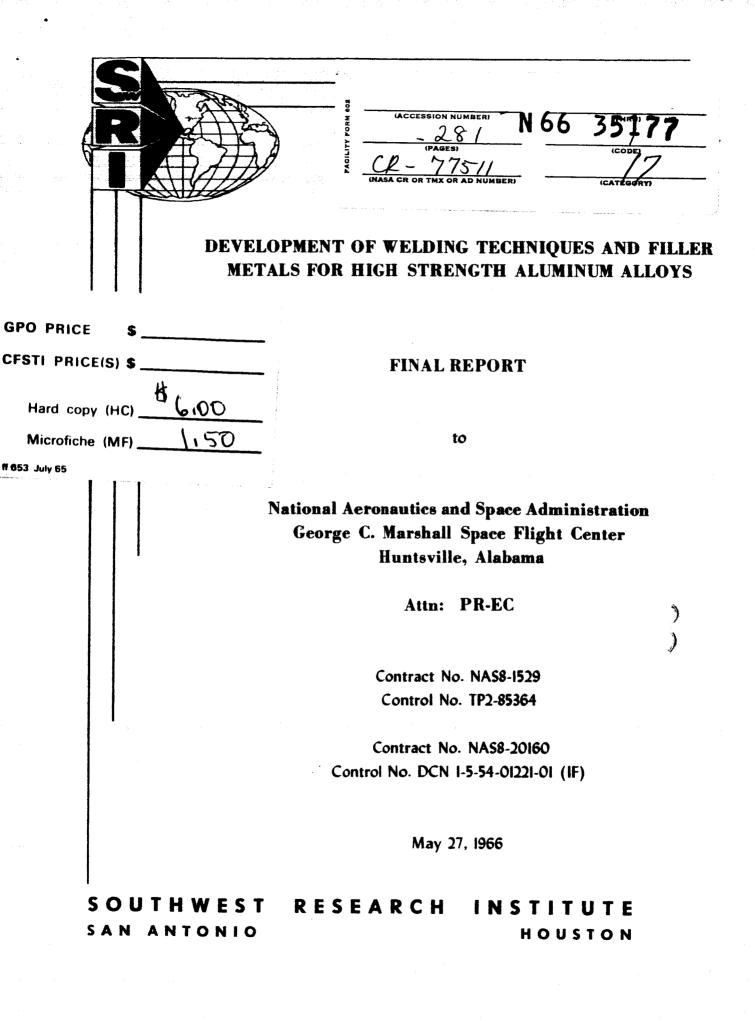
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#### DEVELOPMENT OF WELDING TECHNIQUES AND FILLER METALS FOR HIGH STRENGTH ALUMINUM ALLOYS

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

by

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for

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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 weld-ments. In general, the TIG process produced the most desirable weld bead configuration for all weldment types investigated. In addition, the TIG weld-ments were in general less susceptible to porosity than were the MIG weld-ments.

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  $CuAl_2$  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 heataffected 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 highstrength 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.

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#### 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 1 (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-onplate 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  $CuAl_2$  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 heataffected 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 processfiller 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:

- 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 highstrength 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 l 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.

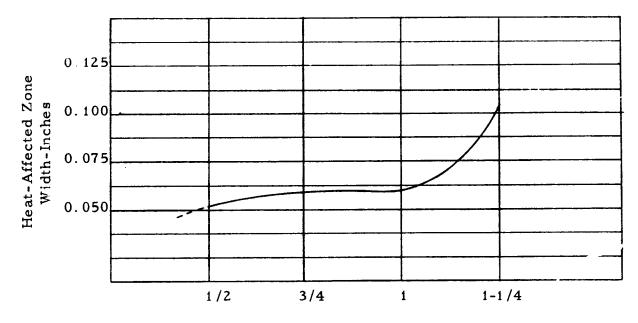
In this portion of the research program, all work was confined to welding 0.090-inch thick 2014, 2024, and X2020 high-strength aluminum alloys. Both tungsten inert gas (TIG) and metallic inert gas (MIG) processes were used, although most efforts were directed toward the utilization of the TIG process. 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

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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:

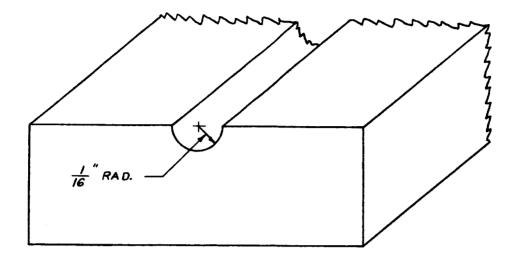
- (1) Joint preparation plate surfaces adjacent to the joint were scraped and the abutting edges were draw filed immediately prior to welding.
- (2) Wire shield the spools of welding wire were placed in shields on the welding equipment to protect them from atmospheric contamination.

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.

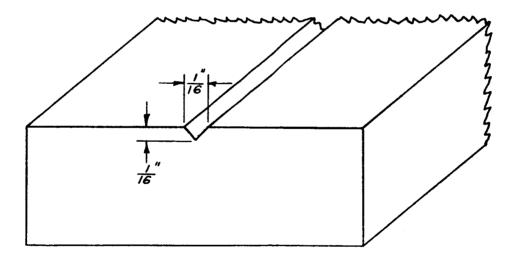
2. Age Hardening Characteristics

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  $750^{\circ}$ F to  $950^{\circ}$ F. Artificial aging of 2014 and X2020 produced an increase in hardness of those samples quenched from  $750^{\circ}$ F to  $950^{\circ}$ F, but the X2020 alloy was much more sluggish in its response to aging.

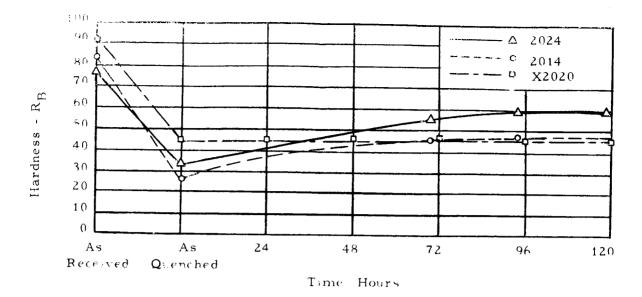


(a) Semicircular Groove

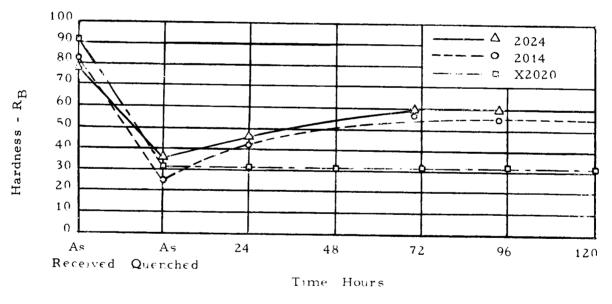


(b) V Groove

## FIGURE 2. BACKUP STRIP GROOVE CONFIGURATIONS



(a) Quenched from 750°F



(b) Quenched from 800°F



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.

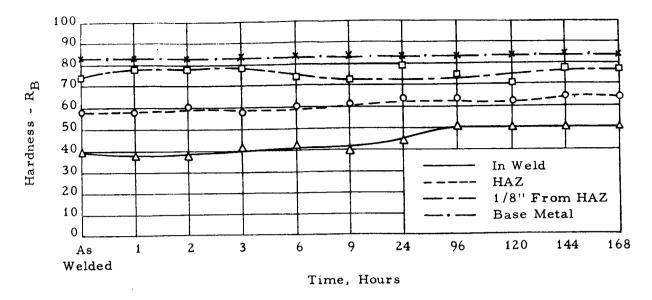
The test weld was made on 1/4-inch 2014 and 2024 base metal using a manual MIG process with 716 filler wire and a weave bead so that a sizeable sample of weld metal could be obtained for analysis.

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.

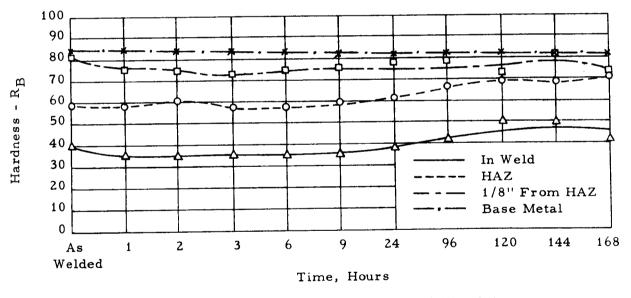
Wet chemical analysis for Si was performed on chips from successive 0.010-inch layers removed from a weld deposit specimen. The results were inconclusive, probably because of the small sample sizes and the lack of a uniform line of fusion.

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.

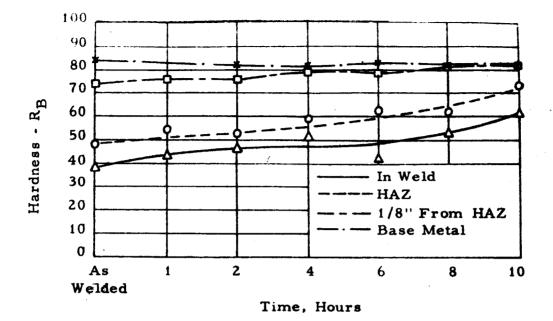


(a) 0.090-Inch TIG 2014-T6 Weldment, 716 Filler Wire

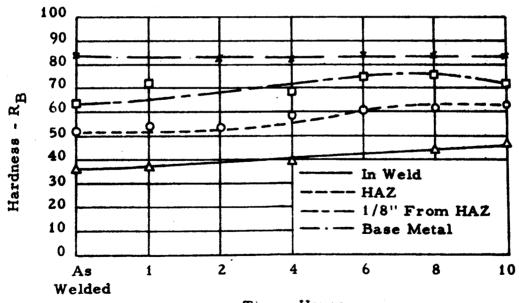


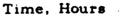
(b) 0.090-Inch TIG 2014-T6 Weldment, 2319 Filler Wire

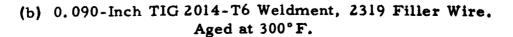
FIGURE 4. NATURAL AGING CHARACTERISTICS OF ALUMINUM ALLOY WELDMENTS



(a) 0.090-Inch TIG 2014-T6 Weldment, 716 Filler Wire. Aged at 300°F.









# B. 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.

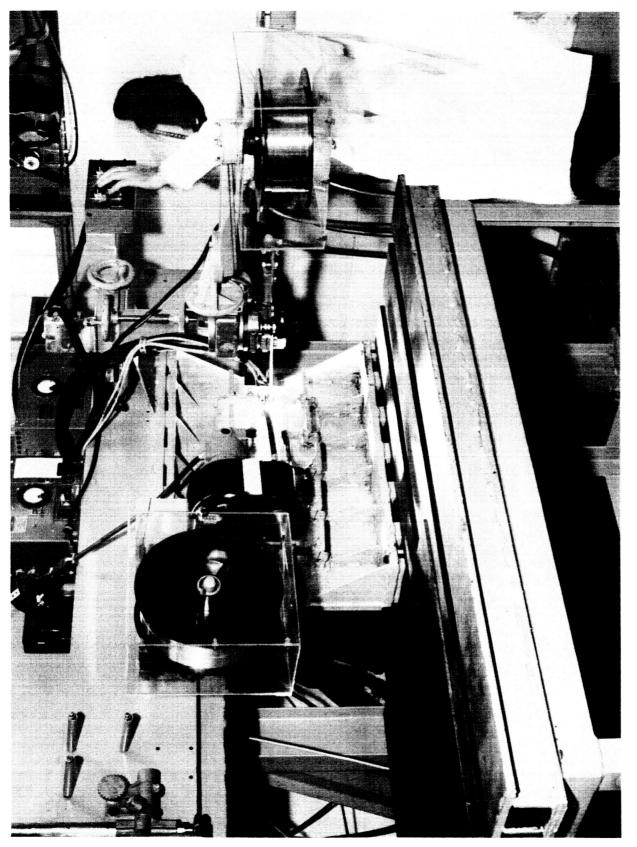


FIGURE 6. MIG WELDING EQUIPMENT SET UP IN HORIZONTAL POSITION. Note cold wire feed attachments.

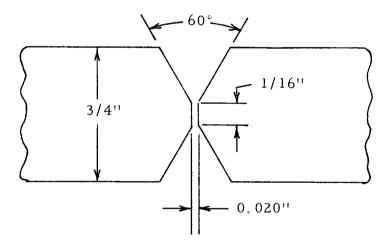
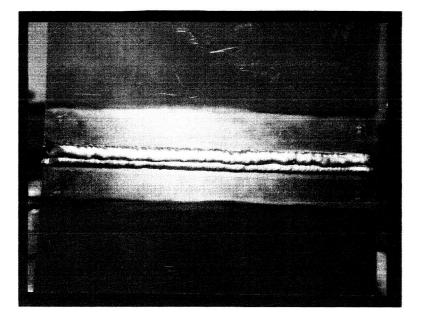
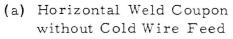
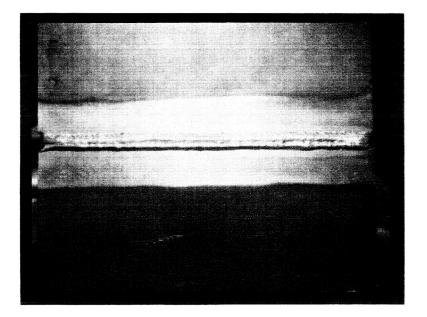


FIGURE 7. 60° DOUBLE "V" GROOVE DESIGN







(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  $325^{\circ}$  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.

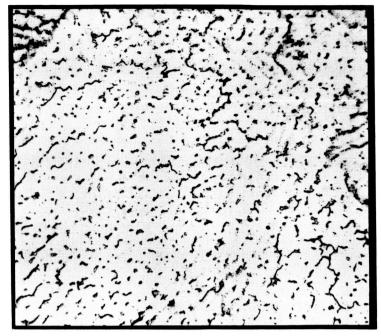
The influence of the addition of copper directly to the molten weld puddle on the properties of welded joints was also studied. In this study, bead-on-plate weld deposits were made employing the MIG process with copper cold wire feed. The rate of feed of the copper wire was varied to produce weld beads 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.

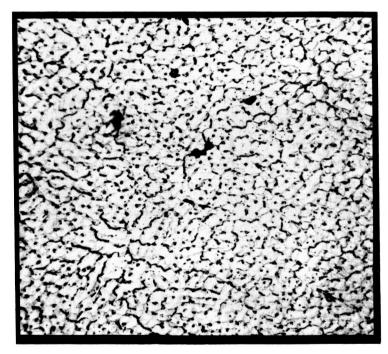
#### C. Contract NAS8-1529, Mod 5 (27 April 1963 to 26 June 1964)

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.<sup>(3)</sup>



500X

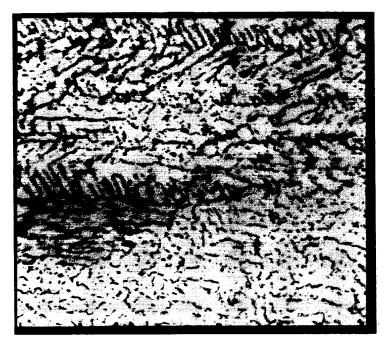
(a) Al-3.25% Cu Filler Wire



500X

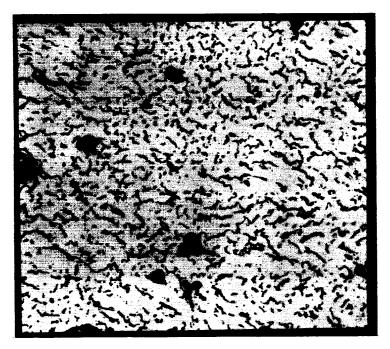
## (b) Al-4.25% Cu Filler Wire

# 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 Al-Cu ALLOY FILLER WIRE

#### 1. Weld Zone Investigation

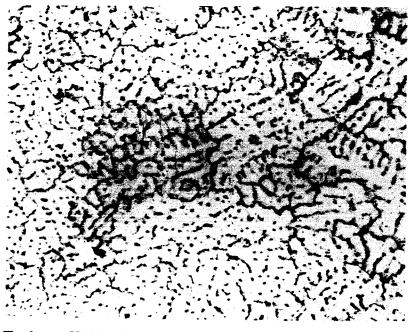
The mechanical properties of the 2219 alloy are dependent on the manner in which the CuAl<sub>2</sub> precipitate is dispersed in the weldment. The microstructure of the parent metal in the fully heat treated (T87) condition was compared to structures produced in various parts of the HAZ and weld metal. The finely dispersed and agglomerated CuAl<sub>2</sub> 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:

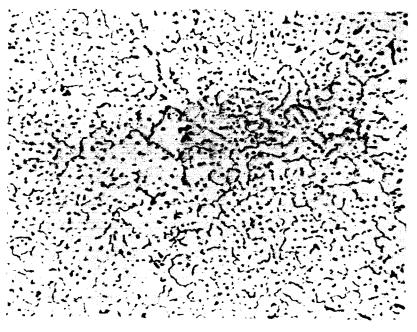
(1) Tensile fracture of 2219-T87 base metal and weldments occurred generally by the nucleation of microvoids at



Etchant-Keller's

250X

(a) First Pass

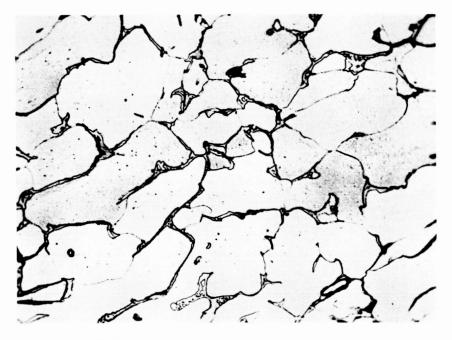


Etchant-Keller's

250X

(b) Second Pass

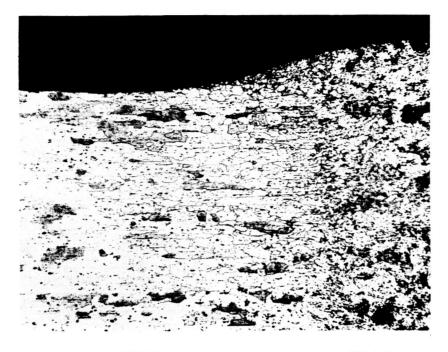
FIGURE 11. MICROSTRUCTURE OF WELD METAL IN FIRST AND SECOND PASSES OF A 2219-T87 WELDMENT



Etchant-Keller's

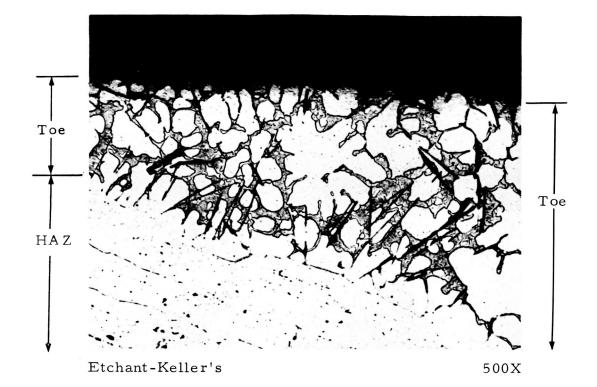
1000X

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



HAZ Etchant-Keller's Weld 50X

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



(a)

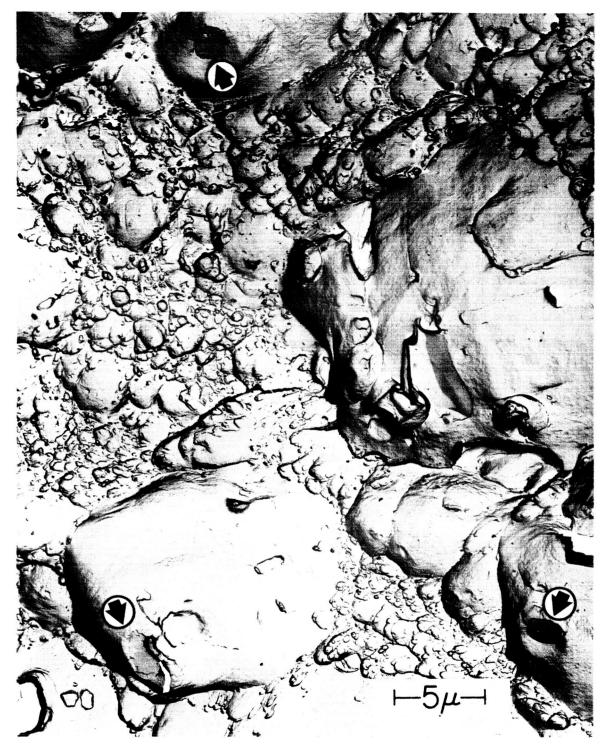


Etchant-Keller's

1500X

**(**b**)** 

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  $\times$  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

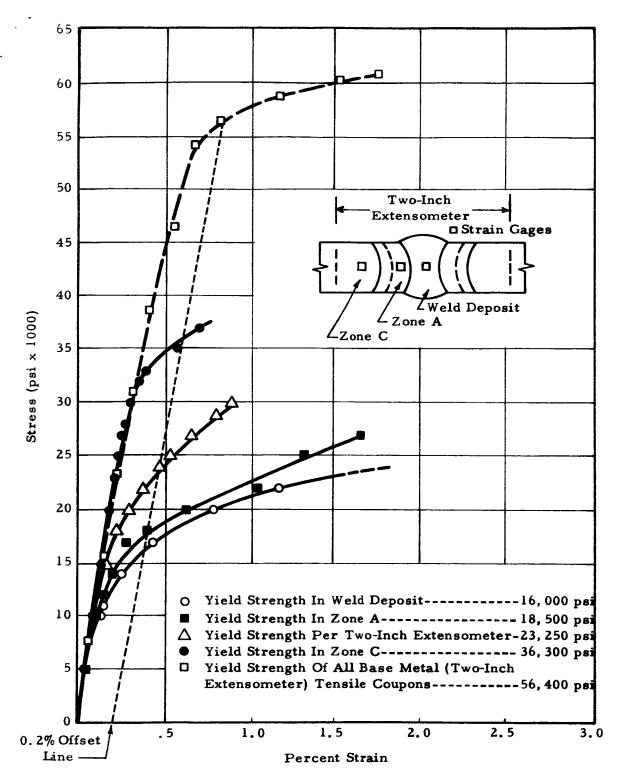


FIGURE 18. STRESS-STRAIN CURVES OF WELD DEPOSIT, ZONE A, ZONE C, AND PER TWO-INCH EXTENSOMETER OF TENSILE COUPON. [Note all base metal (two-inch extensometer) curve from different tensile coupon.]

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:

		age Yield S 2% Offset)	0	Average	Ultimate (ksi)	Strength,	Ave	rage Elong (% in 2 in.	
	No	2 lb	4 lb	No	2 lb	4 lb	No	2 lb	4 lb
	Charge	Pentolite	Pentolite	Charge	Pentolite	Pentolite	Charge	Pentolite	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)

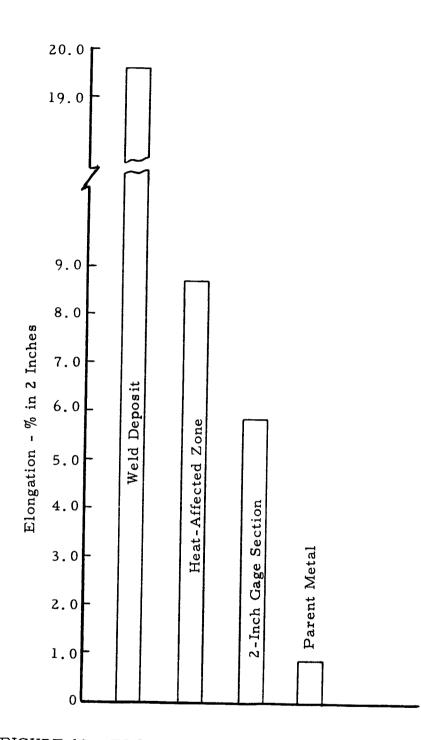
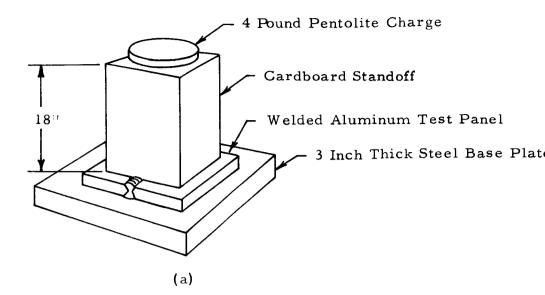
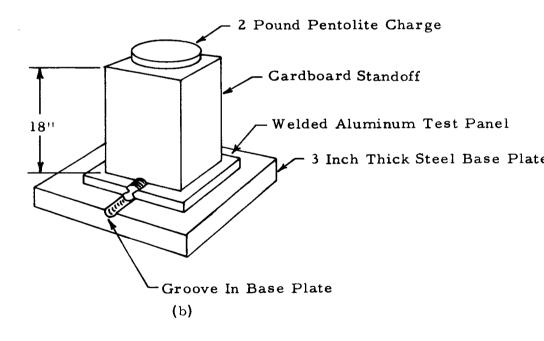


FIGURE 19. ELONGATION AT FRACTURE MEASURED IN VARIOUS ZONES OF A 3/4-INCH 2219-T87 WELDMENT





# 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

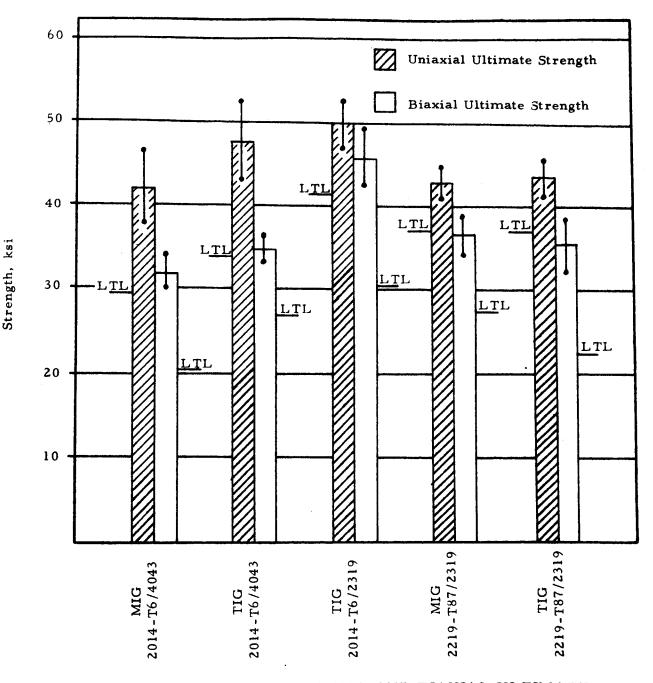


FIGURE 21. AVERAGE UNIAXIAL AND BIAXIAL ULTIMATE STRENGTHS FOR MIG AND TIG WELDMENTS

stress measurements were made on as-welded panels utilizing strain gages to determine the relaxation occurring in specimens cut from the panels. These 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 0.187inch 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 grainboundaries 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

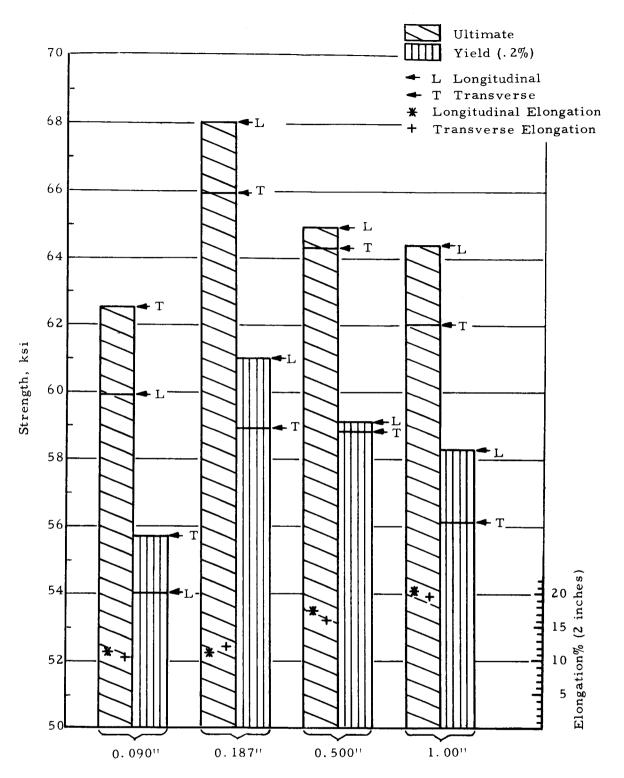
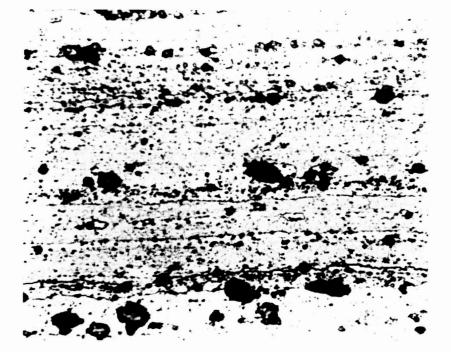


FIGURE 22. BAR GRAPH OF MECHANICAL PROPERTIES OF VARIOUS THICKNESSES OF X7106-T63

100X



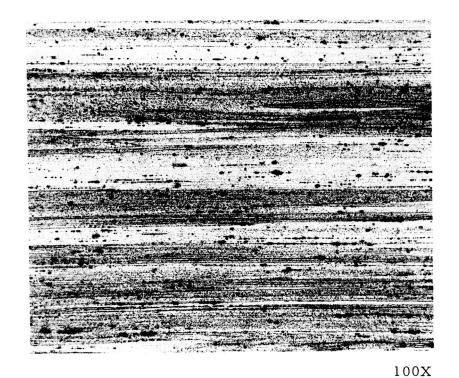


Etchant-Keller's

1500X

(b)

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



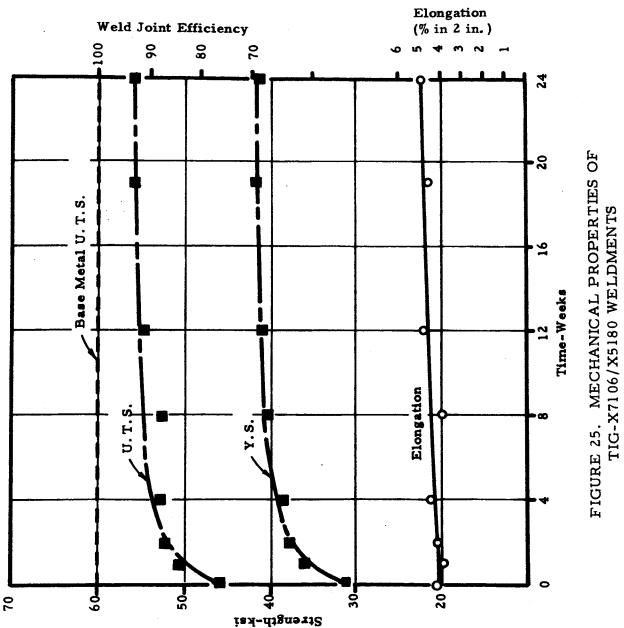
(a)



Etchant-Keller's

**(**b**)** 

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



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.

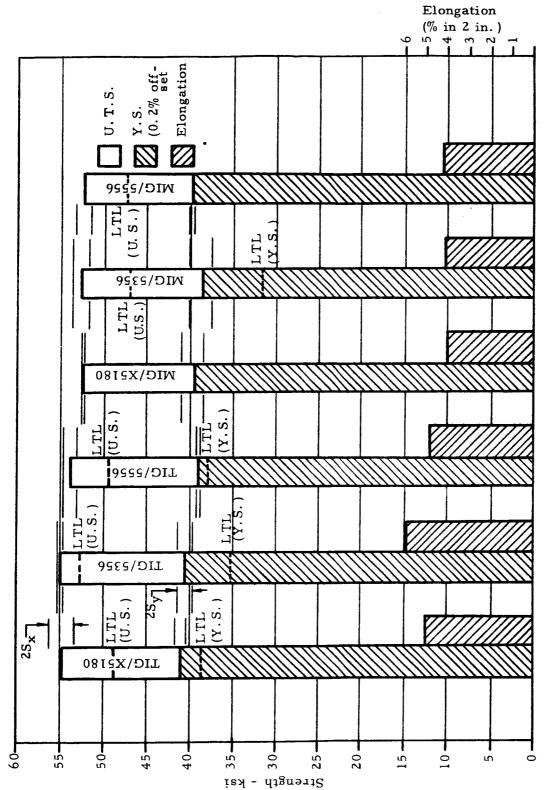
Microhardness surveys conducted on panels aged from two to eight weeks showed that a region of low hardness existed approximately 1/8 inch from the fusion line, corresponding to the general location of failure in the HAZ. The weld metal was softer, but the reinforcement of the crowns apparently more 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  $500^{\circ}$  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. <u>Contract NAS8-20160 (29 June 1965 to 29 April 1966)</u>

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



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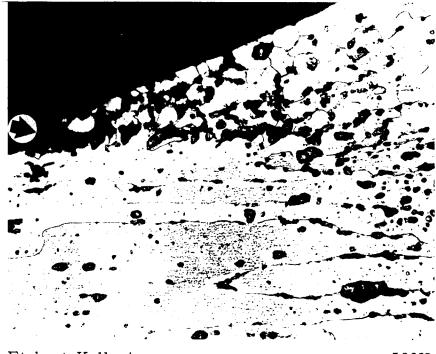
FIGURE 26. AVERAGE MECHANICAL PROPERTIES OF X7106-T63 WELDMENTS AGED 24 WEEKS

49



100X





Etchant-Keller's

500X

**(**b)

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

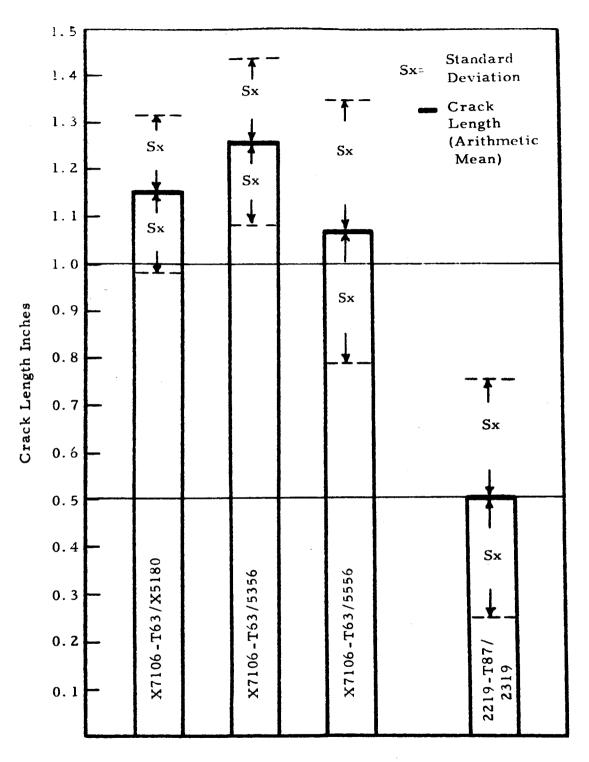
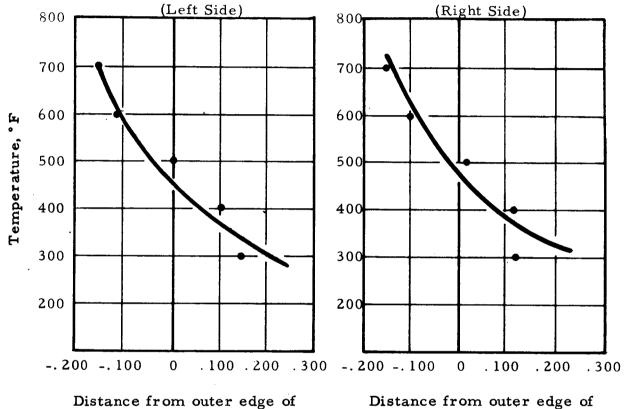


FIGURE 28. GRAPHICAL PRESENTATION OF CRACK DATA OBTAINED FROM HOULDCROFT TESTS



HAZ\* (inches)

Distance from outer edge of HAZ\* (inches)

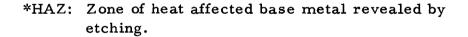


FIGURE 29. TEMPERATURE DISTRIBUTION IN THE VICINITY OF JOINT IN A TIG WELDED X7106-T63/X5180 PANEL AS REVEALED BY TEMPERATURE SENSITIVE CRAYONS of the uniaxial and biaxial properties of a number of weldments and further investigations into the weldability of X7106-T63 aluminum alloy. The Appendices A 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

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

where

 $\sigma$  = 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 Ultimate Strength, (ksi)		Biaxial Ultimate Strength, (ksi)		Biaxial/Uniaxial	
	Mean	$\underline{LTL}$	Mean	$\underline{LTL}$	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 joirts 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 Q. 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, 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 additon 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 <b>-</b> 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-l 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

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



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

 $\sigma = \text{engineering stress}$   $\epsilon = \text{engineering strain}$   $\bar{\sigma} = \text{true stress}$   $\bar{\epsilon} = \text{true strain}$   $\sigma_e = \frac{1}{\sqrt{2}} \sqrt{(\bar{\sigma}_1 - \bar{\sigma}_2)^2 + (\bar{\sigma}_2 - \bar{\sigma}_3)^2 + (\bar{\sigma}_3 - \bar{\sigma}_1)^2}$   $\epsilon_e = \frac{\sqrt{2}}{3} \sqrt{(\bar{\epsilon}_1 - \bar{\epsilon}_2)^2 + (\bar{\epsilon}_2 - \bar{\epsilon}_3)^2 + (\bar{\epsilon}_3 - \bar{\epsilon}_1)^2}$ 

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

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

where

- $\mu$  = 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 heataffected 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

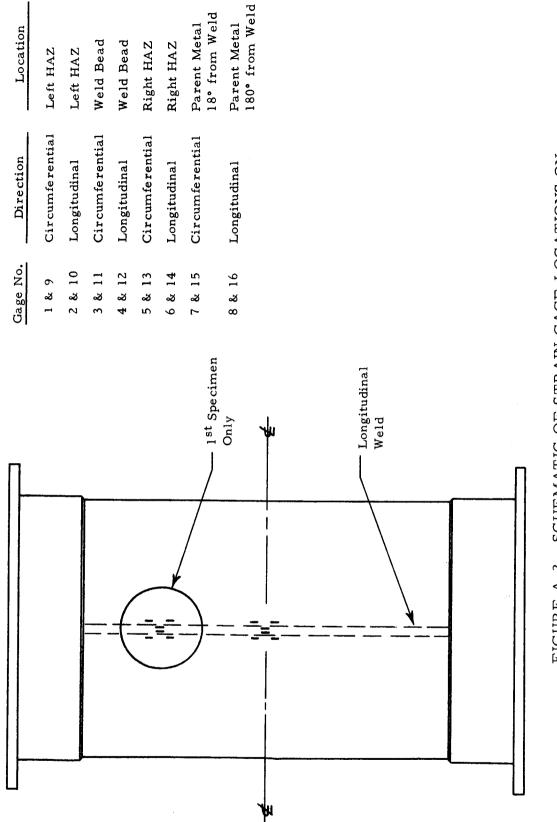


FIGURE A-2. SCHEMATIC OF STRAIN GAGE LOCATIONS ON CYLINDER TEST SPECIMENS

# 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> (ъ)
12	CY-9	2:1	<sub>995</sub> (c)
13	CY-15	2:1	<sub>1010</sub> (c)
14	CY-7	1:1	450(d)
14-A	CY-7	1:1	<sub>640</sub> (e)

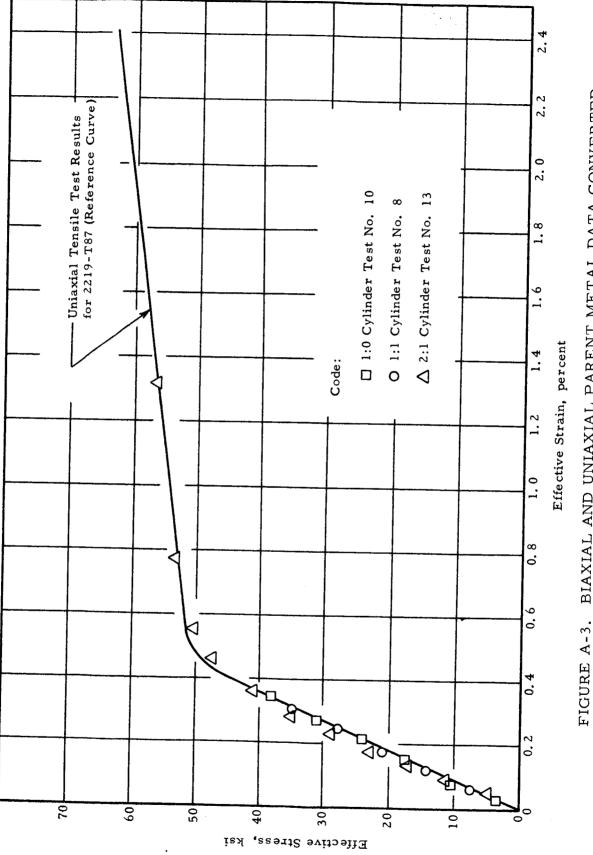
(a) Weld crowns ground off

(b) Longitudinal weld reinforced; parent metal failure

(c) Longitudinal weld reinforced; patch blew off

(d) Longitudinal weld reinforced; stopped because of excessive leaks

(e) Longitudinal weld reinforced; end rivets failed



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BIAXIAL AND UNIAXIAL PARENT METAL DATA CONVERTED TO EFFECTIVE STRESS AND STRAIN

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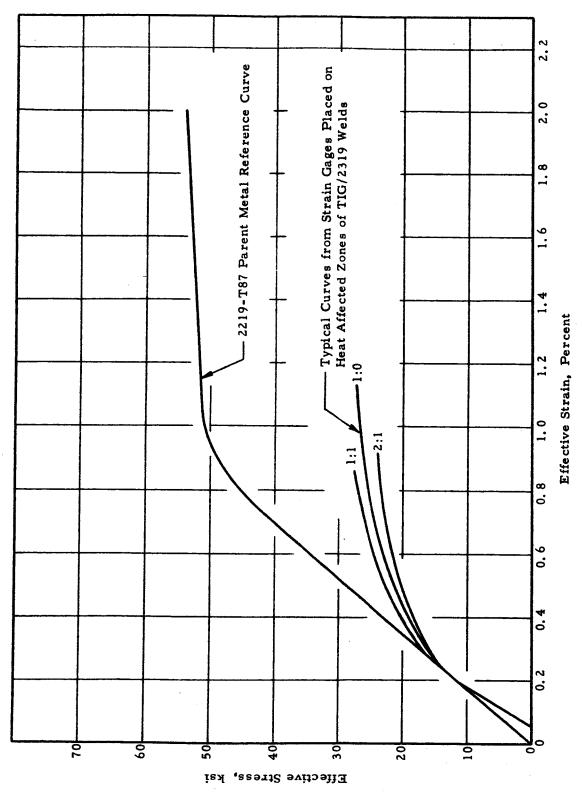


FIGURE A-4. BIAXIAL AND UNIAXIAL HAZ DATA CONVERTED TO EFFECTIVE STRESS AND STRAIN

so many variables involved that one cannot associate cause with effect in analyzing these data. Test 1 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<sup>(7)</sup> for calculating the stresses in the hydraulic bulge test panel

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

where

P = pressure, psi

- R = radius of curvature, inches (calculated from bulge height and die geometry)
- t = panel thickness, inches

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

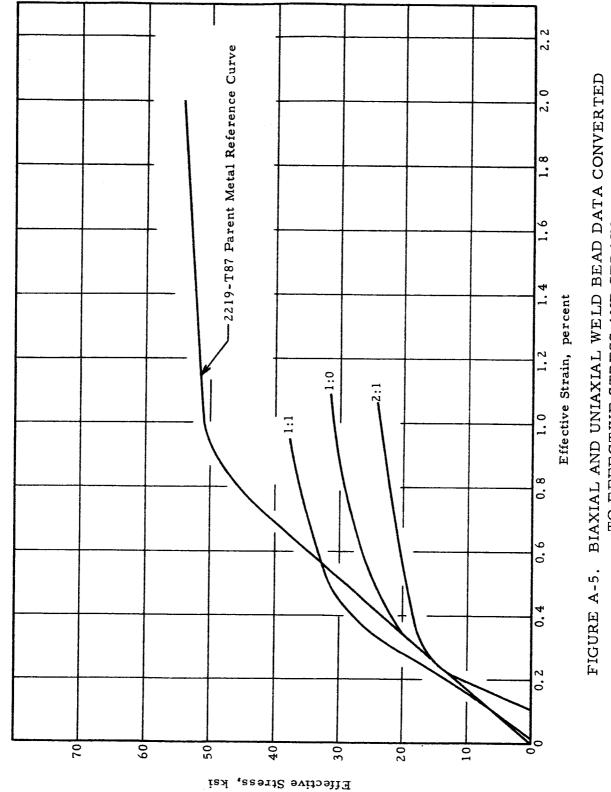


FIGURE A-5. BIAXIAL AND UNIAXIAL WELD BEAD DATA CONVERTED TO EFFECTIVE STRESS AND STRAIN

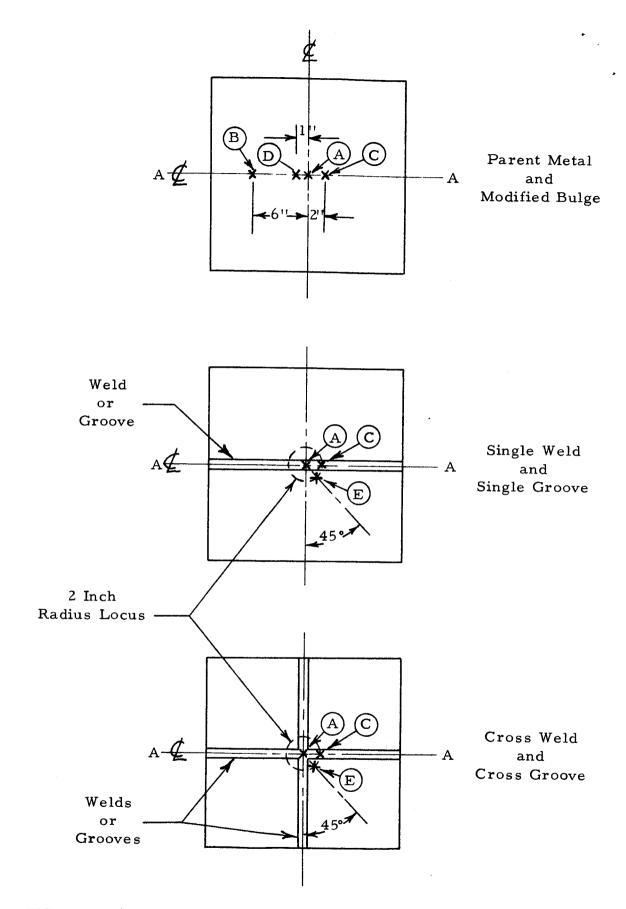


FIGURE A-6. SCHEMATIC OF STRAIN GAGE LOCATIONS ON 1:1 BULGE TEST PANELS

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

where

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 twoinch 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:

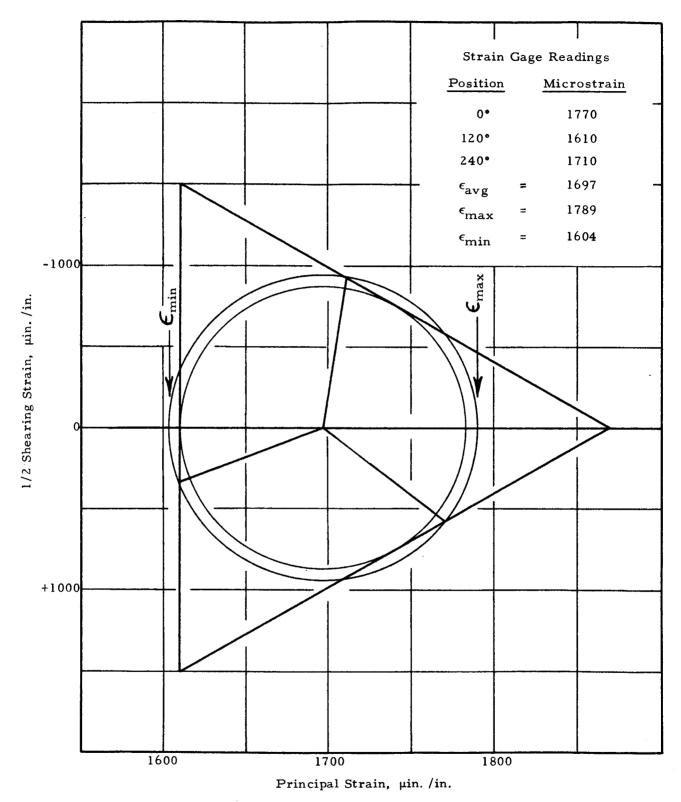


FIGURE A-7. MOHR'S CIRCLE FOR 1:1 BULGE . TEST PANEL A-1 AT P = 40 PSI

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

where

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

 $\sigma_{min}$  = 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,

Panel Description		Test	Principal Stresses				
Material &			Pressure	Max	Min		
Process	Type	No.	(psi)	(psi)	(psi)	Ratio	Direction(a)
2219-T87 Parent Metal	Parent	A1 A27 A28	40 - -	19,900 (Ъ) (Ъ)	18,400 - -	1.08 - -	19° - -
	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°

# TABLE A-3.PRINCIPAL STRESSES IN 1:1 HYDRAULICBULGE TEST PANELS BELOW YIELD STRESS

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

(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)

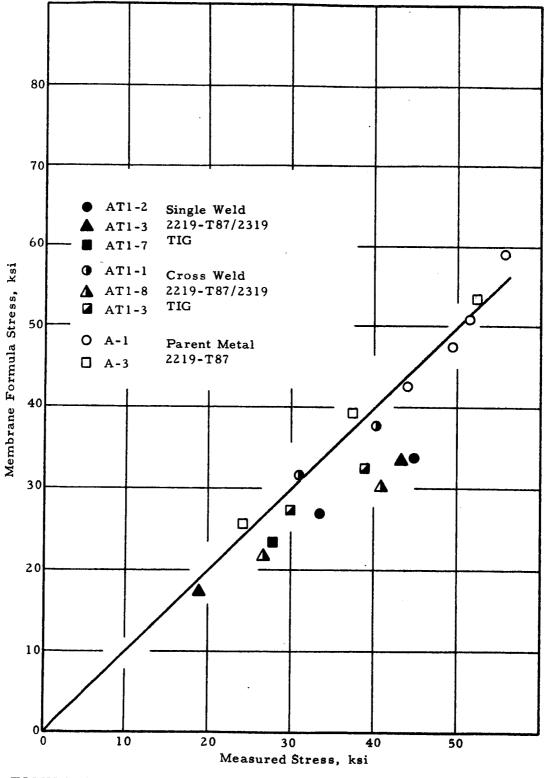


FIGURE A-9. COMPARISON OF MEMBRANE FORMULA STRESSES WITH MEASURED STRESSES. (Membrane Formula Stresses Calculated from  $\sigma = PR/2t$ . Measured Stresses Determined Experimentally with Strain Gages.)

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

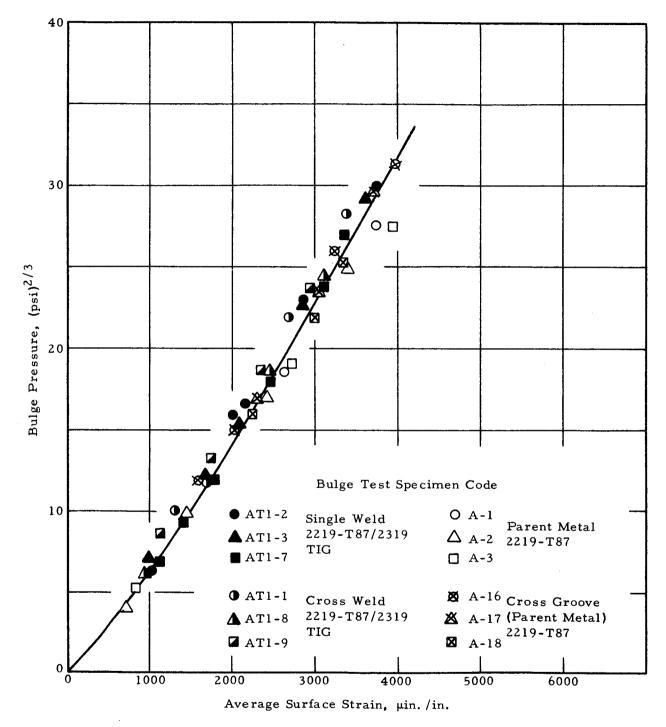


FIGURE A-10. STRAIN-PRESSURE DATA FROM CIRCULAR HYDRAULIC BULGE TESTS

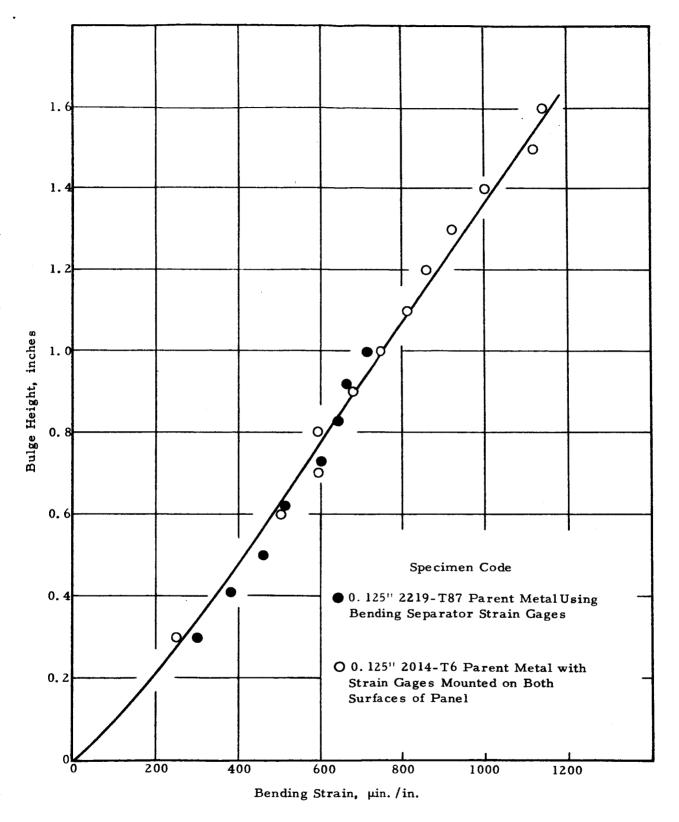
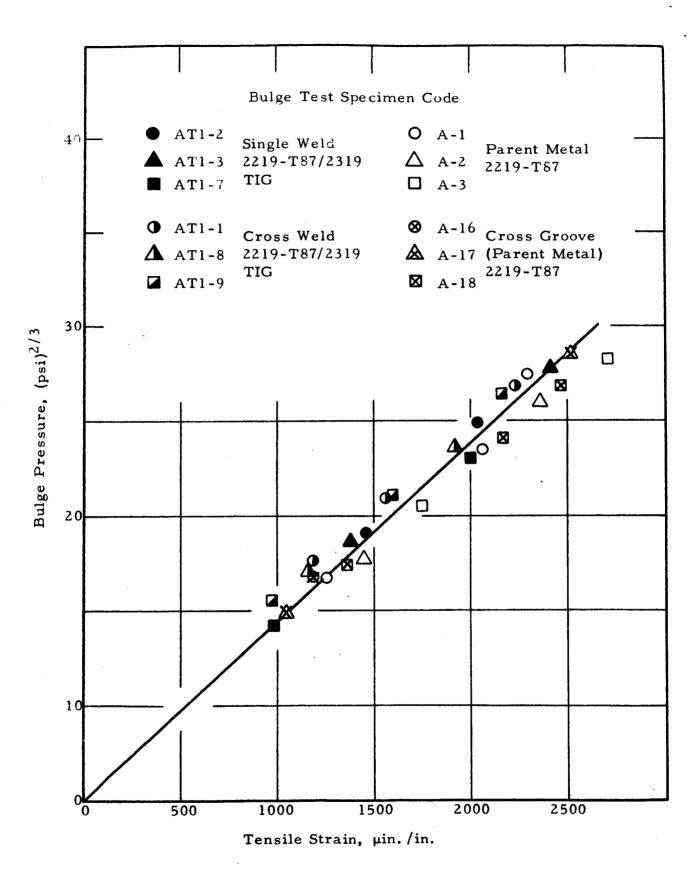


FIGURE A-11. BENDING STRAIN AS A FUNCTION OF BULGE HEIGHT IN THE CIRCULAR HYDRAULIC BULGE TEST





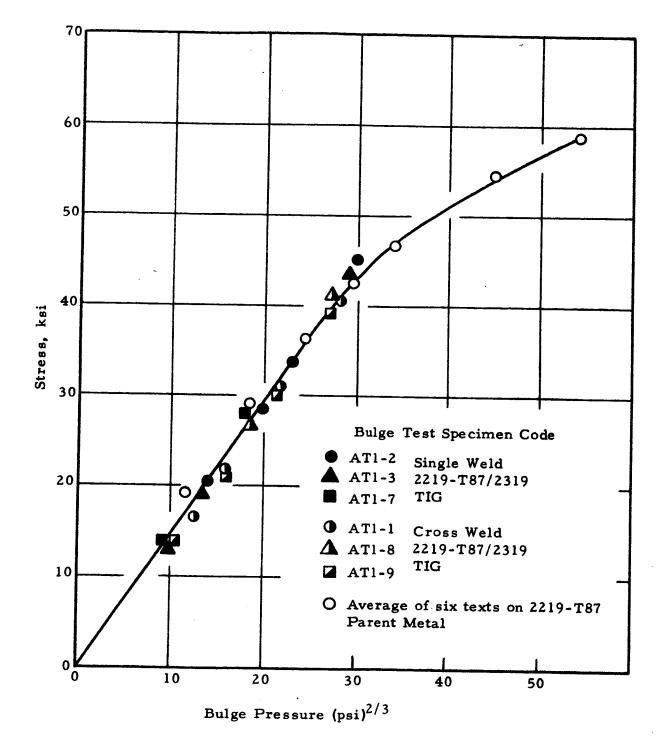


FIGURE A-13. RELATIONSHIP BETWEEN STRESS AND PRESSURE FOR 1:1 BULGE PANEL

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-l 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

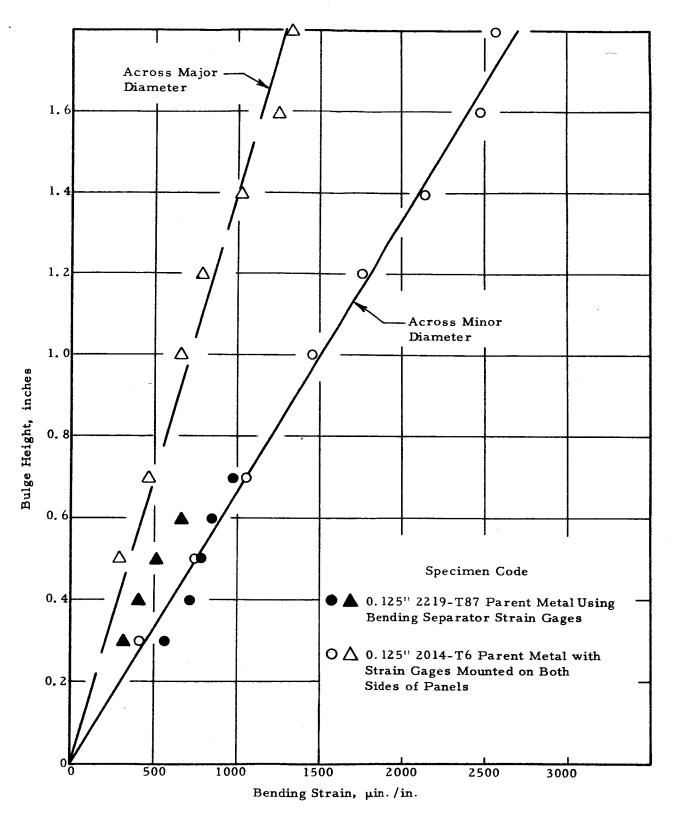


FIGURE A-14. BENDING STRAIN AS A FUNCTION OF BULGE HEIGHT IN THE ELLIPTICAL BULGE TEST

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.

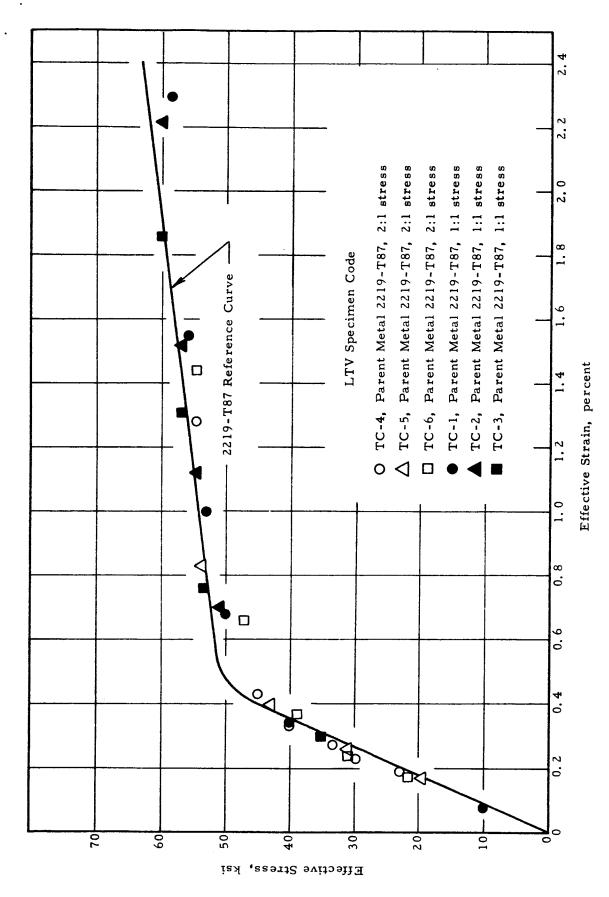
The analysis of the data on the remainder of the elliptical bulge tests, as discussed above, showed that a 2:1 stress state was not achieved in any of the tests.

#### 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.

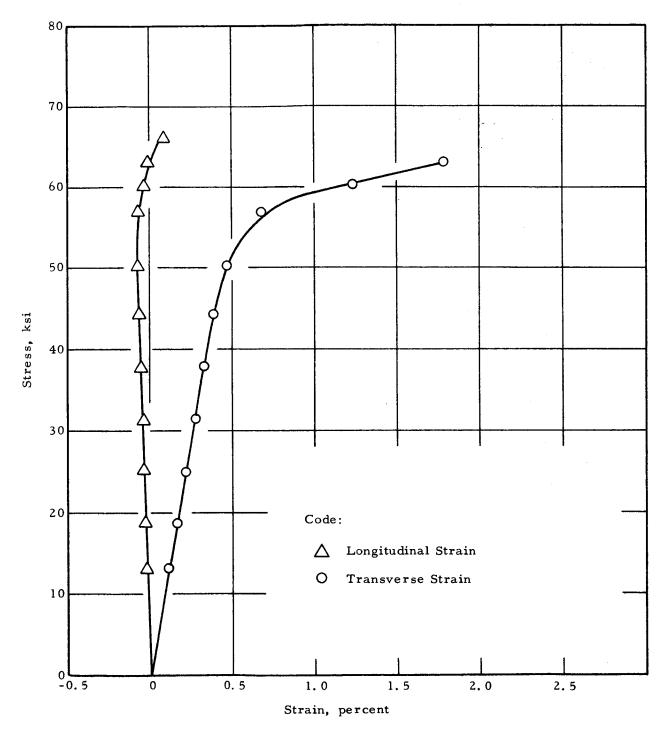


FIGURE A-16. STRESS-STRAIN DATA OBTAINED ON MIT SPECIMEN

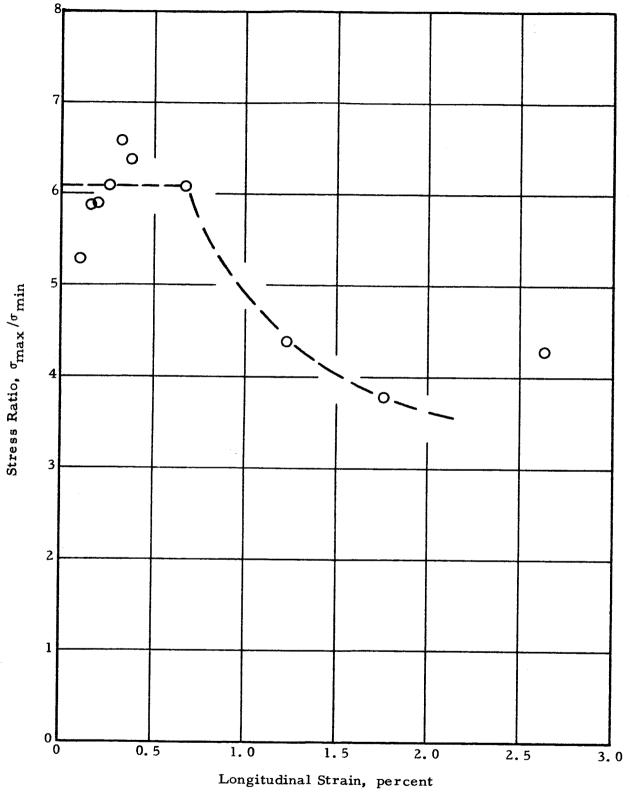


FIGURE A-17. STRESS RATIO IN MIT SPECIMEN AS A FUNCTION OF LONGITUDINAL STRAIN

## 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.

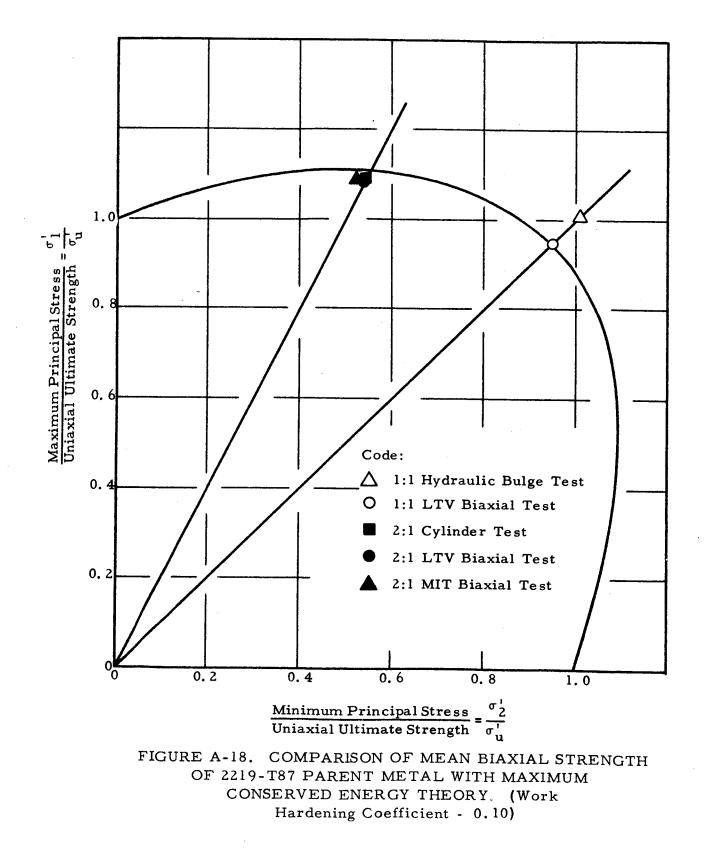
The LTV test worked well at both 1:1 and 2:1 stress ratios on parent metal. The specimen design presently used has a machined test section and does not permit the testing of welds in full cross section.

