grained and exhibits good strength, lower tensile ductility, and relatively good fracture toughness associated with such structures.

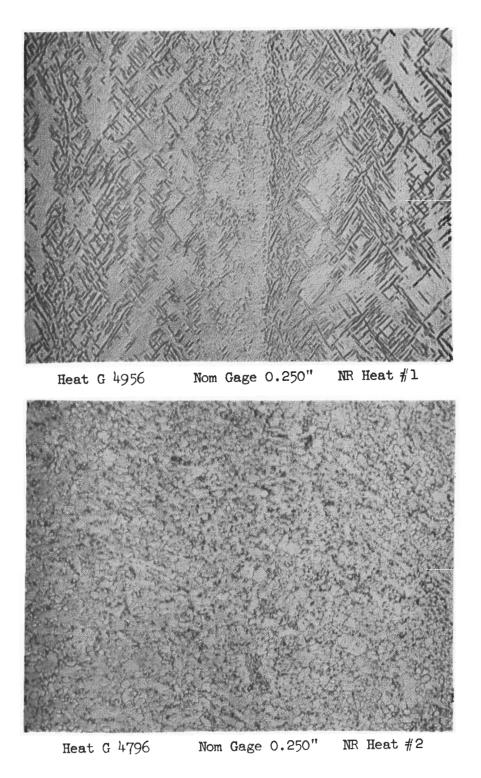
Material in the nominal 0.500-inch gage again displays a variation in microstructure. Heats G6539 and G7278, are similar and more nearly typify structures normally associated with heat treated and aged thin-sectioned Ti-6Al-4V products. Both show a mixture of primary alpha plus aged alpha prime with the latter heat showing some gross rolling deformation. Properies too reflect typical strength levels and tensile ductilities for such material in both cases, the latter indicating greater anisotropy, as might be expected. Material from heat 302634, Figure2-9 again illustrates material finish rolled from above the beta transus, quenched from high in the alpha-beta field and aged. Microstructure is similar to that of 0.250-inch gage heat X53788 with somewhat higher strength, probably due to higher oxygen content.

In the nominal 1.00-inch plate gage somewhat different microstructures were obtained for the two heats of material displayed, Figure2-10, representing somewhat different working histories. Both display material rolled and heat treated in the alpha-beta field; however, with properties expected of material so processed.

Contrails

FIG.2-7



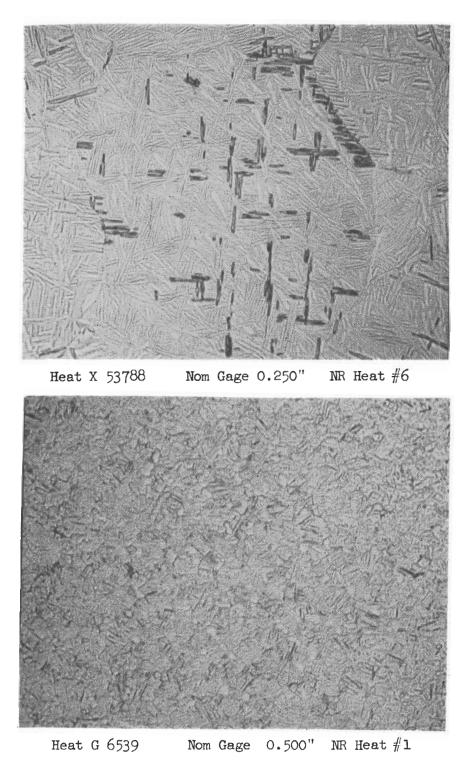


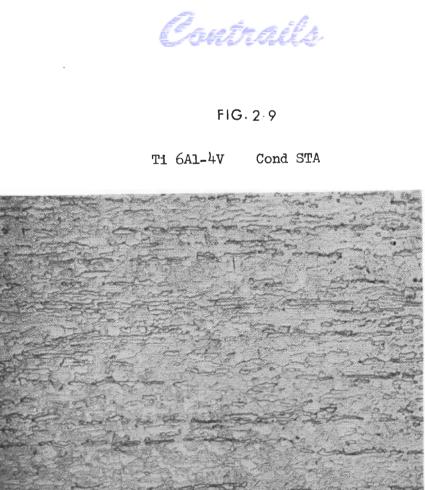
250 X

Contrails

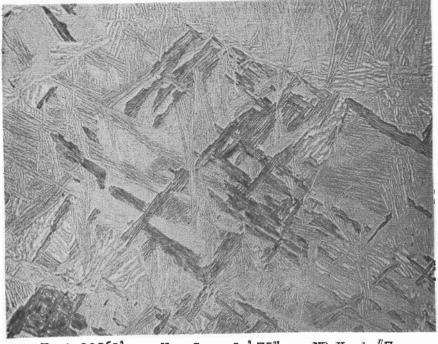
FIG. 2-8







Heat G 7278 Nom Gage 0.500" NR Heat #2



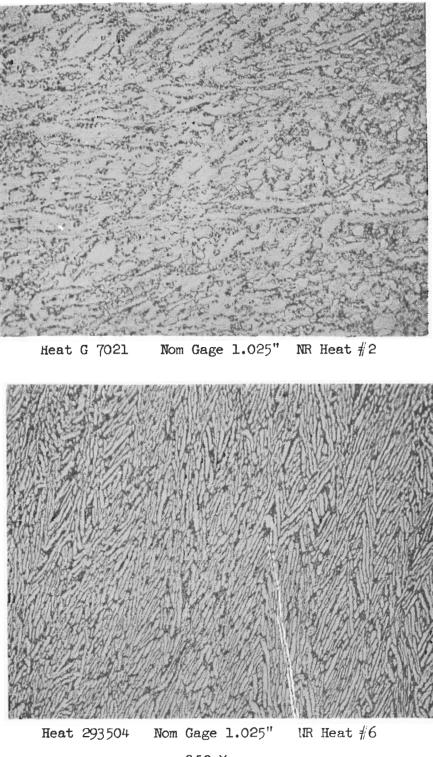
Heat 302634 Nom Gage 0.475" NR Heat #7 250 X

Contrails

FIG. 2-10

Ti 6Al-4V

Cond STA



250 X

Contrails

244 <u>Ti-6Al-6V-2Sn</u>, Cond. A and STA: Typical microstructures of 14 heats of alloy Ti-6Al-6V-2Sn plate both annealed and fully heat treated are shown in Figures 2-11 through 2-25. Photomicrographs for annealed plate of the nominal 0.250 inch gage (0.310 to 0.340-inch), Figures 2-11 through 2-13 depict thoroughly worked microstructures of primary alpha phase in a retained beta phase matrix. Phase delineation is not distinct in any of the five, the microstructures all showing evidence of considerable grain deformation from working at low, final rolling temperatures, and of course fine grain size. Variations among the five heats are extremely small metallographically and, as expected, properties are also uniformly high.

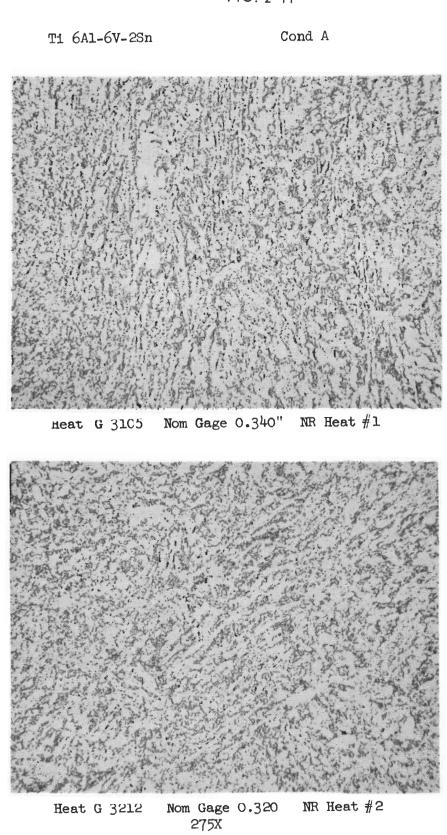
As gages are increased, variation in rolling practice becomes evident. The five heats of the nominal 0.500-inch gage (0.610 to 0.630-inch) plate shown in Figures2-14through2-16, both annealed and heat treated, continue to illustrate a fine-grained, thoroughly-worked microstructure. Fhase demarkation is somewhat greater; however, even in the annealed material suggesting higher finish rolling temperatures. This is a matter of small degree, nevertheless, since annealed properties remain quite high for the annealed 0.500-inch material in comparison to the 0.250-inch. The effects of heat treatment to Cond. STA are quite clearly illustrated showing an increase in the beta phase at the expense of alpha due to quenching from high in the alpha-beta field.

With increase in gage of plate to 1.50-inch nominal gage (1.50 to 1.60-inch), the higher finish rolling temperature required becomes evident, particularly in the microstructures of annealed material, Figures2-17through2-19. The alpha phase is seen to be present, in all five heats, in the form of moderately coarse platelet form, fairly well distributed throughout the microstructure with little evidence of prior beta grain boundaries. Properties are correspondingly lower than the annealed thinner gage material, as would be expected. Again uniformity of properties among the five heats is evident both annealed and heat treated, in spite of the localized aberations noted in two of the microstructures of Cond. STA material. Some rather pronounced coarseness of the primary alpha plates with the suggestion of prior beta grain boundary alpha formation is seen in NR heat #8, Figure 2-24, and in contrast, a localized enrichment of beta phase material is evident in the microstructure of NR heat #10, Figure 2-25, due probably to chemical segregation of beta-stabilizer element(s) in the ingot. Neither of these conditions appears to be general throughout the material to the extent that mechanical properties test results show no effect.

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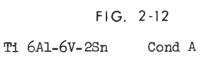
FIG. 2-11

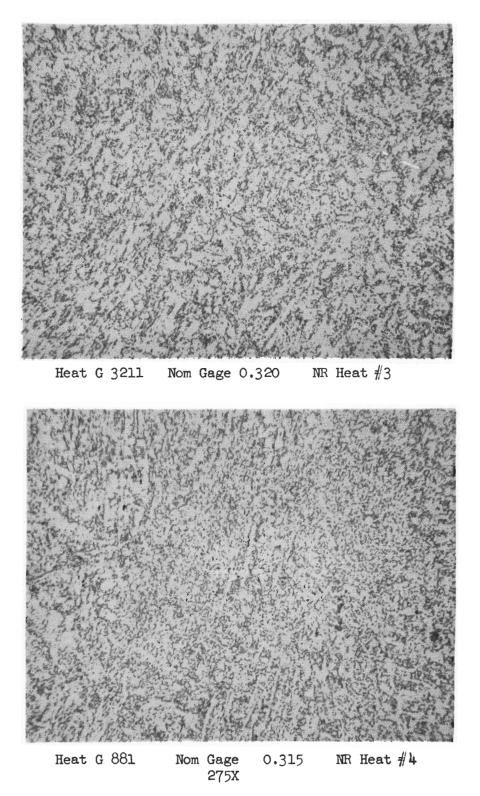
Contrails



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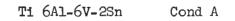
Contrails

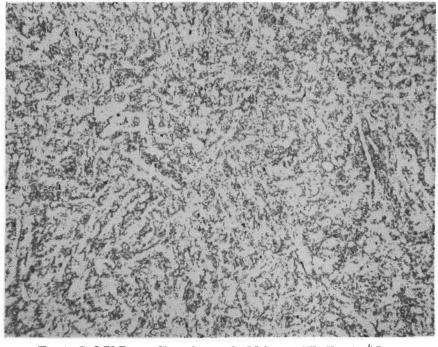




Contrails

FIG. 2-13

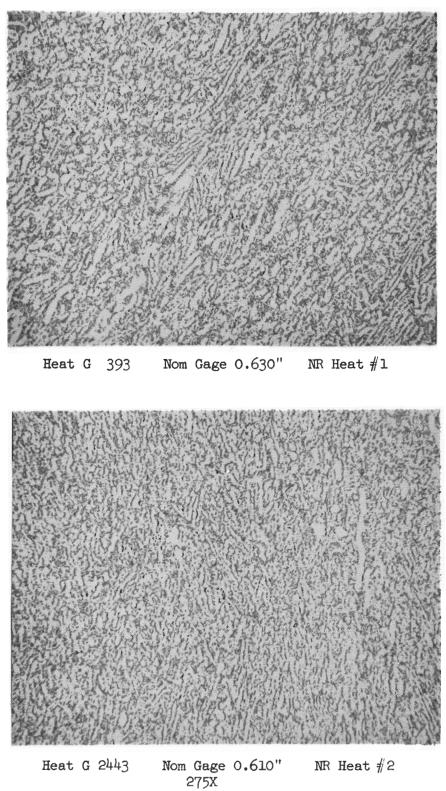




Heat G 1537 Nom Gage 0.310 NR Heat #5

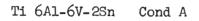
FIG. 2-14

Ti 6A1-6V-2Sn



Contrails

FIG. 2-15



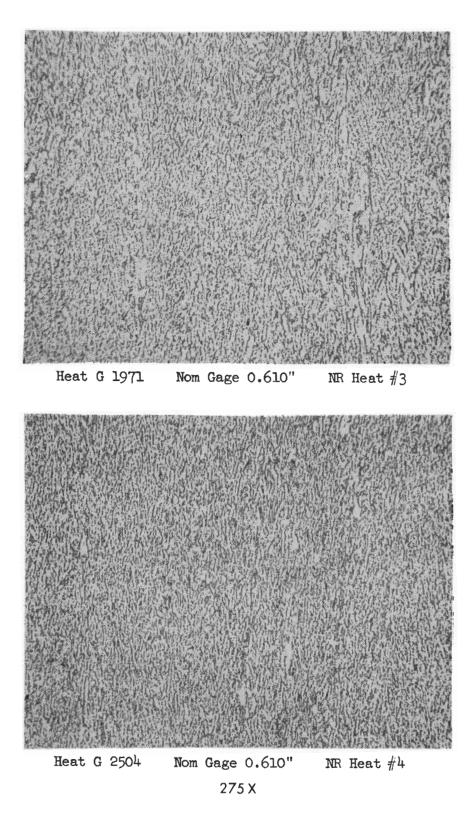
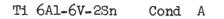
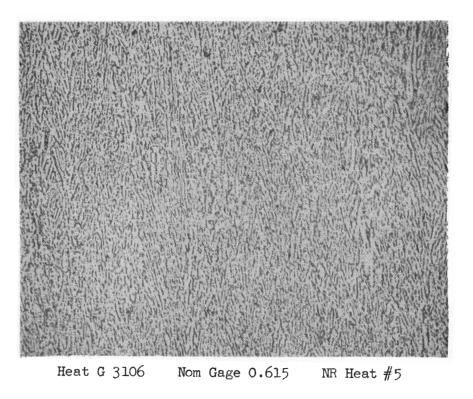


FIG. 2-16

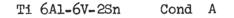


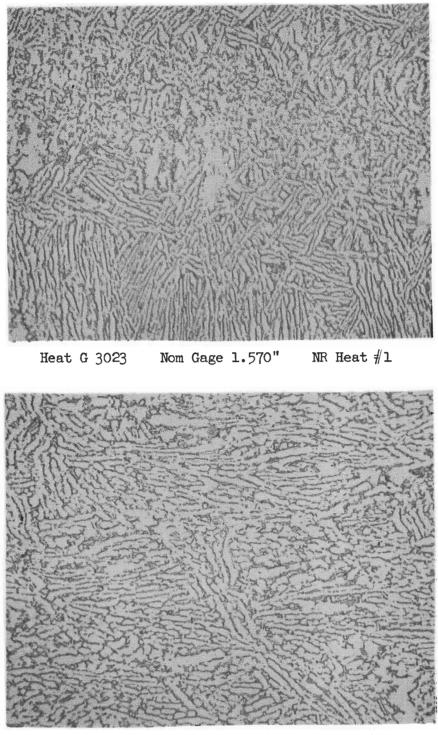


275X

Contrails

FIG. 2-17



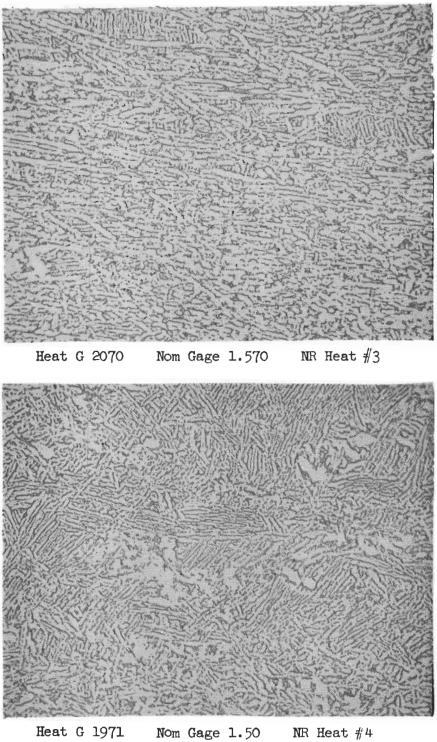


Heat G 3214 Nom Gage 1.570 NR Heat #2 275X

Contrails

FIG. 2-18

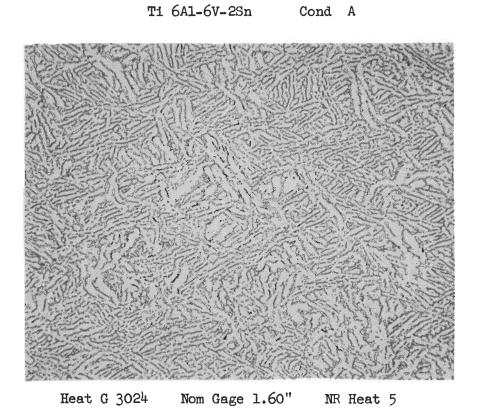
Ti 6A1-6V-2Sn Cond A



275X

Contrails

FIG. 2-19

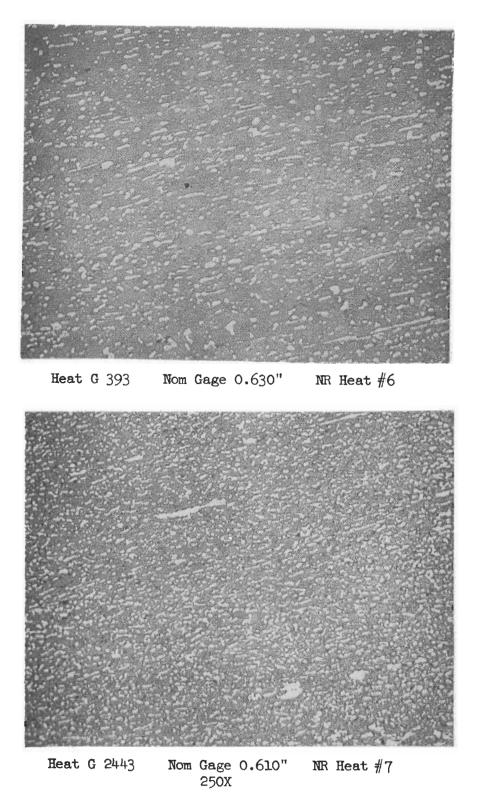






F1G. 2-20

Ti 6A1-6V-2Sn Cond STA



Contrails

FIG. 2 -21 Ti 6A1-6V-2Sn Cond STA

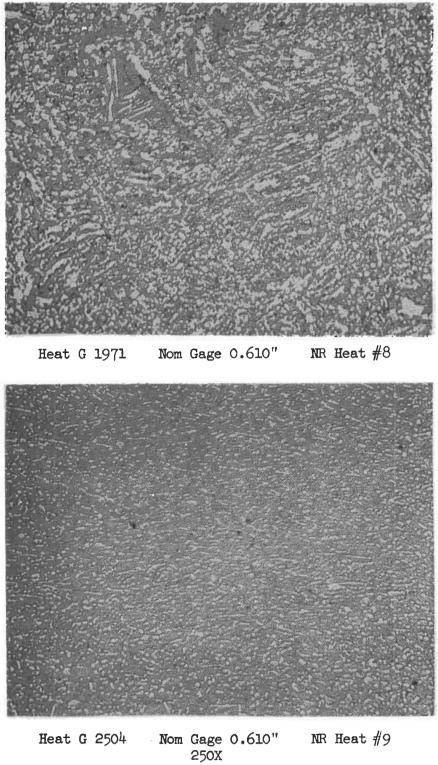
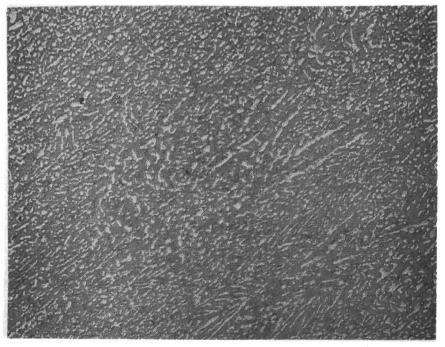




FIG. 2-22

Ti 6A1-6V-2Sn Cond STA

1



meat G 3106 Nom Gage 0.615 NR Heat #10



67

Contrails

FIG. 2-23 Ti 6A1-6V-2Sn Cond STA

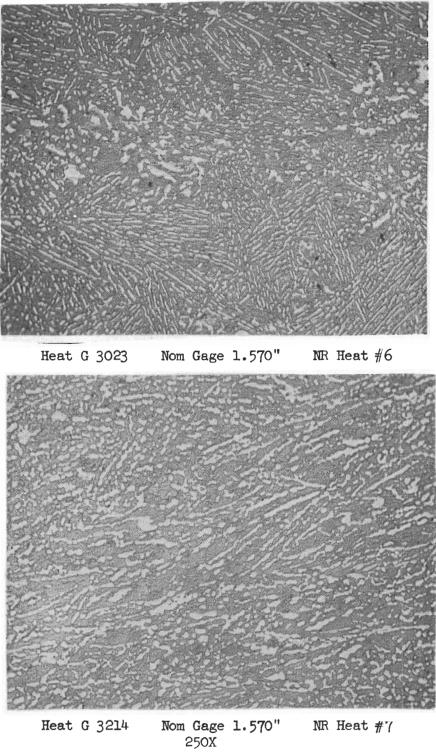
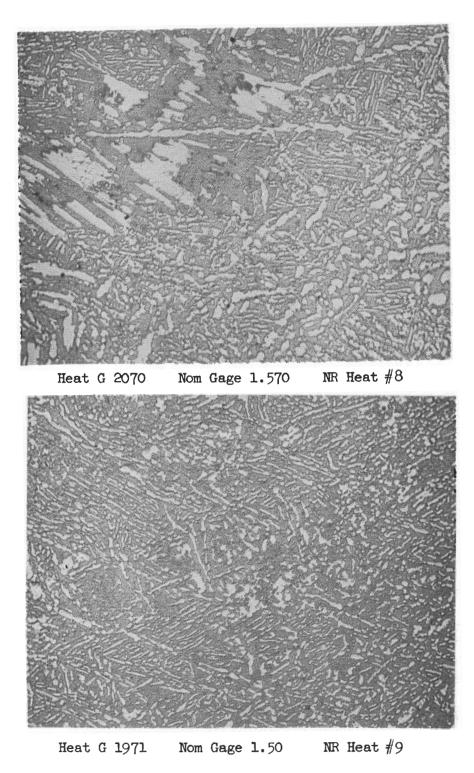




FIG. 2-24

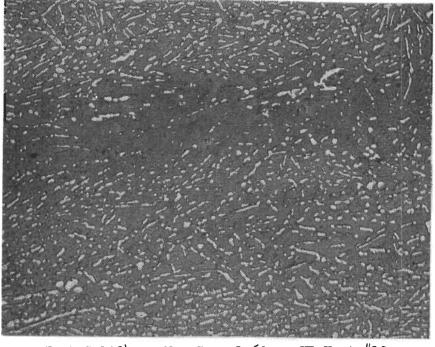
Ti 6A1-6V-2Sn Cond STA



250 X

Contrails

FIG. 2-25 Ti 6Al-6V-2Sn Cond STA



Heat G 3024 Nom Gage 1.60 NR Heat #10

250 X

70

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Mechanical Properties Determined

- 2.5 The various mechanical properties determined from each type of test performed are as follows:
 - 1. Tensile Tests Sheet and Plate
 - (a) Ultimate Tensile Strength
 - (b) 0.2% Offset Tensile Yield Strength

 - (c) Percent Elongation(d) Percent Reduction of Area
 - (e) Precision Elastic Tension Modulus (Selected Sample)
 - 2. Compression Tests Sheet and Plate
 - (a) 0.2% Offset Compression Yield Strength
 - 3. Bearing Tests Sheet and Plate e/D = 1.5 and e/D = 2.0
 - (a) Ultimate Bearing Strength
 - (b) 2% Offset Bearing Yield Strength
 - 4. Shear Tests Sheet and Plate
 - (a) Ultimate Shear Strength
 - 5. Fracture Toughness Tests Plate
 - (a) Plane Strain Fracture Toughness Value (Kic)
 - 6. Thermal Stability Tests Sheet and Plate
 - (a) Ultimate Tensile Strength, 0.2% Offset Yield Strength, % Elongation, % Reduction in Area for test specimens at room temperature and elevated temperature after exposure to elevated temperature for prolonged periods of time.
 - 7. Fatigue Tests Sheet and Plate
 - (a) Stress versus number of cycles to failure, as a function of specimen geometry (smooth and notched) as well as stressratio.

2.6 Test Conditions

Room and elevated temperature, tension, compression, bearing, and shear mechanical property tests for the longitudinal and transverse direction as well as limited test in the short transverse direction for the four materials were performed in an air atmosphere. The range of elevated test temperatures included 400F, 600F, and 800F. The thermal stability tests which determined the effects of exposure

in air temperatures of 400F, 600F, and 800F for times of 10, 100, and 1000 hours, were complied from tests at exposure temperature and at room temperature after exposure.

Fracture toughness test data were obtained at room temperature in air. In addition, fracture toughness tests were made on specimens at room temperature which had been exposed at 400F, 600F, and 800F for periods of 10, 100, and 1000 hours.

Axial fatigue tests were performed on three of the materials in the longitudinal direction using smooth test specimen configurations ($K_t = 1.0$) and notched test specimen configurations ($K_t = 3.0$). The tests were run at room temperature at stress ration of R = 1.0, -0.3, 0 and +0.3 where:

R = Minimum Stress Maximum Stress

Test conditions for the complete program are shown in Tables II-1 through 11-6.

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Table ||-|

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LENSIT NOLENSIT

NUMBER OF TESTS FER TEMPERATURE

Aj			a source full			•			The	Thermal Sta	Stability		
pp	Material		(inches)	H	1001	1 009	800 F	Tested	at Rm.	Temp.	Tested	at Elevato	ed Temp.
rc			(annual)					1-00t	600 F	800 F	400 F	4,009	800 F
ove					Ċ		4						
ed		(cond. A)	0.110	12	Ð	σ	σ	m	m	m	m	m	m
		13V-11CR-3AL(COND.A) 2 0.110	20.110	5	9	9	9	m	m	m	m	m	~
fo		3	0.250-0.300	9	5	5	5	m	- m) m) (r
r	QAL-4V	P)	0.500-0.650	9	. 0	. (1	. വ	ŝ) (r)) 6	•
Ρı	TH GAL-4V (STA	(F	000.1 <	Ó	m	ŝ	ŋ		•	•	1	1	1
ub	TH GAL-6V-2Sh	(Cond. A)	0.250-0.300	2	5	5	Ś	m	m	m	m	m	m
3	TH GAL-6V-2Sh	(Cond. A)	0.500-0.650	5	2	Q	. ณ	m	ŝ		•	1) 1
С	TH GAL-6V-2Sh	(Cond. A)	000 T ح	15	m	ŝ	m	ŝ	m	ŝ	•	•	1
R	TH GAL-6V-2Sh	(STA)	0.250-0.300	ŝ	Ч	Ч	Ч	н			1	1	1
e]	TH GAL-6V-2Sh	(STA)	0.500-0.650	77	cu	Q	N	m	~	~	1		1
_ea	TH GAL-6V-2Sh	(STRA)	000 . 1د	ର୍ଷ	m	ŝ	m	ŝ	ŝ	 - ~			
as													

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Material	Thickness (inches)	R	1400°F	600 °F	800 °F
T: 4.AL-3M0-1V (Cond. A) T: 1.3V-11CR-3AL (Cond. A) T: 5.AL-4V (STA) T: 6.AL-4V (STA) T: 6.AL-4V (STA) T: 6.AL-6V-2Sn (Cond. A) T: 6.AL-6V-2Sn (Cond. A) T: 6.AL-6V-2Sn (Cond. A) T: 6.AL-6V-2Sn (STA) T: 6.AL-6V-2Sn (STA) T: 6.AL-6V-2Sn (STA) T: 6.AL-6V-2Sn (STA)	<pre>40.110 40.110 0.250-0.300 0.250-0.650 2.1.000 0.250-0.300 0.250-0.300 0.250-0.300 0.250-0.300 0.250-0.650 *1.000</pre>	ដីខ្លួ _ល ទីខ្លួស ភូទីខ្លួស ភូទីខ្លួ		40400000100	๚๛๚๛๛๛๛๛๛๛๛

Table ||-2

COMPRESSION TESTS

NUMBER OF TESTS PER TEMPERATURE

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V.+C.M.	Thickness		e/D =	1.5			e/D =	2.0	
TRTJ 20 BU	\sim	RT	400 F	600 F	800 F	탪	1,000 F	600°F	800 F
TH 4AL-3Mo-1V (Cond. A)	€0.110	8	4	.+	+ †	æ	4	t 4	4
TH 13V-11CR-3AL (Cond. A)	≤0.110	9	2	Q	2	9	N	ີ ເບ	Q
TH GAL-4V (STA)		5	4	4	4	ŝ	.+	-†-	t t
TH GAL-4V (STA) 0.500-0	0.500-0.650	4	Ч	ч	-1	4		7	٦
TH GAL-4V (STA)		5	Ч	Ч	Ч	5	г	Ч	н
TH 6AL-6V-2Sh (Cond. A)		9	ณ	Q	N	9	Q	Q	ŝ
TH 6AL-6V-2Sh (Cond. A)		9	Ч	Ч	Ч	9	ч		ч
TH 6AL-6V-2Sn (Cond. A)		8	Ч	ч	Ч	æ	Ч	-1	-1
TH GAL-6V-2Sh (STA)			I	I	1	ч	ı	i	•
TH 6AL-6V-2Sh (STA)		9	٦	1	Ч	9	Ъ	Ч	н
TH GAL-6V-25n (STA)	21.000	æ	1	~-1	Ч	ω	Ч	Ч	ч
					-				

Table ||-3

BEARING TESTS

NUMBER OF TESTS PER TEMPERATURE

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Contrails

Table ||-4

SHEAR TESTS

NUMBER OF TESTS PER TEMPERATURE

Material		Thickness (inches)	퉖	1400°F	600 °F	800 °F
TH 4AL-3M0-1V (Cond. A) TH 13V-11CR-3AL (Cond. A) TH 13V-11CR-3AL (Cond. A) TH 6AL-4V (STA) TH 6AL-4V (STA) TH 6AL-6V-2Sh (STA) TH 6AL-6V-2Sh (Cond. A) TH 6AL-6V-2Sh (Cond. A) TH 6AL-6V-2Sh (Cond. A) TH 6AL-6V-2Sh (STA) TH 6AL-6V-2Sh (STA) TH 6AL-6V-2Sh (STA)	(Y	<pre>\$ 20.110 \$ 20.110 \$ 20.110 \$ 0.250-0.310 \$ 20.250-0.310 \$ 20.250-0.310 \$ 20.250-0.310 \$ 20.250-0.310 \$ 20.250-0.630 \$ 20.1.00 \$ 20.10</pre>	005 000 th 200	********	ようれてこうよう ■ しょ	でてっててのてたる す

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Material	Material Thickness	臣	Thermal S 4000F	Thermal Stability - Tested at R.T. 400 ⁰ F 600 ⁰ F 800 ⁰ F	sted at R.T. 800 ⁰ F
th Gal-4 (Sta)	0.250 to 0.300	2	e	3	£
Ti 6AL-6V-25n (Cond. A)	0.250 to 0.300	9	ŝ	m	£
Th GAL-6V-25n	0.250 to 0.300	-1	ı	1	I

Table!!-5

•

FRACTURE TOUCHDESS TESTS

NUMBER OF TESTS

Contrails

•

		LL H	
Material	Material Thickness	Smooth Kts 1.0	Notched Ktm 3.0
TH 4.AL-3MO-LV (Cond. A)	°011.0 2	32	32
TH GAL-4V (STA)	- 1.000	54	2t
TH GAL-6V-2Sh (Cond. A)	≥ 1.000°	32	32
th Gal-6v-23a (SIA)	¥ 1.000′	32	32

Table ||-6

TENSION-TENSION FAILURE TESTS

NUMBER OF TESTS

Contrails

Section III

TEST SPECIMENS

Contained within this section are the; (1) test specimen identification codes, (2) test specimen sampling, (3) test specimen configurations and (4) test specimen preparation procedures.

		Page	3
Test Specimen Id	entification Codes	80 -	81
Test Specimen Sa	mpling	82	
Test Specimen Co	onfigurations	84 -	95
Test Specimen Pr	reparation	96	

SECTION III

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TEST SPECIMENS

3.) SPECIMEN IDENTIFICATION CODES

A typical test specimen identification would be as follows: TVIZLTR1. In general, test specimen code numbers will have the above form with each letter or number having a specific meaning as indicated below:

The letter "T" or "R" indicates the producer which are <u>T</u>itanium Metals Corp. and <u>R</u>eactive Metals, Inc.

The next letter in the coding system indicates the alloy:

A - T1-6A1-4V (Cond. STA) V - T1-6A1-6V-2Sn (Cond. A and STA) C - T1-13V-11Cr-3Sn (Cond. A or ST) M - T1-4A1-3Mo-1V (Cond. A)

The following number in the coding sequence identifies the heat number for the particular alloy. There can be as many as 10 heats.

The next letter in the coding sequence relates to the gage of material being tested. In this regard these letters have been utilized in the following manner:

X - Gages of Material ≤ 0.250 In. Y - Gages of Material ≤ 0.630 In. Z - Gages of Material ≥ 1.000 In.

The above applies to both sheet and plate stock gages with all sheet specimens using the X designation.

The next letter indicates test specimen orientation in relation to the rolling direction marked on the raw stock. The directions test specimens were taken are as follows:

- L Longitudinal (parallel to the rolling direction)
- T Transverse (perpendicular to the rolling direction)
- S Short transverse (through the thickness of the heavy gage plate)
- LE Refers to bearing specimens only, with the test specimen being taken on edge parallel to the direction of rolling
- TE Refers to bearing specimens only, with the test specimens being taken on edge perpendicular to the direction of rolling

The next letter refers to the type of test which is to be performed. The following indicates the types of tests:

Cautraila

- T Tension
- C Compression
- S Shear
- B1 Bearing $^{\circ}/_{D} = 1.5$
- B2 Bearing e/D = 2.0
- F Fracture Toughness
- V Fatigue
- W Room Temperature Stability
- X Elevated Temperature Stability

Where a stability test is indicated, the type of stability test is identified, i.e., (X) with the type of test specimen following, i.e., (T) tensile.

The next to last letter or number in the coding sequence refers to the test temperature or the exposure temperature:

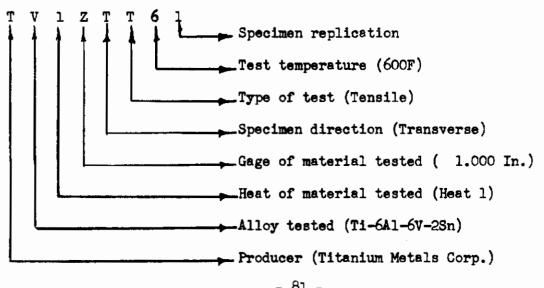
R - Room Temperature 4 - 400F 6 - 600F 8 - 800F

The last number in the sequence reflects individual specimen replication (i.e., 1, 2 and 3).

Miscellaneous notations and exceptions to the coding system: The last number in the coding sequence of the thermal stability test specimen refers to the exposure time rather than specimen replication. In this regard:

- 1 10 hours exposure
- 2 100 hours exposure
- 3 1000 hours exposure

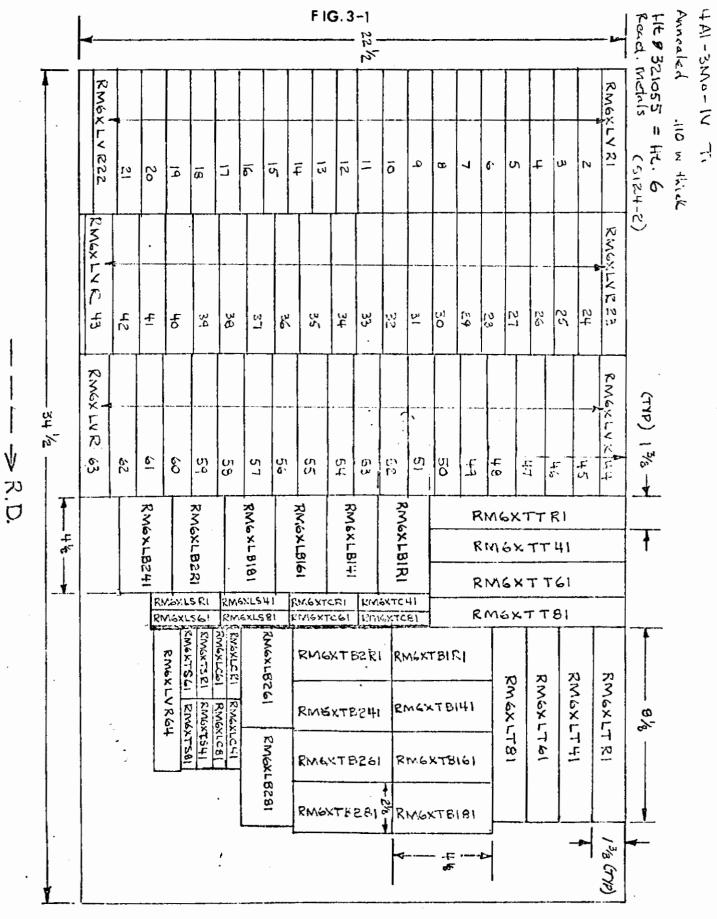
An example of the coding system is shown in the diagram below:



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3.2 SPECIMEN SAMPLING

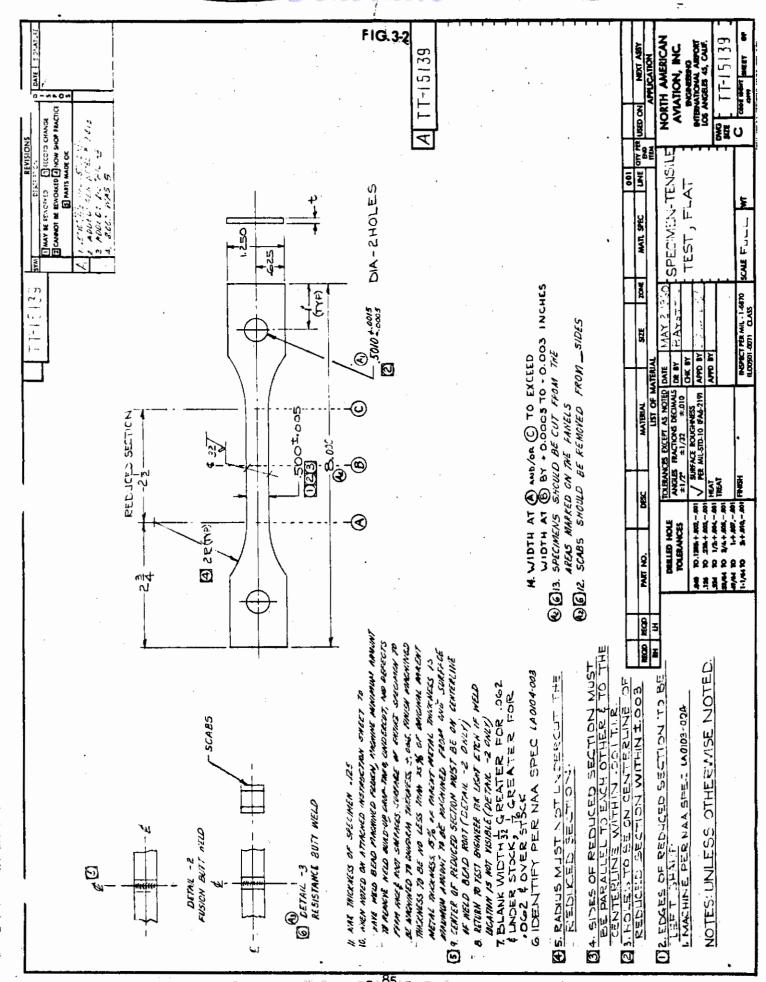
Due to the fact that most of the test material was received from the two suppliers as bits and pieces, the layout of test coupons was necessarily dictated by the size of the piece of material. A typical test specimen layout for one of the sheet gage heats is shown in Figure 3-1. As can be seen, removal of committed test coupons resulted in a minimum of surplus material.



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3.3 SPECIMEN CONFIGURATION

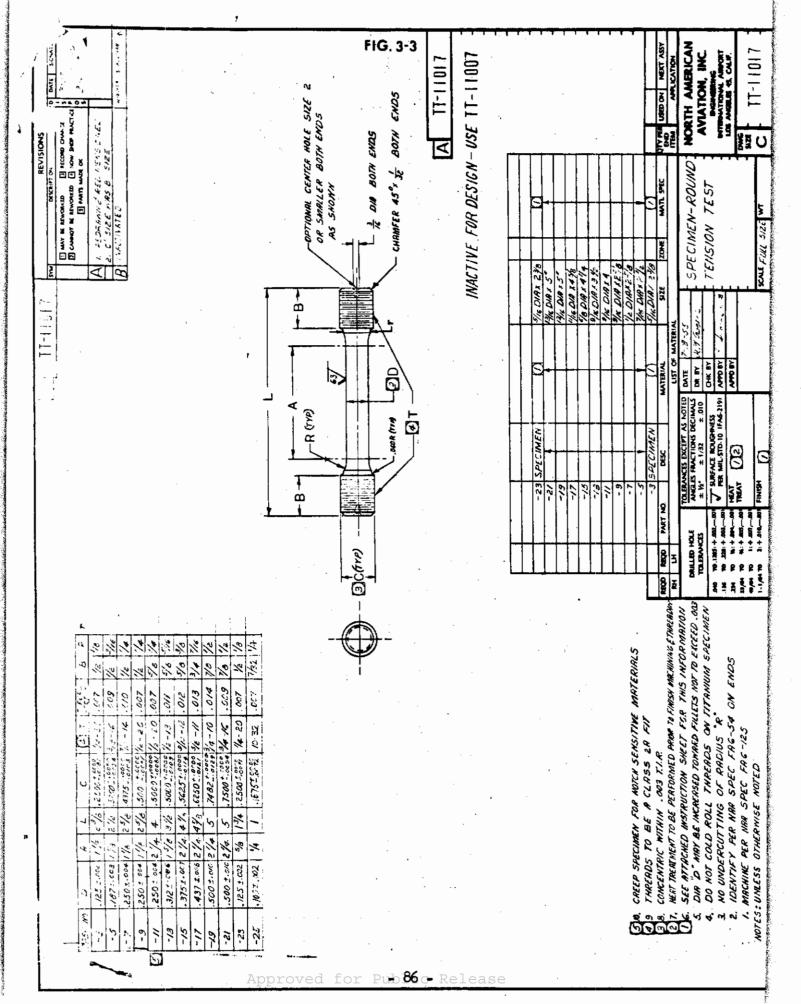
Typical test specimen configurations used on this program are shown in Figures 3-2 through 3-12. The configurations selected were tailored to material sizes available. The use of sub size specimens were avoided with the exception of those test specimens taken in the short transverse direction (through the thickness) of the heavy gage plate stock and the round bar fatigue tests. All test specimens conform, where applicable, to ASTM Standards.

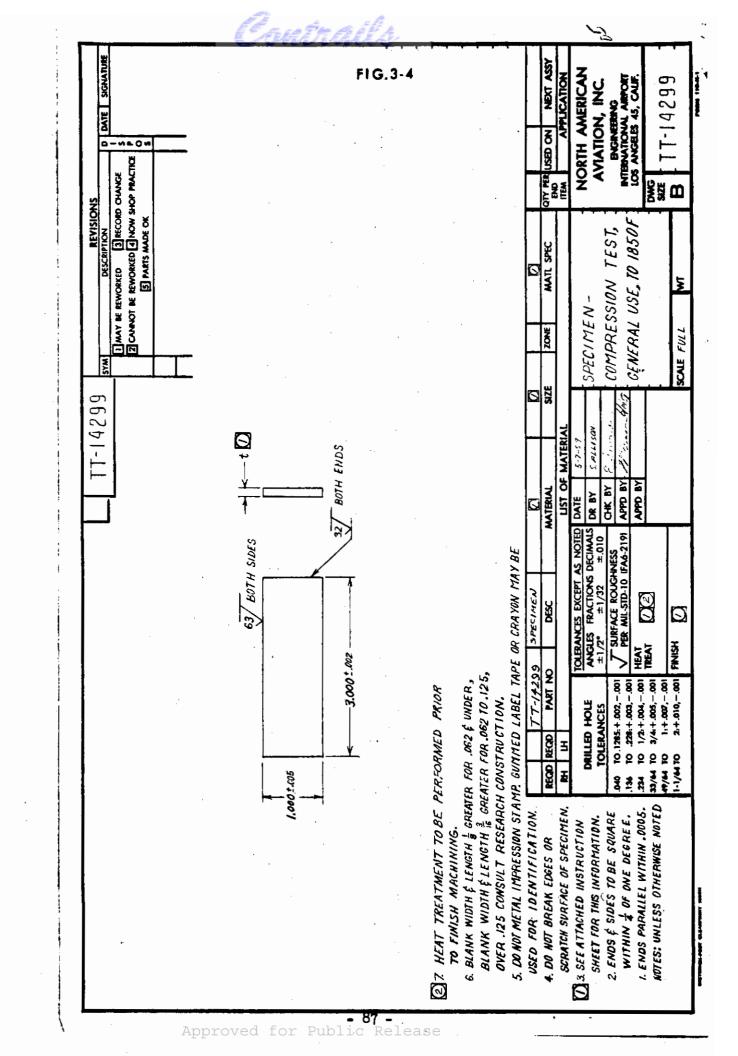


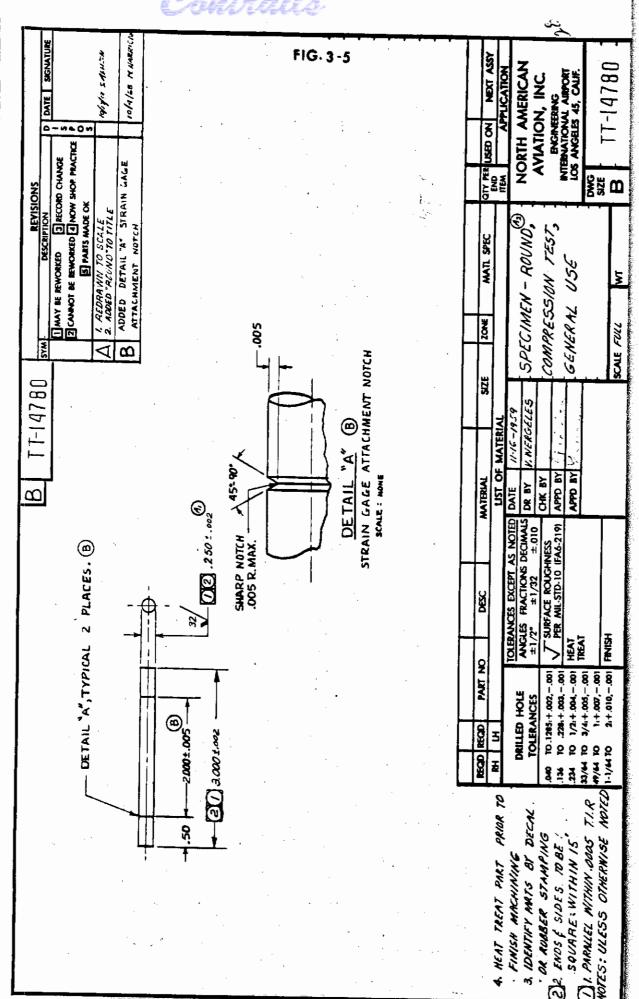
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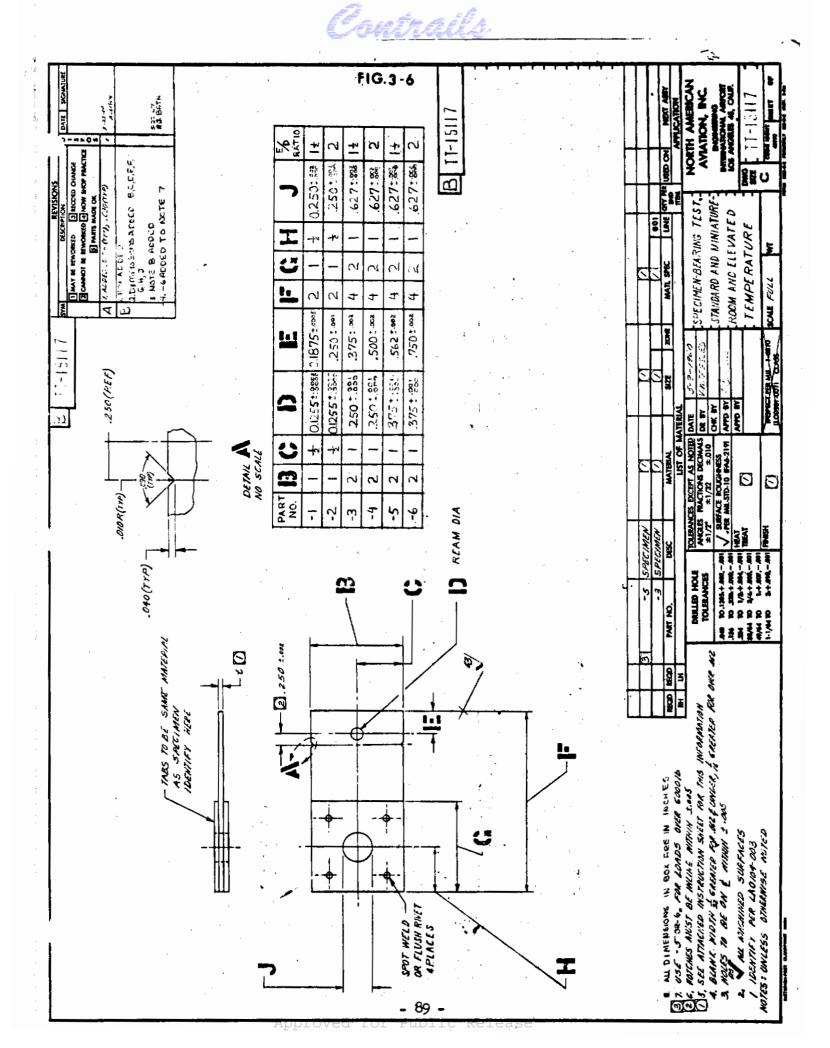
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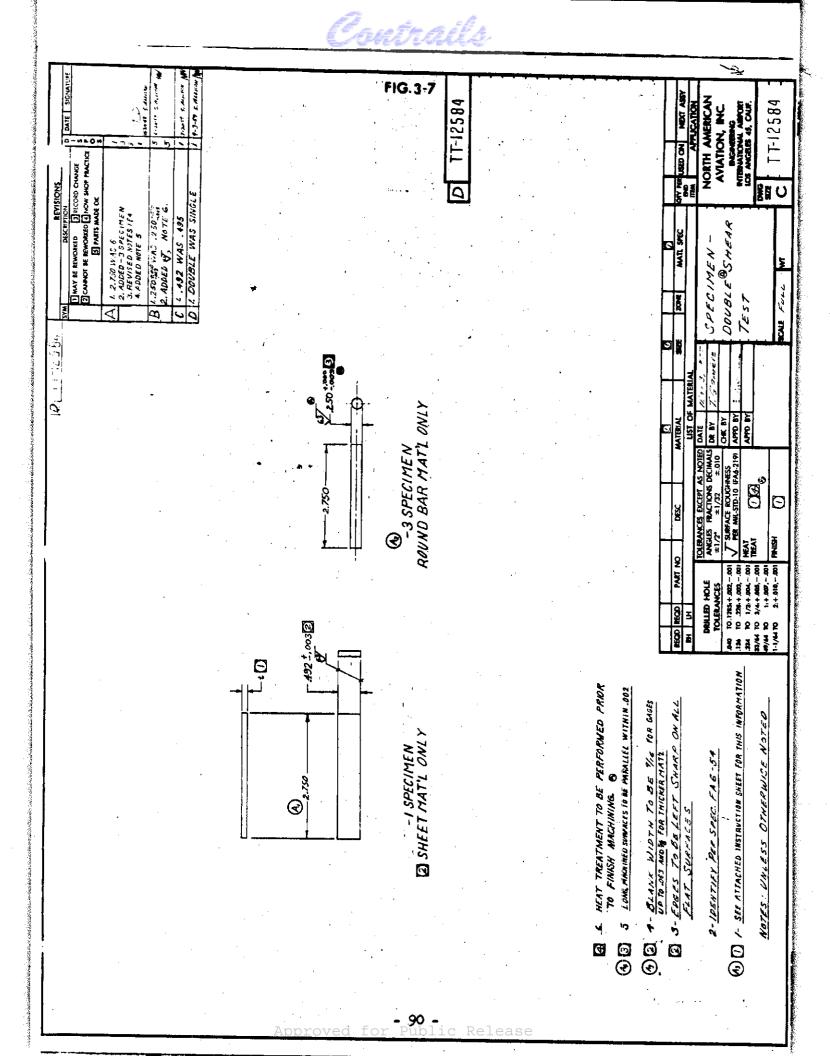
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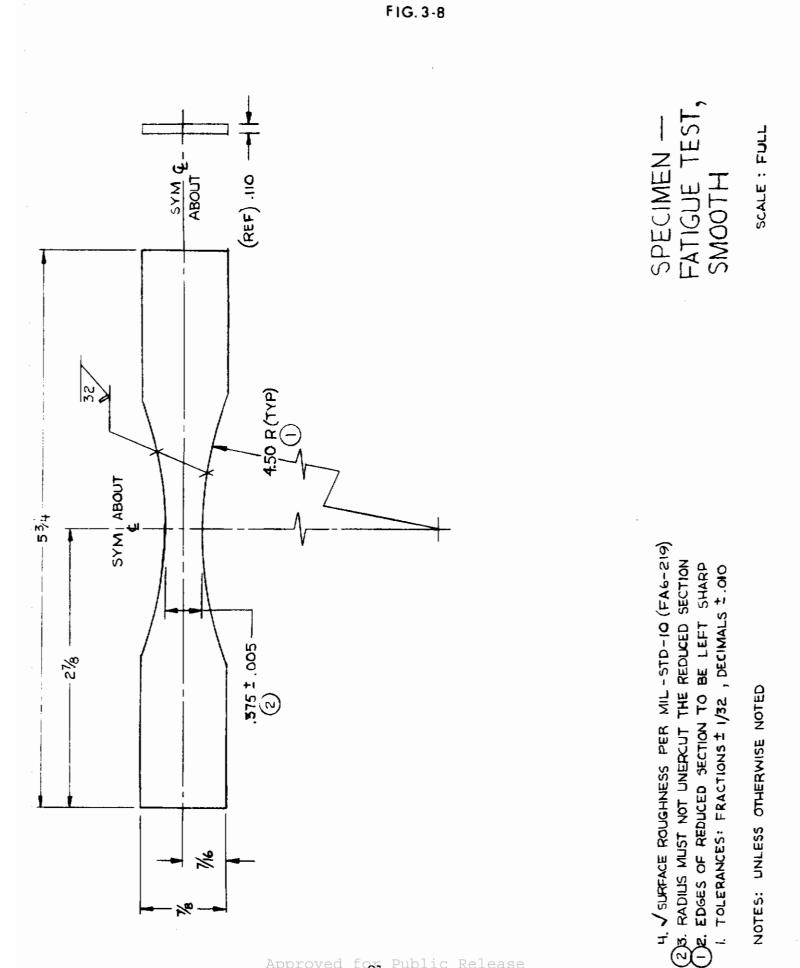




