FRACTURE TOUGHNESS DATA FOR FERRITIC NUCLEAR PRESSURE VESSEL MATERIALS

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(Final Report of Research Project 232-1)

Task A: Volume II
Part I: Appendices 1-4

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LIST OF APPENDICES

FOREWORD

The Appendices presented in Volume II of "Fracture Toughness Data for Ferritic Nuclear Pressure Vessel Materials," represent the detailed analysis of approximately 20,000 experimental test results. Due to the large quantity of data, Volume I was written to familiarize the reader with the overall program and objectives, to present the analytical tools developed for statistically analyzing the data, and to provide specific examples for the interpretation of the data in Volume II. Volume I also contains the conclusions and recommendations reached after the data were analyzed. Note that the objective of the overall program was to gather the data in a well documented and detailed manner and to perform a cursory statistical analysis.

Appendix 1 (A533B-1 Steel) is written in more detail than the other appendices to reemphasize the methodology presented in Volume I. Volume II represents a summary of the test results obtained by Babcock and Wilcox Co., Combustion Engineering, Inc., and Effects Technology, Inc. The full value of Volumes I and II can only be achieved if the reader is familiar with the detailed testing reports from the three laboratories (references 11, 12, and 13).

APPENDIX 1

MATERIAL 1

A533 GRADE B, CLASS 1 STEEL

MATERIAL TYPE 1
A533 GRADE B, CLASS 1 STEEL

INTRODUCTION

Thirteen different heats of A533B-1 steel were studied. Eight heats were tested by Effects Technology, Inc., and five heats were tested by Combustion Engineering, Inc. (both the Chattanooga and Windsor facilities). A tabulated description for each heat of A533B-1 is presented in Table 1.1. Note that the eight ETI heats were actually given nine heat numbers; for the tensile, drop weight-NDTT, and fracture tests which were normally performed in the transverse (T) orientations, heat D (number 4) was tested in the longitudinal (L) orientation. This same heat when tested in the transverse orientation was identified as heat M (number 13). Table 1.1 also lists the measured NDTT and RT_{NDT} values for each heat.

For a further description of the A533B-1 steels and the experimental techniques, the reader is referred to References 12 and 13. Since two different CE laboratories were involved in the testing of material 1, the key word designation for laboratories 3 and 23 is often designated as 0 for access by the computer for all CE data. This same 0 keyword can be used to obtain both CE and ETI data in appropriate circumstances.

TENSILE TEST RESULTS

The 2-in. gage section tensile test results are summarized in the extract from the data bank (see the end of this section). For each test, the yield strength, tensile strength, uniform elongation, total elongation, and reduction in area are shown in successive columns. Curves of the form

$$R = A + BT + CT^2 + DT^3$$

were fitted to each set of data, where T is the temperature, R is the test response, and A, B, C, and D are the regression coefficients.

The ETI tensile results for A533B-1 steel are summarized in Figures

1.1 to 1.5. The CE results, all for transversely oriented material are shown in Figures 1.6 to 1.10. All the tensile data generated on A533B-1 (CE and ETI combined) are shown in Figures 1.11 to 1.15.

The curve fit parameters are listed in Table 1.2 together with the variance (σ^2), degrees of freedom (ϕ), and standard deviation (σ) for each data set. There were some statistically significant differences between the sets of data. The variance of yield strength and ultimate tensile strength was more than ten times greater for the ETI heats than for the CE heats. This difference may be due to the fact that ETI studied A533B-1 steels that were of various thicknesses and production ages, and therefore these heats represented a wider range of properties.

CHARPY V-NOTCH RESULTS

Impact Energy

The Charpy impact energy results are summarized in Table 1.3. The "KEY" is the identification code for the data bank. The "J" column shows the data word in the data bank record, where J = 2 refers to the impact energy. A, B, T_0 and C are the coefficients of the tanh curve fit to the data,

$$(\text{Response}) = A + B \tanh\left[\frac{T - T_0}{C}\right]$$

where (Response) is the Charpy impact energy in this case, and T is the test temperature. PHI is the number of degrees of freedom (ϕ) and VAR is the variance (σ^2) of that data lying in a $\pm 50^{\circ}F$ range about T_0 (the property transition range). The results are shown graphically in Figures 1.16 to 1.41 and are listed in the data bank listing.

The data shown in Table 1.3 were statistically analyzed; Table 1.4 summarizes the statistics for the tanh coefficients. There were no major differences for coefficient A between the heats except for ETI heat E, longitudinal orientation (keyword 25511). The normalized deviation was

2.57. As can be seen in Figure 1.34, this result was due to abnormally high impact values at the highest test temperatures. The statistics for coefficient B were analyzed in Table 1.4; again, the only result which differed substantially from the remainder was result 25511. Since the lower shelf was zero, A must equal B, so that it is to be expected that A and B should both be "out of line." Table 1.4 also shows the statistics for coefficient T_0. CE heat A, key 20112, was high. This result reflects the high RT_{NDT} value for this steel, Table 1.1. With respect to the summarized statistics for coefficient C, again CE heat A, key 20112, was higher than the others. In other words, the property transition from lower to upper shelf was less steep than it was for the other heats.

It is interesting to note from Table 1.1 and the discussion above that the RT_{NDT} for this material is generally fixed by the Charpy V-notch energy curve and is probably a conservative estimate of a ductile-brittle transition temperature.

The variability of the test data is also summarized in Table 1.4 for ϕ and σ^2. The tables for ϕ reveal that the number of data points in the property transition range varied greatly, between a minimum of 3 and a maximum of 10. The variance also varied widely, although only heat 20211 was substantially different from the remainder (greater variance than expected).

Lateral Expansion

The lateral expansion results are summarized in Table 1.5. The data are based on fitting tanh curves, as described in the previous section. The data for each test series are shown graphically in Figures 1.42 - 1.67. Note that in some cases the upper shelf may tend to drop off at high temperatures and the tanh curve fit merely averages the upper shelf.

Each curve fit coefficient has been examined in the same manner as the impact energy test data in the previous section. The results are summarized in Table 1.6. Few of the results differed outstandingly from

the others. Data set 20112 again had a high T_0 value (as for energy), and data set 25111 had a low T_0 value. Data set 25111 also had a sharper property transition than the other sets. Data set 25612 had an abnormally low B value, reflecting the fact that the upper shelf lay at about 64 mils, not the 80 mils characteristic of the other sets.

Percent Shear

Table 1.7 summarizes the curve fit parameters. The curves and data are shown graphically in Figures 1.68 - 1.93. The tanh curve fit was restricted from going below 0%, but the upper shelf was not restricted at 100% (i.e., $A \neq B \neq 50\%$). Therefore, the upper shelf (A + B) may be slightly greater than 100%. This slight error has no noticable effect upon the values of T_0 and C.

The curve fit coefficients were analyzed as in the previous sections. The results are detailed in Table 1.8. For set 25312, A was significantly higher, and B significantly lower than the other data sets. The T_0 value was greater than the others for set 20112. This high value was expected in view of the high RT_{NDT} of this material. Set 25612 had a sharper property transition than the other data sets. Set 20211 had a higher variance than the other data sets.

Summary of Charpy Impact Test Data

Table 1.9 shows the parameter T_0 - C, the temperature at which the tangent to the tanh curve at the center of the transition meets the extension of the lower shelf. This parameter is also shown for percent shear and lateral expansion. Since T_0 - C is a measure of the ductile-brittle transition temperature, the RT_{NDT} and NDTT values are shown for comparison. There is close agreement between the percent shear values in the transverse orientation and RT_{NDT}; of the 13 heats, 8 are within $10^{o}F$ of RT_{NDT}, and only one heat lies more than $20^{o}F$ from the RT_{NDT}. No correlation is evident with NDTT.

INSTRUMENTED PRECRACKED CHARPY RESULTS

Dynamic Fracture Toughness, $K_{Id} - K_d^*$

The data sets for elastic (K_{Id}) and elastic-plastic (K_d^*) toughness results are plotted in Figures 1.94 - 1.107. Statistics extracted from the graphs are summarized in Table 1.10. The curve-fit statistics are summarized in Table 1.11. None of the quantities differed substantially from the other members of the population, except for the high variance of set 30212. Set 35411 had significantly higher A and B values, which is consistent with the higher Charpy V-notch upper shelf energy observed for longitudinal specimens.

Normalized Energy

The data sets for A533B-1 are shown graphically in Figures 1.108 - 1.121. The curve-fit statistics are summarized in Table 1.12. Each column of the table was analyzed separately and the results of the analysis are shown in Table 1.13. The only notable features brought out in this analysis are the high value of C (low slope) for ETI heat M, key 351312, and the abnormally high variability of ETI heat C, key 35312. The high variability is due to one data point which outlies the remainder in the transition temperature range.

Summary of Precracked Charpy Results

The quantity, $T_0 - C$, is a convenient measure of the experimental ductile-brittle transition (lower knee). For percent shear results from the Charpy V-notch test, this quantity related closely to RT_{NDT} for transverse specimens. No such relationships can be found for precracked Charpy data, as shown in Table 1.14.

The instrumented precracked Charpy results have been summarized and compared to the K_{IR} curve in Figures 1.122 and 1.123. The figures

show the K_{Id}, K_d^* results for CE and ETI, respectively. Despite the limited normalization obtained by using RT_{NDT}, discussed previously, the K_{IR} curve is a highly conservative lower bound to these data. The sole exception is at low temperatures where lower shelf data would be very close to or below the K_{IR} curve. In other words, the K_{IR} curve is conservative in the transition range, but slightly optimistic in the lower shelf region. The same behavior was noted in the round robin task of this program[2]. The T_0 - C transition temperature from these figures (temperatures corrected for RT_{NDT}) was 20.6°F for CE data, and -1.7°F for ETI data. Considering the differences between T_0 - C and RT_{NDT} (shown in Table 1.14) these are in good agreement with the expected result of 0°F. The weighted mean of the results (allowing for the different numbers of CE and ETI heats) was 6.3°F, agreeing well with the mean deviation for the individual heats, 5.1°F.

Figures 1.124 and 1.125 show the CE and ETI results for normalized energy. The T_0 - C values in this case were -24.2°F for CE heats, and -36.1°F for ETI heats. The weighted mean deviation was -31.8°F.

STATIC COMPACT AND DYNAMIC ONE-INCH AND FOUR-INCH FRACTURE TOUGHNESS RESULTS

The static fracture toughness tests were performed using one-inch thick compact fracture specimens (test type 5) at four or five test temperatures. In addition, CE conducted additional tests using either one-inch or two-inch thick specimens (test type 11) for their heats. In most cases, however, there were not enough data points to allow an accurate tanh curve fit to be made for a given heat. Also, the upper shelf data were either sparse or nonexistent.

Of the dynamic fracture toughness tests, ETI performed dynamic 1-in. bend (test type 6) and dynamic 3-in. (test type 10 - heat M) compact and 4-in. compact tests (test type 7). CE, on the other hand, did not perform dynamic bend tests, but did perform dynamic compact fracture tests of type 7 and 8 (four-inch and one-inch thickness, respectively). Again, the number of

data points in each set was inadequate for an accurate tanh curve fit to be made to the data. There were sometimes as few as four data points (for a curve with four coefficients), and there were no upper shelf results.

The compact fracture results obtained by CE are shown in Figures 1.126 - 1.130. The ETI static and dynamic data are presented in Figures 1.131 - 1.139.

Conglomerate plots of the data normalized in temperature by the RT_{NDT} are compared to the Code K_{IR} curve in Figures 1.140 - 1.144. The static data are shown in Figures 1.140 and 1.141, the CE dynamic compact data are shown in Figure 1.142, and the dynamic compact and bend data for ETI are shown in Figures 1.143 and 1.144.

EFFECT OF ERROR CODES

The effect of error codes (minor deviations in test procedure from the standard techniques) has been examined in the control material report[2] for test type 3 (instrumented precracked Charpy test). The procedure used was to analyze the full set of data, including the tests with error codes, and then reanalyze, excluding the error code tests. Taking the null hypothesis, that the error code tests were not significantly different from other tests, the variance of the data about the curve should not differ significantly between the two data sets. On the other hand, if the error codes do make a difference, their inclusion with the standard test results should result in a significantly larger variance. This section will cover the influence of error codes on the data from all of the fracture toughness tests.

Static Fracture Toughness

Test types 5 and 11 are shown in Figure 1.145. Seventy-five data sets were available, with fifty-eight free of error codes. The tests which had error codes were marked with an X symbol and flagged with the pertinent acceptance criteria which they did not meet (see Table 3, Volume 1). Most of the

"unacceptable" tests were in the low temperature, lower shelf region. Figure 1.146 shows the same family of data with the unacceptable tests excluded. A tanh curve was fit to the data (even though the upper shelf was not defined) to allow an estimate of the overall variance. Other types of curves could have been fit to the data, but the variance results would have been similar[2]. The overall variance for the data in Figure 1.145 was 1558, whereas that for Figure 1.146 was 1835. There is no significant difference between these two values. A similar result was found for the variance in the transition temperature region. For the "no error codes" data, this variance was 2374, compared to 2113 for the "including error codes" analysis (see Table 1.15).

There were minor changes in the curve fit coefficients which were not believed to be significant (detailed significance tests are being developed but they are not yet available). As expected, the main change was in the position of the lower shelf. For the "no error code" case (Figure 1.146), the shelf was at 51, whereas the "error code" case (Figure 1.145) gave 61. To provide a rough impression of the uncertainty in these quantities, the curve fit analysis was reperformed from a different set of starting T_0 and C values, Figure 1.147. Although this curve appears to be a poorer fit than Figure 1.146, it was statistically equivalent with a variance about the curve of 1858 compared to 1835 for Figure 1.146. The possibility of slight differences in fit arises from the determination of T_0 and C by numerical methods, which determine the values to a level of accuracy appropriate for the scatter about the curve[19]. This alternate fit, Figure 1.147, showed a lower shelf estimate of 64 for the "no error code" case.

Dynamic Fracture Toughness

Test types 6, 7, 8, and 10 were analyzed in the same fashion as the static fracture toughness results. The results are summarized in Table 1.15 along with the previous static fracture toughness error code analysis. Note that the approach of combining different K's is not expected to be entirely appropriate for this analysis. The "error code" data are shown

in Figure 1.148, while the data excluding unacceptable points are shown in Figure 1.149. The two sets of data show no significant difference in variance either overall or in the transition temperature range.

Table 1.1. Summary of A533B-1 Heats (Material 1)

Test Laboratory	Heat Code	Plate Thickness (in.)	NDTT (^{o}F)	RT_{NDT} (^{o}F)	Comments
ETI (5)	A (1)	8	-20	0	Lukens - ASME Code Section II and III through Winter 1972 Addenda
	B (2)	8	-10	10	Same as heat A above
	C (3)	8	0	0	Same as heat A above
	D (4)	8	0	20	Same as heat A above (formed heat C)- Longitudinal orientation
	E (5)	5	-30	0	Lukens - ASME Code Section III, 1968 edition through Summer 1970 Addenda
	F (6)	5	-20	-10	Same as heat E above
	G (7)	9.5	10	10	Lukens - ASME Code Sections II and III, 1971 Edition
	H (8)	5	0	0	Same as heats E and F above
	M (13)	8	0	20	Same as heat D above, but transverse orientation
CE (3 & 23)	A (1)	11.5	-10	60	Lukens
	B (2)	11.5	-50	16	Merrel Freres
	C (3)	11.5	10	10	Lukens
	D (4)	10.5	0	30	Lukens
	E (5)	11	-20	15	Lukens

Table 1.2 Summary of the Regression Analysis of the Tensile Test Data (A533B-1)

Property	Laboratory	A	B	C	D	Variance σ^2	Degrees of Freedom ϕ	Standard Deviation σ
Yield Stress	ETI	63.74	-5.404×10^{-2}	1.178×10^{-4}	-9.013×10^{-8}	28.31	50	5.32
	CE	67.21	-5.790×10^{-2}	1.462×10^{-5}	-1.387×10^{-8}	2.33	26	1.53
	ETI & CE	65.57	-4.951×10^{-2}	7.794×10^{-5}	-4.017×10^{-8}	20.67	80	4.55
Ultimate Tensile Stress	ETI	88.91	-7.333×10^{-2}	1.194×10^{-4}	-8.715×10^{-9}	25.04	50	5.00
	CE	91.00	-7.759×10^{-2}	1.386×10^{-5}	-4.126×10^{-8}	1.05	26	1.02
	ETI & CE	89.95	-7.104×10^{-2}	9.751×10^{-5}	1.740×10^{-8}	16.66	80	4.08
Uniform Elongation	ETI	13.24	-9.516×10^{-3}	1.333×10^{-5}	-6.387×10^{-10}	1.76	50	1.33
	CE	11.20	2.315×10^{-2}	-7.233×10^{-5}	1.167×10^{-8}	1.17	24	1.08
	ETI & CE	12.18	-1.153×10^{-2}	3.229×10^{-5}	-2.518×10^{-8}	2.67	78	1.63
Total Elongation	ETI	30.48	-1.839×10^{-2}	-1.080×10^{-5}	4.490×10^{-8}	5.76	50	2.40
	CE	26.85	-1.669×10^{-2}	-4.853×10^{-6}	2.563×10^{-8}	2.12	26	1.46
	ETI & CE	30.21	-1.881×10^{-2}	-8.933×10^{-5}	4.383×10^{-8}	5.35	92	2.31
Reduction In Area	ETI	63.39	1.926×10^{-2}	-4.994×10^{-5}	-8.205×10^{-9}	14.08	50	3.75
	CE	62.92	1.788×10^{-2}	-1.169×10^{-5}	1.112×10^{-8}	14.76	26	3.84
	ETI & CE	62.88	1.628×10^{-2}	-4.292×10^{-5}	-1.027×10^{-8}	14.86	80	3.85

Table 1.3. Tanh Fit Parameters for Charpy Impact Energy Data (A533B-1)

KEY	J	A	B	T0	C	PHI	VAR
20111	2	61.30	57.68	103.73	55.25	9	20.20
20112	2	81.34	80.95	186.61	157.75	6	62.65
20211	2	62.66	62.66	51.25	75.43	9	199.59
20212	2	50.84	46.81	53.40	71.47	9	121.31
20311	2	68.49	68.49	62.96	73.42	5	171.27
20312	2	57.34	57.34	76.11	103.14	8	91.63
20411	2	70.61	64.54	81.22	53.10	5	126.85
20412	2	52.67	50.45	81.61	93.65	8	25.07
20511	2	62.82	62.09	47.38	76.84	9	16.74
20512	2	53.00	51.29	51.77	76.24	7	44.96
25111	2	81.21	81.21	25.74	106.40	5	142.25
25112	2	44.63	44.63	25.07	79.33	8	26.25
25211	2	79.84	79.84	66.89	103.48	5	92.67
25212	2	51.33	48.84	60.44	92.62	8	43.27
25311	2	79.94	79.94	64.86	106.65	4	103.08
25312	2	60.87	58.16	50.93	107.54	8	45.04
25411	2	64.39	64.39	87.23	98.69	10	94.46
25412	2	59.50	57.67	81.33	83.04	8	20.99
25511	2	100.94	100.94	78.99	130.29	4	57.12
25512	2	51.26	50.20	44.05	100.96	6	38.78
25611	2	78.17	78.17	36.19	103.46	4	30.51
25612	2	36.70	30.85	11.22	61.64	6	17.35
25711	2	68.06	67.56	39.85	88.31	3	23.86
25712	2	47.01	45.13	55.74	107.89	6	7.85
25811	2	75.70	75.70	41.21	78.11	5	143.82
25812	2	49.82	46.76	38.92	86.09	10	12.97

Table 1.4. Deviation of Charpy Impact Energy Curve Fit Parameters from Mean Value (A533B-1)

A

TOTAL	1650.24
MEAN	63.47076923
ST. DEV	14.59190458

KEY	VAL	DEV	NORMALIZED DEV
20111	61.30	-2.17	-0.15
20112	81.34	17.87	1.22
20211	62.66	-0.81	-0.06
20212	50.64	-12.83	-0.88
20311	68.49	5.02	0.34
20312	57.34	-6.13	-0.42
20411	70.61	7.14	0.49
20412	52.67	-10.80	-0.74
20511	62.82	-0.65	-0.04
20512	53.00	-10.47	-0.72
25111	81.21	17.74	1.22
25112	44.63	-18.84	-1.29
25211	79.84	16.37	1.12
25212	51.33	-12.14	-0.83
25311	79.94	16.47	1.13
25312	60.87	-2.60	-0.18
25411	64.39	0.92	0.06
25412	59.50	-3.97	-0.27
25511	100.94	37.47	2.57
25512	51.26	-12.21	-0.84
25611	78.17	14.70	1.01
25612	36.70	-26.77	-1.83
25711	68.06	4.59	0.31
25712	47.01	-16.46	-1.13
25811	75.70	12.23	0.84
25812	49.82	-13.65	-0.94

Table 1.4. (continued)

B

TOTAL	1612.29
MEAN	62.01115385
ST. DEV	15.58639261

KEY	VAL	DEV	NORMALIZED DEV
20111	57.68	-4.33	-0.28
20112	80.95	18.94	1.22
20211	62.66	0.65	0.04
20212	46.81	-15.20	-0.98
20311	68.49	6.48	0.42
20312	57.34	-4.67	-0.30
20411	64.54	2.53	0.16
20412	50.45	-11.56	-0.74
20511	62.09	0.08	0.01
20512	51.29	-10.72	-0.69
25111	81.21	19.20	1.23
25112	44.63	-17.38	-1.12
25211	79.84	17.83	1.14
25212	48.84	-13.17	-0.85
25311	79.94	17.93	1.15
25312	58.16	-3.85	-0.25
25411	64.39	2.38	0.15
25412	57.67	-4.34	-0.28
25511	100.94	38.93	2.50
25512	50.20	-11.81	-0.76
25611	78.17	16.16	1.04
25612	30.85	-31.16	-2.00
25711	67.56	5.55	0.36
25712	45.13	-16.88	-1.08
25811	75.70	13.69	0.88
25812	46.76	-15.25	-0.98

Table 1.4. (continued)

T_0

TOTAL	1604.7
MEAN	61.71923077
ST. DEV	33.42162269

KEY	VAL	DEV	NORMALIZED DEV
20111	103.73	42.01	1.26
20112	186.61	124.89	3.74
20211	51.25	-10.47	-0.31
20212	53.40	-8.32	-0.25
20311	62.96	1.24	0.04
20312	76.11	14.39	0.43
20411	81.22	19.50	0.58
20412	81.61	19.89	0.60
20511	47.38	-14.34	-0.43
20512	51.77	-9.95	-0.30
25111	25.74	-35.98	-1.08
25112	25.07	-36.65	-1.10
25211	66.89	5.17	0.15
25212	60.44	-1.28	-0.04
25311	64.86	3.14	0.09
25312	50.93	-10.79	-0.32
25411	87.23	25.51	0.76
25412	81.33	19.61	0.59
25511	78.99	17.27	0.52
25512	44.05	-17.67	-0.53
25611	36.19	-25.53	-0.76
25612	11.22	-50.50	-1.51
25711	39.85	-21.87	-0.65
25712	55.74	-5.98	-0.18
25811	41.21	-20.51	-0.61
25812	38.92	-22.80	-0.68

Table 1.4. (continued)

C

TOTAL	2370.79
MEAN	91.18423077
ST. DEV	22.79514934

KEY	VAL	DEV	NORMALIZED DEV
20111	55.25	-35.93	-1.58
20112	157.75	66.57	2.92
20211	75.43	-15.75	-0.69
20212	71.47	-19.71	-0.86
20311	73.42	-17.76	-0.78
20312	103.14	11.96	0.52
20411	53.10	-38.08	-1.67
20412	93.65	2.47	0.11
20511	76.84	-14.34	-0.63
20512	76.24	-14.94	-0.66
25111	106.40	15.22	0.67
25112	79.33	-11.85	-0.52
25211	103.48	12.30	0.54
25212	92.62	1.44	0.06
25311	106.65	15.47	0.68
25312	107.54	16.36	0.72
25411	98.69	7.51	0.33
25412	83.04	-8.14	-0.36
25511	130.29	39.11	1.72
25512	100.96	9.78	0.43
25611	103.46	12.28	0.54
25612	61.64	-29.54	-1.30
25711	88.31	-2.87	-0.13
25712	107.89	16.71	0.73
25811	78.11	-13.07	-0.57
25812	86.09	-5.09	-0.22

Table 1.4. (continued)

PHI

TOTAL	175
MEAN	6.73076923
ST. DEV	2.050515883

KEY	VAL	DEV	NORMALIZED DEV
20111	9.00	2.27	1.11
20112	6.00	-0.73	-0.36
20211	9.00	2.27	1.11
20212	9.00	2.27	1.11
20311	5.00	-1.73	-0.84
20312	8.00	1.27	0.62
20411	5.00	-1.73	-0.84
20412	8.00	1.27	0.62
20511	9.00	2.27	1.11
20512	7.00	0.27	0.13
25111	5.00	-1.73	-0.84
25112	8.00	1.27	0.62
25211	5.00	-1.73	-0.84
25212	8.00	1.27	0.62
25311	4.00	-2.73	-1.33
25312	8.00	1.27	0.62
25411	10.00	3.27	1.59
25412	8.00	1.27	0.62
25511	4.00	-2.73	-1.33
25512	6.00	-0.73	-0.36
25611	4.00	-2.73	-1.33
25612	6.00	-0.73	-0.36
25711	3.00	-3.73	-1.82
25712	6.00	-0.73	-0.36
25811	5.00	-1.73	-0.84
25812	10.00	3.27	1.59

