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# DEVELOPMENT OF WELDING TECHNIQUES AND FILLER METALS FOR HIGH STRENGTH ALUMINUM ALLOYS

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May 27, 1966

SOUTHWEST RESEARCH INSTITUTE
SAN ANTONIO HOUSTON

## SOUTHWEST RESEARCH INSTITUTE 8500 Culebra Road, San Antonio, Texas 78206

## DEVELOPMENT OF WELDING TECHNIQUES AND FILLER METALS FOR HIGH STRENGTH ALUMINUM ALLOYS

FINAL REPORT Project No. 07-1063 Project No. 07-1757

by

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for

National Aeronautics and Space Administration George C. Marshall Space Flight Center Huntsville, Alabama Atm: PR-EC

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#### FOREWORD

This report was prepared by Southwest Research Institute under Contracts NAS8-1529 and NAS8-20160, "Development of Welding Techniques and Filler Metals for High Strength Aluminum Alloys," for the George C. Marshall Space Flight Center of the National Aeronautics and Space Administration. The work was administered under the technical direction of the Propulsion and Vehicle Engineering Laboratory, Materials Division of the George C. Marshall Space Flight Center with Mr. Richard A. Davis acting as project manager.

#### ABSTRACT

A program was conducted to investigate possible means of improving the strength of welded aluminum alloys and to better define the mechanical and metallurgical characteristics of such weldments. The program extended over a period of five years and included the following areas of investigation:

- (1) Development of welding techniques and filler metal alloys
- (2) Evaluation of the uniaxial and biaxial mechanical properties of aluminum alloy weldments.

In the portion of the program directed toward the development of welding techniques, MIG and TIG weldments of the following materials were studied:

- 0.090-inch 2014, 2024, and X2020 aluminum alloy
- 0.75-inch 2219 aluminum alloy
- 0.090-inch, 0.187-inch, 0.50-inch, and 1.00-inch X7106 aluminum alloy

It was established that joint preparation methods (machining, cleaning, etc.) exert a strong influence on the soundness of welds for all material-process combinations included in the study. The variables associated with clamping fixtures were found to be the major factor in the control of the size of the zone of heat-affected base metal in the 0.090-inch 2014, 2024, and X2020 weldments. In general, the TIG process produced the most desirable weld bead configuration for all weldment types investigated. In addition, the TIG weldments were in general less susceptible to porosity than were the MIG weldments.

Techniques were developed for welding 0.75-inch 2219-T87 plate by the MIG process. The use of cold-wire feed was shown to reduce sagging of welds made with the torch in the horizontal position. The addition of copper to the molten weld puddle, by means of cold-wire feed, was also studied. Such copper additions resulted in an increase in the hardness of bead-on-plate weld deposits. The use of this technique for the fabrication of weldments resulted in incomplete solution of the added copper and the weldments exhibited lower strength than those made with commercial filler wire.

Bead-on-plate welds were made with several binary aluminum filler alloys (Cu, Ag, Mn and Si) and with one experimental multicomponent aluminum alloy. The results of this investigation indicated that the properties of the experimental alloys were no better than those of the commercial filler alloys.

A study of the microstructure of 0.75-inch TIG 2219-T87 weldments was conducted. Considerable quantities of  $\text{CuAl}_2$  were observed in the grain boundaries of the weld deposits and in the adjacent heat-affected base metal and a needle-like precipitate tentatively identified as  $\beta$  (Al-Cu-Fe) was frequently formed in the toes of the welds. Metallographic and fractographic analysis of failed tensile specimens established that intermetallic precipitates play a significant role in the initiation of fracture.

The natural aging characteristics of X7106-T63 weldments, made with X5180, 5356, and 5556 filler wire were investigated. Marked increases in the uniaxial tensile strength of the weldments were observed to occur for aging of periods up to eight weeks. In some cases, the strength of the weld deposit increased to a value such that the location of the fractures in tensile test specimens shifted from the weld deposit to the heat-affected base metal.

Crack susceptibility tests were conducted on 0.125-inch 2219-T87, 2014-T6, and X7106-T63 sheet material. These tests established that, for this thickness, the susceptibility of X7106-T63 to hot cracking during welding is comparable to that of 2014-T6. The 2219-T87 material exhibited a degree of crack susceptibility considerably lower than that of the other two alloys.

In the evaluation of the mechanical properties of aluminum alloy weldments detailed studies were conducted in the following categories:

- (1) Uniaxial tensile properties of 0.75-inch TIG 2219-T87 weldments
- (2) Uniaxial and biaxial properties of 0.125-inch MIG and TIG weldments of 2014-T6, 2219-T87, and X7106-T63 alloys.

Methods of measurement of the yield strength of 0.75-inch TIG 2219-T87 weldments were studied. It was established that the plastic deformation of tensile specimens was essentially confined to the weld deposit and heat-affected base metal. Measurements of elongation at fracture within the weld deposit resulted in values in the order of 20 percent for specimens exhibiting an overall elongation of approximately 6 percent. It was also determined that the yield strength of the weld metal is exceeded at stress levels well below that corresponding to a strain of 0.2 percent in a 2-inch gage length.

Uniaxial tensile tests, hydraulic bulge tests, cylinder burst tests, MIT biaxial tests and LTV biaxial tests were performed on 0.125-inch 2014-T6, 2219-T87, and X7106-T63 parent metal and weldments. The results of this study established that the hydraulic bulge test may be used for the determination of the 1:1 biaxial mechanical properties of aluminum alloy weldments. It was also shown that the biaxial mechanical properties of such weldments are essentially equivalent to the uniaxial properties. This observation indicates that uniaxial test data are adequate for use in designing high-strength aluminum alloy weldments.

Among the 2014-T6 weldments tested, those fabricated by the MIG process using 4043 filler wire consistently exhibited the lowest mechanical properties. In the case of the 2219-T87 alloy, the MIG and TIG weldments were found to have approximately equal properties. The TIG X7106-T63 weldments exhibited the highest uniaxial and biaxial strength of all of those tested.

## TABLE OF CONTENTS

			Page
LIST	OF II	LUSTRATIONS	ix
LIST	OF T	ABLES	xv
I.	INT	RODUCTION	1
II.	PRO	OGRAM SUMMARY	3
	Α.	Contract NAS8-1529, Mod 1 (7 February 1961 to 27 March 1962)	3
	В. <b>С.</b>	Contract NAS8-1529, Mod 2, Mod 3, and Mod 4 (27 March 1962 to 27 April 1963) Contract NAS8-1529, Mod 5 (27 April 1963 to	. 4
	D,	26 June 1964) Contract NAS8-1529, Mod 6 (27 June 1964 to	6
	E.	29 June 1965) Contract NAS8-20160, Mod 1, Mod 2 (29 June	7
	F.	1965 to 29 April 1966) Conclusions	9 10
III.	PRO	OCEDURES AND DISCUSSION OF RESULTS	12
	Α.	Contract NAS8-1529, Mod 1 (7 February 1961 to 27 March 1962)	12
	В.	Contract NAS8-1529, Mod 2, Mod 3, and Mod 4 (27 March 1962 to 27 April 1963)	20
	C.	Contract NAS8-1529, Mod 5 (27 April 1963 to 26 June 1964)	25
	D.	Contract NAS8-1529, Mod 6 (27 June 1964 to 29 June 1965)	38
	E.	Contract NAS8-20160 (29 June 1965 to 29 April 1966)	48
APP	ENDIC	ES	
	Α.	Evaluation of the Methods for the Determination of the Biaxial Strength of Aluminum Alloy Sheet and Weldments (NAS8-20160, Phase I)	59

## TABLE OF CONTENTS (Cont'd)

		Page
B.	Evaluation of the Mechanical Properties of	
	Aluminum Alloy Sheet and Weldments Subjected to	
	Uniaxial and Biaxial Stress Fields (NAS8-20160,	
	Phase II)	95
c.	Investigation of the Weldability of X7106-T63	
	Aluminum Alloy (NAS8-20160, Phase III)	113
D.	A Survey of the Literature Related to Mechanical	
	Properties of Materials Subjected to Biaxial	
	Stresses	139
E.	Experimental Procedures (Contract NAS8-20160)	147
F.	Fabrication Data (Contract NAS8-20160)	169
G.	Phase I Bulge Test, Tensile Test, Cylinder Test	
	and MIT Test Data (Contract No. NAS8-20160)	191
н.	LTV Biaxial Test Data (Contract NAS8-20160)	223
I.	Phase II Tensile and Hydraulic Bulge Test Data	
	(Contract NAS8-20160)	241
J.	Phase III Tensile Test Data (Contract NAS8-20160)	251
K.	Statistical Analysis of Test Data	265
LIST OF RE	EFERENCES	267
DISTRIBUT	ION LIST	271

#### LIST OF ILLUSTRATIONS

Figure		Page
1	Effect of Positioner Finger Spacing on the Heat Affected Zone Width	13
2	Backup Strip Groove Configurations	15
3	Aging Characteristics of 2024, 2014, and X2020 Aluminum Alloys	16
4	Natural Aging Characteristics of Aluminum Alloy Weldments	18
. 5	Artificial Aging Characteristics of Aluminum Alloy Weldments	19
6	MIG Welding Equipment Set Up in Horizontal Position	21
7	60° Double "V" Groove Design	22
8	Comparison of "Sagging" of Weld Bead with and without Cold Wire Feed	23
9	Microstructure of Weld Beads Made with Al-Cu Alloy Filler Wire	26
10	Microstructure of Weld Beads Made with Al-Cu Alloy Filler Wire	27
11	Microstructure of Weld Metal in First and Second Passes of a 2219-T87 Weldment	29
12	Microstructure of Heat-Affected Base Metal in a 2219-T87 Weldment	30
13	Weld Crown Profile at the Toe of a 2219-T87 Weldment	31
14	Intermetallic Constituents in the Toe of a 2219-T87 Weldment	32

Figure		Page
15	Fracture Surface of 2219-T87 Base Metal Tensile Specimen	33
16	Fracture Surface of 2219-T87 Welded Joint Tensile Specimen	34
17	Fracture Surface of 2219-T87 Welded Joint Tensile Specimen	35
18	Stress-Strain Curves of Weld Deposit, Zone A, Zone C, and Per Two-Inch Extensometer of Tensile Coupon	37
19	Elongation at Fracture Measured in Various Zones of a 3/4-Inch 2219-T87 Weldment	39
20	Explosive Impact Loading of Butt-Welded Test Panels	40
21	Average Uniaxial and Biaxial Ultimate Strengths for MIG and TIG Weldments	42
22	Bar Graph of Mechanical Properties of Various Thicknesses of X7106-T63	44
23	Microstructure of X7106-T63 0,090-Inch Sheet	45
24	Microstructure of X7106-T63 1.00-Inch Plate	46
25	Mechanical Properties of TIG-X7106/X5180 Weldments	47
26	Average Mechanical Properties of X7106-T63 Weldments Aged 24 Weeks	49
27	Toes of Weld Crown of a MIG X7106 Tensile Specimen that Failed in the Heat-Affected Base Metal	50
28	Graphical Presentation of Crack Data Obtained from Houldcroft Tests	51
29	Temperature Distribution in the Vicinity of Joint in a TIG Welded X7106-T63/X5180 Panel as Revealed by Temperature Sensitive Crayons	52

Figure		Page
<b>A-</b> 1	Tested Cylinder Specimen in Universal Testing Machine	63
A-2	Schematic of Strain Gage Locations on Cylinder Test Specimens	66
A-3	Biaxial and Uniaxial Parent Metal Data Converted to Effective Stress and Strain	68
A-4	Biaxial and Uniaxial HAZ Data Converted to Effective Stress and Strain	69
A-5	Biaxial and Uniaxial Weld Bead Data Converted to Effective Stress and Strain	71
A-6	Schematic of Strain Gage Locations on 1:1 Bulge Test Panels	72
A-7	Mohr's Circle for 1:1 Bulge Test Panel A-1 at P = 40 psi	74
A-8	Stress-Strain Curve for 2219-T87 Aluminum Alloy Subjected to a 1:1 Stress State	77
A-9	Comparison of Membrane Formula Stresses with Measured Stresses	78
A-10	Strain-Pressure Data from Circular Hydraulic Bulge Tests	80
A-ll	Bending Strain as a Function of Bulge Height in the Circular Hydraulic Bulge Test	81
A-12	Adjusted Strain-Pressure Data from Circular Hydraulic Bulge Tests	82
A-13	Relationship between Stress and Pressure for 1:1 Bulge Panel	83
A-14	Bending Strain as a Function of Bulge Height in the	85

Figure		Page
A-15	Ling-Temco-Vought Biaxial Data Converted to Effective Stress and Strain	87
A-16	Stress-Strain Data Obtained on MIT Specimen	88
A-17	Stress Ratio in MIT Specimen as a Function of Longitudinal Strain	89
A-18	Comparison of Mean Biaxial Strength of 2219-T87 Parent Metal with Maximum Conserved Energy Theory	92
A-19	Comparison of Biaxial Strength of TIG 2219-T87 Weld- ments with the Maximum Stress Theory	94
B-1	The Biaxial and Uniaxial Strengths of 2219-T87, 2014-T6, and X7106-T63 High Strength Aluminum Alloys	100
B-2	Bulge Panel Stress as a Function of the Two-Thirds Power of the Applied Pressure for 2219 Aluminum Alloy	101
B-3	Bulge Panel Stress as a Function of the Two-Thirds Power of the Applied Pressure for 2014 Aluminum Alloy	102
B-4	Bulge Panel Stress as a Function of the Two-Thirds Power of the Applied Pressure for X7106 Aluminum Alloy	103
B-5	The Biaxial and Uniaxial Strengths of Naturally Aged 2219-T87, 2014-T6, and X7106-T63 Weldments	105
B-6	The Biaxial and Uniaxial Strengths of 2219-T87 and 2014-T6 Weldments Produced during the Fourth and Fifth Years of the Program	109
C-1	Tensile Properties of 0.187-Inch MIG X7106-T63/X5180 Weldments	117
C-2	Tensile Properties of 0.187-Inch TIG and MIG X7106- T63 Weldments Aged Twelve Weeks	120

Figure		Page
C-3	Tensile Properties of 0.50-Inch TIG X7106-T63/ X5180 Weldments	122
C-4	Tensile Properties of 0.50-Inch TIG and MIG X7106- T63 Weldments Aged Twelve Weeks	126
C-5	Tensile Properties of 1.00-Inch TIG and MIG X7106- T63 Weldments	128
C-6	Tensile Properties of 1.00-Inch TIG and MIG X7106- T63 Weldments Aged Twelve Weeks	131
C-7	0.50-Inch TIG X7106-T63/5356	133
C-8	Average Crack Lengths Measured in Crack Susceptibility Tests	137
C-9	Typical Crack Susceptibility Specimens after Completion of Tests	138
E-1	Tensile Test Specimens	152
E-2	Parent Metal Bulge Test Specimens	153
E-3	Single-Groove Bulge Panel	154
E-4	Cross-Groove Bulge Panel	155
E-5	Reduced-Section Bulge Panel	156
E-6	Single-Weld Bulge Panel	157
E-7	Cross-Weld Bulge Panel	158
E-8	Circular Bulge Die and Test Panel Assembly in Test Cell	159

Figure		Page
E-9	Elliptical Bulge Fixture Installed in Test Cell	160
E-10	Schematic Diagram of Hydraulic Bulge Test Fixture	161
E-11	Calibration for Pressure Transducer Instrumentation	162
E-12	Redesigned Test Cylinder and Closure Fixture Assembly	163
E-13	Cylinder Reinforcement Plate	164
E-14	MIT 2:1 Biaxial Stress Test Specimen	165
E-15	Modified Houldcroft Crack Susceptibility Test Specimen	166
F-1	Typical Cross-Section and Joint Preparation for 0.125-Inch TIG Weldments	173
F-2	Typical Cross-Section and Joint Preparation for 0.187-Inch TIG Weldments	174
F-3	Typical Cross-Section and Joint Preparation for 0.187-Inch MIG Weldments	175
F-4	Typical Cross-Section and Joint Preparation for 0.50-Inch TIG Square Butt Weldments	176
F-5	Typical Cross-Section and Joint Preparation for 0.50-Inch TIG Double V Weldments	177
F-6	Typical Cross-Section and Joint Preparation for 0.50-Inch MIG Weldments	178
F-7	Typical Cross-Section and Joint Preparation for 1.00-Inch TIG Weldments	179
F-8	Typical Cross-Section and Joint Preparation for 1.00-Inch MIG Weldments	180

## LIST OF TABLES

Table		Page
A-l	Phase I Biaxial Test Program (NAS8-20160)	61
A-2	Summary of Cylinder Test Results	67
A-3	Principal Stresses in 1:1 Hydraulic Bulge Test Panels Below Yield Stress	76
A-4	Biaxial and Uniaxial Ultimate Strength of 2219-T87 Aluminum Alloy	91
A-5	Biaxial and Uniaxial Strength of 2219-T87 Aluminum Alloy TIG Welded with 2319 Filler	93
B-1	Phase II Test Program (NAS8-20160)	97
B-2	Summary of Biaxial and Uniaxial Strengths of 2219-T87, 2014-T6, and X7106-T63 Parent Metal	98
B-3	Summary of Biaxial and Uniaxial Strengths of Naturally Aged 2219-T87, 2014-T6, and X7106-T63 Weldments	104
B-4	Summary of Biaxial and Uniaxial Strengths of 2219-T87 and 2014-T6 Weldments Tested in NAS8-1529, Mod 6	107
B-5	Combined Results of Fourth Year and Fifth Year Uni- axial and Biaxial Tests on 2219-T87 and 2014-T6 Weldments	108
B-6	Biaxial and Uniaxial Properties of Annealed and Stress Relieved 2219-T87, 2014-T6, and X7106-T63 Parent Metal and Weldments	111
C-1	Phase III Weldments	115
C-2	Summary of Tensile Properties of 0.187-Inch TIG-	118

Table		Page
C-3	Summary of Tensile Properties of 0.187-Inch MIG-X7106 Weldments	119
C-4	Summary of Tensile Properties of 0.50-Inch TIG-X7106 Weldments	123
C-5	Summary of Tensile Properties of 0.50-Inch MIG-X7106 Weldments	125
C-6	Summary of Tensile Properties of 1.00-Inch TIG-X7106 Weldments	129
C-7	Summary of Tensile Properties of 1.00-Inch MIG-X7106 Weldments	130
C-8	Crack Susceptibility Test Results	136
E-1	Welding Procedures for Houldcroft Crack Susceptibility Tests	167
F-1	Welding Procedures	181
F-2	Weld Dimensions for Single-Weld Bulge Panels	185
F-3	Weld Dimensions for Cross-Weld Bulge Panels	188
F-4	Weld Dimensions for 0.187-Inch and 0.50-Inch Square Butt Weldments	189
F-5	Weld Dimensions for 0.50-Inch and 1.00-Inch Double V Weldments	190
G-l	l: l Hydraulic Bulge Test Stress Analysis Data for 2219- T87 Parent Metal Panels	192
G-2	1:1 Hydraulic Bulge Test Stress Analysis Data for TIG 2219-T87/2319 Single-Weld Panels	192
G-3	1:1 Hydraulic Bulge Test Stress Analysis Data for TIG 2219-T87/2319 Cross-Weld Panels	193

Table		Page
G-4	1:1 Hydraulic Bulge Test Stress Analysis Data for 2219- T87 Parent Metal Panels with a Reduced Center Section	193
G-5	1:1 Hydraulic Bulge Test Stress Analysis Data for 2219- T87 Parent Metal Panels with a Machined Groove	194
G-6	1:1 Hydraulic Bulge Test Stress Analysis Data for 2219- T87 Parent Metal Panels with a Machined Cross Groove	194
G-7	l: l Hydraulic Bulge Test Pressure - Bulge Height - Strain Data for 2219-T87 Parent Metal Panels	195
G-8	1:1 Hydraulic Bulge Test Pressure - Bulge Height - Strain Data for TIG 2219-T87/2319 Single-Weld Panels	195
G-9	l: l Hydraulic Bulge Test Pressure - Bulge Height - Strain Data for TIG 2219-T87/2319 Cross-Weld Panels	196
G-10	1:1 Hydraulic Bulge Test Pressure - Bulge Height - Strain Data for 2219-T87 Parent Metal Panels with a Machined Groove	196
G-11	1:1 Hydraulic Bulge Test Pressure - Bulge Height - Strain Data for 2219-T87 Parent Metal Panels with a Machined Cross Groove	197
G-12	1:1 Hydraulic Bulge Test Bending Strain Analysis Data for 2219-T87 and 2014-T6 Parent Metal Panels	197
G-13	2:1 Hydraulic Bulge Test Stress Analysis Data for 2219-T87 Parent Metal Panels	198
G-14	2:1 Hydraulic Bulge Test Stress Analysis Data for TIG 2219-T87/2319 Single-Weld Panels	198
G-15	2:1 Hydraulic Bulge Test Stress Analysis Data for TIG 2219-T87/2319 Cross-Weld Panels	199
G-16	2:1 Hydraulic Bulge Test Stress Analysis Data for 2219-	199

Table		Page
G-17	2:1 Hydraulic Bulge Test Results Using Tensile Machine Instead of Bolts to Hold Test Die Together, 2219-T87 Parent Metal Specimen No. A-29	200
G-18	Phase I Uniaxial Tensile Test Results on 2219-T87 Parent Metal	200
G-19	Phase I Uniaxial Tensile Test Results on 2219-T87 Weldments for 1:1 Bulge Tests	201
G-20	Phase I Uniaxial Tensile Test Results on 2219-T87 Weldments for 2:1 Bulge Tests	201
G-21	MIT Biaxial Specimen Test Data	202
G-22	Summary of Cylinder Test Results	202
G-23	Stress-Strain Data on Cylinder No. XCY-1 (2:1)	203
G-24	Stress-Strain Data on Cylinder No. CY-1 (2:1)	204
G-25	Stress-Strain Data on Cylinder No. CY-4 (1:0)	205
G-26	Stress-Strain Data on Cylinder No. CY-5 (1:1)	206
G-27	Stress-Strain Data on Cylinder No. CY-2 (2:1)	207
G-28	Stress-Strain Data on Cylinder No. CY-10 (2:1)	208
G-29	Stress-Strain Data on Cylinder No. CY-11 (1:1)	209
G-30	Stress-Strain Data on Cylinder No. CY-12 (1:1)	210
G-31	Stress-Strain Data on Cylinder No. CY-13 (1:0)	211
G-32	Stress-Strain Data on Cylinder No. CY-16 (1:0)	212
G-33	Stress-Strain Data on Cylinder No. CY-14 with Reinforced Weld (2:1)	213

Table		Page
G-34	Stress-Strain Data on Cylinder No. CY-9 with Reinforced Weld (2:1)	215
G-35	Stress-Strain Data on Cylinder No. CY-15 with Reinforced Weld (2:1)	217
G-36	Stress-Strain Data on Cylinder No. CY-7 with Reinforced Weld (1:1)	219
G-37	Stress-Strain Data on Retest of Cylinder No. CY-7 with Reinforced Weld (1:1)	221
I-1	Uniaxial Tensile Test Results on Parent Aluminum Alloys	243
I-2	Uniaxial Tensile Test Results on Heat Treated Parent Aluminum Alloys	243
I-3	Uniaxial Tensile Test Results on 2219-T87 and X7106-T63 Aluminum Alloy Weldments	244
I-4	Uniaxial Tensile Test Results on 2014-T6 Aluminum Alloy Weldments	245
I-5	Uniaxial Tensile Test Results on Heat Treated 2219- T87 and X7106-T63 Aluminum Alloy Weldments	245
I-6	Uniaxial Tensile Test Results on Heat Treated 2014-T6 Aluminum Alloy Weldments	246
I-7	1:1 Hydraulic Bulge Test Pressure - Bulge Height Data, 2014-T6, 2219-T87 and 7106-T63 Weldments	247
I-8	1:1 Hydraulic Bulge Test Pressure - Bulge Height Data as Received and Heat Treated Parent Metal	248
I-9	l: l Hydraulic Bulge Test Pressure - Bulge Height Data Heat Treated Weldments	249
J-1:-J-22	Uniaxial Tensile Test Results on X7106-T63 Aluminum	253 - 26

#### I. INTRODUCTION

The decision to use high-strength aluminum-copper alloys for the construction of the tankage required for the SATURN vehicle was based primarily on their favorable strength-to-weight ratio and their inherent freedom from embrittlement at the low temperatures encountered in the storage of liquid hydrogen. It was recognized by NASA that the performance of fabricated structures of the candidate alloys, 2014-T6 and 2219-T87, is limited by the mechanical properties of the welded joint. It was thus apparent that investigation of the variables affecting the mechanical properties of welded joints was necessary to improve the reliability of the SATURN vehicle.

In February 1961, Contract NAS8-1529 was issued by the Marshall Space Flight Center of the National Aeronautics and Space Administration to initiate a program to investigate possible means of improving the strength of welded aluminum-copper alloys and to better define the mechanical and metallurgical characteristics of such weldments for this critical application. This basic contract was amended through a series of change notices until it was terminated in June 1965. The change notices and their effective dates were as follows:

NAS8-1529, Mod 1 - 7 February 1961 to 27 March 1962 NAS8-1529, Mod 2, Mod 3, and Mod 4 - 27 March 1962 to 27 April 1963 NAS8-1529, Mod 5 - 27 April 1963 to 26 June 1964 NAS8-1529, Mod 6 - 27 June 1964 to 29 June 1965

At this point, a new contract, NAS8-20160, was issued to continue the investigation of the strength of welded joints in aluminum-copper alloys subjected to multiaxial loading conditions. In addition, the new contract provided for investigation of some of the characteristics of weldments of alloy X7106 (aluminum-zinc-magnesium) which develops higher strengths through natural aging processes.

By natural evolution and redirection, the program emphasis was changed from one year to the next, keyed to meet the urgent NASA program requirements. Early attempts to provide higher weld strength by control of weld chemistry were ineffective, and, as the hardware programs were defined, it was considered necessary to provide a better understanding of the performance of welded structure. The later phases of the program were therefore directed toward establishing the strength and failure characteristics of weldments which exhibited an ultimate strength lower than the yield strength of the parent metal.

In the course of the five-year period, annual summary reports were submitted at the conclusion of each portion of the program. Since Contract NAS8-20160 was, in effect, a continuation of NAS8-1529, it was desirable that the results of the two contracts be included in a single report covering the entire program. This report, therefore, summarizes the investigations carried out during the period from February 1961 to February 1966 and is organized to present a review of the most important conclusions from the work performed indicating the basis for the evolution of the program. In addition, the details of the work carried out under Contract NAS8-20160 are included in this report as appendices, constituting an annual summary report for that contract.

#### II. PROGRAM SUMMARY

#### A. Contract NAS8-1529, Mod l (7 February 1961 to 27 March 1962)

The scope of work set forth in Contract NAS8-1529 provided for investigations related to the following major topics:

(1) The development of welding techniques for high-strength aluminum alloys.

In this phase of the program, emphasis was to be placed on alloys 2014, 2024, and X2020 as specified by the technical supervisor of the contract. The scope of work included investigations of methods of fusion welding of the alloys, the determination of the mechanical properties of the welded joints, and metallurgical examination and analysis of the weldments. An investigation of the use of applicable, commercially available filler materials and specially prepared filler metal alloys was also included in the scope of work. Both the automatic tungsten-inert-gas technique (TIG)\* and the automatic metal-inert-gas technique (MIG)\* were to be employed in this phase of the program.

- (2) Assessment of the role of diffusion of elements from the molten weld puddle into the base metal.
- (3) The development of manual repair welding techniques for the alloys included in the program.

In the course of the work carried out under this contract, techniques for welding 0.090-inch 2014, 2024, and X2020 high-strength aluminum alloys using commercial filler wire alloys were developed. The influence of travel speed, wire feed, backup groove design and the spacing of the positioner fingers on the weld contour, penetration and the size of the heat affected zone were investigated. Among the above variables, the spacing of the positioner fingers exhibited the strongest influence on the width of the heat affected zone. It was also found that special precautions in joint preparation and environmental control were necessary to reduce porosity in the welds.

<sup>\*</sup>These welding processes are also referred to as the gas-tungsten-arc (GTA) and the gas-metal-arc (GMA) processes.

The age hardening characteristics of 2014, 2024, and X2020 parent metal alloys and 2014-T6 TIG and MIG weld deposits were also established. The results of this study indicate that no significant increase in the mechanical properties of weldments of these alloys occur as the result of natural aging.

A number of techniques were employed to detect the extent of the diffusion of elements within the weld zone. No indications of any significant degree of diffusion of the alloying elements were observed.

The filler metal development and the weld repair study, included in the initial scope of work, were not accomplished because of the urgent need for additional data in the foregoing areas of investigation.

# B. Contract NAS8-1529, Mod 2, Mod 3, and Mod 4 (27 March 1962 to 27 April 1963

The research program was continued for a second year under Modifications 2, 3, and 4 of Contract NAS8-1529. The scope of work for this phase of the program was established to accomplish the following objectives:

(1) The continuation of the development of welding techniques and filler metals to improve the as-welded joint efficiency of high-strength aluminum alloys.

Equipment procured and methods developed during the first year of the contract were to be employed in this phase. In this portion of the program, however, the major emphasis was to be placed upon the development of welding techniques for the plate thicknesses, i.e., 0.25 inch and up. The development of techniques for welding with the torch in the horizontal position, simulating production methods planned for future SATURN vehicles, was included in this portion of the program. Both the automatic TIG and the automatic MIG welding processes, employing either helium or argon, as appropriate, or a combination of the two, as the shielding gas, were to be utilized in the welding technique development study. The work in this portion of the program was to be directed toward optimizing the joint efficiency of the as-welded alloys. Postweld heat treatment was not included in this investigation; however, provision was made to establish the extent of strengthening which may be derived from natural aging of the weldments.

(2) Continuation of the efforts to assess the role of diffusion of elements from the molten weld puddle into the base metal.

(3) A development of manual repair welding techniques for the alloys included in the program.

Provision was made for the investigation of the feasibility of repairing defective welds without any postweld heat treatment and for the determination of the efficiency which may be expected from such repaired welds.

During this phase of the research program, techniques for welding 3/4-inch 2219-T87 aluminum alloy, utilizing the MIG process, were investigated. Both 60° and 90° double-V welded joints, made in the horizontal position, were evaluated. No significant differences in the mechanical properties of sound welds of either of the two joint configurations were noted. In this investigation, both joint geometry and joint preparation techniques, i.e., cleaning, etc., were found to be extremely important in the production of a sound weld. In addition, the results of the investigation indicated that the use of either helium or argon as a shielding gas had no significant influence on the strength of the weldments.

Sagging of the weld puddle, a problem encountered in the fabrication of horizontal welds, was observed to be reduced by the use of cold wire feed. The use of cold wire feed, however, resulted in a slight reduction in the strength of the joints. It was determined that the addition of cold wire to the weld puddle does not affect the age hardening characteristics of the weld bead.

The influence of the addition of copper to the molten weld puddle, by means of cold wire feed, was also studied. The addition of copper in the range of 12 to 36 percent resulted in bead-on-plate weld deposits which were harder than the adjoining heat affected zones. Transverse cracks developed in the beads made with the 36-percent copper addition.

In the work directed toward the development of filler metal, bead-on-plate welds were made with specially prepared binary aluminum alloy filler wire. The influence of copper, silver, manganese, and silicon on the natural and artificial aging characteristics of such weld deposits were established. Based on the results of this work, an experimental 6.5 percent copper, 1.0 percent silicon, 1.0 percent silver, 0.5 percent manganese filler metal was prepared and used to fabricate 2219-T87 weldments. The mechanical properties of the weldment prepared with the experimental wire were slightly lower than those obtained with 2319 filler wire.

The investigation of repair welding techniques was rescheduled for inclusion in an extension of the program in order to provide for the need of additional data in the other phases of this portion of the investigation.

#### C. Contract NAS8-1529, Mod 5 (27 April 1963 to 26 June 1964)

Under Contract NAS8-1529, Mod 5, the research program was extended into the third year. The scope of work was expanded to provide for further investigations directed toward improving the as-welded joint efficiency of high-strength aluminum alloys. In this portion of the program, emphasis was placed on weldments in alloy 2219 made by the TIG process. Provision was made for four specific areas of investigation as follows:

- (1) A study of the microstructural characteristics of the weld zone including both the cast structure and the adjacent zone of heat-affected base metal.
- (2) A study of the failure mechanisms in aluminum alloy weldments under uniaxial and biaxial loading conditions.

This phase of the program provided for the evaluation of weldments in materials and thicknesses representative of production parts.

- (3) An investigation of the possible methods of measuring the yield strength of welded joints.
- (4) A study of the methods of measuring weld ductility.

This portion of the program provided for the development of a method of measuring the ductility of welded joints which would yield results suitable for correlation to base metal properties and which would provide data with a definite design significance.

In the investigation of the microstructure of the weld zone, it was observed that considerably more CuAl<sub>2</sub> formed in the grain boundaries of the weld deposit and the adjacent heat-affected base metal than is normally found in the parent metal. In addition to the characteristic microstructure, a needle-like precipitate was found to be associated with the region of the toes of the weld.

The study of the failure mechanisms established that the failures initiated at the toe of the weld in the region where the needle-like intermetallic precipitate was observed. Typically, the fracture propagated diagonally through the weld to the opposite toe. Electron fractographic analysis of the fractured surfaces indicated that the basic mechanism of failure was that of the nucleation, growth and coalescence of microvoids. The electron fractographs revealed that the amount and distribution of second-phase particles exerted a

significant influence on the nucleation and growth of voids. In general, the same fracture characteristics were observed for the specimens subjected to biaxial loading conditions.

In the work directed toward the measurement of the yield strength and ductility of welded joints, it was found that the plastic deformation occurring in a uniaxial tensile test is essentially confined to the weld deposit and heat-affected base material. Measurements of elongation at fracture within the weld deposit resulted in values in the order of 20 percent for specimens in which a 5.9-percent elongation was determined from a 2-inch gage length. Of the total strain occurring prior to fracture, over half was shown to be associated with deformation of the weld deposit. The results of the measurements of yield strength and ductility of the weld metal illustrate that the yield strength of the weld deposit is exceeded at stress levels considerably below that corresponding to a 0.2-percent offset based on a 2-inch gage length.

A limited study of the properties of simulated repair welds, originally included in the scope of work of Mods 1 and 2 of this contract, was carried out. The welds tested in this portion of the study exhibited ultimate strengths slightly higher than the weldments prepared by the standard welding procedures.

## D. Contract NAS8-1529, Mod 6 (27 June 1964 to 29 June 1965)

Contract NAS8-1529 Mod 6 extended the research program into the fourth year. Initially, the principle objective of this portion of the program was the development of welding techniques for X7106 aluminum alloy in various thicknesses. The work directed toward the development of these welding techniques was to include an investigation of both the MIG and TIG welding processes. Provision was made to include additional alloys in the program. The scope of work, as initially stated in Mod 6 of the contract, included the following specific topics:

- (1) A literature and industrial survey related to the weldability of the X7106 alloy and similar alloys.
- (2) Selection of optimum filler metal.

In this portion of the program, an investigation was to be carried out to provide the information necessary to select the optimum filler metal alloy from the commercially available filler materials suited to the welding of X7106 alloy.

(3) A study of the weldability of X7106 alloy.

In this portion of the work, both the MIG and TIG processes were to be employed, and consideration was to be given to the soundness of the welds produced by each process and to the mechanical properties obtained.

(4) Evaluation of weldments subjected to uniaxial and biaxial loading conditions.

The primary emphasis was to be placed upon the uniaxial properties of the weldment. Provision was made to generate enough biaxial data to attempt to obtain a relationship between the uniaxial and biaxial properties.

During the course of the program, the primary emphasis was shifted from the investigation of the weldability of X7106 alloy and the development of welding techniques to a study of biaxial and uniaxial properties of 2219-T87 and 2014-T6 weldments. This shift of emphasis was initiated by the NASA project manager and reflected the most immediate requirements of the SATURN program. As a result, the work related to X7106 alloy was more limited than that intended by the initial scope of work.

A survey of published literature and of information available from industrial organizations, related to the properties and the weldability of X7106 alloy, was conducted. This survey established the general state of knowledge in this particular area and served as a basis for the organization of the experimental program.

A study of the natural aging characteristics of 0.090-inch thick MIG and TIGX7106 weldments was conducted. Weldments made with three commercially available filler alloys (X5180, 5356, and 5556) were included in this study. A marked increase in the hardness and strength of the weld deposit and adjacent heat-affected base material occurred upon natural aging for periods in excess of eight weeks for all of the weldments studied. Of the combinations of welding process and filler metal included in the study of X7106 weldments, the TIG weldments, as a group, exhibited higher uniaxial tensile properties than those of the MIG weldments. Only slight differences in mechanical properties were noted among the weldments made with the three different filler alloys by either process.

The hot cracking characteristics of X7106-T63 weldments relative to those of 2219-T87 were also investigated. The results of these tests indicated that X7106-T63 is more susceptible to hot cracking during welding than 2219-T87. No significant difference in the crack susceptibility of the X7106-T63 weldments made with the three filler metals was noted.

The properties of MIG and TIG weldments of 2014-T6 and 2219-T87 aluminum alloys under biaxial and uniaxial loading conditions were measured and compared. The results of this study indicate that the TIG process is superior to the MIG process for the fabrication of 2014-T6. In the case of 2219-T87, no significant differences were noted in the average properties of TIG and MIG weldments. In the course of this portion of the program, a number of observations were made which indicate that the membrane stress formula, derived for a spherical shell, is not adequate for the determination of the aboslute value of biaxial ultimate strength from hydraulic bulge test data.

#### E. Contract NAS8-20160, Mod 1, Mod 2 (29 June 1965 to 29 April 1966)

Contract NAS8-20160 provided for a continuation of the work initiated under Contract NAS8-1529. The scope of work for this new contract included the following major items:

- (1) The evaluation of the mechanical properties of weldments in high-strength aluminum alloys subjected to biaxial stresses.
  - This portion of the program was to include MIG and TIG weldments in 2014-T6, 2219-T87, and X7106-T63 aluminum alloys.
- (2) Determination of the true ultimate strengths of biaxially loaded specimens subjected to bulge pressure tests and the establishment of the relationship between the biaxial properties and the uniaxial properties of aluminum alloy weldments.
- (3) The development of welding techniques for X7106 aluminum alloy and the establishment of the optimum welding process-filler metal combination for this alloy.
- (4) Further investigation of the susceptibility of X7106 aluminum alloy to hot cracking during welding.

A study of the biaxial strength of 2219-T87 parent metal and weldments using circular hydraulic bulge tests, cylinder tests, LTV and MIT biaxial tests was made. The results of this study established that the stress in welded panels subjected to bulge pressure tests is described by the equation

 $\sigma = KP^{2/3}$ 

where

 $\sigma$  = biaxial stress, psi

P = bulge pressure, psi

K = material and geometry constant

A series of uniaxial and biaxial tests was conducted on 2014-T6, 2219-T87, and X7106-T63 parent metal and weldments. The results of these tests were combined with those from the previous year (Contract NAS8-1529 Mod 6) to provide a better statistical basis for a comprehensive analysis. Among the 2014-T6 weldments tested, the MIG weldments made with 4043 filler wire consistently exhibited the lowest mechanical properties. Considering the lower tolerance limits of both the uniaxial and biaxial ultimate strengths, the TIG 2014-T6/4043 and TIG 2014-T6/2319 weldments were comparable. In the case of 2219-T87 alloy, the MIG and TIG weldments (2319 filler wire) exhibited approximately equal properties. The TIG X7106-T63/X5180 weldments exhibited the highest uniaxial and biaxial strength of all the panels tested.

A study of the natural aging characteristics of MIG and TIG X7106-T63 weldments in thickness of 0.187 inch, 0.50 inch, and 1.00 inch, was performed. Significant increases in ultimate strength were observed for all types of X7106-T63 weldments aged for periods of 30 days or longer. For the two thinner gages, no significant differences were noted in the properties of MIG and TIG weldments. In the case of the 1.00-inch weldments, those fabricated by the TIG process exhibited significantly higher ultimate strengths than those made utilizing the MIG process.

The susceptibility of X7106-T63 weldments to hot cracking, initially studied in the previous year, was investigated further. The results of this study indicate that the crack susceptibility of X7106-T63 is comparable to that of 2014-T6 and that both of these two alloys are significantly more susceptible to hot cracking during welding than is alloy 2219-T87.

#### F. Conclusions

The principle conclusions drawn from the research program are summarized as follows:

- (1) No significant improvement in the strength of weldments of Al-Cu alloys occurs as the result of aging at room temperature.
- (2) Special precautions in joint design and joint preparation (including cleanliness) must be employed to assure sound welds in the high-strength aluminum alloys.

- (3) Second phase precipitates, formed in the weld deposit and heat-affected base metal, play a significant role in the initiation of fracture of the welded joint.
- (4) In the case of weldments of 2014-T6, 2219-T87, and X7106-T63 alloys, the biaxial ultimate strength is not significantly different from the uniaxial ultimate strength.
- (5) Uniaxial test data are adequate for use in design of high-strength aluminum weldments.
- (6) Hydraulic bulge tests may be utilized for the determination of the biaxial ultimate strength of parent metal and welded panels.
- (7) MIG 2014-T6/4043 weldments exhibit the lowest uniaxial and biaxial ultimate strengths of those tested.
- (8) TIG 2014-T6/4043 and TIG 2014-T6/2319 weldments exhibit equivalent mechanical properties.
- (9) The mechanical properties of MIG 2219-T87/2319 and TIG 2219-T87/2319 weldments are comparable.
- (10) In general, TIG weldments of 2014-T6 and 2219-T87 aluminum alloys exhibit ultimate strengths either higher than or comparable to MIG weldments. In addition, the MIG process is subject to erratic behavior and results in less control of weld bead size and shape.
- (11) X7106-T63 aluminum alloy may be welded by both the TIG and MIG processes using procedures similar to those generally employed in the fabrication of high-strength aluminum alloys.
- (12) TIG X7106-T63/X5180 weldments exhibit mechanical properties superior to those of 2014-T6 and 2219-T87 weldments after reasonably short periods of aging at room temperature.

#### III. PROCEDURES AND DISCUSSION OF RESULTS

## A. Contract NAS8-1529, Mod 1 (7 February 1961 to 27 March 1962)

The work carried out under Mod 1 of Contract NAS8-1529 consisted of studying some of the variables which affect the strength of welded joints in high-strength aluminum alloys. The variables investigated were as follows:

- (1) Weld contour, penetration and size of heat-affected zone (HAZ)
- (2) Age hardening characteristics of parent metal, weld deposit and HAZ
- (3) Diffusion of alloying elements between weld metal and HAZ.

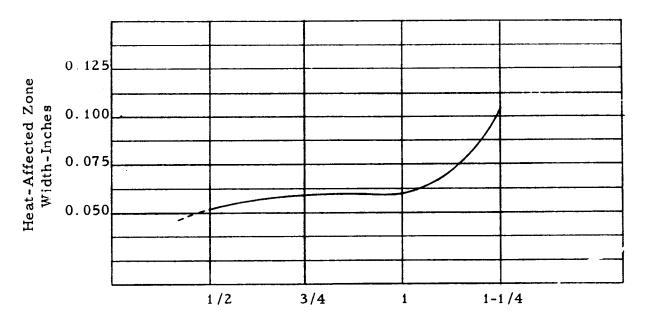
In this portion of the research program, all work was confined to welding 0.090-inch thick 2014, 2024, and X2020 high-strength aluminum alloys. Both tungsten inert gas (TIG) and metallic inert gas (MIG) processes were used, although most efforts were directed toward the utilization of the TIG process. Detailed test data and precedures were previously reported in the First Annual Summary Report. (1)

#### 1. Weld Contour, Penetration and HAZ Width

A study of travel speed, wire feed, positioner finger spacing, and back-up groove design was undertaken to show the influence of these parameters on weld contour, penetration and the width of heat-affected zone of TIG welds. As travel speeds and wire feeds were increased from 20 inches per minute to 70 inches per minute (other variables held constant), the weld bead was narrowed, the penetration was decreased and the width of the HAZ was slightly reduced.

A test series was also conducted with variations in the spacing of the copper hold-down fingers while other parameters were held constant. TIG 2014-T6 weldments were employed in this test series. The width of the HAZ for weldments made with a finger spacing of 1-1/4 inches was twice that resulting from a 1/2-inch spacing, as shown in Figure 1. This parameter was found to exert a more marked influence on the HAZ width than did travel speed.

The influence of the configuration of the groove in the copper backup bar heat-affected zone was evaluated. The configuration of the



Positioner Finger Spacing - Inches

FIGURE 1. EFFECT OF POSITIONER FINGER SPACING ON THE HEAT AFFECTED ZONE WIDTH

backup bar plays the same role as hold-down finger spacing in that it influences the heat transfer from the weld zone. Early attempts were made to obtain complete penetration with no groove in the backup strip. Inconsistent penetration resulted, indicating that the bottom edge of the square-butt joint was being chilled too rapidly. Two backup bar groove designs, illustrated in Figure 2, were employed, and the V configuration produced the narrower HAZ.

In the early stages of the program, one of the major problems encountered was the occurrence of macroporosity and microporosity. The following steps were found to substantially eliminate the problem:

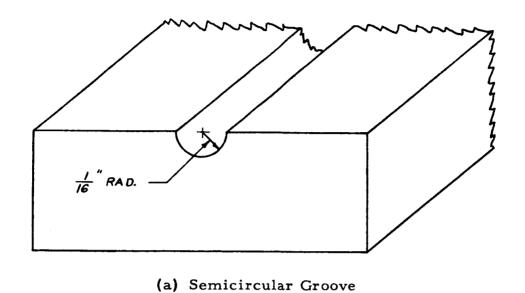
- (1) Joint preparation plate surfaces adjacent to the joint were scraped and the abutting edges were draw filed immediately prior to welding.
- (2) Wire shield the spools of welding wire were placed in shields on the welding equipment to protect them from atmospheric contamination.

In this particular case, involving relatively high travel speeds, the use of a preweld root gap of 0.018 inch aided in the prevention of porosity. A flow of helium gas in the groove of the backup bar was also employed to provide additional assurance of soundness.

#### 2. Age Hardening Characteristics

The strength and ductility of copper-bearing aluminum alloy weldments are affected by the CuAl2 phase which precipitates in the matrix and grain boundaries as the weld solidifies from the molten state. A program was initiated to study this effect. Samples of 2014, 2024, and X2020 were heated to temperatures of 600°, 700°, 750°, 800°, 850°, 900°, and 950°F, held for fifteen minutes, and quenched in water. Hardness readings were taken at intervals during room temperature aging up to 120 hours. Typical results are shown in Figure 3. Metallographic examination of the samples indicated that the CuAl2 phase agglomerated into large particles at temperatures of 650°F for 2024, 750°F for X2020, and 800°F for 2014 alloy. Similar studies on 2014-T6, 2014-T3, and X2020-T6 alloys were conducted to investigate artificial aging at 200°F and 300°F.

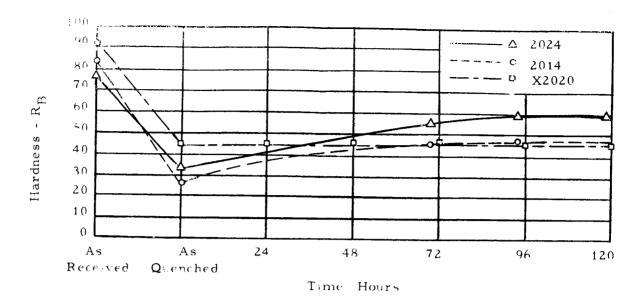
At room temperature, X2020 did not age harden at all, but significant increases in hardness were observed for 2024 and 2014 alloys quenched from temperatures in the range of 750°F to 950°F. Artificial aging of 2014 and X2020 produced an increase in hardness of those samples quenched from 750°F to 950°F, but the X2020 alloy was much more sluggish in its response to aging.



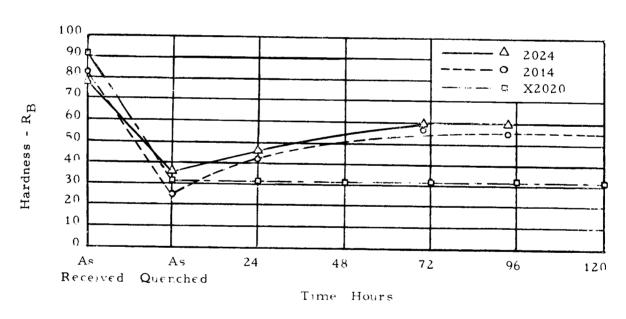
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FIGURE 2. BACKUP STRIP GROOVE CONFIGURATIONS

(b) V Groove



(a) Quenched from 750°F



(b) Quenched from 800°F

FIGURE 3. AGING CHARACTERISTICS OF 2024, 2014, AND X2020 ALUMINUM ALLOYS

The aging characteristics of weld deposits in TIG 2014-T6 weldments made with 716 and 2319 filler wire were also studied. Natural aging at room temperature and artificial aging at 200°F and 300°F were employed. It was observed that 2319 weld deposits do not respond to aging as readily as 716 weld deposits, Figures 4 and 5.

A limited study of the aging characteristics of the weld deposits in 0.090-in 2014-T6 MIG weldments made with both 716 and 2319 filler wire was made. The results were similar to those obtained on TIG welds.

#### 3. Diffusion Studies

Since there are substantial differences between the alloy content of the base metal and filler wire in many cases, a study of the tendency for diffusion of the alloying elements was undertaken. The various methods used were: (1) microhardness surveys, (2) wet chemical analysis, (3) x-ray fluorescent analysis, and (4) microradiography.

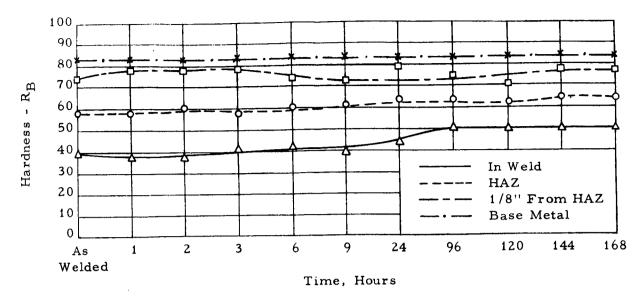
The test weld was made on 1/4-inch 2014 and 2024 base metal using a manual MIG process with 716 filler wire and a weave bead so that a sizeable sample of weld metal could be obtained for analysis.

Microhardness measurements were taken across the fusion lines. No marked changes in hardness near the fusion line, which would indicate that diffusion had occurred, were observed.

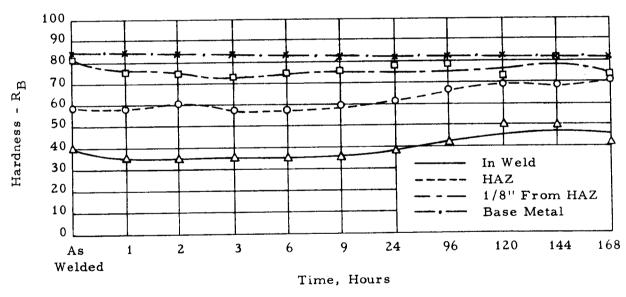
Wet chemical analysis for Si was performed on chips from successive 0.010-inch layers removed from a weld deposit specimen. The results were inconclusive, probably because of the small sample sizes and the lack of a uniform line of fusion.

X-ray fluorescent analyses were obtained at incremental depths of 0.002 inch on a weld-deposit specimen. No appreciable differences in element concentration across the fusion line were noted.

The region of the fusion line of the welds was studied using microradiographic techniques. Indications of zones in which the x-rays were more highly absorbed were noted on each side of the fusion line, suggesting that further development of this technique may be helpful in studies of diffusion processes in the vicinity of welded joints.

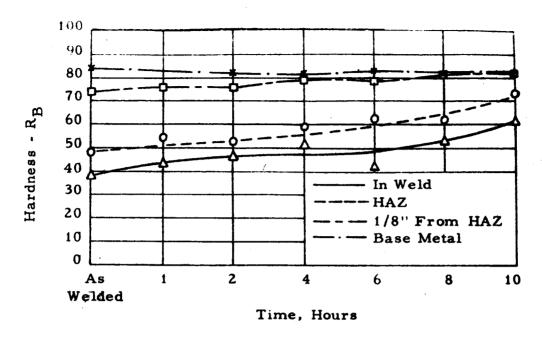


(a) 0.090-Inch TIG 2014-T6 Weldment, 716 Filler Wire



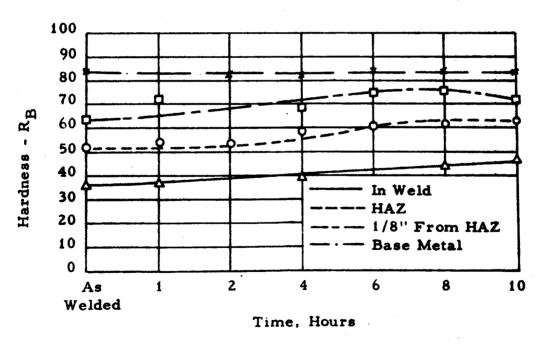
(b) 0.090-Inch TIG 2014-T6 Weldment, 2319 Filler Wire

FIGURE 4. NATURAL AGING CHARACTERISTICS OF ALUMINUM ALLOY WELDMENTS



(a) 0.090-Inch TIG 2014-T6 Weldment, 716 Filler Wire.

Aged at 300°F.



(b) 0.090-Inch TIG 2014-T6 Weldment, 2319 Filler Wire.
Aged at 300°F.

FIGURE 5. ARTIFICIAL AGING CHARACTERISTICS OF ALUMINUM ALLOY WELDMENTS

# B. Contract NAS8-1529, Mod 2, Mod 3, and Mod 4 (27 March 1962 to 27 April 1963)

During the second year of the program, the emphasis was switched to the study of techniques for welding 3/4-inch 2219-T87 high-strength aluminum alloy. Also, a study was made to develop an improved filler metal for this alloy for the purpose of increasing joint strength efficiency. The equipment and procedures used for these investigations are described in the Second Annual Summary Report.(2)

#### 1. Welding Techniques

In this portion of the program, essentially all welding was performed in the horizontal position using the MIG process and a specially designed fixture, Figure 6. A number of welding parameters were investigated, but 3/32-inch diameter, 2319 filler wire was used exclusively. Initial welds were made on panels with edges prepared by sawing and buffing with a wire disc. This technique proved to be unsatisfactory because of the excessive porosity produced. An improved preparation procedure, consisting of milling the edge, and draw filing immediately prior to welding, eliminated the porosity. Defects resulting from incomplete fusion were also encountered. This problem was eliminated by reducing the land at the root of the double V and by employing a root gap of 0.020 inch. The final joint configuration employed in this portion of the program is shown in Figure 7.

A series of weldments were fabricated, from which tensile test coupons were removed to evaluate flat versus horizontal position weld, 90° versus 60° double V joints, argon versus helium-argon shielding gas, and the effect of cold wire feed. The only significant effect on ultimate tensile strength noted was the reduction in strength resulting from the use of cold wire feed. The cold wire feed had been successfully used to reduce the amount of "sagging" of the weld puddle which occurs naturally when welding in the horizontal position, Figure 8. However, the scope of the year's program did not permit the development of optimum welding parameters for use with cold wire feed.

Explosion bulge tests were run on one parent and one welded 2219-T87 panel. On both plates, the cracks ran into the hold-down regions, where only elastic deformation occurs, and the fracture surfaces exhibited full shear.

## 2. Filler Metal Development

A program was established for evaluating the effects of four elements (Cu, Mn, Ag, and Si) on the age hardening characteristics of aluminum.

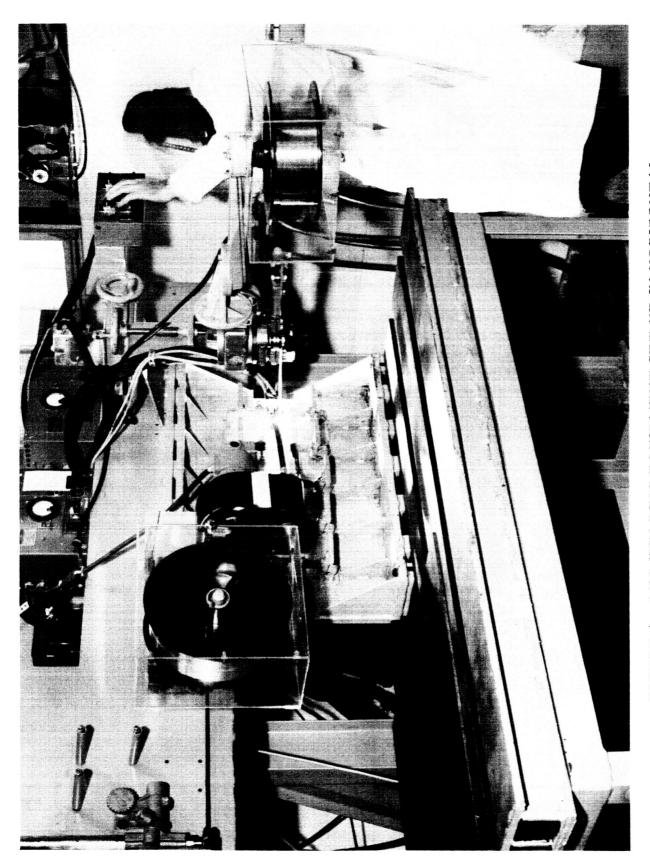


FIGURE 6. MIG WELDING EQUIPMENT SET UP IN HORIZONTAL POSITION. Note cold wire feed attachments.

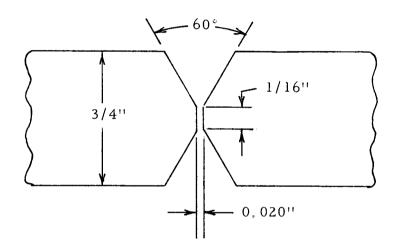
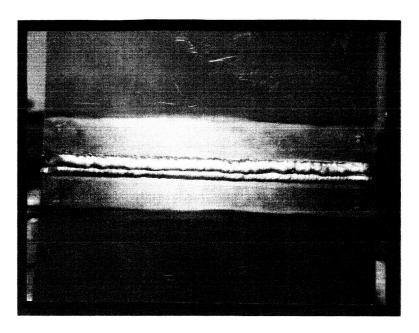
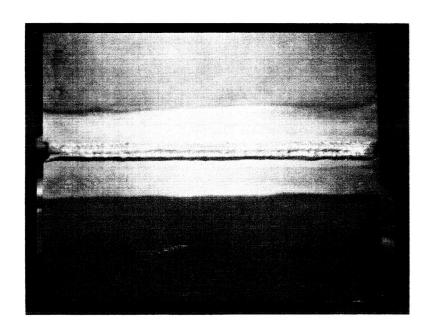


FIGURE 7. 60° DOUBLE "V" GROOVE DESIGN



(a) Horizontal Weld Coupon without Cold Wire Feed



(b) Horizontal Weld Coupon with Cold Wire Feed

FIGURE 8. COMPARISON OF "SAGGING" OF WELD BEAD WITH AND WITHOUT COLD WIRE FEED

Four heats of Al-Cu alloys, containing 1.0%, 3.0%, 5.0%, and 6.5% Cu, were made. Specimens of these alloys were solution treated and artifically aged at 325°F. As expected, a higher hardness level was attained as the copper content was increased from 1.0% to 6.5%. Four additional Al-Cu alloys, containing 3.25% to 7.36% Cu, were prepared and drawn into 3/32-inch wire for welding. Beads were deposited on 2219-T87 aluminum plate with these alloys and with 2319 filler metal for comparison. The addition of copper increased the hardness of the welds, but none of them hardened significantly on aging at room temperature. The hardness of the 2319 weld deposit was comparable to that of deposits made with the 6.35% and 7.36% Cu alloys.

Four heats of Al-Mn alloy, containing from 0.13% to 1.0% Mn, were drawn into welding wire and deposited on 2219-T87. Weld deposits of these alloys were much softer than those of the Al-Cu alloys, but the Al-Mn alloys age hardened somewhat in a two-week period at room temperature.

A similar process was used to evaluate Mn, Ag, and Si in concentrations up to 1.0% in a Al-6.5% Cu base alloy. The Mn and Ag had no measurable effect on the hardness or aging characteristics of the weld metal. Si, in concentrations up to 0.3%, appeared to provide a slight increase in hardness.

Based on the results previously obtained, the following composition was chosen for analysis as a potential filler alloy:

Copper	6.5%
Silicon	1.0%
Silver	1.0%
Manganese	0.5%
Zirconium	0.15%
Vanadium	0.10%
Aluminum	Balance

An ingot of this composition was drawn into 3/32-inch diameter filler wire. Test panels were prepared, using a U-groove design instead of a double-V groove, with the new alloy and with 2319 filler wire. Tensile tests were performed on specimens from each plate and the following average strengths were obtained:

	0.2% YS	UTS	% Elong
Experimental Alloy	22,400	30,600	1.7
2319 Filler Metal	33,300	40,200	4.2

The panel welded with experimental wire was also found to have considerable porosity.

A metallographic examination of specimens of all of the experimental alloys previously described was carried out. As expected, the amount of CuAl<sub>2</sub> precipitate increased with increasing copper content as shown in Figures 9 and 10. In the aluminum-manganese alloys, the presence of an MnAl<sub>6</sub> phase was noted. In general, the addition of any of the four elements investigated resulted in additional second-phase particles in the microstructure.

The experimental alloys did not prove to be as satisfactory for welding alloy 2219-T87 as the commercially available type 2319 filler wire.

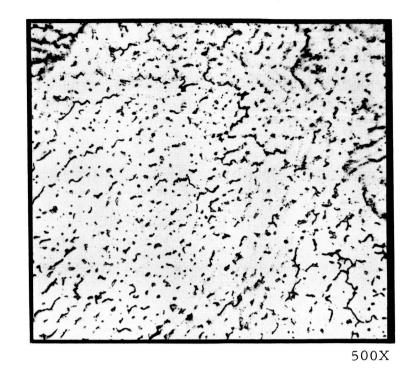
The influence of the addition of copper directly to the molten weld puddle on the properties of welded joints was also studied. In this study, bead-on-plate weld deposits were made employing the MIG process with copper cold wire feed. The rate of feed of the copper wire was varied to produce weld beads with nominal copper concentrations of 12, 21, 31, and 36 percent. The bead crowns were then machined off, and the hardness of the weld deposit and the adjacent heat-affected zone was measured.

No significant increases in hardness on aging at room temperature were noted for any of the weld deposits; however, the hardness of the weld deposit increased significantly with increasing copper content. Transverse cracks developed in the beads made with a copper addition of 36 percent.

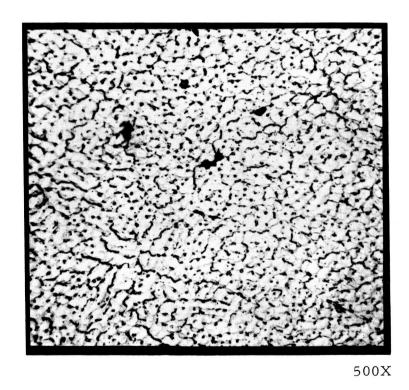
A MIG 2219-T87 weldment was prepared with a copper cold wire feed to give nominal copper concentration of 12 percent. Tensile specimens, containing the welded joint, were cut from the panel and a cross section of the weld was examined metallographically. Large globules of undissolved copper were observed in the weld deposit, and the tensile specimens exhibited an average ultimate strength of 34,800 psi, 2,500 psi below that of a weldment prepared without the addition of copper.

### C. Contract NAS8-1529, Mod 5 (27 April 1963 to 26 June 1964)

During the period covered by Mod 5 of Contract NAS8-1529, work was continued on the weldability of 3/4-inch 2219-T87 high-strength aluminum alloy. The program included a metallurgical study of the weld zones, a study of failure mechanisms under uniaxial and biaxial loading, an investigation of the yield behavior of weldments, and an evaluation of the effect of explosion impact loading on the properties of welds. Details of the test procedures and data obtained are contained in the Third Annual Summary Report. (3)



(a) Al-3.25% Cu Filler Wire



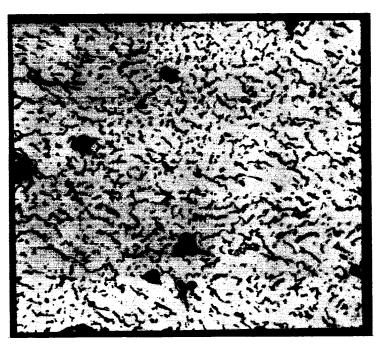
(b) Al-4.25% Cu Filler Wire

FIGURE 9. MICROSTRUCTURE OF WELD BEADS MADE WITH Al-Cu ALLOY FILLER WIRE



500X

(a) Al-6.36% Cu Filler Wire



500X

(b) Al-7.36% Cu Filler Wire

FIGURE 10. MICROSTRUCTURE OF WELD BEADS MADE WITH A1-Cu ALLOY FILLER WIRE

#### 1. Weld Zone Investigation

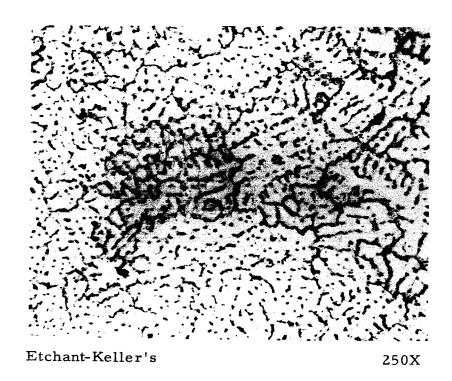
The mechanical properties of the 2219 alloy are dependent on the manner in which the CuAl2 precipitate is dispersed in the weldment. The microstructure of the parent metal in the fully heat treated (T87) condition was compared to structures produced in various parts of the HAZ and weld metal. The finely dispersed and agglomerated CuAl2 in the parent metal was quite different from the form of the precipitate found in the weld metal and heat-affected base metal, Figures 11 and 12. A needle-like precipitate, tentatively identified as  $\beta(Al-Cu-Fe)$ , was observed in the toes of the weldments. The typical weld crown profile in this region is shown in Figure 13, and the microstructure is illustrated in Figure 14.

## 2. Study of Failure Mechanisms in Aluminum Alloy Weldments under Uniaxial and Biaxial Loading

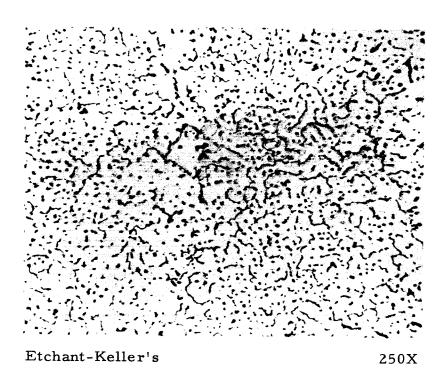
Uniaxial tensile specimens machined from a 3/4-inch thick 2219-T87 welded panel were tested with the weld crowns intact. These weldments were prepared using a square butt joint design and welded in the horizontal positional using one weld pass on each side. The gage section was 1/4 inch  $\times 3/4$  inch  $\times 4-1/2$  inches and symmetrical about the weld. The fracture path, the same in all cases, ran from the "toe" of the first weld pass diagonally to the opposite "toe" of the second pass. A few specimens were incrementally loaded to determine the stress required to initiate cracking. These were found to occur at 92-97 percent of the ultimate tensile strength (no cracking was found at the 0.2 percent offset yield stress) and were located in the "toe" region of the first pass. A few tests were conducted on specimens with the crown removed, and, in these cases, the fracture occurred completely within the weld metal. In another group of tests, minimum heat fusion passes were run along the weld "toes". This reduced the severity of the geometric notch, improved the microstructure, increased the uniaxial strength and moved the failure path into the weld metal. A simulated weld repair panel was also prepared by making an additional fusion pass over a portion of the original weld and tested. Uniaxial tensile specimens from this panel exhibited ultimate tensile strengths comparable to or slightly higher than those of the standard panels.

The technique of electron fractography was employed in the study of the failure mechanisms. Fractographs illustrating typical topography of parent and weld metal fractures are shown in Figures 15, 16, and 17. The following observations were made in this study:

(1) Tensile fracture of 2219-T87 base metal and weldments occurred generally by the nucleation of microvoids at



(a) First Pass



(b) Second Pass

FIGURE 11. MICROSTRUCTURE OF WELD METAL IN FIRST AND SECOND PASSES OF A 2219-T87 WELDMENT

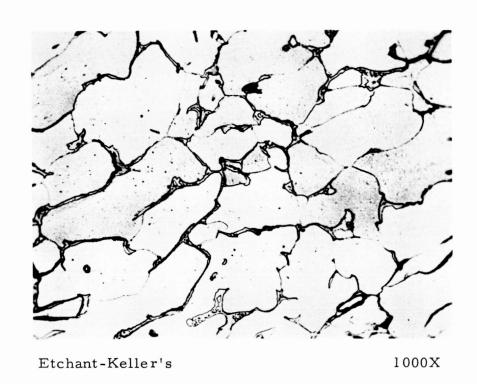
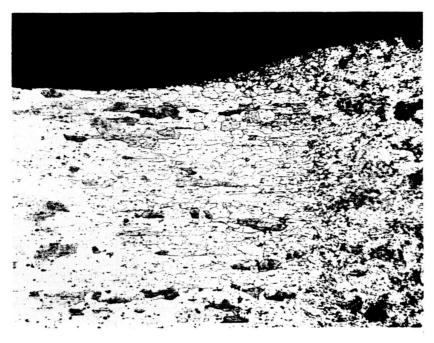
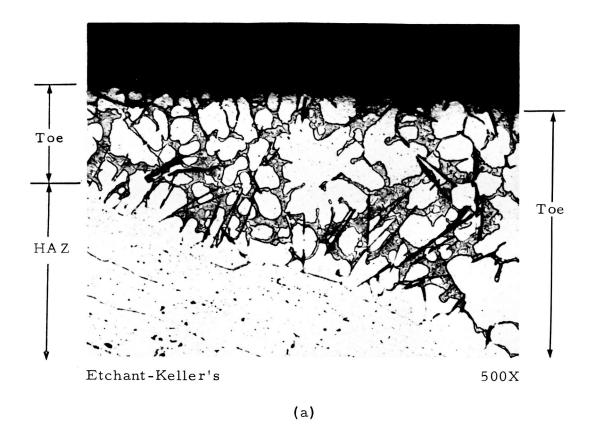


FIGURE 12. MICROSTRUCTURE OF HEAT-AFFECTED BASE METAL IN A 2219-T87 WELDMENT



HAZ Weld Etchant-Keller's 50X

FIGURE 13. WELD CROWN PROFILE AT THE TOE OF A 2219-T87 WELDMENT



Toe

Etchant-Keller's 1500X

FIGURE 14. INTERMETALLIC CONSTITUENTS IN THE TOE OF A 2219-T87 WELDMENT



Two-Stage Plastic Carbon Replica

5000X

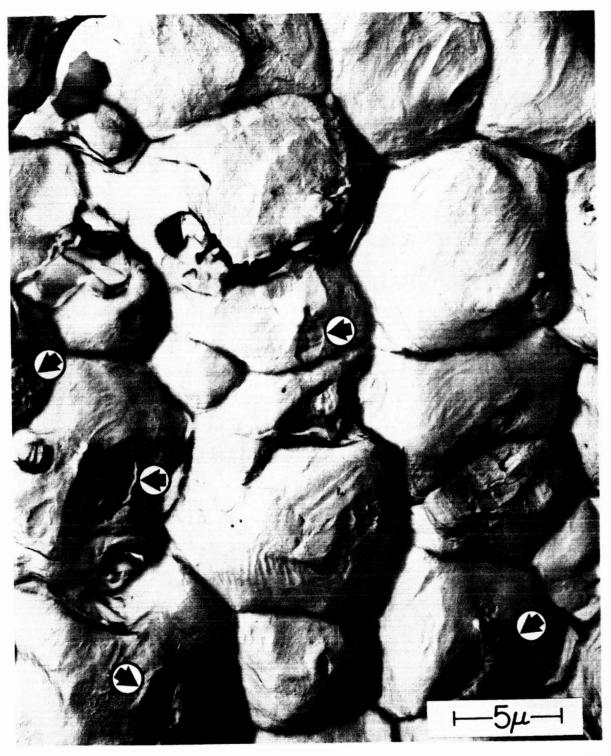
FIGURE 15. FRACTURE SURFACE OF 2219-T87 BASE METAL TENSILE SPECIMEN. (Fractograph taken in central "fibrous" region. Note the range of size of dimples. Arrows indicate origin of larger dimples at second-phase platelets.)



Two-Stage Plastic Carbon Replica

6000X

FIGURE 16. FRACTURE SURFACE OF 2219-T87 WELDED JOINT TENSILE SPECIMEN. [Specimen tested with weld crowns machined off. Fractograph taken from location near root of weld passes. Note irregular shape of shear dimples (oblique arrows) and dispersed second-phase particles in fracture surface (horizontal arrows).]



Two-Stage Plastic Carbon Replica

6000X

FIGURE 17. FRACTURE SURFACE OF 2219-T87 WELDED JOINT TENSILE SPECIMEN. (Specimen tested with weld crowns machined off. Fractograph taken from location near root of weld passes. Note the large, uniform equiaxed dimples. Arrows indicate origin of voids at second-phase platelets.)

- inclusions and second-phase particles followed by the growth of these voids during plastic deformation
- (2) The size, shape and distribution of second-phase particles exert a marked influence on the initiation and growth of voids
- (3) There was a distinct difference in void shape and distribution in parent metal and weld metal fractures, and
- (4) Massive second-phase particles at the "toe" of the welds played a significant role in the initiation of the uniaxial tensile failures.

Circular hydraulic bulge tests were conducted to investigate the fracture characteristics under biaxial conditions. Four test panels, 32 inches × 32 inches were tested as described in Appendix E. Two 3/4-inch, single butt welds and a 3/4-inch T butt weld with the crowns intact and one 3/4-inch single weld with the crowns removed were tested. The fracture path through the thickness was similar to that observed in uniaxial test specimens. In each case, the cracks were arrested in the vicinity of the hold-down region of the test die, where the panel is subjected to elastic strains. The similarity between uniaxial and biaxial fracture modes was also borne out by both optical metallographic and electron fractographic examinations.

## 3. Methods for Measuring Yield Strength and Ductility of Welds

The yield strength of a metal which does not exhibit a well defined yield point is usually taken as the stress producing 0.2 percent plastic deformation, more commonly known as the 0.2 percent offset yield strength. When the standard test method is applied to a heterogeneous test section consisting of weld metal, heat-affected zones and parent metal, the measured strain is the sum of the incremental strains contributed by the various components. At an applied stress greater than the yield strength of the weakest part, the strain distribution over the length of the gage section could be quite nonuniform. A series of uniaxial tensile specimens, with strain gages applied to the weld metal, HAZ and parent metal, were tested to investigate the extent of this condition. The results showed that, at the 0.2-percent offset (extensometer) stress, the weld metal had reached a plastic strain of nearly one percent and the parent metal had not begun to yield. Figure 18.

Another series of uniaxial tests was conducted to determine the strain distribution at failure. The various weld zones were located by chemical etching and microhardness traverses before testing. After fracturing

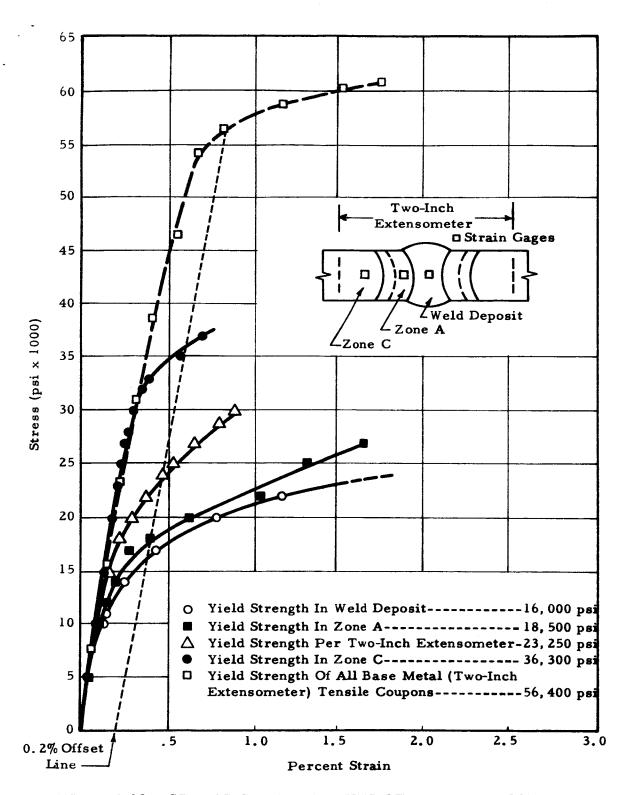


FIGURE 18. STRESS-STRAIN CURVES OF WELD DEPOSIT, ZONE A, ZONE C, AND PER TWO-INCH EXTENSOMETER OF TENSILE COUPON. [Note all base metal (two-inch extensometer) curve from different tensile coupon.]

the specimens, the halves were mated together and the zones were again measured. The results, summarized in Figure 19, also show that a large amount of the total strain occurs in the weld metal.

#### 4. Explosion Impact Treating of Weldments

Two 3/4-inch  $\times$  12-inch 2219-T87 weldments were explosion impact treated as shown in Figure 20. Weld metal tensile specimens, cut from the weldment along the axis of the weld, and transverse tensile specimens containing a section of the welded joint were prepared and tested. The results of these tests and tests on similar specimens from an as-welded panel are as follows:

	Average Yield Strength (0,2% Offset), (ksi)		Average Ultimate Strength, (ksi)		Average Elongation (% in 2 in.)				
	No Charge	2 lb Pentolite	4 lb Pentolite	No Charge	2 lb Pentolite	4 lb Pentolite	No Charge	2 lb Pentolite	4 lb Pentolite
Weld Metal	14.2	30.8	33.1	39.3	41.6	41.4	19.3	19.3	10.1
Transverse Weld Specimen	22.0	30.8	32.7	40.5	40.3	41.9	5.1	4.5	5.7
Parent Metal	54,9	53.3	52.1	66.4	64.2	63.1	13.7	14.5	12.4

As may be noted in the above data, marked increases in the yield strength of both the weld metal and transverse tensile specimens resulted from the explosive impact treatment. No significant changes in ultimate strength were observed. In the case of the panel treated with the grooved back-up plate, the gain in yield strength occurred without any sacrifice of tensile elongation. The ductility of the panel using a flat back-up plate was reduced, apparently as a result of the gross plastic deformation imparted to the weld metal in this case. Microhardness surveys across the top (explosion side) and bottom (die side) of each weld showed only small increases in the hardness. The largest increase was noted on the bottom (die side) of the panel impacted against a flat plate, as might be expected from the larger amount of plastic deformation experienced in this zone.

## D. Contract NAS8-1529, Mod 6 (27 June 1964 to 29 June 1965)

In the fourth year of this research program, the emphasis was placed on determining the uniaxial and biaxial mechanical properties of 1/8-inch 2219-T87 and 2014-T6 MIG and TIG weldments and studying the weldability of a new Al-Mg-Zn alloy, X7106. Detailed test data and descriptions of test equipment and procedures are given in the Fourth Annual Summary Report. (4)

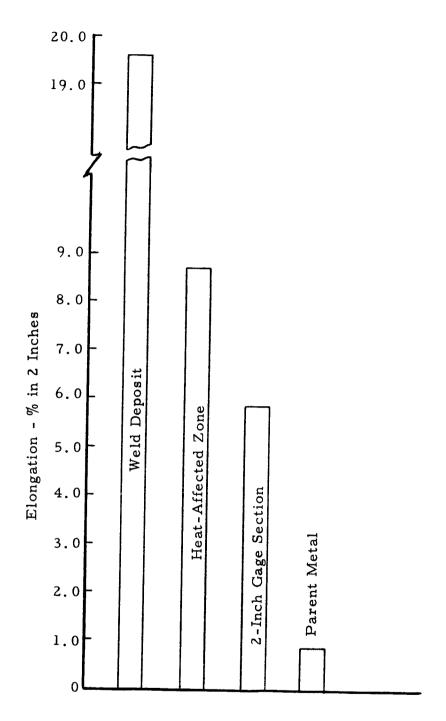
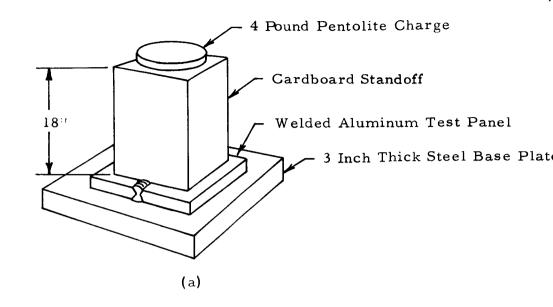


FIGURE 19. ELONGATION AT FRACTURE MEASURED IN VARIOUS ZONES OF A 3/4-INCH 2219-T87 WELDMENT



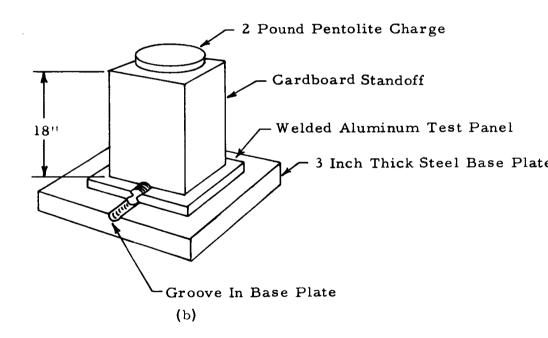


FIGURE 20. EXPLOSIVE IMPACT LOADING OF BUTT-WELDED TEST PANELS

#### 1. Welding Process Evaluation

The evaluation of the TIG and MIG processes was carried out on the basis of the mechanical properties of weldments of the following process combinations:

Process	Alloy	Filler Metal
TIG	2014-T6	2319
TIG	2014-T6	4043
MIG	2014-T6	4043
TIG	2219-T87	2319
MIG	2219-T87	2319

Single welds, tee welds, and cross welds were subjected to uniaxial and biaxial loading conditions. The biaxial strengths were determined with the circular bulge test using the membrane stress equation,  $\sigma = PR/2t$ . The low biaxial strengths obtained led to the initiation of an investigation into the applicability of this equation to the circular bulge test. Sufficient information was gathered to show the need for a more thorough study of the use of the bulge test for the determination of biaxial strength. Although the indicated values of biaxial strength might be in error, the effect of changes in welding process, filler metal, etc., could be examined by this technique.

The mean values of the biaxial and uniaxial strengths, along with standard deviations and lower tolerance limits, are presented in Figure 21. These results show that, for 2014-T6/4043 weldments, the TIG process produced stronger welds than did the MIG process. The TIG 2014-T6/2319 and TIG 2014-T6/4043 weldments had essentially the same uniaxial strength, but those with 2319 filler had biaxial ultimate strength significantly higher than that of all other combinations. No significant differences were observed in the mean values of biaxial and uniaxial ultimate strengths for the MIG 2219-T87/2319 and TIG 2219-T87/2319 weldments. However, the biaxial lower tolerance limit for the MIG process was significantly higher than for TIG because of the higher degree of scatter observed in the biaxial test results on TIG 2219-T87/2319 welds. All of the conclusions based on biaxial strength are subject to the limitations of the applicability of the membrane stress equation.

In the course of the test program, it was observed that the uniaxial mechanical properties of the 2014-T6/4043 TIG and MIG weldments exhibited a higher degree of scatter than did the other types.

An investigation was conducted to study the effects of residual stresses on the biaxial to uniaxial strength ratio of weldments. Residual

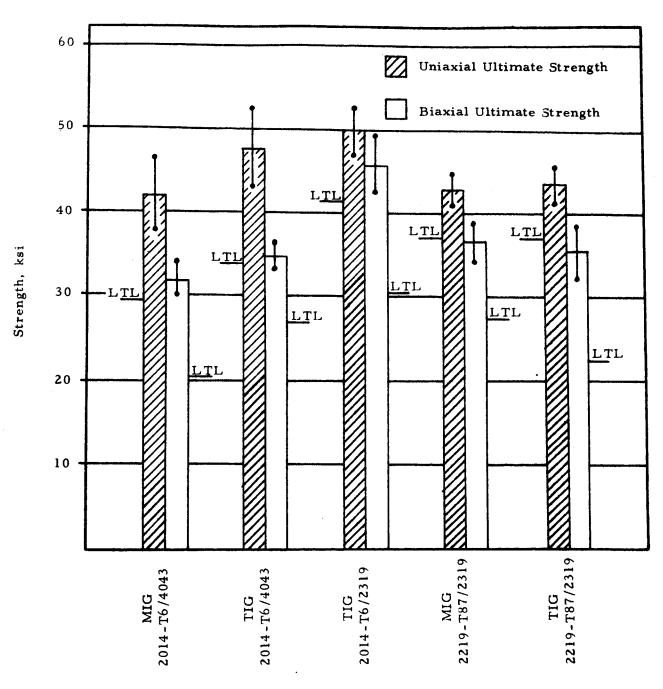


FIGURE 21. AVERAGE UNIAXIAL AND BIAXIAL ULTIMATE STRENGTHS FOR MIG AND TIG WELDMENTS

stress measurements were made on as-welded panels utilizing strain gages to determine the relaxation occurring in specimens cut from the panels. measurements indicated the presence of tensile stresses parallel to the length of the weld of the order of the yield strength and smaller tensile or compressive stresses perpendicular to the weld. Stresses induced from clamping in the welding fixture were generally lower in magnitude although considerable variation in these values was evident. Uniaxial and biaxial tests were run on annealed parent metal, as-welded TIG 2219-T87/2319, annealed TIG 2219-T87/ 2319 weldments, and on an as-welded TIG 2219-T87/2319 welded panel with crowns removed and multipass TIG 2219-T87/2319 panel in the as-welded condition. The results were that all of the above conditions had essentially the same biaxial/uniaxial strength ratio, indicating that neither residual stresses nor stress concentrations associated with the weld crown affected this ratio. Removal of the weld crown slightly lowered both the uniaxial and biaxial strength, and annealing significantly lowered these properties, as might be expected. The multipass welds had essentially the same biaxial to uniaxial strength ratio as the single pass weldments.

## 2. Weldability of X7106-T63 Aluminum Alloy

A survey of the literature pertaining to the 7000 series aluminum alloys was conducted, and visits were made to several industrial plants and laboratories to consolidate the available information on the weldability of the X7106 alloy.

Uniaxial tensile properties measured for four thicknesses of X7106-T63 alloy are given in Figure 22. Of the four thicknesses, the 0.187-inch material was the strongest and 0.090 inch the weakest. The longitudinal properties were higher than the transverse properties in all cases except for the 0.090-inch material.

The microstructures of each of the four thicknesses were examined. Typical structures observed in the 0.090-inch and 1.0-inch thicknesses are shown in Figures 23 and 24. The microstructure of the 0.187-inch material was similar to that of the 0.090-inch sheet, and those from the 0.050-inch and 1.00-inch plates were comparable. The grain boundaries of the two thinner materials were clearly defined and appeared to be outlined by an intermetallic precipitate. No such features were observed in the two thicker sections.

A uniaxial tensile test program was conducted to study the natural aging characteristics of X7106-T63 weldments made with three filler metals (X5180, 5356, and 5556). The results on TIG X7106-T63/X5180 weldments are shown in Figure 25 as being typical of the rate of aging observed. A summary of the properties of MIG and TIG weldments after 24 weeks of aging are given

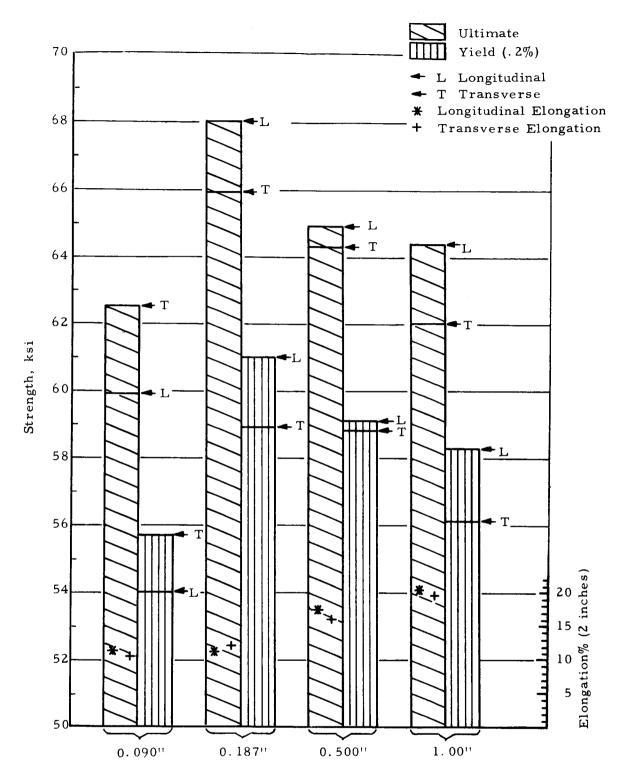
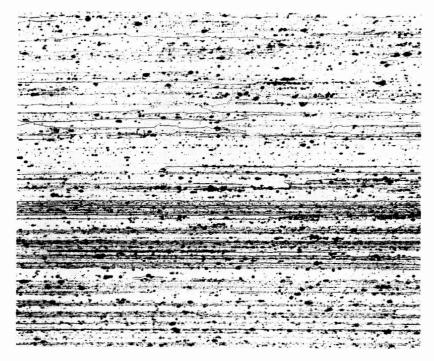


FIGURE 22. BAR GRAPH OF MECHANICAL PROPERTIES OF VARIOUS THICKNESSES OF X7106-T63



100X

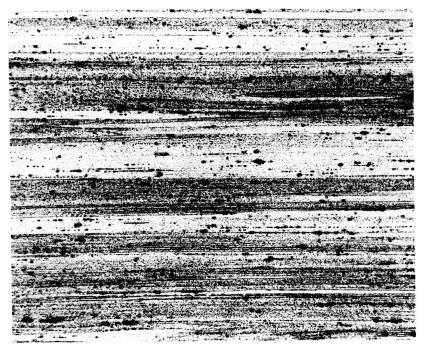
(a)



Etchant-Keller's

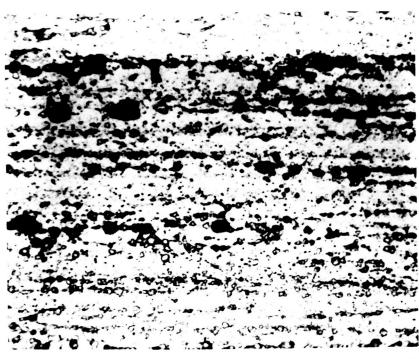
1500X

FIGURE 23. MICROSTRUCTURE OF X7106-T63 0.090-INCH SHEET



100X

(a)



Etchant-Keller's

1500X

FIGURE 24. MICROSTRUCTURE OF X7106-T63 1.00-INCH PLATE

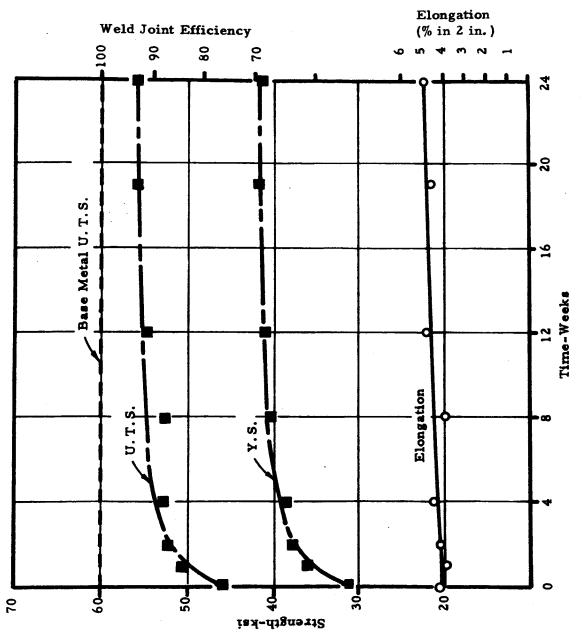


FIGURE 25. MECHANICAL PROPERTIES OF TIG-X7106/X5180 WELDMENTS

in Figure 26. As a group the TIG weldments exhibited higher ultimate strengths than the MiG weldments. In addition, the degree of scatter was less for TIG welds, resulting in significantly higher values of the lower tolerance limit of ultimate strength. The yield strengths of the MiG weldments were either comparable to or slightly lower than those of the TIG weldments. Of the group of TIG weldments, those made with 5556 filler wire exhibited a significantly lower ultimate strength than the other two (X5180 and 5356). All three MiG weldments had approximately equal tensile properties.

All of the failures occurred at one of two locations; within the HAZ or at the fusion line. The fusion line failures occurred predominantly after one day of aging for the TIG X7106-T63/X5180 and TIG X7106-T63/5356 weldments and after four weeks of aging of TIG X7106-T63/5356 weldments. In the specimens which failed in the HAZ, the fractures were located in a region between 0,08 inch and 0,32 inch from the fusion line. Metallographic examination revealed secondary cracks at the toes of the welds in many cases, some of which extended along the fusion line, as shown in Figure 27.

Microhardness surveys conducted on panels aged from two to eight weeks showed that a region of low hardness existed approximately 1/8 inch from the fusion line, corresponding to the general location of failure in the HAZ. The weld metal was softer, but the reinforcement of the crowns apparently more than offset this weakness. No significant differences were noted in the age hardening of the HAZ of MIG and TIG weldments, but the TIG deposited weld metal reached a higher hardness than the MIG after eight weeks aging time.

A series of Houldcroft crack susceptibility tests was performed on 0.090-inch X7106-T63 and 2219-T87 specimens. The results indicate that the X7106-T63 alloy is more susceptible to hot cracking during welding than the 2219-T87 alloy, as shown in Figure 28.

The temperature distribution in the vicinity of welded joints was determined with the aid of temperature sensitive crayons. A typical result is illustrated by Figure 29. This figure shows that the heat-affected zone, as revealed by chemical etching, consists of material heated to a temperature of 500°F or higher during the welding operation. It was apparent then, from the results of this study and other data in the literature, that the location of failures in X7106-T63 weldments may be associated with a region of base metal which was overaged during the welding operation.

## E. Contract NAS8-20160 (29 June 1965 to 29 April 1966)

The fifth year of the program for developing welding techniques and filler metals for high-strength aluminum alloys was devoted to the determination

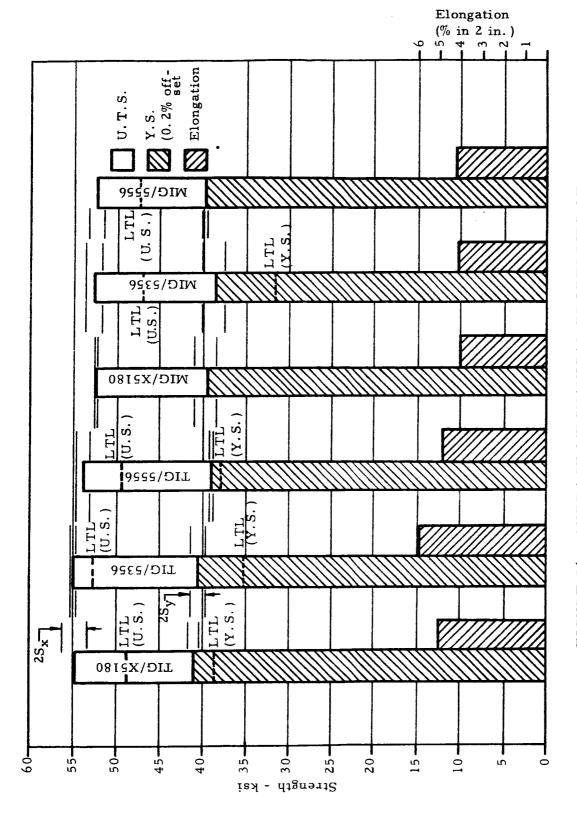
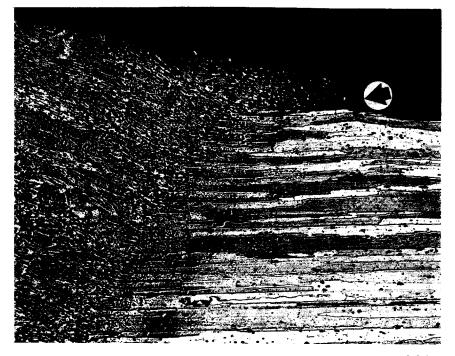


FIGURE 26. AVERAGE MECHANICAL PROPERTIES OF X7106-T63 WELDMENTS AGED 24 WEEKS



100X

(a)

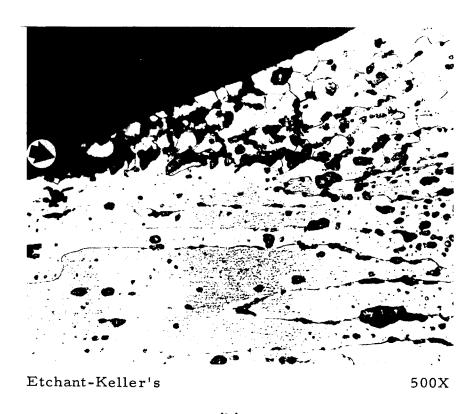


FIGURE 27. TOES OF WELD CROWN OF A MIG X7106 TENSILE SPECIMEN THAT FAILED IN THE HEAT-AFFECTED BASE METAL (Arrows indicate secondary cracks.)

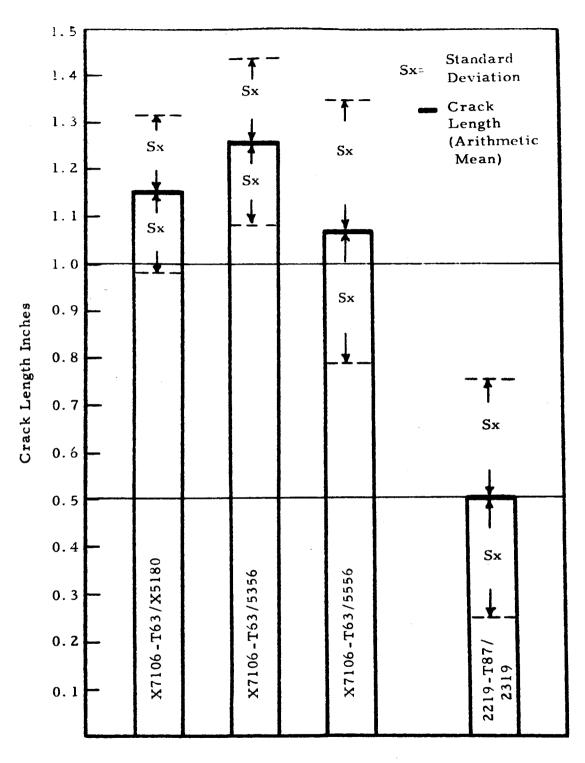
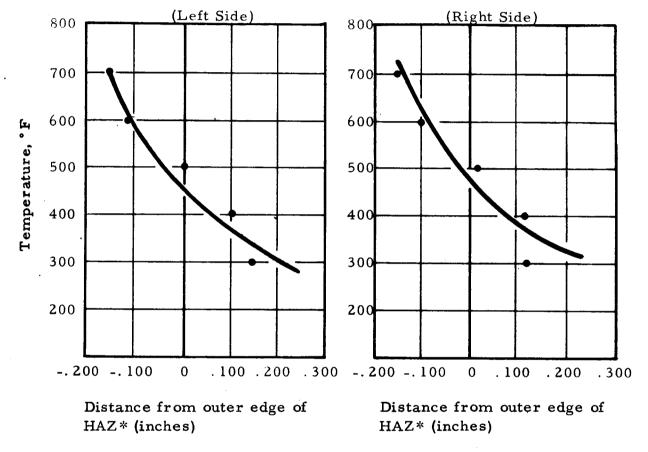


FIGURE 28. GRAPHICAL PRESENTATION OF CRACK DATA OBTAINED FROM HOULDCROFT TESTS



\*HAZ: Zone of heat affected base metal revealed by etching.

FIGURE 29. TEMPERATURE DISTRIBUTION IN THE VICINITY
OF JOINT IN A TIG WELDED X7106-T63/X5180 PANEL
AS REVEALED BY TEMPERATURE
SENSITIVE CRAYONS

of the uniaxial and biaxial properties of a number of weldments and further investigations into the weldability of X7106-T63 aluminum alloy. The Appendices A through K of this report constitute the Fifth Annual Summary Report.

#### 1. Evaluation of the Hydraulic Bulge Test

A biaxial and uniaxial test program was set up for 1/8-inch 2219-T87 parent metal and weldments as follows:

- (1) Cylinder tests at stress ratios of 1:1, 2:1, and 1:0
- (2) Circular hydraulic bulge tests at a 1:1 stress ratio
- (3) Elliptical hydraulic bulge tests at a 2:1 stress ratio
- (4) LTV biaxial tests at stress ratios of 1:1 and 2:1
- (5) MIT biaxial tests at a stress ratio of 2:1

The cylinder tests were used primarily to determine the basic stress-strain relationships for the alloy at three ratios of principal stress. Using the theory of constant elastic strain energy of distortion, as described in Appendix A, the results were compared to uniaxial tensile data on the basis of effective stress and strain. The agreement of these data, as shown in Figure A-3 in Appendix A, indicated that the behavior of the material could be described by the above mentioned theory. The cylinder specimens were adequate for determining strength of weldments but attempts to force failure in the parent metal were unsuccessful.

Once the biaxial stress-strain relationships were established, a strain gage stress analysis of the circular and elliptical hydraulic bulge tests was initiated. The first objective of the program was to determine the applicability to the circular bulge test of the membrane stress equation

$$\sigma = \frac{PR}{2t}$$

and the Timoshenko circular plate equation for large deflections

$$\sigma = KP^{2/3}$$

 $\sigma$  = biaxial stress, psi

P = bulge pressure, psi

R = radius of curvature of bulge, inches

t = panel thickness, inches

K = constant depending upon material constants and die geometry

The membrane stress equation was found to hold for parent metal panels, but was unsatisfactory for welded panels once the weld deposit started to yield, as shown in Figure A-9 in Appendix A. The Timoshenko equation, however, using an experimentally determined constant, could be applied to either type of panel up to the yield strength of the parent metal, as Figure A-13 in Appendix A illustrates. The stress-ratio produced in the elliptical bulge test was much lower than expected, so this procedure was eliminated from the program.

LTV biaxial tests were performed at LTV Vought Aeronautic Division, Dallas, Texas. The stress-strain data reported by LTV was converted to effective stress-effective strain and compared to the standard curve. The data fit well, as shown in Figure A-15 in Appendix A. A stress analysis of the MIT biaxial test was performed, but the results were inconclusive since the strain gages failed before the specimen fractured.

2. Evaluation of the Mechanical Properties of Aluminum Alloy
Sheet and Weldments Subjected to Uniaxial and Biaxial Stress
Fields

The 1:1 circular bulge test was selected to evaluate the biaxial properties since considerable data from such tests were available from the previous work. Thus, the results of the two programs (NAS8-1529 Mod 6 and NAS8-20160) could be combined to form a better statistical basis for analysis. The cylinder burst tests and the LTV and MIT biaxial tests were utilized to establish the validity of the results of the bulge test and to provide a means of calibration.