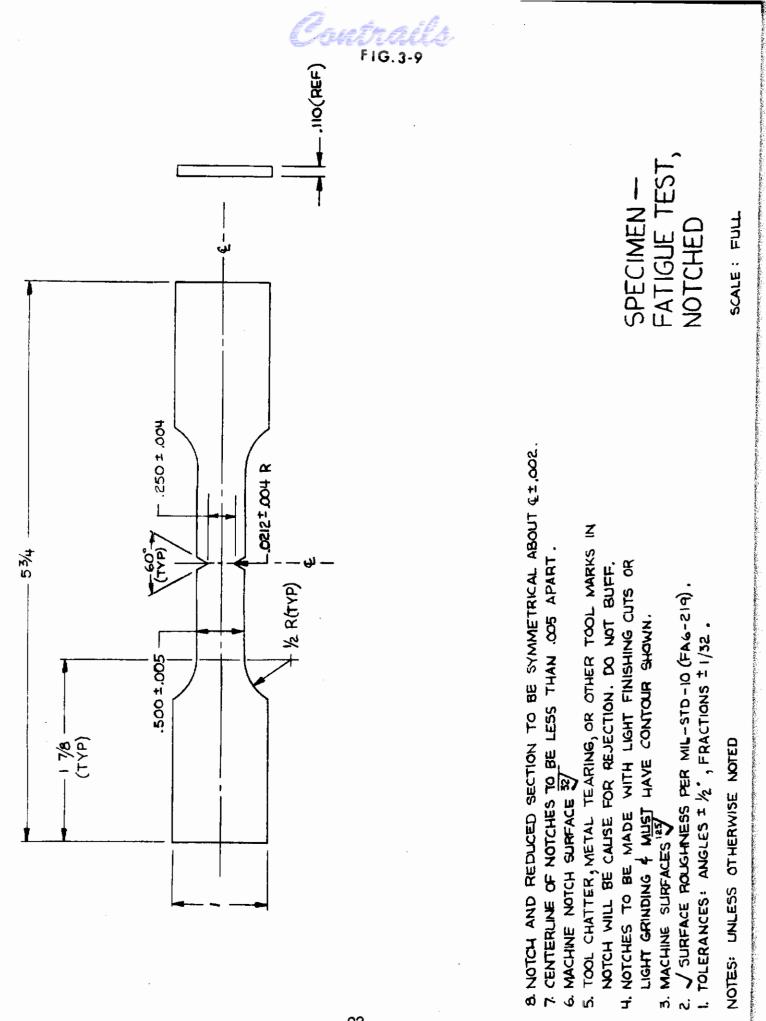


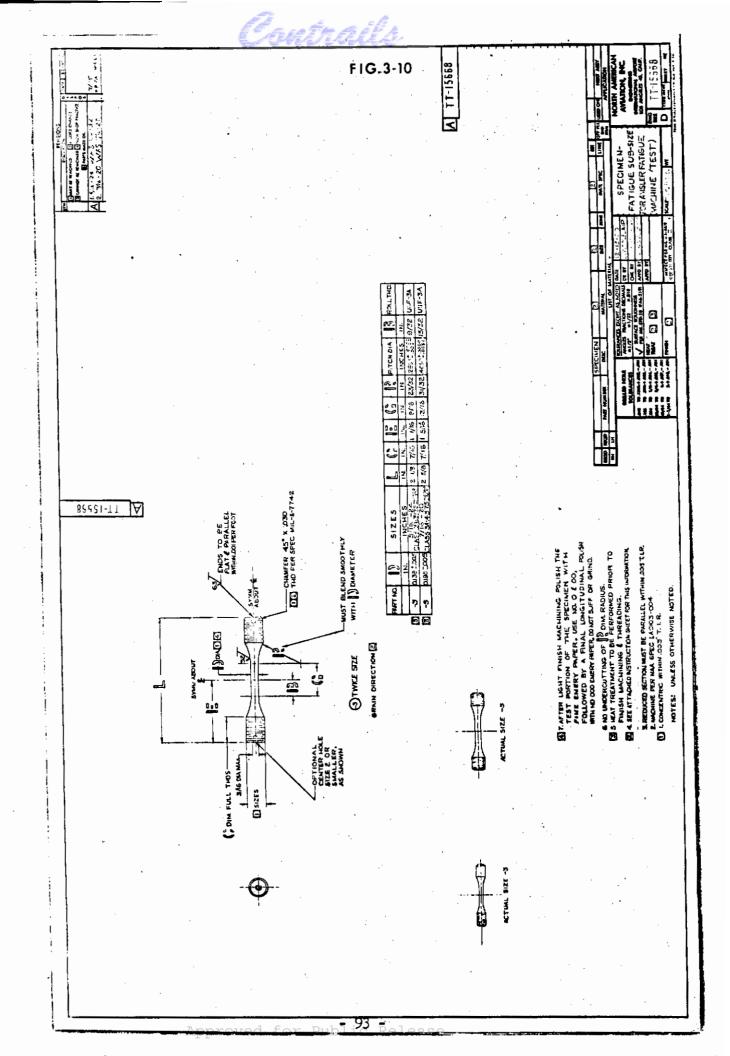


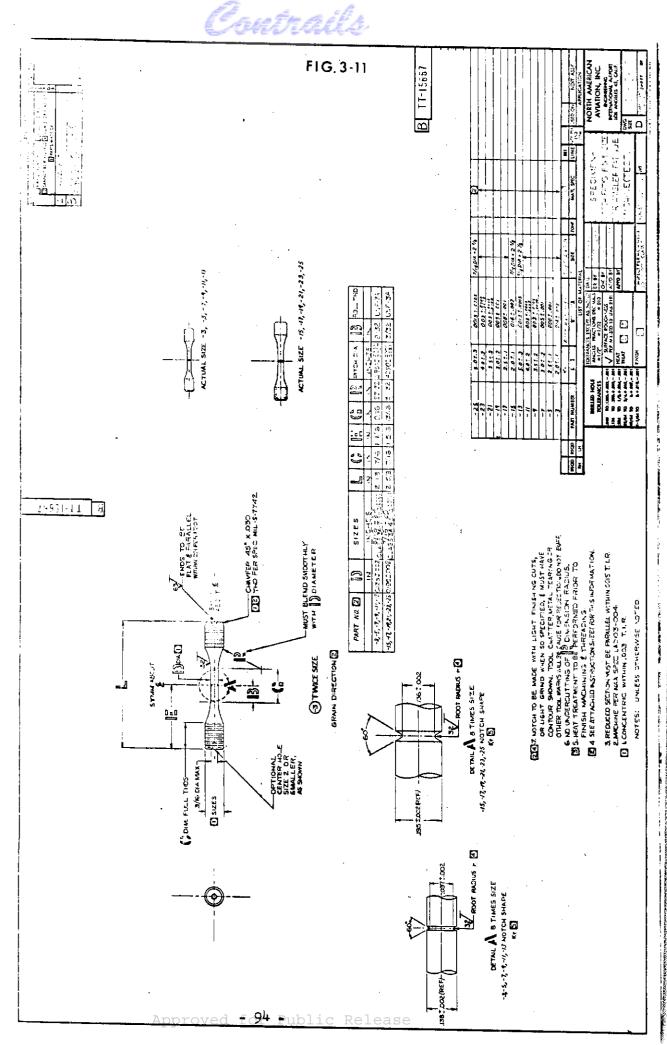




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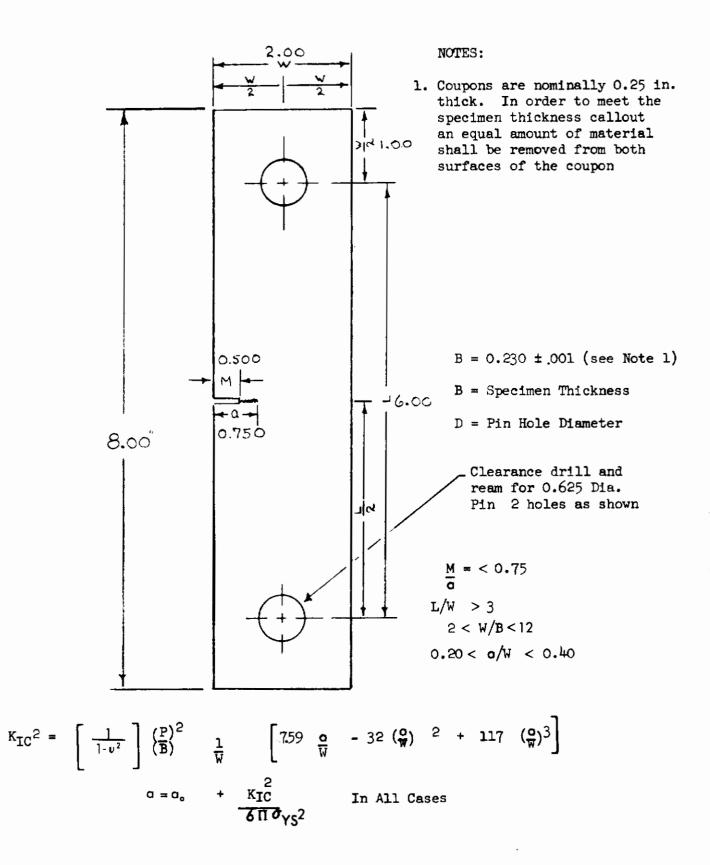


Figure 2 Recommanded Single-Edge-Notch Tensile Specimen Geometry

3.4 SPECIMEN PREPARATION

Every effort was made to insure that the variations in test results would be due to material properties, by requiring and holding close test specimen machining tolerances. The conditions for machining were carefully chosen to provide a minimum of distortion and surface defects which might influence the resulting test data. Additionally, care was exercised to insure that the material was not overheated during any of the cutting or machining operations.

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Section IV

TEST EQUIPMENT

 \sim intrinsic within this section are the various pieces of test equipment used in this investigation,

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Static Tests	98 - 99
Fatigue Tests	99

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SECTION IV

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TEST EQUIPMENT

41 STATIC TESTS

411 Loading Apparatus

The loading apparatus used in the performance of tension, compression, bearing, shear, fracture toughness, and stability tests, are as follows:

One Instron Univeral Testing Machine - 10,000 capacity

- One Instron Universal Testing Machine 20,000 capacity
- One Baldwin-Lima-Hamilton Universal Testing Machine 50,000 capacity
- One Baldwin-Lima-Hamilton Universal Testing Machine 120,000 capacity
- One Richle Universal Testing Machine 120,000 capabity

All of the above mentioned machines are equipped with strain-rate pacers and autographic recorders.

41.2 Extensometers

Weideman Dual Range Extensometer, Model TSMD Weideman Dual Range Extensometer, Model KSMD Weideman Averaging Type Extensometer, Model PS-SM Weideman Averaging Type Extensometer, Model PS-3MH Instron Strain Gage Extensometer, Model G-51-12 Instron Strain Gage Extensometer, Model G-51-11 Baldwin Strain Beams, Model SB1E Aminco-Tuckerman Optical Strain Gage System

With the exception of the Tuckerman optical strain gage system, the above listed extensometers and strain gage extensometers were used with autographic recording equipment which are built in to the various Universal testing machines to measure load versus deformation.

413 Furnaces

The furnaces used for achieving the static elevated test temperatures are as follows:

- (1) Pacific Scientific Forced Air Furnace 1400F capability Honeywell-Brown "Electronik" recorder controller
- (2) Hevi-Duty Split Tube Radiant Furnace ~ 2000F capability Wheelco pyrometer controllers
- (3) Messimers Circulating Air Chamber 1000F capability Brown proportional controller
- (4) NR/LAD built Split Tube Radiant Furnaces 2000F capability Wheelco pryrometer controllers

The furnaces used for thermal stability exposure work were:

- (1) Pacific Scientific Forced Air Furnaces 1400F capability Honeywell-Brown Pry-O-Vane controllers
- (2) Arcweld Radiant Tube "Dial-O-Matic" Furnace 2000F capability Honeywell-Brown controllers

Contrails

The furnaces used for heat treating the Ti-6A1-6V-2Sn material to Cond. STA are as follows:

- (1) Hevi-Duty Radiant Furnace 2100F capability Leeds and Northrup controllers
- (2) Pacific Scientific Forced Air Furnaces 1400F capability Honeywell-Brown controllers

4.2 FATIGUE TESTS

The fatigue test machines used to construct the Goodman Diagrams included:

(1) Amsler Vibraphone Fatigue Machine - 22,000 Lb. capacity, 60 - 300 CPS

(2) Baldwin-Sonntag Fatigue Machine - 10,000 Lb. capacity (has a 5:1 load multiplier 50,000 Lb.), 30 CPS

 (3) Krouse Direct Stress Fatigue Machine - 5000 Lb. capacity (has a 2:1 load multiplier, 10,000 Lb.)

NOTE: The fracture toughness tests were pre-cracked using the above listed Krouse Direct Stress Fatigue Machine

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Section V

TEST PROCEDURES

Contained within this section are the procedures utilized for the various mechanical property tests performed in this investigation

	Page
Tensile Tests	101
Compression Tests	102
Bearing Tests	103
Shear Tests	104
Fracture Toughness Tests	105
Metallurgical Stability Tests	105
Fatigue Tests	106

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SECTION V

Crutrails

TEST PROCEDURES

5.1 TENSILE TESTS

Tensile tests on the subject program were performed using a Riehle, Baldwin-Lima-Hamilton, and Instron Universal test machines which are fully equipped with autographic recorders and automatic strain pacers. These machines are calibrated at least once each year to the appropriate ASTM Standard to ensure loading accuracy.

Tensile specimens tested at the indicated elevated temperatures were heated by means of a Pacific Scientific forced air furnace that has a capability of 1400F and tube radiant-type furnaces that have a temperature capability of 200F. All furnaces are capable of maintaining \pm 5F over a 2-inch gage length.

Specimen temperature measurements were made by means of 20 A.W.G diameter chromel-alumel thermocouples attached to the center of the test specimen and calibrated potentiometers for obtaining emf readings.

All measurements of individual specimens for area determinations were made using a calibrated micrometer capable of measuring \pm 0.0001 inch of the nominal specimen dimension. A minimum of five width and thickness measurements were taken over the individual specimens' gage length for the cross-sectional area determination.

Determination of the tensile yield strength and the elastic modulus of each individual specimen tested were performed by attaching a Baldwin-Lima-Hamilton or an Instron strain gage extensometer to the gage length of the test specimen.

An automatic strain pacer was used to monitor the induced strain to the tensile yield strength. A strain rate of 0.005 in./in./min. was maintained up to the yield strength. After yielding occurred, the loading rate was increased so as to produce failure of the specimen in approximately one minute.

In addition to the autographically recorded load-elongation graphs, a limited number of stress-strain plots were made, using Tuckerman optical strain gages. This instrument conforms to ASTM E83-57T, Class A, requirements which limit the maximum error of indicated strain to 0.00001 or 10 times as limiting as the requirements specified for Class B-1 extensometers. Data generated using this instrument serves as a base line for comparing subsequent test data obtained using the conventional autographic extensometers.

Typical full range stress-strain curves for each of the materials tested in conjunction with the precision elastic modulus obtained for the various materials are reported in Section VII of this report.

Typical room temperature and elevated temperature tensile setups are shown in Figures 5-1 and 5-2, respectively.

5.2 COMPRESSION TESTS

Compression testing of the four materials was accomplished by employing a compression subpress in conjunction with a Universal-type testing machine. One of the compression subpresses used was designed and built at NR/LAD, and employs a rigid frame containing a lower carbide loading anvil which is parallel to the bed of the testing machine. Within the frame, a sliding plunger is contained which accommodates the upper carbide loading anvil. The plunger is rigidly aligned within the support frame by the use of low-friction graphite plugs.

Contrails

Specimen side support is provided by a plate assembly made up of small carbide balls backed up by a carbide plate with the balls protruding through a front retaining plate in which the holes for the balls are large enough to allow rotation and translation of each ball while, at the same time, retaining the ball within the plate. This method of support provides nearly frictionless contact even at high temperatures.

A special fixture is used to make gage mark indentations on each side of the specimen into which the hardened points of the extensometer arms fit. The extensometer arms pass through an access hole in the bottom of the subpress frame and, in turn, are connected to a common lineal differential transducer located in an ambient temperature zone. The extensometer system used meets ASTM Standard E83-57T, Class B-1, requirements.

The NR/LAD built compression subpress has proven to yield exceptionally reliable and highly reproducible compressive yield strengths as well as elastic moduli on a variety of materials tested in it from room temperature to 1800F. Materials with known moduli have been tested and the results obtained from the subpress agree remarkably well with the known values. The reproducibility of the subpress has been demonstrated time and again on large NR test programs where replication of test effort has been necessary.

Elevated temperature compression testing is provided for by a specially constructed resistance wound furnace, which is designed so that the elements are in close proximity to the subpress body. Temperature uniformity is measured by three thermocouples inserted in the side support plates adjacent to the specimen. The test machine employed temperature measurement and specimen measurement techniques as well as strain pacing paralleling those described for the tensile. All compression tests were conducted in accordance with ASTM E 209-63T. Figure 5-3 shows the NR/LAD built compression subpress.

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5.3 BEARING TESTS

Bearing tests on the program were performed using a Universal-type testing machine and a bearing fixture. One of the fixtures used, Figure 5.4, accommodates the bearing test specimen and is basically an adjustable clevis that contains the loading pin as well as providing for appropriate deformation measurements.

Contrails

When the specimen is in place within the test fixture, the extension arms employing point contacts, locate on the sides of the bearing test specimen. When a load (tension) is applied, the relative displacement occurring between the pin, which is an integral part of the test fixture, and the pickup arms located on the sides of the test specimen is transferred to a linear differential transducer. The obtained signal is, in turn, fed into the test machine's autographic recorder, providing the necessary load-deformation plots necessary to obtain the 2 percent bearing yield strength.

The bearing fixture itself is made from Haynes 25 and contains carbide bushings that accommodate the loading pin. The loading pins themselves are fabricated from hot work die steels, heat-treated to the 280 - 300 Ksi range to resist brinelling during test.

Temperature measurements were made by attaching a thermocouple to the test specimen in the area of the pin.

Elevated test temperatures were achieved using a tube furnace previously described in the Tensile Test section.

All bearing tests were performed in accordance with ASTM E 234-64T.

5.4 SHEAR TESTS

Shear tests on the subject program were accomplished using an NR/LAD-built double shear subpress, shown in Figure 5-5. A Universal-type testing machine previously described provided the necessary loading requirements.

Contrails

The shear subpress is basically a rigid frame containing the necessary load bearing edges which are carbide, and provides the required lateral restraint of the sheet shear specimen during test. Contained within the frame is a plunger which, in turn, is placed within the frame. By applying a compressive load, the subpress imparts a double-shear load condition to the restrained specimen. When the shear subpress is properly adjusted, the respective carbide load bearing edges, contained within the plunger and frame, pass within 1/100 of an inch of each other during tests. It has been NR/LAD experience that this subpress provides highly reproducible and reliable shear test data.

NR/LAD has tried a variety of shear test specimens and fixtures in an effort to obtain consistent and reliable shear property data. Methods tried and discarded after proving unsatisfactory have included the conventional singleshear tension sheet specimen as we well as fixtures which test specimens in single shear. The double-shear subpress described has proved superior to the various other methods explored so far as producing both reliable and reproducible shear test data.

Elevated test temperatures were achieved using a specially constructed resistance-wound furnace designed for use with the shear subpress. Temperature measurements were made from a thermocouple which is inserted into the subpress in very close proximity to the test specimen.

Since only ultimate load was determined, no deformation measurements were made.

Specimen measurement techniques paralleled those described for the tensile tests.

The single-shear ultimate strength was derived from the double shear load by merely taking half the failing load and dividing it by the cross-sectional area of the specimen.

The shear tests performed were in accordance with ARTC 13-S-1 detail requirements.

5.5 FRACTURE TOUGHNESS TESTS

The fracture toughness test used to obtain plane strain (K_{Ic}) values for the four titanium alloys employed the single-edge-notch tension-type specimen. Selection of this configuration was based on several considerations: First, and most important, specimens conforming to this configuration yield correct and consistent K_{Ic} values, References 1 and 2. Secondly, while this configuration provided the necessary plane strain test data for the program, it also has the advantage of substantial material economy.

Contrails

Precracking of the individual test specimens to the desired predetermined depth was accomplished using a fatigue machine. The total depth of the sawed crack, plus that induced by fatigue (natural crack), will equal approximately one third of the specimen width, with the sawed crack depth being equal to or less than 0.75 of the total crack depth. Crack growth induced by fatiguing was carefully monitored by means of a binocular microscope.

Tension testing of the precracked fracture toughness test specimens was performed using a Universal-type testing machine. Load deflection curves were obtained for each specimen tested using a Class B-1 extensometer applied to the edge of the specimen across the crack zone as a compliance gage. A cross-head speed of .05 In./Min. was used for the fracture toughness tests. Upon completion of testing, the load versus deflection plots were analyzed for "pop-in" load. K_{Ic} values were then determined by means of the following relationship:

$$K_{IC} = \left[\frac{1}{1-\nu^2}\right] \left(\frac{P}{B}\right)^2 \frac{1}{W} \left[7.59 \frac{\alpha}{W} - 32\left(\frac{\alpha}{W}\right)^2 + 117\left(\frac{\alpha}{W}\right)^3\right]$$

where

B = specimen thickness
a = crack length at "pop-in" (in)
w = specimen width (in)
w = Poisson's ratio

All of the fracture toughness testing was conducted at room temperature and was limited to the 1/4-inch thick materials.

5.6 METALLURGICAL STABILITY TESTS

The effect of exposure to selected elevated temperatures for prolonged periods of time was determined for the four selected alloys using tensile and fracture toughness tests as the measuring criteria.

Tensile test specimens of the appropriate configuration were exposed to elevated temperatures of 400F, 600F, and 800F for time durations of 10, 100, and 1000 hours. After exposure, some of the test specimens were tested at room temperature with the remaining being tested at the elevated temperatures at which they were exposed. .

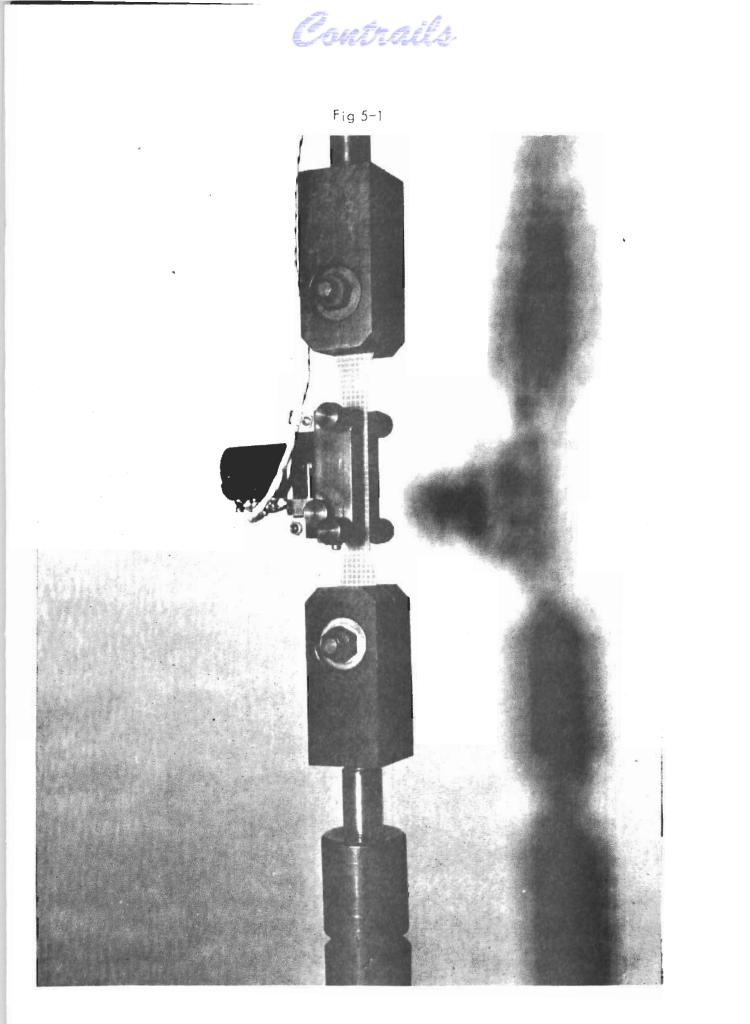
Contrails

Fracture toughness test specimens were exposed at 400F, 600F and 800F for 10, 100, and 1000 hours, and tested at room temperature after elevated temperature exposure.

Test equipment, fixtures and procedures for each type of test are described in the preceding text.

5.7 FATIGUE TEST

Fatigue tests were performed on the subject program using the equipment described in Section IV. All tests were at room temperature, employing both smooth and notched ($K_t = 3.0$) fatigue test specimen configurations. Four minimum-to-maximum stress ratios (R factors) were used. These were R = -1.0, R = -0.3, R = 0 and R = +0.3. The stress levels were varied within a group of specimens so that S-N curves could be constructed. From the various S-N curves generated for the four R factors for a given alloy and K_t , constant life diagrams were then constructed. A photograph of one of the fatigue test machines employed in this investigation is shown in Figure 5-6.



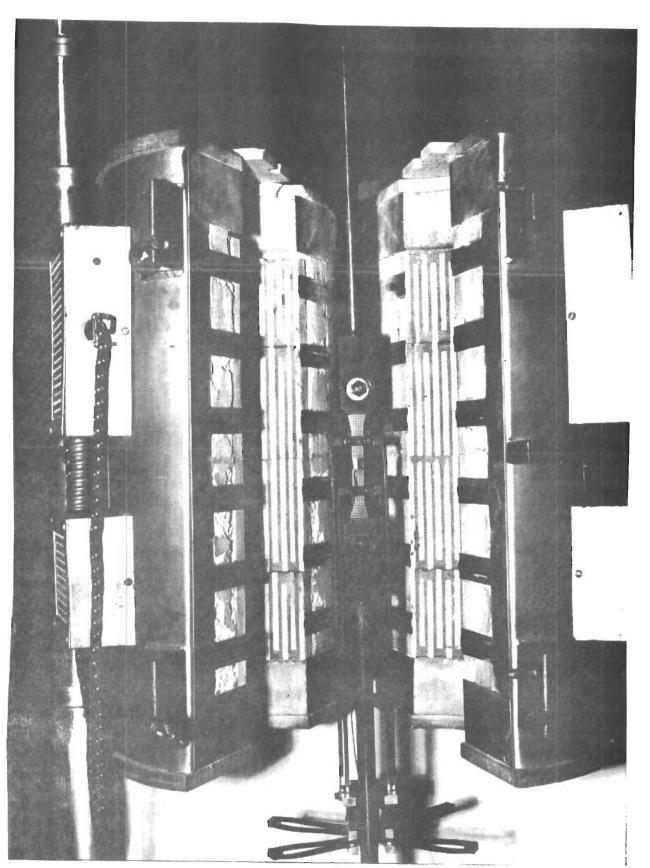
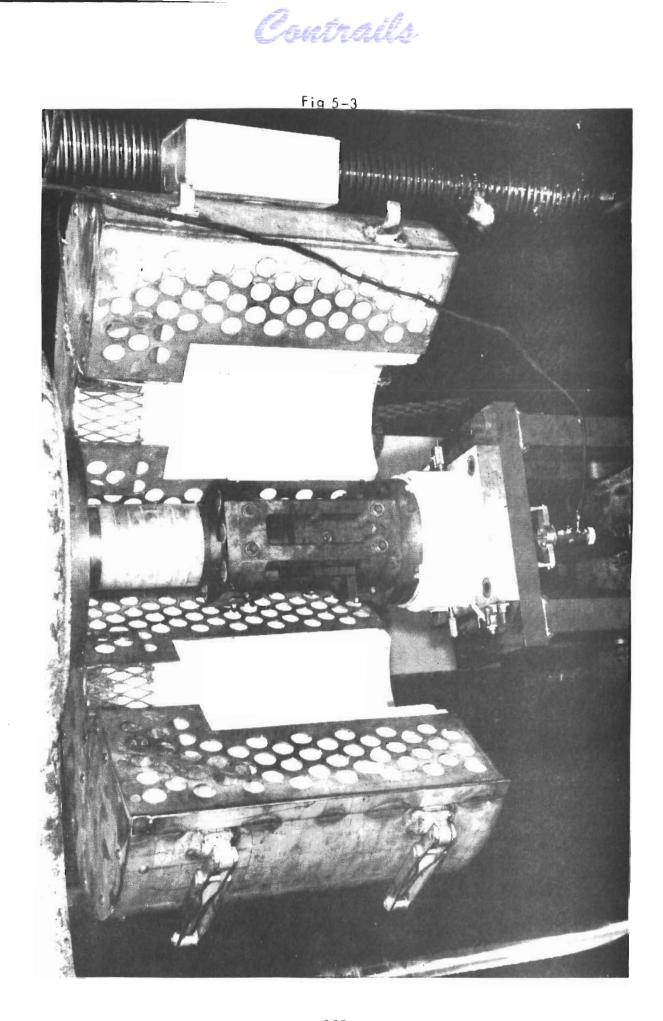
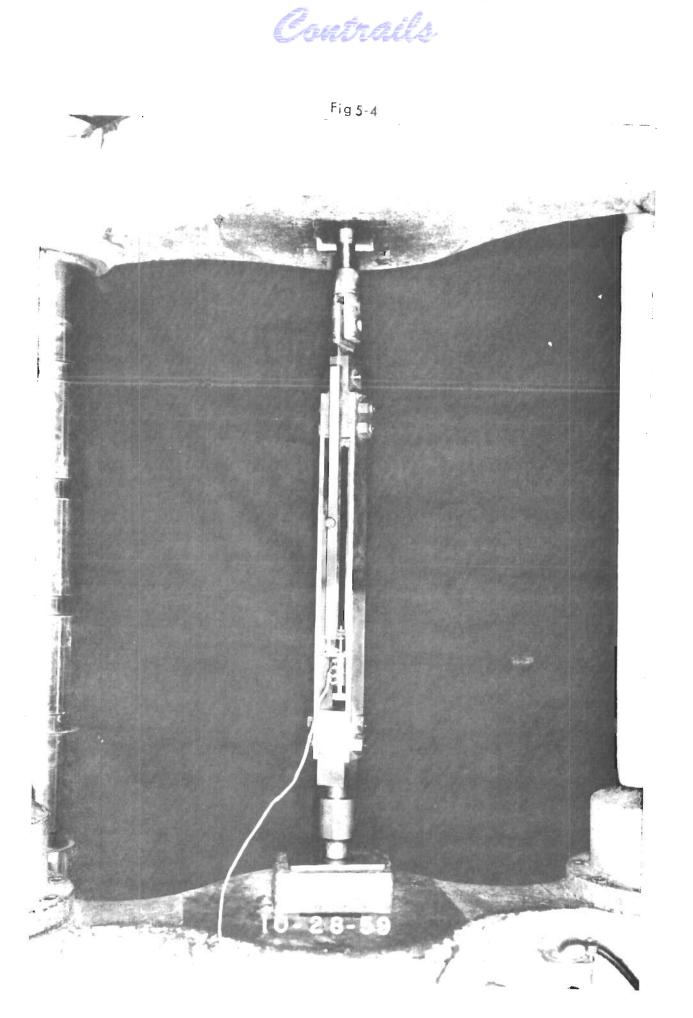
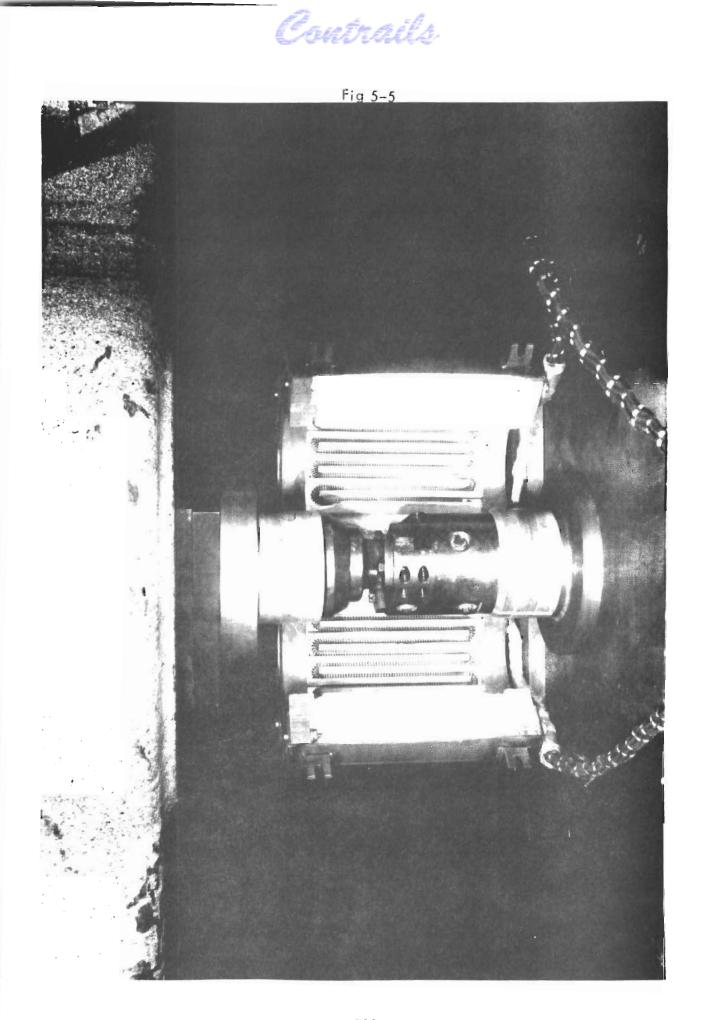


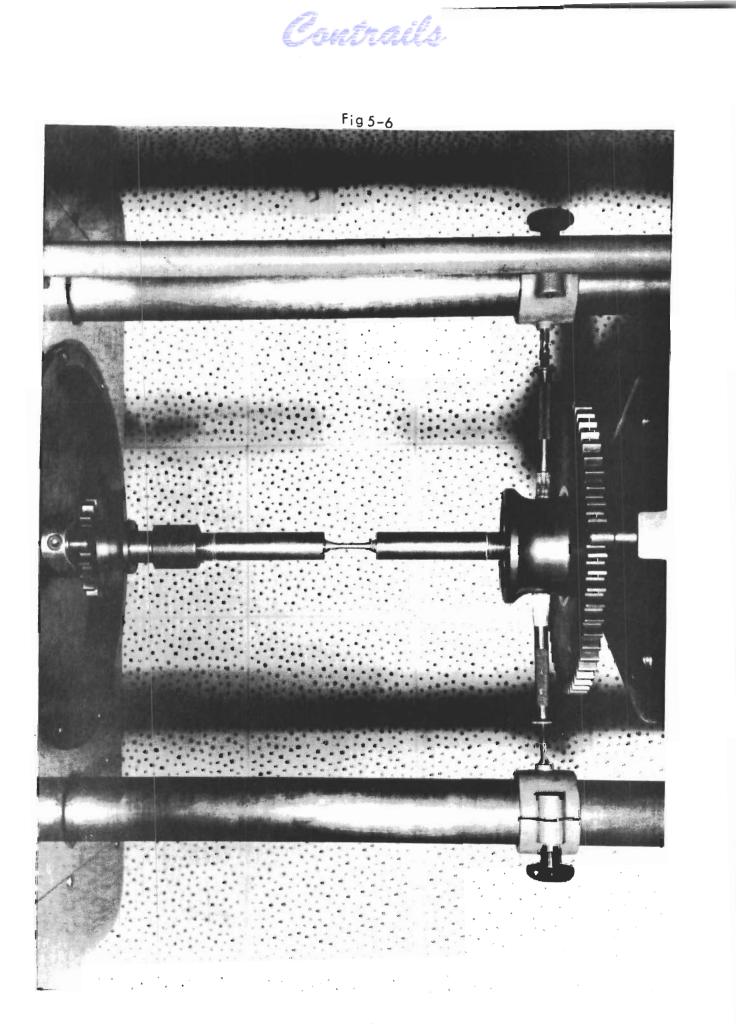
Fig 5-2

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Section VI

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SUMMARY AND ANALYSIS OF TEST RESULTS

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Contained within this section are the statistical analysis procedures used to obtain the "A" and "B" Design Allowables, in addition to summary tables of the test results obtained in this investigation.

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6.1 METHODS OF STATISTICAL ANALYSIS - R.T. DESIGN ALLOWABLES

This analysis was accomplished in accordance with "MIL'HDBK-5 Guidlines for the Presentation of Data", AFML TR-66-356 Battelle Memorial Institute.

The mechanical properties presented here are identified by a letter (i.e., A or B) to indicate the basis upon which they were established. An "A" value is the property above which 99 percent of the population is expected to fall with a confidence of 95 percent. A "B" value is the property above which 90 percent of the population is expected to fall with a confidence of 95 percent.

There are two methods of obtaining these values and they are:

1. Directly Calculated Values - The directly calculated "A" values are obtained as follows:

'A" value =
$$\bar{x} - KS$$

Where $\overline{x} = \frac{\sum x}{n}$ $S_x = \sqrt{\frac{(x - \overline{x})^2}{(n - 1)}}$

where \bar{x} is the average value of individual measurements, S_{x} standard deviation of individual measurements, n the number of individual measurements and K, the one-sided tolerance factor for normal distribution and specified probability, confidence, and population (i.e., for "A", $K = K_{.99}$, $_{.95}$, $_{n}$).

The "B" values are calculated as follows:

'B' value = $\bar{x} - KS_{x}$

Where $K = K_{.90}$, .95, n.

The values of K were obtained from the table "One-Sided Tolerance Factors for of .95", in Tables of Normal Prothe Normal Distribution and a Confidence bability Functions in above referenced document.

An additional requirement is that the population, n, must consist of at least 100 points from a minimum of ten different heats of material. Because of the scarcity of available data, this requirement usually can be satisfied for room temperature tensile ultimate and yield only.

2. Derived Values - These values are established through their relationship to directly calculated "A" or "B" values of F_{tu} or F_{ty} as obtained in the foregoing section. This method consists of pairing individual ultimate strength values (i.e., F_{tu} , F_{su} , F_{bru}) with individual tensile ultimate strength values, or individual yield strength values (i.e., F_{ty} , F_{bry}) with individual tensile yield strength values, determining the mean ratio of these pairs with a probability of 95 percent and multiplying the directly calculated "A" or "B" values of F_{tu} or F_{ty} by this factor. Derived values are therefore equal to:

Contrails

$$(\bar{\mathbf{r}} - t_{.05} S_{\bar{\mathbf{r}}}) F_{tu}$$
 (A or B)

or

 $(\bar{r} - t_{.05}S_{\bar{r}}) F_{ty}$ (A or B)

where

$$S_{\overline{r}} = \sqrt{\frac{\sum (r - \overline{r})^2}{n (n - 1)}}$$

and t .05 is the two-sided tolerance factor for the "t" distribution, a probability of 95 percent and the population, n, involved. The values of t .05 were obtained from a table in the referenced document. The derived values of the mechanical properties have the same validity (A or B) as the values of F_{tu} or F_{ty} used in equations (4) and (5). Ten pairs of measurements (n = 10) are the minimum for establishing a derived allowable.

LIST OF STATISTICAL SYMBOLS

 $\vec{r} = \Sigma r$

A	"A" basis for mechanical property values
в	"B" basis for mechanical property values
K	One-sided tolerance factor for the normal distribution and the specified probability, confidence and population
n	The number of individual measurements or paired measurements - population
r	Ratio of two paired measurements
r	ratio of two paired measurements
Sr Sx	Standard error of paired measurement ratios
Sx	Standard deviation of individual measurements
r	Two-sided tolerance factor for the "t" distribution and the specified probability and population
x	Value of an individual measurement
x	The average value of individual measurements
2:	The summation of

6.2 DISCUSSION OF ROOM TEMPERATURE ALLOWABLES

The values of all the mechanical properties for the Ti-4Al-3Mo-1V Cond. A sheet, Ti-6Al-4V Cond. STA plate, and Ti-6Al-6V-2Sn Cond. A and STA plate are presented as "S" values. This was a result of insufficient quantities of producers and users test data being supplied to NR/LAD during the solicitation of data phase of the subject contract. It should be noted that NR/LAD solicited the industry for test data applicable for the alloy covered in the scope of this contract. Much of the data obtained as a result of solicitation could not be used because of it not being the proper gage range, wrong condition, or inadequately identified to confidently be used.

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The desired property values (i.e., all properties except F_{tu} , F_{ty} and e) for all alloys are limited because only five ratios were used to obtain each value, while a minimum of ten ratios is required by the MIL-HDBK-5 Guidelines.

The F_{tu} , F_{ty} and e values for the Ti-13V-11Cr-3Al sheet alloy are valid "A" and "B" values to the extent that sufficient number of test data were available to establish valid statictical values; however, all test data reflect one producer only. Additionally, much of the applicable data was obtained in summary form which did not show the distribution. Therefore, a test for normality could not be made.

Table VI-1 to VI-4 indicate the populations and other pertinent information used in calculation of the allowables.

6.3 DATA PRESENTATION

6.3.1 Effect of Temperature Curves

These curves are presented as Per Cent Strength at Room Temperature vs Test Temperature. The procedure used to obtain these curves is as follows:

- a. Plot the individual values for the property at each temperature.
- b. Indicate the average value at each temperature.
- c. Draw the curve passing through the average at room temperature and either the average or 5 percent above minimum value, whichever is lowest, at each elevated temperature.
- d. Obtain the curve value at each temperature as a percentage of the curve value at room temperature.
- e. Plot the per cent values and fit the curve.

To obtain in a smooth curve in step (e), engineering judgement was used and the curves do not necessarily pass through the stated values at each temperature.

6.3.2 Effect of Exposure Curves

These curves are presented in "Per Cent Strength at Room Temperature vs Exposure Temperature"; they show the effect on the properties of specimens tested at room temperature after exposure to elevated temperature. These curves are drawn using the same technique described above.

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The working curves (steps (a), (b), and (c)) can be found in the Appendix. Where aging has occurred and strength has increased with either temperature or exposure time, as in the case of Ti-13V-11Cr-3Al, a dashed line indicates this phenomena. In accordance with the MIL-HDBK-5 Guidelines, the working curve is drawn so that strength is not shown to increase with either temperature or exposure time.

6.3.3 Stress-Strain Curves

The method used to obtain these curves is as follows:

- a. For each alloy and at each temperature, select several well defined typical curves.
- b. Measure the plastic strains at different percentages of the yield strength and compute the average plastic strain at each percentage.
- c. Select the modulus values to be used: at room temperature use the value obtained by precision modulus measurements made in this program; at elevated temperatures obtain a value from data contained in MIL-HDBK-5, where available, or from data generated in this program.
- d. Use the average value for the yield strength at room temperature; find the elevated temperature average yield strengths using the appropriate "Effect of Temperature" curve and the room temperature value.
- e. Draw the straight line portion of the curve using the selected modulus; add the plastic strain and the elastic strain at the percentages of the yield strength chosen in step (b) to obtain the remainder of the curve.

5.3.4 Constant Life Diagrams

The fatigue constant life diagrams presented in Section VII for the test materials were constructed from the S-N curves contained within the Appendix. Engineering judgement was exercised in the construction of constant life diagram to smooth out some of the humps.

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6.3.5 Fracture Toughness Tests

The fracture toughness test results are presented in Section VII in tabular form. As there is no standardized treatment of these test data listed within the "Guidelines" for inclusion into MIL-HDBK-5, pertinent detail test data is included along with the computed fracture toughness values. No attempt was made to summarize either the fatigue or fracture toughness test data.

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6.3.6 Summary of Room Temperature Test Results

A summary of room temperature test results for the various materials tested are presented in Table VI-5 to VI-9. The summary presents averaged test values for the various mechanical property tests performed with the exception of the fatigue tests and plane strain fracture toughness tests.

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6.4 POPULATIONS USED TO OBTAIN ALLOWABLES

Table VI - 1

Material Form	UCHUI UIUN	Values *	**				
and Property	Direction	Obtained	Method	Pairs	Heats	Vendors	Specimens
Sheet							
Ftu	L LT	3 5	Direct Direct		9 8	3 3	19 17
Fty	L LT	S S	Direct Direct		9 8	3 3	19 17
Fcy	L LT	S S	Derived Derived	6 6	6 6	2 2	6 6
Fsu	L LT	S	Derived	6	6 2	2 2	6 2
F _{Bru} (e/D=1.5)	L LT	S	Derived	6	6 2	2 2	6 2
(e/D=2.0)	L LT	S	Derived	6	6 2	2 2	6 2
F _{bry} (e/D=1.5)	L LT	S	Derived	6	6 2	22	62
е		S	Direct		9	3	36

Ti 4A1-3Mo-1V Condition A

* See 6.2 for discussion of the validity of these values.

** Direct "S" values were taken from MIL-T-9046.

Contrails

6.4 (continued)

Table VI - 2

Ti 13V-11Cr-3Al Condition A

Material Form		Values *		1	<u> </u>	T	<u> </u>
and Property	Direction	Obtained	Method	Pairs	Heats	Vendors	Specimens
Sheet Ftu	L LT	A & B A & B	Direct Direct		Unknown Unknown	1 1	4385 2929
Fty	L LT	A & B A & B	Direct Direct		Unknown Unknown	1 1	4385 2929
Fcy	L LT	A & B A & B	Derived Derived	4 5	4 5	1 1	4 5
Fsu	L LT	A & B	Derived	5	5 1	1 1	5 1
F _{bru} (e/D=1.5)	L LT	A & B	Derived	5	5 1	1 1	5 1
(e/D-2.0)	L LT	A & B	Derived	5	5 1	1 1	5 1
F _{bry} (e/D=1.5)	L LT	A & B	Derived	5	5 1	1 1	5 1
(e/D=2.0)	L LT	A & B	Derived	5	5 1	1 1	5 1
е	L LT	A A	Direct Direct		Unknown Unknown	1 1	2828 2962

* See 6.2 for discussion of the validity of these values.

Contrails

6.4 (cont'd)

Table VI - 3

Ti 6Al-4V Condition STA

Material Form		Values	**	1	1	
and Property	Direction	Obtained	Method	Heats	Vendors	Specimens
Plate .250 to .300 Ftu	L	ន	Direct	15	2	33 29
	LT -		Direct	13	2	
^F t y	L LT	S S	Direct Direct	15 13	2 2	33 29
Fcy	L LT			3 3	2 2	3 3
F _{su}	L LT			32	22	3 3
F _{bru} (e/D=1.5)	L LT			3 2	2 2	3 2
(e/D=2.0)	L LT		-	3 2	2 2	3 2
F _{bry} (e/D=1.5)	L LT			3 2	2 2	3 2
(e/D=2.0)	L LT			3 2	2 2	3 2
е		S	Direct	15	2	62
Plate .500 to .630						
Ftu	L LT	S S	Direct Direct	20 11	2	35 21
Fty	L LT	S S	Direct Direct	20 11	2	35 21
Fcy	L LT			3 3	2 2	3 3
Fsu	L LT			3	2 1	3 1
Fbru (e/D=1.5)	L LT			3 1	2 1	3 1

****** Direct "S" values were taken from MIL-T-9046.

Contrails

6.4 (cont'd)

Table VI-3 (Cont'd)

Ti 6A1-4V Condition STA

Material Form		Values	**			
and Property	Direction	Obtained	Method	Heats	Vendors	Specimens
(e/D=2.0)	L LT			3 1	2 1	3 1
F _{bry} (e/D=1.5)	L LT			3 1	2 1	3 1
(e/D=2.0)	L LT			3 1	2 1	3 1
e		S	Direct	20	2	56
Plate .750 to 1.000	-					
F _{tu}	L LT	S S	Direct Direct	5 5	2 2	27 27
Fty	L LT	5 5	Direct Direct	5 5	5 5	27 27
Fcy	L LT			2	2 2	2
F _{su}	L LT			2 1	2 1	2 1
F _{bru} (e/D=1.5)	L LT			2 1	2 1	2 1
(e/D=2.0)	L LT			2 1	2 1	2 1
F _{bry} (e/D=1.5)	L LT			2 1	2 1	2 1
(e/D=2.0)	L LT			2 1	2 1	2 1
e		S	Direct	5	2	54
Plate 1.200 to 1.500						
^F tu	L LT	S S	Direct Direct	9 9	2 2	16 16
F _{ty}	L LT	S S	Direct Direct	9 9	2 2	16 16
e		S	Direct	9	2	32

* Direct "S" values were taken from -f122 Fublic Release MIL-T-9046.

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Table VI - 4

Ti 6A1-6V-2Sn Condition A

Material Form	1	Values *	**	· · ·	T	l	1
and Property	Direction	Obtained	Method	Pairs	Heats	Vendors	Specimens
Plate .250 to .300							
F _{tu}	L LT	S S	Direct Direct		7 7	1 1	15 15
F _{ty}	L LT	S S	Direct Direct		7 7	1 1	15 14
Fcy	L LT	S S	Derived Derived	5 5	5 5	1 1	5 5
Fsu	L LT	S	Derived	5	5 1	1 1	5 1
Fbru (e/D=1.5)	L LT	S	Derived	5	5 1	1 1	5 1
(e/D=2.0)	L LT	S	Derived	5	5 1	1 1	5 1
F _{bry} (e/D=1.5)	L LT	S	Derived	5	5 1	1 1	5 1
(e/D=2.0)	L LT	S	Derived	5	5 1	1 1	5 · 1
e		s	Direct		7	l	30
Plate •500 to .630							
Ftu	L LT	S S	Direct Direct		6 6	1 1	12 12
Fty	L LT	S S	Direct Direct		6 6	1 1	12 12
F _{Cy}	L LT	S S	Derived Derived	5 5	5 5	1 1	5 5
F _{su}	L LT	S	Derived	5	5 1	1 1	5 1

* See 6.2 for discussion of the validity of these values

****** Direct "S" values were taken from MIL-T-9046.

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6.4 (cont'd)

Table VI - 4 (cont'd)

Ti 6A1-6V-2Sn Condition A

Material Form		Values *	**	1			<u> </u>
and Property	Direction	Obtained	Method	Pairs	Heats	Vendors	Specimens
Plate .500 to .630							
F _{bru} (e/D=1.5)	L LT	S	Derived	5	5 1	1 1	5 1
(e/D=2.0)	L LT	S	Derived	5	5 1	1 1	5 1
F _{bry} (e/D=1.5)	L LT	S	Derived	5	5 1	1 1	5 1
(e/D=2.0)	L LT	S	Derived	5	5 1	l l	5 1
е		S	Direct		6	l	24
Plate <u>≥1.50</u> F _{tu}	L LT	S 3	Direct Direct		5 5	1 1	10 10
F_{ty}	L LT	S S	Direct Direct		5 5	1 1	10 10
Fcy	L LT	S	Derived Derived	5 5	5 5	1 1	5 5
Fsu	L LT	S	Derived	5	5 1	1 1	5 1
F _{bru} (e/D=1.5)	L LT	S	Derived	5	5 1	l l	5 1
(e/D=2.0)	L LT	S	Derived	4	4 1	1 1	4 1
F _{bry} (e/D=1.5)	L LT	S	Derived	5	5 1	1 1	5 1
(e/D=2.0)	L LT	S	Derived	5	5 1	1 1	5 1
e		S	Direct		· 5	1	20

** Direct "S" values were taken from MIL-T-9046

* See 6.2 for discussion of the validity of these values

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Table VI - 5

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Ti-6A1-6V-2Sn Condition STA

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Material Form		Values *	**				<u> </u>
and Property	Direction	Obtained	Method	Pairs	Heats	Vendors	Specimens
Plate						× .	
.500 to .630							
F	Ŧ		D		_	_	
^F tu	L LT	S S	Direct Direct		5 5	1 1	5 5
Fty Fty							
Fty	L LT	SS	Direct		5 5	1 1	5 5
	Tet	5	Direct		2	T	7
Fcy	L	S S	Derived	5 5	5 5	1 1	5
•	LT	S	Derived	5	5	l	5 5
Fsu	L	S	Derived	5	5 1	1	5 1
	LT				1	l	1
F _{bru} (e/D=1.5)	L	S	Derived	5	5	ı	5
	LT				5 1	1 1	5 1
(e/D=2.0)	L	S	Derived	5	5	l	5
(0)2 -00)	ĹT	-	Derived		5 1	ì	5 1
	L	S	Derived	5	E E		E
F _{bry} (e/D=1.5) (e/D=2.0)	LT	5	Dellaed	,	5 1	1	5 1
	-	2		_	_	-	_
(e/D=2.0)	L LT	S	Derived	5	5 1	1	5 1
e		S	Direct		5	1	10
≥1.50							
$\frac{\geq 1.50}{F_{tu}}$	L	S S	Direct	1	5 5	1 1	5 5
	LT	S	Direct		5	1	5
F _{ty}	L	S S	Direct		5 5	1 1	5 5
v	LT	S	Direct		5	l	5
Fcy	L	S	Derived	5	5	1	5
- .	LT	S	Derived	5 5	5 5	1	5 5
^F su	L	S	Derived	5	5	1	5
su	LT		Derred	,	5 1	ì	5 1
	1						

* See 6.2 for discussion of the validity of these values.

** Direct "S" values were taken from MIL-T-9046.

Contrails

Table VI - 5 (continued)

Material Form and Property	Direction	Values * Obtained	** Method	Pairs	Heats	Vendors	Specimens
F _{bru} (e/D=1.5)	L LT	S	Derived	5	5 1	1 1	5 1
(e/D=2.0)	L LT	S	Derived	5	5 1	1 1	5 1
F _{bry} (e/D=1.5)	L LT	S	Derived	5	5 1	1 1	5 1
(e/D=2.0)	L LT	S	Derived	5	5 1	1 1	5 1
e		S	Direct		5	1	10

Ti 6A1-6V-2Sn Condition STA

* See 6.2 for discussion of the validity of these values.

** Direct "S" values were taken from MIL-T-9046.

Table VI-6

Contrails

SUMMARY OF ROOM TEMPERATURE TEST RESULTS

Ti 4A1-3Mo-1V Annealed Condition

Property	Thickness	Direction	No. of Tests	Property Value *
Tensile Ultimate Strength (KSI)	<u> </u>	L LT	6	131.1 136.7
Tensile Yield Strength (KSI)	< <u><</u> .110	L LT	6 6	124.2 132.8
Compressive Yield Strength (KSI)	≤.110	L LT	6 6	127.6 136.3
Bearing Ul t imate Strength (KSI) e/D = 1.5	<u></u> .110	L LT	6 2	210.8 219.7
Bearing Ultimate Strength (KSI) e/D = 2.0	<u> </u>	L LT	6 2	277.3 283.9
Bearing Yield Strength (KSI) e/D = 1.5		L LT	6 2	171.4 177.9
Bearing Yield Strength (KSI) e/D = 2.0	110	L LT	6 2	202.9 218.6
Shear Ultimate Strength (KSI)	<u><</u> .110	L LT	6 2	82.8 84.2

Table VI-7

SUMMARY OF ROOM TEMPERATURE TEST RESULTS

Contrails

Ti 13V-11Cr-3Al Annealed Condition

roperty	Thickness	Direction	No. of Tests	Property Value *
Tensile Ultimate Strength	₹.110	L	5	135.3
(KSI)		LT	5	137.8
Tensile Yield Strength	≤.110	L	5	134.6
(KSI)		LT	5	136.9
Compressive Yield Strength	≤.110	L	4	132.3
(KSI)		LT	5	137.2
Bearing Ultimate Strength (KSI) ≤.110 e/D = 1.5	\$. 110	L	5	221.5
		LT	1	224.0
Bearing Ultimate Strength (KSI)	<u>\$</u> .110	L	5	303.4
e/D = 2.0		LT	1	311.0
Bearing Yield Strength (KSI)	≤. 110	L	5	173.0
e/D = 1.5		LT	1	176.9
Bearing Yield Strength (KSI)	≤.110	L	5	192.0
e/D = 2.0		LT	1	205.0
Shear Ultimate Strength (KSI)	≤ .110	L LT	5	96.8 98.2

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Table VI-8

SUMMARY OF ROOM TEMPERATURE TEST RESULTS

Ti 6A1-4V STA Condition

Property	Thickness	Direction	No. of Tests	Property Value *
	.250 to .300	L	3	161.4
Tensile Ultimate		LT	3	167.1
Strength	.500 to .630	L	3	175.9
(KSI)		LT	3	178.2
	· · · · · · · · ·	L	2	152.9
	≥ 1.00	LT	2	159.0
		ST	2	152.9
	.250 to .300	L	3	149.7
Tensile Yield		LT	3	155.5
Strength	.500 to .630	L	3	161.7
(KSI)		LT	3	164.5
		L	2	146.2
	≥ 1.00	LT	2	151.4
		ST	2	145.0
	.250 to .300	L	3	157.1
0	<u>,</u>	LT	3	176.5
Compressive Yield	.500 to .630	L	3	171.6
Strength		LT	3	166.9
(KSI)		L	2	156.8
	<u>≥</u> 1.00	– LT	2	158.7
		ST	2	153.2
	.250 to .300	L	3	262.9
	,_, c , c , j , c ,	LT	2	268.8
Bearing Ultimate	.500 to .630	<u> </u>	3	274.1
Strength	•)•• •• ••)•	LT	1	274.1
(KSI)		L L	2	250.9
e/D = 1.5	<u>></u> 1.00	LT	1	267.3
4	<u> </u>	LE	1	233.8
1		TE	1	224.0
	.250 to .300	<u>_</u>	3	317.9
	•2,0 00 .900	LT	2	330.8
Bearing Ultimate	.500 to .630	L	3	339.2
Strength	•)00 00 •000	LT	1	331.2
(KSI)		L	2	315.7
e/D = 2.0	<u>></u> 1.00	LT	1	334.3
	2 2100	LE	1	310.8
		TE	l	299.4
	.250 to .300	L	3	222.8
1	12/0 00 1000	LT	2	232.9
Bearing Yield	.500 to .630	L L	3	240.2
Strength (KSI) e/D = 1.5	.,00 00 .030	LT	1	240.2
		LI L	2	215.9
	N 1 00			
	≥ 1.00		1	217.8
		LE	1	214.0
	more than 1 test.	TE	1	207.7

Contrails

Table VI -8 (cont'd)

SUMMARY OF ROOM TEMPERATURE TEST RESULTS

Ti 6A1-4V STA Condition

	and the second secon	وسيرا فواجوا بالبالا فكالمثلا مناوحة مقاومة فتنصحه ومحمد		
Property	Thickness	Direction	No. of Tests	Property Value *
Poortna Viold	.250 to .300	L LT	3	256.0
Bearing Yield Strength (KSI) e/D = 2.0	.500 to .630	Lar L	3	279•3 283•8
		LT	1	271.7
		L	2	251.1
		\mathbf{LT}	1	264.2
	≥1.00	LE	1	265.8
		TE	1	257.3
	.250 to .300	L	3	98.7
		LT	2	105.4
Shear Ultimate Strength (KSI)	.500 to .630	L	3	103.6
	_	LT	1	98.3
	≥ 1.00	L	2	95.2
		LT	1	102.0

Contrails

Table VI · 9

SUMMARY OF ROOM TEMPERATURE TEST RESULTS

Ti 6Al-6V-2Sn Annealed Condition

Property	Thickness	Direction	No. of Tests	Property Value *
	.250 to .300	L	5	161.2
		LT	-5	171.2
Tensile Ultimate	.500 to .630	L	5	160.9
Strength		LT	5 5 5 5 5	163.5
(KSI)		L	5	154.6
1	1.00	LT	5	154.1
		ST	5	154.8
	.250 to .300	L		158.8
		LT	5	166.6
Tensile Yield	.500 to .630	L		158.3
Strength		LT	5	160.2
(KSI)		L	5	148.5
	1.00	LT	5	149.1
		ST	5	143.1
	.250 to .300	L	5	162.6
~ · · · · · · · · · · · · · · · · · · ·			5	184.3
Compressive Yield	.500 to .630	L	5	170.6
Strength		LT	5 5 5	173.2
(KSI)		L	5	161.4
	1.00	LT		157.5
		ST	5	153.6
	.250 to .300	L	5	261.8
		LT	1	274.6
Bearing Ultimate	.500 to .630	L	5	275.5
Strength		ĹT	1	264.4
(KSI)		L	5	264.1
e/D = 1.5	1.00	LT	1	256.4
4		LE	1	244.9
		TE	11	212.9
	.250 to .300	L	5	330.8
		LT	1	354.3
Г	.500 to .630	L	5	344.7
		LT	1	392.9
Bearing Ultimate		L	4	337.6
Strength	1.00	LT	1	327.4
(KSI)		LE	1	317.4
e/D = 2.0		TE	1	294.5

* Average value for more than 1 test.

