1.0

4.5
5.0
5.6
6.3

2.8

2.5

1.1

3.2

3.6

4.0

2.2

2.0

1.8

1.25

1.4

1.6

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

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HEADQUARTERS

OGDEN AIR LOGISTICS CENTER

UNITED STATES AIR FORCE

HILL AIR FORCE BASE, UTAH 84406

PROPELLANT
SURVEILLANCE REPORT
LGM-30A, B, F&G STAGE 1
TP-H 1043

PROPELLANT LAB. SECTION

MANCP REPORT

NR 385(77)

DECEMBER 1977

APPROVED FOR PUBLIC RELEASE, DISTRIBUTION UNLIMITED

PROPELLANT SURVEILLANCE REPORT

LGM-30 A, B, F & G STAGE I

TP-H1043 AFT CLOSURE PROPELLANT

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December 1977

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United States Air Force
Hill Air Force Base, Utah 84406

(See 1473)

ACCESSION for

RHS	White Section ☑
DOC	Buff Section ☐
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ABSTRACT

This report contains propellant test results from cartons of
TP-H1043 propellant representing selected batches used in the aft
closure of First Stage Minuteman Motors. Data from TP-H1043
propellant obtained from the aft closures of the LGM-30A, B, F and
G Motors are reported in regression analyses for the fourth time
and the third time using the GO85 computer system. Testing was
accomplished in accordance with MMWRME Project M82937C and M82938C.

An analysis of all parameters indicate that no significant
degradation is anticipated for at least two years past the oldest
data point.

Each point on the regression plot represents all samples at
that particular age. The number of samples at each point is
indicated on the sample size summary sheet on the page accompanying
each regression plot. The data range at any age can be found by
suitable inquiry of the GO85 system.

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LIST OF REFERENCES

Report Nr	Title	Report Date
	LGM-30 First Stage, Wing I Test Reports	
29D	Zero Time Test Results (Aft Closure)	9 Jun 64
29E	Zero Time (Aft Closure Supplement 1)	24 Jun 64
32B	Zero Time, Wings II-V Test Results (Aft Closure)	18 Mar 65
185	ATP Phase I, Wing VI Series III	Jun 70
195	ATP Phase III, Wing II-V	Nov 70
239	Propellant Surveillance Report (TP-H1043)	Apr 72
288	Propellant Surveillance Report (TP-H1043)	Mar 74
337	Propellant Surveillance Report (TP-H1043)	Feb 76

GLOSSARY OF TERMS AND ABBREVIATIONS

Aging Trend	A change in properties or performance resulting from aging of material or component
CSA	Cross Sectional Area
DB	Dogbone
Degradation	Gradual deterioration of properties or performance
E	Modulus (psi), defined as stress divided by strain along the initial linear portion of the curve
EB	End Bonded
EGL	Effective Gage Length
em	Strain at maximum stress
er	Strain at rupture
"F" ratio	The ratio of the variance accounted for by the regression function to the random unexplained variance. The regression function having the most significant "F" ratio is used for plotting data. The ratio is also used in detecting significant changes in random variation between succeeding time points.
JANNAF	Joint Army, Navy, NASA, Air Force Committee
MAGCP	Propellant Lab Section at OOAMA
OOAMA	Ogden Air Materiel Area, Air Force Logistics Command
Regression Equation	The general form of the regression equation is $Y = a + bx$
Regression Line	Line representing mean test values with respect to time
S_b	Standard error of estimate of the regression coefficient
S_e or $S_{Y.X}$	Standard deviation of the data about the regression line

SM	Maximum Stress
Sr	Stress at rupture
Standard Deviation(S)	Square root of variance
Strain Rate	Crosshead speed divided by the EGL
"t" test	A statistical test used to detect significant differences between a measured parameter and an expected value of the parameter (determines if regression slope differs from zero at the 95% confidence level)
Variance	The sum of squares of deviations of the test results from the mean of the series after division by one less than the total number of test results
3 Sigma Band	The area between the upper and lower 3 sigma limit. It can be expected that 99.73% of the inventory represented by the test samples would fall within this range assuming that the population is normally distributed.
90-90 Band	It can be stated with 90% confidence that 90% of the inventory represented by the test samples would fall within this range assuming that the population is normally distributed.

INTRODUCTION

A. PURPOSE:

Quality assurance tests have been conducted for 10 1/2 years on First Stage LGM-30 TP-H1043 aft closure propellant.

Statistical analysis of the tests performed, as directed by Engineering, should provide early warning if serious degradation trends occur. Evaluation of the propellant provides data that can be put directly into engineering reliability and service life predictions. Testing was performed in accordance with MMWRME Directive GTD-1C, Amendments 1 and 2.

B. BACKGROUND:

TP-H1043 propellant is used in the aft closure of LGM-30A, B, F and G First Stage Motors.

This test period represents the fourth time that TP-H1043 propellant has been reported by regression analysis. This is also the third time that data has been processed utilizing the GO85 system.

This report represents a large increase in the number of samples tested. Moreover, the age distribution increased to cover a 10 1/2 year time period (4 to 14 1/2 years).

The slope of the respective regressions for this report (Figures 1 thru 14) and the previous report (1976) are very close. This is the first time that the regression slopes of two successive test periods matched well. This is probably due to the increased number of samples and the stabilizing of post cure chemical changes in the binder.

C. SAMPLING PLAN:

As many as four aft closures are cast from the one TP-H1043
propellant mix. In order to reduce the number of tests, only one
batch from each mix will be tested to obtain uniform test results.
The selected batches are from the same batch as those previously
tested and reported in MAGCP Reports 185(70), 195(70), 239(72),
and 288(74).

Low rate tensile, high rate tensile and hardness tests were
performed on each propellant batch mix.

D. STATISTICAL APPROACH:

Linear regression analysis was used as the method of data
evaluation. Data from different time periods were used to establish
a least squares trend line for the data. The variance about the
regression line, obtained using individual values of the dependent
variable, was used to compute a tolerance interval such that at
the 90% confidence level, 90% of the sample distribution fall within
this interval. This tolerance interval was extrapolated to a
maximum of 24 months. The "t" values and the significance of this
statistic, which are reported for each regression model, give an
indication of the "statistical significance" of the slope of the
trend line as compared to a line of zero slope.

Each point on the regression analysis is a calculation of all
samples at that particular age. The number of samples at each point
is indicated on the sample size summary sheet accompanying each
regression plot. The data range at any age can be found by suitable
inquiry of the GO85 system.

SECTION II

TEST RESULTS

A. LOW RATE TENSILE:

All of the low rate test parameters show a statistically
significant decrease (Figures 1 thru 5). The strain regressions
(Figures 1 and 3) show a very gradual decrease. Regression slopes
for stresses and modulus (Figures 2, 4 and 5) show a change with
respect to time. This change is less than in the previous report.
Although all of the regression trends show a decrease, the propellant
still shows good stability and from this analysis the propellant
will perform satisfactorily for at least two years beyond the last
data point.

B. HIGH RATE TENSILE:

The strain and stress regressions show a statistically significant
decrease with the modulus showing a statistically significant
increase (Figures 6 thru 10). For all of the regressions, the slopes
are gradual.

C. HARDNESS:

Shore A and C initial hardness test data regressions show a
statistically significant gradual decrease and the 10 second test
data regression shows no significant change.

SECTION III

CONCLUSIONS AND RECOMMENDATIONS

The slopes of the regressions are gradual and closer to a line
of zero slope than in the previous report. From this analysis, no
significant degradation seems likely and the propellant service
life may be extended for at least two years from the date of
last testing.

It is recommended that testing be continued to assure service
life extension and confirm the present trend.

AGE (MONTHS)	NR SAMPLES	AGE (MONTHS)	NR SAMPLES	AGE (MONTHS)	NR SAMPLES	AGE (MONTHS)	NR SAMPLES
57.0	3	93.0	54	119.0	3	146.0	18
59.0	9	94.0	93	120.0	15	147.0	6
60.0	3	95.0	33	121.0	21	148.0	15
61.0	6	96.0	27	122.0	3	149.0	9
62.0	9	97.0	3	123.0	12	150.0	5
63.0	6	98.0	3	124.0	9	151.0	3
64.0	3	99.0	6	126.0	6	152.0	12
65.0	6	101.0	6	127.0	3	154.0	6
66.0	9	102.0	9	128.0	12	155.0	5
67.0	6	103.0	9	130.0	6	156.0	9
69.0	3	104.0	3	131.0	6	157.0	12
70.0	5	105.0	6	132.0	9	158.0	12
80.0	3	106.0	6	133.0	12	159.0	8
81.0	12	107.0	21	134.0	12	160.0	6
82.0	9	108.0	33	135.0	6	161.0	12
83.0	15	109.0	33	136.0	9	162.0	9
84.0	39	110.0	27	137.0	12	163.0	6
85.0	28	111.0	33	138.0	12	164.0	9
86.0	29	112.0	27	139.0	9	165.0	9
87.0	33	113.0	33	140.0	12	166.0	12
88.0	30	114.0	26	141.0	12	167.0	17
89.0	56	115.0	15	142.0	12	168.0	9
90.0	67	116.0	12	143.0	17	169.0	10
91.0	151	117.0	9	144.0	9	170.0	12
92.0	144	118.0	23	145.0	15	171.0	3
						172.0	12
						173.0	9

