AFWAL-TR-86-4100

AD-A176 787

DTIC FILE COPY

# REVISION OF DESIGN VALUES FOR 7075-T7351 AND 7075-T7651 ALUMINUM PLATE

Torsten M. Rhode, First Lieutenant, USAF
Materials Engineering Branch
Systems Support Division



December 1986

Final Report for Periods September - October 1984 and June - July 1985

Approved for public release; distribution unlimited.

MATERIALS LABORATORY
AIR FORCE WRIGHT AERONAUTICAL LABORATORIES
AIR FORCE SYSTEMS COMMAND
WRIGHT-PATTERSON AIR FORCE BASE, OHIO 45433-6533

## NOTICE

*When Government drawings, specifications, or other data are used for any purpose other than in connection with a definitely related Government procurement operation, the United States Government thereby incurs no responsibility nor any obligation whatsoever; and the fact that the government may have formulated, furnished, or in any way supplied the said drawings, specifications, or other data, is not to be regarded by implication or otherwise as in any manner licensing the holder or any other person or corporation, or conveying any rights or permission to manufacture use, or sell any patented invention that may in any way be related thereto.*

*This report has been reviewed by the Office of Public Affairs (ASD/PA) and is releasable to the National Technical Information Service (NTIS). At NTIS, it will be available to the general public, including foreign nations.*

*This technical report has been reviewed and is approved for publication.*

TORSTEN M. RHODE, 1LT, USAF
Engineering & Design Data
Materials Engineering Branch
Systems Support Division

CLAYTON L. HARMSWORTH, Tech Mgr
Engineering & Design Data
Materials Engineering Branch
Systems Support Division

*FOR THE COMMANDER*

THEODORE J. REINHART, Chief
Materials Engineering Branch
Systems Support Division

*"If your address has changed, if you wish to be removed from our mailing list, or if the addressee is no longer employed by your organization please notify* AFWAL/MLSE *, W-PAFB, OH 45433 to help us maintain a current mailing list".*

*Copies of this report should not be returned unless return is required by security considerations, contractual obligations, or notice on a specific document.*

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE

AD-A176 727

## REPORT DOCUMENTATION PAGE

| | |
|---|---|
| 1a. REPORT SECURITY CLASSIFICATION<br>UNCLASSIFIED | 1b. RESTRICTIVE MARKINGS |
| 2a. SECURITY CLASSIFICATION AUTHORITY | 3. DISTRIBUTION/AVAILABILITY OF REPORT<br>Approved for public release; distribution unlimited. |
| 2b. DECLASSIFICATION/DOWNGRADING SCHEDULE | |
| 4. PERFORMING ORGANIZATION REPORT NUMBER(S)<br>AFWAL-TR-86-4100 | 5. MONITORING ORGANIZATION REPORT NUMBER(S) |
| 6a. NAME OF PERFORMING ORGANIZATION<br>Air Force Wright Aeronautical Laboratories/Materials Lab<br>6b. OFFICE SYMBOL (If applicable)<br>AFWAL/MLSE | 7a. NAME OF MONITORING ORGANIZATION |
| 6c. ADDRESS (City, State and ZIP Code)<br>Wright-Patterson AFB OH 45433-6533 | 7b. ADDRESS (City, State and ZIP Code) |
| 8a. NAME OF FUNDING/SPONSORING ORGANIZATION<br>8b. OFFICE SYMBOL (If applicable) | 9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER |
| 8c. ADDRESS (City, State and ZIP Code) | 10. SOURCE OF FUNDING NOS.<br>PROGRAM ELEMENT NO.: 62102F<br>PROJECT NO.: 2418<br>TASK NO.: 07<br>WORK UNIT NO.: 03 |
| 11. TITLE (Include Security Classification) Revision of Design Values for 7075-T7351 & 7075-T7651 Aluminum Plate | |
| 12. PERSONAL AUTHOR(S)<br>TORSTEN M. RHODE, 1LT, USAF | |
| 13a. TYPE OF REPORT<br>Final<br>13b. TIME COVERED<br>FROM Sep-Oct 84 TO Jun-Jul 85 | 14. DATE OF REPORT (Yr., Mo., Day)<br>Dec 86<br>15. PAGE COUNT<br>26 |
| 16. SUPPLEMENTARY NOTATION<br>Supplement to AFWAL-TR-83-4128 | |
| 17. COSATI CODES<br>FIELD / GROUP / SUB. GR. | 18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)<br>7075-T7351; 7075-T7651; Mechanical Properties; Shear Testing; Amsler Shear Tool |

19. ABSTRACT (Continue on reverse if necessary and identify by block number)


Basic mechanical property data were developed on 7075-T7651 aluminum plates. The data, consisting of tension, compression, bearing, and shear results, were needed to supplement the data base on the plate material and to allow the calculation of MIL-HDBK-5 design allowables. The bearing test results from this effort were compared to similar results recently published in AFWAL-TR-83-4128. The comparison showed there were significant differences which prompted the retesting of the samples from the reference work. The final analysis concluded the reference bearing data were erroneous.


| | | |
|---|---|---|
| 20. DISTRIBUTION/AVAILABILITY OF ABSTRACT<br>UNCLASSIFIED/UNLIMITED ☒ SAME AS RPT. ☐ DTIC USERS ☐ | 21. ABSTRACT SECURITY CLASSIFICATION<br>UNCLASSIFIED | |
| 22a. NAME OF RESPONSIBLE INDIVIDUAL<br>TORSTEN M. RHODE, 1LT, USAF | 22b. TELEPHONE NUMBER (Include Area Code)<br>(513)255-5128 | 22c. OFFICE SYMBOL<br>AFWAL/MLSE |

DD FORM 1473, 83 APR EDITION OF 1 JAN 73 IS OBSOLETE.