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Contrails

Table VI-9(cont'd)

SUMMARY OF ROOM TEMPERATURE TEST RESULTS

Ti 6A1-6V-2Sn Annealed Condition

Property	Thickness	Direction	No. of Tests	Property Value *
	.250 to .300	L	5	224.5
			1	212.2
Bearing Yield	.500 to .630	L	5	230.2
Strength		LT	1	222.5
(KSI)		L	5	218,4
e/D = 1.5	1.00	LT	1	217.3
		LE	1 1	215.6
		TE	1	200.6
	.250 to .300	L	1 5	252.8
		LT	1	286.1
Bearing Yield	.500 to .630	L	5	271.6
Strength		LT	1	307.1
(KSI)		L	5	264.0
e/D = 2.0	1.00	LT	1	253.4
1		LE	1 1	267.7
		TE	1	256.4
	.250 to .300	L	5	99.6
Shear Ultimate		LT	1	108.7
Strength	.500 to .630	L	5	106.0
(KSI)		LT	1	108.2
[1.00	L I	5	102.0
		LT	1 1	105.3

* Average value for more than 1 test.

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Table VI - 10

SUMMARY OF ROOM TEMPERATURE TEST RESULTS

Ti 6A1-6V-2Sn STA Condition

Property	Thickness	Direction	No. of Tests	Property Value *
	.250 to .300	L LT	1 1	184.6 191.2
Tensile Ultimate Strength	.500 to .630	L LT	5 5	183.1 183.5
(KSI)	≥ 1.00	L LT ST	5 5 5	187.4 188.3 182.3
	.250 to .300	L LT	1 1	176.5 186.0
Tensile Yield	.500 to .630	L LT	5 5	177.1 176.5
Strength (KSI)	<u>≥</u> 1.00	L LT ST	5 5 5	176.2 179.0 167.6
	.250 to .300	L LT	1 1	184.1 206.0
Compressive Yield Strength	.500 to .630	L LT	5 5	188.8 188.3
(KSI)	<u>></u> 1.00	L LT ST	5 5 5	195.4 191.4 194.4
	.250 to .300	L	1	298.6
Bearing Ultimate	.500 to .630	L LT	5 1	291.5 287.4
Strength (KSI) e/D = 1.5	<u>></u> 1.00	L LT LE TE	5 1 1 1	295.4 289.0 261.1 251.7
	.250 to .300	L	1	360.4
Bearing Ultimate Strength	.500 to .630	L LT	5 1	365.2 350.2
(KSI) e/D = 2.0	1.00 <u>ح</u>	L LT LE TE	5 1 1 1	360.6 343.7 350.3 342.5

* Average value for more than 1 test.

Contrails

Table VI- 10 (cont'd)

SUMMARY OF ROOM TEMPERATURE TEST RESULTS

Ti 6A1-6V-2Sn STA Condition

Property	Thickness	Direction	No. of Tests	Property Value *
	.250 to .300	L	· 1	277.7
Bearing Yield	.500 to .630	L LT	5 1	263.5 265.1
Strength (KSI) e/D = 1.5	≥ 1.00	L LT LE TE	5 1 1 1	270.9 266.5 240.0 242.5
Bearing Yield	.250 to .300 .500 to .630	L L LT	1 5 1	296.7 298.3 298.1
Strength (KSI) e/D = 2.0	<u>></u> 1.00	L LT LE TE	5 1 1 1	304.9 283.3 289.4 312.0
	.250 to .300	L	1	107.0
Shear Ultimate Strength	.500 to .630	L LT	5 1	111.8 118.0
(KSI)	<u>></u> 1.00	L LT	5 1	114.6 111.0

* Average value for more than 1 test.

Contrails

Section VII

TEST RESULTS

Contained within this section are the results of the various mechanical property tests performed in this investigation.

	Page
Ti-4Al-3Mo-1V Cond. A	135 - 149
Ti-13V-11Cr-3Al Cond. A	150 - 1 58
Ti-6Al-4V Cond. STA	159 - 180
Ti-6Al-6V-2Sn Cond. A	181 - 205
Ti-6Al-6V-2Sn Cond. STA	206 - 226

Contrails

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7.1 Ti 4Al-3Mo-1V Cond A

ſ				-			_	6	5	Pe	e/	2	R.	Û	đ		-				-							
	§ Reduction Area	11	1	I	1	ı	I	1	I	3	1	ł	ŀ	1	I	1	i	1	I	ŀ	I	1	1	1	I	i	ł	I
	≶ Elongetion	12.0	7.5	7.5	0.11	10.0	7.0	7.0	12.5	12.5	8.0	7.5	11.5	12.0	12.5	8.5	9.5	12.0	12.0	125.	9.5	8.5	13.5	12.0	13.0	0.0	0.0	12.0
	F _{tu} (Ksi)	133.6 103 A	6.96	86.5	134.7	107.6	97.6	90.6	133.2	106.4	96.4	87.1	135.4	130.0	102.2	92.2	85.6	136.5	128.1	102.3	96.4	88.4	132.3	130.4	100.7	90.8	85.2	142.2
CONDITION	Fty (Esl)	126.2 80 //	81.9	71.2	125.2	1.46	81.8	78.7	128.7	100.4	85.7	75.0	132.8	123.4	93.8	81.6	74.1	135.9	120.9	88.5	79.2	71.2	127.2	121.2	9.06	79.4	73.5	139.4
4A1-3Mo-1V ANNEALED CONDITION	Test Temperature (of)	RT	600	80.0	RT	400	600	800	RT	100	600	800	RT	RT	400	600	800	RT	RT	100	600	800	RT	RT	400	600	800	RT
Ti 4A1-3Mo-	Test Direction			 I	ç.	E-I	E	Ę⊣	Ч	Ļ	Ĺ	Ļ	E	ц	ц	IJ	7	Ľ	ĿЛ	Ţ	⊢-1	ц	E⊣	Г	Ц	Γ	IJ	Ē
	Specimen Number	TMLXLTR1	T# ITYTMI	TML XL/T81	TATTTAL	T41TTIMT	TML XTT61	TMT TATA	TM2X1TR1	TMZSLT41	TM2XLT61	TM2XLT81	TM2XTTR1	TM3XLTR1	TM3XLT41	TM3XLT61	TM3XLT81	TM3XLTR1	TM4 XLTR1	TM4XLT41	TM4XLT61	TM4XLT81	TM4 XTTR1	TM5 XLTR1	TM5XLT41	TM5XLT61	TM5XLT81	TM5XTTR1
Tensile Tests	Manufacturer and Heat No.	Timet G 1596 1	4					Timet G 1596	Timet G 895				Timet G 895	Timet G 2446			-	Timet G 2446	Timet G 1523	-4		-	Timet G 1523	Timet G 1401				Timet G 1401
7.1.1 Ten	Thickness (Inches)	011. >	.										13	7 -														≤ .110

	Contralls
5 Reduction Area	, , , , , , ,
\$ Elongration	12.0 15.0 12.0 12.0 12.0 12.0
F _{tu} (Kei)	131.5 99.4 138.8 138.8 95.4 4.7 4.7
Fty (Kal)	124.8 88.7 78.4 136.0 136.0 177.9 77.9
Test Tempersture (oF)	RT 600 600 800 600 800 00 1 7 7 1 7 0 0 0 1 7 1 7 1 7 1 7 1
Test Direction	그그그는 "
Specimen Number	RM6XLTR1 RM6XLT61 RM6XLT81 RM6XTT81 RM6XTT61 RM6XTT81 RM6XTT81
Manufacturer and Heat No.	RMI 321055
Thickness (Inches)	

Totation Totation Totation Table 10 RT 122.6 (1) 10 RT 122.6 (1) 10 RT 122.6 (1) 10 RT 122.6 (1) 10 RT 121.0 (1) 10 RT 121.0 (1) 10 RT 121.0 (1) 10 RT 122.6 (1) 10 RT 121.0 (1) 10 RT 122.6 (1) 10 RT 122.6 (1) 10 RT 122.6 (1) 100 RT 122.6 (1) 100 RT 123.5 (1) 100 800 73.2 (7) 100 800 73.2 (7) 100 800 73.2 (7) 100 800 73.2 (7) 100 800 7					Exposure	2					
Timet G 1596 PULLIANI, I. L L00 100 RT 122.6 133.7 13.0 PULLIANI, I. L L00 100 RT 122.6 133.5 122.0 PULLIANI, I. L 600 100 RT 122.0 133.5 123.0 PULLIANI, I. L 600 100 RT 122.0 133.5 123.0 PULLIANI, PULLIANI L 600 100 RT 122.1 133.0 133.0 PULLIANI L 600 100 RT 122.5 131.1 133.0 PULLIANI L 600 100 RT 122.5 133.0 12.0 PULLIANI L 800 1000 RT 122.5 131.1 13.0 PULLIANI L 800 1000 RT 122.5 131.0 122.0 PULLIANI L 1000 RT 120.4 131.1 12.0 PULLIANI L 1000 1000 RT 123.5 114. PULLIANI L L 000 1000 80.5 104.2 12.6 PULLIANI L L 000 1000 80.5 14	Thickness (Inches)	Manufacturer and Heat No.	Specimen Number	Test Direction	Temperature (of)	Time (Hrs.)	Test Tempersture (°P)	^F ty (Kai)	Ftu (Kei)	Percent Elongation	<pre>% Medwotion</pre>
Time Contractive L Uo0 100 RT 122.5 122.5 122.0 133.5 123.5 123.5 123.5 123.5 123.5 123.5 123.5 123.5 123.5 123.5 123.5 123.6 123.5 123.6 123.5 123.6 123.5 123.6 123.5 123.6 123.5 123.6 <th123.6< th=""> <th123.6< th=""> 123.6<!--</th--><th>011.2</th><th>0</th><th></th><th>ц</th><th>1400</th><th>10</th><th>Ш</th><th>122.6</th><th>133.7</th><th>13.0</th><th>. ,</th></th123.6<></th123.6<>	011.2	0		ц	1400	10	Ш	122.6	133.7	13.0	. ,
$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$		-	-	г	100	100	R	122.8	132.5	12.0	I
************************************			TMLXLTW43	Ч	100	1000	RT	121.8	130.0	13.5	ı
Timet 0 1596 Timet 0 1596 L 600 100 RT 122.6 131.1 122.6 131.1 Timet 0 1596 Timet 0 1596 Timet 0 120 RT 122.6 131.1 122.0 122.0 Timet 0 1596 Timet 0 1596 Timet 1 120.2 131.1 122.0 131.1 122.0 Timet 0 1596 Timet 0 1596 Timet 1 120.2 131.1 122.5 131.2 132.0 Timet 0 1596 Timet 0 1596 Timet 1 1 100 100 RT 122.5 131.8 12.5 Timet 0 1596 Timet 0 1596 Timet 0 1996 100 100 RT 123.5 131.8 12.5 Timet 0 1596 Timet 0 1996 100 100 RT 123.5 141.2 13.0 RULXING3 L 600 100 800 73.2 94.9 8 13.6 RULXING3 L 800 100 800 73.2 89.1 8 13.6 RULXING3 L 800 100 800 73.2 89.1 8 13.6 RULXING3 L 800 100 800 73.2 89.1 8 15.5 RULXING3 L 800<			TMLXLTW61	Г	600	10	RT	121.0	131.7	13.0	1
Timet d 1996 Timet d 1996 Timet d 1996 1000 RT 122.6 134.4 13.0 12.0 Timet d 1996 TAXTW63 L 800 1000 RT 122.5 131.5 12.0 12.0 Timet d 1996 TAXTW63 L 800 1000 RT 122.5 131.6 12.5 12.6 Timet d 1996 TAXTW63 L 400 100 100 RT 122.5 131.8 12.5 12.6 Timet g 1996 TAXTR42 L 400 100 100 89.5 104.2 12* <td< th=""><th></th><th></th><td>TMLXLTW62</td><td>Г</td><td>600</td><td>100</td><td>RT</td><td>121.0</td><td>132.5</td><td>12.0</td><td>ŀ</td></td<>			TMLXLTW62	Г	600	100	RT	121.0	132.5	12.0	ŀ
Timet 6 1596 Timet 6 1996 10 RT 120.4 131.1 12.0 Timet 6 1996 Timet 6 1996 Timet 1 1 000 100 RT 123.5 131.8 12.5 Timet 6 1996 TAXTRV1 L 000 1000 RT 123.5 131.8 12.5 Timet 6 1996 TAXTRV1 L 400 100 400 90.5 104.2 12.5 Timet 1 1996 TAXTRV2 L 400 100 400 90.5 104.2 12.5 Timet 1 1996 TAXTRV2 L 600 1000 600 75.7 92.9 13 MAXURV6 L 800 1000 800 72.7 89.1 8 1 MAXURV6 L 800 1000 800	Ap		TIMIXITW63	ц	600	1000	RT	122.6	134.4	13.0	,
Timet 0 1596 [multirred: Timet 0 1596 [multirred: Tubutrred: Tubutrred: Timet 0 1596 [multirred: Tubutrred:	pr		TMLXLTW81	ц	800	10	RT	120.4	131.1	12.0	I
Tilmet G 1596 PnLXLTM03 L 800 1000 RT 123.5 131.8 12.5 - Tilmet G 1596 PnLXLTM12 L 400 100 400 89.5 104.2 12* - Tilmet G 1596 PnLXLTM12 L 400 100 400 89.5 104.2 12* - PnLXLTM12 L 400 100 400 89.5 104.2 12* - PnLXLTM21 L 400 100 600 79.3 94.9 14 - PnLXLTM62 L 600 100 600 75.7 95.9 15 8 - PnLXLTM63 L 600 100 600 75.7 95.9 15 8 - PnLXLTM68 L 800 1000 800 72.7 89.1 8 - PnLXLTM68 L 800 1000 800 73.2 89.1 8 - PnLxLTM68 L 800 1000 800 73.2 89.1 8 - <td< th=""><th>rov</th><th>-</th><td></td><td>гı</td><td>800</td><td>100</td><td>RT</td><td>120.2</td><td>131.5</td><td>13.0</td><td>•</td></td<>	rov	-		гı	800	100	RT	120.2	131.5	13.0	•
Tilmet G 1596 MMXLTX41 L 400 10 400 89.5 104.2 12* Tubut XIX L 400 100 400 89.5 104.2 12* Thimet G 1596 MMXLTX61 L 400 100 400 89.5 104.2 12* TMAXLTX61 L 600 100 600 75.2 95.1 13* TMAXLTX63 L 600 100 600 75.7 95.1 8 14* ThinkLTTX63 L 600 100 600 75.7 92.9 15 8 15* ThinkLTTX63 L 800 1000 600 75.7 92.9 15 15 ThinkLTTX63 L 800 1000 800 71.8 8 15 Thimet G 1596 MALLTX83 L 800 1000 800 73.2 89.1 8 15 Tillo Timet G 1596 MALLTX83 L 800 73.2 89.1 8 15 Timet G 1596 MALLTX83 L 800<	red	Ċ		Ч	800	1000	RT	123.5	131.8	12.5	
Broke through gues 1 400 100 400 90.6 105.1 13 *MUXITYC: 1 400 100 400 90.6 104.2 14 *MUXITYC: 1 400 100 400 90.6 101.2 14.9 *MUXITYC: 1 400 100 100 600 73.2 94.9 8 *MUXITYC: 1 1 600 100 600 77.7 92.9 1 8 *MUXITYC: 1 800 10 800 71.8 87.6 8 8 6 8 6 1 8 1 8 1 8 1 8 1 1 8 1 1 8 1 1 8 1 1 8 1	fc	Ċ		1	100	OL	100	89.5	2.401	* 0	10
*Broke through guage mark or within specimen vidth of guage marks. 1 400 1000 400 100 104.2 14 muxinx61 1 600 100 600 79.9 94.9 8 muxinx62 1 600 100 600 79.9 95.1 8 muxinx63 1 600 100 600 77.7 92.9 15 muxinx881 1 800 10 800 72.7 92.9 15 muxinx881 1 800 100 800 72.7 92.9 15 muxinx881 1 800 1000 800 72.7 92.1 8 100 800 72.7 99.1 8 15 15 ************************************	or.	-		1 -	100		100	9.00	1.201	***	
• Imn.xrr.rx61 L 600 10 600 78.2 94.9 8 • Imn.xrr.rx63 L 600 100 600 79.9 95.1 8 15 • Imn.xrr.rx63 L 600 100 600 79.9 92.9 15 • Imn.xrr.rx81 L 800 10 800 75.7 92.9 15 • Imn.xrr.rx83 L 800 100 800 72.7 89.1 8 - • Imn.xrr.rx83 L 800 1000 800 72.7 89.1 8 - - • Imn.tr.rx81 L 800 1000 800 72.7 89.1 8 - - - • Imn.tr.rx81 L 800 1000 800 72.7 89.1 8 - <	- ^P 1		TWT XT TX IMT	1 1	400	1000	100		104.2	14	Í,
Timet G 1596 PMLXLTX62 L 600 100 600 75.7 95.1 8 PMLXLTX63 L 600 100 600 75.7 92.9 15 PMLXLTX63 L 800 10 800 75.7 92.9 15 PMLXLTX63 L 800 100 800 75.7 92.9 15 PMLXLTX83 L 800 100 800 77.8 89.1 8 - Illo 1000 800 73.2 89.1 8 - - - * * 800 1000 800 73.2 89.1 8 - - * * 800 1000 800 73.2 89.1 8* - - * * 800 1000 800 73.2 89.1 8* -	39		T9XT/IX IWL	ب ا	600	10	600	78.2	94.9	80	
Broke through guage marks tor within specimen vidth of guage marks. 1 600 1000 600 75.7 92.9 15 15 15 16 100 800 17.8 87.6 8 1 16 100 100 800 77.7 99.1 8* 1 16 100 800 77.7 89.1 8* 1 16 100 100 800 72.7 89.1 8* 1 16 100 100 100 100 100 100 100 100 100 100 100 100 100 100 100 100 100 11.0 100	11		TMLXLTX62	Ч	600	100	600	6.67	95.1	8	
Timet G 1596 TMLSLTX83 L 800 10 800 71.8 87.6 8* 1 Timet G 1596 TMLSLTX83 L 800 100 800 72.7 89.1 8 1 Timet G 1596 TMLSLTX83 L 800 100 800 72.7 89.1 8 1 ** ** 800 1000 800 72.7 89.1 8 1 ** ** 800 1000 800 73.2 89.1 8 1 1 ** ** 8 1000 800 73.2 89.1 8 1 1 ** ** 8 1000 800 73.2 89.1 8 1 1 ** ** ** 8 8 1	С		TML XLTX63	Ч	600	1000	600	75.7	92.9	15	
110 Timet G 1596 TMIXLTX62 L 800 100 800 72.7 89.1 8 - * * 800 1000 800 73.2 89.1 8 - - * * 800 1000 800 73.2 89.1 8 - - * * 8 1 8 - - 8 - - - - - - 8 -	Re		TML XL TX81	ч	800	10	800	71.8	87.6	*	4
Lilo rimet G 1596 rMLSLTXB3 L 800 1000 800 73.2 89.1 8*	le	•	TIML XL TX 82	Ч	800	100	800	72.7	89.1	80	
*Broke through guage mark or within specimen vidth of	011	Timet G		ц	800	1000	800	73.2	1.68	*	ı
*Broke through guage mark or within specimen vidth of											
*Broke through guage mark or within specimen vidth of										•	
*Broke through guage mark or within specimen vidth of											
*Broke through guage mark or within specimen vidth of											
*Broke through guage mark or within specimen vidth of	•					-					
guage mark or within specimen vidth of	• . •										
guage mark or within specimen width of											
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guage mark or within specimen vidth of											
guage mark or within specimen width of										<u> </u>	
Buase mark or within specimen width of		*Broke through									
			Buage		specimen	of	uage marks.				-

Ti 4A1-3Mo-IV ANNEALED CONDITION

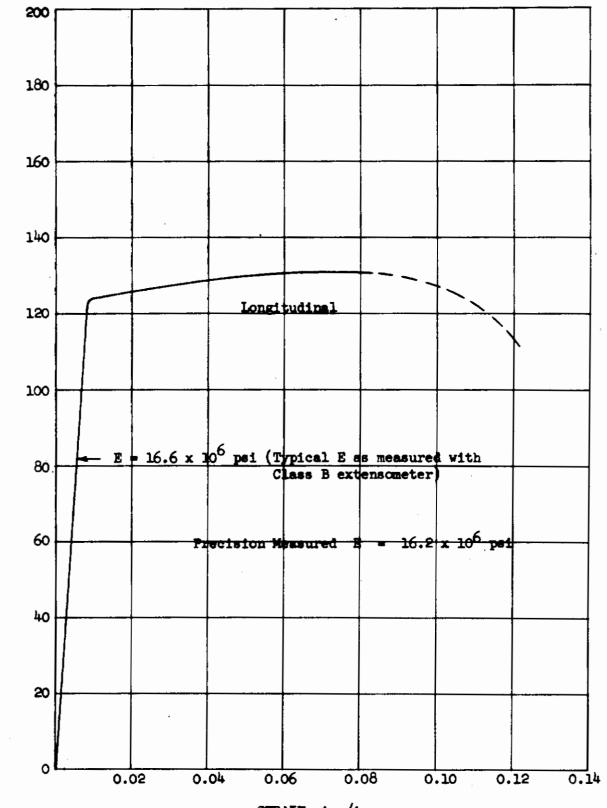
7.1.1 Tensile Stability Tests

4
COND.
3Mo-IV
-441-3
4 2

	Test Temperature	12 I
ulus (Tuckerman)	Test Direction	н
ton Klastic Mod	Specimen Number	THU XUILL
<u> Tuckernen</u> (Tuckernen)	Manufacturer and Heat No.	Timet G 1596
7.1.1.2 Te	Thickness (inches)	• • •

Precision "E"6 x 10

16.2



STRESS (KSI)

STRAIN, in./in.

Figure 7-1 Typical Tensile Stress-Strain Curve (full-range) for Annealed Ti-4A1-3Mo-1V Alloy Sheet at Room Temperature

	Thickness (Inches)	Manufacturer and Heat No.	Specimen Number	Test Direction	Test Tempersture (or)	Foy (Kei)
Think G 150 Think G 2446 Think G 1523 Thin	≤.110	Timet G 1596	TM1 XL/CR1	Г	RT	125.9
Timet G 1596 Timet G 200 Timet G 1523 TWXXCR1 Timet G 1523 TWXXCR1 Timet G 1523 TWXXCR1 Timet G 1523 TWXXCR1 Timet G 1523 TWXXCR1 Timet G 100 Timet G 100 TWXTCR1 Timet G 100 TWXTCR1 TIME T			TMLXLC41	ц	100	91.5
Timet G 1596 TMXIGh L 900 Timet G 1596 TMXIGh 7 800 Timet G 1596 TMXIGh 7 900 Timet G 895 TMXIGh 7 800 Timet G 895 TMXIGh 7 800 Timet G 895 TMXIGh 7 800 Timet G 2446 TMXIGh 7 800 Timet G 2446 TMXIGh 7 860 Timet G 2446 TMXIGh 7 860 Timet G 1523 TMMXIGh 7 87 Timet G 1401 TMXIGh 7 87 Timet G 1401 TMXIGh 7 87			TMIXIC61	Ļ	600	81.1
Timet G 1596 TMLXLCRI T RUXTCAI Timet G 1596 TMLXTCBI T 600 Timet G 895 TMLXTCBI T 800 Timet G 895 TMLXTCBI L RT Timet G 2446 TMLXTCBI L RT Timet G 2446 TMLXTCBI L RT Timet G 1223 TMLXTCBI I RT Timet G 1523 TMLXTCBI I RT Timet G 1523 TMLXTCBI I RT Timet G 1401 TMLXTCBI I RT			TMLXLC81	Г	800	72.7
The c 1596 Three T 1600 The c 1596 Three T 1506 Three C 1596 Three C 1595 Three C 1595 Three C 1595 Three C 1500 Three C 1500 Three C 1466 Three C 1466 Three C 1466 Three C 1523 Three C 1461 Three C 1523 Three C 1401 Three C 1523 Three C 1401 Three C 1501 Three C 1401 Three C 1			TMIXICRI	E1	RT	122.6
Timet G 1596 TMLXTG61 T 600 Timet G 895 TMEXLGR1 L R R Timet G 895 TMEXLGR1 L R R Timet G 895 TMEXLGR1 L R R Timet G 2446 TM3XLGR1 L R R Timet G 1523 TMMXLGR1 L R R Timet G 1401 TM5XLGR1 T R R Timet G 1401 TM5XTGR1 T R			THOTXTM	E	100	90.6
Timet G 1596 TMLXTGR1 T B00 Timet G 895 TMEXLGR1 L Rf Timet G 2446 TMJXTGR1 L Rf Timet G 2446 TMJXTGR1 L Rf Timet G 1523 TMMLKLR1 L Rf Timet G 1523 TMMXLGR1 L Rf Timet G 1401 TM5XLGR1 L Rf Timet G 1401 TM5XLGR1 T Rf		•	TMIXTC61	E	600	81.2
Timet G 895 TM2XLGR1 L Timet G 895 TM2XLGR1 T Timet G 2446 TM3XLGR1 L Timet G 2446 TM3XLGR1 L Timet G 2446 TM3XTGR1 T Timet G 1523 TM4XLGR1 L Timet G 1523 TM4XLGR1 L Timet G 1401 TM5XLGR1 L Timet G 1401 TM5XLGR1 L Timet G 1401 TM5XLGR1 T Timet G 1401 TM5XTGR1 T		5	TML XTC81	Ľ	800	72.9
Timet G 895 TW2XLCRL T HE Timet G 2446 TM3XTCRL L RR Timet G 2446 TM3XTCRL L RR Timet G 1223 TM4XLCRL L RR Timet G 1523 TM4XLCRL L RR Timet G 1401 TM5XLCRL L RR Timet G 1401 TM5XLCRL L RR		9	TM2XLCR1	ц	RT	131.2
Thimet G 2446 TM3XLCR1 L RT Timet G 2446 TM3XLCR1 T R Timet G 1523 TM4XLCR1 L R Timet G 1523 TM4XLCR1 L R Timet G 1523 TM4XTCR1 L R Timet G 1401 TM5XTCR1 L R Timet G 1401 TM5XTCR1 T R		G	TM2XLCR1	H	LL LL	131.5
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7.1.2 Compression Tests

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7.1.2 Compression Tests (continued)

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Ti 4A1-3Mo-1V ANNEALED CONDITION

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7.1.3 Bearing Tests (continued)

Approved 145 Public Release

Thickness (Inches)	Manufacturar and Heat No.	Specimen Number	Test Direction	Test Temperature (OF)	Per (Kei)
ott. >	Timet G 1596	TACKLERI	ц	£	83.8
		THSIXUAL	н 	00	65.0
	•	196TXUMI	-1	600	8.95
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		T9SLXUME	F	89	6.92
	Timet G 1596	18stxthe	E	88	51.9
	Timet G 895	TMZXLSR1	г	RT	82.2
	Timet G 2446	TM3XLSR1	н	RT	81.0
	Trimot C 1500	LAP TANAT	- -	RT	82.7
	Cacr n namit	THINKING	1		
	Timet G 1401	THEYTKENT	Ч	E.	83.6
	RMI 321065	RMEXISRI	H	RT	83.5
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ک. ک	RMI 321065	RMGXTS81	E-1	00 00	61.6
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Thicknee Memufacturer Specian Tast initial (Inother) RMI 321055 RM6XLVR25 E A.110 RMI 321055 RM6XLVR26 E RM6XLVR29 RM6XLVR29 E E RM6XLVR29 RM6XLVR29 E RM6XLVR29 E RM6XLVR29 E RM6XLVR31 RM6XLVR31 E E RM6XLVR32 RM6XLVR31 E E RM6XLVR31 RM6XLVR31 E E RM6XLVR32 RM6XLVR31 E E RM6XLVR31 RM6XLVR143 E E RM6XLVR14 RM6XLVR14 E E S<.110 RM1 321055 RM6XLVR15						1
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RM6XLVR29 RM6XLVR29 RM6XLVR30 RM6XLVR31 RM6XLVR10 RM6XLVR11 RM6XLVR13 RM6XLVR13 RM6XLVR14 RM6XLVR14 RM6XLVR14 RM6XLVR15 RM7 RM7 RM7 RM7 RM7 RM7 RM7 RM7 RM7 RM7		1.0	-1.0	000 1	.69	20,000
INVEXTURES INVEXTURES		1.0	-1.0	65,000	<u>R</u>	10,000,000
INMEXLVR29 RMEXLVR30 RMEXLVR31 RMEXLVR31 RMEXLVR10 RMEXLVR13 RMEXLVR13 RMEXLVR13 RMEXLVR13 RMEXLVR14 RMEXLVR15 RMEXLVR15 RMEXLVR15 RMEXLVR15 RMEXLVR15 RMEXLVR15 RMEXLVR15	*=	1.0	-1.0	72,800	55.	20,000
RM6XLVR30 RM6XLVR31 RM6XLVR32 RM6XLVR10 RM6XLVR14 RM6XLVR14 RM6XLVR14 RM6XLVR15 RM6XLVR15 RM6XLVR15 RM6XLVR15 RM6XLVR15 RM6XLVR15		1.0	-1.0	70,200	53.	83,000
INMÉXILVR31 INMÉXILVR32 RMÉXILVR10 RMÉXILVR11 RMÉXILVR11 RMÉXILVR13 RMÉXILVR13 RMÉXILVR15 RMÉXILVR15 RMÉXILVR15 RMÉXILVR15		1.0	-1.0	67,000	51.	146,000
RM6XLVR32 RM6XLVR10 RM6XLVR11 RM6XLVR12 RM6XLVR12 RM6XLVR13 RM6XLVR15 RM6XLVR15 RM6XLVR15 RM6XLVR15 RM6XLVR16	_	1.0	-1.0	66,000	50.	000,411
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III0 RMC IVR14 RMC IVR15 RMC IVR13 RMC IVR15 RMC IVR15 RMC IVR16 RMC 321055 RMC XIVR16		1.0	-0 -	91,000	69.	68,000
IIIO RMI 321055 RM6XLVR14 RM6XLVR15 RM6XLVR16 RMI 321055 RM6XLVR16	_	1.0	-0.3	84,500	64,	91,000
.110 RMI 321055 RM6XLVR13 RM6XLVR14 RMI 321055 RM6XLVR16		1.0	-0.3	104,000	. 67	24,000
-110 RMI 321055 RW6XLVR15 RMGXLVR15		1.0	-0.3	78,000	59.	116,000
-110 RMI 321055 RM6XLVR16 RM6XLVR16	<u>.</u>	1.0	-0.3	65,000	8	10,000,000
.110 RMI 321055 RM6XLVR16		1.0	-0.3	75,400	75.	14,307,000
		1.0	-0.3	110,500	84.	23,000
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(Inches)	and Heat No.	Mumber	Direction	2		(Kei)	5	Pellero)	
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			ц	1.0	0	104,000	.61	65,000	-
		RM6XLVR 3	ц	1.0	0	90°,19	69	11,163,000	
		RM6XLVR 4	ц	1.0	0	61,500	17	-93 , 000	
		RM6XLVR 5	ц	1.0	0	110,500	84	53,000	
		RM6XLVR 6	ч	1.0	0	94,900	72	15,600,000	
Apr		RM6XLVR 7	 	1.0	0	120,900	92.	17,000	
		RMGXLVR 8	ц	0.1	0	96,200	73	000° #0T	
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fo		RM6XI,VR19	1 -1	1.0	۳ . 04	122,200	93	39,000	74
r		RM6XLVR20	Ч	1.0	£•0+	001,411	87	212,000	Ż
D113		RM6XLVR21	ц	1.0	+0-3	113,100	96	133,000	'n
		RM6XLVR22	ц	1.0	+0.3	110,500	ස් ද	10,000,000	Ø.
•	-	RM6XLVR23	ц	1.0	+0.3	112,450	88	000 91	é
	RMI 321055	RM6XLVR24	н 	1.0	+0.3	NC1.021	7	40°000	ls.
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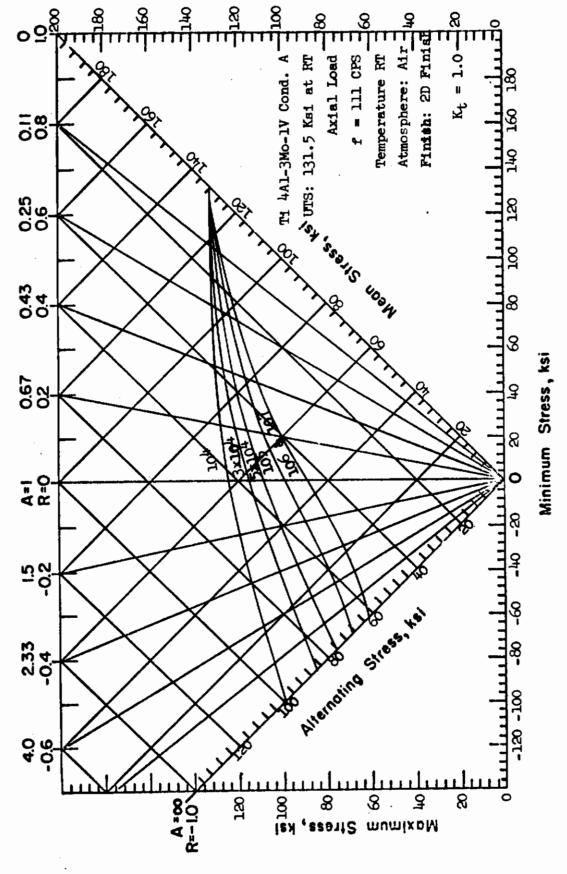
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	Spectmen Mumber	RM6XLVR41 RM6XLVR42 RM6XLVR45 RM6XLVR45 RM6XLVR45 RM6XLVR47 RM6XLVR58 RM6XLVR58 RM6XLVR58 RM6XLVR58 RM6XLVR61 RM6XLVR61 RM6XLVR61 RM6XLVR61
gue Tests	Manufacturer and Heat No.	RMI 321055 RMI 321055
7.1.5 Fatigue	Thickness (Inches)	No Fa

Ti 4A1-3Mo-1V ANNEALED CONDITION

		Specimen Number	Test Direction	at.	R	Max. (Kai)	\$ Per	(Oyelee to Pailure)
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		RM6XLVR34	Ŀ	3.0	0 0	91,000		000°*
		RM6XLVR35	-1 -	0.0		52,000	R.#	2,106,000
		RM6XI.VR30	ц н	0.0 0	0	62,400		15,000
		RM6XLVR38		3.0	0	57,200	\$	35,000
		RM6XLVR39	, ப	3.0	0	49,400	8	2,593,000
		RM6XI,VR40	<u>ы</u> ғ	0.0 0.0	0 0	46,800	R 6	6.063.000
		RM6XLVH04		3.0	5	163700	3	
		DIAN TY AND	Ļ	3.0	+0-3	65,000	8	
	•	CHIN TATING	1	3.0	е о т	78,000	59	16,000
		CULATIVICAL	<u>ب</u> ہ	3.0	e.0+	58,500	5	000, 66
		RM6XLVR52	і н і		+0•3	52,000	8	114,000
		RM6XLVR53	ц	3.0	+0,3	45,500	35	10,210,000 +
		RM6XLVR54	ц	3.0	+0.3	149,000	80	10,312,000
-	-	RM6XLVR55	 	3.0	+0.3	50,700	£	10,000,000
orr. >	Rect 321055	RM6XLVR56	ц	3.0	+0.3	85,000	65.	000,11
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Ti 4A1-3Mo-1V ANNEALED CONDITION

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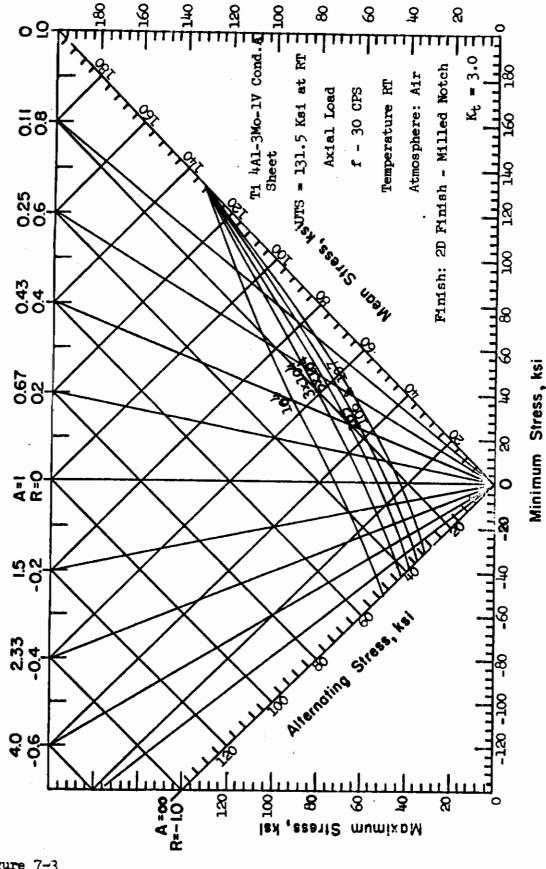


Figure 7-3

Approved fo**l52**Pablic Release

Contrails

7.2 Ti 13V-11Cr-3Al Cond. A(or ST)

Tests
Tensile
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TI 13V-11Cr-3A1 ANNEALED

			coun	ana	
5 Reduction Area	1111	111			
\$ Elongstion	12 22.5 16.5 13.0	19.5 16.5 14.0	22.5 22.5 15.0 16.0	22.5 27.0 25.0 18.0 17.0	
r F tu (Keil)	133.6 110.3 108.1 112.4 143.7	113.9 113.6 115.9	135.8 114.7 113.7 115.8 135.0	137.1 111.9 111.1 111.1 132.8	
Fty (fai)	131.8 100.8 96.2 95.2 141.0	108.0 105.5 100.0	135.8 103.4 101.1 98.4 134.7	137.1 101.1 98.9 92.8 132.4	
Test Temperature (or)	RT 400 800 RT	400 600 800	RT 400 800 RT	RT 400 800 RT	
Test Direction	년 년 년 년	ft ft ft	다 다 다 다 다	ччччн	
Specimen Number	TCLXLTR1 TCLXLTR1 TCLXLT61 TCLXLT81 TCLXTTR1	TC1XTT41 TC1XTT61 TC1XTT81	TC2XLTR1 TC2XLT41 TC2XLT61 TC2XLT81 TC2XTTR1	TC 3XLTR1 TC 3XLT41 TC 3XLT61 TC 3XLT81 TC 3XTTR1	
Manufacturer and Hast No.	Timet D 7855	Timet D 7855	Timet D 7770	Timet D 7107	
Thickness (Inches)	0II. 2	Approv	ved fo 154 Pāb	olic Release	

$\begin{array}{ c c c c c c c c c c c c c c c c c c c$	ANTINIA THE FOTTLEST I			
-122 - 122	Test Temperature (or)	Fty Ftu (Kai) (Kei)	\$ Blongstion	5 Reduction Area
Timet D 7639 Timet D 7639 Timet D 7639 Timet D 7110 Totstarful		137.4 137.4 103.4 117.1 103.7 115.3	20.0 16.0 22.5	1 1 1
Timet D 7110 TC5XLTR1 TC5XLTR1 TC5XLTR1 TC5XLTR1 TC5XLTR1 TC5XLTR1 TC5XLTR1 TC5XLTR1 TC5XTTR1 TC5XTTR1 TC5XTTR1 TC5XTTR1 TC5XTTR1 TC5XTTR1 TC5XTTR1 TC5XTTR1 TC5XTTR1 TC5XTTR1 TC5XTTR1 TC5XTTR1 TC5XTTR1 TC5XTTR1 TC5XTTR1 TC5XTTR1 TC5XTTR1 TC5XTTC1		0.041 1.051	19.0	H 1
JIE LC2XITBI Timet D 7110 TC5XITBI Timet D 7110 TC5XITBI TC		131.1 131.1 104.5 113.4 100.0 113.2	24.0 28.0 26.5	
			18.0 20.5	1.
				ile
			<u> </u>	

		K Reduction Area	Contrails
		Percent \$ M	18,0 15.0 14,0 17,0 5.0 5.0 28 20.5 22 20.5 22 20.5 22 20.5 22 20.5 22 20.5 22 22 20.5 22 22 20.5 22 22 22 22 22 22 22 22 22 22 22 22 23 22 22
		Ftu (Kei)	132.6 132.6 132.6 132.6 132.6 1337.7 202.9 1338.1 202.9 1337.7 1112 1112 1112 1112 1112 1112 1112 1
	ſ	rty (Kai)	129.0 132.4 132.4 132.4 132.4 132.4 132.4 132.5 137.1 104 104 104 104 104 104 104 104 104 10
3A1 ANNE# TED		Test Temperature (°r)	RR RR FR FR FR FR FR FR FR FR FR FR FR F
TI 13V-11Cr-3A1	9.10	Time (Hrs.)	10 1000 1000 1000 1000 1000 1000 1000
ΤT	Exposure	Temperature (oF)	80000000000000000000000000000000000000
-		Test Direction	аараааа арааааа
r Tests		Specimen Number	TCLXLTW41 TCLXLTW42 TCLXLTW61 TCLXLTW61 TCLXLTW62 TCLXLTW62 TCLXLTW82 TCLXLTW82 TCLXLTW83 TCLXLTX62 TCLXLTX61 TCLXLTX61 TCLXLTX63 TCLXLTX63 TCLXLTX81 TCLXLTX81 TCLXLTX83 TCLXLTX83 TCLXLTX83 TCLXLTX83 TCLXLTX83 TCLXLTX83
Tensile Stability		Manufacturer and Heat No.	Timet D 7855 Timet D 7855
7.2.1.1 Te		Thickness (Inches)	Approved for Public Release

TH 13V-11CR-3AL COND. A

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Thickness (inches)	Manufacturer and Heat No.	Specimen Number	Test Direction	Test Temperature	Precision "E" x 10 ⁶
د لد.	Timet D 7855	TCLIXITIAN	r	IKI.	14.6

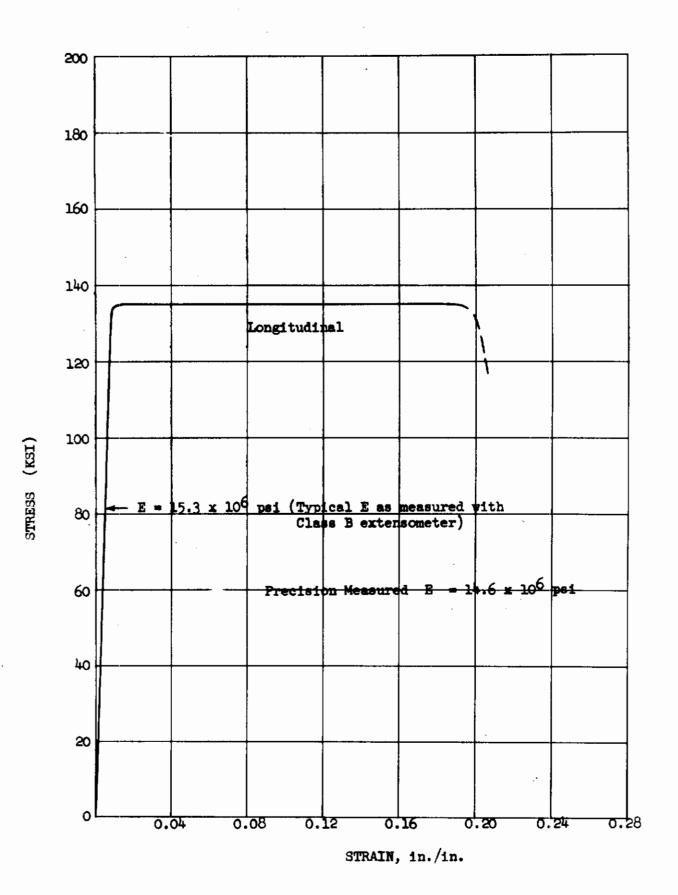


Figure 7-4 Typical Tensile Stress-Strain Curve (full-range) for Annealed Ti-13V-11Cr-3Al Alloy Sheet at Room Temperature

ThicknessManufacturerSpecienItentionItention $f_{100}(he0)$ Timet D 7855TCLXRRALLHot $f_{11met D}$ 7855TCLXRCALLHot $f_{11met D}$ 7855TCLXRCALL600Timet D 7855TCLXRCALTT800Timet D 7710TC2XLCALTT800Timet D 7710TC2XLCALTT800Timet D 7710TC2XLCALTT800Timet D 7710TC2XLCALTT800Timet D 7710TC2XLCALTT800Timet D 7710TC2XLCALTT800Timet D 7710TC2XLCALTTTimet D 7710TC3XCALTTTimet D 7634TTTTimet D 7110TC5XLCALTTTimet D 7110TC5XLCALTTTimet D 7110TC5XLCALTTTimet D 7110TC5XLCALTTTimet D 7110TC5XLCALTTimet D 7110TC5XLCALT					Test	
 110 Timet D 7855 TCIXLGA1 L Timet D 7855 TCIXLGA1 L Timet D 7855 TCIXLGA1 L Timet D 7855 TCIXTCA1 L Timet D 7855 TCIXTCA1 T Timet D 7855 TCIXTCA1 T Timet D 7855 TCIXTCA1 T Timet D 7855 TCIXTCA1 T Timet D 7770 TCIXTCA1 T Timet D 7770 TCIXTCA1 T Timet D 7770 TCIXTCA1 T Timet D 7770 TCIXTCA1 L Timet D 7770 TCIXTCA1 T Timet D 7107 TCIXTCA1 T T Timet D 7107 TCIXTCA1 T Timet D 7107 TCIXTCA1 T Timet D 7107 TCIXTCA1 T Timet D 7107 TCIXTCA1 T Timet D 7007 TCIXTCA1 T Timet D 7007 TCIXTCA1 T T	Thickness (Inches)	Manufacturer and Heat No.	Specimen Number	Test Direction	Temperature (of)	roy (Kai)
<pre>Control Control C</pre>	<u>4</u> .110	А	TCIXLCR1	Г	RT	132.1
<pre>Climet D 7855 TCIXL661 L Timet D 7855 TCIXT681 L Timet D 7855 TCIXT681 T Timet D 7855 TCIXT611 T Timet D 7770 TCIXT61 T Timet D 7770 TCIXT681 L Timet D 7107 TCIXT681 L Timet D 7107 TCIXT681 T Timet D 7107 TCIXT681 T Timet D 7107 TCIXT681 L Timet D 7107 TCIXT681 L Timet D 7107 TCIXT681 L Timet D 7100 TCIXT681 L Timet D 7110 TCIXT681 L Timet D 7110 TCIXT681 L Timet D 7110 TCIXT681 L Timet D 7110 TCIXT681 L T</pre>		р	TCLXLC41	Г	1400	105.8
Timet D 7855 FCIXL681 L Timet D 7855 TCIXT681 T Timet D 7855 TCIXT661 T Timet D 7770 TCIXT681 T Timet D 7770 TCIXT681 L Timet D 7770 TC2XL6R1 L Timet D 7770 TC2XL6R1 L Timet D 7770 TC2XL6R1 L Timet D 7107 TC3XL6R1 L Timet D 7107 TC5XL6R1 L Timet D 7110 TC5XL6R1 L Timet D 7110 TC5XL6R1 L Stress - Strain Curve Erratic - Specimen Probally not seated		А	TC1XLC61	Г	600	97.2
<pre>Timet D 7855 TCLXTCR1 T Timet D 7855 TCLXTC61 T Timet D 7855 TCLXTC61 T Timet D 7770 TC2XTCR1 L Timet D 7770 TC2XLCR1 L Timet D 7107 TC2XTCR1 L Timet D 7107 TC3XLCR1 L Timet D 7107 TC3XLCR1 L Timet D 7107 TC3XLCR1 L Timet D 7107 TC3XTCR1 L Timet D 7100 TC5XLCR1 L Timet D 7110 TC5XTCR1 L Timet D 7110 TC5XTCR1 L Timet D 7110 TC5XLCR1 L Timet D 7110 TC5XTCR1 L</pre>		А	ICLXLC81	Г	800	6.66
<pre>Control Control C</pre>	-	ρ	TCL XTCR1	Ц	RT	134.9
<pre>Timet D 7855 TCIXTC61 T Timet D 7855 TCIXTC81 T Timet D 7770 TC2XLCR1 L Timet D 7770 TC2XLCR1 L Timet D 7107 TC3XLCR1 T Timet D 7107 TC3XLCR1 L Timet D 7107 TC3XLCR1 L Timet D 7639 TC4XLCR1 L Timet D 7639 TC4XLCR1 L Timet D 7634 TC4XTCR1 L Timet D 7110 TC5XLCR1 L Timet D 7110 TC5XTCR1 T Stress - Strain Curve Erratic - Specimen Probally not seated</pre>		Р	TCLXTC41	H	400	113.9
<pre>Timet D 7855 TCLXTC81 T Timet D 7770 TC2XTCR1 L Timet D 7770 TC2XTCR1 L Timet D 7107 TC2XTCR1 L Timet D 7107 TC3XTCR1 L Timet D 7107 TC3XTCR1 L Timet D 7639 TC4XLCR1 L Timet D 7634 TC4XTCR1 L Timet D 7634 TC4XTCR1 L Timet D 7110 TC5XTCR1 L Timet D 7110 TC5XTCR1 L Timet D 7110 TC5XTCR1 L Timet D 7110 TC5XTCR1 T Timet D 7110 TC5XTCR1 T Timet D 7110 TC5XTCR1 T</pre>		р	TCLXTC61	F	600	107.4
Timet D 7770 TC2XLCR1 L Timet D 7770 TC2XTCR1 T Timet D 7107 TC3XLCR1 L Timet D 7107 TC3XLCR1 L Timet D 7107 TC3XLCR1 L Timet D 7639 TC4XLCR1 T Timet D 7634 TC4XLCR1 L Timet D 7634 TC4XLCR1 T Timet D 7110 TC5XTCR1 T Timet D 7110 TC5XTCR1 T Stress - Strain Curve Erratic - Specimen Probally not seated Strested		р	TCLXTC81	£	800	105.7
Timet D 7770 TC2XTCR1 T Timet D 7107 TC3XLCR1 L Timet D 7107 TC3XTCR1 T Timet D 7107 TC3XTCR1 L Timet D 7107 TC3XTCR1 L Timet D 7639 TC4XLCR1 L Timet D 7639 TC4XLCR1 L Timet D 7639 TC4XCR1 T Timet D 7110 TC5XLCR1 L Timet D 7110 TC5XTCR1 T Stress - Strain Curve Erratic - Specimen Probally not seated Strested		А	TC2XLCR1	Г	RT	134.2
Timet D 7107 TC3XLCR1 L Timet D 7107 TC3XTCR1 T Timet D 7107 TC4XLCR1 L Timet D 7639 TC4XLCR1 L Timet D 7634 TC4XTCR1 L Timet D 7634 TC4XTCR1 L Timet D 7634 TC4XTCR1 L Timet D 7110 TC4XTCR1 T Timet D 7110 TC5XTCR1 T Timet D 7110 TC5XTCR1 T Timet D 7110 TC5XTCR1 T Stress - Strain Curve Erratic - Specimen Probally not seated Stressed			TC2XTCR1	LI.	RT	140.0
Stress - Strain Curve Erratic - Specimen Probably not seated		F	ומיז דער יישי	÷		1, 151
<pre> Timet D 7639 TC4XLCR1 L Timet D 7634 TC4XTCR1 T Totation Timet D 7110 TC5XLCR1 L Timet D 7110 TC5XTCR1 L Temperature D 7110 TC5XTCR1 T T Stress - Strain Curve Erratic - Specimen Probably not seated</pre>		а П	TC3XTCR1	÷ ₽ E+	RT	141.7
<pre> Timet D 7639 TC4XLGR1 L Timet D 7634 TC4XTGR1 T Timet D 7110 TC5XLGR1 L Timet D 7110 TC5XTGR1 L T Stress - Strain Curve Erratic - Specimen Probably not seated</pre>						
<pre>\$\$.110 Timet D f034 TC4XTCKL T \$\$.110 TC5XLCR1 L T T T Stress - Strain Curve Erratic - Specimen Probably not seated</pre>		A	TC4XLCR1	Н 1	RT	131.5
<pre> Stress - Strain Curve Erratic - Specimen Probably not seated L T L L L L L L L L L L L L L L L L L</pre>	•	9	TANTAR I	Ţ	RT	133.0
Timet D 7110 TC5XTCR1 T Stress - Strain Curve Erratic - Specimen Probally not seated	1 10	Ω	TC5XLCR1	Г	RT	116.1 ⁽¹⁾
Stress - Strain Curve Erratic - Specimen Probably not seated	,	А	TC5XTCR1	Т	RT	135.7
Stress - Strain Curve Erratic - Specimen Probably not seated						
Stress - Strain Curve Erratic - Specimen Probably not seated			<u></u>	•		
Stress - Strain Curve Erratic - Specimen Probably not seated						
Stress - Strain Curve Erratic - Specimen Probably not seated			• <u>•</u>			
Stress - Strain Curve Erratic - Specimen Probably not seated						
Stress - Strain Curve Erratic - Specimen Probably not seated						
DELESS - DELATIN CALVE ELLAVIC - EPICETERI ILODALLY NOC SCREEK	0 4 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	П то то то то	Greatmen Droholl	w not cooted	Tact involid	

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7.2.2 Compression Tests

TI 13V-11Cr-3A1 ANNEALED

221 200.0 200.0 200.0 200.0 205.6 311 265.1 265.1 266.0 266.0	
172.2 149.1 153.7 155.5 176.9 170.4 170.4 188.2 205.0 182.0 205.0 200.0	
RT 400 600 800 600 600 800 800 800 800 800 8	
1111111 0000000 000000 000000	
- ЧЧЧЧЧ	
TCLXLBLR1 TCLXLBL61 TCLXLB161 TCLXTB161 TCLXTB181 TCLXTB141 TCLXTB261 TCLXLB261 TCLXLB261 TCLXLB261 TCLXTB281 TCLXTB281 TCLXTB281 TCLXTB281 TCLXTB281	
Timet D 7855 Timet D 7855	
	110 Timet D 7855 TCIXLBHR L 1.5 FF 1.72.2 Timet D 7855 TCIXLBHR L 1.5 KT 1.49.1 Timet D 7855 TCIXLBHR L 1.5 B00 149.1 Timet D 7855 TCIXLBHR T 1.5 B00 149.1 Timet D 7855 TCIXLBHR T 1.5 B00 155.5 Timet D 7855 TCIXTBLR T 1.5 B00 155.5 Timet D 7855 TCIXTBLR T 1.5 B00 176.9 Timet D 7855 TCIXTBLR T 1.5 B00 176.9 Timet D 7855 TCIXTBCH T 1.5 B00 176.6 Timet D 7855 TCIXTBCH L 2.0 B00 176.6 Timet D 7855 TCIXTB281 T 2.0