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 ULTIMATESTRENGTH OF 2219-T87 ALUMINUM ALLOY

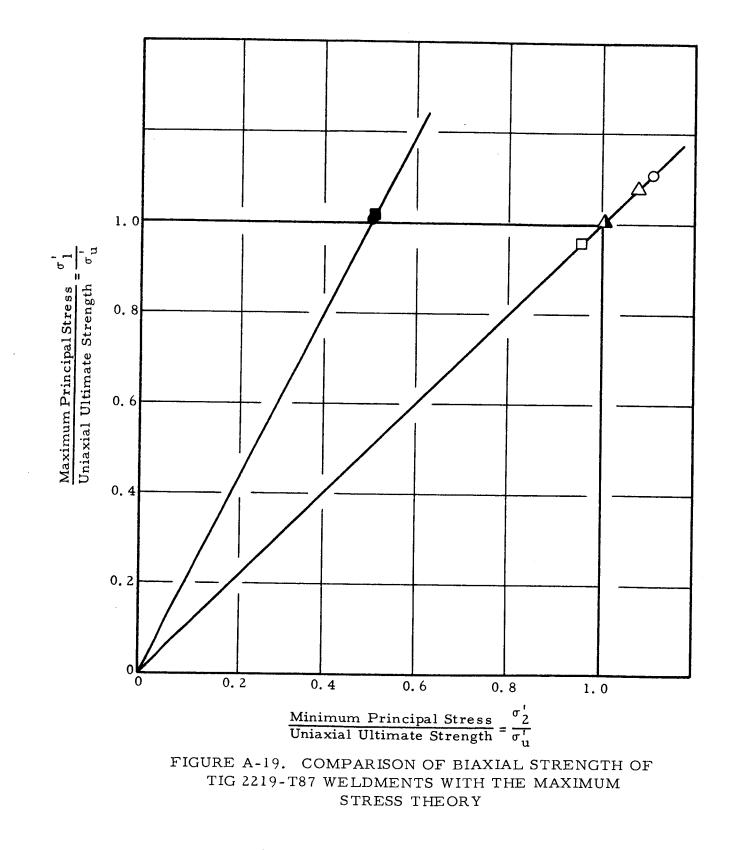
Test Method	Stress Ratio	No. of Biaxial Tests	Average Biaxial Strength	Biaxial/Uniaxial Ratios(a)
∆ SwRI Bulge	1:1	3	66.4 ksi	1.01
O LTV Biaxial	1:1	3	62.2 ksi	0.95
SwRI Cylinder	2:1	1	70.7 ksi	1.08
• LTV Biaxial	2:1	3	71.1 ksi	1.08
▲ MIT Biaxial	>2:1	5	71.5 ksi	1.09

(a) Uniaxial Tensile Strength of 2219-T87 = 65.8



# 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
<ul> <li>LTV Biaxial</li> <li>(Cross Weld)</li> </ul>	2:1	3	37.4	37.2	1.01



# 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

					antity per Co	ndition
Alloy	Welding Process	Filler Metal	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

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

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

(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			Uniaxial	ıxial	
		Avg Ult			Avg Ult	$\operatorname{Std}$	
Alloy	No. of	Str,	Min/Max	No. of	Str,	Dev,	99% LTL,
	Tests	ksi	ksi	Tests	ksi	ksi	ksi
	(			Ļ	0		C C 7
28,T,-6122	Υ,	00°4	04°.5/01°.4	c1	0.00	0.11	c.co
2014-T6	~	74.2	72.9/76.0	15	70.4	1.26	66.0
	)						
X7106-T63	ŝ	70.0	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).

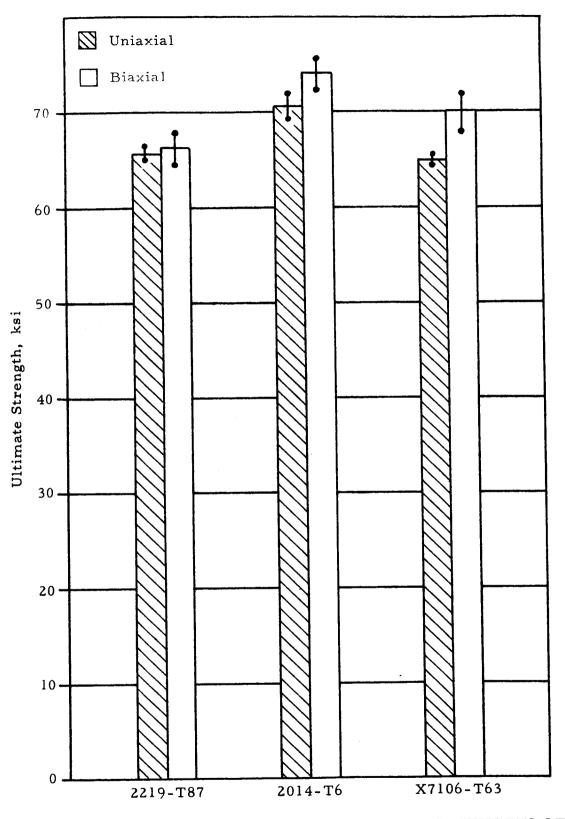
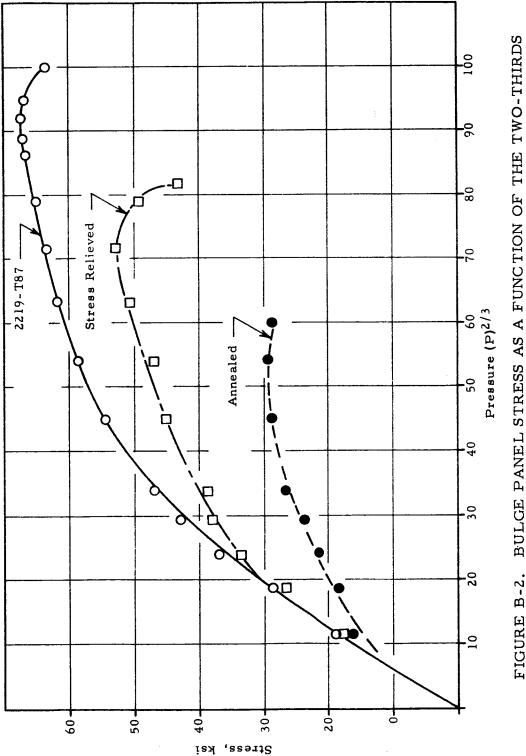


FIGURE B-1. THE BIAXIAL AND UNIAXIAL STRENGTHS OF 2219-T87, 2014-T6, AND X7106-T63 HIGH STRENGTH ALUMINUM ALLOYS





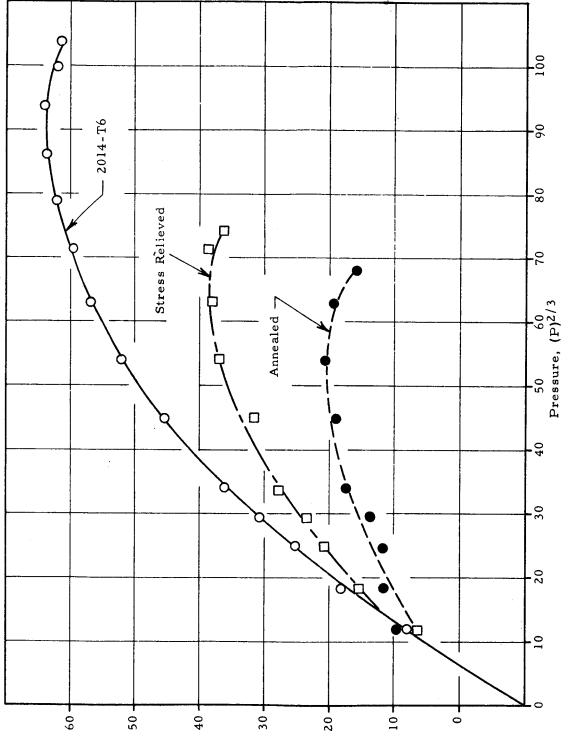
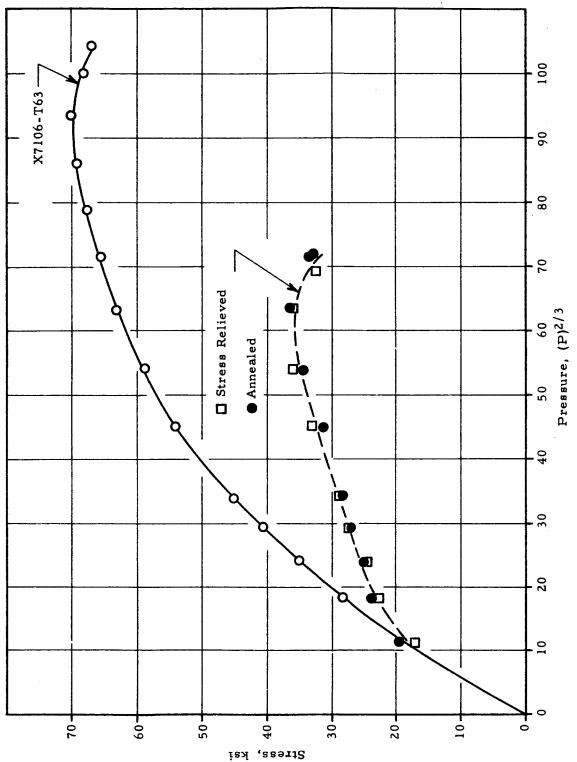


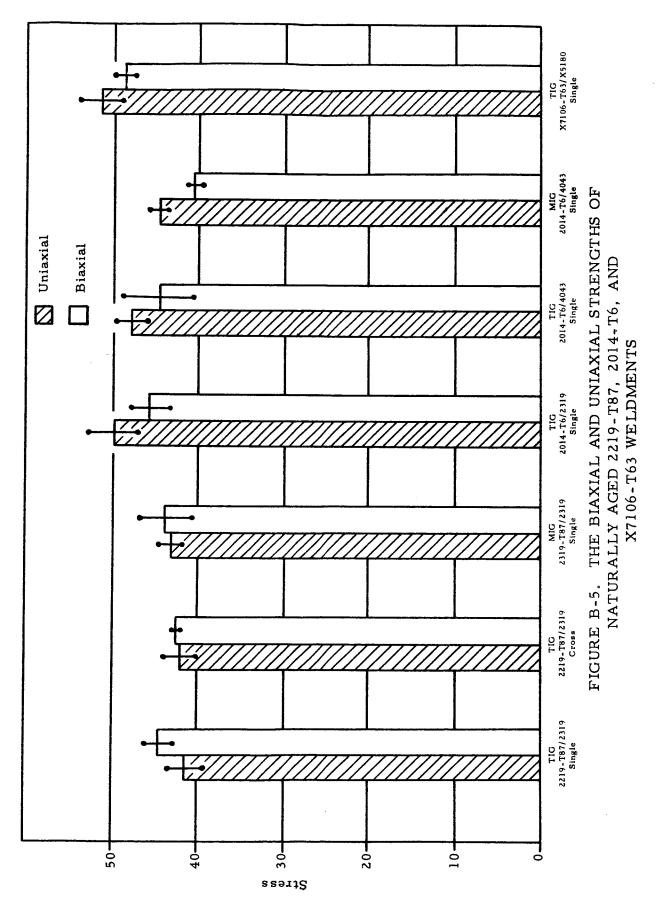
FIGURE B-3. BULGE PANEL STRESS AS A FUNCTION OF THE TWO-THIRDS POWER OF THE APPLIED PRESSURE FOR 2014 ALUMINUM ALLOY

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		ΤĽ,	2	1	ŝ	10	M		2
		99% LTL, ksi	35.2	36.1	38,3	39.5	41.8	40.9	42.7
ALLY									
ATUR.		Std Dev, ksi	1.97	1.87	l. 35	2.90	1.67	1.06	2.45
ENTS	Uniaxial								
ELDMI	D	Avg Ult Str, ksi	41.3	41.8	43.0	49.8	47.7	44.7	1.3
TABLE B-3. SUMMARY OF BIAXIAL AND UNIAXIAL STRENGTHS OF NATURALLY AGED 2219-T87, 2014-T6, AND X7106-T63 WELDMENTS		Avg U k	4	4	4	4	4	4	51
XXIAL 7106-7		No. of Tests	0	6	Ъ	ß	Б	LO	10
AND X		Lo. L	30	29	15	15	15	15	15
AL ANI 4-T6,		Max, i	46.0	42.5	46.6	47.6	48.5	41.2	49.2
3IAXI/ 7, 2014		Min/Max, ksi	43.8/46.0	41.8/42.5	40.6/46.6	43.1/47.6	42.0/48.5	39.7/41.2	47.3/49.2
Y OF 1 19-T87	ial	tr,							
AMAR ED 22	Biaxial	Avg Ult Str, ksi	44.6	42.1	43.7	45.4	44.2	40.5	48.4
, SUN AG		Ave							
Ъ-В-3		No. of Tests	ξ	ŝ	ŝ	ŝ	ŝ	ŝ	ŝ
TABI			· .						<u>'</u>
		Weldment Type	TIG 2219- T87/2319 Single	TIG 2219- T87/2319 Cross	MIG 2219- T87/2319 Single	TIG 2014- T6/2319 Single	TIG 2014- T6/4043 Single	MIG 2014- T6/4043 Single	TIG X7106- T63/X5180 Single
		Wel T	TIG 22 T87/2: Single	TIG 27 T87/2 Cross	MIG 22 T87/23 Single	TIG 20 T6/23 Single	TIG 20 T6/404 Single	MIG 2( T6/40 Single	TIG X' T63/X Single



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  $(PR/2t)^{(4)}$ . 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 pre-viously reported.

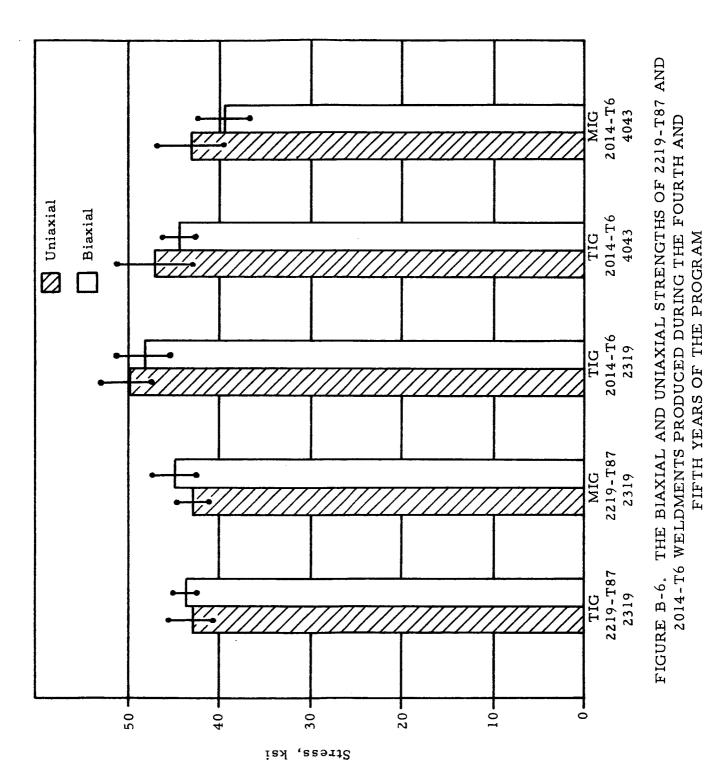
Based on the mean values, the biaxial-uniaxial strength ratio of the welds are as follows:

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			29.9	
Uniaxial	Std Dev,	ksi		2.20			1.91			2.84			4.74			4.14	
'n	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	ŝ	3	3	3	ŝ	4	6	ŝ	2	2	ŝ	3	ŝ	3	ŝ
	Weldment	Configuration		Tee	Cross	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	52
	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
Д	Ult Str, ksi	43.6	44.8	48.0	44.1	39.1
	No. of Tests	15	13	11	11	12
	Weldment Type	TIG 2219-T87 2319	MIG 2219-T87 2319	TIG 2014-T6 2319	TIG 2014-T6 4043	MIG 2014-T6 4043



Biaxial/Uniaxial
Strength Ratio
1.02
1.05
0.96
0.92
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.

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

)

:

99% LTL. 28.2 28.4 28.8 28.4 32.6 52.6 42.9 45.8 41.2 44.5 47.7 ksi 28.( 34. 30. ( 31. 37. 38. 38. Std Dev, 0.34 0.19 1.26 0.46 0.30 0.17 0.13 0.21 0.42 0.67 0.68 0.37 0.42 1.01 0.51 1.05 0.15 0.11 ksi Uniaxial Ult Str, 47.4 39.4 44.4 39.5 29.8 35.0 29.6 29.4 29.6 35.0 56.5 51.6 48.3 47.0 30.8 30.7 50.1 33.1 ksi No. of Tests ບບບບບບບບບ ഹ ഗഗ ŝ ഗഗ ഗഗ ŝ Ult Str, 44.0 44.0 35.9 35.9 44.5 41.7 32.7 35.7 29.5 30.4 29.5 30.4 30.4 48.5 35.7 29.3 24.7 53.1 ksi Biaxial No. of Tests Treatment(a) Heat Ann Ξ SR= Ξ = Ξ = = = Ξ = Ξ = = Ξ TIG/X7106-T63/X5180 TIG/X7106-T63/X5180 MIG/2219-T87/2319 TIG/2219-T87/2319 MIG/2219-T87/2319 TIG/2219-T87/2319 MIG/2014-T6/4043 MIG/2014-T6/4043 TIG/2014-T6/2319 TIG/2014-T6/2319 TIG/2014-T6/4043 TIG/2014-T6/4043 Panel Type X7106 X7106 2219 2014 2219 2014

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

# 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
0.187 Inch	TIG	Sq Butt	
0,187 Inch	MIG	Sq Butt	
		Sq Butt	
	TIG		
0.50 Inch		Double V*	X5180 5356 5556
0. 30 men	MIG	Double V*	0000
	TIG	Double V*	
1,00 Inch	MIG	Double V*	

\*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.

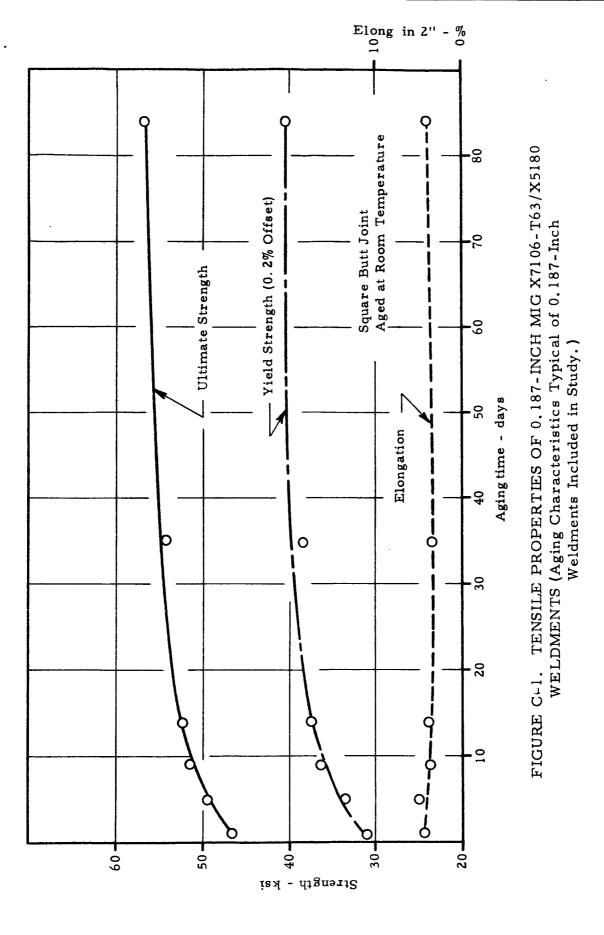
In general, all types of 0.187-inch weldments exhibited similar aging behavior. Increases in ultimate strength and yield strength in the order of 20 percent of the as-welded values were observed for the 0.187-inch weldments after aging periods of 12 weeks. The typical aging characteristics of this group 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



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

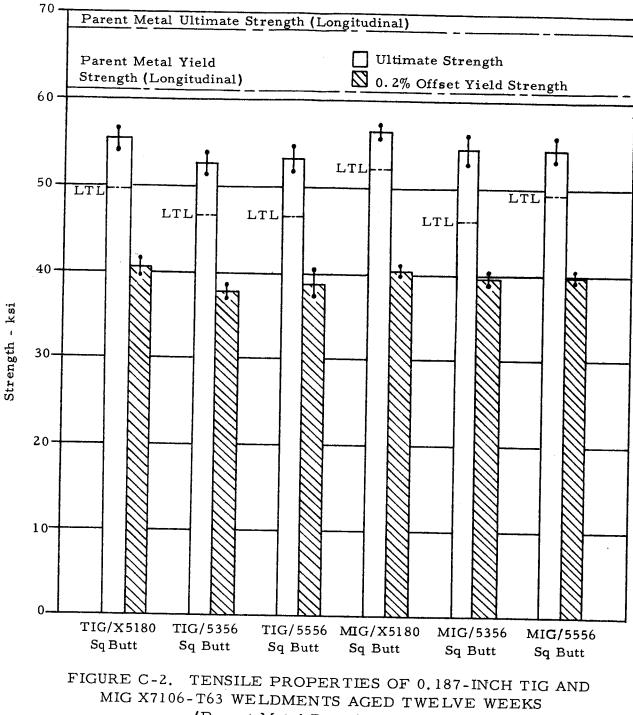
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$\sim$ $\sim$ $\tau$ <td>Weldment</td> <td>Panel</td> <td>Aging</td> <td>No. of</td> <td>Avg.</td> <td>S<sub>y</sub><sup>(2)</sup></td> <td><math>LTL^{(3)}</math></td> <td>of</td> <td>Avg.</td> <td>Su<sup>(2)</sup></td> <td>LTL<sup>(</sup></td> <td>Avg.</td> <td>i s</td>	Weldment	Panel	Aging	No. of	Avg.	S <sub>y</sub> <sup>(2)</sup>	$LTL^{(3)}$	of	Avg.	Su <sup>(2)</sup>	LTL <sup>(</sup>	Avg.	i s
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			12 weeks	6				6		1.36			1.10

0. 2% Offset
 Standard Deviation
 99% Lower Tolerance Limit (95% Confidence)

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

				Viald St	Viald Strength(1)			Iltimate	Jltimate Strength	ų	Elongation	m in 2 in.	
Weldment	Panel	Aging	1	17 11211		12/	Т		1 (2) 7	+ ++ (3)	A A	U	
	N.	Time	No. of	Avg.	S ( <sup>e</sup> )	LTL	No. 01	Avg.	an n	, , , , , , , ,	Avg.	e f	
ad t		1	Tests	ksi	ksi	ksi	Tests	ksi	ksi	ksi	%₀	0/'n	
		1 40.0	4	30.9	0.47		9				4.1		
			0 4				9			42.8	4.7		
MIG-X7106		o days	о ч _	7 98	1 2 3		9			47.8	3.5		
X5180	CM3-1	7 uays	<u>ہ</u> م	37.1	0.49	34.6	6	52.2	1.40	45.1	3.7	0.40	
Sa. Butt		5 wooks	، رد ا	38.6	0.45		9			_	3.5		
		12 weeks	9	40.4	0.59	37.3	9	56.8	0.84	52.5	4.0		
		1 day	6	31.1	0.62	28.0	9	46.4	1.29	39.9			
		r davs Ridavs	9	33.1	0.20	32.1	6	47.9	1.27	41.5	4.2	0.90	
MIG-X7106		9 davs	0.0	34.6	1.14		30	50.4	1.13				
5356	CM4-1	2 weeks	9	35.7	0.60	32.6	6	51.7	1.37	44.8			
Sq. Butt		5 works	9	37.0	0.56		9		0.96	47.9			
1		12 weeks	9	39.3	0.66	36.0	9	54.8	1.71	46.1			<b>`</b>
		1 454	6	31.2	0.93	26.6	9		0.44				
		E dave	) ~C	33.5		31.1	9	48.5	1.47	41.0	4.1	0.71	
MIG-X7106		o dave		36.1		26.1	9		1.15	45.0			
5666	CM5-2	2 monto	о ч				9		0.70				
Se Bitt		r Mecha	<u>ب</u> د	2.7.5	5 - C	1	9		0.76				
od. put		5 weeks 12 weeks	9	39.9	0.52	37.2	6	54.7	1.06	49.4			
													ľ

0. 2% Offset
 Standard Deviation
 99% Lower Tolerance Limit (95% Confidence)



(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 weldability, 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.

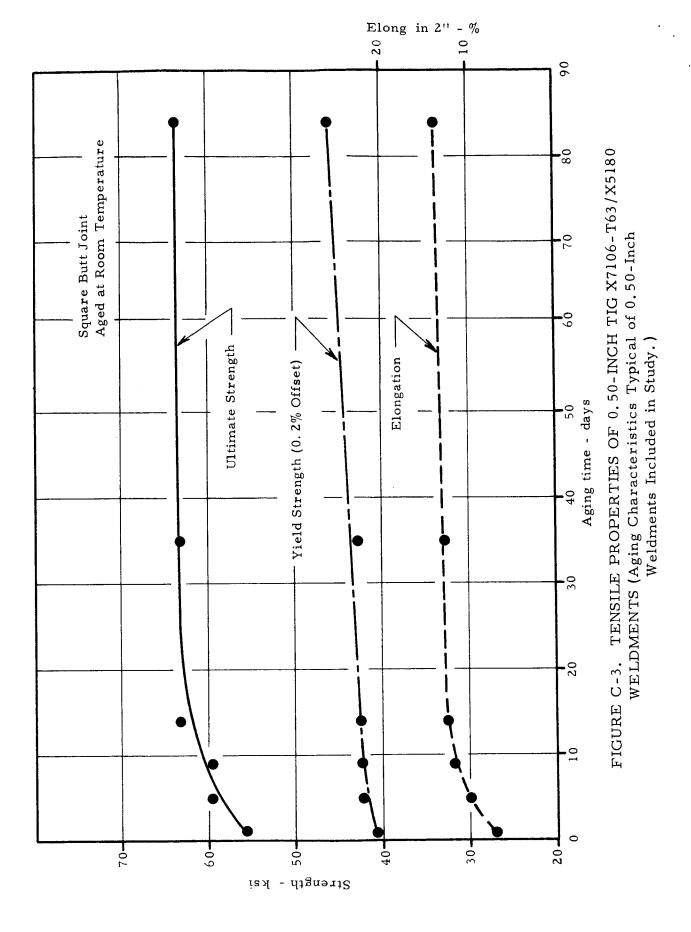


TABLE C-4. SUMMARY OF TENSILE PROPERTIES OF 0.50-INCH TIG-X7106 WELDMENTS

Waldmant	[orcd	Arina		Yield Strength <sup>(1</sup>	ength(1)		Ð	Ultimate Strength	Strengt		F.longation	on in 2 in
Type	No.	Time	No. of	Avg.	S <sub>y</sub> <sup>(2)</sup>	$LTL^{(3)}$	5	Avg.	s <sup>u (2)</sup>		Avg.	Se
			rests	K S1	K81	K 81	Tests	ksi	ksi	kai	%	%
		1 day	4	26.8	0.19	26.6	ŝ		0.28	44. 2	10.7	0.63
		5 days	+	29.9	0.67	29.3	ŝ	49.9	0.96		12.2	
VE180	( t. )	9 days	ŝ		0.37	29.5	ß		1.56	40.8		1.84
	013-6	2 weeks	+	32.1	0.33	31.7	+		1.50	51.2		0.93
ing .pe		5 weeks	5	34.6	0.27		Ś	53.3	0.44	50.8	11.6	2.37
		12 weeks	5	35.8	0.48	33.0	5		0.94	48.0		0.57
		l day	9	26.3	0.45	24.1	é	45.1	0.58	42.2	9.1	1.36
		5 days	9	30.0	0.64	26.8	9	48.7	0.37	46.8	9.8	0.72
	ς τ.Η.ζ	9 days	9	30.6	0.29	29.2	6	49.7	0.67		10.9	2.17
	3-#10	2 weeks	9	31.8			6	51.0		49.2	10.9	1.71
ung be		5 weeks	6	33.2	0.66	29.9	9		0.24	51.4	12.7	
		12 weeks	9	35.1	0.27		6	53.0		49.7	12.7	0.78
		l day	9	26.8	0.61	23.7	6		0.78	41.4	8.9	0.72
		5 days	9	30.3	0.25	29.1	9	48.8	0.74	45.1	9.4	0.55
	L L L	9 days	6	30.3		28.3	9	49.1	ŝ	47.1	9.8	0.62
0000	0-610	2 weeks	9	30.8	0.39	28.8	<i></i>		1.19	43.5	10.8	1.94
ing .pd		5 weeks	9	34.1			Ś	53.2	30	48.3	11.5	0
		12 weeks	9	35.0	0.46	32.7	9		1.14	48.7		1.14

0.2% Offset
 Standard Deviation
 99% Lower Tolerance Limit (95% Confidence)

TENSILE PROPERTIES OF	WELDMENTS (Cont'd)
OF	. 90
SUMMARY OF TENSILE	0.50-INCH TIG-X7106
TABLE C-4.	0.50-IN

				Yield Strength <sup>(</sup>	$ength^{(1)}$			Jltimate	Ultimate Strength	th	Elongation in	ion in 2 in.
Weldment	Panel	Aging	No. of	Avg.	S <sub>V</sub> <sup>(2)</sup>	LTL <sup>(3)</sup>	No. of	Avg.	s <sub>u</sub> (2)	$LTL^{(3)}$	Avg.	Se <sup>(2)</sup>
Type	No.	Time	Tests	ksi	ksi	ksi	Tests	ksi	ksi	ksi	%	%
		3 days	6	28.9	0.85	24.6	9	47.8	0.54	45.0	8.9	0.73
		5 days	9	30.5	0.33	28.8	9			47.4		0.34
11G-X /100	Ē	10 days	6	34.1	0.51	31.6	9	52.0	0.37	50.1	8.7	0.34
091cY	CT3-+	17 days	6	34.6	1.07	29.2	6		0.24	51.2	9.2	0.39
Double V		5 weeks	9	34.4	0.46	32.1	6			51.2	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	26.8	9	47.7	0.43	45.5	8.9	0.73
		5 days	6	30.3	1.01	25.1	9	48.8	-	46.5	8.7	0.56
TIG-X7106		10 days	6	33.8	1.42	26.6	9		0.31	49.4	9.5	0.43
5356	CT4-4	17 days	9	34.1	0.48	31.7	9	51.5	0.62	48.3	9.7	0.44
Double V		5 weeks	9	32.8	0.51	30.2	9	52.0		50.2	9.4	0.79
		12 weeks	6	34.2	0.50	31.7	9	52.4	0.45	50.2	9.7	0.43
		3 days	9		0.50	76.0	9	48.1	0.58	45.1		0.77
		5 days	9	29.8	0.42	27.7	6	49.5	0.23	48.3	8.7	0.32
TIG-X7106	:	10 days	9	33.6	0.40	31.6	9		0.39	49.4	9.8	0.99
5556	CT5-8	17 days	6	34.4	0.27	33.0	9	51.5		49.1	9.6	0.20
Double V		5 weeks	6	32.6		30.0	6		0.52	49.3	9.1	0.81
		12 weeks	9	33.5	0.68	30.1	9	52.6	0.91	48.0	9.4	0.86

0. 2% Offset
 Standard Deviation
 99% Lower Tolerance Limit (95% Confidence)

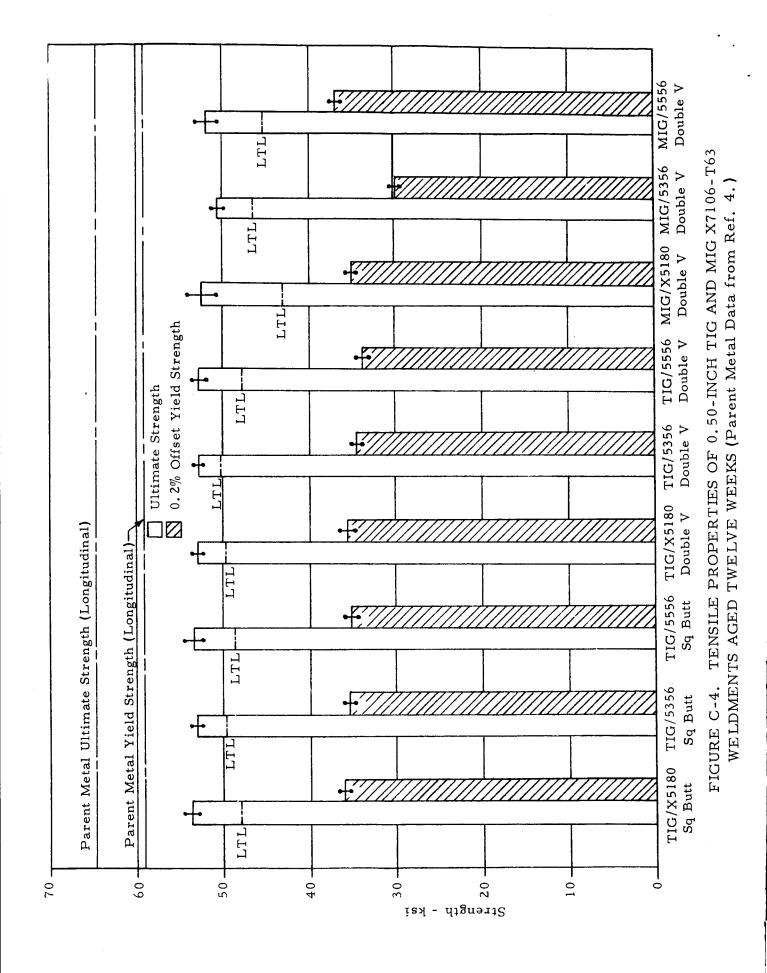
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TABLE C-5. SUMMARY OF TENSILE PROPERTIES OF 0.50-INCH MIG-X7106 WELDMENTS

				Yield Strength <sup>(1)</sup>	ength(1)		n	Ultimate Strength	Strength		Elongation in	on in 2 in.
Weldment Type	Panel No.	Aging Time	No. of Tests	Avg. ksi	sy (2) ksi	LTL <sup>(3)</sup> ksi	No. of Tests	Avg. ksi	Su <sup>(2)</sup> ksi	LTL <sup>(3)</sup> ksi	Avg. <sub>0,0</sub>	S <sub>e</sub> σ <sub>0</sub>
MIG-X7106	,	l day 4 days 1 week	6 6	26. <del>1</del> 30. 5 30. 2	0.69 2.78 0.29	22.9 16.5 29.2	ووي	44.8 46.9 47.3	1.11 0.83 2.84	39. 2 42. 7 33. 0	9.5 8.6 8.0	1.30 0.99 1.60
X5180 Double V	2-CWO	2 weeks 5 weeks 12 weeks	\$ \$	<b>31</b> .6 32.5 34.8	0.35 0.41 0.55	29.8 30.4 32.1	مو	50.3 51.2 52.2	1.08 1.25 1.80	44.9 44.8 43.1		0.95 1.81 1.41
MIG-X7106 5356 Double V	CM4-2	l day 4 days 1 week 2 weeks 5 weeks 12 weeks	6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6	24.1 25.5 26.1 27.0 28.1 29.7	0.47 0.88 0.68 0.68 0.49 0.49	21.7 21.1 22.6 22.8 22.8 25.6 27.4	C O O O O O	44.3 45.7 47.4 47.4 48.4 48.7 50.2	0.64 1.23 1.00 0.50 1.46 0.75	41.4 39.5 42.3 45.9 41.3 46.4	9.0 9.0 8.2 8.4 7.1	0.49 1.13 0.85 0.56 0.63 0.81
MIG-X7106 5556 Double V	CM5-1	l day 6 days 9 days 2 weeks 5 weeks 12 weeks	000000	28.7 31.6 32.3 32.7 31.0 36.7	0.63 0.53 0.29 0.70 0.61 0.44	25.5 28.9 30.9 29.2 27.9 34.4	0000-10	43.8 46.9 48.0 48.3 49.7 51.9	1.62 1.50 0.81 0.89 0.89 1.14 1.28	35.6 39.9 43.9 43.8 43.8 45.4	8.5 7.9 8.1 8.1 8.1	.84 1.77 0.30 1.00 0.96 1.10

0.2% 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.

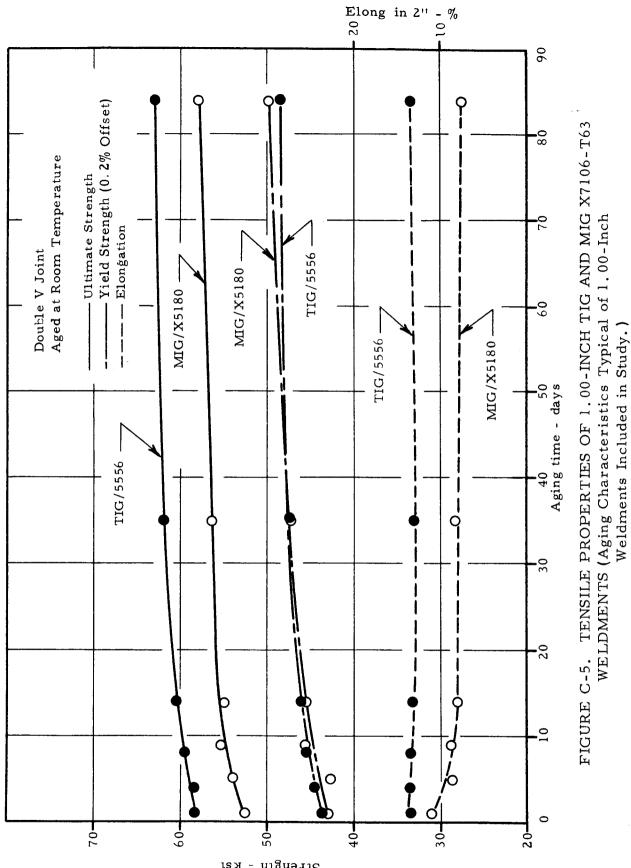
The tensile properties, as a function of aging time, are summarized in Tables C-6 and C-7 and the average tensile properties after an aging period of 12 weeks are presented in Figure C-6.

Figure C-6 presents the average tensile properties of the 1.00inch 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 heataffected 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



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

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	1			Yield Strength(1	ength(1)			Ultimat	Ultimate Strength	th	Elongatic	Elongation in 2 in.
W cldment Tyme	Panel	Aging	No. of	Avg.	S <sub>V</sub> <sup>(2)</sup>	LTL <sup>(3)</sup>	No. of	Avg.	S <sub>u</sub> (2)	$LTL^{(3)}$	Avg.	S <sub>e</sub> (2)
2467		21117 T	Tests	ksi	k si	ksi	Tests	ksi	ksi	ksi	, <i>⊧</i> ⊲	0,
		-		( (	1							
		I day	0	30.2	0.83	26.0	m	44.3	2.17	(4)	16.6	0.60
TTG- X7106		4 days	9	32.0	0.95	27.2	3	46.5	0.66	(4)	13.5	(2)
X E180	CT3_3	8 days	9	33.2	1.22	27.1	ε	46.9	1.18	(4)	15.3	(9)
Double W	n-01)	2 weeks	9	34.4	0.83	30.2	m	47.5	1.27	(4)	16.7	(9)
		5 weeks	6	34.4	0.59	31.4	ñ	47.8	0.93	(4)	(2)	
		12 weeks	6	35.6	1.20	29.5	ŝ	48.2	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	ç	32.7	0.46	30.4	ß	46.8	0.65	43.0	14.3	1.71
5356	ς T 4 - 2	9 days	9		0.20	33.0	9	47.6	0.93	42.9	14.4	1.68
Double V		2 weeks	5	34.7	0.11	34.0	9	48.8	0.99	43.8	15.1	1.46
		5 weeks	6		0.23	34.7	6	49.8	0.79	45.8	14.1	1.27
		12 weeks	6	37.0	0.45	34.8	6	51.4	0.82	47.2	14.3	0.43
		36 hours	6	33.4	0.22	32.3	5	48.3	0.46	45.6	14.6	0.48
		5 days	6	34.4	0.73	30.7	ŝ	48.4	0.37	46.3	14.2	0.69
	r H L	9 days	9	35.4	0.32	33.7	ഹ	+9.6	0.32	47.8	13.5	0.46
00000	0.10-0	2 weeks	9	35.9	0.38	33.9	5	50.5	0.21	49.3	13.4	0.67
Double V		5 weeks	6	37.3	0.48	34.9	6		0.44	49.4	13.1	0.99
		12 weeks	6	38.5	0.51	36.0	9	52.8	0.54	50.1	13.8	0.51

0.2% Offsct
 Standard Devii
 Standard Devii
 99% Lower To
 Insufficient da
 Insufficient da
 Data from two
 Data from one
 No elongation

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

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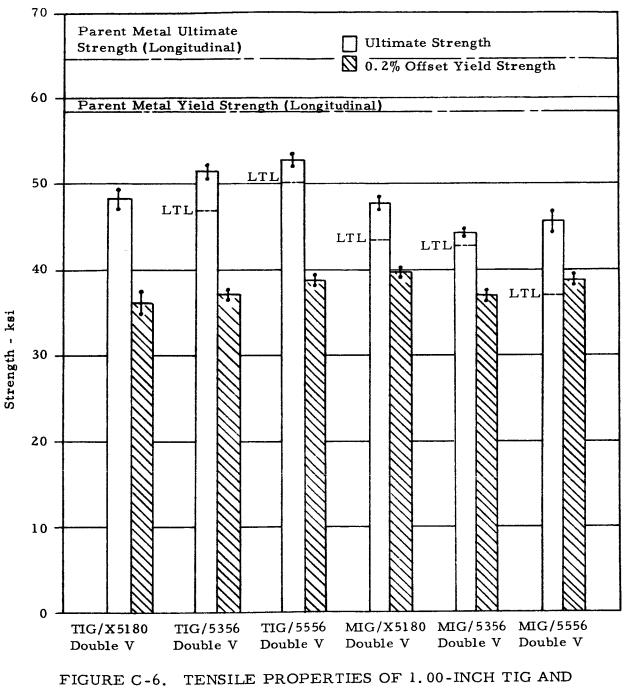
				Yield Strength <sup>(1)</sup>	$_{n{ m gth}^{(1)}}$			Jltimate	Ultimate Strength	th	Elongati	Elongation in 2 in.
W eldment	Panel	Aging	No. of	Avg.	S <sub>v</sub> <sup>(2)</sup>	$LTL^{(3)}$	No. of	Avg.	S <sub>u</sub> <sup>(2)</sup>	$LTL^{(3)}$	Avg.	s <sub>e</sub> (2)
Type	.0N	TIMe	Tests	ksi	ksi	ksi	Tests	ksi	ksi	ksi	%	%
		l dav	6	32.7	1.52	25.0	9	42.1	0.44	39.9	11.0	
		5 davs	9	32.5	1.53	24.7	6	43.7	0.49	41.2	8.6	0.82
MIG-X7106		9 davs	9	35.5		34.0	9		0.94	40.2		
X5180	CM3-3	2 weeks	9	35.2		33.5	9	44.7	0.99		7.7	0.59
Double V		5 weeks	6	37.1	0.63	33.9	9	46.3	0.41	44.2		
		12 weeks	6	39.8	0.43	37.6	9	47.7	0.83	43.5	7.3	0.81
		l dav	9	31.4	0.56	28.5	9	41.3	0.84	37.1	9.6	0.24
		t davs	, 9	32.0	1.18		6	41.5		38.8	8.7	0.54
MIG-X7106		7 davs	) LC	33.4		31.7	9	41.6	0.84	37.4	8.6	0.37
5356	CM4-3	2 weeks	, <u>,</u>	33.0	0.52	30.4	9	42.4	0.82	38.2	7.5	0.55
Double V		r weeks	) ~c	34.2	0.47	31.8	9				8.2	0.58
		12 weeks	ە (	37.0	0.32	35.4	9	44.2	0.28	42.8	7.2	0.61
		1 day	9	32.4	0.12	31.8	9	44.3		36.4	11.0	0.71
	-	1 days	, y	35.2	0.54	32.4	6	44.4	2.05	34.1	10.0	1.03
MIG-X7106		7 days	) ur		0.13	34.0	9	44.5	1.46	37.1	8.9	0.43
5556	CM5-4	2 modes					Ŷ	45.2	1.29	38.7	8.1	0.84
Double V				36.4	0.33		9	45.4			8.8	0.91
		o weeks 12 weeks	9		0.34		9	45.6	1.70	37.0	8.2	1.26

0.2% Offset
 Standard Deviation
 99% Lower Tolerance Limit (95% Confidence)

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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.

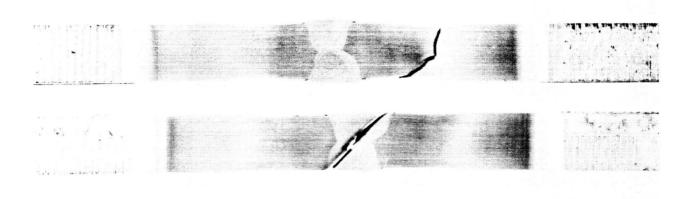
In the present study, the majority of the weldments tested failed in the weld deposit or at the fusion line for all aging periods (12 weeks maximum). A shift in failure location from the weld deposit (or fusion line) to the heataffected base metal with increasing aging time was observed only in the case 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	Failure in HAZ
Fusion Line for All Aging Periods	after Aging
0.187-inch TIG square-butt 0.187-inch MIG square-butt 0.50-inch TIG double-V 0.50-inch MIG double-V 1.00-inch MIG double-V	0.50-inch TIG square-butt 1.00-inch TIG 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 crosssectional area of the weld crown, exceeds the strength of the heat-affected



# Tensile Specimens:

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

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

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

# (0.125-Inch Modified Houldcroft Test Specimens)

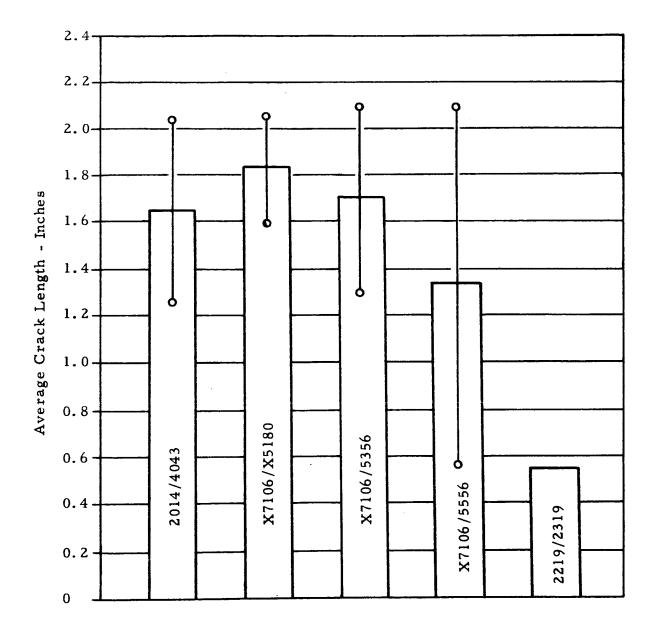
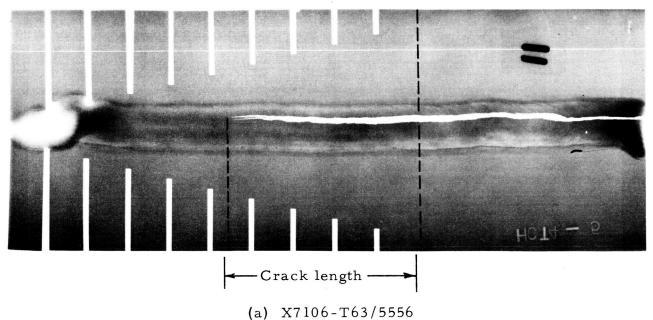
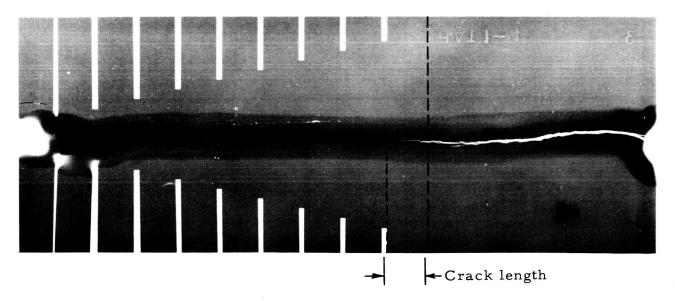


FIGURE C-8. AVERAGE CRACK LENGTHS MEASURED IN CRACK SUSCEPTIBILITY TESTS (0.125-Inch Modified Houldcroft Test Specimens)



(a) 11.100 100,0000



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

(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

(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 Ratio
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

(a) Failed before yielding.

(b) Weld metal yield strength.

(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(13) reported data obtained on both ferrous and nonferrous 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 B	Siaxial
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 1.20
Type 301	L	196	201	1.02	202	1.16
Stainless	Т	203	201	0.99	236	1.16
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	l:l 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	-	-	-	-
B120 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	-	-	-	-	-

\*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 Welded	8,2% 6.0%	3,04%	4.30% -
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., (7) 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., <sup>(15)</sup> 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	Т	Parent	207	224	252	1.13
**	Т	Tungsten				
		Arc	200	219	241	1.10
11	Т	Metal Arc	197	208	224	1.08
11	$\mathbf{L}$	Annealed				
		Parent	86.5	108	122	1.13
D6AC	L	Parent	211	227	258	1.14
	Т	Parent	214	233	267	1.15
	Т	Tungsten				
		Arc	208	225	254	1.13
H11	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<sup>(16)</sup> 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 1:1 biaxial strength is greater than the 2:1 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  $Baird^{(12)}$  and  $Marin^{(5)}$  indicates that the biaxial yield strength follows the maximum distortion energy theory. The data presented by McClaren and  $Best^{(13)}$ , McClaren and  $Terry^{(14)}$ , and Corrigan, et al., (15) indicate that the biaxial ultimate strength can also be predicted by the maximum distortion energy theory, while the ultimate strength data reported by  $Marin^{(5)}$  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:

$$\sigma_{\rm mem} = \frac{PR}{2t}$$
$$\sigma_{\rm mem} = KP^{2/3}$$

C. Cylinder Tests

or

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  $(17-5/8" \text{ OD} \times 1/8" \text{ wall} \times 23" \text{ long})$  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 200,000pound 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)

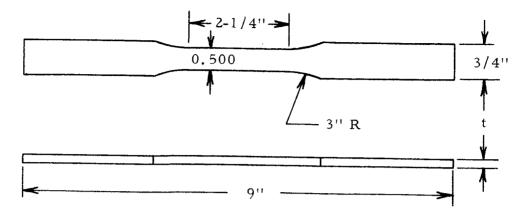
These tests were performed in an Instron testing machine in a manner similar to a conventional uniaxial tensile test. The biaxial strength is calculated from the maximum load and the initial cross-sectional area of the reduced section.

### 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  $\times$  36-inch sections to form a 10-inch  $\times$  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.

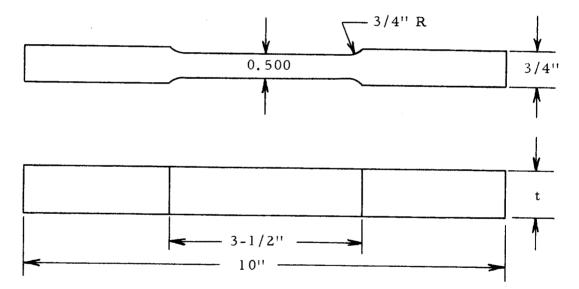
#### H. Crack Susceptibility Tests

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.



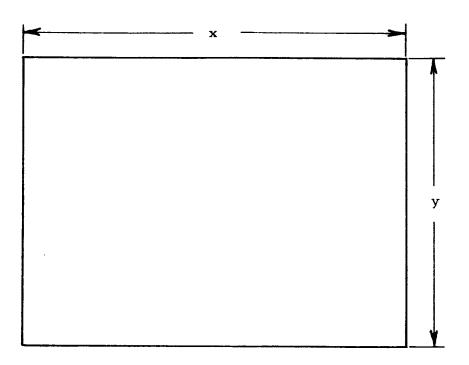
(a) 0.125-Inch and 0.187-Inch Sheet Specimen

ł



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

FIGURE E-1. TENSILE TEST SPECIMENS



Panel Sizes				
Dimension 1:1 2:1				
x	36''	30''		
y 36'' 24''				

# FIGURE E-2. PARENT METAL BULGE TEST SPECIMENS

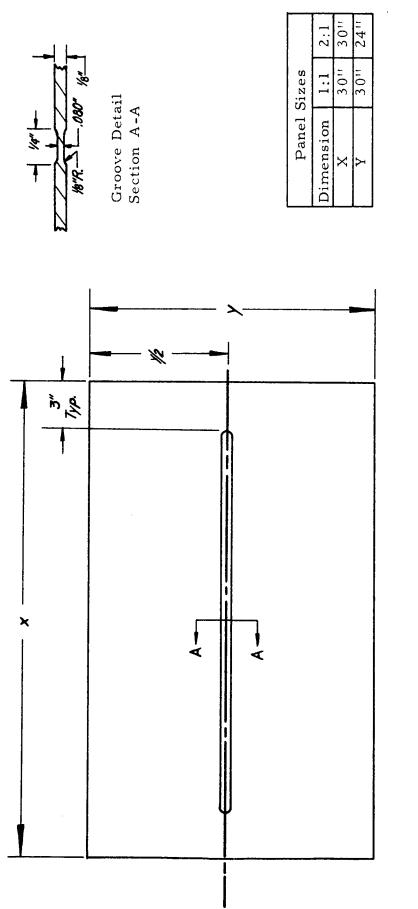
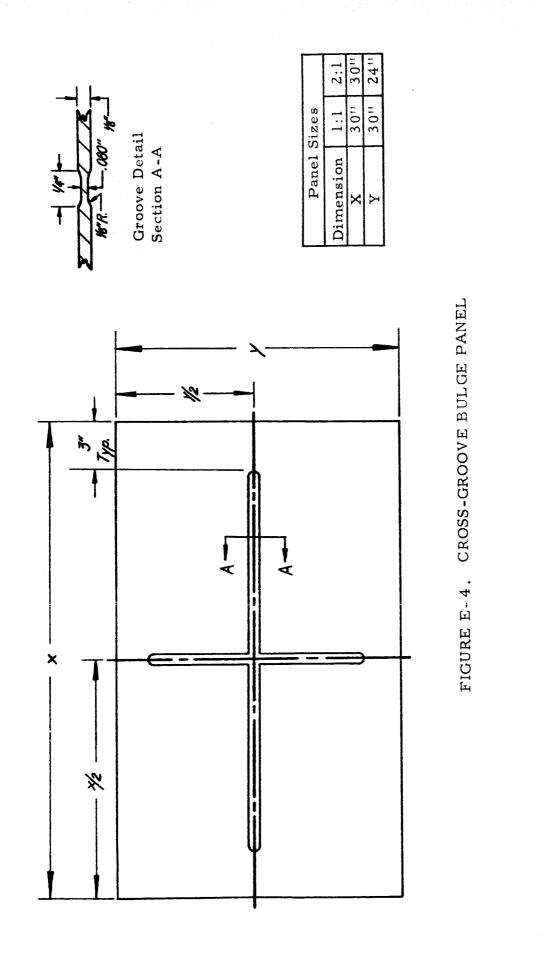


FIGURE E-3. SINGLE-GROOVE BULGE PANEL



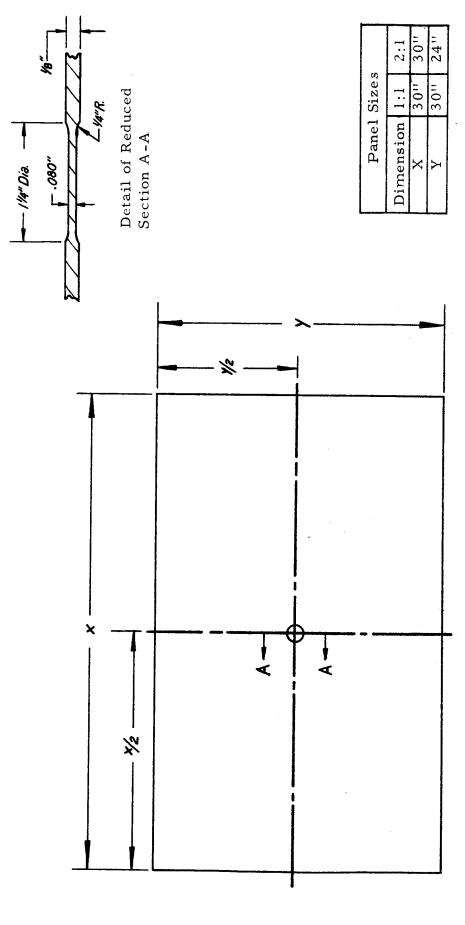
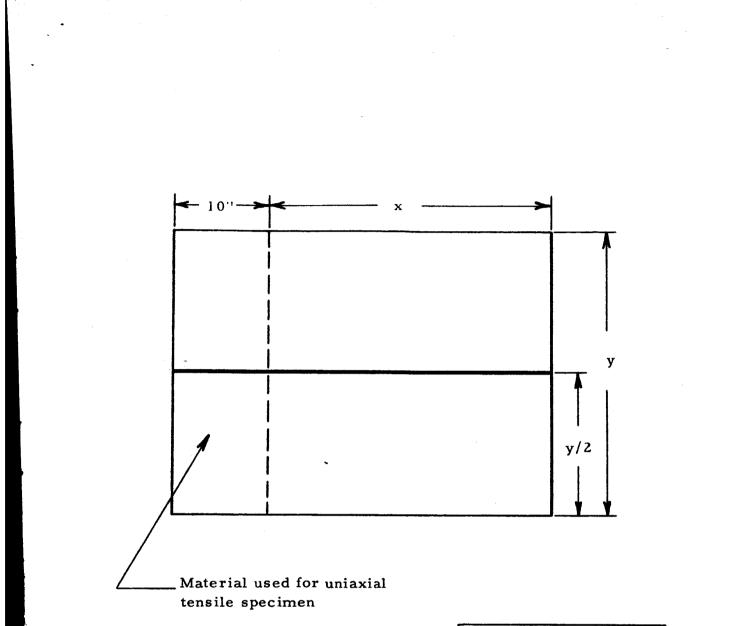
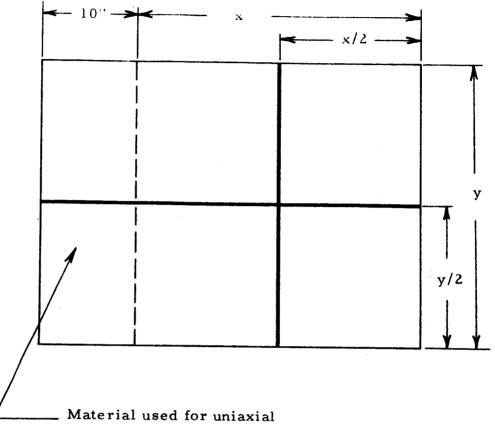


FIGURE E-5. REDUCED-SECTION BULGE PANEL



Panel Sizes				
Dimension 1:1 2:1				
x	30''	30''		
y 30'' 24''				

FIGURE E-6. SINGLE-WELD BULGE PANEL



tensile specimens

Panel Sizes				
Dimension 1:1 2:1				
x	30''	30''		
y 30'' 24				

FIGURE E-7. CROSS-WELD BULGE PANEL

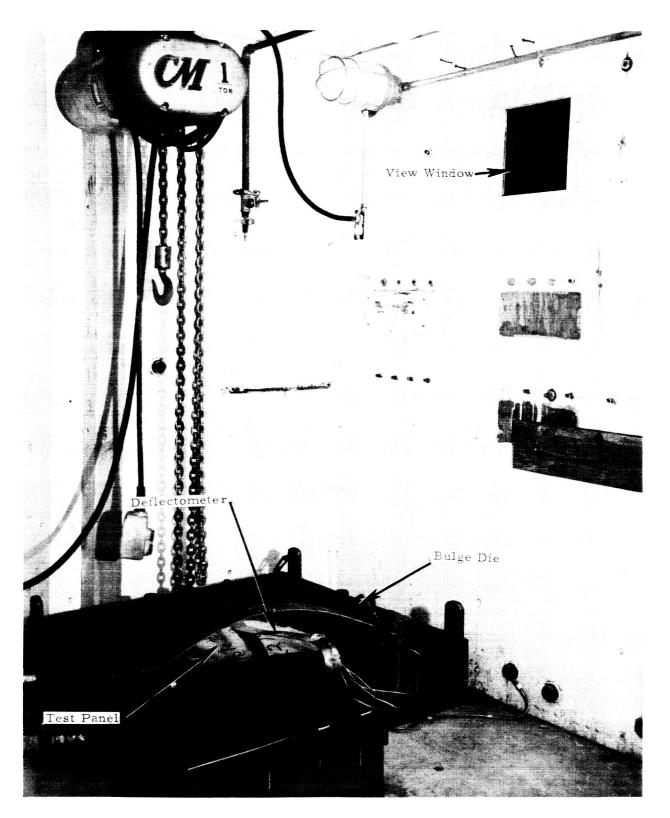


FIGURE E-8. CIRCULAR BULGE DIE AND TEST PANEL ASSEMBLY IN TEST CELL

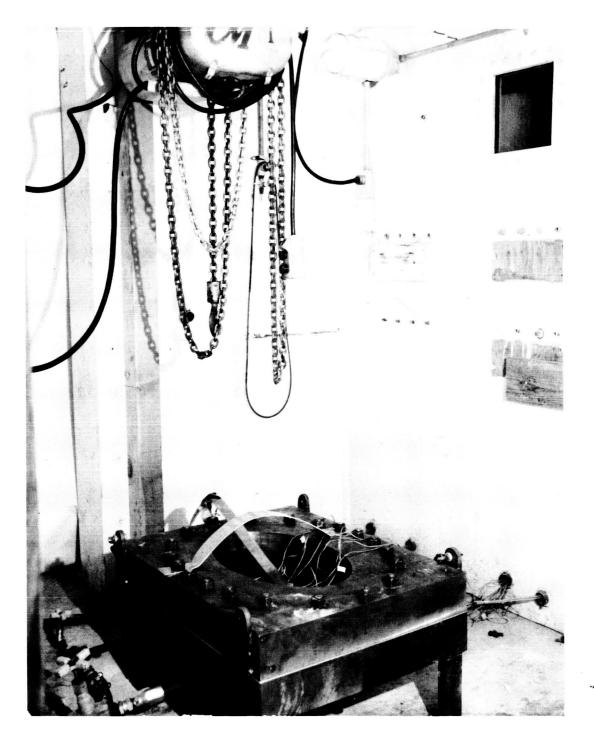


FIGURE E-9. ELLIPTICAL BULGE FIXTURE INSTALLED IN TEST CELL

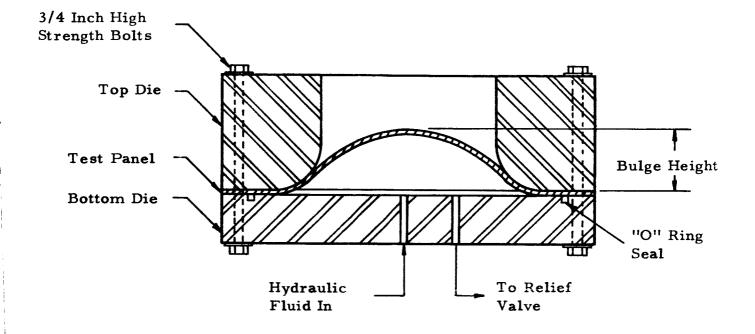


FIGURE E-10. SCHEMATIC DIAGRAM OF HYDRAULIC BULGE TEST FIXTURE

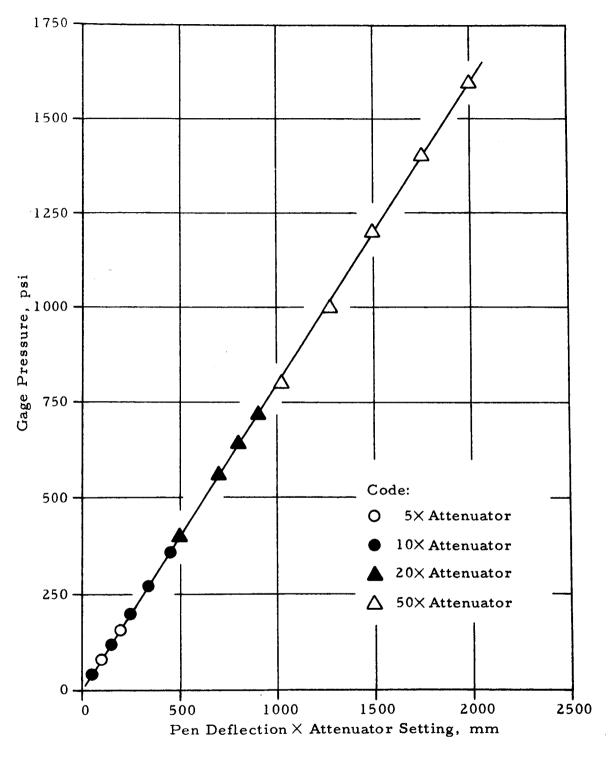
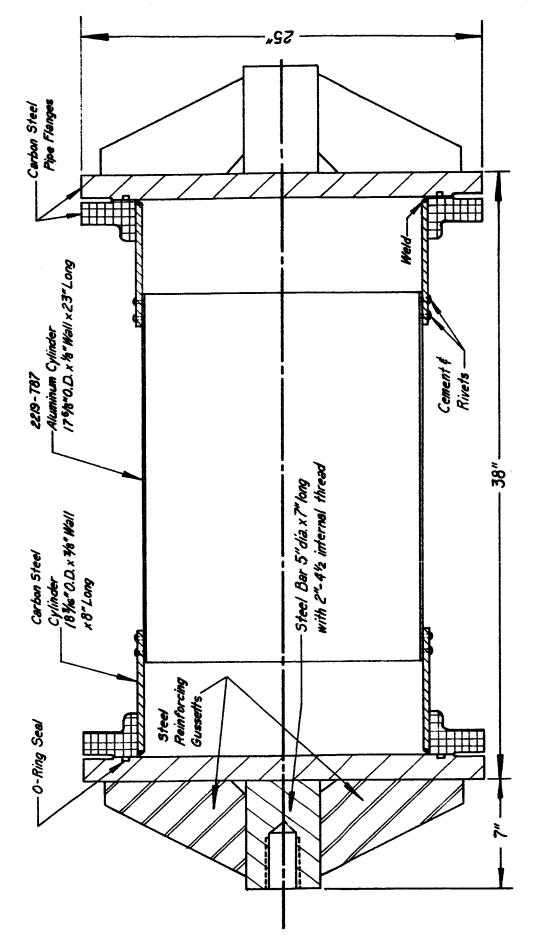
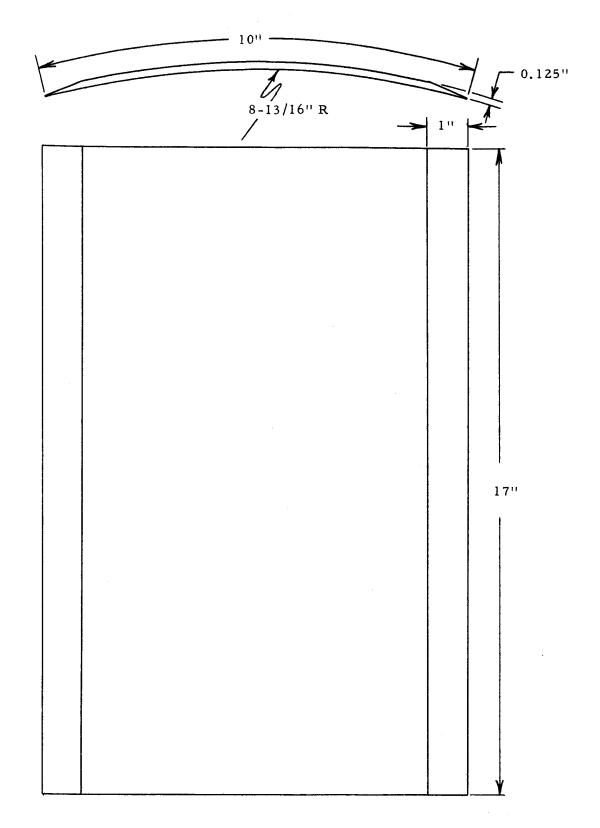


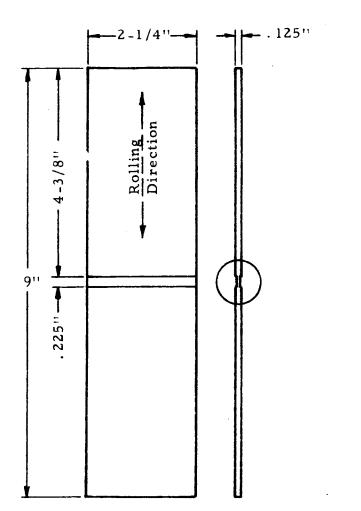
FIGURE E-11. CALIBRATION FOR PRESSURE TRANSDUCER INSTRUMENTATION

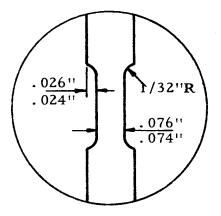






# FIGURE E-13. CYLINDER REINFORCEMENT PLATE



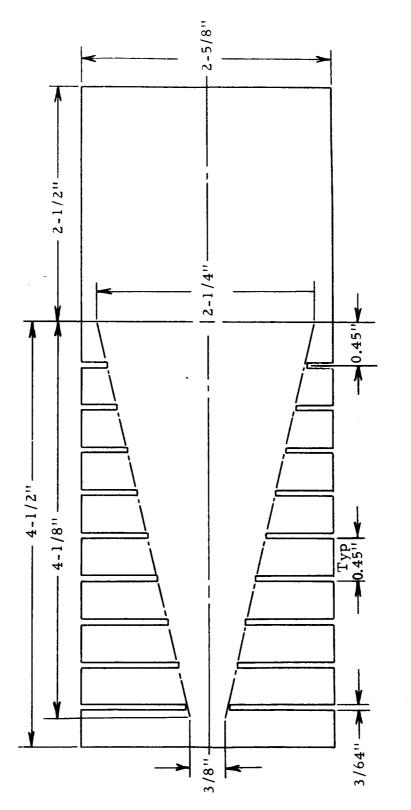


Groove Cross-Section Detail, Approx. 4X

Detail of Test Section

Half Size

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





# TABLE E-1. WELDING PROCEDURES FOR HOULDCROFTCRACK 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, volts	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.