TENSILE STRAIN AT MAX STRESS (EM),CHS=2.0 IN/MIN,TP-H1043,WING 2&6

This sample size summary applies to Figures 1 thru 5

$$Y = ((+1.5199155E-01) + (-8.0246401E-05) \times X)$$

F = +1.3332441E+01   SIGNIFICANCE OF F = SIGNIFICANT σ_1 = +2.4943902E-02
R = -8.7450990E-02   SIGNIFICANCE OF R = SIGNIFICANT S_0 = +2.1977117E-05
t = +3.6513615E+00   SIGNIFICANCE OF t = SIGNIFICANT S_E = +2.4855518E-02
N = 1732   DEGREES OF FREEDOM = 1730

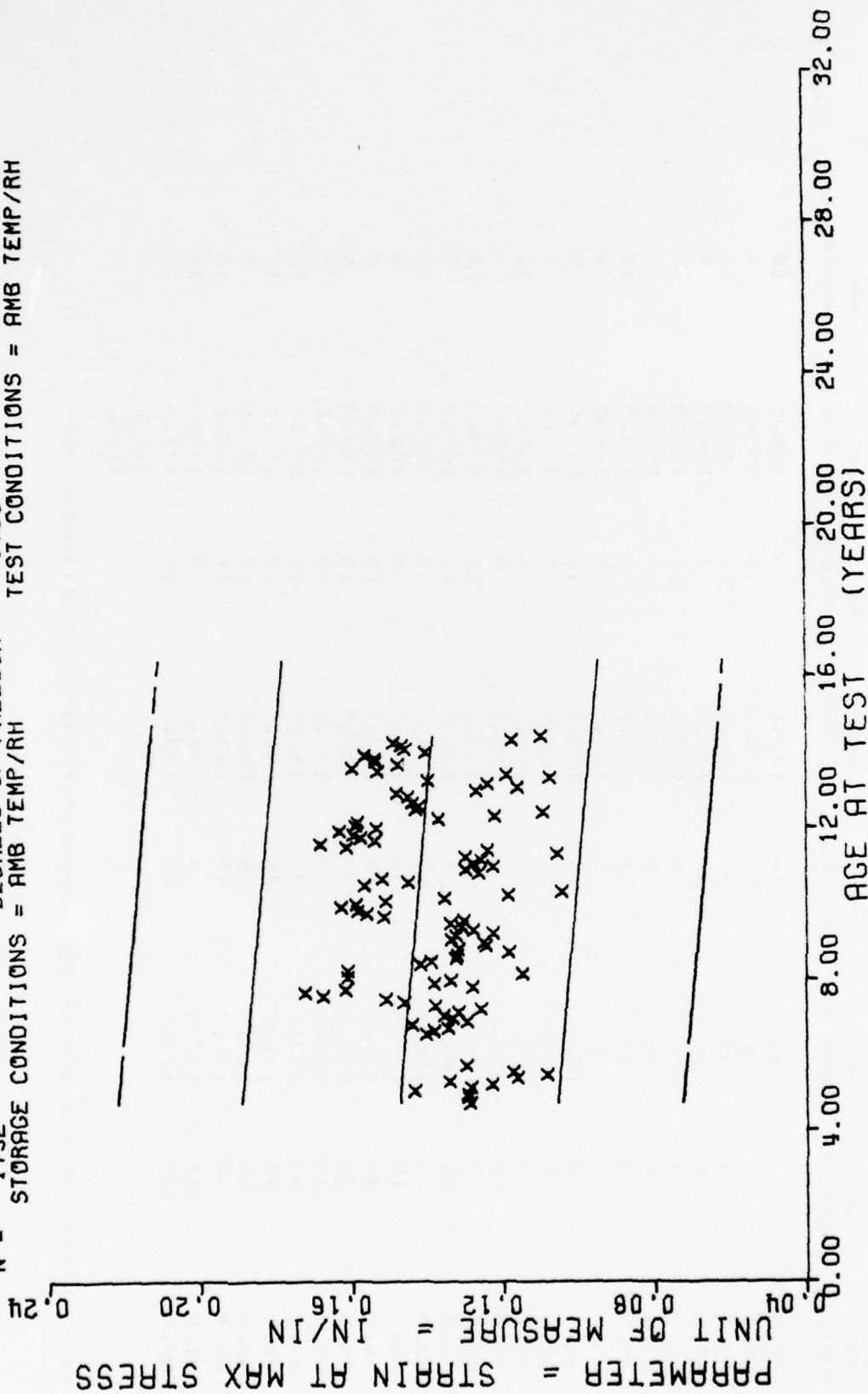STORAGE CONDITIONS = AMB TEMP/RH   TEST CONDITIONS = AMB TEMP/RH

PARAMETER = STRAIN AT MAX STRESS

UNIT OF MEASURE = IN/IN

AGE AT TEST (YEARS)

TENSILE STRAIN AT MAX STRESS (EM),CHS=2.0 IN/MIN,TP-H1043,WING 246

Figure 1

$$Y = ((+1.9262341E+02) + (-2.3928838E-01) * X)$$
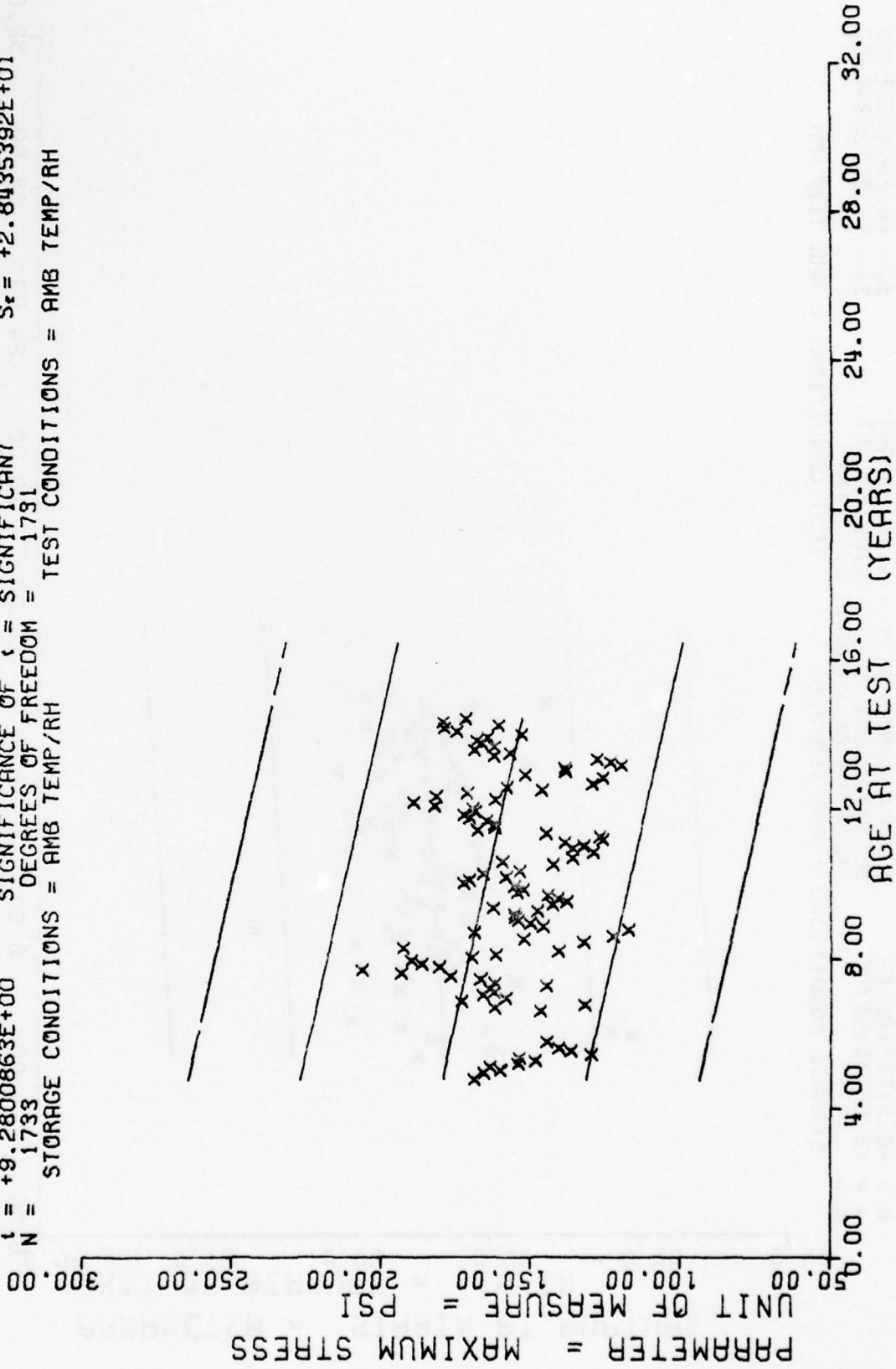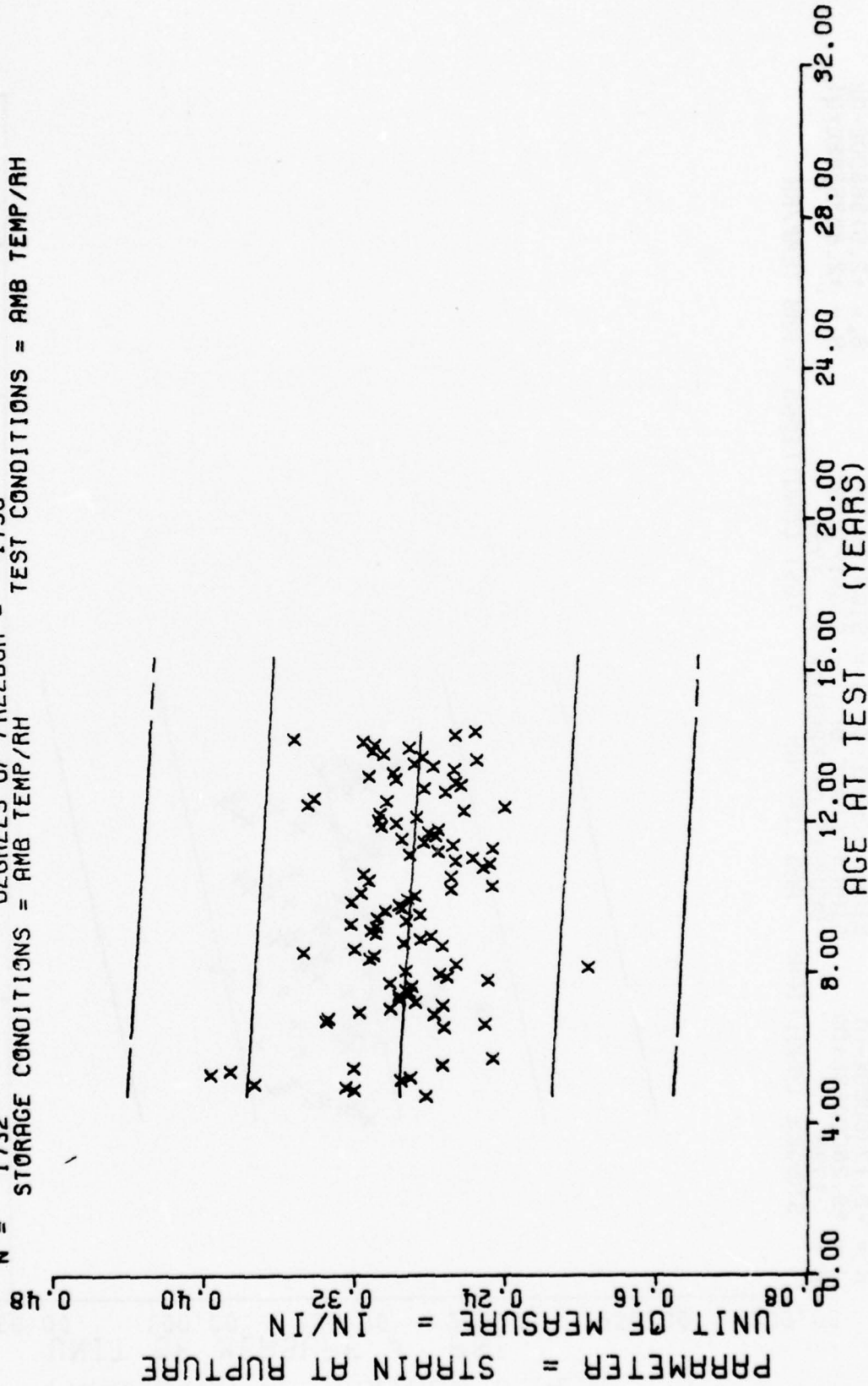
$F = +8.6120002E+01$ SIGNIFICANCE OF F = SIGNIFICANT $\sigma_1 = +2.9125748E+01$