Table 1.4. (continued)

VARIANCE

TOTAL	1779.64
MEAN	68.4476923
ST. DEV	54.65924305

KEY	VAL	DEV	NORMALIZED DEV
20111	20.20	-48.25	-0.88
20112	62.65	-5.80	-0.11
20211	199.59	131.14	2.40
20212	121.31	52.86	0.97
20311	171.27	102.82	1.88
20312	91.63	23.18	0.42
20411	126.85	58.40	1.07
20412	25.07	-43.38	-0.79
20511	16.74	-51.71	-0.95
20512	44.96	-23.49	-0.43
25111	142.25	73.80	1.35
25112	26.25	-42.20	-0.77
25211	92.67	24.22	0.44
25212	43.27	-25.18	-0.46
25311	103.08	34.63	0.63
25312	45.04	-23.41	-0.43
25411	94.46	26.01	0.48
25412	20.89	-47.56	-0.87
25511	57.12	-11.33	-0.21
25512	38.78	-29.67	-0.54
25611	30.51	-37.94	-0.69
25612	17.35	-51.10	-0.93
25711	23.86	-44.59	-0.82
25712	7.05	-61.40	-1.12
25811	143.82	75.37	1.38
25812	12.97	-55.48	-1.01

Table 1.5. Tanh Fit Parameters for Charpy Impact Lateral Expansion Data (A533B-1)

KEY	J	A	B	T0	C	PHI	VAR
20111	3	37.61	37.61	85.53	64.72	9	6.19
20112	3	36.17	35.61	101.80	71.47	9	6.21
20211	3	35.17	35.17	33.08	72.71	12	79.68
20212	3	34.60	33.65	46.67	67.42	12	46.48
20311	3	45.04	43.47	54.39	57.21	5	31.89
20312	3	42.80	40.80	69.33	64.73	8	50.95
20411	3	40.98	40.98	66.39	72.86	5	89.23
20412	3	38.28	38.28	77.27	83.28	8	14.79
20511	3	40.45	40.41	36.35	67.50	6	3.38
20512	3	38.71	38.71	50.00	76.88	7	14.94
25111	3	40.99	40.99	-29.84	50.32	3	44.14
25112	3	34.38	37.84	23.96	66.64	8	31.40
25211	3	41.05	41.05	19.49	61.43	3	8.12
25212	3	31.99	34.99	46.49	83.21	7	26.63
25311	3	40.73	41.25	14.76	68.82	5	58.10
25312	3	35.50	37.50	19.97	83.69	5	64.57
25411	3	38.72	39.33	54.19	71.96	10	75.92
25412	3	37.30	38.32	56.67	76.56	8	15.63
25511	3	42.59	42.59	-4.15	68.23	4	36.65
25512	3	34.11	37.45	23.30	75.45	5	30.80
25611	3	40.95	42.54	11.48	81.31	6	7.59
25612	3	31.97	31.97	12.11	93.46	6	8.40
25711	3	42.64	42.64	12.80	76.05	4	25.41
25712	3	32.60	37.11	47.95	77.15	5	8.39
25811	3	40.62	40.62	9.57	64.93	5	50.25
25812	3	35.17	35.17	27.99	80.28	10	23.33

Table 1.6. Deviation of Charpy Impact Lateral Expansion Curve Fit Parameters from Mean Value (A533B-1)

A

TOTAL	991.12
MEAN	38.12
ST. DEV	3.686556116

KEY	VAL	DEV	NORMALIZED DEV
20111	37.61	-0.51	-0.14
20112	36.17	-1.95	-0.53
20211	35.17	-2.95	-0.80
20212	34.60	-3.52	-0.95
20311	45.04	6.92	1.88
20312	42.80	4.68	1.27
20411	40.98	2.86	0.78
20412	38.28	0.16	0.04
20511	40.45	2.33	0.63
20512	38.71	0.59	0.16
25111	40.99	2.87	0.78
25112	34.38	-3.74	-1.01
25211	41.05	2.93	0.79
25212	31.99	-6.13	-1.66
25311	40.73	2.61	0.71
25312	35.50	-2.62	-0.71
25411	38.72	0.60	0.16
25412	37.30	-0.82	-0.22
25511	42.59	4.47	1.21
25512	34.11	-4.01	-1.09
25611	40.95	2.83	0.77
25612	31.97	-6.15	-1.67
25711	42.64	4.52	1.23
25712	32.60	-5.52	-1.50
25811	40.62	2.50	0.68
25812	35.17	-2.95	-0.80

Table 1.6. (continued)

B

TOTAL	1006.05
MEAN	38.69423077
ST. DEV	3.025536876

KEY	VAL	DEV	NORMALIZED DEV
20111	37.61	-1.08	-0.36
20112	35.61	-3.08	-1.02
20211	35.17	-3.52	-1.16
20212	33.65	-5.04	-1.67
20311	43.47	4.78	1.58
20312	40.80	2.11	0.70
20411	40.98	2.29	0.76
20412	38.28	-0.41	-0.14
20511	40.41	1.72	0.57
20512	38.71	0.02	0.01
25111	40.99	2.30	0.76
25112	37.84	-0.85	-0.28
25211	41.05	2.36	0.78
25212	34.99	-3.70	-1.22
25311	41.25	2.56	0.84
25312	37.50	-1.19	-0.39
25411	39.33	0.64	0.21
25412	38.32	-0.37	-0.12
25511	42.59	3.90	1.29
25512	37.45	-1.24	-0.41
25611	42.54	3.85	1.27
25612	31.97	-6.72	-2.22
25711	42.64	3.95	1.30
25712	37.11	-1.58	-0.52
25811	40.62	1.93	0.64
25812	35.17	-3.52	-1.16

Table 1.6. (continued)

T_0

TOTAL	967.55
MEAN	37.21346154
ST. DEV	29.56799174

KEY	VAL	DEV	NORMALIZED DEV
20111	85.53	48.32	1.63
20112	101.80	64.59	2.18
20211	33.08	-4.13	-0.14
20212	46.67	9.46	0.32
20311	54.39	17.18	0.58
20312	69.33	32.12	1.09
20411	66.39	29.18	0.99
20412	77.27	40.06	1.35
20511	36.35	-0.86	-0.03
20512	50.00	12.79	0.43
25111	-29.84	-67.05	-2.27
25112	23.96	-13.25	-0.45
25211	19.49	-17.72	-0.60
25212	46.49	9.28	0.31
25311	14.76	-22.45	-0.76
25312	19.97	-17.24	-0.58
25411	54.19	16.98	0.57
25412	56.67	19.46	0.66
25511	-4.15	-41.36	-1.40
25512	23.30	-13.91	-0.47
25611	11.48	-25.73	-0.87
25612	12.11	-25.10	-0.85
25711	12.80	-24.41	-0.83
25712	47.95	10.74	0.36
25811	9.57	-27.64	-0.93
25812	27.99	-9.22	-0.31

Table 1.6. (continued)

C

TOTAL	1998.27
MEAN	73.01038462
ST. DEV	9.46478208

KEY	VAL	DEV	NORMALIZED DEV
20111	64.72	-8.29	-0.88
20112	71.47	-1.54	-0.16
20211	72.71	-0.30	-0.03
20212	67.42	-5.59	-0.59
20311	57.21	-15.80	-1.67
20312	84.73	11.72	1.24
20411	72.86	-0.15	-0.02
20412	83.28	10.27	1.09
20511	67.50	-5.51	-0.58
20512	76.88	3.87	0.41
25111	50.32	-22.69	-2.40
25112	66.64	-6.37	-0.67
25211	61.43	-11.58	-1.22
25212	83.21	10.20	1.08
25311	68.82	-4.19	-0.44
25312	83.69	10.68	1.13
25411	71.96	-1.05	-0.11
25412	76.56	3.55	0.38
25511	68.23	-4.78	-0.51
25512	75.45	2.44	0.26
25611	81.31	8.30	0.88
25612	93.46	20.45	2.16
25711	76.05	3.04	0.32
25712	77.15	4.14	0.44
25811	64.93	-8.08	-0.85
25812	80.28	7.27	0.77

Table 1.6. (continued)

PHI

TOTAL	179
MEAN	6.884615385
ST. DEV	2.534985966

KEY	VAL	DEV	NORMALIZED DEV
20111	9.00	2.12	0.83
20112	9.00	2.12	0.83
20211	12.00	5.12	2.02
20212	12.00	5.12	2.02
20311	5.00	-1.88	-0.74
20312	8.00	1.12	0.44
20411	5.00	-1.88	-0.74
20412	8.00	1.12	0.44
20511	6.00	-0.88	-0.35
20512	7.00	0.12	0.05
25111	3.00	-3.88	-1.53
25112	8.00	1.12	0.44
25211	3.00	-3.88	-1.53
25212	7.00	0.12	0.05
25311	5.00	-1.88	-0.74
25312	9.00	2.12	0.83
25411	10.00	3.12	1.23
25412	8.00	1.12	0.44
25511	4.00	-2.88	-1.14
25512	5.00	-1.88	-0.74
25611	6.00	-0.88	-0.35
25612	6.00	-0.88	-0.35
25711	4.00	-2.88	-1.14
25712	5.00	-1.88	-0.74
25811	5.00	-1.88	-0.74
25812	10.00	3.12	1.23

Table 1.6. (continued)

VARIANCE

TOTAL	886.07
MEAN	34.11038462
ST. DEV	25.5783151

KEY	VAL	DEV	NORMALIZED DEV
20111	6.19	-27.92	-1.09
20112	6.21	-27.90	-1.09
20211	79.68	45.57	1.78
20212	46.48	12.37	0.48
20311	51.89	17.78	0.70
20312	50.95	16.84	0.66
20411	89.23	55.12	2.15
20412	14.79	-19.32	-0.76
20511	3.38	-30.73	-1.20
20512	14.84	-19.27	-0.75
25111	44.14	10.03	0.39
25112	31.40	-2.71	-0.11
25211	8.12	-25.99	-1.02
25212	26.63	-7.48	-0.29
25311	58.10	23.99	0.94
25312	64.57	30.46	1.19
25411	75.82	41.71	1.63
25412	15.63	-18.48	-0.72
25511	36.65	2.54	0.10
25512	30.80	-3.31	-0.13
25611	7.59	-26.52	-1.04
25612	8.40	-25.71	-1.01
25711	25.41	-8.70	-0.34
25712	8.39	-25.72	-1.01
25811	58.25	24.14	0.94
25812	23.33	-10.78	-0.42

Table 1.7. Tanh Fit Parameters for Charpy Impact Percent Shear Data (A533B-1)

KEY	J	A	B	T0	C	PHI	VAR
20111	4	50.09	50.09	121.67	56.86	12	16.23
20112	4	51.77	51.77	138.35	65.39	9	17.70
20211	4	51.18	51.18	70.75	65.02	12	78.79
20212	4	50.30	50.30	79.65	63.99	12	49.70
20311	4	50.99	49.94	85.87	91.17	5	7.83
20312	4	51.56	50.01	103.63	91.74	8	6.10
20411	4	52.21	49.50	88.92	59.23	5	67.54
20412	4	51.99	49.99	95.47	70.98	8	50.59
20511	4	48.88	48.88	47.59	79.17	9	16.74
20512	4	53.51	48.14	69.77	55.50	7	14.06
25111	4	48.91	48.91	16.77	82.07	5	56.58
25112	4	48.72	52.93	61.61	69.79	7	69.28
25211	4	49.82	49.82	58.00	85.15	4	19.14
25212	4	48.28	52.61	98.42	83.46	8	25.71
25311	4	49.49	49.49	50.86	71.64	4	37.99
25312	4	56.10	44.83	74.94	61.83	9	16.87
25411	4	50.82	50.54	103.40	94.14	11	30.17
25412	4	49.67	49.98	99.02	80.01	8	27.70
25511	4	49.78	49.78	34.14	81.09	3	25.36
25512	4	49.41	52.57	74.53	90.38	6	14.49
25611	4	50.10	50.10	24.69	79.92	6	28.61
25612	4	53.93	46.84	59.76	35.34	7	15.99
25711	4	50.58	50.58	37.89	85.91	3	33.48
25712	4	49.61	52.44	91.94	66.33	5	28.26
25811	4	50.02	50.02	47.82	64.33	6	51.63
25812	4	50.11	50.11	77.09	95.97	10	39.30

Table 1.8. Deviation of Charpy Impact Percent Shear Curve Fit Parameters from Mean Value (A533B-1)

A

TOTAL	1317.83
MEAN	50.68576923
ST. DEV	1.773692587

KEY	VAL	DEV	NORMALIZED DEV
20111	50.09	-0.60	-0.34
20112	51.77	1.08	0.61
20211	51.18	0.49	0.28
20212	50.30	-0.39	-0.22
20311	50.99	0.30	0.17
20312	51.56	0.87	0.49
20411	52.21	1.52	0.86
20412	51.99	1.30	0.74
20511	48.88	-1.81	-1.02
20512	53.51	2.82	1.59
25111	48.91	-1.78	-1.00
25112	48.72	-1.97	-1.11
25211	49.62	-0.87	-0.49
25212	48.28	-2.41	-1.36
25311	49.49	-1.20	-0.67
25312	56.10	5.41	3.05
25411	50.82	0.13	0.08
25412	49.67	-1.02	-0.57
25511	49.78	-0.91	-0.51
25512	49.41	-1.28	-0.72
25611	50.10	-0.59	-0.33
25612	53.93	3.24	1.83
25711	50.58	-0.11	-0.06
25712	49.61	-1.08	-0.61
25811	50.02	-0.67	-0.38
25812	50.11	-0.58	-0.32

Table 1.8. (continued)

B

TOTAL	1301.35
MEAN	50.05192308
ST. DEV	1.747810103

KEY	VAL	DEV	NORMALIZED DEV
20111	50.09	0.04	0.02
20112	51.77	1.72	0.98
20211	51.18	1.13	0.65
20212	50.30	0.25	0.14
20311	49.94	-0.11	-0.06
20312	50.01	-0.04	-0.02
20411	49.50	-0.55	-0.32
20412	49.99	-0.06	-0.04
20511	48.88	-1.17	-0.67
20512	48.14	-1.91	-1.09
25111	48.91	-1.14	-0.65
25112	52.93	2.88	1.65
25211	49.82	-0.23	-0.13
25212	52.61	2.56	1.46
25311	49.49	-0.56	-0.32
25312	44.83	-5.22	-2.99
25411	50.54	0.49	0.28
25412	49.98	-0.07	-0.04
25511	49.78	-0.27	-0.16
25512	52.57	2.52	1.44
25611	50.10	0.05	0.03
25612	46.84	-3.21	-1.84
25711	50.58	0.53	0.30
25712	52.44	2.39	1.37
25811	50.02	-0.03	-0.02
25812	50.11	0.06	0.03

Table 1.8.(continued)

$\underline{T_0}$

TOTAL	1912.55
MEAN	73.55961538
ST. DEV	29.4757334

KEY	VAL	DEV	NORMALIZED DEV
20111	121.67	48.11	1.63
20112	138.35	64.79	2.20
20211	70.75	-2.81	-0.10
20212	79.65	6.09	0.21
20311	85.87	12.31	0.42
20312	103.63	30.07	1.02
20411	88.92	15.36	0.52
20412	95.47	21.91	0.74
20511	47.59	-25.97	-0.88
20512	69.77	-3.79	-0.13
25111	16.77	-56.79	-1.93
25112	61.61	-11.95	-0.41
25211	58.00	-15.56	-0.53
25212	98.42	24.86	0.84
25311	50.86	-22.70	-0.77
25312	74.94	1.38	0.05
25411	103.40	29.84	1.01
25412	99.02	25.46	0.86
25511	34.14	-39.42	-1.34
25512	74.53	0.97	0.03
25611	24.69	-48.87	-1.66
25612	59.76	-13.80	-0.47
25711	37.89	-35.67	-1.21
25712	91.94	18.38	0.62
25811	47.82	-25.74	-0.87
25812	77.09	3.53	0.12

Table 1.8. (continued)

C

TOTAL	1906.41
MEAN	73.32346154
ST. DEV	13.67769453

KEY	VAL	DEV	NORMALIZED DEV
20111	56.86	-16.46	-1.20
20112	65.39	-7.93	-0.58
20211	65.02	-8.30	-0.61
20212	63.99	-9.33	-0.68
20311	81.17	7.85	0.57
20312	91.74	18.42	1.35
20411	59.23	-14.09	-1.03
20412	70.98	-2.34	-0.17
20511	79.17	5.85	0.43
20512	55.50	-17.82	-1.30
25111	82.07	8.75	0.64
25112	69.79	-3.53	-0.26
25211	85.15	11.83	0.86
25212	83.46	10.14	0.74
25311	71.64	-1.68	-0.12
25312	61.83	-11.49	-0.84
25411	94.14	20.82	1.52
25412	80.01	6.69	0.49
25511	81.09	7.77	0.57
25512	90.38	17.06	1.25
25611	79.92	6.60	0.48
25612	35.34	-37.98	-2.78
25711	85.91	12.59	0.92
25712	66.33	-6.99	-0.51
25811	64.33	-8.99	-0.66
25812	85.97	12.65	0.92

Table 1.8. (continued)

PHI

TOTAL	189
MEAN	7.269230769
ST. DEV	2.706402665

KEY	VAL	DEV	NORMALIZED DEV
20111	12.00	4.73	1.75
20112	9.00	1.73	0.64
20211	12.00	4.73	1.75
20212	12.00	4.73	1.75
20311	5.00	-2.27	-0.84
20312	8.00	0.73	0.27
20411	5.00	-2.27	-0.84
20412	8.00	0.73	0.27
20511	9.00	1.73	0.64
20512	7.00	-0.27	-0.10
25111	5.00	-2.27	-0.84
25112	7.00	-0.27	-0.10
25211	4.00	-3.27	-1.21
25212	8.00	0.73	0.27
25311	4.00	-3.27	-1.21
25312	9.00	1.73	0.64
25411	11.00	3.73	1.38
25412	8.00	0.73	0.27
25511	3.00	-4.27	-1.58
25512	6.00	-1.27	-0.47
25611	6.00	-1.27	-0.47
25612	7.00	-0.27	-0.10
25711	3.00	-4.27	-1.58
25712	5.00	-2.27	-0.84
25811	6.00	-1.27	-0.47
25812	10.00	2.73	1.01

Table 1.8. (continued)

VARIANCE

TOTAL	845.84
MEAN	32.53230769
ST. DEV	19.92552219

KEY	VAL	DEV	NORMALIZED DEV
20111	16.23	-16.30	-0.82
20112	17.70	-14.83	-0.74
20211	78.79	46.26	2.32
20212	49.70	17.17	0.86
20311	7.83	-24.70	-1.24
20312	6.10	-26.43	-1.33
20411	67.54	35.01	1.76
20412	50.59	18.06	0.91
20511	16.74	-15.79	-0.79
20512	14.06	-18.47	-0.93
25111	56.58	24.05	1.21
25112	69.28	36.75	1.84
25211	19.14	-13.39	-0.67
25212	25.71	-6.82	-0.34
25311	37.99	5.46	0.27
25312	16.87	-15.66	-0.79
25411	30.17	-2.36	-0.12
25412	27.70	-4.83	-0.24
25511	25.36	-7.17	-0.36
25512	14.49	-18.04	-0.91
25611	28.61	-3.92	-0.20
25612	15.99	-16.54	-0.83
25711	33.48	0.95	0.05
25712	28.26	-4.27	-0.21
25811	51.63	19.10	0.96
25812	39.30	6.77	0.34

Table 1.9. Comparison of T_0 - C from Impact Test Measurements with RT_{NDT} and NDTT (A533B-1)

KEY	T_0 - C (°F) IMPACT ENERGY	T_0 - C (°F) LATERAL EXPANSION	T_0 - C (°F) PERCENT SHEAR	RT_{NDT} (°F)	NDTT (°F)
20111	48	21	65	60	-10
20112	29	30	74		
20211	-24	-40	6	16	-50
20212	-18	-21	16		
20311	-10	-3	5	10	10
20312	-27	-15	12		
20411	28	-6	30	30	0
20412	-12	-6	24		
20511	-29	-31	-32	15	-20
20512	-24	-27	14		
25111	-81	-80	-65	0	-20
25112	-54	-43	-8		
25211	-37	-42	-27	10	-10
25212	-32	-37	15		
25311	-42	-54	-21	0	0
25312	-57	-64	13		
25411	-11	-17	9	20	0
25412	-2	-20	19		
25511	-51	-72	-47	0	-30
25512	-57	-52	-16		
25611	-67	-70	-55	-10	-20
25612	-50	-81	24		
25711	-48	-63	-48	10	10
25712	-52	-29	26		
25811	-37	-55	-17	0	0
25812	-47	-52	-9		

Table 1.10. Tanh Fit Parameters for Precracked Charpy Toughness Data (A533B-1)

KEY	J	A	B	T0	C	PHI	VAR
30112	2	167.44	128.93	106.97	47.96	5	485.10
30212	2	154.89	108.80	83.11	39.34	8	1386.54
30312	2	172.63	117.29	83.80	27.33	8	1218.41
30412	2	160.18	114.46	84.92	31.51	6	89.72
30512	2	161.55	116.60	66.00	38.41	5	68.26
35112	2	141.95	99.15	34.65	15.61	4	586.35
35212	2	146.44	112.86	73.59	58.56	5	491.05
35312	2	169.86	123.77	59.00	32.85	4	286.88
35411	2	179.03	148.58	106.80	60.90	6	577.07
35512	2	140.69	105.76	33.72	58.16	4	177.46
35612	2	138.52	90.08	30.63	17.64	4	104.12
35712	2	138.75	94.02	45.28	33.34	5	127.08
35812	2	139.22	106.74	40.01	25.55	6	478.05
351312	2	146.85	123.05	99.03	68.88	5	629.06
35812	2	139.22	106.74	40.01	25.55	6	478.05
351312	2	146.85	123.05	99.03	68.88	5	629.06

Table 1.11. Deviation of Precracked Charpy Fracture Toughness Curve Fit Parameters from Mean Values (A533B-1)

A

TOTAL	2444.07
MEAN	152.754375
ST. DEV	13.82692927

KEY	VAL	DEV	NORMALIZED DEV
30112	167.44	14.69	1.06
30212	154.89	2.14	0.15
30312	172.63	19.88	1.44
30412	160.18	7.43	0.54
30512	161.55	8.80	0.64
35112	141.95	-10.80	-0.78
35212	146.44	-6.31	-0.46
35312	169.86	17.11	1.24
35411	179.03	26.28	1.90
35512	140.69	-12.06	-0.87
35612	138.52	-14.23	-1.03
35712	138.75	-14.00	-1.01
35812	139.22	-13.53	-0.98
351312	146.85	-5.90	-0.43
35812	139.22	-13.53	-0.98
351312	146.85	-5.90	-0.43

Table 1.11. (continued)

B

TOTAL	1819.88
MEAN	113.7425
ST. DEV	14.34855556

KEY	VAL	DEV	NORMALIZED DEV
30112	128.93	15.19	1.06
30212	108.80	-4.94	-0.34
30312	117.29	3.55	0.25
30412	114.46	0.72	0.05
30512	116.60	2.86	0.20
35112	99.15	-14.59	-1.02
35212	112.86	-0.88	-0.06
35312	123.77	10.03	0.70
35411	148.58	34.84	2.43
35512	105.76	-7.98	-0.56
35612	90.08	-23.66	-1.65
35712	94.02	-19.72	-1.37
35812	106.74	-7.00	-0.49
351312	123.05	9.31	0.65
35812	106.74	-7.00	-0.49
351312	123.05	9.31	0.65

Table 1.11. (continued)

T_0

TOTAL	1086.55
MEAN	67.909375
ST. DEV	27.80541230

KEY	VAL	DEV	NORMALIZED DEV
30112	106.97	39.06	1.40
30212	83.11	15.20	0.55
30312	83.80	15.89	0.57
30412	84.92	17.01	0.61
30512	66.00	-1.91	-0.07
35112	34.65	-33.26	-1.20
35212	73.59	5.68	0.20
35312	59.00	-8.91	-0.32
35411	106.80	38.89	1.40
35512	33.72	-34.19	-1.23
35612	30.63	-37.28	-1.34
35712	45.28	-22.63	-0.81
35812	40.01	-27.90	-1.00
351312	99.03	31.12	1.12
35812	40.01	-27.90	-1.00
351312	99.03	31.12	1.12

Table 1.11. (continued)

C

TOTAL	642.47
MEAN	40.154375
ST. DEV	17.24160819

KEY	VAL	DEV	NORMALIZED DEV
30112	47.96	7.81	0.45
30212	39.34	-0.81	-0.05
30312	27.33	-12.82	-0.74
30412	31.51	-8.64	-0.50
30512	38.41	-1.74	-0.10
35112	15.61	-24.54	-1.42
35212	58.56	18.41	1.07
35312	32.85	-7.30	-0.42
35411	60.90	20.75	1.20
35512	50.16	10.01	0.58
35612	17.64	-22.51	-1.31
35712	33.34	-6.81	-0.40
35812	25.55	-14.60	-0.85
351312	68.88	28.73	1.67
35812	25.55	-14.60	-0.85
351312	68.88	28.73	1.67