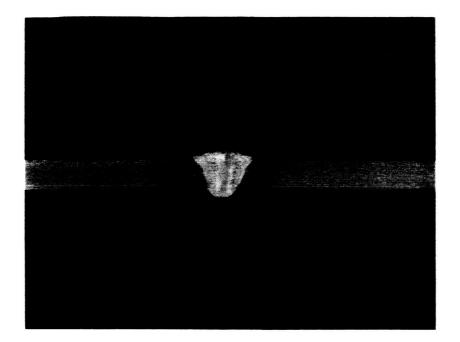
Localized regions of unacceptable porosity were noted in some of the weldments. These weldments were accepted for further testing if the regions of porosity were located so as not to influence the test results. Bulge panels containing such defects were accepted if the defects were located outside of 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°F ± 25°F Furnace cool to 300°F Air cool to room temperature <u>Stress-Relieving Treatment</u> 5 hours at 525°F ± 25°F Air cool to room temperature



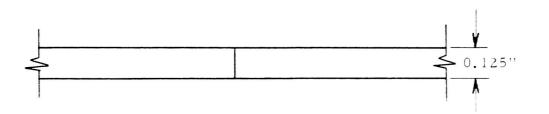
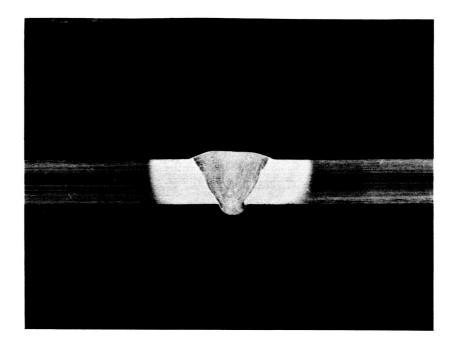


FIGURE F-1. TYPICAL CROSS-SECTION AND JOINT PREPARATION FOR 0.125-INCH TIG WELDMENTS



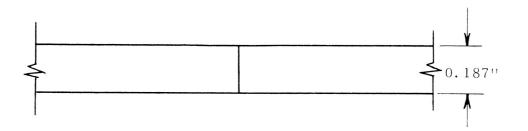
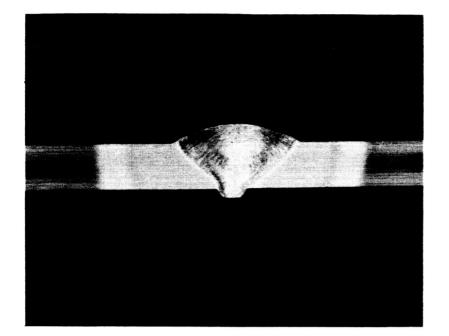


FIGURE F-2. TYPICAL CROSS-SECTION AND JOINT PREPARATION FOR 0.187-INCH TIG WELDMENTS



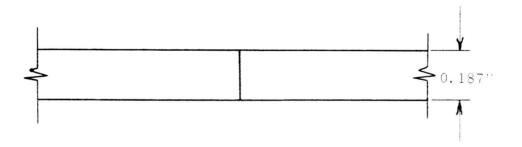
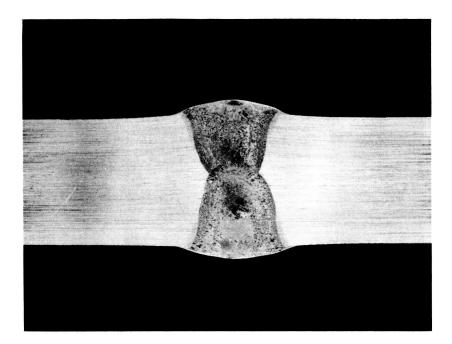


FIGURE F-3. TYPICAL CROSS-SECTION AND JOINT PREPARATION FOR 0.187-INCH MIG WELDMENTS



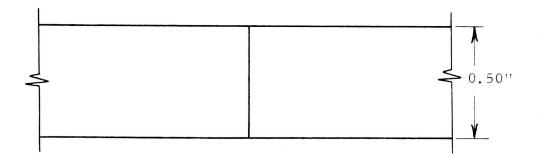
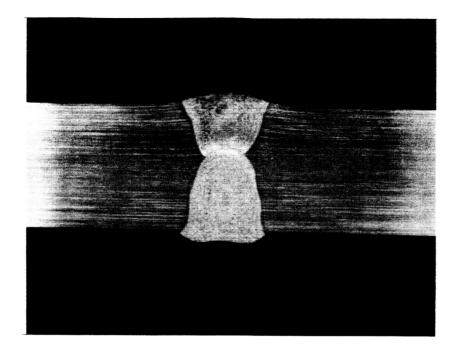


FIGURE F-4. TYPICAL CROSS-SECTION AND JOINT PREPARATION FOR 0.50-INCH TIG SQUARE BUTT WELDMENTS



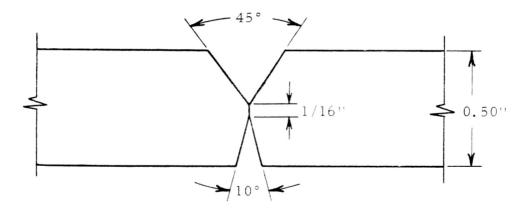
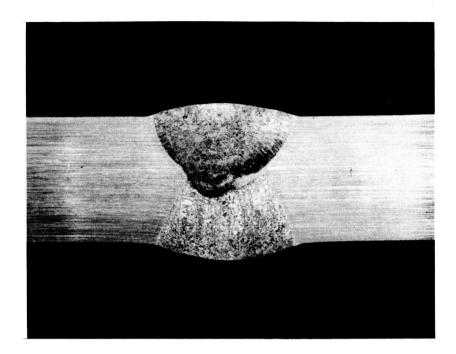


FIGURE F-5. TYPICAL CROSS-SECTION AND JOINT PREPARATION FOR 0.50-INCH TIG DOUBLE V WELDMENTS



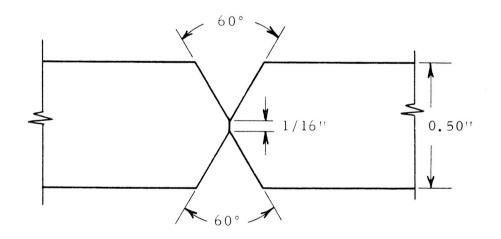
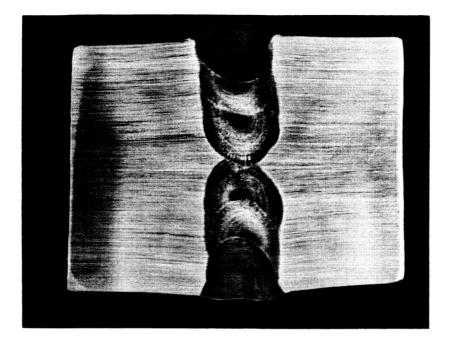


FIGURE F-6. TYPICAL CROSS-SECTION AND JOINT PREPARATION FOR 0.50-INCH MIG WELDMENTS



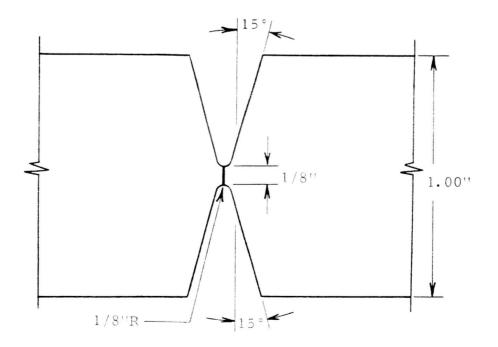
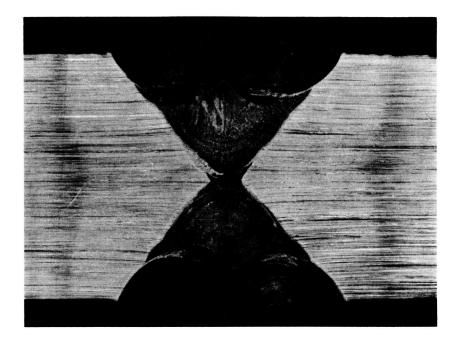


FIGURE F-7. TYPICAL CROSS-SECTION AND JOINT PREPARATION FOR 1.00-INCH TIG WELDMENTS



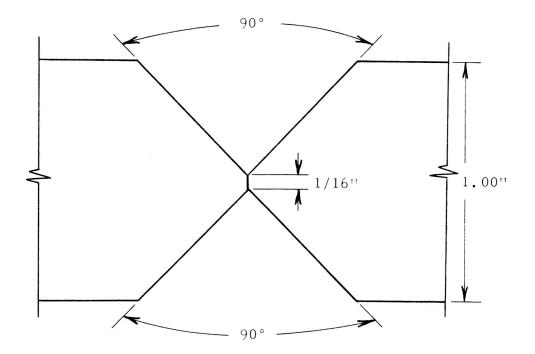


FIGURE F-8. TYPICAL CROSS-SECTION AND JOINT PREPARATION FOR 1.00-INCH MIG WELDMENTS

# TABLE F-1. WELDING PROCEDURES

		Material		Filler Metal/		Electrode Composi-			Shield Gas/	Back-up	Trevel	Filler
Welding Procedure	Alloy/Joint Design	Thickness (inches)	Welding Process	Size (inches)	No. of Passes	tion/Size (inches)	Current (amps)	Voltage (volts)	Flow (cfh)	Gas/ Flow (cfh)	Travel Speed (ipm)	Metal Speed (ipm)
65 <b>A-1</b>	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
65 <b>A-3</b>	7106-T63/ Sq Butt	0.187	TIG	5356/ 3/64	1	Tungsten 2% Thoria/ 1/8	280 DCSP	11	He/30	He/5	14	85
65 <b>A-</b> 4	7106-T63/ Sq Butt	0,187	TIG	5556/ 3/64	1	Tungsten 2% Thoria/ 1/8	280 DCSP	11	He/30	He/5	14	85
65 <b>A-</b> 5	7106-T63/ Sq Butt	0.187	MIG	X5180 3/64	1	X5180 3/64	250 DCRP	31	He/50 A+O <sub>Z</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/ 3/64	1	5556/ 3/64	250 DCRP	31	He/50 A+O <sub>2</sub> /5	-	33	-
65 <b>A-</b> 8	7106-T63/ Double V	0.50	MIG	X5180/ 3/64	2	X5180/ 3/64	300 DCRP	34	He/50 A+O2/5	-	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>Z</sub> /5	-	33	
65A-10	7106-T63/ Double V	0.50	MIG	5556/ 3/64	2	5556/ 3/64	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	2	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-1</b> 3	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-1</b> 4	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	l of Z	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-16</b>	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	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

# 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-1</b> 7	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	-	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 DC <b>S</b> P	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	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

# 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 <b>A+O<sub>2</sub>/</b> 5	-	26	-
-						2 of 8	X5180/ 1/16	290 DCRP	34	He/50 A+O <sub>Z</sub> /5	-	26	-
ļ						3 of 8	X5180/ 1/16	320 DCRP	34	He/50 A+O <sub>Z</sub> /5	-	11	-
1						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 A+O <sub>2</sub> /5	-	26	-
1						6 of 8	X5180/ 1/16	300 DCRP	34	He/50 A+O <sub>2</sub> /5	-	26	-
İ						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	-
ł	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	-
ļ						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>Z</sub> /5	-	26	-
	į					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	1					7 of 8	5556/ 1/16	300 DCRP	34	He/50 A+O <sub>Z</sub> /5	-	26	-
	65 <b>A-</b> 23	7104 17/2/	0.125			8 of 8	5556/ 1/16	300 DCRP	34	He/50 A+O <sub>2</sub> /5	-	26	-
	v3 <b>A-43</b>	7106-T63/ Sq Butt	0.125	TIG	X5180/ 3/64	1	Tungsten 2% Thoria/ 3/32	200 DC5P	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-2</b> 4	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-25</b>	2014-T6/ Sq Butt	0.125	TIG	4043/ 3/64	1	Tungsten 2% Thoria/ 3/32	220 DC <b>S</b> P	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

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		Direct	ion of Weldin	-		8				<b>{</b> 0, 2	25''
		Direct	ion of weight	g	- 1 (	L	d		·		
							¯ Î			Ţ	
							-	e 🖛			
						A = di	stance f	rom start	of weld		
8											
Panel	А	w	h	đ	e	Panel	А	w	h	đ	e
No.			Inches			No.			Inche		c
AT1-2	4	0.130	0.025	0.048	0.120	AT1-13	24	0.285	0.020	0.046	0.118
	8 12	0.122	0.024 0.029	0.048 0.037	0.120 0.120	(cont'd)	28	0.278	0.022	0.040	0.125
	16	0.220	0.029	0.057	0.120		32 36	0.285 0.293	0.024 0.024	0.039 0.048	0.115 0.117
	20	0.235	0.022	0.051	0.125		10	0.275	0.024	0.040	0.117
	24	0.228	0.025	0.048	0.125	AT1-20	4	0.289	0.028	0.032	0.119
	28	0.245	0.023	0.053	0.125		8	0.239	0.024	0.038	0.125
AT1-3	4	0.240	0.025	0.045	0.120		12	0.285	0.030	0.029	0,115
	8	0.286	0.020	0.049	0.120		16 20	0.293 0.291	0.026 0.026	0.035 0.036	0.119 0.116
	12	0.290	0.025	0.030	0.120		24	0.300	0.024	0.037	0.119
	16	0.265	0.025	0.039	0.130		28	0.295	0.024	0.034	0.116
	20	0.300	0.024	0.032	0.120		32	0.285	0.024	0.039	0.116
	24 28	0.285 0.291	0.026 0.029	0.034 0.027	0.120 0.120		36	0.287	0.025	0.034	0.119
	20	0.271	0.027	0.027	0.120	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 16	0.310 0.300	0.025 0.025	0.025 0.026	0.120 0.120		16	0.460	0.056	0.055	0.118
	20	0,293	0.025	0.032	0.120		20 24	0.470 0.474	0.048 0.046	0.059 0.058	0.122 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	0.024	0.044	0.120		36	0.466	0.046	0.060	0.118
	8	0.240	0.032	0.036	0.120	AM1-2	4	0.432	0.066	0.058	0.108
	12	0.280	0.027	0.042	0.120		8	0.442	0.055	0.047	0.103
	16	0.285	0.026	0.027	0.120		12	0.433	0.055	0.045	0.101
	20 24	0.245 0.292	0.029 0.029	0.035 0.043	0.123 0.122		16	0.459	0.054	0.045	0.091
	28	0.250	0.027	0.043	0.122		20	0.460	0.055	0.046	0.088
							24 28	0.465 0.432	0.056 0.053	0.047 0.048	0,104
AT1-11	4 8	0.250 0.250	0.030	0.034	0.120		32	0.468	0.055	0.048	0.103 0.120
	12	0.264	0.031 0.032	0.036 0.033	0.120 0.120		36	0.462	0.057	0.061	0.116
	16	0.286	0.027	0.023	0.120	AM1-3	4				
	20	0.255	0.030	0.037	0.120	AMI-J	8	0.473 0.458	0.049 0.054	0.061 0.062	0.118 0.116
	24	0.235	0.027	0.047	0.120		12	0,438	0.053	0.057	0.118
	28	0.242	0.029	0.047	0.120		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 36	0.446 0.451	0.043 0.046	0.062 0.060	0.117
	20	0.256	0.030	0.041	0.120						0.115
	24 28	0.245 0.241	0.026	0.050	0.118	AM1-4	4	0.439	0.043	0.063	0.117
			0.026	0.048	0.120		8 12	0.441	0.045	0.061	0.119
AT1-18	4	0.280	0.028	0.029	0.120		12	0.431 0.444	0.041 0.049	0.060 0.050	0.116 0.107
	8 12	0.285 0.270	0.023	0.036	0.121	,	20	0.440	0.048	0.059	0.122
	16	0.270	0.029 0.022	0.032 0.045	0.122 0.122		24	0.436	0.050	0.060	0.118
	20	0,280	0.025	0.036	0.115		28	0.436	0.041	0.063	0.117
			-		-						

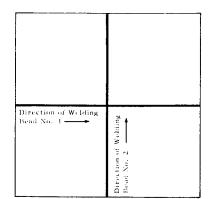
# TABLE F-2. WELD DIMENSIONS FOR SINGLE-WELD BULGE PANELS (Cont'd)

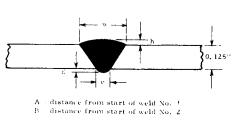
								•			
Panel	А	~	h	d	e	Panel	۸		,	,	
		••		ч	C		A	w	h	$\mathbf{d}$	e
No.			Inches			No.			Inches	5	
AM1-4	32	0,445	0.053	0.061	0.116	BT2-2	28	0.325	0.034	0.022	0.116
(cont'd)	36	0.430	0.053	0.060	0.115	(cont'd)	32	0.320	0.031	0.023	0.115
							36	0.328	0.030	0.025	0.116
AM1-5	4	0.460	0.039	0.062	0.114				•••••	0.000	•••••
	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						
	20	0.465	0.055	0.059	0.113		12	0.323	0.029	0.023	0.124
							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				
BT1-1	4	0.287	0.022	0.040	0.124		30	0.323	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		50	0.285	0.025	0.038	0.119
	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			D12 J					
				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	0.031	0.110
	32	0.308	0.030	0.021	0.104		28	0.291	0.029	0,032	0.118
	36	0.301	0.029	0.022	0.105		32	0.315	0.030		
	20	0.001	0.02)	0.022	0.105					0.028	0.126
BT1-3	4	0.275	0.020	0.043	0.128		36	0.287	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	10.000	8	0.468	0.045		
	16	0.294	0.027							0.063	0.125
				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				
BT1-4	4	0.293	0.025	0.040	0,125		50	0.470	0.046	0.061	0.118
	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				
	20							0.470	0.046	0.055	0.122
		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
							36	0.463	0.046	0.062	0.120
BT1-5	4	0.310	0.031	0.023	0.123						V. 12V
	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	
	20	0.307	0.030	0,025	0.122						0.126
	24	0.313	0.030				16	0.458	0.048	0.061	0.118
				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	0 215	0 035	0 033	<b>0</b> • • • •	•	36	0.444	0.042	0.059	0.118
512-1	4	0.315	0.025	0.023	0.120						
	8	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		
	24	0.320	0.031	0.020	0.115					0.055	0.109
	28	0.321	0.031				20	0.444	0.049	0.047	0.116
	20	0.541	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	0.023			32	0.463	0.048	0.060	0.126
	12	0.320			0.122		36	0.451	0.051	0.058	0.111
			0.028	0.022	0.117		-				~
	16	0.320	0.029	0.023	0.122	B M2 - 5	4	0.455	0.047	0.056	0.124
	20	0.315	0.030	0.022	0.114		8	0.457	0.055	0.043	0.115
	24	0.310	0.030	0.021	0.106		12	0.453	0.048	0.052	0.115
							-			0.052	v

# 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	5	
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
<b>a a a</b>							32	0.276	0.029	0.034	0,123
CT3-5	4	0.271	0.044	0.024	0.088	<b>653</b> 0		/			
	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		24	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
СТ3-6	4	0.284	0.040	0.026	0.127		32	0.311	0.035	0.024	0.105
015-0											
		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	••••	8	0.269	0.025	0.024	0.118
	16	0.286	0.035	0.029	0.120		12				
	20	0.286	0.033	0.040	0.118			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

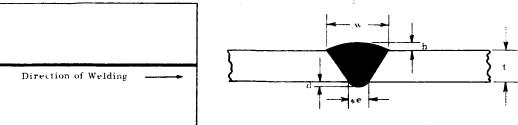




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			ad No.	I			Be	ad No.	2				Be	ad No.	1			Be	ad No.	2	
Panel	А	w	h	d	e	в	w	h	d	e	Fanel	А	w		d	e	в	w	h h	d	e
No.			nches					Inches			No.		I	nches					nches		•
AT1-1		0.250					0.275	0.023	0.052	0.140	AT1-9	24	0.280	0.030	0.037	0.126	24	0.250		0.047	0.124
	8	0.260					0.225	0.021	0,057	0.140	(Cont'd)	28	0.240	0.028	0,051	0,125	28			0.049	
	12	0.240								0.132	<b>TO -</b>										
	16	0.241								0,131	TC - 7				0.026	0.106		0.269		0.041	0.132
	20			0.044				0.027					0,292					0,258	0.026		
	24	0.300						0.033					0.251		0.010	0.10/	4			0.043	0.125
	28	0,207	0.037	0.038	0.125	28	0.255	0.037	0.038	0,125			0,255		0.029	0.106	4-1/2				
ATI-4	4	0,246	0.022	0.042	0.125	4	0.282	0.016	0 051	0 135		7-1/8					7 7-1/4	0.280			
	8	0.246						0.021							0 0 1 2		8			0.015	0.130
	12	0,250						0.027				-	0.268		0.045	0.122		0.270		0,035	0.120
	16	0,253	0,024	0.043	0.125	16		0.018							0.032	0.112	10	0.255			
	20	0.282	0.030	0.032	0.125	20		0.025				14-3/4			0.052	0.112	12	0.255		0.033	0.115
	2.1	0.285	0.031	0.041	0.115					-					0 042	0 117	12-1/2			0.055	0.115
	28	0.263	0.025	0.031	0.120								0.265		0.012	0	14-1/4				
AT1-5	4	0.240	0.014	0.04/	0.133		o		· · · · ·				0, 200	0, 0.0			16	0.210	0.029	0.033	0 1 25
/11/-/	8	0.240						0.020									16-1/2	0 270	0 031	0.055	0.125
	12	0.250						0.019													
	16	0.260								0.135	10-8						1/2				
	20	0.242						0.025							0.020			0.275			
	24	0.240				20	0.272	0.029	0.044	0,125					0.018			0.304			
	28	0.255													0.039			0.265			
		••••	0.029	0.040	0.122							10	0.304	0.040	0.042	0.116	16	0.306	0.040	0.031	0.135
AT1-6	4	0.245	0.028	0,025	0,119	4	0.225	0.021	0.048	0,135	TC - 9	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	0.125	8		0,022							0.027					0.041	
	12	0.235	0.023	0.045	0.123	12	0.223	0.033	0.050	0,125					0,027			0.265			
	16	0.243	0.013	0.040	0.124	16	0.240	0.027	0.050	0,123		12	0,260	0.027	0,030	0.120	12	0.245			
	20	0.231				20	0.241	0.029	0.049	0.125		16	0,255	0.025	0,034	0.124	16	0.292			
	24	0.232										. (.)									
	28	0.240	0.024	0,048	0.125						TC-10						1/2	0.250			
AT1-8	4	0.250	0 023	0 033	0 123	4	0 238	0.021	0 014	0 125					0.029 0.027			0.265			
	8	0.264						0.021							0.027			0.275			
	12	0.250						0,026							0.028			0.235 0.255			
	16	0.239						0.023					0.200	0.055	0.022	0.120	10	0.200	0.035	0.033	0.125
	20	0.225						0.026			TC - 11	1/2	0.275	0.035	0.021	0.120	1/2	0.285	0.020	0.024	0.125
	24	0.224						0.028				4	0,250	0.031	0.029	0.120	4	0.250			
	28	0.225						0.029				8	0,270	0.031	0.030	0.120	8	0.250			
AT1-9		<b>A</b> 303											0,265	0.036	0.026	0.116	12	0.250			
A11-9	4 8	0.282						0.024				16	0.265	0.032	0,026	0.115	16	0.246			
	12	0.295						0.023			<b>TC</b> 13	1.12	0.3/0	0 0 0 0 0	o oo-	0.13-					
	16	0.285 0.296									TC-12	1/2					1/2	0.288			
	20	0.296						0.022							0.028			0.275			
		0.010	0.029	0.050	0.124	20	0.250	0.027	0.046	0.125					0.026			0.267			
															0.031			0.240			
												10	0.207	0.032	0.042	0,120	10	0.261	0,032	0.034	0.125

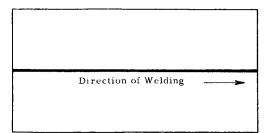
# TABLE F-4.WELD DIMENSIONS FOR 0.187-INCH AND0.50-INCH SQUARE BUTT WELDMENTS

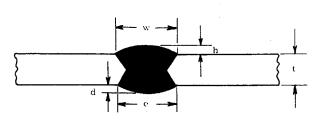


A - distance from start of weld

Panel No.	А	w	h Inche <b>s</b>	d	e	Panel No.	Α	w	h Inches	d	e
CT3-1	4	0.340	0.039	0,056	0.131	CM5-2	4	0.492	0,076	0.054	0.125
1 = 0,187"	8	0.340	0.040	0.056	0.131	t = 0.187''	8	0.461	0.081	0.051	0,118
	12	0.340	0.039	0,061	0.130		12	0.486	0.078	0.059	0,118
	16	0.340	0.036	0.053	0.130		16	0.520	0.081	0.050	0.125
	20	0.340	0.040	0.048	0.125		20	0.476	0.072	0.053	0,135
	24	0.340	0.051	0.026	0.087		24	0.495	0.083	0.046	0.125
	28	0.340	0.046	0.034	0.100		28	0.480	0.085	0.046	0,125
	32	0.340	0.038	0.053	0.120		32	0.503	0.077	0.049	0.113
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		
CT5-5	4	0.315	0.049	0.034	0.115		22			0.057	0.490
t = 0.187"	8	0.330	0.050	0.039	0.116		24	0.510	0.069		
	12	0.331	0.053	0.033	0.106		26		0.0/0	0.057	0.490
	16	0.331	0.048	0.040	0.113		28	0.510	0.069		<u> </u>
	20	0.325	0.055	0.027	0.100		30	0 5 1 0	0 0//	0.057	0.490
	24	0.331	0.051	0.033	0.113		32 34	0.510	0.066	0.0(0	<b>0</b> 100
	28	0.345	0.050	0.034	0.118		54			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
$t = 0.187^{11}$	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	0.086	0.054	0.120	t = 0.50	8	0.450	0.066	0.054	0.535
t = 0.187"	8	0.500	0.082	0.050	0.110		12	0.475	0.061	0.045	0.535
	12	0,500	0,088	0,049	0,110		16	0.470	0.057	0.052	0.505
	16	0,527	0.081	0.053	0,120		20	0.470	0.056	0.056	0.505
	20	0,510	0.077	0.053	0.131		24	0.470	0.062	0.056	0.505
	24	0.510	0,081	0.045	0,120		28	0.470	0.062	0.050	0.505
	28	0.520	0.087	0.046	0,120		32	0.475	0.046	0.050	0.505
	32	0.520	0,088	0.050	0.110						

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





e

0.691

0.675

0.665

0.665

0.690

0.680

0.690

0.630

0.099

0.090

0.096

0.097

0.098

0.101

0.008

0.086

0.500

0.580

0.580

0.580

0.617

0.617

0.617

0.625

1.000

0.975

0.975

0.975

0.960

0.970

0.970

0.970

0.661

0.675

0.695

0.685

0.690

0.690

9.690

0.710

0.950

0.958

0.960

0.960

0.985

0.970

0.975

0.965

A = distance from start of weld

Panel No.	A	w	h Inches	d	e	Panel No.	А	w	h Inches	d
CT3-3	-4	0. 175	0.070	0.057	0.480	CM3-2	4	0.655	0.067	0.100
t = 1.00"	ŭ	0.500	0.075	0.067	0.490	t = 0.50''	8	0.610	0.070	0.102
	12	0.525	0.078	0.061	0.500		12	0.610	0.068	0.098
	16	0.520	0.952	0.029	0.450		16	0.610	0.066	0.098
	20	0,525	0.052	0.020	0.480		20	0.625	0.062	0.096
	24	0.525	0.049	0.032	0.500		24	0.610	0.075	0.094
	28	0.520	0.066	0.030	0.480		28	0.610	0.075	0.098
	32	0.525	0.067	0.039	0.480		32	0.624	0.0.79	0.101
CT3-4	4	0.475	0.046	0.050	0.395	СМ3-3	4	0.980	0.076	0.950
t = 0.50''	8	0.475	0.045	0.049	0.395	t = 1.00''	8	0.975	0.080	0.950
	12	0.512	0.049	0.045	0.400		12	0.975	0.079	0.955
	16	0.512	0.042	0.045	0.400		16	0,965	0.079	0.950
	20	0.520	0.042	0.944	0.410		20	0.970	0.079	0.950
	24	0.520	0.049	0.046	0.410		24	0.965	0.079	0.950
	28	<b>0.5</b> ±0	0.050	0.042	0.410		28	0.965	0.077	0.950
	32	0.525	0.044	0.049	0.410		31	0.965	0.069	0.950
CT4-3	4	0.500	0.025	0.029	0.475	CM4-2	4	0.635	0.082	0.041
$t = 1.00^{11}$	8	0.510	0.035	0.040	0.515	t = 0.50"	8	0.670	0.387	0.043
	12	0.510	0.039	0.047	0.500		12	0.650	0.067	0.040
	16	0.493	0.033	0.050	0.500		16	0.640	0.081	0.042
	20	0.500	0.029	0.046	0.500		20	0.610	0.079	0.052
	24	0.500	0,028	0.044	0.500		24	0.650	0.084	0.051
	28	0.500	0.026	0.038	0.500		28	0.625	0.071	0.054
	32	0.510	0.032	0.043	0.525		32	0,605	0.071	0.049
CT4-4	4	0.479	0.038	0.941	0.400	CM4-3	4	0.975	0.043	0.985
$t = 0.50^{11}$	გ	0.490	0.034	0.043	0.400	t = 1.00''	8	0.990	0.053	0.101
	12	0.475	0.036	0.047	0.402		12	1.029	0.058	0.094
	16	0.486	0.032	0.043	0.400		16	1.024	0.070	0.086
	20	0.475	0.045	0.046	0.400		20	1.024	0.063	0.094
	24	0.495	0.040	0.0±5	0.400		24	1.015	0.063	0.094
	28	0.484	0.037	0.048	0.390		28	1.010	0.052	0.090
	32	0.490	0.039	0.041	0.400		32	0.99)	0.044	0.080
СТ5-7	4	0.500	0.065	0.077	0.537	CM5-1	4	0.625	0.082	0.104
t = 1.00"	8	0.485	0.074	0.099	0.525	t = 0.50"	8	0.625	0.098	0.103
	12	0.473	0.920	0.044	0.525		9.5	0.590	0.081	
	16	0.50)	0.019	0.043	0.550		12	0.605	0.084	0.103
	20	0.500	0.019	0.040	0.555		16	0.600	0.087	0.102
	24	0.513	0.027	0.040	0.538		20	0.586	0.086	0.103
	28	0.525	0.039	0.037	0.526		24	0.600	0.095	0.117
	32	0.525	0.038	0.027	0.520		28	0.640	0,088	0.104
СТ5-8	4	0.422	0.058	0.026	0.370		32	0.660	0.091	0.099
t = 0.50"	8	0.455	0.040	0.030	0.396	CM5-3	4	0.950	0.052	0.074
	12	0.507	0.049	0.030	0.396	$t = 1.00^{11}$	8	0.983	0.082	0.080
	16	0.495	0.049	0.030	0.396		12	0.955	0.072	0.094
	20	0.520	0.046	0.035	0.396		16	0.975	0.084	0.099
	24	0.500	0.054	0.036	0.396		20	0.975	0.085	0.077
	28	0.475	0.045	0.037	0.396		24	0.975	0.082	0.075
	32	0.492	0.043	0.039	). 396		28	0.975	0.068	9.110

# 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

Panel	Pressure,	Height,	Gage	Surface	Microstrain at	Various Positions(b)	sitions(b)
No.	psi	in.	Angle(a)				6 in.
			0	1730		1//0	0117
	40	0.55	120	1750	(c)	1/10	1440
		•	240	1640		1610	1330
			(	0010		3500	06.06
			0	3420		0065	
	112	0.85	120	3290	(c)	3180	2670
			240	2970		2940	2220
			0	6060		0609	6250
A-1	208	1.13	120	5750	(c)	5440	4430
			240	4990		4950	3500
				7480		7500	2090
	046	1 22	061	6950	(-)	6520	5150
	0 <b>E</b> 7		240	2660	51	2200	4030
:.			c	89.40		9000	7970
	076	1 22	001	8040	1.1	7550	5920
	007		240	6920	5	6830	4590
	•	07		673	127	112	704
•		00		1 2 0 5		1466	1 570
2-V	97	16.0	>	1367	101	1+20	10.01
	96	0.83	0	2680	(c)	2970	•
	40	0.54	0	1640	1680	1710	2020
	112	0.80	0	3210	3260	3320	3840
A-3	144	06.0	0	3820	3910	3950	4550
	232	1.20	•	6230	6380	6480	6700
	286	1.40	0	8320	8510	8720	8700
		• .					
(a) Ang	Angle of strain gage element to reference axis,	age elemen	t to refere		degrees.	J	
	Distance of strain gage from center of panel.	n gage fron	a center of	el.	÷		
(c) Stra	Strain gage was not placed at this position.	ot placed a	t this posi-	tion.			

TABLE G-2.

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

Panel	Pressure.	Height.	Parent 1	Parent Metal Microstrain	M	eld Metal	Weld Metal Microstrain
No.	t togett c, psi	in.	Angle(a)	2 in. from Center	Angle(a)	Center	2 in. from Center
							5
			45	1740	0	1, 760	
	40	0.70	165 285	1600 1920	06	2, 940	2, 410
			45	2590	0	2, 890	•
AT1-2	68	1.03	165	2360	60	10, 900	11,000
			285	2590			
			45	3920	0	1	•
	164	1.33	165	3650	06	•	•
			285	3720			
			45	1820	0	2.020	1, 840
	50	0.81	165	1790	96	3, 370	. 1
		-	285	1950			
			45	2460	0	2, 610	2, 520
AT1-3	85	1.0 <sup>(b)</sup>	-	2470	06	10, 800	•
			285	2510			
			45	3630	0	1	. •
	158	1. 3(b)	-	3730	06	•	•
			285	3480			
			45	1810	0	2,010	1, 820
	41	0.70	165	1680	60	1,920	1, 610
			285	1890			
			45	2750	0	3, 710	3, 050
AT1-7	93	1.00	165	2770	06	6, 220	5, 890
			285	2790			
			45	3730	0	6, 180	4, 570
	165	1.31	165	3830	06	18,400	20, 900
			285	3710			
(a) Angle (b) Estir	Angle of strain gage element to reference axi Estimated value. Deflectometer inoperative.	ige elemen Deflector	t to referen 1eter inoper	Angle of strain gage element to reference axis through weld, degrees Estimated value. Deflectometer inoperative.	, degrees.		

TABLE G-3.

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

Panel	Pressure,	Height,	Parent 1	Parent Metal Microstrain	*	'eld Metal	Weld Metal Microstrain
No.	psi	in.	Angle(a)	2 In. from Center	Angle(a)	Center	2 In. from Cen
;	45	0.60	45 165 285	1670 1620 1700	0 0 6	2, 200 4, 780	1, 740 1, 950
AT1-1	81	0.80	45 165 285	2370 2320 2380	0.6	12, 200 9, 860	2, 660 4, 780
	150	1.10	45 165 285	3450 3310 3390	06	+ 1	3, 820 10, 500
-	42	0.82	45 165 285	1590 1610 1900	0 0 0 6	2, 290 3, 210	1, 970
AT1-8	08	1.02	45 165 285	2340 2310 2750	0 0	5, 590 7, 070	2, 770
	142	1.30	45 165 285	3350 3170 3740	0 0	t 1	4, 140
	48	0.71	45 165 285	1800 1970 1550	06	3, 960 3, 840	1, 850 1, 450
AT1-9	80	06.0	45 165 285	2420 2600 2020	0 06	8, 340 7, 520	2, 500 3, 180
	140	1.20	45 165 285	3500 3550 2780	0 66	1 8	3, 240 8, 690

TABLE G-4.

1:1 HYDRAULIC BULGE TEST STRESS ANALYSIS DATA FOR 2219-T87 PARENT METAL PANELS WITH A REDUCED CENTER SECTION

ntei

Panel	Pressure,	Height,	Full This	Thickness Microstrain	Reduced Sectio	Reduced Section Microstrein
.0 <u>v</u>	psi	í'n.	Angle(a)	2 In. from Center	Angle(a)	Center
			c		c	
	40	, C7 U	-		2	7° 770
	2	20.0	120	1 800	120	2, 220
			240	1880	240	2, 340
			c	1220	c	010 5
A-8	108	10 0	, 1 2 U	140		014.6
;	2		071	1100		3, 800
			0 <b>±</b> 3	0000	<b>64</b> 0	4, 020
			0	5320	c	
	220	1.30	120	6050	120	
			240	6210	240	
			0	1660	c	0 40
	33	0.55	120	1540		120
	,		240	04.61	071	051 2
			01.7	0.41	c40	2, 030
			0	3410	0	6.950
6-V	120	0.95	120	3350	120	5.430
			240	3160	240	5, 020
	0		0	5520	0	24, 700
	220	1.32	120	6210	120	16, 200
			240	2600	240	12, 700
			0	1690	c	2. 950
	39	0.63	120	1780	120	3, 080
			240	1770	240	3, 000
			0	3220	c	6 700
A-25	104	0.92	120	3280	120	7, 140
			240	3340	240	7, 300
			-	40 E.N	-	10 000
	210	1 30	1 20	1 2 2 2		11, 000
	2		240	0160	120	
			-		2	
(a) Angl	e of strain ga	ge element	to reference	(a) Angle of strain gage element to reference axis, degrees.		

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

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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 Section	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
	41	0.53	165	1570	06	2660	2, 960
	ł		285	1620			
			45	2380	0	3630	2, 310
A-16	. 78	0.72	165	2430	06	4670	5, 520
			285	2550			
					,		
			45	3570	>	ı	•
	148	1.00	165	3710	06	•	•
			285	3790			
			45	2060	0	3060	1, 830
	48	0.62	165	1780	90	3100	4, 220
	2		205	1 770			
			687	1110			
			45	2990	0	6020	2, 830
A-17	20	0.82	165	2550	60	6500	10, 700
	Į		285	2600			
			45	3690	0	,	4, 020
	1 132	1.00	165	3180	06	•	37, 400
			285	3240			
			45	1710	0	2720	
	44	0.62	165	1880	06	2820	3, 880
			285	1920		_	
				0276	6	16.20	2 730
			£	01.57	2	0705	001 13
A-18	84	0.81	165	2740	06	2820	9, 370
			285	2880			
			45	30.80	c	•	4.360
					, c		12 000
	971	1.00	<b>601</b>	3420	06		000 tc #
			285	3580			
					-		

-		MI		A MACHINED GROOVE	GROC	OVE	
Panel No.	Pressure, psi	Height, in.	Full Thio Angle(a)	Full Thickness Microstrain (ngle(a) 2 In. from Center	Redu Angle(a)	ced Section Center	Reduced Section Microstrain e(a) Center 2 In. from Center
_	38	0.52	45 165 285	1540 - 1560	06	1, <del>44</del> 0 2, 700	2, 640
A-13	78	0.71	45 165 285	2410 - 2410	06 0	2, 370 5, <b>4</b> 20	4, 770
	125	0.90	45 165 285	3020 - 3180	0 90	3, 220 39, 300	28, 300
	46	0.65	45 165 285	1920 1960 2000	06 0	1, 790 4, 210	3 1
A-14	98	0.90	45 165 285	2910 3020 3120	06 0	3, 000 12, 600	
	154	1.10	45 165 285	3680 3770 <del>4</del> 270	06 0	4, 700	
	32	0.62	45 165 285	1670 1720 0 1690	06 0	1, 540 3, 360	
A-15	74	0.83	45 165 285	2570 2590 2640	0 90	2, 460 6, 600	1 1
	118	1.01	45 165 285	3290 3450 3370	06	3, 940 32, 800	1 1
(a) Ang	e of strain g	gage eleme	int to refer	(a) Angle of strain gage element to reference axis through groove,		degrees.	

TABLE G-5.

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

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TABLE G-7.

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

200 10 10 10 10 10 10 10 10 10 10 10 10 1	€ (a) . /:	ų	ć	(a)
1. ps 30 1 51 2			2,	
30 41 51 2	µ1n. / 1n.	in.	psi	hin. /in.
30 51 1 Z 1				
21	711	0.33	12	840
51	1050	0.42	22	1190
	1460	0.54	40	1710
0.62 45	1920	0,64	61	2250
0.73 70	2440	0.73	84	2740
	2970	0.83	112	3320
0.92 124	3410	0.93	144	3950
1.00 132	3880	1.03	175	4660
•	•	1.14	208	5580
. 20 220	•	1.22	232	6480
•	•	1.33	258	7640
.40 276	1	1.42	286	8720
, 	,	1.52	325	,
.60 332	•	. •	,	•
	,	1.72	400	,
.80 390	,	•	,	,
•	,	•	'	•
2.00 448	1	2.00	480	•
•	•	•	1	•
dn gage re	osette at the	e 2-in. f	rom ce	nter
	0 390 0 448 0 448 1 agage r	0 390	0 390 - 1.72 	390 - 1.72 3448 - 2.00 448 - 2.00 8age rosette at the 2-in. fro

TABLE G-8.

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

Nominal	Sper	Spec. No.	AT1-2	Spec.	c. No.	AT1-3	Spee	Spec. No.	AT1-7	
Height,	,ч	'd	(a)	4 H	å	€(a)	, î	đ	<[a]	
in.	in.	psi	µіп. /in.	in.	рыі	uln. /in.	in.	ряі	µin. / in.	_
0.5	0.50	16	1040	0.50	19	1000	0.50	18	1130	
0.6	0,60	26	1340	0.61	31	1600	0.60	28	1450	_
0.7	0.70	40	1750	0.73	43	1690	0.70	41	1790	
0.8	0.80	53	1930	0.81	50	1850	0.81	57	2120	
0.9	0.90	68	2160	0.90	99	2100	0.91	76	2470	_
1.0	1.03	. 68	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.	ge of thr n.	ee elen	nents of a	strain g	age rot	sette at the	2-in. fr	rom ce	nter	_
•										

TABLE G-9.

I 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	Spe	c. No.	Spec. No. ATI-8	Spe	ec. No.	Spec. No. AT1-9
Height,	°4	d	€(a)	'ų	đ	€(a)	ч <b>,</b>	þ,	€(a)
in.	in.	psi	µin. /in.	in.	psi	µin./in.	in.	psi	µin. /in.
	;	0					:	,	
0.5	0.51	32	1310	0.50	∞	685	0.51	54	1140
0.6	0.61	45	1660	0.60	15	960	0.61	34	1440
0.7	0.71	63	2030	0.72	27	1370	0.71	48	1770
0.8	0.80	81	2360	0.82	42	1700	0.81	64	2070
0.9	0.90	102	2700	16.0	58	2090	0.90	80	2350
1.0	1.00	126	3080	1.02	80	2470	1.00	98	2630
1.1	1.11	150	3380	1.11	67	2690	1.09	116	2940
1.2	1	ı	•	1.21	121	3110	1.20	140	3280
1.3		•	,	1.30	142	3420	,	,	•
Failure	1.15	161	,	1.35	156	•	1.26	158	'
(a) Avera	ge of thr	ee eler	a) Average of three elements of a strain gage	strain g	age ro	rosette at the 2-in. from center	e 2-in. f	rom ce	nter
position.	'n.								

TABLE G-10.

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

Nominal	$s_p$	ec. No	Spec. No. A-13	Sp	ec. Nc	Spec. No. A-14	Sp	ec. No	Spec. No. A-15
Height,	"પ	Р,	€(a)	'ų	۰d	€ (a)	'n,	ь,	€ (a)
in.	in.	psi	μin./in.	in.	psi	μin. / in.	in.	psi	µin. /in.
6.0	0.30	10	740	0.32	œ	062	0.31	4	610
0.4					' ,	,	0.41	10	910
0.5	0.52	38	1550	0.55	30	1540	0.52	20	1290
0.6	0.62	57	2035	0.65	46	1970	0.62	32	1690
0.7	0.71	78	2410	0.72	64	2350	0.72	50	2120
0.8	0.80	102	2825	0.80	83	2740	0.83	74	2600
6.0	0.90	125	3100	0.90	98	3020	0.92	96	3010
1.0	•	•	1	1.00	124	3420	1.01	118	3370
1.1	,	•	1	1.10	154	3910	1	,	,
Failure	0.95	140	ı	1.16	176	ı	1.11	150	•
(a) Averag	te of thr	ee elei	ments of a	strain g	age ro	a) Average of three elements of a strain gage rosette at the 2-in. from center	e 2-in. fr	rom ce	nter

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

Spec. No. A	4, p.	in. psi µin./in. in. p		0.32 12 730 0.30 10	0.41 19 1040 0.42 18	0.53 31 1460 0.52 29	0.62 48 1870 0.62 44	50 0.73 69 2310 0.72 64 2270	0.82 92 2710 0.81 84	0.91 114 3060 0.90 102	1.00 132 3370 1.00 126	1.13 162 3730	1.15 172	 
No. A-	-	-												 
Spec.		-		. 32										
-16	_	uin. /in.			-	•••		2450 0.						 
Spec. No. A-16	'n.	+		14				18						 
Spec	ч,	ġ	1	0.32	,	0.53	0.63	0.72	0.82	0.92	1.00	1.12	1.15	
Nominal	Height,	ul		0.5	0.4	0.5	0.6	0.7	0.8	6.0	1.0	1.1	Failure	 

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

TABLE G-12.

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

Nominal	Sp	ec. No	Spec. No. A-2(2219-T87)	-T87)	Spe	ec. No.	Spec. No. B-1 (2014-T6)	(-T6)
Height,	ų,	'd	€t(a)	€ <sup>b</sup> (b)	ų,	ď	ε <sub>t</sub> (a)	ε <sup>μ</sup> (b)
in.	in.	psi	μin. /in.	µin./in.	in.	pai	uin. /in.	uin./in.
0.3	0.30	æ	112	314	•	1	1	•
0.4	0.41	16	1052	380	•	1	,	,
0.5	0.51	26	1456	459	0.50	6	920	495
0.6	0.62	45	1920	510	0.62	14	1285	495
0.7	0.73	20	2440	600	0.70	24	1740	594
0.8	0.83	96	2970	645	0.83	40	1990	592
0.9	0.92	124	3410	660	06.0	60	2545	680
1.0	1.00	132	3880	705	1.00	80	3095	745
1.1	1	,	1	,	1.10	108	3490	810
1.2		+	•	1	1.20	136	3955	855
1.3	1	ı	1	1	1.30	168	4480	918
1.4	•	•	1	1	1.39	202	5215	995
1.5	•	,	,	•	1.50	240	6050	1115
1.6	1	1	,	•	1.60	265	0069	1140
(a) Total c	outer fibe	er surf	(a) Total outer fiber surface strain.					

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

TABLE G-13.

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

Panel         Pressure, in.         Height, in.         Cage         0         It.         Normal         2 In.         Along         2 In.         Anong         2 In.         2 In.					Sur	Surface Microstrain	at Various	Positions(b)
75 $0.50$ $3,000$ $3,000$ $3,000$ $5,210$ $2,200$ $(c)$ $240$ $2,210$ $2,120$ $2,120$ $2,120$ $2,100$ $(c)$ $240$ $0.92$ $120$ $5,310$ $6,160$ $(c)$ $240$ $0.92$ $120$ $7,890$ $(c)$ $320$ $1.13$ $120$ $7,840$ $7,170$ $(c)$ $320$ $1.13$ $120$ $7,840$ $7,170$ $(c)$ $320$ $1.13$ $240$ $7,170$ $(c)$ $(c)$ $410$ $1.20$ $2,130$ $8,140$ $(c)$ $(c)$ $1.120$ $120$ $0,100$ $8,100$ $(c)$ $(c)$ $(c)$ $410$ $1.20$ $2,400$ $9,480$ $9,480$ $(c)$ $(c)$ $(c)$ $126$ $0.510$ $0.100$ $0.100$ $0.100$ $(c)$ $(c)$ $(c)$ $(c)$ $106$ $0.510$	Panel No.	Pressure, psi	Height, in.	Gage Angle(a)	0	l In. Normal to Ref. Axis	2 In. Along Ref. Axis	2 In. Normal to Ref. Axis
240 $0.92$ $120$ $5,310$ $5,10$ $(c)$ $240$ $4,950$ $4,960$ $(c)$ $320$ $1.13$ $120$ $7,840$ $7,980$ $(c)$ $320$ $1.13$ $120$ $7,840$ $7,780$ $(c)$ $360$ $1.20$ $2,800$ $8,710$ $(c)$ $410$ $1.20$ $10,000$ $9,500$ $(c)$ $110$ $0.51$ $00$ $10,000$ $9,360$ $(c)$ $106$ $0.51$ $00$ $1,710$ $(c)$ $(c)$ $106$ $0.51$ $00$ $1,710$ $(c)$ $(c)$ $106$ $0.51$ $00$ $2,750$ $(c)$ $(c)$ $106$ $0.51$ $00$ $2,750$ $(c)$ $(c)$ $106$ $0.50$ $0.70$ $00$ $1,710$ $(c)$ $106$ $0.51$ $00$ $2,750$ $(c)$ $(c)$ $106$ $0.50$ $0.51$ $00$ $2,760$ $(c)$ $106$ $0.50$ $0.70$ $00$ $2,760$ $(c)$ $106$ $0.51$ $00$ $2,760$ $(c)$ $(c)$ $106$ $0.70$ $00$ $2,760$ $(c)$ $(c)$ $130$ $0.70$ $00$ $2,760$ $(c)$ $(c)$ $130$ $0.70$ $00$ $2,760$ $(c)$ $(c)$ $106$ $0.70$ $00$ $2,760$ $(c)$ $(c)$ $130$ $1.02$ $00$ $2,760$ $(c)$ $(c)$ $130$ $1.02$ $00$ $2,730$ $(c)$ <td></td> <td>75</td> <td>0,50</td> <td>0 120 240</td> <td>3, 000 2, 210 2, 120</td> <td>3, 000 2, 220 2, 150</td> <td>(c)</td> <td>2960 2110 2090</td>		75	0,50	0 120 240	3, 000 2, 210 2, 120	3, 000 2, 220 2, 150	(c)	2960 2110 2090
3201:131:20 $7, 180$ $7, 170$ $(c)$ $340$ $7, 180$ $7, 170$ $(c)$ $360$ 1:20 $8, 920$ $8, 730$ $(c)$ $410$ 1:20 $120$ $8, 130$ $8, 910$ $(c)$ $410$ 1:30 $120$ $8, 130$ $8, 910$ $(c)$ $72$ $0.51$ $0, 240$ $8, 130$ $8, 140$ $(c)$ $72$ $0.51$ $0, 200$ $9, 360$ $(c)$ $(c)$ $106$ $0.60$ $9, 240$ $(c)$ $(c)$ $(c)$ $106$ $0.60$ $00$ $2, 750$ $(c)$ $(c)$ $116$ $0.51$ $00$ $2, 750$ $(c)$ $(c)$ $116$ $0.60$ $90$ $2, 750$ $(c)$ $(c)$ $116$ $0.60$ $90$ $2, 750$ $(c)$ $(c)$ $116$ $0.70$ $90$ $2, 750$ $(c)$ $(c)$ $116$ $0.70$ $90$ $2, 750$ $(c)$ $(c)$ $1130$ $0.70$ $90$ $2, 500$ $(c)$ $(c)$ $270$ $1.02$ $00$ $4, 130$ $(c)$ $(c)$ $270$ $1.02$ $00$ $2, 530$ $(c)$ $(c)$ $340$ $1.122$ $90$ $1.122$ $90$ $-100$ $340$ $1.22$ $90$ $-100$ $-100$ $-100$ $340$ $1.22$ $90$ $-100$ $-100$ $-100$ $340$ $1.22$ $90$ $-100$ $-100$ $-100$ $340$ $1.22$ $90$ <		· •	0.92	0 120 240	6, 310 5, 310 4, 950	6; 160 5, 310 4, 960	(c)	6140 5000 4910
360 $1.20$ $0$ $8,920$ $8,730$ $8,910$ $(c)$ $410$ $1.20$ $2,870$ $8,140$ $(c)$ $(c)$ $410$ $1.30$ $120$ $9,480$ $9,500$ $(c)$ $72$ $0.51$ $90$ $1,710$ $(c)$ $(c)$ $72$ $0.51$ $90$ $1,710$ $(c)$ $(c)$ $106$ $0.60$ $90$ $2,750$ $(c)$ $(c)$ $106$ $0.60$ $90$ $2,720$ $(c)$ $(c)$ $1166$ $0.60$ $90$ $2,720$ $(c)$ $(c)$ $1166$ $0.70$ $90$ $2,720$ $(c)$ $(c)$ $1166$ $0.70$ $90$ $2,720$ $(c)$ $(c)$ $1166$ $0.70$ $90$ $2,500$ $(c)$ $(c)$ $1130$ $0.70$ $90$ $2,600$ $(c)$ $2,670$ $1130$ $0.70$ $90$ $2,630$ $(c)$ $(c)$ $270$ $1.02$ $90$ $4,130$ $(c)$ $2,630$ $270$ $1.02$ $90$ $4,130$ $(c)$ $2,630$ $300$ $1.102$ $90$ $4,120$ $(c)$ $5040$ $340$ $1.22$ $90$ $2.60$ $(c)$ $6940$	A-4	320	1.13	0 120 240	8, 150 7, 840 7, 140	1 1	(c)	7860 7340 7020
4101. $30$ 10, 100 2409, 500 9, 360(c) 10, 100 9, 360(c) (c)72 $0.51$ $0$ $2, 750$ 1, 710(c)(c)106 $0.60$ $90$ $2, 750$ 1, 710(c)(c)1166 $0.60$ $90$ $2, 200$ 2, 200(c)(c)156 $0.70$ $90$ 2, 200 $4, 330$ 1, 570(c)(c)156 $0.70$ $90$ 2, 200 $4, 330$ 1, 570(c) $2670$ 1550130 $0.70$ $90$ 2, 630 $4, 130$ 2, 630(c) $2670$ 2, 630270 $1.02$ $90$ 4, 920 $4, 130$ 4, 920(c) $2670$ 2, 630300 $1.10$ $90$ 9 $4, 920$ 4, 920(c) $8180$ 6040340 $1.22$ $90$ 9 $-7$ 20 $-7$ 20 $-7$ $-7$ 20			1.20	0 120 240	8, 920 8, 870 8, 130	8, 730 8, 910 8, 140	(c)	8520 8350 7960
72 $0.51$ $0$ $2.750$ (c)         (c)           106 $0.60$ $90$ $3.420$ (c)         (c)           156 $0.60$ $90$ $2.200$ (c)         (c)           156 $0.70$ $90$ $4.330$ (c)         (c)           65 $0.51$ $90$ $4.330$ (c)         (c)           65 $0.51$ $90$ $4.130$ (c) $2.670$ 130 $0.70$ $90$ $4.130$ (c) $2.670$ 130 $0.70$ $90$ $4.130$ (c) $2.670$ 130 $0.70$ $90$ $4.130$ (c) $2.670$ 270 $1.02$ $90$ $4.130$ (c) $2.630$ 300 $1.02$ $90$ $4.920$ (c) $8.160$ 340 $1.22$ $90$ $-7$ $0$ $-7$ $0.640$		410	1.30	0 120 240	10, 000 10, 200 9, 480	9, 500 10, 100 9, 360	(c)	9550 9850 9520
		72	0.51	06 0		(c)	(c)	(c)
156 $0.70$ $00$ $4.30$ (c)         (c)         (c)         (c) $65$ $0.51$ $90$ $2.560$ (c) $2670$ $1590$ $130$ $0.70$ $90$ $2.650$ $1590$ $1590$ $130$ $0.70$ $90$ $4.130$ $(c)$ $2670$ $270$ $1.02$ $90$ $2.630$ $2.630$ $2.630$ $270$ $1.02$ $90$ $2.630$ $2.630$ $2.630$ $270$ $1.02$ $90$ $2.630$ $2.630$ $2.630$ $270$ $1.02$ $90$ $2.630$ $2.640$ $2.640$ $300$ $1.10$ $90$ $8.160$ $(c)$ $8180$ $2.340$ $340$ $1.22$ $90$ $-1.60$ $-1.60$ $-1.60$ $-1.60$ $-1.60$	A-5	106	0.60	06	3, <b>4</b> 20 2, 200	(c)	(c)	(c)
65 $0.51$ $0$ $2,660$ $(c)$ $2670$ $130$ $0.70$ $90$ $4,130$ $(c)$ $1590$ $130$ $0.70$ $90$ $4,130$ $(c)$ $4150$ $270$ $1.02$ $90$ $7,230$ $(c)$ $2630$ $270$ $1.02$ $90$ $7,230$ $(c)$ $7120$ $300$ $1.10$ $90$ $8,160$ $(c)$ $6180$ $340$ $1.22$ $90$ $ (c)$ $5040$		156	0.70	06 0	4, 330	(c)	(c)	(c)
130 $0.70$ $0.70$ $0.70$ $4.130$ $(c)$ $4.150$ $270$ $1.02$ $90$ $2.630$ $2.630$ $2.630$ $270$ $1.02$ $90$ $7.230$ $(c)$ $7120$ $300$ $1.10$ $90$ $8.160$ $(c)$ $8180$ $340$ $1.22$ $90$ $ (c)$ $6040$		65		06	2, 660 1, 570	(c)	2670 1590	2680 1600
270 $1.02$ $0$ $7.230$ $(c)$ $7120$ $300$ $1.10$ $90$ $4.920$ $(c)$ $8180$ $340$ $1.122$ $90$ $ (c)$ $8180$ $340$ $1.22$ $90$ $ (c)$ $-$		130	0.70	06 0	4, 130 2, 630	(c)	4150 2630	<b>4</b> 160 2680
1.10     0 $8,160$ $c.$ $8180$ $90$ $2,160$ $c.$ $6040$ $1.22$ $90$ $2$ $(c.)$	A-6	270	1.02	06 0	7, 230 4, 920	(c)	7120 50 <b>4</b> 0	7280 5190
1.22 0 - (c) -		300	1.10	06	8, 160	(c)	8180 6040	8400 6220
		340	1.22	06	4 T	(c)	1	9920 7750

TABLE G-14.

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

Panel	Pressure,	Height,	Parent	Parent Metal Microstrain	We	ld Metal M	Weld Metal Microstrain(b)
No.	psi	in.	Angle <sup>(a)</sup>	2 In. from Center	Angletal	Center	2 In. from Center
1			0	2260	0	3, 760	2, 840
	50	0.50	120	1340	06	1,010	980
			240	1295			
			0	2800	0	8, 000	5, 590
AT1-10	94	0.70	120	2060	06	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			
			-	7 390	c	2. 380	2. 710
	- 24	0.51	120	1400	90	1 140	1, 135
			240	1535	· .		•
			c	3270	-	6.430	9.170
AT1-11	105	0 20	120	0161	, 0 <del>0</del>	1.660	1. 570
		2	240	2150			
			0	3860	0		•
	164	0.90	120	2570	06	2, 380	•
			240	2920			
			0	2560	0	3, 490	3, 750
	58	0.50	120	1320	60	934	1, 340
			240	1500			
			0	3400	0	8, 590	9,970
AT1-12	108	0.70	120	1890	06	1, 340	2,040
			240	2100			
			0	3870	0	I	17, 100
	158	0.90	120	2650	06	1,940	3, 070
			240	2820			
						-	
1044 (c)	a of studin o	nome le coco	t to referen	Anda of strain yawa alamant to reference avia degrees			
(b) Weld	(b) Weld at 90° to reference axis.	sference axi	is.	ורב מאומן ערפי רריי			•

(b) Distance of strain gage from center of panel, inches.
 (c) Strain gage was not placed at this position.

TABLE G-16.

# 2:1 HYDRAULIC BULGE TEST STRESS ANALYSIS

TABLE G-15.

DATA FOR TIG 2219-T87/2319 CROSS WELD PANELS

Panel	Pressure,	Height,	Parent	Parent Metal Microstrain	Wei	ld Metal M	Weld Metal Microstrain(b)	
No.	psi	ln.	Angle <sup>(a)</sup>	2 In. from Center	Angle <sup>(a)</sup>	Center	2 In. from Center	
	25	0.30	0 120	1630 1030	00	2, 550 1 500	23	
			240	864	2		Ð	
	ç		0	3000	0	8,410	•	
	ę	16'0	240	1830	06	6, 090	•	
			0	4360	0			
	150	0.72	120 240	2510 2790	06	•		
			•	1580	•	2.960	717	
	18	0.30	120 240	805 670	06	740	528	
			;					
i	3	1	0	2850	ø	7, 780	3140	
4-11.V	<u>م</u>	0.50	120 240	1235	6	2, 100	066	
		1	0	3770	0	15, 100	3660	
	104	0.70	120 240	1660	06	5, 900	1560	
			•					
	22	0.34	120	5107 318	- 6	110 17	618 676	
			240	750	2	2	2	
			0	2820	•	5, 030	2210	
AT1-6	6\$	0.51	120	1320	96	810	1000	
			240	1200				
			0	3270	•	8, 020	4750	
	87	0.71	120	1920	90	3, 240	2040	
			240	1960				
(a) Angl	e of strain g	gage eleme	int to refer	Angle of strain gage element to reference axis, degrees.				
	Reference axis along short weld.	long short	weld.	5				
(c) Strai	Strain gage was not placed at this position.	not placed	at this po	sition.				