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE

# PREFACE

This report was prepared by the Materials Engineering Branch (AFWAL/MLSE), Systems Support Division, Materials Laboratory, Air Force Wright Aeronautical Laboratories, Wright-Patterson Air Force Base, Ohio, under Project 2418, "Aerospace Structural Materials," Task 241807, "Systems Support," Work Unit 24180703, "Engineering and Design Data."

This effort was conducted during the periods September - October 1984 and June - July 1985 by the author, 1Lt Torsten M. Rhode (AFWAL/MLSE). The report was released by the author in June 1986.

The author wishes to thank Ms. Dayle Pearson, University of Dayton Research Institute (UDRI), for her support in performing the pin bearing tests. He would also like to thank 1Lt Jon D. Tirpak for technical support. His report, AFWAL-TR-83-4128, "Revision of Design Values for 7075-T7351 and 7075-T7651 Aluminum Plate," is the sister work to this report.

TABLE OF CONTENTS

## LIST OF ILLUSTRATIONS



## LIST OF TABLES

# SECTION I

# BACKGROUND

Initial B-1 bomber design in the early 1970s specified the use of 7075-T7351 and -T7651 aluminum plate materials which were brought to guaranteed toughness levels in locations where damage tolerance is critical. Since that time, however, the Aluminum Association has supported a position that aluminum producers will guarantee fracture toughness only for a new generation of alloys processed specifically for improved fracture properties; the appropriate replacements for 7075 are 7175 and 7475, which are now used in production B-1B bombers. Both 7175 and 7475 have chemical make-ups almost identical to 7075 except that the impurity elements iron and silicon are lower in the new alloys.

Upon review of design values for the 7475 alloy, we noted that shear and bearing properties reported in MIL-HDBK-5 for 7475-T7351 and 7475-T7651 were lower than the corresponding values for 7075. We assumed that the statistical analysis techniques used to reduce the data might be the reason for the difference. The data for 7075 aluminum were generated in the late 1960s under less stringent statistical requirements than those now in effect. The 7475 allowables were approved in the late 1970s and were analyzed under the new guidelines requiring a larger number of different lots of material.

AFWAL-TR-83-4128, "Revision of Design Values for 7075-T7351 and 7075-T7651 Aluminum Plate," described the test program conducted to support the B-1 System Program Office. That report stated that additional heats of 7075-T7651 in varying thicknesses should be tested to better evaluate that material's characteristics for MIL-HDBK-5. This report (AFWAL-TR-86-4100) presents data from additional tensile, compressive, shear, and bearing tests performed on material supplied by Alcoa and Alcan in 1 3/4-inch and in 45mm and 50mm thicknesses.

In addition, in analyzing the data generated in this current effort, we found some inconsistencies in the data reported in AFWAL-TR-83-4128. The bearing values from this effort (AFWAL-TR-83-4128) were higher than those values obtained from testing the three additional plates. The difference was suspected to be the pin bearing test technique. The specimens evidently had not been allowed sufficient clearance in the fixture to freely deform, and were therefore binding in the grip area, causing the bearing values to be artificially high. Thus, all the bearing specimens tested for report AFWAL-TR-83-4128 were remachined to remove the torn out and deformed material, and new holes were machined into in the nonaffected zone of each specimen. This report contains retests of the same 7075-T7351 and -T7651 bearing specimens tested in the above report, along with the mechanical properties from the new plates of material.

The data generated in this program have been made available for further analysis and incorporation into MIL-HDBK-5.

# SECTION II

# TEST PROGRAM AND PROCEDURES

## 1. MATERIAL

Alcoa supplied one 1 3/4-inch-thick plate and Alcan supplied one 45mm- and one 50mm-thick plate of 7075-T7651 material for tension, compression, shear, and bearing testing. These plates had not been tested in the previous effort. The retested 7075-T7351 and -T7651 bearing specimens had originally been supplied by various companies from their in-house stock; Table I lists the companies and the plate thicknesses from which those specimens were machined.

## 2. SPECIMENS

Figure 1 shows specimen orientations as they were excised from the supplied plates. Specimen geometries are shown in Figures 2 - 5. Specimens taken from plates 1 1/2 inches thick or less were removed from the center thickness location, while specimens taken from thicker plates were removed from the one-quarter thickness location as specified by ASTM Standard B557, "Tension Testing Wrought and Cast Aluminum- and Magnesium-Alloy Products."

Bearing specimens that were retested from the previous program had the original test hole and associated deformed material removed before new holes were bored. The resulting specimens were shorter, but they were still valid according to ASTM Standard E238, "Pin-Type Bearing Test of Metallic Materials."

## 3. TEST PROCEDURES

Tensile tests were performed in a 20,000-lb capacity Instron Model 1125 tensile testing machine. A 1/2-inch Instron extensometer was used on the short tensile specimens while a 1-inch Instron extensometer was used on the round tensile specimens to measure strain. ASTM Standard E8, "Tension Testing of Metallic Materials," was followed.

Compression testing followed ASTM Standard E9, "Compression Testing of Metallic Materials at Room Temperature." The specimens, placed in a Satec compression subpress to insure axial loading, were also tested on the 20,000-lb Instron machine. A 1/2-inch MTS extensometer was used to measure strain.

The 20,000-lb Instron machine was also used to conduct shear tests. No standard presently exists governing shear testing, but several guidelines were followed to ensure accurate results. The Amsler Double Shear Tool (Figure 6) was used to determine shear strengths because of its greater rigidity as compared to other commonly used devices. The Amsler tool generally gives shear strengths which are about 10% higher than those obtained with other tools and provides a more realistic value of a material's shear strength [1]. Also, the ends of the specimens were scribed with lines indicating "L" or "L-T" orientations and the specimens were tested with the load coincident with the scribe line. Kaufman and Davies showed that shear strengths can be as much as 9 per cent higher when specimens were loaded coincident with the scribe lines than if they were loaded perpendicular to the lines [1].