$R = -2.1770089E-01$ SIGNIFICANCE OF R = SIGNIFICANT $S_a = +2.5138600E-02$

$t = +9.2800863E+00$ SIGNIFICANCE OF t = SIGNIFICANT $S_c = +2.8435392E+01$

$N = 1733$ DEGREES OF FREEDOM = 1731

STORAGE CONDITIONS = AMB TEMP/RH   TEST CONDITIONS = AMB TEMP/RH

PARAMETER = MAXIMUM STRESS

UNIT OF MEASURE = PSI

AGE AT TEST (YEARS)

TENSILE MAXIMUM STRESS, CHS=2.0 IN/MIN, TP-H1043, WINGS 2 & 6

Figure 2

$$Y = ((+3.0261188E{-}01) + (-1.1205284E{-}04) \times X)$$

F = +6.9206323E+00   SIGNIFICANCE OF F = SIGNIFICANT σ_1= +4.8255138E-02
R = -6.3122312E-02   SIGNIFICANCE OF R = SIGNIFICANT S_a = +4.2594155E-05
t = +2.6307094E+00   SIGNIFICANCE OF t = SIGNIFICANT S_x = +4.8172824E-02
N = 1732   DEGREES OF FREEDOM = 1730
STORAGE CONDITIONS = AMB TEMP/RH   TEST CONDITIONS = AMB TEMP/RH

AGE AT TEST (YEARS)

TENSILE STRAIN AT RUPTURE (ER),CHS=2.0 IN/MIN,TP-H1043, WINGS 2 4 6

UNIT OF MEASURE = IN/IN

PARAMETER = STRAIN AT RUPTURE

Figure 3

- 8 -

$$Y = ((+1.6286068E+02) + (-2.4581212E-01) \times X)$$

F = +9.1049055E+01   SIGNIFICANCE OF F = SIGNIFICANT σ_Y = +2.9887514E+01
R = -2.2354125E-01   SIGNIFICANCE OF R = SIGNIFICANT S_a = +2.5761169E-02
t = +9.5419628E+00   SIGNIFICANCE OF t = SIGNIFICANT S_c = +2.9139608E+01
N = 1733   DEGREES OF FREEDOM = 1731
STORAGE CONDITIONS = AMB TEMP/RH   TEST CONDITIONS = AMB TEMP/RH

PARAMETER = STRESS AT RUPTURE
UNIT OF MEASURE = PSI

AGE AT TEST (YEARS)
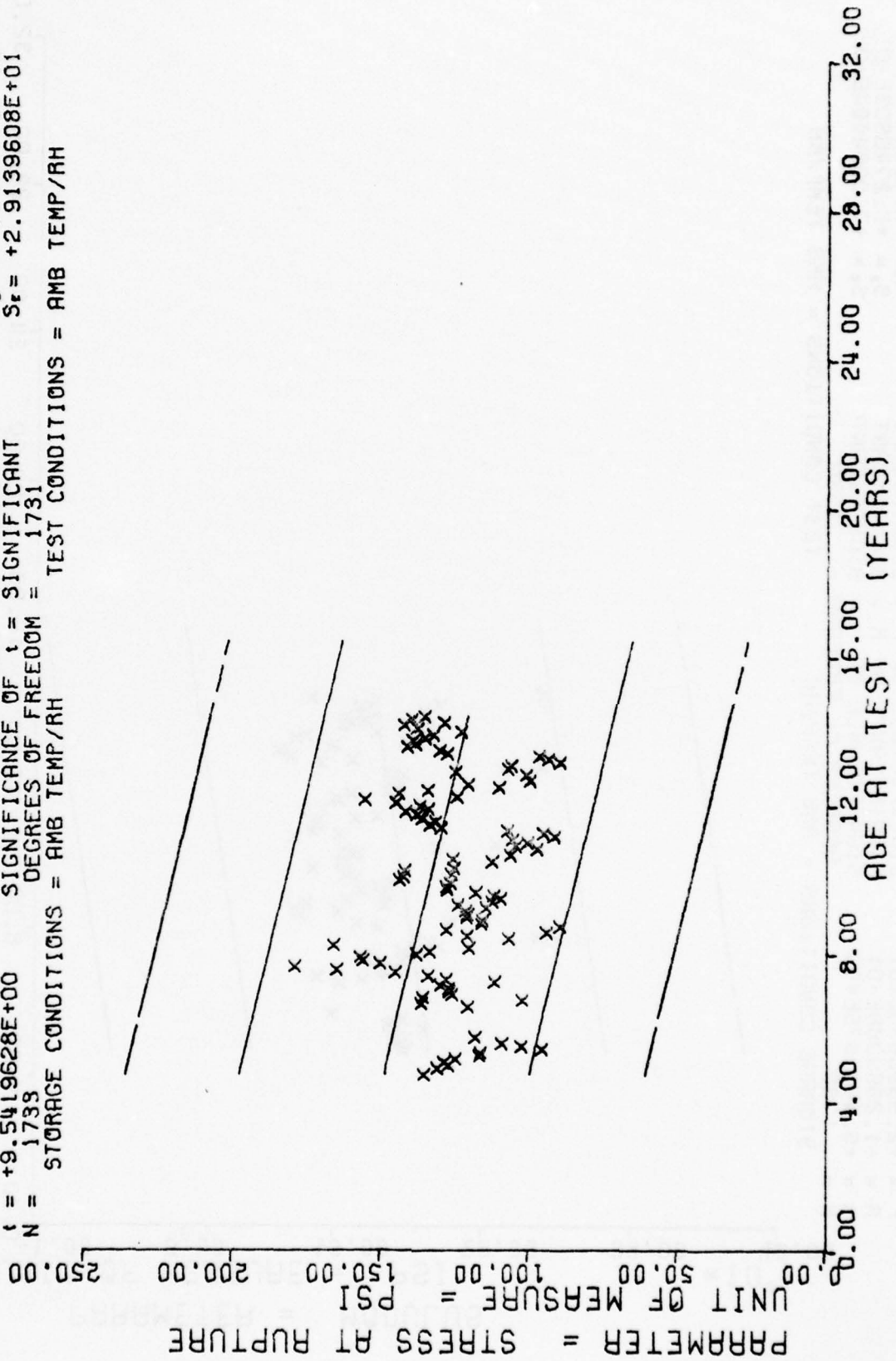
TENSILE STRESS AT RUPTURE (SR).CHS=2.0 IN/MIN.TP-H1043, WINGS 2 & 6