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

Ŀ.	'n.	Angle(a)	hin. /in.   µin	uin./in.	in.	Angle(a)	µin./in.	µìn. / In.
0, 3	0, 30	0 06	1260 727	585 344	0.34	06 0	650 236	265 160
0.4	0.41	0 06	1980 1180	705 416	0.42	0 06	1120 376	454 243
0.5	0.51	06	2750 1710	780 524	0.51	0 06	1645 550	595 225
0.6	0.60	06	3 <b>4</b> 20 2200	840 662	0.63	0 06	2260 982	720 318
0.7	0.70	06	4330		0.72	06	2600 1360	390
8.0	•	1	ı	1	0,81	06	2840 1850	992 410
6.0	1	i	,	ł	0.93	06	3090 2530	1180 500
1.0	ı	1	ı	r	1.01	0 06	3450 3230	1300 580
1.1	•	·	•	¢	1.10	06	3800 3640	1440 450
~~~~	ł	1	•	3	1.20	0 06	4170 4850	1600
£.1	4	•	·	- 4	1.30	0 06	4590 5890	1800 815
1.4	4	1	•	8	1.41	0 06	4900 7200	1990 950

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

ма	22 1
Surface Microstrain Across Minor Diameter	535 764 1240 1690 2340 2346 2410 5446 6640 9880
Surface Microstrain Across Major Diameter	605 722 937 1330 1450 1820 1820 2890 2460 2870
Applied Pressure, psi	16 25 40 58 80 80 108 165 255 250 250 250 250
Actual h, in.	0. 35 0. 42 0. 52 0. 60 0. 72 0. 92 1. 11 1. 11 1. 21 1. 31 1. 31 1. 40
Nominal Height, in.	

TABLE C-18.

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

			<b>Vield Strenoth</b>	Ultimate	Elongation
daterial &	Sheet	Specimen	0.2% Offset,	Strength,	in 2 In.
Process	No.	No.	ksi	ksi	%
		1	52.5	65.0	9.8
		2	52.5	64.8	10.5
	2A	ŝ	53.9	65.8	11.2
		4	53.9	65.6	11.2
		Ś	53.7	65.3	11.2
		-	54.1	65.8	11.3
2219-T87		2	54.0	65.5	11.3
Parent	7A	٣	53.7	65.4	10.3
Metal		4	53.9	65.4	10.4
		5	54.1	65.0	10.4
		1	54.7	66.7	10.5
		2	54.5	66.7	10.3
	8A	m	54.8	66.6	11.0
		4	54.7	66.7	11.0
		2	54.6	66.8	10.7
					ļ

TABLE G-19.

### PHASE I UNIAXIAL TENSILE TEST RESULTS ON 2219-T87 WELD-MENTS FOR 1:1 BULGE TESTS

	<u>+</u>						•				_										_								
Material & Process													TIG	2219-T87	. 2319														
Elongation in 2 In., %	1.0	1.1		1.3	2.3	2.5	2.2	2.7	2.6	2.2	2.0		8.1	1.8	2.2	2.0	1,5	2.1	1.9	1.8	1.8	1.5	1.4	2.0	2.2	- -	1.9	2.0	2.1
Ultimate Strength, ksi	39.7	39.5 39.8	39.2	7.96	44.9	44.0	43.0	43.7	43.3	42.9	43.3	41.9	41.3	42.9	44.8	43.8	43.7	44.3	43.3	38.3	37.9	40.5	41.0	40.0	41.7	42.2	38.8	40.9	43.1
Yield Strength 0.2% Offset, ksi	30,4	31.1	29.8	<b>1</b> .07	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.		J m	4+ L	,		~ ~			'n		2	<b>.</b>	4	5		2	<del>ر</del>	4	5	-	2	e.	4	ŝ	-	2	3	ক'	
Panel No.		AT1-2				, 1.T.A	C-11V					AT1-7					ATI-I					AT1-8					AT1-9		
Material & Process				-1-					. 4					2219-T87	2319					_									

TABLE G-20.

PHASE I UNIAXIAL TENSILE TEST RESULTS ON 2219-T87 WELD-MENTS FOR 2:1 BULGE TESTS

Material & Panci         Specimen         Yield Strength         Ultimate           Process         No.         No.         1         31.5         41.0           Process         No.         No.         31.5         41.0         39.9           ATI-10         2         30.0         39.9         44.3           ATI-11         3         29.4         40.8           ATI-11         3         29.7         44.3           ATI-11         3         30.9         41.1           3         30.9         41.1         44.3           ATI-12         3         30.9         41.0           3         30.9         41.1         44.3           ATI-12         3         30.6         42.4           ATI-12         3         30.9         41.0           2219-TB7         ATI-12         3         30.6         42.8           ATI-12         3         30.9         42.8         42.0           2319         ATI-12         3         31.4         41.9           219.9         41.9         31.4         41.0         44.0           219.9         41.9         31.4         44.0         44.0 </th <th></th> <th></th> <th></th> <th>-</th> <th></th> <th></th>				-		
ATI-10 No. No. Kei Ati - 26 Oliset. ATI-10 2 30.0 ATI-10 3 29.4 ATI-11 2 30.9 ATI-11 2 30.9 ATI-12 3 30.9 ATI-12 3 30.4 31.1 ATI-2 3 30.9 ATI-4 3 31.6 31.6 31.6 31.6 31.6 31.6 31.6 31.6	Material &	Daned	2.2	Yield Strength	Ultimate	Elongation
ATI-10 1 31.5 30.0 4 4 29.7 5 30.6 5 30.6 5 30.6 4 29.7 7 5 3 30.9 4 4 31.1 3 3 30.9 30.4 4 31.1 3 30.9 30.4 4 31.1 3 30.6 5 3 31.3 30.4 4 31.1 3 30.6 5 3 31.3 3 30.4 4 3 31.6 1 3 30.6 5 3 31.3 3 30.4 4 3 31.6 1 3 30.6 5 3 31.3 3 30.4 4 3 31.6 1 1 2 29.5 5 3 30.3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3	Process	No.	opecimen No.	U. 2% Offset, ksi	Strength, kai	tn 2 In., %
ATI-10 1 31.5 ATI-10 2 29.4 5 30.6 5 30.6 7 7 5 30.6 7 7 5 30.9 3 30.9 3 30.9 3 30.9 3 30.9 3 30.9 3 30.9 3 30.9 3 30.9 5 3 3 30.9 5 5 3 30.9 5 5 3 30.9 5 5 3 30.9 5 6 3 30.9 5 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7						N
ATI-10 2 30.0 ATI-10 5 29.4 ATI-11 5 30.9 ATI-11 2 30.9 ATI-12 2 30.9 ATI-12 3 30.6 ATI-12 3 30.6 ATI-4 3 31.6 ATI-4 3 30.9 ATI-6 2 33.1 ATI-6 2 33.1 ATI-6 5 31.3 ATI-6 5 31.9 ATI-6 5 31.9 ATI-6 5 31.9 ATI-6 5 29.0 ATI-6 2 29.0 ATI-6 5 29.0 ATI-6 2 29.0 ATI-6 5 29.0 ATI-6 2 29.0 ATI-6 2 29.0 ATI-6 2 29.0 ATI-6 2 29.0 ATI-6 2 29.0 ATI-6 3 29.0 ATI-6 3 29.0 ATI-6 3 29.0 ATI-6 3 29.0 ATI-6 3 29.0 ATI-6 3 29.0 ATI-6 3 29.0 ATI-6 3 29.0 ATI-6 3 29.0 ATI-6 4 3 31.3 ATI-6 5 31.3 ATI-6 5 31.3 ATI-6 5 31.3 ATI-6 5 31.3 ATI-6 5 31.3 ATI-6 5 31.3 ATI-6 5 31.3 ATI-6 5 31.3 ATI-6 5 31.3 ATI-6 5 31.3 ATI-6 7 ATI-6 7 ATI-7 7 ATI-7 7 ATI-7 7 ATI-7 7 ATI-7 7 ATI-7 7 ATI-7 7 ATI-7 7 ATI-7 7 ATI-7 7 ATI-7 7 ATI-7 7 ATI-7 7 ATI-7 7 ATI-7 7 ATI-7 7 ATI-7 7 ATI-7 7 ATI-7 7 ATI-7 7 ATI-7 7 ATI-7 7 ATI-7 7 ATI-7 7 ATI-7 7 ATI-7 7 ATI-7 7 ATI-7 7 ATI-7 7 ATI-7 7 ATI-7 7 ATI-7 7 ATI-7 7 ATI-7 7 ATI-7 7 ATI-7 7 ATI-7 7 ATI-7 7 ATI-7 7 ATI-7 7 ATI-7 7 ATI-7 7 ATI-7 7 ATI-7 7 ATI-7 7 ATI-7 7 ATI-7 7 ATI-7 7 ATI-7 7 ATI-7 7 ATI-7 7 ATI-7 7 ATI-7 7 ATI-7 7 ATI-7 7 ATI-7 7 ATI-7 7 ATI-7 7 ATI-7 7 ATI-7 7 ATI-7 7 ATI-7 7 ATI-7 7 ATI-7 7 ATI-7 7 ATI-7 7 ATI-7 7 ATI-7 7 ATI-7 7 ATI-7 7 ATI-7 7 ATI-7 7 ATI-7 7 ATI-7 7 ATI-7 7 ATI-7 7 ATI-7 7 ATI-7 7 ATI-7 7 ATI-7 7 ATI-7 7 ATI-7 7 ATI-7 7 ATI-7 7 ATI-7 7 ATI-7 7 ATI-7 7 ATI-7 7 ATI-7 7 ATI-7 7 ATI-7 7 ATI-7 7 ATI-7 7 ATI-7 7 ATI-7 7 ATI-7 7 ATI-7 7 ATI-7 7 ATI-7 7 ATI-7 7 ATI-7 7 ATI-7 7 ATI-7 7 ATI			-	31.5	41.0	1.5
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ATI-11     5     29.7     43.       ATI-11     3     30.6     44.       ATI-12     30.9     41.       ATI-12     3     30.9     41.       ATI-12     3     30.6     43.       ATI-12     3     30.6     43.       ATI-12     3     30.6     41.       ATI-12     3     30.6     41.       ATI-12     3     30.6     42.       ATI-6     3     30.1     42.       ATI-6     3     30.3     42.       ATI-6     3     30.3     44.       ATI-6     3     30.3     40.       ATI-6     3     29.6     38.6       ATI-6     3     29.6     38.9		AT1-10		29.4	40.8	1.3
5     30.6     43.       ATI-11     2     30.9     44.       1     3     30.9     41.       41.     3     30.9     41.       42.     31.1     42.     42.       71-12     3     30.6     42.       7     1     32.6     42.       7     3     30.6     41.       7     3     30.6     42.       7     3     30.6     42.       8     30.9     41.     42.       7     3     30.9     41.       8     30.3     44.     42.       7     31.6     42.     42.       7     31.6     42.     44.       7     30.9     41.     41.       7     30.6     38.9     40.       7     30.8     30.6     38.9       7     30.8     30.6     38.9       7     30.8     30.6     38.9       7     30.8     30.6     38.9       7     30.8     30.6     40.6       8     29.6     38.9     38.9       8     29.6     38.9     38.9       8     29.6     38.9       8<			4	29.7	42.8	1.8
ATI-11 2 35.0 ATI-11 2 30.9 ATI-12 2 30.4 ATI-12 2 30.4 ATI-4 3 31.6 ATI-4 3 31.6 ATI-5 1 31.6 ATI-6 3 30.9 ATI-6 5 31.3 ATI-6 5 30.8 ATI-6 5 29.0 ATI-6 2 29.0 ATI-6 3 29.6 31.3 ATI-6 2 29.0 ATI-6 3 29.6 ATI-6 3 30.6 ATI-6 30.6 ATI-6 30.6 ATI-6 30.6 ATI-6 30.6 ATI-6 30.6 ATI-6 30.6 ATI-6 30.6 ATI-6 30.6 ATI-6 30.6 ATI-6 30.6 ATI-6 30.6 ATI-6 30.6 ATI-6 30.6 ATI-6 30.6 ATI-6 30.6 ATI-6 30.6 ATI-6 30.6 ATI-6 30.6 ATI-6 30.6 ATI-6 30.6 ATI-6 30.6 ATI-6 30.6 ATI-6 30.6 ATI-6 30.6 ATI-6 30.6 ATI-6 30.6 ATI-6 30.6 ATI-6 30.6 ATI-6 30.6 ATI-6 30.6 ATI-6 30.6 ATI-6 30.6 ATI-6 30.6 ATI-6 30.6 ATI-6 30.6 ATI-6 30.6 ATI-6 30.6 ATI-6 30.6			ις	30.6		1.6
ATI-11 2 30.9 ATI-12 3 30.9 ATI-12 2 30.4 ATI-12 2 30.4 ATI-4 3 31.6 ATI-4 3 33.1 ATI-5 1 30.9 ATI-5 2 33.1 ATI-6 2 31.3 ATI-6 2 2.0 ATI-6 5 30.8 ATI-6 2 2.0 ATI-6 3 2.9.6 31.9 ATI-6 3 3.1 ATI-6 4 4 3.1 ATI-6 4 4 3.1 ATI-6 4 4 4 3.1 ATI-6 4 4 4 3.1 ATI-6 4 4 4 3.1 ATI-6 4 4 4 4 3.1 ATI-6 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4	-	-	1	35.0	44.3	-
ATI-12 2 30.9 ATI-12 2 30.4 ATI-12 2 30.4 ATI-4 3 31.6 ATI-4 3 33.1 ATI-5 1 30.9 ATI-5 2 33.1 ATI-6 3 30.9 ATI-6 5 31.3 ATI-6 5 31.9 ATI-6 5 31.9 ATI-6 5 29.0 ATI-6 2 29.0 5 4 30.8 ATI-6 3 29.6 5 31.9 31.9 4 31.4 5 31.4 31.4 31.4 31.4 31.4 31.4 31.4 31.4		AT1-11	~7	30.9	41.1	
ATI-12 2 30.6 ATI-12 2 30.6 ATI-12 3 30.6 ATI-4 3 31.6 ATI-4 3 33.1 ATI-4 3 33.9 ATI-5 1 29.5 ATI-6 3 30.3 ATI-6 5 31.3 ATI-6 5 31.3 ATI-6 5 31.3 ATI-6 5 29.0 5 4 30.8 5 30.3 31.4 31.4 31.4 31.4 31.4 31.4 31.4 31		11-110	ŕ	30.9	41.0	0.1
ATI-12 2 3 30.6 ATI-12 2 3 30.6 5 30.6 4 32.5 31.8 31.6 31.6 31.6 31.1 31.6 31.1 31.6 31.1 31.5 31.1 31.4 31.4 31.4 31.4 31.4 31.4 31.4 31.3 30.9 31.3 ATI-6 5 31.3 30.9 ATI-6 5 31.3 ATI-6 5 31.3 ATI-6 5 31.9 31.9 31.9 31.9 31.9 31.9 31.9 31.9 31.3 31.4 31.4 31.4 31.4 31.4 31.3 30.9 5 31.3 31.3 31.3 31.3 31.3 31.4 31.4 31.4 31.4 31.4 31.3 31.5 31.3 31.3 31.5 31.3 31.3 31.5 31.3 31.5 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 3			4	31.1	44.3	1.9
ATI-12 2 30.4 5 31.6 5 31.8 5 31.6 31.6 31.6 31.6 31.6 31.1 5 31.1 31.4 31.4 31.4 31.4 31.9 31.9 31.9 31.9 31.9 31.9 31.9 31.9			-	32.6	1.	1.4
ATI-12 3 30.6 ATI-12 4 32.5 ATI-4 2 33.1 ATI-4 2 33.1 ATI-6 3 30.3 ATI-6 3 30.6 ATI-6 3 29.6 ATI-6 3 29.6 ATI-6 5 29.6			2	30.4	42.4	1.5
ATI-4 32.5 ATI-4 2 33.1 ATI-4 3 33.1 ATI-5 3 31.4 ATI-5 3 31.4 ATI-6 2 30.6 ATI-6 3 29.6 ATI-6 3 29.6 ATI-6 5 30.8		AT1-12	e.	30.6	40.2	1.3
5     31.8       1     2     31.6       1     2     33.1       AT1-4     3     30.9       5     31.4       31.3     31.4       5     31.3       AT1-5     3       3     30.6       7     2       7     30.3       AT1-5     30.8       7     22.6       7     29.6       7     29.6       7     29.6       7     29.6			4	32.5	42.0	1.6
ATI-4 1 31.6 ATI-4 3 33.1 ATI-5 2 33.1 ATI-5 3 30.3 ATI-5 3 30.3 ATI-6 3 29.6 ATI-6 3 29.6 ATI-6 3 29.6	2219-T87		5	31.8	42.0	1.4
2 33.1 4 4 3 5 4 330.9 5 331.3 2 0.5 5 331.3 2 0.5 5 331.3 2 0.6 5 331.3 2 0.6 5 2 29.0 5 29.0 5 29.6 6 29.6 6 29.6 6 29.6 7 29.6 7 29.6 7 29.6 7 29.6 7 29.6 7 29.6 7 29.6 7 29.6 7 29.6 7 29.6 7 29.6 7 29.6 7 29.6 7 29.6 7 29.6 7 29.6 7 29.6 7 29.6 7 29.6 7 29.6 7 29.6 7 29.6 7 29.6 7 29.6 7 29.6 7 29.6 7 29.6 7 29.6 7 29.6 7 29.6 7 29.6 7 29.6 7 29.6 7 29.6 7 29.6 7 29.6 7 29.6 7 29.6 7 29.6 7 29.6 7 29.6 7 29.6 7 29.6 7 29.6 7 29.6 7 29.6 7 29.6 7 29.6 7 29.6 7 29.6 7 29.6 7 29.6 7 29.6 7 29.7 7	2319		1	31.6	42.8	
30.9 4 30.9 1 29.5 29.5 31.3 30.3 30.3 30.3 30.6 30.8 5 30.8 5 5 29.6 5 5 5 29.6 5 5 5 5 30.9 5 6 5 5 5 5 5 5 8 5 6 5 6 6 6 6 7 6 7 6 7 8 6 7 8 7 8 7 8 7 8 7			2	33.1	43.1	1.6
4         31.4           1         29.5           2         30.3           5         4           31.3         30.3           5         30.6           30.8         30.6           5         30.8           5         29.6           5         29.6           5         29.6		AT1-4	ŝ	30.9	42.0	1.9
5 31.3 1 29.5 2 30.3 3 4 30.6 5 30.8 30.6 5 30.8 30.8 3 29.0 5 29.0 5 29.0 5 29.0 5 29.0 5 29.0 5 29.0 5 29.0 5 29.6 5 29.6 5 29.6 5 29.6 5 29.6 5 29.6 5 5 29.6 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5			4	31.4	41.9	1.9
1 29.5 2 30.3 4 31.9 5 30.6 5 30.6 5 30.8 2 30.8 2 30.8 2 30.8 2 30.8 2 30.8 2 30.8 5 2 29.0 5 2 29.0 5 2 29.6 5 2 29.6			5	31.3	44.0	2.8
2 30.3 4 331.9 5 4 30.6 5 30.6 7 28.3 2 9.0 5 2 29.0 5 2 29.0 5 2 29.0 5 2 29.0 5 2 29.0 5 2 29.0			1	29.5	39.1	۲ ۲
31.9 4 30.6 5 30.6 2 30.8 3 28.3 5 4 2 29.6 5 2 29.6 5 2 29.6 5 2 29.6 5 2 29.6 5 2 29.6 5 2 29.6 5 2 29.6 5 2 29.6 5 2 29.6 5 2 29.6 5 2 29.6 5 2 29.6 5 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2			2	30.3	40.0	1.3
4 30.6 5 10.6 2 29.0 5 4 29.6 5 29.6 29.6 29.8		AT1-5	<del>ر</del>	31.9	41.2	1.4
5 30.8 1 28.3 3 29.6 5 29.6		_		30.6	38.9	1.0
1 28.3 29.0 3 29.6 5 29.6 5 29.8				30.8	40.9	1.2
2 29.0 5 4 5 2 9.6 2 9.6				28.3	38.4	1.5
3 29.6 . 5 29.8 .		····	2	29.0	38.9	1.5
29.6 29.8		AT1-6		29.6	38.5	1.7
29.8			4	29.6	39.7	2.0
			5	29.8	40.6	2.0

TABLE G-21.

## MIT BIAXIAL SPECIMEN TEST DATA

		Test	Test Section Stress-Strain Data	train Data	Ultimate
Material &	Specimen	Stress,	Longitudinal,	Transverse,	Strength,
Process	No.	ksi	uin. / in.	µ1n./1n.	KS1
	M-1	I		ı	72.0
	M-2		•	ł	71.4
	M-3	ı	1	ı	72.0
	M-4	,	-	1	68.5
2219-T87		12.7	1, 125	-130	
Parent		19.0	1,670	-220	
Metal		25.3	2, 200	-290	
		31.6	2, 710	-360	
		38.0	3, 320	-490	
		44.3	3, 880	-560	
	M-5	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	
		,	•	1	73.4
•					

## TABLE G-22.

# SUMMARY OF CYLINDER TEST RESULTS

	Remarke	ACCILICATION	Esiled 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	995	1010	640	450	•	,	 	
	Stress	Ratio	2.1		2:1	1:0	1:1	2:1	2:1	1:1	1:1	1:0	1:0	2:1	2:1	2:1	1:1	1:1	1:1	1:1	 	
	Cylinder	No.	- ^ / >	1-1-2	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		
		No.	-		2	ŝ	4	2	9	2	80	6	10	11	12	13	14A	14B	15	16		

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

HYDRO PRESS PSI	CIRCUM STRAIN MICROI	LONG STRAIN IN/IN	AXIAL LOAD Pounds	MSD CR STRESS PSI	TRU CR STRESS PSI	MSD LN STRESS PSI	TRU LONG STRESS PSI	TRU CIRCM Strain Microin/In	TRU LONG STRAIN MICROIN/IN	TRU RAD Strain Microin/In	EFFECTIVE STRESS PSI	EFFECTIVE Strain Micin/In	) ¥
50	305	<b>6</b> 5.	11855.	3475.	476	73	19.61	304.	4.99	4	9	1 -	U
100.		125.	23710.	6950.	6954	3475.	5.43	554	24,99	6	2	l en	
2.5			00000	10-22	0 0 0 0 0 0 0 0 0 0 0 0	25	13.56 	808	04.98	38	3		0.3
50			17171	13700.	<b>D</b> M	5	27 I 0	1034	49.96	5	2050	857.	0.3
00	1625	400.	71131.	20850.	DARA		2 · 0 · 7 0	1071	4 4 4 T		1906	260	
ŝ	1960	465.	82987.	24325.	1273	4 F			14.47 14.42	2	0809	0.00	0.3
8	229	525.	94842.	27800.	78	390	3907.29	2287	24.84				0
s a	¥.		106697.	31275.	1358	563	20	2646	589.826	-1132.712	27156.7	2184.767	0.3
TEST	VIIMDED 4	6 A C E G						и					
5				c									
HYDRO	53	1	AXIAL	C	υ	-	L ON	TRU CIRC	LON	U RA	CTIV	ECTIV	ĨW
		NININ	POLINAS	<b>—</b>	-	-	_	S	S				
					n –	0	0	HICKDIN			ŝ	1 / 1	
50	609	185.	11855.	3475.	3477.	338	737.	04.81	4.98	-276.430	3011.	08.9	
	1030	305.		÷ O	6957	415	476.	29.47	4.95	-467.048	6025	64.1	
• N C T	100	4 4 1 1 4 4 1 4 4 4 4	00			11	214	98.72	9.90	-713.518	9042.	334.9	
50		A D D		7.0	1000				4 . 82 . 82	-004.004	12064.	872.0	-
300.	~ ~	. 580		∖ c				25.41	9.66	-1345.779	15092.	523.7	7
350.	<b>.</b>	1130.	200		4994	2163	0175	20.10	1001	-11/59.218	18129.	350.8	-
400.	9465.	1285.	1	•	80×	0001	1017		00731 00731	300.4002-	.09112		2
450.	13360.	460	5	31275.	31693.	15638.	15660.331	13271.541	1458.936		27477	10720.195	
TEST NI			-										
5		5		r									
HYDRO	CIRCUM	LONG	AXIAL		TRU CR	HSD LN	2	1RC	LON	U RA	CTIV	ECTIV	Ĩ
ה מ ב ב	NI VIIII	STRAIN	- (	TRES	TRES	TRES	STRES				i	STRAIN	
			0	5	so i	2	co.	1 / 1		I N I	S	INI	
50.	1	165.	19	\$	3477.	1730.	7.78	09.74	64.9A	- 2		•	۴
100.	2	290.	5	695		3475.	5.00	259.20	80.95	1			2
150.	2035.	435.	35566.	10425.		5213.	5214.767	2032.932	434.906	-863.743	9046.7	1675.371	
.002	010		4	1062	3942.	6950.	9.04	3005.47	24.86	ŝ	2074.	460.3	
		000	8	737	7450.	8668.	5.19	280.82	54.78	172	5111.	493.5	1
000 -	00000		25	085	0989.	10425.	2.76	6662.75	44.72	5		412.3	1
		/ 32 .		225	45/8.	12163.	-	356.18	34.73	386	1285.	387.9	10
	2	• • • •	5	0 0 0	. 4800	10001		2452.15	09.74	5	2854*	1.970	3
TEST NU	NUMBER 1	GAGES	AND 1	0						MANN 8 11 1			
			C	J						the distance of the second second			
HYDRO	CIRCUM	PNO	IAL	Ë	č	HSD LN	TRU LONG	1 HC		2	CTIV		ŊΜ
		5		RESS 1	RESS	S	-	STRAIN			5	5	
		2	20	20	ŝ	<b></b>	ISd	NINI		Ξ.	ŝ	MICINIIN	
5	550.	185.	18	.5.	•	1738.	737.82		84.98	257.19	011.	84 . AR	-
8	950.	320.	5	50.	957	3475.	476.11	1	10.94	444.32			
5	1515.	460.	5566.	0425	441.	5213.	214.89	ŝ	59.89	600.81 600.81	143.	000000000000000000000000000000000000000	2 "
8	2235.	610.	7421.	3900.	931.	6950.	954.23	20	09.81		2064.	02 298	
5	3145.	790.	9276.	7375.	130.	5688	694.36	2	89.68	375.41	1004	46.764	
300.	4330.	086	71131.	20850.		110425.	10435.216	4320.652	979.519	-1855.060	18134.8	3569.545	
5.0	6295.	1190.	2987.	1325.	64	12163.	176.97	5	89.29	598.68	1197.	117.64	200
5	9325.	1365.	4842.	7800	059.	13900.	3918.97	5	364.07	726.05	4300.	<b>FAR 00</b>	
ſ											• 0 0 0 r		,

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

PRES PS	_	z S J	AXIAL	ч		MSD LN	TRU LONG	TRU	TRU	TRU RAD	EFFECTIVE	EFFECTIVE	⊒¥
50 100	S STRAIN	STR	LOAD	s	SS	STRESS	STRESS	STRAI	:	STRAIN	STRESS	STRAIN	
100	-	N	SUNDON	0 1	_	PSI	ISd	MICF	MICROI	MICROIN/IN	001	N	
100	-	75.	11855.		3476.	1738.	1737.630		74	-138,231	3010.4	264.742	0
i	. 550	135.			6954.	3475.	3475.469		134	-239.694	6022.2	456.039	ုစ
150	. 820	175.			10434.	5213.	5213.412		174	-348.127	9035.7		0
200		250.	1.	i -	13917.	6950.	6951.737		249	-503.741	12052.1	1	0
250	-	310.			17401.	8688.	8690.193		309	-622.605	15069.3		0.35
300		385.		1_	20888.	10425.	10429.014	1	384	-774.639	18089.7		e
35 n	~	450.			24378.	12163.	12167.973		449	-912.649	21111.6		۰.
400	. 24B	490.	۱.	ί.	27869.	13900.	13906.811		489	-1040.129	24135.3		-
4	. 279	535.	6697.		31362.	15638.	15645.866		534	-1164.085	27160.7		0
500		660.	118552.	34750.	34857.	17375.	17386.467	3075.266	659.783	-1307.267	30187.1	2534.668	0
550	353	725.		-	38360.	19113.	19126.357		724	-1486.982	33220.7		
TEST	NUMBER	2 GAGES	J AND	4			-						
HYDRO	O CIRCUM	ب.			TRU CR	MSD LN	TRU LONG	TRU C	TRU LONG	TRU RAD	EFFECTIVE	EFFECTIVE	<b>B</b> M
PRES	S	STRAL	LOAD		STRESS	STRESS	STRESS		STRAIN				
	N IC		POUNDS	ISd		ISd	Isd	z	MICROIN/IN	MICROIN/IN	ISd	MICINZIN	
50	. 115.	70.	11855.		3475.	1738.	1737.622		69.998	5	3009.8	107.999	0
100	21	130.	23710.	6950.	6951.	3475.	3475.452	214.	129.991	-120.739	6020.2	201.545	$\mathbf{o}_{ }$
150	. 30	200.	35566.	10425.	10428.	5213.	5213.542	304.	199.980	-176.727	9031.1	292.478	0
200	. 39	250.	47421.	13900.	13905.	6950.	6951.737	389.	249	-223.963	12042.4	371.501	
250	. 63	370.	59276.	17375.	17386.	8688.	8690.71	634.798	369	-351.655	15056.7	589.526	
300	134	315.	71131.	20850.	0878.	10425.	0428.28	1339.103	4 - M	-578.918	16080.8	1108.221	
165 201	320	430.	62987.	24325.	4 0 0 4 4 .	12105.	2108.53	160.9625	4 0	+01./001-	21134.8	2024.200	
4 4 0 0	11660.	1120.	106697.	31275.	31640.	15638.	15655.014	11592.546	1119.372	-4449.172	27401.3	9404.878	0.35
TEST	NUMBER	2 GAGES	1 AND	~									
	O CIRCUM		AXIAL	U	æ	SD L	L ON	TRU CIRCM	TRU LONG	TRU RAD	CTIV	EFFECTIVE	Ν
PRESS	STRAIN		LOAD	STRESS	s	STRESS	ш	STRAIN		S	STRESS		
6 G	MICRO	. NI/NI	POUNDS	PSI	ISA	ISd	LS4	MICROIN/IN	MICF	MICROIN/IN	ISd	MICINIIN	
50		80.		3475.	3476.	1738.	1737.639	254.967		-117.238			0.3
100	. 505	150.		6950.	6954.	3475.	3475.521	504		-229.202		423	0.3
150	. 715.	220.			10432.	5213.	5213.647	714		-327.153		601.	0.3
200		270.		÷	13913.	6950.	6951.876	909.587		-412.843		763.	0.35
250	-	335.	1			8688.	8690.410	1334		-584.169		1107.	0.3
300	- 20 <b>u</b>	390.		÷		10425.	10429.066	1998		-835.775		1641.04	0.3
350	3510	445.	1			12163.	12167.912	3503		-1382.065			5
4 004	4445	485. 540.	94842. 106607.	27800.	31400	15900.	15906.741		484.	-1/22.011	24182.6	3602.02	0.35
	1040	470				1 7 7 7 5	771 - 1981 -	1005		ACA 1501-1	Ì	0417.70	
			.2000	•		10113		2000	404.00			2440.1	0

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

				and data to a sect or many responses of the woman of the statements of the					and the second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second se											-																		· · · · · · · · · · · ·				
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EFFECTIVE	STRAT	L VELUAUL	56	-	932.98	149.47	469.76 788.87	998.28	330.94	2729.968 3162.108			S	MICROINTIN	566.486	849	115	1548.061 2030.943	845	<b>4</b> 70.		CTDAIN STDAIN		133.326	÷.				÷.						STRA	0 INZ	66.61	83.13	866.25	165.91		<b>230 2</b>
<b>.</b>	STRA	10101	-299.955	-399.919	-499.874	-649.789	-/24./3/	-924.573	-1024.476	-1124.368 -1274.187		TRU TRAVRS	STRAIN	MICROIN/IN	-124.992	-224.975	-249.969	-399.919	-424.909	-424.909											-1349.090		•	17		in the second	0.00	66.66	199.98	2/4.90	<b>~</b>	~ 0 • ~ ~ *
TRU LONG		66	374.930	624.804	899.596	1074.422	414.0/41	2072.850	2471.943	2970.583 3468.975		TRU LONG	•		724.737	1049.448	1423.986	2646.495	3842.608	0280.238	t t	c v	MICRO IN/IN	149.989	324.94/	399.919	349.939	5	<u>~</u> ;	12	5683.816	F			STRAIN	MICRO INVIN	399.919	774.700	1099.395	414.0.414	2995.500	5771010
EFFECTIVE	^	3475.	6953.	<b>n</b> /	13913.	-	-10012	27858.	31352.	34853.38358.		CTIV	STH	- 1	50	0436	3920		4				1S4				17381				34948.			CT IV		PS1	3476.	6955.	10436.	13461	20913.	ドンド・フレ
 TRUE	-	3475			13913.		24369.	27858.	31352.	34853. 38358.	\$		STRESS	1474	- •	0436	13920.	20905.	24419.	. 61415		STRESS	PSI	3476.	10429	13906.	17381.	20861.	24352	31391.	34948. 34580		~	P	STRESS	ഗ	4	ŝ	21	240	20913.	1 1 0
USH CLOLO		1					1		1	38225.	5 AND	MSD	STRESS	3475.	6950.	10425.	<b>•</b> •	20850.	24325.	- 100/2		STRESS	lSd	3475.	10425.	13900.	1/375.	20850.	24325.	31275	34750. 34225		1 AND	MSD	STRESS	1Sd	3475.	695 695	042	0 X 0 7 X 0	20850.	
LONG CTDATA										3475.	3 GAGES		STR	2	725.	1050.	1075	2650.	3850.		5	ŝ	2127		400						5700.		3 GAGES	LONG	STRAIN	ZIN	400.	775.	1100.	9040	3000.	•••
		-175.					1			-1125.	NUMBER	TRAV	STRAIN	-50.	-125.	-225.	- 16.21	-400.	-425.		DAVDS		MICROI			1				•	-1350.		NUMBER	TRA	STRAIN	MICROI	6	-100		. 4	-500.	
HYDRO	n d	20	100.	50			20	400.	50	500. 550.	EST N	В	PRESS	50.	8	150.	20	300.	350.	-00.		PRESS	I S d	- 0 0 1	150.	200.	250.	300.	1005	450.	550.		EST NI	1YDR0	PRESS	PS1	50.	100.	.061	250.	300.	

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

TEST NUMBER 4 GAGES 7 AND 8

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                                                                                                                                                                                                                             | S -                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | 50.5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | 100.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 150.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | 200.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | 300.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 350.    | 400.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|             |                  | 731 ALCAUMUN FOUND 731 731 731 731 731 731 ALCAUMUN ALCAUMUN ALCAUMUN 731 ALCAUMUN<br>50. 150. 150. 23710. 3475. 3475. 3475.521 149.989 149.989 -104.993 3475.5 169.988 0.3<br>00 225. 450. 274.206. 665. 665. 665. 127 224.275 449.800 -274.206. 695.3 403.875 0.3 | 51 HEROTOVIN FOUND 731 731 731 731 731 HEROTOVINT HEROTOVINT HEROTOVINT FERTINITY<br>50. 150. 150. 23710. 3475. 3476. 3475. 3475.521 149.989 149.989 -104.993 3475.5 169.988 0.3<br>00. 255. 457. 4131. 10432. 10525. 10432.037 249.4975 449.899 -236.206 6952.3 403.875 0.3<br>50. 257. 27121. 10432.110425.10435.037 243.075 244.775 445.596 10431.0 750.723 0.3 | 50.         150.         150.         23710.         3475.         3475.521         149.989         149.989         -104.993         3475.5         169.986         0.3           50.         150.         150.         23710.         3475.         3475.521         149.989         149.989         -104.993         3475.5         169.986         0.3           50.         275.         450.         495.127         224.975         449.899         -104.993         3475.5         163.875         0.3           50.         675.         47421.         6950.         6953.127         224.975         449.899         -104.3993         3475.9         0.3           50.         670.         675.         1032.037         649.789         674.373         -463.596         10431.9         750.723         0.3           00.         850.         870.         13901.13010         13911.308         849.664         584.276         10450.05         0.3 | 50.         150.         150.         23710.         3475.         3475.5         169.988         149.989         110.0000000000000000000000000000000000 | 50.         150.         150.         23710.         3475.         5475.         5475.521         149.989         100.000         23475.5         16993         3475.5         16993         5475.5         16993         5475.5         16993         5475.5         16993         5475.5         16993         3475.5         16993         5475.5         16993         3475.5         16993         3475.5         16993         5475.5         16993         5475.5         16993         5475.5         16993         5475.5         16993         5475.5         16993         5475.5         16993         5475.6         103         50.2         103.1675.1         10300.5         10312.5         10331.6         750.723         0.3           00.         850.         820.5         71045.1         7391.5         7393.6         849.638         849.656         13911.6         946.096         0.3           50.         1125.         1075.         11275.         17393.678         1124.368         1294.422         759.577         17394.4         1246.315         0.3           00.         1425.         1300.         1423.686         1299.645         1246.739         0.3         0.44.739         0.3         0.44.739         0.3 <td< td=""><td>50.         150.         150.         23710.         3475.         5475.         5475.5         169.988         0.3           50.         150.         150.         150.         23710.         3475.5         169.988         0.3           60.         150.         150.         23710.         3475.         3475.5         169.988         0.3           60.         275.         450.         6950.         6953.127         224.075         449.899         -236.206         6952.3         403.875         0.3           60.         870.         870.         10421.9         10421.9         750.723         0.3           60.         860.         870.         849.25         10431.9         750.723         0.3           60.         870.         870.         13911.598         849.638         819.669         13911.6         946.096         0.3           60.         1125.         1074.422         769.577         17394.1         1246.315         0.3           60.         1475.         1300.1         1391.576         13933.671         1344.795         0.3           60.         1475.         1379.63         124.359         1074.422         759.539         1344.795<!--</td--><td>50.       150.       2371.       3475.       3475.521       149.989       149.989       149.989       149.989       10.00.00.000         50.       150.       23710.       3475.00       3475.521       149.989       149.989       149.989       149.989       10.00.000         50.       150.       47425.       1633.00       6953.127       224.975       649.899       236.206       6952.3       403.875       0.3         50.       675.       71131.       10425.       10432.00       5941.398       649.899       674.773       -663.596       10431.6       750.723       0.3         50.       850.       870.13       1331.0       13912.       13912.       13911.6       946.096       0.3         50.       1475.       1300.1       13912.       13911.398       849.638       819.664       -584.256       13911.6       946.096       0.3         50.       1475.       1300.1       13912.       13913.358       1124.358       10.3422       -584.256       13911.6       946.096       0.3         60.       1475.       1500.1       1473.959       1743.596       1074.422       759.511.6       946.096       0.3         1475.       15</td><td>50.       150.       150.       23710.       3475.5       169.988       0.3         50.       150.       150.       23710.       3475.5       169.988       0.3         50.       150.       151.       1675.       169.988       149.989       149.993       3475.5       169.988       0.3         50.       675.       1131.       10475.       16925.       649.785       649.785       443.895       0.3       375.0.3       0.3         50.       675.       675.       1731.       10475.       169.988       149.664       453.696       10431.9       750.733       0.3         50.       860.       675.       674.773       -564.775       -564.775       17391.6       946.096       0.3         50.       1305.       1074.755       17395.       17395.778       13941.2       1246.315       0.3         50.       1425.       1274.378       1244.398       1274.472       -664       -769.577       1746.316       0.3         50.       1425.4355       1274.373       1274.422       -769.577       1744.743       0.3         50.       1675.1257       1279.415       1243.396       1297.4422       -769.577       <td< td=""><td><math display="block">\begin{array}{cccccccccccccccccccccccccccccccccccc</math></td><td>50.100.57.100.57.100.57.100.57.100.57.100.57.100.57.100.57.100.57.100.57.100.57.100.57.100.57.100.57.100.57.100.57.100.57.100.57.100.57.100.57.100.57.100.57.100.57.100.57.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.</td><td>50.       150.       150.       150.       23710.       3475.5       159.       109.089       -104.093       3475.5       169.988       0.3         50.       275.       459.087       675.7       131.       10432.075       133.075       11043.093       3475.5       169.988       0.3         50.       6750.       6757       7131.       10432.0       1391.075       131.01043.1       750.03       3475.5       169.03       3475.5       169.03       3475.5       169.03       3475.5       169.03       3475.5       169.040       0.3       3475.5       169.988       0.3       3475.5       169.040       0.3       750.03       3475.5       169.040       0.3       750.03       3475.5       169.040       0.3       750.03       3475.5       169.040       0.3       750.03       750.03       3476.7       750.03       0.3       750.03       750.03       750.03       750.03       0.3       0.3       0.3       0.3       0.3       0.3       0.3       0.3       0.3       0.3       0.3       0.3       0.3       0.3       0.3       0.3       0.3       0.3       0.3       0.3       0.3       0.3       0.3       0.3       0.3       0.3</td><td>50.       150.       150.       23710.       3475.5       169.988       0.3         50.       150.       150.       150.       150.       149.989       149.989       149.989       104.993       3475.5       169.988       0.3         100.       225.       4131.       1311.       1312.       1312.       1312.       149.989       104.993       3475.5       169.083       0.3         100.       670.       670.       47131.       1312.       13422.       13432.       13432.       149.989       104.993       3475.5       169.080       0.3         200.       650.       670.       47131.       1340.1.125.       144.795       13911.69       640.733       0.3         201.       1775.       1175.       1175.       1074.422       750.577       17394.1       1246.315       0.3         201.       1675.       1675.       16976.       1675.599       1673.599       1673.599       133.41.9       2067.7       2075.7.2075.59       0.3         501.       1675.       16975.       16883.2       27565.2508       1973.656       133.41.9       2067.7       2075.7.559       0.3         501.       1675.       16896.3553</td><td>50.       150.       150.       150.       150.       149.989       149.989       149.989       149.989       103.875       169.988       0.3         100.       255.       4731.       655.       4731.       655.       403.73.9       570.33.65       1331.9       570.75       1331.9       570.75       1331.9       570.75       1331.9       570.75       1331.1       1447.990       1391.398       649.785       649.785       649.785       649.795       464.775       463.596       10431.6       946.096       0.3         250.       850.       870.5       1330.5       13312.13965       13392.13396       13391.356       13391.357       13391.1399    
  1391.475       13391.457       13394.1       124.569       0.3         250.       850.       870.5       13395.1       13395.1       13395.1       13395.1       13391.6       946.056       1973.452       1547.373       13394.1       1246.536       0.3         350.       1675.1       1525.165973.2       2346.565       1973.052       247.473       1744.102       2463.43       0.3       0.3       0.3       0.3       0.3       0.3       0.3       0.3       0.3       0.3       0.3       0.3       0.3<td>50.       150.       251.       149.       989       149.       989       114.       983       1157.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       10431.9       750.       150.       1031.9       150.       1031.9       150.       10431.9       750.       1031.9       150.9       10431.9       750.7       1031.9       150.9       10431.9       750.7       10391.9       1031.9       10431.9       750.7       1031.9       150.9       1031.9       150.9       1031.9       10431.9       750.7       10391.9       1031.9       10431.9       750.7       10391.9       10391.9       10391.9       10391.9       10391.9       10391.9       10391.9       10391.9       10391.9       10391.9       10391.9       1031.9       10391.9       1031.9       10391.9       1031.9       1031.9       1031.9       1031.9       1031.9       1031.9       1031.9       1031.9       1031.9       1031.9       1031.9       1031.9       1031.9       1031.9       1031.9       1031.9       1031.9       1031.9       1031.9       1031.9       1031.9       1031.9       1031.9</td><td>50.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.</td><td>50.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.</td><td>50.       15.       23710.       3475.       3475.521       149.969       140.965       167.75       17131.       16475.5       17131.       16475.5       17131.       16475.5       17131.       16475.5       17131.       16475.5       17131.       16475.5       17131.       16475.5       17355.10475.10475.10475.10475.10475.10475.10475.10475.10467.105       1549.568       695.6       695.6       695.7       71131.10475.116475.116475.110475.10467.105       1591.664       256.266       0595.7       71355.10475.11575.12575       31375.57357.13575.13595.13757.1375       1324.368       129.646.256       1391.1267       1391.1275       31375.575       1393.66       124.556       1391.1267       1391.1267       1391.1398       149.665       1391.1398       1315.157       31375.1575       1393.375       1315.135       1353.315       1315.135       1315.15       1356.15       1315.135       1315.15       1315.15       1357.15       1315.15       1315.15       1315.15       1315.15       1315.15       1315.15       1315.15       1315.15       1315.15       1315.15       1315.15       1315.15       1315.15       1315.15       1315.15       1315.15       1315.15       1315.15       1315.15       1315.15       1315.15       1315.15       1315.15       1315.15       1315.15</td><td>101.       755.       7131.       7131.       707.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.</td><td>50.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.</td><td>50.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.</td><td>50.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.</td><td>50       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150 
     150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       15</td><td><ul> <li>FULCELINTY TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTA</li></ul></td><td>190       275       490       772       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       1</td><td>19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0</td><td>19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1</td><td>11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       <td< td=""><td>101       175       101       175       101       175       101       175       101       175       101       175       101       175       101       175       101       175       101       175       101       175       101       175       101       175       101       175       101       175       101       175       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       1</td><td>5.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1</td><td>9.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.        
1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.</td><td>51       1100       755       490       1100       747       90       140       90       147       90       147       90       147       90       147       90       147       90       147       100       757       100       757       100       757       100       757       100       757       100       757       100       1757       100       1757       100       1757       100       1757       100       1757       100       1757       100       1757       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100</td><td>Filt         Filt         <th< td=""><td>51.         1100.         275.         210.         275.         210.         275.         210.         275.         210.         275.         210.         275.         210.         275.         210.         275.         210.         275.         210.         275.         210.         275.         210.         275.         210.         275.         210.         275.         210.         275.         210.         275.         210.         275.         210.         275.         210.         275.         210.         275.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         <th< td=""><td>51.       100.       755.       991.       3776       100993.       3776       100993.       3776       100993.       3776       100993.       3776       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100933.       100993.       100933.       100933.       100933.       100933.       100933.       100933.       100933.       100933.       100933.       100933.       100933.       100933.       100933.       100933.       100933.       1</td><td>9.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.</td><td>9.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1</td><td>Fight         Fight         <th< td=""><td>Column State         Column State&lt;</td><td>Cols         Cols         <thcols< th="">         Cols         Cols         <thc< td=""><td></td><td>1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1</td></thc<></thcols<></td></th<></td></th<></td></th<></td></td<></td></td></td<></td></td></td<> | 50.         150.         150.         23710.         3475.         5475.         5475.5         169.988         0.3           50.         150.         150.         150.         23710.         3475.5         169.988         0.3           60.         150.         150.         23710.         3475.         3475.5         169.988         0.3           60.         275.         450.         6950.         6953.127         224.075         449.899         -236.206         6952.3         403.875         0.3           60.         870.         870.         10421.9         10421.9         750.723         0.3           60.         860.         870.         849.25         10431.9         750.723         0.3           60.         870.         870.         13911.598         849.638         819.669         13911.6         946.096         0.3           60.         1125.         1074.422         769.577         17394.1         1246.315         0.3           60.         1475.         1300.1         1391.576         13933.671         1344.795         0.3           60.         1475.         1379.63         124.359         1074.422         759.539         1344.795 </td <td>50.       150.       2371.       3475.       3475.521       149.989       149.989       149.989       149.989       10.00.00.000         50.       150.       23710.       3475.00       3475.521       149.989       149.989       149.989       149.989       10.00.000         50.       150.       47425.       1633.00       6953.127       224.975       649.899       236.206       6952.3       403.875       0.3         50.       675.       71131.       10425.       10432.00       5941.398       649.899       674.773       -663.596       10431.6       750.723       0.3         50.       850.       870.13       1331.0       13912.       13912.       13911.6       946.096       0.3         50.       1475.       1300.1       13912.       13911.398       849.638       819.664       -584.256       13911.6       946.096       0.3         50.       1475.       1300.1       13912.       13913.358       1124.358       10.3422       -584.256       13911.6       946.096       0.3         60.       1475.       1500.1       1473.959       1743.596       1074.422       759.511.6       946.096       0.3         1475.       15</td> <td>50.       150.       150.       23710.       3475.5       169.988       0.3         50.       150.       150.       23710.       3475.5       169.988       0.3         50.       150.       151.       1675.       169.988       149.989       149.993      
3475.5       169.988       0.3         50.       675.       1131.       10475.       16925.       649.785       649.785       443.895       0.3       375.0.3       0.3         50.       675.       675.       1731.       10475.       169.988       149.664       453.696       10431.9       750.733       0.3         50.       860.       675.       674.773       -564.775       -564.775       17391.6       946.096       0.3         50.       1305.       1074.755       17395.       17395.778       13941.2       1246.315       0.3         50.       1425.       1274.378       1244.398       1274.472       -664       -769.577       1746.316       0.3         50.       1425.4355       1274.373       1274.422       -769.577       1744.743       0.3         50.       1675.1257       1279.415       1243.396       1297.4422       -769.577       <td< td=""><td><math display="block">\begin{array}{cccccccccccccccccccccccccccccccccccc</math></td><td>50.100.57.100.57.100.57.100.57.100.57.100.57.100.57.100.57.100.57.100.57.100.57.100.57.100.57.100.57.100.57.100.57.100.57.100.57.100.57.100.57.100.57.100.57.100.57.100.57.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.</td><td>50.       150.       150.       150.       23710.       3475.5       159.       109.089       -104.093       3475.5       169.988       0.3         50.       275.       459.087       675.7       131.       10432.075       133.075       11043.093       3475.5       169.988       0.3         50.       6750.       6757       7131.       10432.0       1391.075       131.01043.1       750.03       3475.5       169.03       3475.5       169.03       3475.5       169.03       3475.5       169.03       3475.5       169.040       0.3       3475.5       169.988       0.3       3475.5       169.040       0.3       750.03       3475.5       169.040       0.3       750.03       3475.5       169.040       0.3       750.03       3475.5       169.040       0.3       750.03       750.03       3476.7       750.03       0.3       750.03       750.03       750.03       750.03       0.3       0.3       0.3       0.3       0.3       0.3       0.3       0.3       0.3       0.3       0.3       0.3       0.3       0.3       0.3       0.3       0.3       0.3       0.3       0.3       0.3       0.3       0.3       0.3       0.3       0.3</td><td>50.       150.       150.       23710.       3475.5       169.988       0.3         50.       150.       150.       150.       150.       149.989       149.989       149.989       104.993       3475.5       169.988       0.3         100.       225.       4131.       1311.       1312.       1312.       1312.       149.989       104.993       3475.5       169.083       0.3         100.       670.       670.       47131.       1312.       13422.       13432.       13432.       149.989       104.993       3475.5       169.080       0.3         200.       650.       670.       47131.       1340.1.125.       144.795       13911.69       640.733       0.3         201.       1775.       1175.       1175.       1074.422       750.577       17394.1       1246.315       0.3         201.       1675.       1675.       16976.       1675.599       1673.599       1673.599       133.41.9       2067.7       2075.7.2075.59       0.3         501.       1675.       16975.       16883.2       27565.2508       1973.656       133.41.9       2067.7       2075.7.559       0.3         501.       1675.       16896.3553</td><td>50.       150.       150.       150.       150.       149.989       149.989       149.989       149.989       103.875       169.988       0.3         100.       255.       4731.       655.       4731.       655.       403.73.9       570.33.65       1331.9       570.75       1331.9       570.75       1331.9       570.75       1331.9       570.75       1331.1       1447.990       1391.398       649.785       649.785       649.785       649.795       464.775       463.596       10431.6       946.096       0.3         250.       850.       870.5       1330.5       13312.13965       13392.13396       13391.356       13391.357       13391.1399       1391.475       13391.457       13394.1       124.569       0.3         250.       850.       870.5       13395.1       13395.1       13395.1       13395.1       13391.6       946.056       1973.452       1547.373       13394.1       1246.536       0.3         350.       1675.1       1525.165973.2       2346.565       1973.052       247.473       1744.102       2463.43       0.3       0.3       0.3       0.3       0.3       0.3       0.3       0.3       0.3       0.3       0.3       0.3       0.3<td>50.       150.       251.       149.       989       149.       989       114.       983       1157.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       10431.9       750.       150.       1031.9       150.       1031.9       150.       10431.9       750.       1031.9       150.9       10431.9       750.7       1031.9       150.9       10431.9       750.7       10391.9       1031.9       10431.9       750.7       1031.9       150.9       1031.9       150.9       1031.9       10431.9       750.7       10391.9       1031.9       10431.9       750.7       10391.9       10391.9       10391.9       10391.9       10391.9       10391.9       10391.9       10391.9       10391.9       10391.9       10391.9       1031.9       10391.9       1031.9       10391.9       1031.9       1031.9       1031.9       1031.9       1031.9       1031.9       1031.9       1031.9       1031.9       1031.9       1031.9       1031.9       1031.9       1031.9       1031.9       1031.9       1031.9       1031.9       1031.9       1031.9       1031.9       1031.9       1031.9</td><td>50.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.</td><td>50.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.</td><td>50.       15.       23710.       3475.       3475.521       149.969       140.965       167.75       17131.       16475.5       17131.       16475.5       17131.       16475.5       17131.       16475.5       17131.       16475.5       17131.       16475.5       17131.       16475.5       17355.10475.10475.10475.10475.10475.10475.10475.10475.10467.105       1549.568       695.6       695.6       695.7       71131.10475.116475.116475.110475.10467.105       1591.664       256.266       0595.7       71355.10475.11575.12575       31375.57357.13575.13595.13757.1375       1324.368       129.646.256       1391.1267       1391.1275       31375.575       1393.66       124.556       1391.1267       1391.1267       1391.1398       149.665       1391.1398       1315.157       31375.1575       1393.375       1315.135       1353.315       1315.135       1315.15       1356.15       1315.135       1315.15       1315.15       1357.15       1315.15       1315.15       1315.15       1315.15       1315.15       1315.15       1315.15       1315.15       1315.15       1315.15       1315.15       1315.15       1315.15       1315.15       1315.15       1315.15       1315.15       1315.15       1315.15       1315.15       1315.15       1315.15       1315.15       1315.15       1315.15</td><td>101.       755.       7131.       7131.       707.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       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     150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.</td><td>50.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.</td><td>50.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.</td><td>50       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       15</td><td><ul> <li>FULCELINTY TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTA</li></ul></td><td>190       275       490       772       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       1</td><td>19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0</td><td>19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1    
  19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1</td><td>11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       <td< td=""><td>101       175       101       175       101       175       101       175       101       175       101       175       101       175       101       175       101       175       101       175       101       175       101       175       101       175       101       175       101       175       101       175       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       1</td><td>5.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1</td><td>9.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.</td><td>51       1100       755       490       1100       747       90       140       90       147       90       147       90       147       90       147       90       147       90       147       100       757       100       757       100       757       100       757       100       757       100       757       100       1757       100       1757       100       1757       100       1757       100       1757       100       1757       100       1757       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100</td><td>Filt         Filt         <th< td=""><td>51.         1100.         275.         210.         275.         210.         275.         210.         275.         210.         275.         210.         275.         210.         275.         210.         275.         210.         275.         210.         275.         210.         275.         210.         275.         210.         275.         210.         275.         210.         275.         210.         275.         210.         275.         210.         275.         210.         275.         210.         275.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         <th< td=""><td>51.       100.       755.       991.       3776       100993.       3776       100993.       3776       100993.       3776       100993.       3776       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100933.       100993.  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   10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.</td><td>9.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1  
    1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1</td><td>Fight         Fight         <th< td=""><td>Column State         Column State&lt;</td><td>Cols         Cols         <thcols< th="">         Cols         Cols         <thc< td=""><td></td><td>1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1</td></thc<></thcols<></td></th<></td></th<></td></th<></td></td<></td></td></td<></td> | 50.       150.       2371.       3475.       3475.521       149.989       149.989       149.989       149.989       10.00.00.000         50.       150.       23710.       3475.00       3475.521       149.989       149.989       149.989       149.989       10.00.000         50.       150.       47425.       1633.00       6953.127       224.975       649.899       236.206       6952.3       403.875       0.3         50.       675.       71131.       10425.       10432.00       5941.398       649.899       674.773       -663.596       10431.6       750.723       0.3         50.       850.       870.13       1331.0       13912.       13912.       13911.6       946.096       0.3         50.       1475.       1300.1       13912.       13911.398       849.638       819.664       -584.256       13911.6       946.096       0.3         50.       1475.       1300.1       13912.       13913.358       1124.358       10.3422       -584.256       13911.6       946.096       0.3         60.       1475.       1500.1       1473.959       1743.596       1074.422       759.511.6       946.096       0.3         1475.       15 | 50.       150.       150.       23710.       3475.5       169.988       0.3         50.       150.       150.       23710.       3475.5       169.988       0.3         50.       150.       151.       1675.       169.988       149.989       149.993       3475.5       169.988       0.3         50.       675.       1131.       10475.       16925.       649.785       649.785       443.895       0.3       375.0.3       0.3         50.       675.       675.       1731.       10475.       169.988       149.664       453.696       10431.9       750.733       0.3         50.       860.       675.       674.773       -564.775       -564.775       17391.6       946.096       0.3         50.       1305.       1074.755       17395.       17395.778       13941.2       1246.315       0.3         50.       1425.       1274.378       1244.398       1274.472       -664       -769.577       1746.316       0.3         50.       1425.4355       1274.373       1274.422       -769.577       1744.743       0.3         50.       1675.1257       1279.415       1243.396       1297.4422       -769.577 <td< td=""><td><math display="block">\begin{array}{cccccccccccccccccccccccccccccccccccc</math></td><td>50.100.57.100.57.100.57.100.57.100.57.100.57.100.57.100.57.100.57.100.57.100.57.100.57.100.57.100.57.100.57.100.57.100.57.100.57.100.57.100.57.100.57.100.57.100.57.100.57.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.</td><td>50.       150.       150.       150.       23710.       3475.5       159.       109.089       -104.093       3475.5       169.988       0.3         50.       275.       459.087       675.7       131.       10432.075       133.075       11043.093       3475.5       169.988       0.3         50.       6750.       6757       7131.       10432.0       1391.075       131.01043.1       750.03       3475.5       169.03       3475.5       169.03       3475.5       169.03       3475.5       169.03       3475.5       169.040       0.3       3475.5       169.988       0.3       3475.5       169.040       0.3       750.03       3475.5       169.040       0.3       750.03       3475.5       169.040       0.3       750.03       3475.5       169.040       0.3       750.03       750.03       3476.7       750.03       0.3       750.03       750.03       750.03       750.03       0.3       0.3       0.3       0.3       0.3       0.3       0.3       0.3       0.3       0.3       0.3       0.3       0.3       0.3       0.3       0.3       0.3       0.3       0.3       0.3       0.3       0.3       0.3       0.3       0.3       0.3</td><td>50.       150.       150.       23710.       3475.5       169.988       0.3         50.       150.       150.       150.       150.       149.989       149.989       149.989       104.993       3475.5       169.988       0.3         100.       225.       4131.       1311.       1312.       1312.       1312.       149.989       104.993       3475.5       169.083       0.3         100.       670.       670.       47131.       1312.       13422.       13432.       13432.       149.989       104.993       3475.5       169.080       0.3         200.       650.       670.       47131.       1340.1.125.       144.795       13911.69       640.733       0.3         201.       1775.       1175.       1175.       1074.422       750.577       17394.1       1246.315       0.3         201.       1675.       1675.       16976.       1675.599       1673.599       1673.599       133.41.9       2067.7       2075.7.2075.59       0.3         501.       1675.       16975.       16883.2       27565.2508       1973.656       133.41.9       2067.7       2075.7.559       0.3         501.       1675.       16896.3553</td><td>50.       150.       150.       150.       150.       149.989       149.989       149.989       149.989       103.875       169.988       0.3         100.       255.       4731.       655.       4731.       655.       403.73.9       570.33.65       1331.9       570.75       1331.9       570.75       1331.9       570.75       1331.9       570.75       1331.1       1447.990       1391.398       649.785       649.785       649.785       649.795       464.775       463.596       10431.6       946.096       0.3         250.       850.       870.5       1330.5       13312.13965       13392.13396       13391.356       13391.357       13391.1399       1391.475       13391.457       13394.1       124.569       0.3         250.       850.       870.5       13395.1       13395.1       13395.1       13395.1       13391.6       946.056       1973.452       1547.373       13394.1       1246.536       0.3         350.       1675.1       1525.165973.2       2346.565       1973.052       247.473       1744.102       2463.43       0.3       0.3       0.3       0.3       0.3       0.3       0.3       0.3       0.3       0.3       0.3       0.3       0.3<td>50.       150.       251.       149.       989       149.       989       114.       983       1157.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       10431.9       750.       150.       1031.9       150.       1031.9       150.       10431.9       750.       1031.9       150.9       10431.9       750.7       1031.9       150.9       10431.9       750.7       10391.9       1031.9       10431.9       750.7       1031.9       150.9       1031.9       150.9       1031.9       10431.9       750.7       10391.9       1031.9       10431.9       750.7       10391.9       10391.9       10391.9       10391.9       10391.9       10391.9       10391.9       10391.9       10391.9       10391.9       10391.9       1031.9       10391.9       1031.9       10391.9       1031.9       1031.9       1031.9       1031.9       1031.9       1031.9       1031.9       1031.9       1031.9       1031.9       1031.9       1031.9       1031.9       1031.9       1031.9       1031.9       1031.9       1031.9       1031.9       1031.9       1031.9       1031.9       1031.9</td><td>50.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.    