The test data generated in the fourth and fifth year programs on 2219-T87 and 2014-T6 weldments (no biaxial tests on X7106-T63 welds were performed in the fourth year) were combined and analyzed statistically. The mean values and lower tolerance limits for uniaxial ultimate strength and biaxial strength are tabulated on the following page. The values listed represent the results of from 11 to 15 bulge tests and from 47 to 78 uniaxial tensile tests.

	Uniaxial Ult Strength, ( Mean		Biaxial Ult Strength, Mean		Biaxial/Uniaxial Strength Ratio
TIG 2219-T87/2319	42.7	36.1	43.6	39.1	1.02
MIG 2219-T87/2319	42.8	37.8	44.8	35.9	1.05
TIG 2014-T6/2319	49.9	41.8	48.0	36.2	0.96
TIG 2014-T6/4043	47.9	36.2	44. 1	37.3	0.92
MIG 2014-T6/4043	42.9	32.3	39. 1	28.2	0. 91

Based on the revised method of determining biaxial strength utilizing the formula  $\sigma = KP^{2/3}$ , the TIG process is superior to the MIG process for 2014-T6/4043 weldments. The mean biaxial strength of the TIG 2014-T6/2319 weldments was higher than the MIG and TIG welds using 4043 filler wire, but the lower tolerance limit was essentially the same as the TIG weld with 4043 filler. The mean biaxial ultimate strength of MIG 2219-T87/2319 weldment was slightly higher than their TIG counterparts, but the TIG welds had the better lower tolerance limit because of the lower degree of scatter of these results.

A brief investigation of the properties of annealed panels and stress-relieved panels was conducted. After annealing, the uniaxial and biaxial weld joint efficiencies were essentially 100 percent based on the strength of the annealed base metal, although the strength levels of both were reduced considerably.

One stress relieving treatment, 525°F for five hours, was employed on all weldments studied. This treatment overaged the parent metal, thus reducing the strength. The strengths of the 2219-T87 and 2014-T6 weldments were affected so slightly by the stress relieving treatment that no definite conclusions could be drawn. The same heat treatment reduced the strength of the X7106-T63 welds to the level of the annealed panels.

# 3. Weldability of X7106-T63 Aluminum Alloy

One portion of the investigation of the weldability of X7106-T63 aluminum alloy was directed toward establishing the mechanical properties of naturally aged weldments of this alloy fabricated by both the TIG and MIG processes. This portion of the program included weldments in thicknesses of 0.187 inch, 0.50 inch, and 1.00 inch, made with X5180, 5356, and 5556

filler metal alloys. Square butt joints were employed for the 0.187-inch weldments and double V joints were used in the fabrication of the 1.00-inch weldments. Both square butt and double V joints were included in the 0.50-inch TIG weldments. These two joint types were tested in the one thickness in order to establish the effect of dilution on the properties of the joints made with the various filler alloys.

The results of the tensile tests conducted to establish the natural aging characteristics of X7106-T63 weldments are summarized in Tables C-II through C-VII in Appendix C. In each case, significant increases in tensile properties were noted for aging times of 30 days and longer.

The tensile properties of the various X7106-T63 weldments, after an aging period of 12 weeks, are given in Figures C-4, C-5, and C-6. In the case of the 0.187 inch and 0.50-inch weldments, only relatively small differences between MIG and TIG weldments were noted. For the 1.00-inch weldments, the TIG process resulted in ultimate strengths significantly higher than those of the MIG weldments. The X5180 filler wire produced the highest ultimate strengths for both MIG and TIG weldments of 0.187-inch sheet. Within each group of 0.50-inch TIG weldments (TIG square butt and TIG double V), no appreciable differences were noted in the properties of the weldments made with the various filler wire alloys. For the 0.50-inch MIG weldments, lower yield strengths and ultimate strengths were recorded for the weldments made with 5356 filler wire than for those employing X5180 and 5556. Only small differences in ultimate strength were noted between the TIG square butt and TIG double V weldments.

Based on the average ultimate strength, the test results indicate the optimum weldment types among those tested in the three thicknesses to be as follows:

0.187 inch	TIG X5180 and MIG X5180 equivalent
0.50 inch	TIG X5180 square butt
1.00 inch	TIG 5556

A second portion of the investigation was conducted to further investigate the crack susceptibility of X7106-T63 weldments. Modified Houldcroft test specimens, 0.187 inch thick, were employed for this purpose (see Appendix C). Tests were conducted on 2219-T87, 2014-T6, and X7106-T63 weldments. Three filler metal alloys, X5180, 5356, and 5556, were utilized in the tests on X7106-T63 material. Filler alloys 2319 and 4043 were used for the 2219-T87 and 2014-T6 specimens, respectively.

The results, reported as average crack lengths, are summarized in Table C-IX and Figure C-9 in Appendix C. These results indicate that the crack susceptibility of X7106-T63 is comparable to that of 2014-T6, and that each of these alloys exhibits a degree of crack susceptibility significantly higher than that of 2219-T87 alloy.

In addition to the tests on modified Houldcroft specimens, preliminary cruciform crack susceptibility tests were performed on 0.50-inch X7106-T63 plate. These tests were unsuccessful in that cracks could not be induced with either single-pass or multiple-pass joints. As a result, no further crack susceptibility tests were performed on the 0.50-inch or 1.00inch material.

## APPENDIX A

EVALUATION OF THE METHODS FOR THE DETERMINATION OF THE BIAXIAL STRENGTH OF ALUMINUM ALLOY SHEET AND WELDMENTS (NAS8-20160, PHASE I)

# EVALUATION OF THE METHODS FOR THE DETERMINATION OF THE BIAXIAL STRENGTH OF ALUMINUM ALLOY SHEET AND WELDMENTS (NAS8-20160, PHASE I)

#### A. Introduction

A biaxial and uniaxial test program on 2219-T87 aluminum alloy parent metal and weldments was conducted to evaluate the hydraulic bulge test as a means of measurement of the biaxial mechanical properties of high-strength aluminum alloys. The program was organized as follows:

- (1) Circular and elliptical bulge tests and uniaxial tensile tests were performed on a variety of parent metal and weldment specimens. Stress analyses were performed to determine the applicability of the normally used membrane stress equation and the Timoshenko flat plate formula to the calculation of stresses in the circular bulge test.
- (2) Cylinder tests simulating thin wall pressure vessels were conducted at three ratios of principal stresses (1:1, 2:1, and 1:0) to determine the biaxial stress-strain relationships needed for the quantitative interpretation of the hydraulic bulge test.
- (3) Ling-Temco-Vought (LTV) biaxial tests were conducted on both parent metal and weldments in two stress ratios (2:1 and 1:1) and MIT tests (stress ratio = 2:1) were run on parent metal only.
- (4) A comparison of the biaxial results with existing theories of failure (see Appendix D) was made.

This program, therefore, provided data for the direct comparison of several of the principal methods of biaxial testing in use at the present time. The total number of biaxial tests included in the program are summarized in Table A-1.

A description of the experimental procedures used are given in Appendix E. The test material and fabrication data are given in Appendix F.

TABLE A-1. PHASE I BIAXIAL TEST PROGRAM (NAS8-20160)

Type of Test	Material	Specimen Type	Biaxial Ratio	No. of Tests
Bulge	2219-T87	Parent Metal	1:1	3
Bulge	2219-T87/2319	Single Weld	1:1	3
Bulge	2219-T87/2319	Cross Weld	1:1	3
Bulge	2219-T87	Parent Metal	2:1	3
Bulge	2219-T87/2319	Single Weld	2:1	3
Bulge	2219-T87/2319	Cross Weld	2:1	3
Modified Bulge	2219-T87	Reduced Section	1:1	3
Modified Bulge	2219-T87	Reduced Section	2:1	3
Modified Bulge	2219-T87	Single Groove	1:1	3
Modified Bulge	2219-T87	Cross Groove	1:1	3
Modified Bulge	2219-T87	Single Groove	2: 1	3
Modified Bulge	2219-T87	Cross Groove	2: 1	3
Cylinder	2219-T87/2319	Single Weld	1:1	3
Cylinder	2219-T87/2319	Single Weld	2:1	3
Cylinder	2219-T87/2319	Single Weld	1:0	3
Cylinder	2219-T87	Parent Metal	1:1	3
Cylinder	2219-T87	Parent Metal	2:1	3
LTV Biaxial	2219-T87	Parent Metal	1:1	3
LTV Biaxial	2219-T87/2319	Cross Weld	1:1	3
LTV Biaxial	2219-T87	Parent Metal	2:1	3
LTV Biaxial	2219-T87/2319	Cross Weld	2: 1	3
MIT Biaxial	2219-T87	Parent Metal	2:1	3

### B. Cylinder Tests

The hydraulic bulge test is excellent for screening materials on the basis of fracture propagation behavior and determining mechanical strength. However, the mechanics of the specimen and test fixture prevent analysis of results in terms of stress. Strains can be measured on these specimens and used to calculate stresses once the relationship is established between strain and stress. In the elastic range, stress is proportional to strain and the stress-strain curve is linear. In the plastic range, however, the relationship must be established for particular materials, especially for those that are anisotropic and strain hardenable. The cylinder loaded by internal pressure and axial loads is one of the few test specimen types for which stress can be calculated and on which strains can be measured to obtain the desired relationship for differing ratios of principal stresses.

Previous investigations have demonstrated that, for many materials, the equations of the theory of constant elastic strain energy of distortion or of the constant octahedral shearing stress can be used to fit the stress-strain relationships for all ratios of principal stresses to a single curve. (5) The cylinder tests were performed to establish the validity of this approach for the materials investigated in this program. The results of the cylinder tests were sufficient to determine the desired stress-strain relationship which enables quantitative interpretation of the hydraulic bulge test results.

The specimen design was determined by the characteristics of the materials, base plate and weldment, and equipment limitations involved. The specimen cross section size was 18-inch diameter made of 0.125-inch thick sheet. The test section length was 23 inches, which was estimated as being sufficient to eliminate end effects at midsection. The specimen was installed in the Universal Testing Machine as shown in Figure A-1 so that tensile or compressive axial loads could be imposed on the specimen simultaneously with internal pressure loading.

The instrumentation, described in Appendix E, provided for the recording of synchronous values of axial load, internal pressure, longitudinal strains, and circumferential strains. These data were tabulated and stress values calculated from the loadings using thin cylinder formulae which provided engineering stress-strain relationships for the loading investigated. The true stress and true strain values were calculated from the engineering values and used to calculate effective stress and effective strain values by the usual formulae

$$\overline{\sigma}_{i} = \sigma_{i} (1 + \epsilon_{i})$$
  $\overline{\epsilon}_{i} = \ln (1 + \epsilon_{i})$ 

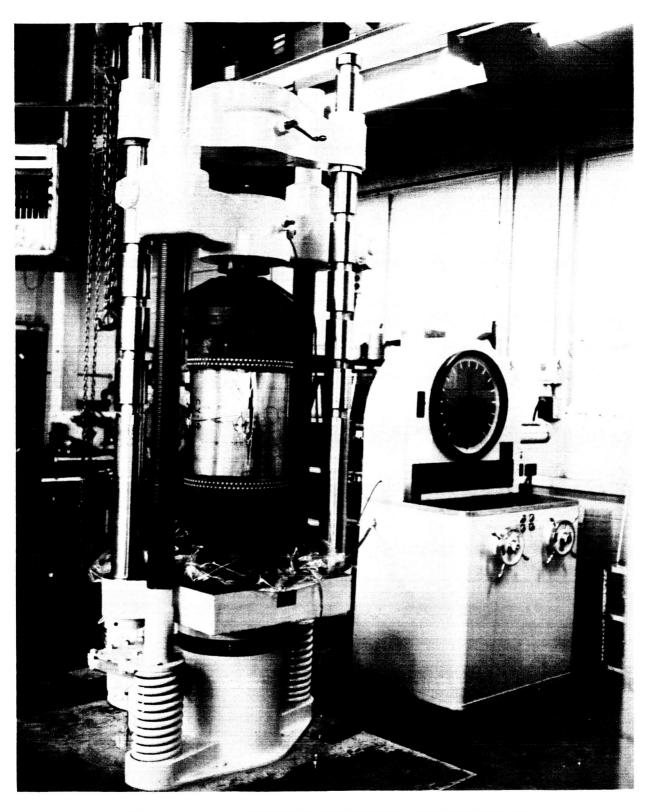


FIGURE A-1. TESTED CYLINDER SPECIMEN IN UNIVERSAL TESTING MACHINE

 $\sigma$  = engineering stress

 $\epsilon$  = engineering strain

 $\bar{\sigma}$  = true stress

 $\bar{\epsilon}$  = true strain

$$\sigma_{e} = \frac{1}{\sqrt{2}} \sqrt{(\bar{\sigma}_{1} - \bar{\sigma}_{2})^{2} + (\bar{\sigma}_{2} - \bar{\sigma}_{3})^{2} + (\bar{\sigma}_{3} - \bar{\sigma}_{1})^{2}}$$

$$\epsilon_{\rm e} = \frac{\sqrt{2}}{3} \sqrt{(\bar{\epsilon}_1 - \bar{\epsilon}_2)^2 + (\bar{\epsilon}_2 - \bar{\epsilon}_3)^2 + (\bar{\epsilon}_3 - \bar{\epsilon}_1)^2}$$

where the subscript e denotes effective stress or strain, and the subscript i = 1, 2 or 3; subscripts 1, 2, 3 denote principal stress or strain values.

The development of these equations assumes Poisson's ratio equals 1/2 in the plastic region, but experience has shown that the variation from this value makes little difference in practical results, as this variable approaches the assumed value in plastic flow. The minor principal strain had to be calculated by using Poisson's ratio, and its elastic value was used in the first set of calculations. Trail calculations showed that refinement of results by correcting Poisson's ratio by the secant modulus formula

$$\mu = \frac{1}{2} - \frac{Es}{E} \left( \frac{1}{2} - \nu \right)$$

where

μ = Poisson's ratio

Es = secant modulus

E = elastic modulus

 $\nu$  = elastic value of Poisson's ratio

was not justified because the correction was less than experimental error in data obtained. The portion of the experimental error arising from specimen out-of-roundness is greatest in the elastic range because stress redistribution by plastic flow automatically corrects the geometric imperfections in

most cases. The majority of this type of error can be corrected graphically by shifting coordinate axes of the stress-strain curves just as one would do when correcting tensile test results of initially bent specimens.

Sixteen cylinder test specimens were fabricated. The first specimen tested was instrumented with strain gages, as shown by Figure A-2, in order to demonstrate that the strains in the specimen midsection were not affected by end restraint. The remainder of the specimens were instrumented only on the central diameter. Strain gages were mounted on the weld metal, both heat-affected zones, and on parent metal 180° from the weld. Uniaxial specimens were also tested in a Universal Testing Machine with data obtained and reduced in the same manner as was used for the cylindrical specimens to compare test results.

After conducting the first test, it was found necessary to stiffen the end plates and improve the seal design to prevent leakage at the fixtures. Joint sealing procedure at the riveted attachment was also improved. Nine specimens were used to determine weldment behavior. On the remaining six specimens, the welds were reinforced in an unsuccessful attempt to obtain failure in the base plate material. The results of the tests are summarized in Table A-2, and the tabular stress-strain data are given in Appendix G.

The curves in Figure A-3 compare the strain data from the 90° rosette on the base plate material at 180° from the weld, with the curve derived from uniaxial tensile tests of base plate material. The data show good fit, presuming initial out-of-roundness to affect the results. Tests 3 and 9, performed at a stress ratio of 1:0, were the only ones with elastic moduli varying significantly from the reference curve. The mean of the results of these two specimens fits the results of Test 10 (also run at a stress ratio of 1:0) which was plotted in Figure A-3. The other deviation from the reference curve is in the "knee" of the curves of those specimens in which the base plate material could be loaded into the plastic range (Tests 11, 12, and 13). This was probably due to the moment induced by the reinforcing plate over the weld while the reinforced section was still in the elastic range and before stress redistribution by plastic flow(6). The set of results justified the procedure investigated and provides a sound basis for transforming strain data from the bulge tests to stress values.

The comparison of the results derived from the rosettes on the heat-affected zones, for Tests 2 through 10, displayed considerably more scatter. Typical curves are shown in Figure A-4. The elastic moduli fit the base plate curve well, but the scatterband increased with plastic strain. It was, of course, difficult to place strain gages on this zone precisely, and there are

Location	Left HAZ	Left HAZ	Weld Bead	Weld Bead	Right HAZ	Right HAZ	Parent Metal 18° from Weld	Parent Metal 180° from Weld
Direction	Circumferential	Longitudinal	Circumferential	Longitudinal	<b>Circumferential</b>	Longitudinal	Circumferential	Longitudinal
Gage No.	1 & 9	2 & 10	3 & 11	4 & 12	5 & 13	6 & 14	7 & 15	8 & 16
							1 st Specimen	Only Weld Weld

FIGURE A-2. SCHEMATIC OF STRAIN GAGE LOCATIONS ON CYLINDER TEST SPECIMENS

TABLE A-2. SUMMARY OF CYLINDER TEST RESULTS

Test No.	Cylinder No.	Type Loading	Burst Pressure (psi)
1	XCY-1	2: 1	(a)
2	CY-1	2: 1	572
3	CY-4	1:0	570
4	CY-5	1:1	575
5	CY-2	2:1	572
6	CY-10	2:1	575
7	CY-11	1:1	540
8	CY-12	1:1	542
9	CY-13	1:0	575
10	CY-16	1:0	575
11	CY-14	2: 1	<sub>1010</sub> (b)
12	CY-9	2: 1	<sub>995</sub> (c)
13	CY-15	2: 1	<sub>1010</sub> (c)
14	CY-7	1:1	<sub>450</sub> (d)
14-A	CY-7	1:1	<sub>640</sub> (e)

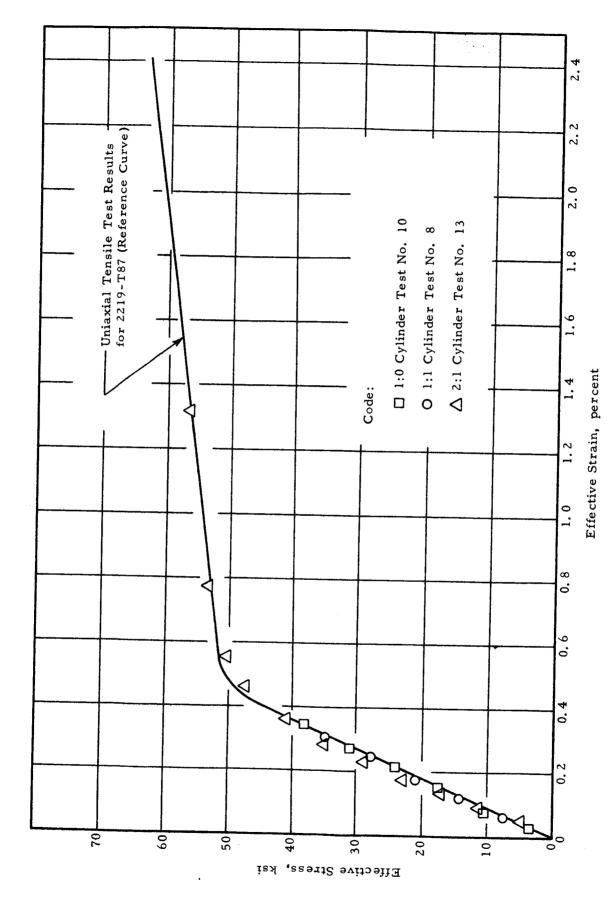
<sup>(</sup>a) Weld crowns ground off

<sup>(</sup>b) Longitudinal weld reinforced; parent metal failure

<sup>(</sup>c) Longitudinal weld reinforced; patch blew off

<sup>(</sup>d) Longitudinal weld reinforced; stopped because of excessive leaks

<sup>(</sup>e) Longitudinal weld reinforced; end rivets failed



BIAXIAL AND UNIAXIAL PARENT METAL DATA CONVERTED TO EFFECTIVE STRESS AND STRAIN FIGURE A-3.

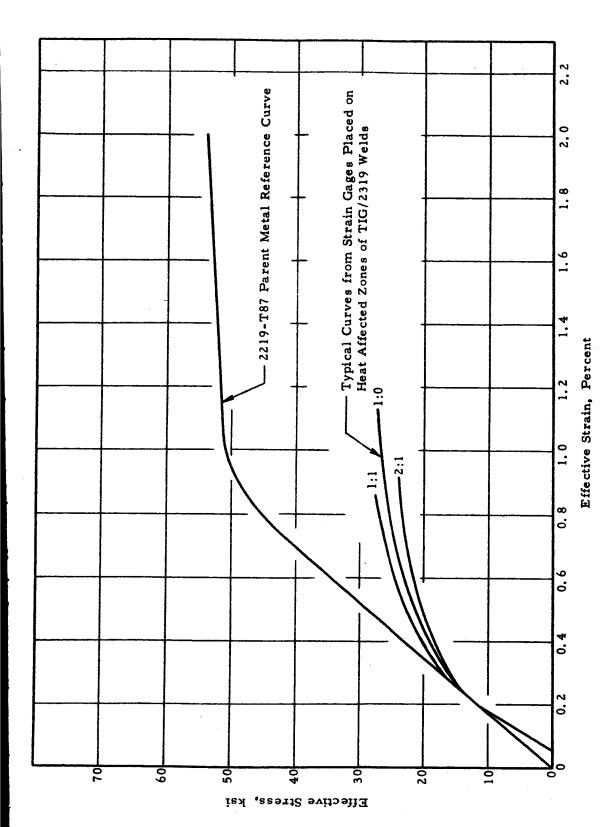


FIGURE A-4. BIAXIAL AND UNIAXIAL HAZ DATA CONVERTED TO EFFECTIVE STRESS AND STRAIN

so many variables involved that one cannot associate cause with effect in analyzing these data. Test I results were quite different from those of Tests 2 through 10, possibly because of the preloading used to check out fixtures and test procedures.

The rosettes on the weld metal gave very erratic results. Characteristic curves are given in Figure A-5. Obviously, the mechanics of loading and geometry of this part of the structure is the most complex and liable to deviate from the ideal assumed in stress calculations for the cylinder. The resulting stress-strain curves do show characteristic dependence on state of stress, however. This dependence most likely results from the mechanism of loading the material rather than from materials properties.

In all cases, failure in the cylindrical specimens occurred at the fusion line in the same fashion as was observed in the bulge panels. The typical appearance of the fractures in the cylinders is shown in Figure A-1. It may be noted that the failure pressure was not affected by state of stress to the degree or in the direction that would be predicted by the theory of failure that corresponds to the relationship which correlates flow behavior of the base plate material. The failure behavior of base plate material could not be determined in this program because of specimen design limitations; however, the results do provide a method of determining stress magnitudes in bulge tests by measuring strains in base plate material as a function of stress.

# C. Stress Analysis of the Circular Hydraulic Bulge Test

The membrane stress equation has been suggested (7) for calculating the stresses in the hydraulic bulge test panel

$$\sigma_{\text{mem}} = \frac{PR}{2t}$$

where

P = pressure, psi

t = panel thickness, inches

The membrane stress in a circular flat plate clamped at the edge is also given by Timoshenko(8) as:

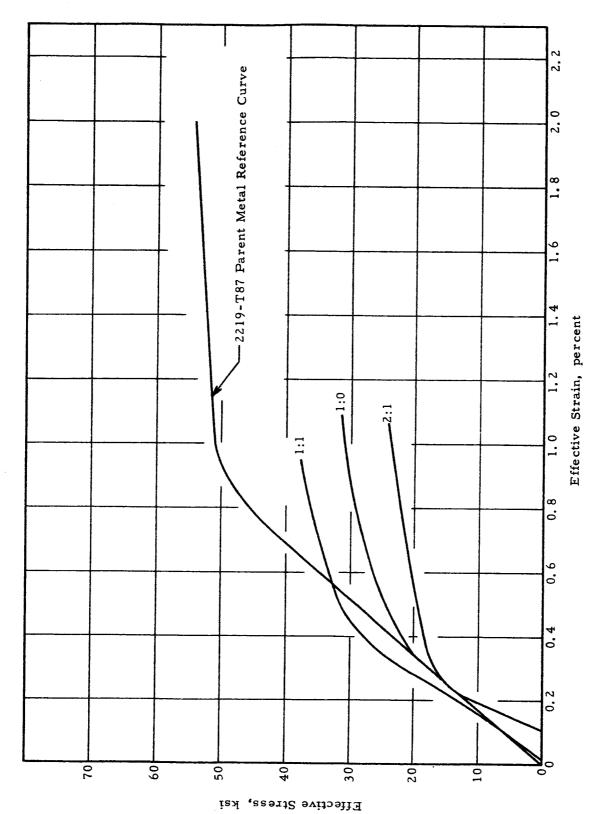


FIGURE A-5. BIAXIAL AND UNIAXIAL WELD BEAD DATA CONVERTED TO EFFECTIVE STRESS AND STRAIN

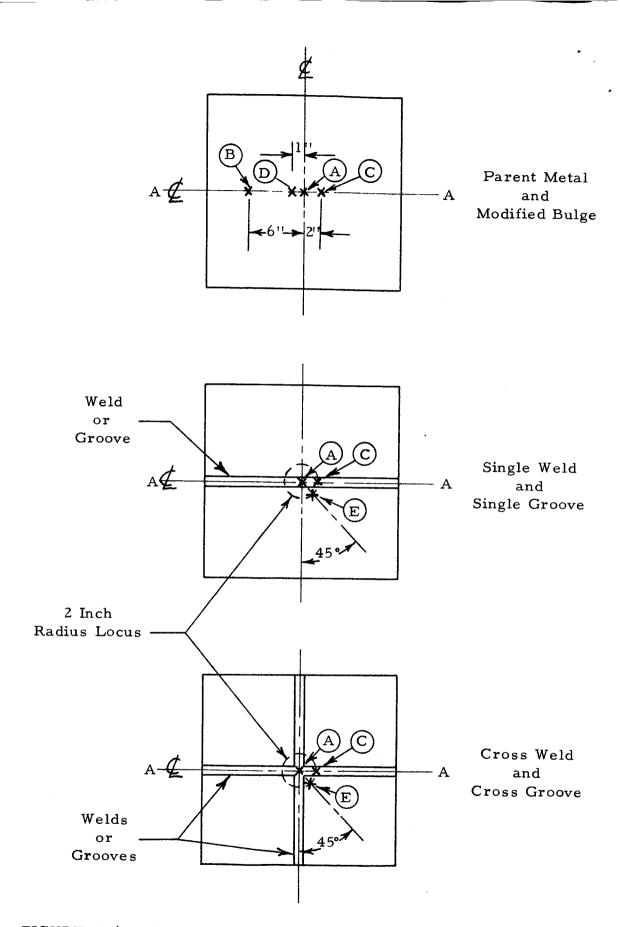


FIGURE A-6. SCHEMATIC OF STRAIN GAGE LOCATIONS ON 1:1 BULGE TEST PANELS

$$\sigma = 0.423 \left( \frac{EP^2a^2}{h^2} \right)^{1/3} = KP^{2/3}$$

 $E = modulus of elasticity = 10.5 \times 10^6 psi$ 

P = pressure, psi

a = radius of circular plate = 9 inches

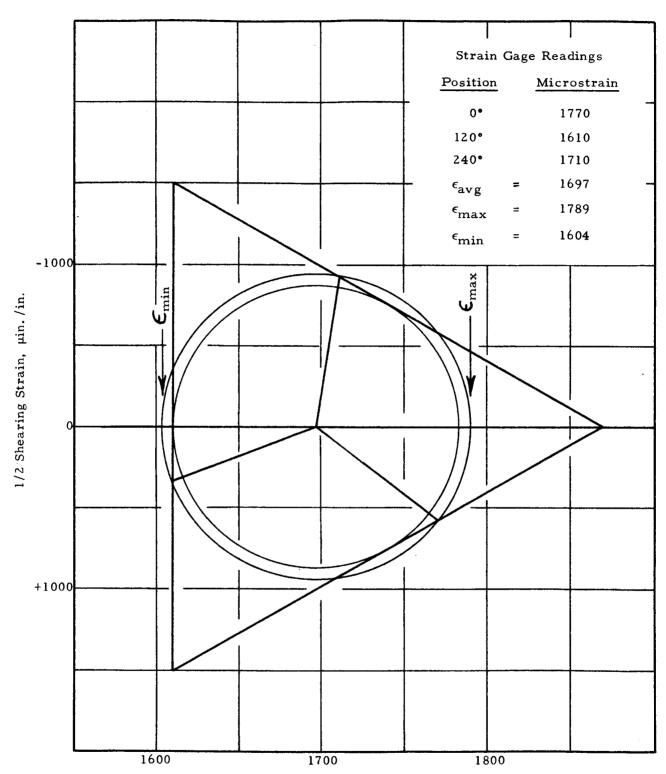
h = thickness of plate = 0.125 inch

 $\sigma$  = biaxial stress in panel, psi

The stresses produced in the circular hydraulic bulge test were measured at low bulge heights by correlating hydraulic bulge test strain data with the cylinder test stress-strain curves described in the previous section, so that the applicability of these equations could be studied.

All of the bulge test panels listed in Table A-1 were instrumented with electric resistance-type strain gages on the parent metal, and the weld metal when appropriate. Typical locations of these strain gages for the 1:1 hydraulic bulge tests are shown schematically in Figure A-6. The pressure, bulge height and strain data are given in Appendix G. The strain measured at a point two inches from center was essentially the same as that measured at the center. Since the approach to the problem was to monitor parent metal strain versus pressure on all tests, the center position could not be used on panels with welds through the center. Therefore, the two-inch-from-center position was selected for the reference strain gage.

The first objective of this program was to determine the stress ratio produced in a circular bulge test panel. For an isotropic material, a 1:1 stress state should produce a 1:1 strain state on that plane. Examination of the data from the three-element 120° rosette strain gages mounted on the parent metal showed that, in general, a strain state very close to 1:1 was obtained. To determine the ratio of principal stresses in a specimen, the stress state was calculated for the highest elastic strain condition at the two-inch position on the panel. The principal strains were calculated by constructing Mohr's circle, Figure A-7. After correcting for bending (discussed in a later paragraph), the principal strains were converted to principal stresses in the usual way for an isotropic material by:



Principal Strain, µin. /in.

FIGURE A-7. MOHR'S CIRCLE FOR 1:1 BULGE . TEST PANEL A-1 AT P = 40 PSI

$$\sigma_{\max} = \frac{(\epsilon_{\max} + \mu \epsilon_{\min}) E}{1 - \mu^2}$$

$$\sigma_{\min} = \frac{(\epsilon_{\min} + \mu \epsilon_{\max})E}{1 - \mu^2}$$

E = modulus of elasticity =  $10.5 \times 10^6$  psi

 $\mu$  = Poisson's ratio = 0.29

 $\epsilon_{\max}$  = maximum principal strain

 $\epsilon_{\min}$  = minimum principal strain

 $\sigma_{max}$  = maximum principal stress

σ<sub>min</sub> = minimum principal stress

The results of this analysis are given in Table A-3. The values of the stress ratios varied from 1.01 for specimen A-7 to 1.22 for specimen AT1-9. In general, the welded panels produced a more unbalanced stress strain state than the parent metal and grooved parent metal panels. The reason for this is not clear, but may be related to the stiffening effect of the weld bead before it reaches its yield stress. The direction of maximum principal stress, Table A-2, is approximately normal to the weld in the single weld panels and normal to one of the two welds in the cross-weld panels. In the machined groove panels, the direction of maximum principal stress does not show a definite trend.

As discussed previously in the section on cylinder tests, the effective stress-effective strain reference curve and associated equations provide a means for determining the stress-strain relationship for any desired state of stress. The curve in Figure A-8 was derived in this manner for a 1:1 stress ratio.

Pressure, bulge height and strain had been measured at discreet intervals throughout each bulge test so that the membrane stress (PR/2t) could be calculated and compared to the stress determined from the strain data and Figure A-8. The result of this comparison is shown in Figure A-9. This graph illustrates the validity of the membrane stress equation for parent metal panels. It also shows that (for this particular combination of material,

TABLE A-3. PRINCIPAL STRESSES IN 1:1 HYDRAULIC BULGE TEST PANELS BELOW YIELD STRESS

Panel Description			Test	Principal Stresses			
Material &			Pressure	Max	Min		, ,
Process	Туре	No.	(psi)	(psi)	(psi)	Ratio	Direction(a)
	Parent	A1 A27 A28	40 - -	19,900 (b) (b)	18,400 - -	1.08 - -	19° - -
2219-T87 Parent Metal	Reduced Section Parent	A7 A8 A9 A25	(b) 40 33 39	22,700 22,000 18,000 16,800	22,400 21,100 16,200 16,000	1.01 1.04 1.11 1.05	0° 30° 11° 80°
	Single Groove Parent	A13 A14 A15	- 46 32	(b) 23,500 19,400	- 22,800 18,900	- 1.03 1.03	30° 27°
	Cross Groove Parent	A16 A17 A18	41 48 44	19,200 24,700 23,700	18,700 21,600 21,600	1.03 1.14 1.10	75° 45° 90°
TIG 2219-T87 2319	Single Weld	AT1-2 AT1-3 AT1-7	40 50 41	21,600 22,300 21,600	18,500 20,700 19,600	1.17 1.08 1.10	85° 80° 90°
	Cross Weld	AT1-1 AT1-8 AT1-9	45 42 48	19,100 20,900 22,400	18,300 17,700 18,400	1.04 1.18 1.22	3° 5° 88°

<sup>(</sup>a) Angle of maximum principal stress to reference axis (through center of panel and parallel to one panel edge).

<sup>(</sup>b) Data not obtained.

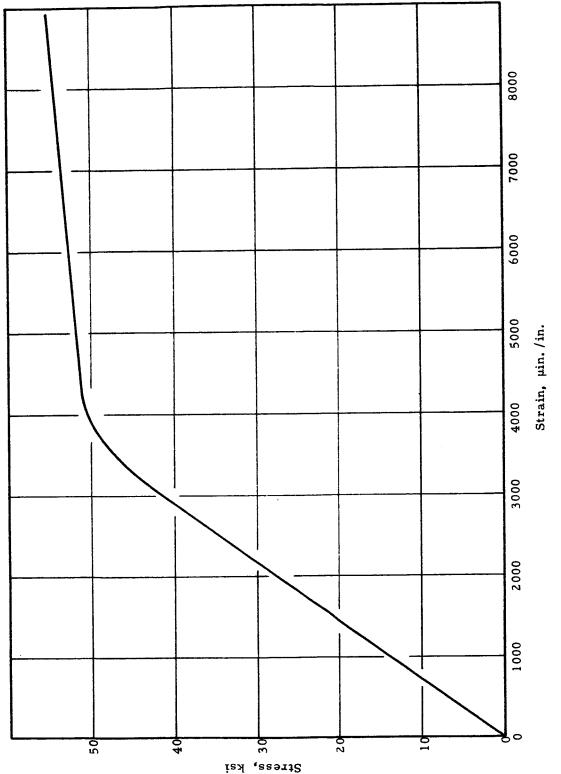


FIGURE A-8. STRESS-STRAIN CURVE FOR 2219-T87 ALUMINUM ALLOY SUBJECTED TO A 1:1 STRESS STATE (Derived from Reference Curve in Fig. A-3)

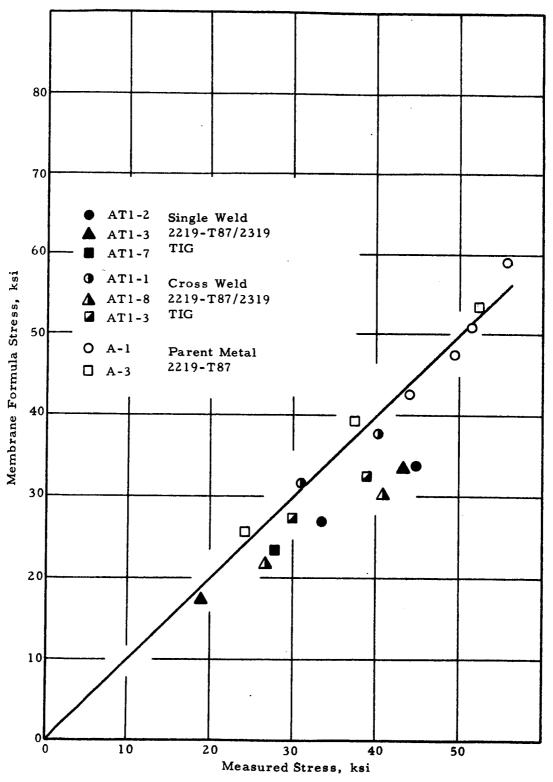


FIGURE A-9. COMPARISON OF MEMBRANE FORMULA STRESSES WITH MEASURED STRESSES. (Membrane Formula Stresses Calculated from  $\sigma$  = PR/2t. Measured Stresses Determined Experimentally with Strain Gages.)

material thickness, and die geometry at least) that the membrane stress equation gives stress values as much as 25% lower when applied to welded panels.

As discussed earlier, Timoshenko's formula for stress for large deflections of a circular plate clamped at the edge predicts that this stress will be proportional to the two-thirds power of the applied pressure. In Figure A-10, the parent metal strain two inches from center is shown to be a smooth function of this parameter. Where two-element or three-element gages were used, the average strain at that point was computed to construct this curve since the direction of maximum principal strain varied considerably within this group of tests.

Since the radius of curvature of the test panel decreases continuously during the bulge test, an increasing amount of bending strain is experienced by the panel as it is pressurized. Two tests were run to determine the amount of bending strain as a function of bulge height for parent metal panels. The results of these two tests are given in Figure A-11.

As long as a panel is uniform in cross-section and properties, the curve in Figure A-11 is applicable. However, panels containing low strength welds or grooves follow the relationship in Figure A-11 only until yielding occurs in the outer fibers of the weld or groove. If the material were ideally elastic-plastic, the bending moment and the corresponding bending strain would not increase beyond the value at which yielding occurred. Actual experience has shown<sup>(9)</sup> that, for a rectangular section, the stress at which a material has become fully plastic in bending is 1.5 times the stress which produced initial yielding in the outer fibers. This means that it can carry 1.5 times the bending moment that was sufficient to initiate yielding. These procedures also do not take into account the effect of strain hardening. Since the strain hardening coefficients of the 2219 and 2319 alloys are small (approximately 0.1), the effect of strain hardening on the bending moment was not considered in this analysis.

Using this criteria, the bulge panel strain data were corrected for bending strain. The adjusted data (Fig. A-12) show a linear relationship between strain and the two-thirds power of the applied pressure for welded panels, panels with machined grooves, and parent metal panels.

The bulge panel stress for welded panels determined from the strain data and Figure A-11 is plotted versus (P)2/3 in Figure A-13. Also included in this figure is the parent metal membrane stress (PR/2t) data (average of six tests). The curve is linear in the elastic strain region as predicted by the Timoshenko formula. However, the slope of the curve is less than that

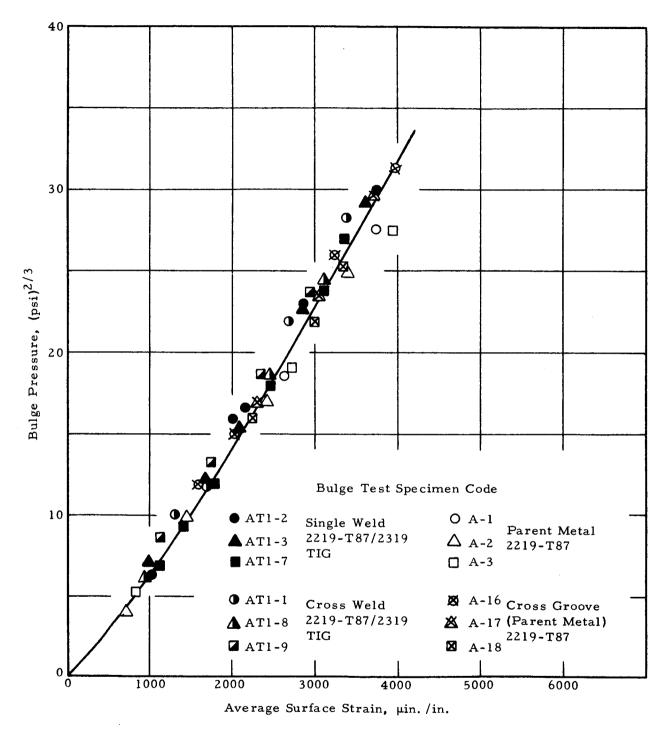


FIGURE A-10. STRAIN-PRESSURE DATA FROM CIRCULAR HYDRAULIC BULGE TESTS

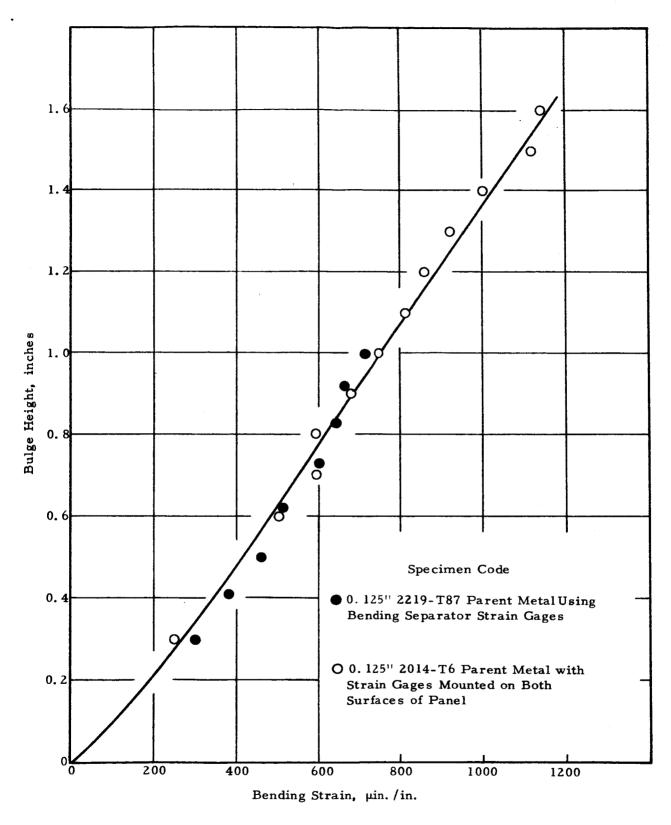


FIGURE A-11. BENDING STRAIN AS A FUNCTION OF BULGE HEIGHT IN THE CIRCULAR HYDRAULIC BULGE TEST

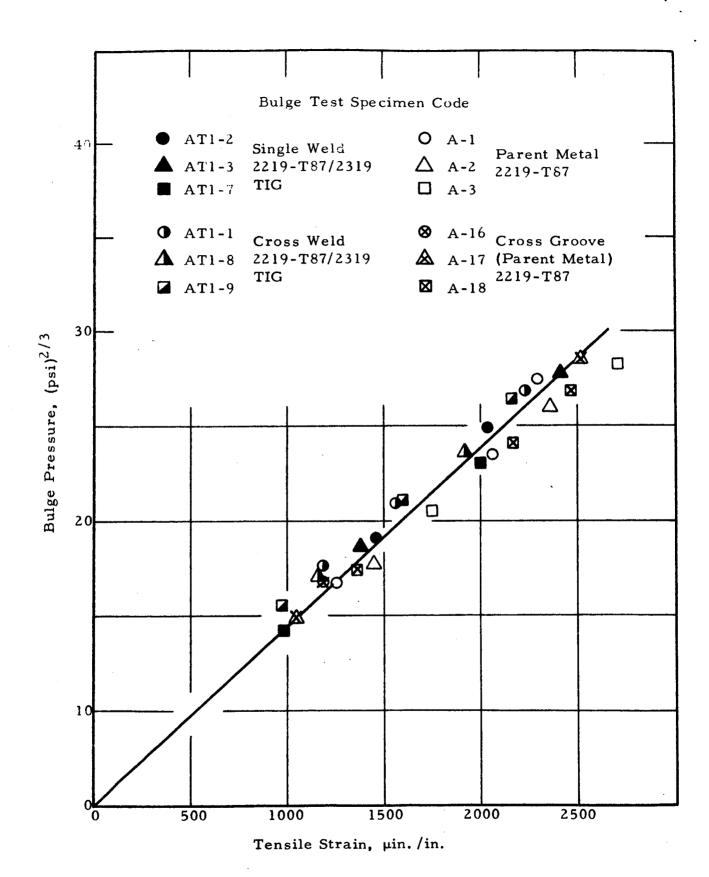


FIGURE A-12. ADJUSTED STRAIN-PRESSURE DATA FROM CIRCULAR HYDRAULIC BULGE TESTS

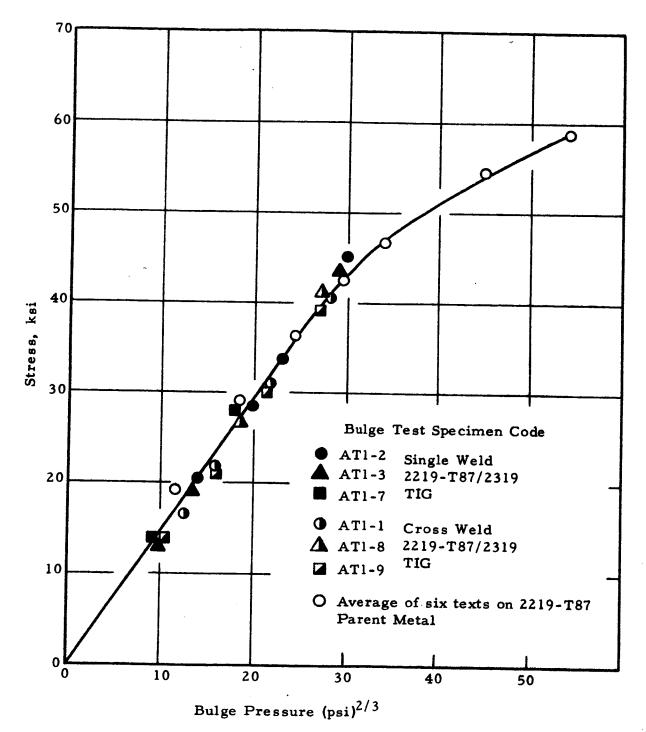


FIGURE A-13. RELATIONSHIP BETWEEN STRESS AND PRESSURE FOR 1:1 BULGE PANEL

predicted by the elastic constants and the die geometry. This may be a result of not achieving the ideal boundary conditions of a perfectly clamped edge assumed in the derivation of the formula.

It appears, however, that the stress versus (P)2/3 curve can be established with parent metal bulge tests, using the membrane stress (PR/2t) equation. Then, the ultimate strength of welded panels can be obtained from this curve and the pressure necessary to fail the panel.

# D. Stress Analysis of the Elliptical Bulge Test

All of the elliptical bulge test panels listed in Table A-1 were instrumented with electric resistance strain gages on both the parent metal and on the weld metal. The pressure, bulge height and strain data are given in Appendix G. The strain uniformity in the vicinity of the panel center was determined, and it was established that a position two inches from the center of the panel could be used for the reference strain gage.

The stress ratio obtained in the elastic range was calculated from the standard formulas previously described in the analysis of the circular bulge test. The principal strains were measured as a function of pressure and bulge height. Before calculating membrane stresses, the strain data was corrected by subtracting that portion attributed to the bending of the panel.

The bending strain versus bulge height was determined with bending separator strain gages or by strain gages mounted on a concave as well as the convex side of a parent metal panel. The results are given in Figure A-14.

Three 2219-T87 parent metal panels were instrumented with strain gages. The principal strains were calculated and were found to be in the direction of the two axes of the ellipse, with the maximum strain across the short dimension. At a bulge height of 0.5 inch, the stress ratios were found to vary from 1.23:1 to 1.27:1 for the three panels.

Not only was the stress ratio lower than desired, it did not remain constant throughout the duration of the test. It decreased from its value of approximately 1.25:1 in the elastic region towards a value of 1:1 at stress levels producing plastic strains of approximately one percent.

One additional parent metal test was conducted without using the bolts normally used to hold the die halves together. This was done to determine whether or not a change in the restraint would have a beneficial effect on the stress ratio. Specimen A-29 (2219-T87 parent metal) was bulged while the die was held together in a Baldwin Universal Testing Machine. The test had

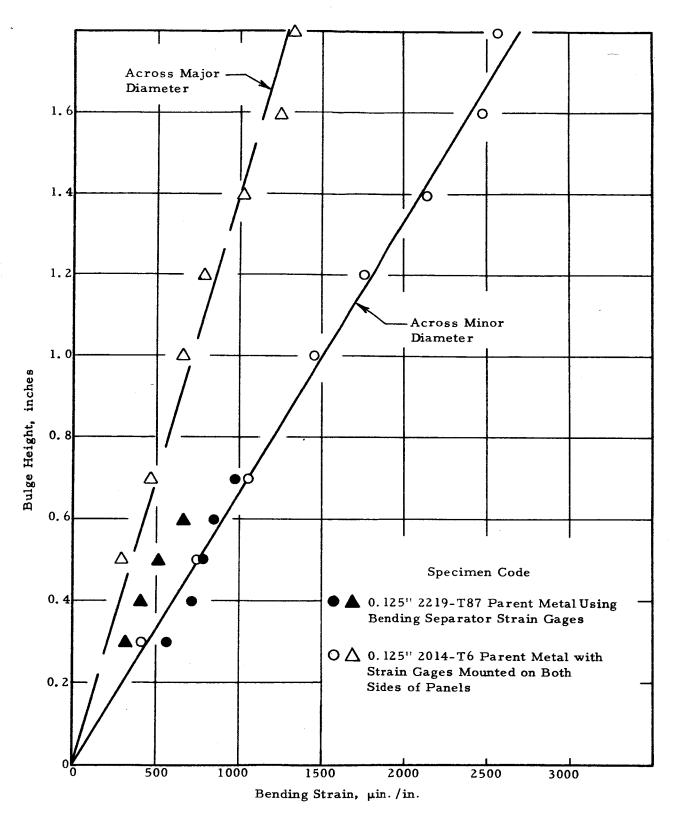


FIGURE A-14. BENDING STRAIN AS A FUNCTION OF BULGE HEIGHT IN THE ELLIPTICAL BULGE TEST

to be discontinued after reaching a bulge pressure of 280 psi because the capacity of the machine was insufficient to prevent leakage beyond this point. At a bulge height of 0.8 inch, the maximum and minimum principal stresses were 22,900 psi and 16,100 psi, respectively. This represents a stress ratio of 1.42:1, which is higher than that obtained when the die halves and specimen were bolted together. More important, however, was the indication that the stress ratio remained relatively constant and plastic strain was observed in the high stress direction only. This more closely approaches the strain behavior characteristic of cylinders in a 2:1 stress state. Based on the preceding test result, it appears that elimination of the hold down bolts would improve the performance of the elliptical bulge test. This would require a substitute method for holding the die halves together during a test.

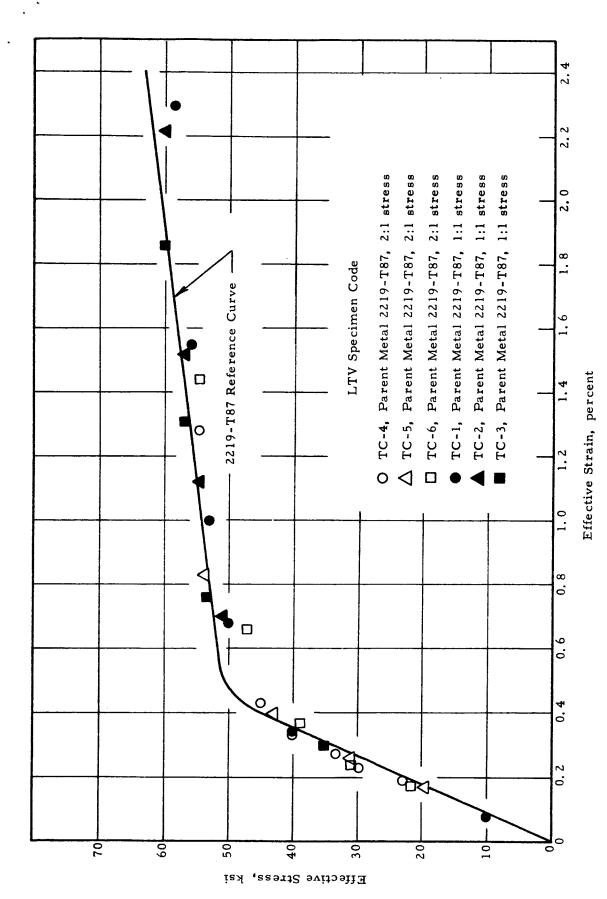
The analysis of the data on the remainder of the elliptical bulge tests, as discussed above, showed that a 2:1 stress state was not achieved in any of the tests.

#### E. Ling Temco Vought Biaxial Tests

These tests were conducted at LTV Vought Aeronautics Division, Dallas, Texas, on a subcontract basis. Their report on this work is presented in Appendix H. Both parent metal and welded specimens were tested in a l:l and 2:l stress field. Data from the parent metal stress-strain curves were converted to effective stress and effective strain. These data are compared to the reference curve in Figure A-15. A good fit was obtained, which indicates again that the stress-strain behavior of this alloy can be described by the theory of constant elastic strain energy of distortion.

#### F. MIT Biaxial Tests

These tests were run on 2219-T87 parent metal only. One specimen was instrumented with strain gages (longitudinal and transverse) in the reduced section. The stress-strain data given in Appendix G are plotted in Figure A-16. The stress ratio, as a function of longitudinal strain, is presented in Figure A-17. Below the elastic limit, a stress ratio of the order of 6:1 was measured. As the test section became plastic, the stress ratio began to decrease. The stress ratio in the plastic region was calculated from the effective stress-effective strain curve developed previously. At 66,500 psi, the limit of the strain gages was reached. The stress ratio at this point was higher than the desired value of 2:1. It is not known if a 2:1 state was achieved prior to failure of the specimen.



LING-TEMCO-VOUGHT BIAXIAL DATA CONVERTED TO EFFECTIVE STRESS AND STRAIN FIGURE A-15.

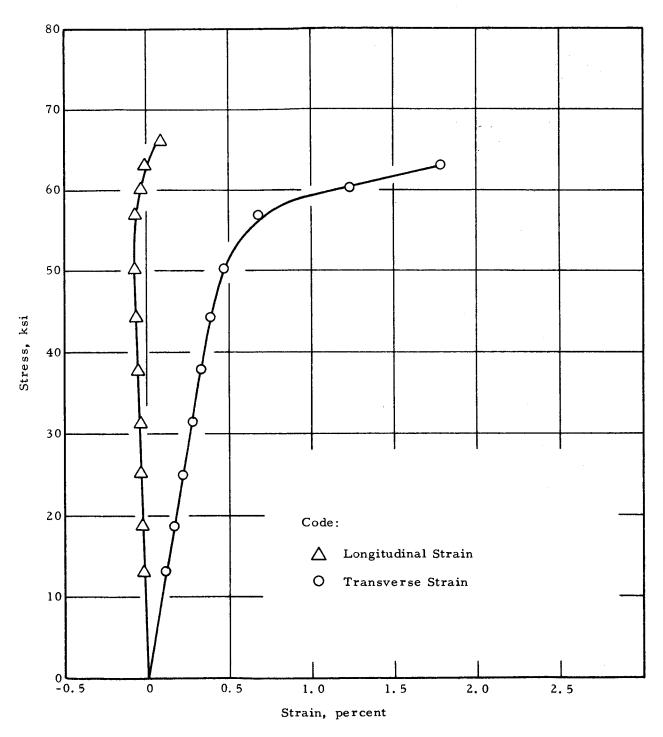


FIGURE A-16. STRESS-STRAIN DATA OBTAINED ON MIT SPECIMEN

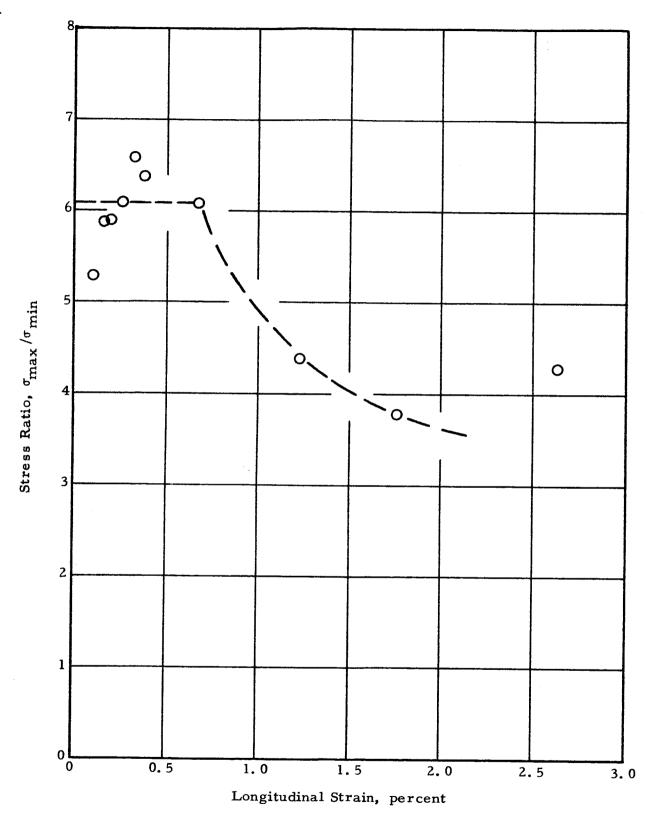


FIGURE A-17. STRESS RATIO IN MIT SPECIMEN AS A FUNCTION OF LONGITUDINAL STRAIN

## G. Summary of Biaxial Strength Results

The biaxial strength of 2219-T87 parent metal was determined by four test methods. The average results, along with the average uniaxial tensile strength and the biaxial-to-uniaxial strength ratios, are presented in Table A-4. As illustrated in Figure A-18, the biaxial-to-uniaxial strengths agree well with the maximum conserved distortion energy theory, which is a modification of the distortion energy theory to take into account the strain hardening properties of the material.

The mean biaxial strengths of the TIG weldments were determined by three methods, and the results are summarized in Table A-5. These results appear to agree better with the maximum stress theory than with the maximum conserved distortion energy theory that the parent metal specimens followed, as shown in Figure A-19.

It appears that no one test method stands out as being universally applicable for the measurement of biaxial properties. Each test has its advantages and disadvantages.

The circular hydraulic bulge test was found to be suitable for determining the 1:1 biaxial strength of both parent metal and weldments. The welds can be tested in full cross section or with the crowns and dropthroughs removed. A 2:1 stress state was not achieved with the elliptical die design investigated.

The cylinder test was successfully employed to study welds subjected to three stress ratios (1:1, 2:1, 1:0). Other stress ratios can be obtained. However, the aluminum alloys investigated typically produced undermatched welds, which made it difficult to get a parent metal failure.

The LTV test worked well at both 1:1 and 2:1 stress ratios on parent metal. The specimen design presently used has a machined test section and does not permit the testing of welds in full cross section.

The MIT test is limited to 2:1 stress ratio, and that can be achieved only if a large amount of plastic deformation occurs in the test section prior to failure. The machined test section used in this specimen results in the same limitations in testing welds that was encountered in the LTV specimen.

TABLE A-4. BIAXIAL AND UNIAXIAL ULTIMATE STRENGTH OF 2219-T87 ALUMINUM ALLOY

Test Method	Stress Ratio	No. of Biaxial Tests	Average Biaxial Strength	Biaxial/Uniaxial Ratios(a)
△ SwRI Bulge	1:1	3	66.4 ksi	1.01
O LTV Biaxial	1:1	3	62.2 ksi	0.95
■ SwRI Cylinder	2:1	1	70.7 ksi	1.08
• LTV Biaxial	2:1	3	71.1 kši	1.08
▲ MIT Biaxial	>2:1	5	71.5 ksi	1.09

<sup>(</sup>a) Uniaxial Tensile Strength of 2219-T87 = 65.8

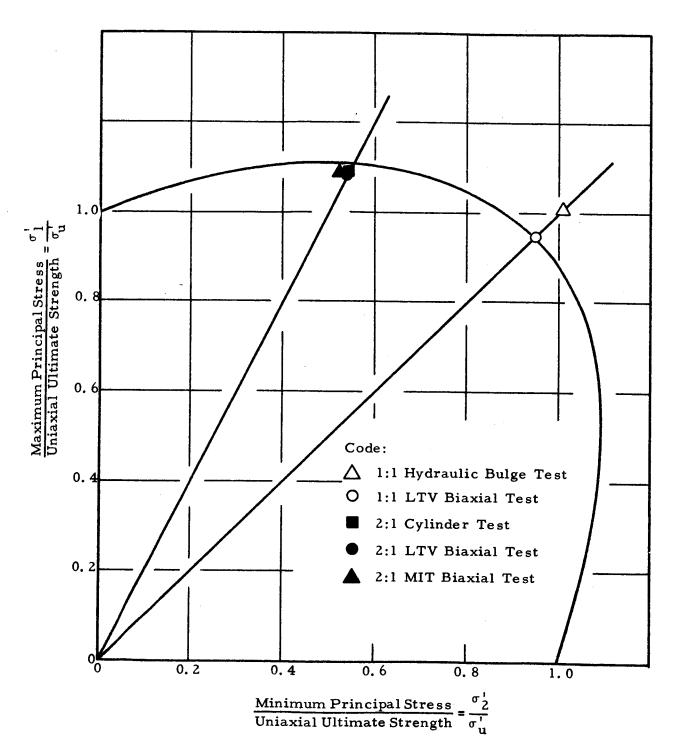


FIGURE A-18. COMPARISON OF MEAN BIAXIAL STRENGTH
OF 2219-T87 PARENT METAL WITH MAXIMUM
CONSERVED ENERGY THEORY (Work
Hardening Coefficient - 0.10)

TABLE A-5. BIAXIAL AND UNIAXIAL STRENGTH OF 2219-T87 ALUMINUM ALLOY TIG WELDED WITH 2319 FILLER

	Stress	No. of Biaxial	Average	Strength	Biaxial/Uniaxial
Test Method	Ratio	Tests	Biaxial	Uniaxial	Ratio
△ SwRI Bulge (Single Weld)	1:1	3	44.6	41.3	1.08
▲ SwRI Bulge (Cross Weld)	1:1	3	42.1	41.8	1.01
□ SwRI Cylinder (Single Weld)	1:1	3	38.7	40.1	0.96
O LTV Biaxial (Cross Weld)	1:1	3	41.4	37.2	1.11
■ SwRI Cylinder (Single Weld)	2:1	3	40.7	40.1	1.02
• LTV Biaxial (Cross Weld)	2:1	3	37.4	37.2	1.01

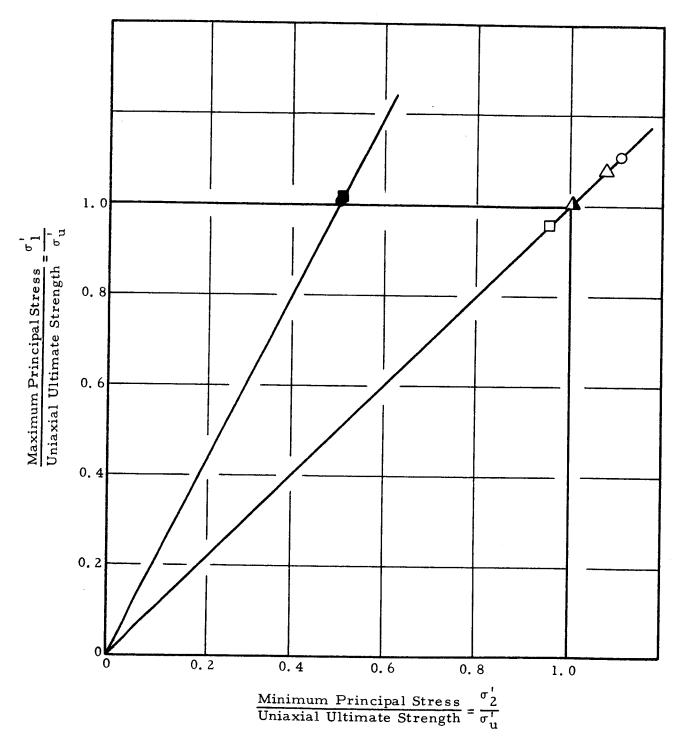


FIGURE A-19. COMPARISON OF BIAXIAL STRENGTH OF TIG 2219-T87 WELDMENTS WITH THE MAXIMUM STRESS THEORY

### APPENDIX B

EVALUATION OF THE MECHANICAL PROPERTIES OF ALUMINUM ALLOY SHEET AND WELDMENTS SUBJECTED TO UNIAXIAL AND BIAXIAL STRESS FIELDS (NAS8-20160, PHASE II)

# EVALUATION OF THE MECHANICAL PROPERTIES OF ALUMINUM ALLOY SHEET AND WELDMENTS SUBJECTED TO UNIAXIAL AND BIAXIAL STRESS FIELDS (NAS8-20160, PHASE II)

#### A. Introduction

This program consisted of a series of uniaxial tensile and circular hydraulic bulge tests on 1/8-inch 2219-T87, 2014-T6, and X7106-T63 parent metal and weldments. The hydraulic bulge test was chosen for biaxial load testing over the other test methods for the following reasons:

- (1) The welds were expected to have joint efficiencies low enough to make it difficult if not impossible to determine parent metal properties with the cylinder test.
- (2) It was desired to test the weld with bead and dropthrough intact. Both the LTV and MIT biaxial test specimens require a reduced test section which would necessitate machining a portion of the weld away.
- (3) Use could be made of data generated in NAS8-1529 to permit the application of statistics in the analysis of the results.

The primary emphasis was placed on fully heat treated parent metal and on welded panels in the naturally aged condition. A limited investigation into the properties of annealed panels and stress relieved panels of parent metal and weldments was also conducted. A summary of the complete test program is given in Table B-1.

All specimens were prepared and tested as described in Appendix E. Details of welding procedures and heat treatments for the three aluminum alloys are given in Appendix F.

# B. Properties of Fully Heat Treated Parent Metal and Naturally Aged Weldments

Three hydraulic bulge tests were conducted on each of three aluminum alloys - 2219-T87, 2014-T6, and X7106-T63. The membrane stress (PR/2t) was calculated as a function of the applied pressure. The maximum value of this stress, which usually occurred prior to specimen fracture, was taken as the ultimate biaxial strength. The results are listed in Table B-2. Also

TABLE B-1. PHASE II TEST PROGRAM (NAS8-20160)

					antity per Co	ndition
Alloy	Welding Process	Filler <u>Metal</u>	Weld Configurations	As <u>Welded</u>	Annealed(a)	Relieved(b)
2014-T6	None	-	-	3	1	1
2219-T87	None	-	-	3	1	1
X7106-T63	None	-	-	3	1	1
2014-T6	TIG	2319	Single	3	1	1
2014-T6	TIG	4043	Single	3	1	1
2014-T6	MIG	4043	Single	3	1	1
2219-T87	TIG	2319	Single	3	1	1
2219-T87	TIG	2319	Cross	3	-	-
2219-T87	MIG	2319	Single	3	1	1
X7106-T63	TIG	X5180	Single	3	1	1

<sup>(</sup>a) Annealing Heat Treatment: 775°F/2 hours/furnace cool to 300°F, air cool to RT.

<sup>(</sup>b) Stress Relief Treatment: 525°F/5 hours/air cool.

TABLE B-2. SUMMARY OF BIAXIAL AND UNIAXIAL STRENGTHS OF 2219-T87, 2014-T6, AND X7106-T63 PARENT METAL

		Biaxial			Unia	Uniaxial	
		Avg Ult			Avg Ult	Std	
Alloy	No. of	Str,	Min/Max	No. of	Str,	Dev,	99% LTL,
-	Tests	ksi	ksi	Tests	ksi	ksi	ksi
2219-T87	€.	66.4	64.5/67.4	15	65.8	0.71	63.3
2014-T6	3	74.2	72.9/76.0	15	70.4	1.26	0.99
X7106-T63	3	0.07	67.8/71.1	15	64.9	0.52	63.1

included in Table B-2 are the uniaxial strengths of each alloy. The average uniaxial and biaxial strengths are presented graphically in Figure B-1. Examination of this figure shows that 2014-T6 is somewhat stronger than either of the other two alloys. Also, the 2219-T87 material had a slightly higher uniaxial strength but a slightly lower biaxial strength than the X7106-T63 alloy.

The average value of the membrane stress as a function of  $(P)^{2/3}$  is presented in Figures B-2, B-3, and B-4 for 2219-T87, 2014-T6, and X7106-T63, respectively. As discussed in Appendix A, the linear dependence of the bulge panel stress on  $(P)^{2/3}$  in the elastic region was confirmed by stress analysis. This linear dependence does not hold in the plastic region; however, the relationship between stress and  $(P)^{2/3}$  may be established experimentally, thus providing a convenient method for evaluating weldments in which the ultimate strength of the weld exceeds the yield strength of the parent metal.

Three bulge tests and five uniaxial tensile tests were performed on each welding process/parent metal/filler metal combination in the as-welded (naturally aged) condition. The 2219-T87 and 2014-T6 weldments were tested approximately two weeks after welding. The X7106-T63 welded panels were naturally aged for six weeks before testing.

The biaxial strength of each welded panel was determined from the curves of Figures B-2, B-3, and B-4. The two-thirds power of the pressure at failure was calculated for each panel, and the stress was read from the appropriate curve. If the  $(P)^{2/3}$  value corresponded to a stress past the peak of the curve, the biaxial ultimate strength was taken as the maximum value of the curve.

The biaxial and uniaxial ultimate strengths obtained on welded panels are summarized in Table B-3. The average strength values of the naturally aged test panels, along with the range of individual results, are given in Figure B-5.

The TIG X7106-T63/X5180 weldments exhibited the highest uniaxial tensile strength (51.3 ksi) of all specimens tested. The TIG 2014-T6/2319, TIG 2014-T6/4043, and MIG 2014-T6/4043 welds had intermediate strengths, while the TIG 2219-T87/2319 specimens had the lowest (41.6 ksi).

On the basis of biaxial strength, the TIG X7106-T63/X5180 welds were again the strongest (48.4 ksi), followed in order by TIG 2014-T6/2319, TIG 2014-T6/4043, MIG 2319-T87/2319, TIG 2219-T87/2319, and MIG 2014-T6/4043 (40.5 ksi).

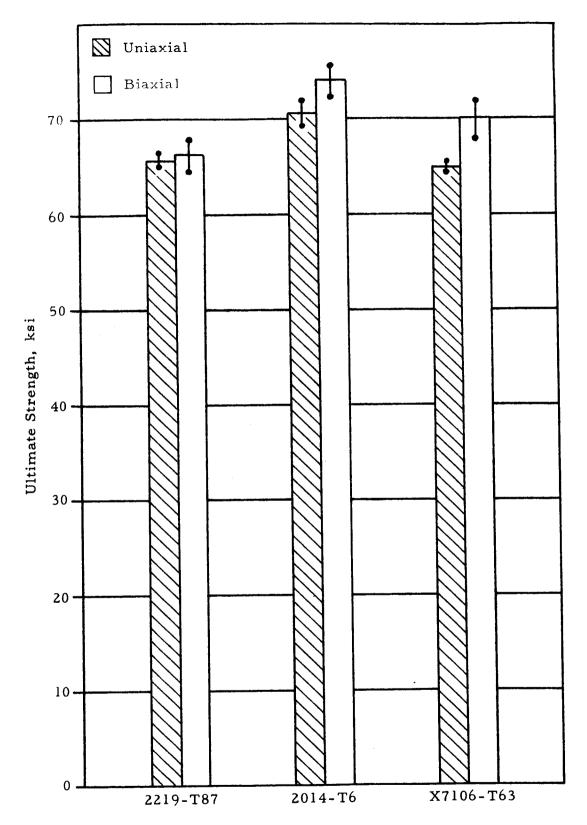
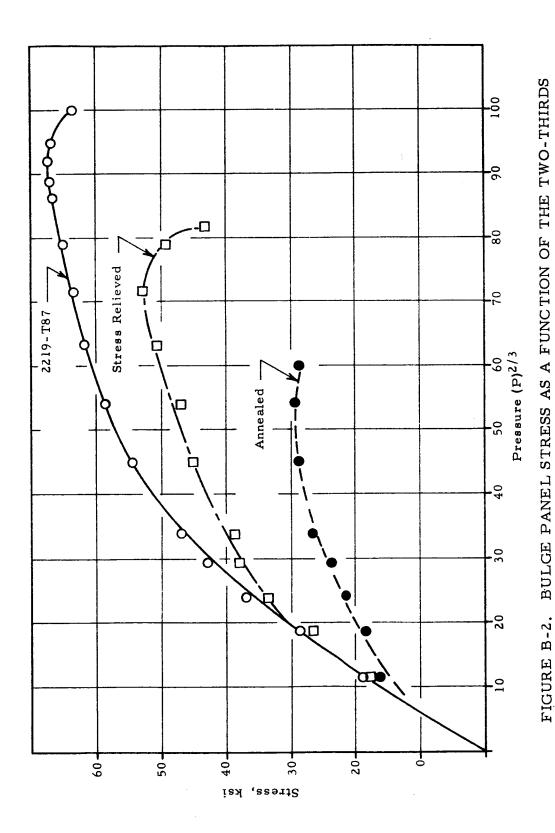


FIGURE B-1. THE BIAXIAL AND UNIAXIAL STRENGTHS OF 2219-T87, 2014-T6, AND X7106-T63 HIGH STRENGTH ALUMINUM ALLOYS



POWER OF THE APPLIED PRESSURE FOR 2219 ALUMINUM ALLOY

101

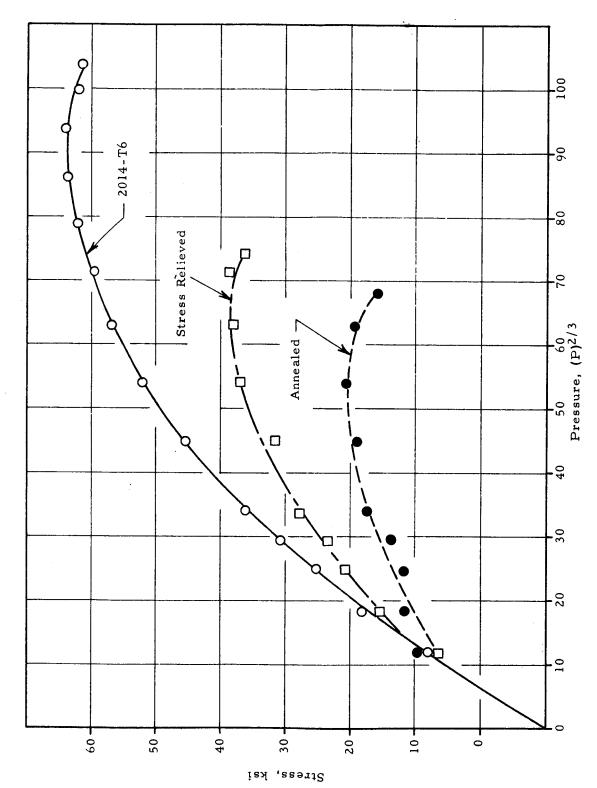


FIGURE B-3. BULGE PANEL STRESS AS A FUNCTION OF THE TWO-THIRDS POWER OF THE APPLIED PRESSURE FOR 2014 ALUMINUM ALLOY

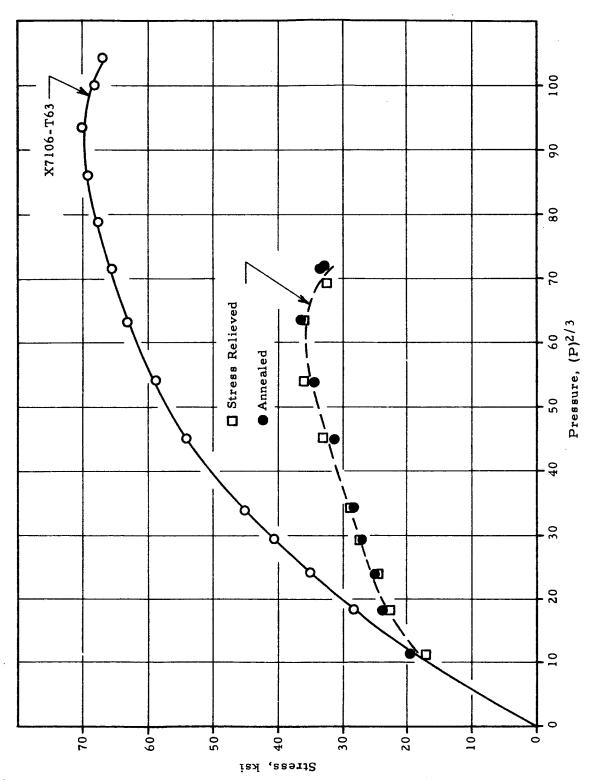
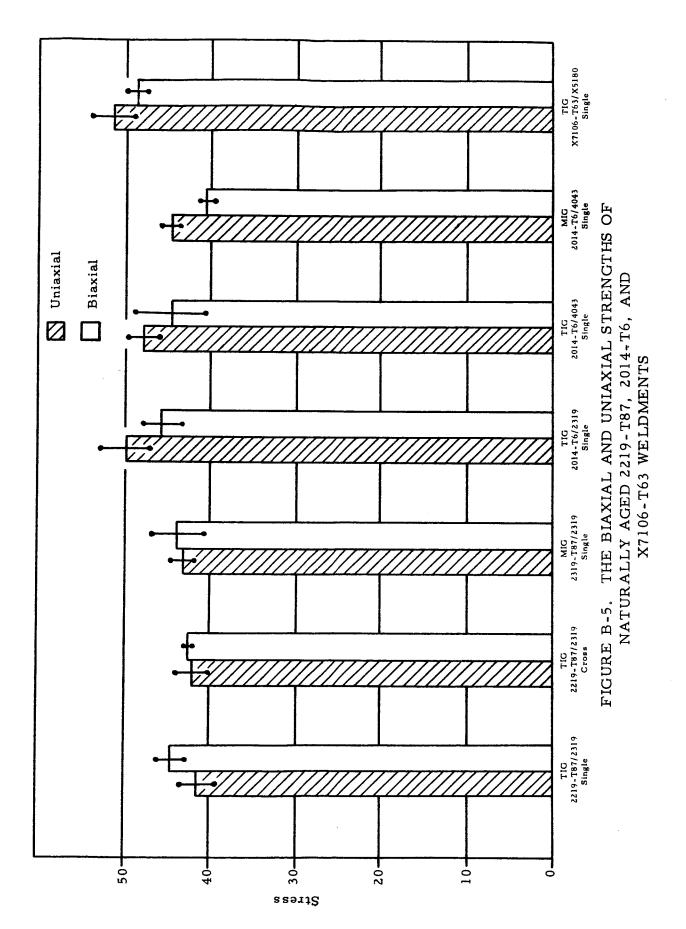


FIGURE B-4. BULGE PANEL STRESS AS A FUNCTION OF THE TWO-THIRDS POWER OF THE APPLIED PRESSURE FOR X-7106 ALUMINUM ALLOY

SUMMARY OF BIAXIAL AND UNIAXIAL STRENGTHS OF NATURALLY AGED 2219-T87, 2014-T6, AND X7106-T63 WELDMENTS TABLE B-3.

No. of Tests	Biaxial Avg Ult Str, ksi	Min/Max, ksi	No. of Tests	Uniz Avg Ult Str, ksi	Uniaxial ir, Std Dev, ksi	99% LTL, ksi
	44.6	43.8/46.0	30	41.3	1.97	35.2
	42.1	41.8/42.5	59	41.8	1.87	36.1
	43.7	40.6/46.6	15	43.0	1.35	38.3
	45.4	43, 1/47, 6	15	49.8	2.90	39.5
·	44.2	42.0/48.5	15	47.7	1.67	41.8
	40,5	39.7/41.2	15	44.7	1.06	40.9
	48.4	47.3/49.2	15	51.3	2.45	42.7



In Mod 6 of NAS8-1529, a large number of circular hydraulic bulge tests had been performed on 2219-T87 and 2014-T6 parent metal and weldments. In this program, the biaxial strengths had been calculated with the membrane stress formula (PR/2t)<sup>(4)</sup>. The biaxial strengths of the weldments were recalculated, using Figures B-2 and B-3, and the new results are given in Table B-4. The differences in the biaxial strengths of the single, tee and cross welds in each alloy system are of the same order of magnitude as the range of results. Therefore, the three types of configurations may be treated as a single group.

The data in Tables B-3 and B-4 were combined to calculate the mean, the standard deviation, and the lower tolerance limit of the biaxial ultimate strength of five parent metal/welding process/filler metal combinations. The results are given in Table B-5 and Figure B-6. Also included is the analysis of the uniaxial tensile data from both programs.

The combined uniaxial tensile test results essentially confirm the conclusions reached in the Fourth Annual Summary Report. Using the newly developed biaxial stress calculation procedure, the conclusions based on biaxial strength are somewhat different, however.

Agreeing with last year's conclusions, the TIG/2014-T6/4043 weldments were superior to the corresponding MIG weldments based on either the mean values or the lower tolerance limits of the uniaxial and biaxial ultimate strengths.

Also supporting the previous conclusions, the TIG/2014-T6/2319 weldments exhibited a uniaxial strength comparable to that of the TIG/2014-T6/4043 group. Contrary to last year's analysis, the biaxial strengths now confirm the similarity of the strengths of the TIG/2014-T6 welds using either filler metal.

Again agreeing with last year's conclusions, no significant differences were observed in the mean values of biaxial and uniaxial ultimate strengths of TIG and MIG 2219-T87/2319 weldments. The new results indicate that the lower tolerance limit of the biaxial strength of the TIG/2219-T87/2319 weldment is higher than the corresponding MIG weld rather than lower as previously reported.

Based on the mean values, the biaxial-uniaxial strength ratio of the welds are as follows:

TABLE B.4. SUMMARY OF BIAXIAL AND UNIAXIAL STRENGTHS OF 2219-T87 AND 2014-T6 WELDMENTS TESTED IN NAS8-1529, MOD 6

	99% LTL,	ksi		37.2			37.2			41.4			33.9			59.6	
Uniaxial	Std Dev,	ksi		2.20			1.91			2.84			4.74			4.14	
Ü,	Avg Ult	Str, ksi		43.5			42.7			50.0			47.9			42.1	
	No. of	Tests		48			46			32			39			37	
	Min/Max,	ksi	42.1/44.2	43.3/46.2	43.3/44.2	41.4/46.5	44.5/47.5	43.5/48.1	51.3/52.3	44.2/47.8	47.8/49.8	44.2/45.5	43.4/44.5	43.2/44.2	37.0/40.5	37.8/44.5	35.3/36.8
Biaxial	Avg Ult	Str, ksi	43.3	44.3	43.7	43.2	45.8	46.2	51.7	46.2	48.8	44.8	44.0	43.6	38.2	41.8	36.1
	No. of	Tests	3	3	3	3	8	4	3	33	2	2	3	3	8	3	3
	Weldment	Configuration	Single	Tee	Cross												
	We	Type	TIG	2219-T87	2319	MIG	2219-T87	2319	TIG	2014-T6	2319	TIG	2014-T6	4043	MIG	2014-T6	4043

TABLE B.5. COMBINED RESULTS OF FOURTH YEAR AND FIFTH YEAR UNIAXIAL AND BIAXIAL TESTS ON 2219-T87 AND 2014-T6 WELDMENTS

	99% LTL, ksi	36.1	37.8	41.8	36.2	32.3
Uniaxial	Std Dev, ksi	2.38	1.78	2.84	4.11	3.71
Un	Ult Str, ksi	42.7	42.8	49.9	47.9	42.9
	No. of Tests	78	61	47	54	25
	99% LTL, ksi	39.1	35.9	36.2	37.3	28.2
Biaxial	Std Dev, ksi	1.27	2.44	3,05	1.77	2.92
В	Ult Str, ksi	43.6	44.8	48.0	44. 1	39.1
	No. of Tests	15	13	11	11	12
	Weldment	TIG 2219-T87 2319	MIG 2219-T87 2319	TIG 2014-T6 2319	TIG 2014-T6 4043	MIG 2014-T6 4043

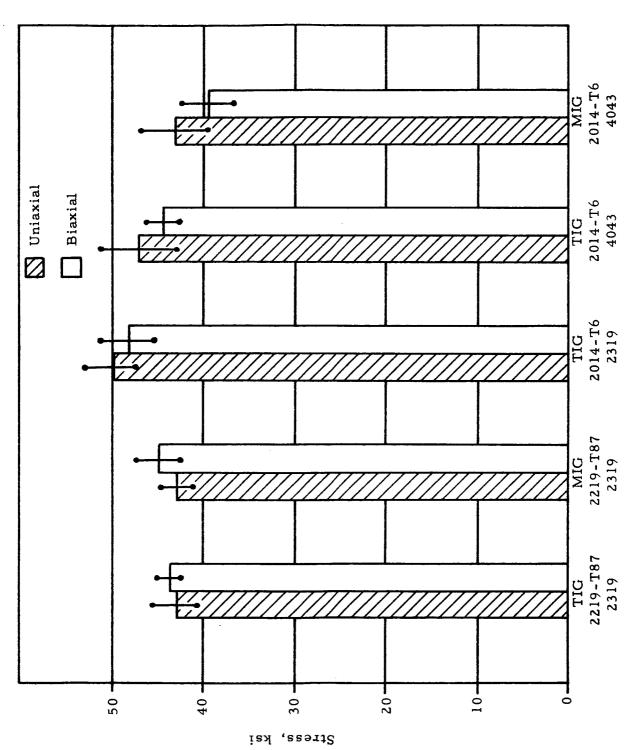


FIGURE B-6. THE BIAXIAL AND UNIAXIAL STRENGTHS OF 2219-T87 AND 2014-T6 WELDMENTS PRODUCED DURING THE FOURTH AND FIFTH YEARS OF THE PROGRAM

Combination	Biaxial/Uniaxial Strength Ratio
TIG/2219-T87/2319	1.02
MIG/2219-T87/2319	1.05
TIG/2014-T6/2319	0.96
TIG/2014-T6/4043	0.92
MIG/2014-T6/4043	0.91

This indicates that for 2014-T6/4043 and 2219-T87/2319 welds, the welding process had no significant effect on the biaxial/uniaxial strength ratio.

### C. Effect of Annealing and Stress Relief Heat Treatments

One circular bulge test and five uniaxial tensile tests were performed on each weldment in each heat-treated condition. This sample size was selected to provide preliminary trend information only.

The properties of the annealed and stress relieved panels are given in Table B-6. It can be seen that, with one exception, the annealed weldments had essentially the same uniaxial and biaxial properties as the annealed parent materials. The exception was the MIG 2014-T6/4043 weld. Although its uniaxial strength was comparable, the biaxial strength of this panel was approximately 80 percent of all other annealed 2014 specimens.

Although the stress relieving treatment overaged all three parent metals, thus reducing their strength, the effect of this treatment on the strength of the welds was quite varied. The uniaxial strengths of the TIG and MIG 2219-T87/2319 welds were slightly increased although the biaxial strengths were not affected. The biaxial and uniaxial strengths of the TIG 2014-T6/2319 and the TIG 2014-T6/4043 specimens were essentially unaffected. The biaxial strength of the MIG 2014-T6/4043 weldment was reduced even though the uniaxial strength was not changed. The properties of the TIG X7106-T63/X5180 welds were reduced to the same level as those which were annealed.

TABLE B-6. BIAXIAL AND UNIAXIAL PROPERTIES OF ANNEALED AND STRESS RELIEVED 2219-T87, 2014-T6, AND X7106-T63 PARENT METAL AND WELDMENTS

		Bia	Biaxial		Un	Uniaxial	
	Heat	No. of	Ult Str,	No. of	Ult Str,	Std Dev,	99% LTL,
Panel Type	Treatment(a)	Tests	ksi	Tests	ksi	ksi	ksi
2219	Ann	7	29.5	J.	30.8	0.46	28.2
2014	Ξ	~	30.4	5	29.8	0.30	28.0
X7106	=	-	35.9	5	35.0	0.17	34.1
TIG/2219-T87/2319	Ξ	~	29.3	5	30.7	0.13	30.0
MIG/2219-T87/2319	Ξ	_	29.5	5	33.1	0.34	31.1
TIG/2014-T6/2319	Ξ	7	30.4	Ŋ	29.6	0.19	28.4
TIG/2014-T6/4043	Ξ	4	30.4	ĸΩ	29.4	0.11	28.8
MIG/2014-T6/4043	=		24.7	ις.	29.6	0.21	28.4
TIG/X7106-T63/X5180	=	-	35.9	Ŋ	35.0		32.6
2219	$_{ m SR}$	_	53.1	Ŋ	56.5	0.67	52.6
2014	Ξ	-	48.5	72	51.6	0.68	47.7
X7106	Ξ	~	35.7	гU	39.4	0.37	37.3
TIG/2219-T87/2319	Ξ	_	44.0	Ŋ	50.1	1.26	42.9
MIG/2219-T87/2319	Ξ	_	44.0	Ŋ	48.3	0.42	45.8
TIG/2014-T6/2319	Ξ	_	44.5	ıΩ	47.0	1.01	41.2
TIG/2014-T6/4043	=	-	41.7	rU	47.4	0.51	44.5
MIG/2014-T6/4043	Ξ	-	32.7	Ŋ	44.4	1.05	38.3
TIG/X7106-T63/X5180	Ξ		35.7	ιC	39.5	0.15	38.7

(a) Ann: Heat to 775°F, hold 5 hours, furnace cool to 300°F, air cool to RT. SR: Stress Relief Treatment; 525°F/5 hours/air cool.

### APPENDIX C

INVESTIGATION OF THE WELDABILITY OF X7106-T63 ALUMINUM ALLOY (NAS8-20160, Phase III)

## INVESTIGATION OF THE WELDABILITY OF X7106-T63 ALUMINUM ALLOY

One phase of the program conducted under Contract NAS8-20160 was organized to evaluate the weldability of X7106-T63 aluminum alloy. This program included an investigation of the natural aging characteristics of weldments of this alloy and a study of the susceptibility of such weldments to hot cracking. The investigation of the natural aging characteristics was carried out on MIG and TIG weldments of X7106-T63 sheet and plate in 0.187 inch, 0.50 inch, and 1.00 inch thicknesses made with three potentially applicable filler metals. The crack susceptibility tests were performed on special specimens of 0.125-inch sheet designed to provide varying restraint along the length of the test weld. These tests also utilized three different filler metal alloys.

### A. Natural Aging Characteristics of X7106-T63 Weldments

The program to establish the natural aging characteristics of X7106-T63 weldments consisted of a series of uniaxial tensile tests and hardness measurements on weldments of three thicknesses aged for periods of up to 12 weeks. The combinations of plate thickness, welding process, filler metal, and joint configuration included in this phase of the program are listed in Table C-1. For this portion of the program, welded panels were presented to provide the necessary tensile specimens and hardness test specimens (see Appendix E). Welding procedures were developed for each type of weldment by preparing various weldments with a range of welding parameters. In each case, selection of the final procedure was based on weld bead appearance and radiographic inspection. Details of the welding processes and inspection procedures employed in fabrication of the test panels are described in Appendix F. The final procedures adopted for each type of X7106-T63 weldment are listed as procedures 65A-2 through 65A-23 in Table F-1.

Results of the individual tests conducted in this portion of the program are listed in Appendix J. In summarizing these results, standard deviations and lower tolerance limits were computed by the procedures described in Appendix K.

### 1. 0.187-Inch X7106-T63 Weldments

The study of the aging characteristics of 0.187-inch X7106-T63 weldments included both MIG and TIG weldments made with X5180, 5356, and

TABLE C-1. PHASE III WELDMENTS

Plate Thickness	Welding Process	Joint Configuration	Filler Metal
	TIG	Sq Butt	
0.187 Inch			
	MIG	Sq Butt	
		Sq Butt	
	TIG		-
0 50 In ab		Double V*	X5180 5356
0.50 Inch			5556
	MIG	Double V*	_
	TIG	Double V*	
1,00 Inch	•		-
	MIG	Double V*	

<sup>\*</sup>Joint Configuration in Accordance with NASA SP-5009

5556 filler alloys. All welds in this portion of the investigation were made with square-butt joints.

In general, all types of 0.187-inch weldments exhibited similar aging behavior. Increases in ultimate strength and yield strength in the order of 20 percent of the as-welded values were observed for the 0.187-inch weldments after aging periods of 12 weeks. The typical aging characteristics of this group of weldments are illustrated in Figure C-1. The results of the tensile tests conducted on the 0.187-inch weldments are summarized in Tables C-2 and C-3. The average tensile properties of the weldments after an aging period of 12 weeks are presented in Figure C-2.

Among the six types in this group, the MIG/X5180 weldments exhibited the highest average ultimate strength (56.8 ksi). The average ultimate strengths of the TIG/X5180, MIG/5356, and MIG/5556 weldments were comparable (54.7 to 55.6 ksi) and slightly lower than that of the MIG/X5180 weldments. The TIG/5356 and TIG/5556 weldments exhibited the lowest ultimate strengths measured for this group (52.8 and 53.5 ksi, respectively). It should also be noted that the degree of scatter in the measured values of ultimate strength for the MIG/X5180 weldments was lower than that of any of the other weldments in this group. As a result, the MIG/X5180 weldments also exhibited the highest value of the computed lower tolerance limit of ultimate strength (see Table C-3). The TIG/X5180 weldments and all three types of MIG weldments had comparable yield strengths (39.9 to 40.3 ksi). The average yield strengths of the TIG/5356 and TIG/5556 weldments were somewhat lower than those of the others in this group (37.9 and 38.9, respectively).

In the fabrication of the test panels, more difficulties were encountered with the MIG process than with the TIG. In general, the MIG weldments were subject to more rejectable defects than were the TIG weldments. The bead configuration produced by the MIG process was less desirable and more difficult to control than that of the TIG weldments. In addition, the tensile test results indicate only small differences between the average ultimate strengths of the MIG/X5180 and TIG/X5180 weldments. Thus, taking the above factors into consideration, the TIG process, using X5180 filler wire, may be considered as the optimum process for welding the 0.187-inch sheet material.

### 2. 0.50-Inch X7106-T63 Weldments

The investigation of the tensile properties of 0.50-inch X7106-T63 weldments was conducted utilizing a double-V joint configuration for the MIG welds and both double-V and square-butt joints for the TIG welds. The two joint configurations were employed for the TIG weldments to establish

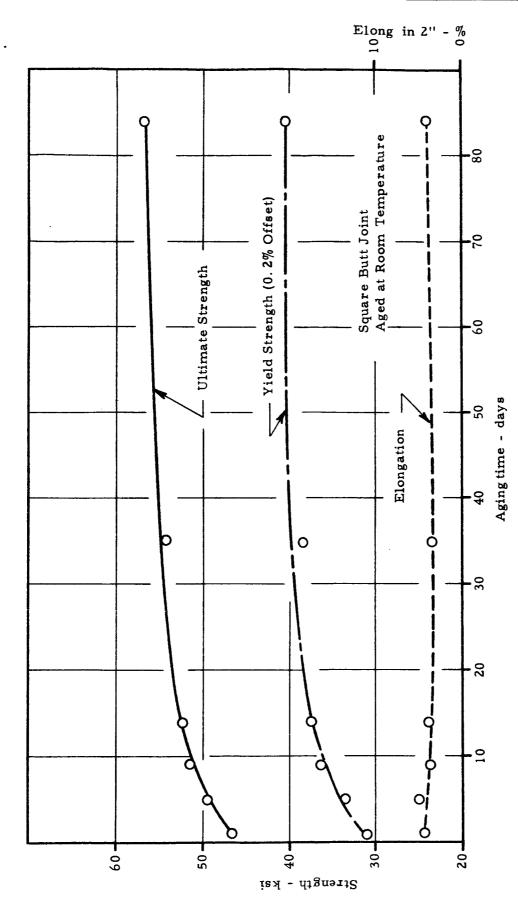


FIGURE C-1. TENSILE PROPERTIES OF 0.187-INCH MIG X7106-T63/X5180 WELDMENTS (Aging Characteristics Typical of 0.187-Inch Weldments Included in Study.)

TABLE C-2. SUMMARY OF TENSILE PROPERTIES OF 0.187-INCH TIG-X7106 WELDMENTS

				Yield St	Yield Strength <sup>(1)</sup>			Ultimate	Strength	h	Elongation in	ion in 2 in.	
Weldment	Panel	Aging	No. of	Avg.	$S_{y}(2)$	LTL(3)	No. of	Avg.	(2) S	LTL(3)	Avg.	1 (	
Туре	No.	Time	Tests	ksi	ksi	ksi	Tests	ksi	ksi	ksi	₽ <sub>6</sub>	) <sub>F</sub> _	
		l day	9	29.3	1.39	22.2	9	+3.2	1.52			0 47	
7		3 days	9	32. 4	0.45	30.1	9	47.2	1.08	41.7			
11G-X/106	· ·	1 week	9	33.1	0.08	27.6	9		1.12		3.3	0.57	
00100	1-010	2 weeks	9	36.0	1.17	2.62	9	51.1	1.71	45.4		0.73	
nna ·be		5 weeks	9	38. +	0.88	34.0	9		1.51			0.39	
		12 weeks	9		0.99	35.3	9	55.6	1.15	49.8		0.29	
		l day	9	29.1	0.71	25.5	9		0.80	39.1		0.72	
70123 211		3 days	9	31.7	1.63	30.8	9	46.5	1.02	+1.+	3.2	0.54	_
11G-A1100	- H	l week	9	32.8	1.00	27.7	9	47.2	1.13	41.5		0.24	
S. Butt	1-+1)	2 weeks	S	34.3	0.73	30.1	9	49.3	1.16	43.4	3.2	0.28	
od: pari		5 weeks	9	36.6	0.43	34. +	9		1.11	45.7	ب	0.35	_
		12 weeks	9	37.9	0.91	33.3	9	52.8	1.19		3.4	99.0	
		l day	9			6.47	9	43.4	1.54			0.66	
70125 714		3 days	9	33. 4	1.55	25.6	9	+ : ; +	1.85	38.0	2.9	0.49	_
001/4-511	i.	l week	9		1.08	27.1	9	47.4	1.65			0.83	
0000	C 15-5	2 weeks	9		1. 48	28.8	9	50.9	1.96			0.38	
od. butt		5 weeks	.c	37. 4	0.53	34.8	9	51.8	1.23			0.28	
		12 weeks	9		1.39	31.8	9	53.5	1.36			1.10	

 <sup>0.2%</sup> Offset
 Standard Deviation
 9% Lower Tolerance Limit (95% Confidence)

TABLE C-3. SUMMARY OF TENSILE PROPERTIES OF 0.187-INCH MIG-X7106 WELDMENTS

Weldment Fa				Yield St	Yield Strength <sup>(1)</sup>			Iltimate		th	Elongation	in 2
•	Panel No.	Aging Time	No. of Tests	Avg. ksi	S <sub>y</sub> (2) ksi	$_{ m LTL}^{(3)}$	No. of Tests	Avg. ksi	S <sub>u</sub> (2) ksi	LTL(3) ksi	Avg. %	Se(2)
		1 25.55	4	1 .			9					
		ו מפא) ה היפה ה		33.6			9					
MIG-X7106		o days	) <b>.</b> c	36. 4	0.54	33.7	9	51.3	69.0	47.8	3.5	0.50
	CM3-1	, ureelts	9 49				9					
tt		5 weeks	) vc	38.6			9		-			-
<del>,</del>		12 weeks	9			37.3	9					. 1
		1 day	9	31.1	0.62	28.0	9	46.4	1.29			0.74
		מאפר ת	, 40	33, 1	0.20	32.1	9		1.27			-
MIG-X7106		s van o	9	34.6	1.1+	28.8	80					
5356 C	CM4-1	Sydow (	9	35.7	09.0		9	51.7				-
Sq. Butt	-	5 weeks	9	37.0	0.56	34.2	9	52.8	96.0	47.9	3.4	0. 49
		12 weeks	9	39.3	99.0	36.0	9	54.8	•	_	-	-
		yeb 1	9	31.2		26.6	9	Ι.	0. 44			0.37
		5 days	9	33, 5		31.1	9	48.5	1.47	41.0	<del>-</del>	
MIG-X7106	_	o days	9	36.1		26.1	9	50.8	1.15			
	CM5-2	) wante	~ 4			35.3	9	51.4				
b11#		i week	) <u>.</u>	37.3		34.5	9					
	•	2 weeks 12 weeks	9		0.52	37.2	9			49.4		

<sup>(1) 0.2%</sup> Offset
(2) Standard Deviation
(3) 99% Lower Tolerance Limit (95% Confidence)

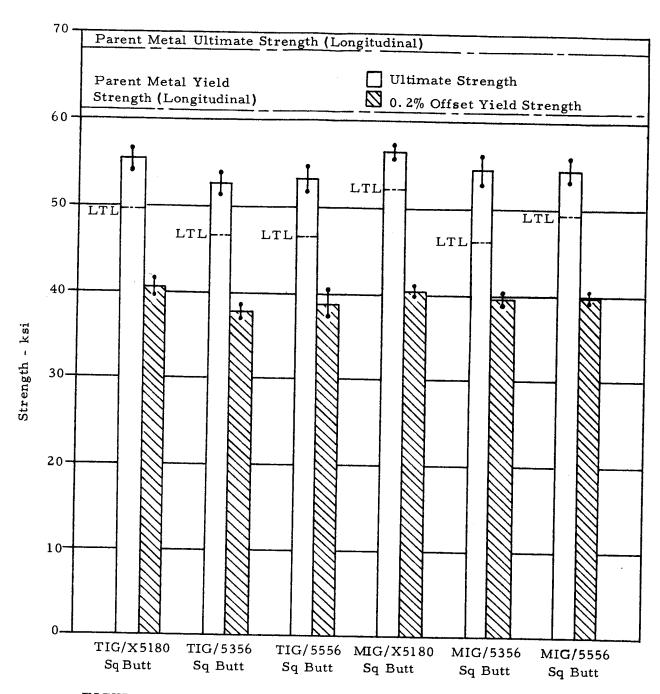


FIGURE C-2. TENSILE PROPERTIES OF 0.187-INCH TIG AND MIG X7106-T63 WELDMENTS AGED TWELVE WEEKS (Parent Metal Data from Ref. 4.)

any effect that dilution of the weld metal may have on the tensile properties of the weldments. Three filler wire alloys, X5180, 5356, and 5556, were used for the fabrication of the test panels.

The typical aging behavior of the 0.50-inch weldments is illustrated in Figure C-3. In this group of weldments, the maximum ultimate strength was attained after an aging period of approximately 30 days. Beyond this aging time, no significant increases in ultimate strength were noted. The tensile properties of each type of 0.50-inch weldment investigated in this portion of the program are summarized in Tables C-4 and C-5. The average ultimate strengths and yield strengths, measured after an aging period of 12 weeks, are plotted in Figure C-4.