Table 1.11. (continued)

PHI

TOTAL	86
MEAN	5.375
ST. DEV	1.258305739

KEY	VAL	DEV	NORMALIZED DEV
30112	5.00	-0.38	-0.30
30212	8.00	2.63	2.09
30312	8.00	2.63	2.09
30412	6.00	0.63	0.50
30512	5.00	-0.38	-0.30
35112	4.00	-1.38	-1.09
35212	5.00	-0.38	-0.30
35312	4.00	-1.38	-1.09
35411	6.00	0.63	0.50
35512	4.00	-1.38	-1.09
35612	4.00	-1.38	-1.09
35712	5.00	-0.38	-0.30
35812	6.00	0.63	0.50
351312	5.00	-0.38	-0.30
35812	6.00	0.63	0.50
351312	5.00	-0.38	-0.30

Table 1.11. (continued)

VARIANCE

TOTAL	7812.34
MEAN	488.27125
ST. DEV	378.4009417

KEY	VAL	DEV	NORMALIZED DEV
30112	485.18	-3.09	-0.01
30212	1386.54	898.27	2.37
30312	1218.41	730.14	1.93
30412	89.72	-398.55	-1.05
30512	68.26	-420.01	-1.11
35112	586.35	98.08	0.26
35212	491.05	2.78	0.01
35312	286.88	-201.39	-0.53
35411	577.07	88.80	0.23
35512	177.46	-310.81	-0.82
35612	104.12	-384.15	-1.02
35712	127.08	-361.19	-0.95
35812	478.05	-10.22	-0.03
351312	629.06	140.79	0.37
35812	478.05	-10.22	-0.03
351312	629.06	140.79	0.37

Table 1.12. Tanh Fit Parameters for Precracked Charpy W/A Data (A533B-1)

KEY	J	A	B	TO	C	PHI	VAR
30112	5	3663.35	3363.55	102.45	87.71	5	11128.80
30212	5	2800.80	2584.87	51.66	65.14	8	69031.90
30312	5	3219.47	3110.60	74.36	64.19	6	1.32E+05
30412	5	3143.37	2687.42	68.33	52.88	4	1.70E+05
30512	5	2556.45	2555.97	29.14	62.88	7	3.04E+05
35112	5	2692.37	2656.62	9.60	66.15	5	22852.20
35212	5	3010.10	2924.02	57.25	82.96	6	1.26E+05
35312	5	3623.27	3180.82	54.95	62.25	4	5.01E+05
35411	5	3511.17	3511.17	76.42	80.41	6	3.18E+05
35512	5	2991.75	2855.57	40.16	81.90	6	19228.60
35612	5	2337.50	2217.63	16.08	76.80	5	5899.31
35712	5	2702.15	2654.00	46.24	86.86	5	38589.10
35812	5	3068.35	3015.75	44.97	93.64	5	46543.80
351312	5	3302.70	3243.60	90.41	106.18	5	2.56E+05

Table 1.13. Deviation of Precracked Charpy W/A Curve Fit Parameters from Mean Values (A533B-1)

A

TOTAL	42622.8
MEAN	3044.485714
ST. DEV	400.5720176

KEY	VAL	DEV	NORMALIZED DEV
30112	3663.35	618.86	1.54
30212	2800.80	-243.69	-0.61
30312	3219.47	174.98	0.44
30412	3143.37	98.88	0.25
30512	2556.45	-488.04	-1.22
35112	2692.37	-352.12	-0.88
35212	3010.10	-34.39	-0.09
35312	3623.27	578.78	1.44
35411	3511.17	466.68	1.17
35512	2991.75	-52.74	-0.13
35612	2337.50	-706.99	-1.76
35712	2702.15	-342.34	-0.85
35812	3068.35	23.86	0.06
351312	3302.70	258.21	0.64

Table 1.13. (continued)

B

TOTAL	40561.59
MEAN	2897.256429
ST. DEV	360.9556425

KEY	VAL	DEV	NORMALIZED DEV
30112	3363.55	466.29	1.29
30212	2584.87	-312.39	-0.87
30312	3110.60	213.34	0.59
30412	2687.42	-209.84	-0.58
30512	2555.97	-341.29	-0.95
35112	2656.62	-240.64	-0.67
35212	2924.02	26.76	0.07
35312	3180.82	283.56	0.79
35411	3511.17	613.91	1.70
35512	2855.57	-41.69	-0.12
35612	2217.63	-679.63	-1.88
35712	2654.00	-243.26	-0.67
35812	3015.75	118.49	0.33
351312	3243.60	346.34	0.96

Table 1.13. (continued)

T_0

TOTAL	772.02
MEAN	55.14428571
ST. DEV	26.77519625

KEY	VAL	DEV	NORMALIZED DEV
30112	102.45	47.31	1.77
30212	51.66	-3.48	-0.13
30312	74.36	19.22	0.72
30412	68.33	13.19	0.49
30512	29.14	-26.00	-0.97
35112	9.60	-45.54	-1.70
35212	67.25	12.11	0.45
35312	54.95	-0.19	-0.01
35411	76.42	21.28	0.79
35512	40.16	-14.98	-0.56
35612	16.08	-39.06	-1.46
35712	46.24	-8.90	-0.33
35812	44.97	-10.17	-0.38
351312	90.41	35.27	1.32

Table 1.13. (continued)

C

TOTAL	1069.95
MEAN	76.425
ST. DEV	14.74930546

KEY	VAL	DEV	NORMALIZED DEV
30112	87.71	11.29	0.77
30212	65.14	-11.29	-0.77
30312	64.19	-12.24	-0.83
30412	52.80	-23.55	-1.60
30512	62.88	-13.55	-0.92
35112	66.15	-10.28	-0.70
35212	82.96	6.54	0.44
35312	62.25	-14.18	-0.96
35411	80.41	3.99	0.27
35512	81.90	5.48	0.37
35612	76.80	0.38	0.03
35712	86.86	10.44	0.71
35812	93.64	17.22	1.17
351312	106.18	29.76	2.02

Table 1.13. (continued)

PHI

TOTAL	77
MEAN	5.5
ST. DEV	1.091929428

KEY	VAL	DEV	NORMALIZED DEV
30112	5.00	-0.50	-0.46
30212	8.00	2.50	2.29
30312	6.00	0.50	0.46
30412	4.00	-1.50	-1.37
30512	7.00	1.50	1.37
35112	5.00	-0.50	-0.46
35212	6.00	0.50	0.46
35312	4.00	-1.50	-1.37
35411	6.00	0.50	0.46
35512	6.00	0.50	0.46
35612	5.00	-0.50	-0.46
35712	5.00	-0.50	-0.46
35812	5.00	-0.50	-0.46
351312	5.00	-0.50	-0.46

Table 1.13. (continued)

VARIANCE

TOTAL	2017303.21
MEAN	144093.0864
ST. DEV	149631.4972

KEY	VAL	DEV	NORMALIZED DEV
30112	11128.80	-1.33E+05	-0.89
30212	68031.90	-76061.19	-0.51
30312	1.32E+05	-12334.09	-0.08
30412	1.70E+05	26205.91	0.18
30512	3.04E+05	1.60E+05	1.07
35112	22852.20	-1.21E+05	-0.81
35212	1.26E+05	-18007.09	-0.12
35312	5.01E+05	3.57E+05	2.39
35411	3.18E+05	1.74E+05	1.16
35512	19228.60	-1.25E+05	-0.83
35612	3899.81	-1.40E+05	-0.94
35712	39589.10	-1.06E+05	-0.71
35812	46543.90	-97549.29	-0.65
251312	2.56E+05	1.12E+05	0.75

Table 1.14. Comparison of Precracked Charpy Transition Behavior with NDTT and RT_{NDT} (A533B-1)

KEY	$T_o - C$ (^oF) K_{Id}, K_d^*	$T_o - C$ (^oF) W/A	RT_{NDT} (^oF)	NDTT (^oF)
30112	59	15	60	-10
30212	44	-14	16	-50
30312	56	10	10	10
30412	53	15	30	0
30512	28	-34	15	-20
35112	19	-57	0	-20
35212	15	-16	10	-10
35312	26	-7	0	0
35411	46	-4	20	0
35512	-16	-42	0	-30
35612	13	-61	-10	-20
35712	12	-41	10	10
35812	14	-49	0	0
351312	30	-16	30	0

Table 1.15. Summary of Error Code Analysis For Material 1 (A533B-1)

TEST TYPE	INCLUDES ERROR CODES	NO. OF POINTS	SHELF (Ft-Lb) LOWER	SHELF (Ft-Lb) UPPER	VARIANCE OVERALL	VARIANCE TRANSITION REGION*	VARIANCE RATIO F** OVERALL	VARIANCE RATIO F** TRANSITION REGION
Static (5,11)	Yes+	75	61	--	1558	2113		
							0.849	0.890
	No++	58	51	--	1835	2374		
Dynamic (6,7,8,10)	Yes	93	56	--	1427	2622		
							1.044	1.110
	No	78	54	--	1367	2362		

* Transition Range - To $\pm$ 50°F

** The variance ratio F equals the ratio of the variance for all points including the error codes (unacceptable points) over the variance for the points with no error codes (acceptable points).

\+ Yes - Analysis included all data.

++ No - Analysis only included data which met the EPRI procedures.