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   150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.</td><td>50.       15.       23710.       3475.       3475.521       149.969       140.965       167.75       17131.       16475.5       17131.       16475.5       17131.       16475.5       17131.       16475.5       17131.       16475.5       17131.       16475.5       17131.       16475.5       17355.10475.10475.10475.10475.10475.10475.10475.10475.10467.105       1549.568       695.6       695.6       695.7       71131.10475.116475.116475.110475.10467.105       1591.664       256.266       0595.7       71355.10475.11575.12575       31375.57357.13575.13595.13757.1375       1324.368       129.646.256       1391.1267       1391.1275       31375.575       1393.66       124.556       1391.1267       1391.1267       1391.1398       149.665       1391.1398       1315.157       31375.1575       1393.375       1315.135       1353.315       1315.135       1315.15       1356.15       1315.135       1315.15       1315.15       1357.15       1315.15       1315.15       1315.15       1315.15       1315.15       1315.15       1315.15       1315.15       1315.15       1315.15       1315.15       1315.15       1315.15       1315.15       1315.15       1315.15       1315.15       1315.15       1315.15       1315.15       1315.15       1315.15       1315.15       1315.15       1315.15</td><td>101.       755.       7131.       7131.       707.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       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 150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.</td><td>50.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.     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   157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.</td><td>50       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       15</td><td><ul> <li>FULCELINTY TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL 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140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       1</td><td>19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0</td><td>19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1</td><td>11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11 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101       175       101       175       101       175       101       175       101       175       101       175       101       175       101       175       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       1</td><td>5.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1</td><td>9.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.</td><td>51       1100       755       490       1100       747       90       140       90       147       90       147       90       147       90       147       90       147       90       147       100       757       100       757       100       757       100       757       100       757       100       757       100       1757       100       1757       100       1757       100       1757       100       1757       100       1757       100       1757       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100</td><td>Filt         Filt         <th< td=""><td>51.         1100.         275.         210.         275.         210.         275.         210.         275.         210.         275.         210.         275.         210.         275.         210.         275.         210.         275.         210.         275.         210.         275.         210.         275.         210.         275.         210.         275.         210.         275.         210.         275.         210.         275.         210.         275.         210.         275.         210.         275.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.        
210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         <th< td=""><td>51.       100.       755.       991.       3776       100993.       3776       100993.       3776       100993.       3776       100993.       3776       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100933.       100993.       100933.       100933.       100933.       100933.       100933.       100933.       100933.       100933.       100933.       100933.       100933.       100933.       100933.       100933.       100933.       1</td><td>9.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.</td><td>9.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1</td><td>Fight         Fight         <th< td=""><td>Column State         Column State&lt;</td><td>Cols         Cols         <thcols< th="">         Cols         Cols         <thc< td=""><td></td><td>1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1</td></thc<></thcols<></td></th<></td></th<></td></th<></td></td<></td></td></td<> | $\begin{array}{cccccccccccccccccccccccccccccccccccc$ | 50.100.57.100.57.100.57.100.57.100.57.100.57.100.57.100.57.100.57.100.57.100.57.100.57.100.57.100.57.100.57.100.57.100.57.100.57.100.57.100.57.100.57.100.57.100.57.100.57.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100.100. | 50.       150.       150.       150.       23710.       3475.5       159.       109.089       -104.093       3475.5       169.988       0.3         50.       275.       459.087       675.7       131.       10432.075       133.075       11043.093       3475.5       169.988       0.3         50.       6750.       6757       7131.       10432.0       1391.075       131.01043.1       750.03       3475.5       169.03       3475.5       169.03       3475.5       169.03       3475.5       169.03       3475.5       169.040       0.3       3475.5       169.988       0.3       3475.5       169.040       0.3       750.03       3475.5       169.040       0.3       750.03       3475.5       169.040       0.3       750.03       3475.5       169.040       0.3       750.03       750.03       3476.7       750.03       0.3       750.03       750.03       750.03       750.03       0.3       0.3       0.3       0.3       0.3       0.3       0.3       0.3       0.3       0.3       0.3       0.3       0.3       0.3       0.3       0.3       0.3       0.3       0.3       0.3       0.3       0.3       0.3       0.3       0.3       0.3 | 50.       150.       150.       23710.       3475.5       169.988       0.3         50.       150.       150.       150.       150.       149.989       149.989       149.989       104.993       3475.5       169.988       0.3         100.       225.       4131.       1311.       1312.       1312.       1312.       149.989       104.993       3475.5       169.083       0.3         100.       670.       670.       47131.       1312.       13422.       13432.       13432.       149.989       104.993       3475.5       169.080       0.3         200.       650.       670.       47131.       1340.1.125.       144.795       13911.69       640.733       0.3         201.       1775.       1175.       1175.       1074.422       750.577       17394.1       1246.315       0.3         201.       1675.       1675.       16976.       1675.599       1673.599       1673.599       133.41.9       2067.7       2075.7.2075.59       0.3         501.       1675.       16975.       16883.2       27565.2508       1973.656       133.41.9       2067.7       2075.7.559       0.3         501.       1675.       16896.3553 | 50.       150.       150.       150.       150.       149.989       149.989       149.989       149.989       103.875       169.988       0.3         100.       255.       4731.       655.       4731.       655.       403.73.9       570.33.65       1331.9       570.75       1331.9       570.75       1331.9       570.75       1331.9       570.75       1331.1       1447.990       1391.398       649.785       649.785       649.785       649.795       464.775       463.596       10431.6       946.096       0.3         250.       850.       870.5       1330.5       13312.13965       13392.13396       13391.356       13391.357       13391.1399       1391.475       13391.457       13394.1       124.569       0.3         250.       850.       870.5       13395.1       13395.1       13395.1       13395.1       13391.6       946.056       1973.452       1547.373       13394.1       1246.536       0.3         350.       1675.1       1525.165973.2       2346.565       1973.052       247.473       1744.102       2463.43       0.3       0.3       0.3       0.3       0.3       0.3       0.3       0.3       0.3       0.3       0.3       0.3       0.3 <td>50.       150.       251.       149.       989       149.       989       114.       983       1157.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       10431.9       750.       150.       1031.9       150.       1031.9       150.       10431.9       750.       1031.9       150.9       10431.9       750.7       1031.9       150.9       10431.9       750.7       10391.9       1031.9       10431.9       750.7       1031.9       150.9       1031.9       150.9       1031.9       10431.9       750.7       10391.9       1031.9       10431.9       750.7       10391.9       10391.9       10391.9       10391.9       10391.9       10391.9       10391.9      
10391.9       10391.9       10391.9       10391.9       1031.9       10391.9       1031.9       10391.9       1031.9       1031.9       1031.9       1031.9       1031.9       1031.9       1031.9       1031.9       1031.9       1031.9       1031.9       1031.9       1031.9       1031.9       1031.9       1031.9       1031.9       1031.9       1031.9       1031.9       1031.9       1031.9       1031.9</td> <td>50.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.</td> <td>50.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.</td> <td>50.       15.       23710.       3475.       3475.521       149.969       140.965       167.75       17131.       16475.5       17131.       16475.5       17131.       16475.5       17131.       16475.5       17131.       16475.5       17131.       16475.5       17131.       16475.5       17355.10475.10475.10475.10475.10475.10475.10475.10475.10467.105       1549.568       695.6       695.6       695.7       71131.10475.116475.116475.110475.10467.105       1591.664       256.266       0595.7       71355.10475.11575.12575       31375.57357.13575.13595.13757.1375       1324.368       129.646.256       1391.1267       1391.1275       31375.575       1393.66       124.556       1391.1267       1391.1267       1391.1398       149.665       1391.1398       1315.157       31375.1575       1393.375       1315.135       1353.315       1315.135       1315.15       1356.15       1315.135       1315.15       1315.15       1357.15       1315.15       1315.15       1315.15       1315.15       1315.15       1315.15       1315.15       1315.15       1315.15       1315.15       1315.15       1315.15       1315.15       1315.15       1315.15       1315.15       1315.15       1315.15       1315.15       1315.15       1315.15       1315.15       1315.15       1315.15       1315.15</td> <td>101.       755.       7131.       7131.       707.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.</td> <td>50.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.</td> <td>50.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.</td> <td>50.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.</td> <td>50       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       15</td> <td><ul> <li>FULCELINTY TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL
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140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       1</td> <td>19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0</td> <td>19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1</td> <td>11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11      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  175       101       175       101       175       101       175       101       175       101       175       101       175       101       175       101       175       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       1</td><td>5.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1      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 1.         1.         1.         1.         1.         1.         1.         1.         1.         1.</td><td>51       1100       755       490       1100       747       90       140       90       147       90       147       90       147       90       147       90       147       90       147       100       757       100       757       100       757       100       757       100       757       100       757       100       1757       100       1757       100       1757       100       1757       100       1757       100       1757       100       1757       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100      
100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100</td><td>Filt         Filt         <th< td=""><td>51.         1100.         275.         210.         275.         210.         275.         210.         275.         210.         275.         210.         275.         210.         275.         210.         275.         210.         275.         210.         275.         210.         275.         210.         275.         210.         275.         210.         275.         210.         275.         210.         275.         210.         275.         210.         275.         210.         275.         210.         275.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.    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    10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.</td><td>9.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1</td><td>Fight         Fight         <th< td=""><td>Column State         Column State&lt;</td><td>Cols         Cols         <thcols< th="">         Cols         Cols         <thc< td=""><td></td><td>1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1</td></thc<></thcols<></td></th<></td></th<></td></th<></td></td<></td> | 50.       150.       251.       149.       989       149.       989       114.       983       1157.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       10431.9       750.       150.       1031.9       150.       1031.9       150.       10431.9       750.       1031.9       150.9       10431.9       750.7       1031.9       150.9       10431.9       750.7       10391.9       1031.9       10431.9       750.7       1031.9       150.9       1031.9       150.9       1031.9       10431.9       750.7       10391.9       1031.9       10431.9       750.7       10391.9       10391.9       10391.9       10391.9       10391.9       10391.9       10391.9       10391.9       10391.9       10391.9       10391.9       1031.9       10391.9       1031.9       10391.9       1031.9       1031.9       1031.9       1031.9       1031.9       1031.9       1031.9       1031.9       1031.9       1031.9       1031.9       1031.9       1031.9       1031.9       1031.9       1031.9       1031.9       1031.9       1031.9       1031.9       1031.9       1031.9       1031.9 | 50.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150. | 50.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150. | 50.       15.       23710.       3475.       3475.521       149.969       140.965       167.75       17131.       16475.5       17131.       16475.5       17131.       16475.5       17131.       16475.5       17131.       16475.5       17131.       16475.5       17131.       16475.5       17355.10475.10475.10475.10475.10475.10475.10475.10475.10467.105       1549.568       695.6       695.6       695.7       71131.10475.116475.116475.110475.10467.105
      1591.664       256.266       0595.7       71355.10475.11575.12575       31375.57357.13575.13595.13757.1375       1324.368       129.646.256       1391.1267       1391.1275       31375.575       1393.66       124.556       1391.1267       1391.1267       1391.1398       149.665       1391.1398       1315.157       31375.1575       1393.375       1315.135       1353.315       1315.135       1315.15       1356.15       1315.135       1315.15       1315.15       1357.15       1315.15       1315.15       1315.15       1315.15       1315.15       1315.15       1315.15       1315.15       1315.15       1315.15       1315.15       1315.15       1315.15       1315.15       1315.15       1315.15       1315.15       1315.15       1315.15       1315.15       1315.15       1315.15       1315.15       1315.15       1315.15 | 101.       755.       7131.       7131.       707.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750.       750. | 50.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150.       150. | 50.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175. | 50.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157.       157. | 50       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       150       15 | <ul> <li>FULCELINTY TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL 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  140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       140       1 | 19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0  
    19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0       19.0 | 19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1       19.1 | 11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11       11 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 101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       1</td><td>5.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1</td><td>9.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.</td><td>51       1100       755       490       1100       747       90       140       90       147       90       147       90       147       90       147       90       147       90       147       100       757       100       757       100       757       100       757       100       757       100       757       100       1757       100       1757       100       1757       100       1757       100       1757       100       1757       100       1757       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100</td><td>Filt         Filt         <th< td=""><td>51.         1100.         275.         210.         275.         210.         275.         210.         275.         210.         275.         210.         275.         210.         275.         210.         275.         210.         275.         210.         275.         210.         275.         210.         275.         210.         275.         210.         275.         210.         275.         210.         275.         210.         275.         210.         275.         210.         275.         210.         275.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.  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   1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1</td><td>Fight         Fight         <th< td=""><td>Column State         Column State&lt;</td><td>Cols         Cols         <thcols< th="">         Cols         Cols         <thc< td=""><td></td><td>1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1</td></thc<></thcols<></td></th<></td></th<></td></th<></td></td<> | 101       175       101       175       101       175       101       175       101       175       101       175       101       175       101       175       101       175       101       175       101       175       101       175       101       175       101       175       101       175       101       175       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       101       1 | 5.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1 | 9.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1.         1. | 51       1100       755       490       1100       747       90       140       90       147       90       147       90       147       90       147       90       147       90       147       100       757       100       757       100       757       100       757       100       757       100       757       100       1757       100       1757       100       1757       100       1757       100       1757       100       1757       100       1757       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100       100 | Filt         Filt         Filt         Filt         Filt         Filt         Filt         Filt         Filt         Filt         Filt         Filt         Filt         Filt         Filt         Filt         Filt         Filt         Filt         Filt         Filt         Filt         Filt         Filt         Filt         Filt         Filt         Filt         Filt         Filt         Filt         Filt         Filt         Filt         Filt         Filt         Filt         Filt         Filt         Filt         Filt         Filt         Filt         Filt         Filt         Filt         Filt         Filt         Filt         Filt         Filt         Filt         Filt         Filt         Filt         Filt         Filt         Filt         Filt         Filt         Filt         Filt         Filt         Filt         Filt         Filt         Filt         Filt         Filt         Filt         Filt         Filt         Filt         Filt         Filt         Filt         Filt         Filt         Filt         Filt         Filt         Filt         Filt         Filt         Filt         Filt         Filt         Filt         Filt         Filt         Filt         Filt <th< td=""><td>51.         1100.         275.         210.         275.         210.         275.         210.         275.         210.         275.         210.         275.         210.         275.         210.         275.         210.         275.         210.         275.         210.         275.         210.         275.         210.         275.         210.         275.         210.         275.         210.         275.         210.         275.         210.         275.         210.         275.         210.         275.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         <th< td=""><td>51.       100.       755.       991.       3776       100993.       3776       100993.       3776       100993.       3776       100993.       3776       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.      
100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100933.       100993.       100933.       100933.       100933.       100933.       100933.       100933.       100933.       100933.       100933.       100933.       100933.       100933.       100933.       100933.       100933.       1</td><td>9.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.</td><td>9.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1</td><td>Fight         Fight         <th< td=""><td>Column State         Column State&lt;</td><td>Cols         Cols         <thcols< th="">         Cols         Cols         <thc< td=""><td></td><td>1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1</td></thc<></thcols<></td></th<></td></th<></td></th<> | 51.         1100.         275.         210.         275.         210.         275.         210.         275.         210.         275.         210.         275.         210.         275.         210.         275.         210.         275.         210.         275.         210.         275.         210.         275.         210.         275.         210.         275.         210.         275.         210.         275.         210.         275.         210.         275.         210.         275.         210.         275.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210.         210. <th< td=""><td>51.       100.       755.       991.       3776       100993.       3776       100993.       3776       100993.       3776       100993.       3776       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       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10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.</td><td>9.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1</td><td>Fight         Fight         <th< td=""><td>Column State         Column State&lt;</td><td>Cols         Cols         <thcols< th="">         Cols         Cols         <thc< td=""><td></td><td>1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1
        1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1</td></thc<></thcols<></td></th<></td></th<> | 51.       100.       755.       991.       3776       100993.       3776       100993.       3776       100993.       3776       100993.       3776       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100993.       100933.       100993.       100933.       100933.       100933.       100933.       100933.       100933.       100933.       100933.       100933.       100933.       100933.       100933.       100933.       100933.       100933.       1 | 9.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10.         10. | 9.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1.1       1 | Fight         Fight         Fight         Fight         Fight         Fight         Fight         Fight         Fight         Fight         Fight         Fight         Fight         Fight         Fight         Fight         Fight         Fight         Fight         Fight         Fight         Fight         Fight         Fight         Fight         Fight         Fight         Fight         Fight         Fight         Fight         Fight         Fight         Fight         Fight         Fight         Fight         Fight         Fight         Fight         Fight         Fight         Fight         Fight         Fight         Fight         Fight         Fight         Fight         Fight         Fight         Fight         Fight         Fight         Fight         Fight         Fight         Fight         Fight         Fight         Fight         Fight         Fight         Fight         Fight         Fight         Fight         Fight         Fight         Fight         Fight         Fight         Fight         Fight         Fight         Fight         Fight         Fight         Fight         Fight         Fight         Fight         Fight         Fight         Fight         Fight         Fight         Fight <th< td=""><td>Column State         Column State&lt;</td><td>Cols         Cols         <thcols< th="">         Cols         Cols         <thc< td=""><td></td><td>1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1</td></thc<></thcols<></td></th<> | Column State         Column State         Column State         Column State         Column State         Column State         Column State         Column State         Column State         Column State         Column State         Column State         Column State         Column State         Column State         Column State         Column State         Column State         Column State         Column State         Column State         Column State         Column State         Column State         Column State         Column State         Column State         Column State         Column State         Column State         Column State         Column State         Column State         Column State         Column State         Column State         Column State         Column State         Column State         Column State         Column State         Column State         Column State         Column State         Column State         Column State         Column State         Column State         Column State         Column State         Column State         Column State         Column State         Column State         Column State         Column State         Column State         Column State         Column State         Column State         Column State         Column State         Column State         Column State         Column State         Column State         Column State         Column State< | Cols         Cols         Cols         Cols         Cols         Cols         Cols         Cols         Cols         Cols         Cols         Cols         Cols         Cols         Cols         Cols         Cols         Cols         Cols         Cols         Cols         Cols         Cols         Cols         Cols         Cols         Cols         Cols         Cols         Cols         Cols         Cols         Cols         Cols         Cols         Cols         Cols         Cols         Cols         Cols         Cols         Cols         Cols         Cols         Cols         Cols         Cols         Cols         Cols         Cols         Cols         Cols         Cols         Cols         Cols         Cols         Cols         Cols         Cols         Cols         Cols         Cols         Cols         Cols         Cols         Cols         Cols         Cols         Cols         Cols         Cols         Cols         Cols         Cols         Cols         Cols         Cols         Cols         Cols         Cols         Cols         Cols         Cols         Cols         Cols         Cols         Cols         Cols         Cols <thcols< th="">         Cols         Cols         <thc< td=""><td></td><td>1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1       
 1.1         1.1         1.1</td></thc<></thcols<> |         | 1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1         1.1 |

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

TEST NUMBER 5 GAGES 7 AND

Machine Linke         Mild, wild, wild, wild wild, wild wild, wild wild wild wild wild wild wild wild	יבסמי	5.0		×.	S	٩	MSD L	RU LON	TRU	RU LO	RA	112233	CCCCCT1V	
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100.         500.         500.         500.         500.         500.         500.         500.         500.         500.         500.         500.         500.         500.         500.         500.         500.         500.         500.         500.         500.         500.         500.         500.         500.         500.         500.         500.         500.         500.         500.         500.         500.         500.         500.         500.         500.         500.         500.         500.         500.         500.         500.         500.         500.         500.         500.         500.         500.         500.         500.         500.         500.         500.         500.         500.         500.         500.         500.         500.         500.         500.         500.         500.         500.         500.         500.         500.         500.         500.         500.         500.         500.         500.         500.         500.         500.         500.         500.         500.         500.         500.         500.         500.         500.         500.         500.         500.         500.         500.         500.         500. <th< td=""><td>000</td><td></td><td>NIN</td><td></td><td>1Sd</td><td>a.</td><td>PS</td><td>ISd</td><td>5</td><td>CR01N/</td><td>CROIN/I</td><td>Sd</td><td>HICINI</td><td></td></th<>	000		NIN		1Sd	a.	PS	ISd	5	CR01N/	CROIN/I	Sd	HICINI	
Title:         Title:         Title:         Title:         Title:         Title:         Title:         Title:         Title:         Title:         Title:         Title:         Title:         Title:         Title:         Title:         Title:         Title:         Title:         Title:         Title:         Title:         Title:         Title:         Title:         Title:         Title:         Title:         Title:         Title:         Title:         Title:         Title:         Title:         Title:         Title:         Title:         Title:         Title:         Title:         Title:         Title:         Title:         Title:         Title:         Title:         Title:         Title:         Title:         Title:         Title:         Title:         Title:         Title:         Title:         Title:         Title:         Title:         Title:         Title:         Title:         Title:         Title:         Title:         Title:         Title:         Title:         Title:         Title:         Title:         Title:         Title:         Title:         Title:         Title:         Title:         Title:         Title:         Title:         Title:         Title:         Title:         Title:         Title:         Title:<		250		11855.	475	3476.	5	737	249.9	5.00	-96.2	3010	202.85	0.3
7011         1175         7071         1175         7071         1175         7071         1175         7071         1175         7071         1175         7071         7071         7071         7071         7071         7071         7071         7071         7071         7071         7071         7071         7071         7071         7071         7071         7071         7071         7071         7071         7071         7071         7071         7071         7071         7071         7071         7071         7071         7071         7071         7071         7071         7071         7071         7071         7071         7071         7071         7071         7071         7071         7071         7071         7071         7071         7071         7071         7071         7071         7071         7071         7071         7071         7071         7071         7071         7071         7071         7071         7071         7071         7071         7071         7071         7071         7071         7071         7071         7071         7071         7071         7071         7071         7071         7071         7071         7071         7071         7071 <th< td=""><td>ŝ</td><td>825</td><td></td><td>5 7 7 0 •</td><td>1000</td><td></td><td>2</td><td></td><td>940</td><td>66.6</td><td>227.4</td><td>6022</td><td>450.62</td><td>0</td></th<>	ŝ	825		5 7 7 0 •	1000		2		940	66.6	227.4	6022	450.62	0
770.         177.         773.         773.         773.         773.         773.         773.         773.         773.         773.         773.         773.         773.         773.         773.         773.         773.         773.         773.         773.         773.         773.         773.         773.         773.         773.         773.         773.         773.         773.         773.         773.         773.         773.         773.         773.         773.         773.         773.         773.         773.         773.         773.         773.         773.         773.         773.         773.         773.         773.         773.         773.         773.         773.         773.         773.         773.         773.         773.         773.         773.         773.         773.         773.         773.         773.         773.         773.         773.         773.         773.         773.         773.         773.         773.         773.         773.         773.         773.         773.         773.         773.         773.         773.         773.         773.         773.         773. <th73.< th="">         773.         773.         7</th73.<>	00	1125		421.	3900	1010	55	613 951	1124.3	8 × 0 × 0	8	1206	679.39	
Wile         Trans.         Wile         Trans.         Wile	0 5 0	1475		276.	7375	7401	8688	8690	1473.9	9.95	520.8	15069	1212	0.35
Min.         Min.         Min.         Min.         Min.         Min.         Min.         Min.         Min.         Min.         Min.         Min.         Min.         Min.         Min.         Min.         Min.         Min.         Min.         Min.         Min.         Min.         Min.         Min.         Min.         Min.         Min.         Min.         Min.         Min.         Min.         Min.         Min.         Min.         Min.         Min.         Min.         Min.         Min.         Min.         Min.         Min.         Min.         Min.         Min.         Min.         Min.         Min.         Min.         Min.         Min.         Min.         Min.         Min.         Min.         Min.         Min.         Min.         Min.         Min.         Min.         Min.         Min.         Min.         Min.         Min.         Min.         Min.         Min.         Min.         Min.         Min.         Min.         Min.         Min.         Min.         Min.         Min.         Min.         Min.         Min.         Min.         Min.         Min.         Min.         Min.         Min.         Min.         Min.         Min.         Min.         Min. <th< td=""><td>່ວ່າ</td><td>0400</td><td><u>, i</u></td><td>.101.</td><td>0420</td><td>1987</td><td>1 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2</td><td>0428</td><td>1773.4</td><td>4.93</td><td>751.9</td><td>16088</td><td>1460.82</td><td>0.3</td></th<>	່ວ່າ	0400	<u>, i</u>	.101.	0420	1987	1 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2	0428	1773.4	4.93	751.9	16088	1460.82	0.3
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910.         3737.         619.         1109.         1109.         1113.         11213.         1213.         1213.         1213.         1213.         1213.         1213.         1213.         1213.         1213.         1213.         1213.         1213.         1213.         1213.         1213.         1213.         1213.         1213.         1213.         1213.         1213.         1213.         1213.         1213.         1213.         1213.         1213.         1213.         1213.         1213.         1213.         1213.         1213.         1213.         1213.         1213.         1213.         1213.         1213.         1213.         1213.         1213.         1213.         1213.         1213.         1213.         1213.         1213.         1213.         1213.         1213.         1213.         1213.         1213.         1213.         1213.         1213.         1213.         1213.         1213.         1213.         1213.         1213.         1213.         1213.         1213.         1213.         1213.         1213.         1213.         1213.         1213.         1213.         1213.         1213.         1213.         1213.         1213.         1213.         1213.         1213. <th1< td=""><td>20</td><td>2825</td><td></td><td>697.</td><td>1275</td><td>31363.</td><td>5638</td><td>5646</td><td>2821.0</td><td></td><td></td><td>27141</td><td>2132.00</td><td></td></th1<>	20	2825		697.	1275	31363.	5638	5646	2821.0			27141	2132.00	
790.         300.         710.         130407         31224.1         19125.09         5443.35         699.756         -1570.09         31224.1           EST NUMER         5 ddES         5 AND         6         710.         130407         711.1         910.00         411.1         910.01         711.1         910.01         711.1         910.01         711.1         910.01         711.1         910.01         711.1         910.01         711.1         910.01         911.1         910.01         911.1         910.01         911.1         911.1         911.1         911.1         911.1         911.1         911.1         911.1         911.1         911.1         911.1         911.1         911.1         911.1         911.1         911.1         911.1         911.1         911.1         911.1         911.1         911.1         911.1         911.1         911.1         911.1         911.1         911.1         911.1         911.1         911.1         911.1         911.1         911.1         911.1         911.1         911.1         911.1         911.1         911.1         911.1         911.1         911.1         911.1         911.1         911.1         911.1         911.1         911.1         911.1         911	0	22		1552.		34862.	737	7386	3219.8	9.78	54.3	30191	2647.62	
ET         NUMBER         5.4.06         5.4.00         6.7         FUL         FUL <th< td=""><td>n -</td><td>÷0</td><td></td><td>407.</td><td></td><td>38365.</td><td>911</td><td>9125</td><td>3643.3</td><td>9.75</td><td>520.0</td><td>33224</td><td>2990.86</td><td>0.3</td></th<>	n -	÷0		407.		38365.	911	9125	3643.3	9.75	520.0	33224	2990.86	0.3
EST NUMBER 5 GAGE 5 AND A         Constrained         FRU LONG						:								
RESS         STRUIN         FILL         <	EST	UMRER	GAGE	AN	¢								:	
PRES         THERS         THERS <tht< td=""><td>× DR</td><td>CIR</td><td>No</td><td>XIAL</td><td>SD C</td><td>5 05</td><td>us Su</td><td>R()   0N</td><td></td><td></td><td></td><td></td><td></td><td></td></tht<>	× DR	CIR	No	XIAL	SD C	5 05	us Su	R()   0N						
PS1         HICROINVIN         POUNDS         PS1         FS1         PS1         HICROINVIN         HICROINVIN         HICROINVIN         PS0         S0         S0 <ths0< th="">         S0         S0         <ths0< <="" td=""><td>RES</td><td>STRAIN</td><td>STRAT</td><td>LOAD</td><td>TRES</td><td>TRES</td><td>TRES</td><td>STRES</td><td>STRAI</td><td>STRAI</td><td>STR</td><td>STRES</td><td>È.</td><td>2</td></ths0<></ths0<>	RES	STRAIN	STRAT	LOAD	TRES	TRES	TRES	STRES	STRAI	STRAI	STR	STRES	È.	2
Give         Give         Give         Give         Give         Give         Give         Give         Give         Give         Give         Give         Give         Give         Give         Give         Give         Give         Give         Give         Give         Give         Give         Give         Give         Give         Give         Give         Give         Give         Give         Give         Give         Give         Give         Give         Give         Give         Give         Give         Give         Give         Give         Give         Give         Give         Give         Give         Give         Give         Give         Give         Give         Give         Give         Give         Give         Give         Give         Give         Give         Give         Give         Give         Give         Give         Give         Give         Give         Give         Give         Give         Give         Give         Give         Give         Give         Give         Give         Give         Give         Give         Give         Give         Give         Give         Give         Give         Give <thgive< th="">         Give         Give         <thg< td=""><td>PS I</td><td>MICROI</td><td>N</td><td>UNDO</td><td>S</td><td>v:</td><td>cn.</td><td>S</td><td>CROIN/I</td><td>CROINLI</td><td>I CRO I N</td><td>5</td><td>MICIN/I</td><td></td></thg<></thgive<>	PS I	MICROI	N	UNDO	S	v:	cn.	S	CROIN/I	CROINLI	I CRO I N	5	MICIN/I	
00.         400.         205.         53710.         6950.         6973.         3475.437         599.437         199.930         -1337.337         600.         600.         200.         600.         205.         6470.1         1371.1         521.0         999.437.337         10090.1           00.         800.         575.         57270.1         1371.1         521.0         974.437         1370.0         773.1         1270.0         721.137         1400.007         741.000         747.431         1270.0         741.000         721.137         1270.0         721.137         1270.0         721.137         721.137         1270.0         721.137         1270.0         721.000         721.137         1270.0         721.000         721.137         1270.0         721.000         721.137         1270.0         721.000         721.137         1270.0         721.000         721.000         721.137         1270.0         721.000         721.000         721.000         721.000         721.000         721.000         721.000         721.000         721.000         721.000         721.000         721.000         721.000         721.000         721.000         721.000         721.000         721.000         721.000         721.000         721.000         721.000	c	200	50.	1855	47	4	5	7.58	80.98	00.00	87. 4	0.0	00.441	
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CUL         CUL         CUL         CUL         CUL         CUL         CUL         CUL         CUL         CUL         CUL         CUL         CUL         CUL         CUL         CUL         CUL         CUL         CUL         CUL         CUL         CUL         CUL         CUL         CUL         CUL         CUL         CUL         CUL         CUL         CUL         CUL         CUL         CUL         CUL         CUL         CUL         CUL         CUL         CUL         CUL         CUL         CUL         CUL         CUL         CUL         CUL         CUL         CUL         CUL         CUL         CUL         CUL         CUL         CUL         CUL         CUL         CUL         CUL         CUL         CUL         CUL         CUL         CUL         CUL         CUL         CUL         CUL         CUL         CUL         CUL         CUL         CUL         CUL         CUL         CUL         CUL         CUL         CUL         CUL         CUL         CUL         CUL         CUL         CUL         CUL         CUL         CUL         CUL         CUL         CUL         CUL         CUL         CUL <thcul< th=""> <thcul< th=""> <thcul< th=""></thcul<></thcul<></thcul<>		600	Ο'L	5566	0425.	0431	213	3.54	99.82	99.98	279.9	9033	508.62	• •
GOU         FORM         FORM <thf< td=""><td>2.5</td><td>0.04</td><td></td><td>.124/</td><td></td><td>101</td><td>950</td><td>5</td><td>899.59</td><td>49.93</td><td>437.3</td><td>2048</td><td>775.93</td><td>•</td></thf<>	2.5	0.04		.124/		101	950	5	899.59	49.93	437.3	2048	775.93	•
350         575         675         87887         5449         113         113         113         113         113         113         113         113         113         113         113         113         113         113         113         113         113         113         113         113         113         113         113         113         113         113         113         113         113         113         113         113         113         113         113         113         113         113         113         113         113         113         113         113         113         113         113         113         113         113         113         113         113         113         113         113         113         113         113         113         113         113         113         113         113         113         113         113         113         113         113         113         113         113         113         113         113         113         113         113         113         113         113         113         113         113         113         113         113         113         113         113<	20	1800	< c	0/2/	10/30	5.0		0001.02	299.15	74.88	650.9	5066	1112.24	•
400         4500         773         710         710         7260         773         710         7260         773         710         7260         773         710         7260         773         713         713         713         713         713         713         713         713         713         713         713         713         713         713         713         713         713         713         713         713         713         713         713         713         713         713         713         713         713         713         713         713         713         713         713         713         713         713         713         713         713         713         713         713         713         713         713         713         713         713         713         713         713         713         713         713         713         713         713         713         713         713         713         713         713         713         713         713         713         713         713         713         713         713         713         713         713         713         713         713         71	20	2675	> <	2987.				12.00-0	140°08/	/ 20 · 4 / 4	5° # 00		1502.71	•
450.         8000.         775.         31275.         31244.         15640.619         8563.231         774.700         -3268.276         2733.61           FST NUMER 5         GAGES 3 AN         A         FST ALM         5040.619         8563.231         774.700         -3268.276         2733.61           FYDR CIACUM         LOAD STRESS STRESS         STRESS         STRAIN         LOAD STRESS STRESS         STRESS         STRAIN	2	4500	1	4842.	7800.	001	3900	3909.38	480.90		174.0		C2 0122	•
EST NUMER 5 GAGES 3 AND 4 HYDRO CIRCUM LONG AX AL MSD CR TRU CR MSD LN TRU LONG TRU LONG TRU RAD EFFECTIVE PRESS STRAIN STRAIN A CAD STRESS STRESS STRESS STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN LOUG STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN STRAIN ST	2	8670		6697.	1275.	154	563	5649.61	563.23	74.70	268.2	7318	6944.08	0.35
DRO CIRCUM LONG AX AL MSD CR TRU CR MSD LN TRU LONG TRU LONG TRU RAIN STRAIN ST	EST	ИВЕР	GAGE	C N N	•					ī		and a constant of the second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second se		1000 - 1000 - 1000 - 1000 - 1000 - 1000 - 1000 - 1000 - 1000 - 1000 - 1000 - 1000 - 1000 - 1000 - 1000 - 1000 -
Figs         STRAIN         STRAIN <td>YDR</td> <td>CIRCUM STR.</td> <td></td> <td>XAL</td> <td>SD C</td> <td>RU CR</td> <td>30 F</td> <td>U LONG</td> <td>RU CIRC</td> <td>RUL</td> <td>RU RA</td> <td>FECTIV</td> <td>EFFECTIVE</td> <td>PH</td>	YDR	CIRCUM STR.		XAL	SD C	RU CR	30 F	U LONG	RU CIRC	RUL	RU RA	FECTIV	EFFECTIVE	PH
0.       75.       75.       175.       175.       175.       175.       575.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       5213.412       1997.90       -787.41       9029.76       -787.41       9029.76       9029.76       9129.76       9129.76       9129.76       9129.76       9129.76       9129.76       9129.76       9129.77       9129.77       9129.76       9129.77       9129.77       9129.77       9129.77       9129.77       9129.77       9129.77       9129.77       9129.77       9129.77       9129.77       9129.77       9129.77       9129.77       9129.77       9129.77       9129.77       9129.77       9129.77       9129.77       9129.77       9129.77       9129.77       9129.77       9129.77       9129.77       9129.77       9129.77       9129.77       9129.77       9129.79       9129.77       9129.77       9129.79       9129.77       9129.79       9129.79       9129.79       9129.79       9129.71       9129.71       9129.71       <		MICROI		UNDS	- R P S S	PSI	x u v v	PS	CROINTIN	STR	STRA1	S B C	TRAI	
00       175.       75.       75.       75.       75.       74.997       74.997       74.997       75.496       500.7         01       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.       175.	i					' ,								
01       575       5745       5745       5745       5745       5745       5745       5745       5745       5745       5745       5745       5745       5745       5745       5745       5745       5745       5745       5745       5745       5745       5745       5745       5745       5745       5745       5745       5745       5745       5745       5745       5745       5745       5745       5745       5745       5745       5445       5445       5445       5445       5445       5445       5445       5445       5445       5445       5445       5445       5445       5445       5445       5445       5445       5445       5445       5445       5445       5445       5445       5445       5445       5445       5445       5445       5445       5445       5445       5445       5445       5445       5445       5445       5445       5445       5445       5445       5445       5445       5445       5445       5455       5445       5455       5445       5455       5456       5456       5456       5456       5456       5456       5456       5456       5456       5456       54566       54566       54566	200	10 10 10 10 10		11855.	3475.	475	738	2.63	6.6	6		600	84.99	10
00.       250.       575.       47421.       1390.5.       6510.       240.963       374.930       -11121       1200.5         01.       575.       575.       47421.       1390.5.       6510.       540.963       524.65       -411.128       1507.0         01.       1900.       575.       575.       17375.       1390.5.       10425.       10425.       10425.       10425.       1391.4.595       524.65       74.112       1972.5.71       1809.9.9         01.       1900.       8785.       244.663       649.763       939.5.19       -411.128       1509.9.1         01.       8765.       1050.       12163.       12163.       12163.       1214.595       8588.018       1049.48       -411.128       1509.9       21304.1         01.       8675.       244.663       8588.018       12163.1       12163.1       1200.9       21304.1       1209.4       12163.1       1209.6       12163.1       1209.6       12163.1       12163.1       12163.1       12163.1       12163.1       12163.1       12163.1       12163.1       12163.1       12163.1       12163.1       12163.1       12163.1       12163.1       12163.1       12163.1       12163.1       12163.1       12163.1	5	150			0406.	1070	1 1 M		5	66.66 		010	28.30	1
50.         575.         59276.         17375.         1736.         8688.         8692.061         649.789         524.662         411.128         15091.9           00.         1900.         7501.         7515.         749.719         -975.711         18090.9           01.         1900.         7501.         749.719         -975.711         18090.9           01.         1905.         749.719         -975.711         18090.9           01.         8655.         1040.8         124.595         24438.12103.1134.595         8698.018         1049.448         -3373.113         24288.4           01.         8655.         1040.4         15914.595         8698.018         1049.448         -3373.113         24288.4           01.         8655.         13900.1         13914.595         8588.018         18090.28         24288.4           01.         8655.         1050.1         13914.595         8588.018         1049.448         -3373.113         24288.4           01.         8678.018         17040.448         749.018         749.018         745.753         24288.4           010.         1275.235         5176.53         1737.633         1737.633         124.995         1309.06         3009.	20	250			3900.	3903	950		50	74 . 97 74 . 93	2	9029	84.71 41.71	2
00.       1900.       749.779       -926.771       1809.09         00.       4650.       1000.       82987.       24385.       1214.663       4630.223       999.500       -926.771       18090.9         00.       8650.       1000.       82987.       24385.       1214.663       4630.223       999.500       -1973.553       21164.1         00.       8657.       1000.       82987.       24386.128       1214.663       4630.223       999.500       -1973.553       21164.1         01.       8675.       1040.480       13914.595       8588.018       1049.488       -1373.113       24283.48         010.       86765       1       81       174.060       174.060       1373.113       24283.48         010.       170.       1000       28781       1781       1049.48       54865       54745         010.       170       1000       171       1700       171       171       171       24283         010.       125.       11855       1475       1736.01       1737.63       1737.63       1737.63       1709.64       9020.56       9020.56         010.       125.       1731.10       1733.63       1737.63       1737.93 <td>50</td> <td>650</td> <td></td> <td>1.</td> <td>7375.</td> <td>7385</td> <td>688</td> <td>2.06</td> <td>F</td> <td>24.86</td> <td></td> <td>1047</td> <td>22.04</td> <td>2</td>	50	650		1.	7375.	7385	688	2.06	F	24.86		1047	22.04	2
00.       8699.01       1273.553       24385       12174.663       4695.223       999.500       -1973.553       21164.1         01.       8655.1050.       94842.27800.28040.13900.13914.595       8588.018       1049.448       -3373.113       24283.4         1       NUMRER 5 GAGES 1 AND       2       -3373.113       24283.4         DPD CIRCUM LONG       AXIAL MSD CM TRU CR MSD LN       TRU LONG       TRU RAD EFFECTIVE         ESS STRAIN STRAIN       LOAD STRESS STRESS       STRESS       STRAIN       STRAIN       STRAIN         FSI       LONG       AXIAL MSD CM TRU CR MSD LN       TRU LONG       TRU RAD EFFECTIVE       STRESS         FSI       MICROIN/IN       POUNDS       PSI       TRU LONG       TRU LONG       TRU RAD EFFECTIVE         FSI       MICROIN/IN       POUNDS       PSI       TRU LONG       TRU LONG       TRU RAD EFFECTIVE         FSI       MICROIN/IN       POUNDS       PSI       TRU LONG       TRU RAD EFFECTIVE         FSI       MICROIN/IN       MICROIN/IN       MICROIN/IN       MICROIN/IN       FFFECTIVE         FSI       MICROIN/IN       POUNDS       FSI       1737.653       1737.653       1737.953       1009.456         FSI       125.213.653	2	190	750.		0850.	089	42	0432.81	898.19	49.71		8090	640.46	