Ti 13V-11Cr-3A1 ANNEALED

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7.2.3 Bearing Tests

	······	٤.	ばん	THER	·
Pane (Led.)	215.6 300	224 303	221 306	226 308	
Plant (Kai) (25 Offeet)	176.0 188.8	172.7 192.0	169.4 193.9	174.7 193.7	
Test Tempereture (of)	RT RT	RT	RT RT	RT RT	,
e/p	1,5 2,0	1,5 2.0	1,5 2,0	1.5 2.0	
Test Direction	다다	цц	цц	ч н	
Specimen Number	TC2XLBIR1 TC2XLB2R1	TC3XLBIR1 TC3XLB2R1	T¢4XLBIR1 T¢4XLB2R1	TC5XLBIR1 TC5XLB2R1	
Manufacturer and Heat No.	Timet D 7770 Timet D 7770	Timet D 7107 Timet D 7107	Timet D 7639 Timet D 7639	Timet D 7110 Timet D 7110	·
Thickness (Inches)	₹.110			1 10	

Ti 13V-11Cr-3Al ANNEALED

7.2.3 Bearing Tests

Foy (Kat)	96.1 81.9 82.8 76.7 98.2 84.0 82.1 78.2	99.4 94.4 98.2 98.2	
Test Temperature (°F)	RT 400 600 800 800 400 600 800	ተ የ የ ከ የ ከ የ ከ የ ከ የ ከ የ ከ የ ከ የ ከ የ ከ የ	, *************************
Test Direction	ччччөөө	ылын	•
Specimen Kumber	TCLXLSR1 TCLXLS41 TCLXLS61 TCLXLS81 TCLXTS81 TCLXTS41 TCLXTS61 TCLXTS81 TCLXTS81	TC2XLSR1 TC3XLSR1 TC4XLSR1 TC5XLSR1	
Manufacturer and Heat No.	Timet D 7855 Timet D 7855	Timet D 7770 Timet D 7107 Timet D 7639 Timet D 7110	
Thickness (Inches)		• • • • • • • • • • • • • • • • • • •	

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Ti 13V-11Cr-3Al ANNEALED

7.2.4 Shear Tests

Contrails

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7.3 TI 6A1-4V COND. STA

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% Reduction Area	1 1	1 1 1 1	1 1	11111	1 1 1 1 1 1 1	1
\$ Elongetion	6 01	12 12 12 12	10	13 17 17 14	- 13 * 13 * 15 17 17 17 17 17 17 17 17 17 17 17 17 17	13
r _{tu} (fei)	170.2 135.1	127.2 109.1 182.5 153.2	143.8 138.1	146.9 116.8 105.6 98.6 152.1	167.2 133.7 124.0 133.1 132.3 132.3	1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1
Fty (Ksi)	155.6 115.7	105.0 87.5 169.0 135.6	126.0 118.4	140.0 100.9 86.0 80.8 146.0	153.6 95.4 108.5 151.4 151.4 22.8	87.1
Test Tempersture . (oF)	КТ 400	600 800 1400	600 800	RT 400 800 81	RT 4 00 8 00 6 4 1 7 0 0 0 0 0 0 0	800 of guage mark
Test Direction	ц.	나 다 단 단	Et Et	ччччн	ы ц ц ц ц ц ц ц	T width
Specimen Number	L4TXLAT TATXLAT	TAIXLT61 TAIXLT81 TAIXTTR1 TAIXTT41	TAIXTT61 TAIXTT81	TA2XLTR1 TA2XLT41 TA2XLT61 TA2XLT61 TA2XLT81 TA2XTTR1	RA6XLTR1 RA6XLT41 RA6XLT41 RA6XLT61 RA6XTT41 RA6XTT41 RA6XTT61	
Manufacturer and Heat No.	Timet G 4956	.	Timet G 4956	Timet G 4796	RMI X 53788	to 300 RMI X 53788 Broke through guage mark or Broke through Extensometer
Thickness (Inches)	.250 to .300	P	approved	1_for 164 0lic	Release	.250 to .300 *Broke thr *Broke thr

Tensile Tests

7.3.1

Contrails

			_			Ć	r outr	ai	ls		
	<pre>% Reduction %rea</pre>	36 52	7	28	11 11	55	32	33	16 14	22 25 25	
	≰ Elongation	12 17	15	, .	15	16	ΟΓ	TT	~ ~	12 12 10	
	F _{tu} (Kei)	178.7 146.4	134.3 123.5	173.8	142.7 126.9	122.3	177.0	188.5	172.0 172.4	152.0 166.7 147.6	
	Fty (Esl)	164.9 125.5	107.8 101.0	158.4	120.3 97.8	97.4	164.7	178.0	155.6 157.2	142.3 157.6 141.9	
	Test Temperature _ (97)	КТ 14.00	600 800	RT	400 600	800	RT	RT	RT	RT RT RT	——————————————————————————————————————
	Test Direction	<u>ы</u> н	►. ⊢	E	64 64	EI	ц	E	цн	J F R	
	Specimen Number	LATYLTR1 TATYLTAT	TALYLT61 187.1717	LATTYLAT	L4TTYLAT L4TTYLAT	ТАТ ҮТТВТ	TA2YLTR1	TA2YTTR1	RA7 YLTRL RA7 YTTRL	TA2ZLTR1 TA2ZTTR1 TA2ZSTR1	
CACT STICIST	Manufacturer and Heat No.	Timet G 6539			•	Timet G 6539	Timet G 7278	Timet G 7278	RMI 302634 RMI 302634	Timet G 7021 Timet G 7021	
T T.C.I	Thickness (Inches)	.500 to .630	.	Ар	pro	ved	for Pu	6 1 10	00 to .630 Release	2 1.00	

Ti 6A1-4V Cond. STA

Tensile Tests 7.3.1

		Contrails
	\$ Reduction Area	ゆみびびかいのかぶ
	\$ Elonga tion	58775531 5 35
	rtu (Kei)	153.7 104.7 97.0 151.2 105.8 102.3 112.4 102.3
STA	Fty (Kei)	150.1 91.0 84.2 93.2 93.2 96.3 96.3 89.2 89.2
4V Cond.	Test Temperature (of)	жн 800 800 800 800 800 800 800 800 800 80
T1 6A1-4V	Test Direction	石石石石石 电磁磁磁路
	Specimen Number	RAZLTR1 RAGZLTG1 RAGZLTG1 RAGZTT41 RAGZTT61 RAGZTT81 RAGZST81 RAGZST81 RAGZST81 RAGZST81
Tensile Tests	Manufacturer and Heat No.	RMI 293504
7.3.1 T	Thickness (Inches)	Approved for for the formed for the formed f

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and the construction that the

6: 10 A

T1 6A1-4V

	tton	Contrails
	\$ Beduetion Area	
	Percent Elongstion	BOBHORF ODD STORE
	rtu (Ksi)	170.7 170.6 170.6 171.0 171.6 171.6 171.4 171.6 172.2 172.2 126.1 126.1 122.2 122.2
•	rty (Ksi)	157.0 157.0 156.7 157.7 157.7 158.0 158.2 159.8 161.0 104.4 105.6 100.2 100.2 100.3 99.0
	Temperature (°F)	КТ КТ КТ КТ КТ КТ КТ КТ КТ КТ КТ КТ КТ К
2	Time (Brs.)	
Exposure	Temperature (of)	400 400 400 600 600 800 800 800 800 800 800 800 8
	Test Direction	
	Specimen Number	
	Manufacturer and Heat No.	Timet G 4956 Timet G 4956
	Thickness (Inches)	. 300 . 300

Cond. STA Ti 6Al-4V

		S Meduotion Area	<i>Contrails</i> ଜଟନନ୍ଦ୍ ଶଳନ୍ଦ୍ ନ
		Percent Elongration	21933339
	•	(Kei)	175.5 1772.5 1772.6 1772.6 1772.6 1772.6 1772.5 1772.5
	þ	(Ksi)	164.7 160.5 160.9 160.5 161.5 162.6 162.1
• STA		Test Tempereture (°F)	2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2
4V Cond.	e la	Time (Hrs.)	001 0001 0001 0001 00001
TH 6A1-4V	Exposure	Temperature (of)	1,000 600 800 800 1,00 1,0000 1,000 1,00000000
ts		Test Direction	
Stability Tests		Specimen Number	TALYLTW44 TALYLTW45 TALYLTW62 TALYLTW63 TALYLTW63 TALYLTW82 TALYLTW83 TALYLTW83
Tensile		Manufacturer and Heat No.	Timet G 6539 Timet G 6539
7.3.1.1		Thickness (Inches)	crease crease

STA	
COND.	
TH-6AL-4V	

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			P
	Precision "E" x 10 ⁶	16.2	
	Test Temperature	R	
dulue (Tuckerman)	Test Direction	ц	
Precision Elastic Modulus	Specimen Number	TATATA	
(•)•T•C - SISAL ALLERTS - T-COL	Manufacturer and Heat No.	Timet G 4956	
1at. 2.1.6./	Thickness (inches)	-250300	

Contrails

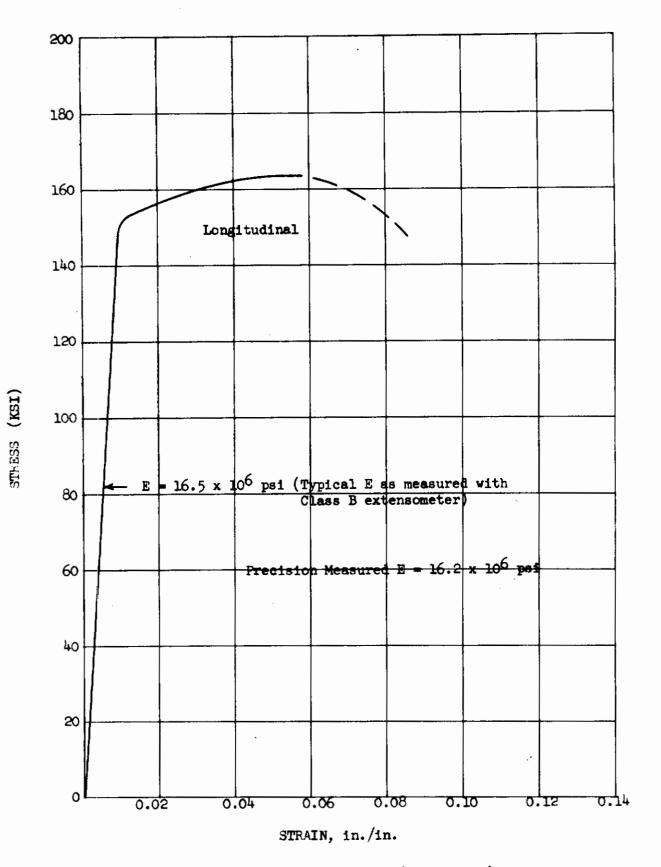


Figure 7-5 Typical tensile stress-strain curve (full-range) for solution treated and aged Ti-6Al-4V alloy sheet at room temperature.

Poy (Kai)	154.2 118.7 113.0 99.8 186.9 143.2 143.2 143.2 143.2	150.8 187.2	166.4 117.3 103.4 155.3 115.8 99.9 93.1	<u>.</u>
Test Tempersture (or)	RT 400 800 400 600 800 800	RT RT	RT 800 600 800 800 800	
Test Direction	니 니 니 너 단 단 단	ы Ч	, ччччөөө	
Specimen Number	TALXLCR1 TALXLCR1 TALXLC61 TALXLC61 TALXTC81 TALXTC61 TALXTC61 TALXTC61	TA2XLCR1 TA2XLCR1	RA6XLCR1 RA6XLCR1 RA6XLC61 RA6XLC61 RA6XTC81 RA6XTC61 RA6XTC61 RA6XTC81	
Manufacturer and Heat No.	Timet G 4956 Timet G 4956	Timet G 4796 Timet G 4796	RMI X 53788 RMI X 53788	
Thickness (Inches)	.250 to .300		.250 to .300	

TI GAL-4V COND. STA

d.

7.3.2 Compression Tests

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Foy (Kai)	173.5 127.7 114.6	102.0 165.7 125.4	107.8	177.2 163.8	164.1 171.3	156.0 157.6 148.7	
Test Temperature (of)	RT 400 600	800 RT 400	000	RT RT	ጽፓ	RT RT RT	
Test Direction	니니니	ныны	÷ı E→	년 년 :	ы Ч Е	л н Ц	
Specimen Number	TALYCRI TALYLCRI TALYLCRI	TALYLC81 TALYTC81 TALYTC81	TATYTC61 TATYTC81	TA2YLCR1 TA2YTCR1	RATYLCR1 RATYTCR1	TA2ZLCR1 TA2ZTCR1 TA2ZSCR1	
Manufacturer and Heat No.	Timet G 6539		T imet G 6539	Timet G 7278 Timet G 7278	RMI 302634 RMI 302634	Timet G 7021 Timet G 7021 Timet G 7021	
Thickness (Inches)	.500 to .630	· · · ·			.500 to .630	00 1 00 00 00 1 00 0 0 0 1 0 0	

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Contrails

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Thickness Manufactures Specials Test Test Test 21.00 Intil 293504 Mailer Mailer Mailer Mailer Test Test Test 21.00 Intil 293504 Mailer Mailer L Mailer Mailer Mailer 1 Mailer Mailer Mailer Mailer L Mailer Mailer 1 Mailer Mailer Mailer L Mailer Mailer Mailer 1 Mailer Mailer Mailer L L Mailer Mailer 1 Mailer Mailer Mailer T Mailer Mailer Mailer 1 Mailer Mailer Mailer T Mailer Mailer Mailer 1 Mailer Mailer Mailer Mailer Mailer Mailer Mailer 1 Mailer					+	
RMT 293504 RA6ZLCR1 L RT A6ZLC61 L - 65LC61 L 600 A6ZLC81 L B00 RA6ZLC81 L RA6ZLC81 L R 800 RA6ZLC81 T R 800 RA6ZLC81 T R 800 RA6ZLC81 T R 800 RA6ZLC81 T R 800 RA6ZLC81 ST 900 RMT<293504 RA6ZSC81 ST RMT<293504 RA6ZSC81 ST 800	Thickness (Inches)	Manufacturer and Heat No.	Specimen Number	Test Direction	Temperature (or)	Foy (Ist)
RM6ZLC41 L 46ZLC41 L ~6ZLC61 L ~6ZLC61 L ~6ZLC61 L RA6ZLC81 L RA6ZLC61 L R 600 RA6ZLC61 T T R RA6ZSC61 ST R R RA6ZSC61 ST R R R RA6ZSC61 ST R R R R R R R R R R R R R R R R R R R R R R R R R R R R R R<	> 1.00	RMI 293504	RA6ZLCR1	1	RT	157.5
об ми 293504 вид 293504 ви			RA6ZLC41	Г	1400	4.411
NMI 293504 RA62rC81 F RA62rrCR1 F RA65rrC41 F RA65rrC41 F RA65rrC41 F RA65rrC41 F RA65rrC61 F RA65rrC61 F RA65rrC61 F RA65rrC61 F RA65rrC61 F RA65rrC61 F R R R R R R R R R R R R R R R R R R R	ę		v6ZLC61	Ч	600	96 . 4
00 RMI 293504 RM 2235031 RM 223504 RM 223504 RM 223504 RM 223504 RM 223504 RM 293504 RM 29	-		RA6ZLC81		800	95.4
00 RM6ZTC611 F RA6ZTC611 F RA6ZTC61 F RA6ZSC811 ST RA6ZSC811 ST RA6ZSC611 ST RA7 RA7 RA7 RA7 RA7 RA7 RA7 RA7			RAGZTCR1	Er	RT	159.7
00 RMI 293504 RMI 293504 RM			RA6ZTC41	E	400	117.1
00 HMI 293504 TI 800 HMI 293504 RA62SCB1 ST 4400 HMI 293504 RA62SC61 ST 600 RMI 293504 RA62SC61 ST 600			RA6ZTC61	E-1	600	101.5
00 RMI 293504 BMI 290504 BMI 293504 BMI 293504 BMI 293504 BMI 293504 BMI 293504 BMI 2935			RA6ZTC81	£	800	98.7
00 RMI 293504 RA6ZSC&1 ST 400 RA6ZSC&1 ST 600 RA6ZSC&1 ST 600 00 0			RA6ZSCR1	ST	RT	157.7
00 RMI 293504 BrA6ZSC61 ST 600 RA6ZSC81 ST 800 800			RA6ZSC41	ST	400	112.0
00 RMI 293504 BG	;		RA6ZSC61	ST	600	96.1
		RMI 293504	RA6ZSC81	ST	800	1.68
				·		

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300 Timet G 4956 TAXTBIRI L 1.5 Kr 241.2 7 743X18111 L 1.5 600 197.6 7 743X78111 L 1.5 600 197.6 7 743X78111 T 1.5 600 197.6 7 743X78111 T 1.5 600 196.4 7 743X78111 T 1.5 600 176.7 7 743X78111 T 1.5 600 173.5 7 7.1.5 800 173.5 800 216.4 7 7.1.5 800 206.4 133.9 7 7.1.5 800 219.2 219.2 7 7.1.5 800 219.2 7 2.0 800 216.3 7 2.0 800 219.2 7 2.0 800 211.5 7 1.5 80 210.3 7 1.5 80 210.3 7 2.0 800 211.5 7 7.1.1.5 7.1 2.0 200.3 7 7.1.7.78261 7 2.0 800 211.5 7 7.1.	Thickness (Inches)	Manufacturer and Heat No.	Specimen Munber	Test Direction	e∕⊅	Test Tempersture (oF)	fiet) (Kei) (2% Offeet)	
0.0.00 TMAXEMAL 1.5 400 197.6 1.5 7.4.00 1.5 600 190.5 7.4.XTRBLA 1.1 1.5 600 190.5 7.4.XTRBLA 7.4.XTRBLA 7.4.1.5 600 190.5 7.4.XTRBLA 7.4.XTRBLA 7.4.1.5 600 190.5 7.4.XTRBLA 7.4.1.5 600 190.5 166.4 7.4.XTRBAL 7 1.5 600 190.5 7.4.XTRBAL 7 1.5 800 176.4 7.4.XTRBAL 7 1.5 800 176.4 7.4.XTRBAL 1 2.0 800 175.5 7.4.XTRBAL 1 2.0 800 219.2 7.4.XTRBAL 1 2.0 800 215.7 7.4.XTRBAL 7 2.0 800 215.7 7.4.XTRBAL 7 2.0 800 215.7 7.4.XTRBAL 7 2.0 800 215.7 7.4.1.XTRBAL 7 2.0 800 215.7 7.5.6 7.4.00 <	4	ر بر ا	וקואזעואיי	· ·	1.5	RT	2,142	256.8
max.match L 1.5 600 190.5 max.match L 1.5 800 176.7 max.match T 1.5 800 173.5 max.match L 2.0 800 173.5 max.match L 2.0 800 255.2 max.match L 2.0 800 219.5 max.match L 2.0 800 215.7 max.match T Max.match T 2.0 max.match T 2.0 800 215.7 match G4956 T T 2.0 800 match G4796 T T 2.0 800	р Р		TALELA TALE	а ,д		00	197.6	1.412
the spectment retested 1.5 800 176.7 TAIXTBALI T 1.5 800 176.7 TAIXTBALI T 1.5 800 126.4 TAIXTBALI T 1.5 800 126.4 TAIXTBALI T 1.5 800 133.9 TAIXTBALI T 1.5 800 133.9 TAIXTBALI T 2.0 800 133.9 TAIXTBACI L 2.0 800 133.5 TAIXTBACI L 2.0 800 133.5 TAIXTBACI L 2.0 800 239.3 TAIXTBACI L 2.0 800 230.3 TAIXTBACI T 2.0 800 230.3 Timet G 4796 TAIXTB21 T 1.5 800 Timet G 4796 TAIXTB21 T 2.0 800 210.5 tothe 2.0 800 232.0 230.3 tothe 1.5 RT 2.0 240.5 tothe 1.5 RT 2.0 240.5 tothe 1.5 RT 2.0 240.5 tothe 1.5 RT 2.0 240.5 <t< td=""><th>4</th><td>4</td><td>ТАТХГАТ 1618.ТХГАТ</td><td>1</td><td>1,5</td><td>600</td><td>190.5</td><td>196.8</td></t<>	4	4	ТАТХГАТ 1618.ТХГАТ	1	1,5	600	190.5	196.8
TALXTBLR1 T 1.5 RT 237.5 TALXTBL61 T 1.5 000 196.4 TALXTB261 T 1.5 600 183.9 TALXTB261 L 2.0 RT 265.2 TALXTB261 L 2.0 RT 255.2 TALXTB261 T 2.0 800 219.2 TALXTB261 T 2.0 800 215.7 TALXTB261 T 2.0 800 225.7 Timet G 4796 TALXTB281 T 2.0 800 Timet G 4796 TALMERE1 L 2.0 800 Timet G 4796 TALAXLB281 T 2.0 800 </td <th></th> <td></td> <td>TALXLE181</td> <td>ı н</td> <td>1.5</td> <td>800</td> <td>176.7</td> <td>185.6</td>			TALXLE181	ı н	1.5	800	176.7	185.6
the specimen retested TALXTB141 T 1.5 400 196.4 TALXTB161 T 1.5 600 196.4 TALXTB131 T 1.5 600 183.9 TALXTB211 T 2.0 FT 265.2 TALXLB211 L 2.0 400 183.9 TALXLB211 L 2.0 400 219.2 TALXLB211 L 2.0 600 215.7 TALXLB21 L 2.0 600 215.7 TALXTB21 L 2.0 800 206.4 Timet G 4956 TALXTB21 T 2.0 800 Timet G 4796 TAZXLB11 L 2.0 800 Timet G 4796 TAZXLB11 L 2.0 800 Timet G 4796 TAZXLB11 L 2.0 800 Totos 2.0 800 2.1.5 80.3 totos 2.1.5 RT 2.0 80.3 totos 2.0 800 <			TALXTBIRL	Ŀ	1.5	RT	237.5	278.1
training T 1.5 600 183.9 TAIXTB161 T 1.5 600 183.9 TAIXTB21 T 1.5 800 173.5 TAIXTB21 L 2.0 RT 265.2 TAIXTB21 L 2.0 800 173.5 TAIXTB21 L 2.0 800 219.2 TAIXTB21 L 2.0 600 215.7 TAIXTB21 L 2.0 800 206.4 TAIXTB21 T 2.0 800 206.4 TAIXTB21 T 2.0 800 205.3 TAIXTB21 T 2.0 800 219.2 TAIXTB21 T 2.0 800 206.4 TAIXTB21 T 2.0 800 211.5 Timet G 4796 TAIXTB21 T 1.5 RT Timet G 4796 TAIXTB21 L 2.0 800 211.5 trimet G 4796 <td< td=""><th></th><td></td><td>T41XTB141</td><td>E</td><td>1.5</td><td>400</td><td>196.4</td><td>229.4</td></td<>			T41XTB141	E	1.5	400	196.4	229.4
TAIXTB131 T 1.5 800 173.5 TAIXLB2R1 L 2.0 RT 265.2 TAIXLB261 L 2.0 100 215.7 TAIXLB261 L 2.0 100 215.7 TAIXLB261 L 2.0 800 225.2 TAIXTB281 L 2.0 800 206.4 TAIXTB281 T 2.0 800 232.0 Timet G 4056 TAIXTB281 T 2.0 800 232.0 Timet G 4796 TAIXTB281 T 2.0 800 232.0 to .300 Timet G 4796 TAIXTB281 T 2.0 800 232.0 to .300 Timet G 4796 TAIXTB281 L 2.0 800 232.0 to .300 Timet G 4796 TAIXTB281 L 2.0 800 232.0 to .300 Timet G 4796 TAIXTB281 L 2.0 800 232.0 to .300 Timet G 4796 TAIXTB281 L 2.0 800 232.0 to .300 Timet G 4796 TAIXTB281 L 2.0 800 231.5 brocke = specimen retested specimen retested 1.5 RT 22			TALXTB161	F	1.5	600	183.9	213.0
the specimen retested L 2.0 RT 265.2 TAIXLB2R1 L 2.0 400 219.2 TAIXLB2G1 L 2.0 400 219.2 TAIXLB2G1 L 2.0 400 205.4 TAIXLB2G1 L 2.0 800 206.4 TAIXLB2G1 T 2.0 800 206.4 TAIXLB2G1 T 2.0 800 206.4 TAIXTB2L1 T 2.0 800 232.0 Timet G 4796 TAIXTB2L1 T 2.0 800 232.0 Timet G 4796 TAIXTB2L1 L 2.0 800 232.0 to .300 Timet G 4796 TAIXTB2L1 L 2.0 800 232.0 to .300 Timet G 4796 TAIXTB2L1 L 2.0 800 235.6 to .300 Timet G 4796 TAIXTB2L1 L 2.0 800 235.6 to .300 Timet G 4796 TAIXTB2L1 L 2.0 800 235.6 to .300 Timet G 4796 TAIXTB2L1 L 2.0 800 235.6			TAIXTB181	E	1.5	800	173.5	198.1
the construction the construction the construction the construction 25.2 TAIXLB241 L 2.0 RT 265.2 TAIXLB261 L 2.0 000 219.2 TAIXLB261 L 2.0 800 206.4 TAIXTB241 T 2.0 800 206.4 Timet G 4956 TAIXTB241 T 2.0 400 240.3 timet G 4796 TAIXTB281 T 2.0 600 232.0 timet G 4796 TAIXTB281 T 2.0 800 211.5 to .300 Timet G 4796 TAIXTB281 L 2.0 800 211.5 to .300 Timet G 4796 TAIXTB281 L 2.0 800 211.5 to .300 Timet G 4796 TAIXTB281 L 2.0 800 211.5 to .300 Timet G 4796 TAIXTB281 L 2.0 800 221.5 to .300 Timet G 4796 TAIXTB281 L 2.0 800 211.5 to .300 Timet G 4796 TAIXTB281 L 2.0 800 211.5 to .300 Timet G 4796 TAIXTB281 L 2.0 800 211.5								
TAIXLB241 L 2.0 400 219.2 TAIXLB261 L 2.0 600 215.7 TAIXLB261 L 2.0 600 215.7 TAIXTB241 T 2.0 800 206.4 TAIXTB241 T 2.0 800 206.4 TAIXTB241 T 2.0 800 215.7 Timet G 4956 TAIXTB261 T 2.0 400 240.3 Timet G 4796 TAIXTB281 T 2.0 800 232.0 Timet G 4796 TAIXTB281 L 1.5 RT 290.7 timet G 4796 TAIXTB281 L 2.0 800 211.5 tube Taimet G 4796 TAIXTB281 L 2.0 800 211.5 tube Finet G 4796 TAIXTB281 L 2.0 800 211.5 tube Finet G 4796 TAIXTB281 L 2.0 800 211.5 tube Finet G 4796 TAIXTB281 L 2.0 800 211.5 tube Finet G 4796 TAIXTB281 L 2.0 800 211.5 tube Finet G 4796 TAIXTB281 L 2.0 800 <td< td=""><th></th><td></td><td>TALXLB2R1</td><td>Ц</td><td>2.0</td><td>RT</td><td>265.2</td><td>324.5</td></td<>			TALXLB2R1	Ц	2.0	RT	265.2	324.5
TalXLB261 L 2.0 600 215.7 TalXTB281 L 2.0 800 206.4 TalXTB281 T 2.0 800 206.4 TalXTB241 T 2.0 800 206.3 TalXTB261 T 2.0 800 232.0 Timet G 4796 TalXTB281 T 2.0 800 211.5 to .300 Timet G 4796 TAZXLBIR1 L 1.5 RT 199.7 to .300 Timet G 4796 TAZXLB2R1 L 2.0 800 211.5 to .300 Timet G 4796 TAZXLB2R1 L 2.0 800 211.5 to .300 Timet G 4796 TAZXLB2R1 L 2.0 800 211.5 to .300 Timet G 4796 TAZXLB2R1 L 2.0 800 211.5 to .300 Timet G 4796 TAZXLB2R1 L 2.0 800 225.6 broke specimen retested 2.0 800 225.6			TALXLB241	Ц	2.0	1,00	219.2	251.9
TALXLB2B1 L 2:0 800 206.4 TALXTB2B1 T 2:0 800 289.3 TALXTB2b1 T 2:0 800 289.3 Timet G 4956 TALXTB2B1 T 2:0 800 232.0 Timet G 4796 TALXTB2B1 T 2:0 800 232.0 Timet G 4796 TALXTB2B1 L 1.5 RT 290.7 Timet G 4796 TALXTB2B1 L 2:0 800 211.5 toTimet G 4796 TALXTB2B1 L 2:0 800 232.0 toTimet G 4796 TALXTB2B1 L 2:0 800 211.5 toTimet G 4796 TALXTB2R1 L 2:0 800 211.5 toTimet G 4796 TALXTB2R1 L 2:0 800 211.5 toTimet G 4796 TALXTB2R1 L 2:0 800 211.5 broke specimen retested T 2:0 800 2:0			TALXLB261	Ţ	2.0	600	215.7	231.5
TalXTB2R1 T 2.0 RT 289.3 Timet G 4956 TALXTB261 T 2.0 400 240.3 Timet G 4956 TALXTB281 T 2.0 800 232.0 Timet G 4796 TALXTB281 T 2.0 800 232.0 Timet G 4796 TALXTB281 L 1.5 RT 199.7 to.300 Timet G 4796 TALXTB281 L 2.0 800 231.5 to.300 Timet G 4796 TALXTB281 L 2.0 800 231.5 to.300 Timet G 4796 TALXTB281 L 2.0 800 231.5 to.300 Timet G 4796 TALXTB281 L 2.0 800 231.5 to.300 Timet G 4796 TALXTB281 L 2.0 800 231.5 to.300 Timet G 4796 TALXTB281 L 2.0 800 231.5 to.300 Timet G 4796 TALXTB281 L 2.0 800 231.5 to.300 Timet G 4796 TALXTB281 L 2.0 800 231.5 to.300 Sto.30 T 2.0 800 2.0 2.0			TALXLB281	Ч	2.0	800	206.4	234.8
timet G 4956 TAIXTB241 T 2.0 400 240.5 Timet G 4956 TAIXTB261 T 2.0 600 232.0 to.300 Timet G 4796 TAIXTB281 L 1.5 RT 199.7 to.300 Timet G 4796 TAIXTB281 L 1.5 RT 232.0 to.300 Timet G 4796 TAIXTB281 L 2.0 800 211.5 to.300 Timet G 4796 TAIXTB281 L 2.0 800 211.5 to.300 Timet G 4796 TAIXTB281 L 2.0 800 211.5 to.300 Timet G 4796 TAIXTB281 L 2.0 800 211.5 to.300 Timet G 4796 TAIXTB281 L 2.0 800 211.5 to.300 Timet G 4796 TAIXTB281 L 2.0 800 211.5 to.300 Timet G 4796 TAIXTB281 L 2.0 800 211.5 to.300 T 2.0 R 2.0 800 211.5 to.300 T 2.0 R 2.0 800 211.5 to.300 T L 2.0 R 2.0 800			TA1XTB2R1	EI	2.0	RT	289.3	344.0*
Timet G 4956 TAIXTB261 T 2.0 000 235.0 to.300 Timet G 4796 TAZXLBIR1 L 1.5 RT 199.7 timet G 4796 TAZXLBIR1 L 1.5 RT 199.7 to.300 Timet G 4796 TAZXLBIR1 L 2.0 800 211.5 to.stimet G 4796 TAZXLBIR1 L 1.5 RT 199.7 to.stimet G 4796 TAZXLBIL1 L 2.0 800 211.5 to.stimet G 4796 TAZXLBIL1 L 2.0 RT 225.6			TALXTB241	E-1	2.0	400	240.5 222 0	1.002 8 070
to .300 Timet G 4956 TAXIB261 T 2.0 000 C.10 Timet G 4796 TA2XLB2R1 L 1.5 RT 199.7 Timet G 4796 TA2XLB2R1 L 2.0 RT 225.6 broke specimen retested			TALXTB261	E-I E		800	5 110	2-7-7-2 1
to .300 Timet G 4796 TAZXIBIRI L 1.5 RT 199.7 Timet G 4796 TAZXIB2RI L 2.0 RT 225.6 broke - specimen retested		Timet G 4956	TOZRIATAL	H	0 V			
to .300 Timet G 4796 TA2XLBIRL L 1.5 KT 29.1 Timet G 4796 TA2XLB2RL L 2.0 RT 225.6 broke specimen retested	->				,	Ē		7 0 10
specimen retested	to to	Timet G	TAZXLBIRI	Ϊ⊢		КТ ВП	225.6	294.9
		5	Τυράμλρα	۹.	0	4		
		÷						
	*Pin broke -	specim e n retested						
		1						

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	and the second s	269.2 216.8 200.6 186.2 186.2 259.4 274.9 274.5 278.6 278.6 278.6 274.1 228.6 274.1 274.1
	Fint (Kal) (25 Offeet)	227.4 179.0 165.7 155.8 228.3 179.0 165.6 196.6 197.1 269.3 269.3 269.3 269.3 269.3 269.3 269.3 269.3 277.1 289.0 177.3 215.2 240.9 2240.9
	Test Tempersture (oF)	RI 600 800 800 800 800 800 800 800 800 800
	•/D	
	Test Direction	чорынын чорынын чорон.
	Specimen Mumber	RA6XLB1R1 RA6XLB141 RA6XLB161 RA6XLB161 RA6XTB141 RA6XTB141 RA6XTB161 RA6XLB2R1 RA6XLB2R1 RA6XLB261 RA6XLB261 RA6XLB261 RA6XTB261 RA6XTB261 RA6XTB261 RA6XTB261 RA6XTB281 RA6XTB261 RA6XTB281 RA6XTB281 RA6XTB281 RA6XTB281 RA6XTB281 RA6XTB281 RA6XTB281 RA6XTB281 RA6XTB281 RA1YLB1R1 TA1YLB1R1 TA1YLB181 TA1YLB181 TA1YTB181
g Tests	Manufacturer and Heat No.	RMI X53788 RMC X 53788 Timet G 6539 Timet G 6539
(.3.3 Bearing	Thickness (Inches)	.250 to .300 .250 to .300 .500 to .630

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TI 6A1-4V Cond. STA

Contrails

		C	ontra	rils	
Red)	351.0 27 6 .7 266.0 23 9.0 331.2	281.3 336.4	262.5 330.1	247.8 306.7	253.9 209.6 1177.9 267.3 283.8 224.0
Fuer (Kai) (26 Orteet)	293.2 228.4 209.7 208.2 21.7	238.6 276.0	2,142 275.1	212.2 247.0	219.5 168.8 156.8 150.4 217.8 214.0 207.7 207.7
Teat Temperature (oF)	RT 400 600 800 RT	RT RT	RT RT	RT RT	КТ 400 800 КТ КТ
€∕D	00000 00000 00000	1.5 2.0	1.5 2.0	1.5 2.0	
Test Direction	ЧЧЧЧЧӨ	ц	цц	н н	니니니다 E+ 그 없
Specimen Number	TALYLB2RI TALYLB241 TALYLB261 TALYLB261 TALYLB281 TALYTB2R1	TA2YLB1R1 TA24LB2R1	RATYLBJRJ RATYLB2RJ	TA2ZLB1R1 TA2ZLB2R1	RA6ZLB1R1 RA6ZLB141 RA6ZLB161 RA6ZLB181 RA6ZTB1R1 RA6ZTEB1R1 RA6ZTEB1R1
Manufacturer and Heat No.	Timet G 6539 Timet G 6539	Timet G 7278 Timet G 7278	TNU 302634 RMI 302634	Timet G 7021 Timet G 7021	RMI 293504
Thickness (Inches)	.500 to .630	••• •••••••	.500 to .630	00.1 ~	00 1 1 1

Cond. STA T1 6A1-4V

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		Contrails
Tana (Itad	324.6 234.6 234.0 219.5 334.3 310.8 310.8 299.4	
Pimer (Kai) (26 Offent)	255.1 213.4 179.9 166.2 264.2 264.2 265.8 257.3	
Test Tespers ture (of)	RT 4-00 600 800 RT RT RT	
e/p	0.0000 0.000 0.0000	
Test Direction		``````````````````````````````````````
Specimen Mumber	RA6ZLB2R1 RA6ZLB241 RA6ZLB261 RA6ZLB281 RA6ZLB281 RA6ZLB281 RA6ZLEB2R1 RA6ZTEB2R1	
Manufacturer and Heat No.	RMI 293504 RMI 293504	
Thickness (Inches)	2 1.00	

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(-3.4 Snear lests	1				
Thickness (Inches)	Manufacturer and Heat No.	Specimen Number	Test Direction	Test Temperature (of)	F _{au} (Kei)
.250 to .300	Timet G 4956	TALKIRL	Ч	RT	0.10L 0.28
-	4	TALXIST	a ia ia	888	74.8
		TALXTSR1	1 E1 E1	8 E 9	113.0 19.7
	1 Timet G 4956	TALXTS61 TALXTS81	F1 F1	88	85.3 79.2
	Timet G 4796	TAZKLSR1	Ч	RT	93.2
	1911 x53788 4	RAGXLSR1 RAGXLSH1 RAGXLSH1	니머니	₽ 29 09	102.0 87.3 71.6
		RAGXII-SB1 RAGXTISR1	н Н	8 2	73.2
.250 to .300	RMI X53788	RA6XTS41 RA6XTS61 RA6XTS81	타타타	Ş & &	84.0 76.8 72.0
.500 to .630	Timet G 6539	TALYLSR1 TALYLSR1	ЧЧ	1400 1400	96.3 88.3
.500 to .630	Timet G 6539	TALYLS61 TALYLS81 TALYTSR1	거 너 더	888 888 888 888 888 888 888 888 888 88	74.7 77.4 98.3

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a Kaij	106.0	108.0	88.3	102.0 77.6 70.0 73.5 102.0	
Test Tesperature (or)	RT	RT	RT	RT 400 800 RT	
Test Direction	۰۰۰ ۲۰	н а	ц	ччччы	· · · · · · · · · · · · · · · · · · ·
Specimen Number	TA2YLSR1	TA7YLSRI	TA2ZLSR1	RA6ZLSR1 RA6ZLS41 RA6ZLS61 RA6ZLS81 RA6ZLS81 RA6ZTSR1	
Manufacturer and Haat No.	Timet G 7278	RMI 302634	Timet G 7021	RMI 293504 RMI 293504	
Thickness (Inches)	.500 to .630	.500 to .630	1 ,00	~ 0	

TH 6A1-4V Cond. STA

7.3.4 Shear Tests

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STA	
Cond.	
T1-6A1-4V	

7.3.5 Fracture Toughness Tests

Load at Pailure (lbs)	UC3L	8330	5680	7520	7420	7570	0912		5730	8160	9030	10960	09/11	
Met Fracture Strength, ^E n	5	***	17.5	35.4	37.1	35.6	38.2	45.5 24.0	86.6	44.3	38.8	448.5	L.74	
K _I c Kat v In	6). E	1.1	26.2	43.7	16. 5	45.7	39.6	32.4	39.4	40.0	53.4	66.0	61.5	
F actor		19 19 19	62.4	6.84	8 9	8	88	88	8.2	8.32	9 1 4.7	6.48	6.604	
Crack Depth	Ę	<u>8</u>	99.	82.	8	8.8	83.0		88	047.	.700	.760	012.	
Pop-in (1bs)	545	6850	5180	6400	6500	6500	5500		056t	5000	7200	10200	9300	
Tenp.	E C	L.L.	FT	RT	T	I.			RT	RT	RT	RT	RT	
Bure Time (Hrs.)		9	001	1000	9	8	897	9 2	0001	1	1	ť	•	
Temp.		001	0	8	8	8	88		8	I	1	1	1	
Test Direc- tion	F F	а на	н	ы		<u>н</u> а (] ,	-1	н н	F	Ч		H	
Spectmen Number	L GALTY L M	TAIXIN	TALXLEWAR	TALXLEWAS	TOWNTOCTAT	TALXIM62	TALIXIES	TANALXIAT	TALKLIW83	TATYTER	TAZXLERI	RAGXLFRI	RAGXTFRI	
Manufacturer and Heat No.	THEFT C LOCK		•					-		Timet G 4956	Timet G 4796	RMIT X53788	RMI X53788	*****
Thickness ((inches)	260 - 300		•••••	I	7bl	or	ov	ed	fo	r Pu	180	lc R	250-300	ase

	·.		Contra	ls	
153.7	N (Cyeles to Pellure)	13,000 81,000 72,000 608,000 5,768,000 10,000,000	20,000 16,000 2,716,000 955,000 1,699,000 1,362,000	343,000 8,000 198,000 362,000 522,000 1,429,000	
Ftu =	\$ F _{tu}	82 55 55 53 53 56 52 52 53 53	ዳ	ぬみぬアでぴ	
	Max. (Kei)	120,000 100,000 90,000 80,000 62,000	130,000 110,000 90,000 85,000 78,000	130,000 145,000 118,000 110,000 95,000	
	R	-1.0 -1.0 -1.0 -1.0 -1.0	0-0-0-0-0-0-0-0-0-0-0-0-0-0-0-0-0-0-0-	00000	
	K t			0.0000	
	Test Direction	чччччч	нччччч	лчачча	
	Specimen Number	RA6ZLVR19 RA6ZLVR20 RA6ZLVR21 RA6ZLVR22 RA6ZLVR23 RA6ZLVR23 RA6ZLVR24	RA6ZLVR13 RA6ZLVR14 RA6ZLVR15 RA6ZLVR15 RA6ZLVR16 RA6ZLVR17 RA6ZLVR18	RA6ZLVR 7 RA6ZLVR 8 RA6ZLVR 9 RA6ZLVR10 RA6ZLVR11 RA6ZLVR12	
Fatigue Tests	Manufacturer and Heat No.	RMI 293504		RMI 293504	No Failure
7.3.6 Fatigu	Thiokness (Inches)	×1.00			

Ti 6A1-4V Cond STA

\$

Athene Kuntfacturer Spection Totat A. R. M. K. X. A. X. X. <thx< th=""><th>7.3.6 Fati</th><th>Fatigue Tests</th><th></th><th></th><th></th><th></th><th></th><th>F</th><th>r_{tu} = 153.7</th></thx<>	7.3.6 Fati	Fatigue Tests						F	r _{tu} = 153.7
IMI 293504 RAGZUWR-1 L 1.0 + 0.3 120.0 RAGZUWR-2 L 1.0 + 0.3 110.0 + 0.3 110.0 RAGZUWR-3 L 1.0 + 0.3 110.0 + 0.3 110.0 RAGZUWR-5 L 1.0 + 0.3 100.0 + 0.3 100.0 RAGZUWR-45 L 1.0 + 0.3 100.0 + 0.3 100.0 RAGZUWR-45 L 1.0 + 0.3 200.0 + 0.3 200.0 RAGZUWR-45 L 1.0 + 0.3 20.0 - 1.0 40.3 20.0 RAGZUWR-46 L 3.0 - 1.0 40.3 20.0 20.0 20.0 RAGZUWR-45 L 3.0 - 1.0 40.3 30.0 20.0 20.0 RAGZUWR-46 L 3.0 - 1.0 2.0 <	Thickness (Inches)	Manufacturer and Heat No.	Spectmen Rumber	Test Direction	Kt.	R.	Mar. (Kai)	\$ P _{tu}	I (Cyulae to Pailare)
MAGZUWR-2 L 1.0 + 0.3 130.0 MAGZUWR-4 L 1.0 + 0.3 100.0 RAGZUWR-6 L 1.0 + 0.3 90.0 RAGZUWR-6 L 1.0 + 0.3 90.0 RAGZUWR-45 L 3.0 - 1.0 45.0 RAGZUWR-46 L 3.0 - 1.0 37.5 RAGZUWR-41 L 3.0 - 0.3 37.5 RMC PAGZUWR-42 L 3.0 - 0.3 37.5 RAGZUWR-41 L 3.0 - 0.3 37.5 45.0 RAGZUWR-41 L 3.0 - 0.3 37.0 - 0.3 45.0	21.00	RMI 293504	RA6ZLVR-1	н ^а	1.0	+ 0.3	120.0	78	000 ° 65†
MACTUR-3 L 1.0 + 0.3 110.0 RAGZIVR-6 L 1.0 + 0.3 100.0 RAGZIVR-9 L 1.0 + 0.3 100.0 RAGZIVR-9 L 1.0 + 0.3 100.0 RAGZIVR-9 L 1.0 + 0.3 90.0 RAGZIVR-9 L 3.0 - 1.0 45.0 RAGZIVR-9 L 3.0 - 1.0 45.0 RAGZIVR-9 L 3.0 - 1.0 15.0 RAGZIVR-3 L 3.0 - 1.0 24.0 RAGZIVR-3 L 3.0 - 1.0 24.0 RAGZIVR-4 L 3.0 - 1.0 24.0 RAGZIVR-4 L 3.0 - 0.3 37.5 RAGZIVR-4 L 3.0 - 0.3 45.0 RAGZIVR-4 L 1 3.0 - 0.3 45.0 RAGZIVR-4 L 1 3.0 - 0.3 45.0 RAGZIVR-4 L 1 3.0 - 0.3 45.0			RA6ZLVR-2	ч	1.0	+ 0.3	130.0	8	487,000
RAGZUNR-H L 1.0 + 0.3 100.0 RAGZUNR-S L 1.0 + 0.3 100.0 RAGZUNR-H L 3.0 - 1.0 4.0.3 RAGZUNR-H L 3.0 - 1.0 4.0.3 RAGZUNR-H L 3.0 - 1.0 4.0.3 RAGZUNR-H L 3.0 - 1.0 4.0.0 RAGZUNR-H L 3.0 - 1.0 4.0.0 RAGZUNR-H L 3.0 - 1.0 4.0.0 RAGZUNR-H L 3.0 - 1.0 30.0 RAGZUNR-H L 3.0 - 1.0 37.5 RAGZUNR-H L 3.0 - 0.3 37.5 RAGZUNR-H L 3.0 - 0.3 45.0			RA6ZLVR-3	Г	1.0	+ 0.3	0.011	ß	1,101,000
RAGZLWR-5 L 1.0 + 0.3 100.0 RAGZLWR-4 L 1.0 + 0.3 90.0 RAGZLWR-4 L 3.0 - 1.0 45.0 RAGZLWR-4 L 3.0 - 1.0 30.0 RAGZLWR-4 L 3.0 - 1.0 30.0 RAGZLWR-4 L 3.0 - 1.0 37.5 RAGZLWR-4 L 3.0 - 1.0 37.5 RAGZLWR-9 L 3.0 - 1.0 37.5 RAGZLWR-9 L 3.0 - 1.0 37.5 RAGZLWR-9 L 3.0 - 0.3 37.5 RAGZLWR-4 L 3.0 - 0.3 45.0 RAGZLWR-4 L 3.0 - 0.3 45.0 RAGZLWR-4 L 3.0 - 0.3 45.0			RA6ZLVR-4	Ч	1.0	+ 0.3	140.0	<u>م</u> ر	205,000
RM6ZLVR-4:3 L 1.0 + 0.3 90.0 RA6ZLVR-4:3 L 1.0 + 0.3 90.0 RA6ZLVR-4:5 L 3.0 - 1.0 45.0 RA6ZLVR-4:6 L 3.0 - 1.0 30.0 RA6ZLVR-3:6 L 3.0 - 1.0 37.5 RA6ZLVR-4:0 L 3.0 - 0.3 45.0 RMI 293504 RA6ZLVR-4:0 L 3.0 - 0.3 45.0 RMI 293504 RA6ZLVR-4:0 L 3.0 - 0.3 45.0			RA6ZLVR-5	11	1.0	+ 0.3	100.0	65	2,237,000
RAGZUNR-L4 L 1.0 +0.3 80.0 RAGZUNR-L4 L 3.0 -1.0 45.0 RAGZUNR-L4 L 3.0 -1.0 20.0 RAGZUNR-L4 L 3.0 -1.0 30.0 RAGZUNR-L4 L 3.0 -1.0 24.0 RAGZUNR-L4 L 3.0 -0.3 60.0 RAGZUNR-L4 L 3.0 -0.3 45.0 RMI 23504 RAGZUNR-L4 1 3.0 -0.3 45.0 RAGZUNR-L4 L			RA6ZLVR-6	Г	1.0	+ 0.3	0.06	8	4,186,000
RAGZIVR-44 RAGZIVR-44 RAGZIVR-44 RAGZIVR-44 RAGZIVR-44 RAGZIVR-44 RAGZIVR-47 RAGZIVR-47 RAGZIVR-48 RAGZIVR-48 RAGZIVR-48 RAGZIVR-48 RAGZIVR-48 RAGZIVR-48 RAGZIVR-48 RAGZIVR-48 RAGZIVR-48 RAGZIVR-40 RAGZIVR-40 RAGZIVR-40 RAGZIVR-40 RAGZIVR-40 RAGZIVR-40 RAGZIVR-40 RAGZIVR-40 RAGZIVR-42 RAGZIVR-44 RA			BAGELYR-64	Ч	1.0	+ 0•3	80.0	52	000° 112 6
MO EXIVR-44 L 3.0 -1.0 45.0 RA6ZLVR-445 L 3.0 -1.0 35.0 RA6ZLVR-47 L 3.0 -1.0 35.0 RA6ZLVR-47 L 3.0 -1.0 35.0 RA6ZLVR-47 L 3.0 -1.0 24.0 RA6ZLVR-37 L 3.0 -1.0 24.0 RA6ZLVR-38 L 3.0 -1.0 37.5 RA6ZLVR-38 L 3.0 -0.3 37.5 RA6ZLVR-48 L 3.0 -0.3 37.5 RA6ZLVR-42 L 3.0 -0.3 37.5 RMI<293504			RA6ZLVR-43	ц	3.0	Ē	60.0	39	10,000
RA6ZLVR-45 L 3.0 -1.0 30.0 RA6ZLVR-46 L 3.0 -1.0 30.0 RA6ZLVR-46 L 3.0 -1.0 30.0 RA6ZLVR-46 L 3.0 -1.0 24.0 RA6ZLVR-46 L 3.0 -1.0 37.5 RA6ZLVR-37 L 3.0 -1.0 37.5 RA6ZLVR-38 L 3.0 -1.0 37.5 RA6ZLVR-40 L 3.0 -0.3 37.5 RA6ZLVR-42 L 3.0 -0.3 37.5 RMI< 293504			RA6ZLVR-44	1	3.0	Ч	45.0	8	10,000
RAGZLWR-46 L 3.0 -1.0 15.0 RAGZLWR-47 L 3.0 -1.0 24.0 RAGZLWR-48 L 3.0 -1.0 24.0 RAGZLWR-48 L 3.0 -1.0 24.0 RAGZLWR-48 L 3.0 -1.0 37.5 RAGZLWR-48 L 3.0 -1.0 37.5 RAGZLWR-39 L 3.0 -0.3 37.5 RAGZLWR-40 L 3.0 -0.3 37.5 RAGZLWR-41 L 3.0 -0.3 37.5 RMT 293504 RAGZLWR-42 L 3.0 -0.3 45.0 No 5510 RAGZLWR-42 L 3.0 -0.3 45.0			RA6ZLVR-45	Ч	3.0	Ч	30.0	ક	210,000
Ra6ZLVR-47 L 3.0 -1.0 24.0 Ra6ZLVR-48 L 3.0 -1.0 24.0 Ra6ZLVR-37 L 3.0 -1.0 37.5 Ra6ZLVR-38 L 3.0 -0.3 60.0 Ra6ZLVR-38 L 3.0 -0.3 60.0 Ra6ZLVR-40 L 3.0 -0.3 52.5 Ra6ZLVR-41 L 3.0 -0.3 52.5 Ra6ZLVR-41 L 3.0 -0.3 45.0 RMT 293504 Ra6ZLVR-42 L 3.0 -0.3 45.0 RMT 293504 RA6ZLVR-42 L 3.0 -0.3 45.0 RMT 293504 RA6ZLVR-42 L 3.0 -0.3 45.0			RA6ZLVR-46	г	9. 0	Ч	15.0	2	15,700,000
RA6ZLVR-46 L 3.0 -1.0 37.5 RA6ZLVR-37 L 3.0 -0.3 60.0 37.5 RA6ZLVR-36 L 3.0 -0.3 60.0 37.5 RA6ZLVR-38 L 3.0 -0.3 60.0 37.5 RA6ZLVR-39 L 3.0 -0.3 37.5 RA6ZLVR-40 L 3.0 -0.3 37.5 RMI<293504			RA6ZLVR-47	ц	3.0	Ч	24.0	Ŗ	83 8,0 00
Mo Triangle Construction of the second secon			RA6ZLVR-48	ц	3.0	Ч	37.5	춦	53,000
MO E41 MO E41 MO E41 MAGZLVR-37 RA6ZLVR-37 RA6ZLVR-38 RA6ZLVR-38 RA6ZLVR-38 RA6ZLVR-40 RMI 293504 RA6ZLVR-42 RA6ZLVR-42 RMI 293504 RA6ZLVR-42 RMI 293504 RA6ZLVR-42 RMI 293504 RMI 29504 RMI 29504 RMI 2950				•					
MA ELIVR-38 L 3.0 - 0.3 37.5 RA6ZLVR-39 L 3.0 - 0.3 52.5 RA6ZLVR-40 L 3.0 - 0.3 52.5 RA6ZLVR-41 L 3.0 - 0.3 45.0 RMI<293504			RA6ZLVR-37	, 1 1	3.0		60.0	39	15,000
RAGZLVR-39 L 3.0 - 0.3 52.5 RAGZLVR-40 L 3.0 - 0.3 45.0 RMI<293504			RA6ZLVR-38	ч	3.0		37.5	đ.	10,000,000
RAGZIVR-40 L 3.0 - 0.3 45.0 RMI 293504 RA6ZIVR-41 L 3.0 - 0.3 39.0 MO E41 L 3.0 - 0.3 39.0 MO E41 L 3.0 - 0.3 39.0			RA6ZLVR-39	ч	3.0		52.5	34	20,000
RMI 293504 RA6ZLVR-41 L 3.0 - 0.3 42.0 RMI 293504 RA6ZLVR-42 L 3.0 - 0.3 39.0 MO TOTAL CONTRUCTION - 0.3 39.0			RA6ZLVR-40	Ч	3.0		45.0	8	39,000
RMI 293504 RA6ZLVR-42 L 3.0 - 0.3 39.0	->		RA6ZLVR-41	Ч	3.0		42.0	51	37,000
	5 1,00		RA6ZLVR-42	ц	3.0		39.0	8	146,000
					~				
							_		
NO FAILURE		No Failure							

Ti 6A1-4V Cond. STA

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153.7	2 C	77,000 27,000 10,000 102,000 074,000 407,000	1,109,000 18,000 32,000 74,000 9,800,000		
^F tu = 1	Cyules Pailinge	77,000 27,000 10,000 2,074,000 4,407,000	9,800 31 37	·····	
jε,	s r _{tu}	እን ይ ይ ይ ይ	808 9 6 5 6 7		
	, Мах. (Xsi)	60.0 90.0 45.0 35.0 30.0	45.0 90.0 39.0 32.5		
	Æ	000000	+ + + + + + + + + + + + + + + + + + +		
	Kt				
	Test Direction	нн тнн ц	ЧЧЧЧЧ		
	Specimen Kumber	RA6ZLVR25 RA6ZLVR26 RA6ZLVR27 RA6ZLVR28 RA6ZLVR28 RA6ZLVR29 RA6ZLVR20 RA6ZLVR30	RA6ZLVR31 RA6ZLVR32 RA6ZLVR33 RA6ZLVR34 RA6ZLVR34 RA6ZLVR36 RA6ZLVR36		
Fatigue Tests	Manufacturer and Heat No.	RMI 293504	RMI 293504		No Failure
7.3.€ F	Thickness (Inches)	↓ 1.00	> 1.00		
		Approv	ed for Public Relea:	se	

Ti 6A1-4V Cond. STA

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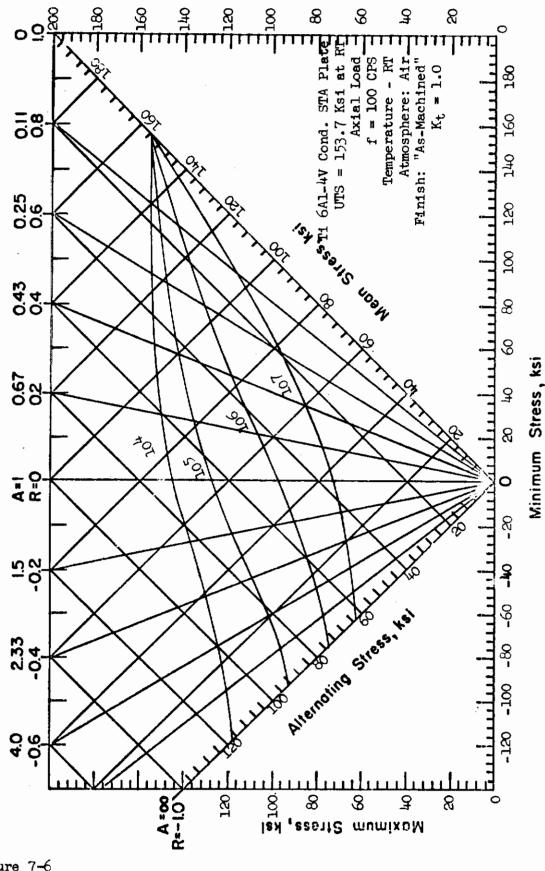