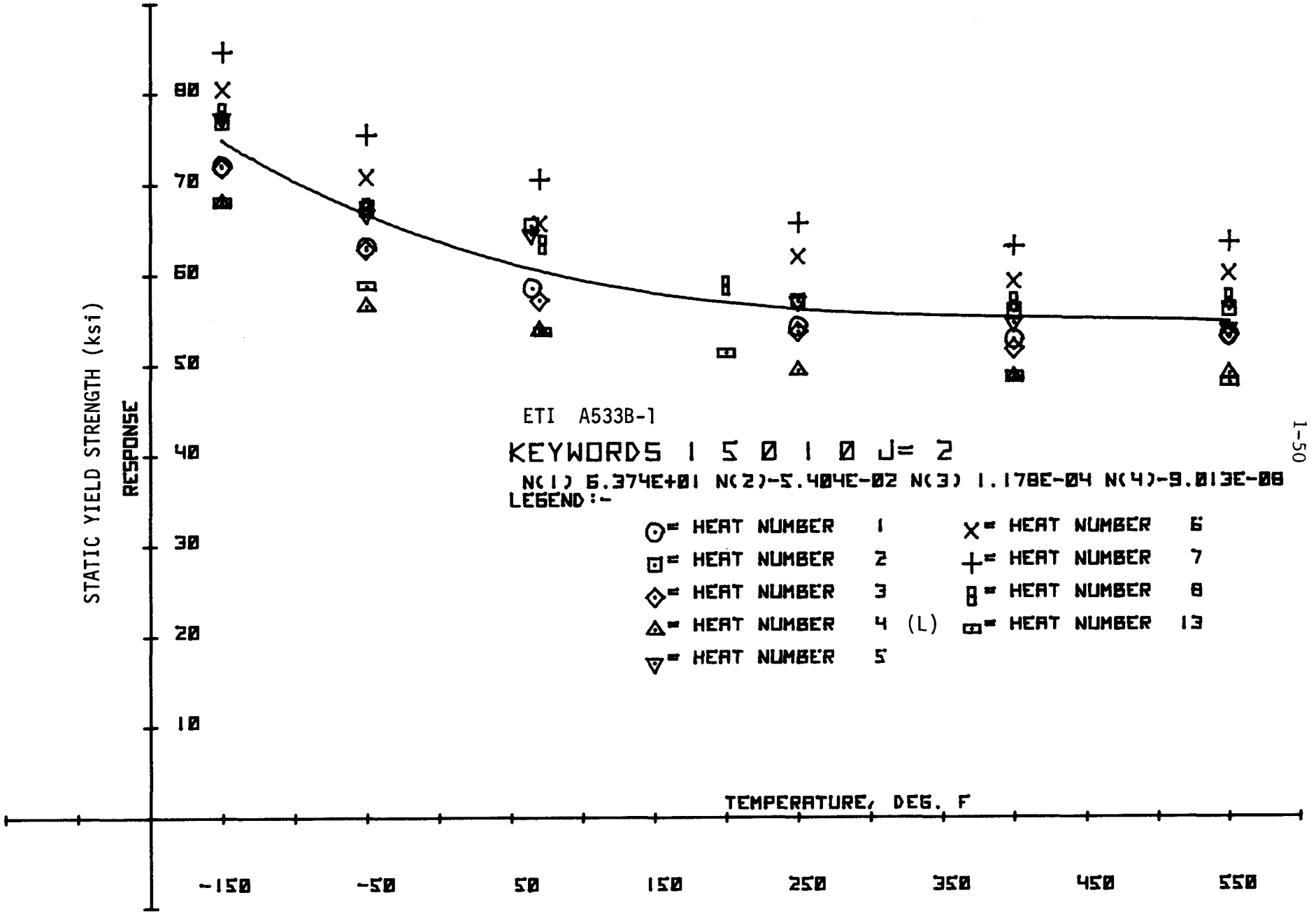

Figure 1.1 Tensile Static Yield Strength for ETI Heats

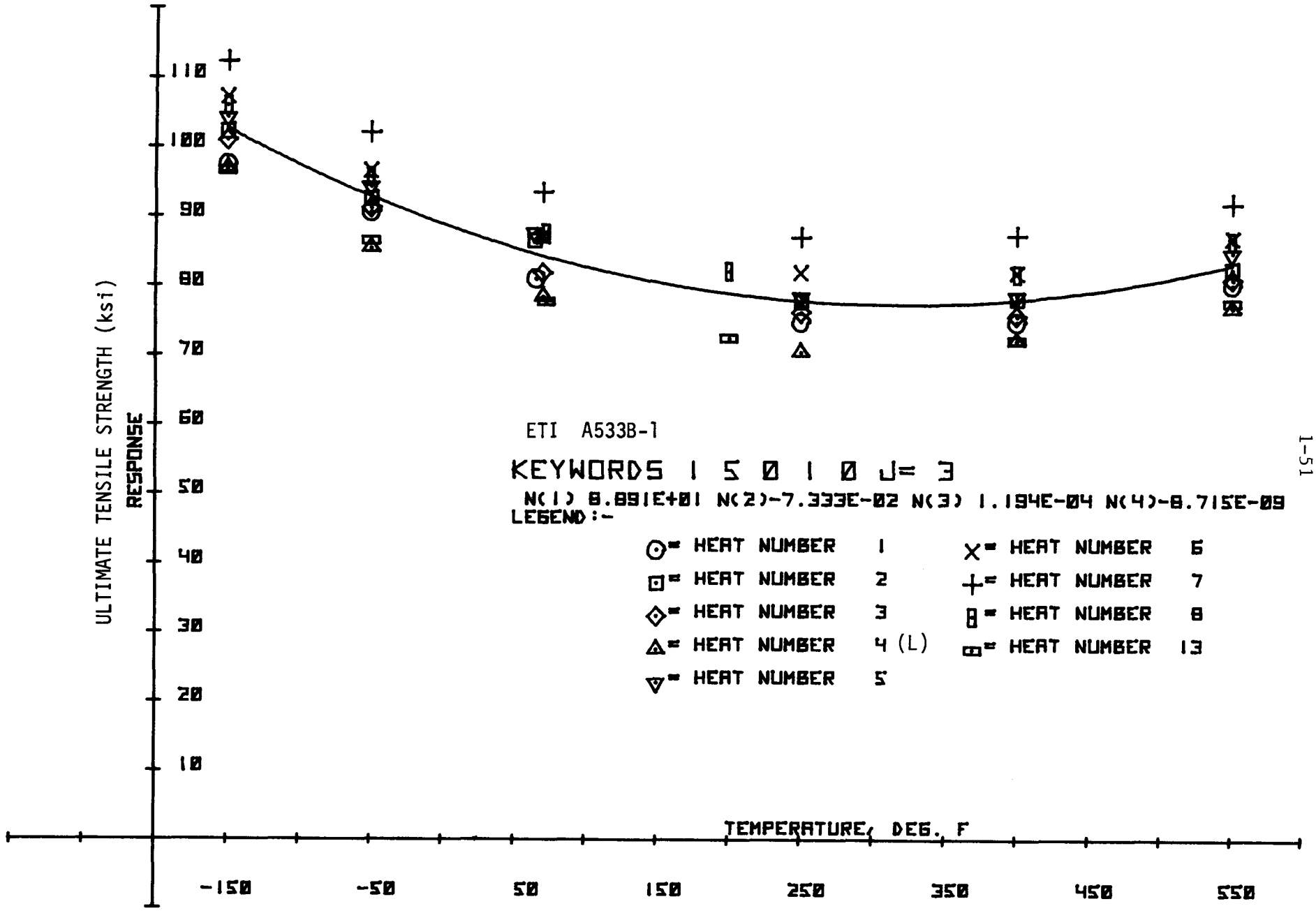

Figure 1.2 Tensile Ultimate Strength for ETI Heats

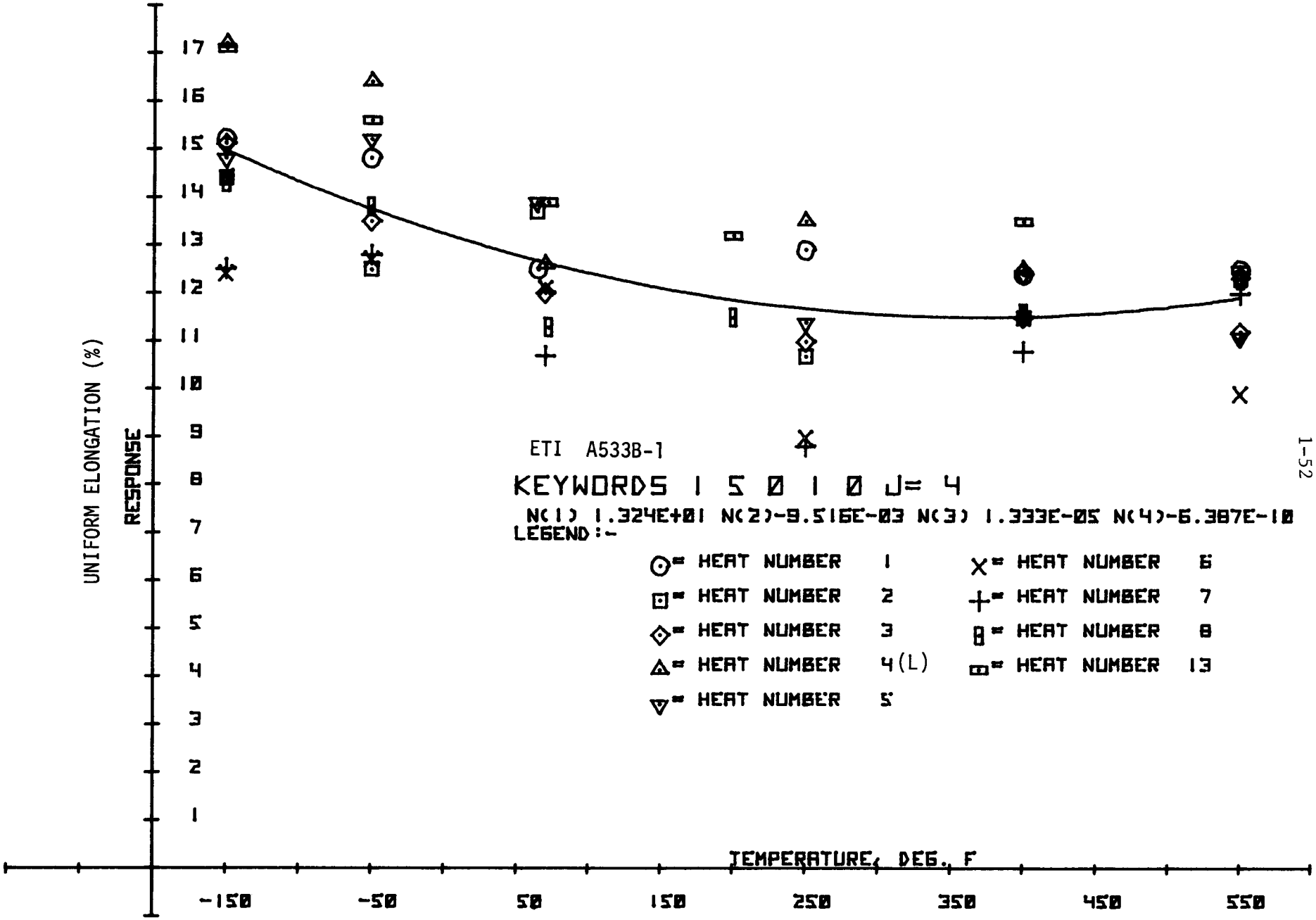

Figure 1.3 Tensile Uniform Elongation for ETI Heats

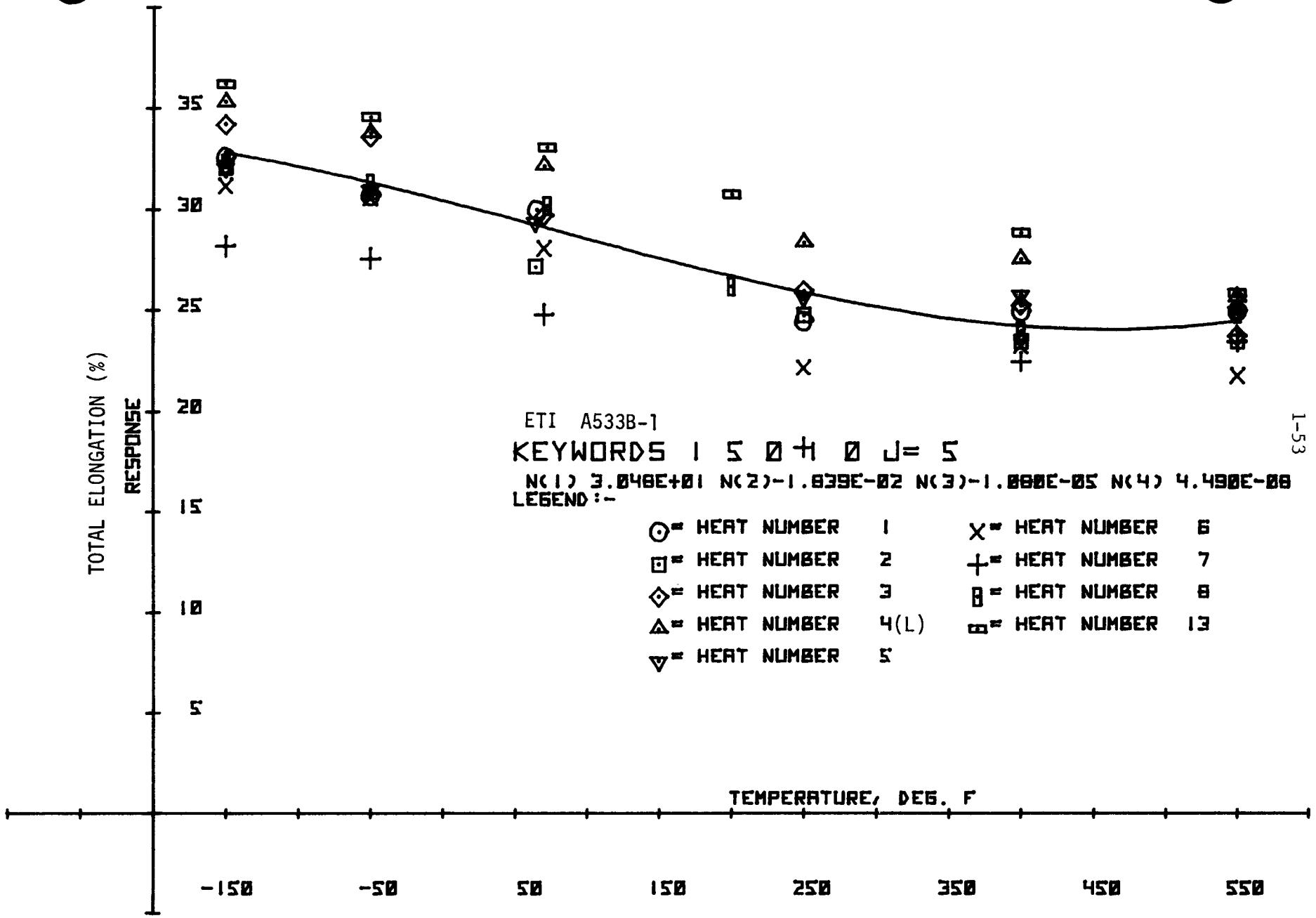

Figure 1.4 Tensile Total Elongation for ETI Heats

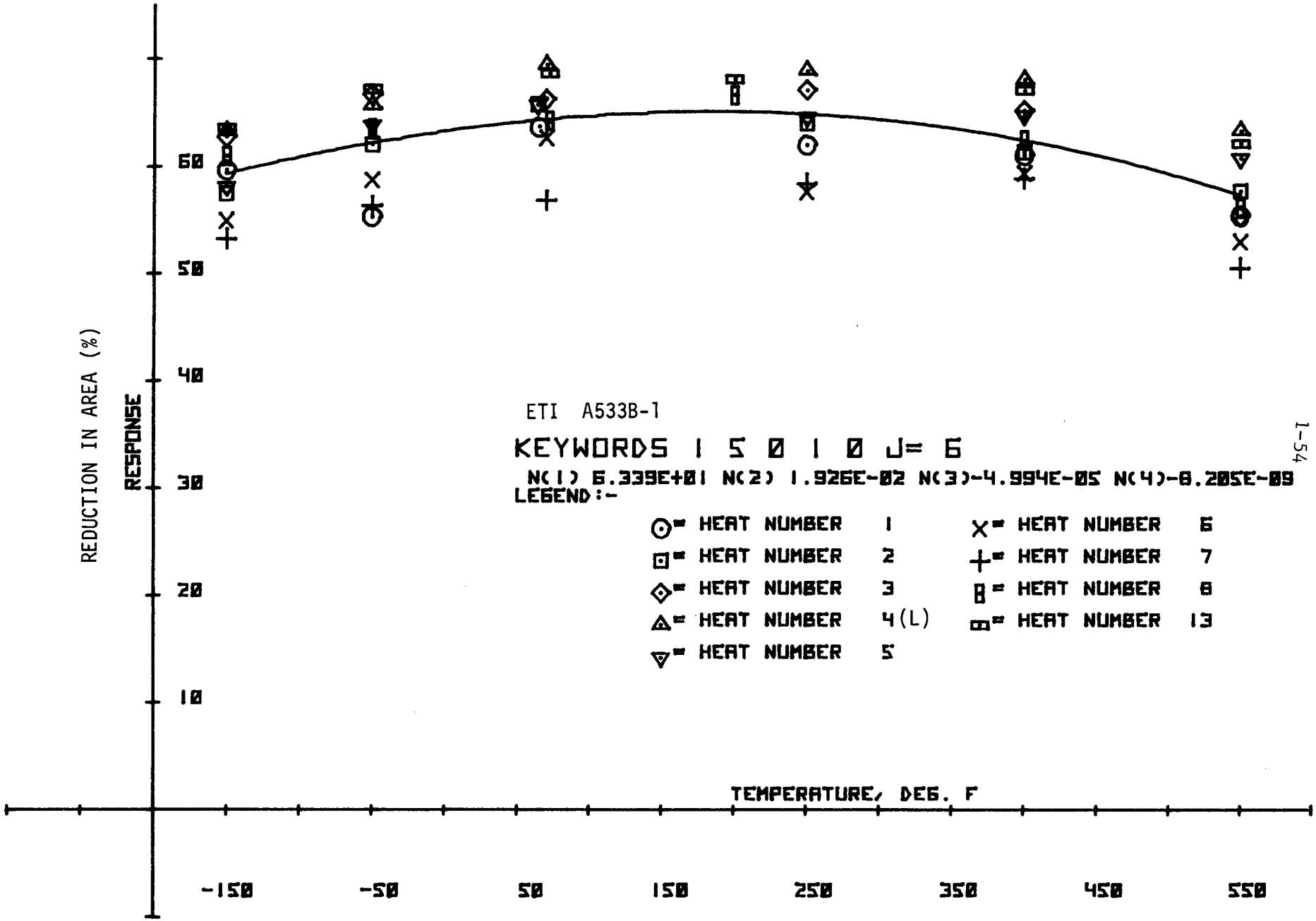

Figure 1.5 Tensile Reduction in Area for ETI Heats

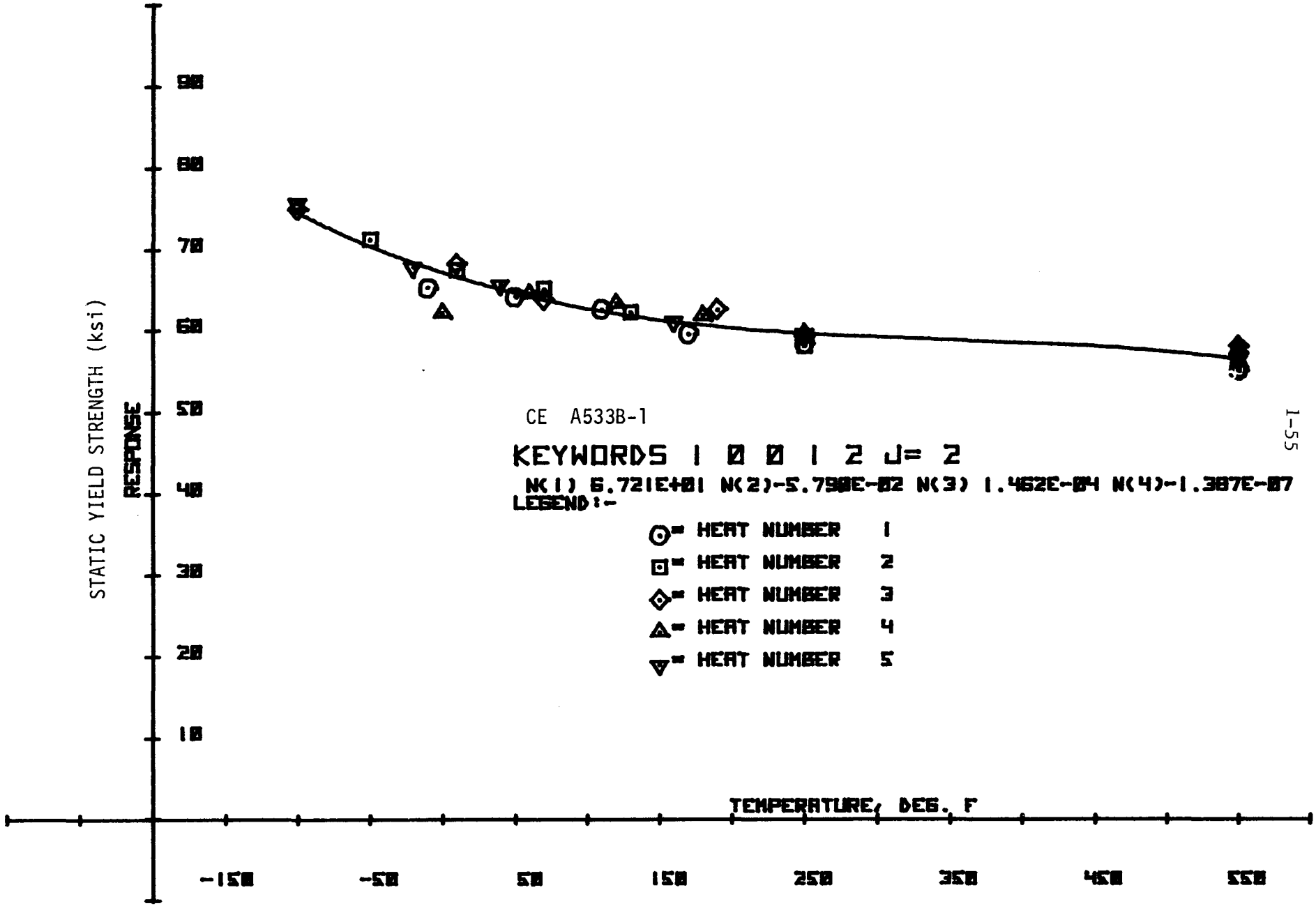

Figure 1.6 Tensile Static Yield Strength for CE Heats

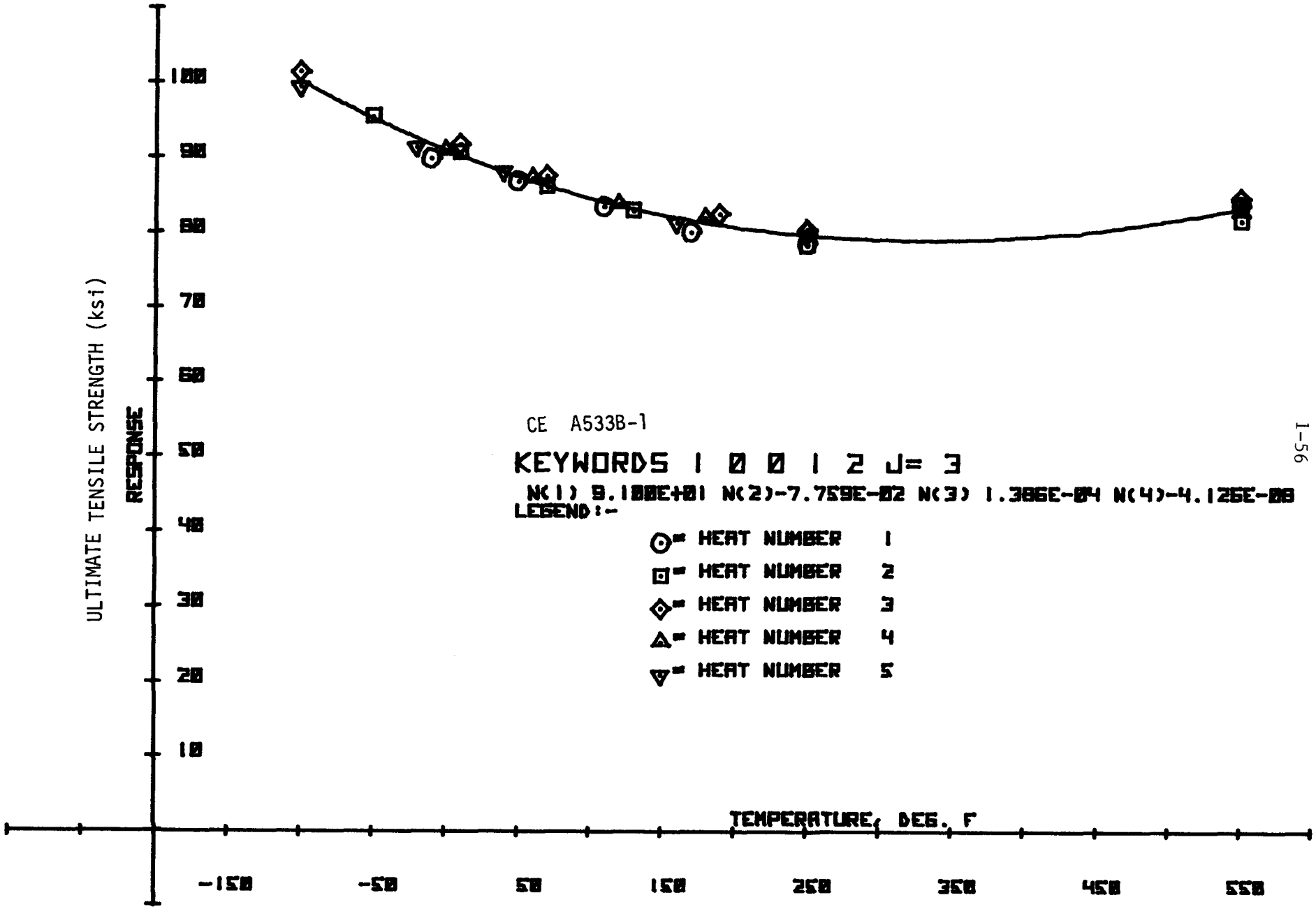

Figure 1.7 Tensile Ultimate Strength for CE Heats

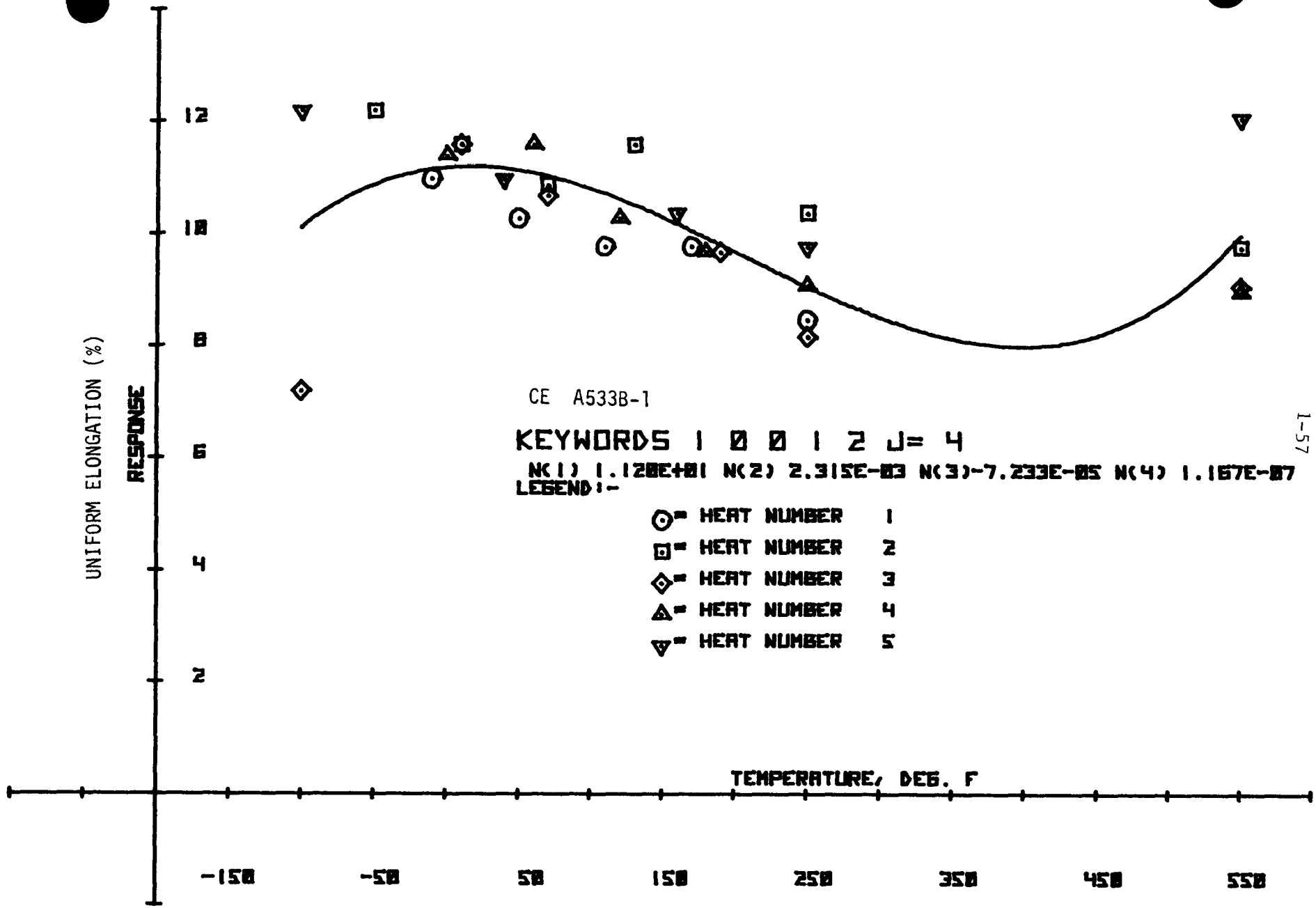

Figure 1.8 Tensile Uniform Elongation for CE Heats

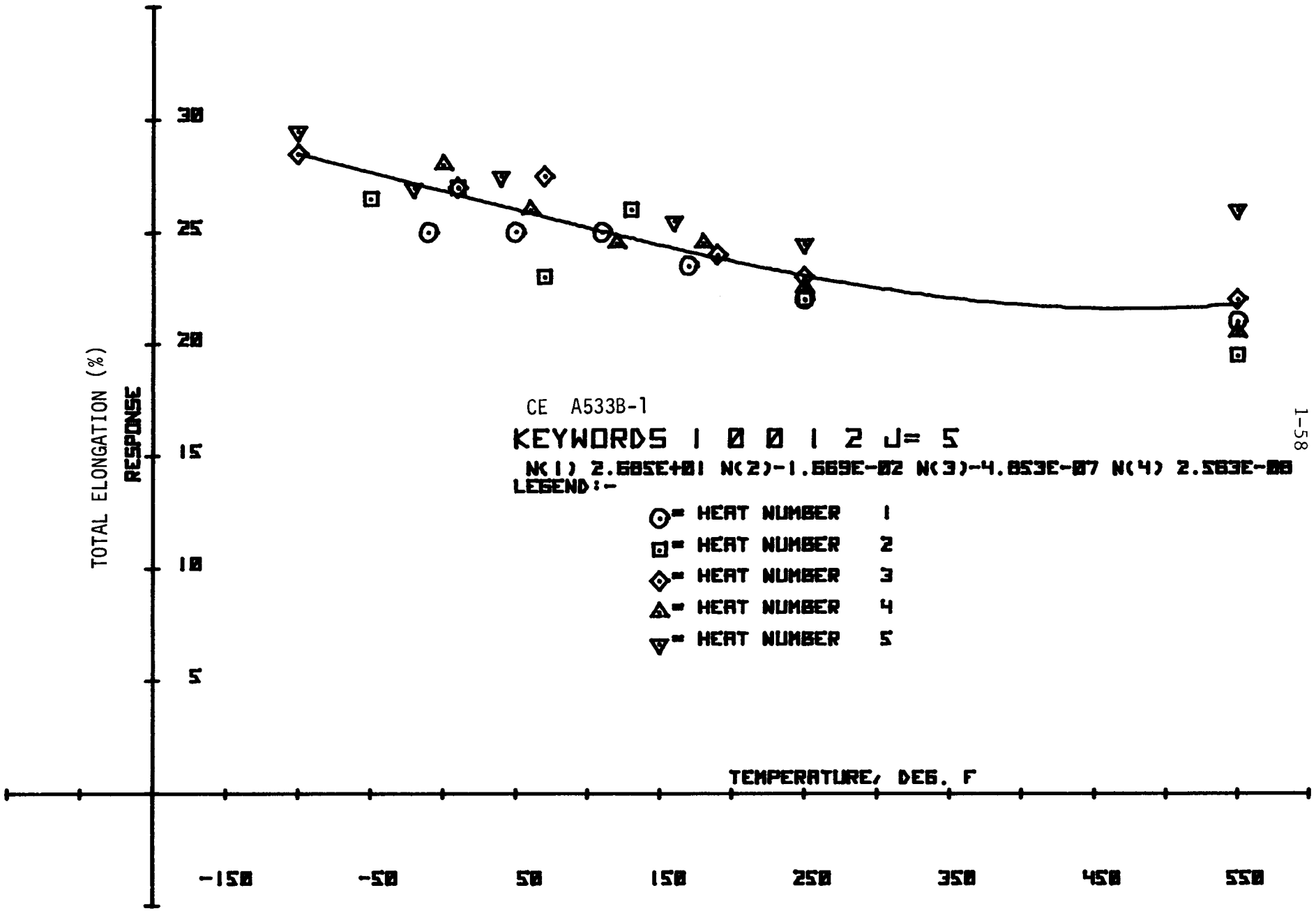