T NUHRER 5 GAGES 1 AND       2475       24283.4         T NUHRER 5 GAGES 1 AND       2475       2475         DPD CIRCUM LONG       AXIAL MSD CM TRU CR MSD LN       TRU LONG       TRU RAD EFFECTIVE         ESS STRAIN STRAIN       LOAD STRESS STRESS       STRESS       STRAIN       STRAIN       STRAIN         FSS       TRUN       LONG       AXIAL MSD CM TRU CR MSD LN       TRU LONG       TRU RAD EFFECTIVE         ESS STRAIN STRAIN       LOAD STRESS STRESS       STRESS       STRESS       STRESS       STRAIN       STRAIN       STRAIN         FSS       MICROIN/IN       POUNDS       PSI       TRU LONG       TRU LONG       TRU RAD EFFECTIVE         50       125       75       1185       STRESS       STRESS       STRESS       STRESS       STRAIN       STR	200	4 0 4 0 4 0 0 4 0	.000		4325.	500	19	2174.66	639.22	999.50	ີ. ເ	1164	3824.350	0.35
T NUMBER         5 GAGES         I ANN         2           DPD CIRCUM         LONG         AXIAL         MSD CK         TRU CR         MSD CK         STRESS         STRESS         STRESS         STRESS         STRESS         STRESS         STRESS         STRESS         STRAIN         STRESS         STRESS         STRAIN         STRAIN         STRAIN         STRAIN         STRESS         STRAIN         STRESS         STRAIN         STRAIN         STRAIN         STRAIN					• በ ስ ስ ነ			AC+ TAO	10.000	***		283 4	983.43	
DPD         CIRCUM         LONG         ÄXIAL         MSD         CR         TRU         LONG         TRU         RAIN         TRU         LONG         TRU         RAIN         STRAIN	st	HRER	GAGE		2									
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TABLE G-28. STRESS-STRAIN DATA ON CYLINDER NO. CY-10 (2:1)

TEST NUMBER 6 GAGES 7 AND 8

	EFFECTIVE MU Strain	NIN	.679 0.		046.724 0.3	311.434 0.3	.319 0.3	383.109 U.S	498.582 0.3	802.515 0.3	106.414 0.3			- <b>U</b>	STRAI	gene i	5.267 0.3	7.166 0.3	578.576 0.35	146 741 0.3	8.737 0.3	910.139 0.3	016.258 0.3		CTIV	STRAIN	3,016 0.3	02.748 0.3	42.621 0.3	05.483 0.3	25.342 0.3	35.267 0.3	5 0 <u>7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 </u>	1.102 1.00 1.0	55.495 0.3	901.535 0.35		CTIVE MU	MICIN/IN	54 348 D 3	395.427 0.35	97.554 0.3	788.163 0.3	80./28 U.3	615 828 0 3	203 ED2 0 3
	EFFECTIVE	ŝ	3010.4	-	2053.	5071.		1114. 4170	147	0197.	3229.		:	CTIV	4	S	010	021	9034.4	2 U 4 7 2 D 4 7	095	1141	4224		CTIV		000	19	028.	038.	047.	058.			000	33126.2		> <	PSI		6021.7	9034	2048	c.	1 4 9 4	
	TRU RAD STRAIN	N.	621	1.1	-533.455	664.	813.	266		415	563.		;	TRU RAD	STRAIN	MICROIN/IN	~	2		? :	14	-	۰.		A R A	STRAIN				· _•		•	÷.,	•	•	-551.029		TRU RAD	MICROIN/IN	000	-209.958	32.40	37.33	00° 40		
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	RU CIRCM STRAIN	NI/NI		•	1274.187	98.	-		-		5			TRU LIRCM	STR	MICROIN/IN	96	.90	674.773	70.4/7		568.62	180.86		TRU CIRCM	STRAIN	00	5.00	5.00	0.0	0.00	66.06	24.97		79.00	674.773		CIRC	SIMAIN MICROIN/IN	jog ÖS	474.888	9.75	924.57	4.18 1.18	740.1U	
!	TRU LONG STRESS	PSI		າ່ປ		17	0428.9	2167.6		7385.8				20	STR	1Sd	737.67	475.69	5213.803	80.244	0429.69	2168.88	908.68		20	STRESS	5	5.	1		e	0427.	2165.	5902. 5477	7470	19129.701		TRU LONG	-	727	3475.434	213.	952.	8691.		
	MSD LN STRESS	PS	1738.	5475.	5213. 6950.	8688.	042	12163.	0.00	200	19113.	1		- 65	STRESS	S	738	47	5213.	950		2163	006			STRESS				6950.	<b>a</b>	042	216	0 N 0 N 0 N 0 U	000	19113.		، ت		9779	3475.	m	6950.	868	10167	
	TRU CR STRESS	PS	3476.	6955.	13918.	17403.	20891.	24381.	2/8/4.	34869.	38370.				20	•	476	6953.	0432	m r	1/399.	24	27972.			STRESS PSI	15	ις Γο	. 4	6	3	35	Ê	20	2.4	38251.		υ	-	5	6953.	043	301	60		
œ	MSD CR STRESS	PS	3475.	6950.	13900.	17375.	20850.	24325.	27800.	312/212	38225.		Ŷ	ر د د	20	PS1	475	6950.	5	065	200	432	27800.	4	20	STRESS	11	10	0 4 0	1061	737	085	432	180	14/	38225.	N	0	-	1	6473. 6950.	042	390	50		
7 AND	AXIAL LOAD	POUNDS	11855.	23710.	47421	59276.	71131.	82987.	94842.	18553	30407.	•	5 AND			POUNDS	11855.	23710.	35566.	4/421.	71131	82987.	94842	3 AND	1 X Y X Y	LOAD	11055	23716.	35566.	47421	59276.	71131.	82987.	94842.	5,	130407.	UNA 1	AXIAL	POUNDS		23710.	ŝ		ο,	- 0	••
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TABLE G-29. STRESS-STRAIN DATA ON CYLINDER NO. CY-11 (1:1)

(1:1)-12 C K NO. YLINDER ΰ Z O 4 ESS-STRAIN DAT. щ STJ 30 Ϋ́ TABLE

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 MSD LN STRESS PSI MSD LN STRESS PSI MSD LN STRESS PSI MSD LN STRESS PSI TRU CR STRESS PSI TRU CR STRESS PSI STRESS PSI TRU CR STRESS PS1 MSD CR STRESS MSD CR STRESS PSI MSD CR STRESS PSI MSD CR STRESS PSI œ ∾ ø AXIAL LOAD POUNDS AXIAL LOAD POUNDS AXIAL LOAD POUNDS AXIAL LOAD POUNDS **UNA** QNA AND **UN** 1 2 3 -1 CIRCUM LONG STRAIN STRAIN MICROIN/IN CIRCUM LONG STRAIN STRAIN MICROIN/IN CIRCUM LONG STRAIN STRAIN MICROIN/IN CIRCUM LONG STRAIN STRAIN MICROIN/IN GAGES i GAGES GAGES GAGES 150. 150. 350. 400. 500. 725. 3400. æ æ æ æ 300. 450. 700. 1260. 1750. 2100. 2100. 2100. 375. 575. 1025. 1575. 2350. 3800. 325. 500. 800. 1075. 1500. 2175. 3375. 6100. TEST NUMBER **TEST NUMBER** NUMBER NUMBER HYDR0 PRESS 50. 150. 250. 350. 450. HYDRO PRESS PSI HYDRO PRESS PSI HYDRO PRESS PSI 50. 350. 450. 500. 50. 150. 250. 350. 50. 150. 250. 350. TEST TEST Ì

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

EFFECTIVE STRAIN MICROINZIN EFFECTIVE SFAIN MICROIN/IN 166.656 299.966 233.263 643.220 935.001 1365.897 1365.897 1365.897 3128.013 3128.013 3128.013 3128.013 3128.013 1349.142 1681.981 2064.587 2847.071 2812.720 3228.119 3659.937 EFFECTIVE STRAIN MICROINZIN 749.724 1748.413 783.039 1032.827 1299.146 999.532 83.302 16.549 349.087 3542.462 1681.885 149.951 683.12) 4091.380 EFFECTIVE STRATS MICROIN/IN 299.963 549.864 3542.181 TRU TRAVRS STRAIN HCRDINJN -199.980 -374.930 -374.930 -374.930 -599.821 -699.756 -824.661 -899.596 -1024.476 -1149.340 -1199.280 TRU TRAVRS STRAIN MICROIN/IN STRAIN MICHOIN/IN -224.975 -499.874 -574.835 -224.975 -524.862 MICROIN/IN -149.989 -374.930 -374.930 -399.919 TRU' TRAVRS -424.909 -224.975 -174.984 -149.989 -699.756 -749.719 TRU TRAVRS -574.835 -599.821 -274.963 -824.661 19.4.8. STRATS -499.87 -499.87 TRU LONG Strain Micho Invin 324.947 724.737 1124.368 1523.858 1923.150 2397.124 2845.946 3817.703 4340.565 4937.789 MICRO IN/IN 99.995 224.975 874.617 1199.260 1598.720 2122.746 2845.946 4713.872 LONG 249.969 1349.090 2322.302 3867.512 TRU LONG 3319.485 2696.361 4813.397 TRU LONG STRAIN HICRO IN/IN STRAIN 24.947 474.888 N I N I 299.955 1174.310 799.681 899.59 546.80 022.95 TRU MICRO E EFFECTIVE 5 STRESS 3476 3476 3476 13437 13437 13437 13437 24394 24394 24394 34901 34901 34901 EFFECTIVE STRESS PS1 3475. 6952. 10428. 17389. 17389. 20878. 24382. 24382. 21478. EFFECTIVE STRESS 6954. 10434. 13917. 17403. 20894. 224394. **FRESS** 3476. 0434. 13916 17402 20892 24391 3476. EFFECTIVE PSI ٤ TRUE STHESS PSI STRESS 3476. 3476. 106354. 13917. 20894. 224394. 27931. TRUE STRESS PSI 6955. TRUE 3476. 3475. 6952. 10428. 113907. 17389. 20878. 20878. 224382. 27908. 31478. 10437. 13921. 17408. 20900. 224394. 234992. 34901. RESS 10434. 13916. 17402. 20892. 24391. 27934. 3476. 6954. PS I a: ÷ N MSD STRESS PST MSD STRESS PSI MSD STRESS PSI 6950. 110425. 13900. 13900. 13755. 24825. 34750. 34750. 3475. TRESS PSI 10425. 13900. 17375. 20850. 24325. 27800. 3475. 6950. 10425. 13900. 17375. 20850. 27800. 3475. 6950. 10425 13900 17375 20850 24325 24325 27800 7 AND 5 AND 3475. 6950. 3 AND MSD 1 AND TEST NUMBER 9 GAGES LONG TRAVRS LONG STRAIN STRAIN 9 GAGES GAGES TRAVRS LONG STRAIN STRAIN GAGES HYDRO TRAVRS LONG PRESS STRAIN STRAIN 1175. 1550. 2025. 2700. 725 550. 1200. 1200. 2125. 2125. 325 3325 4350 4725. 325.4 1350.2325.3875. 6475. 250 100 225 800 300 4950 600 006 4825. MICROIN/IN **MICROINZIN** MICROIN/IN CROTNZ HYDRO TRAVRS PRESS STRAIN S PSI MICROINZ 50. -175. 100. -225. 150. -250. o TEST NUMBER 9 -375. -825. -225. TRAVRS -150. -200 -300 006-TEST NUMBER -225. -325. 004 -1025 -425. -575. - 600 -009--150 -225. -400. - 750 -500. -500. -1150 200 -700 -275 -375 -575 -120 TEST NUMBER - 80 HYDR0 PRESS PRESS PSI 50. 150. PRESS PS1 50. 100. HYDRO 400. 200.50 300 450. 500 350. 50 0.0 250. 250. 300. 350. 150 350 4 1 1 200 250

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

TEST NUMBER 10 GAGES 7 AND R

FECTIVE Strain	N//N	3.217	3.023	5.112 5.000	1.049	3.039			2.190			ECTIVE Strain	N1/N	5.637	. 465			. 225	1.211	.870			RAIN	N/IN	. 964	5.243			003.15/ 187 Rek	.314	.182	3011.639 2050 4.0			TTVE		1 1 M	.504	060	.166	
Ū	Σ	Ì	}		1		2380	2713	3477	•	ļ		MICR											MICROIN/IN					•						EFFECTIVE Strain					1016.166	
STRAIN STRAIN	MICROIN/IN	-274.963	-349.939	-474.888	-699.756	-774.700	-899.596	-974.525	-1224.251		i	STRAIN STRAIN	MICROIN/IN	-124.992	-224.9/2 - 224 047	- 100 010	-499.874	-574.835	-599.821	-649.789		TRU TRAVES	STRAIN	MICROIN/IN	• 224.975	-299.955	-324.947	• 399 • 919	-574.835	-674.773	-699.756	- 699.756			TRU TRAVRS	MICEUNIN	-99,995	-174.984	· O	-349.939	•
	1 CI				1	2297.359	2671.429	3095.205	3992.022			STRAIN	MICRO IN/IN	274.963	200.926	174.348	1498.875	1998.003	2646.495	4465.016		TRU LONG	STRAIN	MICRO IN/IN	299.955	424.909	424.909	449.899	4/0°//4/4	1898.198	2821.017	3817.703 4087 542	8		TRU LONG	MICRO TN/IN		674.773	799.681	1174.310	
STRESS	PSI -	6954.	10434.	13917.	20890.	24381.	27874.	31372.	38378.		111 10100	EFFECTIVE STRESS		3476.	10434	13016.	17401.	20892.	24389.	27924.		FFFCTIVE	STRESS	PSI N	6952.		•	1/383.	24351.	27853.	31363.	34883. 38416.			STRESS			6955	10433.	13916.	
RESS	PSI 7476		- el.			24381.	27874.	31372	38378.	Y			PS1	3476.	0 4 2 4 4	13916	17401.	20892.	24389.	27924.		TRUF	ESS	PSI 7476	10	0	6.6	17383.	24351.	27853.	31363.	34883. 38416			STRESS	PS1	3476.	6955.	10433.	13916.	
STRESS	PSI 3476	6450.	10425.	13900. 17375	20850.	24325.	27800.	512/5.	38225.	5 AND	-	STRESS	ISd	3475.	10425.	13900.	17375.	20850.	24325.	2/800.	AND 3	MSN	STRESS	PSI 3475	6950.	10425.	13900.	1/3/5.	24325.	27800.		34750. 38225.	C UNA I	202	STRESS		3475.	695A.	10425.	13900.	
STRAIN	N/IN 225	525.	006	1550.	10	300	675	-10	000	GAGES		STRAIN	z	275	925. 825.	1125.	1500.	2000.	2650.	44/5.	GAGES	LONG	STRAIN	1 N N N N N N N N N N N N N N N N N N N	300.	425.	425.	470.	1050.	1900.	2825.	5825. 5000.		UND 1	TRAIN	N	300				
N I N	MICROIN	-275.	-350.	-550.	- 200	-775.	-006-	- 9/9-	-1225.	48ER 10		STRAIN	ICR01N/	-125.	-305.	- 400 -	-500.	-575.	-000-	- 650.	NIMBER 10	RAVRS	TRAIN	MICROIN/I	-225.	-300.	-325.	- 400.	-575.	-675.	- 200 -	- 800-	NUMBER ID GAGES		STRAIN S	2	•		ł		
PRESS :			•							TEST NUMBER		PRESS									FST NUM	02	SS	PS S S S S S S S S S S S S S S S S S S	•   •	٠	٠				- ÷	550.	TEST NUM	000	PRESS S	L S d	50.	.00	50.		, ,

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

<i>r</i>	STR	STRAIN		MSD CR	180	MS0 STR	TRU LONG	TRU CIRCH	TRU LONG	TRU RAD	19119	EFF	£
lSd	Ĭ	CROINTIN	POUNDS	50 20	Sd	Sa	<b>F</b>		MICROIN/IN	MICROINTIN		MICIN	
50	175.			3475.	3476.	~	~	74.	0.0.0	4	<u>ି</u> କ	141.	
Ē	450			6950.	6953	Ψ.	ы. С	449.899	9.995	-192.463	5	371.	-
150.				10425.	10432	5213.	5213.282	699.756	149.989	-297.411	9034.6	576	0.35
	1000 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	1		10400	10014	on ∖•	;	004.999	1.975	-428.566	12049	825.	-
				1/3/7.		••	8690.	1274.187	.955	-550.950	15056	1054.	•
2 2 2 2 2					U 1 0 P 0 P			100.0401		-00400-	19081	1279.	ċ
2				C-0000		0 0 6 0 1 0	10/2		606 · •	-804 354	21105	1547	ċ
	2010			10012	- 1 5 C 1 C 1 C 1			2191.083	4/9.4	- 444.110	24128	1015	-
	0000			31212		D P		110.1262		020 040I-	561/2	2083.	•
20	1250	- 1		102140		<b>n</b> :-	1000	+00.0402	1.189	-1240.95/-	30181	2391.	-
				00667.			4175.	5244./29		-1380.570	33211	2674.	ċ
5 2				• D D / T •	4 4	Dł		2093.171	. 119	-1555.011	36246	3037.	ė
	4800			40T/0.				001.0124	1001	-1/64.260	39288	3463	-
				- 100		2		916.99.4	996	-1990.839	42334	3928.	ė.
					52418.	5	6087.	5609.239	. 525	-2304.317	45395	4591.	•
	ľ	- 1	- 1	55600.	55978.		7829.	6776.984	.448	-2739.251	48478	5532.	•
0.00	-			54075.	59684.	ŝ	9570.	10321.549	1.368	-4006.071	916	8382.	6
				.04429	62961.	2	1314.	6553.478	1.187	-2739.683	54526.	5381.96	•
	9052		1				•	7992.971		-2797.540		6466.1	•
948.	8025.		224775.	65886.	66415.	32943.		7992.971	49.719	-3059.941	57517.	6483.22	
	R150.	275.					5	8116.968	74.963	-2937.176	•	6566.0	
.066	8075.	1075.	234733.	69805.	69361.	34402.	•	8042.572	4.422	-3190.948	60068	6547.951	•
TEST N	NUMRER 11	GAGËS	5 AND	¢									
нүрко	CIRCUM	LONG	AXIAL	SDC	с Э	MSD L	LON	TRU CIRCM	TRU LONG	A N	2	EFFECT	Ĩ
PRESS	STRAIN	STRAIN	LOAD	STRESS		SIRESS	STR	STRAIN	STR	STRAIN	STR	STR.	
PSI	MICRO	N   /N	POUNDS	PS	PS	PS	PS.	MICROIN/IN M	I CROIN/I	MICHOIN/IN	S	MICINIIN	
50.	50	50.		75.		1734.	~	40.03	000	ģ	· .		
100.	750.	100.	23710.	6950.	6955	3475.	2470° 0740	749.719	00.005	104 107 -	C'DINC	202 CIA	10.07
150.	75	175.	÷ .	5		5213.			80		•		•
200.	60	225.	_	:		6950.		1598.720	5	91.9	•	1302 701	•
250.	20	300.	Ι.	75.	Ι.	H688.			95			0	•
300.	247	350.	_	50.		10425.	÷	4	0			4	•
350.	295	425.		5.		12163.		6	6				•
400.	3425	475.	_	.00		13900.		4	8			4	•
450.	395	525		75.		15638.		0		:			•, •
500.	550	550.		50.		17375.		ŝ	4		:_		•
550.	5150	F.	30407.	5	1.	19113.			-	:i_:	:		• • •
600.	61 N		42263.	• 00		20850.		č	00	::		4	•
650.	702	925.		75.		22597.	-	5	57	-2791.132	1	1	• •
700.	8 B D D	050.	65973.	20.		24325.		~	44			0	•
750.	1052	1125.		5.		26063.		4	36	1		78	•
800.	1260	1175.		:		27800.	~	252	5	793		0156.20	
850	1540	1325.	01539.	75.	1.	29537.		526	1	10.16		A DATC	• • •
.n06	1752	629	213394.	2550.		31275.		5	891	299.30	:_	e e	• •
c					• •	•	-	7571	00.	649.		6124.	•
948.	1770	75.	224775.	65886.	67052.	32943.	32945.471	ŝ.	66.	167.06	98071.8	65	•
	782	150.	c	¢	•	•		į	•				
			•	5	• D	•	0.000	194	÷	∞	0.0	ഹ	

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

EFFECTIVE MU STRAIN MICIN/IN	80.894	141.558	0. 4 0	486.171	588	730.732	875.365	105/.84	102 CUL 1		1649.927	1814.896	2019.774	2201.863		111.111	2735.315	238.107	2850.694		EFFECTIVE MU	STRAIN	HICIN	0 69	5	0	5	5 9 5 9			) 	)   ()	4811.443	5736.309 0	7318.543 0	9636.855 0	12366.846 0	5068.909 0	5 0 2	ŝ
EFFECTIVE STRESS PST	ျင့	6019.9	11		5	33	님	51		ŝ	1	5	20	티		25	57245.9		59786.5		-5	STRE	ISd					15083.7					33300.9	36369.9	39478.2	42637.5	45838.3		51878.2	
TRU RAD STRAIN MICROIN/IN	-34,998	-61.244	-104.984	-227.437	-279.907	-349.857	-428.544	-545 2310	200 929-	-734.405	-813.018	-900.364	-1005.152	-1092.445	-1214./24 -1708 236		10	61.23	54		TRU RAD	-	>	157		523	751	5 H 5 H 5 H	0 F	2 - -	228	999	-2268.776	409	398	4 2 0	100	5	-5075.954	
TRU LONG STRAIN MICROIN/IN	0.000		0.000	0.000	4.997	966.6	9.989	984	4.075	4.963	9.955	9.939	9.919	4.909	2035 2035			•	4.		TRU LONG	STRAIN	I C R D ]	5.00	4.99	4.98	. 97				. 80	88.4	0	1.80		1.73	11	. 70	÷.	
TRU CIRCM STRAIN MICROIN/IN N	00.005	174.984					074				022	222	471	696	5 C C		r (1)	274	-	į	TRU CIRCM	5	MICROIN/IN M	-6	54	98	5	5	2 10	3 10	606	19	5932.369	5	9034.07	1903.86	\$9	8625.46	616	
TRU LONG Stress Pst	1737.500	3475.000	5212.500	8687.934	10425.782	12163.716	13902.085	15640.237	19116.Ann	20855.734	22594.276	24333.514	26072.925	27811.815	2999.46642 11204 204	000.0	32973.472	0.000	34442.923	:	TRU LONG	STR	ISe	737.54	475.	213.41	951.56	007.00 100 70	2166.75	3905.56	5644.53	7383.25	19123.012	0863.03	2602.74	4342.63	6082.04 7824 E4	7821.54	9555.22	5
MSD LN STRESS PSI	1738.	3475.	5213.	8688.	10425.	12163.	13900.	17175	10113.	20850.	22587.	24325.	26063.	27800	24231.		32943.		34402.		MSD LN	RES	ko –	1738.	3475.	5213.	6950.	10405	12163.	13900.	15638.	17375.	19113.	20850.	22587.	24325.	26063.	2/800.	29931.	
TRU CR STRESS PST				. I .				•••	- I .		۱.		-	_		. t	66102.	0	69035.	:	TRU CR	TRE	0	3476.		0440.	3927.		4408	7909.	1416.	4929.	8452.	1996.		9233.	2928.	6645.		
MSD CR STRESS PSI	n 'in	6950.				•	•	÷ -		: ::		:		<u>.</u>	590/5.		65886.		68805.	2	MSD CR	TRES	PS	3475.	6950.	10425.	13900.	1/3/5.	24325.	27800.	31275.	34750.	38225.	41700.	45175.	48650.	52125.	55600.	590/5.	
AXIAL LOAD POUNDS	11855.	23710.	35566.	59276.	71131.	82987.	94842.	106697.	30407	42263	54118.	65973.	17828.	89683.	211559.		224775.	;	34733.	1 AND	AXIAL	LOAD	POUNDS								06697.	18552.	30407.	42263.	54118.	65973.	77828.	89683.		
LONG		•		•í.							1			•			5	.00	ഹി	GAGES	LONG	STRAIN	NIN										550.1	-						
CIRCUM LON Strain Strai Microintin	100.	175.	0.4	600.	725.	006	5	1275.		10	02	22	47				10	5	3350.	MBER 11	CIRCUM	STRAIN 5	MICROIN	425.	950.	1425.	1925.	2025	3400-	3925.	4500.	5150.	5950.	7100.	9075.	1975	5400	8800	14000.	
PRESS	50.	100.	150.	רים∣ כר	0	5		400. 700.	20	600.	ŝ	0	750.	թև	. 000	>	948.		.066	TEST NUMB	HYDRO (	PRESS	ISd	50.	100.	150.	200.	.002	350.	400.	450.	500.	550.	600.						

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

æ TEST NUMBER 12 GAGES 7 AND

- ISA	MICROIN/IN	LINN C											
5			DUINDS	1.90	0 I KESS	2222		CLEOSTRAIN	1	NI VI SIRAIN	STRE	STRAI	
						L			E			MICININ	
50.	275.	75.	11955.	3475.	3476.	1738.	1737.630		74.997	-122.486	3010.3	1	င
100.		175.	23710.	6950.	6955.		3475.608			-288.670	6022.8	541.832	0
150.	-	275.	35566.	10425.	10435.	5213.	5213.933	-		-446.062	9037.3	i.	-
200.			47421.	13900.			6952.085	1249.220		-542.211	12052.8	_	
250.			59276.	17375.			8691.192			-708.270		-	16
300.			71131.	20850.	20890.		10430.212		4	-839.325			C
350.			82987.	24325.	24380.		12169.189	1		-987.792		1883.291	e
400.			94842.	27800.	27874.	13900.	13909.383			-1171.171			0
450.		725.	106697.	31275.	31372.		15648.837			-1336.980		1	
500.	i	825.	118552.	34750.	34874.	17375.	17389.334			-1537.650			-
.055		.006	• •	38225.		19113.	19129.701	1		-1712.066		3297.154	P
600.		975.		41700.		20850.	20870.329			-1938.682			0
650.	5225.	1025.	154118.	45175.	Ψ.	22587.	22610.652		1024.476	-2182.556		:	10
700.	6050.	1125.		48650.		24325.	24352.366			-2504.649	42387.2		
750.	7150.	1250.		52125.	52498.	26063.	26095.078			- 2930.823	45464 6	5832.916	0.35
800.	9050.	1325.	189683.	55600.	56103.	27800.	27836.835	9009.294		1616 A06	44547.1		• •
850.	-		201539.	59075.	aire,	29537.	29579.501	T		-4742.558	10/01	DAKK ADD	기며
900.	18650.		213394.	62550.	63717.	31275.	31323.476	18478.222	1548.800	-7009.458	-	14977.546	
Y DRO	CIRCUM	LONG	AXIAL	MSD CR	TRU CR		TRU LONG	TRU CIRCM	TRU LONG		FFFFCTIVE	FFFFTTVE	X
RESS		STRAIN			STORCO		etocec		N1 1 0 4 3	NI VIII			-
PSI		2		ISd	l Sd	I Sd	IS4	<b>HICR</b>	MICROININ	MICROININ	ISd		1
50.	325.	50.	11855.	3475.	3476.	1738.	1737.587	324.947	50.000	-131,231	3010.4		0.35
100.	750.	100.	23710.	6950.	6955.	3475.	3475.348		6	-297.400	6023.4	610.	0.35
150.	1175.	150.	35566.	10425.	10437.	1	5213.282		14	-463.505	9038.9		0.35
200.	1575.	200.		13900.	13922.		6951.390			-620,809	12056.7	-1	0.35
250.	2025.	275.		17375.			8689.889			-804.271	15077.7	-	0.35
300.	2375.	325.				10425.	10428.388			-943.996		-	0.35
350.	2875.	400.				12163.	12167.365			-1144.778		2338.	0.35
400.	3225.	450.	•	27800.	1	13900.	13906.255			-1284.399			0.35
450.	3825.				31395.	15638.	15645.319			-1511.152		3107.	0.35
500.	4275.		118552.		34899.	173,75.	17384.991	4265.888		-1694.253		3473.	0
550	4800.	•	130407.	38225.	38408.	19113.	19124.445		624.804	-1894.662		3897.	•
600	5300-		142263.	41700.	41921.	20850.	20864.074			-2086.272		4300.	0
650.	6000.		•	45175.	4	22587.	22604.441			-2356.126			0
700.	6900.		165973.	48650.	48986.	24325.	24345.068			-2695.337			0
750.		925.	177828.	52125.		26063.	26086.608			-3286.028		6874.	0.35
800.	11200.		189683.	55600.	•	27800.	27828.495	11137.744	-	-4256.777	48691.1	9032.79	0.35
850.									l				
۱	13475.		201539.	59075.	59871.	29537.	29569.991		1099.395	+5069.545	51851.1	-	10 - C

51851.1 10070.075 55125.7 14129.376

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

	0	LONG	AXIAL		TRU CR		CTPESS		STDATN		STRESS		2
PRESS	n	MICROIN/IN	POUNDS	PSI ISd		ISd	ISU	MICROIN/IN	MICROINTIN	MICROIN/IN	ISd	MICINIIN	
50.	100.	.0	11855.	3475.	3475.	1738.	1737.500	99.995	0.00	-34.998	3009.7	80.894	0.35
100.	275.	25.	23710.	6950.			3475.087			-104.987	ł	222.980	
150.	; ,	50.	35566.	10425.			5212.761			-157.472		325.294	0
200.		75.	47421.	13900.	13907.		6950.521			-209.950		427.	0
250.	675.	100.	59276.	17375.			8688.369			-271.169	15057.3		0
300.	775.	125.	71131.	20850.		-	10426.303	774.700		-314.892			0
350.	875.	150.	H2987.	24325.		12163.	12164.324	874.617		-358.612	21084.5		0
400.			94842.	27800.		13900.	13902.432	999.500	174.	-411.070	24099.6		٥.
450.	1	225.	106697.	31275.	31309.		15641.018		224.975	-463.530	27114.7		0
500.	1175		118552.	34750.			17379.344			-498.498	30129.7		-
550	1075		130407	38225		19113.	19117.756	1274.187	274.	-542.203	33146.0	-	0
	1 3 5 0		142263	41700.			20856.255			-577.166	36162.0		0
650.		350.	154118.	45175.	1	2258	22595.406			-612.136	39177.5		0
- 002			165973.	48650.			24334.122			-629.621	42192.2		0
750			177828.		52100		26072.925		399.919	-638.367	45205.9	-	-
.000	1450.		1 ROART		55681		27812.510	1448.95		-664.597	48220.8		0
	- 1 4 0 E		201570	K007F	50150	20517	20553.746	1423.986	ļ	-690.842	51233.4	1227.095	0
			24 3 30 4	4 7 6 6 0	ADADE	11075	11206.803	1100.28		-664.663	54234.9	1114.096	0
950.	1200.	1000.	225240.	66025.	66084.	33012.	• •	899.596	999.500	-664.684	57230.8	1077.699	9
ICSI NUMHEN	IUMHER 12		ÜNA T	Z	-	-			÷				
HYDRO		LONG	AXIAL		TRU CR		TRU LONG			TRU RAD	EF	۳I	£
PRESS	STRAIN STRAIN	STRAIN	LOAD		STRESS					STRAIN		STRAIN	
PSI		NIN	POUNDS	PSI	ÎSd	PSI		MICROIN/IN	MICROINLIN	MICROIN/IN	ISd	-	i
50.		25.	11855.	3475.	3476.	1738.	1737.543			-157.468	3010.7	343.959	0
100.		100.	23710.	, 40	6956.		3475.348			-358,599	6024.4		-
150.	1475	150.	35566.	-	10440.		5213.282			-568.366	9041.6	۲	9
200.		200.	47421.		13927.		6951.390	1948.101	199.980	-751.828	12061.2		0
250.		250.	59276.	-	17415.		8689.672		,	1	15082.2	- 1	ç
300.		300.	71131.		20908.	10425.	10428.127				18107.2		¢
350.		350.	82987.	24325.	24404.		12166.757		;	1	21134.6		φ,
400.		400.	94842.	27800.	27904.	13900.	13905.560		399.919	-1450.01	24165.8	3039.212	
450.		425.	106697.	31275.	31406.	15638.	15644.146				27198.1		-
500.		500.	118552.	34750.	34912.	17375.	17383.688	4639.223		-1798.684	30234.4		0
550.			130407.	38225.	38419.	19113.	19122.534		524.	-1955.460	33271.9		0
600.		550.	142263.	41700.	41932.	20850.	20861.467		549.	-2138.278	36314.7		
650.			154118.	45175.	45469.	22587.	22601.617			-2486.320	39377.2		
700.	7150.		165973.	48650.	48998.	24325.	24340.811	7124		-2721.022	42433.7	-	0
750.	. 7900.		177828.	52125.	52537.	26063.	26080.744		-	-2999.050			익
.008	9350.	725.	189683.	55600.	56120.	27800.	27820.155			-3510.953	8601.	7540.666	-
0 2 0		( 								LLE VYLY		0	1
20		.06/	.924105	- 4/ 164	59/63.	./2662	540.44442	11282.001	AI/ · At/		4.10/IC	入口す。ロンク入	

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

α TEST NUMBER 13 GAGES 7 AND

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	STRAIN	STRAIN STRAIN		STRESS	STRESS	S18	STRESS		STRAIN	STRAIN	STRESS	STRAIN	Ş
ISd	MICROI	NIN	POUNDS	PSI	ISd	ISd	lSd	H C H	HICROI	MICH		HICINZI	
50.	225.	50.	11855.	3475.	3476.	1738.	1737.587	ļ		-96.241	3010.1		
.00		100.	23710.			3475.	3475.348						
50.		150.	35566.	10425.	-1	i.	5213.282	699.756	149.989	-297.4	9034.6	576.725	0.35
.00		200.	47421.	13900.	13913.		6951.390						. <b>.</b> .
	-	275.	59276.	17375.	17396.	8688.	8689.889						0.35
		300.	71131.	20850.	20881.		10428.127						
50.		350.		24325.	24368.		12166.757			-743.178		1457.130	
00	2075.	400.	94842.	27800.	27858.	13900.	13905.560	2072.850					. 6
50.		475.		31275.	31349.	15638.	15644.928		474.	-996.475	27149.3	1950.071	
00.			•	34750.		17375.	17383.688			-1109.956	30174.9		
.05			130407	38225.	1	19113.	19123.490			-1284.514	33206.5	2538.214	0.35
	3525.		142263.	41700.			20863.553		649.789	-1459.007	36240.6		1.35
.50.			154118.	45175.	45355.		22603.311		1	-1633.407	39278.3	÷	ή <b>c</b>
.00			165973.	48650.			24343.244			1833.86	42321.8		- C
750.	522		177828.	52125.	52397.	26063.	26084.002	5211.398			45377.6	4256.037	, c
.00			189683.	55600.	<u>.</u>	27600.	27825.020			-2539.026			
50.	9100.	1000.	201539.	59075.	59613.	29537.	29567.038	9058.844		1	51626.	7167.447	1.15
.00.	1595	1200.	213394.	62550.	63548.	31275.	31312.530	15824.135			55035	12820.000	
	۰ I	·		D									
HYDRO	CIRCUM	LON	AXIAL	MSD CR	TRU CR	MSD LN	TRU LONG	TRU CIRCH	TRU LONG	TRU RAD	EFFECTIVE	EFFECTIVE	NW
ESS	STRAIN	STRAIN	LOAD	STRESS	STRESS	STRESS	STRESS	STRAIN		STRAIN	STRESS	STRAIN	
ISd	MICRO	2112	POUNDS	PS I	lsd	ISd	ISd	MICROIN/IN	MICR	MICROIN/IN	ISd	MICINIIN	
50.	550.	•••	11855.	3475.	3477.	1738.	1737.500		0.00	-192.447	3011.1	444.815	0.35
	1125.		23710.	6950.	6958.	3475.	3475.348		0	-428.527	6025.6		0.35
	1525.			10425.	10441.	5213.	5213.152			-577.091	9042.1	1235.007	0.35
	2100.			13900.		6950.	6951.390			-804.222	12063.0		0.35
	2500.					8688.	8689.455			-952.649	15084.8	2024.714	0.35
	3000.		71131.	20850.	-	10425.	10428.127		299.955	-1153.412			0.35
	3475.			24325.		12163.	12166.453			-1327.873			0
	3975.		94842.	27800.	_	13900.	13905.213		374.930	-1519.718			¢
	4475.	422.		31275.			15644.146		424.90	-1711.474			9
	5050.	475.	118552.	34750.		17375.	17383.253		474.	-1929.263	30246.5		0
	5775.	500.		38225.			19122.056		499.87	-2190.392	-	1	
	6900.	575.		41700.	٠	_	20861.989			-2607.698		5573.516	0
	8575.	600.	154118.	45175.	<b>5</b> 2.		22601.053		599.82	-3198.392			_
	11200.	675.	165973	48650.	49195.		24341.419		674.	-4134.381	42604.8	9016.522	0.35
	14550.		177828.	52125.	52883	TAAAC	740 24030	4 4 A A E 4 A E	710 710	NAA ALF			-
							1-0-10001		AT/ • A + /	VUS.0100-	8.99754	11690.223	0.35

HYDRO PRESS PSI													
	ပဖ	TRAIN STRAIN	AXIAL LOAD	MSD CR STRESS	TRU CR STRESS	MSD LN STRESS	TRU LO STRE	TRU CIRCM STRAIN	TRU LONG STRAIN	TRU RAD STRAIN	EFFECTI	EFFECTIVE Strain	₽ ₩
			STINON	151				MICKUINZIN	MICHOINZIN	MICHDININ	181		
50.	100.	•0	11855.	3475.	3475.		1737.500	99.995	0.000	-34.998	3009.7	80.894	0.35
100.			23710.	6950.	6952.		3475.000	224.975	0.000	-78.741	6020.2	182.000	0.35
150.		25.	35566.	10425.	10428.		5212.630	299.955	25.000	-113.734	9031.0	243.121	0.35
200.	475.	50.	47421.	13900.	13907.		6950.347		50.000	-183.711	12043.5	385.545	0.35
250.	575.	100.	59276.	17375. 20850.	17385. 20865	8688.	8688.152 10426 042	574.835 400 764	74.997	-227.441	15055.8	467.845 E70 340	0.35
350		125.	82987.			• •	12164 020		124.902	-323 636		A52.010	
400.		150.	94842.		27825		13902.085	899.596	149.989	-367.355	24097.	735.560	0.35
450.	i i	175.	106697.	31275.	31307.		15640.237	1024.476	174.984	-419.811	27112	838.170	0.35
500.		200.	118552.	34750.	34788.		17378.475	1099.395	199.980	-454.781	30127.5	901.003	0.35
550.		225.	130407.	38225.	38270.	19113.	19116.800	1174.310	224.975	-489.750		963.923	0.35
600.	1225.	275.	142263.	41700.	41751.		20855.734		274.963	-524.725		1011.002	0.35
650.	**	300.	154118.	45175.	45233.		22594.276		299.955	-550.950		1054.545	0.35
700.	13 <b>n</b> 0.	325.	165973.	48650.	48713.	24325.	24332.906	**	324.947	-568.436		1078.591	0.35
750.	1300.	375.	177828.	52125.	52193.	26063.	26072.273	1299.155	374.930	-585,930		1088.423	0.35
0	1325.	450.	189683.	55600.	55674.	27800.	27812.510	1324.123	449.899	-620.908	48214.8	1124.874	0.35
850.	1275.	2	201539.	59075.	59150.	29537.	29553.007	1274.187	524.862	-629.667	51225.7	1107.458	0.35
ο.	1025.	725.	213394.	62550.	62614.	31275.	31297.674	1024.476	2	-612.224		1006.213	0.35
.066	775.	62	225249.	-	66076.	33012.	33043.037	774.700	924.573	94.	57223.6	vo.	0.35
1000.	i	1575.	23/104.	69500.	69500.	34750.	34804.731	0.00	1573.762	-550.817	60188.	1273.138	0.35
TEST NI	NUMBER 13	GAGES	1 AND	2	!								
нурго	-	LONG	AXIAL	MSD CR	TRU CR	MSD LN	TRU LONG	TRU CIRCM	TRU LONG	TRU RAD	EFFECTIVE	FFFCTIVE	II.
PRESS	• •	STRAJN STRAIN	LOAD	STRE			STRESS	S	STRAIN	STRAIN	STRESS	STRAIN	
١S٩	1	NIN	POUNDS		ISd	PSI	ISd	MICROINZIN	MICROIN/IN	MICROIN/IN	PSI	MICINIIN	
50.	525.		11855.	3475.	3477.		1737.500	524.862	0.000	-183.702	3011.0	424.601	0.35
100.	-	75.	23710.	6950.	6957.		3475.261	1074.422	74.997	-402.297	6025.	870.167	0.35
150.		100.	35566.	10425.	10440.	5213.	5213.021	1473.914	99.995	-550.868	9041	1193.596	0.35
200.		175.	47421.	13900.	13928.	6950.	6951.216	2022.953	174.984	-769.278	12062.1	1639.998	0.35
250.		225.	59276.	17375.	17418.	8688.	8689.455	~	224.975	-952.649	15084.8	2024.714	0.35
300.		300.	71131.	20850.	20913.	10425.	10428.127	m'	299.955	-1162.136	1	2450.969	0.35
350.		350.	82987.	24325.	24412.	12163.	12166.757	ю	349.939	-1371.498		2895.518	0.35
400.	4075.	375.	94842.	27800.	27913.	13900.	13905.213		374.930	-1554.578	24173	3298.191	0.35
4 J C 4	40/04 10/0	4 M	10009/.	512/5.	51+20 ·	12038.	12044.928	4614.538	474.888	-1781.229	27240.3	3745,468	5
200.	26120	• 0 0 6					001 10421						

35

19084

-7084.013 -5733.21 4360.0 20

874.617 999.500 1099.395 774.700 59.92 674.77 499.87

15381.102 19140.643

7248.665 9934.963 1582.661

22605.01

4325 6063 27800

18968

600. 650. 750. 750.

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

OC CIRCUM         LONG         AXIAL         WSD         CR         TRU         LONG         TRU         TRU         CINC         TRU         CONG         TRU         TRU         CONG         TRU         STRIN         STRN         STRIN         STRIN         <								:						
N/IN         PUUDD SIRES SIRES         STRAIN         STRAIN         STRAIN         STRAIN         STRAIN         STRAIN         NINN           700         7131         10455         10475         10475         10475         10475         10475         10475         10475         10475         10475         10475         10475         10475         10475         10475         10475         10475         10475         10475         10475         10475         10475         10475         10475         10475         10475         10475         10475         10475         10475         10475         10475         10475         10475         10475         10475         10475         10475         10475         10475         10475         10475         10475         10475         10475         10475         10475         10475         10475         10475         10475         10475         10475         10475         10475         10475         10475         10475         10475         10475         10475         10475         10475         10475         10475         10475         10475         10475         10475         10475         10475         10475         10475         10475         10475         10475	HYDRO		LONG	AXIAL	MSD CR		MSD LN	TRU LONG		TRU LONG	TRU RAD	EFFECTIVE	EFFECTIVE	Ĩ
225.       23710.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475. <td< td=""><td>ISd</td><td></td><td></td><td>POUNDS</td><td>STRESS PSI</td><td>S HESS</td><td>PSI</td><td>STRESS</td><td></td><td>MICROIN/IN</td><td>NIVALOBUN</td><td>STRESS</td><td>STRAIN</td><td></td></td<>	ISd			POUNDS	STRESS PSI	S HESS	PSI	STRESS		MICROIN/IN	NIVALOBUN	STRESS	STRAIN	
700:       7131:       10425.       5472.       54721.       54721.       54721.       54721.       54721.       54721.       54721.       54721.       54721.       54721.       54721.       54721.       54721.       54721.       54721.       54721.       54721.       54721.       54721.       5491.       54721.       5491.       5491.       5491.       5491.       5491.       5491.       5491.       5491.       5491.       5491.       5491.       5491.       5491.       5491.       5491.       5491.       5491.       5491.       5491.       5491.       5491.       5491.       5491.       5491.       5491.       5491.       5491.       5491.       5491.       5491.       5491.       5491.       5491.       5491.       5491.       5491.       5491.       5491.       5491.       5491.       5491.       5491.       5491.       5491.       5491.       5491.       5491.       5491.       5491.       5491.       5491.       5491.       5491.       5491.       5491.       5491.       5491.       5491.       5491.       5491.       5491.       5491.       5491.       5491.       5491.       5491.       5491.       5491.       5491.       5491.	9	300	300									101	21,21,51,51	
700.       4/421.       6953.475       473.686       699.694       -489.629         700.       9442.       13911.       13900.       13912.51       699.596       -683.409       1         900.       94442.       13901.       13912.51       0493.51       1391.51       13900.       1394.52       1390.56       -683.499       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       <					0110	04/0		3479./82	224.975	224.975	-157.482	3475 .8	254.971	0
700         713.1         10425.         10432.297         699.756         699.756         -480.829           1200         118952         17371.         13901         13911         13901         13911         13901         14912         -480.829         690.956         -680.490         -680.490           1200         118952         17375.         13901         13911         13901         -480.829         -680.490         -680.493         -680.495         -680.495         -680.495         -680.495         -680.495         -680.495         -110.359         -690.1097.80         -690.495         -700.4110.359         -700.4120         -480.495         -720.80         -720.76         -480.495         -720.76         -7480.720         -720.76         -7480.720         -720.72         -720.72         -792.756         -792.756         -792.756         -792.756         -792.756         -792.756         -792.756         -792.756         -792.756         -792.756         -792.756         -792.756         -792.756         -792.756         -792.756         -792.756         -792.756         -792.756         -792.756         -792.756         -792.756         -792.756         -792.756         -792.756         -792.756         -792.756         -792.756         -792.756         -792.7	.011		.004	47421.	6950.	6953.	6950.	6953.475	474.888	499.874	-341.167	6953.4	552.553	
900:       94442:       13900:       13911:       13901:       13912:       551       13901:       13911:       13911:       13911:       13911:       13911:       13911:       13911:       13911:       13911:       13911:       13911:       13911:       13911:       13911:       13911:       13911:       13911:       9501:       25011:       25011:       25011:       25011:       25011:       13131:       9501:       13131:       3501       13131:       35011:       31371:       31371:       31371:       31371:       31371:       31371:       31371:       31371:       31371:       31371:       31371:       31371:       31371:       31371:       31371:       31371:       31371:       31371:       31371:       31371:       31371:       31371:       31371:       31371:       31371:       31371:       31371:       31371:       31371:       31371:       31371:       31371:       31371:       31371:       31371:       31371:       31371:       31371:       31371:       31371:       31371:       31371:       31371:       31371:       31371:       31371:       31371:       31371:       31371:       31371:       31371:       31371:       31371:       31371:       31371:	170.		200.	71131.	10425.	10432.	10425.	10432.297	699.756	699.756	-489.829	10432	70% 057	
1200.       118952.       17375.       17395.85       17395.85       1399.196       1399.196       1399.120       961.537         1470.       147253.       20857.20874.17375.       17395.850       1344.860       1544.80       1544.80       1544.80       1545.80         1200.       189683.       78303.24357.20850.       27850.20873.24354       1293.68       -1110.20       961.537         1200.       189683.       7876.234341.459       2141.459       2047.901       2499.726         2225.       23304.34756.34344.3452.549       3141.459       2047.901       2422.064       -1293.803         2455.       23104.34756.33434.38229.3344.459       2045.946       244.495       1746.495       -1952.354         2455.       2650.20815.38344.362       3454.269       2645.945       2445.946       -2105.571         2455.       2650.20815.38344.352       3169.970       2845.946       2445.946       -12753.354         2450.20815.38257.41700.4183.38258       3169.9797       2845.946       2445.946       -2105.571         2450.2010.7110.4183.455       3169.9797       2164.995       -1922.349       -1975.357         2451.0       6477.170       41818.845       3169.9797       2105.946       -1975.357      <	200.		.006	94842.	13900.	13911.	13900.	13912.510	824.661	A00 50K	107 TAA-			
1400.       142263.       20850.       27850.       27850.       27850.       27850.       27850.       27850.       27850.       27850.       27850.       27850.       27850.       27850.       27850.       27850.       27850.       27850.       27850.       27850.       27850.       27850.       27850.       27850.       27850.       27850.       27850.       27850.       27850.       27850.       27850.       27850.       27850.       27850.       2465.946       2646.495       -1767.269       256         2425       237104.       74750.       34841.459       2640.495       2646.495       -1767.269       2565         28501.       260815.       36334.       38225.       38336.296       2646.495       -1767.269       2766       -1757.269         28501.       260815.       36334.       38225.       38334.269       2646.495       2646.495       -1757.269         28501.       28457.560       2845.946       2646.495       742       2646.495       -1755.276         28501.       28457.540       2845.946       2646.495       740       740.470       740.470         28511.       2845.540       2845.546       2646.495       740       744.964       77	250.	1100.	1200.	118552.	17375.	-	17375.	17305.460	1000 106	040.0011		0.31401	000°0/6	CC•0
1625       165973       27857       24044124       1794103         1000       187683       27850       27850       27850       27850       27850       27850       27850       27850       27850       27850       27850       27850       27850       27850       27850       27850       27850       27850       27850       27850       27850       27850       27850       27850       27850       27850       27850       27850       27850       27850       27850       27850       27850       27850       27450       27450       27450       27450       27450       27450       27450       27450       2755       2755       2755       2755       2755       2755       2755       2755       2755       2755       2755       2755       2755       275       2755       275       2755       275       2755       275       275       275       275       275       275       275       275       275       275       275       275       275       275       275       275       275       275       275       275       275       275       275       275       275       275       275       275       275       275       275	300.	1350.	1400.	142263	20850	1	2 T E E T	100*C4047		192.44TT	196.400-	1/395.0	1303.859	
1000:       1797/3       7407/3       7407/3       7407/3       7407/3       7407/3       7407/3       7407/3       7407/3       7407/3       7407/3       7407/3       7407/3       7407/3       7407/3       7407/3       7407/3       7407/3       7407/3       7407/3       7407/3       7407/3       7407/3       7407/3       7407/3       7407/3       7407/3       7407/3       7407/3       7407/3       7407/3       7407/3       7407/3       7407/3       7407/3       7407/3       7407/3       7407/3       7407/3       7407/3       7407/3       7407/3       7407/3       7407/3       7407/3       7407/3       7407/3       7407/3       7407/3       7407/3       7407/3       7407/3       740/3       740/3       740/3       740/3       740/3       740/3       740/3       740/3       740/3       740/3       740/3       740/3       740/3       740/3       740/3       740/3       740/3       740/3       740/3       740/3       740/3       740/3       740/3       740/3       740/3       740/3       740/3       740/3       740/3       740/3       740/3       740/3       740/3       740/3       740/3       740/3       740/3       740/3       740/3       740/3       740/3	150		14.05					14T*4/002		1394.020	- 961.839	20878.7	1557.529	1
17900.       27850.       27800.       27852.820       1981.198       -1282.748       -1785.259         2425.       231394.31275.       31341.459       2047.901       2122.746       -1359.726         2425.       231394.31750.31275.       31341.459       2047.901       2122.746       -1359.726         2455.       231704.34750.3481.34726.       31341.459       2047.901       2122.746       -1359.726         2650.       260815.38275.38334.38225.       38326.296       2845.946       246.495       -1759.25         2650.       260815.38275.38334.38226.       3154.497       3154.971       2845.946       -2405.455         2851.       2845.946       246.495       -1755.564       -2105.571       -1952.354         2851.       28334.33226.238376.250       2845.946       2646.495       -1952.354         5701.       2871.4       7101.418.845       3154.910.70       2845.945       -1952.354         571.1       1010       171       1710       7114.10       711       7114       711         571.1       741.91       711       711.91       711.91       711.91       713.73       713.73         571.1       711.1       711.1       711.1       711.1       711				0/4/01		< + 000 · ·		24304.528	1548.800	1623.681	-1110.368	24363.6	1798.259	0.35
2129: 213394. 31275. 31341.459       2047.901       2122: 746       -1459.726         2650: 203104. 34750. 34341.459       2047.901       2122: 746       -1952.254         2650: 203104. 34750. 34341.459       2045.946       246.495       -1922.354         2650: 203104. 34750. 34341.459       2045.946       246.495       -1922.354         2650: 203104. 34750. 34341.459       2045.946       246.495       -1922.354         2650: 203104. 34750. 34341.459       3049.970       245.946       -2105.571         26465       58.3834.4852. 34170. 41818.845       3169.970       2845.946       -2105.351         26465       57.41       7100. 41832. 41700. 41818.845       3169.970       2845.946       -2105.351         2106       711       710       711       710       711       710       711         2104       776       517       710       713       710       711       711         211       711       711       711       711       711       714.94       713       717         211       713       711       713       713       713       714.94       713       714         211       711       711       711       711       713       714 <td></td> <td></td> <td>1900</td> <td>189683.</td> <td>27800.</td> <td>27850.</td> <td>27800.</td> <td>27852.820</td> <td>1798.383</td> <td>1898.198</td> <td>-1293.803</td> <td>27851.4</td> <td>2105.521</td> <td></td>			1900	189683.	27800.	27850.	27800.	27852.820	1798.383	1898.198	-1293.803	27851.4	2105.521	
2425: 237104. 34750. 34841. 34750. 34834.269       2621.560       2425.064       -1755.269         2650: 260815: 36225. 38334. 38225: 38326.296       2845.946       2646.495       -1755.269         2850: 260815: 36225. 38334. 38225: 38326.296       2845.946       2646.495       -1755.269         2850: 260815: 3622. 38334. 38225: 38326.296       2845.946       2646.495       -1755.269         2850: 260815: 38225. 38334. 38225: 38326.296       2845.946       2646.495       -1755.259         2006       AXIAL MSD CR TRU CR MSD LN TRU LONG TRU CIRCM TRU LONG TRU RAD FI       710.511       711.101         STRAIN       LONG AXIAL MSD CR TRU CR MSD LN TRU LONG TRU CIRCM TRU LONG TRU RAD AXIAN       714.984       -209.963         N/IN       POUNDS       PSI       PSI       PSI       924.909       174.984       -209.963         3576. 23710       5975. 3375.035       3475.038       3479.099       174.984       -209.963       37337         3570. 2482       13470. 1040.375       3479.090       349.979       349.9799       -7937.337       375         3570. 2482       13479.090       13499.090       1349.090       374.937       -4937.337       375         3570. 2482       34799.1817       929.1817       929.174       949.935       -7937.337       375	450.		2125.	213394.	31275.	31339.	31275.	31341.459	2047.901	2122.746	-1450 726		13/1/1/03	
2650.       20815.       38255.       38326.206       2845.946       2666.495       -1222.354         2650.       20815.       41700.       41818.645       3169.970       2845.946       -2105.571         6465.       5       AND       6       -2105.571       -2105.571         6465.       5       AND       6       -2105.571       -2105.571         57810.       2845.946       2646.495       -1222.354         57810.       AXIAL MSU CR TRU CR MSD LN TRU LONG TRU CIRCM TRU LONG TRU RAD       5781N         STRAIN       PLOND       STRAIN       5781N       1781N         N/IN       POUNDS       PS1       PS1       PS1       PS1         N/IN       POUNDS       PS1       PS1       PS1       PS1         N/IN       POUNDS       PS1       PS1       PS1       PS1         175.       23710.       3475.       3475.608       424.909       174.984       -209.965         175.       23710.       3475.       3475.608       424.909       174.984       -209.965         174.263       104392.       13970.135       1349.099       1474.919       -209.965         500.       114252.       13475.6188	500.		2425.	237104.	34750.	34841.	34750.	34834.240	2621.560	TAN CCAC				
Z6571.       Z64525.       41700.       41818.445       3169.970       Z645.945       -1722.354         GGGES       5       AND       6       2105.571       2169.970       2845.945       -1722.354         LONG       AXIAL       MSD       41818.445       3169.970       2845.945       -1722.354         LONG       AXIAL       MSD       FRESS       ATRESS       3169.970       2845.945       -2105.571         STRAIN       LONG       TRU       CR       MSD       TRU       LONG       TRU       CR       MAD         N/IN       POUNDS       PSI       PSI       MICROIN/IN       MICROIN/IN       MICROIN/IN         N/IN       POUNDS       PSI       PSI       PSI       MICROIN/IN       MICROIN/IN         N/IN       POUNDS       PSI       1951       1951       1951       14721       0596       -2107.963         3500       7131       175       23710       34721       0950       13799       979       975       975       975       975       975       975       975       975       975       975       975       975       975       975       975       975       975       975       9	550.	2850.	2650.	260815	TROOR	ATTAT	TROOF	10104 004			402.00/1-	>	2000.3/4	
GAGES 5 AND 6       AIX00. 41835. 41700. 41818.845       3169.970       2845.946       -2105.571         GAGES 5 AND 6       AXIAL MSD CR TRU CR MSD LN TRU LONG TRU CIRCM TRU LONG TRU RAD       STRAIN       UNG       AXIAL MSD CR TRU CR MSD LN TRU LONG TRU CIRCM TRU LONG TRU RAD         STTAIN       LOAD STRESS STRESS STRESS STRESS       STRAIN       STRAIN       STRAIN       STRAIN         N/IN       POUNDS       PSI       PSI       PSI       PSI       PSI       PSI       PSI       PSI         1750       23710       34750       54750       99995090       197959       PSI       <					0.3300		+ 22200	2020000000	2047.740	2040.495	-1922.354	38330.1	3114.513	0.35
GAGES         5         AND         6           GAGES         5         AND         6           STRAIN         LONG         AXIAL MSD         CR TRU CR MSD         IRU LONG         TRU RAD           STRAIN         POUNDS         PSI         BTCROIN/IN         MICROIN/IN         MICROIN/IN         MICROIN/IN           N/IN         POUNDS         PSI         BSI         STRAIN         STRAIN         STRAIN           N/IN         POUNDS         PSI         BSI         STRAIN         MICROIN/IN         MICROIN/IN         MICROIN/IN           N/IN         POUNDS         PSI         BSI         STRAIN         STRAIN         STRAIN           N/IN         POUNDS         PSI         BSI         STRAIN         MICROIN/IN         MICROIN/IN           N/IN         POUNDS         PSI         BSI         STRAIN         STRAIN         STRAIN           JF0         34721         BSI         BSI         JAT220         BSI         STAIN         STAIN           J50         71331         JAT2265         JAT302         L3797         JAT302         L3797         JAT302         STAIN           J50         JAT31         JAT31         JAT30	• 0 0 0	• 6 / 10	• 1662	. ( ) ( + 0 )	•00/1•	41832.	•1700.	41818.845	3169.970	2845.946	1/5.2015-	41825.6	3414.148	0.35
LONG         AXIAL MSU         CR TRU         CR MSU         CR MSU         CR TRU         CINC         TRU         LONG         TRU         LONG         TRU         RAIN           SITAIN         LUAD         STRESS         STRESS         STRESS         STRAIN	TEST N	UMBER 14	GAGES	5 AND	¢					· · ·				
STRAIN         LUAD         STRESS         STRESS         STRAIN         STRAIN <td>HYDRO</td> <td>CIRCUM</td> <td>LONG</td> <td></td> <td>MSD CR</td> <td>TRU CR</td> <td>MSD LN</td> <td>TRU LONG</td> <td></td> <td>TRU LONG</td> <td>Teu eAD</td> <td>CEFECTIVE</td> <td>CCCCT1VC</td> <td>2</td>	HYDRO	CIRCUM	LONG		MSD CR	TRU CR	MSD LN	TRU LONG		TRU LONG	Teu eAD	CEFECTIVE	CCCCT1VC	2
MICROIN/IN         POUNDS         PSI         MICROIN/IN	PRESS		STRAIN	LOAD	STRFES	STRESS	STRESS	CTDECE						Ē
425. $175.$ $23710.$ $3475.$ $3475.608$ $424.909$ $174.984$ $-209.963$ $900.$ $350.$ $47421.$ $6950.$ $6952.432$ $899.596$ $349.939$ $-437.337$ $1357.$ $500.$ $7131.$ $10425.$ $10430.212.$ $1349.090$ $499.874$ $-647.137.$ $1675.$ $550.$ $7131.$ $10425.$ $10430.212.$ $1349.090$ $499.874$ $-647.137.$ $11575.$ $1675.$ $550.$ $7130.212.$ $1349.090.$ $499.638.$ $-137.357.$ $1157.575.$ $2175.$ $850.$ $11855.$ $17375.$ $17412.$ $113709.208.$ $2122.746.$ $849.638.$ $-1040.335.$ $12755.$ $7525.$ $925.$ $142263.$ $20951.$ $2095.288.$ $2395.1697.$ $12606.237.$ $228.573.$ $2176.237.27.2.$ $700.$ $1100.$ $165973.$ $24325.$ $24325.$ $24351.758.2945.509.$ $1099.395.209.2122.746.233.717.2.27.66.237.27.2.233.717.7.2.2300.11276.233.717.7.2.233.717.7.2.233.717.7.2.2300.11276.233.717.7.2.233.717.7.2.233.717.7.2.233.717.7.2.233.1.77.7.2.233.717.7.2.233.1.77.7.2.233.717.7.2.233.1.77.7.2.233.717.7.2.233.717.7.2.233.777.2.233.717.7.2.233.777.7.2.233.777.2.233.777.2.233.777.2.233.777.2.233.777.2.233.777.2.233.777.7.2.233.777.7.2.233.7275.2133.777.7.2.233.777.2.233.7275.2133.7775.2133.7775.2133.7775.2133.7173.2.33725.33725.33727.338.777.3372.3372.3372.3372.3372.$	lSd		NIN	POUNDS	1Sd	154	I S d	ISA		MICROIN/IN	MICROININ	PSI	MICINIIN	
900. 350. 47421. 6950. 6950. 6950. 6952.432 899.596 349.939 -437.337 1357. 500. 71131. 10425. 10439. 10430.212 1349.090 499.874 -647.137 1 1625. 650. 94842. 13900. 13901. 13903.012 1349.090 499.638 -195.714 1 2125. 850. 118552. 17375. 17412. 13703. 17389.708 2122.746 849.638 -1040.335 1 2525. 925. 142263. 20850. 20903. 20850. 20899.886 2521.817 924.573 -1040.335 1 2500. 1100. 165973. 24355. 24351.758 2995.509 1099.395 -1433.717 2 3400. 12750. 189683. 24808. 24351.758 2995.509 1099.395 -1433.717 2 3400. 12750. 189683. 27800. 27895. 24351.758 2995.509 1099.395 -1433.717 2 3400. 12750. 237103. 34750. 31324.570 3372.458 2995.509 1099.395 -1433.717 2 3475. 1650. 237103. 34750. 38275. 38275. 38291.894 5201.136 1748.470 -2453.362 3 5755. 1270. 260815. 38275. 38275. 38291.894 5201.136 1748.470 -2453.362 3 5755. 1270. 260815. 38275. 38275. 38291.894 5201.136 1748.470 -2453.362 3	50.	425.	175.	23710.	3475.	3476.	3475.	3475.608	424.919	174.084	-200 043	0 9692	100 011	
1350.       500.       71131.       10425.       10425.       10430.212       1349.090       497.87       -647.137         1675.       650.       94862.       13975.       17412.       17375.       17389.768       -647.137         2157.       850.       114952.       17412.       17375.       17389.768       -795.714         2157.       850.       114952.       17412.       17375.       17389.768       -795.714         2157.       850.       114952.       17412.       17375.       17389.769       2153       -449.789       -795.714         2157.       850.       114952.2       17412.       17375.2       17389.769       2160.6.237         3700.       1100.       165973.2       24325.2       24351.758       2995.509       1993.373       1206.237         3400.       1100.       165973.2       24325.2       24351.758       2995.509       1993.371       2493.217         3400.       1150.       15963.2       27834.790       3394.233       1296.220       1943.317         3400.       1455.2       24351.351       3137.55       31321.131       3794.233       1295.209         3400.       1455.2       24351.353       313	100.	-006	350.	47421.	6950.	6956.	6950.	6952.432	ROO 50A	140 070				
1625. 650. 94842. 13900. 13923. 13900. 13575. 13568. 647.67 2125. 850. 14852. 13375. 17412. 17375. 17489.769 2525. 850. 148552. 17475. 17412. 17375. 17489.769 2525. 850. 148563. 20850. 20850. 20850. 20869.286 3700. 1100. 165973. 24325. 24395. 24351.758 3400. 1250. 189683. 27800. 27895. 27834.750 3400. 1250. 189683. 27800. 27834.750 3400. 1250. 189683. 27800. 27834.750 3475. 1650. 231394. 31275. 31294. 31275. 31221.131 3703. 1550. 231104. 31275. 31294. 31275. 31221.131 3765. 1750. 250415. 34750. 34827. 38225. 34291.894 5261.136 2755. 1750. 250415. 34725. 38225. 38291.894 5261.136 1748.470 2755. 1750. 250415. 34725. 38225. 38291.894 5261.136 1748.470	150.	1350.	500.	71131.	10425.	10439	10425	10430.919	1340,000				204.011	
2175. 850. 118552. 1377. 17412. 17375. 17897.069 242.001 899.038 -1040.355 7525. 925. 142263. 20850. 20903. 20850. 20869.286 2521.817 924.573 -1206.237 3000. 1100. 165773. 24325. 24325. 24351.758 2995.509 1099.395 -1433.217 3400. 1250. 189683. 27800. 27894. 27834.750 3594.233 1249.220 -1255.209 3400. 1475. 213944. 31275. 31394. 31275. 3131.313 3792.797 1473.914 -1843.349 4775. 1650. 237104. 34750. 34976. 343750. 34801.438 4763.636 4263.362	200.	1625.	650.	94842.	1.400.	11021	13000	1 TONO DIE	1231252	- / 0 · / / / / / / / / / / / / / / / / /		10+0+0	1170./89	<b>65.0</b>
7575     925     14263     2000     2000     2000     2000     2000     2000     2000     2000     2000     2000     2000     2000     2000     2000     2000     2000     2000     2000     2000     2000     2000     2000     2000     2000     2000     2000     2000     2000     2000     2000     2000     2000     2000     2000     2000     2000     2000     2000     2000     2000     2000     2000     2000     2000     2000     2000     2000     2000     2000     2000     2000     2000     2000     2000     2000     2000     2000     2000     2000     2000     2000     2000     2000     2000     2000     2000     2000     2000     2000     2000     2000     2000     2000     2000     2000     2000     2000     2000     2000     2000     2000     2000     2000     2000     2000     2000     2000     2000     2000     2000     2000     2000     2000     2000     2000     2000     2000     2000     2000     2000     2000     2000     2000     2000     2000     2000     2000     2000     2000     2000	250.		A50.	118552	17376	17413				AG/ A+0	1/ 26/	8.019.8	1405.657	0.0
707. 177. 177. 177. 100. 2003. 20050. 20050. 20050.286 2521.617 924.573 -1206.237 300. 1100 165973. 24325. 24394. 24325. 2451.758 2995.509 1090.395 -1433.217 3400. 1270. 189683. 2780. 27834.75 27834.758 2995.509 1090.295 -1625.209 3800. 1475. 213394. 31275. 31394. 31275. 31334.131 3792.797 1471.914 -1843.349 4775. 1550. 237104. 34750. 34916. 34750. 34807.338 4763.635 1648.640 -2244.797 577. 1750. 250815. 35225. 38477. 38225. 38291.894 5201.135 1744.470 -244.797	100		900				• 6 / 6 / 1	1/307.109	2122./40	849.638	-1040.335	17400.9	1837.745	0.35
3000. 1100. 1007/3. 24325. 24325. 24351.758 2995.509 1099.395 -1433.217 3600. 1250. 189683. 27800. 2789. 27804. 27834.750 3394.233 1249.220 -1629.209 3800. 1475. 213944. 31275. 31394. 31275. 3131.313 3792.797 1473.914 -1843.349 4775. 1550. 237104. 34750. 34916. 34750. 34807.338 4763.635 1548.540 -2244.597 5275. 1750. 256015. 35225. 38427. 38225. 38291.894 5201.136 1748.470 -2453.362					- nconz	<0602	.06805	20869.286	2521.817	924.573	-1206.237	20886.0	2159.729	0.35
. 3400. 1270. 182963. 27800. 27895. 27800. 27834.750 3394.333 1249.220 -1625.209 . 3800. 1475. 213994. 31275. 31394. 31275. 31321.131 3792.797 1473.914 -1643.349 . 4775. 1650. 237104. 34750. 34976. 34755. 348275. 38291.894 5261.136 1748.470 -2453.362 . 5775. 1070. 260115. 38225. 38427. 38225. 38291.894 5261.136 1748.470 -2453.362			1100.	1029/5.	24325.	24398.	24325.	24351.758	2995.509	1099.395	-1433.217	24374.9	2565.714	
· 3000 1475 213394 31275 31394 31275 31321.131 3792.797 1473.914 -1843.349 · 4775 1650 237104 34750 34916 34750 34807.338 4763.636 1648.640 -2244.297 · 5275 1050 260415 38225 38427 38225 38225 38291.894 5261.136 1748.470 -2453.362		040	.0621	189683.	27800.	27895.	27800.	27834.750	3394.233	1249.220	-1625.209	27864.7	2908.158	
• 4/75. 1650. 237104. 34750. 34916. 34750. 34807.338 4763.636 1648.640 -2244.297 • 5275 1050. 260815 38225. 38827. 38225. 38291.894 5261.136 1748.470 -2453.362 • 6075 1000 2260815 1750. 2017. 38225. 38221.894 5261.136	400.	3800	1475.	213394.	31275.	31394.	31275.	31321.131	3792.797	1473.914	-1843.349	31357.6	3271.004	0.35
• 5275 1750, 2600455 38225, 38427, 38225, 38291,894 5261,436 1748,470 -2453,362	004	4775.	1650.	237104.	34750.	34916.	34750.	34807.338	4763.636	1648.640	-2244.997	34RA1 A	275.574	1.15
	550.	5275.	1750.	260815.	39225.	38427.	38225.	38291.894	5261.136	1748.470	- 2453 1AD	A DESC		
· 77/70 17/00 - 204727.	600.	6075.	1000	100700										

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

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PRESS	STRAIN STRAIN	STRAIN	LOAD	STRESS	STRESS	SIRESS	STRESS	STRAIN	STRAIN	STRAIN		STRAIN	
١Sd	MICROIN/IN	NIN	POUNDS	PS1	ISd ISd ISd	I S d	ISd	MICROIN/IN	MICROIN/IN	MICROIN/IN	ISd	MICIN/IN	
.05		100.	23710.	3475.	3475.		3475.348	66 <b>.</b> 66	99.995	-69.996	3475.3	113.327 0.35	÷ 0
100.		225.	47421	6950.	6952.	6950.	\$951.564	224.975	224.975	-157.482	6951.6	254.971	0.3
150.		350.	71131.	0425.	10429.	10425.	10428.649		349.939	-244.957	10428.6		ē.0
200.		425.	94842.	3900.	13906.	13900.	13905.907		424.909	-297.437	13905.9		0.3