Figure 4

- 9 -
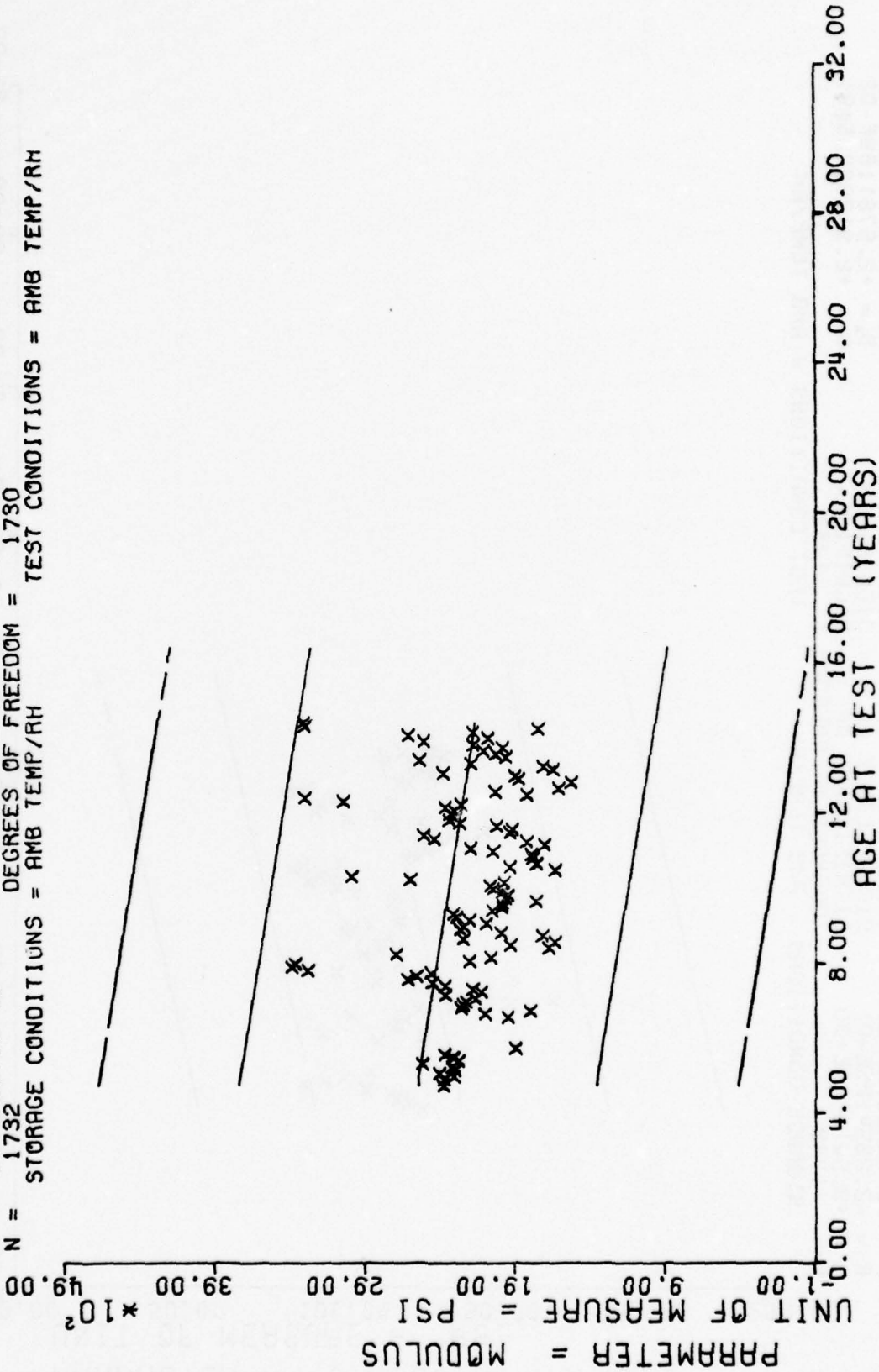
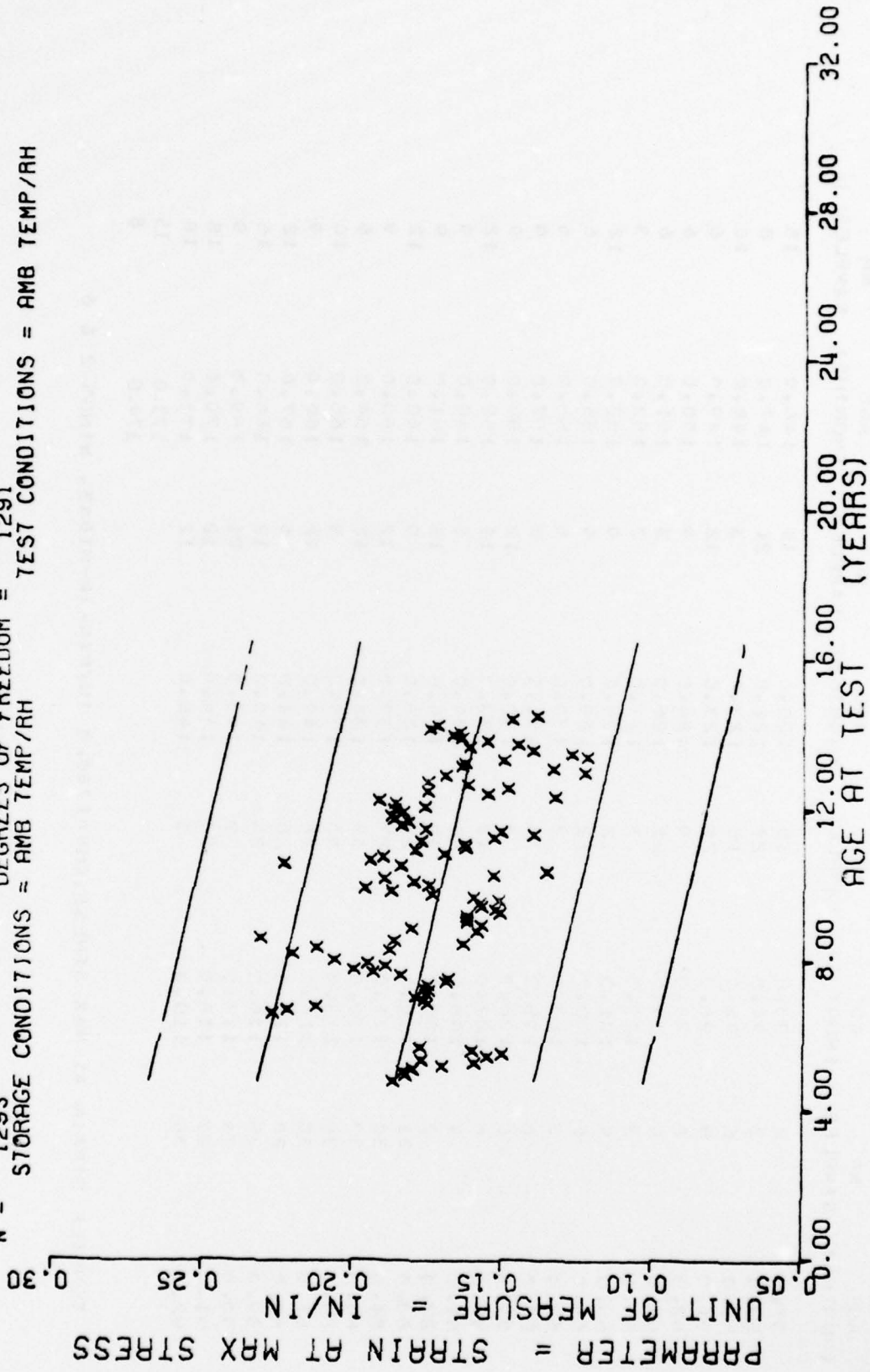Figure 5

TENSILE MODULUS (E),CHS=2.0 IN/MIN,TP-H1043, WINGS 2 & 6

*** SAMPLE SIZE SUMMARY ***

AGE (MONTHS)	NR SAMPLES	AGE (MONTHS)	NR SAMPLES	AGE (MONTHS)	NR SAMPLES	AGE (MONTHS)	NR SAMPLES
57.0	2	93.0	15	120.0	15	146.0	15
58.0	3	94.0	27	121.0	21	147.0	8
60.0	6	95.0	15	122.0	3	148.0	10
61.0	9	96.0	24	123.0	12	149.0	6
62.0	6	98.0	9	124.0	9	150.0	6
63.0	9	99.0	21	126.0	3	151.0	6
64.0	3	100.0	3	127.0	3	152.0	3
65.0	6	101.0	12	128.0	9	153.0	12
66.0	6	102.0	12	129.0	9	155.0	6
67.0	6	103.0	3	130.0	6	156.0	6
69.0	6	105.0	5	131.0	3	157.0	9
79.0	6	106.0	3	132.0	12	158.0	9
80.0	9	107.0	12	133.0	11	159.0	12
81.0	9	108.0	24	134.0	6	160.0	9
82.0	3	109.0	32	135.0	15	161.0	9
83.0	21	110.0	29	136.0	9	162.0	12
84.0	30	111.0	27	137.0	12	163.0	9
85.0	33	112.0	33	138.0	12	164.0	6
86.0	30	113.0	30	139.0	9	165.0	10
87.0	30	114.0	28	140.0	12	166.0	9
88.0	28	115.0	28	141.0	6	167.0	12
89.0	29	116.0	24	142.0	12	168.0	18
90.0	34	117.0	9	143.0	21	169.0	9
91.0	37	118.0	23	144.0	12	170.0	15
92.0	39	119.0	3	145.0	12	171.0	18
						173.0	15
						174.0	8