Figure 1.9 Tensile Total Elongation for CE Heats

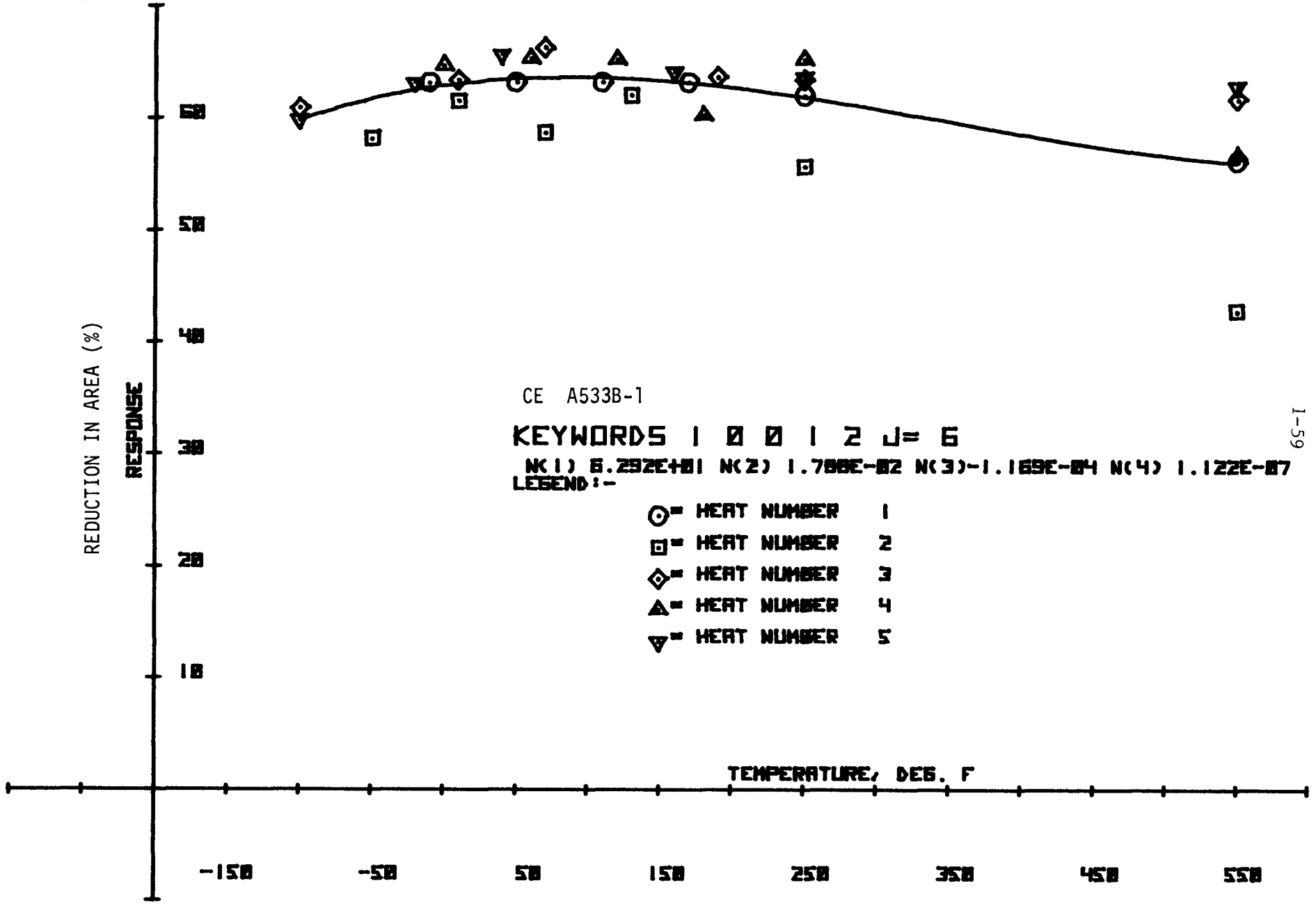

Figure 1.10 Tensile Reduction in Area for CE Heats

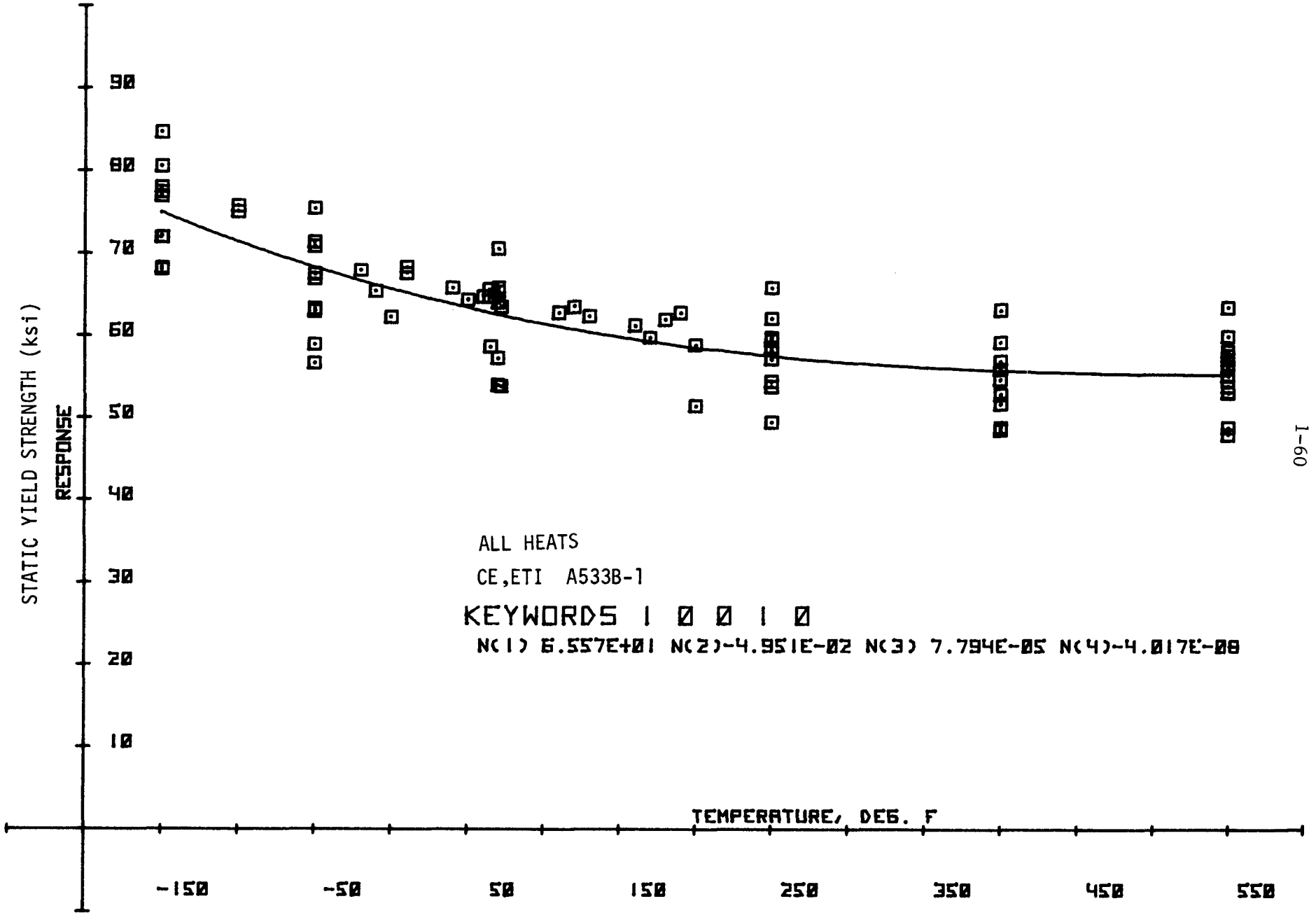

Figure 1.11 Tensile Static Yield Strength for All Heats

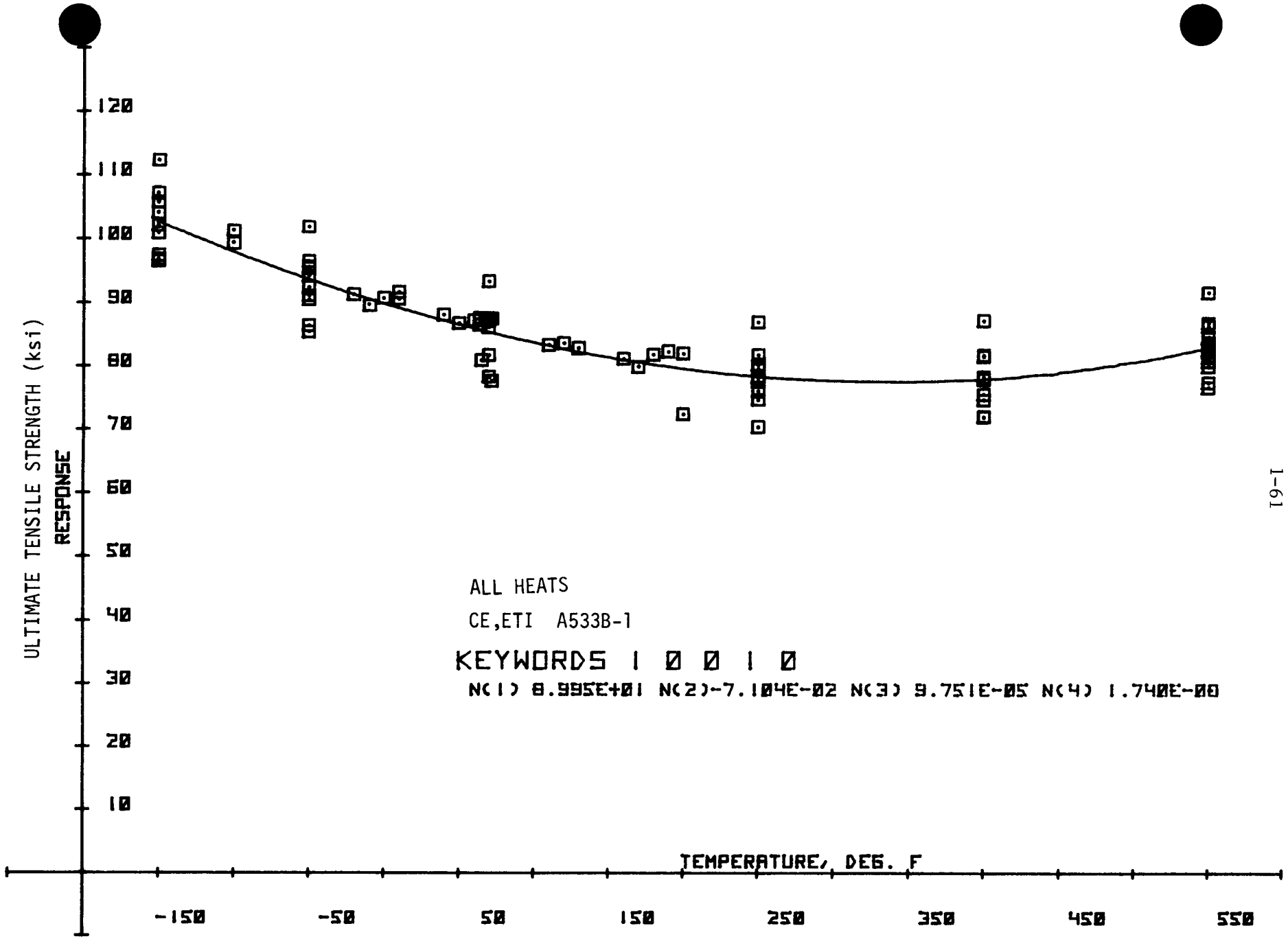

Figure 1.12 Tensile Ultimate Strength for All Heats

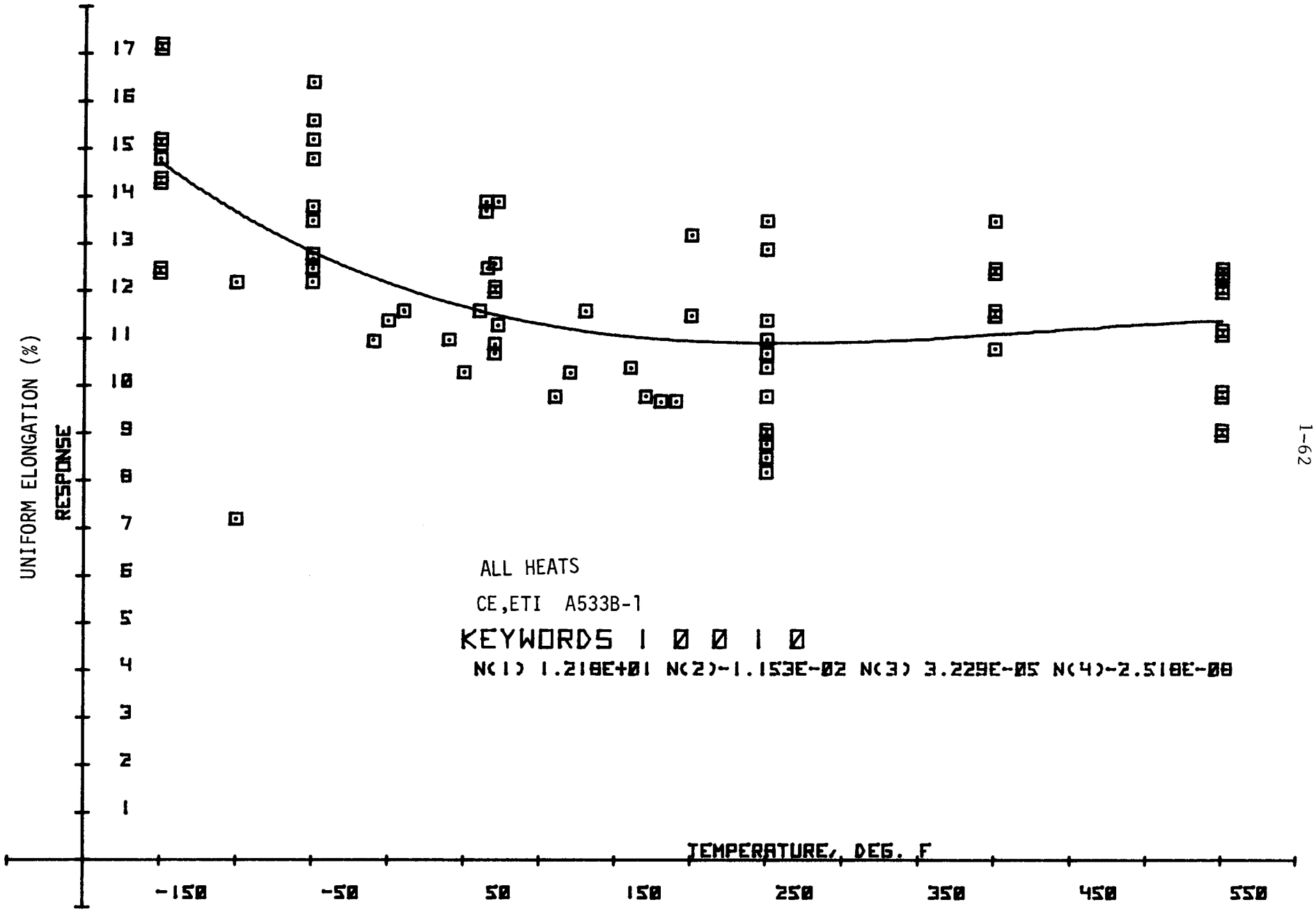

Figure 1.13 Tensile Uniform Elongation for All Heats

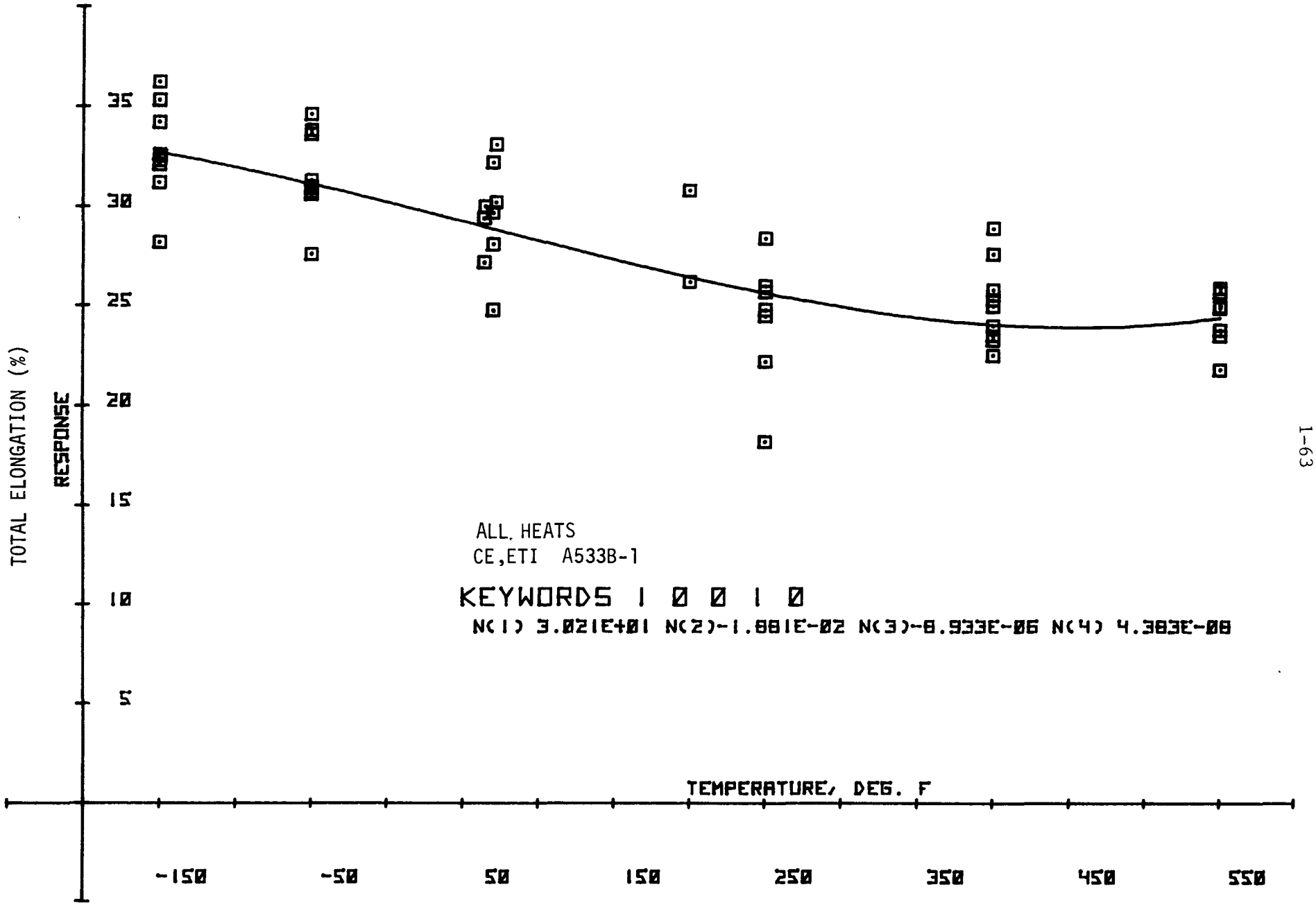

Figure 1.14 Tensile Total Elongation for All Heats

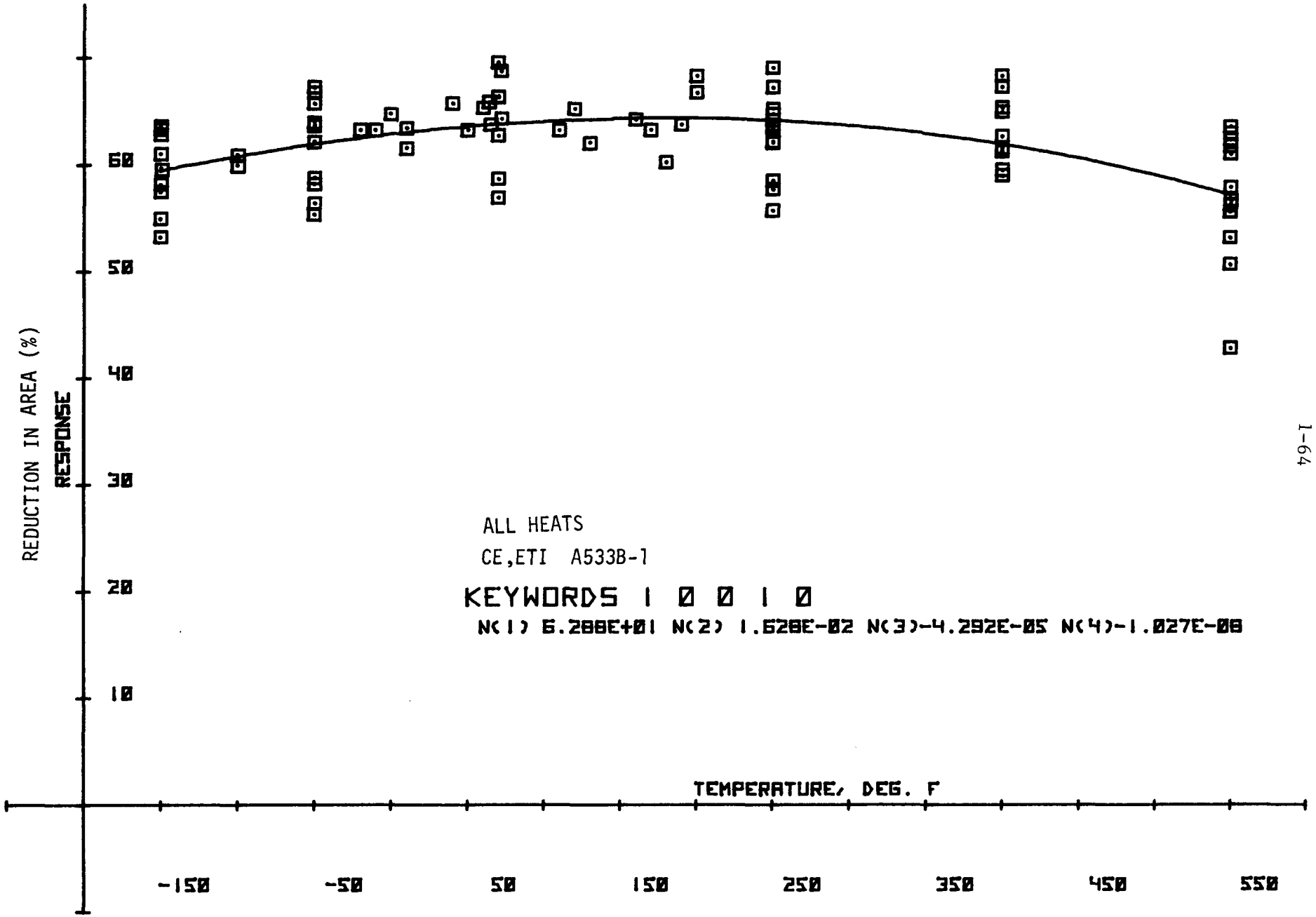

Figure 1.15 Tensile Reduction in Area for All Heats

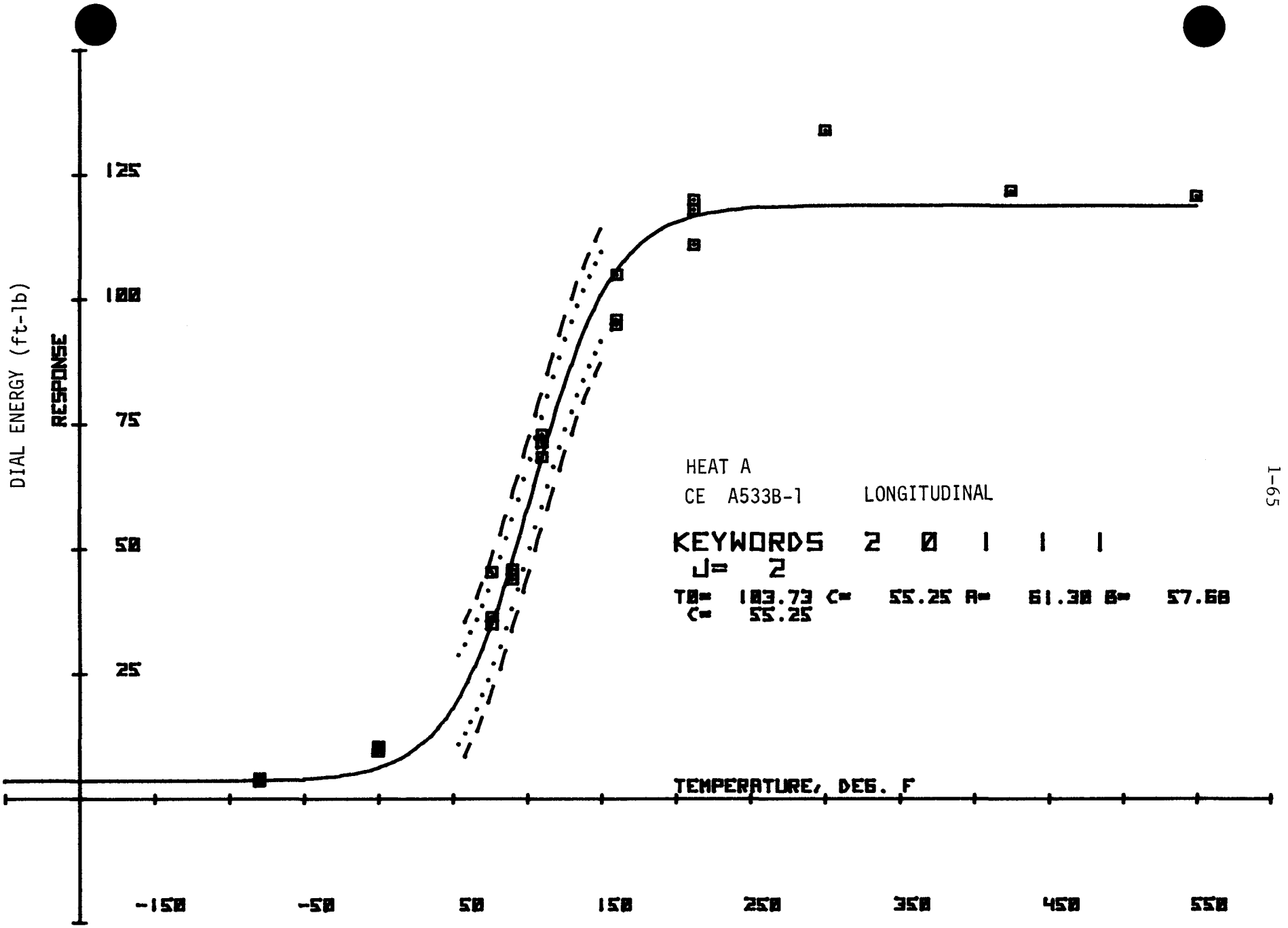

Figure 1.16 Charpy V-Notch Dial Energy for CE Heat A (L)

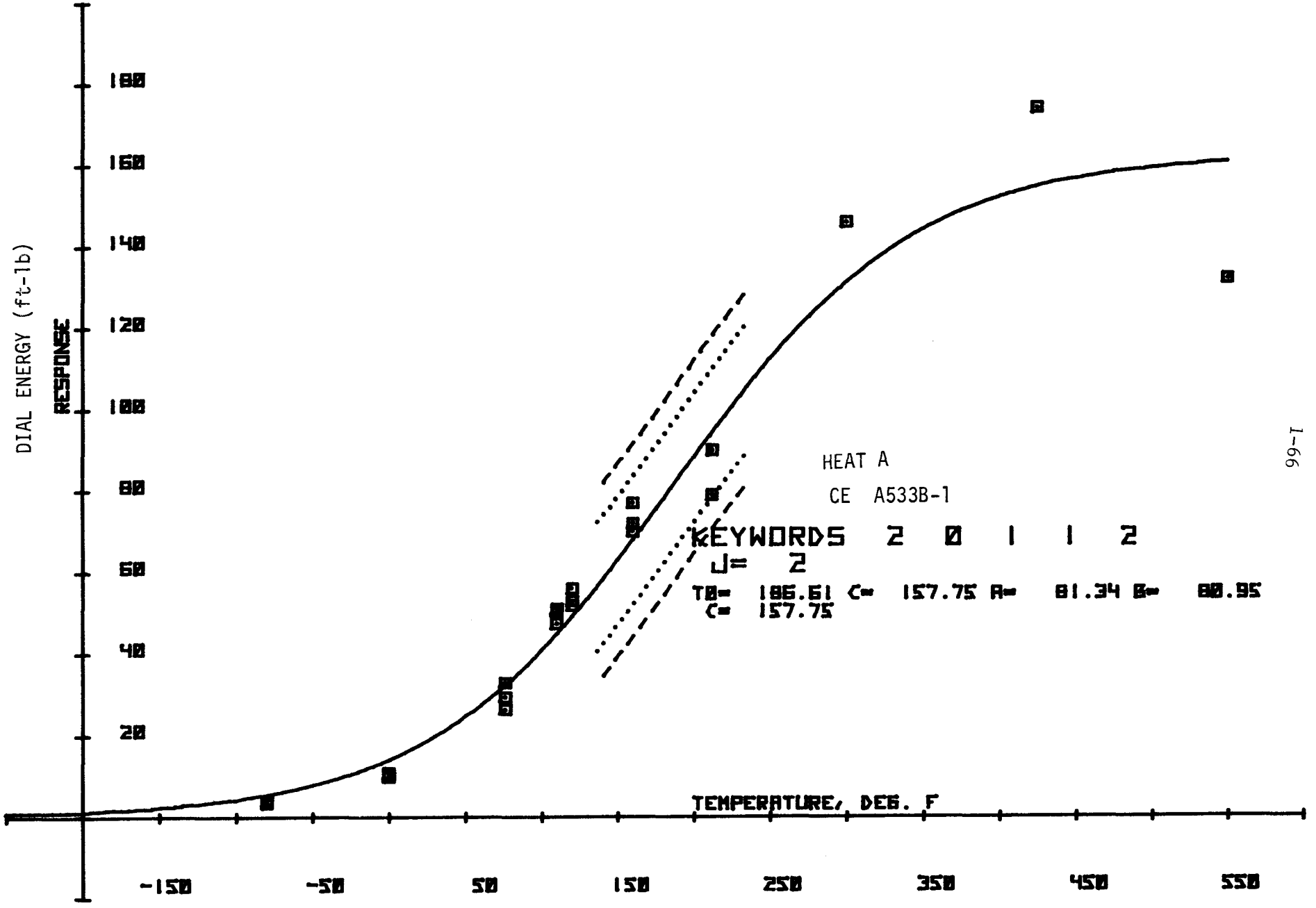

Figure 1.17 Charpy V-Notch Dial Energy for CE Heat A (T)