250.		600.	118552.	17375.	17385.	1/375.	17385.425		599.821	-402.384	17385.0		. J
300.		700.	142263.	20850.	20864.	20850.	20864.595		699.756	-481.085	20864.3		5.0
350.	800.	825.	165973.	24325.	24344.	24325.	24345.068		824.661	-568.520	24344.8	920.573 0.35	0.3
400.		925.	189683.	27800.	27824	27800.	27825.715	874.617	924.573	-629-717	27825.0		0.35
450.	-	1050.	213594.	31275.	31308.	31275.	31307.839	•	1049.448	-734.614	31307.8		0.35
500.	•	1200.	237104.	34750.	34793.	34750.	34791.700	• •	1199.280	-856.975	34792.6		0.35
550.	1325.	1300.	260815.	38225.	38276.	38225.	38274.693	• •	1299.155	-918.147	38275.2		0.3
600.	1350.	1350.	284525.	41700.	41756.	41700.	41756.295	1349.090	1349.090	-944.363	41756.3	1528.969	0.35
TEST N	FEST NUMBER 14 GAGES	GAGES	1 AND	∾.			!				:		
N D D D	MIJOID DOUNH	ONO 1	A Y T A I	מי עסא			TDU LONG		000 1 001	Tou DAD			3
					2				ואט בטאפ			EFFELI VE	

	STRESS	N/IN PSI MICIN/IN	3475.9 314.139	.624 6953.9 682.851 0.35	10433.7 1014.914	13914.8 1283.767	17398.9 1650.660	20884.2 1994.427	24370.3 2262.850	27859.5 2594.348	31351.3 2952.131	34850.4 3530.574	38347.4 3928.042	41847.1 4344.285
	STRAIN STRAIN			349.939 -393.624										
	STRAIN	MICROIN/IN M	349.939	774.700	1149.340	1448.950	1848.290	2272.415	2571.691	2945.657	3344.402	4041.820	4514.793	5012.416
	STRESS	ISd	3475.608	6952.432	10430.473	13909.383	17390.638	20870.850	24352.974	27836.835	31322.694	34809.944	38296.672	41784.442
	STRESS STRESS STRESS	ISd		6950.										
2	STRESS	ISA		6955.										
			3475.	6950.	10425.	13900	17375.	20850.	24325.	27800.	31275.	34750.	38225.	41700.
	LOAD	POUNDS	23710.	47421.	71131.	94842.	118552.	142263.	165973.	189683.	213394.	237104.	260815.	284525.
LUNG	STRAIN	NIN		350.									- 1	
L L L L U L	STRAIN	PSI MICROIN/IN	350.	775.	1150.	1450.	1850.	2275.	2575.	2950.	3350.	4050.	4525.	5025.
	PRESS	ISd	50.	100.	150.	200.	250.	300.	350.	400.	450.	500.	550.	600.

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

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<b>NH</b>	0000 000 000 000 000 000 000 000 000 0	0.35 0.35 0.35	£	0.35 0.35 35 35 35 35 35 35 35 35 35 35 35 35 3	0.35
EFFECTIVE STRAIN HICIN/IN	384.877 595.542 906.305 1161.072	1472.376 0.35 1727.016 0.35 1996.209 0.35 2504.310 0.35 2604.310 0.35	EFFECTIVE Strain Micin/in	610.640 915.221 1296.306 1683.572 2108.573 2438.651 2850.694	3212.454
EFFECTIVE STRESS PSI	3476.2 6953.6 10433.3 13914.2	17397.6 20881.8 24367.9 27857.1 31346.9	EFFECTIVE STRESS PSI	3476.7 6955.0 10435.7 13918.1 17404.1 20890.2 24380.1	27870.3
TRU RAD Strain Hicroin/in	-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 -1349.890 -1549.890	-1764.706
TRU LONG STRAIN	299.955 499.874 799.681 1024.476	1299.155 1523.838 1723.513 1998.003 2247.473	TRU LONG STRAIN MICROIN/IN	224.975 374.930 524.862 699.756 874.617 974.575 1174.310	1249.220
TRU CIRCM STRAIN MICROIN/IN	374.930 549.849 799.681 1024.476	1299.155 1523.838 1798.383 2097.798 2347.244	TRU CIRCM Strain Microin/in P	724.737 1074.422 1523.838 1973.052 2471.952 2871.952 2871.952 3344.402	3792.797
TRU LONG STRESS PSI 1	3476.042 6953.475 10433.340 13914.248	17397.587 20881.796 24366.941 27855.600 31345.389 31345.389	TRU LONG STRESS PSI	3475.782 6957.606 69530.473 13909.730 17390.203 20870.329 24353.582	27834.750
MSD LN STRESS PST	3475. 6950. 10425.	17375 20850 24325 27800 31275	MSD LN SIRESS PSI	3475. 6950. 10425. 13900. 17375. 20850. 20850.	27800.
TRU CR STRFSS PSI	34/6. 6954. 10433.	17398. 20882. 24369. 27858. 31348.	TRU CR STRESS PSI	3478. 6957. 10441. 13027. 17418. 20910. 24405.	
MSD CR STRESS PSI	· · · · ·	17375. 20850. 24325. 31275.	MSD CR STRESS PSI	3475. 6950. 10425. 13900. 17375. 24325.	
AXIAL LOAD POUNDS	23710. 47421. 71131. 94842.	118552 142263. 165973. 189683. 213394.	AXIAL LOAD POUNDS	23710. 47421. 71131. 94842. 118552. 118552.	189683.
LONG	300. 500. 800.		STRAIN V/IN	225 375 225 700 875 1175	1250.1
HYDRO CIRCUM LONG PRESS STRAIN STRAIN PSI MICROIN/IN	375. 550. 800. 1025.	250. 1300. 1300. 300. 1575. 1525. 350. 1870. 1525. 410. 2101. 2705. 410. 2351. 2250.	HYDRO CIRCUM LONG PRESS STRAIN STRAIN PSI MICROINVIN	725. 1075. 1525. 1975. 2875. 2875.	3800.
HYDRO PRESS PSI	50. 150. 200.	250. 304. 350. 450.	HYDRO PRESS PSI	500 500 550 550 550	400.

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

WEBR         CHARL         CHARL <thc< th=""><th>CIRCUM STRAIN MICROI 500. 500. 1000. 1000.</th><th>STRAIN N/IN N/IN 150 375 500 525 725 125 125 100 100 100</th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th></thc<>	CIRCUM STRAIN MICROI 500. 500. 1000. 1000.	STRAIN N/IN N/IN 150 375 500 525 725 125 125 100 100 100											
<ul> <li>Grain Loub STRESS STRESS STRAIN STAIN STRESS STRAIN STRESS STRAIN STRESS STRAIN STRESS STRAIN VIN POUNDS PSI PSI PSI PSI PSI PSI PSI PSI PSI PS</li></ul>	MICROIN 2255 2755 500 525 700 700 860 100 900 1000	STRAIN N/IN 150 250 375 500 525 725 1225 1125			1	MSD LN	TRU LONG		TRU LONG	TRU RAD	EFFECTIVE	Ë.	Ĩ
W/IN         POUNDS         FSI         PSI         MICROIN/IN         MICROIN/IN         MICROIN/IN         PSI         MICLUIN           150         23710         3475         3475         3475         3475         751         751         751         751         751         751         751         751         751         751         751         751         751         751         751         751         751         751         751         751         751         751         751         751         751         751         751         751         751         751         751         751         751         751         751         751         751         751         751         751         751         751         751         751         751         751         751         751         751         751         751         751         751         751         751         751         751         751         751         751         751         751         751         751         751         751         751         751         751         751         751         751         751         751         751         751         751         751         751	MICROI 275. 275. 275. 275. 275. 275. 275. 275.	N/IN 150 250 375 500 625 725 1125 1125				STRESS	STRESS		STRAIN	STRAIN	STRESS		
150.       23710.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475.       3475. <td< td=""><td></td><td>150. 250. 375. 525. 625. 125. 1125.</td><td></td><td></td><td>ISd</td><td>PS1</td><td>ISd</td><td></td><td>MICROIN/IN</td><td>MICROIN/IN</td><td>ISd</td><td></td><td></td></td<>		150. 250. 375. 525. 625. 125. 1125.			ISd	PS1	ISd		MICROIN/IN	MICROIN/IN	ISd		
250.       47421.       6952.       6952.       6952.       6952.       6952.       6952.       6952.       6952.       6952.       6952.       6952.       6952.       6952.       6952.       6952.       6952.       6952.       6952.       6952.       6952.       6952.       6952.       6952.       6952.       6952.       6952.       6952.       13907.       13907.       13907.       13907.       13907.       13907.       13907.       13907.       13907.       13907.       13907.       13907.       13907.       1307.       11127.       142635.       24355.       24356.       177.       1699.       730.       11127.       699.       1000       1000       1000       107.       10965.       107.       107.       1000       1000       1000       1000       1000       1000       1000       1000       1000       1000       1000       1000       1000       1000       1000       1000       1000       1000       1000       1000       1000       1000       1000       1000       1000       1000       1000       1000       1000       1000       1000       1000       1000       1000       1000       1000       10000       1000       1000		250. 375. 500. 625. 725. 1125.	23710.	3475.	3476.	3475.	3475.521	224.975	149.989	-131.237	3475.7	216.845	3.0
575.       71131.       10425.       10429.       10429.       10429.       10429.       10429.       10429.       10429.       10429.       10429.       10429.       10429.       10429.       10429.       10429.       10429.       10429.       10429.       10429.       10429.       10429.       10429.       10429.       10429.       1042.       1042.       1042.       1042.       1042.       1042.       1041.       1041.       1041.       1041.       1041.       1041.       1041.       1041.       1041.       1041.       1041.       1041.       1041.       1041.       1041.       1041.       1041.       1041.       1041.       1041.       1041.       1011.       1041.       1011.       1041.       1011.       1041.       1011.       1011.       1041.       1011.       1011.       1011.       1011.       1011.       1011.       1011.       1011.       1011.       1011.       1011.       1011.       1011.       1011.       1011.       1011.       1011.       1011.       1011.       1011.       1011.       1011.       1011.       1011.       1011.       1011.       1011.       1011.       1011.       1011.       1011.       1011.       1011.	-	375. 500. 625. 725. 1125. 1125.	47421	6950.	6952	6950-	6951.737	274.963		-183.726	6951.8	297.812	35.0
500       04842       13900       13900       13907       15900       500       54364       624364       524,137       53955       708,111       524,137       53155       708,111       524,137       745,137       53156       708,111       524,137       745,137       708,111       525       113555       7386,1375       7385,185       708,111       975,118       708,111       975,118       708,111       975,118       708,111       975,118       708,111       975,118       708,111       975,118       708,111       975,118       708,111       975,118       708,111       975,118       708,111       975,118       700,100       975,118       708,111       975,118       700,100       975,118       700,100       975,118       700,100       975,118       700,100       975,118       700,100       975,118       700,100       975,118       776       776       776       776       776       776       776       776       776       776       776       776       776       776       776       776       776       776       776       776       776       776       776       776       776       776       776       776       776       776       776       776       776		500. 525. 875. 1125.	71131		10420	10425.	10428.909	399.919		-271.197	10429.0	439.319	.35
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### 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

2. R. Loreman

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.

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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 ratios. However, this does not change the stress-state very much. This can be observed if one plots C. /C. versus J. J. and this 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. This 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.
- 4. 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.
- 5. 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.

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### BASIC EQUATIONS

### FOR 1:1 STRESS STATE:

 $e_{1} = \frac{1}{E_{1}} \quad (\sigma_{1} - \mu_{1}\sigma_{2})$   $e_{2} = \frac{1}{E_{2}} \quad (\sigma_{2} - \mu_{2}\sigma_{1})$   $\therefore \quad e_{1} = \sigma_{1} \quad (1 - \mu_{1})$   $e_{2} = \sigma_{2} \quad (1 - \mu_{2})$   $so: \quad \sigma_{1} = \frac{e_{1} E_{1}}{1 - \mu_{1}}$   $\sigma_{2} = \frac{e_{2} E_{2}}{1 - \mu_{2}}$ 

BUT:  $\sigma_1 = \sigma_2$ 

POISSON's Ratio
Developed by load in
the (one) direction.

 $\sigma_2$ 

FOR 2:1 STRESS STATE:

2-51324

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

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

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

$$e_{2} = \frac{\sigma_{2}}{E_{2}} \qquad (1 - 2\mathcal{M}_{2})$$
So: 
$$\sigma_{1} = \frac{e_{1}E_{1}}{1 - 0.5\mathcal{M}_{1}}$$

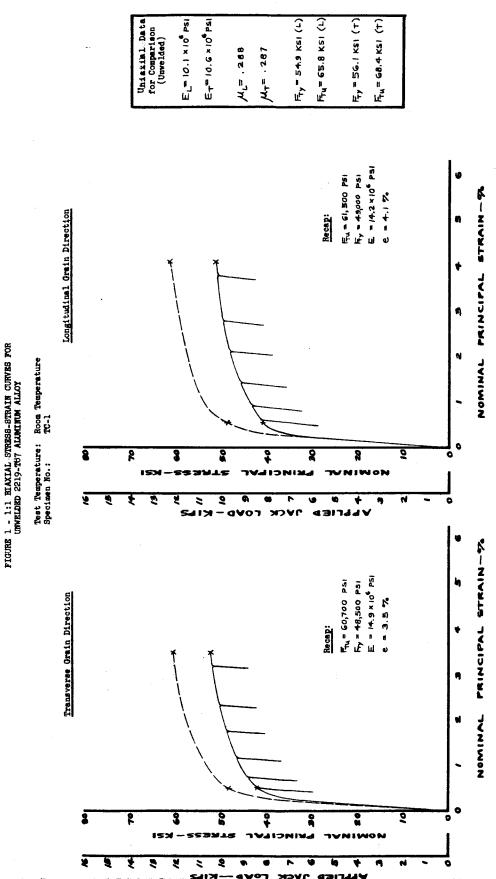
$$\sigma_{2} = \frac{e_{2}E_{2}}{1 - 2\mathcal{M}_{2}} \qquad \text{or also } \sigma_{1} = \frac{e_{2}E_{2}}{0.5 - \mathcal{M}_{2}}$$

228

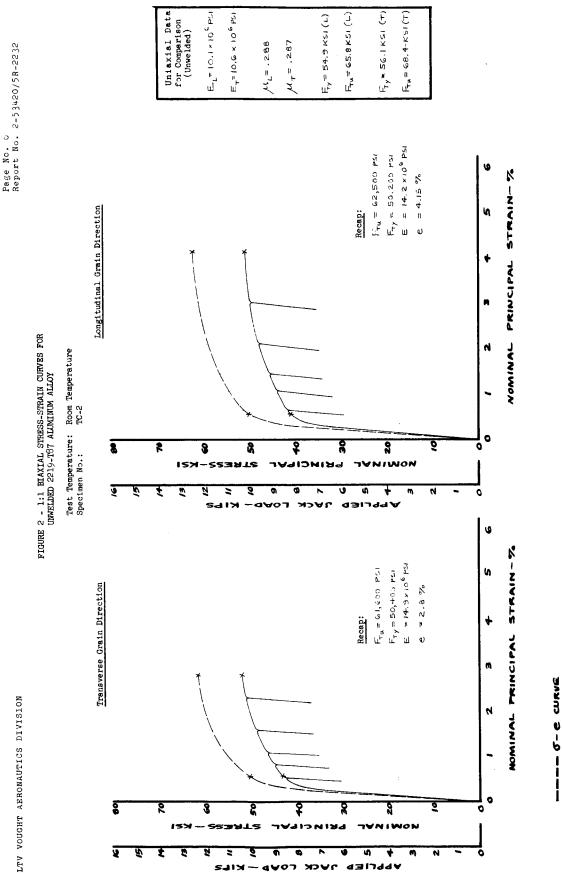
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------ P- & CURVE



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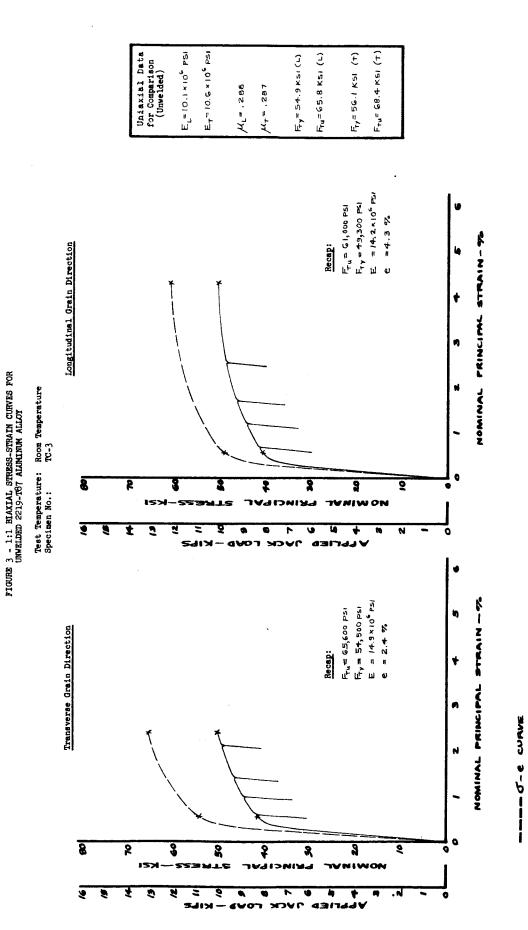
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- P-e curve



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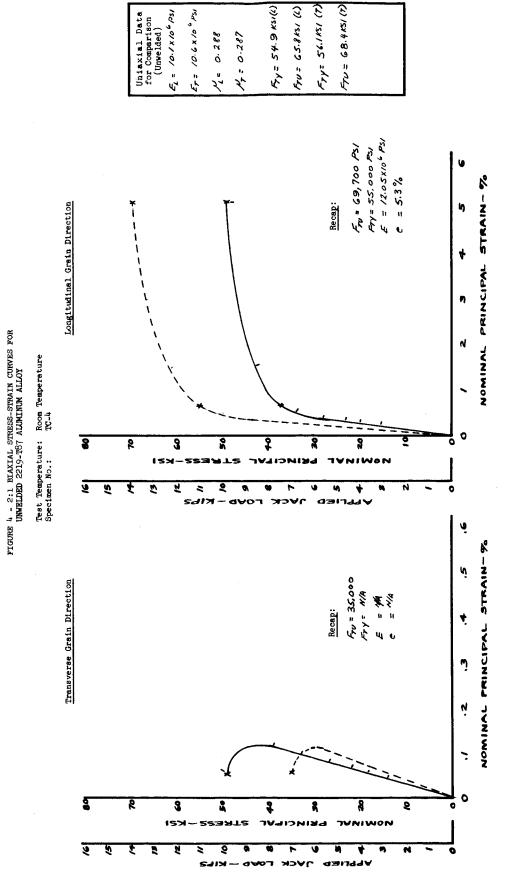


231

- P- e curve

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1

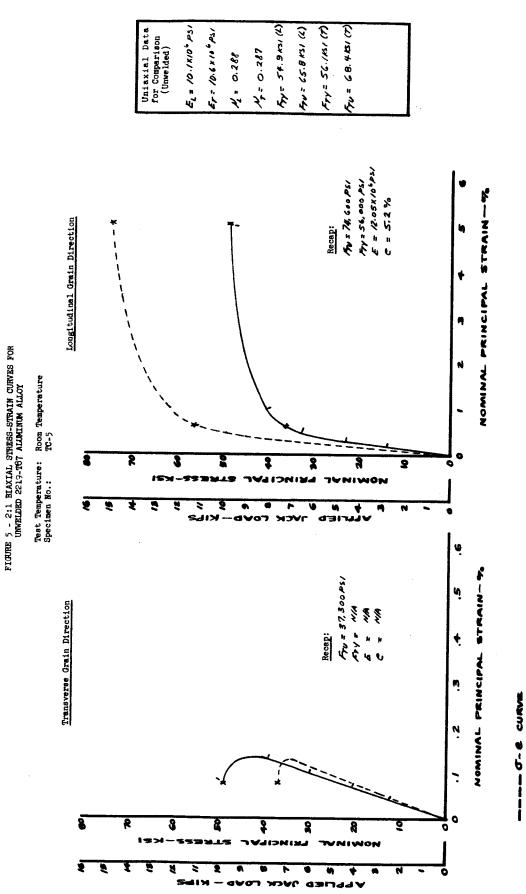
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P-e curve

---- J- C CURVE

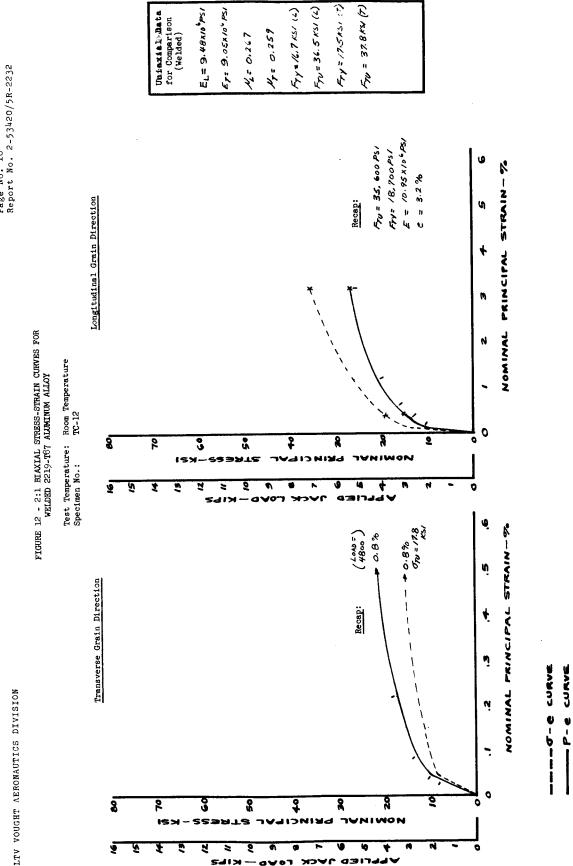
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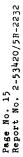
P-e curve

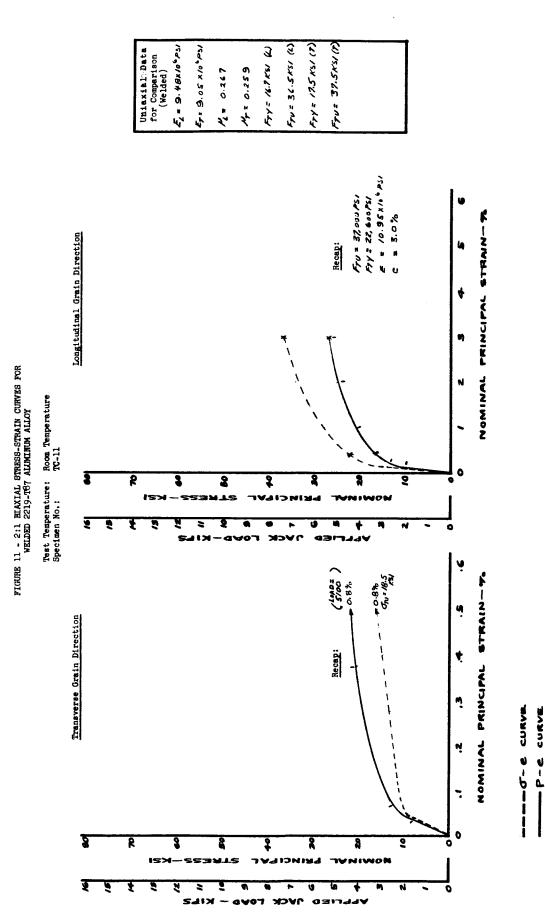


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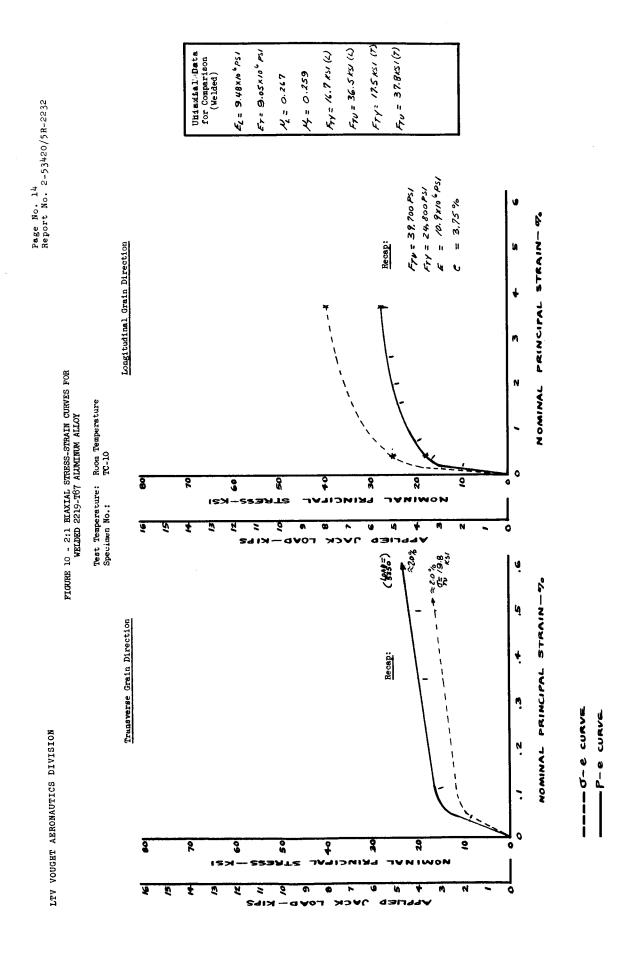
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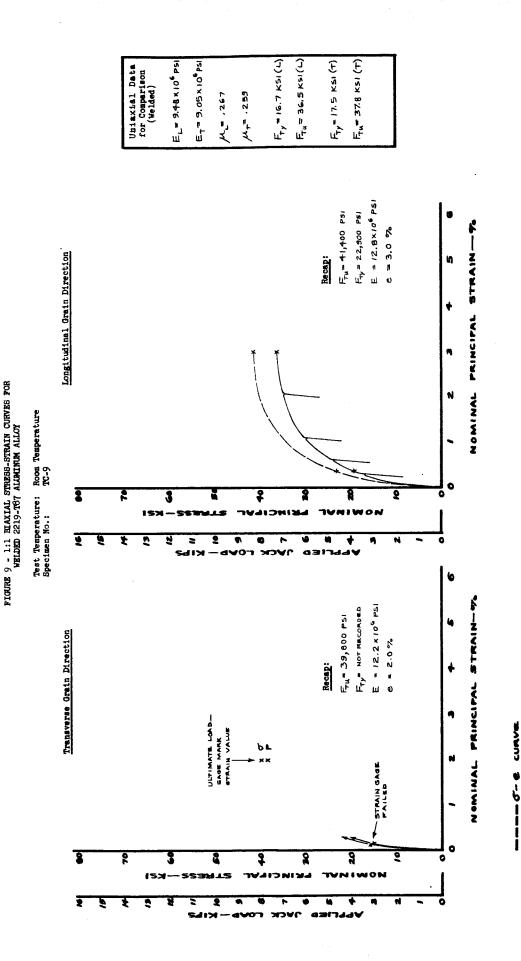
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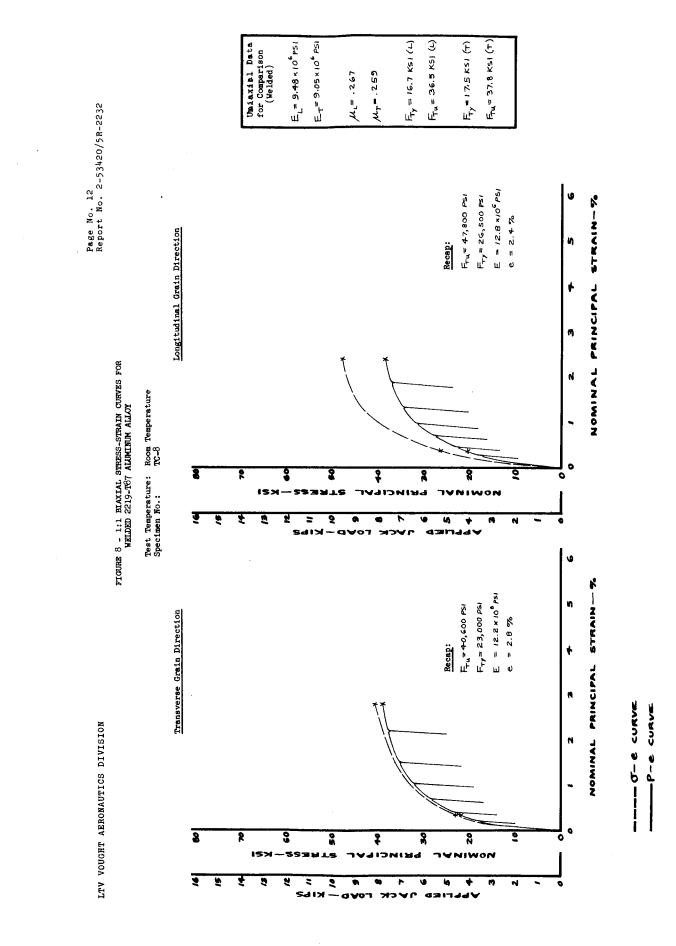
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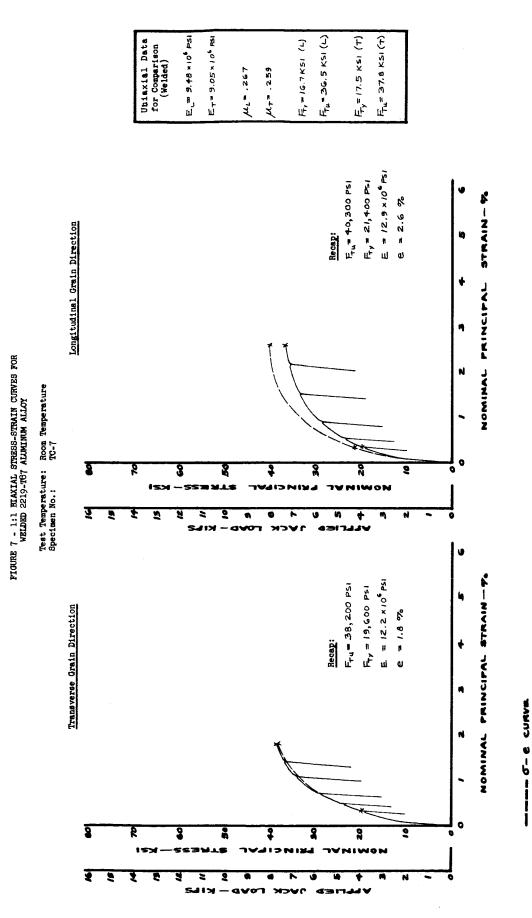


- P- & CURVE

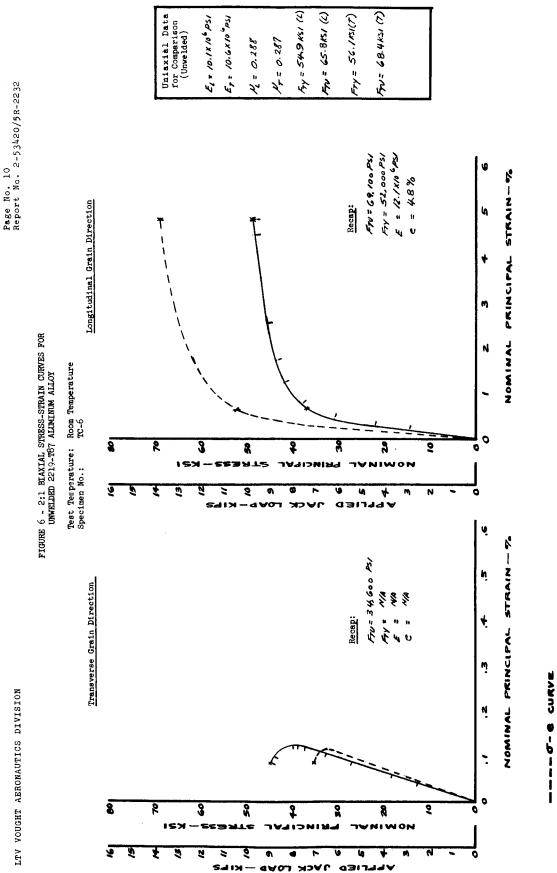


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- P- C CURVE



- P- & 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, %

\$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 = 52.5000007.0454965 - 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.

**TABLE I-1** 

TABLE I-2.

UNIAXIAL TENSILE TEST RESULTS ON PARENT ALUMINUM ALLOYS

71         5.250000000         6.900000000         1.650000000          73         5.300000000         1.6500000000         1.650000000          74         5.3700000000         1.11000000         1.650000000          73         5.300000000         1.11000000         1.11000000          74         5.370000000         1.11000000         1.11000000          75         5.400000000         1.11000000         1.11000000          74         5.370000000         6.90000000         1.1000000          75         5.400000000         6.90000000         1.1000000          75         5.400000000         1.1000000         1.1000000          75         5.400000000         1.1000000         1.1000000          75         5.400000000         1.1000000         1.1000000          75         5.400000000         1.1000000         1.1000000          75         5.4400000000         1.1000000         1.1000000          75         5.4400000000         1.1000000         1.1000000          76         5.440000000         1.1000000         1.1000000          70         5.440000000         1.1000000         1.1000000          70         5.440000000         1.1000000         1.1000000          70         5.4400000000         1.1000000         1.	22       5.370000+01       6.5610000+01         23       5.3700000+01       6.5610000+01         24       5.3700000+01       6.5610000+01         25       5.3700000+01       6.5610000+01         73       5.3700000+01       6.5610000+01         73       5.3700000+01       6.5610000+01         73       5.3700000+01       6.5610000+01         73       5.3700000+01       6.5600000+01         74       5.4800000+01       6.5700000+01         75       5.4800000+01       6.500000+01         74       5.4800000+01       6.500000+01         83       5.4800000+01       6.500000+01         84       5.4800000+01       6.500000+01         84       5.4800000+01       6.500000+01         85       5.4800000+01       6.500000+01         84       5.4800000+01       6.500000+01         85       5.4800000+01       7.000000+01         86       5.4800000+01       7.000000+01         87       5.4800000+01       7.000000+01         88       5.4500000+01       7.000000+01         89       6.4700000+01       7.000000+01         81       6.5000000+01       7.000000+01	NUMBER	Y ADENT META	n	Ŀ
22       5.25500000-01       6.5500000-01       1.1500000-01         74       5.4900000-01       6.5500000-01       1.1000000         73       5.4900000-01       6.5500000-01       1.1000000         74       5.4900000-01       6.5500000-01       1.4000000         75       5.4900000-01       6.5500000-01       1.4000000         74       5.4900000-01       6.500000-01       1.4000000         75       5.4900000-01       6.500000-01       1.4000000         74       5.49700000-01       6.500000-01       1.4000000         75       5.49700000-01       6.500000-01       1.4000000         84       5.4700000-01       6.500000-01       1.4000000         85       5.4500000-01       6.700000-01       1.4000000         84       5.4700000-01       5.4700000-01       1.4000000         85       5.4500000-01       5.4900000-01       1.4000000         84       0.4500000-01       5.4900000-01       5.4000000-01         85       5.4500000-01       5.4900000-01       1.40000000         84       0.45000000-01       5.4000000-01       5.400000000         84       0.45000000-01       5.440000000-01       5.400000000	$\begin{array}{cccccccccccccccccccccccccccccccccccc$	71 CC 2C17-107	5.2500000+0	.5000000+0	. 4000004
<ul> <li>5. 5.3900000-01</li> <li>6. 5500000-01</li> <li>7. 5.400000-01</li> &lt;</ul>	23       5.39000000000       6.5900000000         71       5.3900000000       6.5900000000         72       5.41000000000       6.5900000000         73       5.4100000000       6.590000000         74       5.44000000000       6.590000000         74       5.44000000000       6.590000000         74       5.44000000000       6.590000000         74       5.4400000000       6.590000000         82       5.4400000000       6.500000000         84       5.4400000000       6.500000000         84       5.4400000000       6.500000000         84       5.4400000000       6.500000000         84       5.4400000000       7.0440000000         85       6.4700000000       7.020000000         84       6.4700000000       7.020000000         85       6.4700000000       7.020000000         84       6.55000000000       7.020000000         85       6.4700000000       7.020000000         84       6.55000000000       7.020000000         84       6.500000000       7.020000000         84       6.500000000       7.020000000         84       6.440000000       7.020000000 <td>22</td> <td>0+000042.</td> <td>0+1100004.</td> <td>6194620.</td>	22	0+000042.	0+1100004.	6194620.
27         5.3000000         6.500000000         1.111         1.111          71         5.4100000000         6.5000000000         1.111         1.111          72         5.4000000000         6.5000000000         1.111         1.111           73         5.400000000         6.5000000000         1.111         1.111         1.111           74         5.400000000         6.5000000000         1.111         1.11100000           73         5.400000000         6.5000000000         1.1100000         1.1100000           74         5.400000000         6.500000000         1.100000000         1.100000000           74         5.400000000         6.500000000         1.100000000         1.100000000           75         5.400000000         6.500000000         1.100000000         1.100000000           84         5.4700000000         7.000000000         1.100000000         1.1000000000           84         6.47000000000         7.000000000         1.100000000         1.100000000           84         6.47000000000         7.000000000         1.10000000         1.100000000           84         6.444445101         7.000000000         1.100000000         1.1000000000           84         6.42000000000	25       5.37000010+01       6.5500000+01         73       5.3700000+01       6.5500000+01         73       5.3700000+01       6.5500000+01         75       5.4100000+01       6.5500000+01         75       5.4700000+01       6.5500000+01         75       5.4700000+01       6.5500000+01         75       5.4700000+01       6.5500000+01         75       5.4700000+01       6.5500000+01         75       5.4700000+01       6.5500000+01         75       5.4700000+01       6.5500000+01         83       5.4700000+01       6.5500000+01         84       5.4700000+01       6.500000+01         84       5.4500000+01       6.500000+01         84       5.4500000+01       6.990000+01         84       6.470000+01       7.010000+01         84       6.470000+01       7.010000+01         84       6.470000+01       7.010000+01         84       6.470000+01       7.010000+01         84       6.470000+01       7.010000+01         84       6.470000+01       7.010000+01         84       6.470000+01       7.010000+01         84       6.4700000+01       7.0100000+01	55	.3900000+0	.5800000+0	120000
25         5.370000001         6.530000001         1.130000000           71         5.400000000         6.5300000000         1.130000000           73         5.400000000         6.5300000000         1.130000000           74         5.400000000         6.6000000000         1.10000000           75         5.400000000         6.6000000000         1.10000000           74         5.400000000         6.6000000000         1.10000000           83         5.400000000         6.6000000000         1.10000000           83         5.400000000         6.6000000000         1.10000000           84         5.400000000         6.6000000000         1.10000000           85         5.400000000         6.6000000000         1.10000000           85         5.4000000000         5.4000000000         1.10000000           85         5.4000000000         7.44000000000         1.100000000           84         6.50000000000         7.44000000000         1.1000000000           84         6.50000000000         7.44000000000         1.100000000           84         6.50000000000         7.44000000000         1.1000000000           84         6.50000000000         7.44000000000         1.4000000000	25       5.3700000+01       6.540000+01         74       5.4700000+01       6.5400000+01         73       5.3700000+01       6.5400000+01         74       5.4700000+01       6.5400000+01         75       5.4400000+01       6.5700000+0         84       5.4400000+01       6.570000+0         84       5.4400000+01       6.570000+0         84       5.4400000+01       6.570000+0         84       5.4400000+01       6.570000+0         84       5.4400000+01       6.570000+0         84       5.4400000+01       6.570000+0         84       5.4400000+01       6.500000+0         84       5.4400000+01       6.500000+0         84       5.4400000+01       6.500000+0         82       5.4400000+01       6.500000+0         84       5.4400000+01       7.000000+0         82       6.470000+01       6.9400000+0         82       6.4700000+01       7.4400000+0         82       6.4700000+01       7.000000+0         82       6.4700000+01       7.000000+0         82       6.4700000+01       7.000000+0         84       6.4700000+01       7.000000+0	24		56640001+0	1200001
$\begin{array}{c} 71 & 5.4100700.011 & 6.5670070.011 & 1.1500001.014 \\ 73 & 5.3700700.011 & 6.57007070.011 & 1.1600.010.014 \\ 73 & 5.42007000.011 & 6.57007070.011 & 1.04000.010.014 \\ 84 & 5.42007000.011 & 6.570707070.011 & 1.07070000.014 \\ 85 & 5.44007000.011 & 6.570707070.011 & 1.07070000.014 \\ 85 & 5.44007000.011 & 6.570707070.011 & 1.07070000.014 \\ 85 & 5.45070700.012 & 6.570707070.011 & 1.070700000 \\ 85 & 5.450707000.011 & 6.570707070.011 & 1.070700000 \\ 81 & 6.57070700.011 & 6.570707070.012 & 1.070700000 \\ 82 & 6.47000000.011 & 5.770700000.011 & 1.0700000000 \\ 82 & 6.47000000.011 & 5.7707000000000 & 1.07700000000 \\ 81 & 6.77000000.011 & 7.0707000000000 & 1.0770000000000000000000000000000000000$	$\begin{array}{cccccccccccccccccccccccccccccccccccc$	52	.3700000+0	5300000+0	1200000+
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75 $5.41000000000000000000000000000000000000$	$\begin{array}{cccccccccccccccccccccccccccccccccccc$	74	.3900000+0	.5400000+0	•00000000
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$\begin{array}{c} R_{2} \ 5.4900000401 \ 6.570000401 \ 1.01004004\\ R_{3} \ 5.4900000401 \ 6.570000401 \ 1.01004004\\ R_{4} \ 5.470000401 \ 6.570000401 \ 1.0100004\\ R_{4} \ 5.470000401 \ 6.570000401 \ 1.0100004\\ R_{4} \ 5.4600000401 \ 6.5700000401 \ 1.0100004\\ R_{4} \ 5.4600000401 \ 6.5700000401 \ 1.0100004\\ R_{4} \ 5.4600000401 \ 5.670000401 \ 1.0100004\\ R_{4} \ 5.4600000401 \ 5.670000401 \ 1.0100004\\ R_{4} \ 5.4600000401 \ 7.010000401 \ 1.0100004\\ R_{4} \ 5.4600000401 \ 7.0100000401 \ 2.01000004\\ R_{4} \ 5.700000401 \ 7.0100000401 \ 2.01000004\\ R_{4} \ 5.700000401 \ 7.0100000401 \ 2.01000004\\ R_{4} \ 5.700000401 \ 7.0100000401 \ 7.0100000401 \ 2.01000004\\ R_{4} \ 5.700000401 \ 7.0100000401 \ 7.0100000401 \ 7.0100000401\\ R_{4} \ 5.700000401 \ 7.0100000401 \ 7.0100000401 \ 7.0100000401 \ 7.0100000401\\ R_{4} \ 5.7000000401 \ 7.0100000401 \ 7.0100000401 \ 7.0100000401 \ 7.0100000401 \ 7.0100000401 \ 7.0100000401 \ 7.0100000401 \ 7.0100000401 \ 7.0100000401 \ 7.0100000401 \ 7.0100000401 \ 7.0100000401 \ 7.0100000401 \ 7.0100000401 \ 7.0100000401 \ 7.0100000401 \ 7.0100000401 \ 7.0100000401 \ 7.0100000401 \ 7.0100000401 \ 7.0100000401 \ 7.0100000401 \ 7.0100000401 \ 7.0100000401 \ 7.0100000401 \ 7.0100000401 \ 7.0100000401 \ 7.0100000401 \ 7.0100000401 \ 7.0100000401 \ 7.0100000401 \ 7.0100000401 \ 7.0100000401 \ 7.0100000401 \ 7.0100000401 \ 7.0100000401 \ 7.0100000401 \ 7.0100000401 \ 7.0100000401 \ 7.0100000401 \ 7.0100000401 \ 7.0100000401 \ 7.0100000401 \ 7.0100000401 \ 7.0100000401 \ 7.0100000401 \ 7.0100000401 \ 7.01000000401 \ 7.0100000401 \ 7.0100000401 \ 7.0100000401 \ 7.0100000401 \ 7.0100000401 \ 7.0100000401 \ 7.0100000401 \ 7.0100000401 \ 7.0100000401 \ 7.0100000401 \ 7.0100000401 \ 7.0100000401 \ 7.0100000401 \ 7.0100000401 \ 7.0100000401 \ 7.0100000401 \ 7.0100000401 \ 7.0100000401 \ 7.0100000401 \ 7.0100000401 \ 7.0100000401 \ 7.0100000401 \ 7.01000000401 \ 7.01000000401 \ 7.0100000401 \ 7.01000000401 \ 7.01000000401 \ 7.0100000401 \ 7.01000000401 \ 7.01000000401 \ 7.01000000401 \ 7.01000000401 \ 7.01000000401 $	$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	41	.4700000+0	.6700000+0	•0500000+
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	$\begin{array}{cccccccccccccccccccccccccccccccccccc$	CN C	.450000040	• 67000001+0	<ul> <li>0300000+</li> </ul>
$\begin{array}{c} 5.397333501 \ $Y9AR \ 7.0454955-01 \ $S7 \ $5.1493316+11 \ $1.71000401 \ $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 \ $5.4600000+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 \ $5.4600000+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 \ $5.4600000+01 \ $5.4600000+01 \ $5.4600000+01 \ $5.4600000+01 \ $5.4600000+01 \ $5.4600000+01 \ $5.4600000+01 \ $5.4000000+01 \ $5.4000000+01 \ $5.4000000+01 \ $5.4000000+01 \ $5.4000000+01 \ $5.4000000+01 \ $5.4000000+01 \ $5.4000000+01 \ $5.4000000+01 \ $5.4000000+01 \ $5.4000000+01 \ $5.4000000+01 \ $5.4000000+01 \ $5.4000000+01 \ $5.4000000+01 \ $5.4000000+01 \ $5.4000000+01 \ $5.4000000+01 \ $5.4000000+01 \ $5.4000000+01 \ $5.4000000+01 \ $5.4000000+01 \ $5.4000000+01 \ $5.4000000+01 \ $5.4000000+01 \ $5.4000000+01 \ $5.4000000+01 \ $5.4000000+01 \ $5.4000000+01 \ $5.4000000+01 \ $5.4000000+01 \ $5.4000000+01 \ $5.4000000+01 \ $5.4000000+01 \ $5.4000000+01 \ $5.4000000+01 \ $5.4000000+01 \ $5.4000000+01 \ $5.4000000+01 \ $5.4000000+01 \ $5.4000000+01 \ $5.4000000+01 \ $5.4000000+01 \ $5.4000000+01 \ $5.4000000+01 \ $5.4000000+01 \ $5.4000000+01 \ $5.4000000+01 \ $5.4000000+01 \ $5.4000000+01 \ $5.4000000+01 \ $5.4000000+01 \ $5.4000000+01 \ $5.4000000+01 \ $5.4000000+01 \ $5.4000000+01 \ $5.4000000+01 \ $5.4000000+01 \ $5.4000000+01 \ $5.4000000+01 \ $5.4000000+01 \ $5.4000000+01 \ $5.4000000+01 \ $5.4000000+01 \ $5.4000000+01 \ $5.4000000+01 \ $5.4000000+01 \ $5.4000000+01 \ $5.4000000+01 \ $5.4000000+01 \ $5.4000000+01 \ $5.4000000+01 \ $5.4000000+01 \ $5.4000000+01 \ $5.4000000+01 \ $5.4000000+01 \ $5.4000000+01 $	<pre>5.397333361 \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$</pre>	85	.4800000+0		.1000000+
$ \begin{array}{c} 5.3773333.02 & $7.5700001401 & $6.20001010101 & $1.11000101 & $1.00001001 & $1.000000000000000000000000000000000000$	$ \begin{array}{c} 5.3773.3.3.01 \\ 5.3773.3.01 \\ 5.3773.3.01 \\ 5.70000.01 \\ 1.074000.011 \\ 5.580666.01 \\ 1.0848 \\ 7.0953627-01 \\ 5.580600.01 \\ 8.1 \\ 6.580000.01 \\ 8.1 \\ 6.580000.01 \\ 8.1 \\ 6.580000.01 \\ 8.1 \\ 6.580000.01 \\ 8.1 \\ 6.580000.01 \\ 9.1 \\ 6.580000.01 \\ 9.1 \\ 6.580000.01 \\ 9.1 \\ 6.580000.01 \\ 9.1 \\ 6.580000.01 \\ 9.1 \\ 6.580000.01 \\ 9.1 \\ 6.580000.01 \\ 101 \\ 6.580000.01 \\ 102 \\ 6.5800000.01 \\ 103 \\ 6.5800000.01 \\ 103 \\ 6.470000.01 \\ 103 \\ 6.470000.01 \\ 103 \\ 6.470000.01 \\ 103 \\ 6.470000.01 \\ 103 \\ 6.470000.01 \\ 103 \\ 6.470000.01 \\ 103 \\ 6.470000.01 \\ 103 \\ 6.470000.01 \\ 103 \\ 6.498666.01 \\ 103 \\ 6.498666.01 \\ 103 \\ 6.490000.01 \\ 103 \\ 6.490000.01 \\ 103 \\ 6.490000.01 \\ 103 \\ 5.800000.01 \\ 103 \\ 5.8100000.01 \\ 5.8800000.01 \\ 5.8800000.01 \\ 5.8800000.01 \\ 5.8800000.01 \\ 5.8800000.01 \\ 5.8800000.01 \\ 5.8800000.01 \\ 5.8800000.01 \\ 5.8800000.01 \\ 5.8800000.01 \\ 5.8800000.01 \\ 5.8800000.01 \\ 5.8800000.01 \\ 5.8800000.01 \\ 5.8800000.01 \\ 5.8800000.01 \\ 5.8800000.01 \\ 5.8800000.01 \\ 5.8800000.01 \\ 5.8800000.01 \\ 5.8800000.01 \\ 5.8800000.01 \\ 5.8800000.01 \\ 5.8800000.01 \\ 5.8800000.01 \\ 5.8800000.01 \\ 5.8800000.01 \\ 5.8800000.01 \\ 5.8800000.01 \\ 5.8800000.01 \\ 5.8800000.01 \\ 5.8800000.01 \\ 5.8800000.01 \\ 5.8800000.01 \\ 5.8800000.01 \\ 5.8800000.01 \\ 5.8800000.01 \\ 5.8800000.01 \\ 5.8800000.01 \\ 5.8800000.01 \\ 5.8800000.01 \\ 5.8800000.01 \\ 5.8900000.01 \\ 5.8900000.01 \\ 5.8900000.01 \\ 5.8900000.01 \\ 5.8900000.01 \\ 5.8900000.01 \\ 5.8900000.01 \\ 5.8900000.01 \\ 5.8900000.01 \\ 5.8900000.01 \\ 5.8900000.01 \\ 5.8900000.01 \\ 5.8900000.01 \\ 5.8900000.01 \\ 5.8900000.01 \\ 5.8900000.01 \\ 5.8900000.01 \\ 5.8900000.01 \\ 5.8900000.01 \\ 5.8900000.01 \\ 5.8900000.01 \\ 5.8900000.01 \\ 5.8900000.01 \\ 5.8900000.01 \\ 5.8900000.01 \\ 5.8900000.01 \\ 5.8900000.01 \\ 5.8900000.01 \\ 5.89000000.01 \\ 5.89000000.01 \\ 5.89000000.01 \\ 5.8900000000 \\ 5.8900000000 \\ 5.8900000000 \\ 5.8900000000 \\ 5.8900000000 \\ 5.8900000000 \\ 5.8900000000 \\ 5.8900000000 \\ 5.890000000 \\ 5.8900000000 \\ 5.890000000 \\ 5.8900000000 \\ 5.8900000000 \\ 5.890000000 \\ 5.890000000 \\ 5.890000000 $			0+000019°	•1000000+
<pre>BEL 2014-76 PARENT MLTAL 1.0740006010 11.0100000 BEL 2014-76 PARENT MLTAL 1.07400000401 1.0100000 BEL 2014-76 PARENT MLTAL BEL 6.94700000401 7.95700000401 9.0000004 BEL 6.94700000401 7.92700000401 9.0000004 BEL 6.94700000401 7.00000401 9.0000004 BEL 70.0520000401 7.000000401 9.0000004 BEL 70.0520000401 7.00000401 9.000000401 BEL 70.050000401 7.00000401 9.000000401 BEL 70.0500000401 7.00000401 9.000000401 BEL 70.050000401 7.00000401 1.05000004 BEL 70.050000401 7.00000401 1.05000004 BEL 70.050000401 6.4000000401 1.07000004 BEL 70.050000401 6.4000000401 1.07000004 BEL 70.050000401 6.4000000401 1.07000004 BEL 70.050000401 6.4000000401 1.07000004 BEL 70.05000401 6.4000000401 1.07000004 BEL 70.05000401 6.4000000401 1.07000004 BEL 70.05000401 6.4000000401 1.07000004 BEL 700500401 0.010401 1.07000004 BEL 700500401 0.010401 1.000000401 1.0000004 BEL 8.777000000401 6.4000000401 1.0000004 BEL 8.777000000401 6.4000000401 1.0000004 BEL 8.777000000401 6</pre>	5.75400056501       5.844451-01       5.95000010-01       5.95000010-01       5.95000010-01       5.95000010-01       5.95000010-01       5.95000010-01       5.95000010-01       5.95000010-01       5.95000010-01       5.95000010-01       5.95000010-01       5.95000010-01       5.95000010-01       5.95000010-01       5.95000010-01       5.95000010-01       5.95000010-01       5.95000010-01       5.95000010-01       5.95000010-01       5.95000010-01       5.95000010-01       5.95000010-01       5.95000010-01       5.95000010-01       5.95000010-01       5.95000010-01       5.95000010-01       5.95000010-01       5.95000010-01       5.95000010-01       5.95000010-01       5.950000010-01       5.95000010-01       5.95000010-01       5.95000010-01       5.95000010-01       5.95000010-01       5.95000010-01       5.95000010-01       5.95000010-01       5.95000010-01       5.95000010-01       5.95000010-01       5.9557-01       5.5       5.95000010-01       5.95000010-01       5.95000010-01       5.9557-01       5.95000010-01       5.9557-01       5.95000010-01       5.9557-01       5.95000010-01       5.9557-01       5.95000010-01       5.9557-01       5.95000010-01       5.9557-01       5.95000010-01       5.9557-01       5.95000010-01       5.9557-01       5.95000010-01       5.9557-01       5.95000010-01       5.95000010-01       5.95000010-01       5.95000	10.222202	7.400000441		1.0/0000+
HeL       71074000+01       5047000+01       5047000+01       5040000+01       5040000+01       5040000+01       5040000+01       5040000+01       5040000+01       50400000+01       50400000+01       50400000+01       50400000+01       50400000+01       50400000+01       50400000+01       50400000+01       504000000+01       50600000+01       50600000+01       50600000+01       50600000+01       50600000+01       50600000+01       50600000+01       50600000+01       50600000+01       50600000+01       50600000+01       50600000+01       50600000+01       50600000+01       50600000+01       50600000+01       50600000+01       50600000+01       50600000+01       50600000+01       50600000+01       50600000+01       50600000+01       50600000+01       50600000+01       50600000+01       50600000+01       50600000+01       50600000+01       50600000+01       50600000+01       50600000+01       50600000+01       50600000+01       50600000+01       50600000+01       50600000+01       506000000+01       50600000+01       50600000+01       50600000+01       50600000+01       50600000+01       50600000+01       50600000+01       50600000+01       50600000+01       50600000+01       50600000+01       50600000+01       50600000+01       50600000+01       50600000+01       50600000+01       506000000+01       506000000+01       5	HEL 701470 01 550000401 6.99000040 HEL 701476 PARENT M F. 4.44451-01 55 6.470000401 6.95000040 82 6.4500000401 6.950000040 84 6.4500000401 6.950000040 92 6.4500000401 6.950000040 93 6.450000401 7.06000040 95 6.5500000401 7.06000040 101 6.550000401 7.07000040 102 6.550000401 7.07000040 102 6.550000401 7.07000040 103 6.447000401 7.07000040 103 6.447000401 7.00000040 103 6.430000401 7.00000040 103 6.440000040 103 6.440000040 6.440000040 103 6.440000040 6.440000040 103 5.770000401 6.440000040 23 5.730000401 6.440000040 23 5.730000401 6.440000040 23 5.730000401 6.440000040 24 5.770000401 6.440000400 25 5.770000401 6.440000400 25 5.770000401 6.440000400 25 5.770000401 6.440000400 25 5.770000401 6.440000400 25 5.770000401 6.440000400 25 5.770000401 6.440000400 25 5.770000401 6.440000400 25 5.770000401 6.440000400 25 5.770000401 6.440000400 25 5.770000401 6.440000400 25 5.770000401 6.440000400 25 5.770000401 6.440000400 25 5.770000401 6.440000400 25 5.770000401 6.440000400 25 5.770000401 6.440000400 25 5.770000401 6.440000400 25 5.770000401 6.440000400 25 5.770000401 6.440000400 25 5.770000400 6.550000400 25 5.770000400 6.550000400 25 5.770000400 6.550000400 25 5.770000400 6.550000400 25 5.770000400 6.550000400 25 5.770000400 6.550000400 25 5.7700000400 6.550000400 25 5.7700000400 6.5500000400 25 5.7700000400 6.550000400 25 5.7700000400 6.5500000400 25 5.7700000400 6.5500000400 25 5.7700000400 6.5500000400 25 5.7700000400 6.5500000400 25 5.7700000400 6.5500000400 25 5.7700000400 6.5500000400 25 5.77000000400 6.5500000400 25 5.77000000400 6.5500000400 25 5.77000000400 6.5500000400 25 5.7700000	-5805555401	04401 / 044040 04400 / 004400		346404 41 TI
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	BEL       7014-16       PARENT       METAL         B1       6.5700000401       6.930000000         B2       6.4500000401       7.430000000         B2       6.4500000401       7.4300000000         B2       6.4500000401       7.4300000000         B3       6.4500000401       6.9200000000         B4       6.4500000401       6.9200000000         B3       6.4500000401       6.9400000000         B4       6.4500000401       7.000000000000000         B3       6.4500000401       7.000000000000000000000000000000000000	.074000+01	EBAR 4.641445	-01 \$SE	1130 TOLOL
$ \begin{array}{c} \mbox{Current} \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \$	Current       Current       Current       Current       Current       Current       Current       Current       Current       Current       Current       Current       Current       Current       Current       Current       Current       Current       Current       Current       Current       Current       Current       Current       Current       Current       Current       Current       Current       Current       Current       Current       Current       Current       Current       Current       Current       Current       Current       Current       Current       Current       Current       Current       Current       Current       Current       Current       Current       Current       Current       Current       Current       Current       Current       Current       Current       Current       Current       Current       Current       Current       Current       Current       Current       Current       Current       Current       Current       Current       Current       Current       Current       Current       Current       Current       Current       Current       Current       Current       Current       Current       Current       Current       Current       Current       Current       Current		benî wer.		
R2         6.470000001         7.0300000000         8.00000000000000           83         6.92000000000         7.020000000000         8.000000000000000000000000000000000000	R2       6.470000401       7.030000401         83       6.920000401       7.100000401         84       6.420000401       7.100000401         85       6.470000401       7.100000401         92       6.470000401       7.00000401         93       6.420000401       6.940000401         94       6.00000401       6.940000401         95       6.4970006401       7.00000401         95       6.4970000401       7.000000401         101       6.500000401       7.000000401         102       6.4970000401       7.1700000401         103       6.4970000401       7.1700000401         104       6.500000401       7.1700000401         105       6.4970000401       7.1700000401         106       6.4970000401       7.1700000401         105       6.500000401       7.170000040         106       6.4400000401       6.440000040         108       5.4930000401       6.440000040         21       5.7300000401       6.440000040         22       5.7300000401       6.440000040         23       5.4300000401       6.440000040         23       5.7300000401       6.440000040 <tr< td=""><td>861 2014-10 P</td><td>KENI 78.4L 6.500000040</td><td>040000000</td><td>-010000</td></tr<>	861 2014-10 P	KENI 78.4L 6.500000040	040000000	-010000
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$\begin{array}{c} 10^{\circ} & \circ, 2470000+01 & 7, 2170000+01 & 9, 9, 00000+01 \\ 7, 044000+01 & $1, 8189109+00 & $5, 9, 5, 854410+01 & $1710+01 & $1710+01 & $1710+01 & $1710+01 & $1710+01 & $1, 1200000+01 & $1, 0400000+01 & $1, 0400000+01 & $1, 0400000+01 & $1, 0400000+01 & $1, 0400000+01 & $1, 0400000+01 & $1, 0400000+01 & $1, 0400000+01 & $1, 0400000+01 & $1, 0400000+01 & $1, 0400000+01 & $1, 0400000+01 & $1, 0400000+01 & $1, 0400000+01 & $1, 0400000+01 & $1, 0400000+01 & $1, 0400000+01 & $1, 0400000+01 & $1, 0400000+01 & $1, 0400000+01 & $1, 0400000+01 & $1, 0400000+01 & $1, 0400000+01 & $1, 0400000+01 & $1, 0400000+01 & $1, 0400000+01 & $1, 0400000+01 & $1, 0400000+01 & $1, 0400000+01 & $1, 0400000+01 & $1, 0400000+01 & $1, 0400000+01 & $1, 0400000+01 & $1, 0400000+01 & $1, 0400000+01 & $1, 0400000+01 & $1, 0400000+01 & $1, 0400000+01 & $1, 0400000+01 & $1, 0400000+01 & $1, 0400000+01 & $1, 0400000+01 & $1, 0400000+01 & $1, 0400000+01 & $1, 0400000+01 & $1, 0400000+01 & $1, 0400000+01 & $1, 0400000+01 & $1, 0400000+01 & $1, 0400000+01 & $1, 0400000+01 & $1, 0400000+01 & $1, 0400000+01 & $1, 0400000+01 & $1, 0400000+01 & $1, 0400000+01 & $1, 0400000+01 & $1, 0400000+01 & $1, 0400000+01 & $1, 0400000+01 & $1, 0400000+01 & $1, 0400000+01 & $1, 0400000+01 & $1, 0400000+01 & $1, 0400000+01 & $1, 0400000+01 & $1, 0400000+01 & $1, 0400000+01 & $1, 0400000+01 & $1, 0400000+01 & $1, 0400000+01 & $1, 0400000+01 & $1, 0400000+01 & $1, 0400000+01 & $1, 0400000+01 & $1, 0400000+01 & $1, 0400000+01 & $1, 0400000+01 & $1, 0400000+01 & $1, 0400000+01 & $1, 0400000+01 & $1, 0400000+01 & $1, 0400000+01 & $1, 0400000+01 & $1, 0400000+01 & $1, 0400000+01 & $1, 0400000+01 & $1, 0400000+01 & $1, 0400000+01 & $1, 0400000+01 & $1, 0400000+01 & $1, 0400000+01 & $1, 0400000+01 & $1, 0400000+01 & $1, 0400000+01 & $1, 0400000+01 & $1, 0400000+01 & $1, 0400000+01 & $1, 0400000+01 & $1, 0400000+01 & $1, 0400000+01 & $1, 0400000+01 & $1, 0400000+01 & $1, 0400000+01 & $1, 0400000+01 & $1, 0400000+01 & $1, 0400000+01 & $1, 0400000+01 & $1, 0400000+01 & $1$	$\begin{array}{cccccccccccccccccccccccccccccccccccc$	⇒ķ	0+0000/+-	0+0000000	+0000044
$ \begin{array}{c} 6.398666+01 \\ 3.044000+01 \\ $ $ $ $ $ $ $ $ $ $ $ $ $ $ $ $ $ $ $	$ \begin{array}{c} 6.498666+101 & $YHAR & 1.2597079+00 & $SV & 5.61 \\ 7.044000n+01 & $UHAR & 1.2597079+00 & $SV & 5.61 \\ 9.306666+01 & $EHAR & 1.2597079+01 & $SV & 5.61 \\ 9.306666+01 & $EHAR & 1.2597019+01 & $5E \\ 7.300000+01 & $6.460000+01 \\ 22 & $5.730000+01 & $6.460000+0 \\ 23 & $5.300000+01 & $6.460000+0 \\ 24 & $9.500000+01 & $6.460000+0 \\ 25 & $5.730000-01 & $6.460000+0 \\ 33 & $5.810000-01 & $6.560000+0 \\ 33 & $5.810000-01 & $6.560000+0 \\ 33 & $5.7700000+01 & $6.560000+0 \\ 35 & $5.7700000+01 & $6.560000+0 \\ 55 & $5.7700000+01 & $6.560000+0 \\ 55 & $5.7700000+01 & $6.540000+0 \\ 55 & $5.7500000+01 & $6.540000+0 \\ 55 & $5.7700000+01 & $6.540000+0 \\ 55 & $5.7700000+01 & $6.540000+0 \\ 55 & $5.7700000+01 & $6.540000+0 \\ 55 & $5.760000+01 & $6.540000+0 \\ 55 & $5.7700000+01 & $6.540000+0 \\ 55 & $5.7700000+01 & $6.540000+0 \\ 55 & $5.7700000+01 & $6.540000+0 \\ 55 & $5.7700000+01 & $6.540000+0 \\ 55 & $5.7700000+01 & $6.540000+0 \\ 55 & $5.7700000+01 & $6.540000+0 \\ 55 & $5.7700000+01 & $6.540000+0 \\ 55 & $5.7700000+01 & $6.540000+0 \\ 55 & $5.7700000+01 & $6.540000+0 \\ 55 & $5.7700000+01 & $6.540000+0 \\ 55 & $5.7700000+01 & $6.540000+0 \\ 55 & $5.7700000+01 & $6.540000+0 \\ 55 & $5.7700000+01 & $6.540000+0 \\ 55 & $5.7700000+01 & $6.540000+0 \\ 55 & $5.7700000+01 & $6.540000+0 \\ 55 & $5.7700000+01 & $6.540000+0 \\ 55 & $5.7700000+01 & $6.540000+0 \\ 55 & $5.7700000+01 & $6.540000+0 \\ 55 & $5.7700000+01 & $6.540000+0 \\ 55 & $5.770000+01 & $6.54000+0 \\ 55 & $5.770000+01 & $6.54000+0 \\ 55 & $5.770000+01 & $6.54000+0 \\ 55 & $5.770000+01 & $5.750000+0 \\ 55 & $5.770000+01 & $6.55000+0 \\ 55 & $5.770000+01 & $5.550000+0 \\ 55 & $5.770000+01 & $5.550000+0 \\ 55 & $5.770000+01 & $5.550000+0 \\ 55 & $5.770000+01 & $5.550000+00+0 \\ 55 & $5.770000+01 & $5.550000+00+0 \\ 55 & $5.770000+01 & $5.550000+00+00+00+00+0 \\ 55 & $5.770000+00+00+00+00+00+00+00+00+00+00+00+$	- c	0*000002**	0+0000010.	+00000u2•
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52         5.700000401         6.490000401         1.07000101           53         5.790000401         6.5400000401         1.040001010           54         5.7500000401         6.480000401         1.0900001           54         5.77500000401         6.4800004401         1.0700001           54         5.77500000401         6.48000004401         1.0700001           54         5.77500000401         5.64300004401         1.070001401           7640000401         5749469-01         55030307401         1.17L           49066664401         4084R         5.2027965-01         550         520730301401	52 5.750000+01 6.490000+0 55 5.790000+01 6.5400000+0 54 5.75000001 6.3900000+0 54 5.77000010 6.4800009+0 55 5.7700000+01 6.4800009+0 7040000+01 5YBAR 3.7189469-01 557 5.6		.7800000+0	4900000+0	.1300000+
5.4 5.790000+01 6.540000+01 1.0400000 54 5.7500000+01 6.3900000+01 1.0300000 55 5.750000+01 6.480000+01 1.020000+0 764000+01 5YBAR 3.7199469-01 557 5.633030+01 hLTL -4906666+01 \$UBAR 5.2027965-01 \$59 6.3075282+01 hLTL	5, 5,790000+01 6,540000+0 5,5 5,5900000-01 6,3900000-0 55 5,770000+01 6,480000-01 764000+01 5,494 3,7189469-01 557 5,6		.7600000+0	.4900001+0	.080040.
54 5,750000+01 6,390000+01 1,0900000+ 55 2770000401 6,360000+01 1,070000+01 1,0700000+0 -7640000+01 5,7799469-01 557 5,6330307+01 hLTL -4906666+01 \$UBAR 5,2027965-01 559 6,3075282+01 bLTL	54 5.770000+01 6.3900000 55 5.770000+01 6.4800000+0 .764000+01 \$Y8A 3.7189469-01 \$SY 7.6.		0+0000067.	.5400000+0	.0406030+
55 5.7700004-01 6.480000-01 1.020000401 4.020040404 .7440000-01 \$YBAR 3.7189469-01 \$SY 5.6330930+01 bLTL .49066664-01 \$UBAR 5.2027965-01 \$SU 6.3075282+01 bLTL	-7640000+01 \$YHAR 3.7189469-01 \$SY 5.0		0+0000042.	.390000040	+0000060*
.7640000+01 \$YBAR 3.7189469-01 \$SY 5.6330930+01 \LTL .4906666+01 \$UBAR 5.20279 <u>65-01</u> \$SU 6 <u>.3075282+01 \$LTL</u>	-7640000+01 \$YBAK 3.7189469-01 \$SY 5.6	55	5.7700000+01	6.4800000+01	1.020040+
.4906666+01 \$UBAK 5.2027965-01 \$5U 6.3075282+01 \$LTL		-7640000+01	YHAH 3.718946	-01 \$5Y 5.633	930+01 PLTL
	.4906666+01 \$UBAR 5.2027965-01 \$5U 6.3	• 4906666+01	UBAR 5.202796	-01 \$50 6.307	282+01 % 11

2 1.470000401 3.00000401 2.050000401 3 1.490000401 3.100000401 2.00000401 4 1.480000401 3.100000401 2.00000401 5 1.51000401 3.1000007401 2.000000401 1.510000401 3.1000007401 1.99000401 4 1.5165967-01 557 1.3987956401 511 Y 401 5USA 1.5165967-01 557 2.8172514401 511 U 01 5USA 0.0063163-01 55 1.0100000+01 11+01 \$LTLY 74+01 \$LTLU 1.3500000+01 1.3700000+01 1.4200000+01 1.8400000+01 1.8400000+01 1.4300000+01 1.02000000001 1.0000000001 1.0100000+U1 1.0400000+U1 2,540000401 3,890000401 1.4200000401 BAH 1.8708756-01 557 2,44246+01 5LTLY BAH 3,7013136-01 55U 3,7291745+01 5LTLU BAH 5,7619505-01 55L 1.10000000001.1 1.10000000+01 1.1200000-01 1.4000000+01 \*1710 1.990000001 1.4900000+01 1.32000004.1 L.5R00000.401 10+01 1.5500000+01 1.9516721+01 \$LfLY 1.1500000+01 1.99000000000 1.440000+01 31760 UNIAXIAL TENSILE TEST RESULTS 11 ON HEAT TREATED PARENT 6.4365048+00 2.8006464+01 3.2327811+01 3,4077712+01 5.270000+01 5.1800000+01 5.1000000+01 5.1300000+01 3.5200000+01 3.4800000+01 3.500000+01 ALUMINUM ALLOYS 5.630000401 2.960000+01 2.9600000+01 5.6200000+01 5.5700000+01 3,9200000+01 3,9200000+01 4 1.230000401 2.960000401 2.9600000401 5 1.320000401 3.030000401 1.2120000401 3.98944 9.883395-01 357 2.89 2.9760004401 36944 7.231872-01 358 2.80 1.8760004401 36944 7.2318722-01 358 3.9500000+01 3.50000000+01 3.9700000+01 3.520000+01 2.0960000-01 \$YBAM 2.5100506-01 \$SY 3.5040000-01 \$UBAM 1.6735444-01 \$SU 1.5660000-01 \$EBAM 2.1208494+00 \$SE د 1 PARENT METAL ANN LABEL 7106-163 PARENT METAL ANN 2 N N PAHENT METAL SH LABEL 7106-T63 PARENT METAL SR 2.12000000001 2.1100000001 2.1100000001 2.060000001 2.060000001 2.080000001 4.0200000+01 1.2400000+01 PANENT METAL SR 3.6800000+01 4.0400000+01 10+0000066\*9 3.8800000+01 2.5700000+01 2.5304000+01 2.5700000+01 0+0000040\*1 PARENT METAL 2.5500000+01 \$YBAN 3.9420000+01 \$UBAN 1.3880000+01 \$EJAR 1.0160000+01 SEBAR 1.4860000+01 \* 3.0820000+01 \* 1.9860000+01 \* LAHEL 2219-14/ 5.1600000+01 LABEL 2219-T87 3.7380000+01 LABEL 2014-T6 LAHEL 2014-T6 RUMHER

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TABLE I-3.

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

1 ADEI 2210-TR	TTC 2310 STM		
	3.04000000001	00000+0	+0000000+
22	3.010000+0	9500000+0	.100000+0
22	3.1100000+0	98000094	400000+0
20	2.98000040	0-0000000	10000040
10	2.8700000+0	870000040	3000000+0
31	2.9300000+0	4900000+0	.3000000
32	2.670000+0	400000+0	.5000000+0
2	2.73000040	.3000000+0	.200000040
₽ <b>₽</b>	2.7100000+0	3700000+0	.700000+0
32	2.630000+0	.3300000+0	.600000+0
. 4	3.1600000+0	.2800000+0	0+0000006.
42	3.310000+0	.3100000+0	600000+0
4	3.09000000		0+0000000
4	3.140000+0	1900000+0	.9000000.
45	3.130000.000	4000000+0	. 8000000+0
51	2.9500000	.9100000+0	.3000000+0
52	3.0300000+0	.0000000+0	.3000000+0
53	3.1000040	120000-0	
	3,06000040	0-00000077	0-00000000
55	3.080000	4.0900000401	+0000000
10			
			0+0000004.
<u>~</u>	0+000004-2	<b>n+0000049</b> .	n+nnnnn
	0+000004*Z	0+000004*	<b>1+000000</b> .
69	2-940000040	• 0 • 0 0 0 0 • 0	0+0000000+
	2.950000040	0+0000062*	.2000000040
7/	0+00000000		0+000000C
		0+0000041	0+0000007*
	0+000000000000000000000000000000000000		
0 * 2 2 2 2 7 7 0		T0+0000062**	7.7.8.00000.1
0.0000000000000000000000000000000000000	310AN 1.7050		7040404 RI 11
0-0000/27+			JIJe Totto/
- 2210-TA	MIG 2319 SINGLE		
-	2-990000+01	30000	.000000
12	.80000004	210000+0	0+000006.
13	.6600000+0	1600000+0	0+000006.
14	.91000040	.1300000+0	.6000000+0
15	.8600000+0	2500000+0	.40000004.
21	.0300000+0	3600000+0	.7000000+0
22	0+0000064.	.3000000+0	.600000040
23	.7400000+0	.2500000+0	.4000004.
24	.8700000+0	.3300000+0	.7000000+0
25	•7500000+0	.390000040	-80000008-
31	.1100000+0	.5000000+0	.60000000.
32	.7600000+0	.5000000+0	.00000000.
33	.7800000+0	.3400000+0	.2000000+0
34	.8500000+0	.1700000+0	.7000000+0
	2.8800000+01	360000+01	3.00000000
2.8520000+01	BAR 1.2007	0 \$SY 2.429	8+01 +LTL
0.522202	71012 1 247012	000 - 154 00	
		1070°0 000 0	0.26+01

TABLE I-3. (Cont'd)

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

I ADEL 2340-T03	TI0 2210 FDAD	D	ىد
DEL 2217-	4T07 511	0 - 0 0 0 0 0	+000000c
	04000020 *		
7			
	0+00001/6-2	. + 0 0 0 0 0 / 5 .	
97 U	0+000060*2	0+0000054°	0+000001.
1	3.100000040	.3300000+0	.+00000004.
	2.92000050	.8300000+0	.800000040
30	2-920000+0	.7900000+0	.80000004
	3.04000040	• 00000040	
4	2.93000000	.1000000+0	.4000000+0
85	2,92000040		•0000000
91	2.910000+0	.1700000+0	.2000000040
2.6	2.8800000+0	22000000+0	0+0000006*
56	2.910000+0	.880000098	0+0000006.
40	2.8600000+0	0+0000060*	0+00000000
66	3.1300000+0	.3100000+0	.1000300+0
	3.1500000+0	1000000+0	-500000+0
-	3.00000040	990000040	.8000000+0
	2.94000040	0800000+0	.3000000+0
, c	2.920000040	280000040	
	3-0600000+0	3200000+0	0+000009.
· -	3.500000000		
4, 🕶			
۰.			
I -		0+000001"	<u>0+0000000</u>
	0*0000011*C	40.0000000 v	
VIC		0+00000cc	
N 6	6.040000+0 2.0100000	400009+0	+2000004
VIC	0+0000000 -	<u> </u>	1+0000000
vc		0+0000002*	
12		TD+000002.4	1.40000040
	STBAK 1.5/66	+00 \$51 2.62/	0+01 2FIF
.1820689+0	SUHAR 1.866319	+00 \$SU 3.609	087+01 \$L
.6689655+0	\$EBAH 3.536579	-01 \$SI	
LABEL 7106-763	<b>TIG X5180 SIN</b>		
	3.6500000+01	5.020000+	.1000000+0
62	3.8900000+0	4700000+0	.400000+0
63	4.0500000+0	.49000044	.5000000+0
64	4.010000-0	500000040	40000040
65	4.0200000+0	1900000+0	-2006000+0
71	3.6400000+0	040000040	.1000000+0
72	3.5200000+0	0.00000.0	0+000000-
73	3.4800000+0	4.790000+01	
74	3.6000000+0	9600000+0	.600000+0
75	3.6000000+0	.0500000+0	.2000000+0
81	3.6200000+0	0+0000060.	.600000040
82	3.600000+0	.9800000+0	.500000+0
8.3	3.6800000+0	.2300000+0	.1000000+0
84	3.6400000+0	.050000040	0+000001.
8	3.6100000+0	0+0000000.	-2000000+0
7073333+0	\$YBAR 1.874060	+00 \$SY 3.047	641+01 SLTLY
.132666640	SUBAR 2.4447	+00 \$SU 4.271	5+01 %11

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TABLE I-4.

### UNIAXIAL TENSILE TEST RESULTS ON 2014-T6 ALUMINUM ALLOY WELDMENTS

	- 1	٢	Э	.T.
LABEL 20	2014-16	TIG 2319 SINGLE		
	11	4.1100000+01	4.860000+01	2.4000000400
	12	4.1100000+01	5.0200000+01	2.2000000400
	13	4.1500000+01		1.20000000+00
	15	4+1200000+01	Ξ.	1.8000000+00
	16	4.0400000+01	4,9000000+01	2.1000000000000000000000000000000000000
	21		5.4300000+01	2.20000000440
	22	4-1600000+01	5.4300000+01	
	53	4-2000000+01	5,0200000+01	2.54000000+00
	24	4.2400000+01	5.240000+01	
	25	٠		2.000000400
	51	4-030000+01	4.8700000+01	2.300000000+00
	è B	4.20000004.4	4.6100000+01	1.9006000+00
	53	4-40000004-4	4.600000+01	2.0000000+00
	54	4-04000040-4	4.5600000+01	1-3904040405
	55	4-10-0000-01	4	1.900∪00u+n0
4.1473	.1473333401	+9	-01 SSY	3.8202336+01 \$LTbY
4.9753	.975333441	÷9	+00 \$SU 3.9	548038+01 \$LT&U
2.0200	.02000000+00	SEBAR 3.8022551	-01 SSE	
LAHEL 20	14-16 1	2014-16 TIG 4843 SIMARE		<b>A</b>
	H	4.0308fi0.44	4.9%00000404	84 8500004 S

3000000 . 7000000 .00000 .0+04 0+0000080\* 00000 H8000 0-000000000 50046

u () + 00+ .3000000+00 00+001 2-0500000+00 .5000000+00 2.4000000+00 00+00000000 0000+000 3.9166667-01 \$Y#AR 6.7259911-01 \$\$Y 3.0799121+01 \$LTLY 4.7686666401 \$UBAR 1.6681419400 \$\$U 4.1814807+01 \$LTLU 999001 . -64 BUNH 2 - 18 10-040.840S 6 74 890 0 + 0 1 0.00 63000000+03 0 + 0 0+000002 .67000000+0 5900000+0 0+000006 5800000+0 00000+01 8500000+01 8500000+0 0+0000006 3.9500000+0 870000 94000 91.00 335544292 100 35 5

2.2266667+00 \$EBAH 2.6313143-01 \$SE

10 644 10 6444 10 6444 10 6444 10 6444 10 6444 10 6444 10 6444 10 6444 10 644	2100.2		4.440000+01	4.550000+01	4.6100000+01	4.520000+01	4,400000+01 2	4.4000009+01	4.3200009+01 1.	0+01 4.270000+01 1.	0+01 4,5500000+01 1.900000+	4.4800000+01 1.	01 4.4700004-01 1.4000000+	01 4.550000+01 1.	01 4,4200000+01 1.	01 4.3600000+01 1.	01 4.6400000+01 1.70000	.7082299-01 \$SY 3.7038703+01	U 4.0916548+01	0/31253+01 \$5E
	NIC ADAT	5	œ.	÷.	m	ч. С	r	4	(°7	~	-	~	*	r.	<b>מי</b>	4 3.	ъ 4	1 \$YBAR A	01 \$UBAR 1.	+00 \$EBAH 4.6

### TABLE I-5.

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

BEL 2219-T87 TI	LABEL 2219-T87 TIG 2319 SINGLE ANN	ANN	
-	1.•50000044.1	3.0700000+01	1.400000404
N	1.4900000+01	3.0900000+01	1.540000404
s,	1.4900000401	3.0800000+01	1.520000001
4	1.4900000401	3.860000+01	
5		3.8600000+01	
Ϋ́	AR 2.8284505-01 457		
3.0720000+01 \$UH	5UBAR 1.3043600-01 450		
1.5920000+01 \$EBAR			1111 In 10+0444

	2.40000000	2+500000+00	2.20000000		2.130000.00			\$SE	
G 2319 SINGLE SR	4.1500000+01 4.9500000+01	3.8900000+01 4.8700000+01	3.900000401 4.970000+01	4.U20000401 5.200000401	10+00000	34R 1.0709841+00 \$5Y 3.3661	3AR 1.2589675+00 \$SU 4.2860	1.8165921-01	
LAGEL 2219-19/ 116 2319 SINGLE SR		~	r	4	۲	3.9820000+01 \$YBAR	5.0100000+01 \$UBAR	2.3400000+0U \$E	[ ADEL 0240-187 HIC 0310 011-1

LABEL 2219-TA7 MIG 2319 SINGLE ANN 51 1.7100000-01 3.350000-01 52 1.7700000-01 3.350000-01 53 1.670000-01 3.2800000-01 54 1.690000-01 3.2800000-01 1.4694000-01 3.270000-01 1.540000-01 3.370000-01 3.300000-01 1.5466646-01 3.81 3.300000-01 1.5466646-01 3.300000-01 3.300000-01 1.5460000-01 3.300000-01 3.300000-01 3.300000-01 3.300000-01 3.300000-01 3.300000-01 3.300000-01 3.300000-01 3.300000-01 3.300000-01 3.300000-01 3.300000-01 3.300000-01 3.300000-01 3.300000-01 3.300000-01 3.300000-01 3.300000-01 3.300000-01 3.300000-01 3.300000-01 3.300000-01 3.300000-01 3.300000-01 3.30000-01 3.300000-01 3.300000-01 3.300000-01 3.300000-01 3.300000-01 3.300000-01 3.300000-01 3.300000-01 3.300000-01 3.300000-01 3.300000-01 3.300000-01 3.300000-01 3.300000-01 3.300000-01 3.300000-01 3.300000-01 3.300000-01 3.300000-01 3.300000-01 3.300000-01 3.300000-01 3.300000-01 3.300000-01 3.300000-01 3.300000-01 3.300000-01 3.300000-01 3.300000-01 3.300000-01 3.300000-01 3.300000-01 3.300000-01 3.300000-01 3.300000-01 3.300000-01 3.300000-01 3.300000-01 3.300000-01 3.300000-01 3.300000-01 3.300000-01 3.300000-01 3.300000-01 3.300000-01 3.300000-01 3.300000-01 3.300000-01 3.300000-01 3.300000-01 3.300000-01 3.300000-01 3.300000-01 3.300000-01 3.300000-01 3.300000-01 3.300000-01 3.300000-01 3.300000-01 3.300000-01 3.300000-01 3.300000-01 3.300000-01 3.30000-01 3.30000-01 3.30000-01 3.30000-01 3.30000-01 3.30000-01 3.30000-01 3.30000-01 3.30000-01 3.30000-01 3.30000-01 3.30000-01 3.30000-01 3.30000-01 3.30000-01 3.30000-01 3.30000-01 3.300000-01 3.300000-01 3.300000-01 3.300000-01 3.300000-01 3.300000-01 3.300000-01 3.300000-01 3.3000000-01 3.3000000-01 3.30000000000000000000000000000000000
--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

0.04.6

SR	4.8400009+01 1.900000+00				800000+01	SSY 3.58H14	155		
LABEL 2219-147 MIG 2319 SINGLE SR	4.180000+01	4.1000000+01	4.0200000+01	4.0600000001	4.2500000+01	4.1220001+01 \$YBAR 9.2844340-01	\$UBAR 4.2191117-01	<b>BEHAR</b>	and the second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second se
LABEL 2219-TH7	Ŧ	~	3	4		4.1220000+01	4.826010A+01	1.880000+00	

### LAHEL 7106-743 71G X5180 STNGLE ANN .04000

1.3200000+01 .3600000+01 .26000000+01 1600000+01 4.1595143+01 \$SU 3.2568279+11 +LTLU 111% T0+, 4998 18000000+01 0+00000 0000 5.480000 7.9246467+01 \$SE 2.0000229-01 \$5 2.02000040 •0000000•0 .0400000+0 0+0000050. 3.4960000+01 \$UBAR 1.2640000+01 \$EBAR SYBAR 2.0300000+01

LAREL 7106-763 TIG X5180 SINGLE SR

1.1400000+01 .22000000+0 .160(U00+U 9300000+01 :-5200000+01 510000+0

9600000+0 .5200000+0-

÷ 2.5500000044

520000

1.5164730-01 \$5Y 2.4364024+01 +LTLY 1.5166416+01 \$5V 3.4667924+01 +LTLY 1.5166416+01 \$5U 3.4667920+01 +LTLU

4.1472874-01 \$SE

2.5240000+01 \$Y3AH 3.9540000+01 \$U3AH 1.1620700+01 \$E3AH

.9700000+0 .960000040

..1×000044 1.1100000+0

### TABLE I-6.

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

				1							ł÷.
т		1.4700090401	1.3600000+01	1.4700010+01	1.5100000+01	1.560000401	9.3682185+00 \$LTLY	2.8439033+01 \$LTLU			
: - -	VGLF ANN	0+01 2.4500000+01			ł	0+01 2.9500000+01	448 5 5857070-01 \$5Y 9.368	1.0405084-01 \$SU 2.843	- 	7.5688613-01 \$SE	
NUMBFR <	1 4 8 1 2 1 4 - 1 4 1 1 G 2 3 1 9 S I NGLF ANN	1 1.3500000+01	2 1.240000+01	1.240000401	1 260000+01		7	- <u>-</u>		1.4740000+01 368AR 7.54	L TO STO EINOLE ED

ABFL 2014-16 1 2 4 4	LABEL 2014-TK TIG 2319 SINGLF SR 1 3,8000000-01 5 2 3,7800000+01 5 3 3,7800000+01 5 4 3,7800000+01 5	5R 4.56(0000+01 4.780000+01 4.640000+01 4.800000+01	2.2000000+00 2.900000+09 2.400001+00 3.100000+00
0	3.7700099+01		2.8600000+60
3.7780000+01	\$YBAK	£S¥	6928+UI %LILT 5205-04 #LTLU