Bearing tests, conducted on the Instron machine, followed ASTM Standard E238, "Pin-Type Bearing Test of Metallic Materials." Two edge distance ratios were tested, e/D = 1.5 and e/D = 2.0. "Clean pin" procedures were followed as outlined in ASTM Standard E238.

All tests were performed at room temperature in laboratory air at 20 - 30 per cent relative humidity.

---

[1] Kaufman, J.G., and Davies, R.E., "Effects of Test Method and Specimen Orientation on Shear Strengths of Aluminum Alloys." Proceedings, Vol. 64, American Society for Testing and Materials.

# SECTION III

# RESULTS AND DISCUSSION

Tensile strength, compression strength, and shear and bearing strengths are reported in Table II for the previously untested 7075-T7651 material.

Shear strengths for the 7075-T7651 material for the 1 3/4-inch plate thickness were compared to those generated in the previous effort. "L"-orientation shear strengths were 6 to 10 KSI higher in this program than the strengths reported in the earlier effort. This could be due to the greater stiffness of the Amsler Shear Tool over the rivet shear tool used before, or the orientation of the shear specimens, or both.

Bearing strengths in Table III (for 7075-T7651) and Table IV (for 7075-T7351) are the retested values for those specimens.

Retests of the 7075-T7351 specimens showed bearing strengths that were markedly lower than those obtained previously. This is probably due to the test technique. It is possible the specimens originally had been clamped too tightly in the bearing test grips so that the deformation of the specimen inhibited its movement in the grips. The retests were run so that the specimen had sufficient clearance to deform, but did not have enough clearance to violate ASTM Standard E238.

# SECTION IV

# CONCLUSIONS

These values will be incorporated into MIL-HDBK-5 and will represent the first time that "A" and "B" design values will be presented for these heat treatments of these materials.

The Amsler Double Shear Tool provided data with very little scatter; the amount of bending inherent in other shear test fixtures is greatly reduced by this fixture. The wide variances in data that are possible due to specimen orientation, the fixture used, and other factors dictate that a standard for shear testing be developed. The results of this test program indicate that the Amsler Double Shear Tool be the fixture specified due to its inherent stiffness.

The side clearance has proven critical for pin bearing data, and care should be used to allow sufficient space for specimen deformation between the parallel plates of the grip, but not enough space should be left to allow bending of the loading pin. It would be desirable for the ASTM pin bearing specification to address this issue on a quantitative basis.

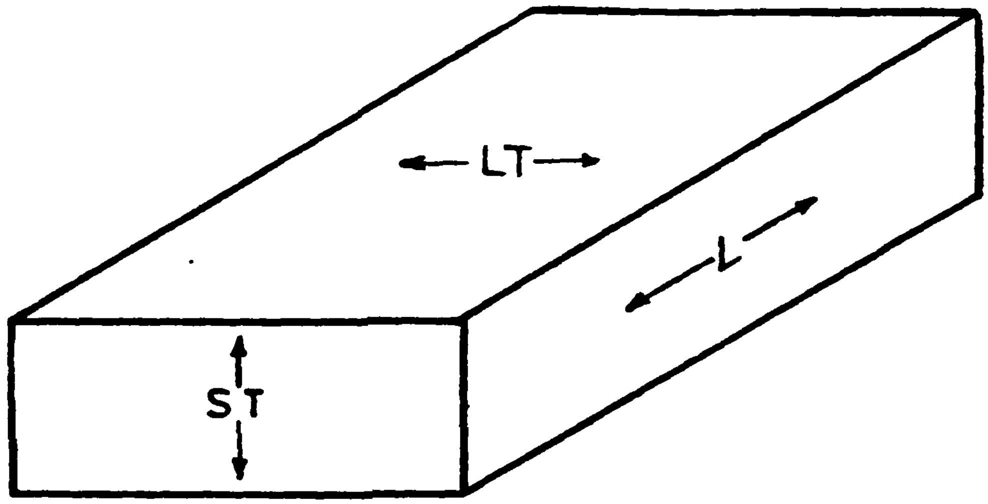



Figure 1. Specimen Orientation Diagram. L is the Rolling Direction.