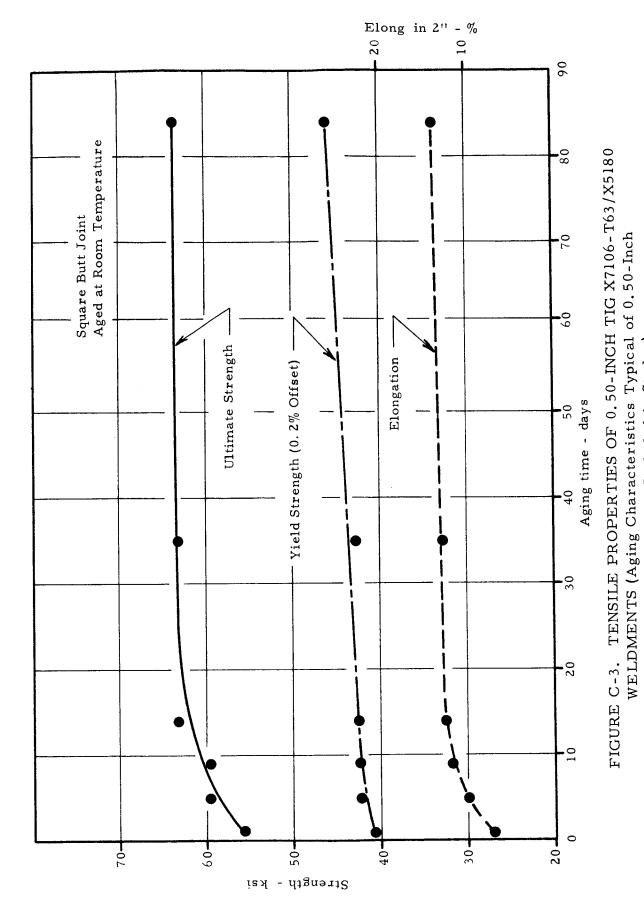
Of all the 0.50-inch weldments tested, the TIG weldments exhibited average ultimate strengths slightly higher than or comparable to that recorded for the strongest MIG weldments (52.4 to 53.5 ksi). Within the group of TIG weldments, the ultimate strengths were comparable, regardless of joint design or filler wire alloy. The ultimate strengths of the MIG/X5180 and the MIG/5556 weldments were comparable (52.2 and 51.9 ksi) while the MIG/5356 weldments exhibited an average ultimate strength approximately 2.0 ksi lower than the other two 0.50-inch MIG weldments.

Comparison of the average tensile properties presented in Figure C-4 shows that the average yield strengths of all but three of the 0.50-inch weldments are comparable (34.8 to 36.7 ksi).

The two TIG double-V weldments made with 5356 and 5556 filler alloys exhibited average yield strengths somewhat lower than those of six types (34.2 and 33.5 ksi) while the average yield strength measured for the MIG/5356 weldments was significantly lower than all other types (29.7 ksi).

As was the case for the 0.187-inch X7106-T63 sheet, the TIG process produced the best results from the standpoint of bead appearance and control of welding parameters. In addition, the MIG weldments, though acceptable according to the inspection procedures employed, exhibited a larger number of defects than did the TIG welds. In particular, a considerable amount of microporosity, undetected by radiographic inspection, was evident on examination of the fracture surfaces of the MIG weldments.

On the basis of both mechanical properties and general weld-ability, the results of this study indicate that the TIG process (using any of the three filler alloys included in the study) produces the optimum results in welding 0.50-inch X7106-T63 plate. Since only slight differences were observed between the TIG square-butt and the TIG double-V weldments, the square-butt joint is the most suitable of the two due to the relative simplicity of joint preparation.



Weldments Included in Study.)

122

TABLE C-4. SUMMARY OF TENSILE PROPERTIES OF 0.50-INCH TIG-X7106 WELDMENTS

Weldment	Danel	Agina		Yield Strength <sup>(1</sup>	ength(1)		Б	Ultimate	Strength		Elongation in	ion in 2 in.
Type	No.	Time	No. of	Avg.	S <sub>y</sub> (2)		No. of	pin.	(2) nS	_		$S_{\rm e}(z)$
			Lests	ksi	ksı	ksi	Tests	ksi	ksi	ksi	%	%
		1 day	4	8.97	0.19	26.6	ιc	45.8	0.28	44. 2	10.7	0.63
TTC: <b>V</b> 7106		5 days	<b>+</b>	59.6	0.67	29.3	īΩ	49.6		44.4	12.2	1.42
VE180	7.73	9 days	ī,	31.7	0.37	29.5	5	49.8		40.8		
7010V	7-610	2 weeks	ナ	32.1	0.33	31.7	+	53.3	1.50	51.2		0.93
nna ·he		5 weeks	τ.	34.6	0.27	33.0	'n	53.3		50.8		
		12 weeks	5	35.8	0. 48	33.0	2	53.5		48.0	13.1	
		1 day	9	26.3	0.45	24.1	9	45.1	0.58	42.2	9.1	
7012		5 days	9	30.0	<b>†9.0</b>	8.97	9	18.7	0.37	46.8	8.6	0.72
11G-A 1100	C I I	9 days	9				9		0.67	46.3		
0000 1	3:41)	2 weeks	9		0.34	30.0	9		0.34	49.5	10.9	
aq. putt		5 weeks	9	33.2		_	9	9.79	0.24	51.4		
		12 weeks	9	35.1	0.27	33, 7	9	53.0	0.65	49.7	12.7	
		l day	9	8.97	0.61	23.7	9	45.4	0.78	41.4	8.9	0.72
( ) ( ) ( ) ( ) ( ) ( ) ( ) ( ) ( ) ( )		5 days	9	30.3	0.25	29.1	9	48.8	-	45.1	9.4	0.55
0017 <b>4-</b> 211	į	9 days	9		0.40	28.3	9			47.1	9.8	0.62
3330	0.13-6	2 weeks	9	30.8	0.39	8.87	9	49.5	1.19			1.94
og. Butt		5 weeks	9	34.1	1.08		'n		-	48.3	11.5	2.07
		12 weeks	9	35.0	0.46	32.7	9	53.2	1.14			1.14

<sup>(1) 0.2%</sup> Offset
(2) Standard Deviation
(3) 99% Lower Tolerance Limit (95% Confidence)

TABLE C-4. SUMMARY OF TENSILE PROPERTIES OF 0.50-INCH TIG-X7106 WELDMENTS (Cont'd)

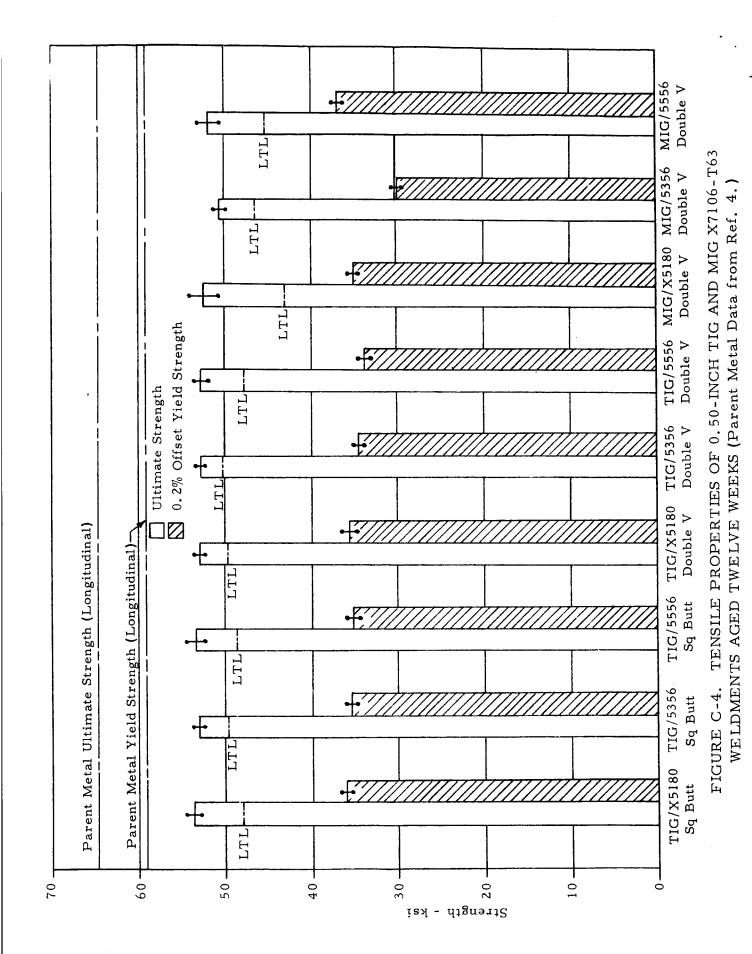
				Yield Strength	$-$ ength $^{(1)}$			Ultimate	e Strength	gth	Elongation	on in 2 in.
Weldment	Panel	Aging	No. of	Avg.	$S_{v}^{(2)}$	$LTL^{(3)}$	No. of	Avg.	$S_{u}^{(2)}$	$\Gamma^{\mathrm{LL}(3)}$	Avg.	S
Type	No.	Time	Tests	ksi	ksi	ksi	Tests	ksi	ksi	ksi	%	%
		3 days	9	58.9	0.85	24.6	9	47.8	0.54	45.0	8.9	0.73
70 11		5 days	9	30.5	0.33	28.8	9		0.43	47.4	8.7	0.34
11G-A/106	E	10 days	9	34.1	0.51	31.6	9	52.0		50.1	8.7	0.34
081cX	C I 2- #	17 days	9	34.6	1.07	29.5	9	52.5	0.24	51.2		0.39
Double v		5 weeks	9	34,4	0.46	32.1	9				9.3	0.77
		12 weeks	9	35.2	0.94	30.4	9	52.8	0.60	49.8	9.4	1.18
		3 days	9	28.6	0.35	8.97	9	47.7	0.43	45.5	6.8	0.73
		5 days	9	30.3	1.01	25.1	9	48.8	0.46	46.5	8.7	0.56
TIG-X7106		10 days	9	33.8	1.42	9.97	9	51.0	0.31	46.4	9.5	0.43
5356	CT4-4	17 days	9	34.1	0.48	31.7	9	51.5	0.62	48.3	6.7	0.44
Double V		5 weeks	9		0.51	30.2	9			50.5	9.4	0.79
		12 weeks	9	34.2	0.50	31.7	9	52. 4	0.45	50.5	9.7	0.43
		3 days	9	28.5	0.50	0.97	9	48.1	0.58	45.1	8.7	0.77
		5 days	9	8.67	0.42	27.7	9	49.5	0.23	48.3		0.32
TIG-X7106	;	10 days	9	33.6	0.40	31.6	9	51.3	0.39	46.4	8.6	
5556	CT5-8	17 days	9		0.27	33.0	9	51.5		<b>49.</b> 1	9.6	0.20
Double V		5 weeks	9	32.6		30.0	9	51.9	0.52	49.3		
		12 weeks	9	33.5	0.68	30.1	9	52.6	0.91	48.0	9.4	0.86

 <sup>0.2%</sup> Offset
 Standard Deviation
 99% Lower Tolerance Limit (95% Confidence)

TABLE C-5. SUMMARY OF TENSILE PROPERTIES OF 0.50-INCH MIG-X7106 WELDMENTS

	,			Yield Strength(1)	ength(1)		U	Ultimate Strength	Strengt		Elongati	Elongation in 2 in.
Weldment Type	Panel No.	<b>Ag</b> ing Time	No. of Tests	Avg. ksi	S <sub>y</sub> (2) ksi	$_{ m LTL}^{(3)}$	No. of Tests	Avg. ksi	S <sub>u</sub> (2) ksi	$_{ m LTL}^{(3)}$	Avg.	S <sub>e</sub> (2)
70.124 2.14		l day 4 days	9	26. <del>1</del> 30. 5			9	44.8			ı	
MLG-X/106 X5180 Double V	CM3-2	1 week 2 weeks 5 weeks	999	30. 7 31. 6 32. 5	0.29	29.2 29.8 30.4	9 9 9	47.3 50.3 51.2	2.84 1.08 1.25	33.0 44.9	8.3	1.60 0.95 1.81
		12 weeks	9	3.4.8		32.1	9	- 1	1.80	43.1	. 1	1.41
		l day 4 days	9	2+.1 25.5		21.7	9 2	44.3		41.4		0.49
MIG-X7106 5356	CM4-2	l week	9			22.6	9 \					0.85
Double V		5 weeks 5 weeks 12 weeks	9	28.1 28.1 29.7	0.49	25.6 25.4 27.4	0 0 0	48.7 50.2	1.46	45. 9 41. 3 46. 4	7.5	0.63
		l day 6 davs	9	28.7	0.63	25.5	9 '-				1	
MIG-X7106 5556	CM5-1	9 days 2 weeks	9	32.3 32.7	0.29	30.9 29.2	9	48.0 48.3	0.81	43.9 43.8	7.9	0.30
Double V	•	5 weeks 12 weeks	9		0.61	34.4	9 9					

 <sup>0.2%</sup> Offset
 Standard Deviation
 99% Lower Tolerance Limit (95% Confidence)



### 3. 1.00-Inch X7106-T63 Weldments

The study of the aging characteristics of 1.00-inch X7106-T63 weldments was conducted on panels fabricated by the MIG and TIG processes using X5180, 5356, and 5556 filler alloys. A double-V joint configuration was employed for all test panels in this portion of the program.

In general, the 1.00-inch weldments exhibited less significant increases in strength than did the thinner materials. Increases in ultimate strength of up to approximately 14 percent were noted for this group. Typical aging data for the 1.00-inch weldments prepared by each of the two processes (TIG and MIG) are shown in Figure C-5.

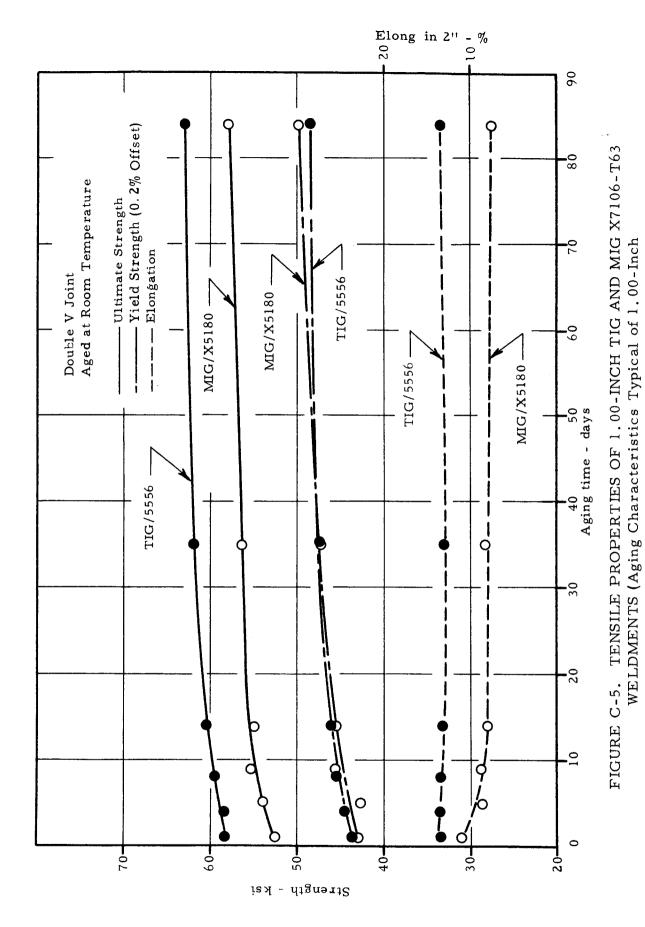
The tensile properties, as a function of aging time, are summarized in Tables C-6 and C-7 and the average tensile properties after an aging period of 12 weeks are presented in Figure C-6.

Figure C-6 presents the average tensile properties of the 1.00-inch weldments after an aging period of 12 weeks. The TIG weldments, as a group, exhibited average ultimate strengths higher than those of the MIG weldments (48.2 to 52.8 ksi for TIG weldments as compared to 44.2 to 47.7 ksi for MIG weldments). The average ultimate strength of the TIG/5556 weldments (52.8 ksi) was significantly higher than that of any of the MIG weldments. Among the TIG welds, those made with 5556 filler alloy also exhibited the highest value of average yield strength (38.5 ksi). In general, the various MIG weldments exhibited yield strengths either comparable to or slightly higher than those of the TIG weldments.

In welding the 1.00-inch test panels, the TIG process again produced the best results when judged by bead appearance and ease of control. This fact, coupled with the mechanical properties of the various weldments, clearly indicates that of the processes investigated, the TIG process utilizing filler alloy 5556 produces the optimum results for this thickness. It should be noted that the 1.00-inch weldments represent the only case where significant differences were noted between the mechanical properties of weldments prepared by the TIG process and those prepared by the MIG process.

#### B. Tensile Test Failure Location

In the previous study of the aging characteristics of 0.090-inch X7106-T63 weldments<sup>(4)</sup>, it was observed that after aging periods of one week or longer the majority of tensile specimens in any group failed in the heat-affected base metal rather than in the weld metal. This observation indicated that natural aging resulted in a weld deposit (crown intact) with a higher ultimate strength than the adjoining heat-affected base metal where some



Weldments Included in Study.)

128

TABLE C-6. SUMMARY OF TENSILE PROPERTIES OF 1.00-INCH TIG-X7106 WELDMENTS

				Yield Strength(1	ength(1)			Ultimat	Ultimate Strength	rth	Elongatic	Elongation in 2 in.
W cldment Type	Panel No.	Aging Time	No. of	Avg.	S <sub>y</sub> (2)	$_{ m LTL}^{(3)}$	No. of	Avg.	S <sub>u</sub> (2)	$_{ m LTL}^{(3)}$	Avg.	S <sub>e</sub> (2)
			1 63 63	K81	KB1	K81	lests	K91	K81	ksi	" <sub>0</sub>	مُ <u>'</u> ہ
		1 day	9	30.2	0.83	26.0	3	44.3	2.17	4	16.6	0,60
TIC. <b>Y</b> 71.06		4 days	9	32.0	0.95	27.2	6		99.0	4	13.5	(5)
X5180	£ ± 5	8 days	9	33.5	1.22	27.1	6	46.9	1.18	(4)	15.3	(9)
Touch V		2 weeks	9	34.4	0.83	30.2	3		1.27	(4)	16.7	(9)
nonne v		5 weeks	9	34.4	0.59	31.4	m		0.93	4	(2)	
		12 weeks	9	35.6	1.20	29.5	m	18.5	1.07	(4)	(2)	
		36 hours	9	31.4	0.77	27.6	5	46.1	0.52	43.1	14.9	0.49
TTC. X7106		5 days	9	32.7	9.40	30.4	5	46.8	0.65	43.0	14.3	1.71
5356	CT4.3	9 days	9	34.0	0.20	33.0	9	47.6	0.93	42.9	14.4	1.68
Denkle V	2	2 weeks	5	34.7	0.11	34.0	9	48.8	0.99	43.8	15.1	1.46
A atomor		5 weeks	9	36.0	0.23	34.7	9	8.61	0.79	45.8	14.1	1.27
		12 weeks	9	37.0	0.45	34.8	9	51.4	0.82	47.2	14.3	0.43
		36 hours	9	33.4	0.22	32.3	5	48.3	0.46	45.6	14.6	0.48
70		5 days	9	34.4	0.73	30.7	īΩ	18.4	0.37	46.3	14.2	0.69
114-5/106	( (	9 days	9	35.4	0,32	33.7	ß	9.6+	0.32	47.8	13.5	0.46
55.50	C 13-	2 weeks	9	35.9	0.38	33.9	5	50.5	0.21	49.3	13.4	0.67
Nonpre v		5 weeks	9	37.3	0. 48	34.9	9	51.9	0.44	49.4	13.1	0.99
		12 weeks	9	38.5	0.51	36.0	9	52.8	0.54	50.1	13.8	0.51

0.2% Offset
 Standard Deviation
 99% Lower Tolerance Limit (95% Confidence)
 Insufficient data for specification of LTL of Ultimate Strength
 Data from two tests
 Data from one test
 No elongation data obtained from tests

TABLE C-7. SUMMARY OF TENSILE PROPERTIES OF 1.00-INCH MIG-X7106 WELDMENTS

Weldment         Panel         Aging           Type         No.         Time           MIG-X7106         CM3-3         5 days           X5180         2 weeks           Double V         5 wceks           I2 weeks         12 weeks           MIG-X7106         7 days           Double V         5 wceks           Double V         5 wceks           I2 weeks         7 days           12 weeks         12 weeks           Double V         5 wceks           I2 weeks         12 weeks	VI	Yield Strength	ngth'''			Ultimate	Strength		Elongation	٦,
1 day 1 day 2 days 2 days 2 weeks 2 weeks 2 weeks 2 weeks 3 days 1 day 4 days 4 days 4 days 4 days 4 days 7106 CM4-3 CM4-3 Cweeks 1 day 2 weeks 1 day	_	Avg.	S <sub>v</sub> (2)	$_{ m LTL}^{(3)}$	No. of	Avg.	S <sub>u</sub> (2)	$_{ m LTL}^{(3)}$	Avg.	S <sub>e</sub> (2)
1 day 5 days 7106 CM3-3 2 weeks 9 coeks 12 weeks 7106 CM4-3 2 weeks 7 days 7106 CM4-3 2 weeks 7 days		ksi	ksi	ksi	Tests	ksi	ksi	ksi	%	%
7106  CM3-3  5 days  V  5 weeks  1 weeks  1 day  7106  CM4-3  2 weeks  1 day  4 days  7 days  V  5 weeks  1 day		32.7	1.52	25.0	9	42.1	0.44	39.9	11.0	
7106  CM3-3  Q days V  5 weeks 12 weeks 11 day 1 day	<u> </u>		1.53		9	43.7	0.49	41.2		
V CM3-3 2 weeks  V 5 weeks  12 week  11 day  1 day  1 days  CM4-3 2 weeks  1 day  1 days	=		0.29	÷	9	45.0	0.94	40.2	6.8	0.59
V 5 weeks 12 week 12 week 7106 CM4-3 2 weeks V 5 weeks V 12 week		35.2	0.34	33.5	9	44.7				
12 week. 1 day 1 day 4 days 7106 CM4-3 2 weeks V 5 weeks 12 week		37.1	0.63	33.9	9	46.3		44. 2		
1 day 1 days 1 days 7 days 7 days 7 days 8 2 weeks 1 day	s	39.8	0.43	37.6	9	47.7	0.83	43.5	7.3	0.81
7106 CM4-3 4 days 7 days 7 days V 5 weeks V 12 weeks		31.4	0.56	28.5	9	41.3	0.84	37.1		0.24
7106 CM4-3 7 days V 5 weeks V 12 weeks				26.0	9	41.5			8.7	
V 5 weeks V 5 weeks 12 week	====	33.4	0.29		9	41.6		37.4	9.8	0.37
V 5 weeks 12 week	<del></del>	33.0		30. 4	9	45.4	0.82	38.2	7.5	
12 week	=	34.2	0.47	31.8	9	45.9				
: 1		37.0	0.32	35.4	9	14.2	0.28	42.8	7.2	
(33 -		32. 4	0.12	31.8	9	44.3	١.	36.4	11.0	0.71
3 × c × ·		35.2	0.54	32.4	9	44.4	5.05	34.1	10.0	1.03
MIG-X7106 7 days			0.13	34.0	9	44.5	1.46		8.9	0.43
CM5-4		35.3		33.3	9	45.2	1.29	38.7		0.84
			0.33	34.7	9	45.4	1.11			0.91
	S,	38.6		36.9	9	45.6	1.70		8.5	1.26

<sup>(1) 0.2%</sup> Offset
(2) Standard Deviation
(3) 99% Lower Tolerance Limit (95% Confidence)

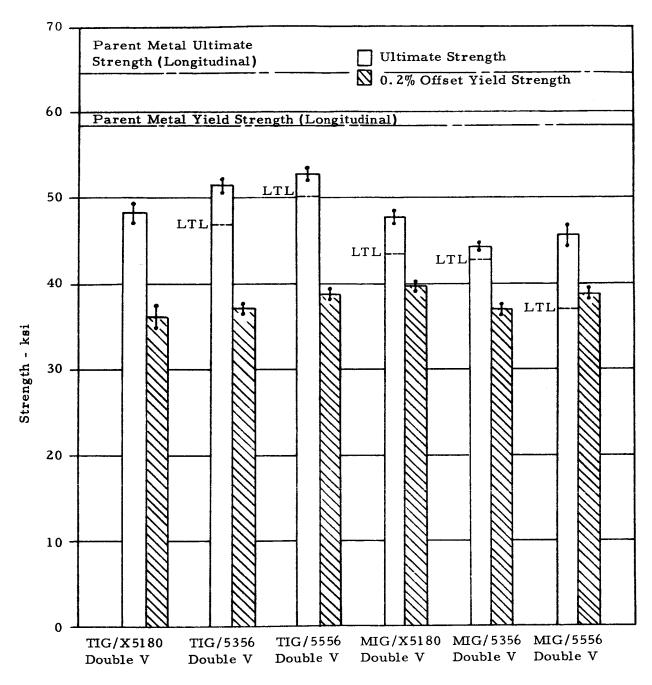


FIGURE C-6. TENSILE PROPERTIES OF 1.00-INCH TIG AND MIG X7106-T63 WELDMENTS AGED TWELVE WEEKS
(Parent Metal Data from Ref. 4.)

degree of overaging occurs. As a result of these previous observations, particular attention was directed to the location of failures of the tensile specimens tested in this program.

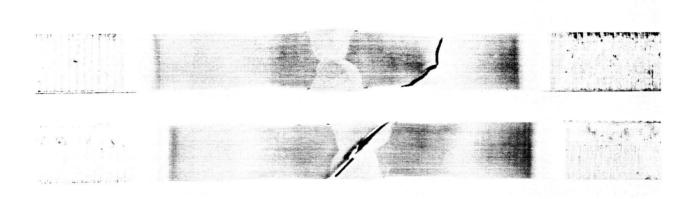
In the present study, the majority of the weldments tested failed in the weld deposit or at the fusion line for all aging periods (12 weeks maximum). A shift in failure location from the weld deposit (or fusion line) to the heat-affected base metal with increasing aging time was observed only in the case of the 0.50-inch TIG square-butt and 1.00-inch TIG double-V weldments. The failure locations for the various weldments are summarized as follows:

Failure in Weld Deposit or at Fusion Line for All Aging Periods	Failure in HAZ after Aging
0.187-inch TIG square-butt	0.50-inch TIG square-butt
0.187-inch MIG square-butt	1.00-inch TIG double-V
0.50-inch TIG double-V	
0.50-inch MIG double-V	
1.00-inch MIG double-V	

In the cases where the failure location shifted from the weld deposit to the heat-affected base metal on aging, all specimens in one group (one weldment type and one aging time) did not necessarily fail in the same relative locations. However, in any case where one or more specimens in one group failed in the heat-affected zone, all specimens in that group exhibited extensive deformation in the heat-affected zone and cracks in the weld deposit. Evidently, in these cases, the strength of the weld deposit and the strength of the weakest portion of the heat-affected base metal were very nearly equal, and the actual failure location was dictated only by slight local variations in strength.

Two tensile specimens, representative of the two types of failure observed in the test series, are shown in Figure C-7. The two particular specimens were cut from the 0.50-inch TIG weldments made with 5356 filler wire, and represent aging periods of one day and 12 weeks. The shift of the location of the failure on aging is apparent.

The observed shift of the failure location in certain X7106-T63 weldments (both in the present study and in that of Contract NAS8-1529) is indicative of a condition in which the strength of the weld bead is not the controlling factor in determining the failure stress of a weldment. Apparently, the strength of the weld bead increases as a result of natural aging, to the point where the strength of the weld deposit, coupled with the additional cross-sectional area of the weld crown, exceeds the strength of the heat-affected



## Tensile Specimens:

Upper specimen aged 12 weeks Lower specimen aged 1 day

FIGURE C-7. 0.50-INCH TIG X7106-T63/5356

base metal, where some degree of overaging occurs. Such a condition would lead to a shift in the failure location as was noted in this study.

The observation of such a condition is consistent with similar observations made on 0.090-inch thick X7106-T63 weldments in the previous study. In addition, it has been established that a significant degree of overaging does occur in regions of the heat-affected base metal. (4)

As noted above, only certain weldment types exhibited the shift of failure location. This difference in aging characteristics may be associated with one of the following conditions:

- (1) Differences in heat input and heat dissipation among the various combinations of material thickness, welding process and joint configuration could lead to variations in the quenching rate of the weld deposit and the degree of overaging in the heat-affected base metal.
- (2) In the thicker materials, the zone of heat-affected base metal may extend beyond the limits of the tensile specimen test section.
- (3) Differences in final bead configuration between the 0.090-inch weldments (4) and the 0.187-inch weldments would result in variations in the degree of dilution of the weld deposit. Such variations could lead to the observed differences in aging characteristics.

## C. Crack Susceptibility of X7106-T63 Weldments

In a previous study of the characteristics of X7106 weldments (Contract NAS8-1529 Mod 6), some attention was directed toward the susceptibility of such weldments to hot cracking. (4) In that study, crack susceptibility tests were made on X7106-T63 and 2219-T87 weldments, employing Houldcroft test specimens. (10) The results of that study indicated that X7106 weldments were more susceptible to hot cracking than the 2219 weldments. In the present study, tests were performed utilizing a modified Houldcroft specimen, as described by Rogerson, et al. (11) This type of specimen is designed to provide uniformly decreasing restraint along the length of the weld and employs an integral run-on tab to stabilize heat flow. The test is performed by depositing a bead-on-plate weld down the centerline of the specimen. The length of the resulting crack, beyond the end of the run-on tab, is used as a measure of the crack susceptibility of a given parent metal-filler metal combination. The details of the test specimen design and the particular procedures employed in the tests are given in Appendix E.

In this portion of the program, crack susceptibility tests were performed on each of the following parent metal-filler metal combinations:

X7106-T63/X5180 X7106-T63/5356 X7106-T63/5556 2219-T87/2319 2014-T6/4043

The results of the crack susceptibility tests are listed in Table C-8 and presented graphically in Figure C-8. Typical examples of the test results, as indicated by radiographs of the test specimens, are shown in Figure C-9. As may be noted in Table C-8 and Figure C-8, the data from the tests on X7106-T63/5556 and 2219-T87/2319 specimens exhibited a higher degree of scatter than that of the other weldments. When the degree of scatter is taken into account, the results of these tests indicate that the degree of crack susceptibility for the X7106-T63 alloy is comparable to that of 2014-T6. In addition, the results indicate that both 2014-T6 and X7106-T63 weldments are significantly more susceptible to hot cracking than 2219-T87 weldments. It may be noted that the scatter in the crack length measurements on the 2219-T87 weldments is in the same order as the average crack length. It is felt that this high degree of scatter is associated with the fact that the welding parameters were selected to prevent complete cracking of the X7106-T63 weldments and resulted in very limited cracking in the 2219-T87 weldments.

In addition to the crack susceptibility tests performed on 0.125-inch sheet, as described above, some effort was directed toward a measurement of the crack susceptibility in thicker plates. For this purpose, two preliminary cruciform crack susceptibility tests were conducted on 0.50-inch X7106-T63 plate. One of these tests was made with a single-pass fillets, and the other with three-pass fillets. In both cases, X5180 filler wire was employed. Upon completion, each cruciform weldment was given a dye penetrant inspection. No cracks were detected in either of the weldments, indicating that this type of test is not suitable for application to aluminum weldments. As a result, no further crack susceptibility tests were performed on the thicker sections of X7106-T63 plate.

TABLE C-8. CRACK SUSCEPTIBILITY TEST RESULTS

(0.125-Inch Modified Houldcroft Test Specimens)

Parent Metal & Filler Metal	Individual Crack Lengths, inches	Mean Crack Length, inches	Standard Deviation, inches
2219-T87/2319	0.080, 0.660, 1.180 0.439, 0.161, 1.115	0.552	0.541
2014-T6/4043	1.464, 1.995, 2.125 1.318, 1.168, 1.833	1.659	0.394
X7106/X5180	1.880, 2.201, 1.617 1.730, 2.009, 1.612	1.840	0.235
X7106/5356	1.810, 1.725, 2.130 1.463, 2.069, 1.060	1.710	0.400
X7106/5556	0.750, 0.240, 1.742 1.936, 1.140, 2.245	1.341	0.765

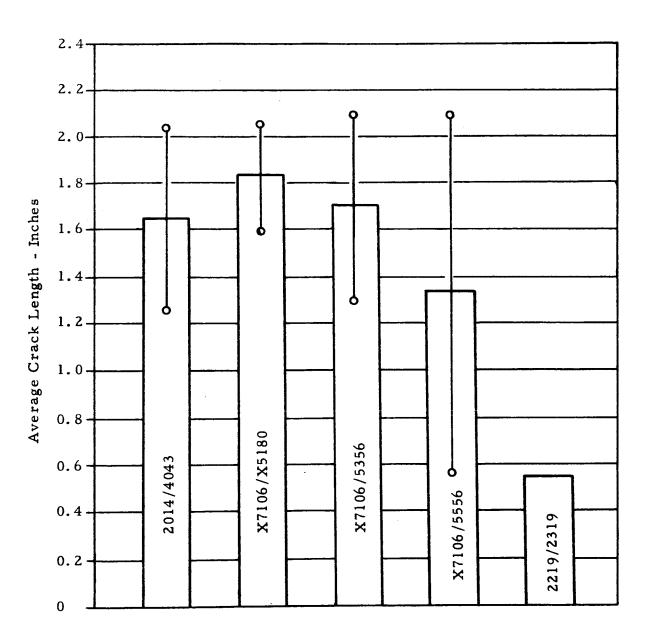
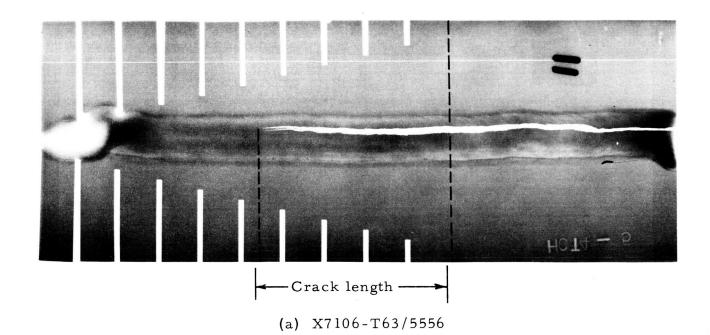


FIGURE C-8. AVERAGE CRACK LENGTHS MEASURED IN CRACK SUSCEPTIBILITY TESTS (0.125-Inch Modified Houldcroft Test Specimens)



→ Crack length

(b) 2219-T87/2319

FIGURE C-9. TYPICAL CRACK SUSCEPTIBILITY SPECIMENS AFTER COMPLETION OF TESTS

Prints from Radiographic Negatives

## APPENDIX D

A SURVEY OF THE LITERATURE RELATED TO MECHANICAL PROPERTIES OF MATERIALS SUBJECTED TO BIAXIAL STRESSES

### A SURVEY OF THE LITERATURE RELATED TO MECHANICAL PROPERTIES OF MATERIALS SUBJECTED TO BIAXIAL STRESSES

The biaxial properties of metals reported in the literature have been determined by a number of methods:

- (1) Circular and elliptical bulge tests
- (2) Burst tests on cylinders and spheres
- (3) Tensile-cross tests
- (4) Uniaxial tensile tests on very wide specimens

Each of these tests has advantages and disadvantages as far as material requirements, fabrication problems, and stress analyses are concerned. The object of this survey is not to evaluate the various methods; rather it is to gather information on the relationships between the biaxial and uniaxial properties determined by any of the methods.

The following overall generalizations can be drawn from the data in the literature:

- (1) For 1:1 biaxial loading, the yield and ultimate strengths are approximated by the corresponding uniaxial properties. The ductility is lower under biaxial loading conditions than under uniaxial loading conditions.
- (2) For 2:1 biaxial loading, the yield strengths are greater than the 1:1 biaxial and the corresponding uniaxial properties. The ultimate strengths are generally equal to or greater than the uniaxial ultimate strengths. The ductility under biaxial conditions is generally lower than the uniaxial ductility.
- (3) There appears to be no general dependence of the biaxial/ uniaxial strength ratio on the strength level of the material. In the case of very high strength alloys, however, reduced biaxial strengths have been reported.

Baird<sup>(12)</sup> reported results on welded cylinders of a number of high-strength ferrous alloys. For 4340 steel, quenched and tempered to four strength levels, he reported the following approximate average results:

Tempering Temperature (°F)	Uniaxial Yield Strength (ksi)	2:1 Biaxial Yield Strength (ksi)	Biaxial/ Uniaxial <u>Ratio</u>
425	205	241	1.17
700	194	218	1.12
900	170	188	1.11
Annealed	88	93	1.06

For Vascojet 1000, at three strength levels, he obtained the following:

Tempering Temperature (°F)	Uniaxial Yield Strength (ksi)	2:1 Biaxial Yield Strength (ksi)	Biaxial/ Uniaxial <u>Ratio</u>
975	252	(a)	-
1050	246	266	1.08
1100	205	262	1.28

<sup>(</sup>a) Failed before reaching yield strength.

For D6AC, heat treated to two strength levels, he obtained:

Tempering	Uniaxial Yield	2:1 Biaxial Yield	Biaxial/
Temperature	Strength	Strength	Uniaxial
(°F)	(ksi)	(ksi)	Ratio
600	229	(a)	-
800	221	259	1.17

<sup>(</sup>a) Failed before reaching yield strength.

For PH15-7 Mo, at three strength levels, he reported the following:

Condition	Uniaxial Yield Strength (ksi)	2:1 Biaxial Yield Strength (ksi)	Biaxial/ Uniaxial <u>Ratio</u>
RH-950	212	(a)	_
TH-1050	198	(a) 196(b)	0.99
TH-1100	192	226(c)	1.18
TH-1100	192	<sub>216</sub> (b)	1.13

<sup>(</sup>a) Failed before yielding.

<sup>(</sup>b) Weld metal yield strength.

<sup>(</sup>c) Parent metal yield strength.

For all these materials, the yield strength was higher under 2:1 biaxial loading than under uniaxial loading and was unaffected by strength level.

McClaren and Best<sup>(13)</sup> reported data obtained on both ferrous and non-ferrous alloys using the tensile-cross type specimen. They did not report yield strength data for the biaxial tests. The following table summarizes ultimate strength results:

		Uniaxial	1:1 B	iaxial	2:1 E	iaxial
Alloy	Orientation	UTS (ksi)	UTS	Ratio	UTS	Ratio
6A-4V Ti	L T	162 169	168 172	1.04 1.02	197 202	1.22
Type 301	L	196	201	1.03	227	1.16
Stainless	Т	203	201	0.99	236	<b>1</b> .16
AM 355	L	228	231	1.01	259	1.14
	Т	231	230	0.99	267	1.15
Maraging Steel	L	301	313	1.04	348	1.16
(300 Grade)	Т	320	312	0.98	-	-

Essentially, the 1:1 biaxial strength was equal to the uniaxial ultimate strength and the 2:1 biaxial strength was approximately 15% greater than the uniaxial ultimate strength.

Marin<sup>(5)</sup> performed biaxial tests on a tubular specimen of 24S-T aluminum alloy. The uniaxial, 1:1 and 2:1 data which he reported (yield, ultimate, and elongation) are summarized below:

### BIAXIAL YIELD STRESS

Stress Ratio	Max Principal Stress	Biaxial/Uniaxial Ratio
Uniaxial	47,5	-
2: 1	54.7	1,15
1:1	49.7	1,04

#### BIAXIAL ULTIMATE STRESS

Stress Ratio	Max Principal Stress	Biaxial/Uniaxial Ratio
Uniaxial	62,5	-
2:1	61.7	0,99
1:1	62,5	1.00

### BIAXIAL DUCTILITY

Stress Ratio	Nominal (in./in.)	True (in./in.)
Uniaxial	0.146	0.136
1:1	0.075	0.074
2:1	0.062	0.060

McClaren and Terry<sup>(14)</sup> presented data on both parent and welded specimens of ferrous and nonferrous alloys using the tensile-cross specimens. The following ultimate strength results were obtained:

		Uniaxial	1:1 Biaxial		2:1 Biaxial	
Alloy	Condition	UTS (ksi)	UTS	Ratio	UTS	Ratio
2014-T6	Parent	71.6	64.0	0.90	78.1	1.09
	Welded	46.2	-	-	-	_
Bl20 VCA	Parent	184.	180.5	0.98	228.3	1.24
	Welded	160.	-	-	-	-
5 Cr Mo V	Parent	275.	256.8	0.93	328.0	1.19
	Welded	278.	304.7	1.10	315.5*	1.13
D6AC	Parent	274.	249.5	0.91	-	-
	Welded	_	-	-	-	-
X 200	Parent	282.	240.6	0.85	335.	1.19
	Welded	_	-	-	-	-

<sup>\*</sup>Data obtained from cylindrical pressure vessel.

The following ductility data were also presented:

Alloy	Condition	Uniaxial	l:l Biaxial	2:1 Biaxial
2014-T6	Parent	8.2%	3,04%	4.30%
	Welded	6.0%		-
B120 VCA	Parent	7.1%	2.15%	2.30%
	Welded	7.0%	-	-
5 Cr Mo V	Parent	8.1%	3.12%	5.12%
	Welded	4.6%	2.61%	1.60%

The above data again indicate that the 2:1 biaxial ultimate strength exceeds the uniaxial results. However, the 1:1 biaxial ultimate strength appears to be somewhat less than the uniaxial ultimate strength. Under conditions of biaxial loading, the ductility is reduced in every case.

Robinson, et al., <sup>(7)</sup> using the circular bulge test on several aluminum alloys, report the biaxial ultimate strength to be equal to the uniaxial ultimate strength. However, the data from this investigation are presented only in graphical form.

Corrigan, et al., (15) performed biaxial tests on parent and welded alloys by employing a very wide tensile specimen with a transverse machined groove. Stress analysis showed that 2:1 biaxiality was obtained in the reduced section after yielding. The following results were reported:

			Uniaxial		2:1 Biaxial	
Alloy	Orientation	Condition	YS	UTS	UTS	Ratio
Tricent	L	Parent	200	221	248	1.12
11	${f T}$	Parent	207	224	252	1.13
11	T	Tungsten				
		Arc	200	219	241	1.10
11	Т	Metal Arc	197	208	224	1.08
11	L	Annealed				
		Parent	86.5	108	122	1.13
D6AC	L	Parent	211	227	258	1.14
11	Т	Parent	214	233	267	1.15
11	T	Tungsten				
		Arc	208	225	254	1.13
Hl l	L	Parent	191	267	357	1.34
4335	L	Parent	-	263	314	1.19

These results also indicate that the ultimate strength of a material is higher under conditions of 2:1 biaxiality than under uniaxial loading.

Jaeger (16) lists a number of criteria for failure by either fracture or flow as follows:

- (1) Maximum principal stress
- (2) Maximum principal strain
- (3) Maximum strain energy
- (4) Maximum shear strain
- (5) Maximum shear stress
- (6) Maximum distortional strain energy
- (7) Maximum conserved distortional strain energy

For failure by flow (yielding), the last three appear to fit the experimental observations the best, but, for failure by fracture, none of the theories are completely adequate. A brief description of these and the octahedral shear stress theory follows.

The maximum principal stress theory predicts failure will occur at a point under any condition of loading when the maximum principal stress at the point reaches the value of the critical stress determined from the uniaxial test. In other words, according to this theory, both the 1:1 and 2:1 biaxial strengths should be equal to the uniaxial strength.

The maximum principal strain theory predicts failure will occur when the maximum principal strain reaches the value of limiting strain, as determined from the uniaxial test. In terms of principal stresses, this theory predicts that in tension-tension or compression-compression, the l:l biaxial strength is greater than the 2:l biaxial strength which in turn is greater than the uniaxial strength.

The maximum strain energy theory predicts failure will occur at a point when the value of the strain energy per unit volume in the material at the point equals the maximum value of the strain energy per unit volume that the material can absorb in simple tension. In terms of principal stresses this reduces to

$$\sigma_1^2 + \sigma_2^2 - 2\mu\sigma_1\sigma_2 = \sigma_u^2$$

which predicts that the 1:1 and 2:1 biaxial strengths will be less than the uniaxial strength.

The maximum shear stress theory predicts that failure will occur when the maximum shear stress reaches the critical value determined in uniaxial tension. In the tension-tension or compression-compression quadrants, this theory leads to the same results as the maximum stress theory. They differ, however, in the two tension-compression quadrants.

The maximum distortion energy theory (Henchy-von Mises theory) predicts that failure will occur when the energy of distortion equals the energy of distortion that the material can absorb under simple tension. This theory can be expressed as

$$\sigma_1^2 - \sigma_1\sigma_2 + \sigma_2^2 = \sigma_u^2$$

For 1:1 biaxial loading, this theory predicts that the biaxial strength will equal the uniaxial strength. For 2:1 biaxial loading, this theory predicts that the biaxial strength will be 1.15 times the uniaxial strength.

The maximum conserved distortional energy theory modified the above theory by taking into account the strain hardening coefficient of the material. It reduces to the above theory when the strain hardening coefficient is zero. When the strain hardening coefficient is greater than zero, the predicted biaxial strengths are reduced.

The octahedral shear stress theory predicts failure will occur when a stress invariant (related to the intensity of the shear stress) reaches some maximum value. This theory leads to

$$\sigma_1^2 - \sigma_1\sigma_2 + \sigma_2^2 = \sigma_u^2$$

which is identical to the expression developed by the maximum distortion energy theory.

In summary, the work of Baird<sup>(12)</sup> and Marin<sup>(5)</sup> indicates that the biaxial yield strength follows the maximum distortion energy theory. The data presented by McClaren and Best<sup>(13)</sup>, McClaren and Terry<sup>(14)</sup>, and Corrigan, et al., <sup>(15)</sup> indicate that the biaxial ultimate strength can also be predicted by the maximum distortion energy theory, while the ultimate strength data reported by Marin<sup>(5)</sup> correlate better with the maximum stress theory. The results of Robinson<sup>(7)</sup> can be expressed by either of the above theories since in the special case of 1:1 biaxiality both theories coincide.

In addition to the references included in the foregoing discussion, several other publications were also reviewed in the literature survey. These additional publications are included in the List of References (17-25) to provide a more complete compilation of published data related to the mechanical properties of materials subjected to biaxial loading conditions.

### APPENDIX E

# EXPERIMENTAL PROCEDURES (CONTRACT NAS8-20160)

## EXPERIMENTAL PROCEDURES (CONTRACT NAS8-20160)

### A. Tensile Tests and Hardness Measurements

A standard uniaxial tensile test specimen, illustrated in Figure E-1, was used to generate the uniaxial tensile data for both parent metal and weldments in all portions of the program. Parent metal specimens were removed from the test panels with the axis of each specimen parallel to the rolling direction unless otherwise noted. Weldment specimens were machined from the test panels, with the specimen perpendicular to the weld, so that the weld was located in the center of the reduced section.

The tensile tests were performed on either a Baldwin 200,000-pound hydraulic tensile machine or on a 10,000-pound Instron testing machine. An LVDT extensometer with a two-inch gage length was utilized to generate the stress-strain curves in each case. A crosshead speed of 0.05 in./min was used in all tests. Yield strength (0.2% offset in 2 inches), ultimate tensile strength and elongation (in two inches) were recorded in each test.

## B. Hydraulic Bulge Tests

The four types of parent metal bulge test panels which were used are illustrated in Figures E-2 through E-5. The machined parent metal panels of Figures E-3, E-4, and E-5 were designed to investigate methods of initiating fracture in the specimen prior to general yielding of the bulge panel. Such a condition was necessary in order that strain gage stress analysis could be used to determine the stress in the panel at failure.

The two types of welded panels which were employed are shown in Figures E-6 and E-7. The weld crown and drop-through on each specimen were left intact except for the two inches at each edge corresponding to the hold-down region of the test fixture.

The hydraulic bulge tests were run on either the circular die shown in Figure E-8 or the elliptical die shown in Figure E-9. In either case, the same test procedures were employed.

A schematic cross section, applicable to either of the hydraulic bulge test dies, is given in Figure E-10. The test specimen is clamped between the lower flat die and the upper die. The lower die is equipped with an inlet for hydraulic fluid and fittings to allow for connection of a relief valve and a

pressure transducer. The lower edge of the opening in the upper die is machined to a radius of three inches to reduce the possibility of failure at the clamping edge. An O-ring in the lower die provides a seal for the pressurizing fluid.

The bulge height indicated in Figure E-10 was measured with a stainless steel deflectometer, shown in position in Figure E-8. The deflectometer was instrumented with a full strain gage bridge and readout was obtained with a Sanborn Model 311A indicator and a Sanborn Model 320 two-channel recorder. Immediately prior to each test, the deflectometer was calibrated with a series of standard test blocks.

The bulge test pressure was monitored with a strain-gage pressure transducer fabricated at SwRI. The complete transducer system consisted of a bourdon tube instrumented with a full strain gage bridge and the same type readout equipment that was used with the deflectometer. The transducer system was calibrated at the beginning of the test program by means of an Ashcroft deadweight tester. The results of this calibration are plotted in Figure E-11.

In the performance of each bulge test, the test panel was pressurized at a rate of approximately 50-75 psi per minute. Synchronous recordings of pressure and bulge height were made throughout the test until the specimen failed. From these data, the stress could be calculated by either of the formulas discussed in Appendix A:

$$\sigma_{mem} = \frac{PR}{2t}$$

or

$$\sigma = KP^{2/3}$$

## C. Cylinder Tests

The configuration of the test specimens used in the cylinder burst tests is shown in Figure E-12. Each specimen consisted of a welded aluminum cylinder (17-5/8" OD X 1/8" wall X 23" long) riveted to a steel extension ring on each end. The extension rings were welded to standard pipe flanges. Standard blind flanges were modified as shown in the drawing to include an O-ring seal. A reinforcement plate, shown in Figure E-13, was cemented to the outside surface of the cylinders intended for parent metal studies. This patch, centered over the weld, was cemented on with Lefkoweld type 109 adhesive and type LM-52 activator.

After assembly, the specimen was installed in a Baldwin 200,000-pound universal testing machine, so that tensile and compressive loads could be superimposed on that resulting from internal pressurization. An X-Y recorder, which monitored a pressure cell measuring internal pressure and a load cell measuring axial load, was used to synchronize and record the two loadings during the test. Electrical resistance strain gage rosettes were cemented to the specimen to measure strain. Details of strain gage procedures are given in a later section of this appendix. A Gilmore multichannel X-Y recorder plotted strain at several locations as a function of the internal pressure (50-psi intervals) during the test. The pressure and load records were checked by visual readout bourdon tube pressure gages and the tensile machine load dial.

The pressure necessary to rupture the cylinder was used to calculate the biaxial ultimate strength by the standard thin-wall cylinder formulas.

### D. LTV Biaxial Test

A biaxial test apparatus utilizing a cross-shaped sheet specimen has been developed by LTV-Vought Aeronautics Division. The equipment, procedures and test specimen are described in a recent report by McClaren and Foreman. (26) Briefly, a transverse load and an axial load are applied simultaneously to the test specimen. The transverse load is obtained with a floating frame separate from that applying the axial load so that no bending stresses are introduced as the specimen strains. The ratio of loads necessary to produce the desired stress ratio under elastic is determined with strain gages, then the load ratio so determined is continued to failure of the specimen.

Since extensive special test equipment is required for their performance, the tests were run at LTV-Vought Aeronautics Division in Dallas, Texas.

## F. MIT Biaxial Test

The MIT biaxial test employs a wide tensile specimen with a transverse machined groove, as illustrated in Figure E-14. The biaxial stress condition is a result of the transverse restraint offered to the reduced section by the specimen geometry. Theoretically, the stress ratio reaches a value of 2:1 after the test section has reached a fully plastic condition. (27)

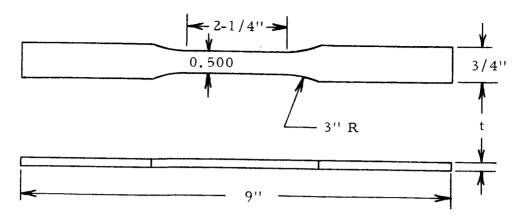
These tests were performed in an Instron testing machine in a manner similar to a conventional uniaxial tensile test. The biaxial strength is calculated from the maximum load and the initial cross-sectional area of the reduced section.

## G. X7106-T63 Tensile Test Specimens

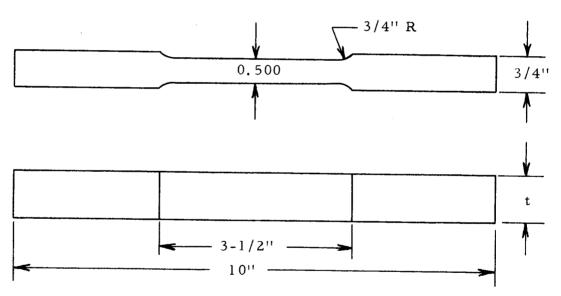
The uniaxial tensile test specimens utilized in the evaluation of the weldability of X7106-T63 were cut from welded panels fabricated for this specific purpose. These panels were fabricated by welding two 5-inch X 36-inch sections to form a 10-inch X 36-inch weldment. The welding processes, filler alloys and joint configurations employed are discussed in Appendix C, and the specific welding procedures utilized are listed as procedures 65A-2 through 65A-23 in Table F-1 of Appendix F. After welding, the panels were cut into tensile specimen blanks 3/4 inch wide and 10 inches long. These specimens were numbered sequentially according to their position in the panel. The finished specimens were tested in groups of six specimens each after selected aging periods. Each group was made up of specimens selected from locations approximately five inches apart, so that each test group contained specimens representative of the entire length of the weld.

### H. Crack Susceptibility Tests

The crack susceptibility test performed in the portion of the program carried out under Contract NAS8-20160 utilized a modified Houldcroft specimen, illustrated in Figure E-15. The tests were performed by depositing a bead-on-plate weld down the centerline of the specimen. The welding procedures employed for this particular series of tests are listed in Table E-1. Upon completion of each test, radiographs of the test specimens were prepared, and the crack length in each case was measured from the indication on the radiograph.

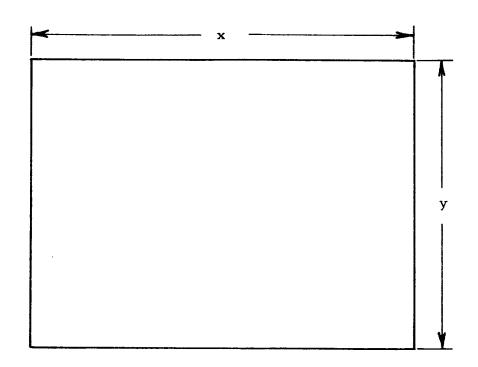


(a) 0.125-Inch and 0.187-Inch Sheet Specimen



(b) 0.50-Inch and 1.00-Inch Plate Specimen

FIGURE E-1. TENSILE TEST SPECIMENS



Panel Sizes				
Dimension 1:1 2:1				
х	36"	30''		
у	36"	24''		

FIGURE E-2. PARENT METAL BULGE TEST SPECIMENS

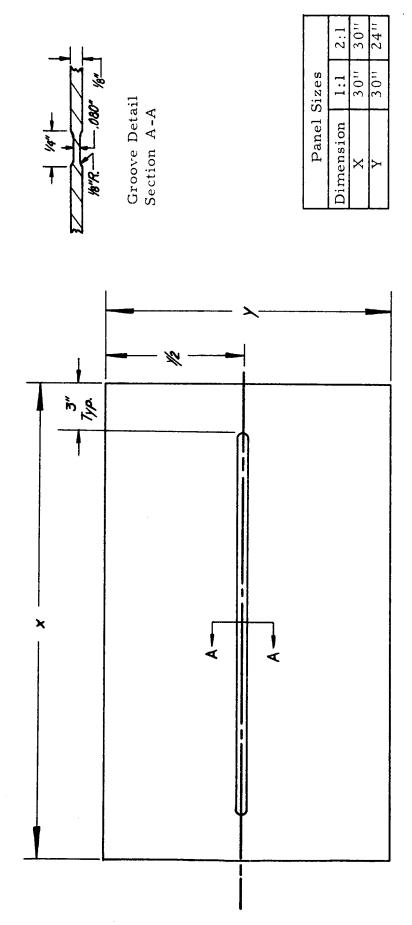


FIGURE E-3. SINGLE-GROOVE BULGE PANEL

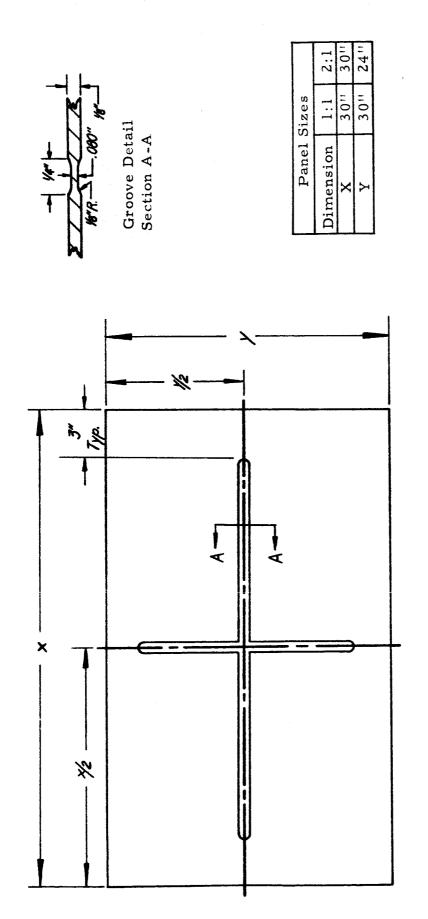


FIGURE E-4. CROSS-GROOVE BULGE PANEL

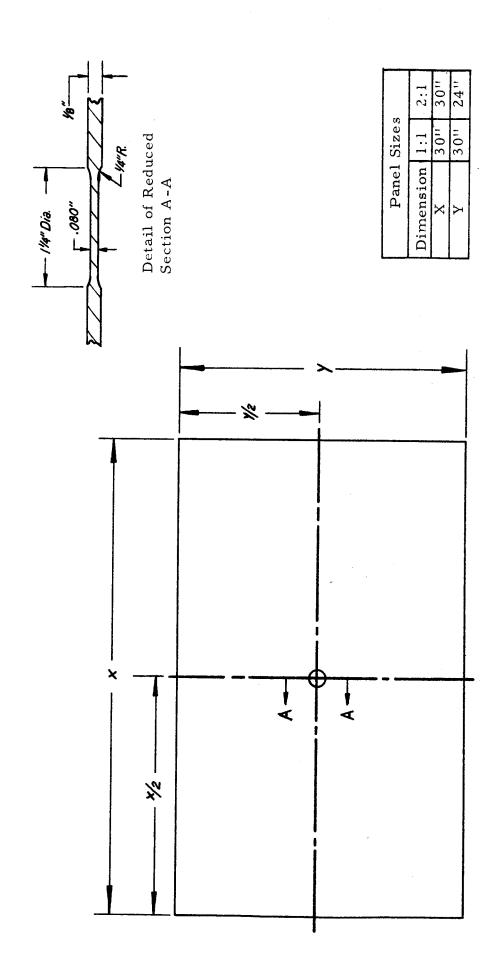
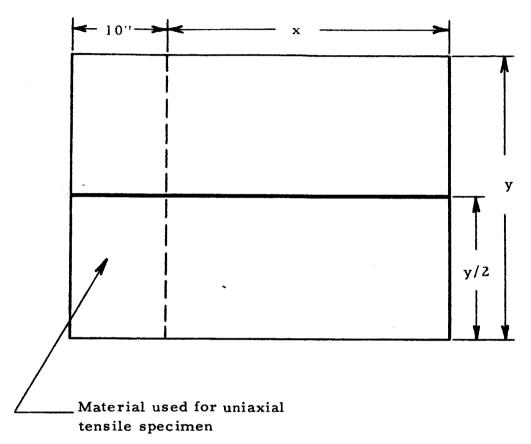
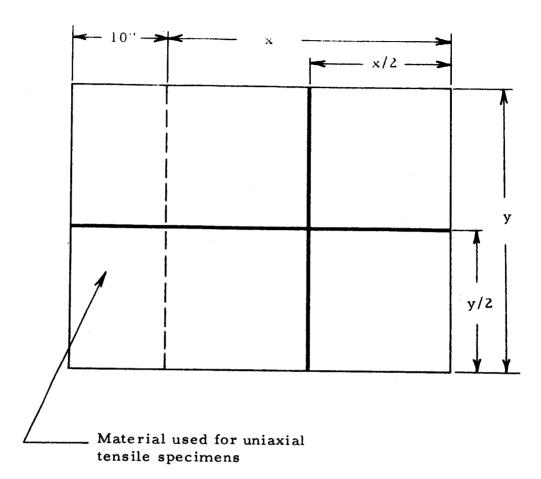


FIGURE E-5. REDUCED-SECTION BULGE PANEL



Panel Sizes				
Dimension	1:1	2:1		
. <b>x</b>	30"	30''		
у	30''	24"		

FIGURE E-6. SINGLE-WELD BULGE PANEL



Panel Sizes				
Dimension	1:1	, 2: 1		
x	30''	30''		
у	30''	24 ''		

FIGURE E-7. CROSS-WELD BULGE PANEL

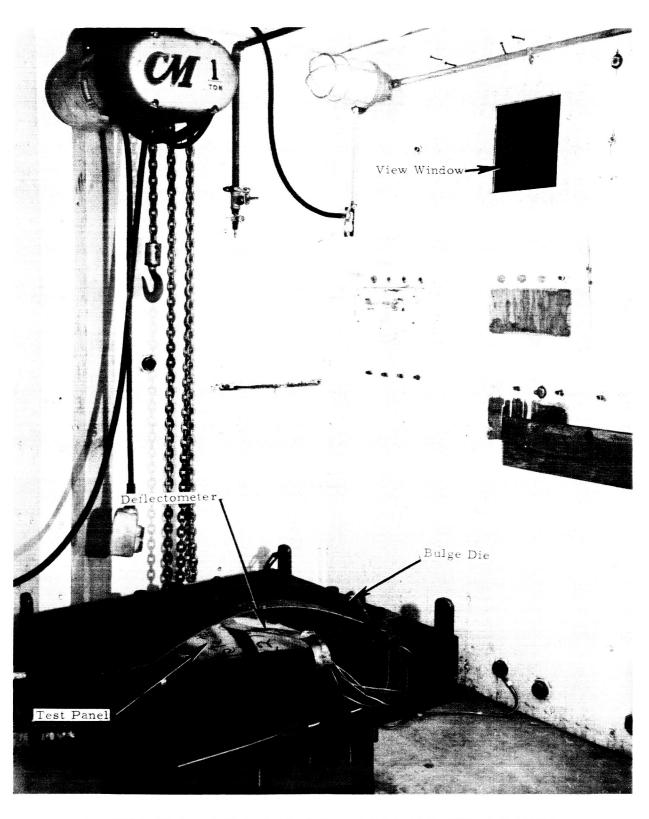


FIGURE E-8. CIRCULAR BULGE DIE AND TEST PANEL ASSEMBLY IN TEST CELL

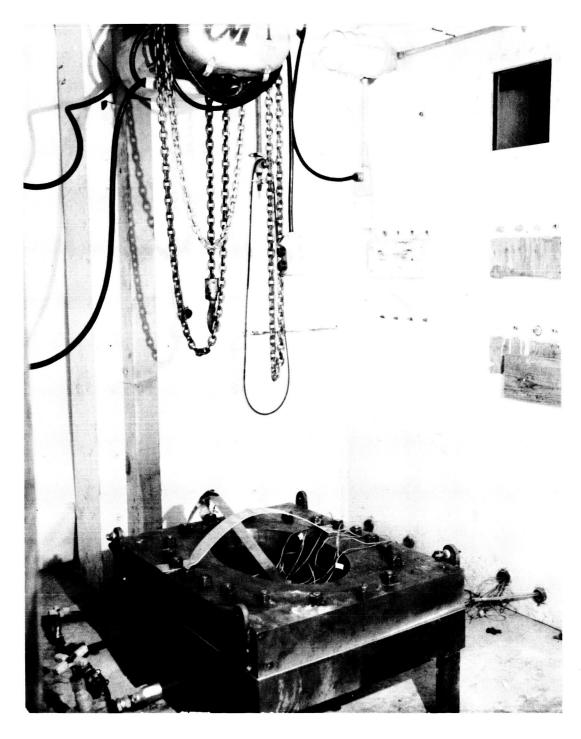


FIGURE E-9. ELLIPTICAL BULGE FIXTURE INSTALLED IN TEST CELL

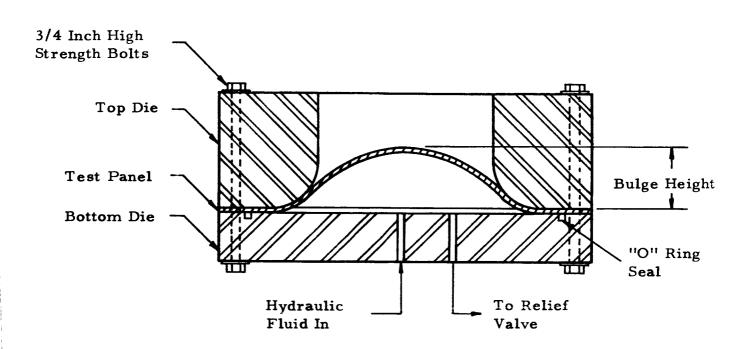


FIGURE E-10. SCHEMATIC DIAGRAM OF HYDRAULIC BULGE TEST FIXTURE

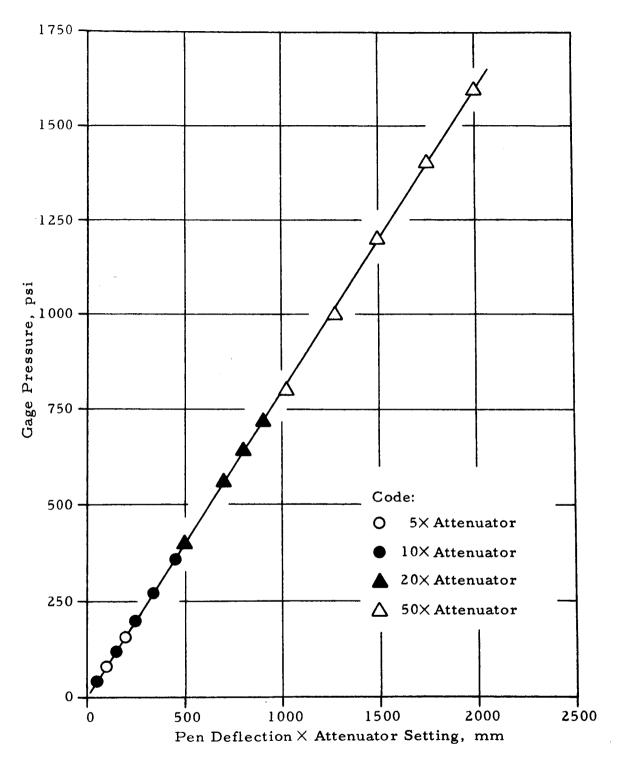
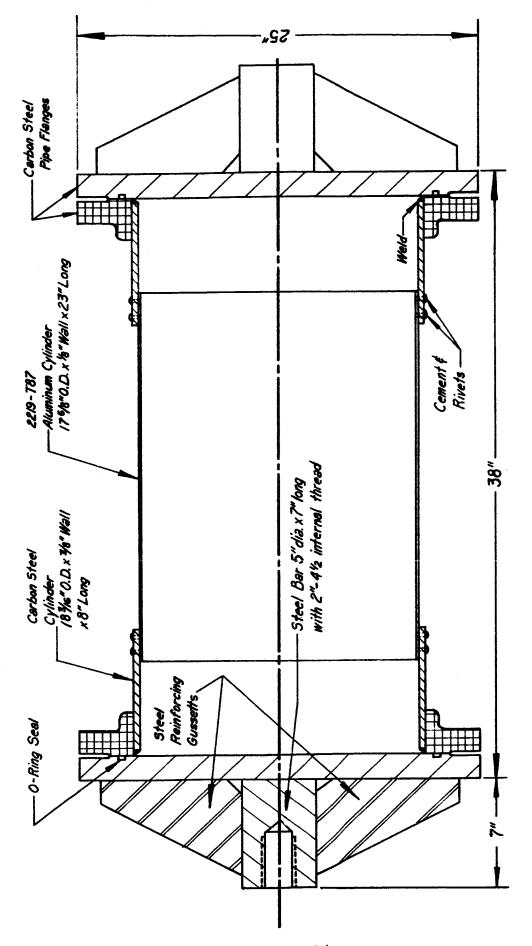


FIGURE E-11. CALIBRATION FOR PRESSURE TRANSDUCER INSTRUMENTATION



REDESIGNED TEST CYLINDER AND CLOSURE FIXTURE ASSEMBLY FIGURE E-12.

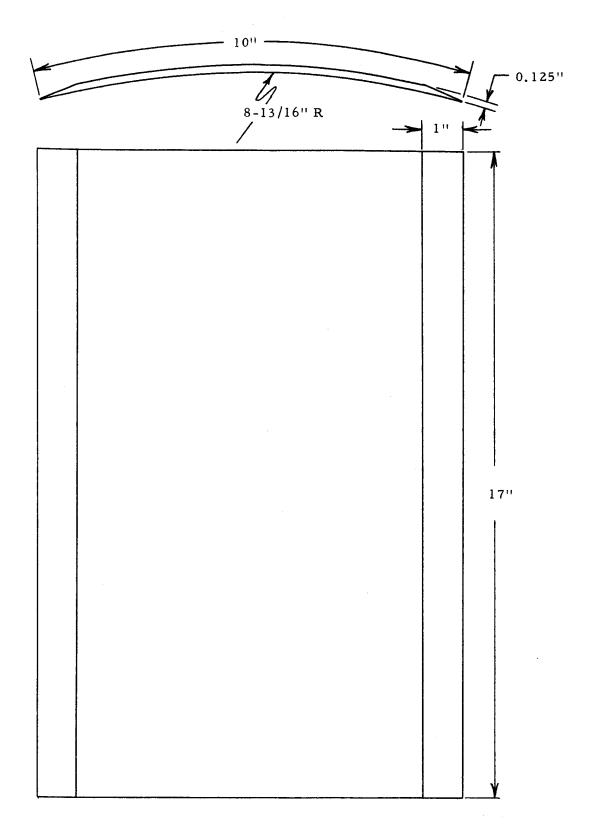
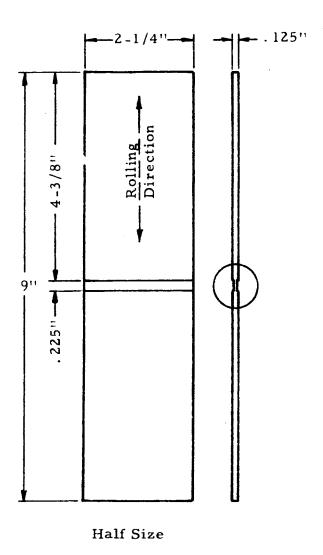
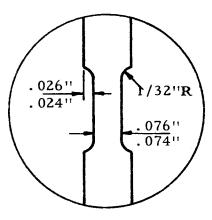


FIGURE E-13. CYLINDER REINFORCEMENT PLATE





Groove Cross-Section Detail, Approx. 4X

Detail of Test Section

FIGURE E-14. MIT 2:1 BIAXIAL STRESS TEST SPECIMEN

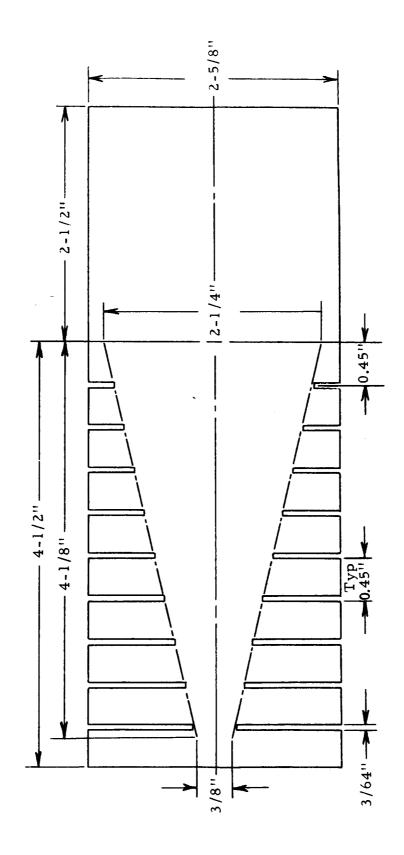


FIGURE E-15. MODIFIED HOULDCROFT CRACK SUSCEPTIBILITY TEST SPECIMEN (REF. 11)

### TABLE E-1. WELDING PROCEDURES FOR HOULDCROFT CRACK SUSCEPTIBILITY TESTS

Current - 216 amps DCSP

Potential - 12 volts

Travel Speed - 14 ipm

Filler Wire Speed - 65 ipm

Electrode - 1/8" dia., 2% Thoriated Tungsten

Backup Block - 1" Thick Carbon

## APPENDIX F FABRICATION DATA (CONTRACT NAS8-20160)

#### FABRICATION DATA (CONTRACT NAS8-20160)

#### A, Welding Procedures

The Tungsten Inert Gas (TIG) welding was carried out utilizing a Miller 600-ampere AC-DC power supply, a Linde HWM-2 contour welding head equipped with a Linde cold wire feeder and a Linde HW13 TIG torch. The Metallic Arc Inert Gas (MIG) welding was carried out using a Linde SVI 500 constant potential power source along with a Linde SEH-2 welding head and a HW13 MIG torch. Both the TIG and MIG welding heads were mounted on a Linde OM-48 side beam carriage. The carriage and wire feed motors were controlled electronically using Linde electronic governors. In most cases, the amperage and voltage were continuously recorded on Leeds and Northrup, Speedomax H, strip chart recorders.

Prior to fabrication, all material was saw cut from the original plates. All weld joint preparation was accomplished by milling. The use of any lubricants and/or coolants was prohibited during the cutting and milling processes. Immediately prior to welding, the weld joint and adjacent plate material was solvent cleaned and hand draw filed.

The 0.125-inch and 0.187-inch thick panel blanks were fit and clamped in position using an Airline pneumatic positioner. A grooved, water-cooled, copper backup bar was used during the fabrication of these panels. Helium gas, directed through holes in the groove of the backup bar, was used to protect the root side of the weld.

The 0,50-inch and 1,00-inch thick panels were fabricated without the use of either backup bar or inert gas shielding of the root.

The welding procedures employed in the fabrication of all test panels are listed in Table F-1. The joint configurations used, along with typical cross sections of the completed welds, are shown in Figures F-1 through F-8.

Upon completion of each test panel, the height and width of the weld crowns were measured at several locations. These measurements are recorded in Tables F-2 through F-5.

#### B. Radiographic Inspection Procedures

Each welded aluminum panel was prepared for X-ray inspection by placing 1/4-inch lead numbers 6 inches apart along the length of the weldment.

In the case of a panel containing a cross weld, the second weld was indicated by the symbol W2 in lead letters. Other information placed on the welded panel with lead numbers included the date, exposure settings, panel thickness, and panel code number. This information was so located on the panels as to appear on each 17-inch length of film. ASME aluminum penetrameters as well as DIN 54 wire penetrameters were placed on each panel at the extreme ends of the weldment on the source side of the panel and shim stock corresponding in thickness to the weld buildup was positioned under each penetrameter.

All radiographs were made with a Baltospot 200 kv, 5 ma portable X-ray unit. Kodak Type M, 70 mm Redi-Pac strip film was used in all cases. The exposures employed for each weldment thickness were as follows:

Material Thickness, in.	Weld Thickness, in,	Penetrameters	Shim Thickness, in.	Source of Film Distance, in.	Potential,	Current,	Exposure Time, min
0.125	0.200	DIN 54 ASME #5, unshimmed ASME #5, shimmed	1/16	48	80	5.0	3
0.187	0.290	DIN 54 ASME #5, unshimmed ASME #5, shimmed	1/8	48	100	5.0	2
0.500	0.575	DIN 54 ASME 0.50, shimmed ASME 0.37, unshimmed	1/8	48	110	4.5	4.5
1.000	1.125	DIN 54 ASME 1.0, shimmed ASME 0.5, unshimmed	1/8	48	1 35	4.5	4.75

After the film was exposed, it was processed in a 68°F constant temperature developing tank according to the following procedure:

- (1) Immersed and agitated intermittently in a 68°F developing solution (Kodak X-Ray Developer) for 6 minutes.
- (2) Immersed and agitated continuously in a 68°F development stopping solution (200-1 mixture of water and acetic acid) for one minute.
- (3) Immersed and agitated intermittently in a 68°F fixing solution (Kodak X-Ray Fixer) for 10 minutes.
- (4) Immersed in flowing water at 68°F and allowed to wash for a minimum of 30 minutes.
- (5) Immersed in a wetting agent (Kodak Photo-Flo), squeegeed off and hung to dry.

After drying, the film was placed on a radiographic film viewer containing a variable intensity light source and analyzed thoroughly. All apparent defects were noted and recorded on a form which indicated type of defect, location and magnitude.

The acceptance of a weldment from the radiographic inspection standpoint was based on the following conditions:

- (1) No cracking was evident in the weldment
- (2) No lack of fusion was evident in the weldment
- (3) No slag greater than 1/8 T was evident in the weldment
- (4) No connected porosity with length greater than 1/8 T was evident in the weldment
- (5) No single porosity locations with diameters greater than 1/8 T were evident in the weldment.

Localized regions of unacceptable porosity were noted in some of the weldments. These weldments were accepted for further testing if the regions of porosity were located so as not to influence the test results. Bulge panels containing such defects were accepted if the defects were located outside of the test section. In cases where localized porosity occurred in the X7106-T63 tensile test panels, the defect regions were cut from the panel and the remaining portion of the panel was used for tensile specimens.

#### C. Heat Treatment

The hydraulic bulge test program included a series of tests on parent metal panels and weldments in the annealed condition and the stress-relieved condition. These panels were heat-treated in a gas-fired muffle furnace. During the treatment, the panels were clamped between steel plates to minimize warping. The heat-treating operations were carried out at KO Steel Castings Company, San Antonio, Texas.

The specific treatments employed were as follows:

#### Annealing Treatment

2 hours at  $775^{\circ}F \pm 25^{\circ}F$ 

Furnace cool to 300°F

Air cool to room temperature

#### Stress-Relieving Treatment

5 hours at  $525^{\circ}F \pm 25^{\circ}F$ 

Air cool to room temperature

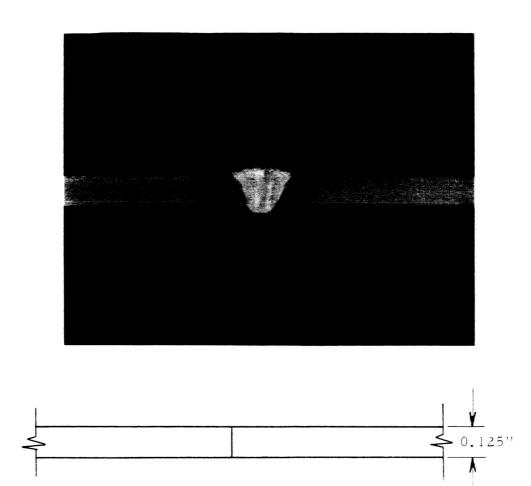


FIGURE F-1. TYPICAL CROSS-SECTION AND JOINT PREPARATION FOR 0.125-INCH TIG WELDMENTS

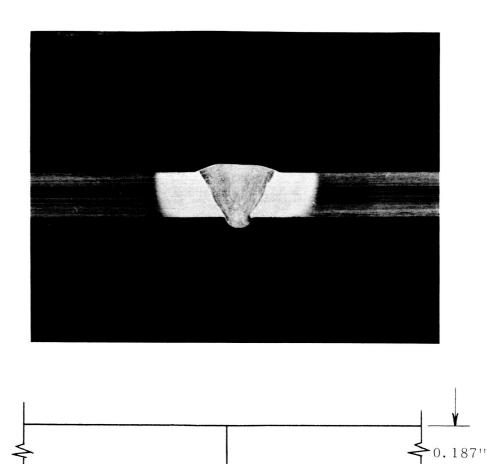


FIGURE F-2. TYPICAL CROSS-SECTION AND JOINT PREPARATION FOR 0.187-INCH TIG WELDMENTS

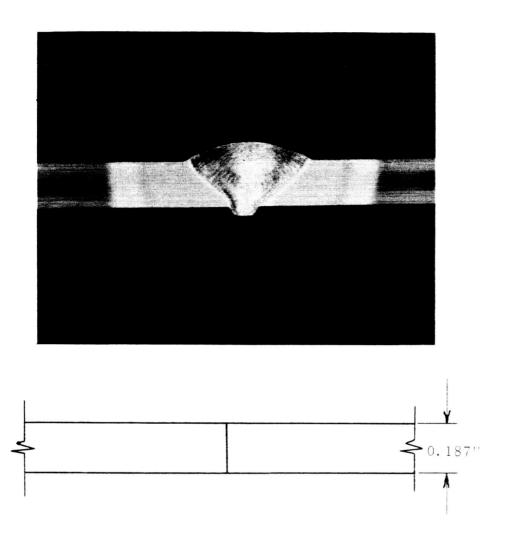
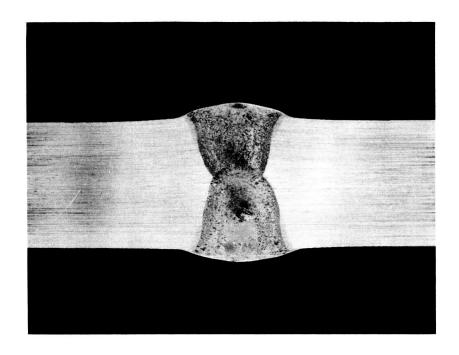


FIGURE F-3. TYPICAL CROSS-SECTION AND JOINT PREPARATION FOR 0.187-INCH MIG WELDMENTS



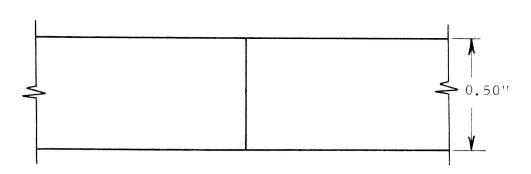
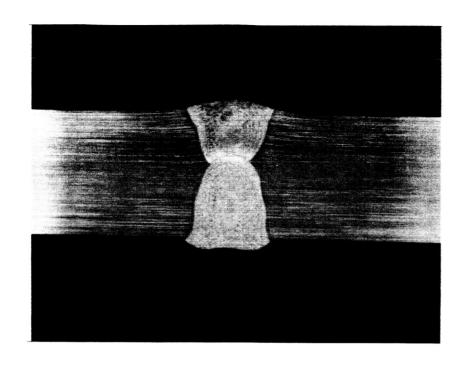


FIGURE F-4. TYPICAL CROSS-SECTION AND JOINT PREPARATION FOR 0.50-INCH TIG SQUARE BUTT WELDMENTS



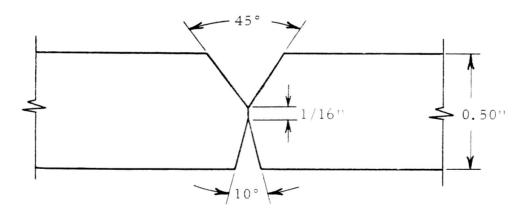
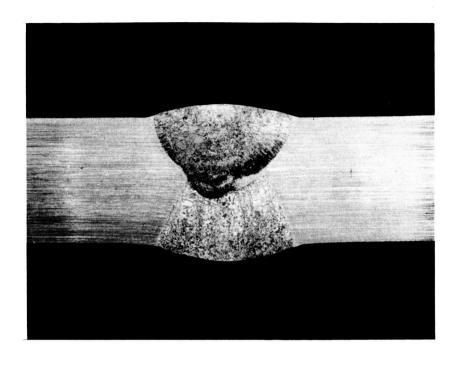


FIGURE F-5. TYPICAL CROSS-SECTION AND JOINT PREPARATION FOR 0.50-INCH TIG DOUBLE V WELDMENTS



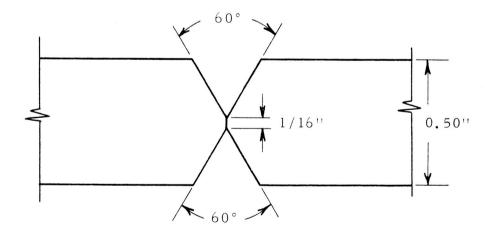
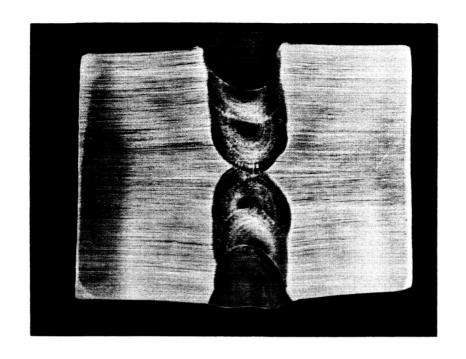


FIGURE F-6. TYPICAL CROSS-SECTION AND JOINT PREPARATION FOR 0.50-INCH MIG WELDMENTS



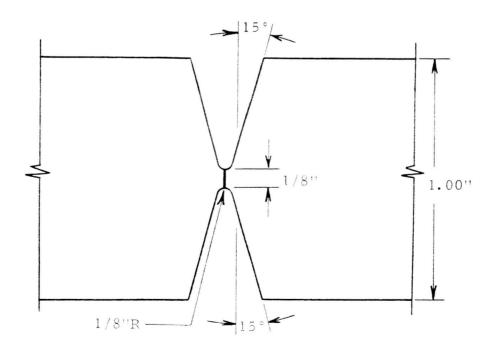
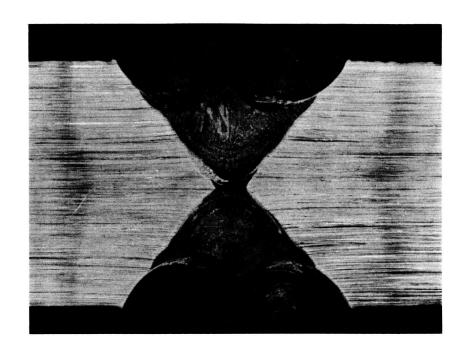


FIGURE F-7. TYPICAL CROSS-SECTION AND JOINT PREPARATION FOR 1.00-INCH TIG WELDMENTS



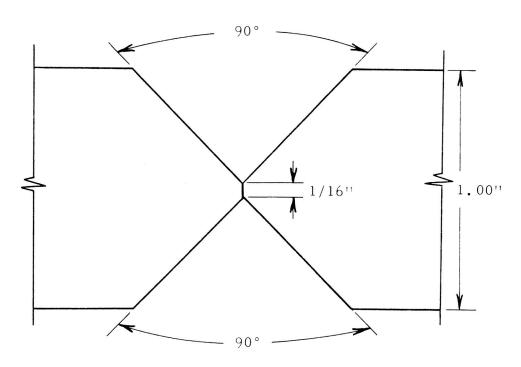


FIGURE F-8. TYPICAL CROSS-SECTION AND JOINT PREPARATION FOR 1.00-INCH MIG WELDMENTS

TABLE F-1. WELDING PROCEDURES

Welding Procedure	Alloy/Joint Design	Material Thickness (inches)	Welding Process	Filler Metal/ Size (inches)	No. of Passes	Electrode Composi- tion/Size (inches)	Current (amps)	Voltage (volts)	Shield Gas/ Flow (cfh)	Back-up Gas/ Flow (cfh)	Travel Speed (ipm)	Filler Metal Speed (ipm)
65 <b>A-</b> 1	2219-T87/ Sq Butt	0,125	TIG	2319/ 3/64	1	Tungsten 2% Thoria/ 1/8	200 DCSP	11	He/30	He/5	15	64
65 <b>A</b> -2	7106-T63/ Sq Butt	0.187	TIG	X5180/ 3/64	1	Tungsten 2% Thoria/ 1/8	280 DCSP	11	He/30	He/5	14	85
65A-3	7106-T63/ Sq Butt	0.187	ŤĬĞ	5356/ 3/64	1	Tungsten 2% Thoria/ 1/8	Z80 DCSP	11	He/30	He/5	14	85
65 <b>A-</b> 4	7106-T63/ Sq Butt	0,187	TIG	5556/ 3/64	ì	Tungsten 2% Thoria/ 1/8	280 DCSP	11	He/30	He/5	14	85
65A-5	7106-T63/ Sq Butt	0.187	MIG	X5180 3/64	1	X5180 3/64	250 DCRP	31	He/50 A+O <sub>2</sub> /5	-	33	-
65 <b>A</b> -6	7106-T63/ Sq Butt	0.187	MIG	5356/ 3/64	1	5356/ 3/64	250 DCRP	31	He/50 A+O <sub>2</sub> /5	-	33	-
65 <b>A-</b> 7	7106-T63/ Sq Butt	0.187	MIG	5556/ 3/6 <b>4</b>	1	5556/ 3/64	250 DCRP	31	He/50 A+O <sub>2</sub> /5	-	33	-
65A-8	7106-T63/ Double V	0.50	MIG	X5180/ 3/64	2	X5180/ 3/64	300 DCRP	34	He/50 A+O <sub>2</sub> /5	-	33	-
65 <b>A~</b> 9	7106-T63/ Double V	0.50	MIG	5356/ 3/64	2	5356/ 3/64	300 DCRP	34	He/50 A+O <sub>2</sub> /5	-	33	
65A-10	7106-T63/ Double V	0.50	MIG	5556/ 3/64	2	5556/ 3/6 <del>4</del>	300 DCRP	34	He/50 A+O <sub>2</sub> /5	-	33	-
65 <b>A-</b> 11	7106-T63/ Sq Butt	0.50	TIG	X5180/ 3/64	Z	Tungsten 2% Thoria/ 1/8	316 DCSP	12	He/35	-	7	56
65 <b>A-</b> 12	7106-T63/ Sq Butt	0.50	TIG	5356/ 3/64	2	Tungsten 2% Thoria/ 1/8	316 DCSP	12	He/35	-	7	56
65 <b>A-</b> 13	7106-T63/ Sq Butt	0.50	TIG	5556/ 3/64	2	Tungsten 2% Thoria/ 1/8	316 DCSP	12	He/35	-	7	56
65. <b>A-14</b>	7106-T63/ Double V	0.50	TIG	X5180/ 3/64	l of 2	Tungsten 2% Thoria/ 1/8	312 DCSP	12	He/35	-	10	52
					2 of 2	Tungsten 2% Thoria/ 1/8	300 DCSP	12	He/35	-	8	122
65 <b>A-</b> 15	7106-T63/ Double V	0.50	TIG	5356/ 3/64	1 of 2	Tungsten 2% Thoria/ 1/8	312 DCSP	12	He/35	-	10	52
					2 of 2	Tungsten 2% Thoria/ 1/8	300 DCSP	12	He/35	-	8	122
65 <b>A</b> -16	7106-T63/ Double V	0.50	TIG	5556/ 3/64	l of 2	Tungsten 2% Thoria/ 1/8	312 DCSP	12	He/35	-	10	52
					2 of 2	Tungsten 2% Thoria/ 1/8	300 DCSP	12	He/35	-	8	122
65 <b>A</b> -17	7106-T63/ Double V	1.0	TIG	X5180/ 1/16	l of 8	Tungsten 2% Thoria/ 5/32	265 DCSP	12	He/35	-	7	42
					2 of 8	Tungsten 2% Thoria/ 5/32	276 DCSP	12	He/35	-	7	42
					3 of 8	Tungsten 2% Thoria/ 5/32	344 DCSP	12	He/35	-	4	42

#### TABLE F-1. WELDING PROCEDURES (Cont'd)

Welding Procedure	Alloy/Joint Design	Material Thickness (inches)	Welding Process	Filler Metal/ Size (inches)	No. of Passes	Electrode Composi- tion/Size (inches)	Current (amps)	Voltage (volts)	Shield Gas/ Flow (cfh)	Back-up Gas Flow (cfh)	Travel Speed (ipm)	Filler Metal Speed (ipm)
65A-17	7106-T63 Double V	1.0	TIG	5180/ 1/16	4 of 8	Tungsten 2% Thoria/ 5/32	344 DCSP	12	He/35	-	4	42
					5 of 8	Tungsten 2% Thoria/ 5/32	320 DCSP	12	He/35	-	5	42
					6 of 8	Tungsten 2% Thoria/ 5/32	320 DCSP	12	He/35	-	5	42
					7 of 8	Tungsten 2% Thoria/ 5/32	260 DCSP	12	He/35	<b>-</b>	5	52
					8 of 8	Tungsten 2% Thoria/ 5/32	260 DCSP	12	He/35	-	5	52
65 <b>A-</b> 18	7106-T63 Double V	1.0	TIG	5356/ 1/16	1 of 8	Tungsten 2% Thoria/ 5/32	265 DCSP	12	He/35	-	7	42
					2 of 8	Tungsten 2% Thoria/ 5/32	276 DCSP	12	He/35	-	7	42
					3 of 8	Tungsten 2% Thoria/ 5/32	344 DCSP	12	He/35	-	4	42
					4 of 8	Tungsten 2% Thoria/ 5/32	344 DCSP	12	He/35	-	4	42
					5 of 8	Tungsten 2% Thoria/ 5/32	320 DCSP	12	He/35	-	5	42
					6 of 8	Tungsten 2% Thoria/ 5/32	320 DCSP	12	He/35	-	5	42
					7 of 8	Tungsten 2% Thoria/ 5/32	260 DCSP	12	He/35	-	5	52
					8 of 8	Tungsten 2% Thoria/ 5/32	260 DCSP	12	He/35	-	5	52
65A-19	7106-T63 Double V	1.0	TIG	5556/ 1/16	1 of 8	Tungsten 2% Thoria/ 5/32	265 DCSP	12	He/35	-	7	
	·				2 of 8	Tungsten 2% Thoria/ 5/32	276 DCSP	12	He/35	•	7	42
					3 of 8	Tungsten 2% Thoria/ 5/32	344 DCSP	12	He/35	-	4	42
				•	4 of 8	Tungsten 2% Thoria/ 5/32	344 DCSP	12	He/35	-	4	42
					5 of 8	Tungsten 2% Thoria/ 5/32	320 DCSP	12	He/35	•	5	42
					6 of 8	Tungsten 2% Thoria/ 5/32	320 DCSP	12	He/35	-	5	42
					7 of 8	Tungsten 2% Thoria/ 5/32	260 DCSP	12	He/35	-	5	52

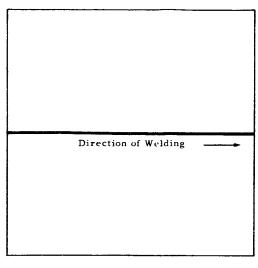
TABLE F-1. WELDING PROCEDURES (Cont'd)

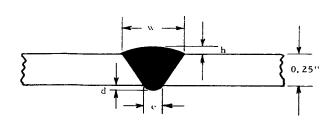
Welding Procedure	Alloy/ Joint Design	Material Thickness (inches)	Welding Process	Filler Metal/ Size (inches)	No. of Passes	Electrode Composi- tion/Size (inches)	Current (amps)	Voltage (volts)	Shield Gas/ Flow (cfh)	Back-up Gas/ Flow (cfh)	Travel Speed (ipm)	Filler Metal Speed (ipm)
65 <b>A-</b> 19	7106-T63/ Double V	1.0	TIG	5556/ 1/16	8 of 8	Tungsten 2% Thoria/ 5/32	260 DCSP	12	He/35	-	5	52
65A-20	7106-T63/ Double V	1.0	MIG	X5180/ 1/16	1 of 8	X5180/ 1/16	280 DCRP	36	He/50 A+O <sub>2</sub> /5	-	26	-
					2 of 8	X5180/ 1/16	290 DCRP	34	He/50 A+O <sub>Z</sub> /5	-	26	-
					3 of 8	X5180/ 1/16	320 DCRP	34	He/50 A+O <sub>2</sub> /5	-	11	-
					4 of 8	X5180/ 1/16	320 DCRP	34	He/50 A+O <sub>2</sub> /5	-	11	-
					5 of 8	X5180/ 1/16	300 DCRP	34	He/50 <b>A</b> +O <sub>2</sub> /5	-	26	-
					6 of 8	X5180/ 1/16	300 DCRP	34	He/50 A+O <sub>2</sub> /5	-	26	-
					7 of 8	X5180/ 1/16	300 DCRP	34	He/50 <b>A</b> +O <sub>2</sub> /5	-	26	-
					8 of 8	X5180/ 1/16	300 DCRP	34	He/50 A+O <sub>2</sub> /5	-	26	-
65 <b>A-</b> 21	7106-T63/ Double V	1,0	MIG	5336/ 1/16	1 of 8	5356/ 1/16	280 DCRP	36	He/50 A+O <sub>2</sub> /5	-	26	-
					2 of 8	5356/ 1/16	290 DCRP	34	He/50 A+O <sub>2</sub> /5	-	26	-
					3 of 8	5356/ 1/16	320 DCRP	34	He/50 A+O <sub>2</sub> /5	-	11	-
1					4 of 8	5356/ 1/16	320 DCRP	34	He/50 A+O <sub>2</sub> /5	-	11	-
					5 of 8	5356/ 1/16	300 DCRP	34	He/50 A+O <sub>2</sub> /5	-	26	-
					6 of 8	5356/ 1/16	300 DCRP	34	He/50 A+O <sub>2</sub> /5	-	26	-
					7 of 8	5356/ 1/16	300 DCRP	34	He/50 A+O <sub>2</sub> /5	-	26	-
					8 of 8	5356/ 1/16	300 DCRP	34	He/50 A+O <sub>2</sub> /5	-	26	-
65A-22	7106-T63/ Double V	1.0	MIG	5556/ 1/16	1 of 8	5556/ 1/16	280 DCRP	36	He/50 A+O <sub>2</sub> /5	-	26	-
					2 of 8	5556/ 1/16	290 DCRP	34	He/50 A+O <sub>2</sub> /5	-	26	-
					3 of 8	5556/ 1/16	320 DCRP	34	He/50 A+O <sub>2</sub> /5	-	11	~
					4 of 8	5556/ 1/16	320 DCRP	34	He/50 A+O <sub>Z</sub> /5	-	11	-
		•			5 of 8	5556/ 1/16	300 DCRP	34	He/50 A+O <sub>2</sub> /5	-	26	-
					6 of 8	5556/ 1/16	300 DCRP	34	He/50 A+O <sub>2</sub> /5	-	26	-
1					7 of 8	5556/ 1/16	300 DCRP	34	He/50 A+O <sub>2</sub> /5	-	26	-
65 A - 22	7104 77/2/	0.135			8 of 8	5556/ 1/16	300 DCRP	34	He/50 A+O <sub>Z</sub> /5	-	26	-
65A-23	7106-T63/ Sq Butt	0.125	TIG	X5180/ 3/64	1	Tungsten 2% Thoria/ 3/32	200 DCSP	11	He/30	He/5	15	64

TABLE F-1. WELDING PROCEDURES (Cont'd)

Welding Procedure	Alloy/Joint Design	Thickness (inches)	Welding Process	Size (inches)	No. of Passes	Electrode Composi- tion/Size (inches)	Current (amps)	Voltage (volts)	Shield Gas/ Flow (cfh)	Back-up Gas Flow (cfh)	Travel Speed (ipm)	Filler Metal Speed (ipm)
65 <b>A-24</b>	2014-T6/ Sq Butt	0.125	TIG	2319/ 3/64	1	Tungsten 2% Thoria/ 3/32	216 DCSP	12	He/30	He/5	15	64
65 <b>A-</b> 25	2014-T6/ Sq Butt	0.125	TIG	4043/ 3/64	1	Tungsten 2% Thoria/ 3/32	220 DCSP	12	He/30	He/5	15	64
65A-26	2219-T87/ Sq Butt	0.125	MIG	2319/ 3/64	1	2319/ 3/64	195 DCRP	32	He/40 A/25	He/5	43	-
65A-27	2014-T6/ Sq Butt	0.125	MIG	4043/ 3/64	1	4043/ 3/64	195 DCRP	32	He/40 A/25	He/5	43	•

### TABLE F-2. WELD DIMENSIONS FOR SINGLE-WELD BULGE PANELS





A = distance from start of weld

Panel No.	A	w	h	đ	e	Panel	Α	w	h	d	e
NO. AT1-2	4	0.130	Inches 0.025	0.048	0.120	No. AT1-13	3.4		Inche		
AII-L	8	0.130	0.024	0.048	0.120		24	0.285	0.020	0.046	0.118
	12	0.122	0.024	0.046	0.120	(cont'd)	28	0.278	0.022	0.040	0.125
	16	0.220	0.029	0.057			32	0.285	0.024	0.039	0.115
	20	0.235	0.022		0.120		36	0.293	0.024	0.048	0.117
	24	0.228	0.025	0.051	0.125	AT1-20	4	0.289	0.028	0.032	0.119
	28	0.245		0.048	0.125	711 1-20	8	0.239	0.028	0.032	0.119
	20	0.245	0.023	0.053	0.125		12	0.285	0.024	0.038	0.125
AT1-3	4	0.240	0.025	0.045	0.120		16	0.293	0.030	0.029	0.119
	8	0.286	0.020	0.049	0.120		20	0.291	0.026	0.035	0.119
	12	0.290	0.025	0.030	0.120		24	0.291	0.026	0.030	0.119
	16	0.265	0.025	0.039	0.130		28	0.300	0.024		
	20	0.300	0.024	0.032	0.120		32	0.295		0.034	0.116
	24	0.285	0.026	0.034	0.120		36	0.287	0.024	0.039	0.116
	28	0.291	0.029	0.027	0.120		30	0.201	0.025	0.034	0.119
						AM1-1	4	0.475	0.044	0.060	0.115
AT1-7	4	0.300	0.024	0.025	0.120		8	0.468	0.052	0.052	0.110
	8	0.293	0.019	0.042	0.118		12	0.476	0.053	0.043	0.108
	12	0.310	0.025	0.025	0.120		16	0.460	0.056	0.055	0.118
	16	0.300	0.025	0.026	0.120		20	0.470	0.048	0.059	0.122
	20	0.293	0.025	0.032	0.120		24	0.474	0.046	0.058	0.118
	24	0.300	0.027	0.026	0.120		28	0.461	0.045	0.062	0.119
	28	0.290	0.045	0.032	0.120		32	0.482	0.040	0.060	0.118
AT1-10	4	0.217	0.034	0.011	0.130		36	0.466	0.046	0.060	0.118
A11-10	8	0.217	0.024	0.044	0.120					.,	
	12		0.032	0.036	0.120	AM1-2	4	0.432	0.066	0.058	0.108
	16	0.280	0.027	0.042	0.120		8	0.442	0.055	0.047	0.103
	20	0.285	0.026	0.027	0.120		12	0.433	0.055	0.045	0.101
		0.245	0.029	0.035	0.123		16	0.459	0.054	0.045	0.091
	24	0.292	0.029	0.043	0.122		20	0.460	0.055	0.046	0.088
<b>:</b>	28	0.250	0.027	0.054	0.120		24	0.465	0.056	0.047	0.104
AT1-11	4	0.250	0.030	0.034	0.120		28	0.432	0.053	0.048	0.103
	8	0.250	0.031	0,036	0.120		32	0.468	0.050	0.062	0.120
	12	0.264	0.032	0.033	0.120		36	0.462	0.057	0.061	0.116
	16	0.286	0.027	0.023	0.120	4343 2		0 473	0.040	0.0(1	
	20	0.255	0.030	0.037	0.120	AM1-3	4 8	0.473	0.049	0.061	0.118
	24	0.235	0.027	0.047	0.120			0.458	0.054	0.062	0.116
	28	0.242	0.029	0.047	0.120		12	0.438	0.053	0.057	0.118
			,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	0.01.	00		16	0.448	0.050	0.053	0.119
AT1-12	4	0.255	0.026	0.041	0.120		20	0.447	0.036	0.059	0.120
	8	0.245	0.029	0.040	0.120		24	0.438	0.034	0.059	0.116
	12	0.244	0.028	0.040	0.118		28	0.443	0.035	0.060	0.118
	16	0.235	0.029	0.046	0.119		32	0.446	0.043	0.062	0.117
	20	0.256	0.030	0.041	0.120		36	0.451	0.046	0.060	0.115
	24	0.245	0.026	0.050	0.118	AM1-4	4	0.439	0.043	0.063	0.117
	28	0.241	0.026	0.048	0.120		8	0.441	0.045	0.061	0.119
ATT 10	4	0.300					12	0.431	0.041	0.060	0.119
AT1-18	4	0.280	0.028	0.029	0.120		16	0.444	0.049	0.050	0.110
	8	0.285	0.023	0.036	0.121	,	20	0.440	0.048	0.059	0.122
1	12	0.270	0.029	0.032	0.122		24	0.436	0.050	0.060	0.118
Ī	16 20	0.279	0.022	0.045	0.122		28	0.436	0.041	0.063	0.117
	20	0,280	0.025	0.036	0.115				~ • ~ • •		*****