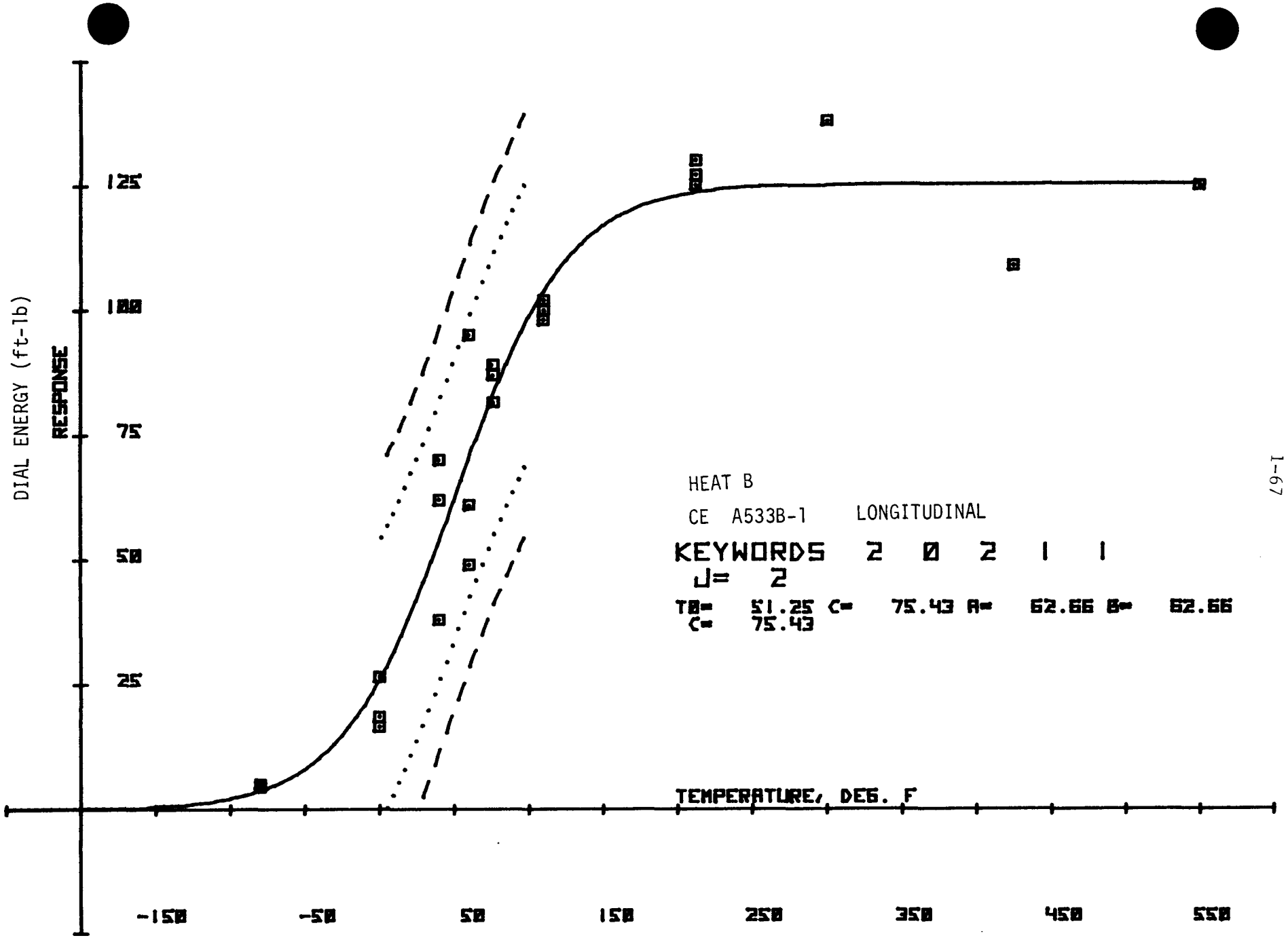

Figure 1.18 Charpy V-Notch Dial Energy for CE Heat B (L)

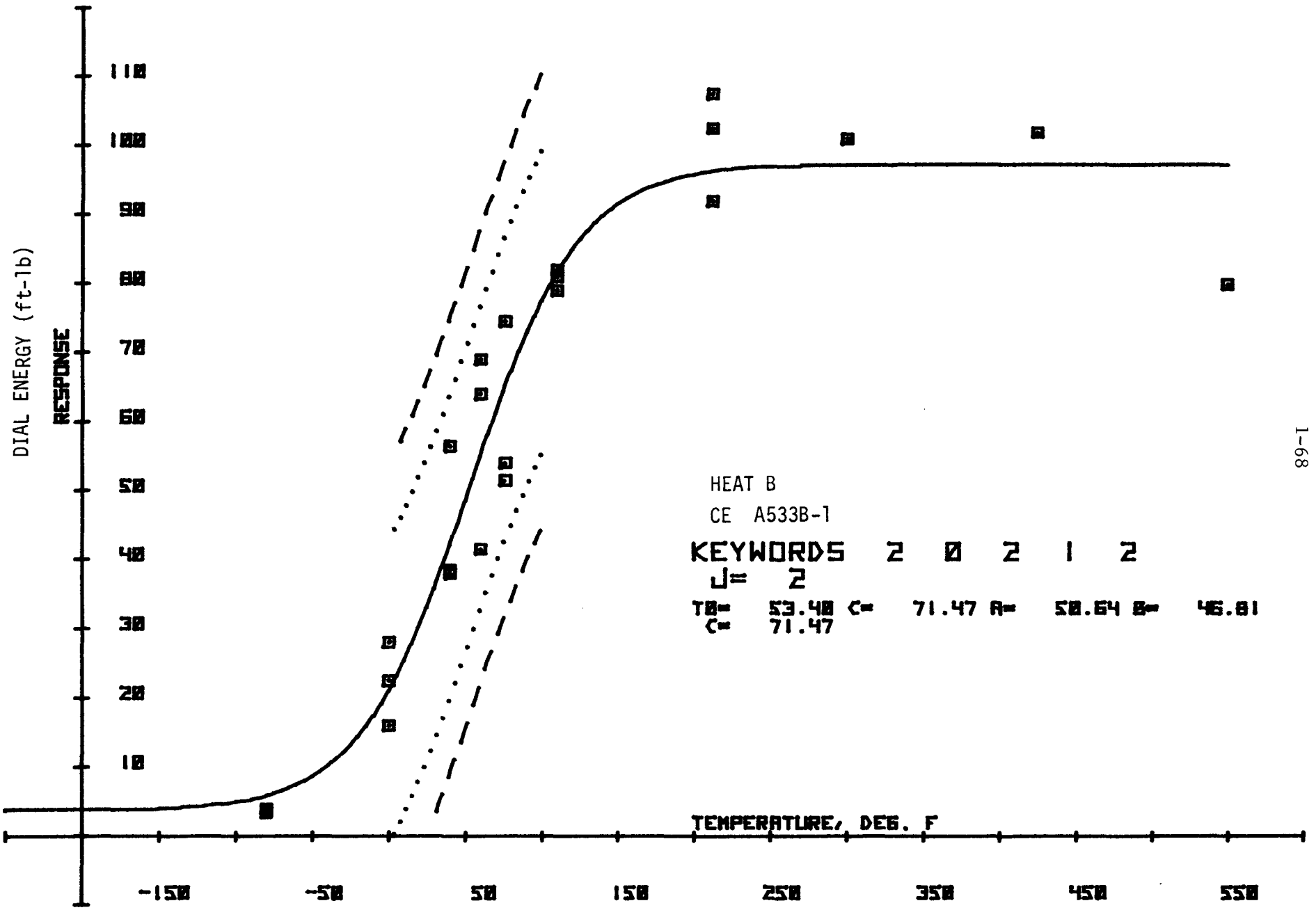

Figure 1.19 Charpy V-Notch Dial Energy for CE Heat B (T)

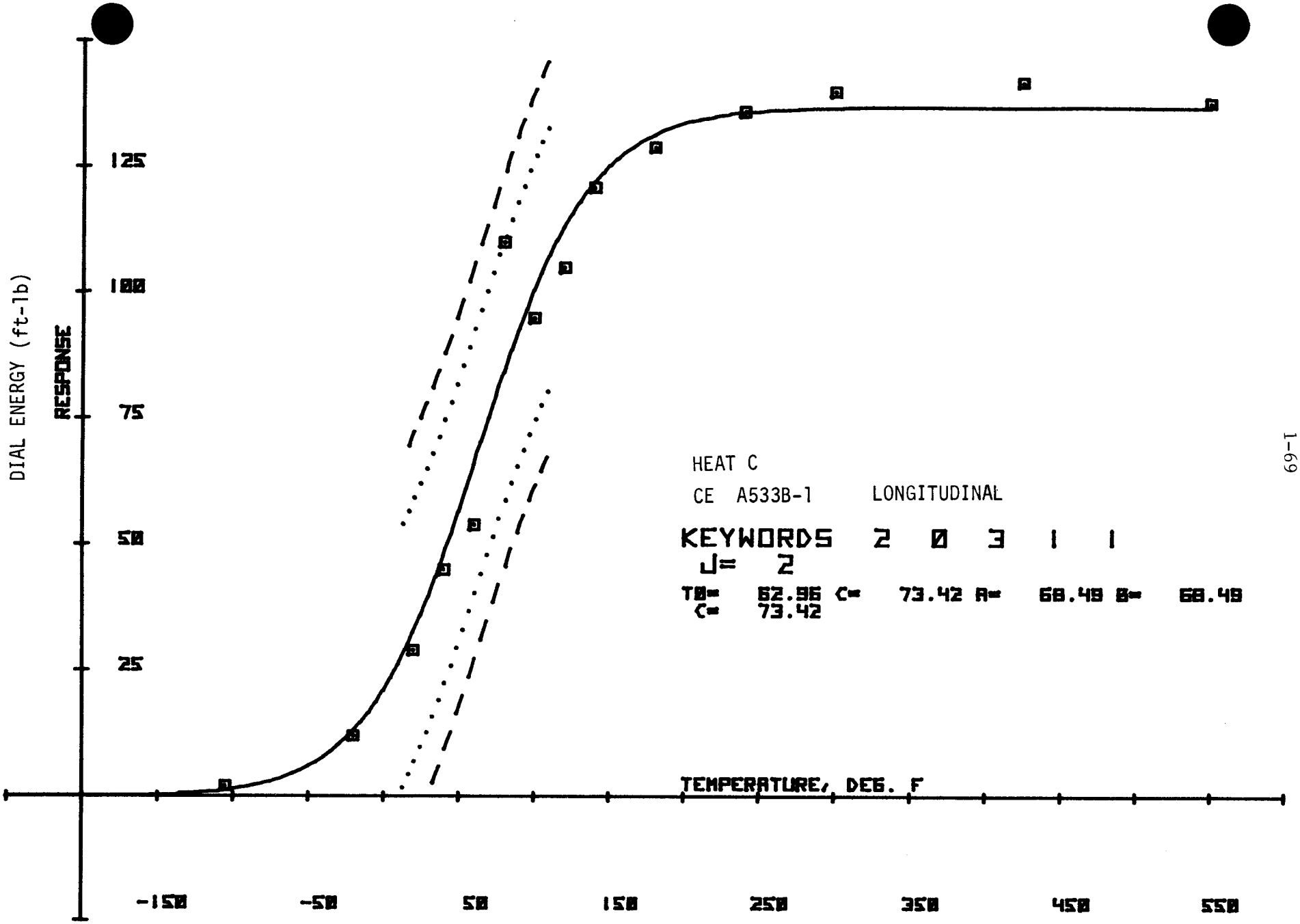

Figure 1.20 Charpy V-Notch Dial Energy for CE Heat C (L)

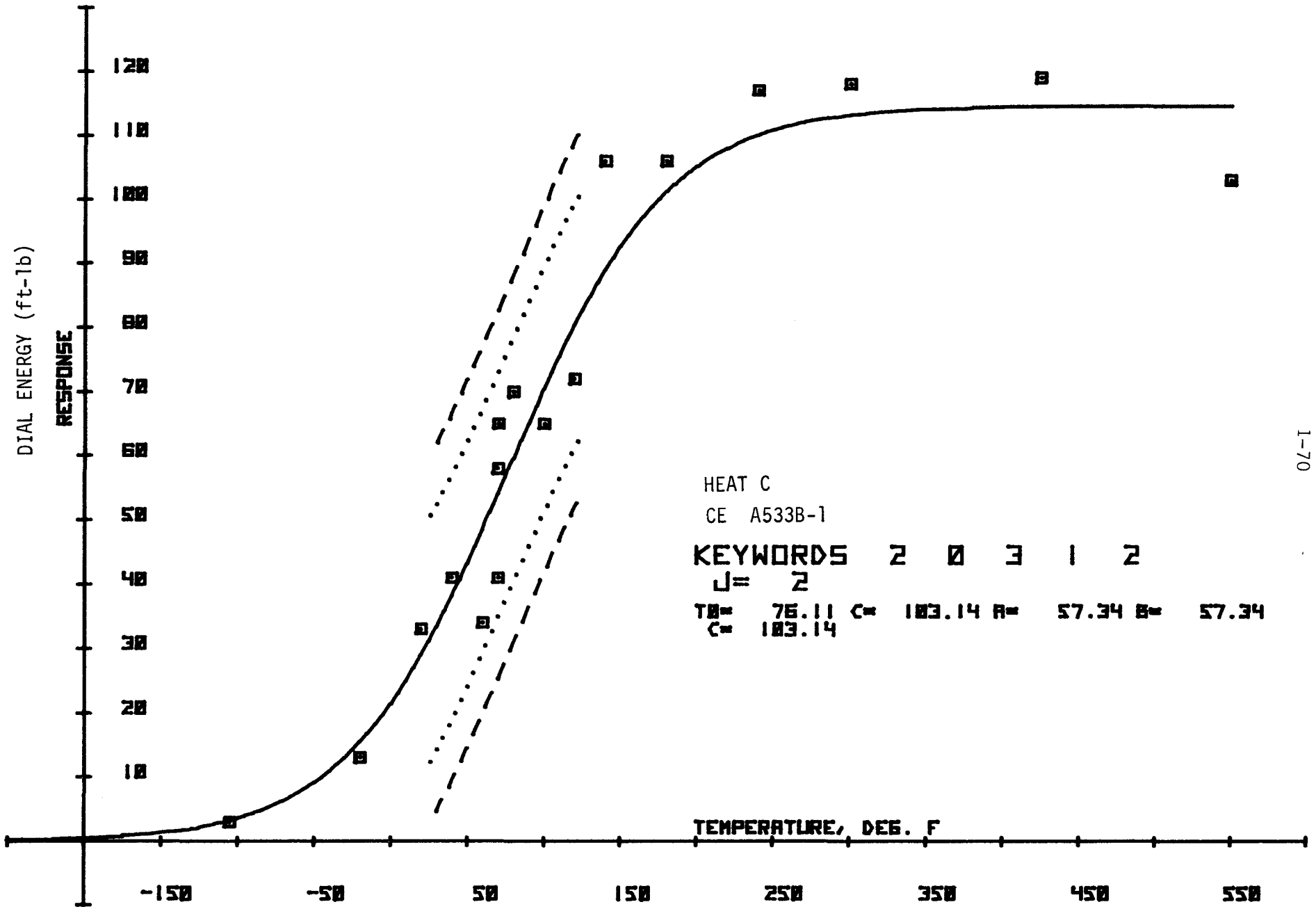

Figure 1.21 Charpy V-Notch Dial Energy for CE Heat C (T)

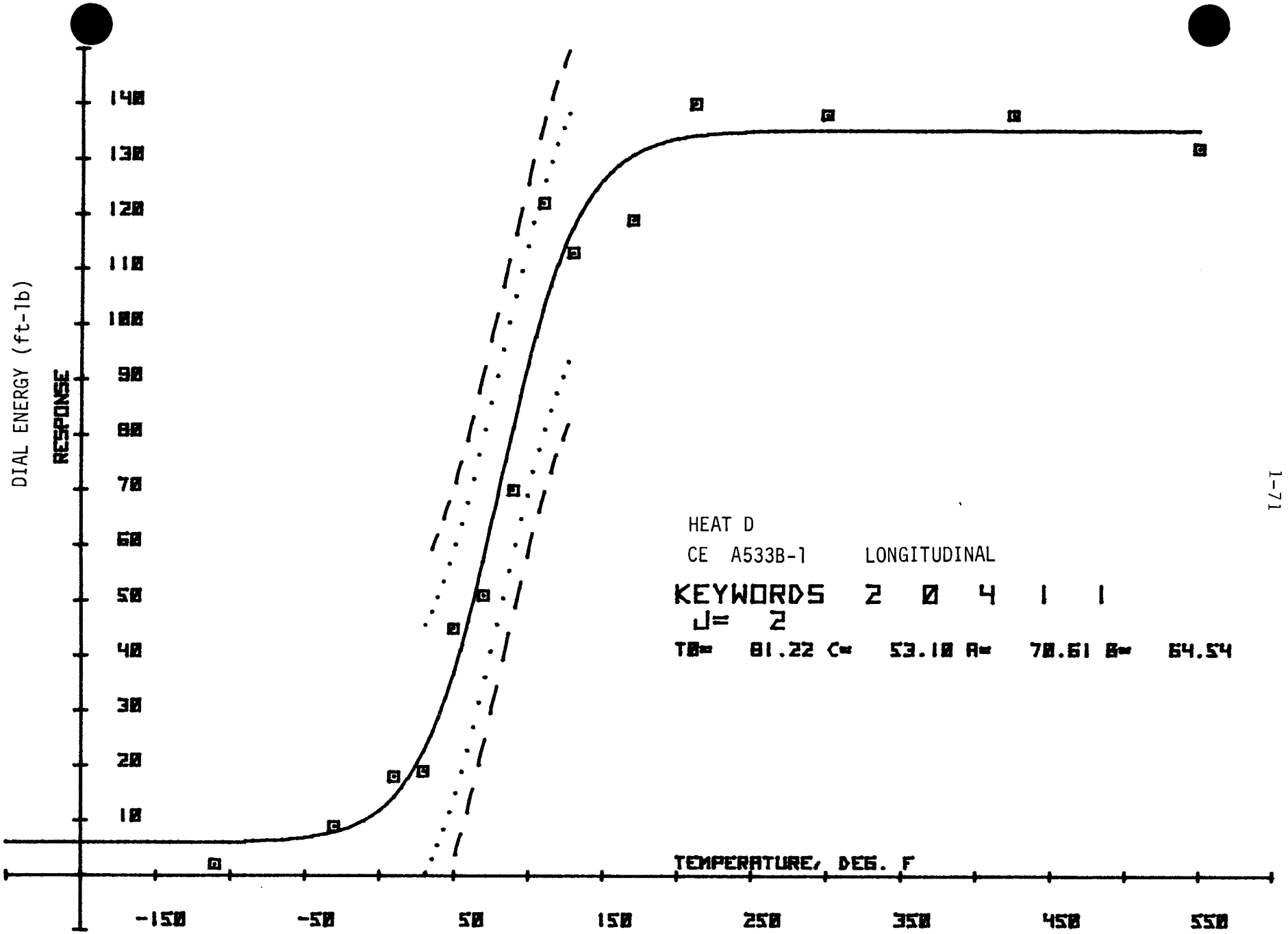

Figure 1.22 Charpy V-Notch Dial Energy for CE Heat D (L)

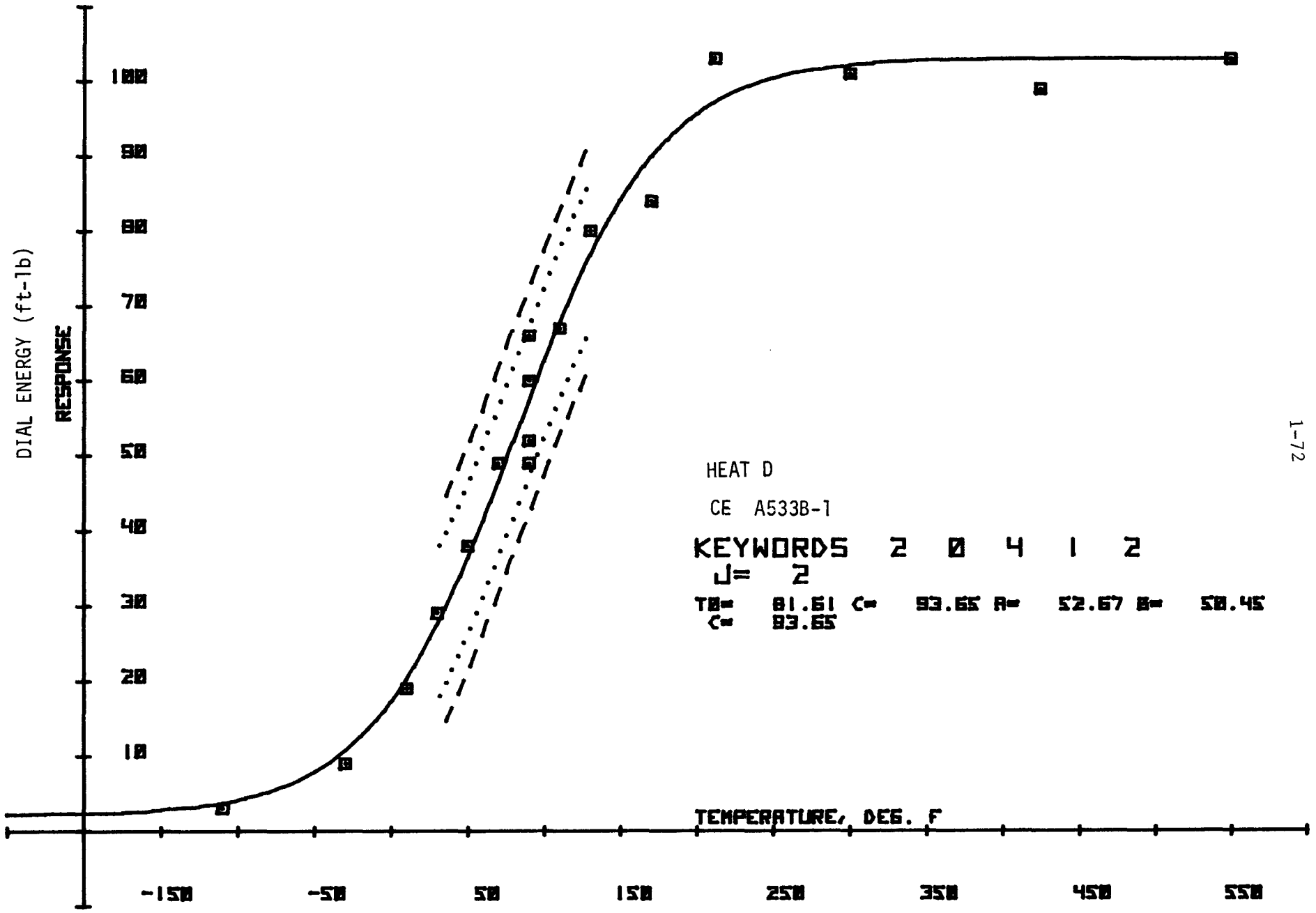

Figure 1.23 Charpy V-Notch Dial Energy for CE Heat D (T)

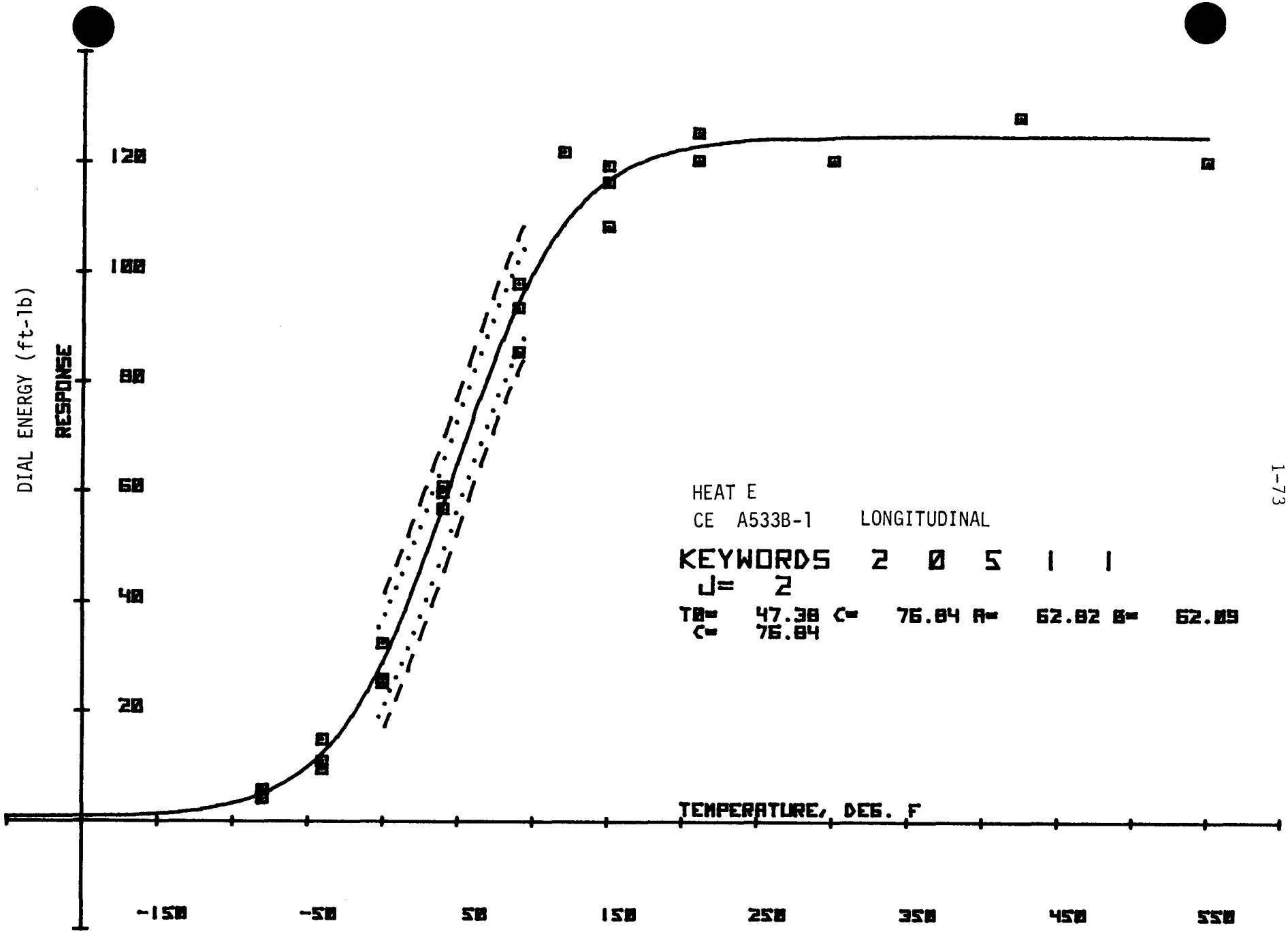

Figure 1.24 Charpy V-Notch Dial Energy for CE Heat E (L)