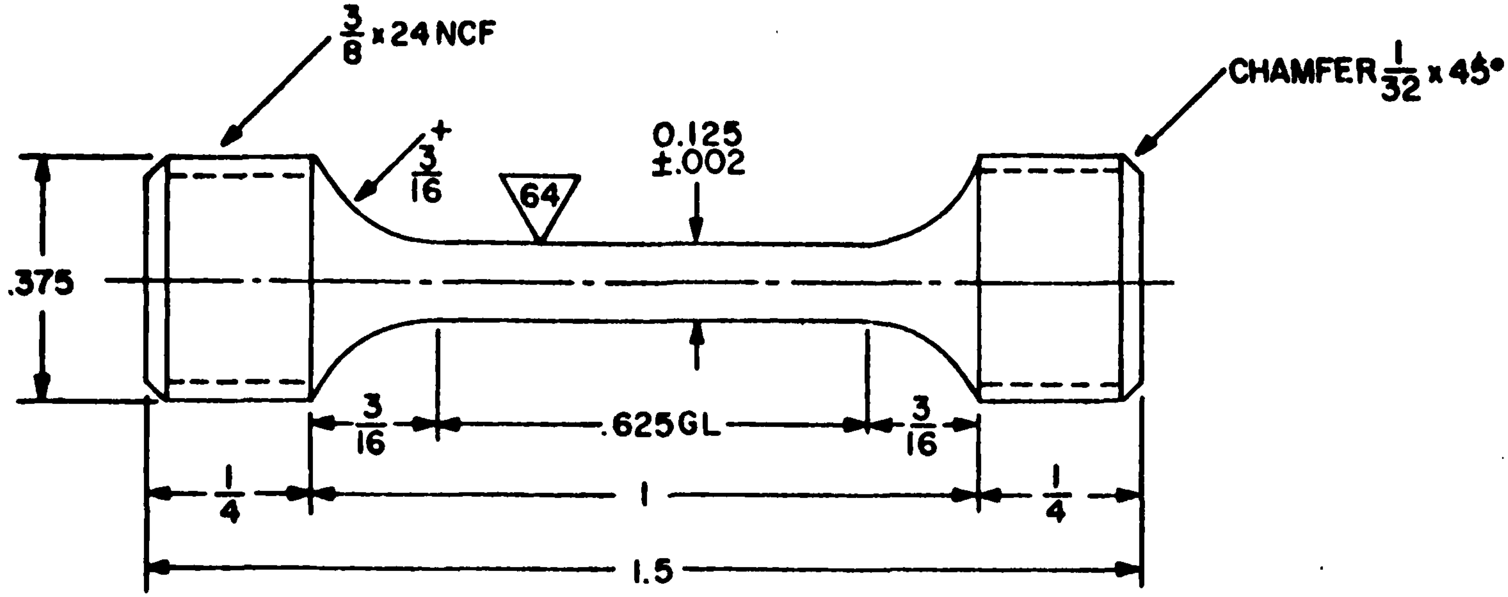



Figure 2. Short Tensile Specimen (in).

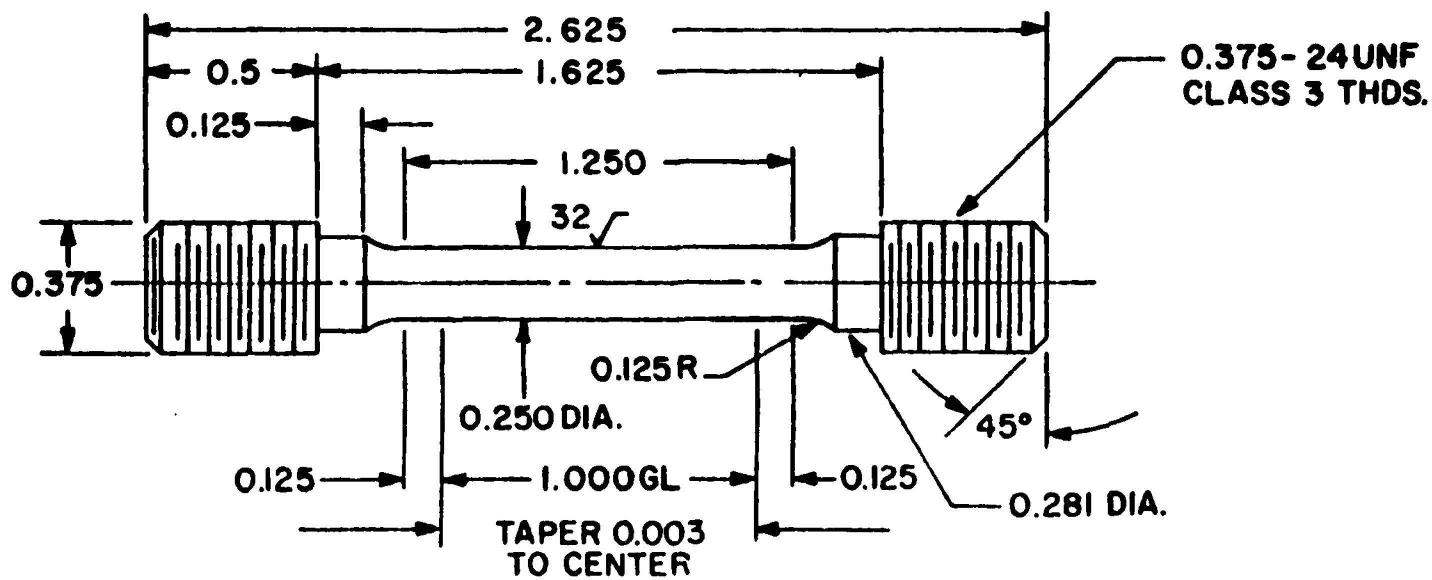
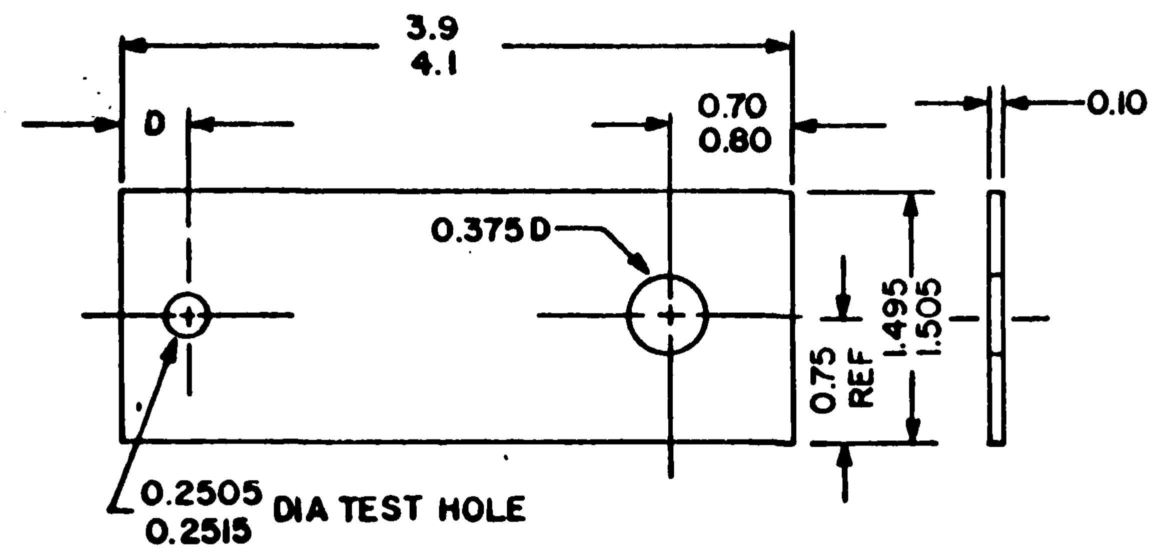