4.7020n00+01		⊃.s \$	4 1235000+1 Ta+00000
2.6800000+00 \$E8AR	\$E8AK 3.7013518-01	8-01 %SF	

	-	÷.	-1
ANN	2.940000+01		2.940000+01
LARFI 2014-16 TIG 4043 SINGLE ANN	1 1.380000+01	2 1.270000+01	5 1.310000+01

۰. ء

246

1.4260000+01	1.4500000401	1.500000+01	1.74000001	9952+01 \$LTLU		
2.940000+01 1.420000+01	2.9400000+61 2.940000+01		2.9600001+U1	1.3000000+01 348AK 4.795841/-01 351 1.02327771 2010 0.000000+01 20144K 1.0056666-01 35U 2.8789992+01 347LU	1.4140000+01 \$EHAR 9.6850435+01 \$SE	
LAREL 2014-TA TIG 4445 SINGLE ANN 1 1.380000+012	1.2700000+01	1.2700000+01	1.2700000+01	ЗҮВАК 4./95841 •Ач 1.005666	\$EHAR 9.685043	
LAHEL 2014-T6 1	2	4	Ð	1.3000000+01	1.4140006+01	

-

								<b>5</b> 5 E
LAREL 2014-T6 TIG 4043 SINGLE SR	3.8500000+01 4.7	3.8100000.01 4.7	3.760000+01 4.8	1	00000+01			\$EAAH 3.6469167-01 \$SE
LAREL 2014-T6 T	-1	2	ی م	4	ΞÛ	TORNOOC+01 PYBAR	4.7440000+01	2.6400000+00 \$EHAK

### A MIC ADAR SINGLE ANN

	2.95vU600	0000
MIG 4040 01 MGLE	÷01	
LAREL 2014-16		

1 000000000	T0+000006-1	1.540000401	1.6560000+01	1.55003090+01	0000+01 1.3506000+61	508+01 \$LILY	2.8447559+01 %LILU
ANN	2.9500601+01	2.960000401	2.9800001011	2.990000401	2,940	0-01 \$SY 1.05944	
ABEL 2014-16 MJG 4043 31 WGLE ANN	1.3700000+01	1.3000000+01	1.2900000+01	1.2800000+01	1.2600000+01	1.300000+01 \$YBAH 4.1832910+01 \$SY	2 044000-01 \$UHAR 2.0738104-01 \$SU
.ABEL 2014-T6 "		2		4	ŝ	1.3000000+01	04000010101

LAHEL 2014-TK MIG 4043 SINGLE SR

.460000+01 .3300000+01 .6000000+01 101000+01 4.2500000+01 4.1600090+01 4.2000006+01 4.1300000+0

1.2000000+00 1.2000000+00 9.0000000-01 1.20000000000 1.2000000000000

4.1200000+0

4.1720000+01 \$Y8AH 4.4380000+01 \$U8AH

1.9493589-01 \$SH

EBAR

0.0+0.000000

2-9640700+01 \$UHAR 2-0738104-01 \$5U 1.67700000+01 \$EHAH 2-2671575+00 \$5E

### 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 Heig	ht(a) at	Pressu	re of	Panel F	ailure
Material &		Welding	Panel	40	80	120	160	200	Pressure,	Height,
Process	Type	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	-
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

(a) Bulge height in inches at applied pressure indicated.

(b) Deflectometer inoperative.(c) Data not obtained.

TABLE I-8.

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

	Panel Description						Bulg	Bulge Height(a)	at	Pressure	e of					Panel Failure	ulure
Material & Process		Panel No.	40 psi	80 psi	120 psi	160 psi	200 psi	300 psì	400 psi	500 psi	600 psi	700 psi	800 psi	900 Psi	1000 psi	Pressure, psi	Height, in.
2219-T87	As Received	A-26 A-27 A-28	0.65 0.59 0.64	0.78 0.80 0.85	0.91 1.00 1.02	1.04 1.15 1.17	1.18 1.27 1.32	1.48 1.62 1.66	1.78 1.97 2.00	2.10 2.24 2.35	2.78 2.60 2.60	- 2.90 2.92	- 3.21 3.25	- 3.60 3.65	- 4.18 4.40	0001 0601 (9)	(b) 4.75 4.40
Parent Metal	Annealed(a)	A-31	0.70	1.18	1.52	1.83	2.04	2.80	3.68		,	•	1	-	1	464	4.35
	Stress Relieved(b)	A-30	0.65	0.85	1.03	1.19	1.41	1.82	2.30	2.68	3.05	3.84	,	ı	•	08.2	5.02
2014-T6	As Received	в-8 в-9 В-10	0.63 0.67 0.57	0.80 0.82 0.78	0.93 1.00 0.92	1.07 1.13 1.07	1.20 1.24 1.18	1.47 1.53 1.45	1.73 1.83 1.72	2.03 2.08 2.00	2.35 2.40 2.29	2.64 2.67 2.60 2.60	2.94 2.96 2.94	3.30 3.35 3.20	3.70 3.80 3.72	1050 1040 1060	4.00 4.00 4.00
Parent Metal	Annealed	B-11	0.58	1.04	1.52	1.84	2.05	2.82	3.56	4.72	6	2	•	,	Ţ	560	6.32
	Stress Relieved	B-7	0.67	0.89	1.08	1.31	1.50	1.98	2.34	2.82	3.34	ı	'	,	•	635	3.75
7106-763	As Received	-5 C -2 C C C	0.65 0.60 0.52	0.80 0.80 0.75	1.00 0.95 0.88	1.17 1.08 1.04	1.27 1.20 1.18	1.60 1.50 1.47	1.92 1.87 1.75	2.24 2.16 2.11	2.54 2.48 2.44	2.86 2.80 2.75	3.20 3.07 3.07	3.60 3.42 3.42	4.16 3.90 3.92	1010 1050 1050	4.25 4.25 4.30
Parent Metal	Annealed	C -4	0.58	0.96	1.35	1.65	1.92	2.58	3, 18	3.78	4.92	r	r	1	ı	610	5.10
	Stress Relieved	c-1	0.67	1.00	1.39	1.63	1.90	2.46	3.02	3.80	-	1	1	1	•	925	4.95
Bulge he	(a) Bulge height in inches.				1												

(b) Failed in bolt holes.

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### TABLE I-9.

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

	Panel Description	tion			Bulg	Bulge Height <sup>(a)</sup>		at Pressure of	e of		Panel Failure	ailure
Material & Process	Heat Treatment	Welding Procedure	Panel	40 7.	80 1 a t	120 nei	160 nei	200 1 a f	300	400	Pressure,	Height,
TIG	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
2219-T87	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	19.0	1.36	1.75	2.02	2.33	2.58	3.02	425	4.12
2319	Stress Relieved	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	0,60	0.78	1.02	1.24	1.51	5	•	265	1.67
MIG	Annealed	65A-27	BM2-5	0.92	1.39	1.72	-	1	-	1	144	2.08
4043	Stress Relieved	65A-27	BM2-4	0.65	06.0	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	2.09	2.52	496	2.52
i) Bulge hei	(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 = 52.5000007.0454965 - 01 = 0.70454965

TABLE J-1

UNIAXIAL TENSILE TEST RESULTS ON X7106-T63

ALUMINUM ALLOY WELDMENTS

### TABLE J-2

UNIAXIAL TENSILE TEST RESULTS ON X7106-T63 ALUMINUM ALLOY WELDMENTS

Panel No. CT3-1, 0.187-inch TIG/5356, Sq Butt. 34 3.400000+01 4.980000+01 3.1000040 3.4340000+01 4.980000+01 3.000000+00 4.9300000+01 5VBAR 7.334884.01 557 3.0122439+01 517LY 4.9300000+01 5UBAR 1.1610358+00 55U 4.3425159+01 517LU 1.6000000+00 <u>4.4500000+01 4.200009+80</u> 01 857 2.5499405+01 8LTLY 01 850 3.9205401401 8LTLU 90+0000004-00 3.2000000+00 3.3088000+00 . 60 - 00 0 0 0 0 0 0 0 .4000000+00 00+0 3.8000000+00 • 0 • 0 0 0 0 0 • 0 • 3.5000000+00 8.0 8.0 8 0 4 0 0 2.4000099+90 3.300000.0000 3.2000000+00 .80880.00.00.0.0 3.1900000+00 2.8000000+00 3.30.00000+00 3.4000000+00 .4000000+00 3.20000000+00 .5000000+00 00+01 3.4000000+01 3.0840331+01 \$LTLY 4.1356535+01 \$LTLU 10+0000004\* .50000000. 3.7000000+01 3.740000046467 .80000000+06 . 70000040 3.4361828+01 8LTLV 4.5717892+01 8LTLU 8 4.1475239+01 SLTLU 3.4310509+01 +LFL 3.7000000 699900+01 5.2100000+01 5.1600000+01 5.1800000+01 4.2300900+01 NYUH N .3000000+01 4.330000004.1 4.7500000+01 0300000+01 .2100000+01 60000000401 2300000+01 .9900000+01 .289900000+U3 . 7600000401 4.5700000+01 4.6200000+01 4.7300000+01 5.2200000+01 5.36000040 0+0080960. .410000f+0. 1.7200000+0 "200000044 0\*00800Z≤\*0 4.8900000+4 1 451 7.0828618-01 \$5Y HEEKS 11871 12 X REXS 1.0013373+00 \$5Y < \$1350000+01 \$UBAR 1.1131044+00 \$\$U 3.4000000+00 \$EBAR 3.5213644-01 \$\$E 1.0230826+00 \$8U 4.5244499-01 \$SY 5.4313914-01 \$SE LABEL CT4-1,TIG,7106,5356,0.187,1 WEEK 2.4013688-01 \$SE 7.9938712-01 \$5 LABEL CT4-1.719.7106.5356.0.187.3 DAY LABEL C14-111G-7100.5356.0.187.1 DAY 3.79355334A1 \$Y8AM /.13501A5+01 LABEL CT4-1.710-7106.5356.0.187.2 LABEL CT4-1.110-7106.5356.0.187.5 1 3.4400000403 2.900000+01 3.2600000+01 3.4500000+01 2-900000401 .1700000+01 10+01 1.0100000+01 3.0900000+01 3.3400000+01 00+07 LAHEL CY4-1, 116-1106, 5354, 9200000+D 3.1800000+01 5.1900000+01 .3600000401 3.4400000+01 10+01 5.750×0n0+04 3.64000000400 5.730 u0 44+0; 5.894UUUU401 3.440.00640 .1500000+0 3.2800000+01 .1600000+0 3.3600000+0 \$78AR 1.0013 00000+0 5.15000000+0 .63000 3.3100( 72.9083333401 \$7848 9.3150000+01 \$1848 9.3500000+00 \$5848 SUBAR \$YBAR SYBAR' SUBAR' 40.0 3.2500000+00 SEBAR SEBAR 1 4.6533333+01 215 33 V3.4166667+00 10+000025000 ٩ \* e. 3.2766667+01 NUMBER 0.187-inch TIG/X5180, Sq Butt. 4.4000000+00 00-01 .2.7600000+00 3.0060000+00 3.2800000+00 25 2.9708000+01 4.3000802+01 3.4000800+00 31 3.0708000+01 4.3900080401 3.4008080400 2.928333401 \$YBAR 1.5934389+01 \$\$Y 2.232827+01 \$LTLY 4.3210667+01 \$UBAR 1.5328615+01 \$\$Y 3.5460388+01 \$LTLY 100-00 SLTLY 000+01 2.7090900+90 2.9222421+01 5LTLY 4.2433961+01 5LTLU 3.2000000+00 .7000000+00 00+0000000.0 3.7000000+00 4.100000+00 2.8000000490 3.4200000+0 3.0000000+00 3.50000000+00 3.1000000000 4.2660161+61 8LTLV 3\_6400000+9( <u>3.8383333401 \$7888 8.7582790-01 \$\$7 3.395692401 \$LTLT</u> 5.3983333401 \$UBAR 1.5065400+00 \$\$U 4.6360195401 \$LTLU 3.4000000401 2.20000**98**40 ÷. .00000000 3.1000000+0 3.2500000+0 0+000000.0 3.4000000+0 2.4000000+0 3.3000000+0 4.5000000+8 2-0000000-2 0+0000001.2 1 55Y 345290363+01 5LTLY 100+01 3.900000 3.0133019+01 SL 4.1692149+01 SL 3.00001 2.7649179+01 5.1600000+01 5.4600000+01 5.5100000+01 4.360000+01 4.300000+01 4.5500000+01 4.5708000+01 4.670000+01 4.790000+01 1.2100000+01 .2600000+01 5.5400000+01 5.4500000+01 4.1100000+01 10000+01 5.2700000+01 4.400000000 .1600000+01 4.8000000+01 5.0200000401 .680000040. 5.1900000+01 .51FU0000+01 00+0 000000 REFAS .66088809+0 LABEL CI3-1. [10-7106.5180.0.187.2 WEEKS .45000 4.9460762-01 \$\$Y 1.0852150+00 \$\$V 4.9966653-01 \$SE NEEK . 12 LABEL CT3-1 TIG-7106.5180.0.187.1 DAY 3.283333+00 \$E8AR 4.2081505-01 \$\$ 1.1178866+00 \$5 LABEL CT3-1, T19-7106, 5180. 187, 5 MEEK 3.8858727-81 \$5 1.079 5.430 7.3143697-01 LABEL CT3-1 TIG-7106.5100.8.187.3 LABEL CT3-1 TIG-7106,5180.0.107.1 .187. - B C 3.910000401 2-8300000+01 · 3100000+01 3.4600000+01 100+01 9.86753 2.2000000+01 3.0400000+01 2.9600000401 3.20000000+01 3.2100000+01 .1400000+01 3.8008000401 . 6808899491 .2600000+01 3.2208000+0 3.7300000+0 - n500000+0-2300000+0 5160, <u>..9000000+0</u> 0+0000046\* .160n000+B + S.5100000+0 3.58000000+0 120000 3.2433333+01 \$YBAR 4. .31001 LABEL CT3-1, 116-7106, . 9283333+01"SYBAR SYBAR 3.283333400 \$EBAR 3.3166666+00 SEBAR 4.718333401 SUBAR Panel No. CT3-1, 3.1500000+00 SEBAR SUBAR SEBAR i ł 5.1066667+01 22 3.5960000+01 522 222 NUMBER

4.6800431+01

1.1.849743+00 \$SU

24724

5.2816667+01

4.9847464+01 %LTLU

2. 3509736-01 \$5

5.5650900+01 \$UMAH

3.15000000000000000000

3.3555557+00 #5348

4.4231926-01 \$5E

63 UNIAXIAL TENSILE TEST RESULTS ON X7106-T6 ALUMINUM ALLOY WELDMENTS	. Panel No. CM3-1, 0.187-inch MIG/X5180, Sq But	NULMHER       Y       Y       U       E         LABEL CM3-1,MIG-7106,5180.0.187,1 DAY       0       3.7000000+01       3.7000000+00       3.7000000+00         7       3.1300000+01       4.5100000+01       3.7000000+00       3.7000000+00       13.7000000+00         19       3.1400000+01       4.5510000+01       3.7000000+00       3.7000000+00       13.7000000+00         19       3.0100000+01       4.7800000+01       4.5900000+01       4.6600000+00       13.700000+00         25       3.0900000+01       4.7500000+01       4.6300000+00       4.5500000+00       4.6000000+00         21       3.0700000+01       4.75000000+01       4.6000000+00       4.75000000+00       4.6000000+00         25       3.0900000+01       4.75000000+01       4.6000000+00       4.160000+00       4.160000+00         21       3.07000000+01       4.75000000+01       4.6000000+00       4.16010555+01       5.11U         4.15333333+00       \$548A       5.0066627-01       \$5501       \$11U         4.15333333+00       \$548A       5.0066627-01       \$511       \$11U	LABEL CM3-1.MIG-7105.5180_0.1187.5 DAYS 2 3.5600000+01 4.9500001401 3.700000400 8 3.7700000+01 4.8900001401 8.400000400 14 3.5600001+01 5.1300001401 5.4000000+00 20 3.5500000+01 4.8300000+01 2.900000400 26 3.5500000+01 4.8300000+01 2.900000400 3.3500000+01 4.4143646-01 5.1280000401 2.9000000+00 4.933333401 518AR 1.4143646-01 557 3.2884331401 5LTU 4.7000000+01 5EBAR 2.0208909+00 55E	LABEL CM3-1,MIG-7106,5180,0.187,9 DAYS 2 3.630000+01 5.040000+01 3.300000+00 2 3.6300000+01 5.1400000+01 3.200000+00 2 3.5400000-01 5.1400000+01 3.200000+00 2 3.5400000+01 5.150000+01 3.200000+00 2 3.6400000+01 5.160000+01 3.2000000+00 3 3.6400000+01 5.160000+01 3.2000000+00 3 3.6400000+01 5.160000+01 3.2000000+00 3 3.6400000+01 5.2500000+01 3.2000000+00 3 3.6400000+01 5.2500000+01 3.2000000+00 3 3.6400000+01 5.2500000+01 5.2500000+01 5.25000000+00 3 3.6400000+01 5.2500000+01 5.2500000+01 5.25000000+00 3 3.6400000+01 5.2500000+01 5.2500000+01 5.25000000+00 3 4.6500000+00 5.2500000+00 5.25000000+00 5.25000000+00 3 5.6400000+01 5.0505591+01 5.2000000+00 5.166000+00 5.2500000+00 5.25000000+00 5.166000+00 5.2500000+00 5.25000000+00 5.166000+00 5.2500000+00 5.25000000+00 5.166000+00 5.2500000+00 5.25000000+00 5.166000+00 5.2500000+00 5.25000000+00 5.1660000+00 5.25000000+00 5.25000000+00 5.1600000+00 5.2500000+00 5.25000000+00 5.160000+00 5.2500000+00 5.1600000+00 5.25000000+00 5.1600000+00 5.2500000+00 5.1600000+00 5.2500000+00 5.1600000+00 5.2500000+00 5.1600000+00 5.2500000+00 5.1600000+00 5.2500000+00 5.1600000+00 5.2500000+00 5.160000+00 5.2500000+00 5.160000+00 5.2500000+00 5.160000+00 5.2500000+00 5.160000+00 5.250000+00 5.160000+00 5.2500000+00 5.160000+00 5.2500000+00 5.160000+00 5.2500000+00 5.160000+00 5.2500000+00 5.160000+00 5.2500000+00 5.160000+00 5.2500000+00 5.160000+00 5.2500000+00 5.160000+00 5.2500000+00 5.160000+00 5.2500000+00 5.160000+00 5.2500000+00 5.2500000+00 5	180.0.18 100.0.11 1000.01 1000.01 1000.01 1000.01 1.026151 1.026151 1.39772725 5.970727	LABEL CmS-1, "11.0-71.00,5180.00.1H7,5       ₩EKKS         > 5.0000000-01       5.2000000-01       3.2000000-00         11       5.4000000-01       5.5000000-01       5.5000000-00         12       5.40000000-01       5.5000000-01       5.5000000-00         13       5.40000000-01       5.5000000-00       5.5000000-00         14       5.4000000-01       5.5000000-01       5.5000000-00         15       5.900000-01       5.5000000-01       5.5000000-00         16       5.900000-01       5.5000000-01       5.5000000-01         17       5.900000-01       5.500000-01       5.500000-01         16       5.910500-01       5.626672701       5.11LV         5.411000-01       5.500000-01       5.500000-01       5.500000-01         5.41100-00-01       5.470000-01       5.5000000-00       5.5000000-00         5.41100-00-01       5.5000000-01       5.5000000-00       5.5000000-00         5.41100-00-01       5.500000-00-01       5.5000000-00       5.5000000-00         5.41100-00-01       5.5000000-01       5.50000000-00       5.50000000-00         5.4000000-01       5.50000000-01       5.500000000000000000000000000000000000	<ul> <li>LAHEL CMT-1, VIU-710r, 51-07, 6,187, 12 wEEAS</li> <li>LAHEL CMT-1, VIU-004-01</li> <li>A. LOURD-01</li> /ul>
UNIAXIAL TENSILE TEST RESULTS ON X7106-T( ALUMINUM ALLOY WELDMENTS	Panel No. CT5-5, 0.187-inch TIG/5556, Sq Butt.	LÅBEL         NUMBER         Y         U         E           LÅBEL         CT9-5,TIG-7106.5556.0.187.1 DAY         4.1100000+01         4.2000000+00           7         3.010000+01         4.3100000+01         4.2000000+00           13         2.9000000+01         4.330000+01         3.5500000+00           19         3.0100000+01         4.3300000+01         3.3000000+00           25         3.0200000+01         4.3300000+01         3.300000+00           25         3.0200000+01         4.3300000+01         3.300000+00           25         3.0200000+01         4.3300000+01         3.3000000+00           26         3.0200000+01         4.3300000+01         3.300000+00           27         3.0200000+01         4.3300000+01         3.300000+00           26         3.0200000+01         4.3300000+01         3.300000+00           27         3.0260000+01         4.3300000+01         3.1000000+00           28         3.3560000+01         3.5552332+01         5.11U           3.55666667+00         568AR         6.5625200-01         55         3.5532332+01         5.11U	LABEL GT5-5TIG-7106,5556,0.187.3 DAY 2 3.150000+01 4.500000+01 2.8000000+00 8 3.2800000+01 4.6100000+11 3.000000+00 14 3.3900000+01 4.6700000+11 3.700000+00 26 3.2700000+01 4.730000+01 2.200000+00 32 3.400000+01 4.730000+01 2.500000+00 32 3.400000+01 4.730000+01 2.500000+00 26 3.2700000+01 4.730000+01 2.500000+00 26 3.2700000+01 4.730000+01 2.500000+00 26 3.2700000+01 4.7300000+01 2.5000000+00 26 3.230000+01 4.730000+01 2.500000+00 27 3.3400000+01 4.730000+01 2.5000000+00 28 3.2400000+01 4.7300000+01 2.5000000+00 2.933333+00 \$FBAR 4.8853528-01 \$SU	• 187 01 01 01 01 6436 66576	LABEL C15-5.T1G-71U6.5556.0.187.2 HEEKS 4 3.4600000+01 5.030000+01 3.6000000+00 10 3.4200000+01 4.8700000+11 2.8000000+00 16 3.6600000+01 5.1400000+01 3.000000+00 28 3.7900000+01 5.3400000+01 3.000000+00 28 3.7900000+01 5.3600000+01 3.000000+00 28 3.7900000+01 5.3600000+01 3.000000+00 28 3.7900000+01 5.3600000+01 3.000000+00 28 3.7900000+01 5.3600000+01 3.000000+00 28 3.7900000+01 5.4600000+01 3.000000+00 28 3.7900000+01 5.4600000+01 3.000000+00 28 3.7900000+01 5.4600000+01 3.000000+00 28 3.7900000+01 5.4600000+01 5.4600000+01 3.000000+00 28 3.79000000+01 5.4600000+01 5.4600000+00 3.6533333+01 5.087 1.4815547+00 55V 2.4865333+01 5.11V 3.0333333+00 5.88A 3.6297085+01 55E	LABEL CT5-5.71G-7106.5556.0.187.5 WEEKS 5 3.6200000+01 5.060000+01 3.4000000+00 11 3.7000000+01 5.060000+01 3.2000000+00 17 3.8100000+01 5.200000+01 3.2000000+00 23 3.7900000+01 5.2200000+01 3.500000+00 29 3.750000+01 5.140000+01 3.500000+00 35 3.750000+01 5.140000+01 3.500000+00 35 3.7450000+01 5.2870000+01 3.500000+00 35 3.7450000+01 5.2870000+01 5.1400000+00 35 3.74500000+01 5.2870000+01 5.1400000+00 35 3.74500000+01 5.2870000+01 5.1400000+00 35 3.74500000+01 5.2870000+01 5.1400000+00 35 3.74500000+01 5.2870000+01 5.1400000+00 35 3.7511428+00 5.884 2.7602622-01 5.8	LABEL CIS-5, (14-710, 556, 0.187, 12 WEEKS 6 3.7105000+01 5.380000401 3.5000000+0 12 3.000000+01 5.490000+01 2.90000040 14 4.136000401 5.490000+01 2.500000404 24 5.5000000+01 5.4500000+01 3.50000040 34 5.5500401401 5.450000+01 3.50000040 36 5.5000010401 5.450000+01 3.50000040 36 5.5000010401 5.450000+01 3.50000040 37 5.515657411 57467 1.555250000401 5.3

TABLE J-4.

TABLE J-3.

UNIAXIAL TENSILE TEST RESULTS ON X7106-T63 ALUMINUM ALLOY WELDMENTS

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UNIAXIAL TENSILE TEST RESULTS ON X7106-T63 ALIMINUM ALLOY WELDMENTS

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556, Sq Butt E 4.900000000 3.800000000 4.4000000000 4.4000000000 4.400000000	3.500000000 4.0000000000 5.30000000000 5.3000000000 3.3000000000 3.3000000000 3.300000000	2,900000+00 3,400000+00 5,4000004-00 5,4000004-00 4,200000+00 4,200000+00 4,200000+00 3179+01 \$LTV 7387+01 \$LTV	4.3000000+00 4.3000000+00 3.6000000+00 3.700000+00 3.700000+00 3.700000+00 3.700000+00 3.700000+00 3.700000+00	4. U000U004U0 4.100U00400 5.00UU004U0 6.000U000004U 7.9000U004U0 5.9U000004U0 5.9U00004U0 5.9U00004U0 5.9U000004U0 5.9U000004U0
No. CM5-2, 0. 187-inch MIG/55 HeL CM5-2, 10. 187-inch MIG/55 HeL CM5-2, MIG-7106,5556.0.187.1 DAY 1 3.1800000+01 4.5500000+01 1 3.180000+01 4.5500000+01 1 3.150000+01 4.5500000+01 3.1250000+01 4.5400000+01 3.125000+01 4.5400000+01 4.5533333-01 5UAR 9.26685727-01 557 4.3333333-01 5UAR 9.26685727-01 557 4.3333333-01 5UAR 4.36655727-01 557	<pre>LL CH5-2.MiG-2106.5556.0.122.5 DAYS 2 3.4100000+01 4.860000+01 8 3.3200000+01 4.860000+01 14 3.3900000+01 4.860000+01 20 3.28000000+01 5.1300000+01 20 3.3400000+01 4.7400000+01 20 3.3400000+01 4.7400000+01 345353+01 5YBM 4.749524-01 5SU 4.1018 .0835333+00 5EBAR 7.0545495-01 5SE</pre>	BEL CM5-2.MIG-7106.5556.0.187.9 DAYS 3 3.5680000+01 5.11000000+01 5 3.9700000+01 5.1100000+01 2 3.4700000+01 5.2300000+01 2 3.5540000+01 5.190000+01 2 3.510000+01 5.190000+01 3 5.5400000+01 5.190000+01 3 5.5400000+01 5.190000+01 3 6.0555540+01 5.181 5.0783333+00 5EBAR 1.9785540+01 55U 4.4957 3.6833333+00 5EBAR 9.6626433-01 55E	BEL CM5-2,MIG-7106,5556,0.187,2 WEEKS 4 3.6200000401 5.200000401 10 3.6300000401 5.200000401 22 3.6300000401 5.1300000401 22 3.6410000401 5.1300000401 28 3.630000401 5.230000401 3.6316666411 \$78AR 2.444408-01 \$57 3.5283 5.1350000401 \$588R 2.6414408-01 \$57 3.5283 5.135000401 \$588R 2.6414908-01 \$57 3.5283 5.135000401 \$588R 2.5619904-01 \$57 3.5283 5.135000401 \$588R 2.5619904-01 \$58 4.7804 3.6566667+00 \$588R 2.5619904-01 \$58 4.7804 3.65066667+00 \$588R 2.56000000000000000000000000000000000000	<pre>BEL CM5+7,M15-7106,2275,U,167,5HEKS</pre>

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UNIAXIAL TENSILE TEST RESULTS ON X7106-T63 ALUMINUM ALLOY WELDMENTS

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

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1.000 1.070 1.070 1.090 1.160 1.160 1.160 1.160 1.160	1,220 1,160 1,440 1,050 1,050 1,230 9795401 3748401	1.150 1.150 1.500 1.500 1.500 1.500 1.500 4552+01	$\begin{array}{c} 1 & 510 \\ 1 & 540 \\ 1 & 540 \\ 1 & 255 \\ 1 & 255 \\ 1 & 256 \\ 1 & 250 \\ 1 & 120 \\ 4 & 961 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 11 \\ 1 & 1$	1.320 1.170 1.270 1.200 1.300 7.500 7.500 7.500 7.500	1.300 1.300 1.300 1.300 1.300
50000+01 60000+01 90000+01 90000+01 90000+01 557 2-663 557 2-663 555 4-422	S 200000+01 000000+01 900000+01 900000+01 5557 2-925 5554 4,437 5556 537 2-925 556 537 2-925 556 537 2-925 556 537 2-925 556 54 54 57 556 54 54 55 556 54 55 556 556 55 556 556 55 556 556 556 55		KS 500000+41 50000+01 50000+01 2000+41 2000+41 250 3+174 850 5+122	KS 20000401 590004401 000004401 000004401 000004401 5.298 352 5.298 352 5.076	
-50,1 DA 01 4.55 01 4.55 01 4.55 01 4.5 01 4.5 0533-01 0875-01 7999-01	• 5 • 5 • 5 • 5 • 5 • 5 • 5 • 5 • 5 • 5	11 5.1 11 5.1 11 5.0 1 4.7 1 4.7 1 3.400 7 3.400 7 3.400	4 2 4 2 4 2 4 2 4 2 4 2 4 2 4 2 4 2 4 2	65,5 MHR 11 5,5 MHR 11 5,5 50 11 5,5 50 11 5,5 50 10 1 5,5 50 8821501 11 12 2367+00 11 12	01 01 0 01 0 01 0 01 0 01 0 01 0 0 0 0 0 0 0
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6-710 2. 2. 2. 2. 2. 2. 5. 8. 8. 8. 8. 8. 8. 8. 8. 8. 8. 8. 8. 8.	G-710 2. 2. 2. 2. 3. 3. 3. 5. 5. 8. 10. 5. 5. 10. 5. 5. 5. 5. 5. 5. 5. 5. 5. 5. 5. 5. 5.	3. 3. 3. 3. 3. 3. 3. 3. 3. 3. 3. 3. 3. 3	5-710 5. 5. 5. 5. 5. 5. 5. 5. 5. 5. 5. 5. 5.	6-716 6-16 6-16 6-16 8-16 8-16 8-16 8-16 8-	16-71 3. 3. 5.
NUTHER CT3-2,T1 7 13 19 19 19 19 19 19 19 19 19 19 19 19 19	CT3-2 7 2 2 2 25000+0 80000+0 00000+0	++00000++	CT3-2, TL 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4	CIS-2, II 11 11 17 17 17 17 17 20 20 20 20 20 20 00 10 10 10 10 10 20 20 20 20 20 20 20 20 20 20 20 20 20	CT3-
LABEL 2.68 1.06	LABEL 1.22 LABEL	₩ <b>4</b> <del>1</del>	LAHEL 3.20 5.13	LAHEL 3.45 5.33 1.16	L . L

TABLE J-8.

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

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TABLEJ-10.

UNIAXIAL TENSILE TEST RESULTS ON X7106-T63

UNIAXIAL TENSILE TEST RESULTS ON X7106-T63 ALUMINUM ALLOY WELDMENTS

Butt. บ บ 0 ED inch TIC/EEEK ショドレ nel No Рал

/5556, Sg But	+01 7.700000 +01 7.700000 +01 9.2000000+00 +01 9.9000000+00	UL 9.00000000 01.8.700000040 3740155401 SLTL4 1428594401 SLTLU 01 8.50000040	+01 9,900000+00 +01 9,700000+00 +01 9,500000+00 +01 9,500000+00 +01 9,500000+00 +01 9,000000+00 *0126+11 5,114 *5078883+01 5,114	+01 9.2000000400 +01 1.000000400 +01 1.0000000401 +01 1.0000000401 +01 1.000000401 +01 1.000000401 +01 9.200000401 +11 9.2153041401	+ui 9.5000000+0 +ui 1.3050000+0 +ui 1.5200000+0 +ui 1.5200000+0 +ui 1.3500000+0 +ui 1.350000040 +ui 1.455000040 +ui 1.45500040 +ui 1.4550040	01 Y.ZUUUU04000 +01 1.170000440 +01 1.160000441 0 1.160000041 0 1.470000441 8674406401 1.114 *8674406401 1.114
inch TIG	0 4444 4000		4.98000 4.98000 4.85000 4.85000 4.85000 4.77000 4.77000 8.00 4.77000 8.85000 4.98000 4.98000 4.980000 4.980000 4.98000000000000000000000000000000000000	-9 DAYS 4-88000 4-95000 4-95000 4-95000 4-95000 4-95000 26-01 550	- 2 H F F K S - 2 H F F K S - 14 H F F F S - 14 H F F S - 14 H	5.4000 5.4000 5.4000 5.3000 5.3000 5.23000 5.23000 5.23000 5.23000 5.23000 5.23000
, 0.50-	6000000+0 2000000+0 2000000+0 2000000+0 2000000+0 2000000+0	7.2295 5.0800 7.2295 5.0800 7.2295	020000401 0500000401 0600000401 0100000401 010000401 AR 2.48328 AR 7.386328 AR 7.38692	06,5556,0.5 9800000+01 0110000401 0120000401 0700001401 0700000401 10400000401 10400000401 10400000401 10400000401 10400000401 104000000401 104000000401 104000000401 104000000401 1040000000401 1040000000401 1040000000401 1040000000401 1040000000401 104000000000401 104000000000401 1040000000000	0.5575.0.5 0.590000-00 1.100000-00 1.100000-00 0.090000-00 0.090000-00 1.100000-00 1.100000 1.100000 1.100000 1.100000	40,000,000 40,0000,000 40,0000,000 40,0000,000
CT5-6		57+01 \$7 00+01 \$7 33+00 \$6 -6.110-7	6 14 20 26 26 37 26 37 32 57 40 57 40 57 40 56 40 56 40 56 50 56 50 50 50 50 50 50 50 50 50 50 50 50 50	-6,71,6-71 3 3 3 9 3 3 15 3 21 3 221 3 221 3 3 3 3 3 3 3 3 3 67+01 \$V8 67+00 \$E8		11111111111111111111111111111111111111
anel No.	LABEL CI5	<pre>\2.68166 4.54000 8.93333 8.93333 LABEL CT5</pre>	3.03166 4.88166 9.41666	LABEL CT5 3.03000 3.03000 9.766666	LABEL 175	LAHEL C/2 3.41500 5.31600

ALUMINUM ALLOY WELDMENTS

Double V 0 50-inch TIC/X5180 CT 3\_4 Panel No.

EI NO. UIS-4, U.SU-INCH IIG/ASIGU, LOUDIE	1 1	1. 1.	000	-inch		164/5	ΩΩ'	nouble
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	~	~	2.***********		1.75000004.1	10+00	8.200	6.200000444
	1.5		2-428-936-03		4./40000401	10+00	0.700	8.70060000+00
	1 ¥	4 - 4	10+00000000.3		4.84160009401	10+01	9.100	9.7006099+03
	22		20+0000002		180.00	4,780000+01	9.700	0010400
			2.00000344401		4.710000011	00+01	9.00	y.600000+00
2.80055555482 FY446 3.4715207+01 557 2.4096744+01 3L1LY	10+5	r + + + + +	114.5 3	10-1024	¥ 5 4	2.4296	744+01	ን ተ የ ተ
4.77000047.4	10+0	1.05443	1 7.344	0.3446999-01 \$5U	\$SU	4.5020282+01 %LTLU	282+01	<b>%L</b> 1LU
<u>, 6 • 88 53 55 88 • 9</u>	د از <b>۲</b>	7 N I I 4		7.2502910-01 \$55	<b>\$</b> .0E			
LAREL CT 3-4, F1G-/100, 5180, 0.5, 5 04Y	ידן א	3-71 U O	0,0414,0	.5.5 UA	*			
	2	5.1	3.1000000+01	11 5.	5.0200000+01	01)+01	8.100	8.1000040+01
	C.	Ü • S	.10+000004040.		4.9400004401	10+01	999.4	900000000+00
	t -		5.U19#09U+U1		4.9200000+01	00+01	8.900	8.9000000409

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8.70004UU+U0	4.920000401	5.47U:400+01	2
8./000000+U0	5,0000000+01	20 5.0769090+01 5.0009900+01 8./000900+00	50
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8.94000009.8	4,9200000+01	5.Ulgue01+01	14
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2.883/122+01 %LILY 4./404051+01 %LTLU 3. Nouveuterut 11944 5.2883149-01 557 4.9565674-01 0.1444 4.224845-01 357 2.7335554-00 4.944 5.36625601 355

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LABEL C[3-4, [14-7145.5180,0.5,10 DAY

<u>Jetton Johnson Brown Jetton Variations Jettones 19. Jetton</u> 19.19466664-J1 Suman Jethon Jetholt asu 5.0109623401 altLu 8.06353554440 S44302941-01 ast	5.010	8 8 C C	41-01	0.670041-01 850 0.6700441-01 850 0.44302541-01 855	10000	3.4400000444 81044 5.190060441 80644 8.063353440 \$5594
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8.5000000+UU	5.2000000+01	2000	9	5.410J00401	5.41	

LABEL CIS-4, [14-7100,5140,0.5,17 DAYS

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10	5.48	5.4800000401	5.2500000+01	8./000003+00
0		10+000014.5	5.2500000+01	8.4000004.00
22		10+0000524.5	5.2700000+01	9.5000000+00
£	3.74	3.74004404401	5.2600000+01	9.+0000004.9
34		10+0000042.5	5.2000000+01	9.30000000+00
3.4035453+41	+ THAH	1. U/0828	№ МАН 1.U/08285+00 А5Y 2.У214941+01 &LFLY	4941+01 &LTLY
5-2466666+61		2.422BH29	9-01 \$SU 5.124	0688+01 \$LTLU
9.2165666+00 BENAR		3.4685H1	J.0695816=01 #5E	
LABEL CT3-4, 116-7196, 5160, 6,5, 5 MEEKS	16-7196	0 0916 0	.5. 5 AREKS	
Ω	.5.45	64040401	3.4564000+01 5.240400+01	8.3000000+00
	4 4 4	0.0.0.0.4.0.4	11 €.4400000±01 € 3060000±01	H.7000000400

8.3000000+00	8.7000000+00 9.800000+00	9.0000000+60 1.0400000+01	9.60000000+00 67+01 &1 TLY	7+01 +LTLU
+01	5,2900000+01 8	5.2800000+01 9	000+01 3.20663	
ιθΕL CT3-4, 116-/136, 5160, 6,5, 5 «ΕἐΚS > 3,4550090403 5,2460090	5.4500000+01 3.460000+01	3.3900000+01 3.3900000+01	5.5104000+01 5.2400 \$Y448 4.5740848+01.55Y	
REL CT3-4, 111	11	5 S C	25 214588848858	5.2610464+01 9.3000006+90

 6 3.54484004-01 5.310888-01 9.2000008-00
 12 3.4909000-01 5.3468000-01 7.500000-00
 12 3.4909004-01 5.286000-01 4.500000-00
 24 3.4909004-01 5.3260000-01
 25 3.500000-01 5.326000-01 1.1000000-00
 3.518353541 5.1200000-01 5.2560000-01 4.11400000-00
 3.518353541 5.1200000-01 5.260000-01 4.114
 3.518353541 5.140946-01 5.5760000-01 4.1141
 3.5281566771 5.444 6.046961-01 5.5
 4.9756887+01 1.1410946-01 5.5
 4.9756887+01 1.11424 LAPEL CT3-4. TIG-7105. 5180. 0.5. 12 HEEKS

1.3200000+01 1.1200000+01

5.450000+01 5.3900000+01 5.2500000+01 5.2500000+01 5.3300000+01

LAHEL CTS-6, 116-7106, 5256, 0.5, 12 WFEKS

5.5200000401 3.5200000401

0 N 0 4 0 0

2.U/77394+90 \$55

1.1480400+01 \*E44K

1.12000000411

### TABLE J-11.

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

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TIG/535 TIG/535 UUU000000101 UUU000000101 UU0000000101 UU000000101 UU000000110100000000000000000000000000	8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8	5 WEEKS 1300000+01 2200000+01 2200000+01 2200000+01 150 150 150 155 155 155 155 1
0.50-inc i i i i i i i i i i i i i i i i i i i	300000401 5 70000401 5 300000401 5 3.440079-0 4.2/39579-0 4.2/39579-0 1.422375640 3.441079-0 4.2/39579-0 5 1.0000401 5 5000401 5 5000401 5 60000401 5 5000401 5 60000401 5 6000401  5 60004001 5 60004000000000000000000000000000000000	1000000401     5       100000401     5       800000401     5       100000401     5       100000401     5       5     152004601       5     152004601       5     152004601       5     153004601       5     15355       5     155565       5     100000401       5     100000401       5     100000401       5     100000401       5     100000401       5     100000401       5     100000401       5     100000401       5     10000401       5     100400401       5     100000401       5     100400401       5     100400401       5     100400401       5     100400401       5     100400401       5     100400401       5     10400401       5     10400401       5     10400401       5     10400401       5     10400401       5     10400401       5     10400401       5     10400401       5     10400401       5     104040401       6     104040401
	21.52 21.52 21.52 25.52 25.52 25.55 25	СТ4-4, Г 16-710 СТ4-4, Г 16-710 2, 2, 2 2, 2, 2 2, 2, 2 2, 3 2, 2 2, 2 2, 2 2, 2 2, 2 2, 3 2, 3 2, 2 2, 2 2, 2 2, 3 2, 4 2, 4 2, 10 2, 10
Zanel N LAHEL 1.011 3.02 3.02 4.956 5.660 5.600 LABEL	3.379 9.100 9.100 9.400 LAHEL 0 3.410 5.140 5.140	2047 L 4100

TABLE J-12.

# UNIAXIAL TENSILE TEST RESULTS ON X7106-T63

# ALUMINUM ALLOY WELDMENTS

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1/556, Doub +u1 7,90000000 +u1 9,000000000 +u1 9,000000000 +u1 8,000000000 +u1 1,000000000 +u1 1,00000000 +u1 9,100000000 +01 9,100000000 +01 9,100000000 +01 9,100000000 +01 9,500000000 +01 9,500000000 +01 9,500000000 +01 9,500000000 +01 9,500000000 +01 9,500000000 +01 9,500000000 +01 9,500000000 +01 1,00000000 +01 9,500000000 +01 9,500000000 +01 1,00000000 +01 1,00000000 +01 1,00000000 +01 1,00000000 +01 1,00000000 +01 1,00000000 +01 1,000000000 +01 1,000000000 +01 1,0000000000 +01 1,0000000000 +01 1,0000000000 +01 1,0000000000 +01 1,0000000000000 +01 1,0000000000000000000000000000000000	0+01 1.000000001 0+01 1.01000001 1+01 8.500000400 1+01 8.100000000 3.0106427-01 %LTLY 4.7995670+01 %LTLJ
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TABLE J-13

TABLE J-14

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

> 0.50-inch MIG/X5180, Double CM3-2, Panel No.

8.6000000+00 09+01 \$LTLY 58+01 \$LTLU 7 2.5500000401 4.370000401 9.2000000400 11 2.6400000401 4.5500000401 1.000000404 19 2.6700001401 4.590000401 1.4800000401 25 2.7500000401 4.3900000401 9.00000040 2.6366667401 5888 6.8655139-01 557 2.2895244\*01 5LLV 4.4766667\*01 5088 1.1075497\*00 550 3.3162465\*01 5LLV 7.200000400 9.3000000400 9.1000000400 8.700000400 8.800000400 55401 \$LTLY 97401 \$LTLY .2000000+00 8.5000000+00 4000000+00 6.2000U00+U0 1.1200000401 9.6000000+00 6.2000000+00 6.900000400 8.2000000+00 .20000000+00 8.1000000+00 9.2000000+00 5.200000400 6.5000000+00 8.30.00000+00 .. D200000+01 .0200000+01 3.0442956+01 5LTLY 4.4859989+01 5LTLU 2049550+01 \$LTLY 8.400000 щ 15 3.0700000+01 4.9800000401 9.50000 21 3.0700000+01 4.9200000+01 9.20000 27 3.0800000+01 4.2200000+01 8.10000 3.060000+01 4.200000+01 8.10000 3.066000+01 4.200000+01 8.20000 4.7333333+01 8UBAR 2.6380791+00 85U 3.2972656+01 81 7.9833335+01 8EBAR 1.5992206+00 85U 3.2972656+01 81 3.1583333.01 \$YBAR 3.5450.60-01 \$\$Y 2.9789555401 5.0316667+01 \$UBAR 1.079**6581+00 \$\$V 4.48**53597+01 8.2666666+00 \$EBAR 9.4798066-01 \$\$E 200000+01 5.060000+01 90000+01 5.3200000+01 100000+01 5.080000+01 000000401 5.2000000+01 000000401 5.2000000+01 4.1411803-01 \$57 3.0442 5.150000+01 5.0500000+01 5.0600000+01 4.8300000+01 5.0200000+01 1900000401 4.590000401 4.6800000+01 4.8200000+01 4.7100000+01 4.9800000+01 .9400000+01 .4600000+01 .3200000+01 5.000000+01 4 2 2 2 2 2 2 0 2 0 0 0 0 0 1 0 1 5.0800000+01 NEEKS 0+0000062\* 1.6800000+0 3YBAR 5.5015478-01 \$SY 05**5** 1.2988457+00 \$SE CM3-2,M1G-7106,5180,0.50,5 WEEKS **\$5E** NEEKS MIG-7106, 5180, 0,50, 12 6 3,390000+01 4,9400 DAYS LABEL CM3-2.419-7106.5180.0.50.4 DAYS NUMBER Y CM3-2, MIG-7106,5180,0.50,1 DAY 1.2496728+00 1.4143870+00 CM3-2, MIG-7106, 5180, 0, 90,7 LABEL CM3-2.MIG-7106.5480.0.50.2 3.2200000+01 3.2200000+01 3.5700000+01 2.9400000+01 3.060000+01 2-840000+01 3.1700000001 3.290000401 2.6000000+01 3.1100000+01 3.1800000+01 3.1800000+01 3.3100000+01 3.2500000+01 3.1500000+01 3.2000000+01 3.5400000403 2.8100000+01 .0200000+01 3.1800000.00 3.4900000+01 3.5100000.0 9.550000+00 SEBAR **\$YUAR** 8.7000000+00 SEBAR **SUBAR** ì 1183353+01 1928 3247 18 G ∕3 17 30 3.4833333+01 3,2533333+01 CH3-2, LABEL LABEL LABEL LABEL

ð 100+01 8.300000+00 100+01 9.0000000+00 100+01 8.100000+00 2.262485+01 \$LTLY 4.23128289+01 \$LTLU Doubl 7.5000000+00 8.700000405 8.0000000+00 8.6000000+00 6.20000000+00 7.80000000.00 9.450000002.90 8.3000000+00 8.7000000+00 9.20000000+00 6.2000004000 6.7000000+00 7.0000000+00 6.0000000+00 7.5000000+00 9.000000.000 9.5000000+00 7.2000000400 8.8000000+00 8.3000000+00 8.7.00.000+00 8.7000000+00 0.50000000+0.0 7.3000000+00 7.20000000+00 V2.4100000-01 \$YBAR 4.6903062-01 \$\$Y 2.1726099-01 \$LTLY V4.4142857+01 \$UBAR 4.8953374-01 \$\$U 4.1373471+01 \$LTLU -9.0285714+00 \$EBAR 4.8950447-01 \$\$E 1.0400000+01 .2000000406 2.8060007+01 \$YHAR 4.8853743+01 \$SY 2.5594667+01 \$LTLY 4.8733433+01 \$\HMAR 1.4010482+00 \$SU 4.1340429+01 \$LTLU Y 2.2842344+01 8LTLY U 4.5879725+01 8LTLU 2.7410991+01 \$LTLY 4.6413451+01 3LTLU ш ALLOY WELDMENTS 0.50-inch MIG/5356, 4.6100000+01 4.7900000+01 4.7700000+01 5.0000000+01 4.9600000+01 4.6500000+01 4.9700004.01 4200000+01 4.8400000+01 4.4500000+01 4.3100000+01 4.7400000+01 4.8400000+01 10+000000 4.8000000401 4.6200000+01 5.0600000+01 5.1200000403 4.4300000+01 4.5200000+01 4.4400000+0 4.7900000+0 1.610000+01 4.8700000+01 4.7900000+01 4.9200000403 4.8200000+0 4.940000+0 WEEKS 7.4832985-01 \$SU 4.4907946-01 \$51 6.8019804-01 \$SY 2.6950000+01 \$YBAR 8.1178980-01 \$\$Y 4.8433333+01 \$UBAR 5.0466973-01 \$\$U 8.383333+00 \$EBAR 5.6005991-01 \$\$E 9.9546846-01 \$SU 8.5479080-01 \$SE LABEL CM4-2, MIG-7106, 5356, 0.50, 4 DAYS NEEKS γv LABEL CM4-2.MIG-7106.5356.0.50.7 DAYS 5.04 6.2609919-01 105.0 5. NUMBER Y CM4-2, MIG-7106, 5356, 0, 50, 1 1 CM4-2, MIG-7106, 5356, 0.5, 2 2.4500000441 2.4300000+01 2.4700000+01 .6600000+01 2.6200000+01 2.740000+01 2.8640004+01 2.9300000+01 2.8200000+01 2.9300000+01 2.9500000+01 2.3700000+01 2.430.000.01+01 2.3400000+01 2.4200000+01 2.2100000+01 .630000401 .80000000. 2+790000404 LABEL CM4-2, MIG-7106, 5356, 5.U200000+01 .790.0000+0. 3.0300000+0 .5200000+0 -6400000+0 .5200000+0 2.6500000+0 .6300000+0 2.4500000+0 .660000 2.9683333+01 \$YHAN 5.0200001+01 \$UBAR 12.5500000+01 \$7848. 14.5683333+01 \$18484 8.9666666+00 \$E848 Panel No. CM4-2, SUBAR SEBAR \$YBAR 17 23 8.1666666400 ø 10 130 V2.6066667+01 v4.7350000+01 35 10 25 31. 202 LABEL LABEL LABEL

6.U663956-01 \$SE

7.56666664+0U \$EHAH

5.2200000+01 \$UBAR 1.7988A81+00 \$SU 4.3097626+01 \$LTLU

8.033333+00 \$EBAH 1.4094918+00 \$5E

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

Panel No. CM5-1, 0.50-inch MIG/5556, Double V

NUMBER	~	>	2	U
LABEL CM5-1,	HIG	CM5-1,MIG-7106,5556,0.5,1	DAY	
	-	2.8000000+01	4.6600000+01	00+0000006-6
	~	2.8200000+01	4.2400000+01	7.6000000+00
	13	2.890000401	4.4600000+01	8.3000000+00
	19	2.8900000+01	4.2200000+01	7.8000000+00
	25	2.9800000+01	4.3700000+01	8.700000+00
	31	2.8700000+01	4.3400000+01	8.9000000+00
2.8750000+01	_	SYBAR 6.3482992-0	SSY.	7760+01 SLTLY
4.3816667+0		\$UBAR 1.6228595+00	\$SU	3.5604997+01 SLTLU
6.533333400		SEBAR 8.3586311-0	-01.SE	

LABEL CH2-1, MIG-/100, 2256, 0.5, 6. DAYS	- / LUU/ / / / / / / / / / / / / / / / /		
~	3.0700000+01	4.7700000+01	8.3000000+00
80	3.1400000+01	4.500000+01	5.2000000+00
14	3.1500000+01	4.6900000+01	8.4000000+00
20		4.4900000+01	7.2000000+00
26	3.2000000+01	4.6600000+01	6.9000000+00
32	3.2000000+01	4.8000000+01	7.9000000+00
39	3.2100000+01	4.8900000+01	1.10000001.1
3.1616667+01	SYBAR 5.3448007-01	5 S Y	2.8912197+01 \$LTLY
4.6857143+01	SUBAR 1.5020653+00	<b>S</b> SU	3.9887560+01 SLTLU
7.8428571+00	SEBAR 1.7690461+00	+00 SE	

### -1

.ABEL CM5-1.MIG-7106.5556.0.5.9 DAYS	-7106.	5556.0.5.9	DAYS			
m	3.21	1000001	4.94000	9400000+01	8.400000400	
0	3.22	.2200000+01	4.800000	10+00	7.8000000+00	
15	3.24	400000+01	4.69000	900000+01	7.8000000+00	
21	3.20	.2000000+01	4.780000	10+01	å	
27	3.24	.2400000+01	4.80000	10+01	7.7000000+00	
33	3.28	3.2800000+01	4.7800000+	0.0+01	8.1000000+00	
.2316667+01	SYBAR	2.8577096	-01 5	3,0870666	)666+01 SLTLY	
.7983333+01	SUBAR	8.0602134-	01 \$S	4.3904	4865+01 <b>SLTLU</b>	
00+0000006.	SEBAR	2.9664780-	01 5			

	10000+00 00000+00 000000	7 • 200 7 • 100 8 • 400 9 • 800 9 • 800 8 • 400 1585 • 01	EKS 2000000401 7800000401 8600000401 920000401 \$20000401 \$50 4,383 \$55 2,916 \$55 \$55 \$55 \$550	10100-01 4. 10100-01 4. 10100-01 4. 10100-01 4. 10100-01 4. 10100-01 4. 10000-01 0-0000-0000-0000-0000-0000-00	5+7106,5 3-210 3-220 3-220 3-220 3-220 3-2340 3-3350 5-2550 5-25500 5-25500 5-25500 5-25500 5-25500 5-25500 5-25500 5-25500 5-25500 5-25500 5-	LABEL CM5-1,MIG-7106,5556,0.5,2 WEEKS 4 3.2000000+01 4.80 10 3.22000000+01 4.80 16 3.2700000+01 4.780 22 3.2900000+01 4.780 28 3.3400000+01 4.920 28 3.3400000+01 4.920 28 3.3400000+01 4.930 28 3.3400000+01 4.800 28 3.3400000+01 4.930 28 3.3400000+01 4.800 28 3.3400000+01 4.8000 28 3.3400000+01 4.800 28 3.3400000+0000+00000+0000 28 3.3400000+00000+00000000+000000000000000
			1			
			<b>S</b> SE	9.9682839-01	SEBAR	8.11666666+00
	SLTLU	1585+01	SU 4.383	8.8637968-01	SUBAR	4.8316667+01
8.8637968-01 \$SU 9.9682839-01 \$SE	SLTLY	1414+01	55Y 2.916	7.0261917-01	SYBAR	3.2716667+01
3.2716667+01 \$YBAR 7.0261917-01 \$\$Y 2.9161414+01 \$LTLY 4.8315667+01 \$UBAR 8.0857968-01 \$\$V 4.3831585+01 \$LTLU 8.1166666400 \$EBAR 9.9882839-01 \$SE	00+0000	8.400	9300000+01	0000+01 4.	3.350	34
00000401 4.93000 7.0261917-01 55Y 8.8637968-01 5SU 9.9682839-01 5SE	00+0000	9.800	9200000+01		3.340	28
28 3.3400004-01 4.920000+01 9.8000000-00 34 3.3500000-01 4.9300000-01 8.4000000-00 3.22716667+01 \$YBAR 7.0261917-01 \$SY 2.9161414+01 \$LIY 4.8316667+01 \$YBAR 9.0637968-01 \$SV 4.3331585+01 \$LIU 8.1166666+00 \$EBAR 9.9682839-01 \$SE	00+0000	7.800	8600000+01	4	3.290	22
22 3.2900000+01 4.8600000+01 7.8000000+00 28 3.3400000+01 4.9200000+01 9.80000000+00 34 3.3500000+01 4.9200000+01 8.4000000+00 3.2716667+01 \$VBAR 7.0261917-01 \$SV 2.9161414+01 \$LTLY 4.8316667+01 \$VBAR 8.0637968-01 \$SV 4.3831585+01 \$LTLU 8.1166666+00 \$EBAR 9.9682839-01 \$SE	00+0000	8.400	7800000+01		3.270	16
16 3.2700000+01 4.7800000+01 8.4000000+00 22 3.5900000+01 4.800000+01 7.8000000+00 28 3.35440000+01 4.9200000+01 9.800000+00 34 3.3500000+01 4.9300000+01 8.400000+00 3.2716667+01 SUBAR 7.2261917-01 SSY 2.9161414+01 SLILY 4.8316667+01 SUBAR 9.9982839-01 SSU 4.3831585+01 SLILU 4.11666660+00 SUBAR 9.9982839-01 SSE	00+0000	7.100	8000000+01		3.180	10
10 3.1800000+01 4.800000+01 7.1000000+00 16 3.2700000+01 4.800000+01 8.4000000+0 22 3.2900000+01 4.8600000+01 7.8000000+0 28 3.390000+01 4.9200000+01 9.8000000+00 34 3.3500000+01 4.930000+01 8.4000000+00 3.2716667+01 \$VAR 9.8637968-01 \$SY 2.916444401 \$LLY 8.11666667+01 \$VAR 9.8637968-01 \$SY 4.3831585+01 \$LLY 8.11666667+01 \$VAR 9.9682839-01 \$SE	00+000	7.200	Z000000+01	0000+01 4.	3.200	4
4         3.2000001+01         4.700000+11         7.20000004-00           10         3.1800000+01         4.800000+01         7.1000000+00           22         3.2700000+01         4.8600000+01         8.4000000+00           28         3.3400000+01         4.9200000+01         9.00000+00           34         3.3500000+01         4.9200000+01         9.00000+00           34         3.3500000+01         4.9200000+01         8.4000000+00           34         3.3500000+01         4.9200000+01         8.4000000+00           34         3.3500000+01         4.9300000+01         8.4000000+00           34         3.3500000+01         4.9316667+01         8.112           4.8316667+01         \$28AR         9.98537968-01<\$58			EKS	556,0.5,2 HE	3-7106,5	BEL CM5-1,MI(

### 6.600000+00 6.8000000+U0 6.0000000+U0 6.600000440 8.750000040 6.40000000+00 3.10000004.01 БҮМАМ <u>0.09</u>2565-01 Б<u>57</u>2.7913776+01 ЪLTLY 4.9685333-01 БОМАМ 1.1391579+00 Б50 4.5919194+01 ЪLTLU 6.853535-01 БОМАМ <u>9.6561727-01</u> \$5 4,8400000+01 4.9500000+01 4.9400000+01 3.1200001+01 5.1400004401 5.1500000+01 5.146JUU+U1 5.000000405 5.000000405 1122 55

8.400000+00 01+000005.0 7.1000000+00 9.50000000+00 5.2266000+01 5.2200000+01 5.2700000+01 4.9800000+01 5.1200000+01 .3500000+01 LAREL CM5-1, MIG-/100, 5356, 0.5, 12 WEEKS 3.660000601 3.5900000401 3.0000000001 3.680u0000401 5.7200000+01 3.6500000401 9 2012 000

45×-22

3.6666667+01 \$YHAN

TABLE J-16.

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

> Panel No. CT3-3, 1.00-inch TIG/X5180, Double

			-	:    -			L
E13-0, [1	- 1100.	0184,1,00	I NCH	L UAY	:		ć
-	0.10	10+000000000			>		0
`	5.48	<ol> <li>.4800000.01</li> </ol>	166,4	4,5560000+01	+	1.6500	1.6500000+01
13	5.32	5.320030401	4.20	4.2080000+01	٦,	1.7200	1.7200000+01
7.1	5.04	5.44446644+01	4,1,81	4.1.600008+01	-	1.6000	1.600000401
60	07.2	2.9000000401			3		0
. 51	2.45	51 2•960-0010+01			3		0
10+10005	* Y 3 A 4	012342-0	5-01 \$	51 2.6	0389	10+69	5 L T L Y
10+356-01	<b>HUHAH</b>	4.4500000000000000000000000000000000000	3+00-6	5.4 Uo	1343	55+01	»LTLU
566667+01	bedan A	1. M5665e2+01 \$E884 5.U277326-01 \$SE	5-01 %	ы. Ун			

# H N J

CH+8 DAY	5.510000+01 4.830000+01 1.5300000+01	4.6200000+01 0	4.6300000+01	0	0 .	0	3.3233333+01 \$Y8AM 1.2176515+00 \$SY 2.7072017+01 \$LTLY	00 \$SU 4.5748702+U1 \$LTLU	38 \$5E	
HEL CIS-3, [14-7106, 5184, 1, 001NCH, 8 UAY	5.510000401	5.5600000401	3.5400000+01	3.1400000+01	2.240000045.2	3.2400000+01	\$YBAH 1.2176515+	▶ UHAH 1.1846311+00 \$SU	\$Е́дАн ∠.+051597+38	
BEL CI3-3, Tu	s	>	с†	21	12	33	3.3233333+01	4.6933355411	1.53000000+01	

	1.6700000+01	0	0	0	0	0	5.43666677+01 679AK 5.2865549-01 85Y 3.0173570+01 &LTLY	4.7533353401 hUGAK 1.2740964+00 \$50 4.6259237+01 \$LTLU		S
EEKS	10+00	00+01	10+00	0	0	0	3.017	4.625		5 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1
CH. 2 W	00006.1	4.6900000401	4.6703000+01				1 151	0 \$20	8 35E	INCH
DIUUI.001NC	3.4/Juv00+01 4,900000+01	3.450000+01 4		5.2/0000+01	5.49Ucvuu+01	3.4500005411	9.2065549-U	1.2740964+0	<.4461597+38 %5E	, 5180, 1.0C
-7106.	5.41	3.45	5+43	5.21	5.44	5.45	4 4 A A K	PUGAK	4FGAR	6-7106
LABEL CT3-3, fig-7106, bis0, 1,001NCH, 2 WEEKS	*	1 U	10	22	20	0.4 1	5.4366657+01	4.7555555+11	1.6700HU0+01 \$FEAK	LABEL CT3-3, TIG-7106, 5180, 1.00 INCH 5 WEEKS

5	3.5200000+01	4.8800000+01		0	
11	3.45000000+01	4.7500000+01		0	
17	3.4600000+01	4.7000000+01		0	
23	3.3706400+01	0	_	0	
50	3.470000401	Ð		ņ	
35	3.3700000401	0		0	
3.440000 <b>0</b> +01	¥ НАН 7.9330010-01 \$51		3.1397901+01	<b>5LTLY</b>	
4.7766667+01	10444 9.2916214-01		4.6837504+01	<b>6LTLU</b>	
5.7896044+70	ьЕлан	0 \$56			
CT3-3, T	AFEL CT3-3, TIG-7106, 5180, 1.00 INCH 12 WEEKS	00 INCH 12 WE	EKS		
¢	3.3400000401	4.9400000+01	_	0	
12	3.6300000401	4,7600000+01		5	
10	3.6400000+01	4.7500000+01		0	
24	3.5800000401	0		0	
3.0	3.5100001C+01	3		0	
36	5.660469 <b>0+01</b>	0		0	
603000-403	3.56030000+91 \$Y3A× 1.2049917+00 \$51		2.9502742+01 ALILY	<b>۱</b> ۲ ر۲ ۲	

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TABLE J-17.

UNIAXIAL TENSILE TEST RESULTS ON X7106-T63 ALUMINUM ALLOY WELDMENTS

# TABLE J-18.

UNIAXIAL TENSILE TEST RESULTS ON X7106-T63 ALUMINUM ALLOY WELDMENTS

5-7, 1.00-inch TIG/5	1 5.500000000000000000000000000000000000	LABEL 515-7,110-710-5550-1,001 NCH 5 DAY 0 1,300000000 U     	LAHEL CIS-7,110-5956,1,001NCH,9 DAY	LARFL C17-7,116+7106,5555,1001MCH,2 WEEKS + 2 UAY 4 5.61300004.01 5.4700004.01 1.5000004.01 10 5.52000004.01 5.4900004.01 1.55000094.01 2 5.52000004.01 5.44000004.01 1.25000004.01 2 5.54000014.01 5.48000014.01 1.4000004.01 2 5.5505657.01 114.47 5.527191.01 5.0 3.325082294.01 2.1LY 5.55056567.01 114.47 5.5557101 550 4.934755594.01 2.1LY 1.3444400164.01 550 4.01 250 4.934755594.01 2.1LY	10-7100, 5556, 1.00, 3.7800006.01 5.72000004.01 5.7200000104.01 5.720000004.01 5.72000004.01 5.7200004.01 5.7200004.01 5.7200004.01 5.7256.01 5.7256.000	LAREL CT5-7, i16-7164, 5554, 1.00 INCH 12 WEEKS 0 5.970000401 5.2200000401 1.340000401 12 5.426000401 5.300000401 1.3500000401 14 5.790004401 5.200000401 1.3500000401 24 3.8300006401 5.2200009401 1.4500000401 24 5.8300006401 5.2200009401 1.4500000401 25 5.300000401 5.3000000401 1.500000401 3.855666664411 11344 2.040009401 5.3000000401 3.855666664411 11344 5.3565677901 550 5.00000401 1.500000401 1.3300000441 1.1444 2.040000401 5.3000000401 1.5000000401 3.8556666664411 1.1444 5.3565677901 550 5.000000401 1.5000000401 3.8556666664411 1.1444 5.3565677901 550 5.000000401 1.500000401 1.33000000441 1.1444 2.00002515-01 550 5.000000401 1.500000401 3.8556666666441 1.1444 5.3565677901 550 5.000000401 1.500000401 3.856666666441 1.1444 5.3565677901 550 5.000000401 1.500000401 1.33000000441 1.1444 5.3565677701 500 5.000000401
Panel No. CT4-3, 1.00-inch TIG/5356, Double V - LAREL GIA-5, 11,05,0555,11,001NCH, 36 HUNKS		HEL CIA-3, Tat 	LAMEL GT4-3,T1G-7106,5956,1,N01NCH,9 UAY 9 5.5700009401 4.7200000401 1.2100000401 1> 5.4700000441 4.7200004401 1> 5.440000441 4.7200004401 21 5.450000441 4.8500006401 1.5500006401 27 5.4500004401 4.8500006401 1.5500006401 3.3993555401 5.4500004401 6.8500006401 1.4500000401 1.00000401 1.4445555401 2004070100550 5.55000200401 2.7000006401 1.4445555401 20040721401 550 4.2955022401 2.710	LABEL C14-5,T14-7140.5355,1.001WCM.2WEEKS + 1 DAY 4 5.4740404.01 1 4.650000441 10 5.4740404.01 4.924040141 1.550000441 22 5.400404401 4.9240400441 1.550000441 22 5.400404401 4.9240400411 1.50000441 23 5.400404441 4.9204000411 1.50000441 24 5.474440441 4.9204000401 1.500000441 25 5.400404441 4.9204000401 1.500000441 26 5.400404441 4.9204000401 1.500000441 27 5.400404441 5.7 5.404445401 2.111 4.8055555591 2.00000441 5.5 1.5110667401 2.111 1.5110667401 1.405441500 5.51	LAREL C14-3, 11G-7106, 5354, 1.00 INCH 5 WEEKS + 1 DAY 5 3.550000+01 4.870000+01 1.2200000+01 11 5.5010700+01 5.7600010+01 1.5200000-01 77 5.61077010+01 5.760000+01 1.5500000-01 23 5.6000400+01 4.980000-01 1.5500000-01 35 5.500000-01 4.940000-01 4.940000-01 3.5950000+01 4YAAR 2.3453120-01 5.7 3.476327+01 4.17 4.976667+01 4.940 7.315264-00 55 1.4116667+01 4.940	LAREL GT4-3. TIG-7106, 5354, 1.00 lvcm 12 wErks         0       5.750r004+01       5.2200000+01       1.396000+01         12       5.750r004+01       5.2200000+01       1.4500004+01         14       5.7400000+01       5.7200000+01       1.4500004+01         18       5.7400000+01       5.7200000+01       1.4300004+01         18       5.740000+01       5.070000+01       1.4300000+01         28       3.050000+01       5.070000+01       1.4300000+01         39       3.050000+01       5.070000+01       1.4100000+01         36       3.650000+01       5.020000+01       1.4100000+01         37       3.5530000+01       1.4100000+01       1.4100000+01         37       3.5300000+01       1.4100000+01       1.42050000+01         3.70550000+01       5.0250000+01       1.4205000+01       1.4205000+01         3.429333+01       505490553+01       552       3.477210467+01       5.112         3.429333+01       505490553+01       555       3.477210467+01       5.112

TABLE J-19.

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

# > Panel No. CM3-3, 1.00-inch MIG/X5180, Double

ABEL CM5-5.11	LABEL CMS-S. "IG-7105.5134.1.001NCH.10AY	INCH, IUAY	
-	<u>3. 29 9 0 0 0 0 4 1 1 1 </u>	3.22990039+014.1900009+01	1,17400000+01
/ .	5.220090+01	4.2400000+01	1.1400000+01
15	3.5890000+ <u>01</u>	4.2100000+01	1.20000004.01
14	5.U9000015	4.230000+01	1.0290000+01
52	5.2544444	4.2500000+01	1.0200000+01
51			1.05000003+01
3.2733553401	3.2733353401 \$YdAM 1.222/212+00 \$5Y 2.5026364+01 \$LTLY	2+00 \$51 2,502	8364+01 \$LTLY
4.2085555401	4.2083555+01 \$JHAR 4.4088028=01 \$SU 3,9856527+01 \$LTLU	484.5 US& 10-8	6527+01 \$LTLU
1.1000000+01 \$53A	85344 7.9749708-01 \$SE	8-01 \$SE	

LABEL CM3-3, M13-7106, 5140,1,001NGH,5UAY	6-71Ub.	5140.1.00	INCH.	5DAY		
v	5.24	5.240000+01	4.3	4.3900000+01	+01	8.4000000+00
٩	5.41		4.5	4.5706000+01	+01	8. vü <u>0</u> 0100+00
14	3.03	3.000000001	4.4	4.430000+01	+01	8.>00000000400
<b>٦</b>	5.14	5.140000401.5	4.2	4.2800000+01	•01	1.01000010.01
20	5.41	5.4100000+01	4.3	4.3600000+01	+01	8.800000+00
32	5.25	5.2500000+01		4,5600000+01	+01	7.6000000+00
3.2466667+01 \$YBAN	YADY #	1.534494	00+1	<b>55Y 2</b>	.4702	1.5344941+00 \$SY 2.4702126+01 \$LTLY
4.3650000+01 tunAx	PUDAR ANDAR	4,9296A13-01 \$5U	3-01		1155	4 1155581+01 %LTLU
A.6000000+00 %E848	<b>VEGAR</b>	3.1731304-01 \$SE	4-01	<b>\$</b> SE		

LAt

NEL CM3-5,M16-7106,5180,1.00 INCH.9 UAY	6-7106.	5150.1.00	INCH.9 L	ΑΥ	
<b>°</b>	5.03	5 5.250u000+01	4,5900009+01	0+01	9.4000000400
т	16.5	10+0000046.2	4.5100000+01	10+01	4.00000000+000
<b>د</b> ا	5.5	5.~70000401	4,5000000+U1	10+00	9.2000004400
21	5.5	3.5200000401	4.56000000+U1	10+00	9.7000000400
51	3 <b>.</b> 6U	5.6u00000+01	4.5100000+01	TO+00:	8.500000000
33	3.54	3.5400000+01	4.3200000+01	00+01	8.00000000+00
3.5516667+01	***¥	2.9268215	Y34 10-0	3.4035	5695+01 &LTLY
4.4983333+01	\$UHAH	9.4110310	1-01 \$SU	4.0221	4.4983333+01 \$UHAH 9.4110310+01 \$SU 4.0221352+01 \$LTLU
8.9000000+00 \$EBAH	<b>JEUAH</b>	5.d651534eu1 \$SE	1-11 \$SE		

and the state that the second second	NCH 5 WEEK	5. 5180. 1.00 1	MIG-710	LAPEL CM3-3, MIG-7106, 5180, 1.00 INCH 5 WEEK
	\$SE	7.650000+90 stdAK 2.9245255-01 \$5E	U SEJAK	7.6500066+9
1319+01 \$LTLU	\$50 3,971	4.470u0u0+01 &UBAR 9.8590531-01 \$5U 3,9711319+01 \$LTLU	L SUBAR	4.470u0u0+0
0606+U1 %LTLY	1245 3.351	5.5210666+U1 %Y84K 5.3716618-01 %SY 3.3510606+U1 %LTLY	1 <b>5</b> 784K	5.521b666+U.
8.4000000406	4.470000+01	5.5KUUUUU+01 4.4	4 3.5	ŝ
7.8000000+00	4.3700000+u1	5.530000000101 4.5	č. č. č	à
6,2000000+00	4 5800000+ 4.	480000+01 4.5	× 3.4	N.
7.5000006+00	4.4500000+01	3.5000000401 4.5	ه.ن ۵	-
7.0006006+00	700000+01	10 3.5200000+01 4.470000+01	ù 3.5	
7.0000000+00	800000+01	3.52uu00+01 4.58uu00+01	4 3.5	
	2KKS+1DAY	LABEL CMS-3, M16-7166.5180.1.001NCH. 2WKS+10AY	16-7166	LABEL CMS-3, M

8.7000300+00 6.7000300+00 9.1000000+00 6.1000000+00 6.9000000+00 7.5000000+00 3.7116667+01 \$Y9AM 6.2743179-01 \$SY 3.5941862+01 \$LTLY 4.6316667+01 \$UBAR 4.1191216-01 \$SU 4.4232391+01 \$LTLU 8.166666+00 \$E8AM 0.5546323-01 \$SE 4.680000+01 .6600000+01 +.6300000+01 .6400000+01 .5600000+01 3.6600000401 10+0000042. 10+0000119\*9 3.6700000+01 5.7300000+01 .6500000.0. 3322112

LAREL CM3-3, MIG-7106, 5180, 1.00 INCH 12 WEEKS ..6700000+01 3.9400000+01 ٥

6.2500000+00 7.1000000+00 7.7000000+00 ..1000000+00 7.2000000+00 8.7006000+60 .8500000+01 .79000000401 .7700000+01 .650000+01 .7100000+01 4.0300000+01 3.9700000+01 4.0200000+0 3.9200000+01 3.980000040 C + α ≤ 2

2580406+01 \$LTL

**\$**54

4.3206727-01

3.9766666+01 \$74АК

6.5000000+00

3.7000000+01 bYHAK 3.2299583-01 85Y 3.5368120+01 6.5000000+01 3.7000000+01 bYHAK 3.2299583-01 85Y 3.5368120+01 5LTLY 81TH

TABLE J-20.

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

e < Ê,

о	M4-3, 1.00-inch	n MIG/53	56, ]
10.4454 1 AREL C445, 31 1 AREL C445, 31 1 0 1 0 2 0 2 0 2 0 2 0 2 0 2 0 2 0 2 0 2 0 2	Y 5 - 5 - 5 - 5 - 5 - 5 - 5 - 5 - 5 - 5 -	1 1 U U U U U U U U U U U U U U U U U U U	<pre>4.5000000000000000000000000000000000000</pre>
31 3,1390300+11 4,155553491 9,0166966430	5.100000101011 4. 5744 2.5489377-01 \$0344 6.4063734-01 \$64647 6.4063734-01	10:003+01 15:7 2:44920 5:0 3.70747	. 1000000+0 3+01 %LTLY 8+01 %LTLU
LABEL CM4-5, X1 	i-7100,5556,1,001NCH,       5.170000401       4.0       5.170000401       4.0       5.29000001       5.29000001       4.1       5.3100000001       4.1       5.3100000001       4.1       5.31000000000       4.1       5.31000000000       4.1       5.310000000000000       4.1       5.31000000000000000000000000000000000000	7047 7047 800000+01 90000+01 100000+01 100000+01 100000+01 100000+01 100000+01	6.200000040 9.200000040 9.400000040 9.400000040 6.400000040 0040040040 7.400000440
3.2000001+0 4.14500000+0 8.7000000000	ь Y ЧАН I. 1632147+00 ь Ч ЧАН I. 1632147+00 ь Ч Ч А Ч О 5891401 в Г З н А 0 5891401	8557 2.60129 8557 2.60129 856 3.87965	4+01 \$LTLY 4+01 \$LTLU
		//UAY 300000+01 200000+01 200000+01 400000+01 200000+01 600000+01 1584	8.500000+03 8.500000+03 9.200000+00 9.2000000+00 8.2000000+00 8.2000000+00 8.2000000+00 8.2000000+00
	61348 6.5586815-01 613484 6.5586815-01 858484 5.7282747-01 6-7105.55551.010401 4. 5.2290000401 4. 5.370000401 4.	850 3.74038 850 3.74038 2 MEEKS 2 00000401 80000401	
10 22 22 24 24 24 24 24 24 24 24 24 24 24	5.240000401 5.310000401 5.500000401 5.270000401 5.270400401 5.273469401 2.9567 2.1544149-01 2.9567 2.134694-01 2.9567 2.437344401	940000+01 40000+01 74000+01 260000+01 257 3,03751 455 3,03751	7.200000000 8.40000000000 7.20000000000 8.4000000000 9.401 1.111 9.401 1.111 49.401 1.111
LABEL CM4-3, M 11 12 14 13 13 14 23 34166667+01 4.2688333401	16-7106, 5356, 1.00 1 3.440000-01 4.2 3.340000-01 4.3 3.440000-01 4.2 3.450000-01 4.2 3.410000-01 4.2 3.470000-01 4.2 3.4700000-01 4.2 3.470000-01 4.2 3.4700000-01 4.2 3.47000000-01 4.2 3.47000000-01 4.2 3.47000000-01 4.2 3.47000000-01 4.2 3.47000000-01 4.2 3.47000000-01 4.2 3.47000000-01 4.2 3.47000000000000000000000000000000000000	NCH 5 HEEKS 400000+01 000000+01 700000+01 700000+01 700000+01 \$SY 3.17789 \$SU 4.08237 \$SE	9.000000000000 7.40000000000 6.20000000000 6.20000000000 8.40000000000 8.400000000000 17.401 %LTLY 21.401 %LTLY
ГАНЕГ Анег Аа-а, 11<0 30 4 20 30 4 20 30 50	0 044444 1448444	NCH 12 WEEKS 50000+01 100000+01 90000+01 600000+01 600000+01 00000+01	7.500000+00 7.500000+00 6.5000000+00 7.0000000+00 7.0000000+00

C HINGY I

UNIAXIAL TENSILE TEST RESULTS ON X7106-T63

ALUMINUM ALLOY WELDMENTS

Panel No. CM5-4, 1.00-inch MIG/5556, Double V

1.1500000+01

LABEL CM5+4, M1G-7106,5556.1.001NCH.1 DAY 1 3.22204010+01 4.42200000+01 7 3.2500000+01 4.1300000+01

NUMHER

5.2500000+01 3.2500000+01 5.240000+01

щ

### **TABLE J-22**,

# UNIAXIAL TENSILE TEST RESULTS ON X7106-T63 TINTING AT LOV DADENT NETAT

		1					ł			i	1				I		-		
METAL f	.120000040	0+000000		468+01 \$LTLY	7178 10+/66		200008	.7800000+0	.7500000+0	171+01 SUTLY	912+01 BLTL	• • • • • • • • • • • • • • • • • • •	0.00000000	+0000060	.0700000+0	2.0500000+0	904+01 SCTL	769+01 \$LTL	
ALUMINUM ALLOY PARENT METAL NUMBER '	CH .780000+0	.83000040	7600	8-01 \$5Y 5.97	8-01 \$SE	CH	0+0000094.	4400000+0	.5000000+0	-01 \$57 5.562	1 \$56 0.18	INCH	410000	0+0000004	4900000	.4300000+01	-01 \$SY 5.6	5U 6.230	• -1 -2
UM ALLO	TAL. 7106. 1 6.190000+0	.130000+0	00001	YBAH 2.167880	AH 5.099021	7106. 5		0+000004	101000+0 10000+0	5.041442		TAL, 71.6. 1.00	5.8100000+01	5.8400000401 5.79000000401	5.880000001	5.8400000+01	YHAH 3.421036	ي زيد	
· /	н З	~ ~	041	.098000+01	10+0000	يلك:	7 2			5.910000+01	10+0000222	LABEL PARENT MF	<b>+</b>	~ ~	4		320000+01		

1.17000000101 1.1700000+01 9.3000000+00 9.7000000+00 8.9000000+00

4.500000+01

3.4800000+01 3.480000+01

200

.5900000+0

.360000+0

LABEL CM5-4,M1G-7106,5556,1,D01NCM.4 DAY 2 5.4800000401 4,1300000401 8 5.5800000401 4,4700000401 14 3.4800000401 4,4400000401

1.0600000+01 32+01 \$LTLY

3.5150000+01 \$Y8AR 5.4314577-01 \$\$Y 3.2401682+01 \$LTLY 4.44433333401 \$V8AR 2.0461383+00 \$\$V 3.4079873+01 \$LTLU 1.0016667+01 \$F8AR 1.0264825+00 \$SE

00+0000000\*6 9.200000+00

00+0000000+6

4.5600000+01 4.4800000001 4.5700000+01

LABEL CM5-4,M1G-7106,5556,1,001NCH,7 Day 3 3.4900000401 4.270000 3 3.4900000401 4.5600000 15 3,4600000401 4.4800000

3.4700000+01

57

9.0000000+00 00+0000000\*6 Motes: (1) Tensile axis normal to rolling direction.

Data taken from tests conducted under Contract NAS8-1529, Mod 6 (hth year). <u>ج</u>

//		10+00009/6"+ 0	9.00000000000
35	3.4700000+01	i.	9.000000+00
3.4760000+01	SYBAR 1.341983	883	60+01 SLTLY
10+0000044**	\$UBAR 1.455215+00	15+00 \$SU 3.7119912+01	
8,8666666400	\$EBAR 4.5205006-01	<b>\$</b> 5E	
LABEL CM5-4,M10	LABEL_CM5-4,M1G-7106,5556,1.00INCH,2 WEEKS	DINCH, 2 WEEKS	
4	3.4900000401	01	8.000000+00
10	5.5400000+01	_	8.200000+00
16	3.5600000+01	4.5200000+01	8.9300000+00
22	3.4900000+01	4.5400000401	6.8000000+00
28	3.5900000401		7.5000000+00
4 10	5.5300000+01	4.3900000+01	9.0000000+00
3.5333333+01	\$78AN 5.9528392-01	\$5Y 3.33433	17+01 SLTLY
4.5200000+01		\$5U	-
8.0666667+00	\$EBAR 4.3825215-01	\$SE	
LABEL CM5-4, M	19-7106, 5556, 1	LABEL CM5-4, MIG-7106, 5556, 1.00 INCH 5 WEEKS	
5	3.6100000+01	4.6500000+01	8.400000+00
11	3.6900000+01		7.700000+00

LABEL CM5-4,	MIG-7106, 5556,	1 5556, 1	1 00.	1.00 INCH 12 WEEKS	N E E K	5
	6 3.86	ł	4	400000+	10	7.5000000+
-	2 3.87	· H700000+01	4.6	<b>6700000+01</b>	01	6.7000000+00
-	6 3.91	00000+01	4	500000+	01	7.2000000+
N	4 3.89	10+0000068.	4.7	7000000+01	01	9.7000000+00
	0 3.82	5.8200000+01	4 2	+000006	10	9.2000000+
-,	6 3.83	-8300000+01	4.5	5300000+01	101	9.200000+00
3.8633333+01	Η <b>λ β</b>	3.4448607-03		<b>557 3.</b>	6890	3.6890234+01 %LTL)
4.5633333+0	1 SUBAH	1.6966603+01		\$5U 3.	7048	
8.2500000+00	U SEHAH	1.2629333+00				

### 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:

$$\overline{\mathbf{x}} = \frac{\mathbf{x}_i}{\mathbf{N}} = \text{mean value}$$

where

 $x_i$  = individual value

N = number of tests

$$S = \sqrt{\frac{\Sigma(x_i - \bar{x})^2}{N - 1}} = \text{Standard deviation}$$

 $LTL = \overline{x} - KS = lower tolerance limit$ 

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	K	Sample	K	Sample	K
Size	Factor	Size	Factor	Size	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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