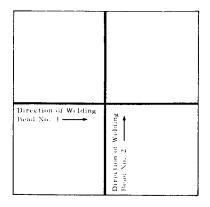
## TABLE F-2. WELD DIMENSIONS FOR SINGLE-WELD BULGE PANELS (Cont'd)

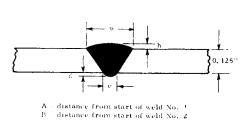
							•	•			
Panel	Α	w	h	d	e	Panel	Α	w	h	d	e
No.			Inches			No.			Inches		
AM1-4	32	0.445	0.053	0.061	0.116	BT2-2	28	0.325	0.034	0.022	0.116
(cont'd)	36	0.430	0.053	0.060	0.115	(cont'd)	32	0.320	0.031	0.023	0.115
						, ,	36	0.328	0.030	0.025	0.116
AM1-5	4	0.460	0.039	0.062	0.114						
	8	0.466	0.045	0.062	0.116	BT2-3	4	0.325	0.024	0.024	0.121
	12	0.440	0.053	0.052	0.101		8	0.322	0.030	0.024	0.124
	16	0.463	0.051	0.050	0.100		12	0.323	0.029	0.023	0.124
	20	0.465	0.055	0.059	0.113		16	0.320	0.026	0.025	0.123
	24	0.448	0.051	0.059	0.113		20	0.317	0.031	0.022	0.122
	28	0.437	0.046	0.062	0.119		24	0.311	0.031	0.020	0.116
	32	0.456	0.048	0.060	0.117		28	0.318	0.031	0.019	0.118
	36	0.460	0.056	0.053	0.108		32	0.320	0.030	0.024	0.119
							36	0.323	0.031	0.022	0.115
BT1-1	4	0.287	0.022	0.040	0.124			0.525	0.031	0.022	0.115
	8	0.286	0.024	0.039	0.125	BT2-4	4	0.284	0.023	0.038	0.126
	12	0.285	0.024	0.040	0.125		8	0.286	0.026	0.039	0.126
	16	0.281	0.025	0.038	0.126		12	0.284	0.019	0.049	0.124
	20	0.284	0.023	0.043	0.128		16	0.286	0.024	0.040	0.126
	24	0.291	0.025	0.045	0.123		20	0.292	0.025	0.034	0.127
	28	0.285	0.024	0.046	0.123		24	0.285	0.027	0.036	0.121
	32	0.302	0.026	0.029	0.134		28	0.288	0.027	0.037	0.122
	36	0.285	0.027	0.042	0.123		32	0.303	0.025	0.027	0.135
							36	0.285	0.025	0.038	0.119
BT1-2	4	0.293	0.027	0.027	0.121		•	0.203	0.023	0.050	0.117
	8	0.293	0.026	0.027	0.123	BT2-5	4	0.284	0.020	0.047	0.122
	12	0.295	0.027	0.033	0.124		8	0.286	0.024	0.040	0.125
	16	0.297	0.029	0.024	0.124		12	0.279	0.020	0.047	0.121
	20	0.291	0.026	0.028	0.123		16	0.286	0.024	0.040	0.128
	24	0.298	0.031	0.026	0.103		20	0.290	0.026	0.036	0.125
	28	0.308	0.030	0.022	0.116		24	0.287	0.028	0.030	0.110
	32	0.308	0.030	0.021	0.104		28	0.291	0.029	0.032	0.110
	36	0.301	0.029	0.022	0.104		32	0.315	0.027	0.032	
			0.02)	0.022	0.103		36	0.287	0.030	0.028	0.126
BT1-3	4	0.275	0.020	0.043	0.128		50	0.201	0.027	0.037	0.119
	8	0.284	0.028	0.036	0.135	BM2-1	4	0.480	0.045	0.061	0.132
	12	0.282	0.021	0.027	0.128		8	0.468	0.045	0.063	0.125
	16	0.294	0.027	0.031	0.132		12	0.458	0.045	0.060	0.122
	20	0.288	0.025	0.036	0.137		16	0.469	0.043	0.053	0.121
	24	0.286	0.026	0.047	0.125		20	0.460	0.046	0.059	0.126
	28	0.290	0.028	0.035	0.126		24	0.472	0.043	0.058	0.122
	32	0.320	0.029	0.023	0.130		28	0.465	0.045	0.060	0.120
	36	0.290	0.024	0.039	0.127		32	0.485	0.044	0.060	0.134
					••••		36	0.470	0.046	0.061	0.134
BT1-4	4	0.293	0.025	0.040	0.125			0.110	0.010	0.001	0.110
	8	0.292	0.026	0.036	0.127	BM2-2	4	0.465	0.048	0.030	0.105
	12	0.280	0.024	0.047	0.125		8	0.464	0.046	0.053	0.122
	16	0.290	0.025	0.035	0.124		12	0.470	0.046	0.055	0.122
	20	0.292	0.025	0.032	0.130		16	0.475	0.047	0.053	0.128
	24	0.292	0.028	0.038	0.126		20	0.470	0.044	0.061	0.120
	28	0.280	0.026	0.039	0.124		24	0.465	0.045	0.057	0.119
	32	0.305	0.029	0.027	0.135		28	0.469	0.050	0.051	0.121
	36	0.295	0.029	0.032	0.120		32	0.475	0.041	0.060	0.130
D.T.) .		0 210	0.001				36	0.463	0.046	0.062	0.120
BT1-5	4	0.310	0.031	0.023	0.123						
	8	0.307	0.028	0.023	0.127	BM2-3	4	0.457	0.045	0.049	0.121
	12	0.305	0.029	0.027	0.124		8	0.447	0.045	0.060	0.123
	16	0.314	0.030	0.023	0.123		12	0.462	0.049	0.052	0.126
	20	0.307	0.030	0.025	0.122		16	0.458	0.048	0.061	0.118
	24	0.313	0.030	0.022	0.106		20	0.458	0.045	0.059	0.124
	28	0.306	0.031	0.024	0.115		24	0.454	0.045	0.055	0.115
	32	0.315	0.034	0.020	0.097		28	0.458	0.043	0.061	0.119
	36	0.313	0.032	0.021	0.104		32	0.464	0.048	0.060	0.128
BT2-1	4	0.315	0.025	0.022		*	36	0.444	0.042	0.059	0.118
D 1 L- 1	8		0.025	0.023	0.120						
		0.317	0.027	0.023	0.122	BM2-4	4	0.440	0.044	0.055	0.119
	12	0.305	0.025	0.022	0.115		8	0.450	0.058	0.064	0.117
	16	0.320	0.029	0.022	0.120		12	0.450	0.053	0.053	0.113
	20	0.318	0.030	0.021	0.120		16	0.454	0.053	0.055	0.109
	24	0.320	0.031	0.020	0.115		20	0.444	0.049	0.047	0.116
	28	0.321	0.031	0.021	0.113		24	0.465	0.045	0.058	0.114
BT2-2	4	0.326	0.027	0.021	0.120		28	0.448	0.051	0.060	0.120
~	8	0.318	0.032	0.021			32	0.463	0.048	0.060	0.126
	12	0.318	0.032		0.122		36	0.451	0.051	0.058	0.111
	16	0.320	0.028	0.022	0.117						
	20	0.320		0.023	0.122	BM2-5	4	0.455	0.047	0.056	0.124
•	24	0.315	0.030	0.022	0.114		. 8	0.457	0.055	0.043	0.115
	~ <b>T</b>	0.310	0.030	0.021	0.106		12	0.453	0.048	0.052	0.115

### TABLE F-2. WELD DIMENSIONS FOR SINGLE-WELD BULGE PANELS (Cont'd)

Panel	Α	w	h	d	e	Panel	Α	w	h	d	e
No.			Inches			No.			Inche		_
BM2-5	16	0.453	0.052	0.053	0.118	CT3-7	8	0.283	0.029	0.026	0.121
(cont'd)	20	0.457	0.044	0.059	0.120	(cont'd)	12	0,278	0.026	0.026	0.122
	24	0.460	0.042	0.059	0.125		16	0.283	0.031	0.020	0.121
	28	0.456	0.040	0.058	0.118		20	0.273	0.033	0.024	0.117
	32	0.472	0.047	0.059	0.115		24	0.289	0.021	0.024	0.121
	36	0.460	0.043	0.061	0.118		28	0.278	0.030	0.029	0.122
	_						32	0.276	0.029	0.034	0.123
CT3-5	4	0.271	0.044	0.024	0.088						
	8	0.271	0.043	0.025	0.100	CT3-8	4	0.296	0.034	0.024	0.107
	12	0.270	0.044	0.023	0.095		8	0.304	0.032	0.024	0.103
	16	0.271	0.046	0.025	0.103		12	0.299	0.035	0.025	0.103
	20	0.274	0.039	0.027	0.113		16	0.290	0.035	0.023	0.104
	24	0.279	0.040	0.026	0.118		20	0.304	0.033	0.022	0.105
	28	0.280	0.045	0.027	0.083		2 <b>4</b>	0.307	0.035	0,024	0.105
	32	0.280	0.042	0.028	0.120		28	0.309	0.032	0.027	0.106
CT3-6		0 204	0.040	0.03/	0.130		32	0.311	0.035	0.024	0.105
C13-0	4	0.284	0.040	0.026	0.127						
	8	0.252	0.032	0.029	0.120	CT3-9	4	0.280	0.026	0.024	0.120
	12	0.282	0.027	0.044	0.122	013 /	8	0.269	0.025		
	16	0.286	0.035	0.029	0.120					0.028	0.118
	20	0.286	0.033	0.040	0.118		12	0.276	0.027	0.025	0.116
	24	0.270	0.036	0.022	0.116		16	0.275	0.027	0.023	0.116
	28	0.287	0.037	0.045	0.114		20	0.277	0.027	0.019	0.110
	32	0,270	0.032	0.021	0.104		24	0.278	0.024	0.021	0.119
							28	0.276	0.026	0.020	0.112
CT3-7	4	0.285	0.030	0.028	0.123		32	0.277	0.027	0.023	0.109

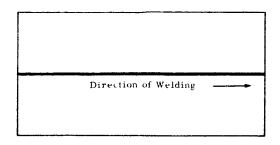
### TABLE F-3. WELD DIMENSIONS FOR CROSS-WELD BULGE PANELS

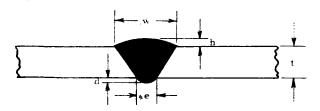




	Bead No. 1		Bead No. 2		Bead No. 1		Dec 1 No. 2
Panel A	w h d	e B	w h d e	Fanel A	w h d	e B	Bead No. 2 w h d e
No.	Inches		Inches	No.	Inches	e n	w h d e Inches
AT1-1 4	0.250 0.024 0.04-	0.121 4	0.275 0.023 0.052 0.140		0.280 0.030 0.037	0 126 24	
8	0.260 0.030 0.03		0.225 0.021 0.057 0.140		0.240 0.028 0.051		0.241 0.028 0.049 0.123
1.2	0.240 0.023 0.046	0.125 12	0.240 0.024 0.057 0.132				
16	0.241 0.022 0.049	0,122 16	0.250 0.027 0.038 0.131				0.269 0.023 0.041 0.132
20	0.250 0.026 0.044	0.124 20	0.247 0.027 0.047 0.127		0,292 0,024		0,258 0.026
24	0.300 0.024 0.05		0.256 0.033 0.037 0.125		0.251 0.030	4	0.043 0.125
28	0,267 0.037 0.038	0,125 28	0,255 0,037 0,038 0,125	4	0,255 0,028 0,029		
AT1-4 4	0,246 0.022 0.042	0 125 4	0,282 0.016 0,051 0,135		0.282 0.019	7	0.280 0.021
8	0,246 0,022 0,04		0.234 0.021 0.052 0.135	7-1/8 8	0,270 0,031 0,291 0,021 0,043		0.310 0.031
12	0,250 0.026 0.047		0,225 0.027 0.061 0.132	10	0.268 0.022		
16	0,253 0,024 0.043		0.240 0.018 0.052 0.130	12	0.255 0.029 0.032		0,270 0.033
20	0,282 0,030 0,032		0.247 0.025 0.044 0.130		0.285 0.020	12	0,255 0,025
2.4	0.285 0.031 0.041	0.115		16	0.290 0.019 0.042		
28	0.263 0.025 0.031	0,120		17	0.265 0.040		0.270 0.030
AT1-5 4	0.240 0.024 0.046	0.112	A 145 A 010 A 05/ T 15		0.200 0.010	16	0.033 0.125
8	0.233 0.021 0.049		0.245 0.020 0.056 0.135				0.270 0.031
12	0.250 0.028 0.041		0.232 0.019 0.057 0.135	TC # 1/1	0.14.0.000.0.00		
16	0.260 0.030 0.031		0.245 0.021 0.055 0.135 0.245 0.025 0.052 0.125				
20	0.242 0.026 0.042		0.272 0.029 0.044 0.125	4 8	0.289 0.040 0.020 0.260 0.025 0.018		0.275 0.025 0.031 0.125
24	0.240 0.023 0.049		0.212 0.027 0.044 0.125	12	0.290 0.023 0.039		0.304 0.023 0.033 0.120
28	0,255 0,025 0,040			16	0.304 0.040 0.042		0,265 0,016 0,031 0,135 0,306 0,040 0,031 0,135
				••	0.304 0.040 0.042	0.110 16	0.300 0.040 0.031 0.135
AT1-6 4	0.245 0.028 0.025		0.225 0.021 0.048 0.135	TC -0 1/2	0.265 0.026 0.036	0.125 1/2	0,235 0.028 0.033 0.131
. 8	0.256 0.029 0.032		0.230 0.022 0.050 0.132	4	0.250 0.027 0.027	0.115 4	0.245 0.028 0.041 0.125
12	0.235 0.023 0.045		0.223 0.033 0.050 0.125	8	0,255 0,029 0,027		0.265 0.027 0.038 0.125
16 20	0.243 0.013 0.040		0.240 0.027 0.050 0.123	12	0,260 0.027 0.030		0.245 0.012 0.034 0.120
24	0.231 0.011 0.050		0.241 0.029 0.049 0.125	16	0,255 0,025 0,034	0.124 16	0.292 0.014 0.035 0.125
28	0.232 0.022 0.049 0.240 0.024 0.048			TC-10 1/2	0,275 0.031 0.026	0 121 1/2	0.250 0.018 0.028 0.125
=-	•	• .		4	0.250 0.027 0.029		0.265 0.018 0.042 0.125
AT1-8 4	0.250 0.023 0.033		0,238 0,021 0,044 0,135	8	0.285 0.031 0.027		0.275 0.017 0.044 0.120
8	0.264 0.022 0.041		0.241 0.026 0.043 0.125	12	0,265 0,031 0.028		0.235 0.029 0.038 0.124
12	0,250 0.033 0.038		0.236 0,026 0.044 0.125	16	0.260 0.033 0.022	0.120 16	0.255 0.033 0.033 0.125
16	0.239 0.027 0.047		0.264 0.023 0.041 0.125				
20	0.225 0.022 0.053		0.238 0.026 0.046 0.125		0.275 0.035 0.021		0,285 0.020 0.024 0.125
24 28	0.224 0.022 0.053		0.235 0.028 0.047 0.125	4 8	0.250 0.031 0.029		0.250 0.020 0.034 0.125
28	0.225 0.025 0.054	0.123 28	0,235 0,029 0.051 0.124	12	0,270 0,031 0,030 0,265 0,036 0,026		0.250 0.019 0.033 0.125
AT1-9 4	0.282 0.024 0.041	0.121 4	0,241 0,024 0,046 0,125	16	0.265 0.032 0.026		0.250 0.029 0.033 0.123
8	0.295 0.021 0.035		0.236 0.023 0.052 0.125	10	0.203 0.032 0.020	0.113 10	0,246 0.030 0.035 0.125
12	0.285 0.016 0.048		0.238 0.024 0.052 0.125	TC-12 1/2	0.260 0.030 0.027	0.125 1/2	0,288 0,024 0,025 0,135
16	0.296 0.031 0.038		0.288 0.022 0.046 0.125	4	0.260 0.033 0.028	0.125 4	0.275 0.023 0.037 0.135
20	0.310 0.029 0.036	0.124 20	0.250 0.027 0.046 0.125	8	0.262 0.032 0.026		0.267 0.024 0.045 0.125
				12	0.263 0.030 0.031		0.240 0.026 0.035 0.124
				16	0.267 0.032 0.042	0.120 16	0.261 0.032 0.034 0.125

## TABLE F-4. WELD DIMENSIONS FOR 0.187-INCH AND 0.50-INCH SQUARE BUTT WELDMENTS

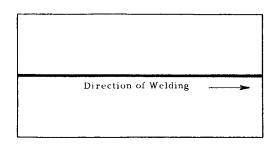


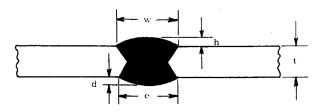


A - distance from start of weld

Panel No.	A	w	h Inches	d	e	Panel No.	Α	w	h Inche	đ	e
CT3-1	4	0.340	0.039	0.056	0.131	CM5-2	4	0.492	0, 076	0.054	0,125
t = 0, 187"	8	0.340	0.040	0.056	0.131	t = 0.187''	8	0.461	0.078	0.054	0.125
	12	0.340	0.039	0.061	0.130	1 - 0.107	12	0.486	0.081	0.051	0.118
	16	0.340	0.036	0.053	0.130		16	0.520	0.018	0.059	0.115
	20	0.340	0.040	0.048	0.135		20	0.320	0.081	0.050	0.125
	24	0.340	0.051	0.026	0.087		24	0.475	0.072	0.053	0.135
	28	0.340	0.046	0.028	0,100		28	0.480	0.085	0.046	0.125
	32	0.340	0.038	0.053	0.120		32	0.503	0.083	0.048	0.125
CT4-1	4	0.357	0.040	0.051	0.132	CT3-2	2.5			0.052	0.492
t = 0.187"	8	0,353	0.040	0.052	0.125	t = 0.50''	4	0.500	0.066		
	12	0.353	0.036	0.052	0.125		8	0.500	0.067		
	16	0.353	0.037	0.052	0.120		12	0.510	0.070		
	20	0.353	0.041	0.044	0.121		14			0.050	0.490
	24	0.353	0.039	0.044	0.118		16	0.510	0.069		
	28	0.350	0.040	0.047	0.118		18			0.058	0.490
	32	0.350	0.036	0.054	0.120		20	0.510	0.066	0 05=	
CT5-5	4	0.315	0.049	0.034	0.115		22	0.510	0.0/0	0.057	0.490
t = 0.187"	8	0.330	0.050	0.039	0.116		24	0.510	0.069	0.057	0 400
	12	0.331	0.053	0.033	0.106		26 28	0.510	0,069	0.057	0.490
	16	0.331	0.048	0.040	0.113		30	0.510	0.069	0.057	0 400
	20	0.325	0.055	0.027	0.100		32	0.510	0.066	0.057	0.490
	24	0.331	0.051	0.033	0.113		34	0.510	0.000	0.068	0.490
	28	0.345	0.050	0.034	0.118		34			0.068	0.490
	32	0.345	0.048	0.044	0.120	CT4-2	4	0.495	0.063	0.058	0.510
CM3-1	4	0.495	0.077	0.055	0,115	t = 0.50	. 8	0.495	0.070	0.050	0.515
t = 0.187"	8	0.480	0.082	0.051	0.115		12	0.495	0.070	0.049	0.515
	12	0.467	0.084	0.048	0.115		16	0.495	0.067	0.059	0.510
	16	0.510	0.077	0.052	0.115		20	0.495	0.066	0.056	0.515
	20	0.495	0.076	0.054	0.141		24	0.495	0.067	0.056	0.510
•	24	0.495	0.083	0.047	0.120		28	0.495	0.067	0.058	0.500
	28	0.495	0.083	0.052	0.120		32	0.495	0.067	0.060	0.500
	32	0.495	0.088	0.049	0.115	CT5-6	4	0.450	0.065	0.051	0,545
CM4-1	4	0 510	0.00/	0.054		t = 0.50"	8	0.450	0.066	0.054	0,535
t = 0.187''	4	0.510	0.086	0.054	0.120		12	0.475	0.061	0.045	0.535
1 - 0.107	8 12	0.500 0.500	0.082	0.050	0.110		16	0.470	0.057	0.052	0.505
	16	0.500	0.088	0,049	0.110		20	0.470	0.056	0.056	0.505
	20	0.527	0.081	0.053	0.120		24	0.470	0.062	0.056	0.505
	24	0.510	0.077	0.053	0.131		28	0.470	0.062	0.050	0.505
	24 28	0.510	0.081	0.045	0.120		32	0.475	0.046	0.050	0.505
	32	0.520	0.087	0.046	0.120					-	- "
ì	24	0.040	0.088	0.050	0.110						

### TABLE F-5. WELD DIMENSIONS FOR 0.50-INCH AND 1.00-INCH DOUBLE V WELDMENTS





A = distance from start of weld

					•						
Panel No.	A	w	h Inches	d	e	Panel No.	Α	w	h <b>I</b> nches	d	e
CT3-3	4	0. 175	0.070	0.057	0.480	CM3-2	4	0.655	0.067	0.100	0.691
t = 1.00"	ő	0.500	0.075	0.067	0.490	t = 0.50"	8	0.610	0.070	0.102	0.675
	12	0.525	0.078	0.061	0.500		12	0.610	0.068	າ.09ຮ	0.665
	16	0.520	0.952	0.029	0.450		16	0.610	0.066	0.098	0.665
	20	0.525	0.052	0.020	0.480		20	0.625	0.062	0.096	0.690
	24	0.525	0.049	0.032	0.500		24	0.6:0	0.075	0.094	0.680
	28	0.520	0.066	0.930	0.480		28	0.610	0.075	0.098	0.690
	32	0.525	0.067	0.039	0.480		32	0.624	0.0.79	0.101	0.630
CT3-4	4	0.475	0.046	0.050	0.395	CM3-3	4	0.980	0.076	0.950	0.099
t = 0.50"	8	0.475	0.045	0.049	0.395	t = 1.00"	8	0.975	0.080	0.950	0.098
	12	0.512	0.049	0.045	0.400		12	0.975	0.079	0.955	0.096
	16	0.512	0.042	0.045	0.400		16	0.965	0.079	0.950	0.097
	20	0.520	0.042	0.744	0.410		20	0.970	0.079	0.950	0.098
	24	0.520	0.049	0.046	0.410		24	0.965	0.079	0.950	0.10:
	28	<b>0.</b> 5±0	0.050	0.042	0.410		28	0.965	0.077	0.950	0.058
	32	0.525	0.044	0.949	0.410		31	0.965	0.069	0.950	0.086
CT4-3	4	0.500	0.025	0.029	0.475	CM4-2	4	0.635	0.082	0.041	0.500
$t = 1.00^{11}$	8	0.510	0.035	0.040	0.515	t = 0.50"	8	0.670	0.087	0.043	0.580
	12	0.510	0.039	0.047	0.500		12	0.650	0.067	0.040	0.580
	16	0.493	0.033	0.050	0.500		16	0.640	0.081	0.042	0.580
	20	0.500	0.029	0.046	0.500		20	0.610	0.079	0.052	0.617
	24	0.500	0.028	0.044	0.500		24	0.650	0.084	0.051	0.617
	28	0.500	0.026	0.038	0.500		28	0.625	0.071	0.054	0.617
	32	0.510	0.032	0.043	0.525		32	0.605	0.071	0.049	0.625
CT4-4	4	0.479	0.038	0.041	0.400	CM4-3	4	0.975	0.043	0.985	1,000
$t = 0.50^{11}$	გ	0.490	0.034	0.043	0.400	t = 1.00"	8	0.990	0.053	0.101	0.975
	12	0.475	0.036	0.047	0.402		12	1.029	0.058	0.094	0.975
	16	0.486	0.032	0.043	0.400		16	1.024	0.070	0.086	0.975
	20	0.475	0.045	0.046	0.400		20	1.024	0.063	0.094	0.960
	24	0.495	0.040	0.0 ±5	0.400		24	1.015	0.063	0.994	0.970
	28	0.484	0.037	0.048	0.390		28	1.010	0.052	0.090	0.970
	32	0.490	0.039	0.041	0.400		32	0.99)	0.044	0.080	0.970
CT5-7	4	0.500	0.065	0.077	0.537	CM5-1	4	0.625	0.082	0.104	0.661
t = 1.00"	8	0.485	0.074	0.099	0.525	t = 0.50"	8	0.625	0.098	0.103	0.675
	12	0.473	0.920	0.044	0.525		9.5	0.590	0.081		
	16	0.500	0.019	0.043	0.550		12	0.605	0.084	0.103	0.695
	20	0.500	0.019	0.040	0.555		16	0.600	0.087	0.102	0.685
	24	0.513	0.027	0.040	0.538		20	0.586	0.086	0.103	0.690
	28	0.525	0.039	0.037	0.526		24	0.600	0.095	0.117	0.690
	32	0.525	0.038	0.027	0.520		28	0.640	0.088	0.104	9.690
CT5-8	4	0.422	0.058	0.03/	0.350		32	0.660	0.091	0.099	0.710
t = 0.50"	8			0.026	0.370	C) 45 2	4	0.050			
	12	0.455 0.507	0.040 0.049	0.030	0.396	CM5-3 t = 1.00"	4	0.950	0.052	0.074	0.950
	16	0.307	0.049	0.030	0.396	ι = ι.σσ	8 12	0.983	0.082	0.080	0.958
	20	0.495	0.046	0.030	0.396		16	0.955	0.072	0.094	0.960
	24	0.500	0.046	0.035	0.396		20	0.975	0.084	0.099	0.960
	28	0.475	0.034	0.036 0.037	0.396		20 24	0.975	0.088	0.077	0.985
	32	0.475	0.043	0.037	0.396 ).396		28	0.975 0.975	0.082	9.098	0.970
	34	0. 776	0.043	0.939	1.390		28 32		0.068	0.110	0.975
							36	0.975	0.069	0.089	0.965

#### APPENDIX G

PHASE I BULGE TEST, TENSILE TEST, CYLINDER
TEST AND MIT TEST DATA
(Contract No. NAS8-20160)

TABLE G-1.

1:1 HYDRAULIC BULGE TEST STRESS ANALYSIS DATA FOR 2219-T87 PARENT METAL PANELS

Positions(b)	6 in.	2110	1440	1330	3930	2670	2220	6250	4430	3500	2090	5150	4030	7970	5920	4590	704	1570		2020	3840	4550	6700	8700			
Various Pos	2 in.	1770	1710	1610	3500	3180	2940	0609	5440	4950	7500	6520	2900	0006	7550	6830	711	1456	2970	1710	3320	3950	6480	8720			
Microstrain at	1/2 in.		(0)			(C			(2)			(၁)			(3)		(0)	(2)	(2)	1680	3260	3910	6380	8510		•	·
Surface A	0	1730	1750	1640	3420	3290	2970	0909	5750	4990	7480	6850	0969	8940	8040	0269	673	1385	2680	1640	3210	3820	6230	8320			
Gage	Angle(a)	0	120	240	0	120	240	,0	120	240	0	120	240	0	120	240	0	٥	0	0	0	0	0	0			
Height,	'n.		0.55			0.85	•		1.13			1,23			1.33		0.30	0.51	0.83	0.54	0.80	06.0	1.20	1.40	-		
Pressure,	psi	,	40			112	•		802	•		240			268		00	26	96	40	112	144	232	286			
Panel	No.								A-1									A-2				A-3	i			•	

(a) Angle of strain gage element to reference axis, degrees.(b) Distance of strain gage from center of panel.(c) Strain gage was not placed at this position.

## TABLE G-2.

# 1:1 HYDRAULIC BULGE TEST STRESS ANALYSIS DATA FOR TIG 2219-T87/2319 SINGLE-WELD PANELS

Weld Metal Microstrain	2, 410	11,000	• 1	1, 840	2, 520	• •	1, 820 1, 610	3, 050 5, 890	<b>4,</b> 570 20, 900
Center	1, 760	2, 890 10, 900	1 1	2,020	2, 610 10, 800		2, 010	3, 710 6, 220	6, 180 18, 400
W W	06	06 0	06 0	96	06 0	06 0	90	06 0	06
Parent Metal Microstrain	1740 1600 1920	2590 2360 2590	3920 3650 3720	1820 1790 1950	2460 2470 2510	3630 3730 3480	1810 1680 1890	2750 2770 2790	3730 3830 3710
Parent h	45 165 285								
Height,	0.70	1.03	1.33	0.81	1.0(b)	1.3(b)	0.70	1.00	1.31
Pressure,	40	- 68	164	50	85	158	4-1	93	165
Panel	No.	AT1-2			AT1-3			AT1-7	

<sup>(</sup>a) Angle of strain gage element to reference axis through weld, degrees. (b) Estimated value. Deflectometer inoperative.

TABLE G-3.

1:1 HYDRAULIC BULGE TEST STRESS ANALYSIS DATA FOR TIG 2219-T87/2319 CROSS-WELD PANELS

1:1 HYDRAULIC BULGE TEST STRESS ANALYSIS

TABLE G-4.

DATA FOR 2219-T87 PARENT METAL PANELS

WITH A REDUCED CENTER SECTION

0 120 240

Panel	Pressure,	H	Parent 1	Parent Metal Microstrain	*	eld Metal	Weld Metal Microstrain	Danal	Dressing	Hotok	5.11				_
No.	pst	in.	Angle(a)	2 In. from Center	Angle(a)	Center	2 In. from Center	No.	psi	neignt, in.	Angle(a)	Angle(a) 2 in. from Center	Reduced Section Microstrain Angle(a) Center	n Microstrain Center	
<i>:</i>	45	09.0	45 165 285	1670 1620 1700	06	2, 200	1, 740 1, 950		40	0.62	0 120 240	1880 1800 1880	0 120 240	2, 220 2, 220 2, 340	
AT1-1	81	0.80	45 165 285	2370 2320 2380	06	12, 200 9, 860	2, 660	A-8	108	0.91	0 120 240	3230 3140 3300	0 120 . 240	3, 910 3, 800 4, 020	
	150	1.10	45 165 285	3450 3310 3390	06	. 1	3, 820 10, 500		220	1.30	0 120 240	5320 6050 6210	0 120 240		
	42	0.82	45 165 285	1590 1610 1900	06	2, 290 3, 210	1, 970		33	0.55	0 120 240	1660 1540 1470	0 120 240	2, 340 2, 130 2, 030	
AT1-8	80	1.02	45 165 285	2340 2310 2750	06 0	5, 590	2, 770	A-9	120	0.95	0 120 240	3410 3350 3160	120 240	6, 950 5, 430 5, 020	
	142	1.30	45 165 285	3350 3170 3740	06		4, 140		220	1.32	0 120 240	5520 6210 5600	0 120 240	24, 700 16, 200 12, 700	
	48	0.71	45 165 285	1800 1970 1550	06 0	3, 960 3, 840	1, 850 1, 450		39	0.63	0 120 240	1690 1780 1770	0 120 240	2, 950 3, 080 3, 000	
AT1-9	80	06.0	45 165 285	2420 2600 2020	06	8, 340 7, 520	2, 500 3, 180	A-25	104	0.92	0 120 240	3220 3280 3340	0 120 240	6, 700 7, 140 7, 300	
	140	1.20	45 165 285	3500 3550 2780	06 0	1 1	3, 240 8, 690		210	1.30	0 120 240	4950 6570 6860	0 120 240	19, 800	

(a) Angle of strain gage element to reference axis through one of the welds, degrees.

TABLE G-5.

1:1 HYDRAULIC BULGE TEST STRESS ANALYSIS DATA FOR 2219-T87 PARENT METAL PANELS WITH A MACHINED GROOVE

Panel No.		A-16			A-17			A-18	
Reduced Section Microstrain e(a)   Center   2 In. from Center	2, 640	4, 770	28, 300	3 (			, t	1 1	1 1
ced Section		2, 370 5, 420	3, 220 39, 300	1, 790	3, 000	4, 700	1, 540 3, 360	2, 460 6, 600	3, 940 32, 800
Redu Angle(a)	06	06	06 O	06 0	06	06	06	06	06
Full Thickness Microstrain	1540	2410	3020	1920 1960 2000	2910 3020 3120	3680 3770 4270	1670 1720 \times 1690	2570 2590 2640	3290 3450 3370
Full Thic	45 165 285	45 165 285	45 165 285	45 165 285	45 165 285	45 165 285	45 165 285	45 165 285	45 165 285
Height,	0.52	0.71	06.0	0.65	06.0	1.10	0.62	0.83	1.01
Pressure,	38	78	125	46	86	154	32	74	118
Panel		A-13			A-14			A-15	

(a) Angle of strain gage element to reference axis through groove, degrees.

# TABLE G-6.

# 1:1 HYDRAULIC BULGE TEST STRESS ANALYSIS DATA FOR 2219-T87 PARENT METAL PANELS WITH A MACHINED CROSS GROOVE

Panel	Pressure.	Height.	Full Thic	Full Thickness Microstrain	Redu	ced Sectio	Reduced Section Microstrain
No.	psi	in.	Angle(a)	2 In. from Center	Angle(a)	Center	2 In. from Center
			45	1570	0	2170	1,440
	14	0.53	165	1570	06	2660	2,960
			285	1620			
						2,72	0.00
			45	2380	0	3630	2, 310
A-16	. 78	0.72	165	2430	06	4670	5, 520
			582	2550			
			45	3570	0	-	•
	148	1.00	165	3710	96		•
			582	3790			
			45	2060	0	3060	1,830
	48	0.62	165	1780	90	3100	4, 220
			285	1770	Ş.		
			45	2990	0	6020	2, 830
A-17	95	0.82	165	2550	96	6500	10, 700
			285	2600			
			45	3690	٥		4,020
	132	1.00	165	3180	06	,	37, 400
			285	3240			
			45	1710	0	2720	1, 720
	44	0.62	165	1880	90	2820	3, 880
			285	1920			
			45	2470	0	4620	2, 730
A-18	84	0.81	165	2740	06	5820	9,370
			285	2880			
			45	3080	0	٠	4, 360
	126	1.00	165	3420	06	ı	43,000
			285	3580			

(a) Angle of strain gage element to reference axis through one of grooves, degrees.

## TABLE G-7.

1:1 HYDRAULIC BULGE TEST PRESSURE -BULGE HEIGHT - STRAIN DATA FOR 2219-T87 PARENT METAL PANELS

		_																				
(a) €	µin. /in.		840	1190	1710	2250	2740	3320	3950	4660	5580	6480	7640	8720	,	ı	,	,	•	•	,	
'd	psi		12	22	40	61	84	112	144	175	807	232	258	586	.325	•	400	•	•	480	•	
,h	in.		0.33	0.42	0.54	0.64	0.73	0.83	0.93	1.03	1.14	1.22	1.33	1.42	1.52	. •	1.72	•		2.00	•	
(a)	µin. /in.		711	1050	1460	1920	2440	2970	3410	3880		,		,	,		,	,	,			
'd	psi		œ	16	92	45	20	96	124	132	•	220		922	,	332	•	390				
'n,	in.		0.30	0.41	0.51	0.62	0.73	0.83	0.92	1.00		1.20		1.40		1.60	•	1.80		2.00	•	
(७)∍	uin. /in.	,	930	1, 295	1, 700						5, 490	6,670	7, 780	9, 180	10, 500	,	ı	,		•		
ď	psi		14	24	\$	64	8	112	144	176	807	240	897	302	334	360	380	410	440	464	200	
'n	in.		0.35	0.46	0.55	0.65	0.74	0.85	0.94	1.03	1.13	1.23	1.33	1.44	1.55	1.63	1.73	1.83	1.93	2.03	2, 15	
Height,	in.		0.3	4.0	6.6	9.0	0.7	8.0	6.0	1.0	1:1	1.2	1.3	1.4	1.5	1.6	1.7	8.	1.9	2.0	2.1	
	$h, p, \epsilon(a)$ $h, p, \epsilon(a)$ $h, p, $	h, p, ε(a) h, p, ε(a) h, p, iii. jii jii jii psi μin. /iii. jiii psi	h, p, $\epsilon(a)$ h, p, $\epsilon(a)$ h, p, in. je, in. psi in. fin. psi	h, p, e(a) h, p, e(a) h, p, in. lin. psi in. /in. h, p. o.35 14 930 0.30 8 711 0.33 12	h, p, e(a) h, p, e(a) h, p, in. lin. jp, in. lin. psi in. lin. jp, in. lin. lin. jp, in. lin. lin. lin. in. jp, in. lin. lin. lin. lin. lin. lin. lin.	h, p, e(a) h, p, e(a) h, p, e(a) h, p, p, 10.35 14 930 0.30 8 711 0.33 12 0.46 24 1, 295 0.41 16 1050 0.42 25 0.55 40 1,700 0.51 26 1460 0.54 40	h, p, e(a) h, p, e(a) h, p, hin./in. in. pei in. o.35 14 930 0.30 8 711 0.33 12 0.54 40 1.700 0.51 26 1460 0.54 40 0.65 44 2, 240 0.65 45 1920 0.64 61	h, p, e(a) e(a) e(a) e(a) e(a) e(a) e(a) e(a)	h, p, e(a) h, p, e(a) h, p, e(a) h, p, e(a) h, p, p, e(a) h, p, pi min./in. in. psi min./in. in. psi n. d.	in. psi µin./in. in, psi 0.35 14 930 0.30 8 711 0.33 12 0.46 24 1,295 0.41 16 1050 0.42 22 0.55 40 1,700 0.51 26 1460 0.54 40 0.65 64 2,240 0.62 45 1920 0.54 40 0.75 64 2,530 0.73 70 2440 0.53 84 0.85 112 3,210 0.83 96 2970 0.83 112 0.94 144 3,860 0.92 124 3410 0.93 144	h, p, e(a) h, p, e(a) h, p, h,	h,         p,         e(a)         h,         p,         e(a)         h,         p,           in.         psi         µin./in.         in.         psi         µin./in.         in.         psi           0.35         14         930         0.30         8         711         0.33         12           0.46         24         1,700         0.51         26         1460         0.54         22           0.55         40         1,700         0.51         26         1460         0.54         40           0.65         44         2,530         0.73         70         2440         0.74         61           0.74         80         2,630         0.73         70         2440         0.73         84           0.85         112         3,210         0.83         96         2970         0.83         112           0.94         144         3,860         0.92         124         3410         0.93         144           1.03         175         4.90         -         -         -         1.14         208	h,         p,         e(a)         h,         p,         e(a)         h,         p,           in.         psi         µin./in.         in.         psi         µin./in.         in.         psi           0.35         14         930         0.30         8         711         0.33         12           0.46         24         1,295         0.41         16         1050         0.42         22           0.55         40         1,700         0.51         26         1460         0.54         40           0.65         44         2,540         0.62         45         1920         0.64         61           0.74         80         2,630         0.73         70         2440         0.73         84           0.85         112         3,210         0.83         96         2970         0.83         114           1.03         176         4,560         0.02         124         3410         0.93         144           1.13         208         5,490         -         -         -         1.03         175           1.23         240         6,670         1.20         220         - <td< td=""><td>h,         p,         e(a)         h,         p,         e(a)         h,         p,           in.         psi         µin./in.         in.         psi         µin./in.         in.         psi           0.35         14         930         0.30         8         711         0.33         12           0.46         24         1,295         0.41         16         1050         0.42         22           0.55         40         1,700         0.51         26         45         1920         0.42         22           0.74         80         2,500         0.62         45         1920         0.54         40           0.85         112         3,210         0.83         96         2970         0.83         112           0.94         144         3,860         0.92         124         3410         0.93         144           1.03         208         1,560         1.00         132         3880         1.03         175           1.123         208         5,490         -         -         -         1.14         208           1.33         268         7,780         -         -         <td< td=""><td>h,         p,         e(a)         h,         p,         e(a)         h,         p,           in.         psi         µin./in.         in.         psi         µin./in.         in.         psi           0.35         14         930         0.30         8         711         0.33         12           0.54         24         1,295         0.41         16         1050         0.42         22           0.55         40         1,700         0.51         26         1460         0.54         40           0.65         64         2,630         0.73         70         2440         0.73         84           0.74         80         2,630         0.73         70         2440         0.73         84           0.74         80         2,630         0.73         70         2440         0.73         84           0.98         112         3,210         0.83         96         2970         0.83         112           0.99         144         3,660         1.00         132         380         1.03         174           1.13         208         5,490         -         -         -</td><td>h,         p,         e(a)         h,         p,         e(a)         h,         p,           in.         psi         µin./in.         in.         psi         µin./in.         in.         psi           0.35         14         930         0.30         8         711         0.33         12           0.46         24         1,295         0.41         16         1050         0.42         22           0.55         40         1,700         0.51         26         1460         0.54         40           0.65         44         2,630         0.73         70         2440         0.73         84           0.74         80         2,630         0.73         70         2440         0.73         112           0.85         112         3,210         0.83         96         2970         0.83         112           1.03         124         3410         0.73         174         114           1.10         4,90         -         -         -         1.93         184           1.13         208         5,490         -         -         -         1.14         208           1.33</td></td<><td>h,         p,         e(a)         h,         p,         e(a)         h,         p,           in.         psi         µin./in.         in.         psi         µin./in.         in.         psi           0.35         14         930         0.30         8         711         0.33         12           0.46         24         1,295         0.41         16         1050         0.42         22           0.55         40         1,700         0.51         26         1460         0.54         40           0.65         46         2,630         0.73         70         2440         0.73         84           0.85         112         3,210         0.83         96         2970         0.63         114           0.94         144         3,860         0.92         124         3410         0.93         144           1.03         176         4,560         1.00         132         3880         1.03         175           1.13         240         6,670         1.20         220         -         1.22         232           1.33         268         7,780         -         -         1.42</td><td>h,         p,         e(a)         h,         p,         e(a)         h,         p,           in.         psi         µin./in.         in.         psi         µin./in.         in.         psi           0.35         14         930         0.30         8         711         0.33         12           0.54         24         1,795         0.41         16         1050         0.42         22           0.55         40         1,700         0.51         26         1460         0.54         40           0.74         80         2,630         0.73         70         2440         0.73         84           0.74         80         2,630         0.73         70         2440         0.73         84           0.74         80         2,630         0.73         70         2440         0.73         84           0.94         144         3,860         0.92         124         3410         0.93         114           1.03         176         4,560         1,00         132         3880         1.03         174           1.13         208         5,490         -         -         -         <t< td=""><td>h,         p,         e(a)         h,         p,         e(a)         h,         p,           in.         psi         µin./in.         in.         psi         µin./in.         in.         psi           0.35         14         930         0.30         8         711         0.33         12           0.46         24         1,295         0.41         16         1050         0.42         22           0.65         44         2,630         0.73         70         2440         0.74         64           0.74         80         2,630         0.73         70         2440         0.73         84           0.85         112         3,210         0.83         96         2970         0.83         112           0.85         176         4,560         0.92         124         340         0.73         144           1.03         176         4,560         0.92         124         340         0.93         144           1.03         176         4,560         1.20         22         -         1.14         208           1.13         208         5,490         -         -         -         <td< td=""><td>h,         p,         e(a)         h,         p,         e(a)         h,         p,           in.         psi         µin./in.         in.         psi         µin./in.         in.         psi           0.35         14         930         0.30         8         711         0.33         12           0.46         24         1,295         0.41         16         1050         0.42         22           0.65         44         1,700         0.51         26         456         0.42         22           0.65         44         2,630         0.73         70         2440         0.73         84           0.85         112         3,210         0.83         96         2970         0.83         112           0.86         112         3,860         0.92         124         3410         0.93         144           1.03         208         5,490         -         -         -         1.14         208           1.13         208         5,490         -         -         -         1.14         208           1.23         240         1.50         -         -         -         1.14</td><td>h, p, e(a) h, e(a) h, e(a) h, e(a) e, e,</td><td>h, p, range (a) h, range (a</td></td<></td></t<></td></td></td<>	h,         p,         e(a)         h,         p,         e(a)         h,         p,           in.         psi         µin./in.         in.         psi         µin./in.         in.         psi           0.35         14         930         0.30         8         711         0.33         12           0.46         24         1,295         0.41         16         1050         0.42         22           0.55         40         1,700         0.51         26         45         1920         0.42         22           0.74         80         2,500         0.62         45         1920         0.54         40           0.85         112         3,210         0.83         96         2970         0.83         112           0.94         144         3,860         0.92         124         3410         0.93         144           1.03         208         1,560         1.00         132         3880         1.03         175           1.123         208         5,490         -         -         -         1.14         208           1.33         268         7,780         -         - <td< td=""><td>h,         p,         e(a)         h,         p,         e(a)         h,         p,           in.         psi         µin./in.         in.         psi         µin./in.         in.         psi           0.35         14         930         0.30         8         711         0.33         12           0.54         24         1,295         0.41         16         1050         0.42         22           0.55         40         1,700         0.51         26         1460         0.54         40           0.65         64         2,630         0.73         70         2440         0.73         84           0.74         80         2,630         0.73         70         2440         0.73         84           0.74         80         2,630         0.73         70         2440         0.73         84           0.98         112         3,210         0.83         96         2970         0.83         112           0.99         144         3,660         1.00         132         380         1.03         174           1.13         208         5,490         -         -         -</td><td>h,         p,         e(a)         h,         p,         e(a)         h,         p,           in.         psi         µin./in.         in.         psi         µin./in.         in.         psi           0.35         14         930         0.30         8         711         0.33         12           0.46         24         1,295         0.41         16         1050         0.42         22           0.55         40         1,700         0.51         26         1460         0.54         40           0.65         44         2,630         0.73         70         2440         0.73         84           0.74         80         2,630         0.73         70         2440         0.73         112           0.85         112         3,210         0.83         96         2970         0.83         112           1.03         124         3410         0.73         174         114           1.10         4,90         -         -         -         1.93         184           1.13         208         5,490         -         -         -         1.14         208           1.33</td></td<> <td>h,         p,         e(a)         h,         p,         e(a)         h,         p,           in.         psi         µin./in.         in.         psi         µin./in.         in.         psi           0.35         14         930         0.30         8         711         0.33         12           0.46         24         1,295         0.41         16         1050         0.42         22           0.55         40         1,700         0.51         26         1460         0.54         40           0.65         46         2,630         0.73         70         2440         0.73         84           0.85         112         3,210         0.83         96         2970         0.63         114           0.94         144         3,860         0.92         124         3410         0.93         144           1.03         176         4,560         1.00         132         3880         1.03         175           1.13         240         6,670         1.20         220         -         1.22         232           1.33         268         7,780         -         -         1.42</td> <td>h,         p,         e(a)         h,         p,         e(a)         h,         p,           in.         psi         µin./in.         in.         psi         µin./in.         in.         psi           0.35         14         930         0.30         8         711         0.33         12           0.54         24         1,795         0.41         16         1050         0.42         22           0.55         40         1,700         0.51         26         1460         0.54         40           0.74         80         2,630         0.73         70         2440         0.73         84           0.74         80         2,630         0.73         70         2440         0.73         84           0.74         80         2,630         0.73         70         2440         0.73         84           0.94         144         3,860         0.92         124         3410         0.93         114           1.03         176         4,560         1,00         132         3880         1.03         174           1.13         208         5,490         -         -         -         <t< td=""><td>h,         p,         e(a)         h,         p,         e(a)         h,         p,           in.         psi         µin./in.         in.         psi         µin./in.         in.         psi           0.35         14         930         0.30         8         711         0.33         12           0.46         24         1,295         0.41         16         1050         0.42         22           0.65         44         2,630         0.73         70         2440         0.74         64           0.74         80         2,630         0.73         70         2440         0.73         84           0.85         112         3,210         0.83         96         2970         0.83         112           0.85         176         4,560         0.92         124         340         0.73         144           1.03         176         4,560         0.92         124         340         0.93         144           1.03         176         4,560         1.20         22         -         1.14         208           1.13         208         5,490         -         -         -         <td< td=""><td>h,         p,         e(a)         h,         p,         e(a)         h,         p,           in.         psi         µin./in.         in.         psi         µin./in.         in.         psi           0.35         14         930         0.30         8         711         0.33         12           0.46         24         1,295         0.41         16         1050         0.42         22           0.65         44         1,700         0.51         26         456         0.42         22           0.65         44         2,630         0.73         70         2440         0.73         84           0.85         112         3,210         0.83         96         2970         0.83         112           0.86         112         3,860         0.92         124         3410         0.93         144           1.03         208         5,490         -         -         -         1.14         208           1.13         208         5,490         -         -         -         1.14         208           1.23         240         1.50         -         -         -         1.14</td><td>h, p, e(a) h, e(a) h, e(a) h, e(a) e, e,</td><td>h, p, range (a) h, range (a</td></td<></td></t<></td>	h,         p,         e(a)         h,         p,         e(a)         h,         p,           in.         psi         µin./in.         in.         psi         µin./in.         in.         psi           0.35         14         930         0.30         8         711         0.33         12           0.54         24         1,295         0.41         16         1050         0.42         22           0.55         40         1,700         0.51         26         1460         0.54         40           0.65         64         2,630         0.73         70         2440         0.73         84           0.74         80         2,630         0.73         70         2440         0.73         84           0.74         80         2,630         0.73         70         2440         0.73         84           0.98         112         3,210         0.83         96         2970         0.83         112           0.99         144         3,660         1.00         132         380         1.03         174           1.13         208         5,490         -         -         -	h,         p,         e(a)         h,         p,         e(a)         h,         p,           in.         psi         µin./in.         in.         psi         µin./in.         in.         psi           0.35         14         930         0.30         8         711         0.33         12           0.46         24         1,295         0.41         16         1050         0.42         22           0.55         40         1,700         0.51         26         1460         0.54         40           0.65         44         2,630         0.73         70         2440         0.73         84           0.74         80         2,630         0.73         70         2440         0.73         112           0.85         112         3,210         0.83         96         2970         0.83         112           1.03         124         3410         0.73         174         114           1.10         4,90         -         -         -         1.93         184           1.13         208         5,490         -         -         -         1.14         208           1.33	h,         p,         e(a)         h,         p,         e(a)         h,         p,           in.         psi         µin./in.         in.         psi         µin./in.         in.         psi           0.35         14         930         0.30         8         711         0.33         12           0.46         24         1,295         0.41         16         1050         0.42         22           0.55         40         1,700         0.51         26         1460         0.54         40           0.65         46         2,630         0.73         70         2440         0.73         84           0.85         112         3,210         0.83         96         2970         0.63         114           0.94         144         3,860         0.92         124         3410         0.93         144           1.03         176         4,560         1.00         132         3880         1.03         175           1.13         240         6,670         1.20         220         -         1.22         232           1.33         268         7,780         -         -         1.42	h,         p,         e(a)         h,         p,         e(a)         h,         p,           in.         psi         µin./in.         in.         psi         µin./in.         in.         psi           0.35         14         930         0.30         8         711         0.33         12           0.54         24         1,795         0.41         16         1050         0.42         22           0.55         40         1,700         0.51         26         1460         0.54         40           0.74         80         2,630         0.73         70         2440         0.73         84           0.74         80         2,630         0.73         70         2440         0.73         84           0.74         80         2,630         0.73         70         2440         0.73         84           0.94         144         3,860         0.92         124         3410         0.93         114           1.03         176         4,560         1,00         132         3880         1.03         174           1.13         208         5,490         -         -         - <t< td=""><td>h,         p,         e(a)         h,         p,         e(a)         h,         p,           in.         psi         µin./in.         in.         psi         µin./in.         in.         psi           0.35         14         930         0.30         8         711         0.33         12           0.46         24         1,295         0.41         16         1050         0.42         22           0.65         44         2,630         0.73         70         2440         0.74         64           0.74         80         2,630         0.73         70         2440         0.73         84           0.85         112         3,210         0.83         96         2970         0.83         112           0.85         176         4,560         0.92         124         340         0.73         144           1.03         176         4,560         0.92         124         340         0.93         144           1.03         176         4,560         1.20         22         -         1.14         208           1.13         208         5,490         -         -         -         <td< td=""><td>h,         p,         e(a)         h,         p,         e(a)         h,         p,           in.         psi         µin./in.         in.         psi         µin./in.         in.         psi           0.35         14         930         0.30         8         711         0.33         12           0.46         24         1,295         0.41         16         1050         0.42         22           0.65         44         1,700         0.51         26         456         0.42         22           0.65         44         2,630         0.73         70         2440         0.73         84           0.85         112         3,210         0.83         96         2970         0.83         112           0.86         112         3,860         0.92         124         3410         0.93         144           1.03         208         5,490         -         -         -         1.14         208           1.13         208         5,490         -         -         -         1.14         208           1.23         240         1.50         -         -         -         1.14</td><td>h, p, e(a) h, e(a) h, e(a) h, e(a) e, e,</td><td>h, p, range (a) h, range (a</td></td<></td></t<>	h,         p,         e(a)         h,         p,         e(a)         h,         p,           in.         psi         µin./in.         in.         psi         µin./in.         in.         psi           0.35         14         930         0.30         8         711         0.33         12           0.46         24         1,295         0.41         16         1050         0.42         22           0.65         44         2,630         0.73         70         2440         0.74         64           0.74         80         2,630         0.73         70         2440         0.73         84           0.85         112         3,210         0.83         96         2970         0.83         112           0.85         176         4,560         0.92         124         340         0.73         144           1.03         176         4,560         0.92         124         340         0.93         144           1.03         176         4,560         1.20         22         -         1.14         208           1.13         208         5,490         -         -         - <td< td=""><td>h,         p,         e(a)         h,         p,         e(a)         h,         p,           in.         psi         µin./in.         in.         psi         µin./in.         in.         psi           0.35         14         930         0.30         8         711         0.33         12           0.46         24         1,295         0.41         16         1050         0.42         22           0.65         44         1,700         0.51         26         456         0.42         22           0.65         44         2,630         0.73         70         2440         0.73         84           0.85         112         3,210         0.83         96         2970         0.83         112           0.86         112         3,860         0.92         124         3410         0.93         144           1.03         208         5,490         -         -         -         1.14         208           1.13         208         5,490         -         -         -         1.14         208           1.23         240         1.50         -         -         -         1.14</td><td>h, p, e(a) h, e(a) h, e(a) h, e(a) e, e,</td><td>h, p, range (a) h, range (a</td></td<>	h,         p,         e(a)         h,         p,         e(a)         h,         p,           in.         psi         µin./in.         in.         psi         µin./in.         in.         psi           0.35         14         930         0.30         8         711         0.33         12           0.46         24         1,295         0.41         16         1050         0.42         22           0.65         44         1,700         0.51         26         456         0.42         22           0.65         44         2,630         0.73         70         2440         0.73         84           0.85         112         3,210         0.83         96         2970         0.83         112           0.86         112         3,860         0.92         124         3410         0.93         144           1.03         208         5,490         -         -         -         1.14         208           1.13         208         5,490         -         -         -         1.14         208           1.23         240         1.50         -         -         -         1.14	h, p, e(a) h, e(a) h, e(a) h, e(a) e,	h, p, range (a) h, range (a

(a) Average of three elements of a strain gage rosette at the 2-in. from center position.

## TABLE G-8.

## 1:1 HYDRAULIC BULGE TEST PRESSURE -BULGE HEIGHT - STRAIN DATA FOR TIG 2219-T87/2319 SINGLE -WELD PANELS

Ц.	Nominal	S. S	Snoo No	AT1.	5	Suc.	A T. 1. 2		Car Ma Ami 7	A T 1 1
	Height.	4	ء	(a)	2		2 (a)	1900	1	(B)
-	, u	÷		utn. /tn.	Ē	. 7	utn /in	î .£	Σ, δ	
1									182	H111. / 1111.
	5.5	0.50	15	1040	0.50	10	1000	0.50	8	1130
_	9.0	0.60	292	1340	0.61	` =	1600	09.0	2 00	1450
	0.4	0.70	40	1750	0.73	43	1690	0.70	3 4	1790
	0.8	0.80	53	1930	0.81	20	1850	0,81	57	2120
	6.0	06.0	89	2160	06.0	09	2100	0.91	92	2470
	1.0	1.03	88	2510	1.00	85	2480	1.00	93	2770
_	1.1	1.13	110	2880	1.10	109	2890	1.11	116	3110
-	1.2	1.23	135	3250	1.20	131	3210	1.20	140	3390
	1.3	1.33	164	3760	1.30	158	3610	1:31	165	3760
	Failure	1.35	176		1.35	172		1.42	192	
-	-									
-								_		
-							•			
				•						

(a) Average of three elements of a strain gage rosette at the 2-in. from center position.

TABLE G-9.

1:1 HYDRAULIC BULGE TEST PRESSURE -BULGE HEIGHT - STRAIN DATA FOR TIG 2219-T87/2319 CROSS -WELD PANELS

Nominal	Spe	Spec. No. AT1-1	AT1-1	Sper	c. No.	Spec. No. AT1-8	Spe	c. No.	Spec. No. ATI-9
Height,	'n	đ	(e)∍	'n,	ď.	(e(a)	h,	'd	(a)
in.	in.	psi	μin. /in.	in.	psi	uin. /in.	in.	psi	μin. /in.
0.5	0.51	32	1310	0.50	80	685	0.51	- 24	1140
9.0	0.61	45	1660	09.0	15	096	0.61	34	1440
0.7	0.71	63	2030	0.72	27	1370	0.71	48	1770
8.0	08.0	81	2360	0.82	45	1700	0.81	64	2070
6.0	06.0	102	2700	0.91	58	2090	06.0	80	2350
1.0	1.00	126	3080	1.02	80	2470	1.00	86	2630
1.1	1.11	150	3380	1.11	44	2690	1.09	116	2940
1.2	1	,	,	1.21	121	3110	1.20	140	3280
1.3			,	1.30	142	3420		,	١
Failure	1.15	161	,	1.35	156		1.26	158	,

(a) Average of three elements of a strain gage rosette at the 2-in. from center position.

TABLE G-10.

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1:1 HYDRAULIC BULGE TEST PRESSURE	BULGE HEIGHT - STRAIN DATA FOR	2219-T87 PARENT METAL PANELS	WITH A MACHINED GROOVE

Nominal	Sp	ec. No	Spec. No. A-13	Sp	ec. No	Spec. No. A-14	Sp	ec. No	Spec. No. A-15
Height,	, h,	P,	€(a)	'n,	'd	(a)	h,	ъ,	€(a)
in.	in.	psi	μin. /in.	in.	psi	μin. /in.	in.	psi	μin. /in.
0.3	0.30	10	740	0.32	∞	190	0.31	4	610
4.0		1	1		,	,	0.41	10	910
0.5	0.52	38	1550	0.55	30	1540	0.52	50	1290
9.0	0.62	57	2035	0.65	46	1970	0.62	32	1690
0.7	0.71	7.8	2410	0.72	64	2350	0.72	20	2120
8.0	0.80	102	2825	08.0	83	2740	0.83	74	2600
6.0	0.90	125	3100	06.0	86	3020	0.92	96	3010
1.0		1	,	1.00	124	3420	1.01	118	3370
1:1	,	•		1.10	154	3910	•	,	,
Failure	0.95	140	,	1.16	176	1	1.11	150	
(a) Averag	ze of thr	ee eler	nents of a	strain g	age ro	a) Average of three elements of a strain gage rosette at the 2-in. from center	, 2-in. fr	ow ce	nter

<sup>(</sup>a) Average of three elements of a strain gage rosette at the 2-in. from position.

## TABLE G-11.

1:1 HYDRAULIC BULGE TEST PRESSURE -BULGE HEIGHT - STRAIN DATA FOR 2219-T87 PARENT METAL PANELS WITH A MACHINED CROSS GROOVE

Nominal	Spe	c. No.	Spec. No. A-16	Spe	Spec. No. A-17	A-17	Spe	Spec. No. A-18	A-18
Height,	Ъ,	'd	(e)3	'n.	ď	£ (g)	Ē	â	(a)
in.	in.	pei	uin. /in.	in.	psi	µin./in.	in.	psi	uin. /in.
0.3	0.32	14	770	0.32	12	730	0.30	10	699
4.0		,	1	0.41	19	1040	0.42	18	1030
0.5	0.53	41	1590	0.53	31	1460	0.52	59	1420
9.0	0.63	58	20 20	0.62	48	1870	0.62	44	1840
0.7	0.72	78	2450	0.73	69	2310	0,72	64	22.70
8.0	0.82	901	2840	0.82	95	2710	0.81	84	2700
6.0	0.92	132	3240	0.91	114	3060	06.0	102	3010
1.0	1.00	148	3690	1.00	132	3370	1.00	126	3360
-:	1.12	180	3990	1.13	162	3730	,	,	,
Failure	1,15	192	į	1.15	172	•	1.10	146	
_									

(a) Average of three elements of a strain gage rosette at the 2-inch from center position.

# TABLE G-12.

1:1 HYDRAULIC BULGE TEST BENDING STRAIN ANALYSIS DATA FOR 2219-T87 AND 2014-T6 PARENT METAL PANELS

1-T6)	(P) (P)	uin./in.	•	,	495	495	594	265	680	745	810	855	918	666	1115	1140	
. B-1 (2014-T6)	£ (a)	uin. /in.	1		9.20	1285	1740	1990	2545	3095	3490	3955	4480	5215	6050	0069	
Spec. No.	ď	pai	,	1	9	14	24	40	09	80	108	136	168	202	240	265	
Spe	'n	in.	•	•	05.0	0.62	0.70	0.83	06.0	1.00	1.10	1.20	1.30	1.39	1.50	1.60	
-T87)	(q) <sup>4</sup> 3	uin. /in.	314	380	459	510	009	645	099	705	,	•	•	•			
Spec. No. A-2(2219-T87)	د <sub>(</sub> (a)	uin. /in.	711	1052	1456	1920	2440	2970	3410	3880	1	,	,	,		,	
ec. No	þ,	psi	æ	16	97	45	20	96	124	132	1	,	,	•	,	,	
Sp	'q	in.	0.30	0.41	0.51	0.62	0.73	0.83	0.92	1.00					•	,	
Nominal	Height,	in.	0.3	4.0	0.5	9.0	2.0	8.0	6.0	0.1	-:	1.2	1.3	4.	1.5	9.1	

(a) Total outer fiber surface strain.
(b) Bending strain.

2:1 HYDRAULIC BULGE TEST STRESS ANALYSIS DATA FOR TIG 2219-T87/2319 SINGLE-WELD PANELS

# TABLE G-13.

2:1 HYDRAULIC BULGE TEST STRESS ANALYSIS DATA FOR 2219-T87 PARENT METAL PANELS

		17-1-1-1	į	Sur	Surface Microstrain	n at Various Positions(b)	Positions(D)	0
No.	Fressure, psi	neignt, in.	Angle(a)	0	to Ref. Axis	2 In. Along Ref. Axis	to Ref. Axis	No.
	75	0.50	0 120 240	3, 000 2, 210 2, 120	3, 000 2, 220 2, 150	(0)	2960 2110 2090	
*	240	0.92	0 120 240	6, 310 5, 310 4, 950	6; 160 5, 310 4, 960	(c)	6140 5000 4910	AT1-10
A-4	320	1.13	0 120 240	8, 150 7, 840 7, 140	7,980 <sup>©</sup> 7,850 7,170	(c)	7860 7340 7020	
	360	1.20	0 120 240	8, 920 8, 870 8, 130	8, 730 8, 910 8, 140	(5)	8520 8350 7960	
	410	1.30	0 120 240	10, 000 10, 200 9, 480	9, 500 10, 100 9, 360	(0)	9550 9850 9520	AT1-11
	7.2	0.51	06	2, 750 1, 710	(c)	(2)	(c)	
A-5	106	09.0	06	3, <b>4</b> 20 2, 200	(0)	(0)	(c)	
-	156	0.70	06	4, 330	(5)	(0)	(0)	
	59	0.51	06	2, 660	(၁)	2670 1590	2680	AT1-12
	130	0.70	06 0	4, 130 2, 630	(2)	4150 2630	4160 2680	
A-6	270	1.02	06	7, 230	(2)	7120 5040	7280 5190	<del></del>
	300	1.10	06 0	8, 160	(>)	8180 6040	8400 6220	·
	340	1.22	06 0	1 1	(2)		9920 7750	

(a) Angle of strain gage element to reference axis, degrees.(b) Distance of strain gage from center of panel, inches.(c) Strain gage was not placed at this position.

Panel	Pressure,	Height,	Parent	Parent Metal Microstrain	We	ld Metal M	Weld Metal Microstrain(b)
	psi	in.	Angle(a)	2 In. from Center	Angle(a)	Center	2 In. from Center
					,		
1			0	2260	0	3, 760	2,840
	20	0.50	120	1340	06	1,010	086
			240	1295			
_							
			0	2800	0	8, 000	5, 590
AT1-10	1 94	0.70	120	2060	96	1,635	1, 700
			240	1960			
			0	3040	0	11, 700	7, 780
	144	0.90	120	2940	96	2, 690	2, 710
			240	2820			
			0	2390	0	2, 380	2, 710
	26	0.51	120	1400	06	1, 140	1, 135
			240	1535			
			0	3270	0	6, 430	9, 170
AT1-11	105	0.70	120	1910	90	1,660	1,570
			240	2150			
-							
			0	3860	0	ı	•
	164	06.0	120	2570	06	2, 380	•
			240	2920			
			ļ	0730	٠	7 700	3 750
	,	,	2 .	0007	> 8	26.6	
	80	06.0	120	1320	06	404	1, 340
			240	1500			
			٥	3400	0	8, 590	9,970
AT1-12	108	0. 70	120	1890	06	1, 340	2, 040
			240	2100			
			0	3870	0	-	17, 100
	158	06.0	120	2650	06	1,940	3,070
		•	240	2820			
	`						
				-			

<sup>(</sup>a) Angle of strain gage element to reference axis, degrees.(b) Weld at 90° to reference axis.

TABLE G-15.

2:1 HYDRAULIC BULGE TEST STRESS ANALYSIS DATA FOR TIG 2219-T87/2319 CROSS WELD PANELS

Pre	Pressure,	Height,	Parent	Parent Metal Microstrain	Wel	d Metal N	Weld Metal Microstrain(b)	
	psi	ļu.	Angle(a)	2 In. from Center	Angle(a)	Center	2 In. from Center	
	25	0.30	0 120 240	1630 1030 864	06	2, 550	99	
	78	0.51	0 120 240	3000 1830 1720	06	8, 410 6, 090	•	
	150	0.72	0 120 240	4360 2510 2790	0 06			
	18	0.30	0 120 240	1580 805 670	0 06	2, 960	717 528	
	56	0.50	0 120 240	2850 1235 1170	06	7, 780 2, 100	3140	-
	104	0.70	0 120 240	3770 1660 1830	06	15, 100 5, 900	3660 1560	
	22	0.34	0 120 240	2015 835 750	06	2, 670	818 576	
	6	15.0	. 0 120 240	2820 1320 1200	06	5, 030 810	2210 1000	
	87	0.71	0 120 240	3270 1920 1960	0 06	8, 020 3, 240	4750 2040	-

<sup>(</sup>a) Angle of strain gage element to reference axis, degrees.
(b) Reference axis along short weld.
(c) Strain gage was not placed at this position.

# 2:1 HYDRAULIC BULGE TEST BENDING STRAIN ANALYSIS DATA FOR 2219-T87 AND 2014-T6 PARENT METAL PANELS

Nominal	, ,	Spec. No. A	A-5 (2219-T87)	187)		Spec. No. F	B-( (2014-T6)	T6)
Height, in.	ŗ,	Angle(a)	e e <sup>(0)</sup> µin. /in.	ε <sub>b</sub> (c) μin./in.	'n,	Angle(a)	ر(5) بانار. / بانا.	e <sub>b</sub> (c) µin./in.
0.3	0, 30	06	1260	585 344	0.32	06	650 256	265 160
4.0	0.41	06	1980	705	0.45	06	1120	454
0.5	0.51	006	2750 1710	780	0.51	06	1645	595
9.0	09.0	0 06	3420	840 662	0.63	06	2260 982	720
0.7	0.70	06	4330	096	0.72	06	3600 1360	390
8.0	,	1	•	1	0,81	06	2840 1850	992
6.0		1	•	,	0.93	0 %	3090 2530	1180
1.0	•	•	,	,	1.01	0 %	3450 3230	1300
:-			•	•	1.10	0 %	3800 3640	1440
1.2	ı	•	,		1.20	0 06	4170	1600
1.3	4	•		- 1	1.30	0 06	4590 5890	1800
4.	•		•	ı	1.4	0 %	4900	1990 950

 <sup>(</sup>a) Angle of strain gage element to reference axis (short dimension of panel), degrees.
 (b) Total outer fiber surface strain.
 (c) Bending strain.

TABLE G-16.

TABLE G-17.

2:1 HYDRAULIC BULGE TEST RESULTS USING TENSILE MACHINE INSTEAD OF BOLTS TO HOLD TEST DIE TOGETHER, 2219-T87 PARENT METAL SPECIMEN NO. A-29

TABLE G-18.

## PHASE I UNIAXIAL TENSILE TEST RESULTS ON 2219-T87 PARENT METAL

						_								
Surface Microstrain Across Minor Diameter	535	764	1240	1690	2340	2916	3650	4460	5410	6640	8000	9886		
Surface Microstrain Across Major Diameter	605	722	937	1030	1330	1450	1820	1890	2240	2230	2460	2870		
Applied Pressure, psi	91	52	40	89	98	108	130	165	200	525	250	280		
Actual h, in.	0.35	0.41	0.52	09.0	0.72	0.81	0.92	1.01	1.11	1.21	1.31	1.40		
Nominal Height, in.	0.3	0.4	0.5	9.0	0.7	8.0	6.0	1.0	1.1	1.2	1.3	4:1		

Elongation in 2 In.,	9.8 10.5 11.2 11.2	11.3 11.3 10.3 10.4	10.5 10.3 11.0 11.0
Ultimate Strength, ksi	65.0 64.8 65.8 65.6	65.8 65.5 65.4 65.4	66.7 66.7 66.6 66.8
Yield Strength 0.2% Offset, ksi	52.5 52.5 53.9 53.9	54.1 54.0 53.7 53.9 54.1	54.7 54.5 54.8 54.6
Specimen No.	1 2 8 4 3	Z E 4 - S	1 2 2 3 2 5 4 4 3 5
Sheet No.	8.A	7.A	8A
Material & Process		2219-T87 Parent Metal	
rain meter		····	

TABLE G-19.

PHASE I UNIAXIAL TENSILE TEST RESULTS ON 2219-T87 WELD.

WELLU-	TESTS
101-6177	1:1 BULGE
PEDOLIS ON	MENTS FOR 1

### RESULTS ON 2219-T87 WELD-MENTS FOR 2:1 BULGE TESTS

PHASE I UNIAXIAL TENSILE TEST

TABLE G-20.

Elongation in 2 in.,	1.5 1.8 1.3 1.8	1.0	4.2.2.2.4.	1.9 . 1.6 1.9 1.9	1.3 1.0 1.0 2.1	1.5 1.7 2.0 2.0
Ultimate Strength, ksi	41.0 39.9 40.8 42.8	44.3 41.1 41.0 44.3	43.5 40.2 42.0 42.0	42.8 43.1 42.0 41.9	39.1 40.0 41.2 38.9 40.9	38.4 38.9 38.5 39.7
Yield Strength 0.2% Offset, ksi	31.5 30.0 29.4 29.7 30.6	35.0 30.9 30.9 31.1	32.6 30.4 30.6 32.5	31.6 33.1 30.9 31.4	29.5 30.3 31.9 30.6 30.8	28.3 29.0 29.6 29.6 29.8
Specimen No.	— vi w 4 m	- 21 E 4		# 2 E 4 E	1 2 2 5 4 5	- N E 4 R
Panel No.	AT1-10	AT1-11	AT1-12	AT1-4	AT1-5	AT1-6
Material & Process	<u></u>	-	TIG 2219-787	2319		
· · · · · · ·						

Mater			TIG			
Elongation in 2 In.,	1.1	6 7 2 5 3		2000	\$ \$ 1.40	
Elon in 2		2.3	2,2	2.2 2.0 1.5 2.1 2.1	1.8 1.8 1.5 1.4 2.0	2.2 1.9 1.9 2.0 2.0 2.1
Ultimate Strength, ksi	39.7 39.5 39.2 38.7	44.9 44.0 43.0 43.7	42.9 43.3 41.9 41.3	44.8 43.8 43.7 44.3	38.3 37.9 40.5 41.0	41.7 42.2 38.8 40.9
Yield Strength 0.2% Offset, ksi	30.4 30.1 31.1 29.8 28.7	29.3 26.7 27.3 27.1 26.3	29.3 29.5 28.6 28.0 29.4	31.0 30.7 29.7 30.9 31.0	29.2 29.2 30.4 29.3 29.2	29.1 28.8 29.1 28.6 31.3
Specimen No.	የነ የነ ቀ ነ	- 2 E 4 E	~ 5 € 4 €	— ८४ छ च छ	1.52.6.4.10	12 16 4 10
Panel No.	AT1-2	AT1-3	AT1-7	AT1-1	AT1-8	AT1-9
Material & Process			TIG 2219-T87	2319		

TABLE G-21.

TABLE G-22.

SUMMARY OF CYLINDER TEST RESULTS

### MIT BIAXIAL SPECIMEN TEST DATA

Test Section Stress-Strain Data   Specimen   Stress, Longitudinal, Transverse,   Longitudinal,   Lin. /in.   Lin. /in. /in. /in. /in. /in. /in. /in. /	Ī						_	ĺ
Specimen Stress, Longitudinal, Transverse, No.         ksi µin./in.         μin./in.         μin./in.           M-1         -         -         -         -           M-2         -         -         -         -           M-3         -         -         -         -           M-4         -         -         -         -           M-4         -         -         -         -           M-5         12.7         1, 125         -130         -220           25.3         2, 200         -220         -220         -220           38.0         3, 320         -490         -490           38.0         3, 320         -490         -560           44.3         3, 800         -560         -560           60.4         12, 350         -570         -570           60.4         12, 350         -570         -570           65.3         17, 650         -80         -80           66.5         5, 66, 350         +950         -80			Test	Section Stress-S	train Data	Ultimate		
M1	Material &	Specimen	Stress,	Longitudinal,	Transverse,	Strength,		Te:
M-1	Process	No.	ksi	uin. /in.	uin. /in.	ksi		žΪ
M-2		M-1	ı	1	1	72.0		
M-4		M-2		•	ı	71.4		
M-4		M-3	ı	•	•	72.0		
12.7 1, 125 -130 19.0 1, 670 -220 25.3 2, 200 -290 31.6 2, 110 -360 38.0 3, 320 -490 44.3 3, 880 -560 56.6 4, 670 -520 56.9 6, 860 -570 60.4 12, 350 -370 66.5 26, 350 +950		M-4	,	-	,	68.5		
19.0 1,670 -220 -220 -220 -220 -220 -220 -220 -2	-T87		12.7	1, 125	-130			
25.3 2, 200 -290 31.6 2, 710 -360 38.0 3, 320 -490 44.3 3, 880 -560 56.9 6, 860 -570 60.4 12, 350 -370 60.5 26, 350 +950	ent		19.0	1,670	-220			_
31.6 2,710 -360 38.0 3,320 -490 44.3 3,880 -560 56.9 4,670 -620 56.9 6,860 -570 60.4 12,350 -370 63.3 17,650 -80 66.5 26,350 +950	tal		25.3	2, 200	-290			_
38.0 3,320 -490 44.3 3,880 -560 50.6 4,670 -620 56.9 6,860 -570 60.4 12,350 -370 63.3 17,650 -80			31.6	2, 710	-360			_
44.3 3,880 -560 50.6 4,670 -520 56.9 6,860 -570 60.4 12,350 -370 63.3 17,550 -80 66.5 26,350 +950			38.0	3, 320	-490			_
50.6 4, 670 -620 56.9 6, 860 -570 60.4 12, 350 -370 63.3 17, 650 -80 66.5 26, 350 +950			44.3	3, 880	-560			_
6, 860 -570 12, 350 -370 17, 650 +950 26, 350 -		M-5	50.6	4,670	-620			_
12, 350 -370 17, 650 -80 26, 350 +950			56.9	6, 860	-570			=
17, 650 -80 26, 350 +950			60.4	12, 350	-370			_
26, 350 +950			63.3	17,650	-80			
			66.5	26, 350	+950			
			•	•	•	73.4		

_		J	_												 H	# 	_				 	_
		Remarks		Failed in heat-affected zone.	Failed in heat-affected zone.	Failed in heat-affected zone.	Failed in heat-affected zone (secondary failure in rivets).	Failed in heat-affected zone.	Failed in heat-affected zone.	Failed in heat-affected zone (secondary failure in rivets).	Failed in heat-affected zone.	Failed in heat-affected zone.	Failed in heat-affected zone.	Failed in base metal at right edge of reinforcing patch.	Failed in heat-affected zone when reinforcing patch blew off.	Failed in heat-affected zone when reinforcing patch blew off.	Failed in upper end rivet row.	Failed in rivets because of excessive leaking.	Not tested.	Not tested.		
Failure	Pressure,	psig		545	595	570	575	572	575	540	542	575	575	1010	966	1010	640	450				
	Stress	Ratio		2:1	2:1	0:1	1:1	2:1	2:1	Ξ	Ξ	1:0	0:1	2:1	2:1	2:1	Ξ	Ξ	===	Ξ		
	Cylinder	No.		XCY-1	CY-1	CY-4	CY-5	CY-2	CY-10	CY-11	CY-12	CY-13	CY-16	CY-14	CY-9	CY-15	CY-7	CY-7	CY-6	CY-8	****	
	Test	Š.		-	2	6	4	ď	9	7	œ	6	10	11	12	13	14A	14B	15	16		

TABLE G-23. STRESS-STRAIN DATA ON CYLINDER NO. XCY-1 (2:1)

TEST NUMBER 1 GAGES 7 AND 8

	FECTIVE MU STRAIN		280 0.3	244	346	280 0.3	398 0.3	229 0.3	890.785 0.35	167 0.3			0 N T N C	ICIN/IN	T 0 770 0	64.160 0.3	34.973 0.3	72.047 0.3	23,748 0.3	50.861 0.3	83.036 0.3	172,195 0.35	/*·162 U·3		7177	2 TO 4 T.	UIVIII	7 0 44 0 7	1.050 0.3	5,371 0.3	0.337 0.3	3.574 0.3	2.390 0.3	079.147 0.35		3 17	24.0	CINT	66.657 0.3	06.004 0.3	73.272 0.3		63.302. D. 3	63.302.0.3	63.302 0.35 07.744 0.35 69.545 0.35
	EFFECTIVE EFF STRESS PSI M		4.0	7.7	0.000	5067.1 1	8086.0 1	1107.4	24130.7 1	7156,7 2		41 971 9	STATE OF STA	PSI	P.		9042.8 1	2064.8 1	5092.8 2	8129.8 3	1186.5 4	24303.6 76			34 24 25	STREES	F 150		2	7	0	ر مع ا دما	4. t	70		ביים ביים	2101010	- ;	011.1	024.6	042.0	4	2064.7	2064.7 1	15064.7 18 15094.9 26 18134.8 35
	TRU RAD STRAIN MICROIN/IN	1	4 6	•	, R	. •	2	0	-984.285	_			2 5	MICHOIN/IN	-276.430	-467.048	-713.518	-994,804	-1348.779	-1759.218	-2589,832	3/46.632	199.6616		TRU PA	STRAI	MICROINTIN	-	2	ě	Č,	_	200	-4606.664				MICROINZIN	2		4	1		1375.41	-1375.413
	TRU LONG STRAIN MICROIN/IN		***	20.40.08	240.04	319.94	399.91	464.89	524.862	589.82		Č	S	N.		_:		<u>.</u>	ψ.	984		1284.175			18U 1 0N	STRAI	MICROINTIN	64.9	89.95	34.90	24.86	94.78	77.47	709.747			7	HICROIN/IN	84.9	19.9	59.8	9		9.0	789.688
:	TRU CIRCH STRAIN MICROIN/IN		100	80.4.6	1034.4	1319.1	1623.6	1958.0	2287.381	2040.4		9	S	Ž	100	•	•	•		a (1		7450.467			CIRC	STRAI	MICROIN/IN		259.	032	000	004	388	12452.150		TRU CIRCH		MICROIN/IN	4	7	3	3	?	9	3140.065
:	TRU LONG STRESS PSI		3475 414	5213.569	6951.737	869	042	2	13907.297	0		Š		S	737	476	214	20.0	4000	040	717	100./1/07			Š	STRE	O.							13040.502		2	STRE	PSI	737.82	476.11	214.89	954.23		694.36	10435.216
	MSD LN STRESS PS1		3 P		ıΛ.	868	042	216	13900.	50.		SD L	STRESS	S	-		2:	2.5	0000	7 6	1012	15410			SDL	ᇎ	လူ	1738.	3475.	5213.	0950	0000	12163.	13031.		فيد	RES	PSI	1738.	3475.	5213.	6950		6689	10425
	TRU CR STRESS PSI			104	139	73	8		27864.	2		180	S	PS	3477.	6957	0442	5931	021	24464	20107	34404			ວ	STRESS	S	3477.	6969	10446	13942	2000	24578	26389.		Ü	RES	PSI	77.	57.	Ξ.	51,		30	20940
	MSD CR STRESS PSI	1475	6950	0425	390	737	0.85	32	27800.	2	e	SDC	STRESS	S)		6950	10425	2000	2 5	2	, ,	) F		*	SD	2	S	7	669	2 6	2 5	9 0	430	9	~	MSD CR	FES	PSI	3475.	ŝ	*	39		7375	17379.
	AXIAL LOAD POUNDS	1 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2	23710	35566	47421.	59276.	71131.	82987	94842	• / 60001	S AND	_	LOAD	•	11855.	23710.	35566	174/1	74474	A 2007	04 R 4 2	06697		3 AND	AXIAL	LOAD	•	11855.	23716.	47404	50274	71131	82987	88914.	1 AND	AXIAL	LOAD	POUNDS	8	3	RU I	4		8	59276. 71131.
	LONG STRAIN N/IN	A.	125.	205	250.	320.	400	403.	500		GAGES	LONG	STRAIN	_	85	305	7 8	0 0	9 45	, ,,	46	1460.		GAGES		STRAIN	7	165.	290.		6. E.	745	735.	710.	GAGES	LONG	TRAIN	N I N	185.	320.	460	610.		790.	980.
	STRAIN MICROI		555	805.	1035.	1320.	1625.	000	26.50	•	MBER 1	CIRCUM	TRAIN	CR0	605.	030		D: ₩	9 6	74.5	. 5			MBER 1	<b>X</b>	TRAIN	I CROI	7	1260.	2 6	000	685	410	293	48ER 1	CIRCUM	TRAIN		550.	950	1515.	2235.		3145.	4330
-	PRESS PSI	50.	00	50	00	250.	9 5	2 0	450.		TEST NUMB	0	RESS	PS.	50.	•	2 5	o Kr	2	) LC	. 0	. 06		TEST NUMB	HYDRO (	RESS	S	50	100	2 0	2 10	0	20.	75.	TEST NUM	HYDRO C	Ľ		50	000	20	00	i	2	300.

TABLE G-24. STRESS-STRAIN DATA ON CYLINDER NO. CY-1 (2:1)

2	E	LONG			_	WSD LN	TRU LONG		11.		- 1	EFFECT	Z.
PRESS PS1	STRAIN	STRAIN	POUNDS	STRESS PS1	STRESS PS1	STRESS PS1	STRESS	STRAIN MICROIN/IN	STRAIN	MICROIN/IN	SIRESS	MICINAIN	
50.		75.	11855.	3475.	3476.	1738.	1737,630	· ·	74.997	-138.231	301	264.742	0.35
100.	İ	135.	23710.	٥	6954.	3475.	3475.469	549.849	134.992	-239.694	602	9	
150.			35566.	50	10434.	5213.	5213.412	819.664	174.984	-348.127		675.	
200.			47421.	1	13917.	6950.	6951.737	1189.292	249.969	-503.741		1	0.35
250.	1470.	310.	276.	17375.	_	8688.	8690.193		309.952	-622.605			0.35
300.			71131.	20850.	20888.	10425.	0429	1	384.925	-774.639		1	0.35
350.			82987.	24325.	24378.	12163.	2167		449.899	-912.649			0.3
400.	ì	490.	١.	i .	27869.	13900.	3906		6	-1040,129	1		0.3
450.		535.		31275.	31362.	15638.	15645.866		534.857	-1164.085			0.3
500		.099	٠.		34857.	17375.	7386		6	-1307.267			0.3
550.	3530.	725.	0407.	- 1	38360.	19113.	19126.357	3523.784	724.737	-1486.982	33220.7	2899.584	0.3
TEST N	NUMBER 2	GAGES	3 AND					i	!			Andrew Co. Co.	
HYDRO	CIRCUM	LONG	AXIAL	MSD CR	TRU CR	MSD LN	TRU LONG	TRU CIRCH	TRU LONG	TRU RAD	<b>EFFECTIVE</b>	EFFECTIVE	₹
PRESS	STRAIN	STRAIN	LOAD	STRESS	STRESS	STRESS	STRESS	STRAIN	STRAIN	STRAIN	STRESS	STRAIN	
PSI	MICROI	NIN	POUNDS	PSI	ISd	ISd	l S d	MICROIN/IN	MICROIN/IN	MICROIN/IN	PSI	MICINIIN	
50.	115.	70.	11855.	3475.	3475	1738.	1737.622	114.993	866.69	-64.747		107.999	0
100.		130.	23710.		6951.	^	3475.452	214.976	129.991	-120,739			0
150.		200.	35566.		10428.	5213.	5213.542	304.954	199.980	-176.727			0
200.	390.	250.	47421.		13905.	6950.	6951.737	389,925	249.969	-223.963	12042.4		0
250.	635.	370.			17386.	8688.	8690.714	634.798	369.931	-351.655			0
300		315.	1131.		20878.	10425.	0428	1339.103	314.950	-578.918	i		0.35
350.	3260.	480	2987	24325.	24404.	12163.	12168.338	3254.697	479.885	-1307.104			0
400	5720.	650	247		27959	13900.	3911	5/03./04	849.038	-2293.6/0	!		_
450.	•	1120.			31640.	15638.	5655	11592.546	1119.372	-4449.172			_
TEST NUMBER	UMBER 2	GAGES	1 AND	2									
HYDRO	CIRCUM	LONG		MSD CR	S CR	MSD LN		TRU CIRCH	TRU LONG	TRU RAD	EFFECTIVE	<b>EFFECTIVE</b>	ž
PRESS	STRAIN	STRAIN	LOAD	STRESS		STRESS	STRESS	STRAIN	STRAIN	STRAIN		STRAIN	
PSI	MICRO	NIN		PSI	_	PSI	PSI	MICROIN/IN	MICROIN/IN	MICROIN/IN		MICIN/IN	
50.	255.		11855.	3475.	3476.	1738.		254.967	79.997	-117.238		215.021	0
100.		1	23710.	6950.	6954	3475.	3475,521	504.873	149.989	-229.202		423,896	.0
150.	715.		35566.	10425.	4	5213.	5213.647	714.745	219,977	-327,153	9034.8	601.793	0
200			47421.	13900.	13913.	6950.	951	900.587	269.963	-412.843		763.641	0
250.	1335.	335.	59276.	17375.	17398.	8688.	8690.410	1334.110	334.944	-584.169			0
300.			71131.	ł	20892	10425.	10429.066	1998.003	389.925	-835.775			0
350.		445.	82987.		24410.	12163.	12167.912	3503.854	444.902	-1382.065			0
400.	4445.	485.	94842	27800.	27924.	13900.	13906.741	4435.150	484.882	-1722.011	24182.6	3602,025	
450.		510.			31409.	15638.	15645.475	4280.824	509.870	-1676.743	į		0
0	3060.		118552.		34856.	17375.	17383,166	3055,328	469.889	-1233,826		2403,724	0.3
								1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1					

TABLE G-25. STRESS-STRAIN DATA ON CYLINDER NO. CY-4 (1:0)

TABLE G-26. STRESS-STRAIN DATA ON CYLINDER NO. CY-5 (1:1)

POUNDS PSI PSI PSI PSI MICROIN/IN MICROIN/IN MICROIN/IN	23710 3475 3476 3475 521 149.989 149.989 -104.9	47421. 6950. 6952. 6950. 6953.127 224.975 449.899 -236.2	71131, 10425, 10432, 10425, 94842, 13900, 13912, 13900,	118552, 17375, 17395, 17375, 17393,678 1124,368 1074,422 -769,5	146263, 20850, 20880, 20850, 2087/-105 1423,986 1299,155 -953,0 165973, 24325, 24366, 24355, 2436, 1066 1673,599 1523,838 -1119,1	189683, 27800, 27855, 27800, 27846,565 1973,052 1673,599 -1276,3	213394. 31275. 31346. 31275. 31337.550 2272.415 1998.003 -1494.6	20/104, 34/20, 34641, 34/20, 34628,18/ 2021,200 224/4/3 "1/04,1 260815, 38225, 38338, 38225, 38320,563 2945,657 2496,880 -1904,8	S 5 AND 6	AXIAL MSD CR TRU CR MSD LN TRU LONG TRU CIRCM TRU LONG TRU	LOAD STRESS STRESS STRESS STRESS STRAIN STR POUNDS PSI PSI PSI PSI MICROIN/IN MICROIN	2371 <u>0</u> , 3475, 3476, 34 <u>75, 3475,869</u> 274,963 249,969 -183 47421, 6950, 6954, 6950, 6953,649 524,862 524,862 -367	. 71131. 10425. 10434. 10425. 10432.819 874.617 749.719 -568.51	. 94842, 13900, 13917, 13900, 13912,850 1249,220 924,573 -760,82 . 118552, 17375, 17405, 17375, 17394,981 1723,513 1149,340 -1 <u>005</u> ,49	. 142263, 20850, 20903, 20850, 20877.626 2521.817 1324.123 -1346.07	. 1895/3. 24362. 64426. 24562. 64562.04 576.1121 1246.000 1738.32. . 189683. 27800. 27980. 27850.040 6454.127 1798.383 -2888.37	S 3 AND 4	46 AXIAL MSD CR TRU CR MSD LN TRU LONG TRU CIRCM TRU LONG TRU RAD IN LOAD STREIN STRAIN STRAIN STRAIN STRAIN POUNDS PSI PSI PSI MICROIN/IN MICR	. 23710. 3475. 3475. 3475. 347 <u>5</u> .956 50.000 274.963 -113.73	. 47421, 6950, 6951, 6950, 6954.170 74.997 599.821 -236.18	. 94842, 13900, 13900, 13910, 13915,985 174,984 1149,340 -463,51	. 118552. 17375. 17379. 17375. 17399.759 249.969 1423.986 -585.88	. 165973. 24325. 24341. 24325. 24370.001 674,773 1848.290 -883.07	. 189683, 27800, 27835, 27800, 27855,600 1274,187 1998,003 -1145,26 . 213394, 31275, 31342, 31275, 31339,804 2147,601 2072,850 -1477,18	237104, 34750, 34870, 34750, 34826,450 3444, 240815, 38225, 38427, 38225, 38305,273 5261	S 1 AND 2	IG AXIAL MSD CR TRU CR MSD LN TRU LONG TRU CIRCM TRU LONG TRU RAD NO LOAD STRESS STRESS STRESS STRESS STRESS STRESS STRESS STRESS STREIN STRAIN STRAIN POUNDS PSI PSI PSI MICROIN/IN MICROI	23710. 3475. 3476. 3475. 3475.782 224.975 224.975 -157	4/421. 8930. 8933. 8930. 8933.998 449.899 3/4.833 -338.63	71131, 10425, 10433, 10425, 10433,340 749,719 799,681 -542,29
	150	450. 47	0. 675. 71 0. 820. 941	1075. 118	1500. 142	1675. 189	2000. 213	2500. 260	w.	LONG	STRAIN	5. 250. 23	750.	. 925. . 1150. 1	1325. 1	1800.1	Ю.	UM LONG A: IN STRAIN H ROIN/IN POO	. 275. 23	. 600. 47	1150. 94	1425. 118	1850. 165	2000. 189	2200. 237	+	∢ ○	5. 23		0000

# TABLE G-27. STRESS-STRAIN DATA ON CYLINDER NO. CY-2 (2:1)

TEST NUMBER 5 GAGES 7 AND 8

	M)		2	? ~	. "		2 6	) M		0.35	1		3	1	۳	2 6		13		•	) M		0.35	-	1	2		•	? "	•	? "	1	'n		0.35			2		,	ĸ,			?"		3	. m	0.35
MICINIIN	8.	9.0	679.394	1010	46.04	720.0		100	447.4	6		:	2	MICININ	0		6	5.93	112.24	502.71	210.23	662.02	6944.085		7	21011	MICINIIN		, ,	3.4	1 8	8	640.46	824.35	6983.436			2 2 2	#ICIN/IN	:	ė,	Ň.	· .	000		BBD	9 6	5571.784
STRESS	010	022	9039	30 40	8000	1110	1 1 1 1	7.4	100	22		. !	EFFECTIVE	PSI			33	48	990	9	2	8	27318.1		> •	STOFF	- 1	0			2040	5087	8090.	1164.	24283.4			7 - 7 - 7 - 7 - 7 - 7 - 7 - 7 - 7 - 7 -	- 1	٠.	<u>.</u>		9032	5040	2000	1112	4150	27270.6
MICROINTIN	23	4	0.40.00.00	000	0	9	5	2	¥	80		i	2	MICHOINZIN	17.40	7. 7.	79.93	37.33	20.91	04.39	53.68	07.63	-3268.276		-	2	MICROINZIN		7.		7.1	175	5.77	5.55	-3373.113			* a	MICROIN/IN	•	6.00	234.9	384.8	542	,,,	0.49.0	529.0	
MICROIN/IN	Į,	6	174.784	00	74	4	0	74	0	66			NO.	HICROININ	0		98	9.93	4.88	9.87	4.80	4.77	-		2	STRAT	Z	0	0	74.08	374.930	24.86	49.71	99.50	4			27247	MICROINTIN	8	5 6	, 6	. 6	7	7 2	8	30	1049.448
MICROINTIN	•	₹ .	1124.368	-	773.42	097.79	471.94	821.01	219.81	643.35			2 -	MICROIN/IN	60.	9	9.82	899.59	299.15	798.38	671.42	489.90	8563.231		2	:	Z.	0		ಿ	•	649.7	7	639.2	588.		0	STRAI	Z Z		124.992	4	10	6	6 4	197	46.9	826
I Set	4	40.	6951.737	1.0	0428.90	2167.97	3906.95	5646.49	5.29	9125.87			CT CON	Ser	737	475	5213.542	952	8691	0430	2170	3909	4		C	STRES	PSI	*	7	÷	6952.606	8692.06	5	2174.66	3914.59		č		PSI	717 61	3478.444	01.0	952.60	691.84	0431.77	2172.23	912.51	5653.91
PSI	1738,	٠.	- 10	TO TO	042	216	390	563	•	911			JU	-	7.3	47	5213.	950	868	0425	216	390	20		SD	STRESS	S	7.1	4	2	6950.	868	42	216	390		- 6	STRESS	S	7 4 8	3475		950	588	0425	2163	5	563
lsd bsl	3476.	9.7.4	13916	7401		4376	7869	1363				-	ں! د		4	953	10431,	913	7398	0888	4390	79	1544		2	STRESS	S	3475	6951.	10427.	13903.	17386.	20890.	24438.	28040.			STRESS	S	7	4050	, M.	2 7	39	30	3	2	8
1Sd	3475.	ť.	9 0	37	5	2	2	7	5	2		2	ں د	-	4	95	10425.	6	737	085	432	780	127	•	as	STRESS	<b>a</b>	ď		0425	13900.	7375.	0850.	4325.	7800.	2	נ	STRESS	S.	478	6950	6475	3900.	7375.	350.	4325.	7800.	1275.
POUNDS	11855.	25544	47421	59276.	71131.	82987.	94842	06697	118552.	130407.	S AND		100	POUNDS	355	23716.	35566.	51	76	71131.	87	9	106697.	3 AND		LOAD		10	23710.	•	47421.	59276.	71131.	82987.	94842.	1 AND	-	LOAD	0	e. R	23716.	566	7421	276	1131	186	9484	6990
ROINZIN	25.	100	250	300.	375.	450.	500.	_	_	١	GAGES	2	STRAIN	NIN	50.	125.	200.	0 1	475	500.	629	75.	73.	GAGES	LONG	STRAIN	>	75.	100.	175.	375.	525.	750.	1000	1050.	GAGES	Š	STRAIN	z	15.	125.	S	1		650	0	00	T.
MICROI	250	<b>ن</b> ا ⊂	25,	1475.	77	c	5	2	چ	5.5	UMRER 5	-	Z	MICROI	200.	400.	.009	006	300	800	6	ò	60	NUMBER 5	I RCUM	N I A	-	75.	10	_	250.	6.5	1900	65	٠,	NUMBER 5	RCIIM	STRAIN	1CR01	•	275.	20	73	0.20	0	200	475	9
PSI	50.	ב ב ב	Ö	20	0	50		R.	500.	r.	TEST NU	, 0	k	S	50.	0	150.	00	20	6	S	0	10	TEST NU	DRO	ESS	PS!	50.	100.	ŝ	200.	50	0	20	0	FEST NU	YDRO	PRESS	S	_	100.	200	8	20	_	2	0	50

TABLE G-28. STRESS-STRAIN DATA ON CYLINDER NO. CY-10 (2:1)

ď	PPECS	CIRCUM	LONG	AXIAL	MSD CR	TRU CR STRESS	MSD LN STRFSS	TRU LONG STRESS	TRU CIRCH STRAIN	TRU LONG STRAIN	TRU RAD STRAIN	EFFECTIVE STRESS	EFFECTIVE STRAIN	£
	PSI	1CR01	. 1	POUNDS	PS	S	PS	PS	MICROIN/IN	MICROIN/IN	MICROINZIN	ISd	-	
i	50.	325.	75.		74	4 (	7.3	737.6	324.94	4.0	-139.980	.00	268.679	D 0
1	100	675.	100.	5/10	695	ر ا	4 6	4/7 5 F	074.77	00.0		77		: :
	200.	1275.	250.	47421.	390	9 5	95	951.7	1274.18	49.96		2053.	046.	0
	250.	1600.	300.	9576	737	0 4	868	8690.1	1598.72	96.66		5071.	311.	٠.
	300.	1950.	375.	1131	0.85	891	042	0428.9	1948.10	74.93		8091		
	350.	300	4 0 7 0	2987	432	9 3	216	216/.6	2297.35	00.40		41.14	101	
	450.	4050.	75.	, ,	127	\ <u>\</u>	563	5646.4	3045.35	74.83		7167.	498	0
	500.	3425.		118552.	34750.	34869.	17375.	17385.859	3419	624.804	-1415.383	6	2802.515	0
	550.	3800.	675.	130407.	822	M	911	9125.4	3/92./9	\ . <del>.</del> .		3664.	100	•
. !							i							
ш -	EST NUMBI	MBER 6	GAGES	S A	vo					!	i .	:	i	
r	DRO	IRCUM	_	AXIAL	SD C	TRU C	MSD L	LON	TRU CIRC	LON	A D	2	717	₹
<u> </u>	RESS PSI	STRAIN	STRAIN	POUNDS	STRESS PS1	S	ST	STRESS	STRAIN MICROIN/IN	STRAIN	STRAIN	STRESS	MICINAIN	į
	i.		5	ū	,	-	1110	7	40 470	9	1 2 4 2 3	-	235.2	
	2 5	۲/۲ 425.	200	23710.	6950	6953	3475	3475.695	424	, D	-218.711	6021.4	377.166	0.3
	150.		50	9	042	043	521	3.80	674.77	8	323.66	9034	5	6
	00	97	0 7	CU F	390	391	6950	2.08	974.52	6.5	446.06	4 4	ë.	
	n c	375	ر ر د د	~ M	ر د م	900	000	420 40	13/4.07	2.0	900.42	8095		
	و ا	7,7	5.0	200	2 M	4 4 4	12163.	8.88	3568.62	8	1432.72	1141	:	
	0.0	6200.	ı o	4	80	1	390	3908.68	6180.86	.8	381.98	4224	5.	:
1	EST NU	MBER 6	GAGES	3 AND	4				ı	·	i :		!	
r	YDRO	180	Š	AXIAL	HSD C	TRU C	MSD L	2	TRU CIRC	LON	A.	>	CTIV	₹
•	ESS PS1	N 02		POUNDS	လ	S	S	STRES	STRAIN MICROIN/IN	STRAIN MICROIN/IN	STRAIN	STRESS	STRAIN	
	50.	25.	100.	35	4.7	3475.	73	737.67	25.00	66.66	43.7	600	4	0
	0.0	5	125.	7	95	6950	47	475.43	25.00	24.99	52.4	919	7	<u>.</u>
1	50	ď	175.	9	042	0	21	213.41	25.00	74.98	6.0	9028.	2 6	-
	200.	50.	250.	40	390	າຕ	v a	951./3 680 88	20.00	5 9	, r	5039	001.000	
			275.	<u> </u>	085	, IC	4	0427.86	66.66	74.96	31.2	8058	18	6
	S RU	25	250.	9	432	4	216	2165.54	224.97	49.96	66.2	1070.	22	ċ
1	0 0	ď	175.	4	780	$\sim$	390	3902.43	349,93	74.98	83.7	4083.	2	6
	50	1	25.	29	127	┥.	563	5637.89	474.88	25.00	ر ارو	7097	2	- !
	550.	500.	900.	118552. 130407.	34750.	34767.	1/375.	-1/3/9.344 19129.701	674.773	899.596	-551.029	33126.2	901.535	; e
Ψ.	EST NU	NUMBER 6	GAGES	1 AND	~									
	D.R		LONG	AXIAL	MSDC	TRUC	MSDL	LON	TRUG	O	<u>α</u> ⊃		CTIV	7
_	PRESS	STRAIN	STRAIN	LOAD	STRESS	STRESS	STRESS	STRESS PSI	STRAI MICROIN/I	STRAIN MICROIN/IN	STRAIN MICROIN/IN	S	STRAIN	
	20	300.	100.	11855.	3475.	476	17	737.67	299.9	. •	-139,982	3010.3	254	0
1	0	475	125.	1. I	0669	۰.	9.0	54.0.43	4 / 4	,		770	040	٥١٥
	150.	710.	325.	47424	13900	13013.	127	, 0	924.57	. v .	7.33	4000	788.1	0.35
	S ITU	1275.	450.	927	17375.	7397	898	691.40	1274.18	68.6	3.43	990	1086.7	0
	0	1950.	550.	113	20850.	•	1042	430.73	1948.10	9.84	4.28	8091	1629.5	ċ
	ı					١							•	

# TABLE G-29. STRESS-STRAIN DATA ON CYLINDER NO. CY-11 (1:1)

N MU	0.0	7 0.5	0 P	7 0 3	17 0.35 84 0.35		VE MU	2 2			0.3	01 0 35 49 0 35		JE JE	2 2	6.0	0.0	7 0 .3	0 0	2 FO	3 0 .3	0 0			22	1 0.3	5 0 35	າ ວ.ເວ	6 0 3	6 0 3
EFFECTIV STRAI MICIN/I	TU CI C	<b>30</b>	~ ~	0	2747.41	•		<b>:</b>	0,1	٠.	381.7	2629.10		=	I	205.48		ໍ່ຄົ	Ç.	0.000	383.6	2552.97		113	STR	407.7	573.18	212.3	.5	304.2
EFFECTIVE STRESS PSI	3475	3913.	7395. 0886.	4367.	20.5		EFFECTIVE STOCK	S	9	33.5	2	20893.8		717		475.	6951.8	906	7382.	2161.	7831.	4828		CTIV	1 1	76.	6992.9	3912.	5	0684
TRU RAD STRAIN	-166,230 -323,675	32.1	50°./	15.1	78.7		TRU RAD		227.45	559.75	804.48	-1468.127 -2313.510		TRU RA	STRAIN	•	-183.717	•	9	, 0	-795.7			¥ 2	MICROIN/IN	201.2	-288.662	620.8	804.3	9.44.0
TRU LONG STRAIN MICROIN/IN	224.975	949.54	399.02	648.64	. 81		TRU LONG	2	4.0	. 6	0	1124.368	:	LO N	STRAIN		424.909 300.801		999	274	-	397		L ON	STRAIN	66.1	124.992	. 95	. 93	9
TRU CIRCH STRAIN MICROIN/IN	249.969 474.888 400.754	999.5	498.8	823.3	9.0	:	TRU CIRCH	Z	9.9	049.4	548.8	3070.282		1. 2.	STRAIN		66		C 0	6.66	699.7	7.7		CIRC	STRAIN MICROIN/IN	99.87	1040.448	473.91	23.15	10.170
TRU LONG STRESS PSI	3475.782 6953.127	25	5 5	13	222		TRU LONG	PSI	75.78	30.73	10.42	24356.623		NO.	TRESS	475.8	6952,954	910.0	390.6	356.0	343.7	100 100 100 100 100 100 100 100 100 100		Š	ESS PSI	75.26	10427.0859	04.17	81.51	0.00
MSD LN STRESS PSI	3475.	3900	085	4 4 4	5.2	1	MSD LN	PS	475	. 6	900	24325.		_	-	3475.	6950.	13900.	737	432	180	175			-	_	6950.		N 15	
TRU CR STRESS PSI	3476. 6953.	3914	. 0	4 6	31354.	ļ	TRU CR	PS	3476		<b>10</b>   <b>1</b>	20914.		- 5	-	3475.	6951.	13902.	~ 0	* * 1	<b>~</b> ~	4		U	-	47	6955. 10436.	392	6 0	4 4 0
MSD CR STRESS PSI	3475.	3900	0.85	4325	275	•	STR	PS	3475.	10425.	13900.	20850.	4	Ü	-	3475.	10425	13900.	7375	32	780	7.5	2	ū	•	7.	10425.	390	37	4 5
AXIAL LOAD POUNDS	23710.	4842	226	969	339	S AND	AXIAL	POUNDS	23710.	71131.	118552	142263.	3 AND	⋖	POUNDS		71131.	9484	1055	6597	~ ~	3710	1 AND	<b>*</b>	LOAD POUNDS	3710	71131.	94842	855	6507
LONG STRAIN N/IN	225.	950	400	900	25.	GAGES	LONG	NIV	225.	550.			GAGES		STRAIN	250.	600.	25.	0.20	275.	. 22	400	GAGES	إب	STRAIN	75	125.	00	75.	
STRAIN MICROI	475.	1000.	200	2 2 2	2525.	UMRER 7	CIRCUM	Σ	in c	1050	1550.	5325.	MBER 7	RCUM	TRAIN MICROI	IC	200.	75	00	8	73	•	NUMBER 7	RCUM	MICROI	00	1050.	475	2825.	y c
HYDRO PRESS PSI	100.	00	0	000		TEST NU	HYDRO	ko	50	100	<b>⊃ k</b> ∩	350.	TEST NUM	OC 1	PRESS PS1	50.	150.	200.	300	350.	4 0 0 4 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	500	TEST NU	0	PSI	E C	150.	00	300	350.