Figure 3. Round Tensile Specimen (in).




| SIZE | D |
| --- | --- |
| 1½ | 0.375 |
| 2 | 0.500 |

FIGURE 4. Bearing Specimen (in)

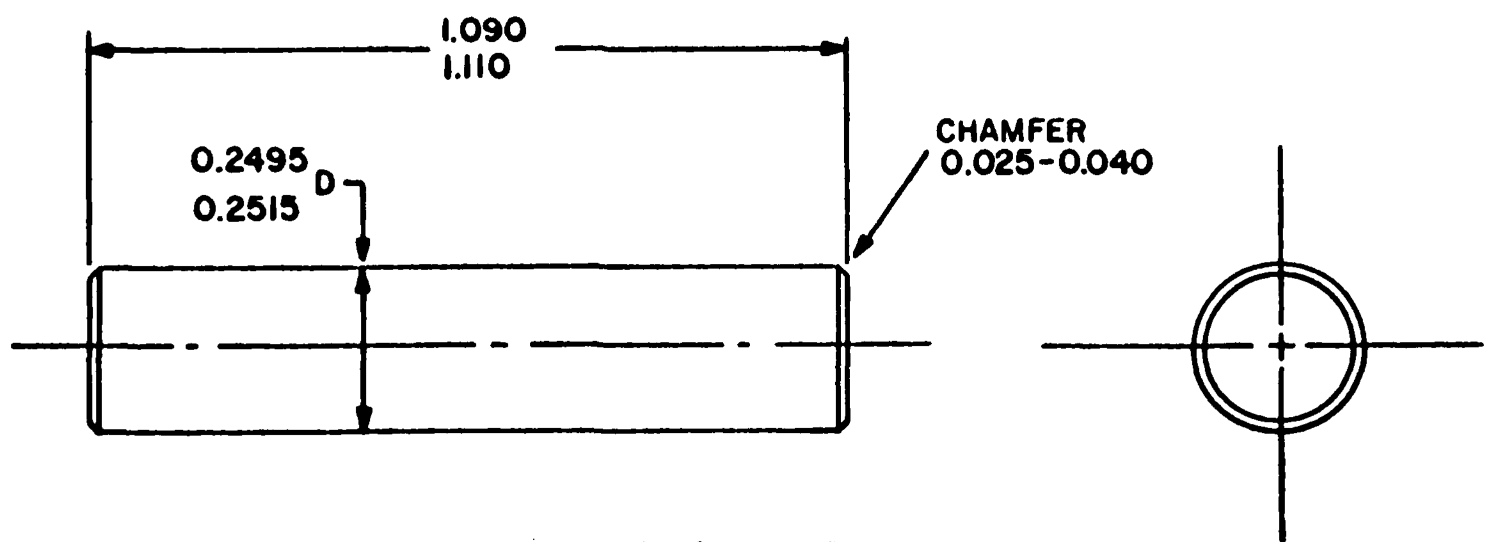



Figure 5. Shear Specimens (in)