Figure 7-6

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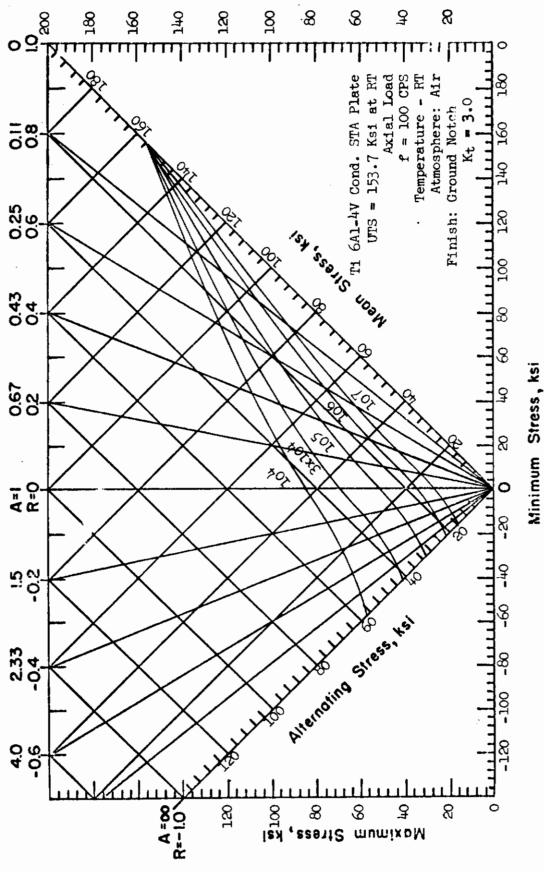


Figure 7-7

Approved for Public Release

Contrails

7.4 **Ti-6A1-6V-2**Sn

7.4.1 T1-6A1-6V-2Sn Cond. A

Approved for Public Release

<pre>% Reduction Area</pre>	
5 Elongstion	9.0 12.5 12.0 12.0 14.0 12.0 13.0 11.0 16.0 16.0
rtu (Kei)	159.1 131.0 122.2 109.9 176.9 145.4 145.4 145.4 164.6 111.6 111.6 111.6 111.6 1116.3 1167.1 1167.1
Fty (Kei)	157.3 118.9 97.3 97.3 171.0 134.6 131.7 116.0 162.1 164.2 164.5 164.5
Test Tempersture (oF)	RT 400 800 800 800 800 800 800 800 800 800
Test Direction	чччччө ччччө
Specimen Number	TV1XLTR1 TV1XLT61 TV1XTT61 TV1XTT61 TV1XTT61 TV1XTT61 TV1XTT61 TV2XLT61 TV2XLT61 TV2XLT61 TV2XLT61 TV2XLT61 TV2XLT61 TV2XLT81 TV3XLT61 TV3XLT61 TV3XLT61 TV3XLT61 TV3XLT61 TV3XTTR1
Manufacturer and Heat No.	Timet G3105 Timet G3212 Timet G3212 Timet G3211 Timet G3211
Thickness (Inches)	00000000000000000000000000000000000000

7.4.1 Annealed

Contrails

_						é	Zo	аź	'na	él.	ŀ				
- daming a while a	<pre>% Reduction Area</pre>	1 1	1 1	I	t) -	11	* .	40.1 50.6	50.9 56.9	34.4	40.7 147.5			
	5 Elongetion	11.0 12.0	13.0	15.0	12.0	10.0	13.0	, ,	17.5 18.5	17.0	17.5 18.0	18.5 19.0			
	rtu (Kei)	161.1 136.8	124.1 112.0	169.5	160.5	139.5	121.2		136.4 136.0	115.1	159.9	127.5		 	
	Fty (Ksi)	158.3 124.8	108.4 99.5	164,3	158.6	127.1 114.7	107.2		154.1 123.9	112.4 102.5	153.8 123.5	103,1			
	Test Tempersture . (oF)	RT 400	600 800	RT	RT	400 600	800 RT		RT 400	600 800	RT	600 800	·		
	Test Direction	цц	цц	EH	ŗ	цч	ЧH		ЧЦ	ы н	E→ E-	4 E-1 E-1			
	Specimen Number	TV4XLTR1 TV4XLT41	TV4XLT61 TV4XLT81	TV4XTTRL	TV5XLTR1	TV5XLT61	TV5XLT81 TV5XTTR1		ТЧТТТТТТ ТТТТТТТТТ	1971YLVT 1871Y IVT	լ ԱԴԴԴԴԴԴԴԴԴ ՄԱԴԴԴԴ ԻՆԻԴ	TATTITAT 19LLATAL			
	Manufacturer and Heat No.	Timet G 881		Timet G 881	Timet G 1537		Timet G 1537		Timet G 393	•		Timet G 393			
	Thickness (Inches)	.250 to .300			App:	rove	1 520 to 300)	1 1 200 to .630	c Re	elea	-500 to .630			

Ti-6Al-6V-2Sn Cond. A

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7.4.1.1 Annealed - Tensile Tests

1000

Tests
Tensile
Annealed

T1-6A1-6V-2Sn Jend. A

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Т

	\$ Reduction Area	4.04	32.9	34.9	33.1	35.7	37.4	35• 4	37.4	8.5 1.6 1.6 1.6 1.6 1.6 1.6 1.6 1.6
	£ Elongetion	17.5	17.0	16.5	16.0	17.5	16.5	17.0	17.5	17.0 19.0 19.0 17.0 15.0 15.0 21.0 20.0
	r _{tu} (Eei)	158.6	161.6	162.2	162.6	165.1	166.9	161.9	166.7	158.0 118.6 118.6 158.0 158.0 117.9 117.9 117.9
	^F ty (Ks1)	157.2	159.0	159.2	160.4	161.8	163.7	159.2	164.3	1149.0 86.6 86.6 86.9 86.9 86.9 86.9 86.9 86.9
	Test Tempersture (oF)	1 22	RT	RT	ЪТ	RT	RT	RT	RT	H 9 8 8 H 9 8 8 H 9 8 8
	Test Direction	г	E+	ы	F	ц	Ħ	г	Ę	
ŝ	Specimen Rumber	TVZYLTR1	TV2YTTR1	TV3YLTR1	TV3YTTR1	TV4YLTR1	TV4TTR1	TATATA	TV5YTTR1	TVJZLTRI TVJZLTVI TVJZLT61 TVJZLT61 TVJZTT61 TVJZTT61 TVJZST61 TVJZST61 TVJZST61 TVJZST61 TVJZST61
Annealed Tensile Tests	Manufacturer and Heat No.	Timet G 2443	Timet G 2443	Timet G 1971	Timet G 1971	Timet G 2504	Timet G 2504	Timet G 3106	Timet G 3106	Timet G 3023
7.4.1.1 Anne	Thickness (Inches)	.500 to .630			Ał	pprc	oved	f ît	500 to .630	8

Contrails

		COW	naus	
\$ Reduction Area	31.7 36.8 11.5	36.8 24.9 34.0 32.6 32.6	32.3 35.4 0.97	
\$ Elongs tion	17.5 17.0 2.5 (*)	16.0 14.5 7.5 20.0 15.0	16.0 18.0 2.5	
Ftn (Keil)	158.8 156.2 157.8	152.0 160.1 152.9 154.3 154.3	152.6 154.0 151.8	
Fty (Kei)	151.6 153.4 145.7	147.4 155.1 143.6 151.0 151.0 144.8	147.2 149.8 143.2	
Test Temperature . (oF)	RT RT	RT RT RT RT RT	RT TR T	x
Test Direction	ក ព ន្ល	기타없 기타없	ᄓ EI S	
Specimen Mumber	TV 2ZL TR1 TV 2ZT TR1 TV 2ZSTR1	TV 3ZLTR1 TV 3ZLTR1 TV 3ZSTR1 TV 4ZLTR1 TV 4ZLTR1 TV 4ZLTR1	TV5ZLTR1 TV5ZTTR1 TV5ZSTR1	
Manufacturer and Heat No.	Timet G 3214	Timet G 2070 Timet G 2070 Timet G 1971 Timet G 1971	Timet G 3024 Timet G 3024	(*) Failed in Gage Mark
Thickness (Inches)	کا. ا	Approved for -P	8 7 N 1901≟c Release	(*) Faile

TH 6A1-6V-2Sn Cond. A

Contrails

		S Meduction	·	
		Percent El montion	่ ส _{&} สธสสส _⊈ ∡ธ _{ู้} ∡ธ _{ู้} ส _ุ ลธ _{ู้}	
		Ftu (Kei)	1588 1589 1581 1581 1581 1581 1581 1581	
	P	rty (rei)	28342222233 83482835856 8.5.5.9.6.1.4.6.	
4 • DIION 1103		Test Temperature (Ow)	EFFFFFF 3338888	
• MIGO UCZ - AQ-TVQ-11	2J	Time (Bra.)		
7	Exposure	Tempersture (of)	400 400 600 600 600 600 600 600 600 600	
Stability Tests		Test	Hadadadadadadadadadadadadadadadadadadad	
		Specimen Mumber	аннанан нананан с о	
Annealed Tensile		Manufacturer and Heat No.		
7.4.1.1.1		Thickness (Tuches)	8	

T1-6A1-6V-2Sn Cond. A

7.4.1.1.1	Annealed Ten:	Tensile Stability	lty	1							,
				Exposure	2		F	f			
Thickness (Inches)	Manufacturer and Heat No.	Specimen Number	Test Direction	Temperature (oF)	Time (Hrs.)	Temperature (°F)	rty (Kei)	rtu (Kei)	Percent Elongstion	<pre>% Reduction Area</pre>	. 1
500 to 630	Timet 6 303	L MMJ: LA L MM		h00	TO	RT	144	150	17	0 1	
3-		TV1YLTW42	ц	1400	100	RT	156	160	17	37	
		EMILIN43	ц	1000	1000	RT	152	157	17	9	
Aj		LOWITYLW61	Ч	600	10	RT	154	158	18	1+1	
ppi		Z9MITITU	ц,	600	001	RT	154	158	17	22	
ro		EVITITW63	н,	89	1000		104	0/T	01	04 06	
ve	+	TEMITALA	-1 F		38	RT	158	165	16	C A e	1
.500 to .630	Timet G 393	TV1YLTW83	ц Ц	800	1000	LT.	162	165	LI .		2
کر م	THMAT G 3023		Ľ	001	JO	RT	145	152	18	34	
P		24MITZIV1	L L	100	201	RT	146	152	17	-	2
ubl	ŧ	LV1ZLTW43	н,	001	000	RT	142 145	151	16	č č	
ic		TOMITZTAT				RT	145	151	17		
: F		20mminiztari	4 F	009	1000	RT	747	154	16		e k
Rel		ISWITZIVI	ц	800	9	RT	148	154	1 6	Ĩ	2
.ea		TV1ZLTW82	ц,	800	01	RT	149	1 156	15 2 a	12	
२ १. १	Timet G 3023	EAWIJZTVI	-1	000	1000	LU .	2(1	0(1	þ	ţ	
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		and an	San an a	elevelanisto francesto constructional actualmente actualmente actualmente actualmente actualmente actualmente a	AND	第二十二十二十二十二十二十二十二十二十二十二十二十二十二十二十二十二十二十二十	and the second set of the providence of the second s	are the fair of the first of the state of th	ne for a for the second sec	orners and a second and a second and a second a second and	A CONTRACTOR OF

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Tensile Tests - Precision Electic Modulus (Tuckerman) 7.4.1.1.2

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8 팀	Manufacturer Specimen and Heat No. Mumber
Ä	THINET G 3105 TVIXUTRI

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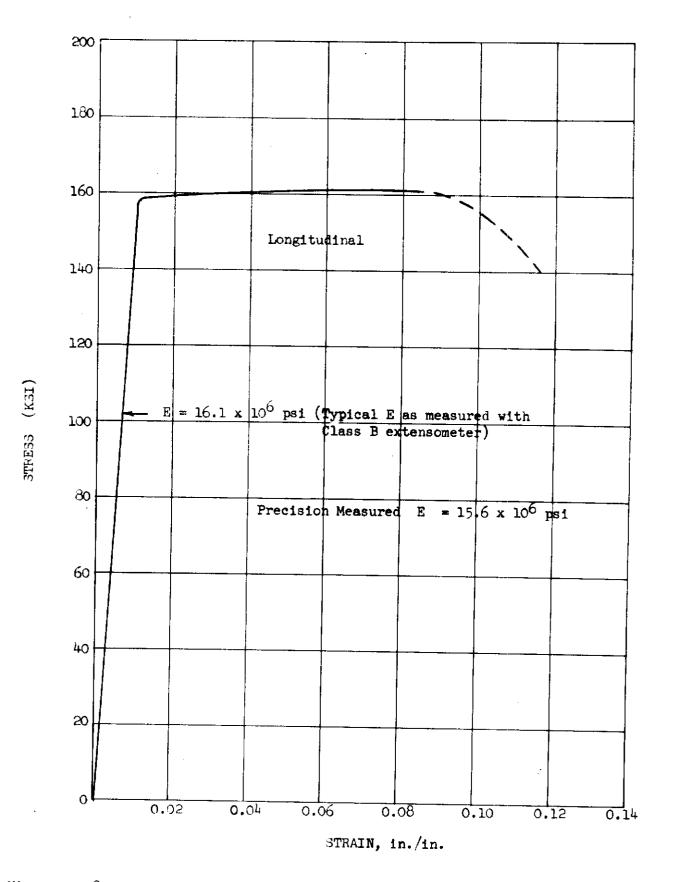


Figure 7-9 Typical Tensile Stress-Strain Curve (full-range) for Annealed Ti-6Al-6V-2Sn Alloy Plate at Room Temperature.

			······································	·					
	Poy (Kal)	157.1 120.9 105.3 97.2	195.3 149.7 135.2 129.2	163.5 177.5	163.8 179.9	163.9 183.4	164.9 185.4		
	Test Temperature (oF)	문 구 00 00 00 00 00 00 00 00 00 00 00 00 00	FF 400000	RT RT	RT	RT	RT RT		
	Test Direction	нччч	E4 E4 E4 E4	цы	나타	ЧH	ц н	、	
	Specimen . Number	TVIXLCRI TVIXLCRI TVIXLCGI TVIXLCGI TVIXLCBI	TV1XTCR1 TV1XTC4.1 TV1XTC6.1 TV1XTC81	TV 2XLCR1 TV 2XTICR1	TV3XLCR1 TV3XTCR1	TV4XLCR1 TV4XTCR1	TV5XLCR1 TV5XTCR1		
COULD TOTOS TOTOS	Manufacturer and Heat No.	Timet G 3105	Timet G 3105	Timet G 3212 Timet G 3212	Timet G 3211 Timet G 3211	Timet G 881 Timet G 881	Timet G 1537 Timet G 1537		
	Thickness (Inches)	.250 to .300					.250 to .300		

T1-6A1-6V-2Sn Cond. A

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Thickness Mandfecturer index Specians moder Teat maker Teat maker Teat maker -500 Timet G 393 TVIIICK1 L R R -500 Timet G 393 TVIIICK1 L M Timet G 393 TVIIICK1 L R R Timet G 393 TVIIICK1 L M R Timet G 393 TVIIICK1 L R R Timet G 393 TVIIICK1 L R R Timet G 393 TVIIICK1 T R R Timet G 393 TVIIICK1 T R R Timet G 393 TVIIICK1 T R R Timet G 2913 TVIICK1 T R R Timet G 293 TVIIICK1 T R R Timet G 2941 TVIIICK1 T R R Timet G 2941 TVIIICK1 T R Timet G 2941 TVIIIC		-				
630 Timet 6 393 TVIYLGH L H Timet 6 393 TVIYTCH1 T H Timet 6 20413 TV2TCR1 L H Timet 6 20413 TV2TCR1 L H Timet 6 2041 TV4YLCR1 T H Timet 6 2504 TV4YLCR1 T H Timet 6 2504 TV4YLCR1 T H Timet 6 2106 TV4YLCR1 T H Timet 6 2106 TV4YLCR1 T H Timet 6 2106 TV4YLCR1 T H	Thickness	Manufacturer	Specimen	Test Dimention	Test Tempersture (OF)	r _{cy} (rei)
.630 Timet G 393 TVLLGAL L M Timet G 393 TVLYLGAL L M Timet G 393 TVLYLCAL L MO Timet G 393 TVLYLCAL L M Timet G 393 TVLYLCAL L M Timet G 393 TVLYTCAL L M Timet G 393 TVLYTCAL T K Timet G 393 TVLYTCAL T K Timet G 393 TVLYTCAL T K Timet G 203 TVLYTCAL T K Timet G 203 TVZTCRI T K K Timet G 2043 TVZTCRI T K K Timet G 2041 TVATCRI T K K Timet G 2041 TVATCRI T K K Timet G 2041 TVATCRI T K K <tr< th=""><th></th><th></th><th></th><th></th><th>Ē</th><th>1 471</th></tr<>					Ē	1 471
Timet G 393 TVINLGAI L 400 Timet G 393 TVINTGBI T R Timet G 293 TVINTGBI T R Timet G 203 TVINTGBI T R Timet G 20413 TVZYLGBI L R Timet G 20413 TVZYLGBI L R Timet G 2041 TVZYLGBI T R Timet G 2041 TVXYLGBI T R Timet G 2106 TVXYLGBI T R Timet G 3106 TVXYLGBI T R .630 Timet G 3106 TVXYLGBI T		5	THOTITAL	·	UT.	
Timet G 393 TV14LGG1 L 600 Timet G 393 TV1YTGb1 L 600 Timet G 393 TV1YTGb1 T R Timet G 2913 TV2YLGB1 T R Timet G 2014 TV2YLCB1 L R Timet G 1971 TV2YLCB1 L R Timet G 1971 TV3YLCB1 L R Timet G 2504 TV4YLCB1 T R Timet G 2504 TV4YLCB1 T R Timet G 2106 TV4YLCB1 T R Timet G 3106 TV5YLCB1 T R	-4	ტ	TUTATCHI	Ч	100	
Timet G 393 TVLYLGB1 L B00 Timet G 393 TVLYTCR1 T T B00 Timet G 393 TVLYTCB1 T T B00 Timet G 393 TVLYTCB1 T T B00 Timet G 393 TVLYTCB1 T T B00 Timet G 2943 TVLYTCB1 T T RT Timet G 2943 TVZYLCR1 L RT Timet G 1971 TV3YLCR1 L RT Timet G 1971 TV3YLCR1 L RT Timet G 1971 TV3YLCR1 L RT Timet G 204 TV4YLCR1 T RT Timet G 204 TV4YLCR1 T RT Timet G 2106 TV5YLCR1 L RT Timet G 3106 TV5YLCR1 T RT		ტ	TV14LC61	Г	600	118.2
Timet G 393 TVIYTCR1 T H NT Timet G 393 TVIYTC61 T H 400 Timet G 393 TVIYTC61 T H 400 Timet G 393 TVIYTC61 T H 800 Timet G 2943 TVZYLCR1 L RT 800 Timet G 2943 TVZYLCR1 L RT RT Timet G 2943 TVZYLCR1 L RT RT Timet G 1971 TV3YLCR1 L RT RT Timet G 1971 TV3YLCR1 L RT RT Timet G 2904 TV4YLCR1 T RT RT Timet G 2006 TV5YLCR1 L RT RT G306 Timet G 3106 TV5YLCR1 T RT ATimet G 3106 TV5YLCR1 T RT RT		ტ	TV1YLC81	Г	800	106.1
Timet G 393 TVLYTCkl1 T thot Timet G 393 TVLYTC61 T H H00 Timet G 393 TVLYTC61 T H H H Timet G 2443 TV2YLCR1 L R 800 800 Timet G 2443 TV2YLCR1 L R 87 600 Timet G 2443 TV2YLCR1 L R 87 800 Timet G 1971 TV3YLCR1 L R 87 87 Timet G 2504 TV4YLCR1 L R 87 87 Timet G 2504 TV4YLCR1 L R 87 87 Timet G 2106 TV4YLCR1 L R 87 87 G30 Timet G 3106 TV5YLCR1 L R 87 .630 Timet G 3106 TV5YTCR1 T R 87		ტ	TVLYTCRI	E	RT	167.2
Timet G 393TUNTG61TF600Timet G 393TUNTC81F800Timet G 2443TV2YTCR1LRTTimet G 2443TV2YTCR1LRTTimet G 2443TV2YTCR1LRTTimet G 2971TV3YTCR1LRTTimet G 1971TV3YTCR1LRTTimet G 2904TV4YTCR1LRTTimet G 2904TV4YTCR1LRTTimet G 2904TV4YTCR1LRTTimet G 2106TV5YTCR1LRTTimet G 3106TV5YTCR1TRT	-	Ċ	TVLYTC41	£-	001	127.9
Timet G 393 TVIYTCB1 F 800 Timet G 2443 TV2YLCR1 L F RT Timet G 2443 TV2YLCR1 L R RT Timet G 1971 TV3YTCR1 L R RT Timet G 1971 TV3YTCR1 L R RT Timet G 2504 TV4YTCR1 L R RT Timet G 2504 TV4YTCR1 L R RT Timet G 3106 TV5YLCR1 L R RT Timet G 3106 TV5YLCR1 L R RT Timet G 3106 TV5YTCR1 T R RT		ტ	TVIYTC61	Т	600	117.7
Timet G 2443TV2YICR1LRTimet G 2443TV2YTCR1LRTimet G 2971TV3YICR1LRTimet G 1971TV3YICR1LRTimet G 2504TV4YICR1LRTimet G 2504TV4YICR1LRTimet G 2504TV4YICR1LRTimet G 2504TV4YICR1RRTimet G 2504TV4YICR1RRTimet G 3106TV5YICR1LRRRRR		G	TV1YTC81	H	800	105.3
Timet G 2443TVZYTCR1TTTimet G 1971TV3YLCR1LRTTimet G 1971TV3YTCR1LRTTimet G 2504TV4YLCR1LRTTimet G 2504TV4YLCR1LRTTimet G 2504TV4YTCR1LRTTimet G 2106TV5YLCR1LRT.630Timet G 3106TV5YTCR1LRT		Ċ	TV2YLCR1	ц	RT	170.4
Timet G 1971TV3XLCR1LRTimet G 1971TV3XTCR1TRTimet G 2504TV4XLCR1LRTimet G 2504TV4YTCR1TRTimet G 2106TV5YLCR1LRTimet G 3106TV5YLCR1LR		Ċ	TV2YTCR1	Н	RT	173.7
		Ċ	TTTTTT	L	RT	171.0
Timet G 2504TV4YLCR1LRTTimet G 2504TV4YTCR1TRTimet G 2106TV5YLCR1LRTRTTimet G 3106TV5YLCR1LRTRTTimet G 3106TV5YTCR1TRT		0	TV3YTCR1	H	RT	174.3
Timet G 2504 TV4YLCR1 L RT Timet G 2504 TV4YTCR1 T R RT Timet G 3106 TV5YLCR1 L L RT Timet G 3106 TV5YTCR1 I R RT RT RT RT RT						;
- G30 Timet G 2504 TV4YTCR1 T Timet G 3106 TV5YICR1 L Timet G 3106 TV5YTCR1 T T RT RT RT RT		ტ	TV4YLCR1	ц	RT	172.3
.630 Timet G 3106 TV5YLCR1 L RT Timet G 3106 TV5YTCR1 T R RT RT RT		Ċ	TV4YTCR1	E-	RT	180.2
.630 Timet G 3106 TV5YTCR1 F		Ċ	TV5YLCR1	ц	RT	172.0
		പ	TV5YTCR1	Н	RT	170.8
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T1-6A1-6V-2Sn Cond. A

Contrails

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TVIZIC41
TVIZIC61
TV1ZLC81
TVLZTCR1
TULZTC41
TV1ZTC61
TV1ZTC81
TVIZSCRI
TVLZSC41
TVIZSC61
TVIZSC81
TV2ZLCR1
TV2ZTCR1
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TV3ZLCR1
TV3ZSCR1

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Contrails

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r _{mu} (Keil)	168.2 155.4 157.7	166.3 157.0 144.5	•
Test Temperature (or)	RT TR RT	RT RT RT	
Test Direction	고 다 없	번 타 없	
Specimen Number	TV4ZLCRL TV4ZTCRL TV4ZSCR1	TV5ZLCR1 TV5ZTCR1 TV5ZSCR1	
Manufacturer and Heat No.	Timet G 1971 Timet G 1971	Timet G 3024 Timet G 3024	
Thickness (Inches)	≥ 1.00	Z 1.00	

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T		
7 (1641)	252.5 213.2 187.3 187.3 231.3 274.6 274.6 231.3 231.3 237.2 237.2 237.2 237.2 253.8 253.8 253.8	273.7 329.6 266.0 331.6
Fint (Kai) (2% Offert)	224.0 186.4 169.3 148.0 150.0 150.0 212.2 22.2 212.2 2.2 2.2	228.0 249.2 222.2 244.7 244.7
Test Temperature (of)	RT 400 800 800 800 400 800 800 800 800 800	RT RT RT
e∕⊅		1.5 2.0 2.1 2.0
Test Direction		нн нн
Specimen Number	TVLXLBLR1 TVLXLB161 TVLXLB161 TVLXLB161 TVLXTB181 TVLXTB161 TVLXTB161 TVLXTB161 TVLXTB261 TVLXLB261 TVLXLB261 TVLXTB261 TVLXTB281 TVLXTB281 TVLXTB281 TVLXTB281 TVLXTB281	TV 2XLBLR1 TV 2XLB2R1 TV 3XLB1R1 TV 3XLB1R1 TV 3XLB2R1
Manufacturer and Heat No.	Timet G 3105 Timet G 3105	Timet G 3212 Timet G 3212 Timet G 3211 Timet G 3211
Thickness (Inches)	.250 to .300	.250 to .300

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250.0 323.9	266.8 354.7	267.8 238.1	200.1 264.4 330.1	255.5 235.0 392.9	277.9 318 .9	274.5 376.2	
221.7 255.7	226.4 267.3	221.6 193.7	1/0.0 222.5 259.1	202.9 176.4 307.1	230.4	234.3 296.2	
RT RT	RT RT	RT 400	600 ВОО ВП	800 800 81	RT RT	, RT RT	
1.5 2.0	л-5 2.0	1.5 2.1		0000	1.5 2.0	1.5 2.0	
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TV4,XLB1R1 TV3XLB2R1	TV5XLB1R1 TV5XLB2R1	TVIYLBIRI TVIYLBIAI	TVIILBIOL TVIYLBIÅL TVIYTBIRL TVIYLB2RI	TV11LB241 TV1YLB261 TV1YLB281 TV1YTB2R1	TV2YLB1R1 TV2YLB2R1	TV3YLB1R1 TV3YLB2R1	
Timet G 881 Timet G 881	Timet G 1537 Timet G 1537	666		5 0 0 0	Timet G 2443 Timet G 2443	Timet G 1971 Timet G 1971	÷
.250 to .300	.250 to .300	.500 to .630				.500 to .630	
	to .300 Timet G 881 TV4XLB1R1 L 1.5 RT 221.7 Timet G 881 TV3XLB2R1 L 2.0 RT 255.7	to.300 Timet G 881 TV4XLB1R1 L 1.5 RT 221.7 Timet G 881 TV3XLB2R1 L 2.0 RT 255.7 Timet G 1537 TV5XLB1R1 L 1.5 RT 226.4 Timet G 1537 TV5XLB2R1 L 1.5 RT 226.4 Timet G 1537 TV5XLB2R1 L 2.0 RT 226.4	to .300 Timet G 881 TV4XLBIR1 L 1.5 RT 221.7 Timet G 881 TV3XLB2R1 L 2.0 RT 255.7 Timet G 1537 TV5XLB1R1 L 2.0 RT 256.4 Timet G 1537 TV5XLB2R1 L 2.0 RT 226.4 to .300 Timet G 1537 TV5XLB2R1 L 2.0 RT 267.3 to .630 Timet G 393 TV1YLB1R1 L 1.5 RT 221.6 to .630 Timet G 393 TV1YLB1R1 L 1.5 1.0 1.5	to.300 Timet G 881 TV4XLBIR1 L 1.5 RT 221.7 Timet G 881 TV3XLB2R1 L 1.5 RT 255.7 Timet G 881 TV3XLB1R1 L 1.5 RT 255.7 Timet G 1537 TV5XLB1R1 L 2.0 RT 255.7 Timet G 1537 TV5XLB1R1 L 2.0 RT 256.4 Timet G 1537 TV5XLB2R1 L 1.5 RT 267.3 to.300 Timet G 393 TV1YLB1R1 L 1.5 RT 221.6 Timet G 393 TV1YLB161 L 1.5 800 193.7 Timet G 393 TV1YLB161 L 1.5 800 160.0 Timet G 393 TV1YLB211 L 2.0 RT 252.5 Timet G 393 TV1YLB211 L	to.300 Timet G 881 TW4KLBIR1 L 1.5 RT 221.7 to.300 Timet G 881 TV3KLBIR1 L 2.0 RT 255.7 to.300 Timet G 1537 TV5XLBIR1 L 2.0 RT 255.7 to.300 Timet G 1537 TV5XLBIR1 L 2.0 RT 256.4 to.300 Timet G 1537 TV5XLBIR1 L 1.5 RT 256.4 to.530 Timet G 393 TV1KLBIR1 L 1.5 RT 267.3 to.630 Timet G 393 TV1KLBIR1 L 1.5 RT 221.6 Timet G 393 TV1KLB2R1 L 2.0 RT 259.1 Timet G 393 TV1KLB2R1 L 2.0 RT 259.1 Timet G 393 TV1KLB2R1 L 2.0 800 <td< td=""><td>to<.300 Timet G 881 TV4XLBLR1 L 1.5 RT 221.7 to<.300 Timet G 1537 TV3XLB2R1 L 1.5 RT 225.7 to<.300 Timet G 1537 TV5XLB1R1 L 1.5 RT 255.7 to<.300 Timet G 1537 TV5XLB2R1 L 2.0 RT 226.4 to<.300 Timet G 1537 TV5XLB2R1 L 1.5 RT 226.4 to<.630 Timet G 1537 TV1XLB1R1 L 1.5 RT 221.6 to<.630 Timet G 393 TV1XLB161 L 1.5 RT 221.6 to<.630 Timet G 393 TV1XLB161 L 1.5 RT 221.6 Timet G 393 TV1XLB201 L 1.5 RT 221.6 Timet G 393 TV1XLB201 L 2.0 RT 222.5 Timet G 393 TV1XLB201 L 2.0 RT 222.5 Timet G 393 TV1XLB201 L 2.0 800 1600 220.6 Timet G 393 TV1XLB201 L</td><td>to .300 Timet G 881 TW4XLBIR1 L 1.5 RT 221.7 timet G 881 TW4XLBIR1 L 1.5 RT 255.7 timet G 137 TW5XLB2R1 L 1.5 RT 255.7 to .300 Timet G 137 TW5XLB2R1 L 1.5 RT 256.4 to .300 Timet G 137 TW7XLB1R1 L 1.5 RT 256.4 trimet G 393 TW1XLB1R1 L 1.5 RT 251.6 Timet G 393 TW1XLB2R1 L 1.5 RT 222.6 Timet G 393 TW1XLB2R1 L 1.5 RT 222.6 Timet G 393 TW1XLB2R1 L 1.5 RT 222.6 Timet G 393 TW1XLB2R1 L 2.0 800 160.0 Timet G 393 TW1XLB2R1 L 2.0 800 166.0 Timet G 393 TW1XLB2R1 L 2.0 800 166.0 Timet G 393 TW1XLB2R1 L 2.0 800 222.5 Timet G 2443 TW2XLB2R1</td></td<>	to<.300 Timet G 881 TV4XLBLR1 L 1.5 RT 221.7 to<.300 Timet G 1537 TV3XLB2R1 L 1.5 RT 225.7 to<.300 Timet G 1537 TV5XLB1R1 L 1.5 RT 255.7 to<.300 Timet G 1537 TV5XLB2R1 L 2.0 RT 226.4 to<.300 Timet G 1537 TV5XLB2R1 L 1.5 RT 226.4 to<.630 Timet G 1537 TV1XLB1R1 L 1.5 RT 221.6 to<.630 Timet G 393 TV1XLB161 L 1.5 RT 221.6 to<.630 Timet G 393 TV1XLB161 L 1.5 RT 221.6 Timet G 393 TV1XLB201 L 1.5 RT 221.6 Timet G 393 TV1XLB201 L 2.0 RT 222.5 Timet G 393 TV1XLB201 L 2.0 RT 222.5 Timet G 393 TV1XLB201 L 2.0 800 1600 220.6 Timet G 393 TV1XLB201 L	to .300 Timet G 881 TW4XLBIR1 L 1.5 RT 221.7 timet G 881 TW4XLBIR1 L 1.5 RT 255.7 timet G 137 TW5XLB2R1 L 1.5 RT 255.7 to .300 Timet G 137 TW5XLB2R1 L 1.5 RT 256.4 to .300 Timet G 137 TW7XLB1R1 L 1.5 RT 256.4 trimet G 393 TW1XLB1R1 L 1.5 RT 251.6 Timet G 393 TW1XLB2R1 L 1.5 RT 222.6 Timet G 393 TW1XLB2R1 L 1.5 RT 222.6 Timet G 393 TW1XLB2R1 L 1.5 RT 222.6 Timet G 393 TW1XLB2R1 L 2.0 800 160.0 Timet G 393 TW1XLB2R1 L 2.0 800 166.0 Timet G 393 TW1XLB2R1 L 2.0 800 166.0 Timet G 393 TW1XLB2R1 L 2.0 800 222.5 Timet G 2443 TW2XLB2R1

T1-6A1-6V-2Sn Cond. A

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Thickness (Inches)	Manufacturer and Heat No.	Specimen Mumber	Test Direction	e∕D	Test Tempers ture (oF)	(Kai) (2% Offeet)	Paurs (Keil)
-							
	5 0	TALELY PORT	ц,		RT	235.1	276.2
•	TIMET U ZDU4	THERT	J	2°0	RT	284.0	356.0
_	Timet G 3106	TV3YLB1R1	ц	1.5	RT	229.7	281.1
.500 to .630	Timet G 3106	TV5YLB2R1	Г	2.0	RT	266.4	342.1
	mimet 6 2000	ומומזקואי	F	Ļ	Ē		
	5 0	LALAUZIVI	a	с и 	J.V.	6.422	202.4
•	9 0	TVIZIAL		י ה קייני קייני	400 600	1.201	0.(22 200 E
	Ċ	TV1ZLB181	ц	1 1	800	154.3	185.0
	Timet G 3023	TVLZTBLR1	H	1.5	RT	217.3	256.4
	Timet G 3023	TVLZLEBIR1	ILE	1.5	RT	215.6	244.9
	ტ	TVLZTEBLR1	TE	1.5	RT	200.6	212.9
	G	TV1ZLB2R1	Г	2.0	RT	277.5	340.0
	Ċ	TULZLB241	1	2.0	00†	209.1	280.1
	Ċ	TV1ZLB261	Ч	2.0	600	199.5	252.0
	ტ	TV1ZLB281	Г	2.0	800	178.0	231.8
	Ģ	TV1ZTB2R1	H	2.0	RT	253.4	327.4
-		TV1ZLEB2R1	TE	2.0	RT	267.7	317.4
≥ 1:00	Timet G 3023	TVIZTEB2R1	TE	2.0	RT	256.4	294.5
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T1-6A1-6V-23n Cond. A

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7.4.1.3 Annealed Bearing Tests

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Thickness (Inches)	Manufacturer and Heat No.	Specimen Number	Test Direction	e/D	Test Tesperature (oF)	Fint (Kal) (2% Offeet)	Finut (Lat)	
> 1.00	Timet G 3214 Timet G 3214	TV2ZLB1R1 TV2ZLB2R1	цц	1.5 2.0	RT RT	211.8 275.0	263.9 (1)	
	Timet G 2070 Timet G 2070	TV 3ZLB1R1 TV 3ZLB2R1	ЪЧ	1.5 2.0	RT RT	220.0 264.1	265.5 338.0	
oprove	Timet G 1471 Timet G 1471	TV4ZLB1R1 TV4ZLB2R1	ЧЧ	1.5 2.0	RT RT	214.8 247.7	259.0 320.7	C
≥ 1 ¹ 00	Timet G 3023 Timet G 3024	TV5ZLB1R1 TV5ZLB2R1	цц	1.5 2.0	RT RT	220.7 255.5	266.7 350.8	Iou
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	allure							-

T1-6A1-6V-23n Cond. A

7.4.1.3 Annealed Bearing Tests

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Thíckness (Inches)	Manufacturer and Heat No.	Specimen Number	Test Direction	Test Temperature (°T)	Fau (Kei)
.250 to .300	Timet G 3105	TALSTAL	ц	RT	.95.5
		TV1XLs41	Ч	1400	80.0
•		TV1XLS61	ц	600	72.5
		TV1XLS81	ц	800	68.8
		TALXTSR1	П	RT	108.7
		T4STXTVT	EI	7100	92.3
		19STX IVT	F	600	85.7
	Timet G 3105	T8STXTVT	E+	800	80.7
	Timet G 3212	TV2XLSR1	ц	RT	100.0
	Timet G 3211	TV3XLSR1	ь	RT	102.4
	Timet G 881	TV4XL3R1	ц	Ъ	1.101
.250 to .300	Timet G 1537	TV3XLSR1	ц	RT	98.8
.500 to .630	Timet G 393	TVLYLSRL	н	RT	105.7
	-	L ⁴ SJYLAT	ц	100	92.5
		LOSIYIVT	Ч	600	74.8
	- *	T8SIYIVI	ц	800	78.5
	Timet G 393	TASTYLVT	E4	RT	
	Timet G 2443	TV2YLSR1	Ч	Ł	7.0II
	Timet G 1471	TV3YLSR1	ы	RT	100.7
~	Timet G 2504	TV4YLSR1	ч	RT	113.0
.500 to .630	Timet G 3106	TV5YLSR1	ц	RT	99.8

Ti-6Al-6V-2Sn Cond. A

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7.4.1.4 Annealed	Shear Tests				
Thickness	Manufacturer	Spectmen	Test	Test Tempersture	Fau
(Inches)	and Heat No.	Number	Direction	(4 0)	(Kei)
> 1.00	Timet G 3023	TVIZLSR1	ц	RT	2.104.2
-1	-	TV1ZLS41	ч	100	86.3
•		TV1ZLS61	Г	600	77.8
		TV1ZLS81	Г	800	72.9
	Timet 6 3023	TV1ZTSR1	Ч	RT	-
	Timet G 3214	TV2XLSR1	Ц	RT	100.6
	Timet G 2070	TV3ZLSR1	.I	RT	102.3
;	Timet G 1971	TV4 ZLSR1	ц	RT	102.7
× 1.00	Timet G 3024	TV5ZLSR1	ц	RT	100.0
		ν.			

Ti-6Al-6V-2Sn Cond. A

Contrails

										(Ć	a	ĸÍ)	a	il.	đ.			
	Load at	Failure (1bs)		13/20	0066		14100	14250	2710	13420	11660	0481 0466	13100	9700	8620	8350	8000		
	Net Fracture	Strength, ^a n (Kai)		0.00	0.42	0.95	20.6	76.0	71.0	53.8	58.0	62-0 37-4	58.2	48.5	38.5	9.14	32.0		
	Kr.	Ks1 Vin				0.45	37.0	34.4	0.04	33.0	33.6	37.6	32.0	36.0	29.4	32.2	40.0		
	X	Factor		6 6	0.132	36.700	6.604	70 9.9	24.509	6.48	6.72	35.457 6.48	7.31	6.72	6.3 ⁴	6.604	6.96		
	8	Crack Depth	000		021.		. 770	ę.	-270	<u>8</u>	8		.830	.780	.750	.770	.80		
	Load	Pop-in (lbs)			36	0 or	895	200	1640	5100	8	2800 1140	14400	5350	14620	t+900	6400		
	l	Temp.	Ę			Te	E.	RT	Ł	E	2	¥ E	퇎	R	Ŀ	RT	R	,	
	sure	Time Hrs.)			٩ş	3	1000	2	90 01	80	ទុ		3	ı	I	1	۱	×.	
	Expos	Temp.		2	<u>}</u>	}	Ş,	8 8	8	8	88	88	1	1	ı	1	ł		Specimen
	Test	Direc- tion		구 -	-	4	н	Ы	ц	Ч	н ,	44	E+	ч	Ч	н	r		
css Tests		Number					EthMITIXTAL	TVIXUTH61	TVIXILTIN621-1	TVIXIJW63	18MJTXTAL	TVIXLW83	TATTAL	TV2XUFR1	TV3XLFR1	TV4XLFR1	TAZTIKI		(1) Subsize
Fracture Toughness Tests		and Heat No.			•								Timet G 3105	Timet G 3212	Timet G 3211	Timet G 881	Timet G 1537		
7.4.1.5		(inches)		mc nc.	4		A	pr	pr	ov	eo	l fo	r Pı	10]i	5 - ^R	elea	.250 - 300	<u> </u>	

Ti-6Al-6V-2Sn Cond. A

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		(Contrails		
= 158.0	N (Cycles to Psilure)	5,000 104,000 104,000 225,000 10,000,000 1,982,000 1,982,000	288,000 20,000 24,000 1,361,000 9,700,000 6,000 126,000		
Ftu	\$ Ftu	\$ # % % 5 4 % 4 %	ଝାରୁ ଅଷ୍ଟ ଅଷ୍ଟ ଅଷ୍ଟ		
	Max. (Kai)	70.0 35.05 43.75 28.075 38.0 38.0 38.0	35.0 61.25 52.5 443.75 31.5 28.0 28.0 145.5		
Cond. A	pz.		\$ 9 9 9 9 9 9 9 9 ~~~~		
6A1 - 6V-2Sn	Бt				
ΙL	Test Direction	н арарара	царарара		
Tests .	Specimen Number	TVLZLVR40 TVLZLVR50 TVLZLVR51 TVLZLVR51 TVLZLVR52 TVLZLVR54 TVLZLVR55 TVLZLVR55	TV1ZLVR57 TV1ZLVR58 TV1ZLVR59 TV1ZLVR60 TV1ZLVR61 TV1ZLVR62 TV1ZLVR63 TV1ZLVR63 TV1ZLVR63		
Annealed Fatigue Te	Manufacturer and Heat No.	Timet G 3023	Timet G 3023		Ro Failure
7.4.1.6 A	Thickness (Inches)	1. 00	00 1		2 1 * -
		Approve	ed for Public Relea	ase.	

the all a E B

H (Cycles to Failure)	7, 000 114, 000 68, 000 3,706, 000 1,883, 000 4, 841, 000 7,850, 000	13, 200 14, 200 18, 200 18, 200 18, 200 18, 200 18, 200 19, 10, 200 19, 200 19, 200 19, 200 10, 10, 200 10, 2	
	,		
\$ Fta	K# 888 8 9 9	9 G 2 単 2 第 8 2 5 7 7 7 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	
Max. (Kei)	2002 2002 2002 2002 2002 2002	96.25 78.75 72.5 113.75 87.5 113.75	
æ	00000000	ႜႜႜႜႜႜႜႜႜႜႜႜႜႜႜႜႜႜႜႜႜႜႜႜႜႜႜႜႜႜႜႜႜႜႜႜႜႜ	
Kt	000000000 		
Test Direction		а чччччччч	
Specimen Number	TVLXLVR33 TVLXLVR34 TVLXLVR34 TVLXLVR35 TVLXLVR36 TVLXLVR38 TVLXLVR38 TVLXLVR38 TVLXLVR39	TVLZLVR4L2 TVLZLVR4L2 TVLZLVR415 TVLZLVR415 TVLZLVR415 TVLZLVR416 TVLZLVR416 TVR146 TVR146	
Manufacturer and Heat No.	Timet G 3023	Timet G 3023	Failure
Thickness (Inches)	×1. 20.	1.8	z t
	Manufacturer Specimen Test Kt R Max. 5 and Heat No. Number Direction	Thickness Manufacturer Specimen Test K Inches) and Heat No. Thickness And Heat No. and Heat No. Thinet G 3023 TVLXLVR33 L Thick G 3023 TVLXLVR33 L 3.0 TVLXLVR35 L 3.0 0 700.0 TVLXLVR36 L 3.0 0 700.0 TVLXLVR39 L 3.0 0 31.5 TVLXLVR39 L 3.0 0 31.5 TVLXLVR39 L 3.0 0 22.5 TVLXLVR39 L 3.0 0 22.5 TVLXLVR39 L 3.0 0 22.0 TVLXLVR39 L 3.0 0 22.5 TVLXLVR39 L 3.0 0 22.5 TVLXLVR39 L 3.0 0 22.0 TVLXLVR39 L 3.0 0 22.0 TVLXLVR30 L 3.0 0 22.0 TVLXLVR30 L 3.0 0 22.0 TVLXLVR30<	Manufacturer and lisest flo. Speciann mulber Teat and lisest flo. Part and mulber Teat and lisest flo. Part and mulber Table t and lisest flo. Part and biretion R Mar. Nat. Thinet G 3023 TYLXUNR33 L 3.0 0 36.0 37.5 31.5 Thinet G 3023 TVLXUNR36 L 3.0 0 31.5 31.5 Thinet G 3023 TVLXUNR36 L 3.0 0 31.5 31.5 TVLXUNR36 L 3.0 0 31.0 0 31.5 31.5 TVLXUNR36 L 3.0 0 0 31.5 31.5 31.5 TVLXUNR36 L 3.0 0 0 31.5 31.5 31.5 31.5 TVLXUNR4 L 3.0 0 0 31.6 45.5 45.5 45.5 47.5 47.5 47.5 47.5 47.5 47.5 47.5 47.5 47.5 47.5 47.5 47.5<

Ti 6A1-6V-2Sn Cond. A

		Contrails
$F_{tu} = 158.0$	N (Cycles to Failure)	5,000 97,000 97,000 374,000 260,000 15,000 15,000 11,200,000 11,200,000 11,200,000 11,200,000 11,200,000 11,200,000 17,000 17,000 17,000
-	% F _{tu}	^ጽ ዻፚፘ፞፞፞፞ቘፚጜ፟፟ፚ፟ጜ፟፟ፚ፝ፚ፝ፚፚፚጜ ዾዾፚፚ፟፟፟፟፟፟ፚ፟፟፟ፚ፝ፚፚፚፚ ዾዾፚፚ፟፟፟፟፟፟
	Мах. (Ks1)	130. 85. 7. 7. 12. 13. 15. 15. 15. 15. 15. 15. 15. 15. 15. 15. 15. 15. 15.
d. A	œ.	444444 www.www.ww
óv-2Sn Cond.	Kt	0000000 0000000 111111 111111
Ti-6A1-6V-2Sn	Test Direction	арараа арараа
Tests	Specimen Number	TVIZLVR17 TVIZLVR19 TVIZLVR19 TVIZLVR20 TVIZLVR20 TVIZLVR21 TVIZLVR25 TVIZLVR26 TVIZLVR28 TVIZLVR29 TVIZLVR29 TVIZLVR30 TVIZLVR31 TVIZLVR31 TVIZLVR31
Annealed Fatigue Te	Manufacturer and Heat No.	Timet G 3023 Timet G 3023
7.4.1.€ A	Thickness (Inches)	21.00
		Approved for Public Release - 208 -

Cond.
6Al-6V-2Sn
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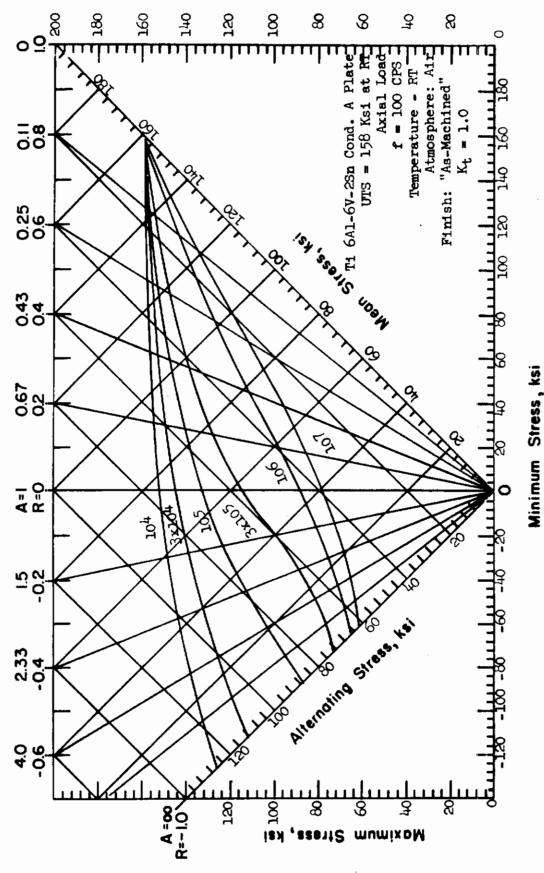
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I (Cyeles to Feilure)	8,000 194,000 70,000 268,000 339,000 339,000 583,000 59,000 585,000 738,000 738,000 738,000
\$ T _{ta}	цая 8 кр га 8 к 8 к 8 к 8 к 8 к 8 к 8 к 8 к 8 к 8
м Маж. (Kei)	160,000 145,000 135,000 125,000 115,000 1155,000 1145,000 1145,000 1146,000 110,000 110,000 110,000
6 4	
R.	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
Test Direction	нанан н ананан
Speci lm en Kumber	TVIZLVR-1 TVIZLVR-2 TVIZLVR-3 TVIZLVR-5 TVIZLVR-6 TVIZLVR-6 TVIZLVR-6 TVIZLVR-8 TVIZLVR-10 TVIZLVR-11 TVIZLVR-12 TVIZLVR-12 TVIZLVR-15 TVIZLVR-15 TVIZLVR-15 TVIZLVR-15 TVIZLVR-15
Manufacturer and Heat No.	Timet G 3023
Thickness (Inches)	× 1.00

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Contrails

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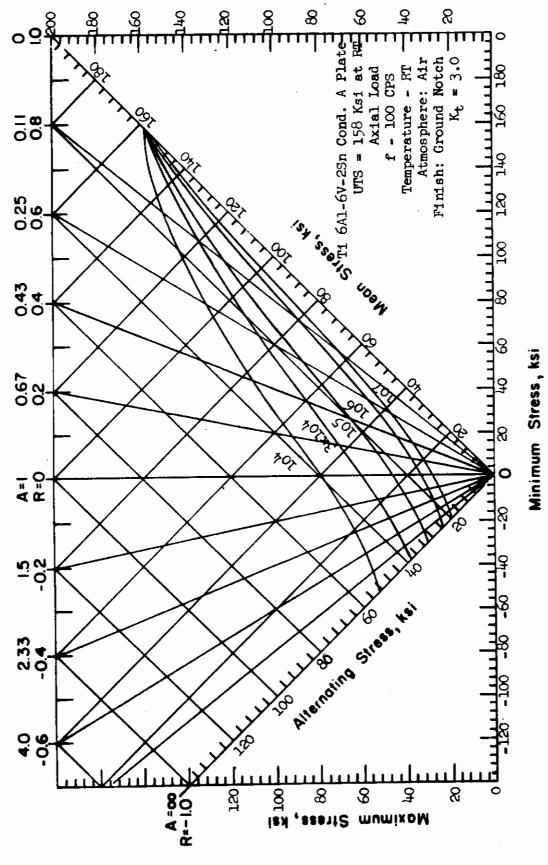


Figure 7-10

Contrails

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7.4.2 Ti 6Al-6V-2Sn Cond. STA

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	g			_	_			_		_				_	_				-						 	
	\$ Reduction Area	, 1	ı	t	1	1	28	38	- 42	63	20	39	31	45	32	20	19	24	30	34	26	54	31			
	\$ Elongetion	8	6	6	12	10	0 F	15	12	17	7			12	٥	8	8	0	Ĩ	12	ω	10	10			
STA	F _{tu} (Kei)	184.0	153.8	142.6	133.1	191.2	ח, ראר	158.6	148.8	141.6	182.6	160.3	149.6	140.8	181.0	183.8	188.0	183.0	184.0	180.8	188.0	188.5	187.7			
Cond.	Fty (Ks1)	176.5	139.7	123.6	6.711	186.0	174.0	143.5	133.0	123.3	174.3	145.6	133.0	122.9	178.0	178.2	182.6	178.0	175.9	174.O	183.0	176.8	180.8			
Ti 6A1-6V-2Sn	Test Tempersture . (07)	RT	1400	600	800	RT	ця	00 1	600	800	RT	100	600	800	RT	RT .	RT	Ē	122	RT	RT	RT	RT			
	Test Direction	F	ы	Г	Ч	£H	Ľ	ч	ц	ц	E	FI	£⊣	E	Ч	ц	f	<u>ь.</u>	<u>ن</u> ا	E	ц	Ч	Ŀ			
	Specimen Number	TXLTR1	TUTXLT4	TV7XLT61	TV7XL781	TV7XTTR1	L ATT TANU	TVGTLT41	TV6TLT61	TV6YLT81	TV6YTTR1	TV6YTT41	TV6YTT61	түбүтүві	TYLTRS	TV7YLTR1	TV76TTR1	TTRI TRI	TV8YLTR1	TV8YTTR1	TV9YLTR2	TV9YLTR1	TV9YTTR1			
Tensile Tests	Manufacturer and Heat No.	Timet G 3105			- >	Timet G 3105	Шіме† С 303	, 🔫					-	Timet G 393	Trimet G 2443	0 C	c	1071 G 1071	30	c	Timet 6 2504	U U	Timet G 2504			
7.4.2.1 STA	Thickness (Inches)	250 to 300	3-		••	250 to 300	7bl7 500 +0 630	3-4	vec	đ f	Eor	2	13	bli	.c]	Rel	lea	se					.500 to .630	_		

	Contrails
k Reduction Area	ዳይች ያህችውሪያችንሯቘችውት ይኖታይ
s Elongetion	10000 110010000 1110 1110 11001000 1110 1110 110010000
Ftu (Kei)	178.2 178.6 178.6 178.6 190.0 137.9 187.8 137.9 133.9 191.0 188.8 188.8 188.8 186.6
Fty (Kal)	176.0 170.8 170.8 170.8 182.0 138.5 125.3 128.0 124.1 179.6 114.3 103.5 103.5 114.3 114.3 103.5 114.3 114.3 179.9
Test Tempersture (oF)	발판함 활탄구 9 8 8 5 4 9 8 8 8 5 5 9 8 8 5 4 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8
Test Direction	고고臣 고고고고中世界的财好的 그그甲级
Specimen Mumber	TV10YLTR2 TV10YLTR1 TV10YTTR1 TV10YTTR1 TV6ZLTR1 TV6ZLT41 TV6ZLT41 TV6ZLT41 TV6ZLT61 TV6ZLT81 TV6ZT711 TV6ZT711 TV6ZT711 TV6ZT781 TV6ZST81 TV6ZST81 TV6ZST81 TV7ZLTR1 TV7ZLTR1 TV7ZLTR1 TV7ZST81 TV7ZST81
Manufacturer and Heat No.	Timet G 3106 Timet G 3106 Timet G 3106 Timet G 3023 Timet G 3023 Timet G 3023 Timet G 3214
Thickness (Inches)	of of of a sport of a

Ti 6A1-6V-2Sn Cond. STA

7.4.2.1 STA Tensile

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		Ċ	mtrails		
\$ Reduction Area	18 23 17 26	32 41 31 18	22 20 60 ·		
\$ Elongstion	0 ~ ~ ~	10 10 8	F 0 0 J		
F _{tu} (Esi)	191.3 192.0 187.0 180.5	185.6 190.0 186.7 186.3	192.1 194.0 191.2 184.6		
Fty (Ksi)	180.0 181.0 179.0 165.3	174.8 182.0 175.8 173.8	180.0 180.0 181.5 168.0	x	
Test Temperature _ (of)	RT RT TR	RT RT RT RT			
Test Direction	ក្រកស្តី	고 그 타 없	니 그 타 <mark>없</mark>		
Specimen Number	TV8ZLTR1 TV8ZLTR2 TV8ZTTR1 TV8ZTTR1 TV8ZSTR1	TV9ZLTR1 TV9ZLTR2 TV9ZTTR1 TV9ZSTR1	TV10ZLTR1 TV10ZLTR2 TV10ZTTR1 TV10ZSTR1		
Manufacturer and Heat No.	Timet G 2070	Timet G 1971	Timet G 3024 Timet G 3024		·
Thickness (Inches)	≥ 1.00	Approved f	S A For P212 ic Relea	se	

Ti 6Al-6V-2Sn Cond. STA

7.4.2.1 STA Tensile

hickness Manuf Inches) and H 500 to .630 Timet							7	F +		
to .630	Manufacturer and Heat No.	Specimen Number	Test Direction	Temperature (of)	Time (Hrs.)	Tempersture (°F)	- uy (Ksi)	- tu (Kai)	Percent Elongstion	S Reduction Area
to .630			,	0	Ç F	Ē	7 '(7 L	8 07 L	۵	00
••••	met G 393 	THMITIQAL	-1 - ²	400	100	RT	169.2	180.4) an	50
	۹	TV6ULTW43	1 1-1	100	1000	RT	174.4	182.5	ŝ	23
		LOWTIYOVT	Ч	600	10	RT	175.3	181.6	<u>о</u> (27
Ap		TV6YLTW62	Ч	600	100	RT m	172.0	180.0		22 70
opro		TV6YLTW63	цц	800 800	1000	RT	0.C)1 177.8	184.7	νœ	25
ove		TV6YLTW82	ц	800	100	RT	183.8	189.0	2	
to .630	Timet G 393	ILV6YLTW83	Ч	800	1000	RT	183.8	192.2	α	
fo										94
r I		<u></u>								Ń
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i		uol	Contrails
		S Meduation Area	い 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2
		Percent Elongstion	8 2 2 8 2 8 3 8 3 8 5 8 5 8 5 8 5 8 5 8 5 8 5 8 5
	•	- tu (Kei)	182.8 185.9 183.0 183.0 192.2 192.2 192.2
	ß	ty (Kai)	175.6 175.0 176.2 174.7 181.2 181.5 185.1 185.1
COLU. STA		Test Tempersture (°F)	HAN
6A1-6V-2Sn C	2	Time (Hrs.)	10 1000 1000 1000 1000 1000
Ti 6Al	Exposure	Tempersture (of)	7 T T T T T T T T T T T T T T T T T T T
Tests		Test Direction	ццццццц
Stability Te		Specimen Number	TV6ZLTW41 TV6ZLTW42 TV6ZLTW42 TV6ZLTW63 TV6ZLTW83 TV6ZLTW83 TV6ZLTW83 TV6ZLTW83
STA Tensile St		Manufacturer and Heat No.	Timet G 3023
7.4.2.1.1		Thickness (Inches)	Approved for Public Release

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TH-6AL-6V-2SD COND. STA

7.4.2.1.2 Tensile Tests - Precision Elastic Modulus (Tuckerman)

		•	•
Precision	"B" * 10 ⁶	16.1	
	Test Temperature	. E	
	Test Direction	ц	
	Specimen. Munher	TVTXLTRI	
	Manufacturer	1 (7)	
	Thickness (tuched)	.250300	

Contrails

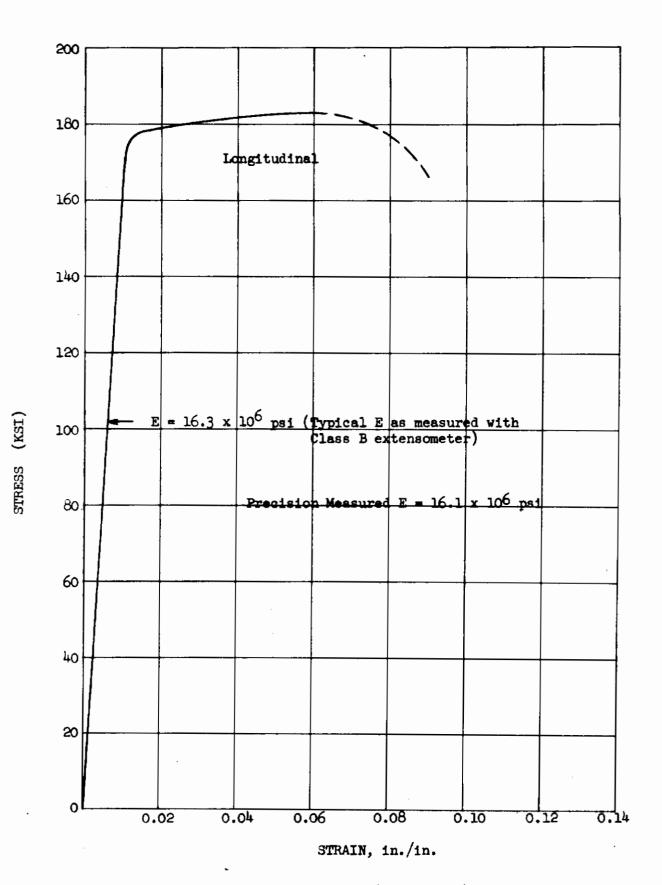


Figure 7-11 Typical Tensile Stress-Strain Curve (full-range) for Solution Treated and Aged Ti-6Al-6V-2Sn Alloy Plate at Room Temperature

	Poy (Kai)	184.1 206.0	182.3 149.2 141.0	125.7 187.0 154.0 139.4	126.3	188.3 194.6	190.7 187.8	195.5 191.0	187.0 183.3	t.	
	Test Temporature (or)	RT RT	RT 400 600	800 RT 600 600	800	L LL	RT RT	RT RT	RT		
	Test Direction	ᆔᆍ	ыыс	ычығы	E	 	цы	цы	 , ,		
	Specimen Number	TV7XLCR1 TV7XTCR1	TV6YLCR1 TV6YLC41 TV6YLC41	TV6YLC81 TV6YTC41 TV6YTC41 TV6YTC61	TV6YTC81	TV7YLCR1 TV7YTCR1	TV8YLCR1 TV8YTCR1	TV9YLCRL TV9YTCR1	TVIOYLCRI TVIOYTCRI	24 - 25 - 25 - 25 - 25 - 25 - 25 - 25 -	· · · · · · · · · · · · · · · · · · ·
Compression Tests	Manufacturer and Heat No.	Timet G 3105 Timet G 3105	Timet G 393		Timet 6 393	Timet G 2443 rimet G 2443	Timet G 1971 Timet G 1971	Timet G 2504 Timet G 2504	Timet G 3106 Timet G 3106		
7.4.2.2 STA Comp		.250 to .300 .250 to .300	.500 to .630	-	· <u>·</u>				.500 to .630		

STA Ti 6A1-6V-2Sn Cond.