TABLE G-30. STRESS-STRAIN DATA ON CYLINDER NO. CY-12 (1:1)

AXIAL LOAD OUNDS	$\times$ $\square$	
3710.	3710.	3475.
7421. 6950. 6	7421. 6950. 6	6950 . 6
1131. 10423. 104884848. 13900. 139	1131. 10423. 104884848. 13900. 139	3900. 139
3552. 17375. 173	3552. 17375. 173	7375. 173
5973. 24325. 243	5973. 24325. 243	4325. 243
9683. 27800. 278	9683. 27800. 278	7800. 278
3394, 31275, 3 7104, 34750, 3	1275. 313 4750. 348	1275. 313 4750. 348
AND 6		
MSD CR TRU	MSD CR TRU C	MSD CR TRU C
PSI PS	POUNDS PSI PS	PSI PS
3710. 3475. 34	23710. 3475. 34	45
7421. 6950. 6954	47421. 6950. 6954	6950 6954
1131. 10425. 104 1842. 13900. 139	71131, 10425, 10436 94842, 13900, 13922	3900. 13922
3552. 17375. 174	118552, 17375, 174	7375. 174
2003. 2005U. 2 3973. 24325. 2	0850. 209 432 <b>5</b> . 244	0850. 209 432 <b>5</b> . 244
AND 4	3 AND	•
MSD CR TRU	AXIAL MSD CR TRU C	SD CR TRU C
STRESS STRES	STRESS STRES	TRESS STRES
3475. 34	23710, 3475, 34	475. 34
10425 104	71131, 10425, 104	5950. 69 8425. 184
13900. 139	94842, 13900, 139	3900. 139
17375. 173	118552, 17375, 173	7375. 173
, 20850, 208 24325 243	142263, 20850, 208	0850. 208
27800. 278	189683. 27800. 278	7800. 278
3394, 31275, 31340, 7104, 34750, 34868,	1275. 313 475n. 348	1275. 313 475n. 348
AND 2		2
XIAL MSD CR TRU C	AXIAL MSD CR TRU C	MSD CR TRU C
LOAD STRESS STRESS	LOAD STRESS STRES	STRESS STRES
UNDS PSI PS	POUNDS PSI PS	PSI PS
3475. 34	3475. 34	34
6950. 6	47421. 6950. 69	6950. 69
10425. 104	71131, 10425, 104	0425. 104
13900 139	94642, 13900, 139 118552, 17375, 174	3900. 139 7375. 174
20850. 20R	142263. 20850. 20R	0850. 20R
24325. 244	165973. 24325. 244	
/> • 0 0 0 / 2	/3 .000/2 .contor	24325. 244

TABLE G-31. STRESS-STRAIN DATA ON CYLINDER NO. CY-13 (1;0)

124.737 -299.955 1124.348 -374.030	13/4.930	10 -599.821	-699.756	15 -899.596	65 -1149.340 3659.937 89 -1199.280 4091.380		TRU TRAVRS EF	STRAIN		24.975	,	.930		821 3542		•	3	166.69				1				Ħ	1	Σ.				 - <del>-</del>
	1523.838	1923.150	5.946	485	800	1		3	Ē .	1 (0)	51	-374	-499	-566		TRU TRA	ST	-149.989	-224.975	-524.862	1509.821	-749.719	-824.661			TRU TRAVRS	STRAI	MICROIN/IN	-224.975	-274.963	-374.930	-499.87
			285	3319.	4340.56			i	249.959	849	617	720	746	4713.872		TRU LONG		266.66 86.66	224.975	474.888	1340,081	2322.302	3867.512			TRU LONG	9	ALCHO LOS ON B	599.821	•	1174.310	١ ٠,
695 7043	13921	17408.	24394.	11305	34901.		EFFECTIVE	STRESS	3476	6954	4840	17403.	20894.	27931.	į	FFFECTIVE	ESS	5	6952	13907	17389.	24382.	31478.			EFFECTIVE	-		6954	10434.	13916.	20892.
6955	13921.	7408	24394.	7 8	4 4	· c	TRUE	PSI	3476.	6954	10434.	17403.	20894.	27931.		TRUE	E 0	० च्या	6952	13907.	17389.	24382.	31478.		€		STRESS	1476.	6954	10434.	13916.	20892.
10425.	13900.	17375.	24325.	31275.	34750.	5 AND	HSD ST	PSI	3475	6950	10425	17375.	20850.	27800.	3 AND	MSD	TRES	3475	10425.	13900	17375.	24325	31275.	. :	1 AND	MSD	STRESS	3475	6950.	10425.	13900.	20850.
1125	1525	1925	2850	3325	4350	GAGES	LONG	NAN	250.	550	975.	1600.	2125.	4725	GAGES	LONG	STRAIN	100.	325.	475.	1350.	2325.	6475.		GAGES	LONG	SIRAIN	300.	600	900	1175.	2025.
-375.	-500	-600-	-825.	-1025.	-1150.		TRAVRS	SIKA IN MICROIN	-175.	-225.	-250	-425.	-500.	-600	22	RAVRS	N A A C	-150	.325.	-525.	- 700.	-750	-875.	:	<u>a</u>	FRAVRS	STRAIN TIRE	-150	-225.	-275.	-375	-500.
.300. 725. 6950.	-175 1135 1043E	-375. 1125. 10425. -560. 1525. 13900.	-375. 1125. 10425. 1 -500. 1525. 13300. 1 -600. 1925. 17375. 1	-375, 1125, 10425, 104 -500, 1525, 13900, 139 -600, 2905, 27375, 174 -700, 2400, 20850, 209 -825, 2850, 24325, 243	-375, 1125, 10425, 1550, 13900, 1550, 13900, 1925, 13900, 1700, 2400, 20850, 24355, 2650,	-375, 1125, 10425, 1500, 1570, 1575, 13900, 1600, 1925, 13900, 17375, 1700, 2400, 24325, 2700, 2700, 3325, 2700, 2700, 3325, 3475, 34750, 1150, 4950, 38225, 3	-375. 1125. 10425. 1570. 1575. 13900. 1575. 13900. 1570. 13900. 1575. 17900. 1575. 17900. 1575. 17900. 17900. 1325. 179000. 17900. 17900. 17900. 17900. 17900. 17900. 17900. 17900. 1790	-375, 1125, 10425, 10437 -500, 1525, 13900, 13921 -600, 1925, 1375, 17408 -900, 3425, 27436 -1025, 3825, 27430, 27892 -1150, 4350, 3470, 34901 -1200, 4550, 38255, 34144 -1200, 4550, 38225, 38414	-375. 1125. 10425. 10437 -500. 1525. 13900. 13929 -600. 1925. 1375. 1740R -700. 2400. 20850. 2090R -825. 2850. 24325. 24394 -927. 3825. 37750. 34391 -1750. 3825. 31275. 31395 -1150. 4550. 38225. 38414 JMBER 9 GAĞES 5 AND 6 TRAVRS LONG MSD TRU	-375. 1125. 10425. 10437 -500. 1525. 13900. 13929600. 1925. 1375. 17408825. 2450. 24325. 24994 -925. 2450. 27825. 24994 -1025. 3825. 3775. 313951150. 4950. 38225. 38414 JHRER 9 GAGES 5 AND 6 TRAVRS LONG MSD TRU STRAIN STRAIN STRESS STRES HICKOINNIN PSI. 3475. 3475.	-375. 1125. 10425. 10437 -500. 1525. 13900. 13929600. 1925. 1375. 17408700. 2400. 20850. 20900825. 2850. 24325. 249941050. 3325. 27800. 319591150. 4850. 34750. 349011150. 4850. 38225. 38414 -1150. 4850. 38225. 38414 -1150. 4850. 4850. TRU TRAVRS LONG MSD TRU STRAIN STRAIN STRESS STRES -175. 550. 6950. 6954	-375. 1125. 10425. 10437 -500. 1525. 13900. 13929600. 1925. 1375. 17407 -700. 2400. 20850. 20900 -825. 2850. 24325. 24994 -1050. 3325. 37750. 34901 -1050. 3825. 3785. 34901 -1700. 4950. 38225. 38414 HRER 9 GAGES 5 AND 6 TRAVRS LONG MSD TRUSTRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRESS TRES -175. 250. 3475. 3475. 3475. 2255. 550. 6950.	-375. 1125. 10425. 10437 -500. 1525. 13900. 13921 -600. 1925. 1375. 17408 -700. 2400. 20850. 20900 -825. 2850. 24325. 24994 -900. 3325. 27800. 3195951150. 4350. 34750. 3195951150. 4950. 38225. 38414 HREWIN STRAIN STRESS STRESS STRESS -175. 550. 6950. 6954 -225. 550. 6950. 6954 -375. 1200. 13375. 17403	-375, 1125, 10425, 10437 -500, 1525, 13900, 13921 -600, 1925, 1375, 17401 -700, 2400, 20850, 20900 -925, 2850, 27825, 27892 -1050, 3325, 3760, 31989 -1050, 3825, 37875, 31989 -1150, 4550, 38225, 38414 -176, 250, 38225, 38414 -175, 250, 3475, 3475, 2756 -225, 350, 6950, 6954 -255, 1600, 17375, 17403 -575, 2850, 26854	-375. 1125. 10425. 10437 -500. 1525. 13900. 13921 -600. 1925. 1375. 17408 -700. 2400. 20850. 20900 -825. 2850. 24356. 278920 -1055. 3825. 31275. 31392 -1150. 4550. 34255. 31392 -1200. 4950. 38225. 38414 -170. 4950. 38225. 38414 -171. 4950. 38225. 38414 -171. 4950. 38225. 38414 -172. 2850. 3475. 3476 -275. 1200. 13900. 13917 -475. 1200. 13900. 13917 -475. 2850. 24325. 26894 -500. 4725. 27327. 27931	150375. 1125. 10425. 10437 200500. 15925. 13900. 13921 350600. 1925. 1375. 17408 350825. 24850. 24836 4501027. 3825. 27870. 27892 4501027. 3825. 31270. 31382 5501150. 4950. 38225. 31492 5501200. 4950. 38225. 38414 5501200. 4950. 38225. 3476 501750. 4950. 38225. 3476 50175. 250. 3475. 10434 500275. 1200. 13900. 13917 500375. 1200. 13917. 10434 500375. 1200. 13917. 10434 500375. 2850. 24350. 24354 500500. 4725. 28850. 24387	-375, 1125, 10425, 10 -500, 1525, 13900, 133 -500, 1925, 17375, 17 -900, 3325, 27800, 278 -1020, 3325, 27800, 345 -1150, 4350, 34750, 345 -1150, 4350, 34750, 345 -1150, 4350, 34750, 345 -1150, 4350, 34750, 345 -1270, 1000, 1000, 1000, 1000, 1000, 1000, 1000, 1000, 1000, 1000, 1000, 1000, 1000, 1000, 1000, 135 -250, 875, 1200, 1375, 1000, 135 -250, 2125, 20850, 20850, 2000, 275, 2850, 24325, 243	-375. 1125. 10425. 10500. 1525. 13900. 133 -500. 1925. 1375. 1775900. 2400. 20850. 24325900. 3825. 27800. 278001025. 3825. 31275. 3161025. 3825. 31275. 3161000. 4950. 38225. 3161000. 4950. 38225. 3161000. 4950. 38225. 3161000. 1000	-375, 1125, 10425, 10 -500, 1525, 13900, 133 -500, 2400, 20850, 26 -825, 2850, 24325, 24 -1026, 3325, 27400, 314 -1026, 34750, 34750, 3475 -1150, 4350, 34750, 3475 -1150, 4350, 34750, 3475 -1150, 4350, 3475, 34 -1260, 1260, 13960, 13960, 1396 -225, 550, 6950, 6950, 275 -225, 1600, 17375, 104 -275, 2850, 24325, 243 -500, 2125, 26850, 278 -500, 2125, 26850, 278 -500, 2125, 26850, 278 -500, 2125, 27800, 278 -500, 4725, 27800, 278	-375, 1125, 10425, 10 -570, 1525, 13900, 133 -600, 1925, 17375, 17 -700, 2400, 24325, 244 -900, 3325, 27400, 375 -1025, 2850, 34750, 347 -1150, 4350, 34750, 347 -1150, 4350, 34750, 347 -1200, 4350, 3475, 347 -175, 1741N STRAIN STRESS STRAIN STRA	-375, 1125, 10425, 10 -500, 1925, 13900, 133 -600, 1925, 13900, 139 -825, 2450, 24325, 244 -1026, 3325, 27400, 314 -1026, 34750, 34750, 3475 -1150, 4350, 34750, 3475 -1150, 4350, 34750, 3475 -1200, 4350, 3475, 3475 -225, 550, 6950, 6950 -225, 550, 6950, 6950 -225, 1600, 17375, 174 -575, 2450, 24325, 243 -575, 2450, 1040, 104, 3475, 34 -525, 325, 10425, 1149	-375, 1125, 10425, 10 -500, 1525, 13900, 133 -500, 2400, 20850, 243 -900, 3325, 27800, 314 -1025, 2850, 24325, 244 -1150, 4350, 34750, 3475 -1150, 4350, 38225, 38 TRAVRS LONG MSD TRESS TH HTCROINZIN STRESS TH -225, 3475, 3475, 34 -225, 550, 650, 66 -375, 1200, 17375, 104 -425, 1600, 17375, 104 -425, 1600, 17375, 243 -500, 24325, 1043 -575, 2850, 24325, 243 -575, 2850, 24325, 243 -575, 2850, 24325, 243 -575, 2850, 24325, 243 -575, 2850, 24325, 104 -575, 2850, 13375, 1133 -575, 2850, 2850, 204 -575, 2850, 2850, 204 -575, 2850, 2860, 204 -575, 2850, 2860, 133	-375. 1125. 10425. 10570. 1925. 13900. 139600. 1925. 13900. 139600. 2400. 20850. 24325. 2401025. 3825. 27800. 37450. 34750.	-375, 1125, 10425, 10437 -500, 1525, 13900, 13921 -600, 1525, 13900, 13921 -600, 2400, 24856, 24896 -900, 3425, 278900, 278920 -1027, 3825, 27800, 278920 -1027, 3825, 27800, 34300 -100, 4350, 34256, 34800 -175, 2850, 375, 3476 -225, 850, 375, 3476 -225, 850, 375, 3476 -275, 2850, 28850, 26894 -500, 4725, 27800, 27931 -178, 2850, 28500, 27931 -178, 2850, 28500, 27931 -178, 2850, 28500, 27931 -178, 2850, 28500, 27931 -178, 2850, 28500, 27931 -176, 2850, 28500, 27931 -178, 2850, 28500, 27931 -178, 2850, 28500, 13907 -150, 1350, 28500, 20878 -176, 2325, 24326, 28438 -176, 2325, 24326, 27908 -176, 2325, 24326, 27908 -176, 2325, 24326, 27908 -176, 2325, 24326, 27908 -176, 2325, 24326, 27908 -176, 2325, 27428	-375, 1125, 10425, 10 -500, 1525, 1300, 133 -600, 1925, 17375, 170 -900, 24325, 24 -1025, 3825, 24325, 24 -1026, 3325, 27800, 279 -1026, 3725, 27800, 34 -1026, 3725, 27800, 34 -170, 250, 3475, 34 -170, 250, 3475, 104 -170, 250, 3475, 104 -170, 250, 3475, 279 -425, 1200, 1390, 1390 -425, 1200, 1390, 279 -500, 4725, 27800, 279 -500, 4725, 2850, 875, 104 -575, 2850, 24325, 24 -575, 2850, 24325, 24 -575, 1200, 1390, 1390 -575, 1200, 1390, 1390 -575, 2850, 875, 10475, 104 -575, 225, 6950, 279 -500, 1350, 20850, 279 -500, 1350, 2780, 279 -500, 1350, 2780, 279 -600, 279 -875, 2435, 2435	-375. 1125. 10425. 10500. 1925. 1390. 133500. 1925. 1390. 135900. 2400. 20850. 243900. 3325. 27800. 3175. 31100. 3425. 31275. 311025. 3825. 31275. 311025. 3825. 31275. 31100. 4950. 38225. 31100. 4950. 38225. 31100. 4950. 38225. 31100. 4950. 38225. 31100. 4950. 38225. 31100. 120. 3475. 33100. 120. 13900. 13900. 13900. 375. 1200. 13900. 13900. 13900. 13900. 375. 1200. 13900. 279. 24325.	-375. 1125. 11425. 10425570500. 1525. 17370600. 1525. 17370825. 27500. 24025770. 2400. 24025. 278001150. 3825. 278001150. 4950. 38255. 27800. 38751270. 4950. 382551270. 4950. 382551270. 4950. 38255275. 250. 3475275. 250. 3475275. 250. 3475275. 2650. 17375575. 22650. 27800. 17375575. 22650. 27800. 17375575. 225. 6950575. 225. 6950575. 225. 6950575. 225. 6950575. 225. 6950575. 225. 6950575. 225. 6950575. 225. 6950575. 225. 6950575. 225. 6950575. 225. 6950570. 2325. 24325770. 1350. 20850770. 1350. 20850770. 225. 6475. 31275770. 3875. 27818. 9 GAGES 1 AND 2	-375, 1125, 10425, -570, -600, 1925, 17375, -600, 1925, 17375, -900, 24325, -700, 24325, 2740, -1150, 4550, 3425, 3425, -1200, 4550, 3425, -1200, 4550, 3425, -1200, 4550, 3425, -225, 875, 1200, 13475, -225, 875, 1200, 13475, -250, 4725, 2750, 24325, -575, 2850, -5750, 2325, 24325, -750, 24325, -750, 24325, -750, 24325, -750, 24325, -750, 24325, -750, 24325, -750, 24325, -750, 24325, -750, 24325, -750, 24325, -750, 24325, -750, 24325, -750, 24325, -750, 24325, -750, 24325, -750, 24325	-375, 1125, 10425, -570, -500, -500, 1525, 17375, -770, 2470, 24325, -770, 2470, 24325, -770, 2470, 24325, -770, 2470, 24325, -1700, 3625, 34275, -1700, 4550, 3625, 34275, -1200, 4550, 3625, -250, 3475, -250, 375, 1200, 1390, -250, 375, 1200, 1390, -250, 375, -250, 375, -250, 375, -250, 375, -250, 375, -250, 375, -250, 375, -250, 375, -250, 375, -250, 375, -250, 375, -250, 375, -250, 375, -255, 375, -270, 375, -275, -275, 375, -275, 375, -275, 375, -275, 375, -275, 375, -275, 375, -275, 377, -275, 370, 377, -275, 377, -275, 377, -275, 377, -275, 377, -275, 377, 377, -275, 377, -275, 377, -275, 377, -275, 377, -275, 377, -275, 377, -275, 377, -275, 377, -275, 377, -275, 377, -275, 377, -275, 377, -275, 377, -275, 377, -275, 377, -275, 377, -275, 377, 377, -275,	-375, 1125, 10425, -375, -375, 1125, 13000, -600, 1525, 17375, -770, 2470, 24325, -770, 2470, 24325, -770, 2470, 24325, -770, 3625, 37276, -1150, 4550, 3625, 37276, -1270, 4550, 3625, -1270, 4550, 3625, -1270, 24325, -250, 3475, -250, 375, 1200, 13900, -250, 375, 1200, 13900, -250, 375, 1200, 13900, -250, 375, 1200, 13900, -250, 375, 1200, 13900, -250, 375, 1200, 13900, -250, 375, 13900, -250, 375, 13900, -255, 4725, 24325, -255, 4725, 24325, -255, 4725, 27800, -275, 3875, 27800, -275, 3875, -2760, 800, 17375, -276, 2850, 2850, -276, 3875, -276, 3875, -276, 3875, -276, 3775, -276, 3775, -276, 3775, -276, 3775, -276, 3775, -276, 3700, -275, 3700, -275, 3700, -275, 3700, -275, 3700, -275, 3700, 5975, -225, 500, 500, 500, 500, 500, 500, 500,	-375, 1125, 11425, 10425, -570, -500, 1525, 17376, -500, 1255, 17376, -770, 2400, 24325, -770, 2400, 24325, -770, 2400, 24325, -1700, 3425, 3426, -1200, 4550, 3425, -1200, 4550, 3425, -225, 2425, -225, 2450, 24325, -575, 2450, 24325, -575, 2450, 24325, -575, 2450, 24325, -575, 2450, 24325, -575, 2450, 24325, -575, 2450, 24325, -575, 2450, 24325, -575, 2450, 24325, -575, 2450, 24325, -575, 2450, 24325, -575, 2450, 24325, -575, 2430, -575, 2430, -575, 24325, -575, 24325, -575, 24325, -575, 24325, -575, 24325, -575, 24325, -575, 24325, -575, 24325, -575, 3432, -1750, 34325, -475, 34325, -475, 34325, -225, 600, 6950, -225, 500, -225, 500, 6950, -22	-375. 1125. 10425. 10500. 1925. 13900. 139 -500. 1925. 13900. 13900. 139 -900. 24325. 249 -1025. 3825. 27800. 27800. 34750. 3

TABLE G-32. STRESS-STRAIN DATA ON CYLINDER NO. CY-16 (1:0)

																							:				:			111111111111111111111111111111111111111										
EFFECTIVE STRAIN	MICROINZIN	249.976	555.21/ 833.023	1116.112	1399,099	1731,969 2048,020	2380.683	2713.153	3062.190 3477.515		EFFECTIVE	STRAIN	MICROIN/IN	499.891	766.405	1016.192	1332.500	1/15.225 2164.211	3409.870	6538.342		EFFECTIVE	X I CAD I X I I I	-	349,953	400.004	566.546	683.157 1182.856	1715.314		3011.639 3858.149		EFFECTIVE	STRAIN	MICROINZIN	266.633 844 804	733.090	1016.166	1465.557	1881.4880
TRU TRAVES STRAIN	MICROIN/IN	-149.989	-2/4.903	-474.888	-549.849	-699.756	-899.596	-974.525	-1099.395		TRU TRAVRS	STRAIN	MICROIN/IN	1			- 1	2 2				F	MICROINZIN	-124.992		i				-699.756	-799.681			STRAIN	2 u		552	33	900	208.470
TRU LONG STRAIN	MICRO IN/IN	224.975	899.596	1199.280	1548.800	2207.350	2671.429	3095.205	3493.889		TRU LONG		MICRO IN/IN	524.862	824.661	1124.368	1498.875	2646.495	4465.016	9182./09		TRU LONG	MICRO IN/IN	174.984	299,955	424.909	449.899	1049.448	1898.198	821	4987.542		TRU LONG	STRAIN	MICRO INZIN	674.773	799.681	1174.310	2207 427	4400 4004
EFFEC ST	ISd	3476.	10434.	917	17402.	20890.	974	372	34872.		EFFECTIVE	- 1		6954.	10434.	13916.	17401.	24389.	27924.	51264.		EFFECTIVE STRESS	_		10420	13906.	17383.	24351.	27853.	31363.	38416.		EFFECTIVE			6955	10433.	13916.	17406.	.04000
TRUE	ISd	3476.	10434.	13917.	17402.	24381.	27874.	31372.	34872.	ç	œ	STRESS	7476.	6954.	10434.	13916.	17401.	24389.	27924.	51564.	+	TRUE	PSI	3476.	10420	13906.	17383.	24351.	27853.	31363.	38416	_	TRUE	STRESS	PSI	6955	10433.	13916.	17406.	040000
ST		54/5.	10425.	13900.	17375.	24325	27800.	31275.	34750.	5 AND	MSD	STRESS	7475.	6950.	10425.	13900.	1/3/5.	24325.	27800.	312/2	3 AND	MSD	15.	3475.	10425	13900.	375	24325.	27800.	31275.	38225	1 AND	MSD	STRESS	PSI	6950	10425.	13900.	2/375.	0 0 0 0 0
LONG	2 6	225		1200	1550	۲ م	2675	3100	3500.	0 GAGES		STRAI	7.1N 275	1	825	1125	1500		;		0 GAGES	LONG	21/2	175.	500°	425.	450.	1050.	1900.	2825	0. 5000. 38	J GAGES		۔ ا	N . / /	675	800.	1175.	2300.	1000
STRAIN	MICROI				-550.	-775.			-1100.	UMBER 1		STRAIN	MICROIN	-225.	-325.	-400.	-500.	-600	-650.	-020-	NUMBER 10	STRA	WICE.	7			4 4	.5.7	-6	7 7	0.0	NUMBER 10	TRAVRS	- ic	200	-175.	0	-350.	-525	
HYDRO PRESS	180	- 1			•				550.	EST NI	HYDRO	PRESS	59.	100.	150.	200.	200.	350.	400.	• 0 0	EST NU	HYDRO	PSI	50.	150.	200	250.	350.	400	450°	550.	TEST NU	HYDRO	PRESS	ָ מ מ מ	100.	150.	200.	300	, u

## TABLE G-33. STRESS-STRAIN DATA ON CYLINDER NO. CY-14 WITH REINFORCED WELD (2:1)

HYDRO	CIRCUM	LONG	AXIAL	MSD CR	THU CR	MSD LN	TRU LONG	TRU CIRCH	TRU LONG	TRU RAD	FFFECTIVE	EFFECTIVE	7
PRESS	STRAIN STRAI	STRAIN	LOAD	STRESS	STRESS STRESS S	STRESS	STRESS		STRAIN	STRAIN	STRESS	STRAIN	•
PSI	MICROL	2     	POUNDS	PSI	PSI	PS I	Isd	MICROIN/IN	MICROINZIN	MICROINZIN	1Se	MICINIIN	
50.	175.	5		3475.	3476.	1738.	1737,500	174.984	0.00	-61.244	3010	44. FEB	, t
100	450.	100.		6950.		3475.	3475,348	449.899	999.99	-102.463	6021	371.362	, K
150.	700.	150.		10425.		5213.	5213,282	699.756	149.989	-297.411	0 4 4 0	876. 72K	
200.	1000.	225.		13900.	13914.	6950.	6951.564	999.508	224,975	-428.566	12040.8	825.480 0.35	
250.	1275.	300.	59274.	17375.	17397.	8688	8690.106	1274.187	299.955	-550.950	15066.4	1054.545	0.35
300.	1550.	350	71131.	20850.	20882.	10425.	10428.649	1548.800	349.939	-664.959		1279.360	35
350.	1875.	425.	82987.	24325.	24371.	12143.	12167,669	1873.244	424.909	-804.354	21105.6	1547.636	0.35
400	.0022	500.	94842		27861.	13900.	13906.950	2197,583	409.874	-944.110		1815.828	0.35
450.	2525.	575.	106697.		31354.	15638.	15646.492	2521.817	574.835	-1083,828		2083.938	0.35
500	2900.	650.	118552.		34851.	17375.	17386.294	2895,804	649.789	-1240.957		2391.294	0.35
. 066	3250.	700.	130407.	38225.	38349.	19113.	19125.879	3244.729	699.756	-1380.570	33211.4	2674.905	35
.009	3700.	750.	142263.	41700.	41854.	20850.	20865.637	3693.171	749.719	-1555.011	36246.9	3037.510	0.35
.020	4225	825	154118.	45175.	45366.	22587.	22606.135		824.661	-1764.266	39288.1	3463,113	0.35
700	4800.	006	165973.	49650.	48884°	24325.	24346.893		899.596	-1990,839	42334.5	3928,188	0.35
750	5625.	975.	177828.		52418.	26063.	26087.911		974.525	-2304.317	45395,7	4591.193	0.35
800.	.0089	- 1	189683.		5597R.	27800.	27829.190		1049.448	-2739.251	48478.7	5532,081	0.35
	10375.		201539.		59689	29537.	29570.730	7	1124.368	-4006.071	51692.0	8382,392	0.35
.006	6575.		213394.	62550.	62961.	31275.	31314.876	6553,478	1274.187	-2739,683	54526.3	5381.964	0.35
ċ	8025.		ė	0	0		000-0	7992.971	0.000	-2797.540		6466.133	0.35
948	8025.		224775.	65886.	66415.	32943.	32967,707	7992.971	749.719	-3059.941	57517.3	6483.227	0.35
ċ	A150.		• 0	.0	0	0	00000	8116.968	274.963	-2937.176		6566.057	0.35
990	A075	1075		1000	. , , ,						•		

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122 0000WWVWVT410WVV	
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TRU LONG STRESS 1747-587 3475-348 5213-442 6951.564 10428-649 1104	32945.471
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AXIAL LOAD POUNDS 11855. 23710. 355710. 355710. 355710. 47421. 1131. 87487. 1130467. 11452263. 1154118. 1154118. 115418. 115418. 115418. 1189583. 2157853.	
CIRCUM STRAIN ST	7600. 17700. 7825.
1 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4	9480.

TEST NUMBER 11 GAGES 5 AND

TABLE G-33. STRESS-STRAIN DATA ON CYLINDER NO. CY-14 WITH REINFORCED WELD (2:1) (Cont'd)

TEST NUMBER 11 GAGES 3 AND 4

100 114.984 0.000 -104.984 6019.9 144. 1010 299.955 0.000 -104.984 9013.0 242. 1024.888 20.000 -174.984 9013.0 242. 1024.888 20.000 -227.437 19056.2 384. 102 1024.82 149.989 -428.584 24101.4 875. 1024.202.953 299.989 -428.384 24101.4 875. 1024.202.953 299.989 -428.384 24101.4 875. 1024.989 222.953 299.999 -1022.45 482. 1026.361 299.995 -4102.45 482. 1026.361 299.995 -4102.45 482. 1026.362 803 3356.8 1302. 102 124.992 -102.45 482. 103 309.995 -102.45 482. 103 309.995 -102.45 1308.9 2379. 103 309.995 -102.45 1308.9 2379. 104 222.52 986 924 573 -447.98 5725.9 184. 105 222.52 999.995 -102.45 1308.9 2379. 106 -274.992 -102.45 1308.9 2379. 107 -274.992 -102.45 1308.9 2379. 108 5784.402 1174.310 -1581.549 59786.5 2850. 109 -274.992 -102.45 1308.9 1507. 109 224.972 -1105.133 2477.1 3179. 108 524.902 -1308.989 1508.995 1508.9 1507. 109 226.730 399.999 -1511.033 2477.1 3179. 108 5282.36 528.999 -1511.033 2477.1 3179. 109 528.36 528.999 -1511.033 2477.1 3179. 109 528.36 528.999 -1511.033 2477.1 3179. 103 5384.402 -128.991 -128.931 2708.9 15	000 174.984 0.000 -14.964 6019.9 144.  501 299.955 0.000 -14.964 12043.6 384.  716 899.596 25.000 -14.961 12043.6 384.  716 899.596 99.995 -429.437 1506.2 384.  717 1074.188 25.000 -14.961 12043.6 384.  718 1074.422 149.989 -428.544 24101.4 875.  719 1074.422 149.989 -428.544 24101.4 875.  710 1598.720 259.995 -913.000 364 4222.3 1160.  711 1223.336 199.999 -1002.445 31156.8 1137.2 1160.  711 1223.336 199.999 -1002.445 31156.8 1130.  712 222.953 399.919 -1002.445 11318.9 1649.  719 124.992 -910.000 124.724 9221.3 1160.  710 124.992 -920.955 -913.82.36 4222.3 1161.  711 124.992 -920.995 -910.000 124.72 1161.  711 124.992 -920.995 -910.000 12.364 4222.3 1161.  711 124.992 -920.995 -910.000 12.45 1161.  712 122.953 399.919 -1002.445 112.900 16.  718 12 122.953 399.919 -1002.445 112.000.  719 124.992 -920.995 -910.000 12.364 12.000.  710 124.992 -920.995 -910.000 12.364 12.000.  711 122.992 1174.310 -1511.549 901.7 7.245.9  711 122.992 1174.310 -1511.033 110.9 5.255.9  712 122.000 1174.994 -1511.033 110.9 5.255.9  713 124.905 -124.909 -1271.945 1150.9  710 124.905 -124.909 -1271.945 1150.9  711 122.992 1174.310 -1511.033 12.900.9  712 122.992 1174.310 -1511.033 12.900.9  713 124.902 -124.903 12.900.9  713 124.903 124.903 125.907 1910.9  713 124.903 125.907 1910.9  713 124.903 125.907 1910.9  714 122.906.905 1810.9  715 126.905 113.7 7.24.906 113.000 12.000.9  715 1150.905 1150.9  717 1150.905 1150.9  718 116.905 1150.9  718 116.905 116.905 116.9  719 116.905 116.906 116.9  719 116.906 116.906 116.906 116.906.9  719 116.906 116.906 116.906 116.906.9  719 116.906 116.906 116.906 116.906.9  719 116.906 116.906 116.906 116.906.9  710 116.906 116.906 116.906 116.906.9  711 116.906 116.906 116.906 116.906.9  711 116.906 116.906 116.906 116.906.9  711 116.906 116.906 116.906 116.906.9  711 116.906 116.906 116.906 116.906.9  711 116.906 116.906 116.906 116.906.9  711 116.906 116.906 116.906 116.906.9  711 116.906 116.906 116.906 116.906.9  711 116.906 116.906 116.906 116.906.9  711 116.906 116.906 116.906 116.906.9  711 11
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434         949,548         25,000         -157,468         5010,7         343,959           434         949,548         124,992         -376,089         6024,6         772,915           564         1923,986         174,984         -559,639         9041,2         1158,010           564         1922,150         274,984         -751,844         12060,9         1156,015           388         2920,730         324,947         -1135,987         18109,5         2372,498           757         3394,233         349,939         -1511,035         24117,1         3772,498           537         4489,905         -1511,035         24171,1         3779,416         1379,416           557         546,949         -178,939         -178,93         24171,1         3779,416           637         547,749         -178,93         -178,93         24171,1         3779,416           636         548,849         -178,889         -178,040         544,051         3643,651           637         407         -178,040         -178,040         3643,651         3643,651           636         1190,386         -178,040         -178,040         3644,55         7368,651           637	543         424,909         25.000         -157,468         3010.7         343.9           434         949,548         124,992         -376,089         6024.6         772,9           412         1423,986         174,984         -559,639         9041.2         1158.0           889         2422,064         274,975         -71,844         12060.9         1563.0           389         2422,064         274,963         -943,987         10109.2         1563.0           757         3394,233         349,947         -1135,987         10109.2         2772.6           757         3394,233         349,949         -178,940         21137.7         2755.1           550         3394,233         349,949         -178,940         21137.7         2755.1           551         336,784         448.886         -178,940         21137.7         2755.1           553         5136,784         474.886         -1264.085         3169.9         7369.9           703         1012         874.886         -2648.06         3569.9         7369.9           703         1018         674.773         -3308.09         38478.2         7318.3           63         1190.867         724
434         949.548         124.992         -376.089         6024.6         772.915           441         1423.986         174.984         -559.639         9044.2         1158.010           864         1923.150         224.963         -943.960         15083.7         1967.849           388         2922.064         274.963         -943.960         15083.7         1967.849           7.57         334.23         324.947         -1135.987         18109.5         2372.498           7.57         334.23         349.39         -1510.460         21137.7         2755.148           7.57         334.27         31.7         37.27         449.399         -1510.046         21137.7         2755.148           7.57         334.905         -1510.03         2417.1         379.476         3643.651         0           557         449.999         -1728.931         2720.915         405.416         0         3643.651         0           12         704.915         624.88         -1964.085         31260.9         401.120         3641.120         0         364.85         367.120         0         364.85         366.112         0         364.85         366.112         0         0	412 949.548 124.992 -376.089 6024.6 772.9 412 1423.986 174.994 -559.639 9041.2 1158.0 889 2422.054 274.955 -453.960 15083.7 1158.0 889 2422.054 274.955 -453.960 15083.7 1967.8 889 2920.730 324.947 -1135.987 18109.5 2372.4 889 2920.730 324.947 -1135.987 18109.5 2372.4 889 2920.730 324.947 -11310.460 21137.7 2.755.1 856 394.233 349.939 -1.758.931 2.7206.9 344.0.4 857 2489.905 449.899 -1.788.931 2.7206.9 4410.1 825 5136.784 474.888 -2648.085 30249.5 4166.1 835 11903.867 724.773 -2640.011 42637.5 9636.8 840 15282.623 749.719 -5041.320 4958.8 12048.8 856 13902.905 599.821 -5075.954 51878.2 11248.5 867 1207.782 25.000 -424.374 5753.6 9760.1
412         1423.986         174.984         -559.639         9041.2         1158.010           564         1923.150         224.975         -751.844         12060.9         1553.015           1889         2422         104         963         -743.96         1506.9         1507.849           1889         2920         -310.46         2113.7         1967.849         1057.86         1106.2         1809.9         1507.849         1107.8         1809.9         1507.849         1507.849         1707.8         1107.7         2755.148         1707.8	412         1423.986         174.984         -559.639         9041.2         1158.0           564         1923.150         224.975         -751.844         12060.9         1563.0           1.88         2922.104         224.975         -751.844         12060.9         1563.0           1.88         2920.104         224.947         -1155.987         1510.93.7         297.2           757         3394.233         349.939         -1310.460         21137.7         2755.1           550         3394.233         349.939         -178.0         2137.7         2755.1           551         348.98         -1264.085         2216.7         3179.4           253         5136.784         474.888         -1264.085         31249.5         4166.1           253         5136.784         474.888         -1264.085         31249.5         4166.1           253         5136.784         474.888         -1264.087         3350.9         5736.9           354         10.0         547.773         -2546.901         3647.8.2         5736.8           354         1190.867         724.773         -2649.901         4263.5         3478.2         5736.8           44         1862.664
564         1923,150         224,975         -751,844         12060,9         1563,015         0           889         2422,064         274,963         -943,961         15183,7         1967,849         0           388         2422,064         274,963         -943,960         15183,7         2372,496         0           394,23         349,93         -1310,460         2113,7         2752,149         0           550         391,317         399,919         -1511,033         24170,1         3179,476         0           557         449,899         -1728,931         27206,9         3643,651         0         0         3643,651         0         0         0         3643,651         0 <td>564         1922,150         224,975         -751,844         12060,9         1563,0           889         292,064         274,961         15083,7         1967,8           389         292,064         324,947         -135,961         15083,7         1967,8           757         3394,233         349,939         -1310,460         21137,7         2755,1           757         3394,233         349,939         -171,60         21137,7         2755,1           550         397,317         399,919         -1751,033         2417n,1         3179,4           537         5136,78         474,88         -1964,931         2417n,1         3179,4           655         5136,78         474,88         -1964,931         2430,5         4363,6           673         5136,78         576,88         -1964,91         350,0         943,6           674         774,70         -264,901         350,0         9411,4           675         1903,40         724,77         -420,011         42637,5         9636,8           675         18628,46         774,700         -6700,05         510,48         51248,5         9769,1           673         13902,96         599,821         -5</td>	564         1922,150         224,975         -751,844         12060,9         1563,0           889         292,064         274,961         15083,7         1967,8           389         292,064         324,947         -135,961         15083,7         1967,8           757         3394,233         349,939         -1310,460         21137,7         2755,1           757         3394,233         349,939         -171,60         21137,7         2755,1           550         397,317         399,919         -1751,033         2417n,1         3179,4           537         5136,78         474,88         -1964,931         2417n,1         3179,4           655         5136,78         474,88         -1964,931         2430,5         4363,6           673         5136,78         576,88         -1964,91         350,0         943,6           674         774,70         -264,901         350,0         9411,4           675         1903,40         724,77         -420,011         42637,5         9636,8           675         18628,46         774,700         -6700,05         510,48         51248,5         9769,1           673         13902,96         599,821         -5
889         2422.064         274.963         -943.960         15083.7         1967.849           386         292.030         324.947         -1135.987         18109.5         2372.496           560         394.233         399.919         -1511.033         2417n.1         3179.476           557         394.299         -1710.033         2417n.1         3179.476         2137.276           557         514.010         -1511.033         2417n.1         3179.476         025.476           253         5136.784         449.899         -1728.931         3649.5         3643.651         026.611           253         5136.784         449.889         -1728.931         36249.5         3643.651         026.611           031         7074.913         624.804         -2694.901         3636.99         5736.309         036.865           034         1190.3867         724.773         -4420.011         3636.99         5736.309         036.865           127         1862.627         749.719         -5611.320         4583.3         12266.86         056.865           128         1862.464         774.70         -6790.057         49058.8         15068.909         0669.327           100         <	889 2422.064 274.963 -943.960 15083.7 1967.8 3584.2920.731 324.947 -1135.987 18109.5 2722.4 3584.2920.731 329.939 -1350.420 21137.7 2755.1 557 4488.905 449.899 -1511.033 24170.1 3179.4 557 4488.905 449.899 -1788.931 27206.9 3643.6 5136.784 474.888 -1964.085 30249.5 4166.1 5136.784 548.899 -2268.91 27206.9 3643.6 536 11903.867 724.737 -4420.011 42637.5 9636.8 636 11903.867 724.737 -4420.011 42637.5 9636.8 637 11903.867 774.710 -6790.057 49058.8 15068.9 522 13902.905 599.821 -5755.954 51878.2 12366.8 647 12206.272 50.000 -4244.374 5753.6 9750.1
2920.75         324.34         347.345         324.345         324.346         3272.498         3272.699         401.443	.588 2920.750 524.947 1155.987 18109.5 2372.4 550 394.233 349.939 -1110.460 21137.7 2755.1 551 4489.905 449.899 -1511.033 24170.7 2755.1 553 4489.905 449.899 -1728.931 27206.9 3643.6 553 5136.784 474.888 -1904.085 30249.5 4166.1 5932.369 549.849 -2268.776 33300.9 4811.4 634 1193.867 724.804 -2664.901 36369.9 5736.5 635 11903.867 724.737 -4420.011 46437.5 9636.8 645 11829.755 599.821 -5075.954 51878.2 11248.5 647 12076.782 50.000 -4248.374 5753.6 9769.1
507 3917.317 399.919 -1511.033 24173.1 5779.476 0 3917.317 349.919 -1511.033 24173.1 5779.476 0 3917.317 349.919 -1511.033 24173.1 5779.476 0 223 4469.905 449.899 -1728.931 27206.9 3643.651 0 312 272.36 49 49.899 -1728.931 27206.9 3643.651 0 312 70.74.913 624.804 -2694.901 3636.919 6311.443 0 33.010.9 674.773 -3398.095 39478.2 7318.543 634 1903.886 7 74.737 -4420.011 3636.9 5736.846 0 223 13902.905 599.801 -5611.320 45833.3 12366.846 0 1 1529.552 13902.905 599.801 -50790.057 49058.8 15068.909 0 647 12076.782 50.000 -4278.845 6 7755.6 9769.172 0 0 9869.387 0 0 0 2200.272 25 000 -4278.845 0 0 0 9869.387 0 0 0 0 9869.387 0 0 0 9869.387 0 0 0 0 9869.387 0 0 0 0 9869.387 0 0 0 0 9869.387 0 0 0 0 9869.387 0 0 0 0 9869.387 0 0 0 0 9869.387 0 0 0 0 9869.387 0 0 0 0 9869.387 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	560 3917.1.50 399.919 -1511.013 24170.1 1772
537         4489.905         449.899         -1728.931         27206.9         3643.6510           253         5136.784         474.888         -1964.085         30240.5         4166.112           012         593.509         33500.9         4011.443           031         7074.913         624.804         -2664.914         36350.9         5736.309           034         070         674.773         -3398.095         39478.2         7318.543           034         190         674.773         -3398.095         39478.2         7318.543           152         18625.623         724.737         -420.011         426437.8         7318.543           223         13902.905         599.821         -5611.320         45833.3         12366.919           101         1829.752         50.00         -4278.4374         5775.6         9769.172           1200.272         25.000         -4278.845         57755.6         9769.387	537         4489,905         449,899         -1728,931         27206.9         3643.6           253         5136,784         474,888         -1964,085         30249.5         4166,11           012         7932,369         549,849         -2664,776         35369.9         5736,9         4611.4           03         7074,970         674,773         -2664,901         36436,9         7318,5         636,8         747,773         -264,901         4647,7         7318,5         736,8         7318,5         736,8         7318,5         736,8         7318,5         736,8         7318,5         736,8         7318,5         736,8         736,9         736,8         736,9         736,9         736,9         736,9         736,9         736,9         736,9         736,9         736,9         736,9         736,9         736,9         736,9         736,9         736,9         736,9         736,9         736,9         736,
253         5136.784         474.888         -1964.085         30249.5         4166.112           012         5932.369         549.849         -2268.776         33300.9         411.443           013         674.913         -264.901         35300.9         5736.309           74         9034.070         674.773         -3398.095         39478.2         7318.543           63         11903.667         724.737         -420.011         42637.5         9636.855           64         11903.667         724.737         -5611.320         45838.3         12566.845           54         1520.897         -670.007         -670.007         49658.8         15068.909           223         1390.905         599.821         -501.057         49658.8         15068.909           00         11829.752         50.000         -4278.375         5188.52         10.0         9869.387           00         12200.272         25.000         -4278.845         0.0         9869.387	253         5136.784         474.888         -1564.085         310249.5         4166.11           012         5932.369         549.849         -2568.776         33500.9         4811.4           03         7074.970         624.804         -2664.804         36350.9         5736.3           77         9034.070         674.773         -3398.095         39478.2         7318.5           636         1190.867         724.737         -4420.011         42637.5         9636.8           147         15282.623         749.719         -5611.320         49638.8         15068.8           223         13902.905         599.821         -5709.954         51078.2         11248.5           647         1210.200         -4157.913         0.0         9569.3           647         12200.272         25.000         -424.374         5753.6         9769.1
012 5932.369 549.849 -2268.776 33301.9 4811.443 0 031 7074.913 624.804 -2694.901 36359.9 5736.309 0 031 9013.667 724.773 -3298.095 39478.2 7318.543 0 047 15282.623 749.719 -5611.320 45838.3 12366.855 0 047 15282.464 774.700 -6790.057 49058.8 15968.909 0 023 13902.905 599.821 -5075.954 51878.2 11248.542 0 010 11829.752 50.000 -4274.374 57753.6 9769.172 0 010 12201.272 25.000 -4278.845 0.0 9869.387 0	131 7074.915 549.849 -2268.776 33300.9 4811.4 131 7074.915 624.849 -2268.776 33500.9 4811.4 132 9034.015 624.773 -2694.901 35359.9 5736.3 1904.867 724.773 -4420.011 42637.5 9636.8 1907.867 749.719 -5611.320 49838.3 12368.8 223 13902.905 599.821 -5075.954 51878.2 11248.5 100 11829.752 50.000 -4244.374 5753.6 9769.1 100 12200.782 25.000 -4244.374 5753.6 9769.1
731 7074.713 624.804 -2694.911 56369,9 5736.309 0 74 773 -3298.095 39478.2 7318.309 0 74 773 -3298.095 39478.2 7318.343 0 74 774 773 -4201.011 42643.3 12366.855 0 74 774.700 -5611.320 45838.3 12366.865 0 74 774.700 -6791.057 49058.8 15068.909 0 7221 13962.905 599.821 -5075.954 51878.2 11248.542 0 74 12076.782 50.000 -4278.845 0 0 969.337 0 0 12201.272 25.000 -4278.845 0 0 969.387 0	747 90134.070 674.773 -2504.901 56.569.9 5736.3 747 90134.070 674.773 -3508.095 39478.2 7318.5 636 11903.86.3 747.773 -3508.095 1947.5 9636.8 647 15282.623 749.719 -5611.320 45838.3 12366.8 545 18625.464 774.700 -6790.057 49058.8 15068.9 623 13902.905 599.821 -5075.954 51878.2 11248.5 647 12076.752 50.000 -4424.374 57753.6 9769.1 000 112200.272 25.000 -4244.374 57753.6 9769.3
747 9034.07 0744.773 -4598.095 39478.2 738.845 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	747 9034-070 074-773 -3590-093 39478-2 7318-2 636 636 19103-867 737 -4420_011 42648-3 1536-8 647 15282-623 749,719 -5641.329 45838.3 12366-8 545 18625-464 774-70 -6790_057 49058-8 15068-9 600 11829-752 50.000 -4157.913 0.0 9569-3 647 12076-722 25.000 -4245-845 0.0 9869-3
047 15282.623 749.719 -5411.320 45633.5 9050.855 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	040 12200.272 74.737 -4.272.011 4.20.7.5 950.80 047 15282.623 74.719 -5611.350 49059.8 15068.9 545 18625.464 774.710 -6790.057 49059.8 15068.9 223 1390.905 599.821 -5775.954 51876.2 11246.5 010 11829.752 50.000 -4157.913 0.0 9569.3 040 12200.272 25.000 -4244.374 57753.6 9769.1 010 12200.272 25.000 -4248.875 0.0
047 18625.023 747.119 -5011.320 42636.3 12056.846 0 223 13602.905 599.821 -5075.057 49058.8 15068.909 0 223 13902.905 599.821 -5075.954 51878.2 11248.842 0 0 0 1829.752 50.000 -4157.913 0 0 9569.332 0 0 122076.782 50.000 -4244.374 57753.6 9769.172 0 0 12207.272 25.000 -4278.845 0 0 9869.387	747 12762.023 749.17 -011.020 49058.81 15068.94 15068.95 15068.97 49058.81 15068.96 15068.97 15078.90 1508.90 1508.90 1508.90 160.00 16
223 13022-103 774-100 -6790-107 49023-8 12006-909 0 223 13022-905 599-821 -5075-954 51878-2 11248-542 0 0 0 11829-752 50.000 -4157-913 5753-6 9769-172 0 0 12200-272 25.000 -4278-845 0 0 9869-387 0 0 9869-387	223 130022.003 599.801 -5790.057 49058.8 15068.90 223 13002.905 599.801 -5075.95 51878.2 11248.54 000 11829.752 50.000 -4157.913 5753.6 9769.13 000 12200.272 25.000 -4278.845 0.0 9869.38
223 13902.705 599.821 -5075,954 51878.2 11248.542 0 070 112076.782 50.000 -4274.374 57755.6 9769.172 0 070 12200.272 25.000 -4278.845 0.0 9869.387 0	223 15902.705 599.821 -5075.954 51878.2 11248.54 670 11692.755 55.000 -4157.913 0.0 9569.33 647 12076.782 50.000 -4244.374 57753.6 9869.38 600 12200.272 25.000 -4278.845 0.0 9869.38
	.00 12076,782 50.000 -4274,374 57757,00 9269,33 -647 12076,782 50.000 -4224,374 57757,0 9869,13 -000 12200,272 25.000 -4278,845
040 12200.272 25.000 -4278.845 0.0 9869.387 0	0.000 12200.272 25.000 -4278.845 0.00 9869.38
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576 AE7 340 040 -4487 340 4614 5 4614 5	576 AE7 240 040 -4407 240 40342 2 4

STRESS-STRAIN DATA ON CYLINDER NO. CY-9 WITH REINFORCED WELD (2:1) TABLE G-34.

13975 3476 1736 1737 691 FIGURIAN INTERCLIPATION IN	STRAIN STRAIN	ء -	OAD	STRESS	STRESS	MSD LN STRFSS	TRU LONG STRESS			STRAIN	STRESS	EFF	D.
7475. 2876. 1739. 1737. 1739. 1737. 1739. 174.944. 174.944. 172. 1739. 1	NOOL NIV		2			0 0		E	Σ.	MICHOIN	ISd	MICIN	1
10425, 12435, 523, 5213 934 1247, 524, 575 1244, 576, 576, 576, 576, 576, 576, 576, 576	175. 23718	23718		6950		3475	, s,	640.780	471	-122.486	3010.3	229.46	0 c
7375 10695 692.089 1249.220 299.955 -542.211 12052,8 1044 1045 1040.212 1999.720 2999 -708.2211 12052,8 10091. 13012. 130		35566		10425.	•	5213.	213	999.500	274	-446.062	1		, -
10550. 20890. 10425. 10400.212 10591. 20890. 10465. 10400.212 10591. 20890. 10465. 10400.212 10591. 20890. 10465. 10400.212 10591. 20890. 10465. 10400.212 10591. 20890. 10465. 10400.212 10591. 20890. 10465. 10400.212 10591. 20890. 10465. 10400.212 10591. 20890. 10465. 10400.212 10591. 20890. 10400. 20890. 10591. 20800. 208	اہ	47421	-	13900.	!		6952.085		299.	-542.211			-
10520. 20890. 10422. 10420. 10	'n.	59276	•	7375.			8691.192		424	-708.270		1	10
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1275. 31372. 15638. 15648.837 3695.626 824.651 -1535.950 31020. 27459.9 2219.995 6170. 1575. 31372. 15638. 15648.837 31095.262 824.651 -1535.950 31020. 0 2950.853 0 1725. 31372. 1573. 15	• •	0 4 9 0	٠.	6220			12169.189						
## ## ## ## ## ## ## ## ## ## ## ## ##	•		•	1000			104CV . 0GO				i	- 1	0
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6650 48941. 22587. 22610.692 5211.398 1024.476 -2182.556 5932.2 4946.893 1024.476 -2182.556 5193.024.649 4237.2 4946.893 1024.500 1249.500 1249.500 1249.500 1249.500 1249.500 1249.500 1249.600 1249.500 1249.500 1249.500 1249.500 1249.500 1249.500 1249.500 1249.500 1249.500 1249.500 1249.500 1249.500 1249.500 1249.500 1249.600 1240.600 1240.500 1240.500 1240.500 1240.500 1240.500 1240.600 1240.500 1240.500 1240.600 1240.500 1240.500 1240.600 1240.600 1240.600 1240.600 1240.600 1240.600 1240.600 1240.600 1240.600 1240.700		4226		1700.			20870.329						-
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6 52496. 26063. 26099.078 7124.560 1249.220 -7930.823 4464.6 5832.916 15600. 56103. 27806.833 9009.294 1324.123 -3616.696 49587.3 7346.794 13500. 56103. 27800. 29779.574 124.525 1548.800 -7002.458 5782. 14977.546 16478.222 1548.800 -7002.458 5782. 14977.546 16478.222 1548.800 -7002.458 5782. 14977.546 16478.222 1548.800 -7002.458 5782. 14977.546 16478.222 1548.800 -7002.458 5782. 14977.546 16478.222 1548.800 -7002.458 5782. 14977.546 16478.222 1548.800 -7002.458 5782. 14977.546 16478. 1738. 1737.587 324.947 50.000 -131.231 3010.4 265.221 16437 5747. 1647.450 1623.4 610.377 1647.850 1137.782 1647.850 1137.782 1647.850 1137.782 1647.850 1137.782 1647.850 1137.782 1647.850 1137.782 1647.850 1137.782 1647.850 1137.782 1647.850 1137.782 1647.850 1137.782 1647.850 1137.782 1647.850 1137.782 1647.850 1137.782 1647.850 1137.782 1144.778 1647.850 1137.782 1144.778 1647.850 1137.782 1144.778 1147.850	125	6597		8650			24352.366						2 6
Selicia   27800   27836-835   9009-294   1324-123   -3616-696   46587-3   3346-794   9075-5979-591   1226-179   1423-986   -3742-598   57867-3   3746-794   9075-5979-591   1226-179   1423-986   -3742-598   57867-3   3746-794   9075-596   5777-596   9757-596   97	250	7782		2125	2498.		26095.078						ع , د
66250. 63717. 31275. 29579.591 12126.179 1423.986 -4742.598 51785.6 9855.822 66250. 63717. 31275. 31323.476 18478.222 1548.80 -7008.458 51785.6 9855.822 66250. 63717. 31275. 31323.476 18478.222 1548.80 -7008.458 5182.7 14977.546 675.5170 67	'n	8968	, m	55600.			27836.835			3616. A0	48587	7346.794	
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6 HSD CR TRU CR HSD LN TRU LONG TRU CIRCH TRU LONG STRIN STRESS S	550.	1339	_			31275.	31323.476	18478.222		-7009.45	55182.7	14977.546	0.35
HSD CR TRU CR HSD LN TRU LONG TRU CIRCH TRU LONG TRU RAD EFFECTIVE EFFECTIVE FFECTIVE FFETTIVE FFETTIV	GAGES 5 AN		ē	•				1	:	1			!
STRESS ST	9	¥	- 1 .	MSD CR	TRUCE	12		MOG LO TOT	- 1		ū		3
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13900 13922 6950. 6951.390 1573.762 199.980 -620.809 12056.7 1280.374.0 17375 1710. 8688. 8689.889 2022.953 274.963 -804.271 15077.7 1647.450 22085.5 274.963 -804.271 15077.7 1647.450 22085.5 274.965 12163. 12167.365 2870.875 399.919 -1144.778 21126.7 2338.907 024325. 24395. 12167.365 2870.875 399.919 -1144.778 21126.7 2338.907 024325. 243900. 13900. 13906.225 3220.811 449.899 -1284.399 24155.2 2623.319 034.750 34899. 17375. 17384.991 4265.888 574.835 -1694.253 30223.1 3773.800 334.750 34899. 17375. 19124.445 4788.516 624.804 -1511.152 27188.6 3107.300 34750. 41921. 20850. 20864.074 5286.005 608.008 854.077 -2086.272 3530.8 4300.834 8510.8 45175. 45446. 22587. 22604.441 5982.071 749.19 -2356.126 39357.6 4865.966 4865.0 2606.008 8644.074 924.61 -2695.337 4242.1 5590.251 0560.0 2606.008 8644.074 924.61 -2695.337 4242.1 5590.251 0560.0 2606.008 8644.074 924.61 -2695.337 4242.1 5590.251 0560.0 2600.0 27828.495 1137.744 1092.476 -4256.777 4865.176 4692.1 10048.076 0560.0 2600.0 27828.495 1137.744 1099.395 -5065.745 5165.1 10048.076 0560.0 2600.0 27828.495 1137.744 1099.395 -5065.545 2426.1 10048.076 0560.0 2600.0 27828.495 1137.744 1099.395 -5065.745 2426.1 10048.076 0560.0 2600.0 27828.495 1137.744 1099.395 -5065.745 2426.1 10048.076 0560.0 2600.0 27828.495 1137.744 1099.395 -5065.745 2426.1 10048.076 0560.0 2600.0 27828.495 1137.744 1099.395 -5065.745 2426.777		3556	١.	1.		1	5213.282	1	149.98	-463,505		956	0.35
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24325, 24395, 12163, 12167,365 2870,875 399,919 -1144,778 21126,7 2338,907 0 27805, 12163, 1256,7 2338,907 0 27806,255 3219,06.255 3219,815,152 27806,1399 24153,2 27806,2319 0 3107,319 0 3127,319 0 3107,319 0		7113	- 2		_		10428.388	•	324.94	-943.996			0.35
27800. 27890. 13900. 13906.255 3219.811 449.899 -1284.399 24151.2 2623.319 0 31275. 31395. 15638. 15645.319 3817.703 499.874 -1511.152 27188.6 3107.300 0 34750. 34699. 17375. 17384.991 4265.889 574.855 -1694.253 310231. 3473.580 0 34750. 41921. 20850. 20864.074 5286.005 674.773 -2086.272 36304.8 4300.834 0 45175. 45446. 22587. 22604.441 5982.071 749.719 -2356.126 3935.6 4865.966 0 465.07 4650. 24325. 24345.068 8464.079 924.573 -3266.038 49523. 5590.251 0 55400. 56223. 27800. 27828.495 11137.744 1024.476 -4256.777 48691.1 10848.079 0		8298			_		12167.365		399.91	-1144.778			0.35
34275, 31995, 15638, 15645,319 3817,703 499,874 -1511.152 27188,6 3107,300 0 34750, 34899, 17375, 17344,991 4265,888 574.835 -1694,253 30223,1 3473,580 0 34275, 38648, 19113, 19124,444 4788,516 674,773 -2086,272 36304,8 4300,834 0 41700, 41921, 20850, 20864,074 5286,076 674,773 -2086,272 36304,8 4300,834 0 45175, 45446, 22587, 22604,441 5982,071 749,719 -2356,126 3935,6 4865,966 0 45650, 48966, 24325, 24345,068 6876,303 624,661 -2695,337 42423,1 5990,251 0 55200, 56203, 27800, 27828,495 11137,744 1024,476 -4256,777 48691, 9032,793 0 55007, 5571, 29537, 29569,991 13385,020 1099,395 -5069,545 51851,1 10848,076 0	ای	9484	- 1			i	13906.255		449.	-1284,399			0.35
34750. 34899. 17375. 17384.991 4269.888 574.835 -1694.253 30223.1 3473.580 0 38255.88408. 19113. 19124.445 478 586.005 624.804 -1894.662 33562.8 3897.266 0 41700. 41021. 20850. 20864.017 5866.005 674.77 -2086.225 36304.8 4300.834 4770.834 4775. 45446. 22587. 22604.441 5982.071 749.719 -2356.126 39357.6 4865.966 0 48650. 48725. 24345.068 6876.303 824.661 -2695.337 42423.1 5590.251 0 57225. 27800. 27828.495 11137.744 1024.476 -4256.777 48691.1 0048.777 0072.793		6990	_		_		15645.319		499.	-1511.152		1	0.35
38255.38408.19113.19124.445 4788.516 624.804 -1894.662 33262.8 3897.266 0 41700.41921.20850.272 9864.074 5286.005 674.773 -2086.272 36304.8 4300.834 0 45175.454646.22567.22604.441 5982.071 749.719 -2356.126 3937.6 48850.266 0 45175.45466.2256.26 1 5987.6 5086.08 6876.303 824.661 -2695.337 4242.1 5590.251 0 55125.55568.26063.26086.608 8464.079 924.573 -3286.028 4552.1 5590.251 0 55600.5623.27800.27828495 11137.744 1024.476 -4256.777 48691.1 9048.076 0 5623.2787 3559075.5959.991 13385.020 1099.395 5169.545 51851.1 10848.076 0		118552			_		17384.991		574.	-1694.253			0.35
41700, 41921, 20850, 20864,074 5286,005 674,773 -2086,272 36304,8 4300,834 0 45175, 45446, 22557, 22644,441 5982,071 749,719 -2356,126 39357,6 48655,956 0 45175, 45446, 22557, 224345,068 6876,303 6876, 212 5986,028 44221, 5590,251 0 55128, 52588, 26653, 26686,608 8464,679 924,573 -3286,628 443524,7 6874,079 0 55400, 56223, 27800, 27828,495 11137,744 1024,476 -4256,777 48691,1 9032,793 0 59075, 5981, 29559,991 13385,020 1099,395 -5069,545 51851,1 10848,076 0	625. 13040	13040			_		19124.445		624	-1894.662			0.35
45175, 45446, 22587, 22604,441 5982,071 749,719 -2356,126 39357,6 4865,966 0 4656,04 2453,1 5982,05 4 4865,966 0 4656,04 2453,1 5990,251 0 4650,04 2650,437 42423,1 5990,251 0 52425, 2250,04 2666,04 8464,079 0 924,57 3 3286,028 4952,7 6892,7 6892,7 6892,7 6892,7 6892,7 6892,7 6892,7 6892,7 6892,7 7 48691,1 9032,7 93 0 59075, 59571, 29569,991 13385,020 1099,395 -5069,545 51851,1 10848,076 0	٠.	777			_		20864.074		674.77	-2086.272			0.35
48650, 48866, 24255, 24345,068 6876,303 824,661 -2695,337 42421, 5590,251 0 52125, 52568, 2500,		1241			_		22604.441		749	-2356.126			0.35
52125, 52568, 26063, 26086,608 8464,079 924,573 -3286,028 45528,7 6874,079 0 55600, 56223, 27800, 27828,495 11137,744 1024,476 -4256,777 48691,1 9032,793 0 59075, 59671, 29537, 29569,991 13385,020 1099,395 -5069,545 51851,1 10848,076 0	٠	669	- 1	- }		- 1	24345.068		824.	-2695.337		- 1	0.35
559005 59671, 29537, 29569,991 13385,020 1099,395 +5689,545 51851,1 10848,076		9//	_				26086.608		954	-3286.028		6874	0.35
. 3907. 3907. 2938. 3508. 391 10848.076 0.3		20,00	_				2/626.495		1024.47	-4256.777		9032.793	0.35
		0010					166.40662		1099.39	-5069.545	51851.1	10848.076	<b>m</b>

TABLE G-34. STRESS-STRAIN DATA ON CYLINDER NO. CY-9 WITH REINFORCED WELD (2:1) (Cont'd)

SI HICROIN/IN HICROIN/	,	MICRC 100. 275. 525. 675.	n Z	LOAD		u	2010	CTOROCO	STOATS	NIAGES	STAAIN	STRE	STRAIN	
0. 11855, 3475, 3475, 1738, 1737,500 99,999 C. 000 -114,990 300,975	50.	100 275 400 525 675	¢	POUNDS	PSI	,	2	PSI	MICROI	MICROINTIN	MICROIN/IN	101	ICIN/1	
5.         5.<	100	275 400 525 675	;	11855.		3475.	1738.		6.66	0.000	-34.99		80.894	0
50. 355.64. 1462. 10429. 5213. 5213. 5213. 6212.16.1         560. 355.64. 1462. 10429. 5213. 5212.16.1         561. 010         -157.472         200. 1000         -157.472         901.909         -201.119         1000         -255.64. 1462. 2146. 1149. 114	* * *	400 525 675	25.	23710.		6952	3475.		274.9	25.000	-10	6020.	222.980	0.35
5. 75, 4742, 13705, 13907, 66590, 6950, 527, 552, 562, 74, 997, 995, 995, 120144, 1  1.155, 97277, 13795, 13807, 13902, 1668, 1046, 103, 77, 700 124, 995, 995, 905, 102104, 5  1.155, 94842, 27805, 27864, 12145, 1046, 103, 77, 700 124, 995, -214, 1692, 18070, 6  1.155, 94842, 27805, 27824, 12145, 11392, 1342, 143, 143, 143, 143, 143, 143, 143, 143	150	525	50.	35566.	•	10429.	5213.	212	399.9	50.000	-157			0
5. 125. 71131. 210550. 28680. 8688. 8688. 8688. 774.700 124.995 - 2211.107 181.707 131.2091. 8597. 859	200		75.	47421.	_	13907.	6950.	950	524.8	74.997	-208			0
125. 71131. 20850. 21866. 12145. 324 874. 517 149. 992 - 534.612 21804.55 1157. 94842. 27801. 22186. 12144. 324 874.617 149. 999 - 536.612 21804.55 1157. 94842. 27801. 27820. 12401. 13901. 13	250		100.	59276.	•	^	8688.	8688.369	674.7	66.66	-271			0
195 196 196 196 196 196 196 196 196 196 196	300			71131.	w	20866.	10425.	10426.303	774.7	124.992	-314			미
15. 175. 98842, 27800, 23000, 13000, 13002, 132 15. 250, 116552, 13475, 13199, 15536, 1739, 344 1174, 310 249,969 -498,498 301129,75 15. 250, 116552, 34750, 34791, 17375, 1739, 344 1174, 310 249,969 -498,498 301129,75 15. 276, 116572, 34750, 44791, 17375, 1739, 344 1174, 310 249,969 -498,498 301129,77 15. 276, 116572, 34750, 47701, 47755, 1739, 344 1174, 310 299,959 -498,498 301129,77 15. 276, 116572, 46650, 48719, 24325, 2686, 2587,408 1349,019 299,919 -498,939 -421,216 36146,10 177828, 27810, 27818, 27819, 27810, 28810,	350			H2987.	100	24346.	12163.	12164.324	874.61	149.989	-358			0
255. 10697 31275 31309 15631 15641.01 1099.395 224.975 -403.520 22114.7  5. 775. 130407 30275 34750 34791 1133. 19117.756 1274.187 229.969 -498.498 31220.7  5. 775. 130407 30225 34750 34791 1113. 19117.756 1274.187 229.965 -577.160 311620 0  5. 350. 15621.28 45175 45238 12.2867. 22656.705 1399.020 299.955 -577.160 311620 0  5. 350. 15621.28 45175 45238 12.2867. 22656.706 1399.020 299.955 -577.160 311620 0  5. 375. 156273, 46550 49119, 24355 24334.12 1423.986 399.999 -622.134 39177.5 2  5. 375. 156273, 46550 49119, 24355 2434.12 1423.986 399.999 -622.134 39177.5 2  5. 375. 169683, 52125 52199, 24355 2434.12 1448.950 499.899 -664.597 46220.8 2  5. 1000. 2702. 213994, 62675 52195 25190 2782.210 1448.950 499.899 -664.663 54233.4 9  6. 700. 213394, 62675 66075 66075 31275 31296.893 1199.280 699.756 -664.663 54233.4 9  6. 700. 213394, 62675 517625 31275 31296.893 1199.280 699.756 -664.663 54233.4 9  6. 700. 223349 50975 59159 2757 3475 3475 3475 3475 3475 3475 3475 3	400			94842.		27828.	390	13902.432	999.50	174.984	-411	1		0
5 256. 136672 34750 34750 34751 3179-344 1174.310 249.999 9185 31146.0  5 375. 136672 38275 34756 210850. 20856.255 1349.090 299.955 -577.166 3116.0  5 376. 142263. 41706. 41756. 22836. 20850. 20856.255 1349.090 299.955 -577.166 3116.0  5 375. 142263. 41706. 41756. 22837. 22857.06 1399.020 374.939 -622.03 3116.0  5 375. 142263. 41206. 42725. 22837. 22857.06 1399.020 374.939 -622.021  5 375. 142263. 48650. 48726. 22857. 22857.06 1399.020 374.939 -622.021  5 400. 177286. 52525. 52199. 22657. 22857.746 1423.986 599.919 -629.627 42820.89  5 400. 177286. 52525. 52199. 22657. 22857.746 1423.986 599.919 -629.627 42820.89  5 550. 201339. 62856. 6285. 31275. 31296.813 899.596 599.819 -664.684 51233.4  12 GAGES 1 AND 2  12 GAGES 1 AND 2  12 GAGES 1 AND 2  13 GAGES 1 AND 2  14 GAGES 1 AND 2  15 GAGES 1 AND 2  16 GAGES 1 AND 2  17 GAGES 1 AND 2  18 GAGES 1 AND 2  18 GAGES 1 AND 2  19 GAGES 1 AND 2  10 GAGES 1 AND 2  11 GAGES 1 AND 2  12 GAGES 1 AND 2  13 GAGES 1 AND 2  14 GAGES 1 AND 2  15 GAGES 1 AND 2  16 GAGES 1 AND 2  17 GAGES 1 AND 2  18 GAGES 1 AND 2  18 GAGES 1 AND 2  19 GAGES 1 AND 2  19 GAGES 1 AND 2  10 GAGES 1 AND 2  10 GAGES 1 AND 2  10 GAGES 1 AND 2  11 GAGES 1 AND 2  12 GAGES 1 AND 2  13 GAGES 1 AND 2  14 GAGES 1 AND 2  15 GAGES 1 AND 2  16 GAGES 1 AND 2  17 GAGES 1 AND 2  18 GAGES 1 AND 2  18 GAGES 1 AND 2  18 GAGES 1 AND 2  19 GAGES 1 AND 2  19 GAGES 1 AND 2  19 GAGES 1 AND 2  10 GAGES 1 AND 2  11 GAGES 1 AND 2  12 GAGES 1 AND 2  12 GAGES 1 AND 2  13 GAGES 1 AND 2  14 GAGES 1 AND 2  15 GAGES 1 AND 2  16 GAGES 1 AND 2  17 GAGES 1 AND 2  18 GAGES 1 AND 1 11432 11442 11443 1144 1144 114	450		l	106697.		31309.	563	15641.018	1099.39	224.975	-463			0
5.         755, 130407, 38225, 38274, 19113, 19117, 756         1274, 180         299, 955         -577,166         33164, 0           5.         300, 142263, 4100, 4150, 21652, 20687, 2065, 199, 020         349, 035         -672,136         39177, 5           6.         350, 15418, 45175, 42287, 22586, 2063, 2434, 22         1423,986         399, 919         -628,621.36         39177, 5           5.         450, 189683, 52125, 52199, 24352, 22         1423,986         399, 919         -684,597         48226, 48226, 2261	500			118552.		34791.	737	17379.344	1174.31	249.969	498			0
12 GAGES 1 AND 2 TREES STRESS STRESS STRESS STRESS STRAIN NOUND STRAIN NOUND STRAIN NOUND STRAIN STRAIN NOUND STRAIN STRA	550		1	130407.		38274.	911	19117.756	1274.18	274.963	-545			0
12 GAGES 1 AND 2 STREES STREES STREES STREES STRAIN BY CROUNDLE STRAIN BY CROUNDLY B	40.4			142263		41756.	085	20856.255	1349.09	299.955				0
375         165973         48650         48719         24325         24334,122         1423,986         374,930         -629,621         42105         26105         26107	650		350	154118.		45238.	258	22595.406	1399.02	349.939				0
5. 400. 177828. 52125. 52199. 26063. 26072.925 1423.986 399.919 -658.367 4520.89 0. 450. 189628. 55600. 55601. 27880. 27812.510 1448.995 -664.599 -664.597 46220.89 0. 550. 2013394. 62550. 66255. 31275. 31296.893 1199.280 699.756 -664.663 54234.99 0. 1000. 225249. 66025. 66084. 33012. 33145.513 899.596 999.500 -664.664 57230.8 0. 1000. 225249. 66025. 66084. 33012. 33145.513 899.596 999.500 -664.664 57230.8 0. 1000. 225249. 66025. 66084. 33012. 33145.513 899.596 999.500 -664.664 57230.8 0. 1000. 225249. 66025. 66084. 33012. 33145.513 899.596 999.500 -664.684 57230.8 0. 1000. 225249. 66025. 66084. 33012. 33145.513 899.596 999.500 -157.468 3010.7 0. 200. 23710. 6950. 6956. 3475. 3476. 1738. 1757.348 924.573 999.995 -568.366 9041.6 0. 200. 23710. 6950. 6956. 3475. 3475. 3476. 1742. 1909.899 -568.366 9041.6 0. 200. 200. 3424. 1390. 13827. 6950. 6951.390 1948.101 199.990 -568.366 9041.6 0. 200. 3424. 1390. 13827. 6950. 6951. 6951. 1042	7007		375.	165973.	48650	48719.	432	24334,122	1423.98	374.930				0
0. 450. 189583. 5560. 5560. 29591. 2980. 29593. 1493.99	750		400	177828	52125	52100	60.6	26072.925	1423.98	399.919	1			_
5. 550. 201539. 50075. 59159. 29537. 29553.746 1423.986 549.849 -600.842 51233.4  0. 700. 213344. 66255. 66684. 33012. 33045.513 809.566 999.766 -664.663 54234.9  1. 666. 225249. 66625. 66684. 33012. 33045.513 809.596 999.766 -664.663 57230.8  1. 6665. 100. 225249. 66625. 66684. 35012. 33045.513 809.596 999.766 -664.684 57230.8  1. 60. 200. 21330. 22510. 6950. 6950. 340.909 25.000 -157.469 3010.7  2. 5. 11855. 3475. 3476. 1738. 1737.543 424.909 25.000 -157.489 3010.7  2. 5. 11855. 3475. 1376. 1377. 348. 424.909 25.000 -157.828 12061.2  2. 50. 200. 47424. 13900. 13927. 6950. 6951.390 1948.101 199.890 -751.828 12061.2  2. 50. 200. 47424. 13900. 13927. 6950. 6951.390 1948.101 199.890 -751.828 12061.2  2. 50. 200. 47424. 13900. 13927. 6950. 6951.390 1948.101 199.890 -751.828 12061.2  2. 50. 200. 47424. 13900. 13927. 6950. 6951.390 1948.101 199.890 -751.828 12061.2  2. 50. 250. 47424. 13900. 13927. 6950. 6951.390 1948.101 199.890 -751.828 12061.2  2. 50. 250. 47424. 13900. 13927. 6950. 6951.390 1948.101 199.890 -751.828 12061.2  2. 50. 250. 47424. 13900. 13927. 6950. 6951.390 1948.101 199.890 -751.828 12061.2  2. 50. 250. 4724. 13900. 13927. 6950. 6951.390 1948.101 199.890 -751.828 12061.2  2. 50. 250. 4725. 11413. 20850. 20940. 12162. 1216			450.	189683.	55600	55681.	27800.	27812.510	1448.95	449.899				0
12 GAGES 1 AND 2 13 GAGES 1 AND 2 14 GAGES 1 AND 2 15 GAGES 1 AND 2 16 GAGES 1 AND 2 17 GAGES 1 AND 2 18 GAGES 1 AND 2 19 GAGES 1 AND 2 19 GAGES 1 AND 2 19 GAGES 1 AND 2 10 GAGES 1 AND 1 A	8		550	201539.	59075.	59159.	29537	29553.746	1423.98	549.849	-690.84	51233,4		0
12 GAGES 1 AND 2  12 GAGES 1 AND 2  12 GAGES 1 AND 2  13 GAGES 1 AND 2  14 GAGES 1 AND 2  15 GAGES 1 AND 2  16 GAGES 1 AND 2  17 GAGES 1 AND 2  18 GAGES 1 AND 2  18 GAGES 1 AND 2  19 GAGES 1 AND 2  19 GAGES 1 AND 2  10 GAGES 1 AND 1 A				213394	62550	•	31275.	31296.893	1199.2		66	34.	60.	ċ
12 GAGES 1 AND 2  HONG AXIAL MSD CR TRU CR MSD LN TRU LONG TRU CIRCM TRU LONG TRAIN STRAIN STRESS STRAIN STRESS ST	950	.006		225249.	602	lac:	10	33045.513	899.5	ī.		30.	1077.699	-
## PST 18	ָּבָּב בּיבּיב	-	5	4:		1		Tour Land		TONG	GAS NOT		FFFFCTIVE	Ī
STRAIN STRAIN LOAD STRESS STRESS STRESS STRAIN STRA	HILH	CINCUM	ا		USE.	2	i	מאס היים	-		200			-
425.         25.         11855.         3476.         1736.         1737.543         424.909         25.000         -157.468         3010.7           925.         100.         23710.         6956.         3475.         3475.348         924.573         99.995         -358.599         6024.4           1475.         150.         3566.         10425.         10440.         5213.282         1473.914         199.980         -568.366         9041.6           1950.         200.         47421.         1390.         1392.7         6951.391         1948.101         199.80         -568.366         9041.6           250.         200.         592.76.         17375.         17415.         10425.         1246.310         249.89         -68.366         9041.2           250.         292.         2013.         2014.1         1390.         13625.         1246.4         1276.08         299.95         -106.29         1010.29           250.         292.         2015.         2016.         1300.         1300.         1300.         1300.         1300.         1300.         1300.         1410.         1410.         1410.         1410.         1410.         1410.         1410.         1410.         1410.	PRES PRES	STRAIN MICRO	Z	POUNDS	STRES	STRES	S O O	STATES PSI	M I CF	I.		n or :	2 2	1
925.         100.         23710.         6950.         6956.         3475.348         924.573         99.995         -556.59.599         6024.4           1475.         150.         35566.         10425.         10440.         5213.582         1443.914         199.999         -556.366         366.366         9041.6           1950.         200.         4742i.         1390.         13927.         6950.         262.302         249.969         -571.828         1201.295         1500.           250.         29276.         17375.         17415.         10428.         127         2796.088         299.955         -106.295         1500.295         1500.295         1500.295         1500.295         1500.295         1500.295         1500.295         1500.295         1500.295         1500.296	ŗ.		25.		3475	3476.	1738.	1737.543	4	25.00	4	10	343,959	0
1475.         150.         35566.         10425.         10440.         5213.282         1473.914         149.989         -568.366         9041.6           1950.         200.         47421.         1390.         1392.         6951.390         1948.101         199.980         -751.828         12061.2           2325.         250.         59276.         17375.         17415.         6868.         8699.327         249.96         -900.295         15062.2           2800.         350.         2798.2         249.96         -900.295         15062.2	100	025	100,		6950.	6956.	En.	3475.348	6	66.66	59	2	750.817	0.3
1950.   200.   47421.   13900.   13927.   6950.   6951.390   1948.101   199.980   -751.828   12061.2   1235.   250.   2506.   17375.   17415.   8688.   8689.672   2322.302   249.969   -900.295   15082.2   2500.   25131.   20820.   2090.295   1900.295   15082.2   2500.   2500.295   24131.   20820.   2090.295   24131.   20820.   2090.295   24131.   241	1.5	1475	150.	3	10425	10440	m	5213.282	147	149.98	-568,366	9041	1196.264	0
2325.         250.         59276.         17375.         17415.         8688.         8699,672         2322.302         249.969         -900.295         1508.25         1508.25         1508.25         1508.25         1508.25         1625.         16428.12         279.95         -939.95         -1678.615         1807.2         350.0         350.0         369.95         -1678.135         1807.2         374.72         379.95         -1678.135         2113.66.75         374.72         374.72         379.95         -165.017         2415.6         2113.6         2113.6         2113.6         372.98         475.00         372.98         475.00         372.99         -1450.017         2415.6         2113.	200		200		13900.	13927.	6950.	6951.390		199.	-751,828	12061.	1581.243	I -
2860.         300.         71131.         20850.         20908.         10425.         10428.127         2796.088         299.955         -1063.615         18107.2           3250.         350.         48287.         24325.         24404.         12165.         12165.         12166.75         3242.986         399.919         -1450.017         24155.8134.6           3750.         425.         106692.         27904.         13900.         13905.56         466.309         424.909         -1606.926         27198.1           4750.         425.         106697.         34750.         34912.         13785.         13644.146         4166.309         424.909         -1606.926         27198.1           5075.         525.         13647.         34912.         13735.         13785.         1368.246         35271.9           5775.         526.         14226.3         4775.         4849.         1912.55         559.51         54.86         -2186.2         1956.246         35371.9           570.         44226.3         4192.         22587.         22611.61         572.56         572.56         36314.7           570.         650.         625.         154118.         45465.         45456.         22436.	250	23.25	250.		17375	17415	8688	8689.672				15082.	1885,783	0
356.         350.         82987.         24325.         24404.         12166.757         3244.729         349.939         -1258.134         21134.6           3750.         400.         94842.         27800.         27904.         13905.560         342.986         399.919         -1400.017         24165.88           4175.         425.         1066.926.         34406.         15380.         15464.146         3466.309         -1606.926         2108.1         24166.384         4650.         250.4909         -1606.926         2684.146         367.223         499.874         -1798.684         30234.4         367.25         367.874.90         -1606.926         35271.9         367.149         -1606.926         35271.9         367.14	300	2800	300		20850	20908	10425.	10428.127		1	:	18107.	2270.440	0
3750.         400.         94842.         27800.         27904.         13900.         13905.560         3742.986         399.919         -1450.017         24465.8           4175.         425.10667.         31275.         31406.         1530.         1564.309         -1666.926         27198.1           5450.         500.         118550.         34475.         1735.         1738.644         4059.223         499.874         -1798.684         35274.9           575.         525.         130407.         38225.         38419.         19113.         19125.         1925.54         468.682         -1955.46         35274.9           5575.         550.         142263.         41700.         41932.         20861.467         559.517         599.89         -2138.274.9         35714.7           550.         142263.         41700.         41946.         22680.         20861.467         559.517         599.89         -2138.278.         35314.7           7150.         620.         15973.         4860.         489.86         24325.         22401.61         499.789         -2999.05         45498.6           700.         17782.         1896.         27820.         27820.05         27820.05         27820.05 <t< td=""><td>350</td><td>3250</td><td>350</td><td></td><td>24325</td><td>24404.</td><td>12163.</td><td>12166.757</td><td></td><td></td><td></td><td>21134.</td><td>2634.872</td><td>0</td></t<>	350	3250	350		24325	24404.	12163.	12166.757				21134.	2634.872	0
4175. 425. 106697. 31275. 31406. 15638. 15644.146 4166.309 424.909 -1606.926 27198.1 4550. 500. 118552. 34750. 35912. 17375. 17385. 4692.223 499.874 -17996.684 30234.4 5775. 550. 13427.3 4170. 41932. 20850. 20861.467 5559.517 549.849 -2138.278 35314.7 6500. 625. 154118. 45175. 45469. 22587. 22601.467 5559.517 549.849 -2138.278 35314.7 7150. 650. 165973. 48650. 48998. 24325. 22601.617 6478.966 624.894 -22486.320 39377.2 7716. 700. 177828. 52125. 52537. 26163. 26160.744 7886.958 699.756 -2999.050 45498.6 7910. 725. 189683. 55600. 56120. 27800. 27820.159 736.559 724.737 -3510.953 48001.8 7150. 700. 201539. 99075. 59763. 29537. 29559.651 1189.6559 724.737 -3510.953 48001.8 7150. 700. 201539. 99075. 59763. 33300.020 31880.046 799.681 -4772.904 55177.5	400	3750	400		27800.	27904.	13900.	13905.560	1	,		24165.	3039.212	
4650.         500.         118552.         34750.         34912.         17383.688         4659.223         499.874         -1798.684         30234.4           5075.         525.         130407.         34225.         38419.         19113.         19122.534         5062.166         524.862         -1995.460         33271.9           5775.         550.         147263.         441932.         20850.         20851.         3671.47         559.51         21804.47         3671.49         -21802.28         36377.2           650.         650.         15973.         48650.         22587.         22601.617         7124.560         649.789         -2721.022         42433.7           790.         770.         17788.         52125.         2537.         26080.744         786.958         699.756         -2999.050         45498.6           790.         776.         7870.         27800.155         936.559         724.737         -3510.953         48601.8           9350.         725.         188683.         55600.         56120.         27800.155         3936.559         724.737         -3510.953         48601.8           14150.         735.         1866.89         56125.         2953.         29559.661	450	4175	425	_	31275.	31406.	15638.	15644.146				27198.	3381,540	0
5075. 525. 130407. 38225. 38419. 19113. 19122.534 5062.166 524.862 1955.460 33271.9 5575. 550. 142263. 41700. 41932. 20850. 20861.467 5599.517 540.849 -2188.278 36514.7 7500. 625. 154118. 45175. 45469. 22587. 22601.481 7424.560 649.789 -2721.022 38377.2 7900. 700. 177828. 52125. 52537. 26063. 26080.744 7868.958 699.756 -2999.050 45498.6 9350. 725. 189683. 55600. 56120. 27800. 27820.155 9306.559 724.737 -3510.953 48611.8 11550. 750. 201539. 92075. 59763. 29537. 29559.653 11582.661 749.719 -4316.333 51775.	500	١.	500	118552.	34750.	34912.	17375.	17383.688		499.	-1798.684	30234.	3767,233	_
, 5575, 550, 142263, 41700, 41932, 20850, 20861,467 5559,517 599,849 -2138,278 35414.7 56500, 622,184,7418, 45175, 45469, 22584, 22581,617 6478,966 624,884 -24686,320 39377,2 7150, 650, 165973, 48650, 48998, 24325, 24301,611 7424,560 649,789 -7721,022 44433,7 7910, 700, 177828, 52125, 52537, 26163, 26180,744 7868,958 699,756 -2999,050 45498,6 9350, 725, 189683, 55600, 56120, 27800, 27820,155 9316,559 724,737 -3510,953 48011,8 71550, 750, 201539, 99175, 59163, 29537, 29559,661 149,717, 799,681 -742,904 55177,5 11550, 790,051 -742,904 55177,5 11550, 790,051 -742,904 55177,5 11550, 790,051 -742,904 55177,5 11550, 790,051 -742,904 55177,5 11550, 790,051 -742,904 55177,5 11550, 790,051 -742,904 55177,5 11550, 790,051 -742,904 55177,5 11550, 790,051 -742,904 55177,5 11550, 790,051 -742,904 55177,5 11550, 790,051 -742,904 55177,5 11550, 790,051 -742,904 55177,5 11550, 790,051 -742,904 55177,5 11550, 790,051 -742,904 55177,5 11550, 790,051 -742,904 55177,5 11550, 790,051 -742,904 55177,5 11550, 790,051 -742,904 55177,5 11550, 790,051 -742,904 55177,5 11550, 790,051 -742,904 55177,5 11550, 790,051 -742,904 574,904 777,5 11550, 790,051 -742,904 574,904 777,5 11550, 790,051 -742,904 574,904 777,5 11550, 790,051 -742,904 574,904 777,5 11550, 790,051 -742,904 574,904 777,5 11550, 790,051 -742,904 574,904 777,5 11550, 790,051 -742,904 574,904 777,5 11550, 790,051 -742,904 574,904 777,5 11550, 790,051 -742,904 777,5 11550, 790,051 -742,904 777,5 11550, 790,051 -742,904 777,5 11550, 790,051 -742,904 777,5 11550, 790,051 -742,904 777,5 11550, 790,051 -742,904 777,5 11550, 790,051 -742,904 777,5 11550, 790,051 -742,904 777,5 11550, 790,051 -742,904 777,5 11550, 790,051 -742,904 777,5 11550, 790,051 -742,904 777,5 11550, 790,051 -742,904 777,5 11550, 790,051 -742,904 777,5 11550, 790,051 -742,904 777,5 11550, 790,051 -742,904 777,5 11550, 790,051 -742,904 777,5 11550, 790,051 -742,904 777,5 11550, 790,051 -742,904 777,5 11550, 790,051 -742,904 777,051 777,051 777,051 777,051 777,051 777,051 777,051 777,051 777,051 777,051 777,051	550	5075	525.	130407.	38225.	38419.	19113.	19122.534	5062.	524.	-1955.460	33271.	4109.236	_
, 6500, 625, 154118, 45175, 45469, 22587, 22601.617 6478.966 624.804 -2486.320 39377.2 , 7150, 650, 165973, 48650, 48998, 24325, 24340.811 7124.560 649.789 -2711.022 42433.7 , 7900, 700, 177828, 52125, 52537, 26063, 26080.744 7868.958 699.756 -2999.050 45498.6 , 9350, 725, 189683, 55600, 56120, 27800, 27820.155 9306.559 724.737 -3510.953 48601.8 , 11550, 750, 201539, 59075, 59763, 29537, 29559.661 749.719 -4316.333 5177.5	9	5575	550	142263.	41700.	41932.	20850.	20861.467	5559.	549.	-2138,278	36314.	4511.192	_
7150. 650. 165973. 48650. 48998. 24325. 24340.811 7124.560 649.789 -2721.022 42433.7 . 7900. 700. 177828. 52125. 52537. 26063. 26080.744 7866.958 699.756 -2999.050 45498.6 . 9350. 725. 189683. 55600. 56120. 27800.155 9306.559 724.737 -3510.953 48601.8 . 11550. 750. 201539. 59075. 59763. 29557. 29559.653 11582.661 749.719 -4316.333 \$1777.5 . 14560. 600. 213394. 42550. 63710. 31275. 31300.020 11880.046 799.681 -4712.904 55177.5	650	6500	625.	154118.	45175.	45469.		22601.617	6478.	624.	-2486.320	39377.	5256.248	0
. 7900. 700. 177828. \$2125. 52537. 26063. 26080.744 7868.958 699.756 -2999.050 45498.6 9350. 725. 189683. 55600. 56120. 27880. 27820.155 9306.559 724.737 -3510.953 48601.8 . 11550. 750. 201539. 59075. 59763. 29537. 29559.663 11580.661 749.719 -4316.333 \$1757.5 1. 11550. 800. 213394. 42550. 53740. 31275. 31300.020 18380.046 799.681 -6712.904 55177.5 1.	700		650.	165973.	48650.	48998.		24340.811	7124.	649.	-2721.022	42433.	5777.745	-
. 9350. 725, 189683, 55600, 56120, 27800, 27820.155 9306,559 724,737 -3510,953 48601.8 .11550. 750, 201539, 59075, 59763, 295937, 29559,683 11582.661 749,719 -4316,333 91757,5 1. 14560. 760, 213394, 42550, 63740, 31275, 31300,020 18380,046 799,681 -4712,904 55177,5 1.	750		700.	177828.	52125.	52537,		26080,744	7868.	669	-2999.050	45498.	6380,390	0.35
. 11650. 750. 201539. 59075. 59763. 29537. 29559.653 11582.661 749.719 -4316.333 51757.5 9378 18550. 860. 21334. 62550. 63710. 31275. 31300.020 18380.046 799.681 -6712.904 55177.5 14871	800		725.	189683.	55600.	56120.		320.15	9306.5	724.73		48601.	99	ė
nn 1856n. 888 213394 6255n, 6371n, 31275, 31380.020 18380.046 799.681 -6712.904 55177.5 14871	850	-	750.	201539.	59075.	59763.		559.65	11582.6	749.71		91757.	9378.409	0.35
1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 -	-				1 1 1	1				0			***	•

### STRESS-STRAIN DATA ON CYLINDER NO. CY-15 WITH REINFORCED WELD (2:1) TABLE G-35.

TEST NUMBER 13 GAGES 7 AND 8

	HYDRO	CIRCUM LONG	LONG	•			MSD LN	TRU LONG	25	TRU LONG	TRU RAD	EFFECT I VE	EFFECTIVE	⊋
	0000	- 1	N W W		SINESS	"!		SHESS		STRAIN	STATIS			
	Š		21/21	POUNDS				184	MICROINZIN	MICROINZIN	MICROINZIN	l S d	ı	
İ	50.	225.	50.	11855.	3475.	3476.	1738.	1737.587		50.000	-96.241			
	100.		100	23710.	6950.	6954	3475	3475.348	524.862	00.00	-218 700	1 0 0 0 0 9	1 4	
1	150.		150.	35566.	10475	10432	5243	5213.282		40 000	200	-		9 6
	200		200	47421	٠-	1.01.1	, C 10 Y	4051		100.001	# F - / / / /	0.00		
	250.		275.	40074	1	17704	AKBB	9440 940	1 00	006.667	100.30 F			0.07
		1475	, ,	7447		0 0 0 0 0	2000	A 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0		2000	CDA. CIC.			5.50
-		7	000	1011/	.0007	C1881.	10475	10468.127	1473	566.662	-620.854		٠,	0.35
	.000		350.	82987	24325.	24368	12163.	12166.757	1773.427	349.939	-743.178			0.35
	400		400	94842.	27800.	27858.	13900.	13905,560	2072.850	399,919	-865.469			E .
	450.		475.	106697.	31275.	31349.	15638.	15644.928	2372.183	474.888	-996.475	27140.1	1	
	500		500	118552.	34750	34843	17375	17387 ABB	2674 420	400 874	440 0044			, ,
	550.	1	57.5	1 30 40 7	10001	19181	4044	10.51	2007 2002	2000	1407.700	A	2171.170	000
		) (C				01000	17110	DATE 0 7 4 T	5075.605	2/4.035	1284.214	33206.		0.35
	0.0		0.00	146603	41/00.	4184/	50820.	20863.553	3518.802	649.789	-1459.007	36240.		0.35
	.069		,00/	154118.	45175.	45355.	22587.	22603.311	3967,121	699.756	-1633.407	39278.3	3248.426	0.35
	700.		750.	165973.	4R650.	48869.	24325.	24343.244	4489.905	749.719	. A B 7.4 B A B	42324		
	750.		825.	177828.	52125	52307	26063	24084.003	R244 308	177 700	40.00		100	
	0	4175	000	100401					2000	700.430	770 777		1500.031	0.33
1		-	.004	100000	22000		.000/2	6/822.020	0354./05	889.596	-2539.020		5178.643	0.35
	. 020	•	1000	201539.	59075	59613.	29537	29567.038	9	005.666	-3520.420	•	7357.847	0.35
	.000	_	1200.	213394.	62550	63548.	31275.	31312,530	15824.135	1199.280	-5958.195	55035.8	12820.000	0.35
•					i i	:	:						The state of the s	:
	2		6 6 6 6 6 6 6	D AND	0								i	
	_		LONG	AXIAL		TRU CR		TRU LONG	TRU CIRCH	PRU DNG	TRU PAD		CCCC	7
	"		STRAIN	LOAD		STR		STRESS	NIAGER	STRAIN	NI VOLU	2 10 10 1	_	2
	PSI	MICROIN/IN	21/2	POUNDS	PSI	S	PSI	PSI	MICROIN	NI CALL	MIT OF TAX	0 0	1	
								•				2	-	
	50.	550.	•	11855.	3475	3477.	1738.	1737.500	540 B40	0.00	100 447		344 046	
	100.	1125.	100.	23710.	6950.	6958	3475	3475 148	1124 368	2000	70000	1 2 2 4		
	150.	1525.	125.	35566.	16425	10441	5213.	5213 182	1421 ATA	124 000	- K77 004	4 64 60		000
	200.	2100.	200	47421	1400	13000	4040	404	2007	366.00	7.00	•	1637,007	•
	250			50074		17440	000	200000	<b>u</b> , t	200.00	777.	•	1/01./25	•
						0711		201.	2470	C/4.477	٠	•	2024.714	٠
		0000	•: •: •:	11101	2002	20913	10425.	10428.127		299.955	-1153,412	18110.8	2430.905	٠
	320		323	82987	24325.	24410.	12163.	12166.453		324.947	*1327,873	21139.3	2813.716	0.35
	400	3975.	375.	94842.	27800.	27911.	13900.	13905.213		374.930	-1519,718	24171.3	3217.968	•
	450.	4475.	425	106697.	31275.	31415.	15638.	15644.146		424.909	-1711.474	27206	3622.020	
	500		475.	118552.	34750.	34925.	17375.	17383.253		474.888	-1929.263		4085.974	
	550.		500.	130407.	38225.	38446;	19113.	19122.056	5758,389	499.874	-2190.392	33205	4668.306	
	600.		575.	142263.	41700.	41988.	20850.	20861.989		574.835	-2607.898	36362.7	R674 816	•
	650.		.009	154118.	45175.	49562	22587.	22601.053	8538	599,821		4040	100	
	700.	11200.	675.	165973.	48650.	49195	24325.	24341.419	1	674.773	-4134.381		0014	) M
	750.	14550.	750.	177828.	52125.	52883.	26063.	26082.047	14445.165	749.719	-431A 200	•  •	11600.0011	4
	800.	18150.	825.	189683.	55600.	56609.	27800.	27822.935	17087.255	824. AA1	-4584 470	49897	44 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4	9 6
		* 1	1	i i		,				****	2 14 0 10 10	00/2066	1177	2

TABLE G-35. STRESS-STRAIN DATA ON CYLINDER NO. CY-15 WITH REINFORCED WELD (2:1) (Cont'd)