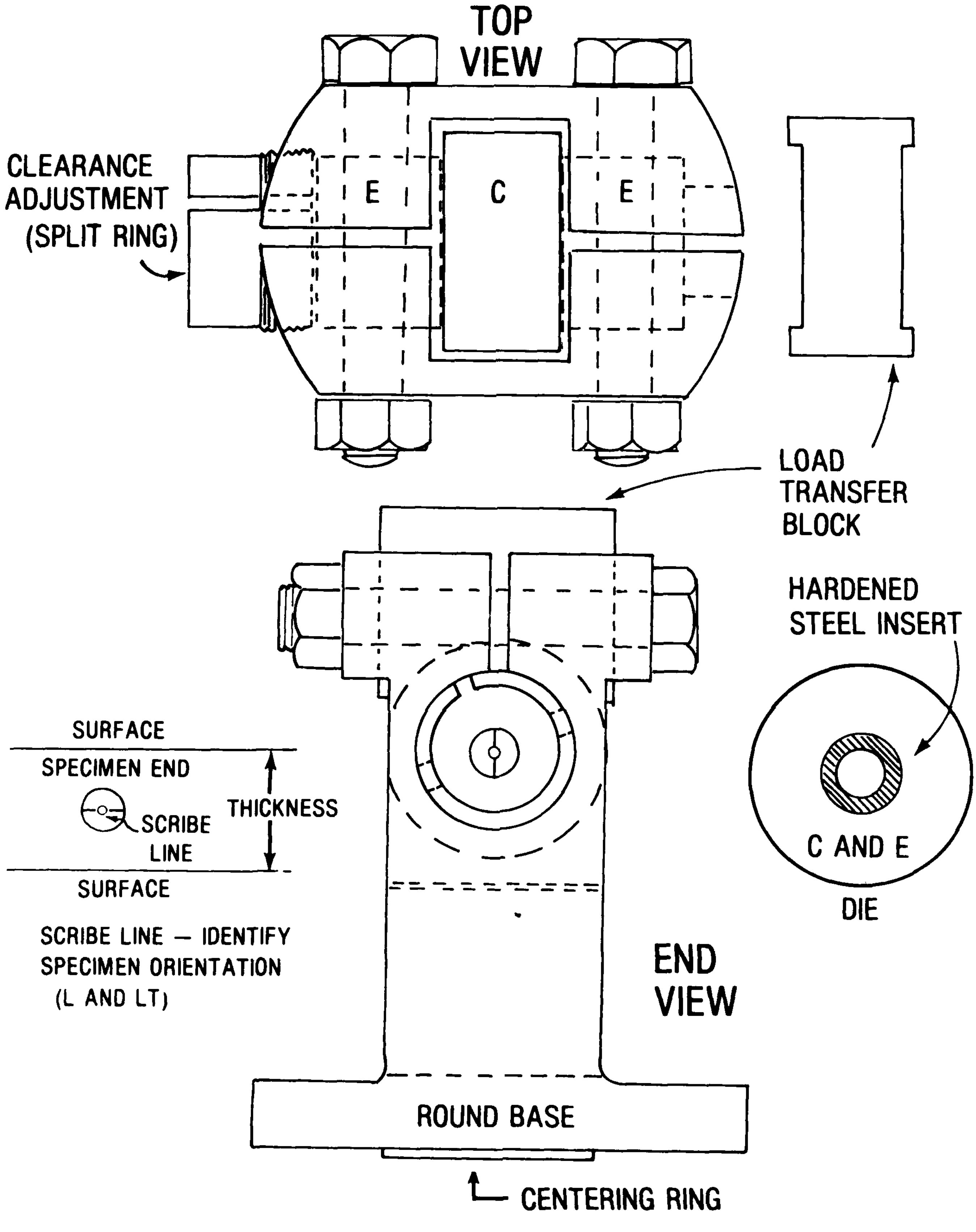



FIGURE 6 AMSLER SHEAR TOOL

TABLE I

7075-T7351 AND -T7651 TEST PROGRAM

| Plate Thickness (in) | Heat Treatment | Supplier |
|---|---|---|
| 0.375 | T7351 | Lockheed-Georgia |
| 0.500 | T7351 | Lockheed-Georgia |
| 0.500 | T7351* | Lockheed-California |
| 0.625 | T7351 | Lockheed-Georgia |
| 0.875 | T7351 | Lockheed-Georgia |
| 1.000 | T7351 | Lockheed-Georgia |
| 1.250 | T7351* | General Dynamics |
| 1.500 | T7351 | Lockheed-Georgia |
| 1.500 | T7351* | Sikorsky |
| 1.750 | T7351* | Sikorsky |
| 1.750 | T7651 | McDonnell-Douglas |
| 1.750 | T7651 | Alcoa |
| 1.750 (45 mm) | T7651 | Alcan |
| 2.000 (50 mm) | T7651 | Alcan |
| 2.000 | T7351 | Alcoa |
| 2.250 | T7351 | Alcoa |
| 2.250 | T7651 | Lockheed-California |
| 2.500 | T7351 | McDonnell-Douglas |
| 3.000 | T7351 | Alcoa |

*Reheat treated from T7651 condition to designated heat treatment.

TABLE II
MECHANICAL PROPERTIES OF 7075-T7651 PLATE

| Nominal Thickness | Grain Direction | Tensile | | | Compressive | Shear | Bearing e/D = 1.5 | | Bearing e/D = 2.0 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Ultimate (ksi) | Yield (ksi) | Elongation % | Yield (ksi) | Ultimate (ksi) | Yield (ksi) | Ultimate (ksi) | Yield (ksi) | Ultimate (ksi) |
| 50mm (2") | L | | | | | 47.7 | 89.8 | 108.4 | 104.6 | 140.4 |
| | L | | | | | 48.8 | 94.2 | 108.6 | 102.2 | 139.4 |
| | Avg. | | | | | 48.3 | 92.0 | 108.5 | 103.4 | 139.9 |
| | LT | 71.6 | 60.1 | 9.4 | | 46.7 | 92.6 | 108.4 | 104.4 | 145.0 |
| | LT | 72.1 | 61.2 | 8.2 | | 47.5 | 90.6 | 109.3 | 108.7 | 147.2 |
| | Avg. | 71.8 | 60.7 | 8.8 | | 47.1 | 91.6 | 108.8 | 106.5 | 146.1 |
| | ST | 68.2 | 56.5 | 4.1 | 66.7 | | | | | |
| | ST | | | | 66.6 | | | | | |
| | Avg. | 68.2 | 56.5 | 4.1 | 66.7 | | | | | |