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	Test Temperature Foy (Kai)	КР КР КР КР КР КР КР КР КР КР	
	Test Temperature (or)		THE THE
	Test Direction	고 그 그 日 日 日 田 匠 匠 匠 匠 匠 더 더 더 더 더 더 더 더 더 더 더 더 더 더	리 타 값
	Specimen Number	TV6ZLCR1 TV6ZLC41 TV6ZLC41 TV6ZLC61 TV6ZTC81 TV6ZTC81 TV6ZTC81 TV6ZTC81 TV6ZSC81 TV6ZSC81 TV6ZSC81 TV6ZSC81 TV6ZSC81 TV7ZLCR1 TV7ZSCR1 TV7ZSCR1	TV8ZSCR1 TV8ZSCR1
Compression lests	Manufacturer and Heat No.	Timet G 3023	Timet G 2070
MICO VIC 2.2.1	Thickness (Inches)	7 1.00	1 00

Ti 6Al-6V-2Sn Cond. STA

Contrails

Thickness (Inches)	Manufacturer and Heat No.	Specimen Number	Test Direction	Test Temporature (oF)	Fcy (Kai)
<u>></u> 1.00	Timet G 1971	TV9ZLCR1 TV9ZTCR1 TV9ZSCR1	고 타 고	RT RT	183.3 192.0 200.5
2 1.00	Timet G 3024 Timet G 3024	TV10ZLCR1 TV10ZTCR1 TV10ZSCR1	니 단 없	RT RT RT	198.2 1 9 4.5 205.3
·					
		۰.			

Ti 6A1-6V-2Sn Cond. STA

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Thickness (Inches)	Manufacturer and Heat No.	Specimen Number	Test Direction	¢/₽	Test Tempersture (oF)	Figur (Kai) (2% Offset)	Tunt (Kei)
.250 to .300 .250 to .300	Timet G 3105 Timet G 3105	TV7XLB1R1 TV7XLB2R1	цц	1.5 2.0	RT RT	277.7 296.7	298.6 360.4
.500 to .630	Timet G 393	TV6YLB1R1 TV6YLB141 TV6YLB141 TV6YLB161 TV6YLB181	니니니다	1 1 1 1 1 2 2 2 2 2 2	RT 400 600 RT	252.5 218.4 222.2 187.9 265.1	276.7 250.8 238.1 213.3 287.4
	Timet G 393	TV6YLB2R1 TV6YLB241 TV6YLB241 TV6YLB281 TV6YTB2R1	디너너머	00000	RT 4,00 600 800 RT	298.8 254.5 254.2 242.9 298.1	343.3 300.3 296.5 292.0 350.2
	Timet G 2443 Timet G 2443 Timet G 2070 Timet G 2070	TV7YLB1R1 TV7YLB2R1 TV8YLB1R1 TV8YLB1R1	년 년년 ,		RT RT RT RT	268.1 302.4 264.0 295.0	293.6 366.3 302.5 371.8
.500 to .630	Timet G 1971 Timet G 1971	TV9YLB1R1 TV9YLB2R1	цц	1.5 2.0	RT RT	277.5 299.3	293.0 373.4

Ti 6A1-6V-23n Cond. STA

7.4.2.3 STA Bearing Tests

			satraile	
Fiiku (Keil)	291.6 371.4	288.6 256.1 227.1 228.5 289.0 261.1 261.1	353.2 306.9 282.2 285.2 343.7 342.5 342.5	295.0 372.1
Funt (Kal) (2% Offset)	255.4 295.8	258.0 226.9 201.4 200.0 266.5 240.0 242.5	299.0 253.3 234.1 226.5 283.3 289.4 312.0	272.5 325.4
Teat Temperature (oF)	RT RT	RT 600 RT RT RT RT	RT 400 600 800 RT RT RT	RT TT
¢∕⊅	1.5 2.0	444444 ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~	 	0 7
Test Direction	ЧЧ	.ㅋㅋㅋㅋㅋㅋㅋ		
Specimen Mumber	TV10YLB1R1 TV10YLB2R1	TV6ZLB1R1 TV6ZLB141 TV6ZLB161 TV6ZLB161 TV6ZLB181 TV6ZLEB1R1 TV6ZTEB1R1	TV6ZLB2R1 TV6ZLB241 TV6ZLB241 TV6ZLB261 TV6ZLB281 TV6ZLB2R1 TV6ZLEB2R1 TV6ZTEB2R1	TV77LB2R1
Manufacturer and Heat No.	Timet G 3106 Timet G 3106	Timet G 3023	Timet G.3023	Timet G 3214 Timet G 3214
Thickness (Inches)	.500 to .630 .500 to .630			- 1.00

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TH 6AL-6V-2Sn Cond. 3Th

L.P.S. STA Hearing

			(Contrails	 	
		303.9 361.4	298.2 368.6			
Fimit (Kai) (2% Offmet)	267.9 284.0	277.2 304.3	279.0 312.0		 	
Test Tesperature (oF)	RT RT	RT RT	RT			
۹∕۰	1.5 2.0	1.5 2.0	1.5 2.0			
Test Direction	д н	ЧЧ	ЧЧ			
Specimen Mumber	TV8ZLB1R1 TV8ZLB2R1	TV9ZLB1R1 TV9ZTB1R1	TV10ZLB1R1 TV10ZLB2R1		 	
Manufacturer and Heat No.	Timet G 2070 Timet G 2070	Timet G 1971 Timet G 1971	Timet G 3024 Timet G 3024			
Thickness (Inches)	00 · T ح				 	

Ti 6A1-6V-2Sn Cond. STA

Пос+с E t

7.4.2.4 STA Shear	Tests				
Thickness (Inches)	Manufacturer and Heat No.	Specimen Number	Test Direction	Test Temperature (or)	Poy (Kai)
.250 to .300	Timet G 3105	TAZXISRI	F	RT	107.0
.500 to .630	<u>ن</u>	TV6YLSR1 TV6YLS41 TV6YLS61 TV6YLS81	니더니니	RT 400 800	108.0 93.7 83.6
	Timet G 393 Timet G 2443	TV6YTSR1	E4 E	RT RT	. 0.011
.500 to .630	0000	TV8YLSR1 TV9YLSR1 TV10YLSR1	ក្កក	RT RT RT	115.0 115.0 115.0
00 -1 -1	Timet G 3023	TV6ZLSR1 TV6ZLS41 TV6ZLS61 TV6ZLS81 TV6ZTSR1	더 더 더 더 더	RT 600 800 RT	0.111.0 96.3 89.7 87.3 111.0
1.00	Timet G 3214 Timet G 2070 Timet G 1971 Timet G 3024	TV7ZLSR1 TV8ZLSR1 TV9ZLSR1 TV10ZLSR1	ЧЧЧЧ	RT RT RT	116.0 114.0 116.0 116.0

Ti 6Al-6V-2Sn Cond. STA

	Load at Failure (lbs)	6860	Contrails	
	Net Fracture Strength, ^E n (Ksi)	34.3		
	Kit Vin	31.0		
STA	K Factor	6.34		
a Cond. STA	a Crack Depth	•750		
T1-6A1-6V-2Sn	Load Pop-in (ibs)	14900		
T1-6/	Test Temp.	RT		
	Exposure ID. Time (Hrs.)	· •		9.
	Temp.	I		
	Test Direc- tion	н		
yhness Tests	Specimen Number	TRTIXL		
Fracture Toughness Tests	Mamufacturer and Heat No.	Timet G 310 5		
7.4.2.5	Thickness (inches)	.250300	- 227 - Approved for Public Release	

T1-6A1-6V-2Sn Cond. STA

		Contrails	
. = 186 . 4	N (Cycles to Feilure)	$\begin{array}{c} 10,000\\ 21,000\\ 86,000\\ 68,000\\ 3,105,000\\ 3,105,000\\ 1,06,000\\ 1,000\\ 1,000\\ (1)\\ 1,066,000\\ (1)\\ 1,066,000\\ (1)\\ 1,066,000\\ (1)\\ 1,066,000\\ (1)\\ 1,066,000\\ (1)\\ 1,066,000\\ (1)\\ 1,066,000\\ (1)\\ 1,066,000\\ (1)\\ 1,066,000\\ (1)\\ 1,066,000\\ (1)\\ 1,066,000\\ (1)\\ 1,066,000\\ (1)\\ 1,066,000\\ (1)\\ 1,066,000\\ (1)\\ 1,066\\ (1)\\ 1,000\\ (1)\\ 1,00$	
$\mathbf{F}_{\mathbf{tu}}$	\$ Fta	钻花石砧孔裙形即 聪明花经络发发神	
	Max. (Keil)	152.0 142.5 133.0 114.0 114.0 161.5 161.5 161.5 104.5 (1) 104.5 (1)	
	pt,	444444 9 6666666	
	Kt	0000000 00000000	
	Test Di re ction	дараара арарарар	
	Specimen Number	TWÉZLWR25 TWÉZLWR25 TWÉZLWR26 TWÉZLWR29 TWÉZLWR30 TWÉZLWR31 TWÉZLWR31 TWÉZLWR32 TWÉZLWR32 TWÉZLWR29 TWÉZLWR29 TWÉZLWR29 TWÉZLWR29 TWÉZLWR29	
Fatigue Tests	Manufacturer and Heat No.	Thimet G 3023	(1) Grip Failure
7.4.2.6 STA	Thichness (Inches)	00°T < √	

STATH 6A1-6V-23n Cond.

		Contrails	
F _{tu} = 186.4	T (Cyules to Failure)	310,000 21,000 36,000 4,773,000 4,773,000 370,000 370,000 699,000 6,986,000 13,000 13,000 13,000	
μ.	\$ P _{tu}	邻死乱九弘花光乱,卯卯死乱花 始 匆匆	
	Max. (Kel)	161.5 177.0 133.0 177.0 177.0 177.0 180.5 180.5 184.3 184.3 184.3	
• STA	æ		
6A1-6V-2Sn Cond.	Кţ	000000 0000000 111111 111111	
ті баі-(Test Direction	ннының адарара	
	Specimen Number	TV6ZLVR1 TV6ZLVR2 TV6ZLVR3 TV6ZLVR3 TV6ZLVR5 TV6ZLVR6 TV6ZLVR10 TV6ZLVR10 TV6ZLVR11 TV6ZLVR114 TV6ZLVR12 TV6ZLVR15 TV6ZLVR15 TV6ZLVR15	
STA Fatigue Tests	Manufacturer and Heat No.	Timet G 3023	(1) Grip Failure
7.4.2.6	Thickness (Inches)	8 	

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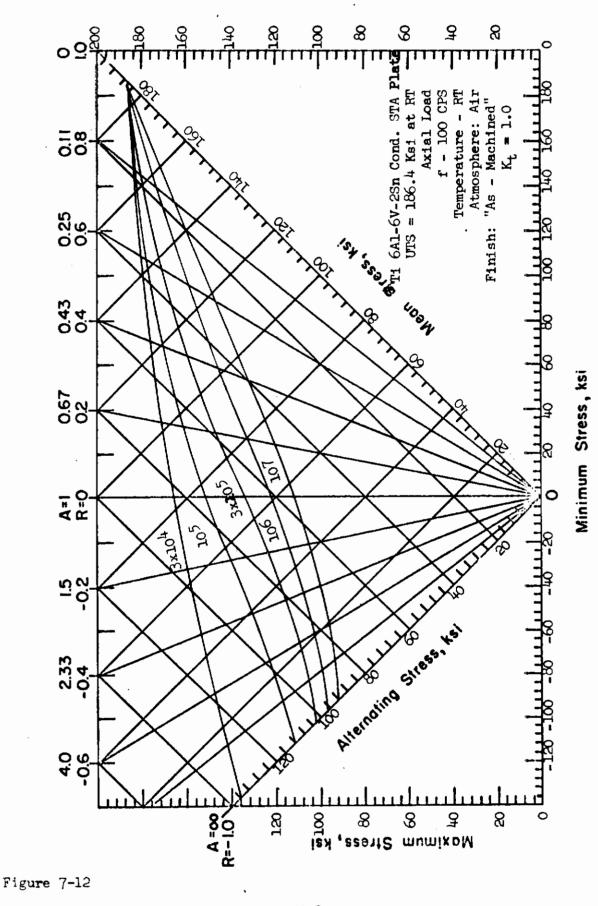
F		Can	trails	
$F_{tu} = 186.4$	n (Cycles to Failure)	175,000 15,000 15,000 15,000 15,000 15,000 15,000 15,000 15,000	10,000,000 10,000,000 112,000 10,000	
Ti 6Al-6V-2Sn Cond. STA	s r _{tu}	%%&%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%	32 8 1 8 2	
	Max. * (Ksi)	847. 334.50 847. 334.50 86.00 37.00 36.00 36.00 36.00 36.00 36.00 36.00 36.00 36.00 36.00 36.00 36.00 36.00 36.00 36.00 37.000 37.000 37.000 37.000 37.000 37.0000000000	288 38.0 66.5 66.5	
	Я	4444444 000 www	, , , , , , , , , , , , , , , , , , ,	
	Кt	00000000 000 0000000 000	00000 00000 00000	
	Test Direction	наннана ана	ГРРРР	
	Specimen Number	TV6ZLVR49 TV6ZLVR50 TV6ZLVR51 TV6ZLVR51 TV6ZLVR53 TV6ZLVR55 TV6ZLVR55 TV6ZLVR55 TV6ZLVR55 TV6ZLVR55	TV6ZLVR60 TV6ZLVR61 TV6ZLVR63 TV6ZLVR63	
STA Fatigue Tests	Manufacturer and Heat No.	Timet G 3023	Timet G 3023	No Failure
7.4.2.6	Thickness (Inches)	×	 8 	ł
			20 -	

= 186.4	N cles to ilure)	25,000,000 11,4,000 28,000 14,000 28,000 14,000 14,000 14,000 14,000 14,000 14,000 14,000 14,000 14,000 14,000 14,000 14,000 14,000 11,4,000 11,4,000 11,4,000 11,4,000 11,4,000 11,4,000 11,4,000 11,4,000 11,4,000 11,4,000 11,4,000 11,4,000 11,4,000 11,4,000 11,4,000 11,000 10	
F _{tu} =	5£	₽ ₽ ~ 3 ³	
	\$ F _{tu}	'¥ጜጜጜቘዀዀ ዄቘዀዀዀ	
	Мах. (Xai)	8627486238 * 0.0	
	R	0000000 99999 999	
	Kt	0000000 0000000 Mmmmmmm mmmmmmmm	
	Test Direction	напарара ререре	· ·
	Specimen Number	TV6ELVR33 TV6ELVR35 TV6ELVR35 TV6ELVR35 TV6ELVR36 TV6ELVR39 TV6ELVR40 TV6ELVR40 TV6ELVR44 TV6ELVR44 TV6ELVR44 TV6ELVR44	TJ.
STA Fatigue Tests	Manufacturer and Heat No.	Thurst G 3023	 No Failure Overstressed
7.4.2.6	Thickness (Inches)	↓ 1.00 ↓ 1.00 ↓ 1.00	

T1 6A1-6V-2Sn Cond. STA

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Contrails



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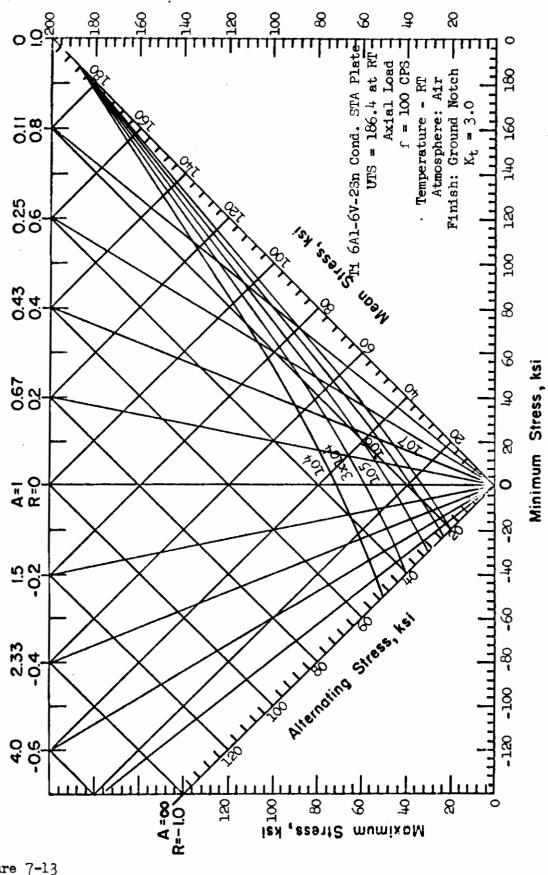


Figure 7-13

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SECTION VIII

Contrails

MIL-HDBK-5 DATA PRESENTATION

Contained in this section are the room temperature design allowables, effect of temperature curves, and stress-strain curves, for Ti 4Al-3Mo-1V Cond. A, Ti 13V-11Cr-3Al Cond. A, Ti 6Al-4V Cond. STA, and Ti 6Al-6V-2Sn Cond. A and Ti 6Al-6V-2Sn Cond. STA. Refer to Section VI for a discussion of the limitations of the allowables contained herein.

Page

8.1	Design Allowables,	Ti-4Al-3Mo-1V Cond. A	235 - 241
8.2	Design Allowables,	Ti-13V-11Cr-3Al Cond. A	242 - 248
8.3		Ti-6Al-4V Cond. STA	249 - 255
8.4	Design Allowables,	Ti-6Al-6V-2Sn Cond. A	256 - 262
8.5	Design Allowables,	Ti-6Al-6V-2Sn Cond STA	263 - 267

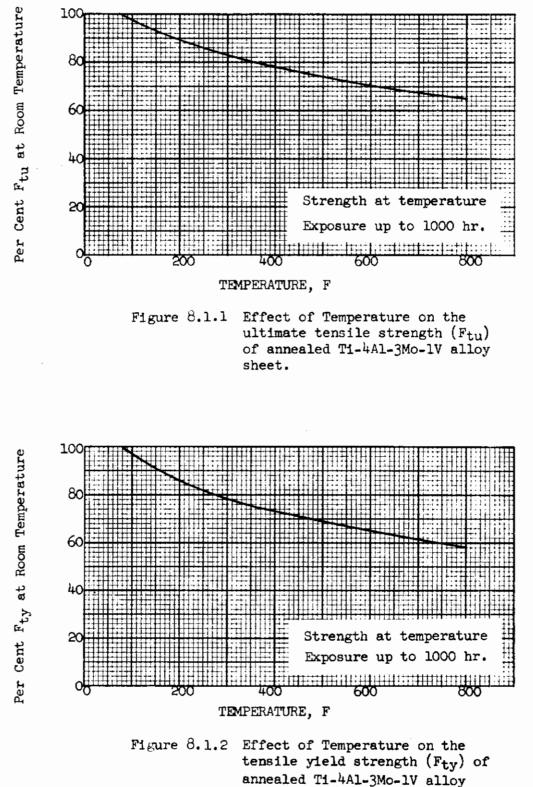
Table VIII-1

Design Mechanical and Physical Properties of Ti-4A1-3Mo-1V

Alloy	MIL-T-4046 Type III Comp. B		
Form	Sheet and Strip Annealed 4 .110		
Condition			
Thickness or diameter, in.			
Basis	S		
Mechanical properties:	<u></u>		
F _{tu} , ksi L	125		
LT			
F _{ty} , ksi	115		
L LT			
F _{cy} , ksi	112		
L LT			
F _{su} , ksi	77		
Fbru, ksi			
(e/D = 1.5) (e/D = 2.0)	191 260		
Fbry, ksi:			
(e/D = 1.5) (e/D = 2.0)	150 . 175		
e, per cent:	-12		
In 2 in.	10		
In 4 D			
E, 10 ⁶ psi	16.2		
E _c , 106 psi G, 106 psi	· · ·		
d, 100 psi			
Physical properties: , lb/in.3 C, Btu/(lb)(F) K, Btu/ (hr)(ft ²)(F)/ft , l0 ⁻⁶ in./in./F			

8.1

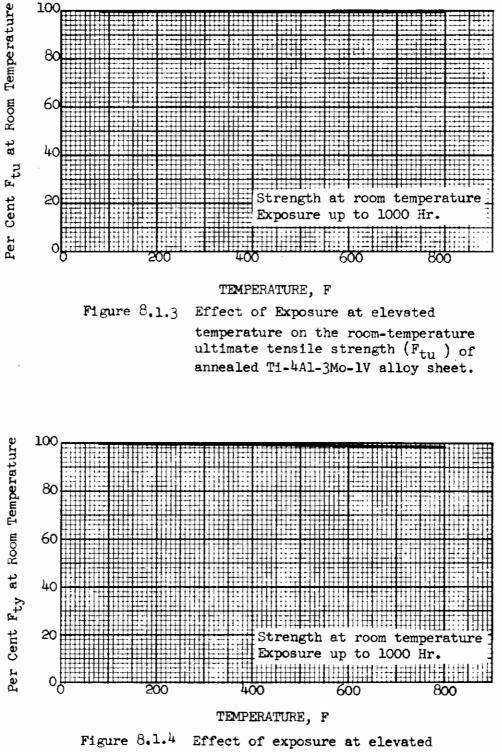
Approved for -P1235i-c Release



sheet.

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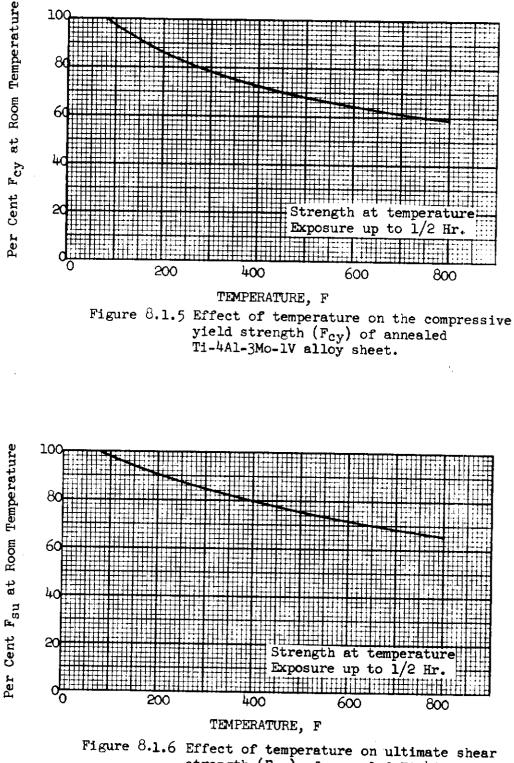
Contrails



temperature on the room-temperature tensile yield strength (F_{ty}) of annealed Ti-4Al-3Mo-1V alloy sheet.

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Contrails



strength (F_{su}) of annealed Ti-4Al-3Mo-1V alloy sheet.

Contrails

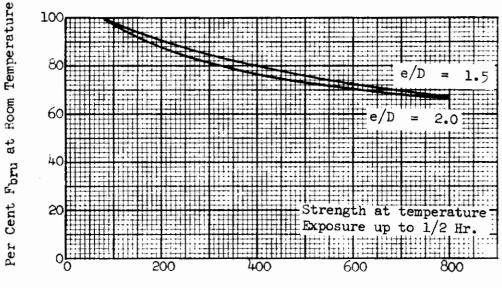




Figure 8.1.7 Effect of Temperature on ultimate bearing strength (F_{bru}) of annealed Ti-4Al-3Mo-1V alloy sheet.

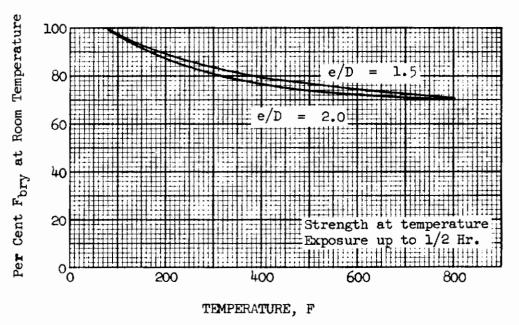
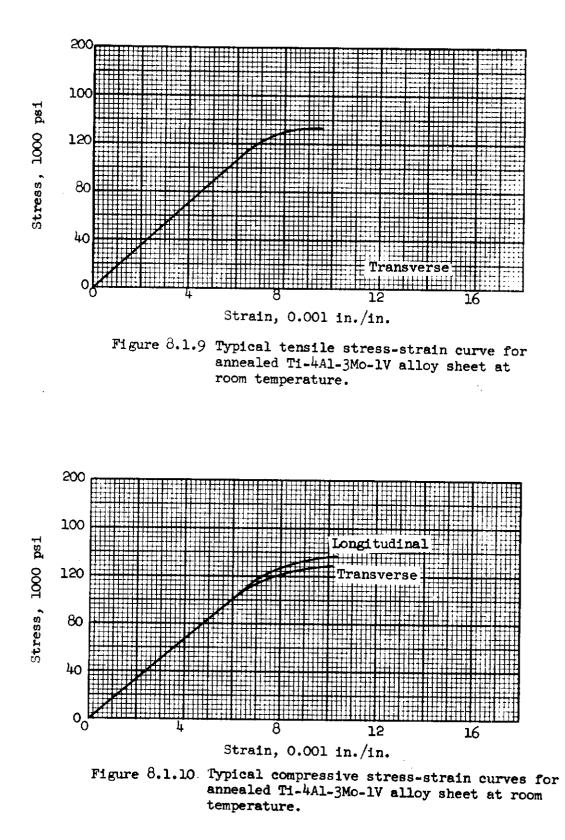
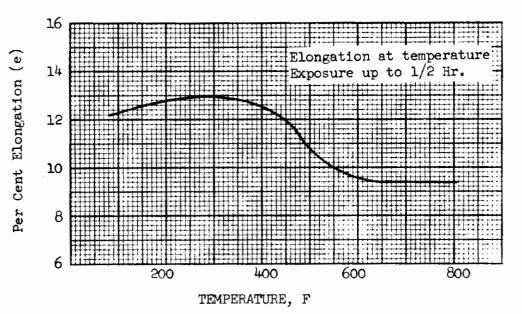
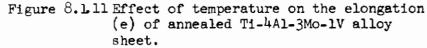


Figure 8.1.8 Effect of Temperature on bearing yield strength (F_{bry}) of annealed Ti-4A1-3Mo-1V alloy sheet.









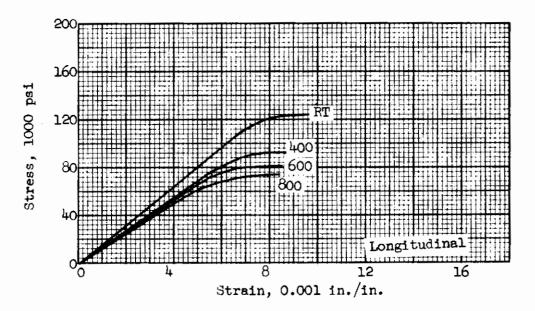


Figure 8.1.12 Typical tensile stress-strain curves for annealed Ti-4Al-3Mo-1V alloy sheet at room and elevated temperatures.

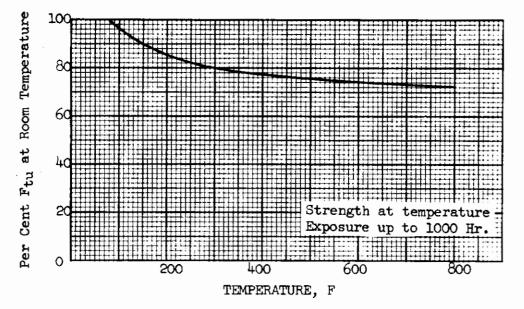
Approved for Fugelc Release

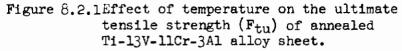
Contrails

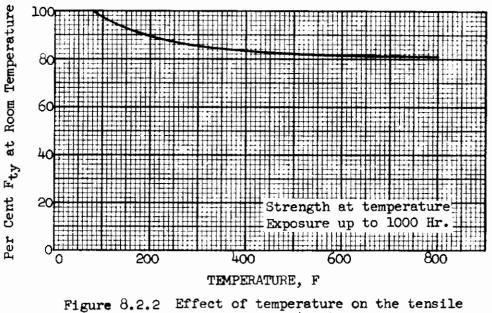
Table VIII-2

Design Mechanical and Physical Properties of Ti 13V-11Cr-3A1 8.2

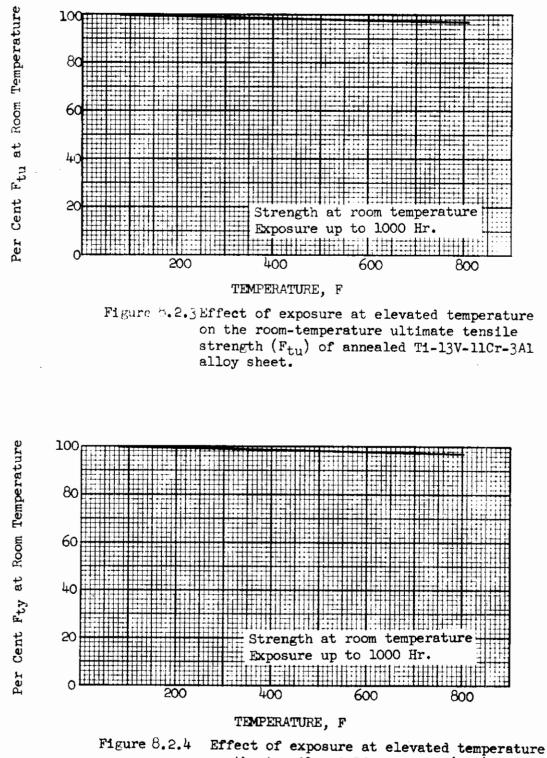
Alloy	MIL-T-9046 Type IV Comp. A Sheet and Strip Annealed ≤ .110					
Form						
Condition						
Thickness or diameter, in.						
	A B		1	Tentative A B		
Basis				'n	هرا.	
Mechanical properties:						
F _{tu} , ksi L	132	134				
LT	136	139				
Fty, ksi	100					
	126 131	129 134				
F _{cy} , ksi						
L				119	122	
LT F _{su} , ksi			· ·	123 90	126 92	
Fbru, ksi				1	-	
(e/D = 1.5) (e/D = 2.0)				207 286	212	
Fory, ksi:				200	292	
(e/D = 1.5)				156	160	
(e/D = 2.0) e, per cent:				174	178	
In 2 in. L	11					
LT	7					
E, 106 psi			14.6			
Ec, 106 psi G, 106 psi			74.0	-		
G, 100 psi				*		
		·				
			·			
Physical properties:	<u></u>					
Physical properties: , lb/in.3						
C, Btu/(1b)(F)						
C, Btu/(lb)(F) K, Btu/ (hr)(ft ²)(F)/ft , 10-6 in./in./F						L.
,						







re 8.2.2 Effect of temperature on the tensile yield strength (F_{ty}) of annealed Ti-13V-11Cr-3Al alloy sheet.



on the tensile yield strength (Fty) of annealed Ti-13V-11Cr-3A1 alloy sheet.

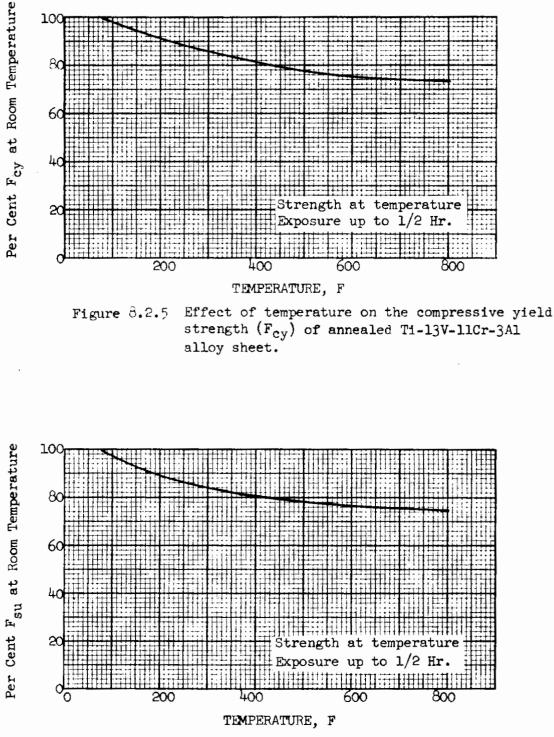
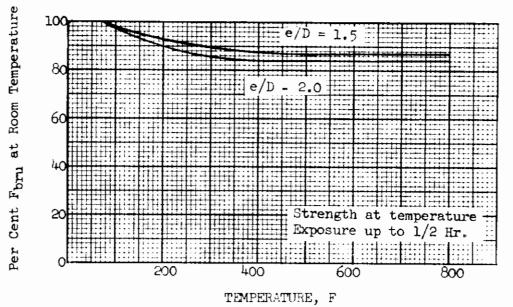
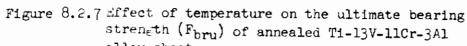


Figure 8.2.6 Effect of temperature on the ultimate shear strength (F_{su}) of annealed Ti-13V-11Cr-3Al alloy sheet.







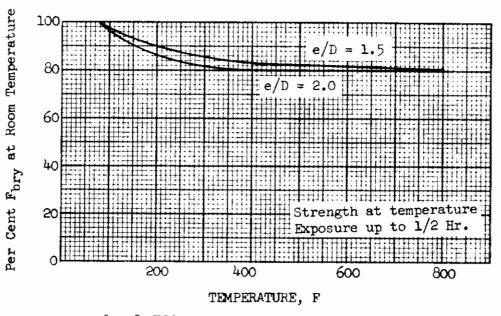
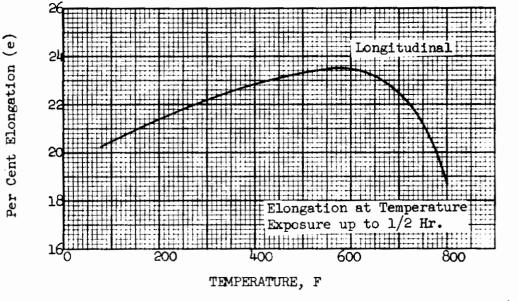
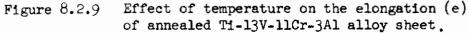


Figure 8.2.8 Effect of temperature on the bearing yield strength (F_{bry}) of annealed Ti-13V-11Cr-3A1 alloy sheet.





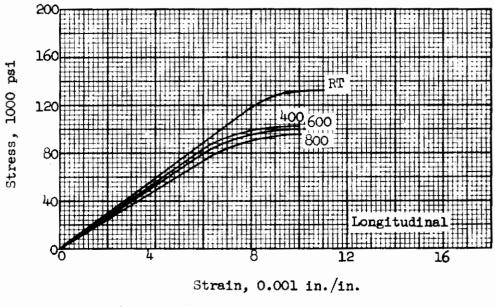


Figure 8.2.10 Typical tensile stress-strain curves for annealed Ti-13V-11Cr-3Al alloy sheet. at room and elevated temperatures.

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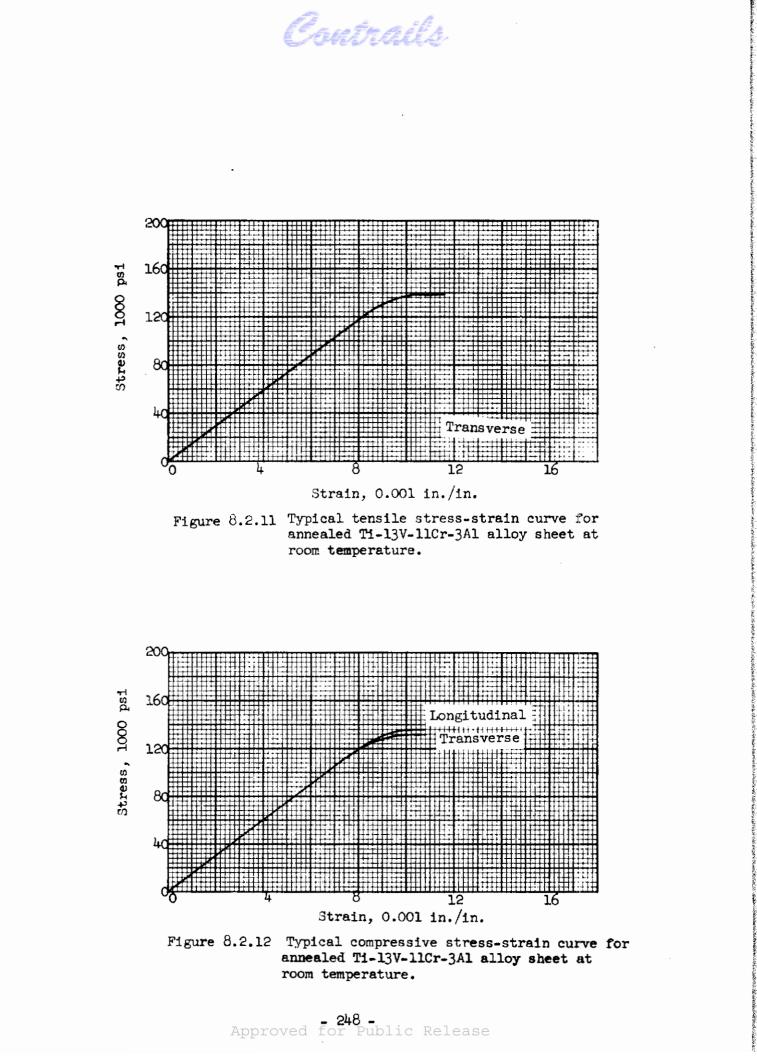


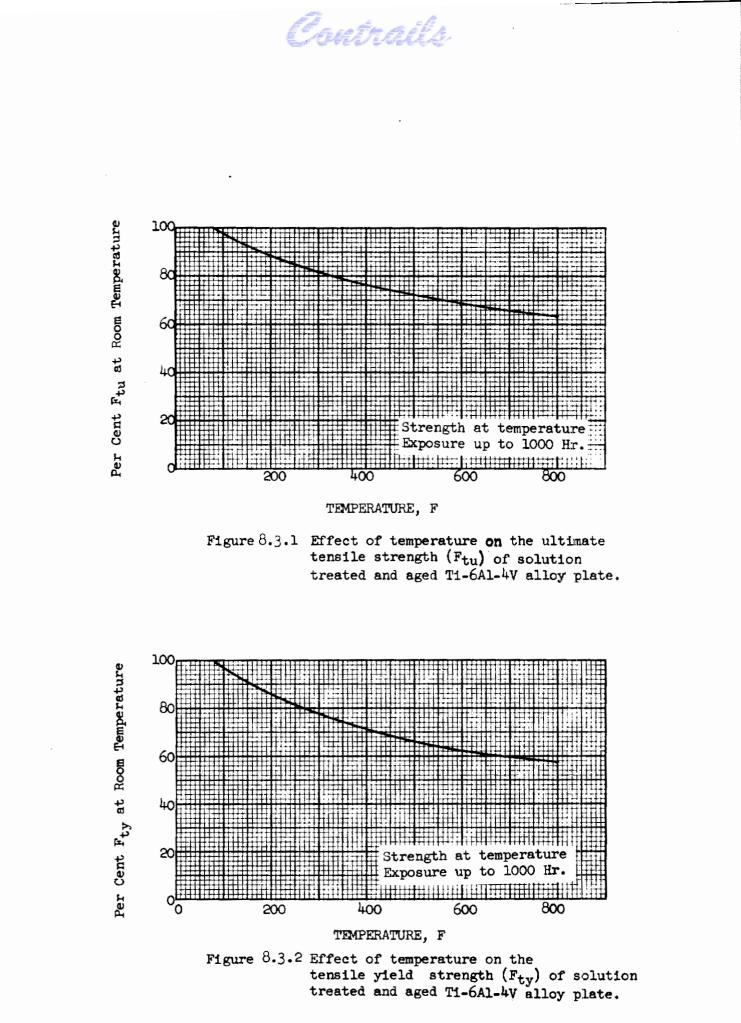
Table VIII-3

Contrails

Design Mechanical and Physical Properties of Ti-6A1-4V

Alloy	MIL-T-9046 Type	e III Comp. C		
Form	Plate			
Condition	Solution Treated and Aged			
Thickness or diameter, in.	.188 to .750	.751 to 1.000		
Basis	S	S		
Mechanical properties: Ftu, ksi L	160	150		
LT F _{ty} , ksi L	145	140		
LT Pey, ksi L LT Fsu, ksi (e/D = 1.5) (e/D = 2.0) Pbry, ksi: (e/D = 1.5) (e/D = 1.5) (e/D = 2.0)				
e, per cent: In 2 in. In 4 D	8	6		
E, 106 psi Ec, 106 psi G, 106 psi		16.2		
	· .			
<pre>Physical properties: , lb/in.3 C, Btu/(lb)(F) K, Btu/ (hr)(ft2)(F)/ft , l0-6 in./in./F</pre>	•			

8.3



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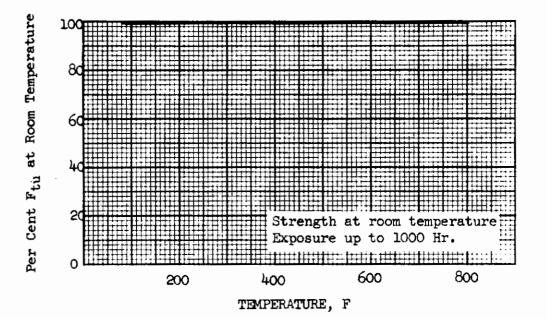


Figure 8.3.3 Effect of exposure at elevated temperature on the room temperature ultimate tensile strength (F_{tu}) of solution treated and aged Ti-6Al-4V alloy plate.

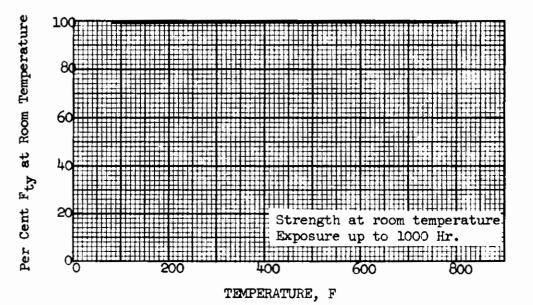
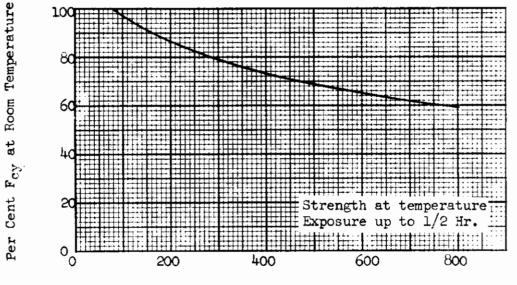


Figure 8.3.4 Effect of exposure at elevated temperature on the room temperature tensile yield strength (Fty) of solution treated and aged Ti-6Al-4V alloy plate.

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Contrails



TEMPERATURE, F

Figure 8.3.5 Effect of temperature on the compressive yield strength (F_{CY}) of solution treated and aged Ti-6Al-4V alloy plate.

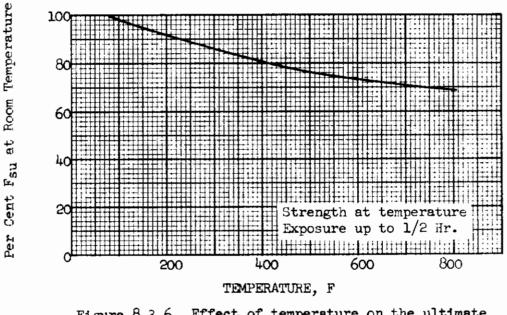
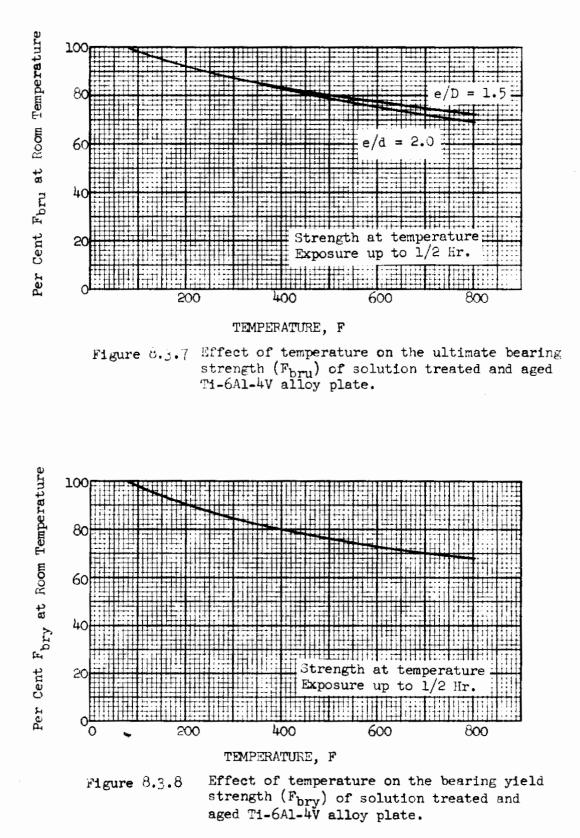
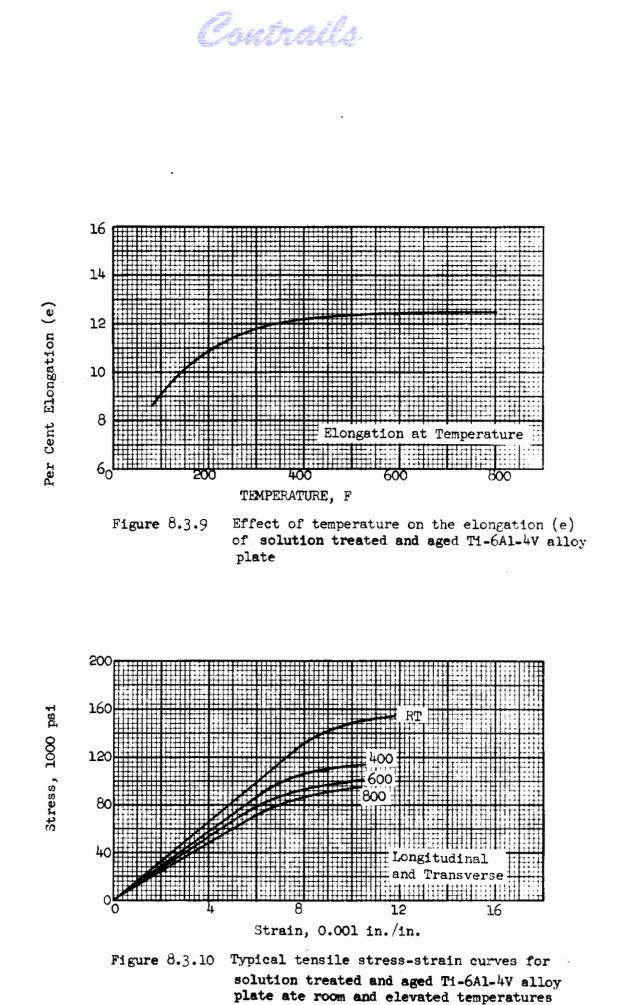


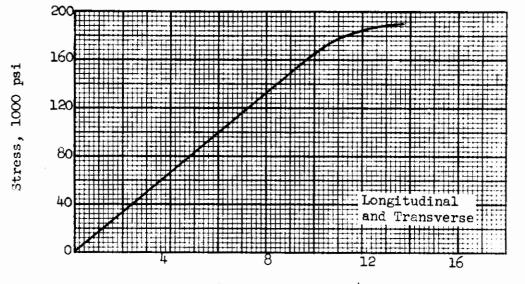
Figure 8.3.6 Effect of temperature on the ultimate shear strength (F_{3u}) of solution treated and aged Ti-6Al-4V alloy plate.

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Strain, 0.001 in./in.

Figure 8.3.11 Typical compressive stress-strain curve for solution treated and aged Ti-6Al-4V alloy plate at room temperature.

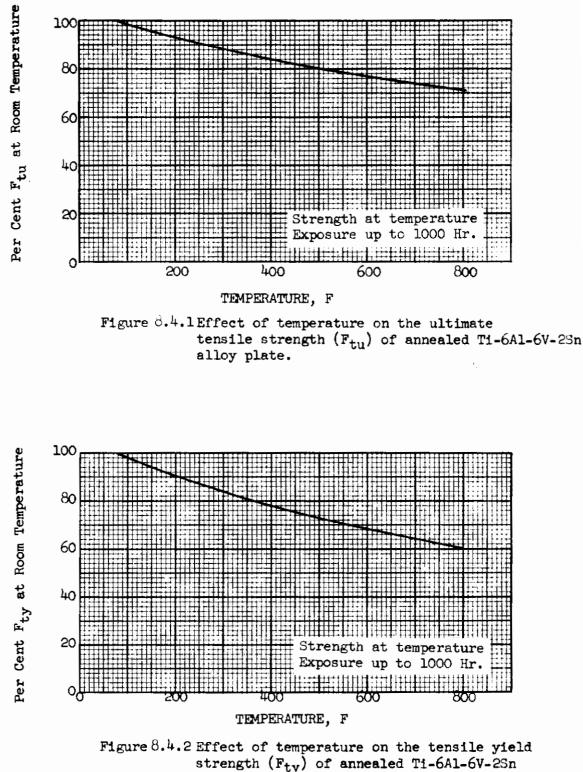
Table VIII-4

Contrails

8.4

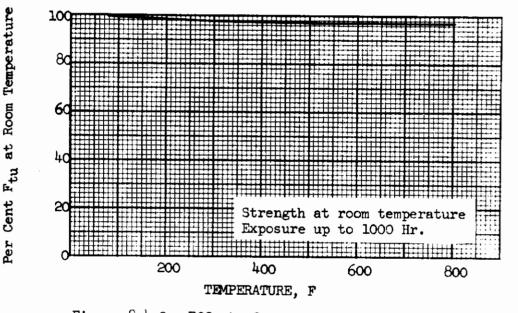
Design Mechanical and Physical Properties of Ti-6Al-6V-2Sn

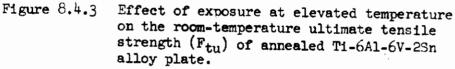
Alloy	MIL-T-9046 Type III Comp. E			
Form	Plate			
Condition	Annealed			
Thickness or diameter, in.	.250 to .300	.500 to .630	1.50	
Basis	S	S	S	
Mechanical properties: Ftu, ksi L	150	150	150	
LT F _{ty} , ksi L	140	140	140	
LT F _{cy} , ksi L	141	147	142	
LT F _{su} , ksi	90	92	95	
Fbru, ksi (e/D = 1.5) (e/D = 2.0)	234 275	251 301	249 310	
Fbry, ks1: (e/D = 1.5) (e/D = 2.0)	195 212	201 223	.198 237	
e, per cent: In 2 in. In 4 D	10	10	10	
E, 10 ⁶ psi Ec, 10 ⁶ psi G, 10 ⁶ psi		15.6		
Physical properties: , lb/in.3 C, Btu/(lb)(F) K, Btu/ (hr)(ft2)(F)/ft , l0-6 in./in./F				

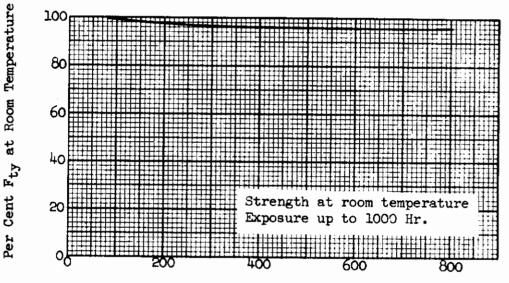


alloy plate.