TENSILE STRAIN AT MAX STRESS, CHS=1750.0 IN/MIN, TP-H1043, WINGS 2 & 6

This sample size summary applies to figures 6 thru 10

- 11 -

$$Y = ((+1.9902030E-01) + (-2.3910342E-04) * X)$$

F = +7.1890013E+01   SIGNIFICANCE OF F = SIGNIFICANT σ_0 = +2.8196456E-02
R = -2.2968341E-01   SIGNIFICANCE OF R = SIGNIFICANT S_0 = +2.8198390E-05
t = +8.4793286E+00   SIGNIFICANCE OF t = SIGNIFICANT S_e = +2.7453261E-02
N = 1293   DEGREES OF FREEDOM = 1291

STORAGE CONDITIONS = AMB TEMP/RH   TEST CONDITIONS = AMB TEMP/RH

PARAMETER = STRAIN AT MAX STRESS

UNIT OF MEASURE = IN/IN

AGE AT TEST (YEARS)

TENSILE STRAIN AT MAX STRESS,CHS=1750.0 IN/MIN,TP-H1043, WINGS 2 & 6

Figure 6

- 12 -

Figure 7

TENSILE MAXIMUM STRESS, CHS=1750.0 IN/MIN, TP-H1043, WINGS 2 & 6

- 13 -

TENSILE STRAIN AT RUPTURE.CHS=1750.0 IN/MIN.TP-H1043. WINGS 2 & 6

Figure 8

- 14 -

$Y = ((+4.4598568E+02) + (-3.4294670E-01) * X)$

F = +2.2571568E+01   SIGNIFICANCE OF F = SIGNIFICANT σ_x = +7.0861607E+01
R = -1.3108530E-01   SIGNIFICANCE OF R = SIGNIFICANT $S_\bullet$ = +7.2184800E-02
t = +4.7509545E+00   SIGNIFICANCE OF t = SIGNIFICANT S_s = +7.0277351E+01
N = 1293   DEGREES OF FREEDOM = 1291
STORAGE CONDITIONS = AMB TEMP/RH   TEST CONDITIONS = AMB TEMP/RH

TENSILE STRESS AT RUPTURE,CHS=1750.0 IN/MIN,TP-H1043, WINGS 2 & 6

Figure 9

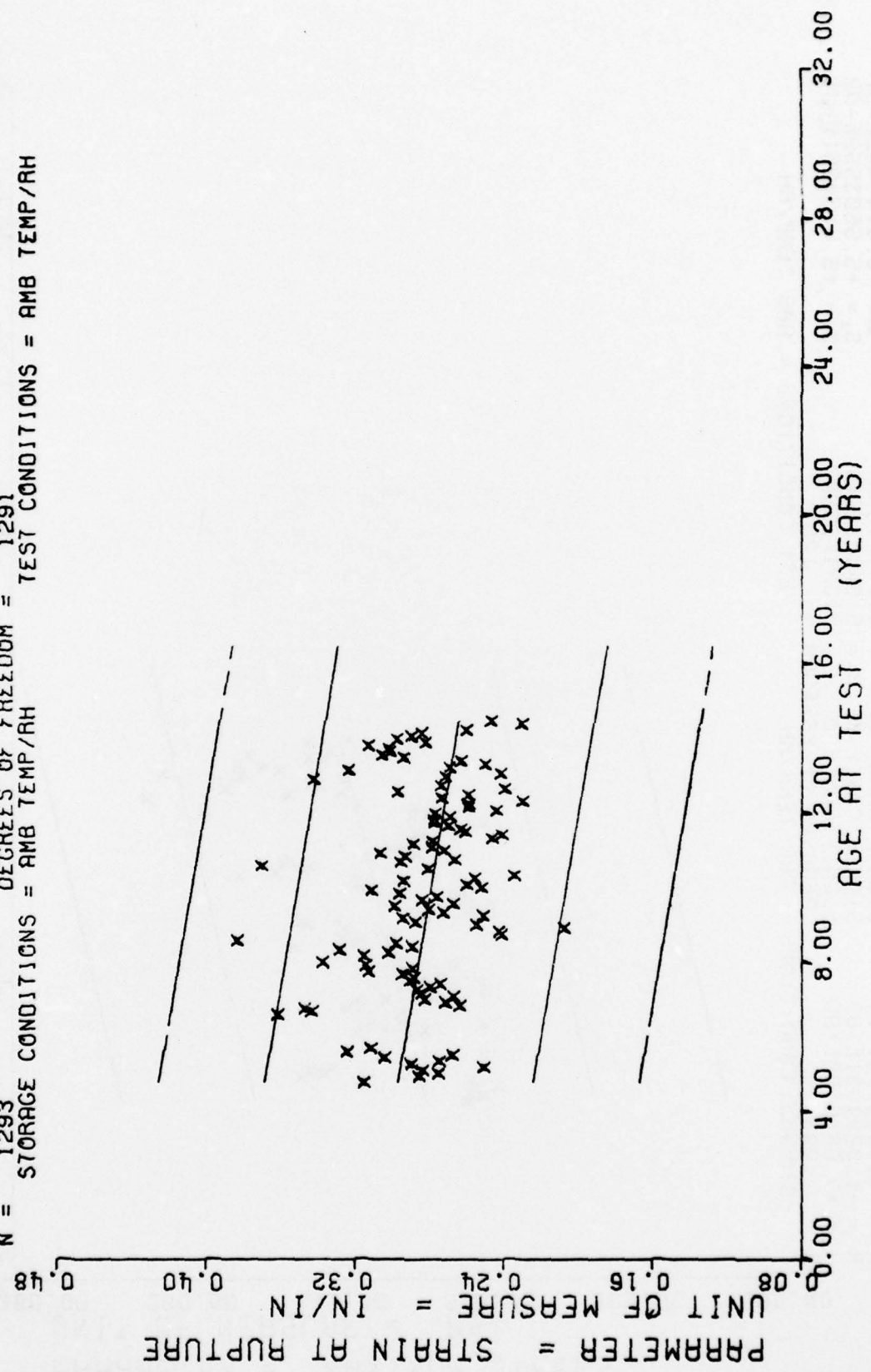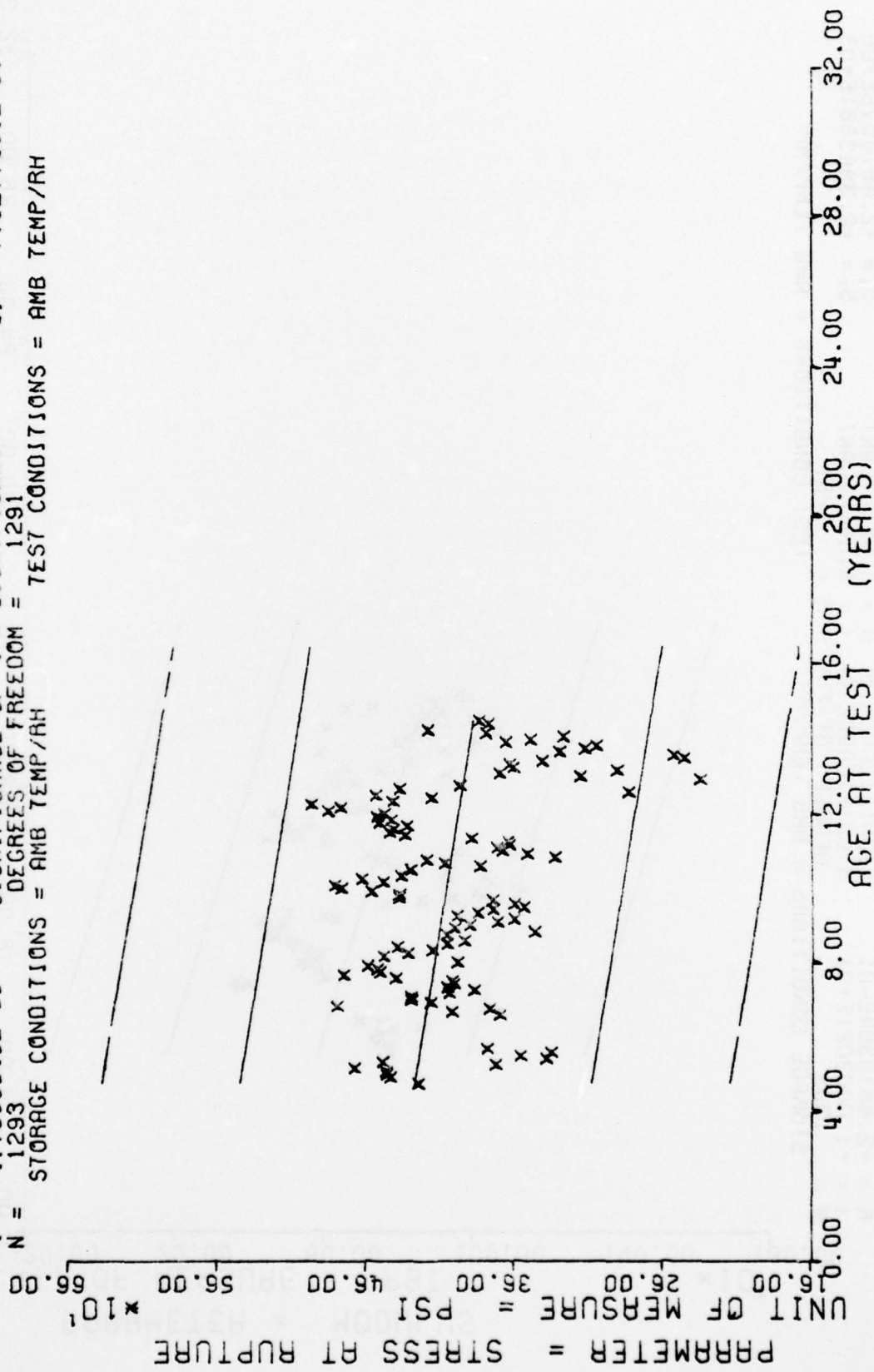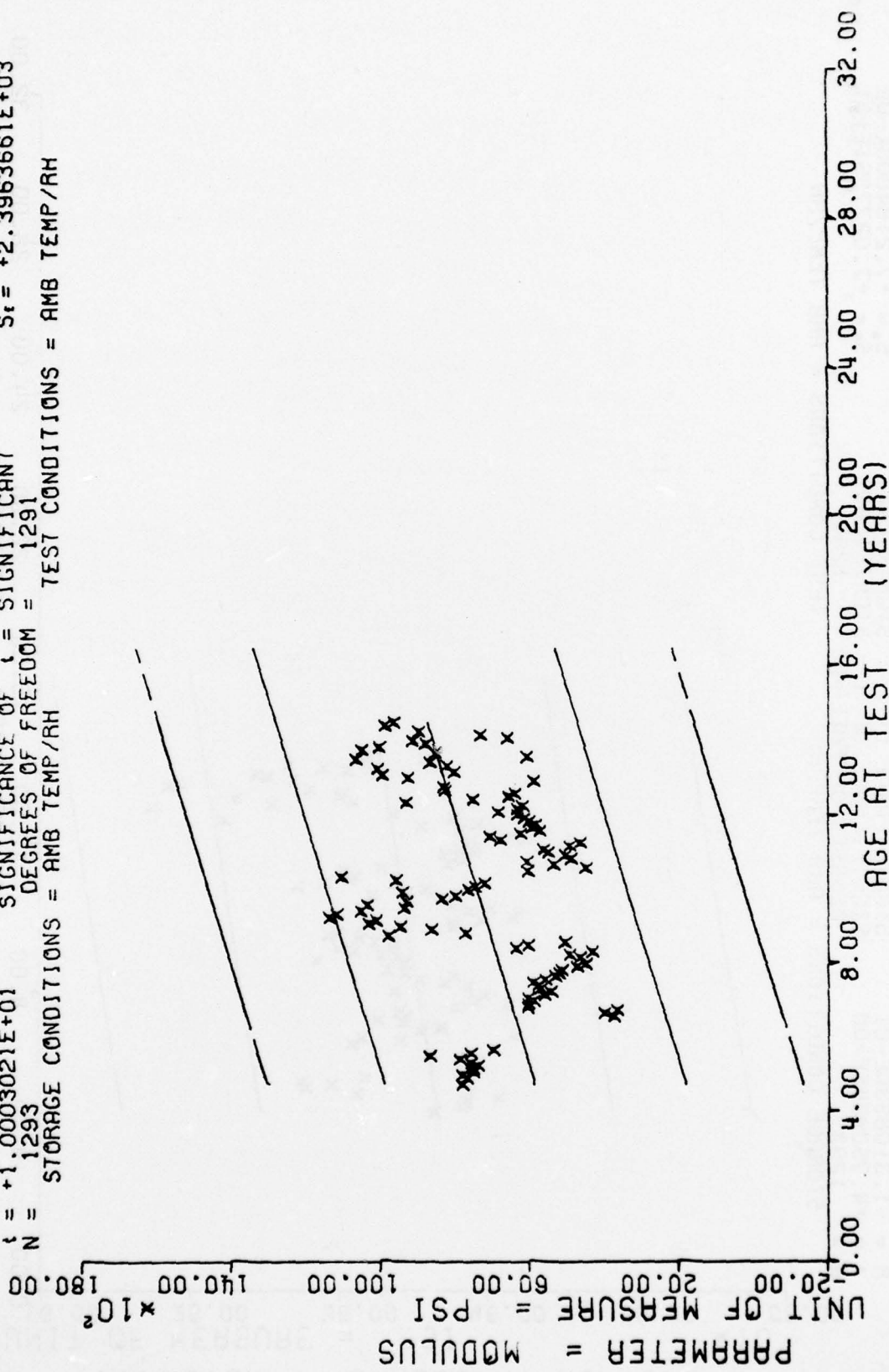- 15 -