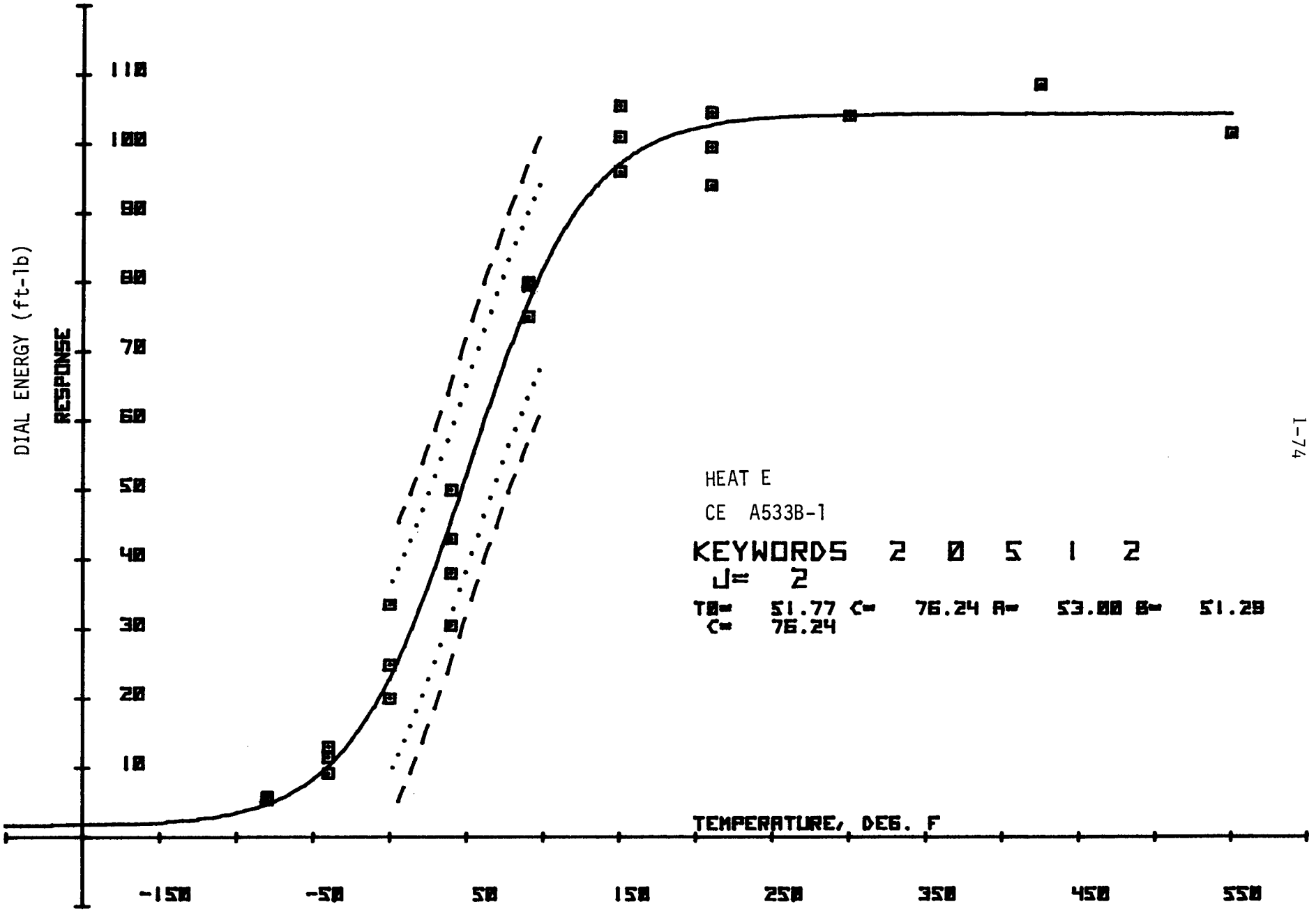

Figure 1.25 Charpy V-Notch Dial Energy for CE Heat E (T)

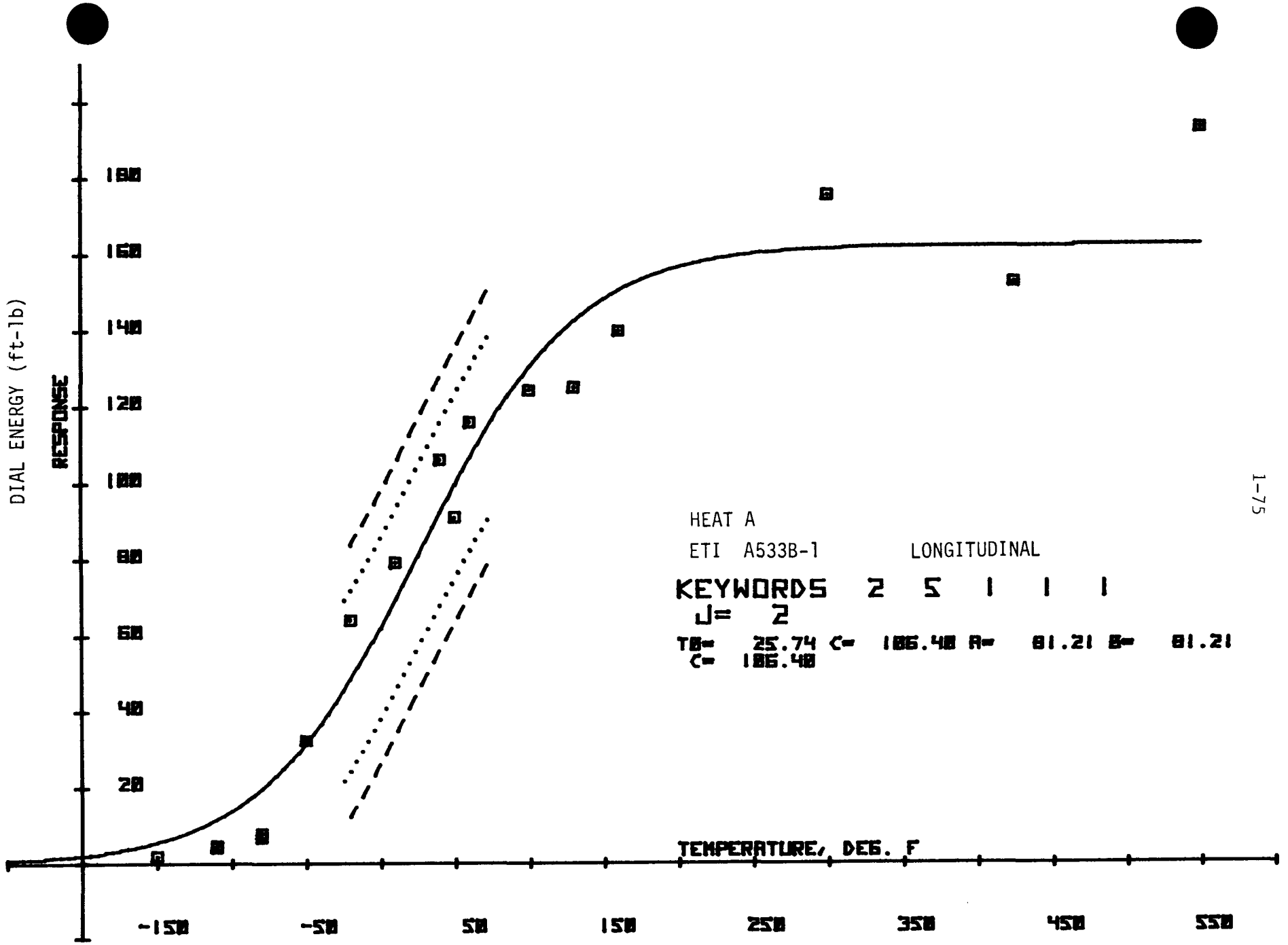

Figure 1.26 Charpy V-Notch Dial Energy for ETI Heat A (L)

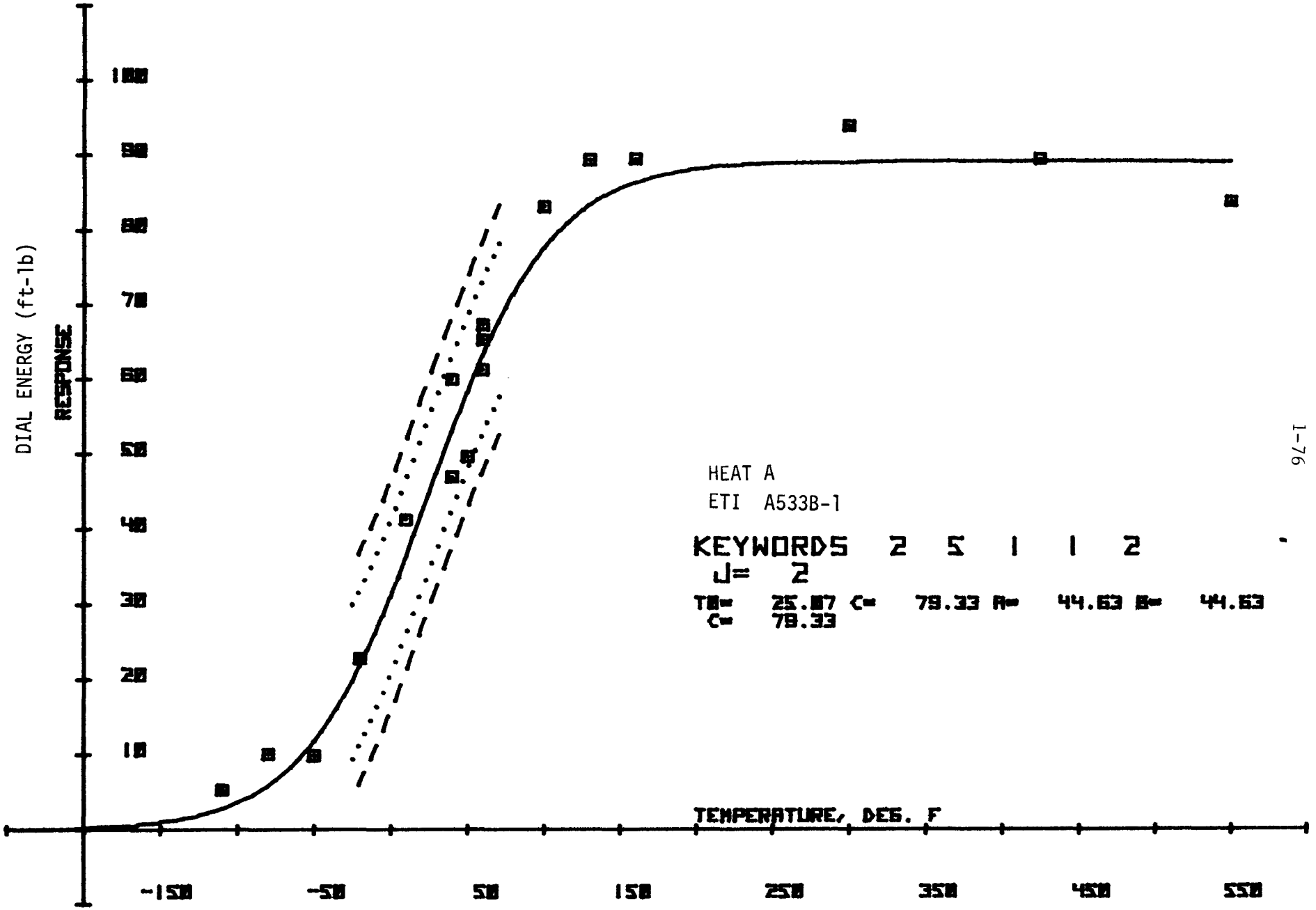

Figure 1.27 Charpy V-Notch Dial Energy for ETI Heat A (T)

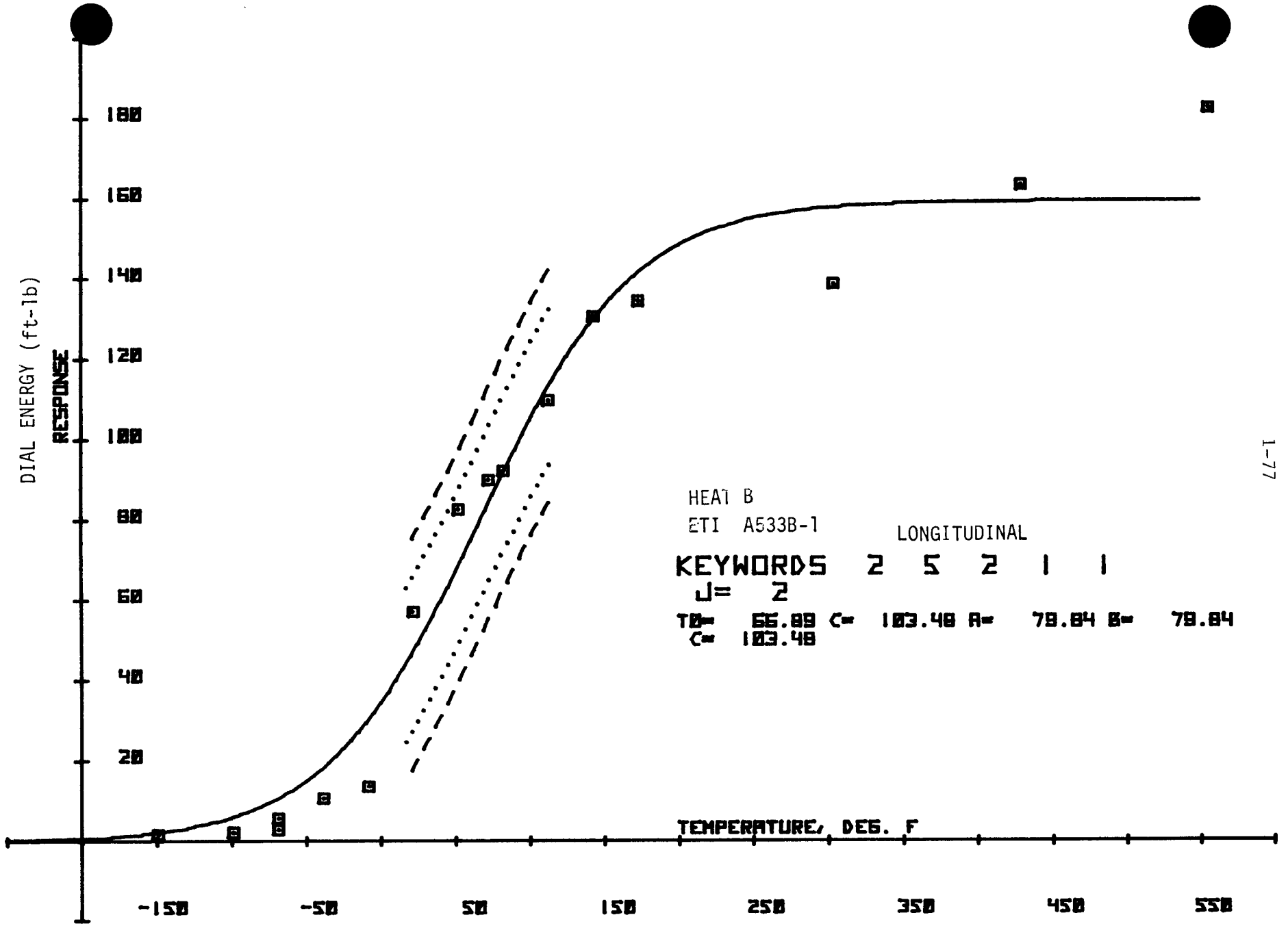

Figure 1.28 Charpy V-Notch Dial Energy for ETI Heat B (L)

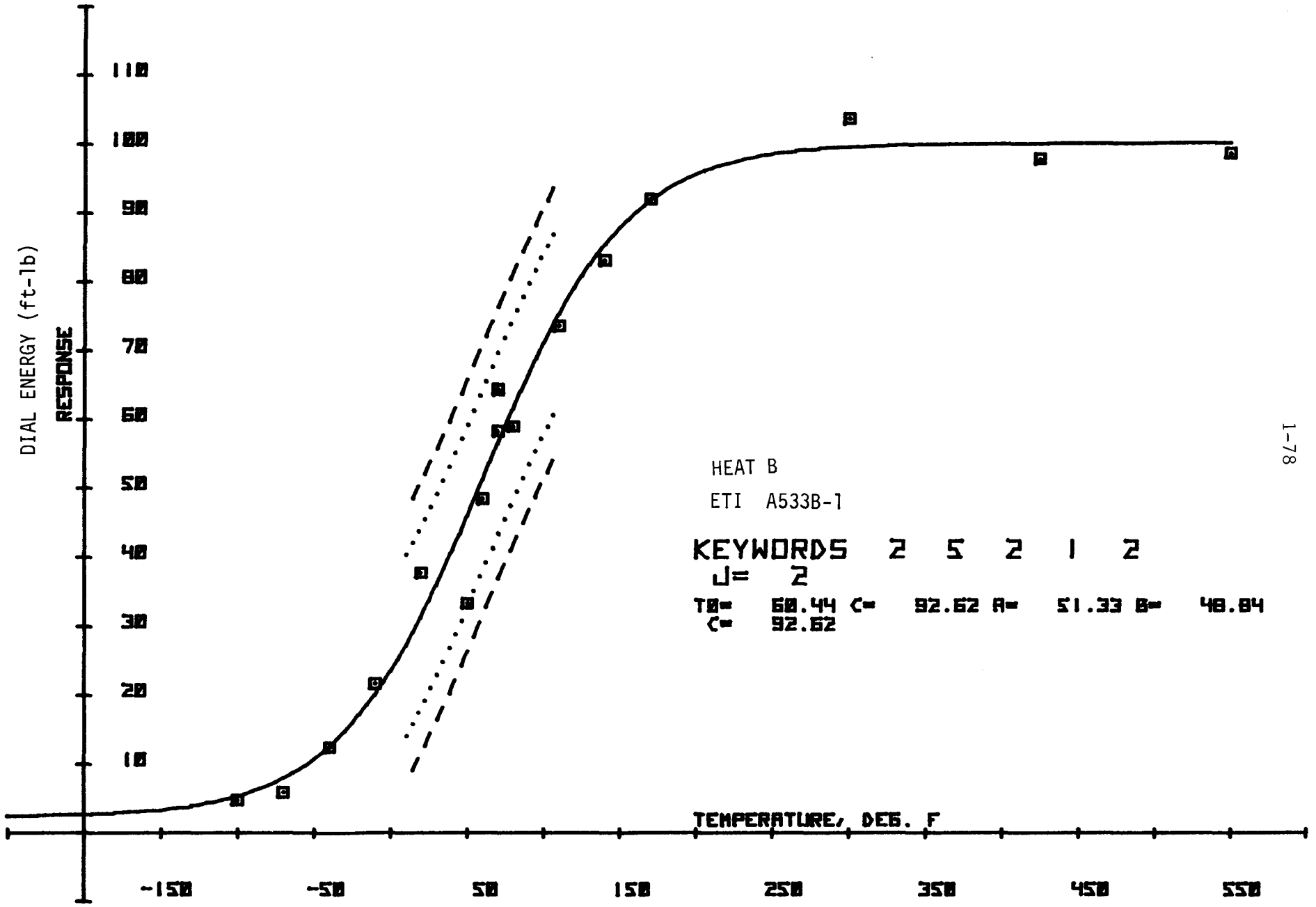

Figure 1.29 Charpy V-Notch Dial Energy for ETI Heat B (T)

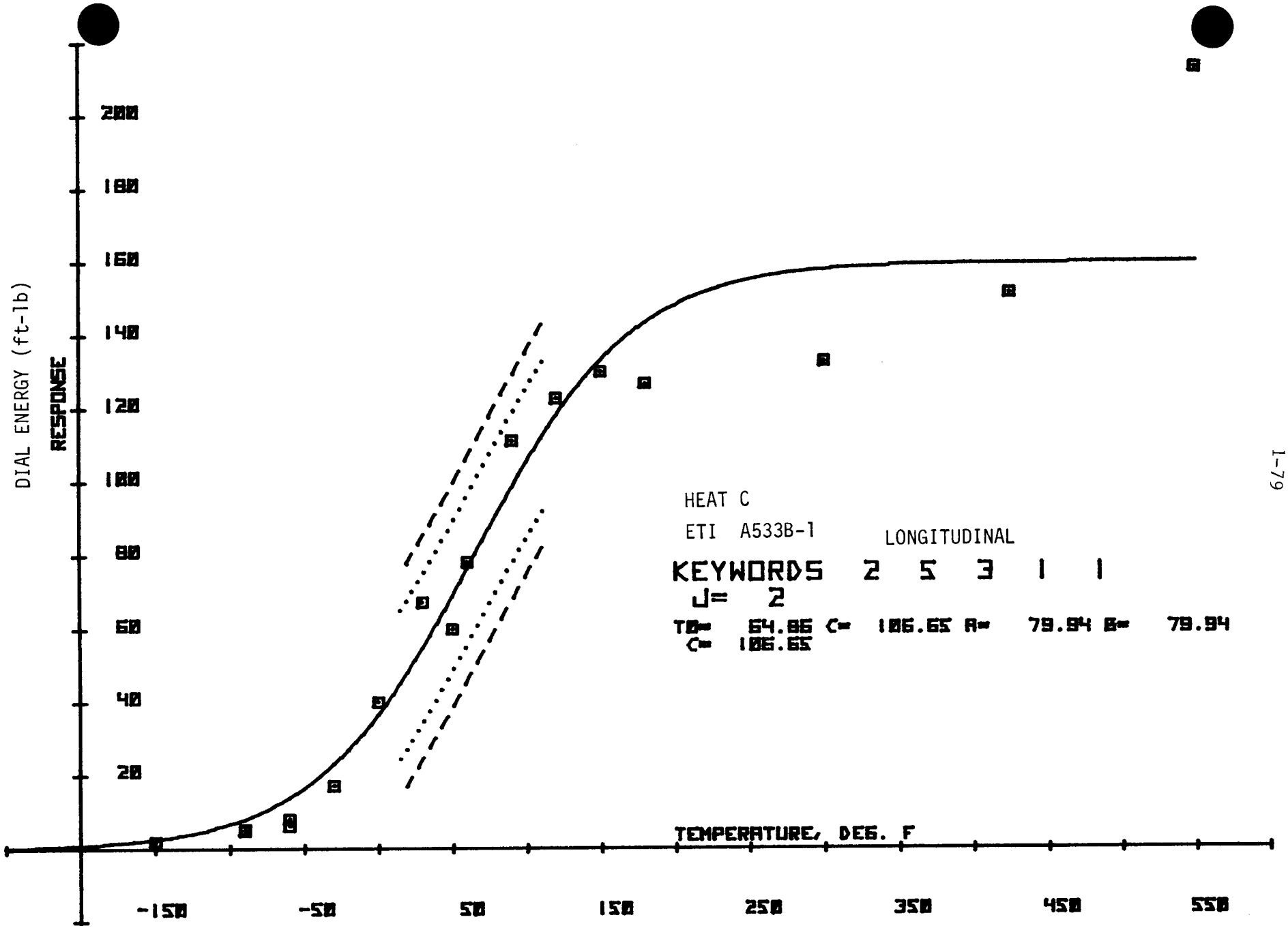

Figure 1.30 Charpy V-Notch Dial Energy for ETI Heat C (L)