HYDRO	CIRCUM	LONG STRAIN	AXIAL LOAD	MSD CR STRESS	TRU CR STRESS	MSD LN STRESS	TRU LONG STRESS	TRU CIRCM STRAIN	TRU LONG STRAIN	TRU RAD STRAIN	EFFECTIVE STRESS	EFFECTIVE STRAIN	⊋
PSI	MICROINZIN	Z	POUNDS	PSI			PSI	MICROINZIN	MICROINZIN	MICROIN/IN	PSI	MICINIIN	:
50.	100.	0.	11855.	3475.	3475.	1738.	1737.500	99,995	0.000	-34.998	3009	80.894	0.35
100.	25	0	23710.	6950.	6952.	3475.	3475.000			-78.741	9	182.000	0.3
150.		25.	35566.	10425.	042	5213.	5212.630		25.000	-113,734	31	243,121	0.3
200.	1	50.	47421.	13900.	13907.	6950.	6950.347			-183,711	12043	385,545	0.3
250.	57	75.	59276.			8688.	8688.152			-227.441	15055	467.845	0.3
300	7.0	100.	71131.	0850.	20865.	10425.	10426.042			-279.913			0.3
50	8	125.	82987,	4325.		12163.	12164.020	79	124.992	-323.636		652.	0.35
400.	6	150.	94842.	٠.	27825.	13900.	13902,085		•	-367,355			0
450.		175.	106697.	1275.	31307.	15638.	15640.237	_	174.	-419.811	27112.7		
500.	110	200.	8552		34788.	17375.	17378.475	1099.395		-454.781	30127.5	901.003	0
550.		225.	_		38270.	19113.	19116.800	_		-489.750			0
600		275.	142263.	41700.	41751.	20850.	20855.734		- 1	-524.725			0
650.		300			45233.	22587.	22594.276	-		-550,950		-	0.3
700.		325.	165973.	48650.	871	24325.	24332.906	-	324.	-568.436	42186.9	-	0.3
750.		375.	177828.	52125.	219	909	26072.273		374.930	-585.930		1	0
800.	1325.	450	189683.	55600.	56	27800.	27812.510	<b>:</b>	449.899	-620.908		1124.874	•
850.		525	201539.	59075.	59150.	29537.	29553.007	•	524.862	-629.667	51225.7	1107.458	0
006	-	725.	213394.	62550.	261	31275.	31297.674	1024.	724.737	-612.224	54225.4	1006.213	0.3
950		925	225249.	602	607	33012.	33043.037		924.573	-594.746	57223.6	ø	0.3
1000.		1575.	237104.	69500.	69500.	34750.	34804.731		1573.762	-550.817	88	1273.138	0.3
TEST NUMBER	UMBER 13	GAGES	1 AND	2	i }				!				1
HYDRO	CIRCUM	LONG		MSD CR	TRU CR	MSD LN	TRU LONG	TRU CIRCH	TRU LONG	TRU RAD	EFFECTIVE	EFFECTIVE	Œ
PRESS	STRAIN	STRAIN	LOAD	SS	STRESS	STRESS	STRESS		STRAIN	STRAIN	SS		
PSI	MICROINZIN	2 ! 2	POUNDS	PSI	lsd.	PSI	ISd	MICROINZIN	MICROIN/IN	MICROIN/IN	PSI	MICINIIN	
50.		0	11855.	3475.	3477.	1738.	1737.500	524.862	0.000	-183.702	3011.0	424,601	0.3
100.		75.	23710.	6950.	6957.	3475.	3475.261	1074.422	74.997	-402.297	6025.3	870,167	0.3
150.	1475.	100.	35566.	10425.	10440.	5213.	5213.021	1473.914	99.995	-550.868	9041.6	1193.596	
200.	2025.	175.	47421.		13928.	6950.	6951.216	2022,953	174.984	-769.278	12062,1	1639.998	0
250.	2500.	225.	59276.	7375.	17418.	8688.	8689.455	2496	224.975	-952.649	15084	2024.714	0.3
300.		300.			20913.	10425.	10428.127		299.955	-1162,136	18111	2450.969	0.3
350.		350.			24412.	12163.	12166.757		349.939	-1371.498	21141	2895.518	0.3
400.		37.5			27913.	13900.	13905.213	- 1	374.930	-1554,578	24173.7	3298.191	0
.000	4625.		5697		31420.	15638.	15644.928	4614	474.888	-1781.229	27210	3745,468	P 0
500.	5275.		1252.	34750.	34933.	1/375.	17383.688	5261	499.874	-2016.353		4267,783	
220.				38225.	56455	19113.	9123.	6006.922	599.821	2312.	33303.4	4874.60	0.3
000		0/0		41/00.	42003.	20850.		7248.665	674.773	•	36376.2		0.3
700	11680	975	124118.	٠.	40000	22587.	22605.005	8934.963	74.700	-3398,382	39474.3	7243.632	0.35
100	٠,		_	46650	1761/	61367	44340.684	205	•		42623.8	9383.601	0
					1000		F / W 000 YC		4	***			

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TABLE G-36. STRESS-STRAIN DATA ON CYLINDER NO. CY-7 WITH REINFORCED WELD (1:1)

TEST NUMBER	UMBER 14	GAGES	7 AND	ac :			1						
HYDRO	CIRCUM	LONG	AXIAL	MSD CR	TRUCR	MSD	TRU LONG	1			EFFECT I VE	EFFECTIVE	ī
ביח מי	2 4 2 3	42.0		STRESS	STRESS	STRESS	STRESS				STRESS	ì	
18.		2 / /2	FUUNDS	25.	PSI	PSI	1 Sd	MICHOIN/IN	MICROIN/IN	MICROIN/IN	PS I	MICIN/IN	
.04		225.	23710.	3475.	3476.	3475.	3475.782	224.975	224.975	-157.482	3475.8	254.971	5
100.		500.	47421.	6950	6953	6950	6953.475	474. RRR	PLB 00P	477 172	F 4802	1	
150.	700.	700.	71131.	10425	10432	10425	10432.207	400 756	470 004	1000	4.0000		0.0
200.	824.	000	04840	1 1000	1.1011	1 4000	1 1010 K	200	2001	420.004	10402.0	į	
	•	1200	11855	13136	1101		016.2161	100.420	944.249	-603,490		978.036	
200	İ	4 4 4 4 4 4	110/72	1/3/7	1/0/4	1/3/2	1/392,090	1099.395	1199.280	-804.537		1303,859	
	1030		146603.	20020	20878	20850	20879.190	1349.090	1399.020	-961,839	20878.7	1	t
.000	Ċ	1022	1629/3.	24325	24303.	24325	24364.528	1548.800	1623.681	-1110,368	24363.6	1798.259	
004		1000	189983	27800.	27850.	27800.	27852.820	1798.383	1898.198	-1293.803	27851.4	-	0.35
100		2125	215394.	31275.	31339.	31275.	31341.459	2047.901	2122.746	-1459.726			
500.		2425.	237104.	34750.	34841.	34750.	34834.269	2621.560	2422.064	-1765.269		2861.374	i
.000	7850.	2650.	260815.	38225.	38334.	38225.	38326.296	2845.946	2646.495	-1922,354		3114.513	
	31/5.	. 0682	284525.	41700.	41832.	41700.	41818.845	3169.970	2845.946	-2105.571	41825.6	3414.148	0.35
	8			. ,		:							
2	UTBEN 14	CAGEO	ONA	•									
HYDRO	HYDRO CIRCUM	LONG		MSD CR	TRU CR	MSD LN	TRU LONG	TRU CIRCH	TRU LONG	TRU PAD	FFFFCTIVE	20110000	3
PRESS	S	STRAIN	LOAD	STRESS	STRESS STRESS	STRESS	STRESS		NIVOLS	NATELO	2010	- 1	2
PS1	MICROINZIN	N I N	POUNDS	PSI	15d	PSI	PSI	MICR	MICROINZIN	MICHOINZIN	S I S I	MICININ	
50.		175.	23710.	3475.	3476.	3475.	3475.608	424,909	174.084	130 000	4 7 6 7 6	44.0	
100.		350.	47421.	6950.	6956	6950	6952.432	800.506	340.040	417 117	24/04	2042 400	
150.		500.	71131.	10425.	10439.	10425.	10430.212	1349,090	400.874	-647.137	10474 6	1156 780	1000
200.	1625.		94842.	13900.	13925	13900.	13909.035	1623.681	649.789	-705.714	1.015.4	1464.447	
250.			118552.	17375.	17412.	17375.	17389.769	2122,746	849.638	-1040 335	17400.0	1017 745	
300.				20850.	20903.	20850.	20869.286	2521.817	924.573	-1206.237	208BA. 3	2150.720	2 6
550.				24325.	24398.	24325.	24351.758	2995.509	1099,395	-1433.217	24374.0		
400.	3400.			27800.	27895.	27800.	27834,750	3394.233	1249.220	-1625.209	27864.7		0.35
40.	5800.			31275.	31394.	31275.	31321.131	3792.797	1473.914	-1843,349	31357.6		0.35
000	1011			34750.	34916,	34750.	34807.338	4763.636	1648.640	-2244.297	34861.8	4054.333	0
000	5275.	.,	•	39225.	38427.	38225.	38291.894	5261.136	1748.470	-2453,362	38359.4	4459.888	0.35
.009	6075.	1900.	284525.	41700.	41953.	41700.	41779.230	6056.622	1896.198	-2784.187	41866.6	5107.231	; <del>; ;</del>

TABLE G-36. STRESS-STRAIN DATA ON CYLINDER NO. CY-7 WITH REINFORCED WELD (1:1) (Cont'd)

TEST NUMBER 14 GAGES 3 AND 4

			1 1	1 1 1
	₹		¥ 5	
	EFFECTIVE STRAIN MICIN/IN	113.327 254.971 396.598 481.564 652.118 652.118 779.033 920.533 1119.949 1189.375 1186.783 1528.969	EFFECTIVE STRAIN MICIN/IN	314.139 682.831 1014.914 1283.767 1283.667 1994.427 1994.427 2294.334 3594.334 3596.134 3596.134 3596.134
	EFFECTIVE STRESS PSI	3475.3 6951.6 113928.6 113928.6 17385.0 278844.8 278244.8 27825.0 31307.8 34792.6 382792.6	EFFECTIVE STRESS PSI	3475.9 6953.9 10433.7 13914.8 173914.8 274370.3 274370.3 31351.3 34850.4 38347.4
	TRU RAD STRAIN MICROIN/IN	-69,996 -157,482 -244,957 -294,957 -402,384 -402,384 -569,717 -734,614 -734,614 -916,357 -944,353	TRU RAD STRAIN MICROIN/IN	-183,723 -393,624 -595,971 -404,303 -904,701 -1145,171 -1302,361 -1404,423 -1703,867 -201,867 -225,813
	TRU LONG STRAIN MICROIN/IN	99.995 324.975 324.903 424.903 699.756 824.561 1049.448 1199.280 1349.090	TRU LONG STRAIN MICROIN/IN	174.984 340.939 524.862 674.773 899.590 1149.340 11723.513 1873.244
	TRU CIRCM STRAIN MICROIN/IN	99.995 224.975 329.939 424.909 549.849 674.773 799.681 1049.448 11349.090	TRU CIRCM STRAIN	349.939 774.701 1149.340 11848.950 1848.290 2272.415 2571.691 2571.691 2545.657 3344.402 4041.820 4514.793
	TRU LONG STRESS PSI	3475,348 6951,564 10428,649 13305,907 17385,425 2084,595 27825,715 31307,839 34791,700 38274,700	TRU LONG STRESS PSI	3475.608 6952.432 1104030.473 110409.638 20870.636 27352.974 27352.974 37322.694 34809.944 34809.944
	TRU CR MSD LN STRESS STRESS PSI PSI	3475, 3475, 13475, 13476, 13476, 13476, 13476, 137876, 173	TRU CR MSD LN STRESS STRESS PSI PSI	3476. 3475. 6955. 6950. 10437. 10425. 17407. 17375. 20897. 20850. 27882. 27800. 31309. 31275. 38398. 38225.
	MSD CR TR STRESS ST PS1	3475. 3 6950. 6 13902. 13 17375. 17 20850. 20 20850. 20 27807. 27 31275. 31 34750. 34	2 MSD CR TR STRESS ST PSI	3475. 3 6950. 6 6950. 13 17376. 13 17376. 13 27806. 20 27807. 27 27807. 37 34750. 34 34750. 34 41700. 41
	AXIAL LOAD POUNDS	23710. 47421. 7131. 718552. 142263. 165973. 165973. 165973. 273594. 237104. 260815.	1 AND AXIAL LOAD POUNDS	23710, 47421, 71131, 94842, 118552, 165973, 18588, 237104, 237104,
	LONG STRAIN IN/IN	100. 225. 350. 425. 600. 700. 825. 1050. 1200.	MRER 14 GAGES CIRCUM LONG STRAIN STRAIN MICROIN/IN	175. 350. 525. 675. 900. 1000. 1325. 1525. 1725. 1875.
	CIRCUM L STRAIN STR MICROIN/I	100. 350. 425. 550. 675. 1050. 1356.	TEST NUMBER 14 GA HYDRO CIRCUM L PRESS STRAIN STR PSI MICROIN/I	350. 1150. 1450. 1850. 2275. 2950. 3350. 4525.
	HYURO PRESS PS1	00110000000000000000000000000000000000	HYDRO PRESS PSI	500. 200. 200. 300. 300. 500.
ı		1	I	1

TABLE G-37. STRESS-STRAIN DATA ON RETEST OF CYLINDER NO. CY-7 WITH REINFORCED WELD (1:1)

TEST NUMBER 14 GAGES 7 AND A

⊋		0.35	0.35	0.35	0.35	0.35	0.35	9.39	0.35	0.35	,	2			0.35	0.35	3.35	3.35	0.35	1.35	0.35	0.35	0.35
EFFECTIVE STRAIN	MICINIA	384.877	595.542	906.305	1161.072	1472.376	1727.016 0.35	1996.209	2321,669	2604.310		EFFECTIVE	STRAIZ	MICIN/IN		915.221	1296,306	1683,572	2108.733	2438.651	2850.694	3212.454	3592,595
EFFECTIVE STRESS	PSI	3476.2	6953.6	10433.3	13914.2	17397.6	20881.8	24367.9	27857.0	31346.9			STRESS	PSI	3476.7	6955.0	10435.7	13918.6	17404.1	208903	24380.1	27870.3	31363.4
TRU RAD STRAIN	MICHOINZIN	-236.210	-367,403	-559.776	-717.133	-909.409	-1066.687	-1232,664	-1433,530	-1608.151		TRU RAD	STRAIN	MICROIN/IN	-332,399	-507.273	-717.045	-935.483	-1171.296	-1345.890	-1581,549	-1764.706	-1974.005
TRU LONG STRAIN	MICROINZIN	299.955	409.874	799.681	1024.476	1299.155	1523.838	1723.513	1998.003	2247.473		TRU LONG	STRAIN	MICROIN/IN	224.975	374.930	524.862	699.756	874.617	974.525	1174.310	1249.220	1399.020
	MICROINZIN	374.930	549.849	799.681	1024.476	1299.155	1523.838	1798.383	2097,798	2347.244		TRU CIRCM	STRAIN	MICHOINZIN	724.737	1074.422	1523,838	1973.052	2471.943	2870.875	3344,402	3792.797	4240.993
	ls <sub>d</sub>	3476.042	6953.475	10433.340	13914.248	17397.587	20881.796	24366.961	27855.600	31345.349		TRU LONG	STRESS	ISd	3475.782	6952,606	10430.473	13909.730	17390.203	20870.329	24353.582	27834.750	31318,785
MSD LN STRESS	1Sd	3475.	6950.	10425.	13900.	17375.	20850.	24325.	27800.	31275.		MSD LN	SIRESS	PSI	3475.	6950.	10425.	13900.	17375.	20850.			
TRU CR STRESS	PSI	3476.	6954	10433.	13914.	17398.		24369.	27858.	31348.			STRESS	PSI	3478.	6957.	10441.	13027.	17418.	20910.	24406.	27906.	31408.
MSD CR STRESS	PSI	3475.	6950.	10425.	13900.	17375.	20850.	24325.	27800.	31275.	·c	MSD OR TRU OR	STRESS	PSI	3475.	6950.	10425.	13900.	17375.	20850.	24325.	27800.	31275.
AXIAL LOAD	SONDO	23710.	47421.	71131.	94842.	118552.	142263.	165973.	189683.	215394.	5 AND	AXIAL	LOAD	POUNDS	23710.	47421.	71131.	94842	118552.	142263.	165973.	189683.	213394.
LONG	2	300.	500.	.008	1025.	ľ					GAGES	LONG	STRAIN	N/IN	225.	375.	525.	700.	875			1250.	
HYDRO CIRCUM LON PRESS STRAIN STRAI	MICRO	375.	550.	. 00B	1025.	1300.	1525.	1800.	2100.	2350.	TEST NUMBER 14 GAGE	HYDRO CIRCUM LON	STRAIN	MICROI	725.	1075.	1525.	1975.	2475.	2875.	3350.	3800.	4250.
PRESS	1Sd	50.	100.	150	200	250.	300.	350.	400.	450.	TEST NU	HYDRO	PRESS	PSI	λo.	100	150.	200.	250.	300.	350.	400	450.

TABLE G-37. STRESS-STRAIN DATA ON RETEST OF CYLINDER NO. CY-7 WITH REINFORCED WELD (1:1) (Cont'd)

	STRAIN STR	TRAIN	LOAD LOAD	STRESS PS1	STRESS PSI	SIRESS PSI	STRESS PSI	STRAIN	STRAIN	STRAIN	STRESS	STRAIN
20	255.	150	23710.	3475	34/6.	3475.	3475.521	224.975	149.989	-131.237	3475.7	216.845
100.	275	250.	47421.	6950	6952	6950	6951.737	274.963	249.969	-183,726	6951.8	297,812
150.	400	375	71131.	10425	10429.	10425.	10428.909	399,919		-271.197	10429.0	439.319
200.	500.	500.	94842	13900.	13907.	13900.	13906.950	469.874	400.874	-349.912	13907.0	566.524
250	625	625.	118552.	17375.	17386.	17375.	17385.859	624.804	624.804	-437,363	17385.9	708.111
300.	700		142263.	20850.	20865.	20850.	20865.116	699.756	724.737	-498.572	20864.9	807.341
١.	850.	75.	165973.	24325.	24346.	24325.	24346.284	849.638	874.617	-603.490	24346.0	977.185
		0.0	189683.	27800.	27825.	27800.	27827.800	899.596	999.500	-664.684	27826.4	1077.699
	1000	25.	213394.	31275.	31306.	31275.	31310.184	999.500	1124.368	-743.354	31308.2	1205.683
			237104.	34750.	34750.	34750.	34750.000	0.000	0.00	0.000	34750.0	0.000
550.			260815.	38225.	38225.	38225.	38225.000	0.00	0.000	0.000	38225.0	000.0
1	1				. !					4	1 1 1 1	17.11.0
	CIRCUM	LONG	AXIAL	MSD CK	I KO CK	MSD LN	DAU LONG	2	PAC CONG	DAR DR	STACES	CTOCES CTECTIVE
PRESS ST	HEAIN SIR	Z Z Z Z Z Z Z Z Z Z Z Z Z Z Z Z Z Z Z	POUNDS	SIRESS PSI	PSI	PSI	PSI	MICROIN/IN	MICROIN/IN	MICROIN/IN	PSI	MICINIIN
5.0	650.	250.	23710.	3475.	3477.	3475.	3475.869	649.789	249.969	-314,915	3476.6	559,683
100	000	400	47421	6950	6956	6950.	6952,780	899.596	399.919	-454.830	6954.5	790,884
150.	1300.	575	71131	10425.	10439.	10425.	10430.994	1299.155	574.835	-655.897	10434.8	1141,302
	1625.	725.	94842	13900.	13923.	13900.	13910.077	1623.681	724.737	-821.946	13916.3	1428.396
	2150.	925	118552.	17375.	17412.	17375.	17391.072	2147.691	924.573	-1075.293	17401.7	1878,717
1	2500.	1075.	142263.	20850.	20902	20850.	20872.414	2496.880	1074.422	-1249.956	20887.3	2184.027
	2950.	1275.	165973.	24325.	24397.	24325.	24356.014	2945.657	1274.187	-1476.945	24376.4	2578.628
		1350.	189683.	27800.		27800.	27837.530	3319.485	1349.090	-1634,001	27865.0	2879.750
450.		1450.	213394.	31275.		31275.	31320.349	3742.986	1448.950	-1817,178	31356,4	3226.474

### APPENDIX H

LTV BIAXIAL TEST DATA (CONTRACT NAS8-20160)

### LTV BIAXIAL TEST DATA (CONTRACT NAS8-20160)

The LTV biaxial tests were conducted and subcontracted by LTV-Vought Aenonautics Division, Dallas, Texas. The results of these tests, as submitted to Southwest Research Institute, are contained in this Appendix.

### LTV VOUGHT AERONAUTICS DIVISION Dallas, Texas

Report No. 2-53420/5R-2232 Page No. 1 of 16

Title

"BIAXIAL TEST RESULTS ON 2219-T87
ALUMINUM ALLOY"

Conducted For: Southwest Research Institute San Antonio, Texas October 1965

Prepared By:

S. W. McClaren Lead Engineer Structures Design Reviewed by:

A. P. Martin Supervisor Structures Design Approved by:

G. A. Starr Chief, Applied R&D

C. R. Foreman

Structures Design Engineer

REPORT NO. 2-53420/5R-2232

### BIAXIAL TEST RESULTS ON 2219-T87 ALUMINUM ALLOY

### INTRODUCTION:

During the period August to October 1965 LTV Vought Aeronautics Division, Dallas, Texas conducted twelve (12) biaxial tests on 2219-T87 aluminum alloy for Southwest Research Institute, San Antonio, Texas under Contract NAS 8-20160. The parent material was furnished by SWR in basic 16.0" x 16.0" x 1/8" sizes to LTV. Six pieces were in the unwelded condition and six pieces were in the welded condition. The welded blanks had weldments parallel with both the longitudinal and transverse grain directions with these weldments intersecting at the predetermined test section locations. LTV machined these specimen blanks into biaxial test specimens configurations (Figure 16 of Reference 1). The machined specimens were instrumented with Baldwin PA-5 (wire) strain gages and tested in the LTV biaxial test machine and facility. The following items summarize the important aspect of this test series:

Test specimen: Figure 16 - reference 1\*

Test Temperature: R.T.

Test Procedures: As discussed in section 5 of reference 1\*

- \*-Reference 1 AFML-TR-65-140 (May 1965), cryogenic design data for materials subjected to uniaxial and multiaxial stress fields (LTV Research)
  - A copy of this document was given to Mr. E. B. Morris of SWR on 29 Sept. 1965 when he visited LTV to observe a portion of the testing effort.

### TEST RESULTS:

The test results are shown in Figures 1 through 12 of this report. These figures are basic load-strain and stress-strain curves for each of the twelve tests. The load strain curves are the raw data that are used to obtain biaxial stress-strain curves. The procedure for this conversion is covered in Section 5 of Reference 1 (Figures 20 and 21 of Reference 1). A summary of the critical mechanical properties for each test is shown in each figure. The uniaxial data ( $E_L$ ,  $E_T$ ,  $\mathcal{N}_L$ ,  $\mathcal{N}_T$ ) used to establish initial strain ratios to obtain the 2:1 stress fields were furnished by SWR and are also shown on each of the test data figures. These ratios were:

WELDED:  $e_1/e_2 = 3.45$ UNWELDED:  $e_1/e_2 = 4.14$ 

The 1:1 biaxial tests were conducted by maintaining equal loads in each of the principal stress directions.

The tests were conducted without any real problem as illustrated by the plotted data and the failed biaxial specimens that are being returned to SWR by separate package. The 1:1 tests are closely characteristic in form with the welded specimens illustrating a lower stress-strain relationship than the unwelded specimens. The 2:1 test in the unwelded condition have a slight strain reversal in the near failure zone and this is probably due to slight errors in POISSON's ratio values and its affect on calculation of the initial strain However, this does not change the stress-state very much. This can be observed if one plots & /c1 versus 0, 102 plot illustrates the relative insensitivity of strain state to stress-state in this 2:1 zone. In addition the affects of early plastic yielding in the minimum stress direction was observed in the 2:1 weldment tests (see Figure 10, 11 and 12). This condition complicated the 2:1 biaxial testing techniques since a basic elastic condition did not exist in the minimum stress direction. Therefore, in light of this condition it was recommended by LTV and approved by SWR that the basic load ratio required to obtain initial strain states (2:1 stress state) be maintained all the way to failure. approach certainly approximates the desired stress state very closely and allowed the welded material to strain as it would under actual pressure vessel (cylinder) conditions:

### CONCLUSIONS:

- 1. The tests results are presented in Figures 1 through 12
- 2. Use of the intersecting weldment conditions creates a very severe material condition that results in large reductions in material allowables under biaxial stress fields.
- 3. Unwelded material properties for the 1:1 stress state are about equal to what biaxial theory would predict.
- Unwelded material properties for the 2:1 stress state are a little lower for two tests than theory would predict and about equal to theory for one test.
- Poisson ratio values from uniaxial tests seem a little low (usually in the 0.30 to 0.33 range for this alloy). Likewise uniaxial modulus values in the welded condition also seem a little low. The values are very critical in developing biaxial data whether in the cross-shaped specimen or in tubular specimens.
- 6. The following page summarizes the basic equational forms used in this effort.

### BASIC EQUATIONS

### FOR 1:1 STRESS STATE:

$$e_{1} = \frac{1}{E_{1}} \quad (\sigma_{1} - \nu_{1}\sigma_{2})$$

$$e_{2} = \frac{1}{E_{2}} \quad (\sigma_{2} - \nu_{2}\sigma_{1})$$

$$\vdots \quad e_{1} = \frac{\sigma_{1}}{E_{1}} \quad (1 - \nu_{1})$$

$$e_{2} = \frac{\sigma_{2}}{E_{2}} \quad (1 - \nu_{2})$$

$$so: \sigma_{1} = \frac{e_{1} E_{1}}{1 - \nu_{1}}$$

$$\sigma_{2} = \frac{e_{2} E_{2}}{1 - \nu_{2}}$$

### N1 = POISSON's Ratio

BUT:  $\sigma_1 = \sigma_2$ 

Developed by load in the (one) direction.

### FOR 2:1 STRESS STATE:

$$e_{1} = \frac{1}{E_{1}} \qquad (\sigma_{1} - \mathcal{N}_{1} \sigma_{2})$$

$$e_{2} = \frac{1}{E_{2}} \qquad (\sigma_{2} - \mathcal{N}_{2} \sigma_{1})$$

$$\vdots \quad e_{1} = \frac{\sigma_{1}}{E_{1}} \qquad (1 - 0.5 \mathcal{N}_{1})$$

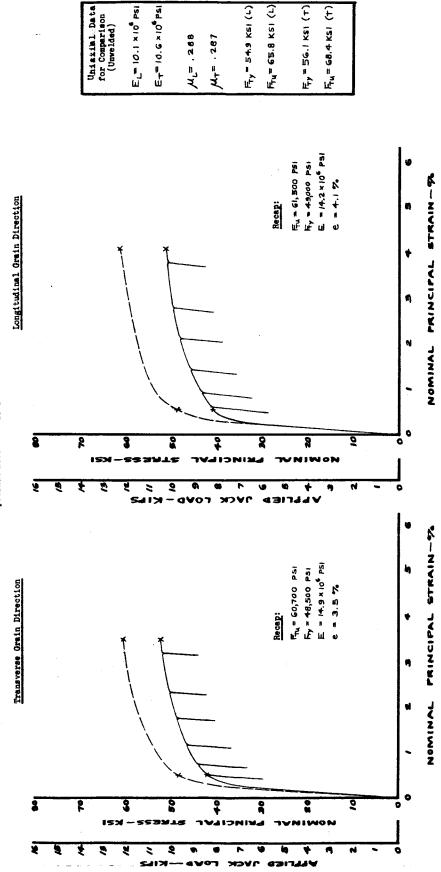
$$e_{2} = \frac{\sigma_{2}}{E_{2}} \qquad (1 - 2 \mathcal{N}_{2})$$

$$\text{So:} \quad \sigma_{1} = \frac{e_{1}E_{1}}{1 - 0.5 \mathcal{N}_{1}}$$

$$\sigma_{2} = \frac{e_{2}E_{2}}{1 - 2 \mathcal{N}_{2}} \qquad \text{or also } \sigma_{1} = \frac{e_{2}E_{2}}{0.5} - \mathcal{N}_{2}$$

FIGURE 1 - 1:1 ELAXIAL STRESS-STRAIM CURVES FOR UNWELDED 2219-T87 ALMINIM ALLOY

Test Temperature: Room Temperature Specimen No.: TC-1



---- G- E CURVE

FIGURE 2 - 1:1 BIAXIAL STRESS-STRAIN CURVES FOR UNWELDED 2219-T87 ALMINUM ALLOY

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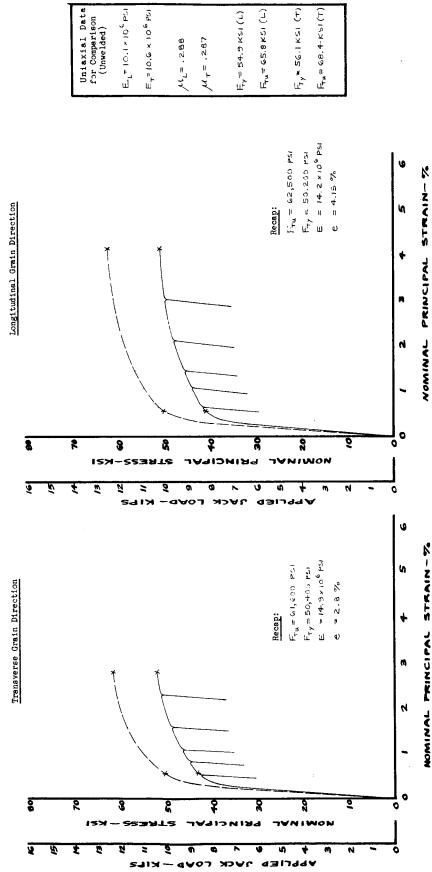
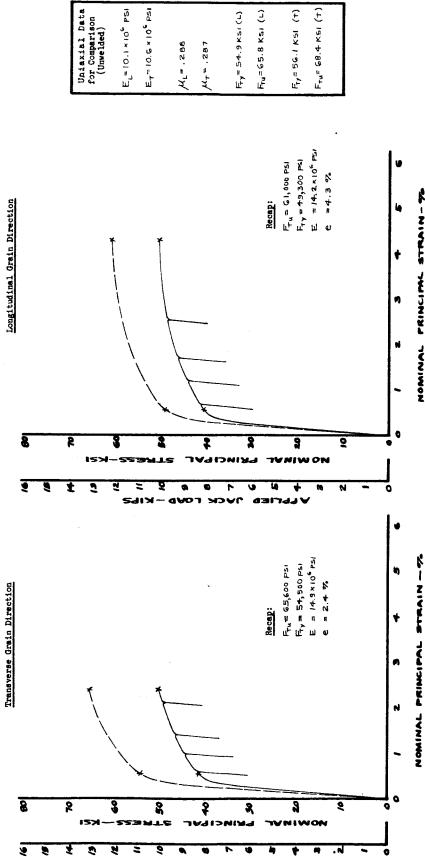


FIGURE 3 - 1:1 BIAXIAL STRESS-STRAIN CURVES FOR UNWELDED 2219-T87 ALMINUM ALLOY

Test Temperature: Room Temperature Specimen No.: TC-3

Longitudinal Grain Direction ٤



- P-e curve ---- G-E CURVE

NOMINAL PRINCIPAL STRAIN-95

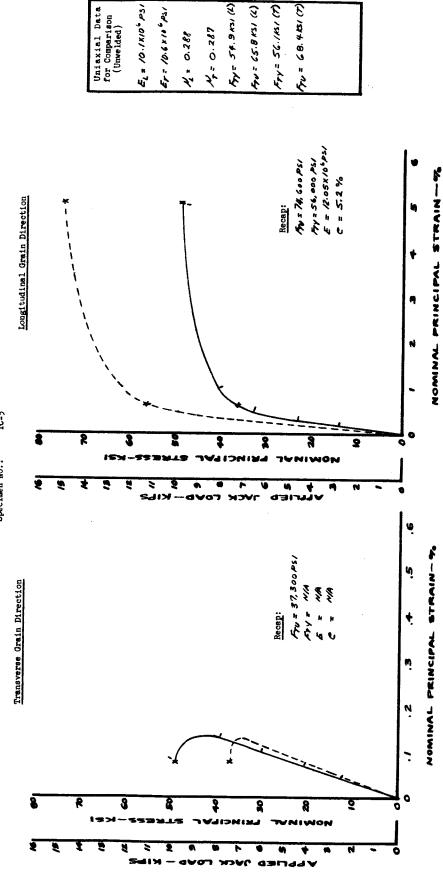
FIGURE 4 - 2:1 BIAXIAL STRESS-STRAIN CURVES FOR UNWELDED 2219-T87 ALMINUM ALLOY

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Fy= 56.1451 (7) FU= 68.4KS1(7) Fy= 54.9 KSI(1) Fru= 65.8 KS1 (4) Uniaxial Data for Comparison (Unwelded) EF= 10.6 x 10 " PSI E = 10.1 x 10 6 131 N= 0.288 1. 0.287 Fy= 55,000 Ps/ E = 12.05×10 Ps/ E = 5.3% Fr. = 69,700 PS1 NOMINAL PRINCIPAL STRAIN- % Longitudinal Grain Direction Test Temperature: Room Temperature Specimen No.: TC-4 15 à NOMINAL PRINCIPAL STRAIN-% Fr = 35,000 Transverse Grain Direction # % " " " U Fry = N/A Recap: 8 \$

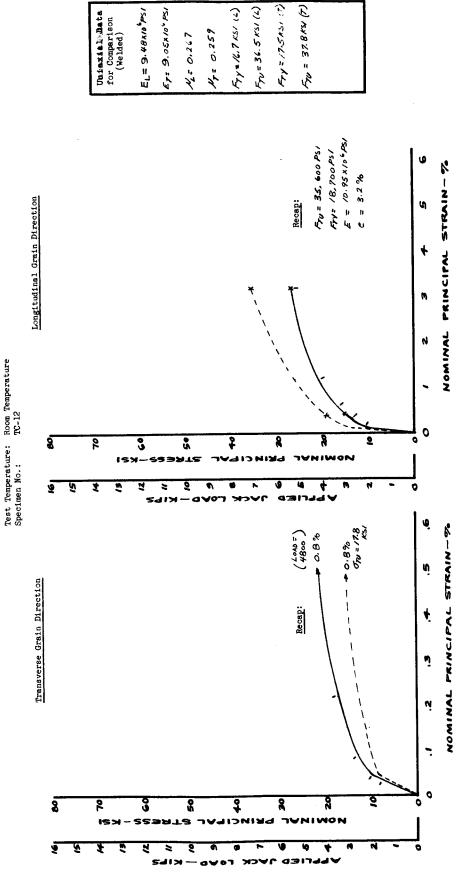
FIGURE 5 - 2:1 BIAXIAL STRESS-STRAIN CURVES FOR UNWELDED 2219-T07 ALLORINUM ALLOY

Test Temperature: Room Temperature Specimen No.: TC-5



---- G. CURVE

FIGURE 12 - 2:1 BIAXIAL STRESS-STRAIN CURVES FOR WELDED 2219-T87 ALAMINUM ALLOY



234

FIGURE 11 - 2:1 BLAXIAL STRESS-STRAIN CURVES FOR WELDED 2219-T87 ALUMINUM ALLOY

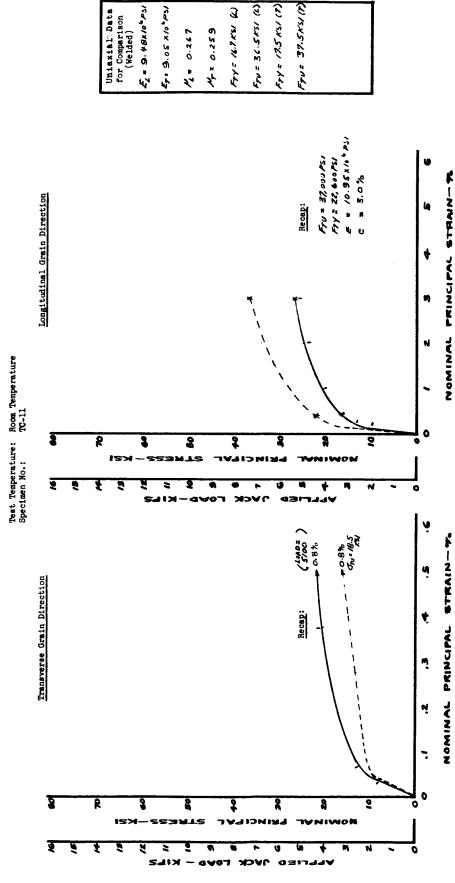


FIGURE 10 - 2:1 BLAXIAL STRESS-STRAIN CURVES FOR WELDED 2219-T87 ALMINUM ALLOY

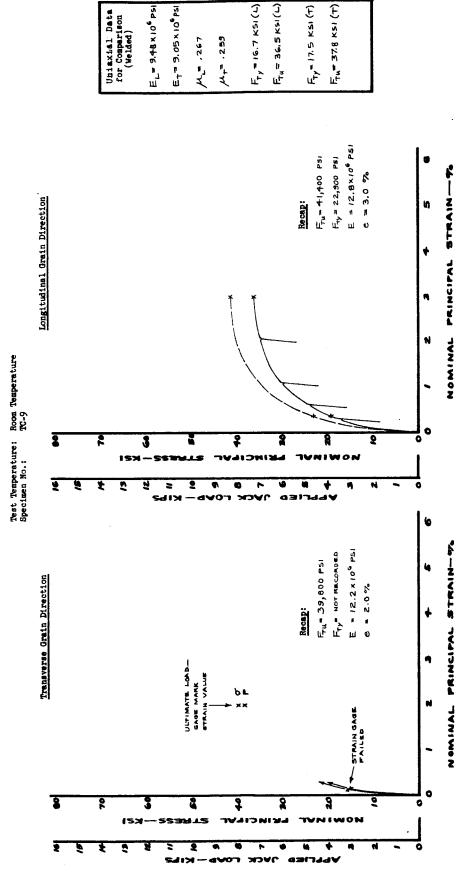
Unitedial Data for Comparison (Welded) FTU = 36.5 KS/ (L) Fry: 17.5 KS1 (7) Fru = 37.8KS1(7) Fy= 16.7 x51 (2) Er= 9.05×10 PSI 154, 01.48x10 = 73 H= 0.259 N= 0.267 = 10.9×10 6 PS1 Fru = 39,700 PS1 Fry = 24,800 PS1 = 3,75% Recap: Longitudinal Grain Direction Test Temperature: Room Temperature Specimen No.: TC-10 8 30 9 ×20% (\$33%) %5.0% 9= /9:8 72 xs. ġ Transverse Grain Direction Recap: 2 5 ŧ

NOMINAL PRINCIPAL STRAIN- %

NOMINAL PRINCIPAL STRAIN-70

---- G- e curve

FIGURE 9 - 1:1 BIAXIAL STRESS-STRAIN CURVES FOR WELDED 2219-T67 ALLARINUM ALLOY

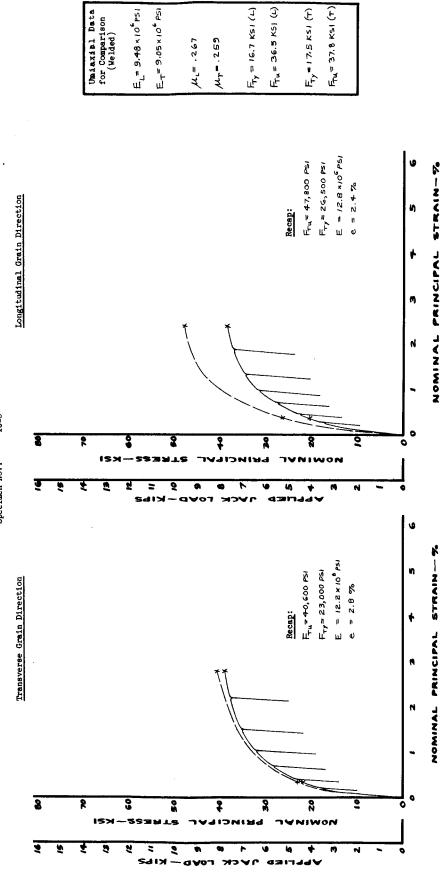


----- G- & CURVE

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FIGURE 8 - 1:1 BLAXIAL STRESS-STRAIN CURVES FOR WELDED 2219-T87 ALMINUM ALLOY

Test Temperature: Room Temperature Specimen No.: TC-3



---- G-e CURVE

FIGURE 7 - 1:1 BIAXIAL STRESS-STRAIN CURVES FOR WELDED 2219-187 ALUMINUM ALLOY

Uniaxial Data for Comparison (Welded) E = 9.48 × 10 PSI ET= 9.05 x 106 PSI Fr = 36.5 KS! (L) Fy= 17.5 KSI (T) FL = 37.8 KSI (T) F,-16.7KS1 (L) ML= .267 MT= .259 E = 12,9 × 10 PSI F, = 21,400 PSI Ft. = 40,300 PSI NOMINAL PRINCIPAL STRAIN-9 Longitudinal Grain Direction Recap: Test Temperature: Room Temperature Specimen No.: TC-7 6 3 8 20 \$ যূ 13 NOMINAL PRINCIPAL STRAIN-P. E = 12.2 x 10 PSI Fru = 38, 200 PS+ Fry = 19,600 PSI Transverse Grain Direction = 1.8 % Recap: 3 3 Ī 20 10

---- G-e curva

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Uniaxial Data for Comparison (Unwelded) Fy = 549 KS1 (2) Fr = 68.4 KSI (7) Fn = 65.8Ks1 (2) FTY = 56.1 MSI(T) E1 = 10.1 x 10 6 PSI Er = 10.6×10 "PSI N = 0.188 N= 0.287 FTY = 52,000 PS/ E = 12.1x10 6.PS FTU = 69, 100 PS1 NOMINAL PRINCIPAL STRAIN-5 c = 48% Longitudinal Grain Direction Recap: FIGURE 6 - 2:1 BLAXIAL STRESS-STRAIN CURVES FOR UNWELDED 2219-T87 ALLMINUM ALLOY Test Temperature: Room Temperature Specimen No.: TC-6 2 3 8 ų NOMINAL PRINCIPAL STRAIN - % FTU= 34600 PS1 Transverse Grain Direction \$ % Recap: M Ņ • 8 8 3 १ 20 8 1 8 6 7

---- G-G CURVE

### APPENDIX I

PHASE II TENSILE AND HYDRAULIC BULGE TEST DATA (CONTRACT NAS8-20160)

### PHASE II TENSILE AND HYDRAULIC BULGE TEST DATA (CONTRACT NAS8-20160)

The results of the individual uniaxial tensile tests and hydraulic bulge tests conducted in the evaluation of the mechanical properties of aluminum alloy weldments (Phase II Contract NAS8-20160) are presented in Tables I-1 through I-9. The computed mean value, standard deviation and lower tolerance limit for each property are also included in the tables. These computations were carried out on a GE-225 digital computer in accordance with the procedures described in Appendix K. Tables I-1 through I-9 are reproduced from the computer print-out sheets and the letter symbols appearing in the tables are as follows:

Y 0.2% Offset Yield Strength, ksi

\$YBAR Average Value of Yield Strength, ksi

\$SY Standard Deviation of Yield Strength, ksi

\$LTLY Lower Tolerance Limit of Yield Strength, ksi

U Ultimate Tensile Strength, ksi

\$UBAR Average Value of Ultimate Strength, ksi

\$SU Standard Deviation of Ultimate Strength, ksi

\$LTLU Lower Tolerance Limit of Ultimate Strength, ksi

E Elongation in Two Inches, %

 $\pm$ EBAR Average Value of Elongation, %

\$SE Standard Deviation of Elongation, %

The floating decimal point system was used in the computations and all values in the tables are given in powers of ten. For example:

5.2500000 + 01 = 52.500000

7.0454965 - 01 = 0.70454965

The specimen identification is contained in the first column. The last digit of this number is a tensile specimen sequence number. The remaining digits are the bulge panel sequence number.

### UNIAXIAL TENSILE TEST RESULTS ON PARENT ALUMINUM ALLOYS

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81 6.500000+01 6.990000+01 1.01000 82 6.4700000+01 7.030000+01 8.00000 84 6.4500000+01 6.9200000+01 9.20000 95 6.4700000+01 6.9800000+01 1.07000 96 6.5200000+01 7.000000+01 1.07000 97 6.4700000+01 7.000000+01 1.07000 98 6.5200000+01 7.000000+01 9.40000 103 6.4700000+01 7.000000+01 9.40000 104 6.5200000+01 7.000000+01 9.40000 105 6.5200000+01 7.000000+01 9.40000 106 6.5200000+01 7.000000+01 9.40000 107 6.4900000+01 7.000000+01 9.50000 108 6.4700000+01 7.000000+01 9.50000 109 6.490000+01 7.000000+01 9.50000 100 6.490000+01 7.000000+01 1.05000 22 5.730000+01 6.4600000+01 1.05000 23 5.730000+01 6.4600000+01 1.05000 24 5.800000+01 6.4600000+01 1.05000 25 7.700000+01 6.4600000+01 1.05000 27 5.700000+01 6.4600000+01 1.05000 28 5.700000+01 6.460000+01 1.06000 29 5.700000+01 6.4600000+01 1.06000 20 5.700000+01 6.4600000+01 1.06000 20 5.700000+01 6.4600000+01 1.06000 21 5.700000+01 6.4600000+01 1.06000 22 5.700000+01 6.4600000+01 1.06000 23 5.700000+01 6.4600000+01 1.06000 24 5.700000+01 6.4600000+01 1.06000 25 5.700000+01 6.5600000+01 1.06000 26 5.700000+01 6.5600000+01 1.06000 27 6.70000+01 6.4600000+01 1.06000 28 5.700000+01 6.4600000+01 1.06000 29 5.700000+01 6.4600000+01 1.06000 20 5.700000+01 1.0000	EL 2014-16	ARENT MET		
82 6.470000401 7.630000401 9.00000000000000000000000000000000000	10	6.5000000+0	0+60000066*	.0100000+0
84 6.92000000000000000000000000000000000000		.4700000+0	0300000+0	0+00000000
## 6.4500000+01 6.9200000+01 9.200000  ## 6.4600000+01 7.000000+01 1.07000  ## 6.4600000+01 6.960000+01 1.07000  ## 6.4700000+01 6.960000+01 1.07000  ## 6.5200000+01 7.060000+01 1.07000  ## 6.5200000+01 7.060000+01 1.07000  ## 6.5000000+01 7.000000+01 1.07000  ## 6.5000000+01 7.000000+01 1.07000  ## 6.4700000+01 7.000000+01 1.07000  ## 6.4700000+01 7.000000+01 9.70000  ## 6.4700000+01 7.000000+01 9.70000  ## 6.4700000+01 7.000000+01 9.70000  ## 6.4700000+01 7.000000+01 9.70000  ## 6.4700000+01 7.000000+01 9.70000  ## 6.4700000+01 7.000000+01 9.70000  ## 6.4700000+01 6.440000+01 1.07000  ## 6.4700000+01 6.440000+01 1.07000  ## 6.470000+01 6.440000+01 1.04000  ## 6.4700000+01 6.440000+01 1.04000  ## 6.470000+01 6.440000+01 1.04000  ## 6.470000+01 6.440000+01 1.04000  ## 6.470000+01 6.440000+01 1.04000  ## 6.470000+01 6.440000+01 1.04000  ## 6.470000+01 6.440000+01 1.07000  ## 6.470000+01 6.440000+01 1.04000  ## 6.470000+01 6.440000+01 1.04000  ## 6.470000+01 6.440000+01 1.04000  ## 6.470000+01 6.440000+01 1.04000  ## 6.470000+01 6.440000+01 1.04000  ## 6.470000+01 6.440000+01 1.04000  ## 6.470000+01 6.440000+01 1.04000  ## 6.470000+01 6.440000+01 1.04000  ## 6.470000+01 6.440000+01 1.04000  ## 6.470000+01 6.440000+01 1.04000  ## 6.470000+01 1.04000  ## 6.470000+01 6.440000+01 1.04000  ## 6.470000+01 6.440000+01 1.04000  ## 6.470000+01 6.440000+01 1.04000  ## 6.470000+01 6.440000+01 1.04000  ## 6.470000+01 6.440000+01 1.04000  ## 6.470000+01 6.440000+01 1.04000  ## 6.470000+01 6.440000+01 1.04000  ## 6.470000+01 1.04000  ## 6.470000+01 6.440000+01 1.04000  ## 6.470000+01 6.440000+01 1.04000  ## 6.470000+01 6.440000+01 1.04000  ## 6.470000+01 6.440000+01 1.04000  ## 6.470000+01 6.440000+01 1.04000  ## 6.470000+01 6.440000+01 1.04000  ## 6.470000+01 6.440000+01 1.04000  ## 6.470000+01 6.440000+01 1.04000  ## 6.470000+01 6.440000+01 1.04000  ## 6.470000+01 6.440000+01 1.04000  ## 6.470000+01 6.440000+01 1.04000  ## 6.4700000+01 6.440000+01 1.04000  ## 6.470000+01 6.440000+01 1.04000  ## 6.470000+01 6.440000+01 1.0400		.9200000+0	4400000+0	0+0000008
95 6.6100000000000000000000000000000000000		.4500000+0	.9200000+0	.2000000+0
91 6.480 000 00 00 00 00 00 00 00 00 00 00 00		.6100000*0	100000000	.4000000+0
92 6.47000000000000000000000000000000000000		.480000040	0200000	0100000
95 6.4600000000000000000000000000000000000		4700000+0	0+00000000	0+00000000
94 6.000000401 7.000000401 9.40000 10 6.500000401 7.000000401 8.60000 102 6.500000401 7.000000401 9.50000 103 6.4700000401 7.000000401 9.50000 6.450000401 7.000000401 9.50000 6.450000401 7.1700000401 9.50000 104 6.450000401 7.1700000401 9.50000 104 1.899109400 \$SV 5.4954100401 \$1 104 1.899109400 \$SV 5.495410401 \$1 104 1.899109400 \$SV 5.495410401 \$1 104 1.8991000401 \$SE 1.00000401 \$1 105000 \$SV 5.495000401 \$1 105000 \$SV 5.4950000401 \$1 105000 \$1		4600000+0	0+0000096	4000000+0
95 6.5200000401 7.060000401 H.9900001 102 6.500000401 7.0600000401 9.800001 103 6.4700000401 7.0000000401 9.800001 104 6.490000401 7.0000000401 9.8000001 105 6.6300000401 7.000000401 9.8000001 20 8.6300000401 7.0700000401 9.800000401 1.08000000000000000000000000000000000		0.0000000	.9400000+0	0+00000008
101 6.510000401 7.040000401 9.500000 102 6.500000401 7.000000401 9.500000 103 6.490000401 7.000000401 9.500000001 104 6.490000401 7.0100006401 9.500000000000001 8.45841004001 1.01000000000000000000000000000		.5200000+0	04000000	0+0000006
102 6.500000001 7.000000011 9.800001 103 6.470000001 7.000000011 9.800001 104 6.4900000001 7.000000001 9.80000 104 6.4900000001 7.000000001 9.00000 104 6.490000001 1.00000 10 854 6.60056400 10 8744 1.2997070400 10 850 6.600543101 1.15000 10 8745	0	.5100000+0	0400000+0	.600000nd.
103 6.4700000001 7.000000001 9.500001 104 6.450000001 7.0100000001 9.500001 105 6.630000001 7.170000001 9.000001 8.4500000001 8.189109000 8.50 6.6005831+01 8.  3066666+00 8EBAH 5.4963257-01 85E 2 5.7300000001 6.4600000001 1.15000 2 5.7300000001 6.4600000001 1.05000 2 5.7300000001 6.4400000001 1.05000 2 5.7300000001 6.44000000001 1.05000 3 5.7300000001 6.4400000001 1.08000 3 5.8100000001 6.4400000001 1.08000 3 5.8100000001 6.4600000001 1.08000 3 5.8100000001 6.5600000001 1.08000 3 5.770000001 6.5600000001 1.08000 3 5.770000001 6.5600000001 1.08000 5 5.770000001 6.500000001 1.08000 5 5.770000001 6.500000001 1.08000 5 5 770000001 6.500000001 1.08000 5 5 7700000001 6.500000001 1.08000 5 5 7700000001 6.5000000001 1.08000 5 5 7700000001 6.5000000001 1.08000 5 5 7700000001 1.08000000000000000000000000000	ō	.500000040	0+0000000.	0+00000068
104 6.490000401 7.0100006401 9.270000 105 6.6500000401 7.1700000401 9.0000 306666400 \$EBAN 1.2597070400 \$SV 5.6500531+01 \$1 004000+01 \$VHNH 1.2597070400 \$SV 5.65000531+01 \$1 22 5.730000401 6.4600000401 1.15000 23 5.730000401 6.4600000401 1.15000 24 5.730000401 6.4600000401 1.25000 25 5.7400000401 6.4600000401 1.2000 25 5.7400000401 6.4600000401 1.2000 25 5.7400000401 6.4600000401 1.2000 25 5.740000401 6.4600000401 1.2000 25 5.740000401 6.4600000401 1.2000 25 5.740000401 6.4600000401 1.24000 25 5.750000401 6.4600000401 1.04000 25 5.750000401 6.4600000401 1.04000 25 5.750000401 6.4600000401 1.04000 25 5.750000401 6.4600000401 1.00000 25 5.750000401 6.4600000401 1.00000 25 5.750000401 6.4600000401 1.00000 25 5.750000401 1.04000 25 5.750000401 1.04000 25 5.7500000401 1.00000	0	.4700000+0	0+0000000.	. \$0000000+0
105 6,6500000+01 7,1700000+01 9,000000 4986666401 3YHAN 1.8189109+00 SSY 5,8584100001 18 306666400 SEBAN 1.8189109+00 SSU 6,6005810-01 18 20 5,7300000-01 6,4600000+01 1,15000 20 5,7300000-01 6,4600000+01 1,00000 20 5,7300000-01 6,4600000+01 1,00000 20 5,7300000-01 6,4600000+01 1,00000 20 5,7400000-01 6,4600000+01 1,20000 20 5,7400000-01 6,4600000+01 1,20000 20 5,7400000-01 6,5600000+01 1,20000 20 5,7400000-01 6,500000+01 1,20000 20 5,7400000-01 6,4800000+01 1,04000 20 5,7500000+01 6,500000+01 1,04000 20 5,7500000+01 6,500000+01 1,04000 20 5,7500000+01 6,500000+01 1,00000 20 5,7500000+01 6,500000+01 1,04000 20 5,750000+01 6,500000+01 1,04000 20 5,750000+01 6,500000+01 1,00000 20 5,750000+01 6,500000+01 1,00000	0	.4900099+0	.0100000.	.2n00000n5.
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0440000+01 \$UBAR 1.2997070+00 \$SU 6.60U5H31+01 & 1066666+00 \$EBAR 5.4963257-01 \$SE	.4986664+0	YHAH 1.818910	+00 \$SY 5.858	100+01
306666+00 \$EBAR 5,4963257-01 \$SE L 7106-763 PARENT METGE 2 5,7300000+01 6,4600000+01 1,15000 22 5,730000+01 6,4600000+01 1,04000 23 5,7400000+01 6,4600000+01 1,15000 24 5,7400000+01 6,4600000+01 1,15000 35 5,8100000+01 6,5600000+01 1,15000 35 5,8100000+01 6,5600000+01 1,04000 35 5,7400000+01 6,5600000+01 1,04000 35 5,7400000+01 6,5600000+01 1,04000 35 5,7400000+01 6,5600000+01 1,04000 35 5,7500000+01 6,500000+01 1,04000 57 5,7500000+01 6,500000+01 1,04000 57 5,7500000+01 6,500000+01 1,04000 57 5,7500000+01 6,500000+01 1,04000 57 5,7500000+01 6,500000+01 1,04000 57 5,7500000+01 6,500000+01 1,04000 57 5,7500000+01 6,500000+01 1,04000 57 5,7500000+01 6,500000+01 1,09000	.0440000+0	UHAH 1.259707	+00 \$SU 6.60U	831+01 \$LTU
106666+00 %EBAR NETAL 6.4600000+01 1.15000 2.2 5.7300000+01 6.4600000+01 1.15000 2.2 5.7300000+01 6.4600000+01 1.15000 2.3 5.7300000+01 6.4600000+01 1.15000 2.3 5.7400000+01 6.4600000+01 1.15000 2.3 5.7400000+01 6.4600000+01 1.15000 3.3 5.810000+01 6.5600000+01 1.04000 3.3 5.8100000+01 6.5600000+01 1.04000 3.3 5.7700000+01 6.5600000+01 1.04000 2.5 5.7700000+01 6.4900000+01 1.04000 5.5 5.7700000+01 6.4900000+01 1.04000 5.5 5.7700000+01 6.4900000+01 1.04000 5.5 5.770000+01 6.4900000+01 1.04000 5.5 5.770000+01 6.4900000+01 1.04000 5.5 5.770000+01 6.4900000+01 1.04000 5.5 5.770000+01 6.4900000+01 1.04000 5.5 5.770000+01 6.4800000+01 1.00000 5.5 5.770000+01 1.04000 5.5 5.770000+01 1.04000 5.5 5.770000+01 1.04000 5.5 5.770000+01 1.04000 5.5 5.770000+01 1.04000 5.5 5.770000+01 1.04000 5.5 5.770000+01 1.04000 5.5 5.770000+01 1.04000 5.5 5.770000+01 1.04000 5.5 5.770000+01 1.04000 5.5 5.7700000+01 1.04000 5.5 5.7700000+01 1.04000 5.5 5.770000+01 1.04000 5.5 5.770000+01 1.04000 5.5 5.7700000+01 1.04000 5.5 5.770000+01 1.04000 5.5 5.77000000+01 1.04000 5.5 5.77000000+01 1.04000 5.5 5.77000000+01 1.04000 5.5 5.770000000+01 1.04000 5.5 5.77000000+01 1.04000 5.5 5.770000000+01 1.04000 5.5 5.770000000+01 1.04000 5.5 5.770000000000000000000000000000				
21 5.7300000-01 6.460000+01 1.15000 22 5.7300000-01 6.460000+01 1.04000 23 5.730000-01 6.4600000+01 1.04000 24 5.7400000-01 6.460000+01 1.05000 25 5.7400000-01 6.4600000+01 1.15000 31 5.830000-01 6.4600000+01 1.15000 32 5.8100000-01 6.560000+01 1.08000 33 5.8100000-01 6.560000+01 1.08000 34 5.7700000-01 6.4800000+01 1.08000 55 5.700000-01 6.4800000+01 1.15000 57 5.700000-01 6.4800000+01 1.15000 57 5.700000-01 6.4800000+01 1.08000 57 5.700000-01 6.4800000+01 1.08000 57 5.700000-01 6.4800000+01 1.08000 57 5.700000-01 6.4800000+01 1.08000 57 5.700000-01 6.4800000+01 1.08000 57 5.770000-01 6.4800000+01 1.08000 57 5.770000-01 6.4800000+01 1.08000 57 5.770000-01 1.08000	306666+0	ENAR 2.49632	1	
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23 5.7500000461 6.4400000461 1.05000 24 5.690000461 6.440000461 1.05000 25 5.740000461 6.480000461 1.12000 31 5.8400000461 6.560000461 1.12000 33 5.8100000461 6.560000461 1.12000 34 5.770000461 6.560000461 1.04000 35 5.7700000461 6.560000461 1.04000 51 5.700000461 6.4800000461 1.08000 52 5.760000461 6.4800000461 1.08000 53 5.750000461 6.480000461 1.08000 54 5.750000461 6.4800000461 1.08000 55 5.750000461 6.4800000461 1.08000		1.000000.	.40000040	0+0000041.
23 5.7200000001 6.4600000001 1.05000 24 5.7400000001 6.4400000001 1.12000 31 5.8100000001 6.5600000001 1.12000 33 5.8100000001 6.5600000001 1.08000 34 5.7700000001 6.5600000001 1.08000 35 5.7800000001 6.5600000001 1.08000 55 5.7800000001 6.4800000001 1.08000 57 5.7800000001 6.4800000001 1.08000 58 5.780000001 6.4800000001 1.08000 59 5.780000001 6.4800000001 1.08000		./300000+0	.4400000+0	.0400900+
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25 5.7400000401 6.4800000401 1.12000 3.1 5.820000401 6.5800000401 1.12000 3.3 5.8100000401 6.560000401 1.104000 3.4 5.700000401 6.500000401 1.04000 5.1 5.700000401 6.500000401 1.04000 5.1 5.700000401 6.4900000401 1.08000 5.2 5.700000401 6.4900000401 1.04000 5.3 5.700000401 6.5900000401 1.04000 5.4 5.7500000401 6.5900000401 1.04000		0+0000060	. 4400000+0	.1200000+0
31 5.8300000401 6.58010009401 1.13000 32 5.8100000401 6.56000009401 1.04000 33 5.8100000401 6.56000009401 1.04000 34 5.7700000401 6.5100000401 1.04000 55 5.7800000401 6.4900001401 1.06000 57 5.760000401 6.4900001401 1.06000 55 5.790000401 6.4900000401 1.04000 55 5.7500000401 6.3900000401 1.04000 55 5.7500000401 6.390000401 1.04000		.7400000+0	.4800000+	.1200000+0
32 5.8100000+01 6.560000+01 1.0A000 33 5.8100000+01 6.500000+01 1.04000 34 5.7700000+01 6.5100000+01 1.08000 51 5.780000+01 6.4800000+01 1.08000 52 5.7800000+01 6.4800000+01 1.13000 52 5.7800000+01 6.4900000+01 1.0A000 54 5.7500000+01 6.390000+01 1.04000 55 5.7700000+01 6.390000+01 1.04000		.8300000+0	•28000000+0	.1300009+0
33 5.810000401 6.560000001 1.04000 34 5.7700000401 6.500000001 1.0000 35 5.7700000401 6.4800000401 1.08000 51 5.7800000401 6.4900000401 1.13000 52 5.780000401 6.4900000401 1.08000 54 5.7500000401 6.3900000401 1.04000		• 810000 t8•	.56000000+0	* 0 × 0 0 0 0 0 + 0
34 5.7700000+01 6.5100000+01 1.0000 55 5.7800000+01 6.4900000+01 1.00000 57 5.7800000+01 6.490000+01 1.3000 57 5.700000+01 6.490000+01 1.0F000 54 5.7500000+01 6.390000+01 1.04000 55 5.7700000+01 6.390000+01 1.09000		.810000018.	.56000000	.0400000
35 5.770000401 6.480000401 1.08000 51 5.780000401 6.4900000401 1.13000 53 5.790000401 6.490000101 1.0800 54 5.790000401 6.590000401 1.04000 55 5.770000401 6.590000401 1.03000		.7700000+0	.5100000+0	0+00000000
51 5,780040461 6,49040461 1,13040 55 5,794040461 6,4904040461 1,07004 54 5,79404611 6,5404040461 1,07004 54 5,750040461 6,3904401 1,07040 55 5,77040461 6,480040441 1,07044		.770000040	.4800000+0	.00000000
52 5.760000461 6.490000401 1.0A000 54 5.7500000461 6.5900000401 1.04000 55 5.7700000401 6.4800006401 1.04000		. /80000087	.490000+0	0+0000001.
54 5.7500000401 6.3900000401 1.04000 55 5.7700000401 6.390000401 1.09000 55 5.7700000401 6.4800000401 1.0200		.7600000+0	.4900000+0	.0800000+0
54 5.7500000+01 6.3900000+01 1.04000 55 5.7700000+01 6.4800000+01 1.02000		0+0000067	.5400000+0	.0406930+
55 5.770000+41 6.4800000+01 1.07000		.7500000+0	.39000006.	0+0000000.
THE CONTRACTOR OF SECTION OF SECTIONS	2 4 4 4 4 7 7 1		10+000000	1.0200
THE PROPERTY OF THE PROPERTY O		70000	C 7 1 1 20 7	1 17

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### UNIAXIAL TENSILE TEST RESULTS ON HEAT TREATED PARENT ALUMINUM ALLOYS

TABLE I-3.

UNIAXIAL TENSILE TEST RESULTS ON 2219-T87 AND X7106-T63 ALUMINUM ALLOY WELDMENTS

23 3.11000000001 3.9500000001 1.0000000000000000000000000000	21 3.6400000e01 3.9900000e01 1.00000000000000000000000000000	2219-187	TIG 2319 SING		
22 3.0100000401 1.1000000401 1.1000000000000	23 3.1100000e01 3.990000e01 1.1000000e00	21	3.0400000	.9700000+	.0000000.
23 3.1100000.01 3.9800000.01 1.1000000000000000000000000000	23 3.1100000001 3.920000001 1.10000000000000000000000000000	22	3.01000000	.05000004	.10000001.
24 2.9800000401 3,9200000401 1.10000000000000000000000000000	24 2.9500000401 4.4900000401 1.300000000 31 2.9300000401 4.4900000401 2.300000040 32 2.6700000401 4.4900000401 2.500000040 33 2.700000401 4.300000401 2.500000040 42 3.300000401 4.300000401 1.90000040 43 3.900000401 4.300000401 1.90000040 44 3.1400000401 4.200000401 1.90000040 45 3.150000401 4.200000401 1.90000040 45 3.150000401 4.200000401 1.90000040 55 3.190000401 4.200000401 1.90000040 55 3.190000401 4.200000401 1.90000040 56 2.900000401 4.120000401 1.90000040 57 2.900000401 4.200000401 1.90000040 58 3.190000401 4.200000401 1.90000040 59 3.190000401 4.200000401 1.90000040 50 2.900000401 4.200000401 1.90000040 50 2.900000401 4.200000401 1.90000040 51 2.800000401 4.200000401 1.90000040 52 2.900000401 4.200000401 1.90000040 53 3.600000401 4.200000401 1.90000040 54 2.900000401 4.200000401 1.90000040 55 3.800000401 4.200000401 2.000000040 56 2.900000401 4.200000401 2.000000040 57 2.900000401 4.200000401 2.000000040 58 2.900000401 4.200000401 2.00000040 59 2.900000401 4.200000401 2.00000040040 50 2.900000401 4.300000401 2.000000040 50 2.900000401 4.300000401 2.0000004040 51 2.8000000401 4.300000401 2.0000004040 52 2.900000401 4.300000401 2.0000004040401 53 2.900000401 4.300000401 2.000004040401 54 2.900000401 4.300000401 2.000004040401 55 2.900000401 4.300000401 2.000004040401 56 2.900000401 4.300000401 2.000004040401 57 2.900000401 4.300000401 2.000004040401 58 2.90000040401 4.300000401 2.000004040401 59 2.900000404 4.300000401 2.000004040401 50 2.900000401 4.300000401 2.000004040401 50 2.900000401 4.300000401 2.000004040401 50 2.900000401 4.300000401 2.000004040401 50 2.900000401 4.300000401 2.000004040401 50 2.900000404 4.300000401 2.000004040401 50 2.900000404 4.300000401 2.000004040401 50 2.900000404 4.300000401 2.000004040401 50 2.900000404 4.300000401 2.000004040401 50 2.900000404 4.300000401 2.000004040401 50 2.900000404 4.300000401 2.000004040401 50 2.900000404 4.300000401 2.00004040401 50 2.900000404 4.300000401 2.00000404040404040404040404040404040404	23	3.11000000	.9800000+	.4000000+0
25 2.8700004011 3,8700004011 1.3000000000000000000000000000000000	25 2.4700000401 4,400000401 1,300000004 33 2.7300000401 4,4000000401 2.500000040 34 2.730000401 4,500000401 2.500000040 35 2.650000401 4,500000401 2.500000040 42 3.450000401 4,200000401 1,90000040 43 3.090000401 4,100000401 1,90000040 44 3.140000401 4,100000401 1,90000040 45 3.1500000401 4,100000401 1,90000040 45 3.1500000401 4,100000401 1,900000040 45 3.1500000401 4,100000401 1,900000040 45 3.1500000401 4,100000401 1,900000040 45 3.1500000401 4,100000401 1,900000040 45 3.090000401 4,100000401 1,900000040 45 3.090000401 4,100000401 1,900000040 45 3.090000401 4,100000401 1,900000040 46 2.900000401 4,100000401 1,00000040 47 2.800000401 4,100000401 1,200000040 48 2.900000401 4,100000401 1,200000040 49 2.900000401 4,100000401 1,200000040 40 2.900000401 4,100000401 1,200000040 40 2.900000401 4,10000401 1,20000040040 40 2.900000401 4,10000401 1,20000040401 41 2.9000000401 4,10000401 1,20000040401 41 2.9000000401 4,10000401 1,200004401 1,1000004401 41 2.9000000401 4,10000401 2,000004401 1,1000004401 41 2.9000000401 4,10000401 2,000004401 4,100004401 1,10000401 4,100000401 2,0000004401 4,100004401 1,100004401 4,1000004401 2,0000004401 4,100004401 1,100004401 4,1000004401 2,0000004401 4,100004401 1,100004401 4,1000004401 2,000004401 4,100004401 1,100004401 4,1000004401 2,000004401 1,10004401 1,10000440	24	2.98000000	.9200000+0	.1000000+0
31 2.9300000±01 4,4900000±01 2.30000000  32 2.7300000±01 4,300000±01 2.700000000  41 3.1600000±01 4,300000±01 1,90000000000000000000000000000000000	31 2.930000.0001 4,4000000.01 2.3000000000000000000000000000000000000	52	2.6700000+0	. 8700000*0	.3000000+0
32 2.6700000e01 4,4000000e01 2.5000000000000000000000000000000000000	32 2.670000be01 4.400000be01 2.5000000be01 33 2.7500000be01 4.3700000be01 2.7000000be01 4.3700000be01 2.7000000be01 4.3700000be01 2.7000000be01 4.3700000be01 1.6000000be01 4.3700000be01 1.6000000be01 4.3700000be01 1.6000000be01 4.3700000be01 1.600000be01 4.3700000be01 1.6000000be01 4.3700000be01 1.6000000be01 4.3700000be01 1.5000000be01 2.9500000be01 4.4000000be01 1.5000000be01 2.9500000be01 4.4000000be01 1.5000000be01 2.9500000be01 3.9100000be01 1.5000000be01 2.9500000be01 3.9100000be01 1.5000000be01 2.9500000be01 3.9100000be01 1.5000000be01 2.9500000be01 3.9600000be01 1.5000000be01 2.9500000be01 1.5000000be01 2.9500000be01 4.1300000be01 1.5000000be01 2.9500000be01 4.1300000be01 1.5000000be01 2.9600000be01 4.1300000be01 1.5000000be01 2.9600000be01 4.1300000be01 1.5000000be01 4.1300000be01 1.5000000be01 1.500000be01 1.500000b	31	2.9300000.	49000006+	.3000000+
33 2.7300000e01 4,300000e01 2,5000000000000000000000000000000000000	33 2.730000±01 4,300000±01 2,20000000000000000000000000000000000	32	2.6700000	.40000004.	.50000004
34 2.7100000e01 4.3700000e01 2.7000000 41 3.400000e01 4.2800000e01 1.90000000 42 3.300000e01 4.200000e01 1.90000000 43 3.400000e01 4.200000e01 1.90000000000000000000000000000000000	34 2.710000001 4.3700000001 2.7000000000000000000000000000000000000	33	2.73000000	.30000000.	.2000000+0
35 2 6300000+01 4,3500000+01 1,500000+01 42 3,3100000+01 4,3100000+01 1,5000000+01 43 3,100000+01 4,1000000+01 1,5000000+01 51 2,9500000+01 4,100000+01 1,90000000+01 52 3,000000+01 4,100000+01 1,9000000+01 53 3,100000+01 4,100000+01 1,3000000+01 54 3,100000+01 4,000000+01 1,3000000+01 55 3,100000+01 4,000000+01 1,3000000+01 56 3,000000+01 4,000000+01 1,5000000+01 57 3,000000+01 3,8900000+01 1,5000000+01 58 3,000000+01 3,8900000+01 1,5000000+01 59 3,000000+01 3,8900000+01 1,5000000+01 50 2,96000000+01 3,8900000+01 1,5000000+01 51 2,9600000+01 4,2900000+01 1,5000000+01 52 2,96000000+01 4,2900000+01 1,8000000+01 53 2,8600000+01 4,2900000+01 1,8000000+01 54 2,9000000+01 4,2900000+01 1,8000000+01 55 2,9000000+01 4,2900000+01 1,8000000+01 56 2,96000000+01 4,2900000+01 1,8000000+01 57 2,9000000+01 4,2900000+01 1,8000000+01 58 2,9000000+01 4,200000+01 1,8000000+01 59 2,000000+01 4,200000+01 2,0000000+01 59 2,000000+01 4,2000000+01 2,0000000+01 59 2,000000+01 4,200000+01 2,0000000+01 59 2,000000+01 4,3000000+01 2,0000000+01 59 2,000000+01 4,3000000+01 2,0000000+01 59 2,000000+01 4,3000000+01 2,0000000+01 59 2,000000+01 4,3000000+01 2,0000000+01 50 2,000000+01 4,3000000+01 2,00000000+01 50 2,000000+01 4,3000000+01 2,000000000+01 50 2,000000+01 4,3000000+01 2,00000000+01 50 2,000000+01 4,3000000+01 2,0000000+01 50 2,000000+01 4,3000000+01 3,0000000+01 50 2,000000+01 4,3000000+01 3,000000+01 50 2,000000+01 4,3000000+01 3,000000+01 50 2,000000+01 4,3000000+01 3,000000+01 50 2,000000+01 4,3000000+01 3,000000+01 50 2,000000+01 4,3000000+01 3,000000+01 50 2,000000+01 4,3000000+01 3,0000000+01 50 2,0000000+01 4,30000000+01 3,000000+01 50 2,0000000+01 4,30000000+01 3,000000+01 50 2,0000000+01 4,30000000+01 3,00000000000000000000000000000000000	35 2.630000+01 4,300000-01 1,6000000-04 3,3100000+01 4,31000000-01 1,6000000-04 3,3100000+01 4,31000000-01 1,6000000-04 3,3100000+01 4,31000000-01 1,6000000-04 3,1400000-01 4,2000000-01 1,90000000-01 2,9000000-01 2,90000000-01 2,90000000-01 2,90000000-01 2,90000000-01 2,90000000-01 2,9000000-01 2,9000000-01 2,9000000-01 2,90000000-01 2,9000	¥	2,71000000	.3700000+0	.7000000+0
41 3.160000+01 4.280000+01 1.900000+01 3.00000+01 4.200000+01 4.200000+01 1.900000+01 4.200000+01 1.9000000+01 3.000000+01 4.200000+01 1.9000000+01 3.000000+01 1.9000000+01 1.9000000+01 1.9000000+01 1.9000000+01 1.9000000+01 1.9000000+01 1.9000000+01 1.90000000+01 1.90000000000000000000000000000000000	41 3.1600000+01 4.200000+01 1.9000000+0 43 3.0900000+01 4.2000000+01 1.6000000+0 44 3.1400000+01 4.2000000+01 1.9000000+0 52 3.0900000+01 4.1900000+01 1.3000000+0 53 3.0900000+01 4.0000000+01 1.3000000+0 54 3.100000+01 4.0000000+01 1.3000000+0 55 3.0800000+01 4.0000000+01 1.2000000+0 56 2.9600000+01 3.9900000+01 1.2000000+0 64 2.9600000+01 3.990000+01 1.2000000+0 65 2.9600000+01 3.950000+01 1.2000000+0 65 2.9600000+01 3.950000+01 1.2000000+0 65 2.9600000+01 4.200000+01 1.2000000+0 65 2.9600000+01 4.200000+01 1.2000000+0 65 2.9600000+01 4.200000+01 1.2000000+0 65 2.9600000+01 4.200000+01 1.2000000+0 65 2.9600000+01 4.200000+01 2.0000000+0 65 2.9600000+01 4.200000+01 2.0000000+0 65 2.9600000+01 4.200000+01 2.0000000+0 65 2.9600000+01 4.200000+01 2.0000000+0 65 2.9600000+01 4.200000+01 2.000000+0 65 2.9600000+01 4.200000+01 2.000000+0 65 2.9600000+01 4.200000+01 2.000000+0 65 2.9600000+01 4.200000+01 2.000000+0 65 2.9600000+01 4.200000+01 2.000000+0 65 2.9600000+01 4.200000+01 2.000000+0 65 2.9600000+01 4.200000+01 2.000000+0 65 2.9600000+01 4.200000+01 2.000000+0 65 2.9600000+01 4.200000+01 2.000000+0 65 2.9600000+01 4.200000+01 2.00000+0 65 2.9600000+01 4.200000+01 2.00000+0 65 2.9600000+01 4.200000+01 2.000000+0 65 2.9600000+01 4.200000+01 2.00000+01 2.00000+01 65 2.9600000+01 4.200000+01 2.00000+01 2.000000+01 65 2.9600000+01 4.200000+01 2.00000+01 2.000000+01 2.	35	2.6300000+0	.3300000+0	.6000000.
42 3.310000001 4.210000001 1.600000001 43 3.190000001 4.2000000001 1.9000000000000000000000000000	42 3.3100000001 4.310000001 1.60000000000000000000000000000	4	3,1600000+0	2800000+0	0+0000006*
43 3.090000001 4,200000001 1,90000000000000000000000000000	43 3.090000+01 4.200000+01 1.9000000+0 4 3.1400000+01 4.400000+01 1.9000000+0 51 2.9500000+01 4.4000000+01 1.8000000+0 52 3.030000+01 4.1200000+01 1.8000000+0 53 3.1900000+01 4.1200000+01 1.8000000+0 64 2.9600000+01 3.8900000+01 1.8000000+0 65 2.9600000+01 3.8900000+01 1.8000000+0 65 2.9600000+01 3.8900000+01 1.8000000+0 65 2.9600000+01 3.8900000+01 1.8000000+0 65 2.9600000+01 3.8900000+01 1.8000000+0 65 2.9600000+01 4.2900000+01 1.8000000+0 65 2.9600000+01 4.2900000+01 1.8000000+0 65 2.9600000+01 4.2900000+01 1.8000000+0 65 2.9600000+01 4.2900000+01 1.8000000+0 65 2.9600000+01 4.2900000+01 2.2000000+0 65 2.9600000+01 4.2900000+01 2.2000000+0 65 2.9600000+01 4.2900000+01 2.2000000+0 65 2.9600000+01 4.2900000+01 2.2000000+0 65 2.9600000+01 4.1300000+01 2.2000000+0 65 2.9600000+01 4.1300000+01 2.8000000+0 65 2.9600000+01 4.200000+01 2.8000000+0 65 2.9600000+01 4.200000+01 2.9000000+0 65 2.9600000+01 4.200000+01 2.9000000+0 65 2.9600000+01 4.200000+01 2.9000000+0 65 2.9600000+01 4.200000+01 2.9000000+0 65 2.9600000+01 4.200000+01 2.9000000+0 65 2.9600000+01 4.200000+01 2.9000000+0 65 2.9600000+01 4.200000+01 2.9000000+0 65 2.9600000+01 4.200000+01 2.9000000+0 65 2.9600000+01 4.200000+01 2.9000000+0 65 2.9600000+01 4.200000+01 2.900000+0 65 2.9600000+01 4.200000+01 2.900000+0 65 2.9600000+01 4.200000+01 2.900000+0 65 2.9600000+01 4.200000+01 2.900000+0 65 2.9600000+01 4.200000+01 2.900000+01 2.900000+01 65 2.9600000+01 4.200000+01 2.900000+01 2.900000+01 65 2.9600000+01 4.200000+01 2.900000+01 2.900000+01 65 2.9600000+01 4.200000+01 2.900000+01	42	3.3100000+0	.3100000+0	.6000000+0
44 3.140000601 4.190000601 1.90000000  52 9500000601 3.9100000601 1.30000000  53 1900000601 3.910000001 1.300000000  54 3.1900000601 3.910000001 1.30000000000000000000000000000	44 3.140000401 4,190000401 1,900000040 52 3.0300000401 3,910000401 1,300000040 53 3.0400000401 4,200000401 1,300000040 54 3.0600000401 4,2000000401 1,000000040 55 3.0800000401 3,8000000401 1,200000040 65 2.9000000401 3,8000000401 1,200000040 65 2.9000000401 3,8000000401 1,200000040 65 2.900000401 3,800000401 1,200000040 72 2.9500000401 3,800000401 2,00000040 73 2.8600000401 4,200000401 1,50000040 74 2.9500000401 4,200000401 1,50000040 75 2.9500000401 4,200000401 1,80000040 75 2.9500000401 4,200000401 1,80000040 76 2.9600000401 4,200000401 2,00000040 77 2.9500000401 4,200000401 2,00000040 78 2.8600000401 4,200000401 2,00000040 79 2.9500000401 4,200000401 2,00000040 70 2.9500000401 4,200000401 2,00000040 70 2.9500000401 4,200000401 2,000000400 70 2.9500000401 4,200000401 2,000000400 70 2.9500000401 4,200000401 2,000000400 70 2.9500000401 4,200000401 2,000000400 70 2.900000401 4,200000401 2,000000400 70 2.900000401 4,200000401 2,000000400 70 2.900000401 4,200000401 2,000000400 70 2.900000401 4,200000401 2,0000000400 70 2.900000401 4,200000401 2,000000400 70 2.900000401 4,200000401 2,000000400 70 2.900000401 4,200000401 2,000000400 70 2.900000401 4,200000401 2,000000400 70 2.900000401 4,200000401 2,000000400 70 2.900000401 4,200000401 2,000000400 70 2.900000401 4,200000401 2,000000400 70 2.900000401 4,200000401 2,000000400 70 2.900000401 4,200000401 2,000000400 70 2.900000401 4,200000401 2,000000400 70 2.900000401 4,200000401 2,000000400 70 2.900000401 4,200000401 2,000000400 70 2.900000401 4,200000401 2,0000004000040000400004000040004000040	4.	3.09000000	.2000000+0	0+0000006.
45 3.1300000001 4,400000001 2.8000000000000000000000000000000000000	45 3.1300000±01 4,4000000±01 2.8000000±0 53 3.030000±01 4,200000±01 1,3000000±0 54 3.030000±01 4,000000±01 1,3000000±0 55 3.190000±01 4,000000±01 1,300000±0 62 2.8300000±01 3,890000±01 1,2000000±0 63 2.8300000±01 3,890000±01 1,500000±0 64 2.960000±01 3,890000±01 1,500000±0 65 2.960000±01 3,890000±01 1,500000±0 65 2.960000±01 4,000000±01 1,5000000±0 65 2.960000±01 4,000000±01 1,5000000±0 65 2.960000±01 4,000000±01 1,5000000±0 65 2.960000±01 4,000000±01 1,5000000±0 65 2.960000±01 4,000000±01 1,5000000±0 65 2.960000±01 4,000000±01 1,5000000±0 65 2.960000±01 4,000000±01 1,5000000±0 65 2.960000±01 4,000000±01 2,000000±0 65 2.960000±01 4,000000±01 2,000000±0 65 2.960000±01 4,00000±01 1,5000000±0 65 2.960000±01 4,10000±01 1,5000000±0 65 2.960000±01 4,10000±01 2,000000±0 65 2.960000±01 4,10000±01 2,000000±0 65 2.960000±01 4,1000±01 2,000000±0 65 2.960000±01 4,1000±01 2,000000±0 65 2.960000±01 4,1000±01 2,000000±0 65 2.960000±01 4,1000±01 2,000000±0 65 2.960000±01 4,10000±01 2,000000±0 65 2.960000±01 4,10000±01 2,000000±0 65 2.960000±01 4,10000±01 2,000000±0 65 2.960000±01 4,10000±01 2,000000±0 65 2.960000±01 4,1000±01 2,000000±0 65 2.960000±01 4,1000±01 2,000000±0 65 2.960000±01 4,1000±01 2,000000±0 65 2.960000±01 4,1000±01 2,00000±0 65 2.960000±01 4,1000±01 2,00000±0 65 2.960000±01 4,1000±01 2,00000±01 2,00000±01 65 2.960000±01 4,1000±01 3,0000±01 2,00000±01 3,	4	3.1400000+0	190000040	0+0000006.
51 2.9500000001 3.910000001 1.30000000000000000000000000000	51 2.9500000±01 3.910000±01 1.3000000±0 53 3.1900000±01 4.1200000±01 1.3000000±0 54 3.0500000±01 3.990000±01 1.3000000±0 64 2.9000000±01 3.9900000±01 1.5000000±0 65 2.9000000±01 3.9900000±01 1.5000000±0 65 2.9000000±01 3.9900000±01 1.5000000±0 65 2.9000000±01 3.9900000±01 1.5000000±0 65 2.9000000±01 3.9900000±01 1.5000000±0 72 2.9500000±01 4.2900000±01 2.2000000±0 73 2.8600000±01 4.290000±01 2.2000000±0 74 2.900000±01 4.290000±01 1.8000000±0 75 2.900000±01 4.290000±01 1.8000000±0 75 2.900000±01 4.290000±01 1.8000000±0 75 2.900000±01 4.2900000±01 1.8000000±0 76 2.900000±01 4.2900000±01 2.2000000±0 77 2.900000±01 4.2900000±01 1.8000000±0 78 2.860000±01 4.2900000±01 1.8000000±0 79 2.900000±01 4.2900000±01 1.8000000±0 70 2.900000±01 4.200000±01 2.0000000±0 70 2.900000±01 4.200000±01 2.0000000±0 70 2.900000±01 4.200000±01 2.0000000±0 70 2.900000±01 4.200000±01 2.0000000±0 70 2.900000±01 4.200000±01 2.0000000±0 70 2.900000±01 4.200000±01 2.000000±0 70 2.900000±01 4.200000±01 2.000000±0 70 2.900000±01 4.200000±01 2.0000000±0 70 2.900000±01 4.200000±01 2.000000±0 70 2.900000±01 4.200000±01 2.000000±0 70 2.900000±01 4.200000±01 2.000000±0 70 2.900000±01 4.200000±01 2.000000±0 70 2.900000±01 4.200000±01 2.0000000±0 70 2.900000±01 4.200000±01 2.000000±0 70 2.900000±01 4.200000±01 2.000000±0 70 2.900000±01 4.200000±01 2.000000±0 70 2.900000±01 4.200000±01 2.000000±01 2.000000±01 2.000000±01 2.000000±01 2.000000±01 2.000000±01 2.000000±01 2.000000±01 2.0000000±01 2.000000±01 2.000000±01 2.000000±01 2.000000±01 2.000000±01 2.000000±01 2.000000±01 2.000000±01 2.000000±01 2.000000±01 2.0000000±01 2.0000000±01 2.000000±01 2.000000±01 2.000000±01 2.00000±01 2.000000±01 2.000000±01 2.000000±01 2.000000±01 2.000000±01 2.000000±01 2.000000±01 2.000000±01 2.000000±01 2.000000±01 2.000000±01 2.000000±01 2.000000±01 2.00000±01 2.000000±01 2.00000±01 2.000000±01 2.000000±01 2.000000±01 2.000000±01 2.000000±01 2.000000±01 2.000000±01 2.000000±01 2.000000±01 2.000000±01 2.000000±01 2.000000±01 2.000000±01 2.000000±01 2.000000±01 2.00000±	45	3,1300000	4000000+0	0.00000000
\$\frac{52}{3.0500000000000000000000000000000000000	52 3.190000-01 4.120000-01 1.4000000-01 3.9000000-01 3.00000000-01 3.0000000-01 1.40000000-01 3.0000000-01 1.40000000-01 3.0000000-01 1.50000000-01 2.0000000-01 3.0000000-01 1.5000000-01 2.9000000-01 3.9000000-01 1.5000000-00-02 2.9000000-01 3.9000000-01 1.5000000-00-02 2.9000000-01 3.9000000-01 1.50000000-01 2.9000000-01 3.9000000-01 1.50000000-01 2.9000000-01 4.300000-01 1.9000000-01 2.9000000-01 2.9000000-01 2.9000000-01 2.9000000-01 2.9000000-01 4.300000-01 1.9000000-00-01 2.9000000-01 1.9000000-01 1.9000000-01 1.9000000-01 1.9000000-01 1.9000000-01 1.9000000-01 1.9000000-01 1.9000000-01 1.9000000-01 1.9000000-01 1.9000000-01 1.9000000-01 1.9000000-01 1.9000000-01 1.90000000-01 1.9000000000-01 1.90000000-01 1.90000000-01 1.900000000-01 1.900000000-01 1.900000000-01 1.900000000-01 1.90000000000000000000000000000000000	5	2.0500000	0100000	400000
53 3.19000000000000000000000000000000000000	53 3.1900000+01 4.120000+01 1.4000000+0  54 3.060000+01 3.8900000+01 1.2000000+0  55 2.900000+01 3.8900000+01 1.5000000+0  65 2.900000+01 3.8900000+01 1.5000000+0  65 2.960000+01 3.8500000+01 1.5000000+0  71 2.9500000+01 3.8500000+01 1.5000000+0  72 2.9500000+01 4.2000000+01 1.5000000+0  73 2.8600000+01 4.2000000+01 1.5000000+0  74 2.800000+01 4.190000+01 1.8000000+0  74 2.800000+01 4.190000+01 1.8000000+0  75 2.9500000+01 4.190000+01 1.8000000+0  76 2.9500000+01 4.190000+01 1.8000000+0  77 2.800000+01 4.1300000+01 1.8000000+0  78 2.800000+01 4.130000+01 2.000000+0  79 2.800000+01 4.130000+01 2.9000000+0  70 2.800000+01 4.130000+01 2.9000000+0  70 2.800000+01 4.130000+01 2.9000000+0  70 2.800000+01 4.130000+01 2.9000000+0  70 2.800000+01 4.130000+01 2.9000000+0  70 2.800000+01 4.130000+01 2.9000000+0  70 2.800000+01 4.130000+01 2.9000000+0  70 2.800000+01 4.130000+01 2.9000000+0  70 2.800000+01 4.130000+01 2.9000000+0  70 2.800000+01 4.130000+01 2.9000000+0  70 2.800000+01 4.130000+01 2.900000+0  70 2.800000+01 4.130000+01 2.900000+0  70 2.800000+01 4.130000+01 2.900000+0  70 2.800000+01 4.130000+01 2.900000+0  70 2.800000+01 4.130000+01 2.900000+0  70 2.800000+01 4.130000+01 2.900000+0  70 2.800000+01 4.130000+01 2.900000+0  70 2.800000+01 4.130000+01 3.00000+01 2.900000+0  70 2.800000+01 4.130000+01 3.00000+01 2.900000+01  70 2.800000+01 4.130000+01 4.130000+01 3.00000+01  70 2.800000+01 4.130000+01 3.0000+01 3.00000+01  70 2.800000+01 4.130000+01 4.130000+01 3.00000+01  70 2.800000+01 4.130000+01 4.130000+01 3.00000+01  70 2.800000+01 4.130000+01 4.130000+01 3.00000+01  70 2.800000+01 4.130000+01 4.130000+01 3.00000+01  70 2.800000+01 4.130000+01 3.0000+01 3.00000+01  70 2.800000+01 4.130000+01 3.0000+01 3.00000+01  70 2.800000+01 4.130000+01 4.130000+01 3.00000+01  70 2.800000+01 4.130000+01 4.130000+01 3.0000+		3.0300000		
54 3.1660000001 3.8950000001 1.200000000000000000000000000000	54 3.0600000401 3.890000401 1.20000000000000000000000000000000000	5.5	4000000	0 0 0 0 0 0 0	
55 3.080000001 3,840000001 1,500000000000000000000000000000	55 3.0800000401 3.840000401 1.500000040 64 2.8300000401 3.8400000401 1.500000040 65 2.9600000401 3.8900000401 1.500000040 65 2.9600000401 3.9700000401 1.500000040 71 2.9500000401 4.2500000401 2.000000040 72 2.9500000401 4.3500000401 1.800000040 73 2.8600000401 4.3300000401 1.800000040 74 2.8600000401 4.3300000401 1.800000040 75 2.9400000401 4.3300000401 1.800000040 75 2.9400000401 4.300000401 1.800000040 76 2.9600000401 4.300000401 2.200000040 77 2.860000401 4.300000401 2.200000040 78 2.860000401 4.300000401 2.000000040 78 2.860000401 4.300000401 2.0000004040 78 2.8600000401 4.300000401 2.0000004040 78 2.860000401 4.300000401 2.0000004040 78 2.860000401 4.300000401 2.0000004040 78 2.860000401 4.300000401 2.0000004040 78 2.860000401 4.300000401 2.000000404001 78 2.860000401 4.300000401 2.00000040401 78 2.860000401 4.300000401 2.00000040401 78 2.860000401 4.300000401 2.00000040401 78 2.860000401 4.300000401 2.00000040401 78 2.860000401 4.300000401 2.00000040401 78 2.860000401 4.300000401 2.00000040401 78 2.860000401 4.300000401 2.00000040401 78 2.860000401 4.300000401 2.00000040401 78 2.860000401 4.300000401 2.00000040401 78 2.860000401 4.300000401 2.00000040401 78 2.860000401 4.300000401 2.00000040401 78 2.860000401 4.300000401 2.00000040401 78 2.860000401 4.300000401 2.00000040401 78 2.860000401 4.300000401 2.00000040401 78 2.860000401 4.300000401 2.00000040401 78 2.860000401 4.300000401 2.00000040401 78 2.860000401 4.300000401 2.00000040401 78 2.860000401 4.300000401 2.00000040401 78 2.860000401 4.30000401 2.00000040401 78 2.800000401 4.30000401 2.00000040401 78 2.800000401 4.300000401 2.00000040401 78 2.800000401 4.300000401 2.00000040401 78 2.800000401 4.30000401 2.00000040401 78 2.800000401 4.300000401 2.00000040401 78 2.800000401 4.300000401 2.00000040401 78 2.800000401 4.300000401 2.00000040401 78 2.80000040401 4.300000401 2.00000040401 78 2.80000040401 4.300000401 2.000000404010401040104010401040104010401	2.4	2 0 C 0 C 0 C C C C C C C C C C C C C C	0.000000	
6.2 2.900000.01 3.890000.01 1.500000.01 6.5 2.900000.01 3.8900000.01 1.500000.01 6.5 2.900000.001 3.8900000.01 1.500000.01 6.5 2.900000.001 3.8900000.01 1.500000.01 6.5 2.9600000.01 3.9700000.01 2.000000.01 2.000000.01 2.000000.01 2.000000.01 2.000000.01 2.000000.01 2.000000.01 2.000000.01 2.000000.01 4.3000000.01 1.5000000.01 2.0000000.01 2.0000000.01 2.0000000.01 2.0000000.01 2.0000000.01 2.00000000.01 2.0000000.01 2.0000000.01 2.0000000.01 2.0000000.01 2.00000000.01 2.000000000.01 2.0000000000	6.2 2.900000401 3.8900000401 1.500000040 6.5 2.9000000401 3.8900000401 1.500000040 6.5 2.900000401 3.8900000401 1.500000040 6.5 2.9600000401 3.8900000401 2.000000040 7.1 2.9500000401 4.2000000401 2.000000040 7.2 2.9500000401 4.300000401 1.5000000040 7.3 2.8600000401 4.300000401 1.8000000040 7.43333401 \$V8AR 1.971954240 \$SU 3.5237044401 \$LILU 5.6666640 \$EBAR 5.164086-01 \$SE 5219-187 MIG 2319 \$SINGLE 1.2 9900000401 2.0000000401 1.2 9900000401 1.2 990000401 4.1300000401 2.900000040401 1.3 2.8600000401 4.1300000401 2.900000040401 1.4 2.9100000401 4.1300000401 2.900000040401 1.5 2.900000401 4.1300000401 2.900000040401 1.5 2.900000401 4.1500000401 2.900000040401 1.5 2.900000401 4.1500000401 2.9000000400401 1.5 2.900000401 4.1500000401 2.9000000400401 1.5 2.900000401 4.1500000401 2.9000000400401 1.5 2.900000401 4.1500000401 2.9000000400401 1.5 2.900000401 4.1500000401 2.9000000400401 1.5 2.900000401 4.1500000401 2.9000000400401 1.5 2.900000401 4.1500000401 2.9000000400401 1.5 2.900000401 4.1500000401 2.9000000400401 1.5 2.900000401 4.1500000401 2.9000000400401 1.5 2.900000401 4.1500000401 2.9000000400401 1.5 2.900000401 4.1500000401 2.9000000400401 1.5 2.900000401 4.1500000401 2.9000000400401 1.5 2.900000401 4.1500000401 2.9000000400401 1.5 2.900000401 4.1500000401 2.9000000400401 1.5 2.900000401 4.1500000401 2.900000400401 1.5 2.900000401 4.1500000401 2.9000000400401 1.5 2.900000401 4.1500000401 2.9000000400401 1.5 2.900000401 4.1500000401 2.9000000400401 1.5 2.900000401 4.1500000401 2.9000000400401 1.5 2.900000401 4.1500000401 2.9000000400401 1.5 2.900000401 4.1500000401 2.9000000400401 1.5 2.900000401 4.1500000401 2.9000000400401 1.5 2.900000401 4.1500000401 2.9000000400401 1.5 2.900000401 4.1500000401 2.90000004000040000400004000040000400004	7 2	3 0 0 0 0 0 0 0 2	0.0000000	
63 2.9600000001 3.890000001 1.59000000000000000000000000000000000000	62 2.9000000+01 3.890000-01 1.5000000+0 63 2.9600000+01 3.8900000-01 1.5000000+0 64 2.9600000+01 3.8900000+01 2.0000000+0 65 2.9600000+01 4.000000+01 2.0000000+0 72 2.9500000+01 4.2900000+01 2.0000000+0 73 2.8600000+01 4.1300000+01 1.5000000+0 74 2.8000000+01 4.1300000+01 1.8000000+0 75 2.9500000+01 4.1300000+01 1.8000000+0 75 2.9500000+01 4.1300000+01 1.8000000+0 75 2.9400000+01 4.1300000+01 1.8000000+0 75 2.9400000+01 4.1300000+01 2.000000+0 75 2.9400000+01 4.1300000+01 2.000000+0 75 2.9500000+01 4.1300000+01 2.0000000+0 75 2.9500000+01 4.1300000+01 2.9000000+0 75 2.900000+01 4.1300000+01 2.9000000+0 75 2.8600000+01 4.1300000+01 2.9000000+0 75 2.8600000+01 4.1300000+01 2.9000000+0 75 2.9500000+01 4.1300000+01 2.9000000+0 75 2.9500000+01 4.1300000+01 2.9000000+0 75 2.9500000+01 4.1300000+01 2.9000000+0 75 2.9500000+01 4.1300000+01 2.9000000+0 75 2.9500000+01 4.1300000+01 2.900000+0 75 2.9500000+01 4.1300000+01 2.900000+0 75 2.9500000+01 4.1300000+01 2.900000+0 75 2.9500000+01 4.1300000+01 2.900000+0 75 2.9500000+01 4.1300000+01 2.900000+0 75 2.9500000+01 4.1300000+01 2.900000+0 75 2.9500000+01 4.1300000+01 2.900000+0 75 2.9500000+01 4.1300000+01 2.900000+0 75 2.9500000+01 4.1300000+01 2.900000+0 75 2.9500000+01 4.1300000+01 2.900000+0 75 2.9500000+01 4.1300000+01 2.900000+0 75 2.9500000+01 4.1300000+01 2.900000+0 75 2.9500000+01 4.1300000+01 2.900000+0 75 2.9500000+01 4.1300000+01 2.900000+0 75 2.9500000+01 4.1300000+01 2.900000+01 2.900000+01 2.900000+01 2.900000+01 2.900000+01 2.900000+01 2.900000+01 2.900000+01 2.900000+01 2.900000+01 2.900000+01 2.900000+01 2.900000+01 2.900000+01 2.900000+01 2.900000+01 2.900000+01 2.900000+01 2.9000000+01 2.900000+01 2.900000+01 2.900000+01 2.9000000+01 2.9000000+01 2.9000000+01 2.9000000+01 2.900000+01 2.900000+01 2.9000000+01 2.900000+01 2.900000+01 2.9000000+01 2.900000+01 2.9000000+01 2.9000000+01 2.9000000+01 2.9000000+01 2.9000000+01 2.9000000+01 2.9000000+01 2.9000000+01 2.9000000+01 2.9000000+01 2.90000000+01 2.9000000+01 2.9000000+01 2.9000000+01 2.90000000+01 2	66	0.0000000	0+0000040*	0+0000002.
62 2.9000000010 3.89000000010 1.5000000000000000000000000000	6.2 2.900000401 3.8900000401 1.5000000040 6.4 2.9600000401 3.9700000401 1.700000040 6.5 2.9600000401 3.970000401 2.000000040 7.1 2.9500000401 4.5200000401 2.000000040 7.2 2.9500000401 4.5200000401 1.500000040 7.3 2.8600000401 4.190000401 1.500000040 7.4 2.8600000401 4.190000401 1.800000040 7.5 2.9400000401 4.200000401 1.800000040 7.5 2.9400000401 4.200000401 1.800000401 7.5 2.940000401 4.200000401 1.800000401 7.5 2.940000401 4.200000401 2.900000401 7.5 2.860000401 4.150000401 2.90000040401 7.5 2.800000401 4.150000401 2.90000040401 7.5 2.800000401 4.150000401 2.90000040401 7.5 2.800000401 4.150000401 3.00000040401 7.5 2.800000401 4.150000401 3.000040401 7.5 2.800000401 4.150000401 3.000040401 7.5 2.800000401 4.150000401 3.000040401 7.5 2.800000401 4.150000401 3.000040401 7.5 2.800000401 4.150000401 3.000040401 7.5 2.800000401 4.150000401 3.00004010401 7.5 2.800000401 4.150000401 3.0004010401 7.5 2.800000401 4.1500040101 3.000401000401040104010401040104010401040	61	2.8300000+0	.84000000+0	.5000000+0
6.5 2.960000401 3.9500000401 1.70000000000000000000000000000000000	6.5 2.960000401 3.9500000401 1.70000000000000000000000000000000000	95	2.90000000	0+0000068	.5000000+0
64 2.9600000401 3.9700000101 2.00000001 6 5 2.9600000401 4.0500000401 2.000000004	64 2.9600000401 3.9700000401 2.000000040  72 2.9500000401 4.290000401 2.000000040  73 2.9500000401 4.3500000401 1.500000040  74 2.8600000401 4.3500000401 1.500000040  75 2.9400000401 4.3500000401 1.800000040  75 2.9400000401 4.3500000401 1.800000040  76 2.8600000401 4.3500000401 1.800000040  77 2.9400000401 4.3500000401 1.800000040  78 2.8600000401 4.3500000401 2.900000040  78 2.900000401 4.3500000401 2.900000040  78 2.900000401 4.3500000401 2.9000000400  79 2.900000401 4.3500000401 2.9000000400  70 2.900000401 4.3500000401 2.9000000400  70 2.900000401 4.3500000401 2.9000000400  70 2.900000401 4.3500000401 2.9000000400  70 2.900000401 4.3500000401 2.9000000400  70 2.900000401 2.900000401 2.90000040000400004000040000400004000040	9	2.9600000+0	.8500000+0	.7000000+0
55 2.9800000401 4,2600000401 2,00000000000000000000000000000000000	55 2.980000401 4.060000401 2.00000000000000000000000000000000000	40	2.960000040	.9700000+0	.0000000.
71 2.93000000011 4.3300000000000000000000000000000000000	71 2.9300000+01 4.3300000+01 1.5000000+01 72 2.9500000+01 4.3300000+01 1.5000000+01 73 2.8600000+01 4.1300000+01 1.8000000+0 74 2.8000000+01 4.1300000+01 1.8000000+0 75 2.8000000+01 4.1300000+01 1.8000000+0 76 2.800000+01 85 2.4789-30+01 1.1710 77 2.800000+01 4.1300000+01 2.9000000+01 78 2.8000000+01 4.1300000+01 2.9000000+01 79 2.800000+01 4.1300000+01 2.9000000+01 70 2.800000+01 4.1300000+01 2.9000000+01 75 2.800000+01 4.1300000+01 2.9000000+01 75 2.800000+01 4.1300000+01 2.9000000+01 75 2.800000+01 4.2500000+01 2.9000000+01 75 2.800000+01 4.2500000+01 2.9000000+01 75 2.800000+01 4.2500000+01 2.9000000+01 75 2.800000+01 4.2500000+01 2.9000000+01 75 2.800000+01 4.2500000+01 2.9000000+01 75 2.800000+01 4.2500000+01 2.9000000+01 75 2.8000000+01 4.2500000+01 2.9000000+01 75 2.8000000+01 2.900000+01 2.9000000+01 75 2.8000000+01 4.2500000+01 2.9000000+01 75 2.8000000+01 4.2500000+01 2.900000+01 75 2.8000000+01 4.2500000+01 2.900000+01 75 2.8000000+01 4.2500000+01 2.900000+01 75 2.8000000+01 4.2500000+01 3.000000+01 75 2.8000000+01 4.25000000+01 3.000000+01 75 2.8000000+01 4.25000000+01 3.000000+01 75 2.8000000+01 4.200000+01 3.00000+01 75 2.8000000+01 4.200000+01 3.00000	65	2.980000040	.060000040	•0000000•
72 2.9500000e01 4,3300000e01 1,50000000 73 2.8600000e01 4,3300000e01 1,800000000 74 2.8000000e01 4,2900000e01 1,80000000 75 2.9400000e01 4,2900000e01 1,80000000 75 2.8000000e01 85Y 2,4789930e01 1,80000000 75 2.8000000e01 85E 75 2.8000000e01 4,1500000e01 2,0000000e01 1,2 2,8000000e01 4,1500000e01 2,2000000e01 1,2 2,8000000e01 4,2500000e01 2,2000000e01 3,3000000e01 2,2000000e01 3,3000000e01 3,30000000e01 3,30000000e01 3,300000000e01 3,30000000000000000000000000000000000	72 2.9500000+01 4.3500000+01 1.5000000+0 73 2.8600000+01 4.1900000+01 1.5000000+0 74 2.8000000+01 4.2900000+01 1.8000000+0 75 2.9400000+01 4.2900000+01 1.8000000+0 75 2.9400000+01 4.2900000+01 1.8000000+0 75 2.9400000+01 4.2900000+01 1.8000000+0 75 2.9400000+01 4.200000+01 2.9000000+0 75 2.9000000+01 4.1300000+01 2.9000000+0 75 2.8600000+01 4.1300000+01 2.9000000+0 75 2.9000000+01 4.1300000+01 2.9000000+0 75 2.9000000+01 4.1300000+01 2.9000000+0 75 2.9000000+01 4.1300000+01 2.9000000+0 75 2.9000000+01 4.300000+01 2.9000000+0 75 2.900000+01 4.300000+01 2.9000000+0 75 2.7900000+01 4.3500000+01 2.8000000+0 75 2.7900000+01 4.3500000+01 2.7000000+0 75 2.7900000+01 4.3500000+01 2.7000000+0 75 2.7900000+01 4.3500000+01 2.7000000+0 75 2.7800000+01 4.3500000+01 2.7000000+0 75 2.7800000+01 4.500000+01 2.7000000+0 75 2.7800000+01 4.5000000+01 2.7000000+0 75 2.8500000+01 4.500000+01 2.7000000+0 75 2.8500000+01 4.500000+01 2.700000+01 2.00000+01 2.00000+01 2.00000+01 2.00000+01 2.00000+01 2.00000+01 2.0000+01 2.00000+01 2.00000+01 2.00000+01 2.00000+01 2.00000+01 2.00	71	2.930000000	.290000040	.20000000+0
73 2.8600000+01 4,1900000+01 1,80000000000000000000000000000000000	73 2.860000+01 4.190000+01 1.200000+00 74 2.800000+01 4.290000+01 1.8000000+00 75 2.9400000+01 4.2900000+01 1.80000000+00 75 2.9400000+01 4.2900000+01 1.8000000+00 770000+01 SUBAR 1.5860799+00 SSV 2.4789930+01 4LLY 770000+01 SUBAR 1.9719542+00 SSV 2.4789930+01 4LLY 770000+01 SUBAR 1.9719542+00 SSV 2.4789930+01 4LLY 770000+01 SUBAR 1.9719542+00 SSV 2.4789930+01 4LLY 7700000+01 2.9000000+01 4.21000000+01 2.90000000+01 72 2.8000000+01 4.2100000+01 2.90000000+01 72 2.7900000+01 4.2500000+01 2.400000+01 72 2.7900000+01 4.2500000+01 2.400000+01 72 2.7500000+01 4.2500000+01 2.7000000+01 72 2.7500000+01 4.2500000+01 2.8000000+01 72 2.7500000+01 4.2500000+01 2.8000000+01 72 2.7500000+01 4.2500000+01 2.8000000+01 72 2.7500000+01 4.2500000+01 2.8000000+01 72 2.7500000+01 4.2500000+01 2.8000000+01 72 2.7500000+01 4.2500000+01 2.8000000+01 72 2.7500000+01 4.2500000+01 2.8000000+01 72 2.800000+01 4.250000+01 3.000000+01 72 2.800000+01 4.250000+01 3.000000+01 72 2.800000+01 8.84 1.20076+01 8.1LV 73 33 3.8289926+01 8.1LV 73 33 3.8289926+01 8.1LV 73 33 3.8289926+01 8.1LV 73 35 3.8289926+01 8.1LV	72	2,9500000+0	.3300000+0	.5000000+0
74 2.8000000001 4.1300000001 1.80000000000000000000000000000	74 2.800000+01 4.130000+01 1.800000+00 1 1.8000000+0 1 1.8000000+0 1 1.80000000+0 1 1.80000000+0 1 1.80000000+0 1 1.80000000+0 1 1.80000000+0 1 1.80000000+0 1 1.80000000+0 1 1.80000000+0 1 1.80000000+0 1 1.80000000+0 1 1 1.80000000+0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	73	2.86000000+0	.19000004	.2000000+0
2.940000.010.01 4.2900000.01 1.800000.01 1.80000.01 1.8000.00.01 1.8000.00.01 1.8000.00.01 1.8000.00.01 1.8000.00.01 1.8000.00.00 1.8000.00 1.80	75 2.940000+01 4.290000+01 1.800000+01 1.800000+01 1.800000+01 8.1LV 770000+01 5UBAR 1.5860799+00 SSY 2.4789930+01 8LTLV 750000+01 5UBAR 1.5860799+00 SSY 3.5237644+01 8LTLV 75000-01 SEBAR 5.1640896-01 SSE 3.5237644+01 8LTLV 75000-01 SEBAR 5.1640896-01 SSE 3.5237644+01 8LTLV 750000+01 12.9900000+01 12.9900000+01 13.2.9900000+01 13.2.9600000+01 13.2.9600000+01 13.2.9000000+01 13.2.9000000+01 13.2.9000000+01 13.2.9000000+01 13.2.9000000+01 13.3.030000+01 13.2.9000000+01 13.2.900000+01 13.2.900000+01 13.2.900000+01 13.2.900000+01 13.2.900000+01 13.2.900000+01 13.2.900000+01 13.2.900000+01 13.2.900000+01 13.2.900000+01 13.2.9000000+01 13.2.900000+01 13.2.9000000+01 13.2.9000000+01 13.2.900000+01 13.2.900000+01 13.2.900000+01 13.2.900000+01 13.2.900000+01 13.2.9000000+01 13.2.900000+01 13.2.900000+01 13.2.900000+01 13.2.900000+01 13.2.900000+01 13.2.900000+01 13.2.900000+01 13.2.900000+01 13.2.900000+01 13.2.900000+01 13.2.900000+01 13.2.900000+01 13.2.900000+01 13.2.900000+01 13.2.900000+01 13.2.900000+01 13.2.9000000+01 13.2.900000+01 13.2.900000+01 13.2.900000+01 13.2.900000+01 13.2.900000+01 13.2.900000+01 13.2.900000+01 13.2.900000+01 13.2.900000+01 13.2.900000+01 13.2.900000+01 13.2.9000000+01 13.2.900000+01 13.2.900000+01 13.2.900000+01 13.2.900000+01 13.2.900000+01 13.2.900000+01 13.2.9000000+01 13.2.9000000+01 13.2.9000000+01 13.2.9000000+01 13.2.9000000+01 13.2.9000000+01 13.2.90000000+01 13.2.9000000+01 13.2.9000000+01 13.2.9000000+01 13.2.90000000+01 13.2.9000000+01 13.2.9000000+01 13.2.9000000+01 13.2.90000000+01 13.2.90000000+01 13.2.90000000+01 13.2.90000000+01 13.2.900000000+01 13.2.90000000+01 13.2.900000000+01 13.2.900000000000000000000000000000000000	74	2.6000000+0	.1300000+0	.8000000+0
17.00000-01 SYBAR 1.5860795-00 SSV 2.4789930+01 SLTL   17.0000-01 SUBAR 1.9718542-00 SSU 3.5237044+01 SLTL   17.0000-01 SEBAR 1.9718542-00 SSU 3.5237044+01 SLTL   17.0000-01 SEBAR 1.9718542-00 SSU 3.5237044+01 SLTL   17.00000-01 SLTL   17.000000-01 SLTL   17.0000000-01 SLTL   17.0000000-01 SLTL   17.0000000-01 SLTL   17.000000000000000000000000000000000000	### ### ### ### ### #### #### ########	75	2.9400000+0	2900000+0	.80000000+0
70000+01 \$UBAR 1.9715542+00 \$SU 3,5237044+01 \$LTL 66666+00 \$EBAR 5.461696+01 \$SE 5219-161 HIG 2319 \$SINGLE 4.1300000+01 2.0000000+01 2.90000000+01 2.90000000+01 2.90000000+01 3.26600000+01 4.20000000+01 2.90000000+01 2.90000000+01 2.90000000+01 2.90000000+01 2.90000000+01 2.9000000+01 2.2 2.7900000+01 4.3000000+01 2.4000000+01 2.2 2.7900000+01 4.3000000+01 2.4000000+01 2.2 2.7900000+01 4.3000000+01 2.4000000+01 2.5000000+01 2.5000000+01 2.5000000+01 2.5000000+01 2.5000000+01 2.5000000+01 2.5000000+01 2.5000000+01 2.5000000+01 2.5000000+01 3.2000000+01 3.2000000+01 3.2000000+01 3.2000000+01 3.2000000+01 3.2000000+01 3.2000000+01 3.2000000+01 3.2000000+01 3.2000000000+01 3.200000000+01 3.2000000000000000000000000000000000000	70000+01 \$UBAR 1.9715542+00 \$SU 3.5237044+01 \$LTLU 66666-01 \$EBAR 5.464086-01 \$SE	43333+0	\$YBAR 1.58607	5+00 \$SY 2,478	930+01 \$LTL
2219-167 MIG 2319 SINGLE 12 2-80000004-01 4.13000004-01 2.0000000+ 13 2-8000000401 4.200000401 2.9000000+ 14 2-9100000401 4.200000401 2.9000000+ 15 2.8000000401 4.200000401 2.9000000+ 21 3-0300000401 4.300000401 2.4000000+ 22 2.7900000401 4.300000401 2.4000000+ 23 2.7900000401 4.300000401 2.4000000+ 24 2.87400000401 4.300000401 2.7000000+ 25 2.7500000401 4.300000401 2.7000000+ 27 2.8500000401 4.300000401 2.7000000+ 28 2.7800000401 4.300000401 2.7000000+ 29 2.7800000401 4.300000401 2.7000000+ 20 2.7800000401 4.300000401 2.7000000+ 20 2.7800000401 4.300000401 3.000000000+ 20 2.7800000401 4.300000401 3.00000000000000000000000000000000000	66666+00 \$EBAR 5,1640896-01 \$SE  2219-187 HIG 2319 \$SINGLE  1	70000+0	\$UBAR 1.97155	2+00 \$SU 3,523	7044+01 \$LTL
11 2.99000000401 4.1300000401 2.00000004 12 2.9900000401 4.2100000401 2.90000004 13 2.6600000401 4.2100000401 2.90000004 14 2.9100000401 4.1300000401 2.60000004 21 3.030000401 4.360000401 2.60000004 22 2.7900000401 4.360000401 2.6000004 24 2.8700000401 4.360000401 2.60000004 25 2.7900000401 4.360000401 2.60000004 26 2.7500000401 4.360000401 2.60000004 27 2.750000401 4.360000401 2.60000004 31 3.110000401 4.360000401 2.60000004 32 2.760000401 4.360000401 2.60000004 33 2.7800000401 4.3600000401 2.7000004 34 2.650000401 4.3600000401 3.00000004 35 2.7800000401 4.3600000401 3.000000004 36 2.7800000401 4.3600000401 3.000000004 37 2.7800000401 4.3600000401 3.000000004 38 2.7800000401 4.3600000401 3.00000000000000000000000000000000000	2219-187 MIG 2319 SINGLE  11 2.9900000+01 4.1500000+01 2.0000000+01  12 2.8000000+01 4.1500000+01 2.9000000+01  13 2.6600000+01 4.1500000+01 2.9000000+01  14 2.9100000+01 4.1500000+01 2.9000000+01  22 2.8600000+01 4.3500000+01 2.4000000+0  23 2.7500000+01 4.3500000+01 2.7000000+0  24 2.8700000+01 4.3500000+01 2.4000000+0  25 2.7500000+01 4.3500000+01 2.4000000+0  25 2.7500000+01 4.3500000+01 2.4000000+0  25 2.7500000+01 4.3500000+01 2.4000000+0  25 2.7500000+01 4.3500000+01 2.4000000+0  25 2.7500000+01 4.3500000+01 2.4000000+0  25 2.7500000+01 4.500000+01 2.4000000+0  25 2.7500000+01 4.500000+01 3.000000+0  25 2.7500000+01 4.500000+01 3.000000+0  25 2.7500000+01 4.500000+01 3.000000+0  25 2.7500000+01 4.500000+01 3.000000+0  25 2.7500000+01 4.500000+01 3.000000+0  25 2.7500000+01 4.500000+01 3.000000+0  25 2.7500000+01 4.500000+01 3.000000+0  25 2.7500000+01 4.500000+01 3.000000+0  25 2.7500000+01 4.500000+01 3.000000+0  25 2.7500000+01 4.500000+01 3.000000+0  25 2.7500000+01 4.500000+01 3.00000+0  25 2.7500000+01 4.500000+01 3.00000+0  25 2.7500000+01 4.500000+01 3.0000+0  25 2.7500000+01 4.500000+01 3.00000+0  25 2.7500000+01 4.500000+01 3.00000+0  25 2.7500000+01 4.500000+01 3.00000+0  25 2.7500000+01 4.500000+01 3.00000+0  25 2.7500000+01 4.500000+01 3.00000+0  25 2.7500000+01 4.500000+01 3.00000+0  25 2.7500000+01 4.500000+01 3.00000+0  25 2.7500000+01 4.500000+01 3.00000+0  25 2.7500000+01 4.500000+01 3.0000+0  25 2.7500000+01 4.500000+01 3.00000+0  25 2.7500000+01 4.500000+01 3.0000+0  25 2.7500000+01 4.500000+01 3.0000+0  25 2.7500000+01 4.500000+01 3.0000+0  25 2.7500000+01 4.500000+01 3.0000+0  25 2.7500000+01 4.500000+01 3.0000+01 3.0000+0  25 2.7500000+01 4.500000+01 3.0000+0	0+99999	SEBAR 5.16408	S\$ 10-9	
11 2.9900000000000000000000000000000000000	11 2.990000401 4.1300000401 2.000000401 12 2.600000401 4.2100000401 2.9000000401 13 2.6600000401 4.2100000401 2.9000000401 14 2.9100000401 4.1300000401 2.600000040 21 3.030000401 4.3500000401 2.700000040 22 2.7900000401 4.3500000401 2.700000040 23 2.7500000401 4.3500000401 2.700000040 24 2.8700000401 4.3500000401 2.700000040 25 2.7500000401 4.3500000401 2.800000040 25 2.7500000401 4.3500000401 2.800000040 25 2.7500000401 4.3500000401 2.800000040 25 2.7500000401 4.3500000401 3.000000040 25 2.7500000401 4.3400000401 3.00000040 25 2.860000401 4.3400000401 3.00000040 25 2.860000401 4.3400000401 3.00000040 25 2.860000401 4.3400000401 3.00000040 25 2.860000401 4.3400000401 3.00000040 25 2.860000401 4.3400000401 3.00000040 25 2.860000401 4.3400000401 3.00000040 25 2.860000401 4.3400000401 3.00000040 25 2.860000401 4.3400000401 3.00000040	219-TB	MIG 2319 SINGL		
12 2.60000001401 4.210000401 2.900000001 14 2.9000001401 4.160000901 2.90000401 15 2.660000401 4.1500000401 2.90000401 21 3.030000401 4.3500000401 2.40000004 22 2.7900000401 4.3600000401 2.70000004 23 2.7400000401 4.3500000401 2.70000004 24 2.8700000401 4.3500000401 2.70000004 25 2.7500000401 4.3500000401 2.70000004 31 2.100000001 4.5000000401 2.70000004 32 2.760000001 4.5000000401 3.00000004 33 2.7600000401 4.3400000401 3.20000004 34 2.8500000401 4.3400000401 3.00000004 35 2.7600000401 4.3500000401 3.00000004 36 2.8600000401 4.5500000401 3.000000004 37 2.8800000401 4.5500000401 3.00000000000000000000000000000000000	12 2.8000000401 4.2100000401 2.9000000401 13 2.6600000401 4.1500000401 2.9000000404 14 2.9100000401 4.1500000401 2.9000000404 15 2.8600000401 4.2500000401 2.40000040 21 3.0300000401 4.2500000401 2.400000040 22 2.7900000401 4.2500000401 2.600000040 23 2.7400000401 4.2500000401 2.600000040 25 2.7500000401 4.2500000401 2.700000040 25 2.8500000401 4.2500000401 2.800000040 25 2.8500000401 4.2500000401 2.200000040 25 2.8500000401 4.2500000401 2.200000040 25 2.8500000401 4.2500000401 2.200000040 25 2.8500000401 4.2500000401 2.800000040 25 2.8500000401 4.2500000401 2.700000040 25 2.8500000401 4.2500000401 2.700000040 25 2.8500000401 4.2500000401 2.700000040 25 2.8500000401 4.2500000401 3.00000040 25 2.850000401 4.250000401 3.000000401 25 2.850000401 4.250000401 3.000000401 25 2.850000401 4.250000401 3.000000401 25 2.850000401 4.250000401 3.000000401 25 2.850000401 4.250000401 3.0000010400401 25 2.850000401 4.250000401 3.0000401 25 2.850000401 4.250000401 3.0000401 25 2.850000401 4.250000401 3.0000401 25 2.850000401 4.250000401 3.0000401 25 2.850000401 4.250000401 3.0000401 25 2.850000401 4.250000401 3.0000401 25 2.850000401 4.250000401 3.0000401 25 2.850000401 4.250000401 3.0000401 25 2.850000401 4.250000401 3.0000401 25 2.850000401 4.250000401 3.0000401 25 2.850000401 4.250000401 3.0000401 25 2.850000401 4.250000401 3.0000401 25 2.850000401 4.250000401 3.0000401 25 2.850000401 4.250000401 3.0000401 25 2.850000401 4.250000401 3.0000401 25 2.850000401 4.2500000401 3.0000401 25 2.850000401 4.250000401 3.0000401 25 2.850000401 4.250000401 3.0000401 25 2.850000401 4.250000401 3.0000401 25 2.850000401 4.250000401 3.0000401 25 2.850000401 4.250000401 3.0000401 25 2.850000401 4.250000401 3.0000401 25 2.85000040401 4.25000401 3.0000401	11	5.9900000+0	.1300000+0	.0000000.
13 2.660000401 4.160000401 2.900000401 14 2.900000401 4.150000401 2.60000000 21 3.030000401 4.2500000401 2.6000000+ 22 2.7900000401 4.2500000401 2.7000000+ 23 2.7400000401 4.2500000401 2.4000000+ 24 2.800000401 4.3500000401 2.4000000+ 25 2.7500000401 4.3500000401 2.60000000+ 31 3.1100000401 4.5000000401 2.600000000+ 32 2.7600000401 4.5000000401 3.00000000+ 33 2.7600000401 4.5000000401 3.00000000000000000000000000000000000	13 2.660000401 4.1500000401 2.900000401 14 2.900000401 4.1500000401 2.6000000401 15 2.8600000401 4.1500000401 2.6000000000000000000000000000000000000	12	2.80000000+0	.2100000+0	0+0000006.
14 2-9100000+01 4,1300000+01 2,6000000000000000000000000000000000000	14 2.910000+01 4.1300000+01 2.6000000+01 2.50000000+01 2.3.0300000+01 4.3500000+01 2.4000000+01 2.5000000+01 2.5000000+01 2.5000000+01 2.5000000+01 2.5000000+01 2.5000000+01 2.5000000+01 2.5000000+01 2.5000000+01 2.5000000+01 2.5000000+01 3.5000000+01 3.5000000+01 3.50000000+01 3.00000000+01 3.50000000+01 3.50000000+01 3.50000000+01 3.5000000+01 3.50000000+01 3.5000000+01 3.5000000+01 3.5000000+01 3.5000000+01 3.50000000+01 3.50000000+01 3.50000000+01 3.5000000+01 3.50000000+01 3.50000000+01 3.50000000+01 3.50000000+01 3.5000000+01 3.50000000+01 3.5000000+01 3.5000000+01 3.5000000+01 3.50000000+01 3.50000000+01 3.50000000+01 3.50000000+01 3.50000000+01 3.500000000+01 3.500000000+01 3.50000000+01 3.50000000+01 3.5000000000000000000000000000000000000	13	2.6600000+0	.1600000+0	0+000006.
15 2.8600000+01 4.2500000+01 2.4000000+ 21 3.0300000+01 4.3600000+01 2.00000+ 22 2.700000+01 4.3600000+01 2.000000+ 23 2.7400000+01 4.3500000+01 2.4000000+ 24 2.8700000+01 4.3500000+01 2.7000000+ 25 2.7500000+01 4.500000+01 2.000000+ 31 3.1100000+01 4.500000+01 3.0000000+ 35 2.760000+01 4.500000+01 3.000000+ 36 2.8600000+01 4.3600000+01 3.0000000+ 37 2.8600000+01 4.3600000+01 3.0000000+ 38 2.8600000+01 4.3600000+01 3.0000000+ 39 2.8600000+01 4.3600000+01 3.0000000+ 30 2.8600000+01 4.3600000+01 3.0000000+ 30 2.8600000+01 4.3600000+01 3.0000000+ 30 2.8600000+01 4.36000000+01 3.00000000+ 30 2.8600000+01 4.3600000+01 3.00000000+ 30 2.8600000+01 4.3600000+01 3.00000000000000000000000000000000000	15 2.860000+01 4.250000+01 2.405000+0 21 3.030000+01 4.360000+01 2.4050000+0 22 2.7900000+01 4.3600000+01 2.6000000+0 23 2.7400000+01 4.3500000+01 2.4000000+0 24 2.8700000+01 4.3500000+01 2.400000+0 25 2.7500000+01 4.3500000+01 2.400000+0 31 3.110000+01 4.3500000+01 2.8000000+0 32 2.760000+01 4.3500000+01 2.8000000+0 33 2.760000+01 4.3500000+01 2.000000+0 34 2.8500000+01 4.3500000+01 2.000000+0 35 2.860000+01 4.3500000+01 3.000000+0 36 2.860000+01 4.3500000+01 3.000000+0 37 2.8500000+01 4.3500000+01 3.000000+0 38 2.8500000+01 4.3500000+01 3.000000+0 38 2.8500000+01 4.3500000+01 3.000000+0 38 2.8500000+01 8.88 1.200000+01 1.200000+0 38 2.8500000+01 8.88 1.20000+01 1.200000+0 38 38 38 38 38 38 38 38 38 38 38 38 38 3	14	2.9100000+0	.1300000+0	.60000000
21 3.0300000+01 4.3600000+01 2.7000000+02 2.7000000+01 2.7000000+01 2.700000+01 2.2000000+01 2.2000000+01 2.2000000+01 2.2000000+01 2.2000000+01 2.20000000+01 2.20000000+01 2.20000000+01 2.20000000+01 2.20000000+01 2.20000000+01 2.20000000+01 2.20000000+01 2.20000000+01 2.20000000+01 2.200000000+01 2.20000000+01 2.20000000+01 2.20000000+01 2.20000000+01 2.20000000+01 2.20000000+01 2.200000000+01 2.200000000+01 2.200000000+01 2.20000000+01 2.200000000+01 2.200000000+01 2.200000000+01 2.200000000+01 2.200000000+01 2.20000000+01 2.20000000+01 2.20000000+01 2.20000000+01 2.20000000+01 2.20000000+01 2.20000000+01 2.20000000+01 2.20000000+01 2.20000000+01 2.20000000+01 2.20000000+01 2.20000000+01 2.200000000+01 2.200000000+01 2.200000000+01 2.200000000+01 2.200000000+01 2.200000000+01 2.200000000+01 2.200000000+01 2.200000000+01 2.200000000+01 2.200000000+01 2.20000000000000000000000000000000000	21 3.030000+01 4.360000+01 2.700000+00 22 2.700000+01 4.360000+01 2.600000+0 23 2.7400000+01 4.3500000+01 2.6000000+0 24 2.8700000+01 4.3500000+01 2.400000+0 25 2.7500000+01 4.3500000+01 2.600000+0 31 3.1100000+01 4.5000000+01 2.600000+0 32 2.760000+01 4.500000+01 2.600000+0 33 2.760000+01 4.500000+01 3.000000+0 34 2.650000+01 4.500000+01 3.000000+0 35 2.8600000+01 4.520000+01 3.000000+0 36 2.860000+01 4.520000+01 3.000000+0 37 3.87333+01 8088 1.20716+01 8SY 2.4293478+01 4.11V	15	2.8600000+0	.2500000+0	.40000004.
22 2.7900000401 4.3000000401 2.6000000000000000401 2.7400000401 4.2500000401 2.400000004 24 2.8700000401 4.3500000401 2.400000004 25 2.7500000401 4.3600000401 2.800000004 35 2.760000401 4.5000000401 3.000000004 35 2.7800000401 4.5000000401 3.00000000000000000000000000000000000	22 2.790000401 4.300000401 2.6000000000000000000000000000000000000	21	3.0300000+0	.3600000+0	.70000004.
23 2.7400000401 4.2500000401 2.4000000 24 2.800000401 4.3500000401 2.70000004 25 2.7500000401 4.3900000401 2.80000004 32 2.7500000401 4.5000000401 2.60000004 33 2.7800000401 4.5000000401 3.000000004 34 2.8500000401 4.3400000401 3.20000004 35 2.8800000401 4.3400000401 2.7000004 36 2.8500000401 4.3500000401 2.7000004 37 2.8800000401 4.3500000401 3.00000004 38 2.8500000401 4.3400000401 2.7000004 39 2.8800000401 4.340000401 2.7000004 30 2.88000000401 4.340000401 2.700000404 30 2.88000000401 4.340000401 3.00000004	23 2.740000+01 4.5500000+01 2.4000000+0 24 2.800000+01 4.3340000+01 2.7000000+0 25 2.7500000+01 4.3940000+01 2.7000000+0 31 3.1100000+01 4.5000000+01 2.6000000+0 33 2.7600000+01 4.5000000+01 3.2000000+0 34 2.8500000+01 4.3400000+01 3.2000000+0 35 2.8600000+01 4.3400000+01 2.7000000+0 36 2.8600000+01 4.3400000+01 2.7000000+0 37 2.8600000+01 4.3400000+01 2.7000000+0 38 2.8500000+01 8.3400000+01 3.000000+0 300000+01 878AR 1.207745+00 85Y 2.4293478+01 4.1700000+0 000000+00 888AR 2.9519987+01 85E	22	2.7900000+0	.30000000+0	.60000000.
24 2.85700000401 4.3300000401 2.70000004 25 2.7500000401 4.39000000101 2.800000004 32 2.7500000401 4.5000000401 3.00000004 33 2.7500000401 4.5000000401 3.00000004 34 2.6500000401 4.3400000401 3.20000004 35 2.8500000401 4.340000401 3.000000003 35 2.8800000401 4.5500000401 3.000000003 35 3800000401 4.5500000401 3.00000000000000000000000000000000000	24 2.8700000+01 4.3500000+01 2.7000000+01  25 2.7500000+01 4.3500000+01 2.8000000+0  31 3.1100000+01 4.5000000+01 2.6000000+0  32 2.7600000+01 4.5000000+01 3.000000+0  33 2.7600000+01 4.5000000+01 3.000000+0  34 2.8500000+01 4.500000+01 2.7000000+0  35 2.8500000+01 4.5300000+01 3.000000+0  35 3.8500000+01 8.88 1.3478431+00 85Y 2.4293478+01 4.11V	23	2.7400000+0	.2500000+0	.4000000+0
25 2.7500000-01 4.3900000-01 2.8000000-03 3 3.11000000-01 4.5900000-01 2.60000000-03 2 2.7600000-01 4.5000000-01 3.0000000-03 2 2.7600000-01 4.3400000-01 3.0000000-03 2 2.86500000-01 4.3700000-01 2.7000000-03 2.8800000-01 4.3500000-01 3.0000000-01 3.00000000000000000000000000000000000	25 2.750000401 4.3900000401 2.800000000 31 3.1100000401 4.5000000401 2.600000040 32 2.7600000401 4.50000000401 3.0000000040 33 2.7800000401 4.5400000401 3.200000040 34 2.8500000401 4.1700000401 2.770000040 35 2.8800000401 4.550000401 2.770000040 353333401 878AR 1.207755540 85Y 2.4293478401 %ULY 00000400 \$E8AR 2.9519987-01 \$SE	24	2.8700000+0	.3300000+0	.7000000+0
31 3.1100000+01 4.5000000+01 2.6000000+ 32 2.7600000+01 4.5000000+01 3.000000000+ 33 2.7800000+01 4.3400000+01 3.2000000+ 34 2.6500000+01 4.1700000+01 2.7000000+ 35 2.88000000+01 4.5500000+01 2.7000000+ 35 2.88000000+01 3.400000+01 3.40000000+ 35.000000000000000000000000000000000000	31 3.1100000+01 4.5000000+01 2.600000+0 32 2.7600000+01 4.5000000+01 3.200000000 33 2.7600000+01 4.3400000+01 3.2000000+0 34 2.6600000+01 4.7700000+01 2.7700000+0 20000+01 8YBAR 1.207765+01 SSY 2.4293478+01 %-ILLY 333335+01 %-ILLY 34 2.9519987+01 %-ILLY 35 2.860000+01 3.00000+01 3.000000+0	25	2,75000000+0	.39000000.	.80000000.
32 2.760000001 4.500000001 3.00000000000000000000000000000	32 2.7600000+01 4.56000000+01 3.0000000+0 33 2.7600000+01 4.3400000+01 3.20000000+01 34 2.9500000+01 4.1700000+01 2.7000000+0 35 2.8600000+01 4.550000+01 3.000000+0 20000+01 SYBAR 1.207745+00 SSY 2.4293478+01 4.ITUV 33333+01 4.00AR 1.3476431+00 SSY 2.4293478+01 4.ITUV 300000+00 SEBAR 2.9519987-01 SSE	31	3.1100000+0	.50000000.	0+00000009.
33 2.780000001 4.3400000001 3.200000000 34 2.8500000001 4.3700000001 3.7000000000000000000000000000000000000	33 2.7800000401 4.3400000401 3.200000004 34 2.6500000401 4.1700000401 2.7700000040 200000401 \$YBAR 1.2007165400 8SY 2.4293478+01 LLLY 33333401 \$UBAR 1.3478431400 8SY 2.4293478+01 LLLY 000000400 8EBAR 2.9519987-01 8SU 3.628926+01 1-LLLU	32	2.7600000+0	.5000000+0	.0000000.
34 2.4550000011 4.1700000001 2.7000000	34 2.8500000+01 4.1700000+01 2.7000000+0 35 2.8800000+01 4.5500000+01 3.000000+01 3.3535000000000000000000000000000000000	33	2.7800000+0	.3400000+0	.20000000+0
35 2.8800000401 4.5360000+01 3.0000000+00 200000000 200000000 887 2.4293478+01 %LTL 33333+01 %UBAR 1.3478431+00 \$SU 3.828926+01 %LTL	35 2.8800000401 4.5300000401 3.000000040 20000401 379AR 1.2007455400 SSY 2.4293478401 %LTLY 33333401 340AR 1.3476431400 SSU 3.82889264401 %LTLU 000000400 \$E8AR 2.9519987-01 \$SE	34	2.850000000	.1700000+0	.74000000+0
20000+01 \$YBAR 1.2007165+00 \$SY 2.4293478+01 %LTL 33333+01 \$UBAR 1.3478431+00 \$SU 3.8288926+01 %LTL	33333401 \$YBAR 1.2007165400 \$SY 2.4293478401 1LTL 33333401 \$UBAR 1.3478431+00 \$SU 3.828926401 \$LTL 000000400 \$EBAR 2.9919987-01 \$SE	3	2.8800000+01	4.5300000+01	3.00000000+0
35353+01 \$UBAR 1.3478431+00 \$SU 3.8288926+01 %L	33333+01 \$UBAR 1.3478431+00 \$SU 3.8288926+01 \$L 000000+00 \$EBAR 2.9519987=01 \$SE	20000+0	\$YBAR 1.200716	+00 \$SY 2,429	478+01 +LTL
	000001+00 SEBAR 2.9519987-01 \$S	35353+0	\$UBAR 1.347843	+00 SSU 3.828	926+01 %L