TABLE II - Continued
MECHANICAL PROPERTIES OF 7075-T7651 PLATE

| Nominal Thickness (in) | Grain Direction | Tensile Ultimate (ksi) | Tensile Yield (ksi) | Tensile Elongation % | Compressive Yield (ksi) | Shear Ultimate (ksi) | Bearing e/D = 1.5 Yield (ksi) | Bearing e/D = 1.5 Ultimate (ksi) | Bearing e/D = 2.0 Yield (ksi) | Bearing e/D = 2.0 Ultimate (ksi) |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 3/4" | L | | | | | 52.0 | 102.4 | 122.1 | 120.5 | 155.8 |
| | L | | | | | 51.9 | 113.8 | 124.7 | | 157.6 |
| | Avg. | | | | | 52.0 | 108.1 | 123.4 | 120.5 | 156.7 |
| | LT | 77.5 | 67.8 | 9.9 | | 52.5 | 98.8 | 122.7 | 114.2 | 156.8 |
| | LT | 77.3 | 67.3 | 10.2 | | 52.5 | 105.6 | 124.1 | 113.6 | 157.2 |
| | Avg. | 77.4 | 67.6 | 10.1 | | 52.5 | 102.2 | 123.4 | 113.9 | 157.0 |
| | ST | 68.5 | 60.4 | 2.1 | 80.5 | | | | | |
| | ST | 73.4 | 63.1 | 4.8 | 74.9 | | | | | |
| | Avg. | 71.0 | 61.8 | 3.5 | 77.7 | | | | | |
| 45mm (1 3/4") | L | | | | | 48.2 | 87.8 | 105.5 | 105.6 | 139.6 |
| | L | | | | | 48.5 | 90.5 | 111.5 | 95.4 | 142.8 |
| | Avg. | | | | | 48.4 | 89.1 | 108.5 | 100.5 | 141.2 |
| | LT | 70.7 | 59.9 | 11.7 | | 45.4 | 91.2 | 111.5 | 104.9 | 137.9 |
| | LT | 71.1 | 59.9 | 13.5 | | 48.7 | 85.8 | 107.7 | 105.6 | 140.0 |
| | Avg. | 70.9 | 59.9 | 12.6 | | 47.1 | 88.5 | 109.6 | 105.2 | 138.9 |
| | ST | 69.1 | 57.6 | 4.3 | 68.0 | | | | | |
| | ST | 68.8 | 57.1 | 4.9 | 68.7 | | | | | |
| | Avg. | 69.0 | 57.4 | 4.6 | 68.3 | | | | | |

TABLE III

BEARING VALUES FOR 7075-T7651 PLATE MATERIAL

| Nominal Thickness (in) | Grain Direction | Bearing e/D = 1.5 Yield (ksi) | Bearing e/D = 1.5 Ultimate (ksi) | Bearing e/D = 2.0 Yield (ksi) | Bearing e/D = 2.0 Ultimate (ksi) |
|---|---|---|---|---|---|
| 2.25 | L | 93.28 | 112.31 | 102.03 | 147.50 |
| | L | 92.04 | 112.22 | 107.16 | 148.09 |
| | Avg. | 92.66 | 112.27 | 104.60 | 147.80 |
| | LT | 91.83 | 115.70 | 105.40 | 151.15 |
| | LT | 91.83 | 112.95 | -- | 150.94 |
| | Avg. | 91.83 | 114.33 | 105.40 | 151.05 |
| 1.75 | L | 92.80 | 116.00 | 111.13 | 156.37 |
| | L | 92.59 | 115.10 | 110.49 | 153.37 |
| | Avg. | 92.70 | 115.55 | 110.81 | 154.87 |
| | L | 92.99 | 116.24 | 107.56 | 149.63 |
| | L | 96.04 | 117.24 | 106.67 | 153.89 |
| | Avg. | 94.52 | 116.74 | 107.12 | 151.76 |

NOTE: These specimens were re-machined and re-tested after values were reported in AFWAL-TR-83-4128.

TABLE IV

BEARING VALUES FOR 7075-T7351 PLATE MATERIAL

| Nominal Thickness (in) | Grain Direction | Bearing e/D = 1.5 Yield (ksi) | Bearing e/D = 1.5 Ultimate (ksi) | Bearing e/D = 2.0 Yield (ksi) | Bearing e/D = 2.0 Ultimate (ksi) |
|---|---|---|---|---|---|
| 3.0 | L | 78.07 | 105.95 | -- | -- |
| | L | 86.72 | 106.09 | 91.89 | 139.43 |
| | Avg. | 82.39 | 106.02 | 91.89 | 139.43 |
| | LT | 81.53 | 108.58 | 93.68 | 140.33 |
| | LT | 77.41 | 108.52 | -- | 137.97 |
| | Avg. | 79.47 | 108.55 | 93.68 | 139.15 |
| 2.5 | L | 86.75 | 109.70 | 87.82 | 143.82 |
| | L | 82.64 | 108.30 | 91.33 | 140.41 |
| | Avg. | 84.70 | 109.00 | 89.57 | 142.11 |
| | LT | 82.18 | 109.09 | 103.56 | 145.51 |
| | LT | -- | 110.11 | 98.53 | 143.38 |
| | Avg. | 82.18 | 109.60 | 101.04 | 144.44 |
| 2.25 | L | 94.83 | 114.39 | 107.43 | 146.28 |
| | L | 86.80 | 110.22 | -- | 142.41 |
| | Avg. | 90.82 | 112.31 | 107.43 | 144.34 |
| | LT | 83.27 | 113.38 | 86.11 | 141.11 |
| | LT | 85.17 | 111.79 | 97.22 | 146.11 |
| | Avg. | 84.22 | 112.58 | 91.67 | 143.61 |
| 2.0 | L | 84.63 | 113.89 | 89.02 | 147.35 |
| | L | -- | 111.11 | 73.05 | 146.10 |
| | Avg. | 84.63 | 112.50 | 81.03 | 146.72 |
| | LT | 80.15 | 112.36 | 93.42 | 145.68 |
| | LT | 92.35 | 113.81 | -- | 144.17 |
| | Avg. | 86.25 | 113.08 | 93.42 | 144.92 |

NOTE: These specimens were re-machined and re-tested after values were reported in AFWAL-TR-83-4128.