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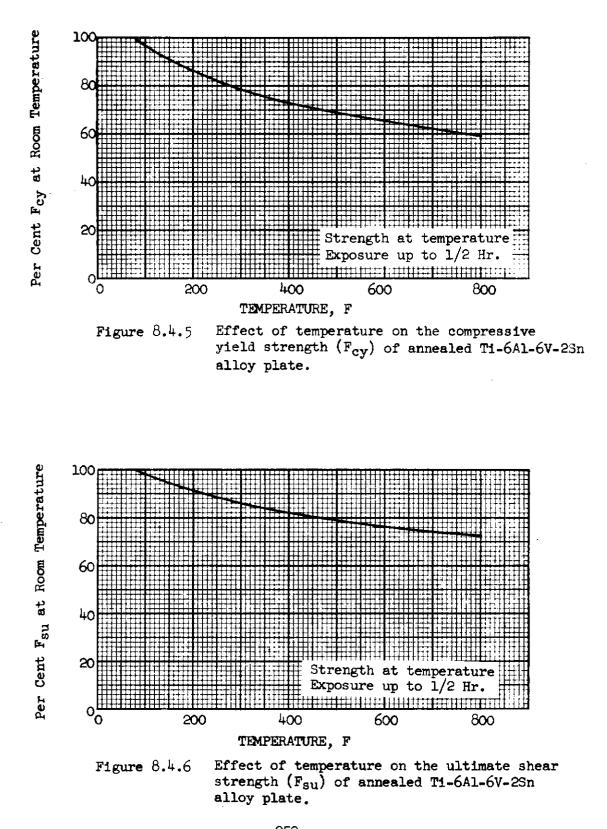






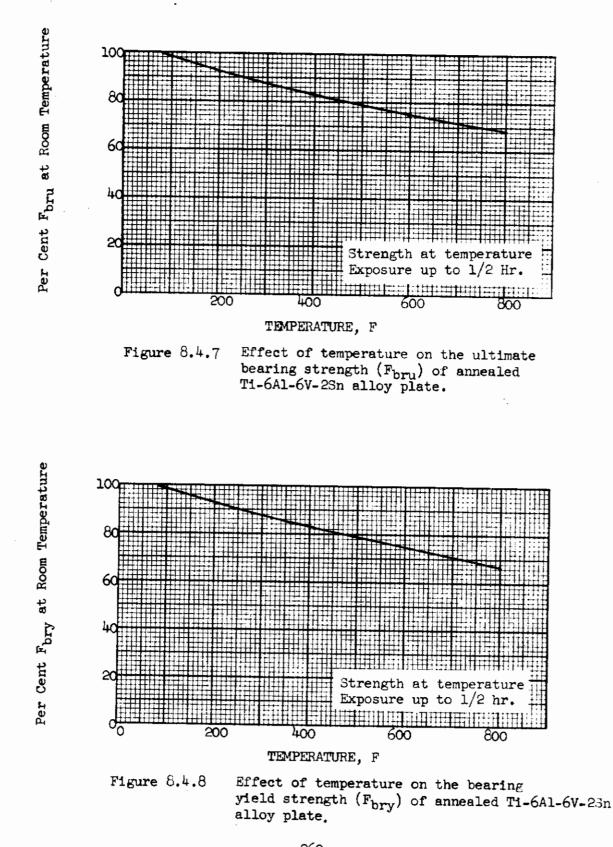
TEMPERATURE, F

Figure 8.4.4 Effect of exposure at elevated temperature on the room temperature tensile yield strength (F_{ty}) of annealed Ti-6Al-6V-2Sn alloy plate.



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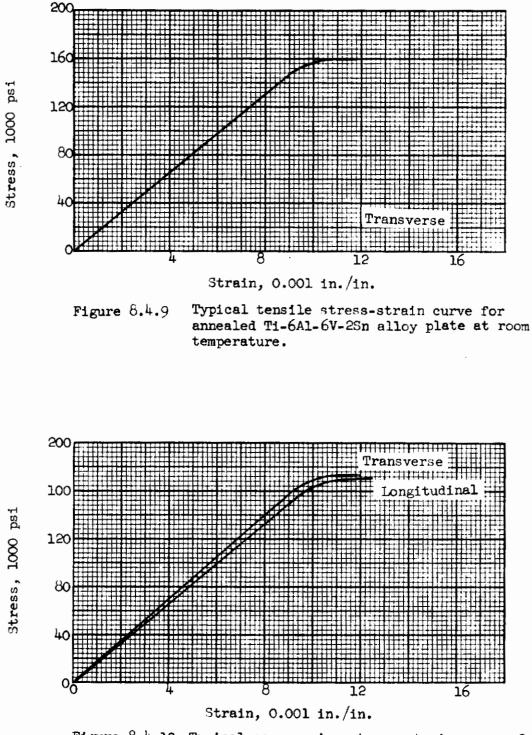
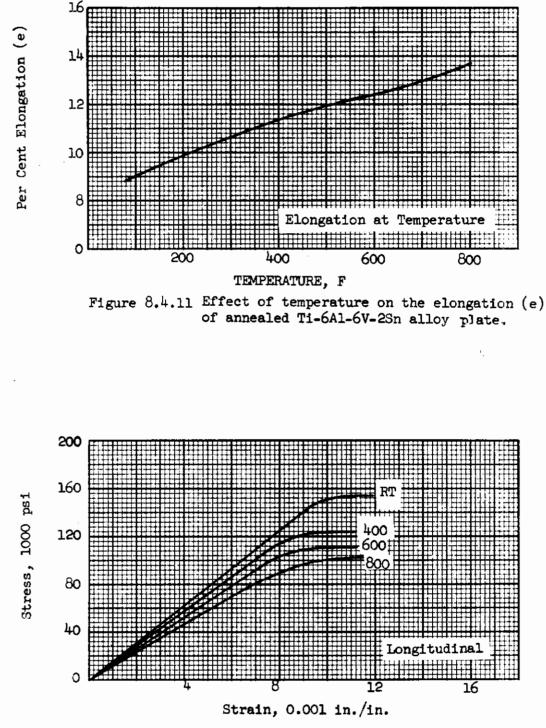
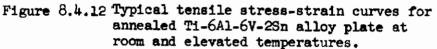


Figure 8.4.10 Typical compressive stress-strain curves for annealed Ti-6Al-6V-2Sn alloy plate at room temperature.







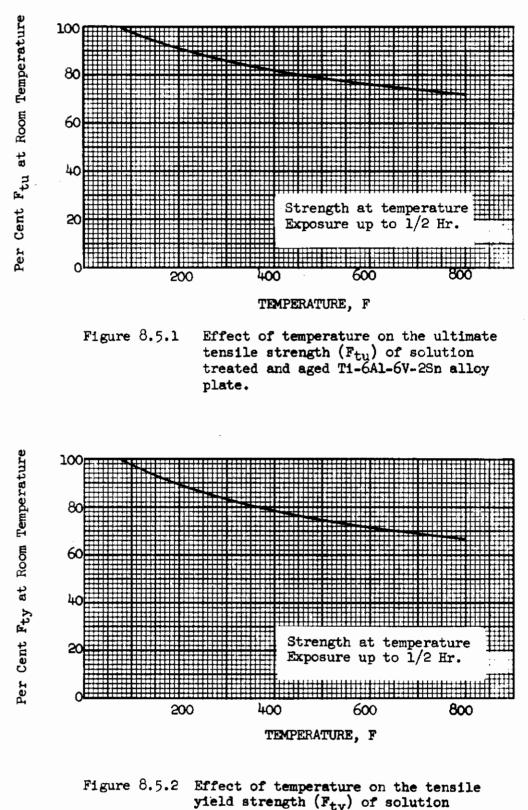
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Design Mechanical and Physical Properties of Ti-6Al-6V-2Sn

Alloy	MIL-T-9046 Type III Comp. E			
Form	Plate			
Condition	Solution Treated and Aged			
Thickness or diameter, in.	.500 to .630	1.50		
Basis	S	S		
Mechanical properties: Ftu, ksi L	170	160		
LT F _{ty} , ksi L	160	150		
LT F _{cy} , ksi L	167	156		
LT Fsu, ksi	98	94		
Fbru, ksi (e/D = 1.5) (e/D = 2.0)	260 325	242 290		
Fbry, ksi: (e/D = 1.5) (e/D = 2.0)	2 32 268	220 - 238		
e, per cent: In 2 in. In 4 D	8	6		
E, 106 psi Ec, 106 psi G, 106 psi	16.1			
Physical properties: , lb/in.3 C, Btu/(lb)(F) K, Btu/ (hr)(ft2)(F)/ft , l0-6 in./in./F	· · · · · · · · · · · · · · · · · · ·			

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treated and aged TI-6A1-6V-2Sn alloy plate.

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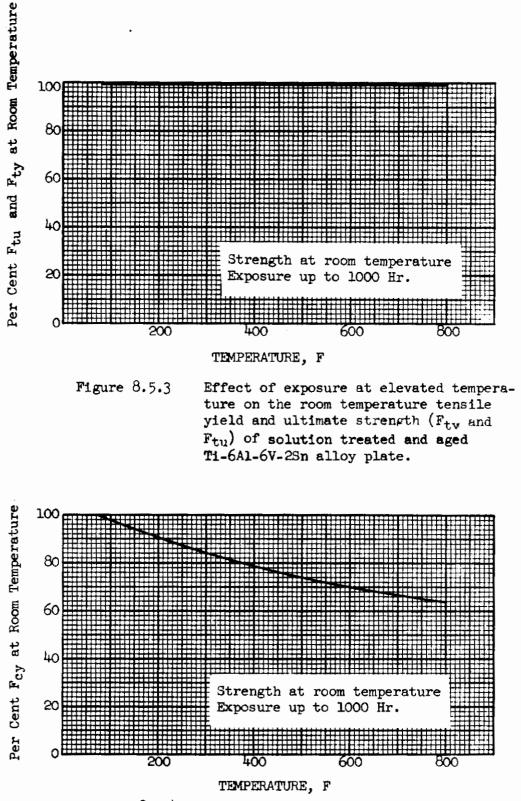
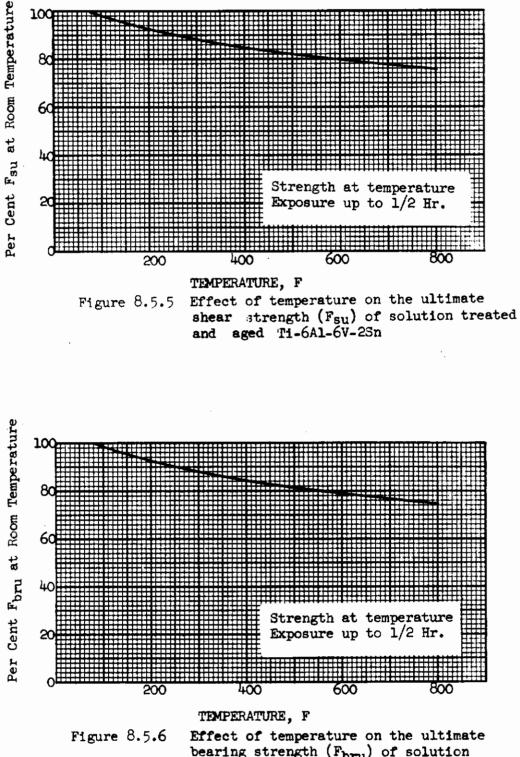
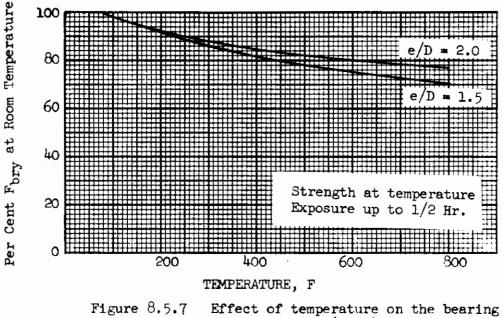


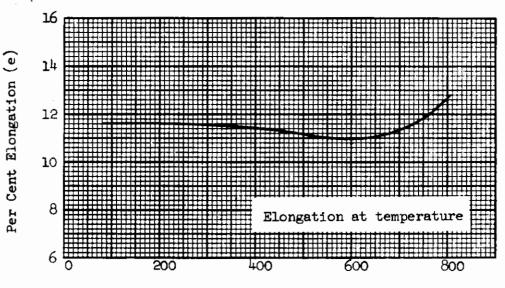
Figure 8.5.4 Effect of temperature on the compressive yield strength (F_{Cy}) of solution treated and aged Ti-6Al-6V-2Sn alloy plate.



bearing strength (F_{bru}) of solution treated and aged Ti-6Al-6V-2Sn alloy plate.



yield strength (F_{bry}) of solution treated and aged Ti-6Al-6V-2Sn alloy plate.



TEMPERATURE, F

Figure 8.5.8 Effect of temperature on the elongation (e) of solution treated and aged Ti-6Al-6V-2Sn alloy plate.

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SECTION IX - REFERENCES



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- 1. AFML-TR-65-213, "Development of Standardized Test Methods to Determine Plane Strain Fracture Toughness", G. L. Hanna and E. A. Steigerwald.
- 2. ASTM STP 410, "Plane Strain Crack Toughness Testing of High Strength Metallic Materials", W. F. Brown Jr., and J. E. Srawley.

APPENDIX

Contained within this Appendix are the; (1) Mechanical property working curves, and, (2) Fatigue S-N curves.

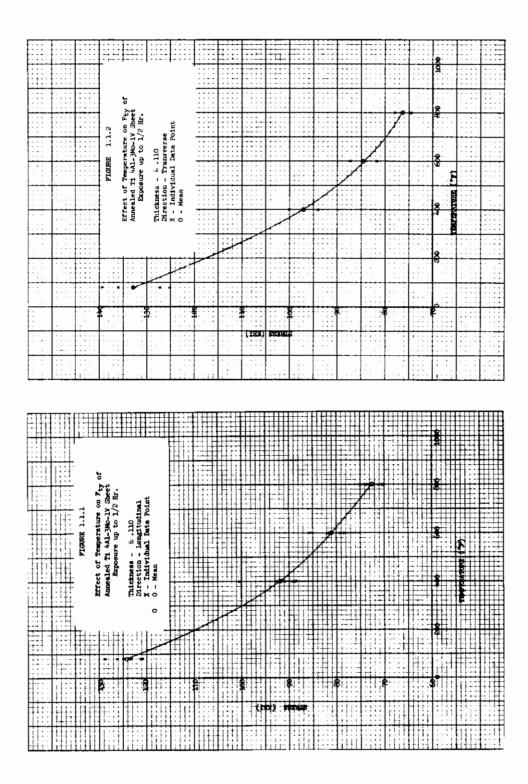
Section		Page
Α.	MECHANICAL PROPERTY WORKING CURVES	271-350
в.	FATIGUE S-N CURVES	351-362

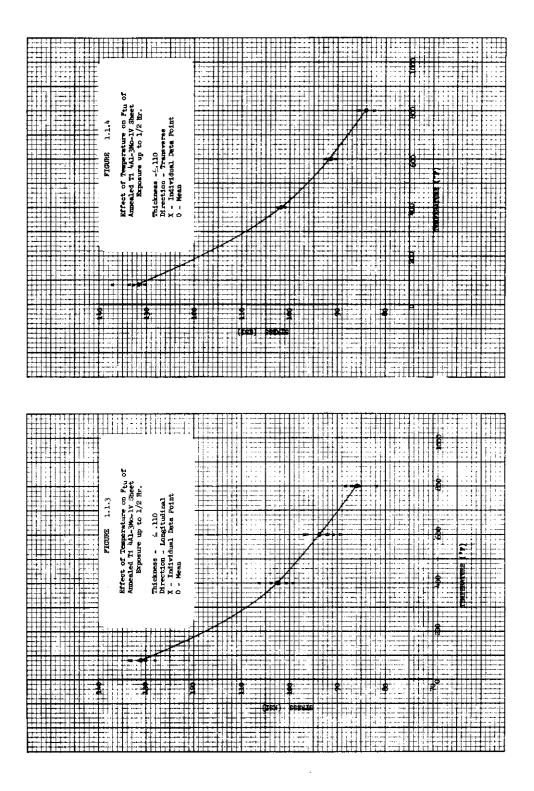
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A. WORKING CURVES

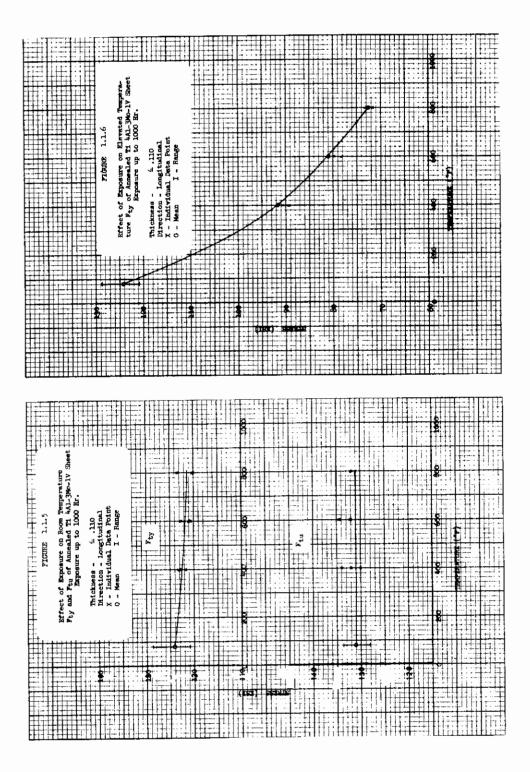
1.1 Ti-4A1-3Mo-1V Cond. A Figures 1.1.1 to 1.1.13

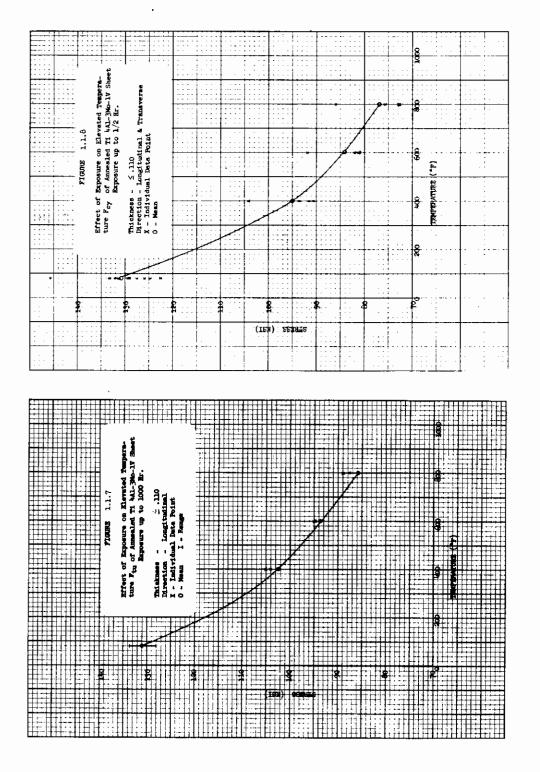


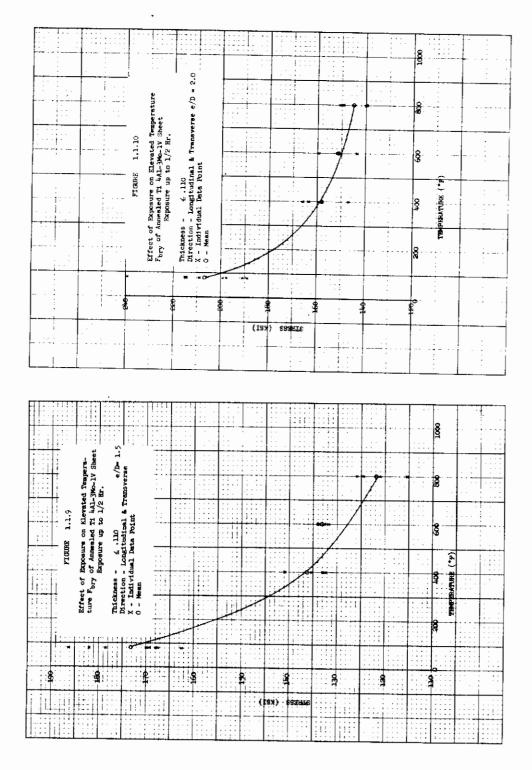


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		Thickness - \$.110 Direction - Longitudinal & Transverse e/D=1.5 X - Individual Deta Point	0 - Mean				-		7	I I				<u> </u>	
	FIGURE 1.1.11 ** Effect of Exposure on Elevated Temper- ture Fbru of Ammediad Ti 4A1-360-17 Sheet ** Exposure up to 1/2 Hr.	Thickness - \$.110 Direction - Longitudinal & Transverse e/D=1.5 X - Individual Deta Point	0 - Mean						7					<u> </u>	
	FIGURE 1.1.11 Effect of Exposure on Elevated Temper- ture Fbru of Amseiled Ti 4A1-360-17 Sheet	Thickness - 5.110 Thickness - 5.110 Direction - Inductual and & Transverse e/bal.5 - X - X - Traivedual Bets Points	0 - Mean						7	I I				<u> </u>	
	FIGURE L.1.11 Image: State of Exposure on Riewated Traper- Image: State of Amselled Ti MAL-36c-1V Sheet Amselled Ti MAL-36c-1V Sheet	The former of th	200 • • • • • • • • • • • • • • • • • •						7					<u> </u>	
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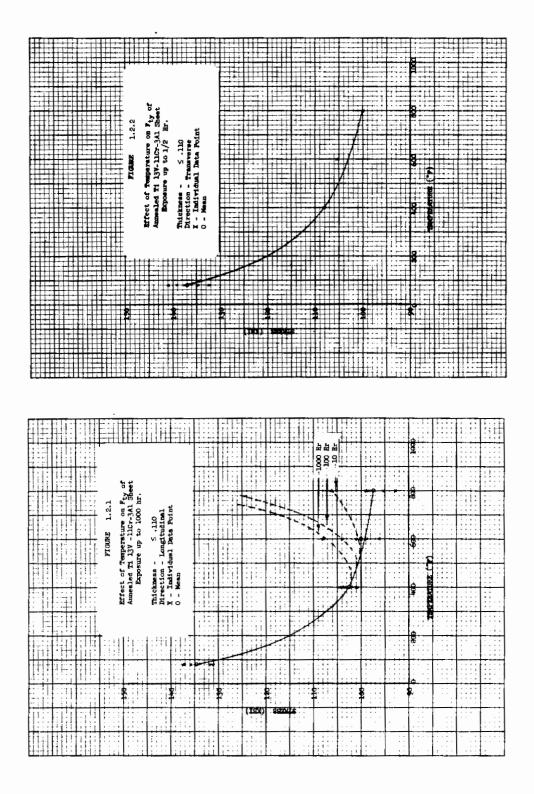
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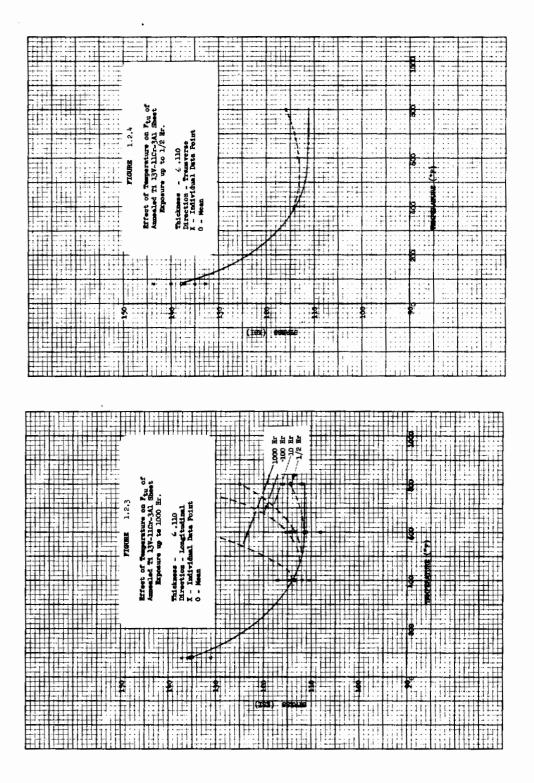
WORKING CURVES (Continued) Α.

1.2 Ti-13V-11Cr-3A1 Cond. A Figures 1.2.1 to 1.2.18

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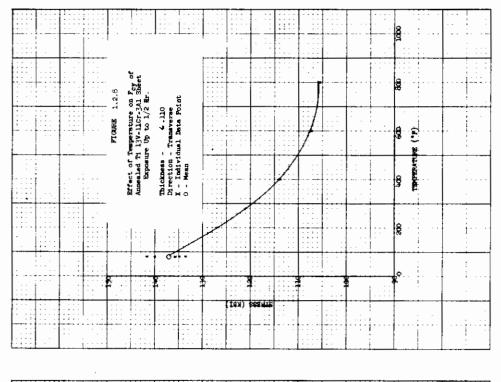




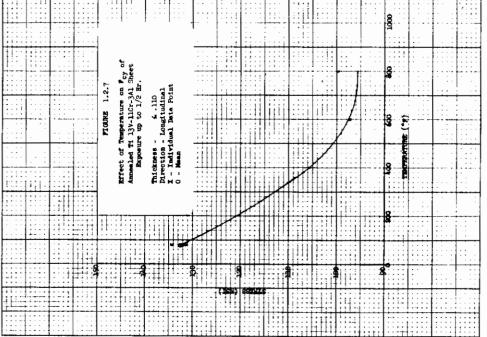
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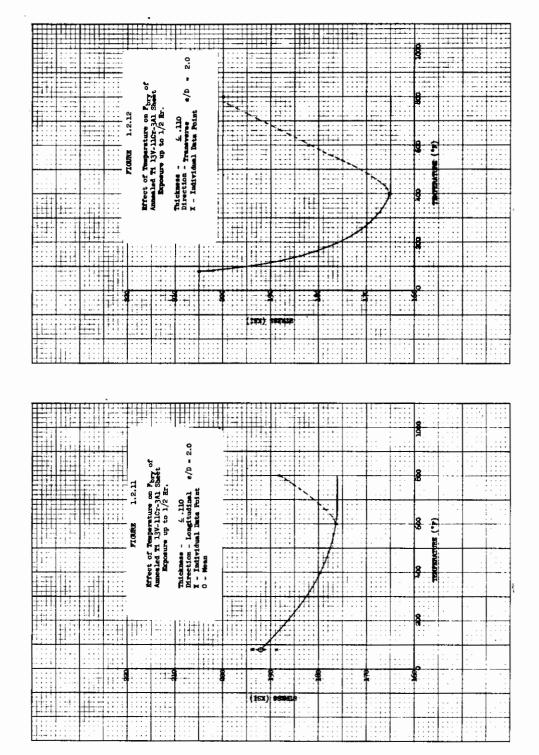
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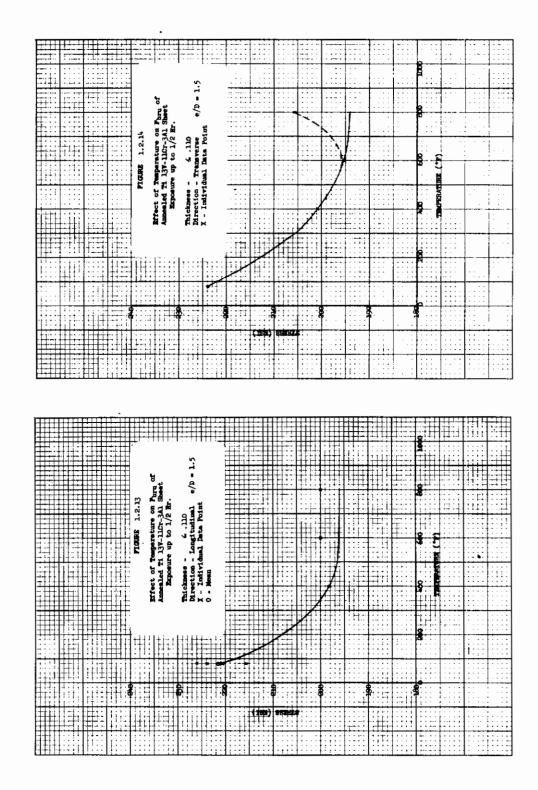
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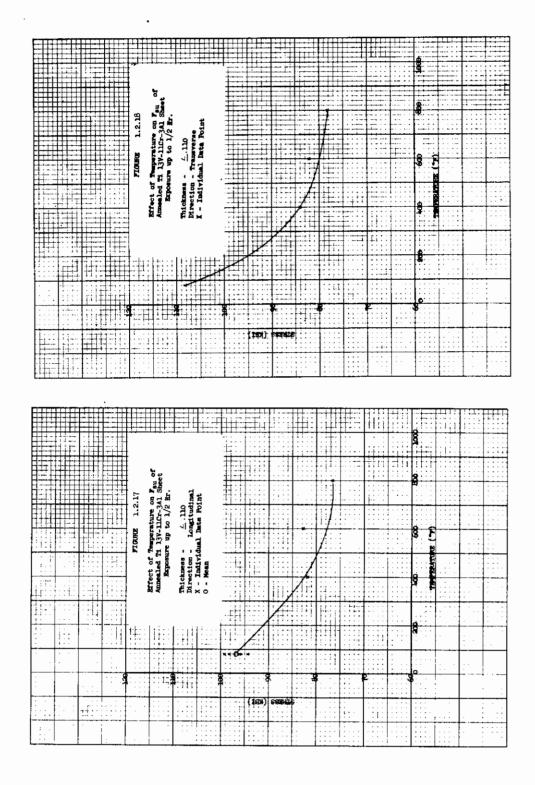
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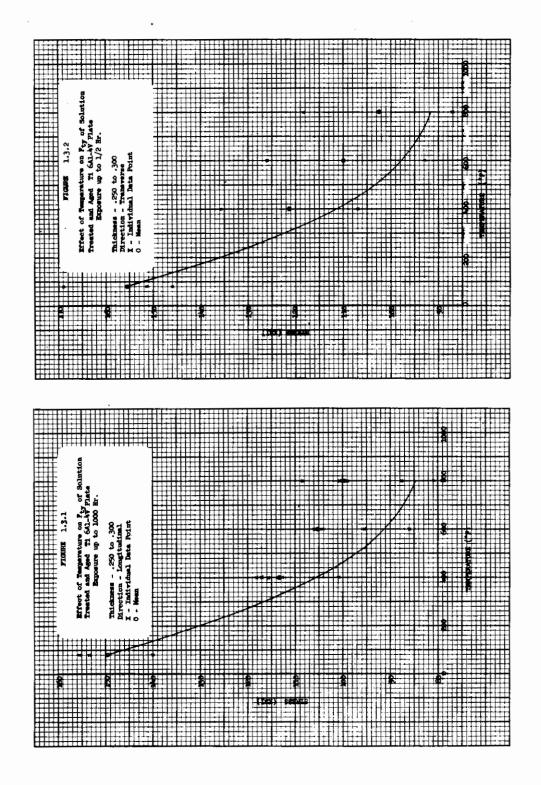


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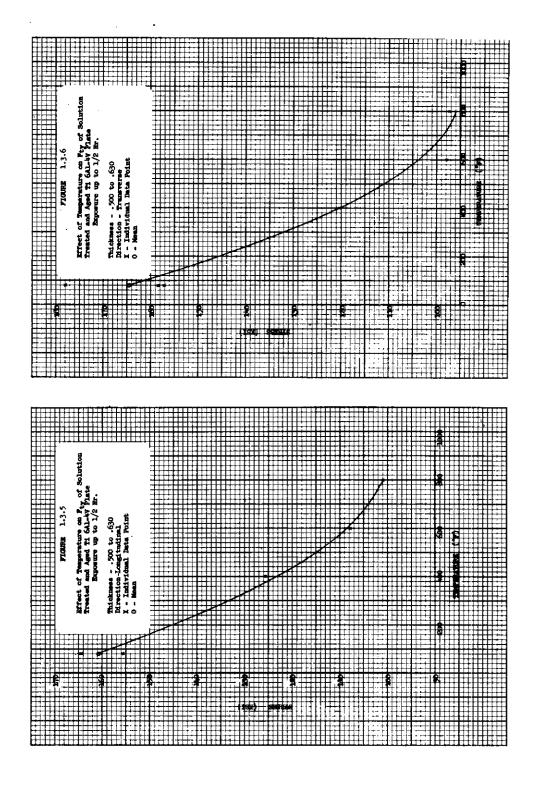
1.3 Ti-6Al-4V Cond. STA Figures 1.3.1 to 1.3.43

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+ **Solution** 8 1.3. Effect of Temperature on F. Treated and Aged T1 6A1-4V Reposure up to 1/2 Thickness - 250 to .300 Direction - Transverse X - Individual Data Point O - Mean PICOURCE V Effect of Tumperature on Fu of Solution Freeted and Aged 71 641-44 Flate Exposure up to 1000 Hr. 1.3.3 Thickness - .250 to .300 Birection - Icogradiani X - Individual Data Foint 0 - Mean **FIGURGE** Ħ 8 餠



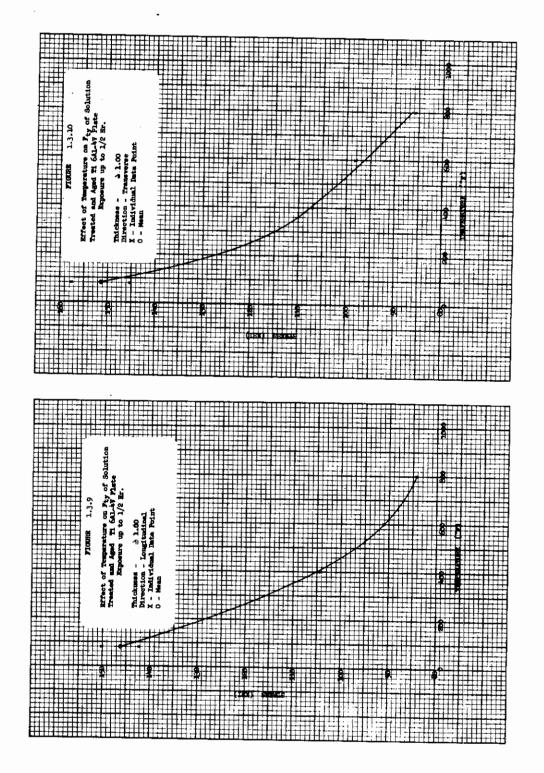
Solution 8 1.3.8 Thickness - 500 to .630 Direction - Transverse X - Individual Data Foint 0 - Maan Effect of Temperature on P. Treated and Aged T1 6Al-4V Exposure up to 1/2 710UEL ŝ ***** •••• 仲 8 Effect of Tumpersture on F_{tu} of Solution Treated and Aged Ti 6Al-4V Plate Express up to 1/2 Hr. PTOURB 1.3.7 Thickness - .500 to .630 Mirection - Longitudinal X - Individual Data Foint 0 - Mean 8

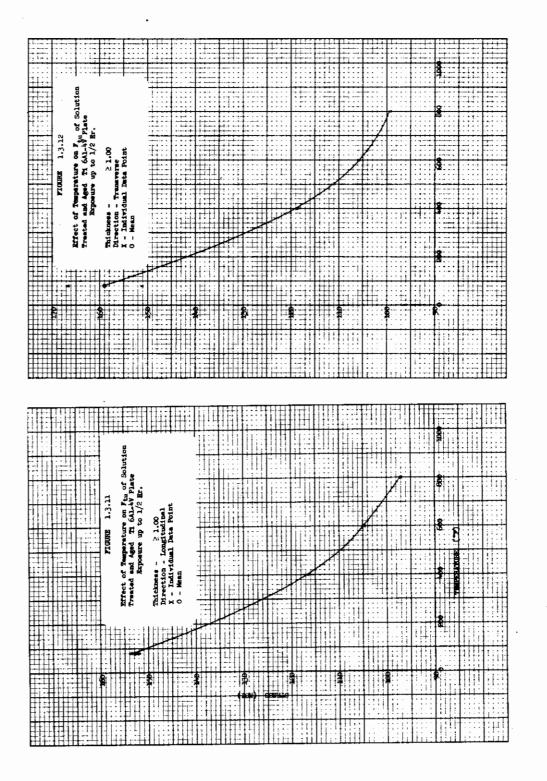
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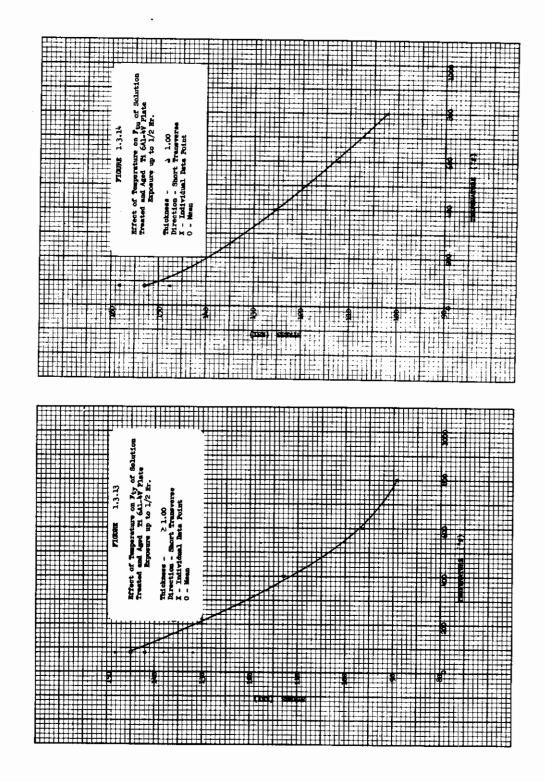
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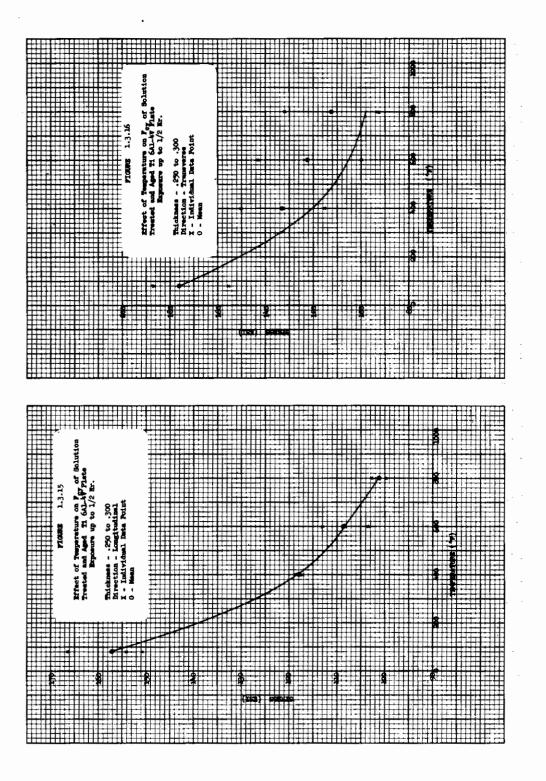
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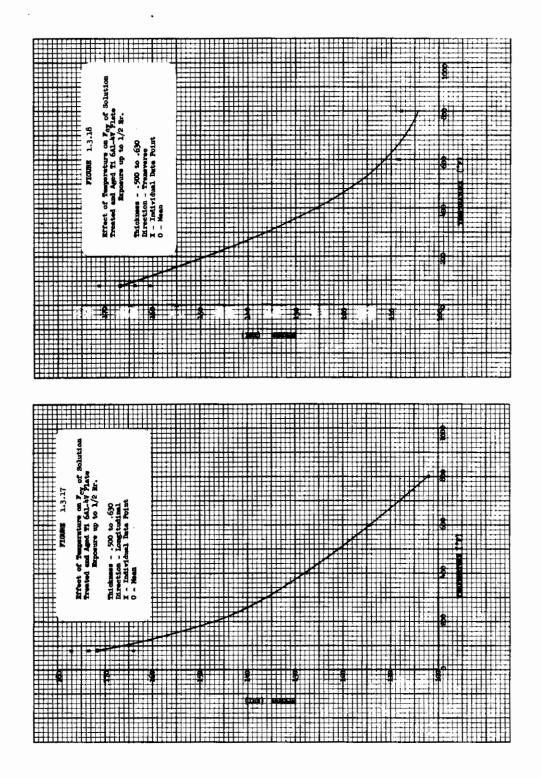


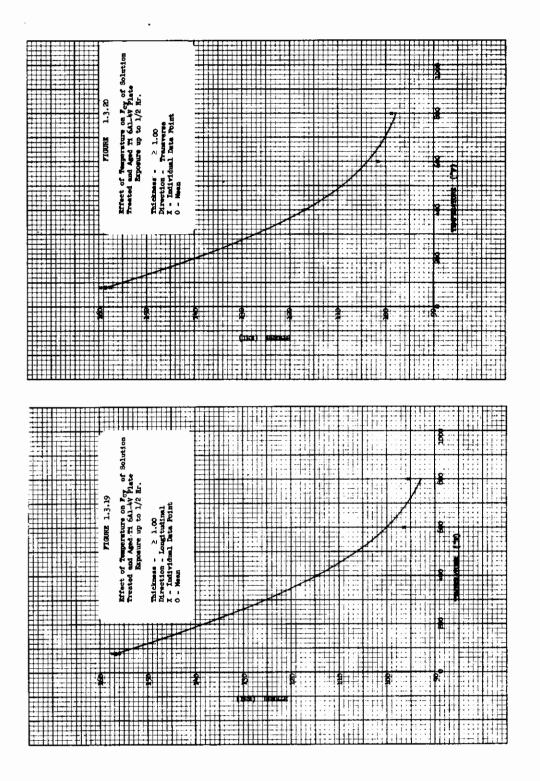


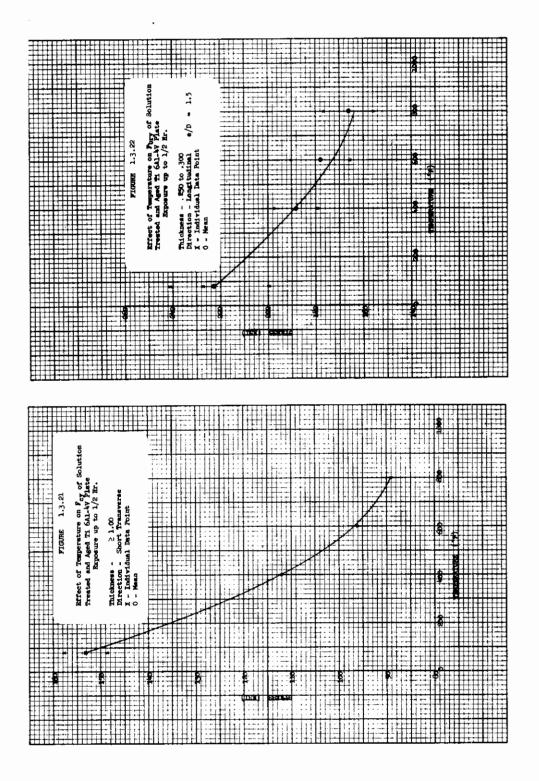
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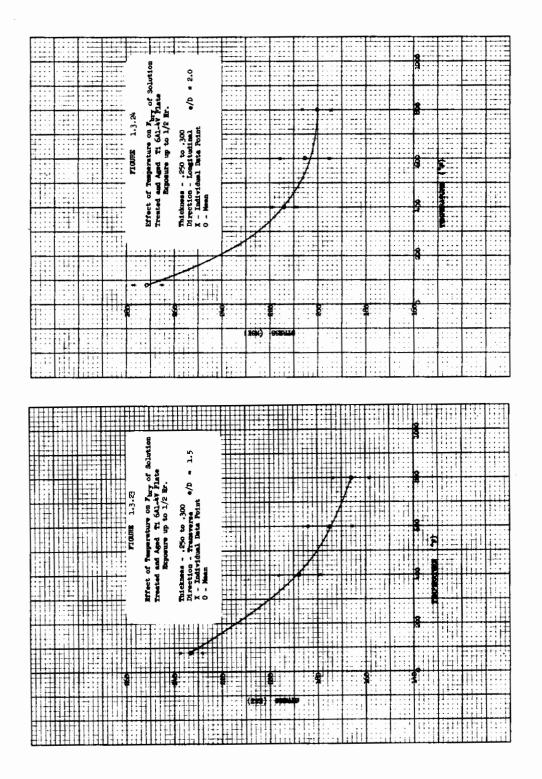


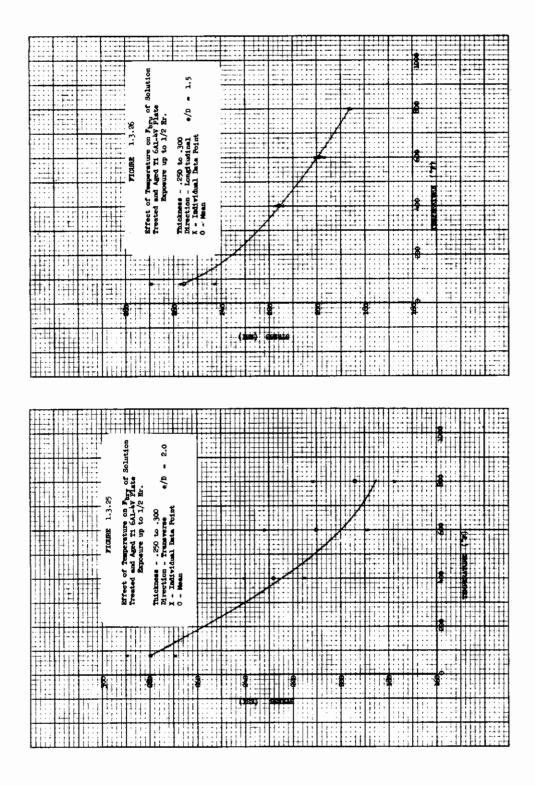




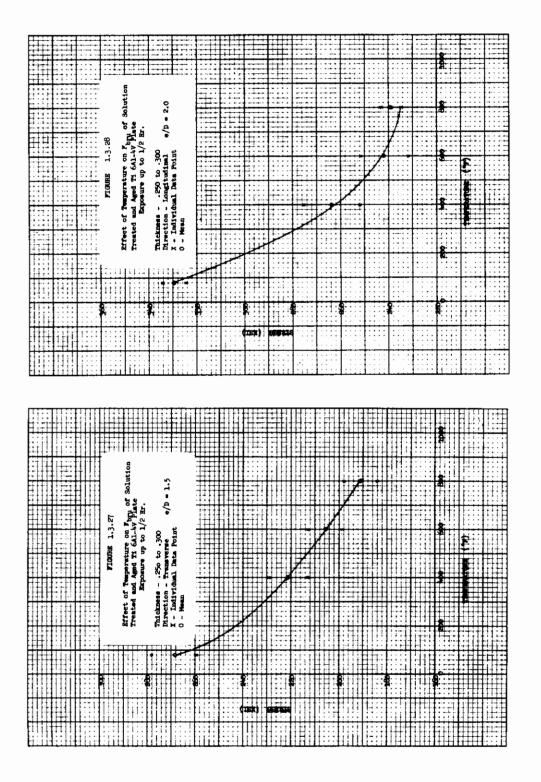


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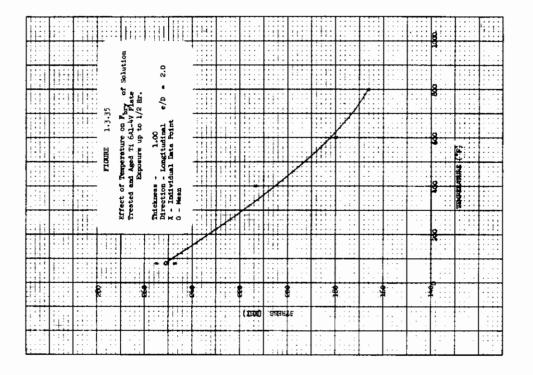
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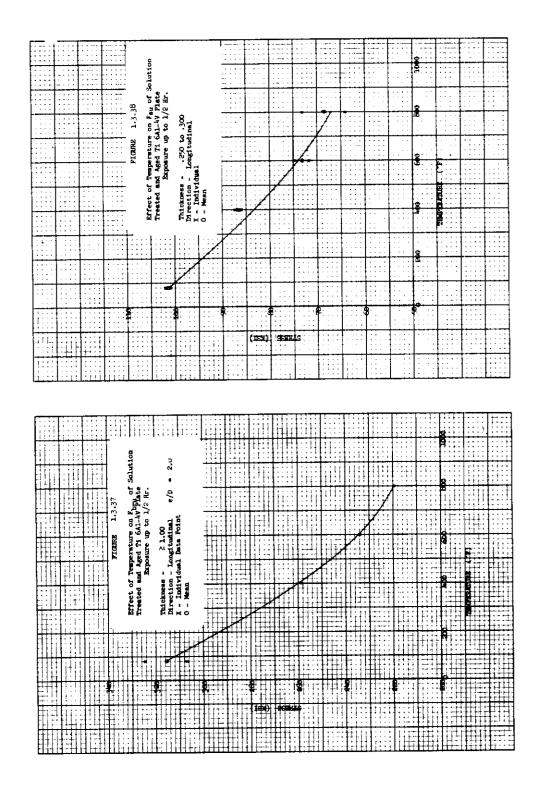
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			FIGURE 1.3.41	Treated of Temperature on Fau of Solution Treated and Aged Tf 601-4V Para		The first of the f															

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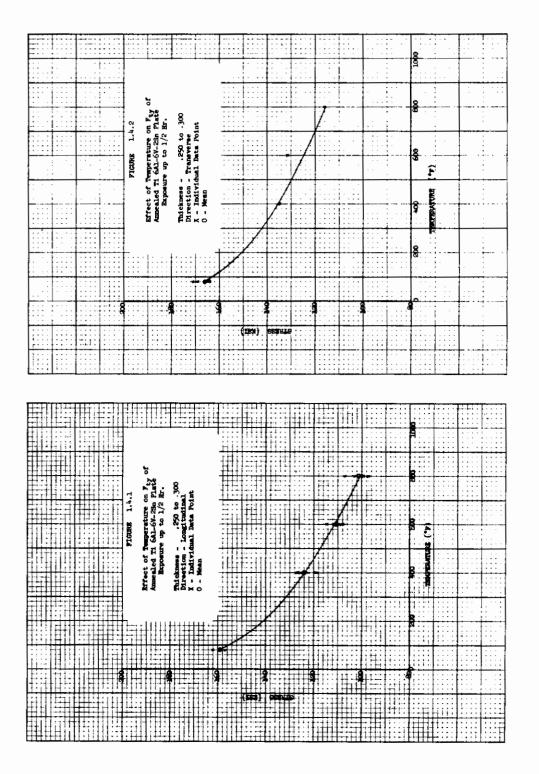
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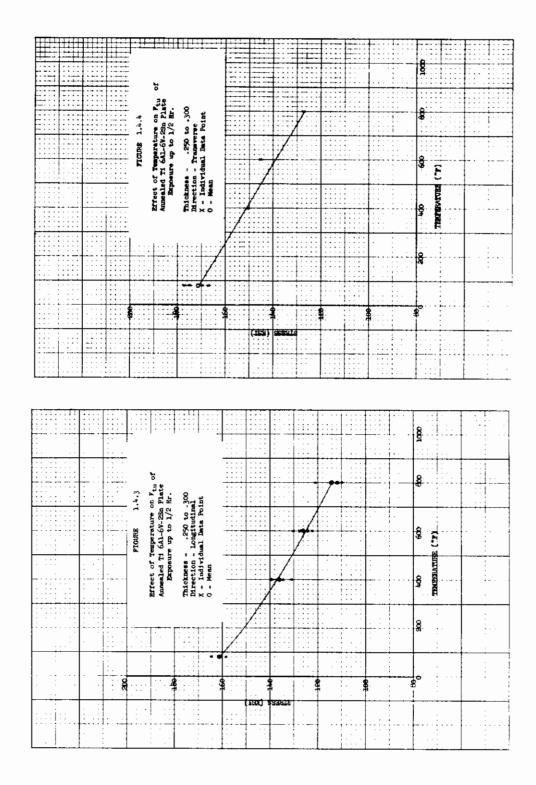
1.4 Ti-6Al-6V-2Sn Cond. A Figures 1.4.1 to 1.4.44

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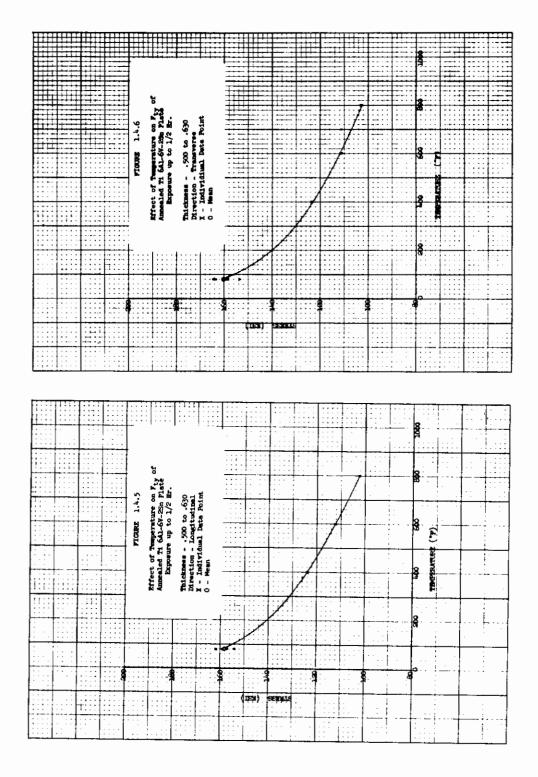


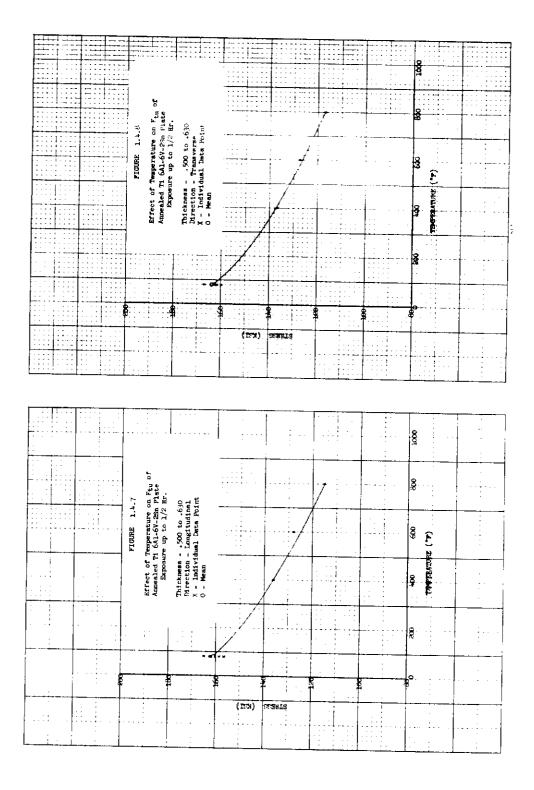
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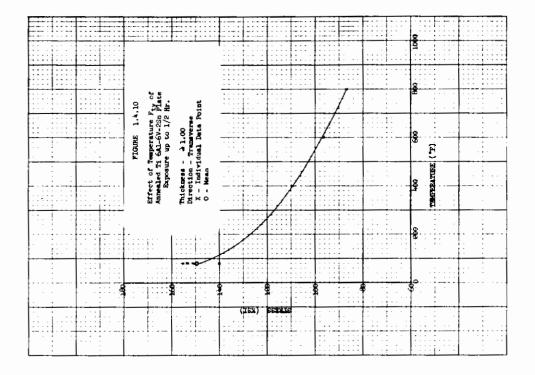
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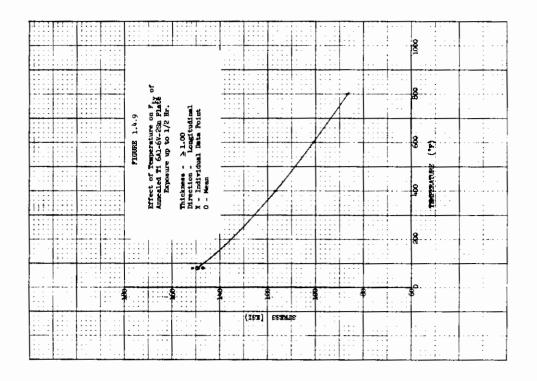