$$Y = ((+4.4487897E+03) + (+2.4621513E+01) * X)$$

F = +1.0006043E+02   SIGNIFICANCE OF F = SIGNIFICANT σ_t = +2.4865369E+03
R = +2.6819964E-01   SIGNIFICANCE OF R = SIGNIFICANT S_a = +2.4614076E+00
t = +1.0003021E+01   SIGNIFICANCE OF t = SIGNIFICANT S_c = +2.3963661E+03
N = 1293   DEGREES OF FREEDOM = 1291
STORAGE CONDITIONS = AMB TEMP/RH   TEST CONDITIONS = AMB TEMP/RH

AGE AT TEST (YEARS)

UNIT OF MEASURE = PSI

PARAMETER = MODULUS

TENSILE MODULUS, CHS=1750.0 IN/MIN, TP-H1043, WINGS 2 & 6

Figure 10

AGE MONTHS	NR SAMPLES	AGE MONTHS	NR SAMPLES	AGE MONTHS	NR SAMPLES	AGE MONTHS	NR SAMPLES
56.0	5	92.0	9	120.0	20	148.0	15
58.0	5	93.0	6	121.0	40	149.0	9
59.0	10	94.0	11	123.0	20	150.0	5
60.0	5	95.0	6	124.0	13	151.0	5
61.0	15	96.0	3	126.0	6	152.0	5
62.0	10	98.0	1	127.0	3	153.0	5
63.0	10	99.0	1	128.0	12	155.0	5
64.0	10	101.0	10	130.0	6	156.0	10
65.0	10	102.0	11	131.0	6	158.0	25
66.0	10	103.0	15	132.0	9	159.0	5
67.0	11	105.0	10	133.0	15	160.0	5
68.0	5	106.0	5	134.0	9	161.0	15
78.0	2	107.0	20	135.0	12	163.0	5
80.0	4	108.0	30	136.0	6	164.0	5
81.0	1	109.0	35	137.0	21	165.0	10
82.0	14	110.0	40	138.0	3	166.0	25
83.0	16	111.0	25	139.0	9	167.0	10
84.0	25	112.0	35	140.0	15	168.0	15
85.0	32	113.0	35	141.0	9	169.0	5
86.0	19	114.0	35	142.0	18	170.0	10
87.0	21	115.0	30	143.0	12	171.0	15
88.0	22	116.0	20	144.0	8	173.0	10
89.0	28	117.0	15	145.0	16	174.0	5
90.0	14	118.0	40	146.0	18		
91.0	13	119.0	10	147.0	3		

WING 2-6 HARDNESS SHORE A 10 SECOND TP/H1043 PROPELLANT

This sample size summary applies to Figures 11 and 12

$$Y = ((+8.5152877E+01) + (-7.1012327E-03) \times X)$$

$\sigma_y = +2.3124438E+00$

F = +1.0647380E+01   SIGNIFICANCE OF F = SIGNIFICANT
R = -8.9926283E-02   SIGNIFICANCE OF R = SIGNIFICANT S_a = +2.1762679E-03
t = +3.2630323E+00   SIGNIFICANCE OF t = SIGNIFICANT S_z = +2.3039563E+00
N = 1308   DEGREES OF FREEDOM = 1306
STORAGE CONDITIONS = AMB TEMP/RH   TEST CONDITIONS = AMB TEMP/RH