### TABLE I-3. (Cont'd)

### UNIAXIAL TENSILE TEST RESULTS ON 2219-T87 AND X7106-T63 ALUMINUM ALLOY WELDMENTS

EL 2219-187 TIG 2319 CROSS  12 3.0000000-01 4.8800000-01 2.2000000-0  13 3.0000000-01 4.3800000-01 1.5000000-0  14 3.0000000-01 4.300000-01 1.5000000-0  15 3.0000000-01 4.300000-01 1.5000000-0  16 3.0000000-01 4.300000-01 1.5000000-0  17 3.0000000-01 4.00000-01 1.5000000-0  18 2.9200000-01 4.00000-01 1.5000000-0  18 2.9200000-01 4.00000-01 1.5000000-0  19 3.000000-01 4.00000-01 1.5000000-0  2 2.9200000-01 4.200000-01 1.5000000-0  2 2.9200000-01 4.200000-01 1.5000000-0  10 3.000000-01 4.200000-01 1.5000000-0  10 3.000000-01 4.200000-01 1.5000000-0  10 3.000000-01 4.200000-01 1.500000-0  10 3.000000-01 4.200000-01 1.500000-0  10 3.000000-01 4.200000-01 1.500000-0  10 3.000000-01 4.200000-01 1.500000-0  11 3.5000000-01 4.200000-01 1.500000-0  11 3.5000000-01 4.200000-01 1.500000-0  11 3.5000000-01 4.200000-01 1.500000-0  11 3.5000000-01 4.200000-01 1.500000-0  11 3.5000000-01 4.200000-01 1.500000-0  11 3.5000000-01 4.200000-01 1.500000-0  11 3.5000000-01 4.200000-01 1.500000-0  11 3.5000000-01 4.20000-01 1.5000000-0  11 3.5000000-01 4.20000-01 1.500000-0  11 3.5000000-01 4.200000-01 1.500000-0  11 3.5000000-01 4.20000-01 1.500000-0  12 3.000000-01 4.20000-01 1.500000-0  13 3.000000-01 4.20000-01 1.500000-0  14 3.100000-01 1.50000-01 1.500000-0  15 3.000000-01 4.20000-01 1.500000-0  16 3.5000000-01 4.20000-01 1.500000-0  17 3.5000000-01 4.20000-01 1.500000-0  18 3.5000000-01 4.20000-01 1.500000-01 1.500000-0  10 3.5000000-01 4.20000-01 1.50000-01 1.500000-0  10 3.5000000-01 4.20000-01 1.50000-01 1.500000-0  10 3.5000000-01 1.50000-01 1.50000-01 1.50000-0  10 3.5000000-01 1.500000-01 1.50000-01 1.50000-01 1.50000-01 1.50000-01 1.50000-01 1.50000-01 1.50000-01 1.50000-01 1.50000-01 1.50000-01 1.50000-01 1.50000-01 1.50000-01 1.50000-01 1.50000-01 1.50000-01 1.50000-01		UMBER	<b>&gt;</b>	ח	ند
11 3.1000100.0.0.1 4.800010.0.0.1 2.2000.00.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0	LABEL	oc.	TIG 2319 CR0S		
12 3.972000000000000000000000000000000000000		11	3.10000000+0	800000+0	.2000000+0
13 2.9700000001 4 4370000001 1.500000000000000000000000000000		12	3.0700000	3600000+0	.00000000.
14 3.0900000+01 4.4300000+01 1.90000000+01 1.90000000+01 1.90000000+01 1.90000000+01 1.90000000+01 1.90000000+01 1.90000000+01 1.90000000+01 1.90000000+01 1.90000000+01 1.9000000+01 1.90000000+01 2.9200000+01 4.1000000+01 1.9000000+01 2.9200000+01 4.1000000+01 1.9000000+01 2.9200000+01 4.1000000+01 1.9000000+01 2.9200000+01 4.1000000+01 1.9000000+01 2.9200000+01 4.1000000+01 1.9000000+01 2.9200000+01 1.900000+01 1.9000000+01 1.900000+01 1.9000000+01 1.900000+01 1.9000000+01 1.9000000+01 1.9000000+01 1.900000+01 1.900000+01 1.9000000+01 1.9000000+01 1.9000000+01 1.900000+01 1.900000+01 1.900000+01 1.900000+01 1.900000+01 1.900000+01 1.900000+01 1.900000+01 1.900000+01 1.900		13	2.9700000+0	3700000+0	.53000000+0
15   3,100 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0		41	3.09000000	.4300000+0	.1006000+0
81 2.9200000401 3.830000401 1.800000040 82 2.9200000401 4.100000401 1.8000000401 84 2.9300000401 4.100000401 1.5000000401 92 2.9200000401 4.100000401 1.5000000401 93 2.9200000401 4.200000401 1.5000000401 94 2.860000401 4.200000401 1.5000000401 95 2.800000401 4.200000401 1.50000000401 95 3.1300000401 4.200000401 1.5000000401 96 3.1300000401 4.200000401 1.5000000401 97 3.000000401 4.200000401 1.5000000401 98 3.1300000401 4.200000401 1.5000000401 99 3.1300000401 4.200000401 1.5000000401 90 3.000000401 4.200000401 1.5000000401 90 3.000000401 4.200000401 1.5000000401 91 3.000000401 4.200000401 1.5000000401 92 3.00000401 4.200000401 1.5000000401 93 3.00000401 4.200000401 1.5000000401 94 3.200000401 4.200000401 1.5000000401 95 3.400000401 4.200000401 1.5000000401 96 3.400000401 4.200000401 1.5000000401 97 3.400000401 4.200000401 1.5000000401 98 3.400000401 5.00000401 3.500000401 99 3.400000401 5.00000401 3.200000401 99 3.400000401 5.00000401 3.200000401 99 3.400000401 5.00000401 3.200000401 90 3.400000401 5.00000401 3.200000401 90 3.400000401 5.00000401 3.200000401 90 3.400000401 5.00000401 3.200000401 90 3.400000401 5.00000401 3.200000401 90 3.400000401 5.000000401 3.200000401 90 3.400000401 5.000000401 3.200000401 90 3.400000401 5.000000401 3.200000401 90 3.400000401 5.000000401 3.200000401 90 3.400000401 5.000000401 3.200000401 90 3.400000401 5.00000401 3.200000401 90 3.400000401 5.000000401 3.200000401 90 3.400000401 5.00000401 3.200000401 90 3.400000401 5.00000401 3.200000401 90 3.400000401 5.00000401 3.200000401 90 3.400000401 5.00000401 3.200000401 3.200000401 90 3.4000000401 5.00000401 3.200000401 90 3.400000401 5.00000401 3.200000401 90 3.400000401 5.00000401 3.200000401 3.200000401 90 3.4000000401 5.00000401 3.200000401 3.200000401 3.200000401 3.200000401 3.200000401 3.200000401 3.200000401 3.200000401 3.200000401 3.200000401 3.200000401 3.200000401 3.200000401 3.200000401 3.200000401 3.200000401 3.200000401 3.200000401 3.2000040401 3.2000040401 3.200000401 3.2000040401 3.2000040401 3.2000040401 3.2000040401		15	3,10000000+0	3300000+0	0+0000006
82 2.9200000401 3.790000401 1.30000000000000000000000000000000000		100	2.9200000+0	830000+0	8000000+0
84 2.500000+01 4.050000+01 1.5000000+01 2.0000000+01 2.5000000+01 4.1000000+01 2.0000000+01 2.5000000+01 2.5000000+01 2.50000000+01 2.5000000+01 2.5000000+01 2.5000000+01 3.5000000000000000000000000000000000000		88	2.9200000+0	7900000+0	0+00000000
84 2.9300000001 4.100000001 1.40000000000000000		88	3.0400000+0	.0500000+0	.5000000+0
94 2.9200000401 4,000000401 2,000000040 95 2.8600000401 4,2100000401 1,900000040 96 2.8600000401 4,200000401 1,900000040 97 2.9100000401 4,200000401 1,900000040 98 2.9100000401 4,200000401 1,900000040 99 2.8000000401 4,200000401 1,900000040 99 2.9200000401 1,900000401 1,900000040 99 2.9200000401 1,900000401 1,900000040 99 2.9200000401 1,900000401 1,900000040 99 2.9200000401 1,900000401 1,900000040 99 2.9200000401 1,900000401 1,90000040 99 2.9200000401 1,900000401 1,90000040 99 2.9200000401 1,900000401 1,900000401 90 2.9200000401 1,900000401 1,900000400401 90 2.9200000401 1,90000401 1,900000400401 90 2.9200000401 1,90000401 1,9000000401 90 2.9200000401 1,90000401 1,900000401 90 2.920000401 1,90000401 1,900000401 90 2.920000401 1,90000401 1,900000401 90 2.920000401 1,900000401 1,900000401 90 2.920000401 1,900000401 1,900000401 90 2.920000401 1,900000401 2,900000401 2,900000401 90 2.920000401 2,900000401 3,900000401 3,900000401 3,900000401 4,900000401 3,900000401 4,900000401 3,900000401 4,900000401 3,9		4.8	2.9300000	10000001	.4000000+0
91 2.910000+01 4.170000+01 2.200000+01 9.2 2.8800000+01 4.22000000+01 1.9000000+0 9.3 2.9100000+01 1.9000000+0 9.3 2.9100000+01 1.9000000+0 9.3 2.9100000+01 1.9000000+0 9.3 2.9100000+01 1.9000000+0 9.3 2.9100000+01 4.100000+01 1.9000000+0 9.3 2.900000+01 4.100000+01 1.9000000+0 9.3 2.900000+01 4.100000+01 1.9000000+0 9.3 2.900000+01 1.9000000+0 9.3 2.900000+01 1.9000000+0 9.3 2.900000+01 1.9000000+0 9.3 2.900000+01 1.9000000+0 9.3 2.900000+0 9.3 2.900000+0 9.4 2.900000+0 9.3 2.900000+0 9.4 2.900000+0 9.3 2.900000+0 9.4 2.900000+0 9.3 2.900000+0 9.3 2.900000+0 9.4 2.900000+0 9.3 2.9000000+0 9.3 2.900000+0 9.3 2.900000+0 9.3 2.9000000+0 9.3 2.9000000+0 9.3 2.9000000+0 9.3 2.9000000+0 9.3 2.9000000+0 9.3 2.9000000+0 9.3 2.9000000+0 9.3 2.9000000+0 9.3 2.9000000+0 9.3 2.9000000+0 9.3 2.9000000+0 9.3 2.9000000+0 9.3 2.9000000+0 9.3 2.90000		85	2,9200000+0	0+00000000	0.0000000.
92 2.860000+01 4.220000+01 1.900000+0 93 2.900000+01 2.000000+01 2.000000+0 94 2.860000+01 3.8800000+01 2.000000+0 101 3.1500000+01 4.3100000+01 1.9000000+0 102 3.000000+01 3.9900000+01 1.5000000+0 103 2.9400000+01 3.9900000+01 1.5000000+0 104 2.9700000+01 4.3200000+01 1.9000000+0 115 3.000000+01 4.3200000+01 1.000000+0 115 3.000000+01 4.3200000+01 1.000000+0 115 3.000000+01 4.3200000+01 1.000000+0 115 3.000000+01 4.300000+01 1.000000+0 115 3.000000+01 4.300000+01 1.000000+0 115 3.2500000+01 4.300000+01 1.000000+0 122 3.040000+01 4.3200000+01 1.000000+0 123 3.040000+01 4.200000+01 1.000000+0 124 3.2500000+01 4.200000+01 1.000000+0 125 3.040000+01 4.200000+01 1.000000+0 126 3.890000+01 4.200000+01 1.3000000+0 127 3.500000+01 4.200000+01 3.100000+0 128 3.640000+01 5.900000+01 3.100000+0 129 3.640000+01 5.00000+01 3.100000+0 129 3.640000+01 5.00000+01 3.100000+0 129 3.640000+01 5.00000+01 3.100000+0 129 3.640000+01 5.00000+01 3.100000+0 129 3.640000+01 5.00000+01 3.100000+0 129 3.640000+01 5.00000+01 3.100000+0 129 3.640000+01 5.00000+01 3.100000+0 120 3.640000+01 5.00000+01 3.100000+0 120 3.640000+01 5.00000+01 3.100000+0 120 3.640000+01 5.00000+01 3.100000+0 120 3.640000+01 5.00000+01 3.1		91	2.9100000+0	.1700000+0	.2000000-0
93 2.910000+01 3.800000+01 1.900000+0 94 2.860000+01 4.100000+01 1.500000+0 95 3.1500000+01 4.100000+01 1.500000+0 101 3.1500000+01 4.100000+01 1.800000+0 102 3.000000+01 4.100000+01 1.800000+0 103 2.9700000+01 4.100000+01 1.8000000+0 113 3.000000+01 4.200000+01 1.8000000+0 113 3.000000+01 4.200000+01 1.000000+0 113 3.000000+01 4.200000+01 1.000000+0 113 3.000000+01 4.200000+01 1.000000+0 114 3.100000+01 4.200000+01 1.000000+0 115 3.000000+01 4.200000+01 1.000000+0 115 3.000000+01 4.200000+01 1.000000+0 116 3.000000+01 4.200000+01 1.000000+0 117 3.000000+01 4.200000+01 1.000000+0 118 3.000000+01 4.200000+01 1.000000+0 119 3.000000+01 4.200000+01 1.000000+0 110 3.000000+01 4.200000+01 1.00000+0 110 3.000000+01 5.00000+01 3.000000+0 110 3.000000+01 5.00000+01 3.000000+0 12 3.000000+01 5.00000+01 3.000000+0 12 3.000000+01 5.00000+01 3.000000+0 12 3.000000+01 5.00000+01 3.000000+0 12 3.000000+01 5.00000+01 3.000000+0 12 3.000000+01 5.00000+01 3.00000+0 12 3.000000+01 5.00000+01 3.00000+0 12 3.000000+01 5.00000+01 3.00000+0 12 3.000000+01 5.00000+01 3.00000+0 12 3.000000+01 5.00000+01 3.00000+0 12 3.000000+01 5.00000+01 3.00000+0 12 3.000000+01 5.00000+01 3.00000+0 12 3.000000+01 5.00000+01 5.00000+01 3.00000+01 5.000000+01 5.00		3.6	2,88000000	.2200000+0	0+0000006.
94 2.860000401 4,09000401 2,00000040 101 3.150000401 1,1500000401 1,500000401 1,50000040 1,00000401 1,500000400 1,00000401 1,500000400 1,00000401 1,5000000401 1,500000040 1,000000401 1,500000040 1,000000401 1,500000040 1,000000401 1,500000040 1,00000040 1,50000040 1,50000040 1,500000040 1,500000040 1,50000040 1,50000040 1,50000040 1,50000040 1,50000040 1,50000040 1,50000040 1,50000040 1,50000040 1,50000040 1,50000040 1,50000040 1,50000040 1,50000040 1,50000040 1,50000040 1,500000040 1,500000040 1,500000040 1,500000040 1,50000040 1,50000040 1,50000040 1,50000040 1,50000040 1,50000040 1,50000040 1,50000040 1,50000040 1,50000040 1,50000040 1,50000040 1,50000040 1,50000040 1,50000040 1,50000040 1,50000040 1,50000040 1,5000040 1,50000040 1,50000040 1,50000040 1,500000		56	2.9100000+0	.88000000+0	0+0000006*
101 3.150000401 4.310000401 1.500000401 103 3.1500000401 1.5000000401 103 3.000000401 1.5000000401 103 3.000000401 1.5000000401 103 3.000000401 1.5000000401 118 3.000000401 1.5000000401 113 3.000000401 4.3200000401 1.500000040 113 3.000000401 4.3200000401 1.00000040 113 3.000000401 4.3200000401 1.00000040 113 3.000000401 4.3200000401 1.00000040 113 3.000000401 4.3200000401 1.000000040 113 3.000000401 4.3200000401 1.00000040 113 3.000000401 4.3200000401 1.500000040 112 3.000000401 4.3200000401 1.500000040 112 3.000000401 4.3200000401 1.500000040 112 3.000000401 4.3200000401 1.500000040 112 3.000000401 4.3200000401 1.500000040 112 3.000000401 4.2000000401 1.500000040 112 3.000000401 4.2000000401 1.500000040 112 3.000000401 4.2000000401 1.500000040 112 3.000000401 4.200000401 3.00000401 3.000000401 3.0		40	2.86000000+0	0+0000060	0+00000000
101 3.1500000+01 4.100000+01 1.500000+0 102 3.000000+01 4.8000000+01 1.3000000+0 103 2.9400000+01 4.8000000+01 1.3000000+0 104 2.9700000+01 4.3200000+01 1.6000000+0 112 3.000000+01 4.3200000+01 1.000000+0 113 3.0900000+01 4.300000+01 1.000000+0 114 3.100000+01 4.300000+01 1.000000+0 115 3.0900000+01 4.300000+01 1.000000+0 122 3.040000+01 4.300000+01 1.9000000+0 123 3.2500000+01 4.2400000+01 1.5000000+0 124 3.2500000+01 4.2400000+01 1.5000000+0 125 3.600000+01 4.2400000+01 1.5000000+0 126 3.2500000+01 4.200000+01 1.5000000+0 127 3.500000+01 4.200000+01 1.5000000+0 128 3.500000+01 4.200000+01 1.5000000+0 1.669901 SEBAR 1.366319+00 SSY 2.627369+01 SLTV 1.6689655+00 SEBAR 3.5365791+01 SSE 61 3.6500000+01 5.4700000+01 3.1000000+0 62 3.8900000+01 5.4700000+01 3.1000000+0 63 4.0200000+01 5.4700000+01 3.2000000+0 64 4.0100000+01 5.4700000+01 3.2000000+0 65 3.6400000+01 5.040000+01 3.200000+0 65 3.6400000+01 5.000000+01 3.200000+0 65 3.6400000+01 5.000000+01 3.200000+0 65 3.6400000+01 5.000000+01 3.100000+0 65 3.6400000+01 5.000000+01 3.1000000+0 65 3.6400000+01 5.000000+01 3.100000+0 65 3.6400000+01 5.000000+01 3.100000+0 65 3.6400000+01 5.000000+01 3.100000+0 65 3.6400000+01 5.00000+01 3.100000+0 65 3.6400000+01 5.000000+01 3.100000+0 65 3.6400000+01 5.000000+01 3.100000+0 65 3.6400000+01 5.00000+01 3.100000+0 65 3.6400000+01 5.000000+01 3.100000+0 65 3.6400000+01 5.00000+01 3.100000+0 65 3.6400000+01 5.00000+01 3.100000+0 65 3.6400000+01 5.00000+01 3.100000+0 65 3.6400000+01 5.00000+01 3.100000+0 65 3.6400000+01 5.00000+01 3.100000+0 65 3.6400000+01 5.00000+01 3.100000+0 65 3.6400000+01 5.00000+01 3.100000+0 65 3.6400000+01 5.00000+01 3.10000+01 3.1000		95	3.1300000.	.3100000+0	.10000001.
102 3.000000401 3.990000401 1.8000000401 1.8000000401 10.2 2.9700000401 4.28000000401 1.80000000401 1.800000401 1.80000401 1.800000401 1.800000401 1.800000401 1.80000401 1.80000401 1.8000040401 1.8000040401 1.8000040401 1.8000040401 1.8000040401 1.8000040401 1.8000040401 1.80000404		0	3.1500000+0	1000000+0	.5000000+0
103 2.940000401 4.080000401 1.300000401 104 2.9700000401 4.3200000401 1.6000000401 105 3.0600000401 4.3200000401 1.6000000401 112 3.0900000401 4.100000401 1.000000401 113 3.0900000401 4.100000401 1.000000401 114 3.100000401 4.3500000401 1.9000000401 125 3.060000401 4.2500000401 1.5000000401 126 3.260000401 4.2200000401 1.5000000401 127 3.2500000401 4.2200000401 1.600000401 128 3.2500000401 4.2000000401 1.600000401 129 3.2500000401 4.2000000401 1.6000000401 120 3.180000401 4.2000000401 1.6000000401 120 3.8500000401 4.2000000401 1.6000000401 120 3.8500000401 5.620000401 3.6091000401 1.668965500 \$EBAR 3.556591-01 \$		0	3.0000000	0+00000066.	.8300000+0
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113 3.090000401 4.100000401 1.000000001 114 5.1000000401 4.3500000401 1.90000000401 122 3.0400000401 4.2400000401 1.900000040 123 3.060000401 4.2400000401 1.500000040 124 3.2500000401 4.2000000401 1.500000040 125 3.160000401 4.2000000401 1.600000040 126 3.160000401 4.2000000401 1.400000040 1.668965540 5EBAR 1.3663599400 5SU 3.6091087401 5LLV 1.668965550 5EBAR 1.3663599400 5SU 3.6091087401 5LLV 1.668965550 5EBAR 3.5365941 01 5SE 61 3.6500000401 5.400000401 3.1000000400 62 3.8900000401 5.400000401 3.400000400 63 4.0500000401 5.400000401 3.200000400 64 4.010000401 5.400000401 3.200000400 72 3.6400000401 5.090000401 3.2000000400 73 3.6400000401 5.090000401 3.2000000400 73 3.6400000401 5.090000401 3.2000000400 73 3.6400000401 5.090000401 3.200000400 73 3.6400000401 5.090000401 3.200000400 73 3.6400000401 5.090000401 3.200000400 73 3.6400000401 5.090000401 3.1000000400 73 3.6400000401 5.090000401 3.1000000400 73 3.6400000401 5.090000401 3.1000000400 74 3.6400000401 5.090000401 3.1000000400 75 3.6400000401 5.090000401 3.1000000400 75 3.6400000401 5.000000401 3.1000000400 75 3.6400000401 5.000000401 3.1000000400 75 3.6400000401 5.000000401 3.1000000400 75 3.6400000401 5.000000401 3.1000000400 75 3.6400000401 5.000000401 3.100000400 75 3.6400000401 5.00000401 3.1000000400 75 3.6400000401 5.000000401 3.1000000400 75 3.6400000401 5.000000401 3.100000040004000400000400040004000400040		4	3.090000000	.1100000+0	0+0000000
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124 3.2500000+01 4.2000000+01 1.6000000+0 3.6500000+0 3.4600000+0 4.30000000-01 1.40000000+0 1.25 3.8000000+0 8SY 2.62369+01 8LTLU 1.6689655+01 8UBAR 1.8663199+00 SSU 3.6091087+01 8LTLU 1.6689655+01 8EBAR 3.5365791-01 \$SE 61 3.6500000+01 \$5.6091087+01 \$SLLU 62 3.8800000+01 \$5.4700000+01 3.1000000+01 63 4.0500000+01 \$5.4700000+01 3.5000000+01 64 4.0100000+01 \$5.4700000+01 3.5000000+01 65 4.0200000+01 \$5.4700000+01 3.5000000+01 65 4.0200000+01 \$5.4700000+01 3.5000000+01 65 3.6400000+01 \$5.4700000+01 2.2000000+01 65 3.6000000+01 \$7.900000+01 2.6000000+01 65 3.6000000+01 \$7.900000+01 2.6000000+01 68 3.600000+01 \$7.900000+01 2.5000000+01 69 3.6100000+01 \$7.900000+01 3.1000000+01 69 3.6100000+01 \$7.900000+01 3.1000000+01 69 3.6100000+01 \$7.900000+01 3.1000000+01 69 3.6100000+01 \$7.900000+01 3.1000000+01 69 3.6100000+01 \$7.900000+01 3.1000000+01 69 3.6100000+01 \$7.900000+01 3.1000000+01 69 3.6100000+01 \$7.900000+01 3.1000000+01 69 3.6100000+01 \$7.900000+01 3.1000000+01 69 3.6100000+01 \$7.900000+01 \$7.900000+01 60 3.6100000+01 \$7.900000+01 \$7.900000+01 60 3.6100000+01 \$7.9000000+01 \$7.900000+01 60 3.6100000+01 \$7.900000+01 \$7.9000000+01 \$7.900000+01 \$7.900000+01 \$7.900000+01 \$7.900000+01 \$7.9000	;	$\sim$	3.06000000	.0200000+0	.30000000.
3.0500000+01 \$YBAR 1.37680400 \$SY 2.6273069+01 \$LTV 4.1820689+01 \$VBAR 1.376804401 \$SY 2.6273069+01 \$LTV 4.1820689+01 \$VBAR 1.376804401 \$SY 3.6921087+01 \$LTV 1.6689655+01 \$EBAR 3.5365791-01 \$SE 5.6273069+01 \$LTV 1.6689655+01 \$EBAR 3.5365791-01 \$SE 5.6273069+01 \$LTV 1.669655+01 \$EBAR 3.5365791-01 \$SE 5.6273069+01 \$LTV 1.62736000401 \$SY 4.020000400 \$SY 4.020000400 \$SY 4.020000400 \$SY 4.020000400 \$SY 4.020000400 \$SY 4.020000400 \$SY 4.020000400 \$SY 4.020000400 \$SY 4.020000400 \$SY 4.020000400 \$SY 4.020000400 \$SY 4.020000400 \$SY 4.020000400 \$SY 4.020000400 \$SY 4.020000400 \$SY 4.020000400 \$SY 4.0200000400 \$SY 4.020000400 \$SY 4.020000400 \$SY 4.020000400 \$SY 4.0200000400 \$SY 4.020000400 \$SY 4.0200000400 \$SY 4.020000400 \$SY 4.020000400 \$SY 4.02000040000400 \$SY 4.020000400 \$SY 4.02000040000400 \$SY 4.020000400 \$SY 4.020000400 \$SY 4.02000040000400 \$SY 4.0200004000040000400004000040000400004		N	3.250000040	.20000002.	0+00000009.
3.0500000-01 \$YBAR 1.3766504-00 \$SY 2.6273069-01 \$LLY 4.689655-00 \$EBAR 1.8663:99-00 \$SU 3.6091687-01 \$LLY 1.8663:99-00 \$SU 3.6091687-01 \$LLY 1.6689655-00 \$EBAR 3.5365791-01 \$SE 6.091087-01 \$LLY 1.8663:99-00 \$SU 3.6091087-01 \$LLY 1.8663:99-00 \$SU 3.6091087-01 \$LLY 1.8689655-00 \$LLY 1.8683:99-00 \$SU 3.609108-01 \$LLY 1.86896899999999999999999999999999999999		12	3.18000000	.2000000+0	.40000004.
4.1820689.01 SUBAR 1.8663199+00 SSU 3.6091087+01 SLTLU 1.6689655-00 SEBAR 3.5365791-01 SSE	c	0+00000	\$YBAR 1.376850	+00 \$SY 2.62	3069+01 SLTLY
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### UNIAXIAL TENSILE TEST RESULTS ON 2014-T6 ALUMINUM ALLOY WELDMENTS

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2.2266667+01 \$EBAH 1.6681419+00 \$SU 4.1814807+01 2.2266667+00 \$EBAH 2.6313143+01 \$SE  ABEL 2014+76 MIG 4043 SINGLE 1 3.8400000+01 4.550000+01 2.2000 13 3.9700000+01 4.550000+01 2.2000 13 3.9700000+01 4.500000+01 2.2000 23 3.9500000+01 4.400000+01 2.5000 22 3.8400000+01 4.400000+01 1.2000 22 3.8400000+01 4.400000+01 1.2000 22 3.9500000+01 4.400000+01 1.5000 23 3.9500000+01 4.4800000+01 1.5000 23 3.950000+01 4.4800000+01 1.5000 23 3.950000+01 4.4800000+01 1.5000 23 3.950000+01 4.500000+01 1.60000 33 3.860000+01 4.860000+01 1.40000 33 3.860000+01 4.8600000+01 1.40000 35 4.000000+01 4.8600000+01 1.40000 35 4.000000+01 4.500000+01 1.70000 35 4.000000+01 4.500000+01 1.70000 35 4.000000+01 4.500000+01 1.70000 35 4.000000+01 4.500000+01 1.70000 35 4.000000+01 4.500000+01 1.70000 35 4.000000+01 4.500000+01 1.70000 35 4.0000000+01 4.500000+01 1.70000 35 4.0000000+01 4.500000+01 1.70000 35 4.0000000+01 4.500000+01 1.70000 35 4.0000000+01 4.500000+01 1.70000 35 4.0000000+01 4.500000+01 1.70000 35 4.0000000+01 4.00000+01 1.70000 35 4.0000000+01 4.00000+01 1.70000 35 4.0000000+01 4.00000+01 1.70000 35 4.0000000+01 4.000000+01 1.70000 35 4.00000000+01 4.000000+01 1.7000000+01 1.7000000+01 1.70000000000000000000000000000000000		10+0000	4.6700000+01	2.3000000+0
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2.2266667+00 \$EBAH 2.6313143-01 \$SE ABEL 2014-16 MIG 4043 SINGE 13.9400000401 4.4400000+01 2.2300 13.9700000+01 4.550000+01 2.2000 13.9700000+01 4.500000+01 2.2000 14.58600000+01 4.400000+01 2.5000 22.38600000+01 4.400000+01 1.2000 23.5960000+01 4.400000+01 1.5000 24.5960000+01 4.500000+01 1.5000 25.59600000+01 4.800000+01 1.5000 25.5960000+01 4.800000+01 1.40000 25.5960000+01 4.400000+01 1.70000 25.5960000+01 4.400000+01 1.70000 25.5960000+01 4.400000+01 1.70000 25.400000+01 4.400000+01 1.70000	.7686666+01 \$U	1.668141	+00 850 4.184	2017 to 4 11 11 1
2.2266667+0U \$EBAH 2.6313143-01 \$SE  AREL 2014-T6 MIG 4043 SINGLE  13.8400000+01  4.550000+01  2.3910000+01  4.550000+01  2.5000  2.145.8400000+01  4.550000+01  2.5000  2.25.8400000+01  4.500000+01  2.50000  2.500000+01  3.8400000+01  4.500000+01  4.500000+01  4.500000+01  4.500000+01  4.60000+01  4.60000+01  4.600000+01  4.60000+01  4.60000+01  4.60000+01  4.600000+01  4.600000+01  4.600000+01  3.9600000+01  4.600000+01  3.9600000+01  4.600000+01  3.9600000+01  4.600000+01  3.9600000+01  4.600000+01  3.9600000+01  4.600000+01  3.9600000+01  4.600000+01  3.9600000+01  4.600000+01  3.9600000+01  4.600000+01  3.9600000+01  4.600000+01  3.9600000+01  4.600000+01  3.9600000+01  4.600000+01  3.9600000+01  4.600000+01  3.9600000+01  4.6000000+01  4.600000+01  4.600000+01  4.600000+01  4.600000+01  4.6000000+01  4.600000+01  4.600000+01  4.600000+01  4.600000+01  4.600000+01  4.600000+01  4.600000+01  4.600000+01  4.600000+01  4.600000+01  4.600000+01  4.600000+01  4.600000+01  4.600000+01  4.60000000+01  4.6000000+01  4.6000000+01  4.6000000+01  4.6000000+01  4.6000000+01  4.6000000+01  4.60000000+01  4.60000000+01  4.60000000+01  4.6000000+01  4.6000000+01  4.6000000+01  4.60000000+01			TOT - CONTRACTOR	10.100
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13 3.970000001 4.50000001 2.2000 14 3.8800000001 4.50000001 2.2000 2.1 4.0400000001 4.400000001 2.8000 2.2 3.8400000001 4.400000001 1.5000 2.3 3.9500000001 4.500000001 1.7000 2.4 3.99000000001 4.500000001 1.50000 2.5 3.99000000001 4.400000001 1.50000 2.5 3.9000000001 4.400000001 1.60000 3.5 3.8600000001 4.500000001 1.60000 3.5 3.86000000000000000000000000000000000000		10000		+0000002.
14 3.8800000001 4.520000001 2.2000 15 3.8800000001 4.520000001 2.5000 22 3.8800000001 4.400000001 1.2000 23 3.8900000001 4.270000001 1.2000 24 3.990000001 4.270000001 1.2000 25 3.9900000001 4.270000001 1.2000 21 4.030000001 4.450000001 1.5000 31 4.0300000001 4.4500000001 1.4000 32 3.960000001 4.450000001 1.4000 33 3.800000001 4.360000001 1.4000 34 3.9600000001 4.360000001 1.4000 35 3.8000000000000000000000000000000000000			1+1000000	.200000040
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22 3.8400000+01 4.3200000+01 1.5000 24 3.9900000+01 4.5500000+01 1.7000 24 5.9900000+01 4.4800000+01 1.9000 31 4.0300000+01 4.4800000+01 1.4000 32 3.990000+01 4.470000+01 1.4000 33 3.8600000+01 4.550000+01 1.4000 34 3.9600000+01 4.360000+01 1.6000 35 3.8600000+01 4.360000+01 1.6000 36 3.8600000+01 4.3600000+01 1.7000 37 4.000000+01 4.3600000+01 1.7000 38 4.0000000+01 4.360000+01 1.7000	1 4.	400000	.4000000+0	.20000000+0
23 3.9500000+01 4.2700000+01 1.7000 25 5.960000+01 4.5700000+01 1.9700 31 4.0300000+01 4.470000+01 1.4000 32 5.990000+01 4.5500000+01 1.4000 33 5.860000+01 4.550000+01 1.4000 34 3.960000+01 4.360000+01 1.6000 35 4.000000+01 4.360000+01 1.6000 35 4.000000+01 4.360000+01 1.7000 35 4.000000+01 4.360000+01 1.7000 35 4.000000+01 4.360000+01 1.7000	e N	400000+	3200000+0	140000005
24 3.990000+01 4.550000+01 1.9000 25 5.960000+01 4.460000+01 1.5000 32 3.990000+01 4.450000+01 1.4000 33 3.990000+01 4.550000+01 1.4000 34 3.960000+01 4.420000+01 1.6000 34 3.960000+01 4.560000+01 1.6000 34 3.9600000+01 4.5600000+01 1.6000 34 4.900000+01 4.600000+01 1.6000 34 1.061506+01 4.5600000+01 1.7000 34 1.061506+01 4.5600000+01 1.7000 34 1.0615000+01 4.5600000+01 1.7000 34 1.0615000+01 4.5600000+01 1.7000	3.	500000	27110000	
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3.4 3.4000000000000000000000000000000000	-	2000000	.47000040	.4000000+0
34 3.860000401 4.420000401 1.6000 34 3.960000401 4.360000401 1.4000 35 4.000000401 4.5400000401 1.7000 9400000401 1.7000 1.40000401 1.7000 4653333401 \$UBAR 1.0515866400 \$SU 4.0914544+01	M	0+000006	.55000000+0	40000040
34 3.9600006401 4.3600003401 1.4600 55 4.000000401 4.6400000401 1.7600 50 4.00000401 3.784 4.7048299401 4.87 3.7048703641 5055333401 8UBAR 1.0615866400 \$SU 4.0916541441	3.	0+000009	42000000	
35 4.000000401 4.64000006.01 1.70009400000+01 8YBAK 6.7082299-01 8Y 3.7038705+01 4655333±01 8UBAK 1.0615866+00 8SU 4.0916544+01		0.00000		
-0410000-01 *******************************			0+0000000	0+0000000
**************************************		10+01000	4.6400000401	1.7000
.4653333+01 \$UBAR 1.0615866+00 \$SU 4.091654H-01	VALS 10+00000+6.	v./082299	01 \$SY 3,703	703+01 4LTL
	.4653333+01 \$UBA	1.0615866	4511 4 001	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
The state of the s	1011	00000000	160 4 Oce 00	344411 61

### TABLE 1-5.

### UNIAXIAL TENSILE TEST RESULTS ON HEAT TREATED 2219-T87 AND X7106-T63 ALUMINUM ALLOY WELDMENTS

NUMBER

### TABLE I-6.

UNIAXIAL TENSILE TEST RESULTS ON HEAT TREATED 2014-T6 ALUMINUM ALLOY WELDMENTS

144- 0000 0014- 0014- 0010 0000 0010 001	ST ST ST ST ST ST ST ST ST ST ST ST ST S	>	9	œ.
1 1.3500000+01 2.950000+01 1.3500000+01 1.4700000+01 1.4700000+01 1.55000000+01 1.5500000+01 1.5	AREL 2014-TA TIG 2	19 SINGLE A		0.410000044
2 1.2400000+01 2.950000+01 1.4700000+01 1.4700000+01 1.4700000+01 1.4700000+01 1.4700000+01 1.4700000+01 1.4700000+01 1.4700000+01 1.4700000+01 1.4700000+01 1.4700000+01 1.4700000+01 1.4700000+01 1.4700000+01 1.4700000+01 2.5000000+01 2.5000000+01 2.5000000+01 2.5000000+01 2.5000000+01 2.500000+01 2.5000000+01 2.5000000+01 2.5000000+01 2.5000000+01 2.5000000+01 2.5000000+01 2.500000+01 2.5000000+01 2.500000+01 2.500000+01 2.500000+01 2.5000000+01 2.5000000+01 2.5000000+01 2.500000+01 2.500000+01 2.500000+01 2.500000+01 2.500000+01 2.500000+01 2.500000+01 2.500000+01 2.500000+01 2.500000+01 2.500000+01 2.500000+01 2.500000+01 2.500000+01 2.500000+01 2.500	-T -T	0+000009	.95001100+0	9 <b>-</b> 06000 <b>7-</b> 0
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4 3.7780000+01 4.400000+01 3.1000000+01 5.7780000+01 4.780000+01 5.7780000+01 5.86004-01 5.7780000+01 5.86004-01 5.7780000+01 5.800000+01 1.2780000+01 2.9400000+01 1.4500000+01 1.2780000+01 2.9400000+01 1.4500000+01 1.2780000+01 2.9400000+01 1.5000000+01 1.2780000+01 2.9400000+01 1.5000000+01 1.2780000+01 2.9400000+01 1.5000000+01 1.27800000+01 2.9400000+01 1.5000000+01 1.27800000+01 2.9400000+01 1.50000000+01 1.27800000+01 2.9400000+01 1.50000000000000000000000000000000000	) M	7600000+01	4,64000000+0	40000000+
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A	7780000+01 \$YB	H 1.4836038	81 \$SY 3.692	928+61 \$LTL
Control   Cont	.782888F01 \$U8	R 1.0059826	00 \$50 4,123	600+01 %LIL
The	.6800000+00 *EB	R 3,7013518	0.1 %	
1.8800000+01   2.940000+01   1.4260000+01   2.940000+01   1.4260000+01   2.940000+01   1.4260000+01   2.940000+01   1.42600000+01   2.940000+01   1.42600000+01   2.9400000+01   1.4200000+01   1.4200000+01   2.9400000+01   1.42000000+01   1.4200000+01   1.4200000+01   1.4200000+01   1.4200000+01   1.4200000+01   1.4200000+01   1.4200000+01   1.4200000+01   1.4200000+01   1.4200000+01   1.4200000+01   1.4200000+01   1.4200	011 21 000	A STAGE		
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ABEL 2014-16 #16 4043 SINGLE ANN  1.370:000-01  2.1.300:000-01  3.1.290:0000-01  3.1.290:0000-01  4.1.280:0000-01  1.360:0000-01  2.964:0000-01  1.360:0000-01  2.964:0000-01  1.360:0000-01  2.964:0000-01  2.964:0000-01  3.4.260:0000-01  4.44:00000-01  4.126:0000-01  4.45:000000-01  4.45:000000-01  4.45:000000-01  4.45:000000-01  4.45:000000-01  4.45:000000-01  4.45:000000-01  4.45:000000-01  4.45:000000-01  4.45:000000-01  4.45:000000-01  4.45:000000-01  4.45:0000000-01  4.45:000000-01  4.45:000000-01  4.45:000000-01  4.45:000000-01  4.45:000000-01  4.45:000000-01  4.45:000000-01  4.45:0000000-01  4.45:00000000000000000000000000000000000	.6400n00+00 \$EB	AK 3.646916	-01 \$8	
AREL 2014-16 MIG 4043 SINGLE ANY SINGLE ANY SINGLE ANY SINGLE ANY SINGLE ANY SINGLE ANY SINGLE ANY SINGLE ANY SINGLE ANY SINGLE ANY SINGLE ANY SINGLE ANY SINGLE ANY SINGLE ANY SINGLE SERVING OF SITE AND SITE AN				
1.5000000+01 2.9800000+01 1.5800000+01 1.5800000+01 2.9800000+01 1.5500000+01 1.5500000+01 1.5500000+01 1.5500000+01 1.5500000+01 1.5500000+01 1.5500000+01 1.5500000+01 1.5500000+01 1.5500000+01 1.5500000+01 1.5500000+01 1.5500000+01 1.570	ABEL 2014-16 MIG	2705030404 2705030404	2.950000000000000	0+0000006.
3 1.290000+01 2.990000+01 1.5500000+01 1.5500000+01 1.5500000+01 2.9900000+01 1.5500000+01 1.5500000+01 1.5500000+01 1.5500000+01 1.5500000+01 1.5500000+01 1.5500000+01 1.5500000+01 1.5500000+01 1.5500000+01 1.5500000+01 1.5500000+01 1.50000+01 1.500000+01 1.500000+01 1.50000+01 1.5000000+01 1.5000000+01 1.5000000+01 1.5000000+01 1.5000000+01 1.5000000+01 1.50000000+01 1.50000000+01 1.5000000+01 1.5000000+01 1.		0+000000	0+60000000	6 8 8 8 8 9 9 9 + J
1.260000+01 1.560000+01 1.560000+01 1.560000+01 1.560000+01 1.560000+01 1.560000+01 1.560000+01 1.560000+01 1.560000+01 1.560000+01 1.560000+01 1.560000+01 1.560000+01 1.5600000+01 1.5600000+01 1.5600000+01 1.5600000+0 1 1.5000000+0 1 1.5000000+0 1 1.500000+0 1 1.500000+0 1 1.500000+0 1 1.500000+0 1 1.500000+0 1 1.500000+0 1 1.500000+0 1 1.500000+0 1 1.500000+0 1 1.500000+0 1 1.5000000+0 1 1.5000000+0 1 1.5000000+0 1 1.5000000+0 1		0+0000066.	0+00000186	.636000000
1.3000000+01 SYBAR 4.1852010-01 SSY 1.0594608+01 %ULY 2.9640000+01 SYBAR 4.1852010-01 SSY 1.0594608+01 %ULY 2.9640000+01 SUBAR 2.07381A4-01 SSY 2.8447594-01 %ULY 2.9640000+01 SEHAR 2.2671575+00 SSE  A+EL 2014-7 MIG 4043 SINGLE SR 4.2500000+01 4.4600000+01 1.2000000+0 4.2500000+01 4.4600000+01 1.2000000+0 5 4.1200000+01 4.500000+01 1.2000000+0 5 4.1200000+01 4.500000+01 1.2000000+0 6 4.1200000+01 4.500000+01 1.2000000+0 7.400000+01 SYBAR 5.357260-01 SSY 4.000000+01 1.1000000+01 1.1000000+01 1.1000000+01 1.1000000+01 1.1000000+01 1.1000000+01 1.1000000+01 1.1000000+01 1.1000000+01 1.1000000+01 1.1000000+01 1.1000000+01 1.1000000+01 1.1000000+01 1.10000000000	ì	.2800000+0	0+0000066	.5600000+0
1.3000000+01 \$YBAR 4.1832010+01 \$SY 1.0594608+01 \$ULV 2.9640000+01 \$UAR 2.0738104-01 \$SU 2.8447559+01 \$ULV 1.700000+01 \$UAR 2.2671575+00 \$SU 2.8447559+01 \$ULV 1.2670000+0 \$ULV 1.267000+0 \$ULV 1.26700+0 \$ULV 1.267000+0 \$ULV 1.26700+0 \$UUV 1.26700+0 \$ULV 1.26700+0 \$ULV 1.26700+0 \$ULV 1.26700+0 \$UUV 1.267		.2600000+0	.940000040	.35060000+6
2.9640000+01 \$UBAR 2.0738104-01 \$SU 2.8447559+61 BLILU 1.670000+01 \$EBAR 2.2671575+00 \$SE A+EL 2014-76 MIG 4043 SINGLE SR A+1500000+01 4.440000+01 1.200000+0 A+1500000+01 4.440000+01 1.200000+0 A+1200005+01 4.440000+01 1.200000+0 A+1200005+01 4.600000+01 1.200000+0 A+120000+01 \$FBAR 5.55750-01 \$SY 3.46504+01 \$LTV A+380000+01 \$FBAR 1.9493589-01 \$SE 3.8316504+51 \$LTV 1.66000+01 \$FBAR 1.9493589-01 \$SE	.30000000+01 SY	AR 4,183291	-01 \$SY 1.05	608+01 %LTL
1.6700000+01 %E9Ak 2.26715/55+00 %SE  AHEL 2014-TK MIG 4043 SINGLE SR  2 4.2500000+01 4.4400000+01 1.200000+0  4 4.1500000+01 4.3400000+01 1.200000+0  5 4.2000005+01 4.500000+01 1.200000+0  5 4.1200000+01 4.500000+01 1.200000+01  4.1720000+01 %F9AR 5.35720-01 %SY 3.453574+01 %LIV  4.4380000+01 %FBAR 1.9493589-01 %SE	.9640100+01 \$0	AR 2.073810	-01 \$SU 2.84	559+01 FLIL
AHEL 2014-TF MIG 4043 SINGLE SR 2 4.2500000+01 4.460000+01 1.200000+0 3 4.1600000+01 4.3400000+01 1.200000+0 4 4.15000005+01 4.3300000+01 1.2000050-0 5 4.2000005+01 4.600000+01 1.2000050+0 6 4.1200000+01 87048 5.357260-01 8574461 4.171 4.4380000+01 87048 1.9545241+00 \$50 3.4316504+51 4.171 1.660000+01 \$2848 1.9493589+01 \$55	.6700000+01 \$E	AH 2.267157	c≉   20+	
2 4.2500000+01 4.4600000+01 1.2500000+04 3 4.16000000-01 4.4400000+01 1.2500000+0 4 4.1500000+01 4.3500000+01 1.2500000+0 5 4.200000+01 4.600000+01 1.290000+0 4.120000+01 4.500000+01 1.290000+0 4.120000+01 8Y6AF 5.55750-01 8SY 3.3630574+01 1.I.V.V.V.V.V.V.V.V.V.V.V.V.V.V.V.V.V.V.	AHEL 2014-TA MIG	4043 SINGLE	æ	
3 4.160000401 4.44010000401 2.500000401 4.50000040040 4.1500000401 4.53000000401 9.4010030540 5 4.25000000401 4.5000000401 1.2000004040 4.5000000401 1.2000004040 4.500000401 1.200000401 4.500000401 1.200000401 4.500000401 8.600000401 4.500000401 8.60000401 4.500000401 8.60000401 4.500000401 8.60000401 4.500000401 8.60000401 4.500000401 8.60000401 4.50000401 8.60000401 4.50000401 8.60000401 4.50000401 8.60000401 4.50000401 8.60000401 4.50000401 4.50000401 8.60000401 4.50000401 8.60000401 4.50000401 8.60000401 4.50000401 8.60000401 4.50000401 8.60000401 4.50000401 8.60000401 4.50000401 8.60000401 4.50000401 8.60000401 4.50000401 8.60000401 4.50000401 8.60000401 4.50000401 4.50000401 4.50000401 4.50000401 4.50000401 4.50000401 4.500040401 4.50	~	.2500000+0	460000+0	0.000000
4 4.1500006+01 4.5506000+11 9.091009-01 5 4.2000009-01 4.60000000-01 1.2000009-01 4.12000009-01 4.560000000-01 8.6000000-01 8.726000-01 8.7260000-01 8.7260000-01 8.7260000-01 8.7260000-01 8.7260000-01 8.7260000-01 8.7260000-01 8.726000000000000000000000000000000000000		.1600000+0	4400000+0	. 20000000.
5 4.2000004-01 4.5000004-01 8.600000-01 8.000000-01 8.700000-01 8.700000-01 8.700000-01 8.7000000-01 8.7000000000-01 8.700000000-01 8.7000000000000000000000000000000000000		.1300000+0	3366690+0	0-00000000
1720000+01 \$VERM 5-357240-01 \$557 3 3039574+01 \$LTLV 3-4380000+01 \$UEAM 1-3545211+00 \$70 3-8316504+31 \$LTLV 3-6500000+01 \$EBAR 1-9493589-01 \$5E		.20000000. .20000000.	0+000000	0-0000000.
*4780000*01 \$UBAR 1.0545214+00 \$50 5.8316504+31 http: *0600000+00 \$EBAR 1.9493589+01 \$5E	7.3 10±00000±	AH 5.357262	-01 88 X 3.30	9574+01 1LTLY
.0600000+00 \$EHAR 1.9493589-01 \$5	.438U000+01 \$U	AR 1.054521	+00 \$5U 3.83	6504+31 full
	.0600000+00 *E	AR 1.949358	-01 \$5	

TABLE I-7.

### 1:1 HYDRAULIC BULGE TEST PRESSURE - BULGE HEIGHT DATA, 2014-T6, 2219-T87 AND 7106-T63 WELDMENTS

	Panel De	scription		Bul	ge Heigi	ht(a) at	Pressu	re of	Panel F	ailure
Material &		Welding	Panel	40	80	120	160	200	Pressure,	Height,
Process	Туре	Procedure	No.	psi	psi	psi	psi	psi	psi	in.
TIG 2219-T87	Single Weld	65A-1	AT1-2 AT1-3 AT1-7 AT1-13	0.69 0.70 0.69 0.62	0.93 (b) 0.93 0.83	1.12 (b) 1.12 1.00	1.29 (b) 1.29		192 172 192 136	1.42 (b) 1.42 1.05
2319	Cross Weld	65A-1	AT1-1 AT1-8 AT1-9	0.56 0.82 0.65	0.79 1.02 0.89	0.96 1.21 1.10	1.14 - -	- - -	163 156 158	1.15 1.35 1.26
MIG 2219-T87 2319	Single Weld	65A-26	AM1-1 AM1-2 AM1-3	(c) (c) (c)	- - -	- - -	-	-	148 174 200	-
TIG 2014-T6 2319	Single Weld	65A-24	BT1-1 BT1-2 BT1-5	(c) 0.67 (c)	- 0.90 -	- 1.06 -	- 1.20 -	-	218 178 200	1.27 -
TIG 2014-T6 4043	Single Weld	65A-25	BT2-1 BT2-2 BT2-3	(c) (c) (c)	- - -	- - -	- - -	- - -	172 224 170	<u>.</u> - -
MIG 2014-T6 4043	Single Weld	65A-27	BM2-1 BM2-2 BM2-3	(c) (c) (c)	-		- - -		152 * 160 165	- -
TIG 7106-T63 X5180	Single Weld	65A-23	CT3-6 CT3-7 CT3-8	0.64 0.78 0.65	0.90 1.10 0.90	1.10 1.32 1.08	1.25 1.50 1.22	1.41 1.68 1.40	225 240 245	1.52 1.95 1.58

<sup>(</sup>a) Bulge height in inches at applied pressure indicated.

<sup>(</sup>b) Deflectometer inoperative.(c) Data not obtained.

TABLE I-8.

1:1 HYDRAULIC BULGE TEST PRESSURE - BULGE HEIGHT DATA AS RECEIVED AND HEAT TREATED PARENT METAL

Panel Failure	Height,	(b) 4.75 4.40	4.35	5.02	4.00 4.00 4.00	6.32	3.75	4, 25 4, 25 4, 30	5.10	4.95
Panel	Pressure,	(b) 1090 1000	464	780	1050 1040 1060	260	635	1010 1050 1050	610	925
	1000 isa	4.18	•		3.70 3.80 3.72	-	•	4.16 3.90 3.92	ı	-
	900	3.65			3.30 3.35 3.20	ı		3.60 3.42 3.42	-	•
	800	3.25	-		2.94 2.96 2.94		1	3.20 3.07 3.07	ı	ı
	700 rei	2.90		3.84	2.64 2.67 2.60	ı	ı	2.86 2.80 2.75	ı	-
re of	600	2.78 2.60 2.60	,	3.05	2.35 2.40 2.29		3, 34	2.54 2.48 2.44	4.92	
Pressure	500	2. 10 2. 24 2. 35		2.68	2.03 2.08 2.00	4.72	28.82	2.24 2.16 2.11	3,78	3,80
at	0	1.78 1.97 2.00	3,68	2.30	1.73 1.83 1.72	3.56	2.34	1.92 1.87 1.75	3.18	3.02
ge Height(a)	300	1.48	2.80	1.82	1.47	2.82	1.98	1.60	2.58	2.46
Bul	200 201	1.18 1.27 1.32	2.04	1.41	1.20 1.24 1.18	2.05	1.50	1.27 1.20 1.18	1.92	1.90
	160	1.04	1.83	1.19	1.07	1.84	1.31	1.17 1.08 1.04	1.65	1.63
	120	0.91 1.00 1.02	1.52	1.03	0.93 1.00 0.92	1.52	1.08	1.00 0.95 0.88	1.35	1.39
	80	0.78	1.18	0.85	0.80 0.82 0.78	1.04	0.89	0.80 0.80 0.75	96.0	1.00
	40	0.65	0.70	0.65	0.63	0.58	0.67	0.65 0.60 0.52	0.58	0.67
	Panel	A-26 A-27 A-28	A-31	A-30	B-8 B-9 B-10	B-11	B-7	C-2 C-3 C-5	C-4	C-1
Panel Description	T tron	As Received	Annealed(a)	Stress Relieved(b)	As Received	Annealed	Stress Relieved	As Received	Annealed	Stress Relieved
Δ,	Material &	2219-T87	Parent Metal		2014-T6	Parent Metal		7106-T63	Parent Metal	

(a) Bulge height in inches.
(b) Failed in bolt holes.

TABLE I-9.

1:1 HYDRAULIC BULGE TEST PRESSURE - BULGE HEIGHT DATA HEAT TREATED WELDMENTS

	Panel Description	tion			Bulg	Bulge Height(a)		at Pressure of	jo a		Panel Failure	illure
Material &		Welding	Panel	40	80	120	160	200	300	400	Pressure,	Height,
Process	Heat Treatment	Procedure	No.	psi	pai	psi	psi	psi	par	pei	psi	ţn.
T1G	Annealed <sup>(a)</sup>	65A-1	AT1-20	0.79	1.25	1,61	1.89	2.17	2.90	3.70	416	3.86
2319	Stress Relieved(b)	65A-1	AT1-18	0.69	0.91	1,15	1, 31	1.58	-		275	1.90
MIG	Annealed	65A-26	AM1-5	0.76	1.20	1.55	1.85	2.15	2,85		360	3, 30
2319	Stress Relieved	65A-26	AM1-4	0.70	0.99	1.20	1.42	1.62	-		275	1.99
TIG	Annealed	65A-24	BT1-4	0.97	1.36	1.75	2.02	2.33	2.58	3.02	425	4.12
2319	Stress Relleved	65A-24	BT1-3	0.70	0.97	1.20	1.41	1.63	2.11	•	320	2.19
TIG	Annealed	65A-25	BT2-5	0.92	1.35	1.69	2.00	2.27	3.02	3.81	420	4.05
4043	Stress Relieved	65A-25	BT2-4	09.0	0.78	1.02	1.24	15.1	ı	٠	265	1.67
MIG	Annealed	65A-27	BM2-5	0.92	1.39	1.72	·	-	,	,	144	2.08
4043	Stress Relieved	65A-27	BM2-4	0.65	0.90	1.14	•	•		•	144	1. 29
TIG	Annealed	65A-23	CT3-5	0.72	1.10	1.50	1.81	2.09	2.71	3.32	485	3.91
X5180	Stress Relieved	65A-23	CT3-9	0.57	0.82	1.14	1.37	1.59	5.09	2.52	496	2, 52

(a) Bulge height in inches.

### APPENDIX J

### PHASE III TENSILE TEST DATA (CONTRACT NAS8-20160)

### PHASE III TENSILE TEST DATA (CONTRACT NAS8-20160)

The results of the individual uniaxial tensile tests conducted in the study of the weldability of X7106-T63 aluminum alloy (Phase III, Contract NAS8-20160) are listed in Tables J-1 through J-22. The computed mean value, standard deviation and lower tolerance limit for each property are also included in the tables. These computations were carried out on a GE 225 digital computer in accordance with the procedures described in Appendix K. Table J-1 through J-22 are reproduced from the computer print-out sheets and the letter symbols appearing in the tables are as follows:

Y 0.2% Offset Yield Strength, ksi

\$YBAR Average Value of Yield Strength, ksi

\$SY Standard Deviation of Yield Strength, ksi

\$LTLY Lower Tolerance Limit of Yield Strength, ksi

U Ultimate Tensile Strength, ksi

\$UBAR Average Value of Ultimate Strength, ksi

\$SU Standard Deviation of Ultimate Strength, ksi

\$LTLU Lower Tolerance Limit of Ultimate Strength, ksi

E Elongation in Two Inches, %

\$EBAR Average Value of Elongation

\$SE Standard Deviation of Elongation, %

The floating decimal point system was used in this computation and all values in the tables are given in powers of ten. For example:

5.2500000 + 01 = 52.500000

7.0454965 - 01 = 0.70454965

TABLE J-2

# UNIAXIAL TENSILE TEST RESULTS ON X7106-T63 ALUMINUM ALLOY WELDMENTS

Panel No. CT3-1, 0.187-inch TIG/X5180, Sq Butt.

LABEL CT3-1 TIG-7106,5180,0,187,2 WEEKS
4 0 9.2600000-01 4.1000000
10 3.7300000+01 9.1600000+01 4.50000000
16 3.4600000+01 9.020000+01 3.9000000
28 3.5900000+01 9.1900000+01 2.9000000
34 3.700000+01 5.1900000+01 2.7000000
5.4066661\*01 \$1800 857 2.9222421\*01 \$LT3
5.5900000+01 \$180 A.7068683\*0 \$SU 4.2433961\*01 \$LT3
5.5900000+00 \$EBAR 7.3143697\*01 \$5E

 LABEL C13-1, 116-7100, 5160, .187, 17 WEEKS
6 3.9100000-01 5.4500000-01 3.600000-01
18 3.9500000-01 5.4500000-01 3.6000000-0
24 3.9500000-01 5.810000-01 3.600000-01
35 4.160000-01 5.810000-01 3.5000000-0
4.028333401 87984 9.8675308-01 857 3.8290363-01 8LTLV
5.5650000-01 5044 1.1457462-00 350 4.9847464-01 1.TLU

## UNIAXIAL TENSILE TEST RESULTS ON X7106-T63 ALUMINUM ALLOY WELDMENTS

Panel No. CT3-1, 0.187-inch TIG/5356, Sq Butt.

3.7935333+01 bY584 /.13601A5+01 45Y 3.4310509+01 bLfL

3.8940010+0

4,6800431+01

# UNIAXIAL TENSILE TEST RESULTS ON X7106-T63 ALUMINUM ALLOY WELDMENTS

TABLE J-3.

Butt. Panel No. CT5-5,

1.4815547+00 \$\$Y 2.885333+01 \$LTLY 1.9612985+00 \$\$Y 2.885333-01 \$LTLY 3.8297085-01 \$\$E 5.282080-01 \$YBAR 5.2820820-01 \$SY 3.477266-01 \$LLY 5.1842857-01 \$UBAR 1.357461-00 \$SU 4.6104355-01 \$LTLU 3.2571428-00 \$EBAR 2.7602622-01 \$SE 3.0600000+01 4.5800000+01 4.5000000+00 \$YBAR 9.4110148-01 \$SY 2.4921360+01 \$LTLY \$UBAR 1.544937+00 \$SU 3.5532332+01 \$LTLU 3.6000000+00 3.80000000+00 3.6000000+00 3.00000000.5 3.50000000+00 2.8000000+00 3.3000000+00 3.1000000+00 2.7000000+00 3.3000000+00 2.2000000+00 1.6000000+00 2.5000000+00 2.5000000+00 2.80000000+00 2.5000000+00 3,4000000+00 3,2000000+00 2.7000000+00 3.3400000+01 \$YBAR 1.5491953+00 \$SY 2.5561072+01 \$LTLY 4.7350000+01 \$UBAR 1.8479709+00 \$SU 3.7999267+01 \$LTLU V3.3280000+01 %YBAR. 1.0756436+00 \$SY 2.7095049+01 \$LTLY 14.7366666+01 \$UBAR. 1.6524776+00 \$SU 3.9005130+01 \$LTLU Sq щ 0.187-inch TIG/5556, 4.2600000+01 4.3300000+01 4.3900000+01 5.2200000+01 5.3500000+01 5.1400000+01 4.5000000+01 4.5200000+01 4,6700000+01 4.9100000+01 4.7300000+01 4.6200000+01 4,7800000+01 4.9700000+01 5.0300000+01 4.9000000+01 5.1400000+01 CT5-5, TIG-7106, 5556, 0, 187, 5 WEEKS 5 3,6700000+01 5,0600000+01 5.0300000+01 5.1600000+01 4.1100000+01 4.3400000+01 4.8700000+01 4.8600000+01 3.566667+00 \$EBAR 6.5625200-01 \$SE 2,933333+00 \$EBAR 4,8853528-01 \$SE LABEL CI5-5, TIG-7106, 5556, 0.187, 1 WEEK 8.3286657-01 \$SE LABEL CT5-5,TIG-7106,5556,0.187,1 DAY LABEL\_CI5-5, IIG-2106,5556,0,187,2 4 3,4600000+01 5, CT5-571G-7106,5556,0.187,3 3.2300000+01 3.2000000+01 3.4400000+01 3.15000000+01 3.01000000+01 3.0200000+01 3.66000000+01 3.70000000+01 2.8100000+01 3.3900000+01 3.3400000+01 3.4100000+01 3.4700000+01 3.63000000+01 3.8100000+01 3.2700000+01 3.7900000+01 3.7900000+01 3.7500000+01 3,3600000+01 3.6100000+01 3.8000000+61 2.8833333+00 \$EBAR 3.6350000+01 \$YBAR 5.0933333+01 \$UBAR SEBAR 5.0933333+01 2.9683333+01 11 17 239 LABEL LABEL

UNIAXIAL TENSILE TEST RESULTS ON X7106-T63 ALUMINUM ALLOY WELDMENTS Sq Butt. Panel No. CM3-1, 0.187-inch MIG/X5180,

LABEL CM3-1, MIG-7106-5180, 0.187,1 DAY   1.0000000-01   3.70000000-01   3.7000000-01   3.70000000-01   3.70000000-01   3.70000000-01   3.70000000-01   3.70000000-01   3.70000000-01   4.60000000-01   4.60000000-01   4.60000000-01   4.60000000-01   4.6000000000000000000000000000000000000	NUMBER		щ
7. 3.130000000000000000000000000000000000	RFI CM3-1-M	IG-7106.5180.0.187.1 DA	
7 3.1300000000000000000000000000000000000		4	0 + 0 0 0 0 0
3   1000000000000000000000000000000000		1 3.08guuuu+ul 4.01guuuu+ul 3	0+000000
13 3.1400000+01 4.680000+01 1 3.700000+01 2.7000000+01 3.7000000+01 3.7000000+01 3.7000000+01 3.7000000+01 3.7000000+01 3.7000000+01 3.7000000+01 4.3000000+01 4.3000000+01 4.3000000+01 4.3000000+01 5.006667-01 \$SY 2.8500000+01 \$1.00000+01 \$1.33333-00 \$EBAR 4.676181-01 \$SY 2.8500000+01 \$1.7000000+01 \$1.3000000+01 \$1.30000000+01 \$1.3000000+01 \$1.3000000+01 \$1.3000000+01 \$1.3000000+01 \$1.3000000+01 \$1.3000000+01 \$1.3000000+01 \$1.3000000+01 \$1.30000000+01 \$1.30000000+01 \$1.3000000+01 \$1.3000000+01 \$1.3000000+01 \$1.3000000+01 \$1.3000000+01 \$1.3000000+01 \$1.3000000+01 \$1.3000000+01 \$1.3000000+01 \$1.3000000+01 \$1.3000000+01 \$1.3000000+01 \$1.3000000+01 \$1.3000000+01 \$1.3000000+01 \$1.300000+01 \$1.300000+01 \$1.300000+01 \$1.3000000+01 \$1.300000+01 \$1.300000+01 \$1.300000+01 \$1.300000+01 \$1.300000+01 \$1.300000+01 \$1.300000+01 \$1.300000+01 \$1.300000+01 \$1.300000+01 \$1.300000+01 \$1.300000+01 \$1.300000+01 \$1.300000+01 \$1.300000+01 \$1.300000+01 \$1.300000+01 \$1.300000+01 \$1.3000000+01 \$1.300000+01 \$1.300000+01 \$1.300000+01 \$1.300000+01 \$1.3000000+01 \$1.3000000+01 \$1.3000000+01 \$1.3000000+01 \$1.3000000+01 \$1.3000000+01 \$1.3000000+01 \$1.3000000+01 \$1		7 3.1300000+01 4.5100000+01 3	0+000000
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35 3.90000401 5.470000401 3.500000401 3.5000000401 4.850006057401 8LTLY 4.450006441 4.850465057401 8LTLY 4.4500057400 8EFFRA 3.85057952611 858 4.850465057400 8EFFRA 3.85057952611 858		4 1000000000000000000000000000000000000	0+000000
.8500567+01 #YRAK 4.9018578-01 %SY 3.6268727+01 %LTL .41160-00+01 %URAK 1.9925607+00 %SU 4.8508309+01 %LTL .4666097+01 %ERAK 3.815792-01 %SE	\$	5 5.90000001 5.47000001 3	0000000
.4116500+41 %UBAK 1.0925407+00 %SU 4.8508509+01 %LTL .4666097+00 beaak 3.0815792-01 %SE	.850006/+0	1 AYBAR 4.5018578=01 \$SY 3.626872	01 \$LTL
.4666057+86 BEHAM 5.0815792-01 \$5	.4116500+d	I TOHAK 1.0925607+00 \$50 4.858830	01 \$LTL
TO TO TO TO THE POST OF THE PARTY OF THE PAR	.4666657+8	U BEHAM 5.0815792-01 \$S	

3.70000000 4.00000000+60 4.5000000+00 4.6060968+PH 4.2000988+90 5.7260000+01 5.7260000+01 5.7260000+61 5.6200000+31 5.590000+01 Flu-718r. 5100, 6,187, 18 4.urije08+01 4.120.0030+01 4.850-886+81 4.026050+01 CM3-1,

> 3.5000000+00 5.93060000+60 2.600000000 9.\*5000000×00

5.3800000+01 5.116000011 .4920000+01 5.3360000+01

ABEL CI5-5, (14-7104, 5256, 0.187, 12 WEEKS

3.710000001

9

3.8600000+01

5.9364000401

4.1300000+01

3.5000:000+00

5.4760000+01

.33000000+01

5.8×0@0uu+01

3.8846667+41

1,3993620+00 %5Y 3,1621315+01 %LTLY 1.3658922+00 %50 4.6605252+01 %LTLU

3.50000000400

5.420000491

3.34900000000

4.0350030+01 %\\AA4 ~~9245335+01 %\\ 3.7352186+01 %LTLY 5.6800060+01 10464 ~.4143925+01 %SU 5.2542317+01 %LTLU

3.5449494-N1 %SE

X44-14 - 00+8880880 - 0

# UNIAXIAL TENSILE TEST RESULTS ON X7106-T63 ALUMINUM ALLOY WELDMENTS

Panel No. CM4-1, 0.187-inch MIG/5356, Sq Butt.

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3.20000000+00 4.00000000+ 3.7016967+01 bYHAK 5.6006962+01 bSY 3.4182714+01 bLTLY 5.2785555401 bUHAK 9.6419034+01 bSU 4.7904530+01 bLTLU 3.3833355400 pEBAK 4.8751067+01 bE 5,2200000+01 5,3500000+01 5,340000+01 5,40000+01 LABEL CM4-1, MIG-7106, 0356, 0, 187, 5 WEFKS 3.6100000+01 3.75000000401 3.7260000+01 3.7200000+01

UNIAXIAL TENSILE TEST RESULTS ON X7106-T& ALUMINUM ALLOY WELDMENTS Panel No. CM5-2, 0.187-inch MIG/5556, Sq Butt.