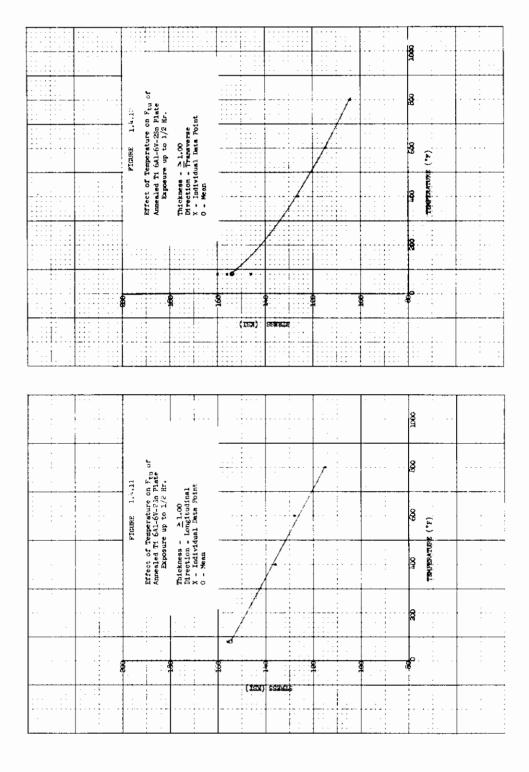




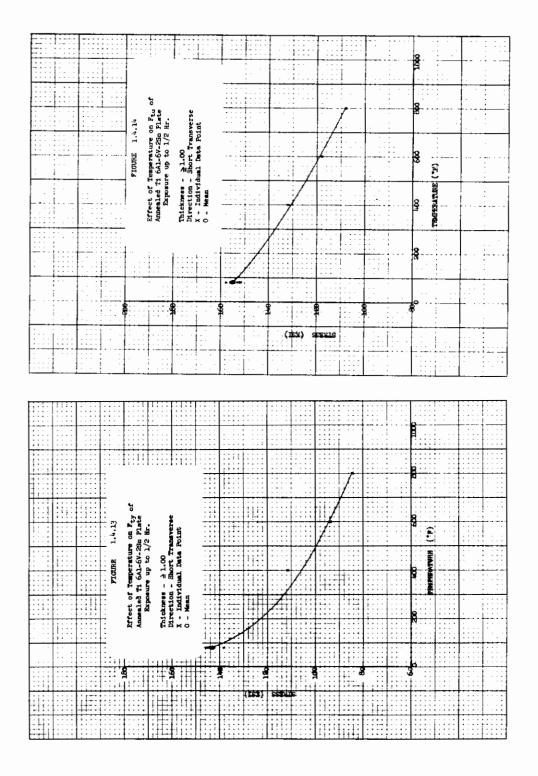


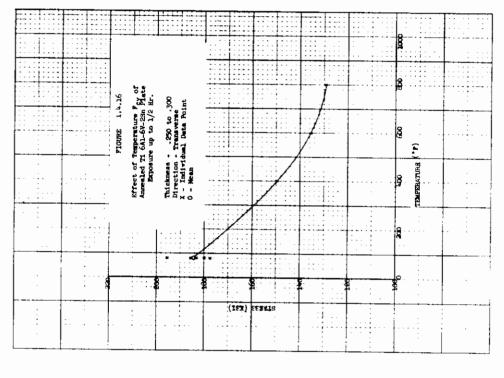


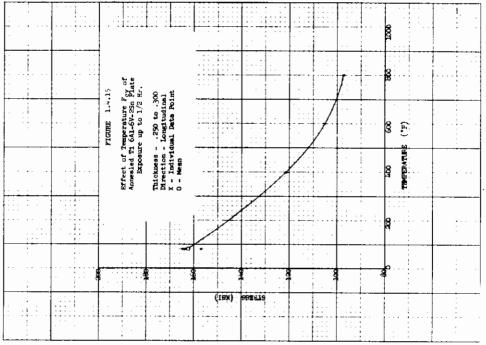
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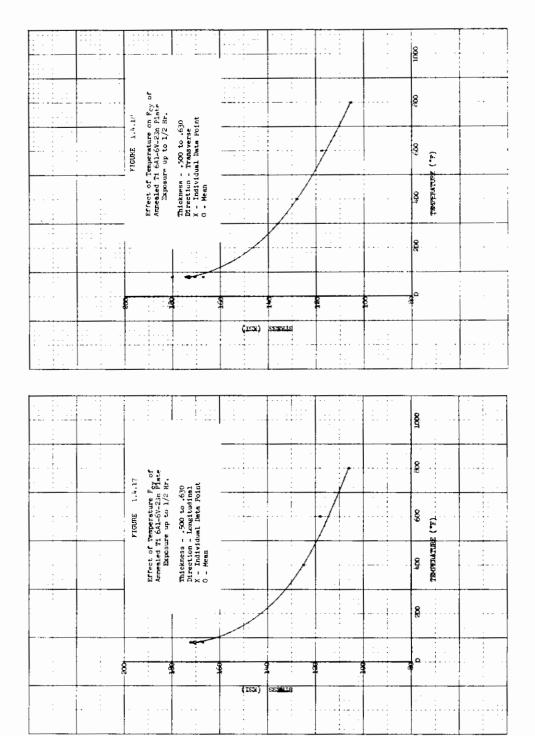
- 318 -Approved for Public Release





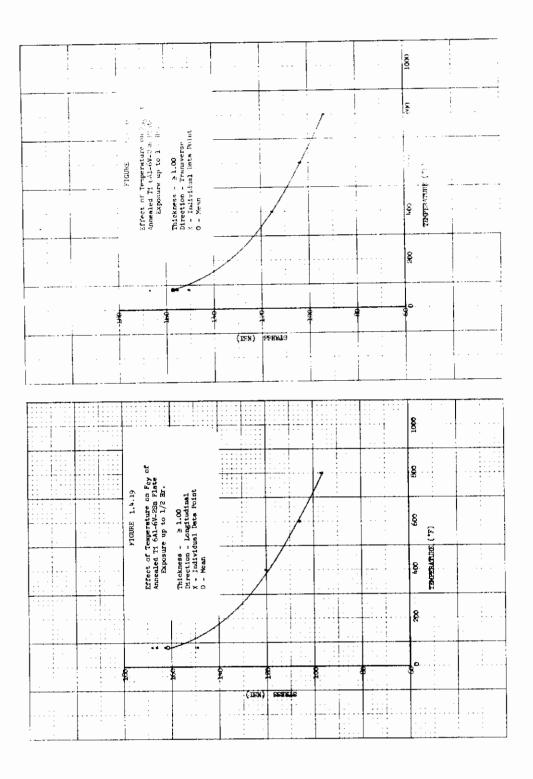


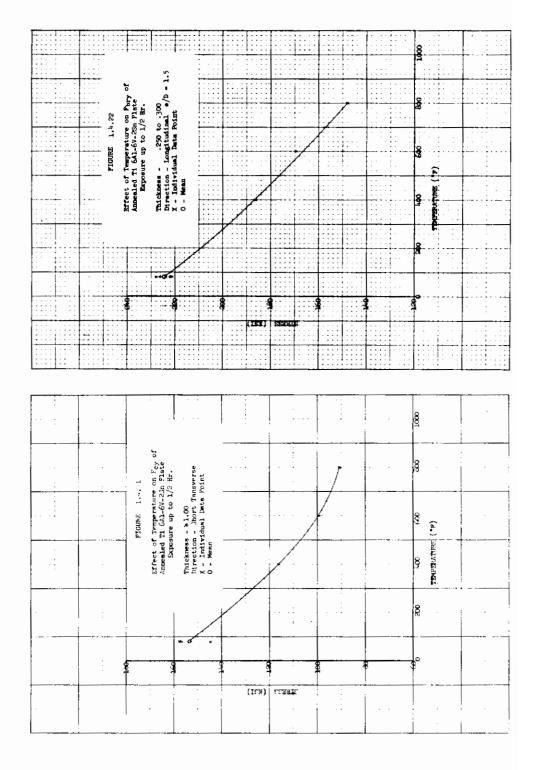
- 320 -Approved for Public Release

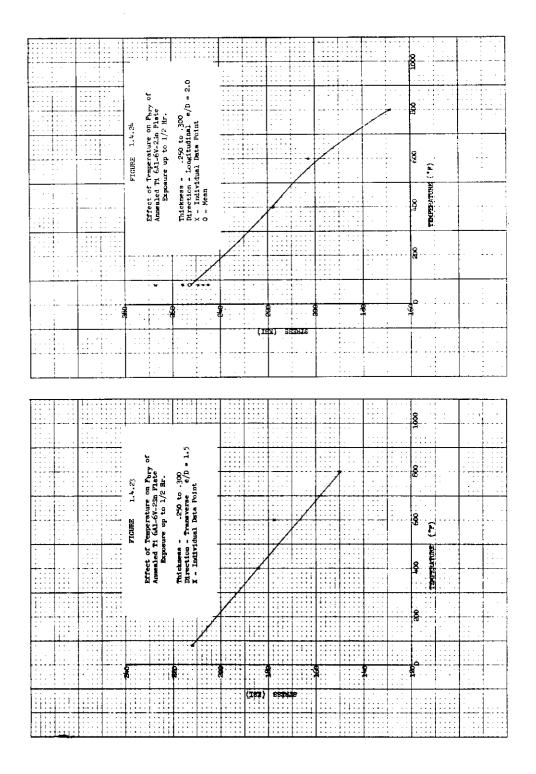


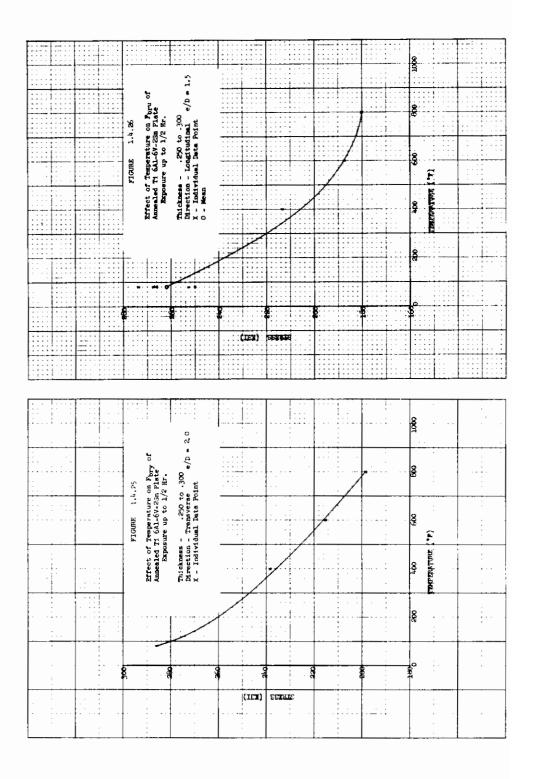
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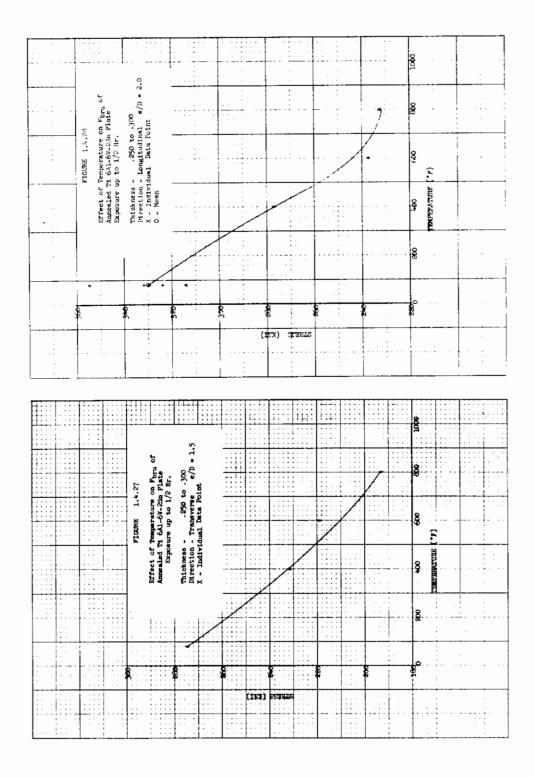




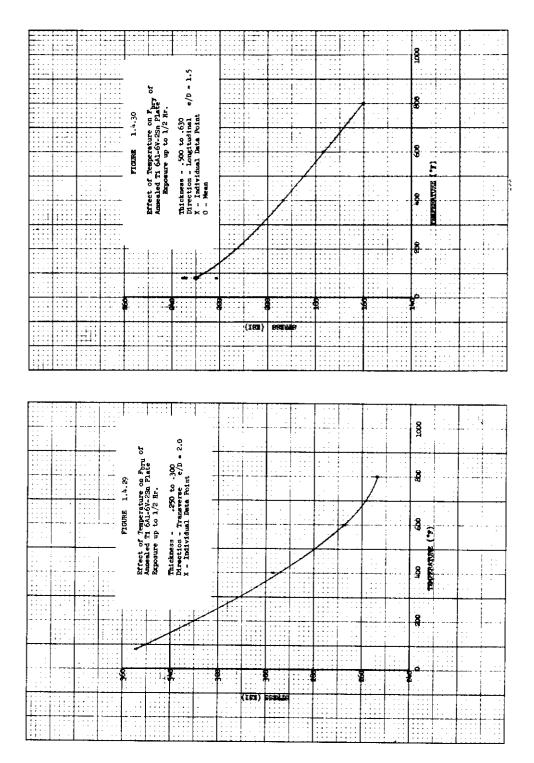


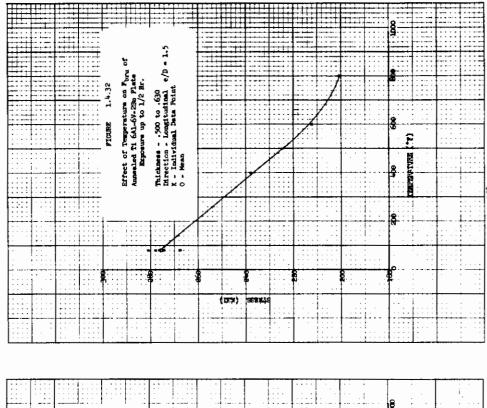


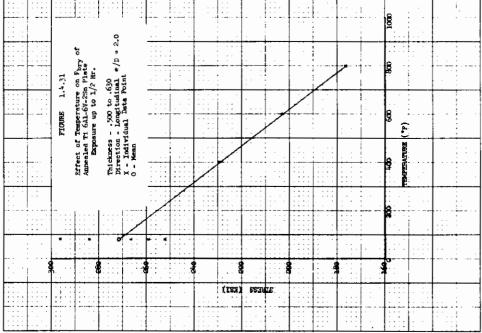
- 325 - Approved for Public Release



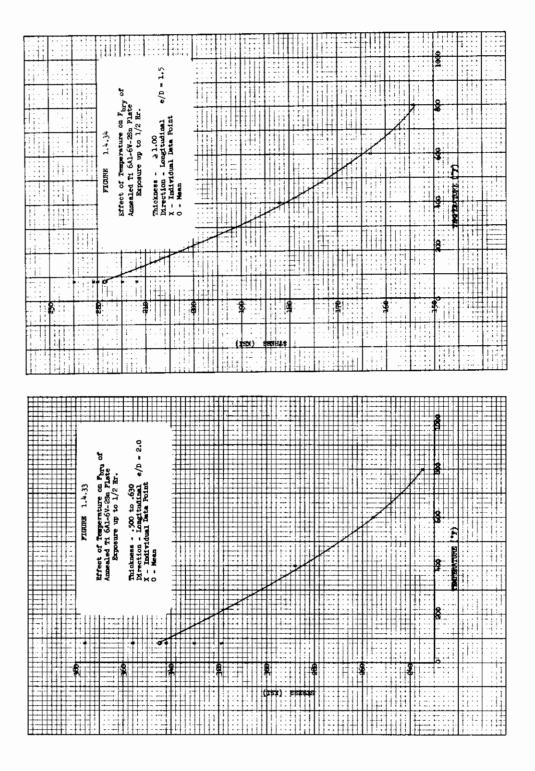
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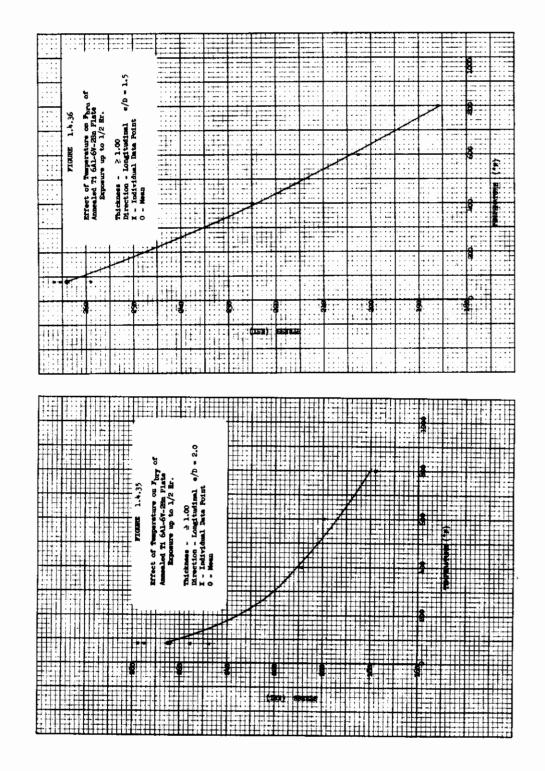


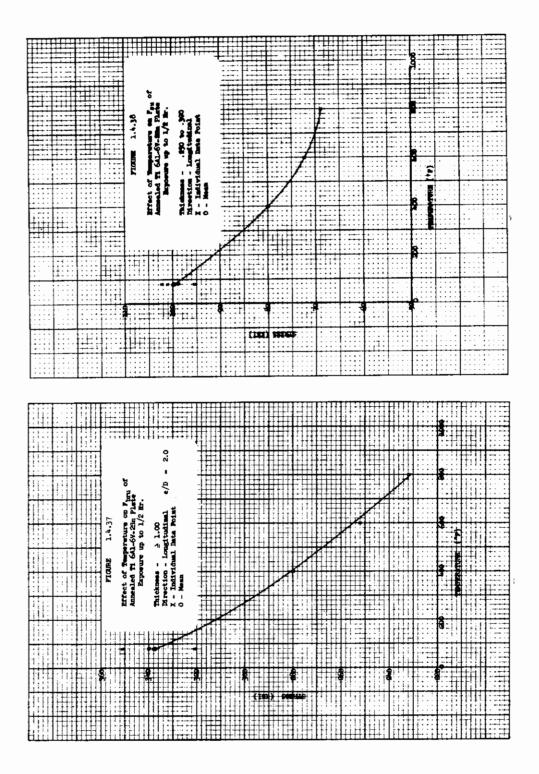




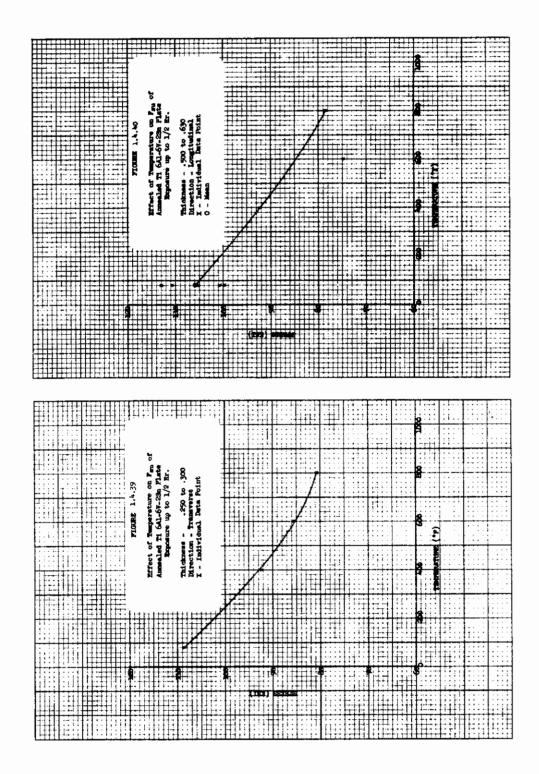
- 328 - Approved for Public Release

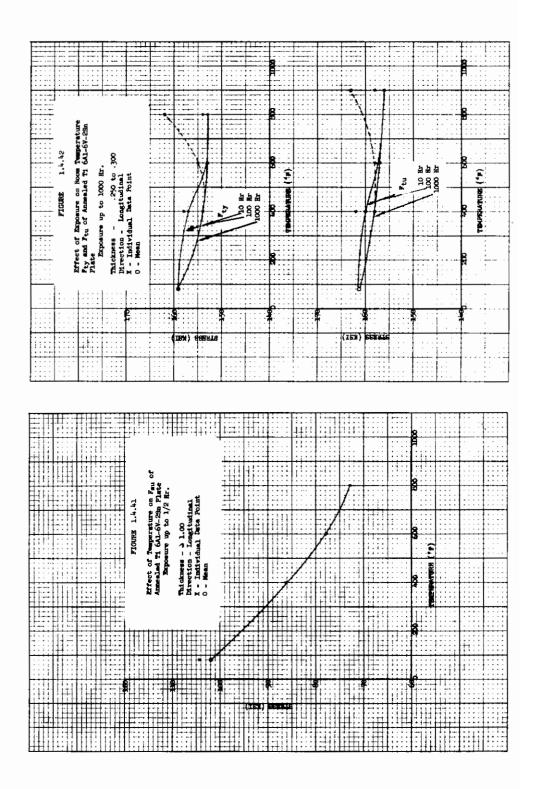


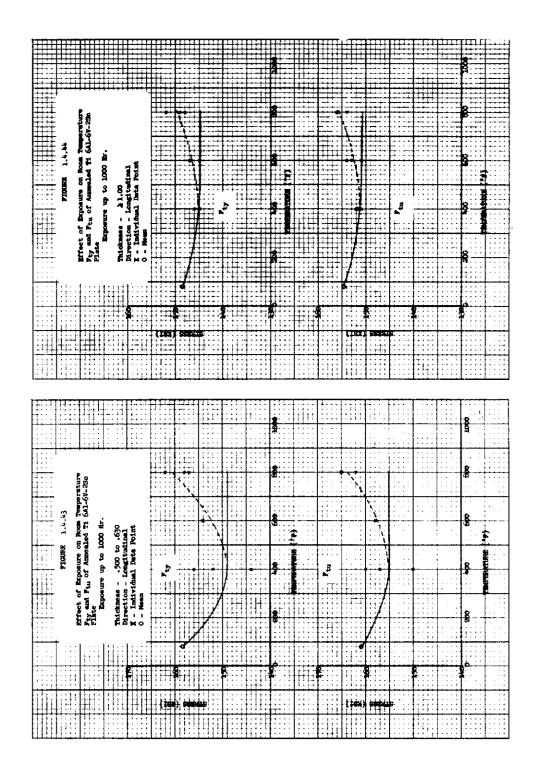




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B. WORKING CURVES

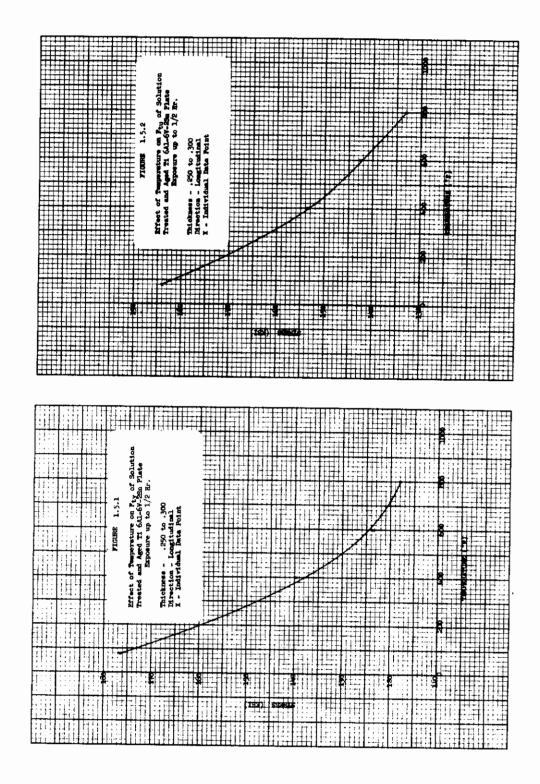
1.4 Ti 6A1-6V-2Sn Cond. STA

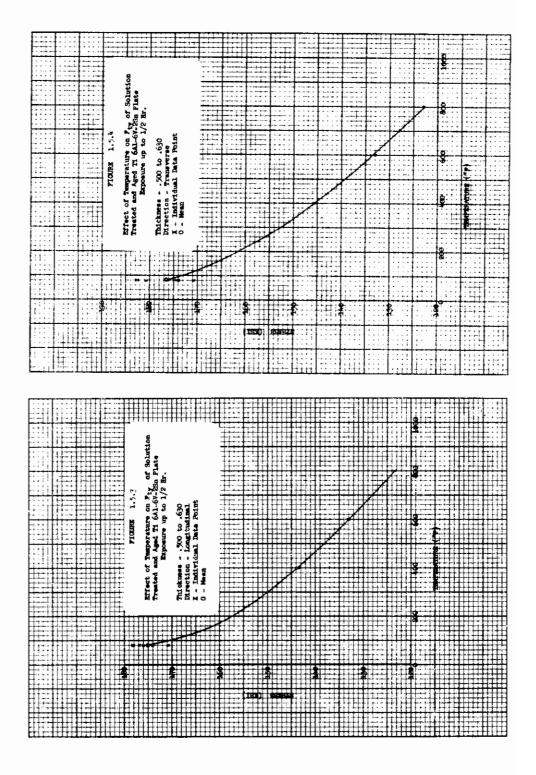
Figures 1.5.1 to 1.5.29

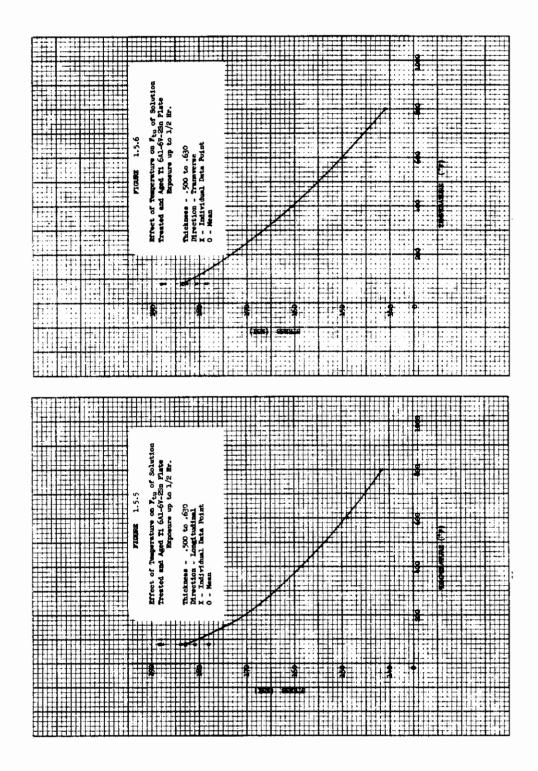
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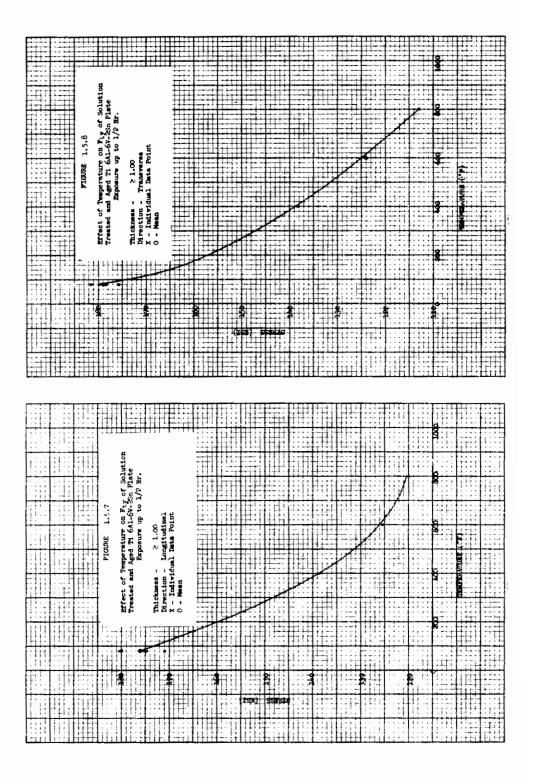
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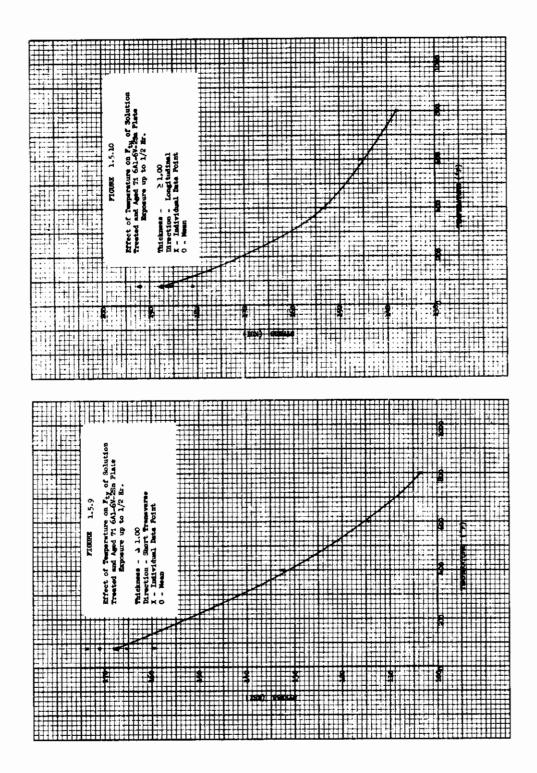


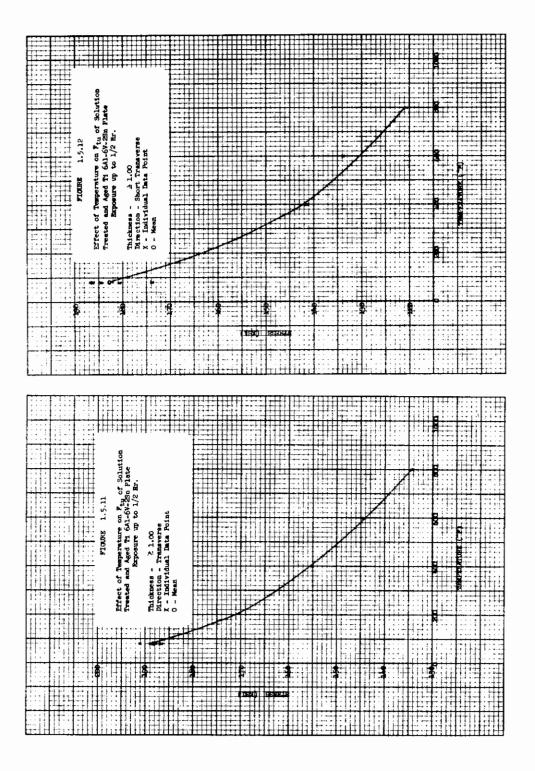


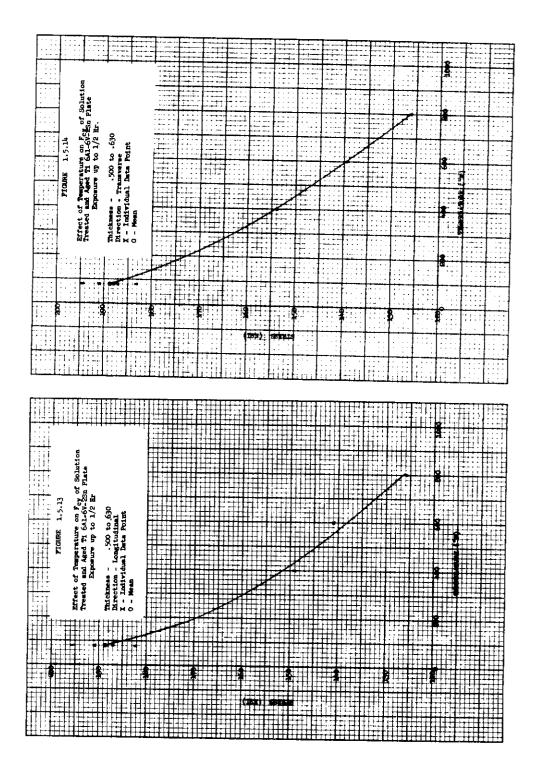


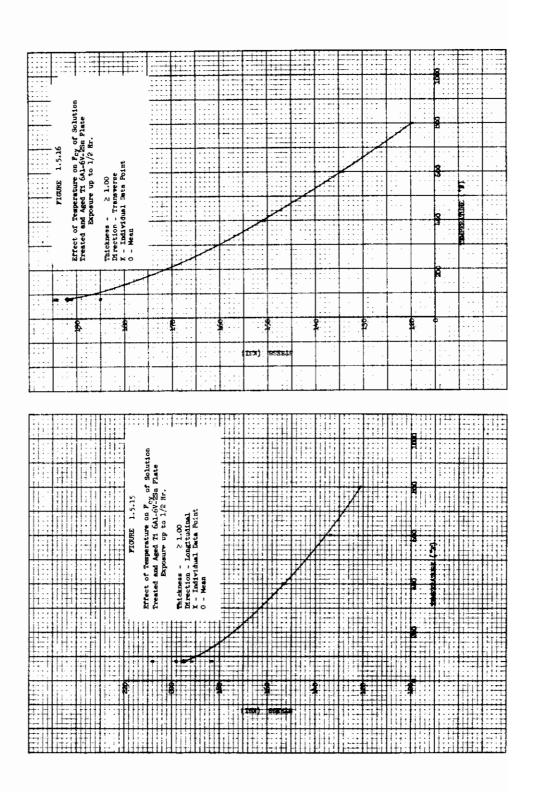


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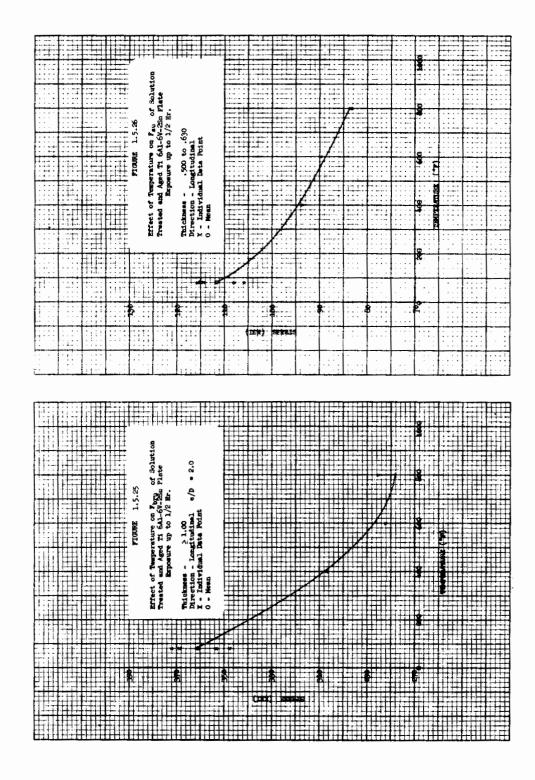
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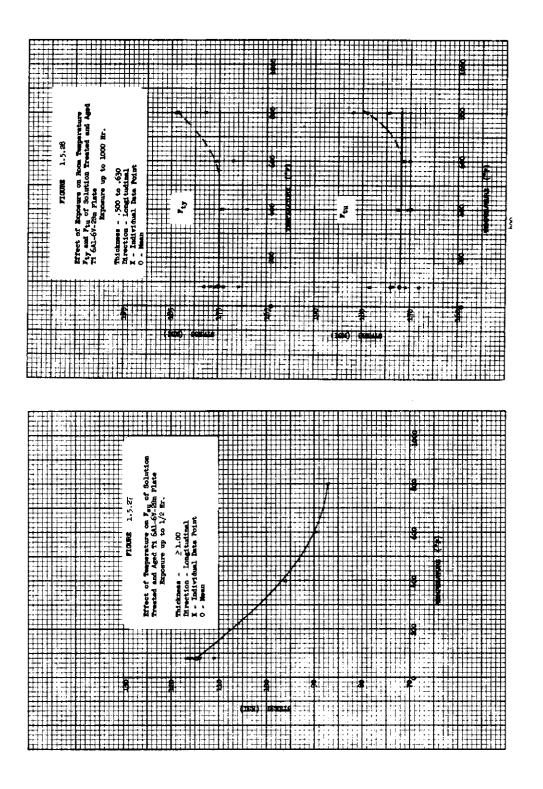
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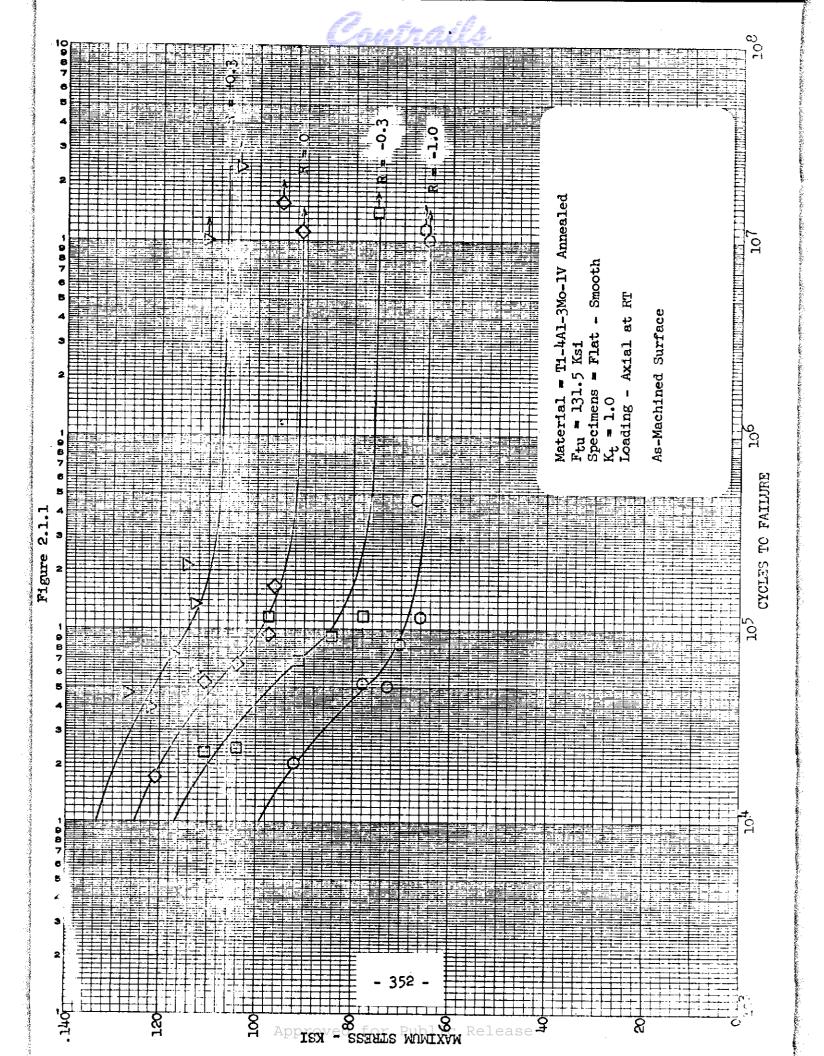
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Ti-4A1-3Mo-1V Cond. A Figures 2.1.1 to 2.1.2



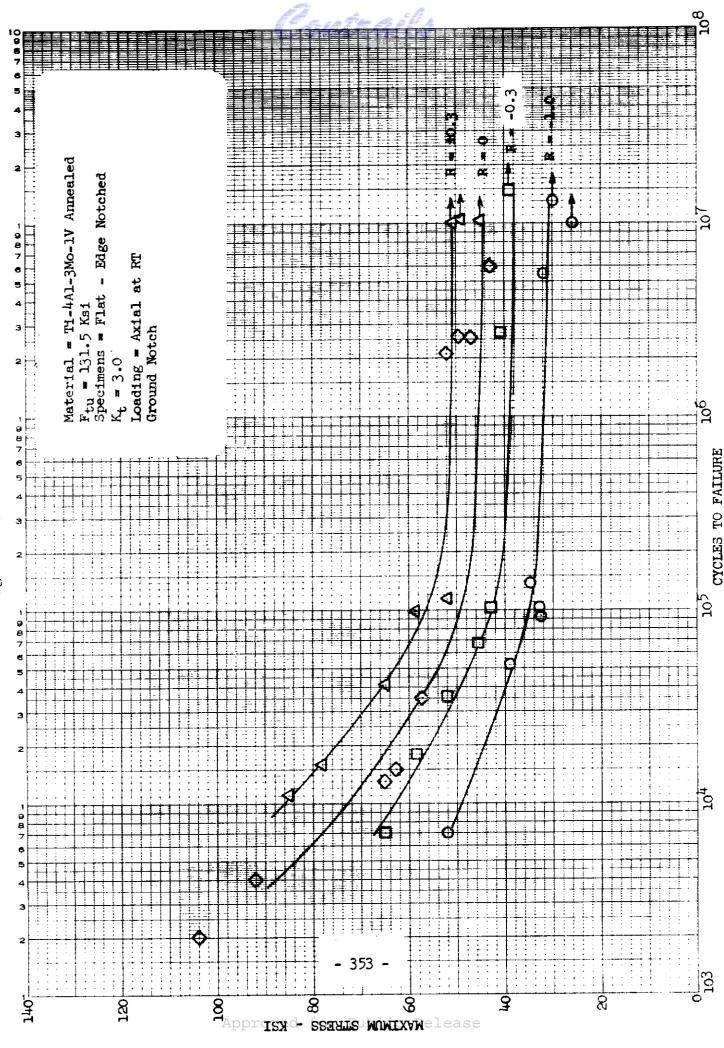


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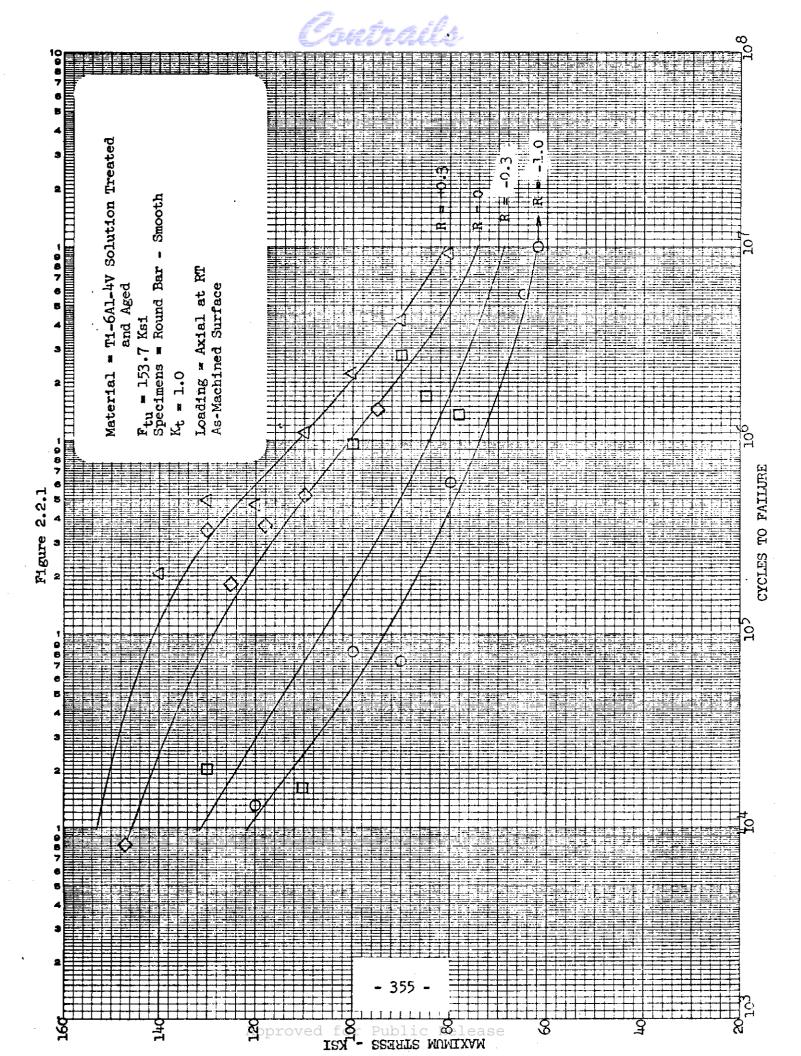
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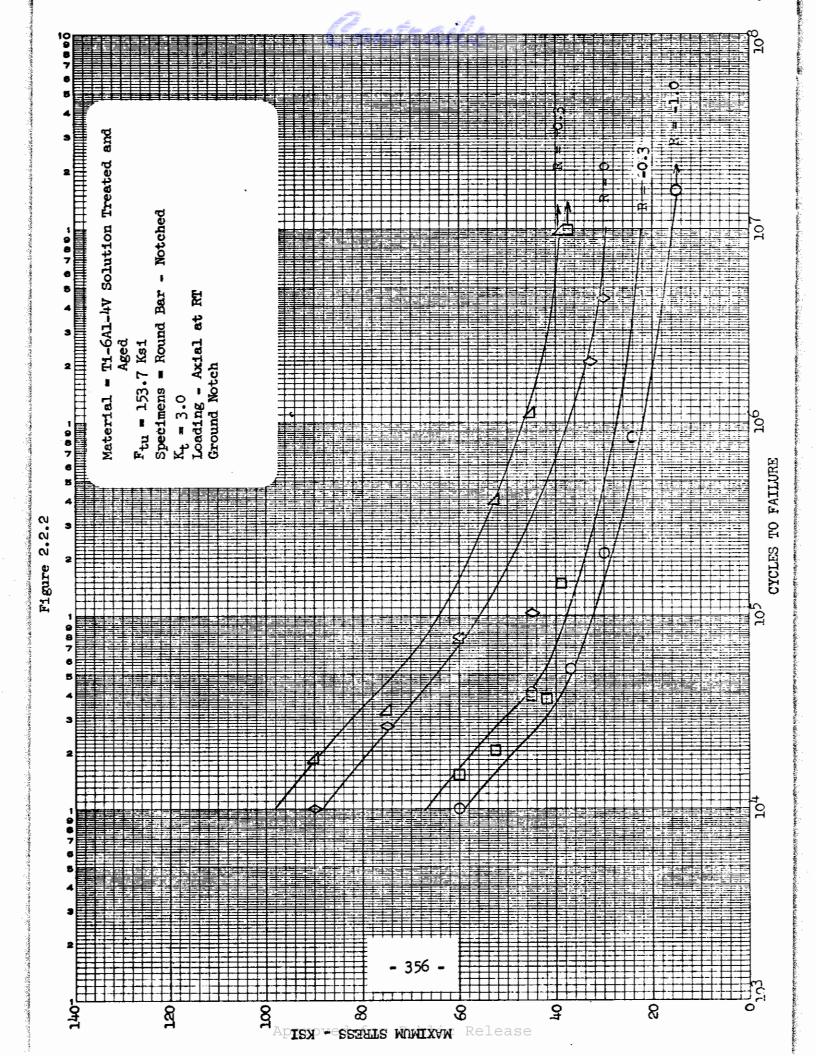
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2.2 T1-6A1-4V Cond. STA Figures 2.2.1 to 2.2.2

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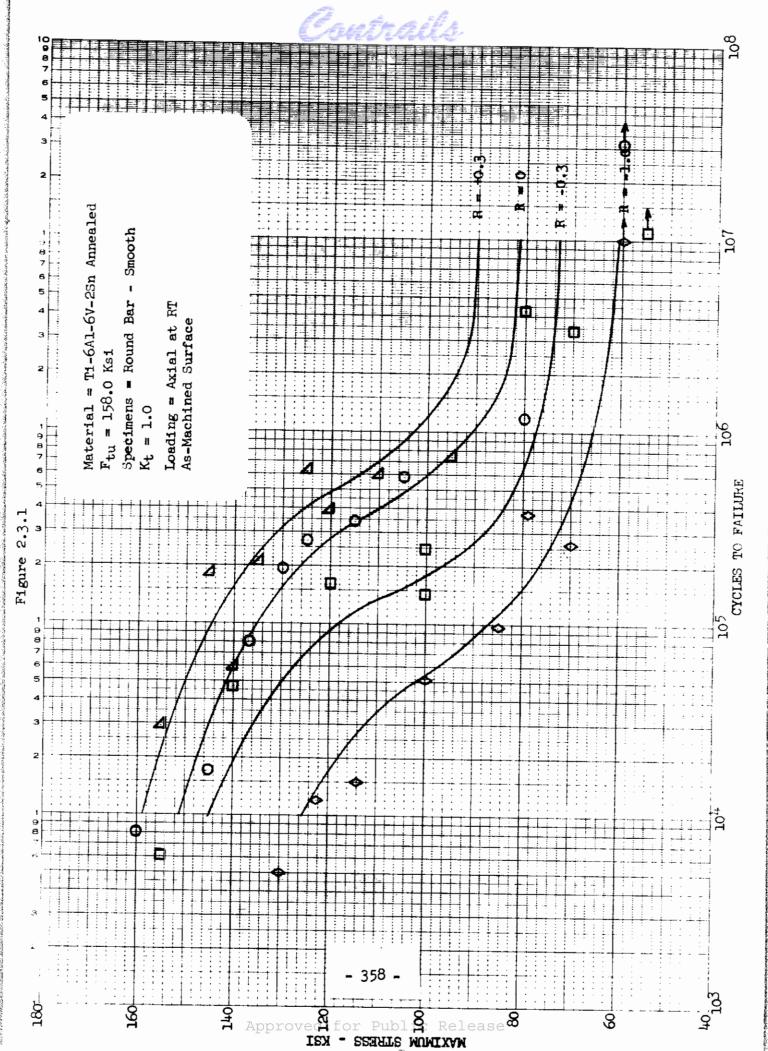
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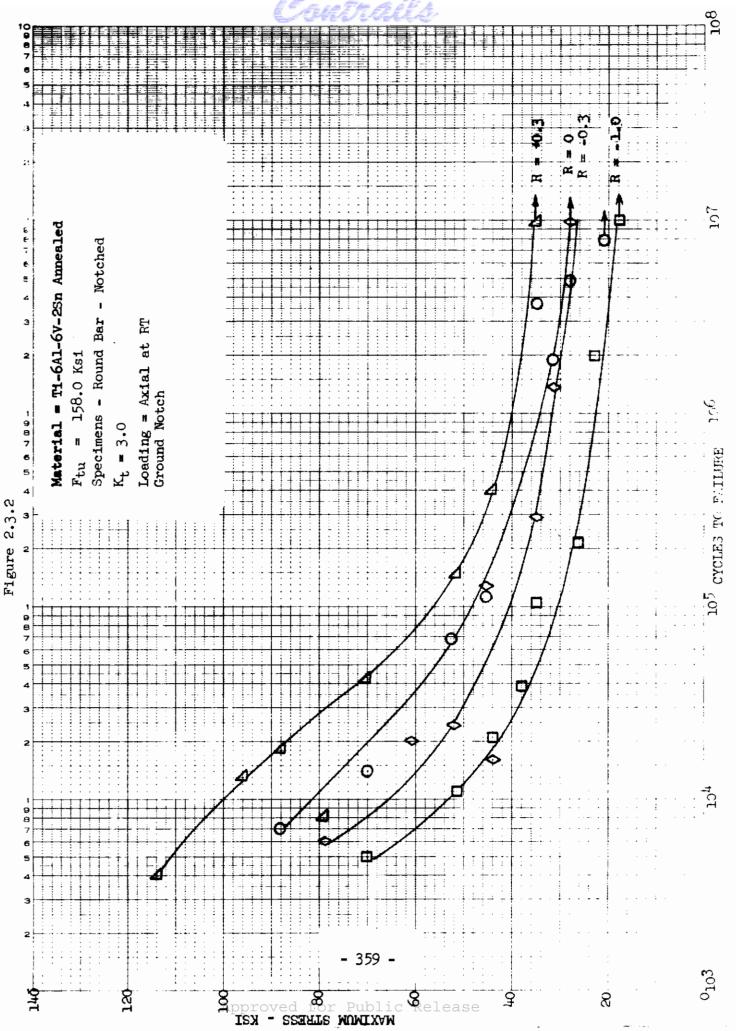
2.3 Ti-6Al-6V-2Sn Cond. A Figures 2.3.1 to 2.3.2

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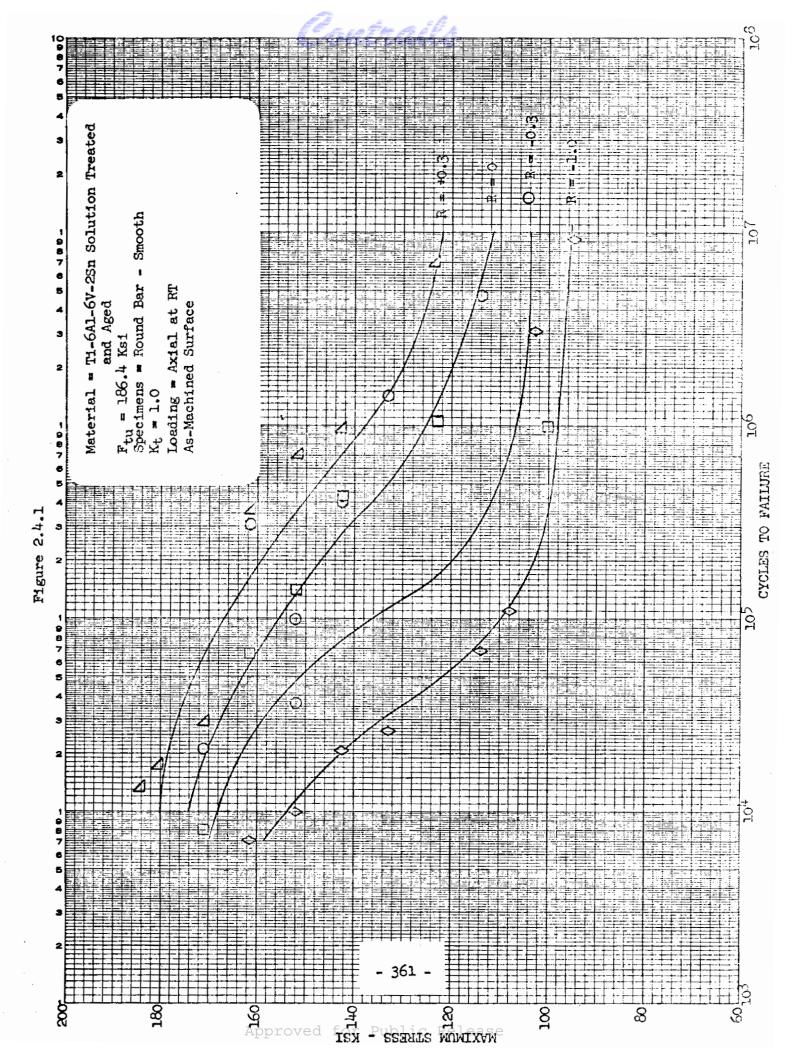
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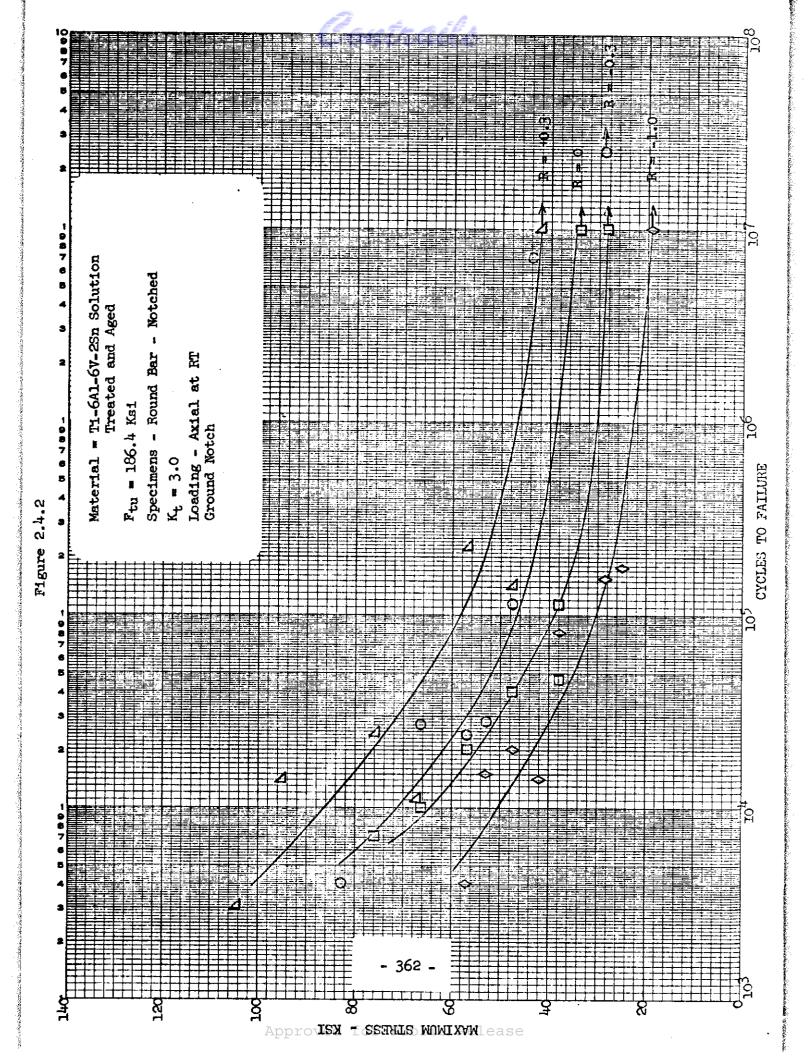
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2.4 Ti-6Al-6V-2Sn Cond. STA Figures 2.4.1 to 2.4.2

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