AGE AT TEST (YEARS)
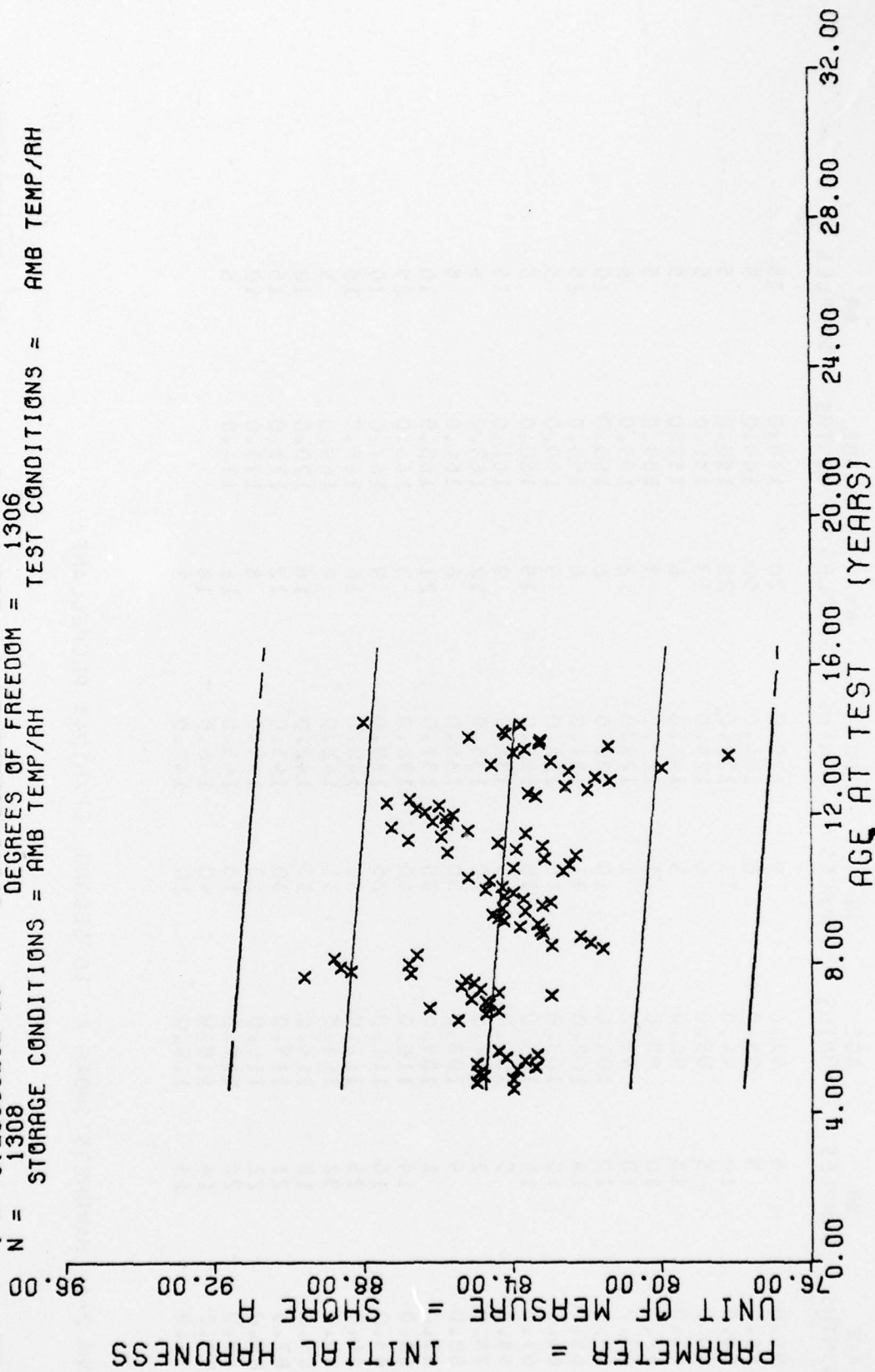
WING 246 HARDNESS SHORE A (INITIAL TP-H1043 PROPELLANT

PARAMETER = INITIAL HARDNESS   UNIT OF MEASURE = SHORE A
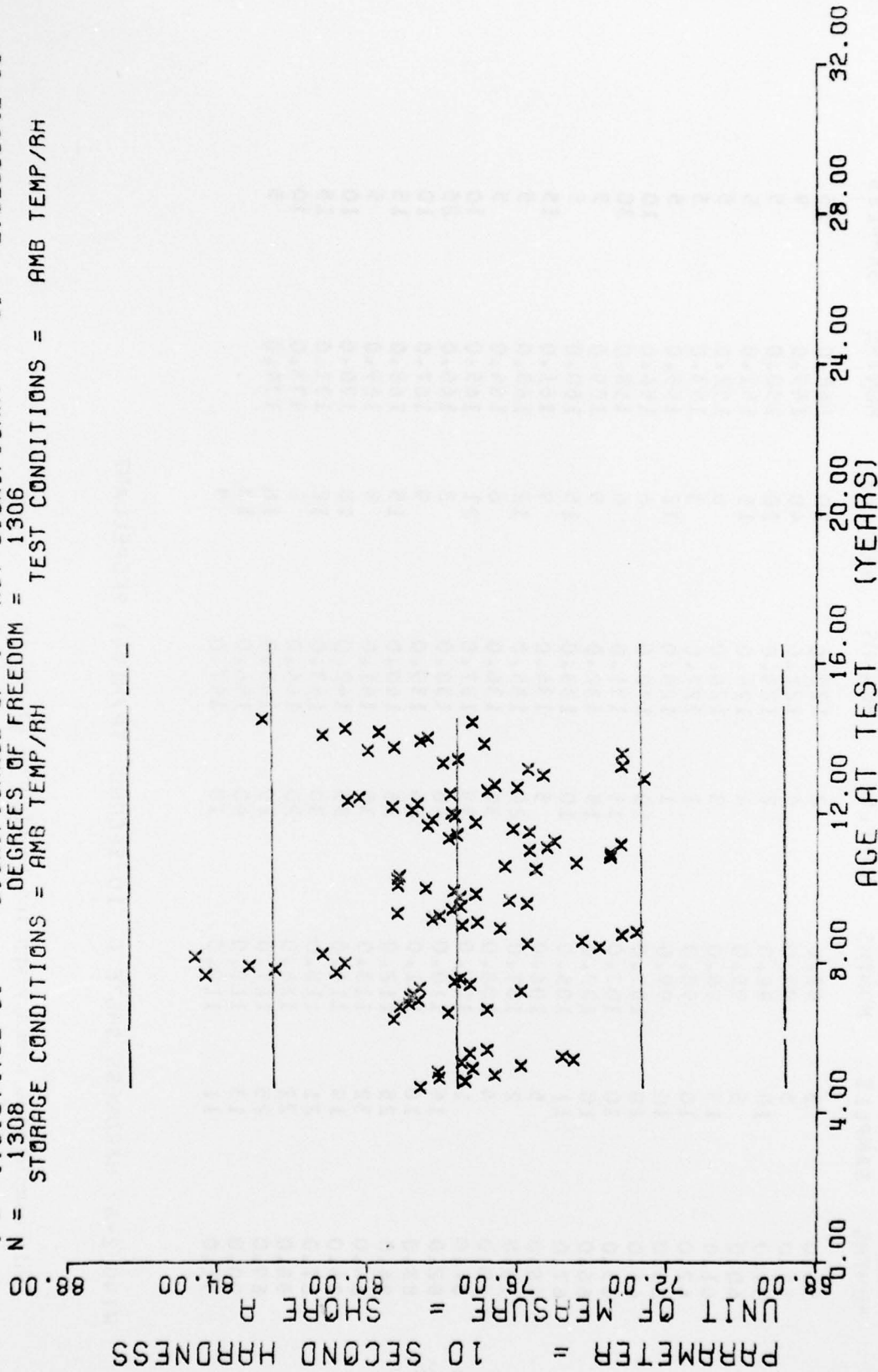
Figure 11

WING 246 HARDNESS SHORE A 10 SECOND TP-H1043 PROPELLANT

Figure 12

*** SAMPLE SIZE SUMMARY ***

AGE MONTHS	NR SAMPLES	AGE MONTHS	NR SAMPLES	AGE MONTHS	NR SAMPLES	AGE MONTHS	NR SAMPLES
56.0	5	92.0	2	120.0	20	148.0	15
58.0	5	93.0	4	121.0	40	149.0	9
59.0	10	94.0	7	123.0	20	150.0	5
60.0	5	95.0	4	124.0	15	151.0	5
61.0	15	96.0	3	126.0	6	152.0	5
62.0	10	98.0	1	127.0	3	153.0	5
63.0	10	99.0	1	128.0	12	155.0	5
64.0	10	101.0	10	130.0	6	156.0	10
65.0	10	102.0	11	131.0	6	158.0	30
66.0	10	103.0	15	132.0	9	159.0	5
67.0	11	105.0	10	133.0	15	160.0	5
68.0	5	106.0	5	134.0	9	161.0	15
78.0	2	107.0	20	135.0	12	163.0	5
80.0	4	108.0	30	136.0	6	164.0	5
81.0	1	109.0	35	137.0	21	165.0	10
82.0	14	110.0	40	138.0	3	166.0	25
83.0	16	111.0	25	139.0	9	167.0	10
84.0	25	112.0	35	140.0	15	168.0	15
85.0	32	113.0	35	141.0	9	169.0	5
86.0	19	114.0	35	142.0	18	170.0	10
87.0	21	115.0	30	143.0	12	171.0	15
88.0	22	116.0	20	144.0	8	173.0	15
89.0	25	117.0	15	145.0	16	174.0	10
90.0	13	118.0	40	146.0	18		
91.0	11	119.0	10	147.0	3		

WING 2-6   HARDNESS SHORE C   10 SECOND   TP/H1043 PROPELLANT

This sample size summary applies to Figures 13 and 14

$$Y = ((+5.7384136E+01) + (-6.5841192E-02) * X)$$

F = +1.8469849E+02   SIGNIFICANCE OF F = SIGNIFICANT σ_t = +5.470362E+00
R = -3.5365985E-01   SIGNIFICANCE OF R = SIGNIFICANT S_a = +4.8446901E-03
t = +1.3590382E+01   SIGNIFICANCE OF t = SIGNIFICANT S_c = +5.1188151E+00
N = 1294   DEGREES OF FREEDOM = 1292

STORAGE CONDITIONS = AMB TEMP/RH   TEST CONDITIONS = AMB TEMP/RH

AGE AT TEST (YEARS)