LABEL CM5-2,MI(	06,5556,0.187,1	<b>∀</b> ∀	
-	.18000000+01 4.	200000+0	0+0000006*
7	.1700000.01 4.	4000004	.80000000+0
	.15000000+01 4.	0+000006	.4000000+0
	.13000000+01 4.	300000+0	.1000000+0
	.9400000401	0+000000	. 40000000
31	18000000+01 4	4000	4.4000000+00
.1250000+0	YBAR 9.2682727-0	SY 2.65	254+01 \$LTLY
55333340	AR 4.3665516-0	SU 4,332	858+01 SLTL
.3333333+0	EBAR 3.6696972-0	S	
	06,5556,0,187,5	AYS	
2	3.4100000+01	300000+0	.5000000
•	.32000000+01 4.	600000+0	0+00000000
14	.39000000+01 4.	20000040	.1000000+0
20	.28000000+01 5.	300000+0	.3000000.
56	.34000000+01 4.	40000004	.3000000.
100	3.3500000+01	0.000000	.3000000.
.3483333	YBAR 4.7082224-01	\$SY 3.110	973+01 SLTLY
0+9999	BAR 1.4719671+	SU 4.1	513+01 SLTL
.08333340	EBAR 7.0545495-0	SE	
2 2 2 2 3	0. 14 4 5 4 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5	2	
	3.54000000+01	100000+0	0+00000000
6	.6800000+01 5.	000000	2.9000000+00
	.9700000+01 4.	0 + 0 0 0 0 0 9	.40000004
	.4100000+01 5.	300000+0	.40000004.
	.5300000+01 5.	0+000006	.2000000+0
	.5100000+01 4.	0+0000008	.3000000+0
.60666640	AR 1.9785548+0	SY 2.6	179+01 SLTLY
.0783333+0	UBAR 1.1513727+	SU 4.4	7+01 SLTL
0	AR 9.6626433-0	Ś	
LABEL CM5-2, MI	06,5556,0,187,2	EEX	
	3.6200000+01 5.	0+000000	.3000000.
10	3.6700000+01 5.	0600000+01	4.0000000+00
	.6300000+01 5.	300000+0	0+0000009.
	.61000000+01 5.	300000+0	.7000000+0
	.6300000+01 5.	300000+0	0+0000006.
34	.6300000+01 5.	0+000009	.700000040
.6316666+0	BAR 2.0414408-0	SY 3.5	697+01 SLTL
0	UBAR 7.0074249-	SU 4.780	243+01 SLTL
.8666667+0	EBAR 2.2819904-0	ū	

4.1000000+00 5.6000000+00 6.6000000+00 7.0000000+00 3,72,00,007+01 + YKHAK 7,5037349-01 \$5Y 3,44,4573+01 \$LILY 5,23,660,50+41 \*UHAK 7,580,7824-01 \$5U 4,8550,791+01 \$LILU 5,533,533,400 \$PHAK 2,5390,787+00 \$5E 5.2500000+01 5.2500000+01 5.2300000+01 5,2300000+01 5.20000000+01 LABEL CM5-7,813-7140,0000,01187,5WEEKS \$•/>010000491 5.0903000+01 5.0900600+01 3.7090000+01 \$ • 0 5 J d u 0 J + 0 1 3.7909060+01

36 4.050000+01 5.510000+01 4.200000+03 3.9866667+01 17448 2.1648564-01 \$5.2000000+03 5.2000000+03 5.2000000+03 5.4733333.43 19348 1.0514546+01 \$5.0 4.9362376+61 \$CTLU 3.68433374-01 \$1.0514540+00 \$5.0 4.9362376+61 \$CTLU 3.68433374-01 \$CTLU 3.68433374-01 \$1.0514540+00 \$1.051440+00 \$1.051440+00 \$1. 3.0000000+60 3.76000000+00 3.7000000+00 \*.500000000\* LAREL GM5-2, FIG-7165, 5554, 0.187, 12 WEFKS 6 .3.3506600+01 5.516000+01 5.5000000401 5.4000000+01 5.50000000+01 4.03000000. 4.0000000+01 3.9100000+01

3.7000000+00 5.0000000+00

6.A232309-01 \$SY 3.5981978-01 FLTLY 1./139742-06 \$SU 4.6143957-01 ALTLU

3.7333333410 BEBRK ...7.5854845-01 3.933333+01 BYHAK 6.4232309-0

104AK

5.4816666+11

3.00060000+00 3.00000000+00 3.50000000+00 4.2960000+60

5.2600000+01 5.3900000+01 .3800000+01 .56000000+01 .56000000+01 .7400000+01

LAREL CM4-1, #16-7106, 5354, 0.187, 12 WFFKS 6 3.8400000-01 5.260000+01

3.90000000.01

4.0200006+03 3.900000040 3.95000000+0

5. yy@uuuuu+01

### TABLE J-7.

# UNIAXIAL TENSILE TEST RESULTS ON X7106-T63 ALUMINUM ALLOY WELDMENTS

Panel No. CT3-2, 0.50-inch TIG/X5180, Sq Butt.

1.1700000+01 1.0000000+01 1.1600000+01 14 3.0100000+01 4.8900000+01 1.0500000+01 2.0700000+01 5.0300000+01 1.2300000+01 2.99250000+01 \$YBAR 6.65200467-01 \$SY 2.9259795+01 \$LTLY 4.9880000+01 \$UBAR 9.5760904-01 \$SU 4.4373748+01 \$LTLU 1.2200000+01 \$EBAR 1.4230253+00 \$SE 1.5000000+01 1.2350000+01 1.1700000.01 7.50000000+01 1.3800000+01 1.3200000+01 1.0700000+01 1.0900000+01 1.4400000+01 1.1500000+01 1.5100000+01 1.34000000+01 1.52000000+01 1.30000000+01 1.3206000+61 2.6825000+01 \$YBAR 1.8929533-01 \$SY 2.6635705+01 \$LTLY 4.5820000+01 \$UBAR 2.7750875-01 \$\$U 4.4224325+01 \$LTLU 1.0680000+01 \$EBAR 6.3007999-01 \$SE 3.1700000+01 \$YBAR 3.7416492-01 \$SY 2.9548552+01 \$LTLY 4.9820000+01 \$UBAR 1.5626929+00 \$SU 4.0834516+01 \$LTLU 1.1600000+0; 5.45×0000000101 2754× 2.7748813\*01 %57 3.2984443\*01 %LTLY 5.35200001+01 20944 4.4586821=01 %SU 5.0767643+01 %LTLU 3.5749000+01 +Y34M 4.5147405+01 %5Y 3.3010374+01 %LTLY 5.346000F+01 %U34M 9.3948459+01 %SU 4.3056802+01 %LTLU ш 1 5.500000+01 5.5000000+01 5.4000000+01 5.2900000+01 5,0600000+01 4,7200000+01 4.55000000+01 5.1200000+01 5.4200000+01 5.4700000+01 4.56000000+01 4.5900000+01 4.5900000+01 5.00000000+01 5,3200000+01 4.6200000+01 5.1100000+01 5,1560000+01 5,1300000+01 5.1500000+01 5.2600000+01 5.2700000+01 5.3100000+01 LABEL CT3-2, 116-7106, 5186, 6.5, 12 WEEKS DAY 1.1960000+01 \$EBAR 1.8365733+00 \$SE 1.3080000+41 #F44K 5.7619588-01 %SE 1.2557500+01 6Edak 9.3574801=01 55E 2.5742367+00 \$5E LAHEL CT3-2, [15-7106,5148,0,5,2 WEEKS LAHEL CIS-2, 110-7100, 5184,0,5,5 WEEKS LABEL CT3-2 71G-7106,5180,0,5,5 DAYS LABEL CT3-2, TIG-7106, 5180, 0.5, 9 DAYS NUMBER LABEL CT3-2,TIG-7106,5180.0.50,1 1 2,7100000+01 4 3.2100000+01 3.6400606+01 5.1740990+01 5.5900000+01 3-5200000+01 2.68000000+01 2.6700000+01 2.6700000+01 2.9100000+01 2.9800000+01 3.1300000+01 3,1500000+01 3.1900000+01 5.25800000±01 5.2100000+01 3.50000000+01 3.4500000+01 3.4400000+01 3.4500000401 3.54000000+01 3.60000000+01 1.16200000+01 XEBAK 3 ب<u>ر</u> 9 5.13759900+61 3,2075000+01

### TABLE J-8.

# UNIAXIAL TENSILE TEST RESULTS ON X7106-T63 ALUMINUM ALLOY WELDMENTS

Panel No. CT4-2, 0.50-inch TIG/5356, Sq Butt.

न r	.6900000+01 4		1
_		2000000	. 70000007.
	.5900000+01 4	5000000	8.70000000+0
	.6300000+01	6100000+0	.0300000+0
	.68000000+01	5100000+0	0+00000000
	.5800000+01 4	5300000+0	.0400000+0
	430000000	0+000004	5000000
047733740	YBAR 4.5018017-0	ECY O ACE	Y 17 19 10 47 7
	0 / T/017/**		111111111111111111111111111111111111111
9.1000000+00	- 0	. 210	460-01 3616
4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4		3	
	6,06,0,066,00	ATO	
<b>V</b>	.010000010 4	0.000018	0+000000+•
<b>30</b>	.0600000+01 4	8800000+0	0.0000000.
14	.99000000+01 4	2000000	.0300000.
20	.0900000+01	8600000+0	.030000+0
26	00+01 4	8800000	1.0000000+01
32	.91000000+01 4	8500000+0	0+00000000
.005000+0	YBAR 6.4420446-0	\$SY 2.679	325+01 \$LTLY
.8666667+0	UBAR 3.6698798-0	SSU 4.6	707+01 SLTL
9.8333333+00	AR 7.1740278	\$SE	
	06,5356,0.50.9	_	
1	3.1000000+01	9800000+0	0+0000000
•	4800000404	0100000	0.000000
, ,		7 2	***************************************
710	TB+0000000		0.0000070
12	***************************************	0+0000000	. 3400000+0
12	.0400001 5	02000000	.1100000+0
•	2.020000000	8800000+01	9.20000000+0
•00000590	BAR 2.9496197-0	\$SY 2.9	492+01 SLTLY
4.9716666+0	UBAR 6.7058834	\$50 4.632	489+01 SLTL
*09333340	BAR 2.1685633+0	ű	
LABEL CIA-2.11	305.0.9556.00	EEKS	
4	.23300000+01 5	1100000011	.3500000+0
	.20000000401 5	1200000+0	0+0000000.
	.19000000 5	060000000	.3500000+0
7.	1260000001 5	-	1.3250000+01
	.1400000401 5	05000040	.0100000+0
	.1000000000	1200000+0	.2800000+
17455555+	THAK 3.4502569.0	\$5Y 3.004	623+01 SLILY
048.555.00	1388 3-4303014=0	9. 4 USB	601+01 5LT
1.0941007+01	*ERAK 1.7074593+00	!	
	0.2350.0.53.5	T T	
	14000000000000000000000000000000000000	000000	0.0000000
	. 5/50000+01	0.0000000000000000000000000000000000000	1300001.
	.2900050461 5	240000042	. \$200096+6
	.20000000001 5	2500000+0	•3200100+n
	.340000011 5	2400000+0	.2400000+n
	.57000000+01 5	26000005	.30000000.
55	5 10+000000	C	3000
.3294649+0	YB4K 6.5726995-0	45Y 2.4	214+01 \$LTLY
	0.001004 / 11	150 5 143	1 1 10 10 10 1
0+1000000	0-62/T624.5 NWGO	2+T*C 000	111¢ T0+400
.26*33340	0 * 7 * 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	Ş	

1.1700000+01 1.3500000+01 1.3000000+01 1.24000000+01 1,33000000+01 5,3900000+01 5,31000000+01 5.2300000+11 5.2300000+01 5.2740040+01 5,350000001 LABEL CT4-2, TIG-7106, 5356, 0.50, 12 WEEKS 3.4900006+01 3.550000000 3.49020000+01 3.4906600+01 \$.>10+0H0+01

3.5110467+03 27484 4.7142474-01 857 3.3745247+01 8LTLY = 20244444101 8LTLU = 20244444411 8LTLU = 20244444411 8LTLU

# UNIAXIAL TENSILE TEST RESULTS ON X7106-T63 ALUMINUM ALLOY WELDMENTS

Panel No. CT5-6, 0.50-inch TIG/5556, Sq Butt.

LABEL CIS-6.11G-7104.5556.0.50.1 A.4900004-01

1 2.6000004-01 4.4900004-01 9.2000004-00

13 2.6000004-01 4.6100004-01 9.20000004-00

22 2.65000004-01 4.6100004-01 9.0000004-00

23 2.5000004-01 4.6000004-01 9.0000004-00

24 2.5000004-01 4.4000004-01 9.0000004-00

25 2.6500004-01 4.4000004-01 9.0000004-00

26 2.6500004-01 \$SPRAR 7.8486274-01 \$SPRAR 7.84862741-01 \$SP

LABEL C19-6,11G-7106,5556,0.5,9 DAYS

3 2-9800000-01 4,8800000-01

9 3.0400000-01 4,9600000+01

15 3.0800000-01 4,9600000+01

21 3.0700000-01 4,9600000+01

33 3.0400000-01 4,9000000+01

33 3.0400000-01 4,9000000+01

34 92116667-01 \$VBAR 3,999313-01 \$SY 2,8276035-01 \$FTLV

4,9116667-01 \$VBAR 6,2593326-01 \$SE

1.3200000+01 1.0550000+01 1.0000000+u1 3.0750000+01 pyram 3.8859629+01 \$57 2.6763703+01 \$LTLY 4.9516467+01 kudam 1.1884819+00 \$50 4.5500418+01 \$LTLU 1.0275000:01 kedam 1.980413+00 \$56 1.30500000+01 5.0100000401 5.0490000+U1 4.9200000+U1 10+00000016 4.4500000+01 LABEL UT5-6, 118-7106, 555, 0,5,2 WEEKS \$ 05000000 3.11000000+01 3.0900000000 5.11.00000+01 5. ueuuuuu+0 4.010UUU.+0 25225

# UNIAXIAL TENSILE TEST RESULTS ON X7106-T63

Panel No. CT3-4, 0.50-inch TIG/X5180, Double V

1000   1000	ELON.		!	,	<u></u>		ע
1   2.   2.   2.   2.   2.   2.   2.	HEL 015-4	-	1001	6.34.64	SUAT		
			7	0000+01	4.8000300+	8.300	001)+1
15		. ~			7500000	2010	1644
APEL CTA-4. List / 100.2180.0.01  APEL CTA-4. List / 100.2180.0.02.5   014  A. 10.000.000.000  B. 5. 10.000.000.000  A. 5. 10.000.0000  A. 5. 10.000.0000  A. 5. 10.0000.000  A.		-		1		007.2	2000
1		2 ;	•	E	0.00000000	001.0	
APPEL CT   A-0.500000-01   A-0.000000-01   A-0.000000-01		<u>~</u>	. y	0.0110.00	.410000040	00/-6	1 + 6 6 0
### ### #### #########################		22	2	0.00000	* 780±000+0	007.6	010+0
### CT   15   15   15   15   15   15   15   1		. 4 .	.0	0 + 0 + 0	.71000000.	9.000	0+000
### C   5.44   19444   7.594999-01 \$50   4.5020287-01 \$1100   #### \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$	Ann and		7. 4	4.47152	7+111 \$5Y 2.4	100744111	· -
### CI A-4, ILA-7100-2180-0-25 0AY  #### CI A-4, ILA-7100-2180-0-25 0AY  ***CONTROLL CONTROLL	Tropies//	-	1	4 5 7 7	7 177 100	047 87 07	-
### C	200000000	4		¥040.	Cor Dea In-C	0.400000	-
APEL CIA-4,   Las   Luo   2180-10.25   0AY   2   4200-1001-01   2   4000-1001-01   3   4000-1001-01   3	endocen.	<b>€</b>	Į.	62022	10-0		
AFEL C. 13-4, 14-7, 100-210-10, 25-2, 144  - 5, 10 10 10 10 10 1, 5, 10 10 10 10 10 10 10 10 10 10 10 10 10					4		
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5.2466n66+60 better 2.4228H29-01 \$5U \$.1240688+01 \$LILU \$.2166666+60 better 3.20698H6-01 \$5E \$.2166666+60 better 3.20698H6-01 \$5E \$.2166666+60 better 3.20609H6-01 \$5E \$.2460909+01 \$1.2460909+01 \$1.2460909+01 \$1.2460909+01 \$1.2460909+01 \$1.2460909+01 \$1.2460909+01 \$1.2460909+01 \$1.2460909+01 \$1.2460909+01 \$1.2460909+01 \$1.2460909+01 \$1.2460909+01 \$1.2460909+01 \$1.246099+01 \$1.246337+01 \$1.11099999+01 \$1.24633333.01 \$1.246337+01 \$1.11099999+01 \$1.246337+01 \$1.11099999+01 \$1.246337+01 \$1.11099999+01 \$1.246337+01 \$1.11099999+01 \$1.246337+01 \$1.11099999+01 \$1.246337+01 \$1.1109999+01 \$1.246337+01 \$1.1109999+01 \$1.246337+01 \$1.1109999+01 \$1.246337+01 \$1.1109999+01 \$1.246337+01 \$1.1109999+01 \$1.246337+01 \$1.1109999+01 \$1.246333333+01 \$1.1109999+01 \$1.246333333+01 \$1.1109999+01 \$1.246333333+01 \$1.1109999+01 \$1.246333333+01 \$1.1109999+01 \$1.246333333+01 \$1.1109994+01 \$1.24633333+01 \$1.1109994+01 \$1.24633333+01 \$1.1109994+01 \$1.2463333+01 \$1.1109994+01 \$1.2463333+01 \$1.1109994+01 \$1.2463333+01 \$1.1109994+01 \$1.2463333+01 \$1.1109994+01 \$1.24633333+01 \$1.1109994+01 \$1.2463333+01 \$1.1109994+01 \$1.2463333+01 \$1.1109994+01 \$1.2463333+01 \$1.1109994+01 \$1.2463333+01 \$1.1109994+01 \$1.2463333+01 \$1.11099994+01 \$1.2463333+01 \$1.1109994+01 \$1.2463333+01 \$1.1109994+01 \$1.2463333+01 \$1.1109994+01 \$1.2463333+01 \$1.1109994+01 \$1.2463333+01 \$1.1109994+01 \$1.2463333+01 \$1.1109994+01 \$1.2463333+01 \$1.1109994+01 \$1.2463333+01 \$1.1109994+01 \$1.2463333+01 \$1.1109994+01 \$1.2463333+01 \$1.1109994+01 \$1.2463333+01 \$1.1109994+01 \$1.2463333+01 \$1.1109994+01 \$1.2463333+01 \$1.1109994+01 \$1.2463333+01 \$1.110994+01 \$1.2463333+01 \$1.1109994+01 \$1.2463333+01 \$1.1109944+01 \$1.2463333+01 \$1.1109944+01 \$1.2463333+01 \$1.1109944+01 \$1.2463333+01 \$1.1109944+01 \$1.2463333+01 \$1.1109944+01 \$1.2463333+01 \$1.1109944+01 \$1.2463333+01 \$1.1109944+01 \$1.24633334+01 \$1.1109944+01 \$1.2463334+01 \$1.1109944+01 \$1.2463334+01 \$1.1109944+01 \$1.2463334+01 \$1.1109944+01 \$1.2463334+01 \$1.1109944+01 \$1.2463344+01 \$1.1109944+01 \$1.2463344+01 \$1.1109944+01 \$1.2463344+01 \$1.1109944	.4635.453	40	T X	.0/082	5+00 45Y 2.9	14941+0	7
##EL CT3-4, 110-7136, 5160, 6.5, 5 weeks  1	.2466ner	4 15	T	4427BH	9-01 \$SU 5.1	40688+0	1
AREL CT3-4, 110-7106, 5160, 0.5, 5 WEEKS  5.4560000+0.5.2200000+0.1  1. 5.4560000+0.1  5.2400000+0.1  5.5200000+0.1  5.5200000+0.1  5.5200000+0.1  5.5200000+0.1  5.5200000+0.1  5.5200000+0.1  5.5200000+0.1  5.5200000+0.1  5.5200000+0.1  5.5200000+0.1  5.5200000+0.1  5.5200000+0.1  5.5200000+0.1  5.5200000+0.1  5.5200000+0.1  5.5200000+0.1  5.5200000+0.1  5.5200000+0.1  5.50000000+0.1  5.5000000+0.1  5.50000000+0.1  5.5000000+0.1  5.500000000+0.1  5.500000	.2166556	0.0	Y.	4689a.	6-01 #SE		1
AREL CT3-4, 1657165, 5167, 655, 5 WEEKS  5.4560000+01  5.4560000+01  5.4560000+01  5.4560000+01  5.4560000+01  5.4560000+01  5.4560000+01  5.4560000+01  5.4560000+01  5.4560000+01  5.4560000+01  5.4560000+01  5.4560000+01  5.4560000+01  5.4560000+01  5.4600000+01  5.4600000+01  5.4600000+01  5.4600000+01  5.4600000+01  5.4600000+01  5.4600000+01  5.4600000+01  5.4600000+01  5.4600000+01  5.4600000+01  5.4600000+01  5.4600000+01  5.46000000+01  5.46000000+01  5.46000000+01  5.46000000+01  5.46000000+01  5.46000000+01  5.46000000+01  5.460000000+01  5.460000000+01  5.460000000+01  5.46000000000+01  5.46000000000+01  5.4600000000000000+01  5.46000000000000000000000000000000000000							
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11 3.4300000000 1 5.2900000001 1 8.7000000000000000000000000000000000000		ν	•	0+000	.2400000+0	8.30	0.0000
3.4383333401 17.9.800000401 2.800000401 2.8000000400 2.3.59000000401 3.2800000401 3.2800000401 3.39000000401 3.28000000401 3.39000000401 3.28000000401 3.3438333301 17844 4.5789849-01 5.2400000401 4.6000000401 3.3438333301 17844 4.5789849-01 5.2400000401 5.2400000401 5.3000000401 5.3000000401 5.3000000401 5.3000000401 5.3000000401 5.3000000401 5.3000000401 5.3000000401 5.3000000401 5.3000000401 5.3000000401 5.3000000401 5.3000000401 5.35000000401 5.35000000401 5.35000000401 5.3500000401 5.3500000401 5.3500000401 5.3500000401 5.3500000401 5.3500000401 5.3500000401 5.3500000401 5.3500000401 5.3500000401 5.3500000401 5.3500000401 5.3500000401 5.3500000401 5.3500000401 5.3500000401 5.3500000401 5.3000000401 5.3500000401 5.35000000401 5.3500000401 5.3500000401 5.35000000401 5.3500000401 5.3500000401 5.3500000401 5.3500000401 5.35000000401 5.35000000401 5.35000000401 5.35000000401 5.35000000401 5.35000000401 5.35000000401 5.35000000401 5.35000000401 5.350000000401 5.350000000401 5.35000000401 5.350000000401 5.35000000401 5.350000000401 5.350000000401 5.350000000401 5.3500000000401 5.350000000401 5.3500000000000000000000000000000000000			4	0+0000	.29600000+0	8.70	00000
23 3.3900000+01 5.2800000+01 9.00000000+0 35 3.3900000+01 5.2800000+01 1.04000000+0 35 3.3900000+01 5.2800000+01 9.2000000+01 89484 4.5789449+01 858 3.2066376+01 8LTLU 9.2000000+01 89484 2.7872127-01 850 5.1206337+01 8LTLU 9.2000000+01 8.7872127-01 850 5.1206337+01 FLTLU 9.2000000+01 5.2800000+01 5.1800000+01 12.1000000+01 12.3500000+01 5.28000000000000000000000000000000000000			4	00000	. 2900F00+0	9.80	0+0000
29 5.390 0.00 0.00 0.00 0.00 0.00 0.00 0.00				0.00000	2400000040	00.0	0 + 0 11 11 11
3.4383333.01 17944 4.5789849-01 55.2800001.01 4.57000001.01 5.28000001.01 4.5789849-01 55.2800000-01 4.500000001.01 5.28000000001.01 5.280000001.01 5.280000001.01 5.2800000001.01 5.2800000001.01 5.28000000001.01 5.28000000000000000000000000000000000000				0.0000	0 - 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	4:	140000
3.4343333.01 FYBAR 4.5749444-01 KSY 3.2066377-01 EULOSSON 5.2066677-01 EULOSSON 5.2066577-01 EULOSSON 5.2066577-01 EULOSSON 5.2066677-01 EULOSSON 5.2066577-01 EULOSSON 5.2066677-01 EULOSSON 5.2066677-01 EULOSSON 5.2066670-01 EULOSSON 5.206667-01 EULOSSON 5.206667-01 EULOSSON 5.206667-01 EULOSSON 5.206667-01 EULOSSON 5.206667-01 EULOSSON 5.20667-01 EULOSSON 5.206687-01 EULOSSON 5.20667-01 EULOSSON 5.206687-01 EULOSSON 5.206687-01 EULOSSON 5.206687-01 EULOSSON 5.206687-01 EULOSSON 5.206687-01 EULOSSON 5.206887-01 EULOSSON 5.206887			•		0+00000100	4 0	
APEL CT3-4, T14-710-6, 5180, 0.5, 12 "FEKS 5.200037-01 ELTLO 9.3000001-90 EFAR 7.7459714-01 \$50 5.1206337-01 ELTLO 9.3000001-90 EFAR 7.7459714-01 \$5. \$12 "FEKS 6.5.5400000-01 5.3100000-01 12 5.5000000-01 5.3100000-01 5.5000000-01 5.25000000-01 5.25000000-01 5.25000000-01 5.25000000-01 5.25000000-01 5.25000000-01 5.25000000-01 5.25000000-01 5.25000000-01 5.25000000-01 5.2500000-01 5.25000000-01 5.2500000-01 5.2500000-01 5.2500000-01 5.25000000-01 5.25000000-01 5.2500000-01 5.2500000-01 5.2500000-01 5.2500000-01 5.2500000-01 5.2500000-01 5.2500000-01 5.2500000-01 5.2500000-01 5.2500000-01 5.2500000-01 5.25000000-01 5.2500000-01 5.2500000-01 5.25000000-01 5.25000000-01 5.2500000-01 5.25000000-01 5.250000000-01 5.25000000-01 5.250000000000-01 5.2500000000000000000000000000000000000		3 6			0 *	0001	
5.261556+11 NUHAM 2.7872127-01 NSU 5.1205357-01 NLILU 9.301010101-01 NEBAR 7.7459714-01 NSE APEL CT3-4. T16-7104, 5180, 0.5, 12 REEKS 6 5.4901000-01 5.3101000-01 7.5000000-0 12 5.49010000-01 5.28010000-01 9.5000000-0 24 5.4901000-01 5.2801000-01 1.11000000-0 35 5.5000000-01 5.3500000-01 1.00000000-0 3.5100000-01 5.2500000-01 1.00000000-0 3.5100000-01 5.2500000-01 1.0000000-0 3.5100000-01 5.2500000-01 1.0000000-0 3.5100000-01 1.00000-01 1.000000-00 1.0000000-00 1.00000000-00 1.00000000-00 1.0000000-00 1.00000000-00 1.0000000-00 1.0000000-00 1.0000000-00 1.0000000-00 1.0000000-00 1.0000000-00 1.000000-00 1.0000000-00 1.0000000-00 1.000000-00 1.0000000-00 1.000000-00 1.000000-00 1.000000-00 1.00000-00 1.000000-00 1.000000-00 1.000000-00 1.00000000-00 1.000000-00 1.000000-00 1.000000-00 1.000000-00 1.000000-00 1.000000-00 1.000000-00 1.000000-00 1.000000-00 1.000000-00 1.000000-00 1.0000000-00 1.000000-00 1.000000-00 1.000000-00 1.000000-00 1.0000000-00 1.000000-00 1.000000-00 1.000000-00 1.000000-00 1.000000-00 1.000000-00 1.000000-00 1.000000-00 1.000000-00 1.000000-00 1.000000-00 1.000000-00 1.000000-00 1.000000-00 1.000000-00 1.000000-00 1.000000-00 1.0000000-00 1.0000000-00 1.000000-00 1.0000000-00 1.0000000000	00000000	4 7 3	4	X / X / C	2.0 LOE 10-6	14/4000	. L
445L CT3-4. Tig-21uh, 518n; 0.5, 12 %EKS  5.5460000+01 5.110000-01 7.5600000+0  12 5.5400000+01 5.1100000+01 7.5600000+0  13 5.5400000+01 5.2800000+01 9.500000+0  3 5.5400000+01 5.2800000+01 5.1100000+0  3 5.5100000+01 5.2800000+01 5.1100000+01  3 5.5100000+01 5.2800000+01 1.1100000+01  3.5100000+01 5.2800000+01 9.1000000+01  3.5100000+01 5.2800000+01 9.1000000+01  3.5100000+01 5.2800000+01 8.1000000+01  3.5100000+01 5.280000+01 8.100000+01  3.5100000+01 5.280000+01 8.100000+01  3.5100000+01 5.280000+01 8.1000000+01  3.5100000+01 5.280000+01 8.10000+01  3.5100000+01 5.280000+01 8.10000+01  3.5100000+01 5.280000+01 8.10000+01  3.5100000+01 5.280000+01 8.10000+01  3.5100000+01 5.280000+01 8.100000+01  3.5100000+01 5.280000+01 8.10000+01  3.5100000+01 5.2800000+01 8.10000+01  3.5100000+01 5.280000+01 8.10000+01  3.51000000+01 5.2800000+01 8.10000+01  3.51000000000000000000000000000000000000	.2616666	, i	∢ ·	.78721	7-01 \$50 5.1	06337+0	7
APEL CT3-4. Tig-7ius, 5180, 0.5, 12 FEKS  6	. 300000	<b>4</b> 36	<b>1</b>	1654/	0.5 E0.4		
3.51466900401 5.31498411 9.246600040 12 3.5969000401 5.18686041 7.566600040 24 3.68696041 5.32686041 1.110000040 35 3.5169641 5.35686041 1.110000040 35 3.51666041 5.35686041 9.106030040 3.518353461 87944 6.0469644 9.410900049 3.52845665741 87944 6.0469644 1.8758887401 84TLV	ABEL CT3-4	1	71.0	3180	12 12 TEEK		
18		. 4		10100000	# # # P P P P P P P P P P P P P P P P P	5	0.40000
18 3.5909309404 18 3.5909300404 24 3.4909306461 5.286060640 1.1100000640 35 5.5009401 5.2859606041 1.110000040 35 3.5106060401 5.2859606040 9.100600040 -518333401 by an y, 4109946-01 \$57 3.0421364*01 & LLLY 4.06066741 \$9544 6.0469644-01 \$57 3.0421364*01 & LLLY 4.060604041 \$9544 6.0469644-01 \$57 3.0421364*01 & LLLY 4.060604041 \$9544 6.0549644-01 \$57 3.0421364*01 & LLLY			•			14	
18 3.5801000401 5.2861000841 9.500000040 24 3.490300641 5.3803000041 1.1100000040 35 3.5106000401 5.2863000401 9.100000040 .518333401 5.487 9.4109946-01 55 3.0421384501 8.11LY AAAAAAAA 1.14744 6.346964-01 55 3.0421384501 8.11LY AAAAAAAAA 1.1473444 6.346964-01 55 4.9756887401 8.11LA			?	0 + 0 0 0 0 0		00.7	0+0000
24 3.4901004-61 5.32010006141 1.11000000403 35 3.51040101401 5.350400041 1.0000000940 35 3.5104000401 5.2504000041 9.100000044  *518333401 by an y, 4109946-81 %5Y 3.0421368401 &LLLY ALGORDON S.			÷	0+00000	.280000085	. v	0 + 0 0 0 0
35 3.980484010+81 5.35648696+81 1.8080486949 35 3.518880441 5.25648086+1 9.18880806+8 5518333481 57244 3.4189946+81 557 3.9421368+91 ELILY 52816667-01 59424 6.045964-01 559 4.9756887+01 ELILY AARDORD 34 3.2434541 1.859 4.9756887+01 ELILY			4	0 4 9 0 0 10 0	.3200000+0	1:11	00000
35 3.5106000+01 5.25040000+01 9.1000300+0 -2846667-01 8944 6.045964-01 85Y 3.0421368+01 8LTLY AAAAAA 1.59444 6.045964-01 85Y 3.0421368+01 8LTLY AAAAAAA 1.54444 6.045964-01 85U 4.9756887+01 8LTLU			J.	0.0000000	.350000040	1.00	0+0400
.5183333.01 87464 9.4109946-01 \$5Y 3.0421368+01 &LTLY 22856572-01 &5J844 6.045961-01 \$5U \$5U 4.9756887+01 \$LTLU ADDOUGH 1.1814-01 \$1.9756887+01 \$LTLU			ı.J	0+60000	.250400044	9.10	0.0000
4.2816667-01 5.9844 6.0449061-01 \$SU 4.9756887+01 \$LTL	.5183333	0.1	T T	9.41199	A-11 %5Y 3.0	71368+0	64. TLY
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	100000	• • • •					2

ALUMINUM ALLOY WELDMENTS

> Panel No. CT4-4, 0.50-inch TIG/5356, Double 0.0000000+00 0.2000000+00 0.0000000+00 00+00000004.6 7.50000000+30 9.2000000+00 4.8000000004 4.8100000+01 4.7900000+01 4.6900000+01 4.77000000+01 LAREL C14-4,113-7100,555,0,50,3 DAY 10+0000006.2 10+000004647 2.89000000+01 2.86000000+01 2.0000000002 2.56000000+61

8.2000000+00 LAHEL 014-4,11:-7130,5356,0,50,50,507 2 3,0800000+01 4,9500000+01 4,8900000+01 5. U1 U 0 0 0 0 + 0 1

4.9166667+40 \$FBAR 7.2778205-01 \$SE

9.4006880+00 9.5000000+00 9.6000000+00 1.0200000+01 2,6553032+01 \$LTLY 4,9443951+01 \$LTLU 5,0500000+01 5,1000000+01 5,1000000+01 5,1300000+01 5.1000000+01 1.4223256+00 \$SY \$JSAR 3.1410719=01 \$SU 9.4000000+3u 1EHAH 4.2/39579=01 1SE LABEL CI4-4, T16-7106, 5356, 0, 50, 10 DAY 5.3100000+01 3.3340000+01 3.2740000+01 3.3390000+01 3,3500000401 5.3750000+01

9.3000000+00 1.00000000+U1 9.80000000+00 9.50000000+00 9.3000000+00 1.1400000+01 3.4100/00+01 1/944 4.7749652-01 \$57 3.1683664-01 \$LTLY 5.1466066+01 \$0936425+01 \$LTLU 4.8356425+01 \$LTLU 9.716656+00 \$FBAR 4.3550746-01 \$5E 5,1800000+01 5,1600000+01 5,1600000+01 5,0300000+01 5,2100000+01 5,14000000+01 LABEL C14-4,116-7100,5356,0,50,17 3.50000000+01 3.41000001+01 3.5900000+01 3.3000000010+01 8.4130000+01 \$0.40000065.s

9.1000000400 9.3000000+00 1.0000000+01 9.2000000+00 1.0600000+01 3.2850000+01 8YBAR 5.1672468-01 8SY 3.0235373+01 \$LTLY 5.1950000+01 %udak 3.3913810+01 %SJ 5.0233961+01 %LTLU 9.4166668+00 \$EBAR 7.9351553+01 %SE 5.2200000+01 5.2200000+01 5,130000+01 3.3000000+01 5.2000000+01 3.28000000+01 5,1900000+01 LABEL CT4-4, [1G-7100, 5356, 0.5, 5 WEEKS 3.21000000+01 3.2500000+01 .3105000+01 3.36000000401

00+0000002\*6 9.4006400+00 1.0000000+01 1.0400000+01 ЪУВЬК 4.9700028-01 \$SY 3.1735178+01 \$LTLY В∪НАК 4.5055845-01 \$SU 5.0170174+01 \$LTLU 5,26000000+01 5,3100000+01 5,23000000+01 5.1800000+01 .2700000+01 5.2200000+01 LAHEL CT4-4, TIG-7164, 5354, 0.5, I2 WEEKS 4.2739623-01 %SE 3.450000001 3.3506000401 3.4100000+01 3.4100000+01 3.5000000401 3.43000000+01 3.4250000+01 bY64K 5.2450000+01 BUBAR 9.7333333+00 £EBAR

# UNIAXIAL TENSILE TEST RESULTS ON X7106-T63 ALUMINUM ALLOY WELDMENTS

Panel No. CT5-8, 0.50-inch TIG/5556, Double V

Ľ	<b>&gt;-</b>	5	.11
-	.0.0455.00	7	
	Z. y4Uru@0+U1	.8200000+0	0+0000006.
	7 × 0   0 0 0 1 4 0	8300000+0	P+00000000.
	0+000000000	0.00000000	0+0000002
	0+0000000.	75000000+0	0+0000004
, , , , , , , , , , , , , , , , , , ,	· +	( X	1.0000000+01
	0.0000000000000000000000000000000000000	7344000+0	0.00000000
8516667+	YAAR 5-0366091	01 #SY 2,596	142+01 BLTLY
. K1	307908 5 AABIO728	01 \$50 4.514	8+01 \$676
	1 ESAK / 7373559		
•			
LABEL CID-C.	00000000	0.20000000	0.40.000
u 1	0+00000000	0.00000000	************
	0.0000000000000000000000000000000000000	0.00000000	3000000+
	D+000an66*	0+0000055	.1000000+n
	.940000+0	0.0000066	.7000000+0
*	. 000000000	.9300000+01	6.7000000+0
980unut+0	YBAR 4.1952834	01 \$SY 2.767	7187+01 \$LTLY
4.95000000+01	TUBAR 2.2801260	834	256+01 \$LTC
• <b>7७</b> 000-666-40	EBAK 3.1622897		
LABEL CIS-6, [1	1,5550,0,5:1	DAY	
2	. 38400000+0	19000000+0	.2000000+0
•	.3>000000+0	.1200000+0	0+0900000
21	+000	160	9.2000000400
12	.5500000+0	.1400000+0	*1700000+C
12	.3100000.	0+0000ngan*	.20000000+6
<b>~</b> :	\$.58JU090+01	5,11000000+01	9.40000000+U
.361666/+3	BAH 3.9707949	01 \$SY 3,160	44+01 3LTL
5,1333333+01 9,7833333+00	USAH 3.8817985 EBAH 9.8877057	936	143+01 %LTL
LABEL CIS-K.II	1,6,0,0552,00	⋖	,
	3.4600000+01	.20000005	.50000004
	.4500000+0	.1500000+0	.70000007.
	.4700000+0	.1600000041.	.50000000.
	) + 0.000000±6•	0+000cost*	0+0000000
97	+ 0 0 0 0 0 P		00+000000000000000000000000000000000000
444444	TOPOCOTORS	7. F. C. C. C. C. C. C. C. C. C. C. C. C. C.	X 12 14 104004
1500001+0	MAK 4.81604020	0.4	500+01 3LIL
633333+	ESAK 1.9663808	01 \$5E	7176 70.776
LABEL CTS-K, 1	106, 5556, 0,	5 MEEKS	
	3.3100000+01	5.28000000+0	0 ± 0 0 0 0 0 0 0 0 •
	.19000000+0	.2100000.	• 600000000
	.2000000	.1600000+0	.4000000+0
	.2700000+0	.1700000+0	.80000008.
	.28000000+0	.1960000+n	+0000000
0.55550	2.010+000+012 5.040 F. T. T. T. T. T. T. T. T. T. T. T. T. T.	5.1309000+01	0 + 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
10000001	12A00ATT - 12A01	10 40 10 10 10 10 10 10 10 10 10 10 10 10 10	7174 7042
9.1333333+00	AK 8.0663921	* * *	70.77
LABEL CT5+K, I	100, 5556, 0.	12 WEEK	
	5.4<00000+01	5.2900000+0	.50000000+0
	.2795000+0	3200000+0	0+00000000
	.2700000±0	38660000+0	0+00000000
	0+0000065.	256660000+1	01000000
	.4100000+0	.1408680+3	.5000000.
3	3.3600000+01	.17600001+01	.1006900+0
3,3535333+91	YAKK N.7725408	01 \$SY 3.010	5427+01 \$LTLY
.2600000+0	BAR 9.1994666	1 35u 4.799	670+01 BLTL
.3000000	EBAK 6.5178085	01 \$5	

> 0.50-inch MIG/X5180, Double Panel No. CM3-2,

.0000000+00 2.8380781+00 \$SU 3.2972658+01 .0500000+01 MEEKS 20000000 LABEL CM3-2, M1G-7106,5180,0,50,5 WEEKS 9.5500000+00 SEBAR 1.2988457+00 \$SE 4.6933333+01 SUBAR 8.3347696-01 SSU 8.6500000+00 SEBAR 9.9347887-01 SSE 7.9833333+00 SEBAR 1.5992708+00 SSE LABEL CH3-2, MIG-7106, 5180, 0,50, 12 LABEL CM3-2,MIG-7106,5180,0,90,7 DAYS LABEL CM3-2, MIG-7106, 5180, 0,50,4 DAYS LABEL CM3-2, MIG-7106,5180,0,50,1 DAY \$.6366667+01 \$YBAR 6.8605139-01 1.5143870+00 LABEL CM3-2, MIG-7106, 5180, 0, 50.2 3.2000000000 8.7000000+00 SEBAR 4.4766667+01 SUBAR 4.7333333+01 SUBAR 1183333+01 3.1583333+01

UNIAXIAL TENSILE TEST RESULTS ON X7106-T63 ALUMINUM ALLOY WELDMENTS 0.50-inch MIG/5356, Double V Panel No. CM4-2,

NUMBER	>		ш
LABEL CM4-2,MI	8-7106,5356,0,50,1	DAY	
And the second s	.3700000+0	4500000	500000000
		4200000+0	.30000000.
P.	.4300000+0	47000000	0+0000000
	7 4700000.04		
	0+00000/+•	0.0000000	******
	.3400000+0	43000000	.50000000
	.4300000+0	.52000000+0	.7000000.
	4200004	44000044	
1	THANKANATA	******	7
2.4100000+0	THAN 4.0903962	01 \$SY 2,1/2	659+01 SLTL
	AR 6.3005	04 880 4.137	1401 517
		400	
.0202/14+0	/****** ******	20	
		1	
LABEL CM4-2,MI	06,5356,0.	DAY	
	2.7100000	4.74000040	64000040
	0+00000/+.	.5500000040	.30000000
	.58000000+0	3600000+0	10000001.
	400000		
	0.0000000	******	*******
	.2300000+0	26D0000+0	.3000000
2	2.5300000+01	4.610	9.4000000+00
5500000+0	YHAR B. 7863888	01 SSY 2,105.	087+01 \$LTLY
			100000
10 - 200 20 20 10 1	308AR 1.22869294	0 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2	14/401 3616
. 90000004	EBAK 1.1307812	25 00	1
LARFI CM4-2.MI	356.0	Y	
•		*******	0+0000002.
•	.6300000+0	7900000+0	.20000000+0
	. 52000000	44.0	7.2000000
	.5200000+0	.29000004	.3000000
	0.0000AA	77000000	0.000000
•	2.02000005	4.0100000401	0.10000010
2.6066667+0	YBAR 6.8010804	01 SSY 2.262	5+01 SLTL
Tn+0000007.44	300AN Y.Y346646	162.1	7178 784020
0.10000001.0	EBAR 6.24/9080	OR IO	
LABEL CM4-2,MI	06,5356,0,	EEK	
	2.4000000464	8400000	
	******	0.0000010.	2+222222
	.6400000+0	8700000+0	.7000000+0
	63000004	70000000	7000000
	.790000940	*93000000	-200000000
	.80000000.	.820	7.3000000+00
C. C. C. C. C. C. C. C. C. C. C. C. C. C	040	A 60 V 3 384	X 14 61 44 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4
* 072000	THE PATTO NAC	17 35 64 60	4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4
4.8466663401	SUBAR 5.0466573-	01 \$SU 4.587	725+01 SLTL
* 3833334D	BAR 5.6005991	85 TO	
A . C . A	0-7106.5356.0.50	XXII	
TOPP ANTER	7877878787878787878787878787878787878787		0.000000
	0+00000//*2		0.0000000
11	2.82000000+0	.800000008	.7000000
1.	2.24000040	07000000	7.20000000
_	D		
62	2.19000045	0.0000020	0+0000000
***	2.8600000+0	0.00000000	0+00000000
	0+0000041	04000000	50000000
٠	Tn+00000000	*****	20000000
.8066667+0	#YHAR 4.8853743	01 \$SY 2,559	7+01 %LTC
07217117	AUMAR 1.46104H2	4.134	429+01 SLTL
0.000000	DIOLOT NEGOT	0000	4
.1000000.	BERAK 6.2609919	10	
ABEL CM4-2. M	16-7106. 5354	D. 12 WEFK	
•	10+000004.2	2.0010010.00	0+0000000
12	0+00000000	.960000040	.500000000
1	0.6306000+0	1400000	+00000000
47	0+0000044.2	1500002t.	0+0000000.
3.0	3.02000000	.92000000+0	.200000000
24	B. B. B. B. B. B. B. B. B. B. B. B. B. B	0.000000	400000
•	2.04000000000	2.0000000000000000000000000000000000000	1.0000000
0457770	4 4 400 704 A	01 SSY 2,741	991+01 5LTL
T0+8080804-2	017/10/1 PER 1	TL/12 LOS TO	- 1-1-1 TO - 1-1-1-1
.020000.	\$UBAR 7.4832985	01 \$5U 4.641	451+01 3LTL
	10630011		1 10.4

7.566666410 \$EHAM 6.0663956-01 \$SE

6.8000000+00 2049550+01 \$LTLY

1900000000 120000040

8.033333400 SEBAH 1.4094918+00 \$5E

### TABLE J-16

# UNIAXIAL TENSILE TEST RESULTS ON X7106-T63 ALUMINUM ALLOY WELDMENTS

> Panel No. CM5-1, 0.50-inch MIG/5556, Double

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9.9000000+00 .80000000+00 8,7000000+00 8.9000000+00 7.2000000+00 .2000000+00 .4000000+00 7.9000000.5 2.8750000+01 \$YBAR 6.3482992-01 \$SY 2.5537760+01 \$LTLY 4.3816667+01 \$UBAR 1.6228595+00 \$SU 3.5604997+01 \$LTLU 8.533333+00 \$EBAR 8.3586311-01 \$SE 3.1616667+01 SYBAR\_5.3448007-01 SSY 2.8912197+01 SLTLY 4.6857143+01 SUBAR 1.5020653+00 SSU 3.9887560+01 SLTLY 7.8428571+00 SEBAR 1.7690461+00 SSE LABEL CH5-1, MIG-7106, 5556, D.5, 6 DAYS
2 3.0700000+01 4.7700000+01
8 3.1400002+01 4.5000000+01
14 3.1500000+01 4.690000+01 4.8900000+01 4.66000000+01 4.2400000+01 4.4600000+01 4.2200000+01 4,34000000+01 4900000+01 .6600000+01 4.8000000+01 LABEL CM5-1.HIG-7106,5556.0.5.1 1 2.8000000+01 7 2.8200000+01 2.9800000+01 2.8700000+01 2.8900000+01 3.2100000+01 3.2000000+01 3.2000000+01

2.8577096-01 \$SY 3.0870666-01 \$LTLY 8.0602134-01 \$SV 4.3904865-01 \$LTLU 7.8000000+00 .80000000. .60000000+00 .70000000+00 4.9400000+01 4.6900000+01 4.78000000+01 4.8000000+01 2.9664780-01 \$SE LABEL CM5-1, MIG-7106, 5556, 0.5, 9 DAYS 3.2000000+01 3.2200000+01 3.2400000+01 3.2400000+01 .2800000+0 SUBAR 7.9000000+00 SEBAR 3.2316667+01

34 3.3500000+01 4.9300000+01 8.4000000+00 3.2716667+01 8YBAR 7.0261917-01 8SY 2.9161414+01 8LTLY 4.8316667+01 8UBAR 8.8637968-01 8SU 4.3831585+01 8LTLU 8.4000000+00 7.80000000+00 9.80000000+00 4,7000000+01 4.8000000+01 4.86000000+01 4.78000000+01 4.9200000+01 8.1166666+00 \$EBAR 9.9682839-01 \$SE LABEL CM5-1,MIG-7106,5556,0.5,2 WEEKS CM5-1, MIG-7100,5006,0,5,5 WEEKS 3.3400000+01 3,20000000+01 3.18000000+01 3.2700000+01 3.2900000+01 LABEL

6.4000000+00 0.40000008.9 0.0000000.00 6.6000000+00 6.0000000+06 8.80000000+00 8.4000000+00 0.50000000+00 7.1000000+00 3.1000000+01 stark o.0992563-01 bst 2.7913776+01 blit 4.9683333+01 bubak 1.1391579+00 bsu 4.891994+01 blitu 4,8400000+01 4.9500000+01 4.9800000+01 4.9400000+01 4,72000004,01 5.2260000+01 5.22000000+01 5,2700000+01 4,9800000+01 .1200000+01 \*FEKS 6.853333+80 \$FR44 9.6561727-01 \$SE 3.1400000+01 5.1500000+01 3.65000000-01 3.1200000+01 3.1469000+01 5.00000000 3.590000000cc. 3.05000000. 3.00000000003 3.680u0000+01 3.6509000+01 LABEL CM5-1, MIG-710A, 5554, 47.25 9 15

Panel No. CT3-3, 1.00-inch TIG/X5180, Double

1. 3.000000-0.0  3. 0.000000-0.0  3. 0.000000-0.0  3. 0.000000-0.0  3. 0.000000-0.0  3. 0.000000-0.0  3. 0.0000000-0.0  3. 0.000000000000000000000000000000		3.133000001.0 3.4800000000		+00000000
### 1.2000000000000000000000000000000000000	:   	3 • d&dedage 0 • 0 • 0 • 0 • 0 • 0 • 0 • 0 • 0	0.0000000000000000000000000000000000000	0+00000009.
13 3.4880000-01 13 3.4880000-01 13 3.4880000-01 14 3.4880000-01 1. 3.4880000-01 1. 3.4880000-01 2. 4.9800000-01 3. 4.8800000-01 3. 4.88000000-01 3. 4.8800000-01 3. 4.88000000-01 3. 4.8800000-01 3. 800000-01 3. 4.8800000-01 3. 4.88	₩ #1 (	3.48000000+D	•	100000000
13 3.3240.90.401 4.2010.0010.0010.000.000.000.000.000.000.	\$ E			
3.0430000-0 3.0430000-0 3.0430000-0 3.0430000-0 3.0430000-0 3.0430000-0 3.0430000-0 3.0430000-0 3.0430000-0 3.24000000-0 3.24000000-0 3.24000000-0 3.24000000-0 3.24000000-0 3.240000000-0 3.24000000-0 3.240000000-0 3.24000000000000000000000000000000000000	· **	5.020000	0+0000000-	. 7200000+0
### APPLICATION OF THE PROPERTY OF THE PROPETTY	<b>.</b> .	0+00000000	0.0000000000000000000000000000000000000	04000004
2.2 2.990.000.010 3.0130.07.10.02 2.4.00.000.010 3.0130.07.10.02 2.4.00.000.010 3.0130.02.10.02 2.4.00.000.010 3.0130.02.10.02 2.4.00.000.010 2.4.00.000.010 2.4.000.000.010 2.4.000.000.010 2.4.000.000.010 2.4.000.000.010 2.4.000.000.010 2.4.000.000.010 2.5.000.000.000.010 2.5.000.000.000.010 2.5.000.000.000.010 2.5.000.000.000.000.000.0000.0000.0000		0+0000000000000000000000000000000000000	******	• • • • • • • • • • • • • • • • • • • •
\$1.000000000000000000000000000000000000	62	0+00000000	3	_
3.013000/11 bY3A4 0.12503193-01 \$SY 2.0038969-01 aLTLY 4.4500016-01 bY3A4 0.12503193-01 \$SY 2.0038969-01 aLTLY 4.4500016-01 bY3A4 0.12503194-01 \$SY 2.0038969-01 aLTLY 4.4500016-01 bY3A4 0.1250310-01 bY3A4 0.1250310-01 bY3A4 0.12500000-01 bY3A4 0.125000000-01 bY3A4 0.12500000-01 bY3A4 0.12500000-01 bY3A4 0.125000000-01 bY3A4 0.12500000-01 bY3A4 0.125000000-01 bY3A4 0.125000000-01 bY3A4 0.125000000-01 bY3A4 0.12500000000000000000000000000000000000		コキコロコニコピティへ	5	
ABEL CIS-3, TLS-7100, 20100000000000000000000000000000000			20 T T T T T T T T T T T T T T T T T T T	V 17 14 40 40 40
### ### ##############################	(+/000t <b>*</b> n•	V.1000000000000000000000000000000000000	000 to 101	10407
1.75chnc7+01 bedar 6, U277326-01 \$SE  ABEE C13-3, T13-7120-5180-1,001NCH+4 DAY  5.5200000+01 4,7200000+01  5.5200000+01 4,5900000+01  20 5.2200000+01 4,5900000+01  20 5.2200000+01  20 5.2200000+01  20 5.2200000+01  3.5200000+01  4.6500000+01 1.5700000+0  20 5.2200000+01  20 5.2200000+01  20 5.2200000+01  20 5.2200000+01  20 5.2200000+01  21 5.2500000+01  22 5.2500000+01  23 5.2500000+01  24 5.2500000+01  25 5.2500000+01  26 5.2500000+01  27 5.2500000+01  28 5.2500000+01  29 5.2500000+01  4.6500000+01  5.2500000+01  5.2500000+01  6.2500000+01  7.5500000+01  7.5500000+01  8.4500000+01  8.4500000+01  9.5400000+01  1.5500000+01  1.5500000+01  1.5500000+01  1.5500000+01  1.5500000+01  2.5500000+01  2.5500000+01  3.45000000+01  3.4500000+01  3.4500000+01  3.4500000+01  3.4500000+01  3.4500000+01  3.4500000+01  3.4500000+01  3.4500000+01  3.45000000+01  3.4500000+01  3.4500000+01  3.4500000+01  3.4500000+01  3.4500000+01  3.4500000+01  3.45000000+01  3.45000000+01  3.45000000+01  3.45000000+01  3.45000000+01  3.45000000+01  3.45000000+01  3.45000000+01  3.45000000+01  3.45000000+01  3.45000000000000000000000000000000000000	. 450001966	*UHAK <.165644	+00 %50 4.213	355+01 %LIL
ABEL CIS-3, TLu-7100-01801.1.00INCH.4 DAY  5.3400000+01  4.6400000+01  2.2200000+01  4.6400000+01  2.2200000+01  3.2200000+01  3.2200000+01  3.2200000+01  4.6900000+01  3.2900000+01  4.6900000+01  3.360000+01  3.3600000+01  4.6300000+01  3.3600000+01  3.3600000+01  4.6300000+01  3.3600000+01  4.6300000+01  3.3600000+01  4.6300000+01  4.6300000+01  5.22000000+01  5.22000000+01  5.24000000+01  6.22000000+01  7.320333341 100000+01  8.32000000+01  8.32000000+01  9.32000000+01  1.53000000+01  1.53000000+01  2.32000000+01  3.4500000+01  3.4500000+01  4.6500000+01  5.4500000+01  1.5700000+01  1.5700000+01  1.5700000+01  2.2500000+01  3.4500000+01  3.4500000+01  4.6500000+01  5.4500000+01  4.6500000+01  5.4500000+01  4.6600000+01  5.4500000+01  5.4500000+01  5.4500000+01  5.4500000+01  5.4500000+01  5.4500000+01  5.4500000+01  5.4500000+01  5.4500000+01  5.4500000+01  5.4500000+01  5.4500000+01  5.4500000+01  5.4500000+01  5.4500000+01  5.4500000+01  6.4500000+01  6.4600000+01  6.46000000+01  6.46000000+01  6.4600000+01  6.46000000+01  6.46000000+01  6.46000000+01  6.46000000+01	. My66607+B	BEBAH 0.027732	-01 \$SE	
ABEL C13-3, T13-7130-7130-7180+1, DUINCH+4 DAY  2				
2 5.340000+01 4.720000+01 1.3300000+0 2 5.220000+01 4.500000+01 2 5.220000+01 2 5.220000+01 2 5.220000+01 2 5.220000+01 2 5.100000+01 3 1950000+01 1.3500000+01 1.3500000+01 1.500000+01 1.3500000+01 1.500000+01 1.350000000+01 1.500000+01 1.350000000+01 1.500000+01 1.350000000+01 1.500000+01 1.350000000+01 1.50000+01 1.350000000+01 1.500000+01 1.350000000+01 1.500000+01 1.350000000+01 1.500000+01 1.350000000+01 1.500000+01 1.3500000000+01 1.500000+01 1.350000000+01 1.500000+01 1.350000000+01 1.500000+01 1.350000000000+01 1.500000+01 1.35000000000000+01 1.500000+01 1.35000000000000000000000000000000000000	AHE# C13-3.T	0-7130-3180-1-00	ACH . 4 DA	
2. 3.2200000+01 4.5900000+01 1.5300000+0 2. 5.2200000+01 4.5900000+01 1.5300000+0 2. 5.2200000+01 4.5900000+01 1.5300000+0 3.22000000+01 4.5900000+01 1.5300000+0 4.6500000+01 6.44 2.424426-01 857 2.7163004+01 \$LTLY 4.65000000+01 6.44 2.424426-01 857 2.7163004+01 \$LTLY 4.65000000+01 6.4573827-01 857 2.7163004+01 \$LTLY 4.65000000+01 6.4573827-01 854 4.58442626-01 \$LTLY 4.65000000+01 6.4500000+01 4.6200000-01 1.5300000+0 3.32333333-14 2.400000+01 4.6200000-01 1.6700000+0 3.32333333-14 2.400000+01 4.6200000-01 1.6700000+0 1.53000000-01 8.400000+01 4.620000-01 1.6700000+0 2. 2.4000000+01 4.9000000-01 1.6700000+0 2.2.400000+01 4.9000000-01 1.6700000+0 3.4500000-01 4.9000000-01 1.6700000+0 3.4500000-01 4.9000000-01 1.6700000+0 3.45000000-01 4.7500000-01 1.6700000+0 3.45000000000000000000000000000000000000	200	200000000000000000000000000000000000000	0.000	0.0000022
14   5.220   100	7	3.3400000+0	0+00000Z/•	0+0000000
14 3.2103000+01 4.590000+01 1.3700000+0 20 5.2000000+01 3.0900000+01 3.09000000+01 3.519500000+01 3.519500000+01 4.65000000+01 3.51000000+01 3.51000000+01 4.6200000+01 5.51000000+01 5.51000000+01 5.52000000+01 5.52000000+01 5.52000000+01 5.54000000+01 6.55000000+01 6.55000000+01 6.55000000+01 6.55000000+01 6.55000000+01 6.55000000+01 6.5500000000 6.5200000000 6.5200000000 6.52000000000 6.5200000000 6.5200000000 6.5200000000 6.5200000000 6.5200000000 6.5200000000 6.5200000000 6.5200000000 6.5200000000 6.52000000000 6.52000000000 6.52000000000000000000000000000000000000		5.22@uu0uu+6	.640000049	
20 5.2200000401 3.1950000401 3.20 5.180000401 3.1950000401 3.1950000401 3.1950000401 4.650000401 5.5100000401 5.5100000401 5.5100000401 5.5100000401 5.5100000401 5.5233533401 5.5200000401 5.5240000401 5.52400000401 5.52400000401 5.52400000401 5.5240000401 5.52400000401 5.52400000401 5.52400000401 5.52400000401 5.52400400401 5.52400000401 5.52400000401 5.524004000401 5.524004000401 5.524004000401 5.5240040		0+0000012.5	5400000	.37000000+0
3.195unun0+01 burker		0 - 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0		
20 5.080000+01 3.19504000+01 4.6594000+01 1.350000+01 1.350000+01 1.350000+01 2.5103000+01 3.5103000+01 2.5103000+01 2.5103000+01 2.520000+01 2.520000+01 2.520000+01 2.520000+01 2.520000+01 2.520000+01 2.520000+01 2.520000+01 3.520000+01 3.520000+01 4.650000+01 5.320000+01 5.320000+01 5.320000+01 5.320000+01 5.320000+01 5.320000+01 6.30000+01 6.30000+01 6.300000+0	0.2	2. < <u></u>		:
32 5.1900000+01 4.65000000+01 break v.4604665-01 BSY 2.7163004+01 brILV 4.6500000+01 break v.4604665-01 BSY 2.7163004+01 brILV 1.3500000+01 break v.4204426-01 BSP 4.58444262-01 brILV 5.5000000+01 4.8300000+01 2.5000000+01 4.6300000+01 2.5000000+01 4.6300000+01 2.52400000+01 4.6300000+01 2.52400000+01 4.6300000+01 2.52400000+01 4.6300000+01 2.52400000+01 4.6300000+01 3.322333333-01 break 1.1846311+00 bsD 4.5748702+01 brILV 4.693333333-01 break 2.4051597+38 bsD 2.7072017+01 brILV 3.436667-01 break 2.4051597+38 bsD 2.406000+01 2.52400000+01 4.670000+01 2.52400000+01 4.670000+01 2.53400000+01 4.670000+01 2.53400000+01 4.670000+01 3.4560000+01 4.700000+01 3.4560000+01 4.700000+01 3.45600000+01 4.700000+01 1.5700000+01 4.700000+01 2.533700000+01 4.7000000+01 2.533700000+01 4.7000000+01 2.533700000+01 4.7000000+01 2.533700000+01 4.7000000+01 2.534766667+01 briak 2.2916214-01 bsV 3.1397901+01 brILV 4.7766667+01 briak 2.2916214-01 bsV 3.1397901+01 brILV	92 20	3.4800000+0		
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UNIAXIAL TENSILE TEST RESULTS ON X7106-T63

ALUMINUM ALLOY WELDMENTS

Panel No. CT5-7, 1.00-inch TIG/5556, Double V

# UNIAXIAL TENSILE TEST RESULTS ON X7106-T63 ALUMINUM ALLOY WELDMENTS

Panel No. CT4-3, 1.00-inch TIG/5356, Double V

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21	3.43	3.450uu0u+01	4,83	4.8300000+01		1.5300000+01
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3,4100000+01 3,430000+01 3,430000+01 3,430000+01 3,430000+01 3,430000+01 3,430000+01 3,430000+01 3,430000+01 3,430000+01 3,430000+01 3,430000+01 3,430000+01 3,430000+01 3,4300000+01 3,4300000+01 3,4300000+01 3,449021=01 4,940000+01 2,3400000+01 2,3400000+01 3,5400000+01 3,5400000+01 3,5400000+01 3,5400000+01 3,5400000+01 3,5400000+01 3,5400000+01 3,5400000+01 3,5400000+01 3,54000000+01 3,54000000+01 3,54000000+01 3,54000000+01 3,54000000+01 3,5400000+01 3,54000000000000000000000000000000000000	``	5.4700001+01		
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3,43500007-01 17404 7,3212020-01 157 3,000734-01 1710-01 174010000-01 1,4700000-01 1,4100000-01 1,4100000-01 1,4100000-01 1,4100000-01 1,4100000-01 1,4100000-01 1,4100000-01 1,4100000-01 1,4100000-01 1,4100000-01 1,4100000-01 1,4100000-01 1,4100000-01 1,4100000-01 1,4100000-01 1,4100000-01 1,4100000-01 1,4100000-01 1,41000000-01 1,41000000-01 1,4100000-01 1,41000000-01 1,41000000-01 1,41000000-01 1,4100000-01 1,41000000-01 1,41000000-01 1,41000000-01 1,41000000-01 1,41000000-01 1,41000000-01 1,41000000-01 1,41000000-01 1,41000000-01 1,41000000-01 1,41000000-01 1,41000000-01 1,41000000-01 1,41000000-01 1,41000000-01 1,41000000-01 1,41000000-01 1,41000000-01 1,410000-01 1,41000000000000000000000000000000000		3.5749999+6	.8700000+0	4700000+0
3.4560667-U1 1YEAR 7.3121202-U1 \$57 5.0666734-01 \$LLLU 1.41-0100-U1 1YEAR 7.3121202-U1 \$54 5.0666734-01 \$LLLU 1.41-0100-U1 1YEAR 7.716.555.1.00INCH.9 DAY  4.5-24-0000-U1 1.310000-U1 2.5-3-40-0000-U1 3.5-3-40-0000-U1 3.5-40-0000-U1 3.5-40-0000-U1 3.5-40-0000-U1 3.5-40-0000-U1 3.5-40-0000-U1 3.5-40-0000-U1 3.5-40-0000-U1 3.5-40-0000-U1 3.5-40-000	*5	5.4100004+0	. M70000A+0	4700000
4.842818.94.31 FDHAR 3.7016.743.01 SD 3.0000.74.91 LTLL 1.415.110.410.41 SE 3.228080.010.01 1.4010.010.01 1.3100.010.01 1.3100.010.01 1.32808.010.01 1.32808.010.01 1.32808.010.01 1.32808.010.01 1.32808.010.01 1.32808.010.01 1.32808.010.01 1.32808.010.01 1.32808.010.01 1.32808.01.01 1.32808.01.01 1.32808.01.01 1.32808.01.01 1.32808.01.01 1.32808.01.01 1.32808.01.01 1.32808.01.01 1.32808.01.01 1.32808.01.01 1.32808.01.01 1.32808.01.01 1.32808.01 1.32808.01.01 1.32808.01.01 1.32808.01.01 1.32808.01.01 1.32808.01 1.33808.01 1.	436667+11	C1015 / NAHY	440 E ASA FUEC	2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2
1.4151810+511 besam 0.9448221=01 \$SE  AMEL CI5-7. ILG-7180-55551.0018CH.9 DAY  5.22408080+01  7.52408080+01  7.52408080+01  7.52608080+01  7.	.8420000+3	10HAM 3./0167	3*01 \$50 4.629	737+01 BLIL
AREL CISTALLS-7180-55551.00INCH.9 DAY  5 5.4400000-01 4.9400000-01 1.3100000-0  2 5.5000000-01 4.9400000-01 1.3200000-0  2 5.5000000-01 4.9200000-01 1.3200000-0  2 5.5000000-01 4.9200000-01 1.3200000-0  2 5.5000000-01 4.9200000-01 1.3200000-0  3 5.5000000-01 4.99000000-01 1.3200000-0  1.3500000-01 8.17444 3.2091930-01 850 4.7794714-01 1.1700000-0  3 5.2000000-01 8.17444 3.2091930-01 850 4.7794714-01 1.1700000-0  2 5.5000000-01 5.000000-01 1.2500000-01 1.2500000-0  3 5.5000000-01 5.000000-01 1.2500000-01 1.2500000-0  3 5.5000000-01 5.000000-01 1.2500000-01 1.2500000-0  3 5.5000000-01 5.00000-01 1.2500000-01 1.2500000-0  3 5.733333 5.000000-01 5.200000-01 1.35000000-01 1.3500000-01 1.3500000-01 1.3500000-01 1.3500000-01 1.35000000-01 1.35000000-01 1.35000000-01 1.35000000-01 1.35000000000000000000000000000000000000	• 4153BBU+0.	91741 0 . V 4982	1-01 %SE	
AREL CISTATIO-7110-750-41,001NCH,9 DAY  5 3-2000000-01  7 3-4400000-01  7 3-4400000-01  7 3-5400000-01  7 3-5400000-01  7 3-5400000-01  7 3-5400000-01  7 3-5400000-01  7 3-5000000-01  7 3-7000000-01  7 3-7000000-01  7 3-7000000-01  7 3-7000000-01  7 3-7000000-01  7 3-7000000-01  7 3-7000000-01  7 3-7000000-01  7 3-7000000-01  7 3-7000000-01  7 3-7000000-01  7 3-7000000-01  7 3-7000000-01  7 3-7000000-01  7 3-7000000-01  7 3-7000000-01  7 3-7000000-01  7 3-70000000-01  7 3-70000000-01  7 3-70000000-01  7 3-70000000-01  7 3-70000000-01  7 3-700000000000000000000000000000000000				
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3.78460000+01 4,9400000+01 1.3100000+0 2. 3.70000000+01 4,9200000+01 1.3200000+0 2. 3.70000000+01 4,9200000+01 1.3200000+0 3.50000000+01 4,94000000+01 1.3200000+0 1.3200000+0 1.3200000+0 1.3200000+0 1.3200000+0 1.3200000+0 1.3200000+0 2.5100000+01 5.040000+01 1.2500000+0 2.5100000+01 5.040000+01 1.2500000+0 2.5100000+01 5.0400000+01 1.2500000+0 2.5100000+01 5.0400000+01 1.2500000+0 3.5200000+01 5.040000+01 1.2500000+0 3.5200000+01 5.040000+01 1.2500000+0 3.5200000+01 5.030000+01 1.2500000+0 3.5200000+01 5.030000+01 1.3500000+0 3.78460000+01 5.180000+01 1.3500000+0 3.7843333+01 4744 3.0297191=01 5.3 3.928429+01 \$LTLY 5.300000+0 3.7343333+01 4744 3.0297191=01 5.3 3.928429+01 \$LTLY 5.300000+0 3.7343333+01 4744 3.0297191=01 5.3 3.98429+01 \$LTLY 5.300000+0 3.7343333+01 4744 3.0297191=01 5.3 3.98429+01 \$LTLY 5.3 3.98429+01 \$LTLY 5.3 3.98429+01 \$LTLY 5.3 3.98429+01 \$LTLY 5.3 3.98429+01 \$LTLY 5.3 3.98429+01 \$LTLY 5.3 3.98429+01 \$LTLY 5.3 3.98429+01 \$LTLY 5.3 3.98429+01 \$LTLY 5.3 3.9 3.9 3.9 3.9 3.9 3.9 3.9 3.9 3.9 3	3	3.5200000+01		
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21 3.5000000000000000000000000000000000000	77	3.24000000	D-DOUDEN.	
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3.5560004.1 by Adm	~-	3.56000006+6	0+00000066	4000000+0
4.9644704+01 hUJARK 4.2091930-01 bSU 4.7794714+01 hLLV 1.35000001+01 hLJARK 4.786917*01 bSU 4.7794714+01 hLLV 4 5.0100001+01 bLJDU000101 1.3000000+0 10 5.7500001+01 5.4910000-01 1.25000001+0 5.0300001+01 5.4910000-01 1.3700000+0 5.03000010101 1.3700000+0 5.0500000101 1.3700000+0 5.05000000001 1.3700000+0 5.05000000000000000000000000000000000	9+1944684.	TALX	47.4 4.37	40 7 TO 1 TO 1 TO 1
AREL CIS-7, 116-7106, 5920-1, 001/04/12 WEEKS + 2 DAY  4	044.00	2000 · A:FIII	1000	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
AREL CIP-7, IIb-7100,5920,1,001MCH,2 WEEKS + 2 DAY  3.0130000401  10 3.5260001401  10 3.5260001401  22 3.5400001401  3.5400001401  3.5400001401  3.5400001401  3.5400001401  1.3400001401  1.3400001401  1.3400001401  1.3400001401  1.35000001401  2.37333334.01  3.7333333.01  3.7333333.01  3.7400001401  3.75000001401  3.75333334.01  3.75000001401  3.750000001401  3.750000001401  3.750000001401  3.750000001401  3.750000001401  3.7500000001401  3.75000000000000000000000000000000000000	3500000 <b>.</b>	**************************************	#01 #50 4.//	/14+01 %LTL
AREL CIP-7, Tib-7100, 500-01, 001MCH, 2 WEEKS + 2 DAY  4			,	
4	REC CIS-7,11	-71U0.5550.1.00	NCH.2 WEEKS +	ď
19	7	.6100000+01	5.0700000401	1.5000000
10 3.570.000.0+01 5.040.000.0+1 1.2500000.000.0 22 3.540.000.0+01 5.040.000.0+1 1.2500000.0+0 24 3.540.000.0+01 5.040.000.0+1 1.4000000.0+0 25.0540.000.0+01 1.40000.0+1 1.400000.0+0 25.0540.000.0+01 1.40000.0+1 1.400000.0+0 1.4440.000.0+01 1.40000.0+0 1.40000.0+0 1.4440.000.0+01 1.40000.0+0 1.40000.0+0 1.4440.000.0+01 1.40000.0+0 1.40000.0+0 1.5500.000.0+01 1.40000.0+0 1.40000.0+0 2.573333.4-01 4.744 4.5440.0+01 1.50000.0+0 1.4120.000.0+0 1.5.20000.0+0 1.350000.0+0 1.4120.000.0+0 1.5.20000.0+0 1.350000.0+0 1.4120.000.0+0 1.5.20000.0+0 1.350000.0+0 1.4120.000.0+0 1.5.20000.0+0 1.350000.0+0 1.4120.000.0+0 1.5.20000.0+0 1.350000.0+0 1.4120.000.0+0 1.5.20000.0+0 1.350000.0+0 1.4120.000.0+0 1.5.20000.0+0 1.350000.0+0 1.4120.000.0+0 1.412.000.0+0 1.4120.000.0+0 1.412.000.0+0 1.4120.000.0+0 1.4120.000.0+0 1.412.000.0+0 1.4120.000.0+0 1.4120.000.0+0 1.412.000.0+0 1.4120.000.0+0 1.4120.000.0+0 1.412.000.0+0 1.4120.000.0+0 1.4120.000.0+0 1.412.000.0+0 1.4120.000	10	0+00000044		
3.53490000+01 5.030000401 1.37900000+0 3.6349000+01 5.030000401 1.4000000+0 3.63490000+01 5.036000+01 1.4000000+0 1.3449000+01 5.0390000+01 1.4000000+0 1.3449000+01 5.780000+01 5.7800000+01 1.4100000+0 11.3449000+01 5.7800000+01 1.410000+01 1.4100000+0 2.5860000000+01 5.1300000+01 1.4100000+0 2.58600000+01 5.1300000+01 1.3500000+0 2.58600000+01 5.1300000+01 1.3500000+0 2.5860000000+01 5.200000+01 1.3500000+0 2.583333+01 ************************************	1 6		0 - 0 0 0 0 0 0 0	
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\$\frac{5.05400\text{0.0}}{1.54400\text{0.0}}\$\frac{7.02500\text{0.0}}{1.54400\text{0.0}}\$\frac{7.02500\text{0.0}}{1.54400\text{0.0}}\$\frac{7.02500\text{0.0}}{1.54400\text{0.0}}\$\frac{7.02500\text{0.0}}{1.54000\text{0.0}}\$\frac{5.05400\text{0.0}}{1.54000\text{0.0}}\$\frac{5.050000\text{0.0}}{1.56000\text{0.0}}\$\frac{7.050000\text{0.0}}{1.56000\text{0.0}}\$\frac{7.050000\text{0.0}}{1.560000\text{0.0}}\$\frac{7.0500000\text{0.0}}{1.560000\text{0.0}}\$\frac{7.0500000\text{0.0}}{1.5600000\text{0.0}}\$\frac{7.0500000\text{0.0}}{1.5600000\text{0.0}}\$\frac{7.0500000\text{0.0}}{1.56000000000000000000000000000000000000	. 5x666.7+	400000000000000000000000000000000000000		
3.73333.401 19444 0.758104=01 1559 4.9347559+01 16. [1.3441000+3.4 [1.3441000+3.4 [1.3441000+3.4 [1.3441000+3.4 [1.3441000+3.4 [1.3441000+3.4 [1.3441000+3.4 [1.3441000+3.4 [1.3441000+3.4 [1.3441000+3.4 [1.3441000+3.4 [1.3441000]]]]] 3.73333.4 [1.3441000+3.4 [1.3441000]]] 3.73333.4 [1.3441000+3.4 [1.3441000]]] 3.73333.4 [1.3441000+3.4 [1.344100]]]] 3.73333.4 [1.3441000+3.4 [1.344100]]]]]]]]]]]]]]]]]]]]]]]]]]]]]]]]]]	0.100000.	A1/620.00 LEG!	255°5 LCS ID.	829+01 317
APEL C15-7, 11%-71%, 5554, 1.00, 5WEEKS + 1 DAY  3.7580000401 5.860000401 5.870000401 5.860000401 5.870000401 5.870000401 5.870000401 5.870000401 5.870000401 5.870000401 5.8800000401 5.8800000401 5.8800000401 5.8800000401 5.880000401 5.8800000401 5.8800000401 5.8800000401 5.8800000401 5.880000401 5.8800000401 5.8800000401 5.8800000401 5.8800000401 5.880000401 5.8800000401 5.8800000401 5.8800000401 5.8800000401 5.880000401 5.8800000401 5.8800000401 5.8800000401 5.8800000401 5.880000401 5.8800000401 5.8800000401 5.8800000401 5.8800000401 5.880000401 5.8800000401 5.8800000401 5.8800000401 5.880000401 5.880000401 5.880000401 5.8800004401 5.880004401 5.8800004401 5.8800004401 5.8800004401 5.8800004401 5.8800004401 5.88	- 10 10 10 10 1	1344 (1) 3810	*11 \$5U 4.934	559+01 \$L TL
AREL C15-7, IIG-7106, 5556, 1.00, 5MEEKS + 1 DAY  3.7800000401  3.78000000401  3.86000000401  3.8700000401  3.8700000401  3.72000004401  3.72000004401  3.72000004401  3.72000004401  3.72000004401  3.72000004401  3.72000004401  3.72000004401  3.72000004401  3.72000004401  3.72000004401  3.72000004401  3.72000004401  3.72000004401  3.72000004401  3.72000004401  3.720004401  3.720004401  3.7200004401  3.7200004401  3.7200004401  3.7200004401  3.7200004401  3.7200004401  3.7200004401  3.7200004401  3.7200004401  3.7200004401  3.7200004401  3.7200004401  3.720004401  3.720004401  3.720004401  3.720004401  3.720004401  3.720004401  3.720004401  3.720004401  3.720004401  3.720004401  3.720004401  3.7	****	7344 0.555830	*0# *2	
AREL CIS-7, 11G-71G-72A-1.00, SWEEKS + 1 DAY  1	A DE LA COMPANIA	· · · · · · · · · · · · · · · · · · ·	1	
2 3.7860000401 11 3.72400000401 12 3.7860000401 13 5.8600000401 23 5.8600000401 24 5.72100000401 25 5.760000401 27 5.760000401 27 5.7860000401 27 5.7860000401 27 5.7860000401 27 5.7860000401 27 5.7860000401 27 5.786000401 27 5.786000401 27 5.786000401 27 5.786000401 27 5.786000401 27 5.786000401 27 5.786000401 27 5.786000401 27 5.786000401 27 5.786000401 27 5.786000401 27 5.7860000401 27 5.786000401 27 5.786000401 27 5.786000401 27 5.7860004401 27 5.786004401 27 5.786004401 27 5.786004401 27 5.786004401 27 5.786004401 27 5.786004401 27 5.786004401 27 5.786004401 27 5.786004401 27 5.786004401 27 5.78	AREL DID-/	6-/10h, 5554, 1	DO DEFERS +	⋖
11 3.7300000+0 12 3.6000000+0 13 5.600000+0 14 4.600000+0 15 5.200000+0 11.500000+0 13.500000+0 13.500000+0 13.500000+0 13.500000+0 13.500000+0 13.500000+0 13.500000+0 13.500000+0 13.500000+0 13.500000+0 13.500000+0 13.500000+0 13.500000+0 13.500000+0 14.510000+0 15.5000000+0 15.5000000+0 15.5000000+0 15.5000000+0 15.5000000+0 15.5000000000+0 15.5000000+0 15.50000000000000000000000000000000000		.7800000ev	0	
17 5.8600000+01 5.210000+01 1.4100000+0 1 2.5 3.6700000+01 1.4500000+0	## ## ## ## ## ## ## ## ## ## ## ## ##	./300000040	.1300000+0	. 350000000
3.3.73333.4-01 15.26000.00.00.00.00.00.00.00.00.00.00.00.00	17	.860000000	2100000	4400000
3.73333.4 http://doi.org/15.2460004-01 1.3500004-01 1.3500004-01 1.3500004-01 1.3500004-01 1.3500004-01 1.3500004-01 1.3500004-01 1.3500004-01 1.3500004-01 1.3500004-01 1.3500004-01 1.35000004-01 1.35000004-01 1.35000004-01 1.35000004-01 1.34000004-01 1.34000004-01 1.34000004-01 1.34000004-01 1.34000004-01 1.34000004-01 1.34000004-01 1.34000004-01 1.34000004-01 1.34000004-01 1.3400004-01 1.34000004-01 1.34000004-01 1.34000004-01 1.34000004-01 1.34000004-01 1.34000004-01 1.34000004-01 1.3500004-01 1.35000004-01 1.35000004-01 1.35000004-01 1.35000004-01 1.35000004-01 1.35000004-01 1.35000004-01 1.35000004-01 1.35000004-01 1.35000004-01 1.35000004-01 1.35000004-01 1.35000004-01 1.35	2.5	.670 uth 0.40	17000000	0+00000Tt.
3.733333*1 1.3500000+01 5.2500000401 1.3500000+01 5.25000000401 1.35000000401 5.2500000401 1.35000000401 1.35000000401 1.3500000401 1.3500000401 1.3500000401 1.3500000401 1.3500000401 1.3500000401 1.340000040 1.3500000401 1.340000040 1.3500000401 1.340000040 1.35000000401 1.340000040 1.35000000401 1.3500000040 1.35000000401 1.3500000040 1.35000000401 1.3500000040 1.35000000401 1.35000004401 1.3500004401 1.35000004401 1.35000004401 1.35000004401 1.35000004401 1.35000004401 1.35000004401 1.35000004401 1.35000004401 1.35000004401 1.35000004401 1.35000004401 1.35000004401 1.3500004401 1.3500004401 1.3500004401 1.3500004401 1.3500004401 1.3500004401 1.3500004401 1.3500004401 1.3500004401 1.35000440004401 1.3500004401 1.3500004401 1.3500044401 1.35000440040040040040040040040040040040040	3	710000000		0.0000000
3.73333.4 http://www.near.near.near.near.near.near.near.near			0+6000042*	
3.635354701 & KYAAR 4.844370=01 & SY 3.4882109+01 & LTLV 5.194000+01 & Y331895=01 & SU 4.941391691 & LTLV 5.194000+01 & Y3590091=01 & SU 4.94139180+01 & LTLV 12.01000+01 & Y3590091-01 & SU 4.94139180-01 & LTLV 12.01000+01 & Y3400000+01 & Y34000000+01 & Y3400000+01 & Y34000000+01 & Y34000000+01 & Y34000000+01 & Y34000000+01 & Y4000000+01 & Y400000+01 & Y400000+01 & Y4000000+01 & Y4000000+01 & Y4000000+01 & Y400000+01 & Y400000+01 & Y4000000+01 & Y4000000+01 & Y4000000+01 & Y400000+01 & Y400000+01 & Y4000000+01 & Y400000+01 & Y400000+01 & Y400000+01 & Y4000000+01 & Y400000+01 & Y400000+01 & Y400000+01 & Y4000000+01 & Y4000000+01 & Y400000+01 & Y400000+01 & Y400000+01 & Y4000000+01 & Y40000000+01 & Y4000000+01 & Y4000000+01 & Y4000000+01 & Y40000		2.7100040401	2.7200000401	1.3000006+0
5.1940000+61 393000 4.3931895-01 \$50 4.9413918+01 6LTLU 1.3120000+61 5F30 7.4590001-01 \$56 4.3413918+01 6LTLU 1.3120000+61 5.556 1.00 INCH 12 WEEKS 5.4500000+01 5.2200000+01 1.3400000+0 1.2 3.46500000+01 5.2200000+01 1.3400000+0 1.3 3.79000000+01 5.79000000+01 1.38000000+0 5.79000000+01 5.78000000+01 1.38000000+0 3.48500000+01 5.2800000+01 1.35000000+0 3.48500000+01 5.28000000+01 1.35000000+0 3.48500000+01 3.50000000+01 3.50000000+01 3.50000000+01 3.50000000+01 3.50000000+01 3.50000000+01 3.50000000+01 3.50000000+01 3.50000000+01 3.5000000000000+01 3.500000000+01 3.5000000000000000000000000000000000000	• / 333333+0	YHAR 4.844317	-01 \$SY 3.48R	109+01 ALTIV
1.3120000:401 367444 9.3590091-01 \$56  ABEL CT5-7, IIG-7166, 5554, 1.00 INCH 12 WEEKS  0 5.9700000401 5.2200000091 1.3400000+0  12 5.4500000401 5.3000000+01 1.3600000+0  14 5.7900000401 5.2000000+01 1.3600000+0  5.85000000401 5.2800000+01 1.4500000+0  5.85000000001 1.4500000+0  5.5000000001 1.3500000+0  5.5000000001 1.37000000+0  5.50000000001 1.37000000+0  5.500000000001 1.37000000+0  5.5000000000000000+0  5.50000000000	.194000+0	UBAN 4.393185	140 4 118 4 1141	018401 4171
ABEL CI5-7, 11G-71Gh, 5554, 1.00 INCH 12 WEEKS  o	.3120066+0	TARK VANDOCES	454 100	10.01
ABEL CI5-7, 11G-7166, 5556, 1.00 INCH 12 WEEKS  0 5.9760000401 5.2200000401 1.340000040  12 3.4560000401 5.7500000401 1.340000040  13 5.7960000401 5.28000000401 1.340000040  34 5.800000401 5.2800000401 1.450000040  3.8050000401 5.3600000401 1.450000040  3.8050000401 5.3600000401 1.350000040  3.8050000401 1.37000000401 1.3700000040  3.8050000401 1.37000000401 1.3700000040  3.80500000401 1.37000000401 1.3700000040			•	
0 5.9720000-01 5.2200000-01 1.3400000-0 12 3.4260000-01 5.3500000-01 1.3400000-0 14 5.796000-01 5.200000-01 1.3600000-0 24 5.8200006-01 5.2800009-01 1.45000000-0 30 5.8000000-01 5.3600000-01 1.4500000-0 3.8560000-01 5.3000000-01 1.3700000-0 3.8560066-01 17444 2.06860515-01 157 5.5993124+01 4.10000-0	AREL CTS-7, 1	6-7166, 5554. 1	ARE OF HUNT ARE	
12 3.750000401 5.2500000001 1.350000040 1 3.540000040 1 3.740000040 1 5.280000040 1 3.540000040 1 3.740000040 1 5.280000040 1 3.540000040 3.750000040 1 3.750000040 3.7500000040 1 3.750000040 3.7500000040 1 3.750000040 3.7500000040 1 3.75000040 3.7500000040 1 3.75000040 3.750000040 1 3.75000040 1 3.750000440 3.750000040 1 3.750000440 3.750000040 1 3.750000440 3.7500000440 3.7500000440 3.75000440 3.750000440 3.750000440 3.750000440 3.750000440 3.750000440 3.750000440 3.750000440 3.75000440 3.75000440 3.7500440 3.7500440 3.7500440 3.7500440 3.7500440 3.7500440 3.7500440 3.7500440 3.7500440 3.7500440 3.7500440 3.7500440 3.7500440 3.75004040 3.75004040 3.75004040 3.75004040 3.75004040 3.75004040 3.75004040 3.75004040 3.75004040 3.75004040 3.75004040 3.75004040 3.75004040 3.75004040 3.75004040 3.75004040 3.75004040 3.75004040			THE ST HOLD S	, , , , ,
12 3.760000401 5.2800000401 1.3500000040 14 3.7900000401 5.2800000040 1.350000040 54 3.8500006401 5.280000040 1.450000040 50 3.7000000401 5.3860000041 1.450000040 50 3.7000000000 5.3860000001 1.450000044 50 5.7000000000 5.38600000041 1.5500000044 50 50 50 50 50 50 50 50 50 50 50 50 50 5	> 		0+000022	.5400000+0
14 3.796600401 5.2804000401 1.380000040 24 3.8304000401 5.220400041 1.450000040 35 3.9060000401 5.3664000041 1.430600040 55 3.804000401 5.36440000401 1.37060044 4556666641 11444 5.6860515-01 \$57 3,5993124401 4.114	<b>3</b> 1	0+0000000	.500000000.	•3400000+0
24 3.830.0006+01 5.2200009+01 1.4500000+0 50 5.4900.0004-01 5.3660000+01 1.4500000+0 5 6.8500.004-01 5.400.0000-11 1.5200000+0 -85000.004-01 1.74* 5.7993124+01 4.0.04	91	0+0600006/•	.2804000+0	.38000000+
3u 3.900.00401 5.366.000+01 1.430600+0 3 3.840.000+01 5.3060000+01 1.306000+0 4.506000+01 1.306000+01 1.506000+01 1.506000+01 1.506000+01 1.506000+01 1.506000+01 1.506000+01 1.506000+01 1.506000+01 1.506000+01 1.506000+01 1.506000+01 1.506000+01 1.506000+01 1.506000+01 1.5060000+01 1.5060000+01 1.5060000+01 1.5060000+01 1.5060000+01 1.5060000+01 1.5060000+01 1.50600000+01 1.5060000+01 1.50600000+01 1.50600000+01 1.50600000+01 1.50600000+01 1.5060000+01 1.5060000+01 1.50600000+01 1.506000+01 1.50600+01 1.506000+01 1.506000+01 1.506000+01 1.506000+01 1.506000+01 1.506000+01 1.506000+01 1.506000+01 1.506000+01 1.506000+01 1.506000+01 1.506000+01 1.506000+01 1.506000+01 1.506000+01 1.506000	37	.8300000	.2200009+0	0+00000044.
\$48400000401 1.3500000401 5.3000000401 1.350000000401 4599803124401 41114 1.359030340	3.6	0+00000006.	.3660000+0	4 40 6 6 6 6 4 6
*856666+11 +1444 2.8860515=01 857 3.5993124+01 4LTLY	95	. Arufanu+n	4080000	0.0000000
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		I CO USING THE	-11 354 2.5493	124+01 166

1.5100000+01 1.4300000+01 1.4000000+01

5.2200000+01 5.2200000+01 5.1800000+01 5.0900000+01 5.0900000+01

LAREL GT4-3, TIG-7106, 5354, 1.00 INCH 12 WEEKS

3.7050000+01 1.4050000+01 3.6050000+01 3.70500000+01 3.70500000+01 3.70500000+01 3.705000000+01 3.7050000000+01 3.70500000+01 3.70500000+01 3.705000000+01 3.705000000+01 3.705000000+01 3.705000000+01 3.705000000+01 3.70500000+01 3.70500000+01 3.70500000+01 3.705000000+01 3.70500000+01 3.70500000+01 3.70500000+01 3.70500000+01 3.70500000+01 3.70500000+01 3.70500000+01 3.70500000+01 3.7050000+01 3.70500000+01 3.70500000+01 3.70500000+01 3.70500000+01 3.70500000+01 3.70500000+01 3.70500000+01 3.70500000+01 3.70500000+01 3.705000+01 3.705000+01 3.7050000+01 3.7050000+01

# UNIAXIAL TENSILE TEST RESULTS ON X7106-T63 ALUMINUM ALLOY WELDMENTS

> Panel No. CM3-3, 1.00-inch MIG/X5180, Double

1.0200000+01 1,1700000+01 1.2000000+01 1.0200000+01 1.1400000+01 3.2733<u>533.91</u> bYgAM <u>1.2227212</u>+00 <u>551</u> 2,5020364+01 \$LTLY 4.20635554+01 bJAM 4.4098028+01 \$5U 3.9856527+01 bLTLU 1.100000<u>U.9.01</u> 85437 7.9749708+01 \$5E 4.1900000+11 4.2400000+01 4.2100000+01 4.2300000+01 4.2500000+01 4,15000000+01 LABEL CM3-5,415-7105,5130,1,001NCH,1DAY
1 3.200000304-01 4.19000 5.2200990+01 3.58900000+01 3.19000000+01 \$ - 45 June | J + U1

8.0000000+00 8.50000000+00 1.0100000-01 80000000+00 00+0000008. 8.4000000+00 3.2466657-01 %YGAN 1.5344941+00 %SY 2.4702126+01 %LTLY 4.3550000+01 %UGAN 4.9296813-01 %SU 4.1155581+01 %LTLU 4,4300000+01 4.3900000401 4,28000000+01 4.5700000+01 4,36000003+01 LAMEL CM3-3, MIG-7106, 5140,1,00 [NCH, 50AY 3.1731304-01 \$SE 3.2400000+01 3.000000000 3.19000001.8 3.4100000+01 3-4100000+01 3.25000000+0 SEBAR A.60000000+0u

00.0000000.6 0.2000000+00 9.7000000409 8.500000000 8.00000000+00 3.4035695+01 %LTLY 4.0221352+01 %LTLU 4,5900009+01 4,5000000+01 4,56000000+01 4.5100000+01 4.51000000+01 4,32000000+01 LABEL CM3-3, M16-7106, 5180, 1,00 INCH, 9 DAY ъҮНАК 2.9268215-01 \$SY \$UНАК 9.4110310-01 \$SU 8.9000000+00 \$EBAK 5.4651534-01 \$SE 3.55000000461 3.5700000+01 5.5.3 J i O J U + 0.1 3.5200000401 3.6000000+01 3.54000000+01 4.4983333+01

7.00000000+00 7.50000006+00 8,20000000+00 7.80000000+00 8.40000000+00 3,3510506+U1 %LTLY 3,9711319+U1 %LTLU LABEL CMS-3, M1G-7106, 51du, 1,001NCH, 2WKS+1DAY 4,5800000+01 .4700000+01 4.3500000+01 4.5800000+01 4.3700000+01 4700000401 ътенК 5.3716618=01 ъът ървий У.8590531=01 \$50 7.6500066+90 SEGAK >.9245255-01 \$SE 3.52000000+01 3.50000000+01 5.4800000+01 5.530 H O U O + D 1 3.54000000+61 3.52000000+01 3.5216666+01 4.4700000+01

6.10000000+00 8.7000300+00 9.10000001.6 8.7000300+00 0.00000006.9 7.50000000+00 ътчан 6.2743179-01 \$SY 3.3941862+01 bLTLY bUBAR 4.1191216-01 \$SU 4.4232391+01 \$LTLU bEBAR 0.3546323-01 \$SE LAPEL CM3-3, MIG-7106, 5180, 1.00 INCH 5 WEEK 4,6800000+01 4.6600000+01 4.6300000+01 .6400000+01 4.5200000+01 .56600000+01 3.66000000+01 1.7500000+01 . 3100000+01 3.67000000+01 3.73000000+01 .65000000. 3.7116667+014.6316667+01 8.1666666+00

UNIAXIAL TENSILE TEST RESULTS ON X7106-T63 ALUMINUM ALLOY WELDMENTS

Panel No. CM4-3, 1.00-inch MIG/5356, Double V

				į	1				
LABEL C44-3,	4	C44-3, M13-7193,5355,1,001NCH,1UAY	100.1.00	NCH	1UAY				
	٦.	19.0500000401	10/0+01	4.0	1000	4.010000.01		0000	9.50000005.8
	`	5.1139930+01	1.10+01	4	7000	4, 0700000+01		000	0.50000000400
	1,	ა. 2 ისსისმყ+ი1	104-01	4 ⊣	1000	4,1100000+11		0000	00+0000004.6
	0	5.1400000+01	100+01	4.1	8600	4.1860000+01	9.7	0000	9.7000000+00
	52	5.20000000+01	100+01	4.2	2000	4.22300000+01	9.70	0000	9.700u000+00
	3.1	5.1000390+01	100401	5.4	1000	4.2100000+01	! !	0000	1.00000001
3.1350390+11 17544 5.5489377+01 157 2.6492093+01 161	=	TYSAK 2.	5480377	-	151	2.44	92093+0	11	, I.L.
4.1555553+91	76.4	<b>\$U∃A</b> ₹ 0.	6.4963734-0	10.	U.S.4.	3.70	3./079/08+01	11 \$	\$L110
9.0166066+3U_bedAd	0.0	BEDAR 2	2.4013988+01	• 01	\$ SE			i	
LABEL CM4-3, MIG-/100, 5356, 1, 88 INCH, /DAY	1.5	-/100,53	1001100	SCH	/ DA Y	Ì			
	.\ <b>J</b>	5.1700000+01	10401	4	000	4.0000000+01	8.20	0001	8.200000000+00
į	c	3.3300000+01	100+01	4,1	8000	4,18000000+01	9.30	0000	8.3000000+40
	4	3.2900000±01	310+01	4.1	0006	4.190000011	00.00	1000	0.4000000.6
	o <b>⊘</b>	5.510000000	300+01	4	1000	4,1100000+01	D • 9	000	8.8000000+00
	26	3.10000000+01	100+01	4.1	4000	4.1400000+01	9.50	000	00+0000004.6
	32	3.30000000+01	100+00	4.1	0006	4,19000000+01		000	8.7000000+00
3.20000000+01	=	PY3AK 1.1632147+00 \$5Y	1632147	0.0+	₹5.4	2.60	2.6012934+01		<b>SLTLY</b>
4.1453800+01	0.7	*CH44	0.2440442-0	- 0	つのチ	3.87	3.8796514+01		<b>\$</b> 1,7∟∪
8.7899998	00.	BESAR D.	5.4405891=01	_	3.0E				

8.5000000+00 00+0000000006 9.20000000-00 3,1683902+01 \$LTLY 3,7403840+01 \$LTLU 4.1400000+01 4.120000011 4,030000+01 4,2200000+01 4.26000000+01 LABEL CM4-3, M14-7100, 5356, 1,00 INCH, 70AY \*YBAH 2.9497361-01 \$SY \$UHAH 6.3586813-01 \$SU 8.65300000+00 SERAR 5.7282747-01 SSE 5.550000000 3.3800000+01 3.3440000401 3.35000000+01 3.3300000+01 3.33800006+01

7.2000000+00 7.1000000-00 7.2000000+00 8.00000000 7.2000000+40 8.4000000+00 4,1200000+01 4.170000001 4.2800000+01 4.2900000+01 4,3400000401 4,2200000+01 LABEL CM4-3,416-7100,5356,1,001NCH 2 WEEKS SSC FSE 7.5166467+94 std44 2.4558844-01 3.2200000+01 3.33000000+01 5 • 3 7 d J J B B B + B 1 3.<u>3</u>1davaŭ+01 3.2/90000+01 3.29855533+11 4.2366667+01

7.6000000+00 01+00000000.6 7.4000000+00 8.2000000+00 8.4000000+110 3.1778917+01 \$LTLY 4.2883333+01 \$UBAK 4.0703800+01 \$SU 4.0823721+01 \$LTLU LABEL CM4-3, MIG-7106, 5356, 1.00 INCH 5 WEEKS 4,3000000+01 4,2700000+01 4,2700000+01 4.2400000+01 4.3600000+01 4.2900000+01 4.7188729-01 \$SY 3.44000000+01 .3900000+01 .4100000+01 ..3400000+01 5.450**u000**+01 .4700000+0 3.4166667+01 \$YBAH

7.0000000+00 7.50000000+00 6.5000000+00 LABEL CM4-3, MIG-7106, 5356, 1.00 INCH 12 WEEKS 4.4500000+01 4,4100000+01 4,3900000+01 4.4600000+01 4,4000000+01 4,4109000+01 3.540000000+01 3.7100000+01 .7300000+01 5.7200000401 .7100000+01 3.69000000+01 24 3 c

7.10000000+00

7.20000000+00 8.7006000+60

.6500000+01

.7100000+01

\*YHAK

3.9766666+01

7580406+01

6.25000000+00

7.10000000+00

4.8700000+01 4.8500000+01

.7960000+01 .7700000+01

LAREL CM3-3, MIG-7106, 5180, 1.00 INCH 12 WEEKS

3.9400000+01

• 0300000+01 .02000000+01

.9700000+01 • 9801000+01 3.9200006+01

8.1666666+00 \$E8AR 5.8537782-01 \$SE

6.50000000+00

3.7000n00+01 bYHAK 3.2250583-01 BSY 3.5368120+01 BLTLY

TABLE J-22,

UNIAXIAL TENSILE TEST RESULTS ON X7106-T63

ALUMINUM ALLOY PARENT METAL

6.8100000+01 sY8AH 2.1678R08-01 \$57 5.9733468-01 \$LTV 6.7960000+01 sY8AH 2.1678R08-01 \$57 5.9733468-01 \$LTLY 1.0900000+01 \$EBAH 2.3077004-01 \$50 6.565947-01 \$LTLU

LABEL PARENT METAL, 7106, . 500 INCH

5.9000000+01 6.0100000+01 5.8500000+01

5.9100000+0

1.1200000+01

6.7800000+01 6.7800000+01

6.1300000+01 6.0700000+01 6.0900000+01

LABEL PARENT

RESULTS ON X7106-T63 ALUMINUM ALLOY WELDMENTS UNIAXIAL TENSILE TEST

Panel No. CM5-4, 1.00-inch MIG/5556, Double V

	06.5556.1.001NCH.1 DAY		4,4700000+01 1.020000+0	1 4.4100000+01 1.0200000+0	.240000+01 4.5800000+01 1.1500000+0	500000+01 4,5000000+01 1	1.1691374-01 \$SY 3.1825083+01 \$LTL	1.5552096+00 \$5U 3.6397306+01	\$EHAR 7.1203930-01 \$SE	-7106,5956,4,001NCH,4 DAY	00000+01 4.1300000+01 9.7000000+0	4,470000401 8,8000000+	.4800000+01 4,4400000+01 1.0000000+0	4.7600000+01 1.1700000+0	4.5000000+01 9.300000	900000+01 4,3600000+01 1,0600000+0	5.4314577-01 \$SY 3.2401682+01 \$LTLY	+00 \$SU 3,4079873	1.0264825+00 \$SE	-7106.5556.4.DO:NOR.7 DAY	900000+01 4.2700000+01	4.56000000+01	*4600000+01 4.4800000+01	.4700000401	0 4,5700000+01	7000000+01 4.2600000+01	444-0841+01 9SY 3-498	SECRET 4.3205006-01 SNF
NUMBER	H11G	7	13	13	2	31	i		1.0980000+01	CM5-4,M1G-	1	30	14	<u>ح</u> ۵	20	32	,,	+01	-	M5-4. M16-	ۍ	э.	5	51	27	33	-4-	

0.0+00000006\*6 4.650000001 4.650000001 4.600000001 4.500000001 4.5900000001 3.3267401-01 \$SY MIG-7106, 5556, 1 5 3.6100000+01 11 3.6900000+01 17 3.65000000+01 3.6500000+01 3.60000000+01 3.5333333+01 \$YBAN 4.5200000+01 \$UBAN 8.066667+00 \$EBAR 3.636667+01 SYBAR 4.5450000+01 \$UBAR CM5-4,

9.2000000+00

6.7000000+00 9.7000000+00

LABEL CM5-4, MIG-7106, 5556, 1,00 INCM 12 WEEKS 6 3.8600000+01 4.2400000+01

3.9100000+0

3.863333401 \$YBAR 4.563333401 \$UBAR 8.2500000+00 \$EBAR

1.1149015+00 \$SU 3.9808598+01

Notes: (1) Tensile axis normal to rolling direction. 5.8320000+01 \$YHAR 6.4360000+01 \$UBAR 2.074000+01 \$EBAR

2.0900000+01

6.4500000+01

5.8400000+01

.4100000+01

LABEL PARENT METAL, 71.6, 1.00 INCH

5.9100000+01 \$YBAM 6.0414422-01 \$SY 5.862617 6.492000+01 \$UBAM 5.4036301-01 \$SU 6.181291 1.772000+01 \$EBAM 1.3038847-01 \$SE

6.5000000+01

Data taken from tests conducted under Contract NAS8-1529,

Mod 6 (4th year).

8

### APPENDIX K STATISTICAL ANALYSIS OF TEST DATA

### STATISTICAL ANALYSIS OF TEST DATA

The data from the uniaxial tensile tests and hydraulic bulge tests were analyzed statistically to establish minimum strength values with a specified degree of confidence. The analysis was based on the "Tolerance Limit Theory" assuming that the data conform to a normal distribution curve.

In the analysis of the data, the mean value, standard deviation and lower tolerance limit were computed for each property. The lower tolerance limit (LTL) was selected such that 99% of the individual values of the variable property are above the limit 95% of the time. The computations were carried out by the procedures indicated below:

$$\overline{x} = \frac{x_i}{N} = \text{mean value}$$

where

 $x_i = individual value$ 

N = number of tests

$$S = \sqrt{\frac{\sum (x_i - \overline{x})^2}{N - 1}} = Standard deviation$$

 $LTL = \overline{x} - KS = lower tolerance limit$ 

where K is a factor statistically computed for a 99% LTL with 95% confidence. K factors for sample sizes up to 50 are listed in the following table:

Sample Size	K <u>Factor</u>	Sample Size	K <u>Factor</u>	Sample Size	K Factor
5	5.75	15	3.52	25	3.15
6	5.06	16	3.46	26	3.13
7	4.64	17	3.42	27	3.11
8	4.35	18	3.37	28	3.09
9	4.14	19	3.33	29	3.07
10	3.98	20	3.29	30	3.06
11	3.85	21	3.26	35	2.99
12	3.74	22	3.23	40	2.94
13	3.66	23	3.21	45	2.90
14	3.58	24	3,18	50	2.86

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