TABLE IV - Continued

BEARING VALUES FOR 7075-T7351 PLATE MATERIAL

| Nominal Thickness (in) | Grain Direction | Bearing e/D = 1.5 Yield (ksi) | e/D = 1.5 Ultimate (ksi) | e/D = 2.0 Yield (ksi) | e/D = 2.0 Ultimate (ksi) |
|---|---|---|---|---|---|
| 1.75 | L | 91.04 | 115.11 | 89.81 | 146.67 |
| | L | 96.34 | 114.47 | 106.04 | 146.89 |
| Re-heat treated from -T7651 | Avg. | 93.69 | 114.79 | 97.93 | 146.78 |
| | LT | 78.33 | 116.11 | 94.80 | 147.40 |
| | LT | -- | 113.06 | -- | 143.89 |
| | Avg. | 78.33 | 114.59 | 94.80 | 145.64 |
| 1.5 | L | 78.44 | 107.43 | 91.30 | 137.96 |
| | L | 84.76 | 104.46 | 87.13 | 136.19 |
| Re-heat treated from -T7651 | Avg. | 81.60 | 105.95 | 89.21 | 137.08 |
| | LT | 81.53 | 105.22 | 62.73 | 138.75 |
| | LT | 81.70 | 104.91 | -- | 140.19 |
| | Avg. | 81.61 | 105.06 | 62.73 | 139.47 |
| 1.5 | L | 92.42 | 109.09 | 92.35 | 142.16 |
| | L | 90.96 | 108.30 | 95.71 | 142.35 |
| | Avg. | 91.69 | 108.70 | 94.03 | 142.26 |
| | LT | 83.33 | 106.04 | -- | 141.14 |
| | LT | 76.87 | 107.46 | 94.10 | 142.07 |
| | Avg. | 80.10 | 106.75 | 94.10 | 141.61 |
| 1.25 | L | 71.84 | 102.30 | 82.40 | 131.65 |
| | L | 81.03 | 105.56 | -- | 132.96 |
| | Avg. | 76.44 | 103.93 | 82.40 | 132.31 |
| | LT | 73.86 | 102.27 | 92.62 | 132.29 |
| | LT | 86.92 | 104.42 | 82.41 | 132.96 |
| | Avg. | 80.39 | 103.35 | 87.51 | 132.63 |

NOTE: These specimens were re-machined and re-tested after values were reported in AFWAL-TR-83-4128.

TABLE IV - Continued

BEARING VALUES FOR 7075-T7351 PLATE MATERIAL

| Nominal Thickness (in) | Grain Direction | Bearing e/D = 1.5 Yield (ksi) | Bearing e/D = 1.5 Ultimate (ksi) | Bearing e/D = 2.0 Yield (ksi) | Bearing e/D = 2.0 Ultimate (ksi) |
|---|---|---|---|---|---|
| 1.0 | L | 83.15 | 109.74 | 95.94 | 140.41 |
| | L | 90.30 | 109.70 | 88.68 | 143.02 |
| | Avg. | 86.73 | 109.72 | 92.31 | 141.71 |
| | LT | 89.93 | 107.84 | 96.67 | 142.41 |
| | LT | 81.04 | 106.51 | -- | 139.19 |
| | Avg. | 85.48 | 107.17 | 96.67 | 140.80 |
| 0.875 | L | 85.32 | 102.97 | 88.49 | 136.23 |
| | L | 75.46 | 102.60 | 93.89 | 134.44 |
| | Avg. | 80.39 | 102.79 | 91.19 | 135.34 |
| | LT | 74.06 | 103.20 | 65.06 | 134.94 |
| | LT | 79.70 | 99.45 | 88.79 | 134.38 |
| | Avg. | 76.88 | 101.32 | 76.92 | 134.66 |
| 0.625 | L | 78.30 | 107.36 | 94.83 | 145.21 |
| | L | 83.98 | 111.97 | 95.12 | 148.44 |
| | Avg. | 81.14 | 109.66 | 94.97 | 146.82 |
| | LT | 80.83 | 109.21 | 70.55 | 133.45 |
| | LT | 86.91 | 107.64 | 73.26 | 139.56 |
| | Avg. | 83.87 | 108.42 | 71.90 | 136.51 |
| 0.5 | L | 86.89 | 106.55 | 82.78 | 139.26 |
| | L | 77.36 | 106.23 | 74.44 | 135.00 |
| | Avg. | 82.12 | 106.39 | 78.61 | 137.13 |
| | LT | 89.22 | 107.43 | 85.85 | 137.50 |
| | LT | 86.98 | 107.55 | 94.81 | 141.48 |
| | Avg. | 88.10 | 107.49 | 90.33 | 139.49 |

NOTE: These specimens were re-machined and re-tested after values were reported in AFWAL-TR-83-4128.

## TABLE IV - Continued

## BEARING VALUES FOR 7075-T7351 PLATE MATERIAL

| Nominal Thickness (in) | Grain Direction | Bearing e/D = 1.5 Yield (ksi) | Bearing e/D = 1.5 Ultimate (ksi) | Bearing e/D = 2.0 Yield (ksi) | Bearing e/D = 2.0 Ultimate (ksi) |
|---|---|---|---|---|---|
| 0.5 | L | 83.52 | 107.78 | 95.86 | 146.24 |
| | L | 83.02 | 109.70 | 98.88 | 145.13 |
| | Avg. | 83.27 | 108.74 | 97.37 | 145.69 |
| | LT | 93.31 | 113.01 | 84.87 | 143.36 |
| | LT | 90.84 | 110.99 | 97.57 | 139.74 |
| | Avg. | 92.08 | 112.00 | 91.22 | 141.55 |
| 0.375 | L | 95.20 | 116.61 | 107.27 | 152.00 |
| | L | 86.63 | 114.47 | 97.27 | 144.55 |
| | Avg. | 90.92 | 115.54 | 102.27 | 148.27 |
| | LT | 84.56 | 110.85 | 92.86 | 148.31 |
| | LT | 91.06 | 114.05 | -- | 147.06 |
| | Avg. | 87.81 | 112.45 | 92.86 | 147.68 |

NOTE: These specimens were re-machined and re-tested after values were reported in AFWAL-TR-83-3128.



U.S.Government Printing Office: 1987 — 748-061/60625