PARAMETER = INITIAL HARDNESS   UNIT OF MEASURE = SHORE C
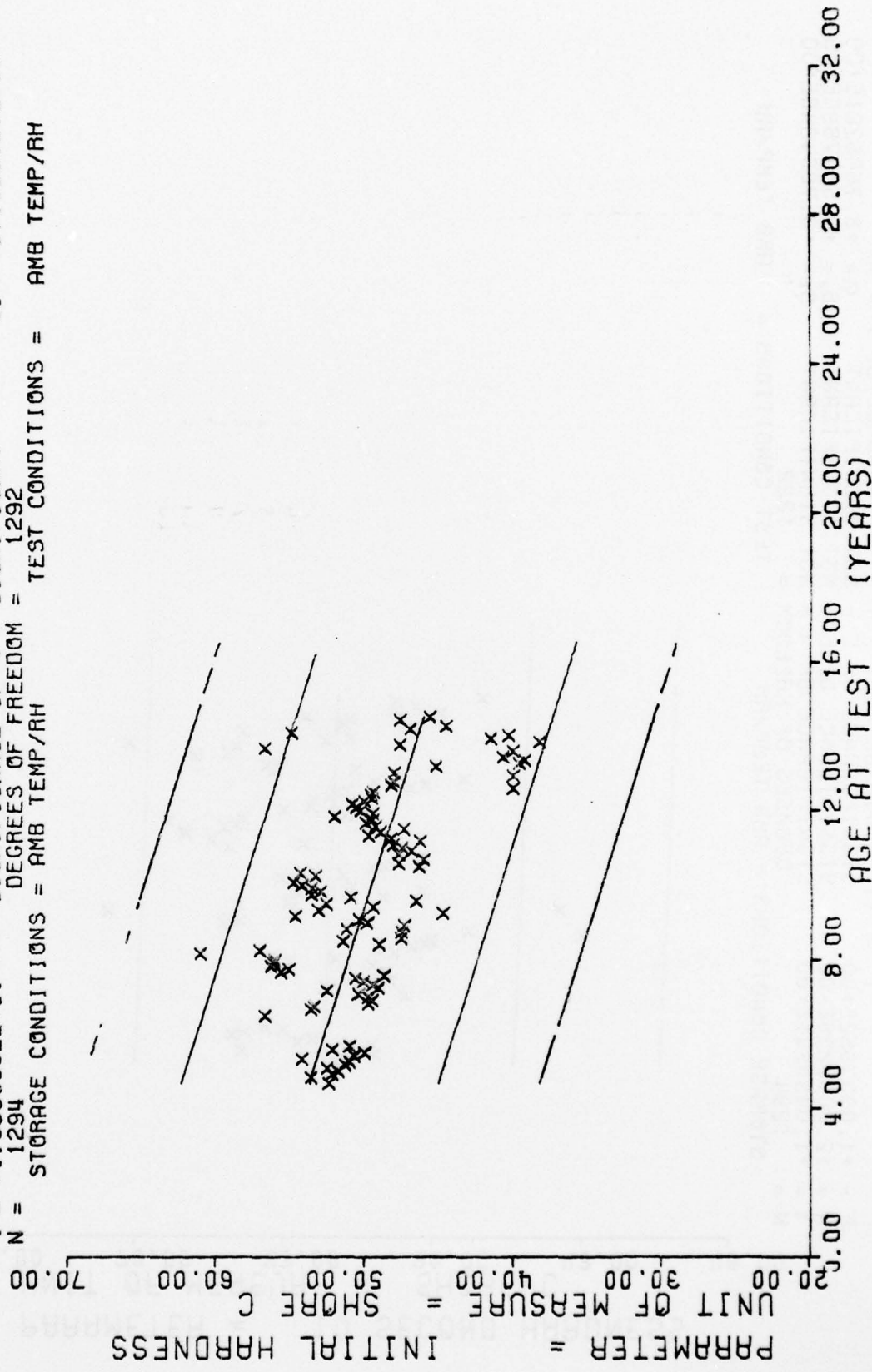
WING 246   HARDNESS SHORE C   INITIAL   TP-H1043 PROPELLANT

Figure 13

- 21 -

$Y = ((+3.4165867E+01) + (+3.7264669E-03) \times X)$

F = +1.0927652E+00   SIGNIFICANCE OF F = NOT SIGNIFICANT σ_1 = +3.7666291E+00
R = +2.9070238E-02   SIGNIFICANCE OF R = NOT SIGNIFICANT S_a = +3.5647890E-03
t = +1.0453541E+00   SIGNIFICANCE OF t = NOT SIGNIFICANT S_2 = +3.7664940E+00
N = 1294   DEGREES OF FREEDOM = 1292

STORAGE CONDITIONS = AMB TEMP/RH   TEST CONDITIONS = AMB TEMP/RH

WING 246 HARDNESS SHORE C 10 SECOND TP-H1043 PROPELLANT

AGE AT TEST (YEARS)

PARAMETER = 10 SECOND HARDNESS

UNIT OF MEASURE = SHORE C

Figure 14

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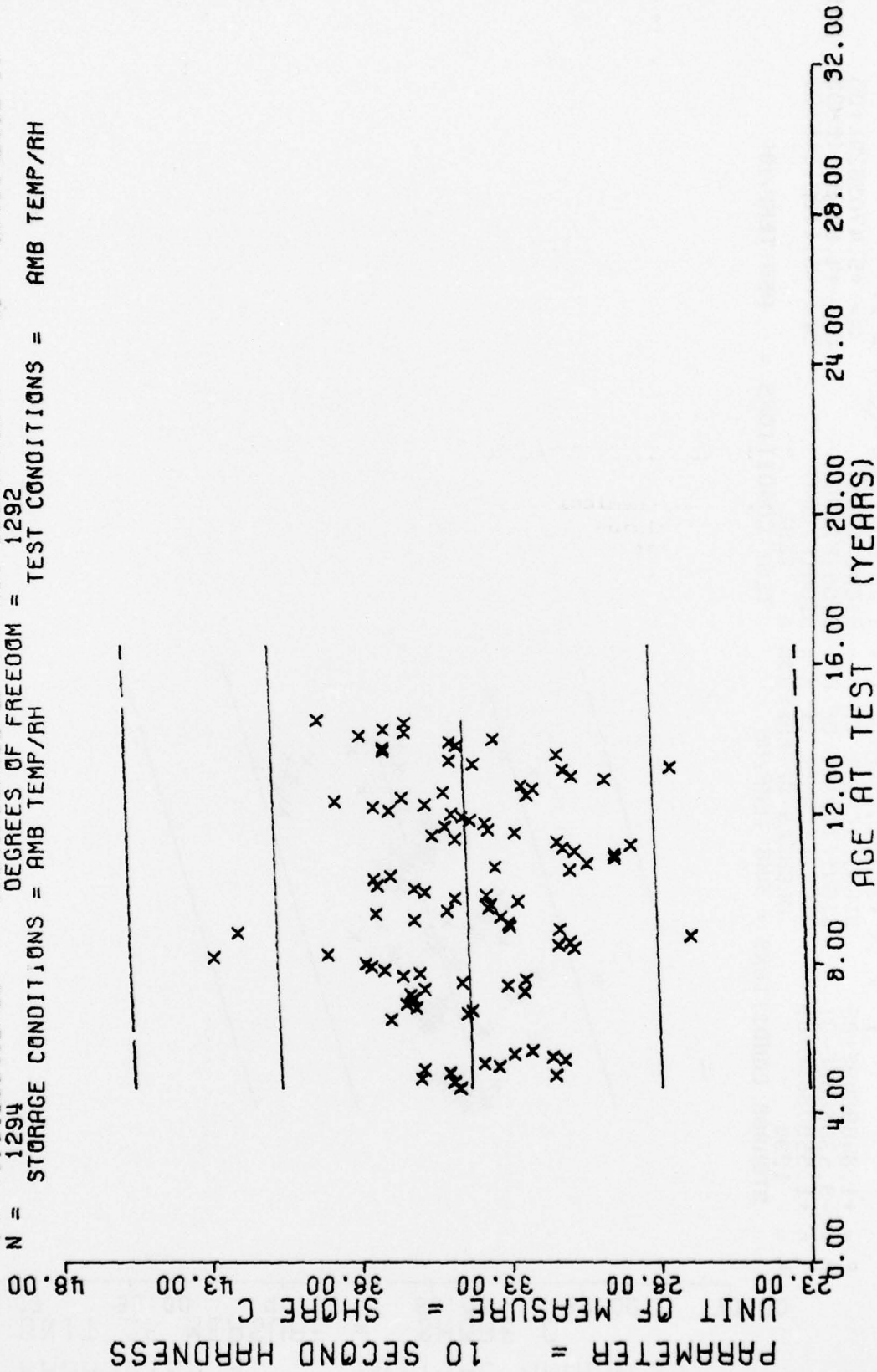
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Solid Propellant
Minuteman
Aft Closure

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

This report contains propellant test results from cartons of TP-H1043 propellant representing selected batches used in the aft closure of First Stage-Minuteman Motors. Data from TP-H1043 propellant obtained from the aft closures of the LGM-30A, B, F and G Motors are reported in regression analyses for the fourth time and the third time using the GO-85 computer system. Testing was accomplished in accordance with MMWRME Projects M82937C and M82938C.
An analysis of all parameters indicate that no significant degradation is

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anticipated for at least two years past the oldest data point.

Each point on the regression plot represents all samples at that particular age. The number of samples at each point is indicated on the sample size summary sheet on the page accompanying each regression plot. The data range at any age can be found by suitable inquiry of the GO-85 system.