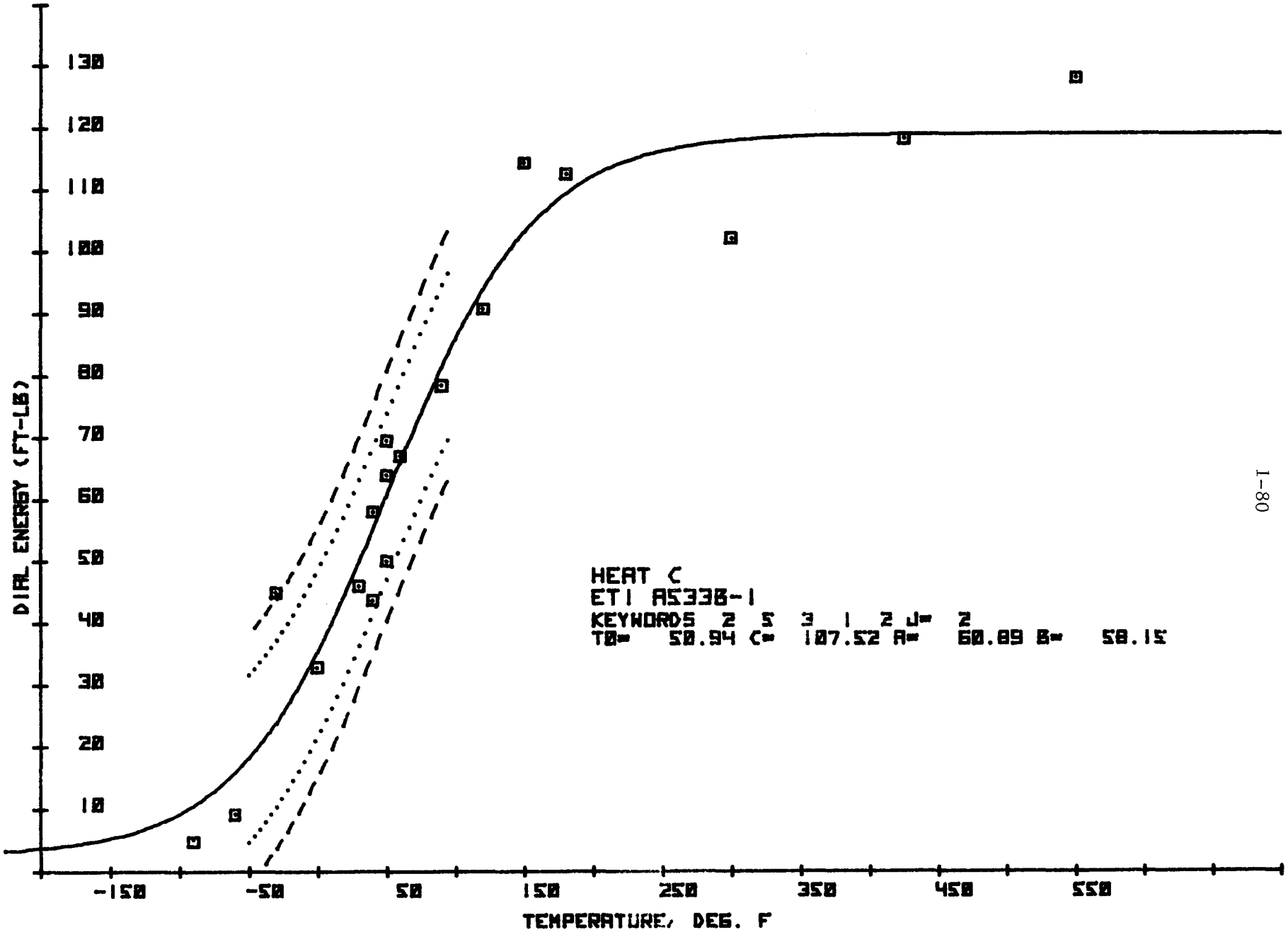

Figure 1.31. Charpy V-Notch Dial Energy for ETI Heat C (T)

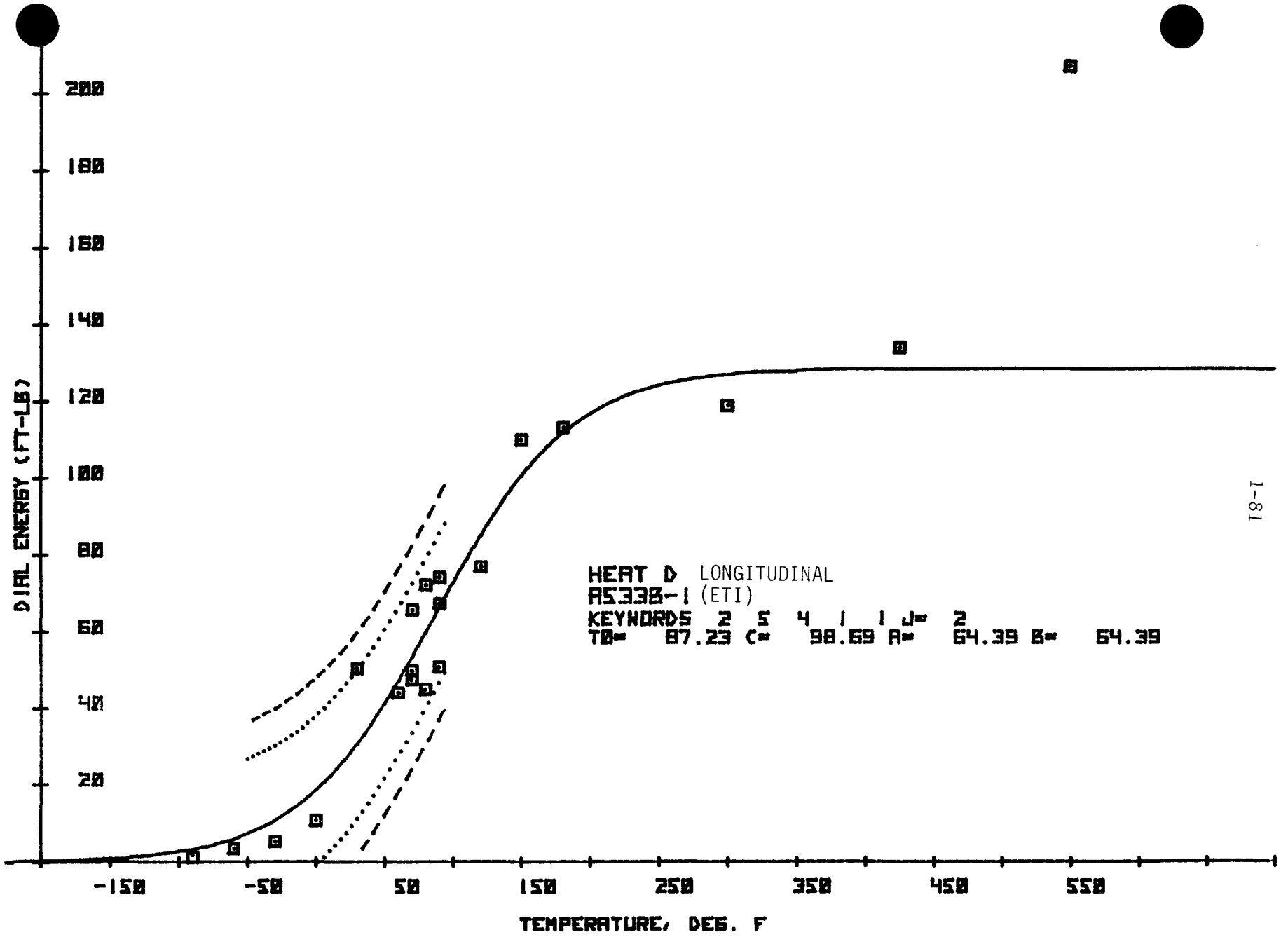

Figure 1.32. Charpy V-Notch Dial Energy for ETI Heat D (L)

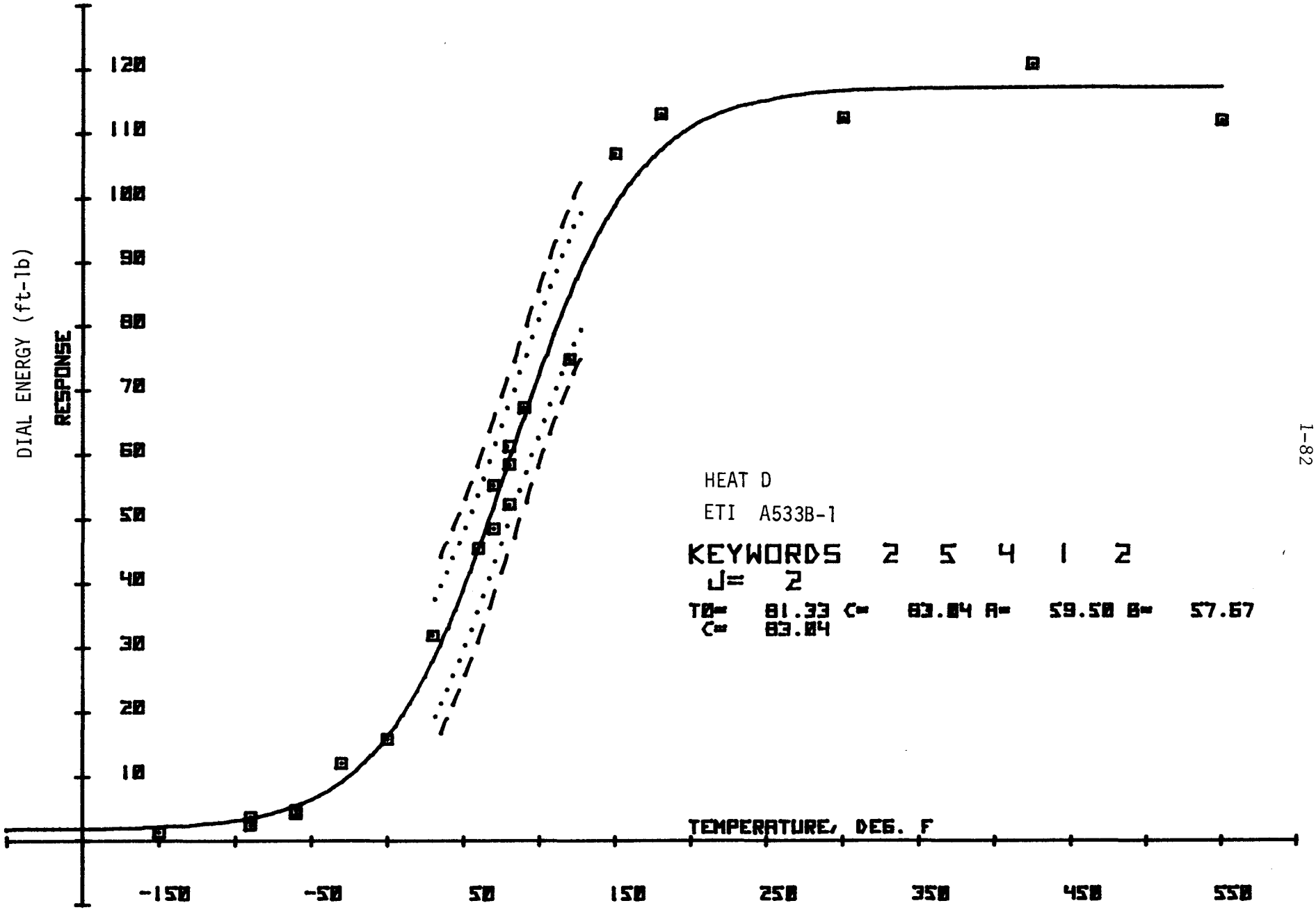

Figure 1.33 Charpy V-Notch Dial Energy for ETI Heat D (T)

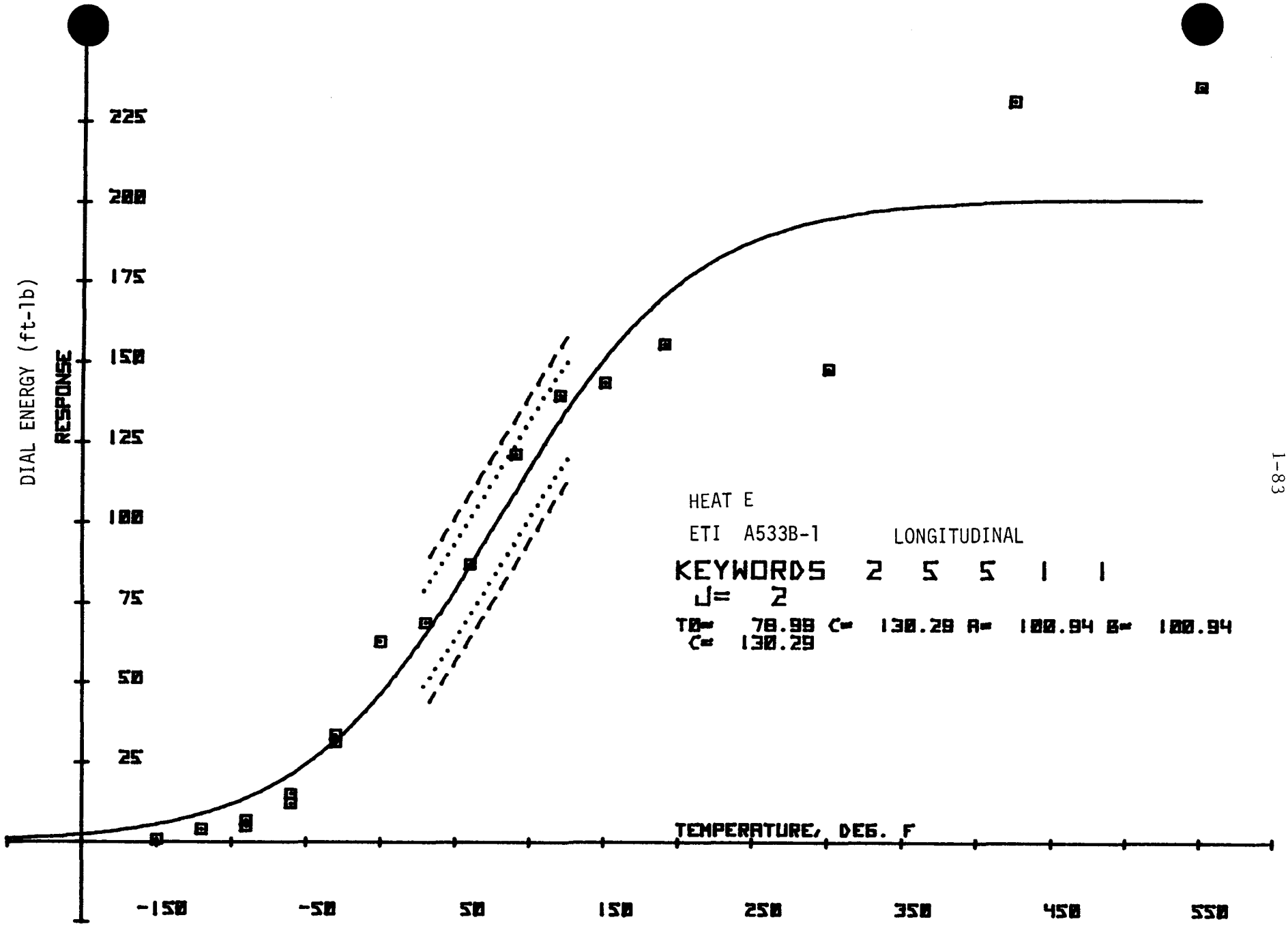

Figure 1.34 Charpy V-Notch Dial Energy for ETI Heat E (L)

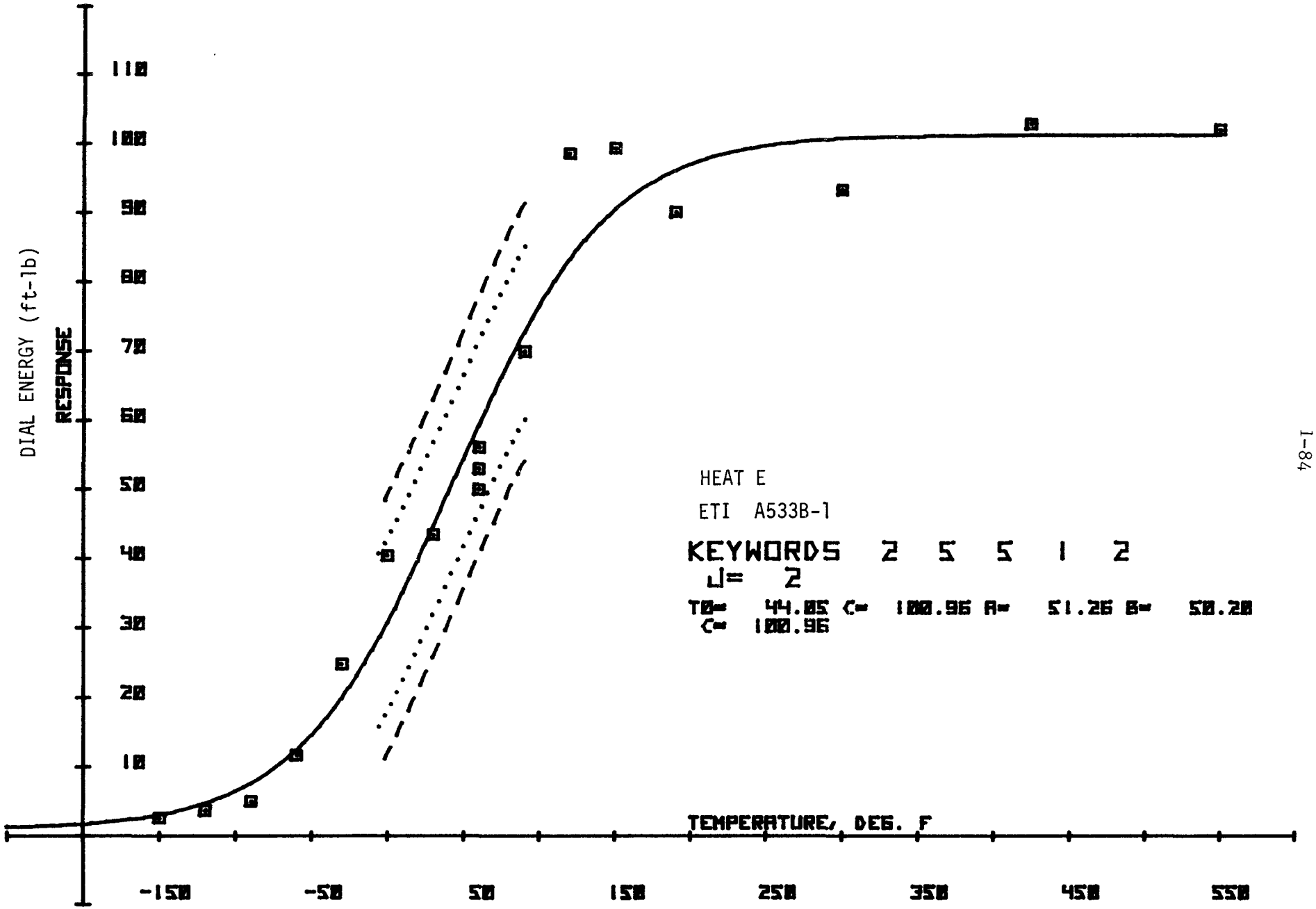

Figure 1.35 Charpy V-Notch Dial Energy for ETI Heat E (T)

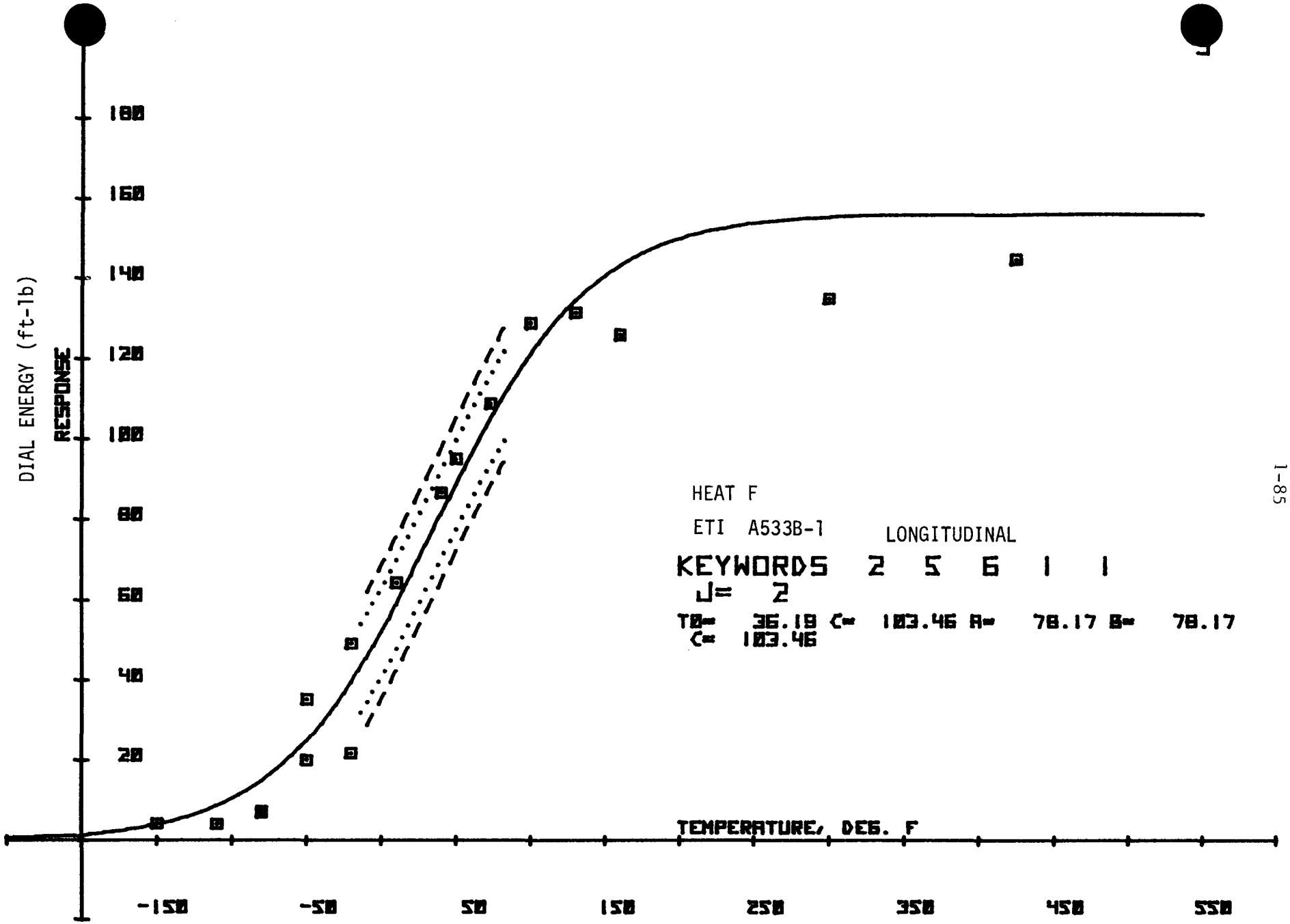

Figure 1.36 Charpy V-Notch Dial Energy for ETI Heat F (L)

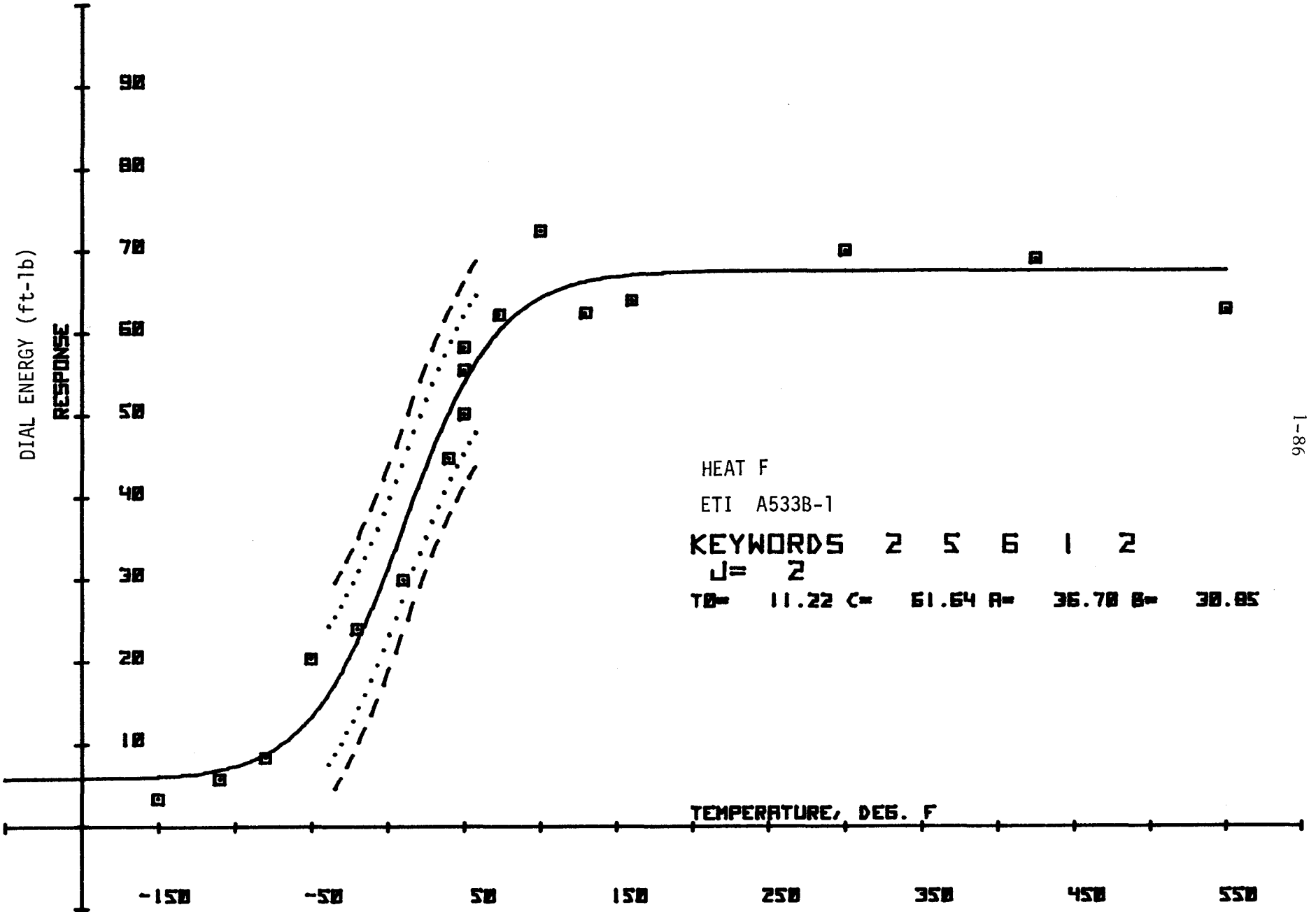

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Figure 1.37 Charpy V-Notch Dial Energy for ETI Heat F (T)

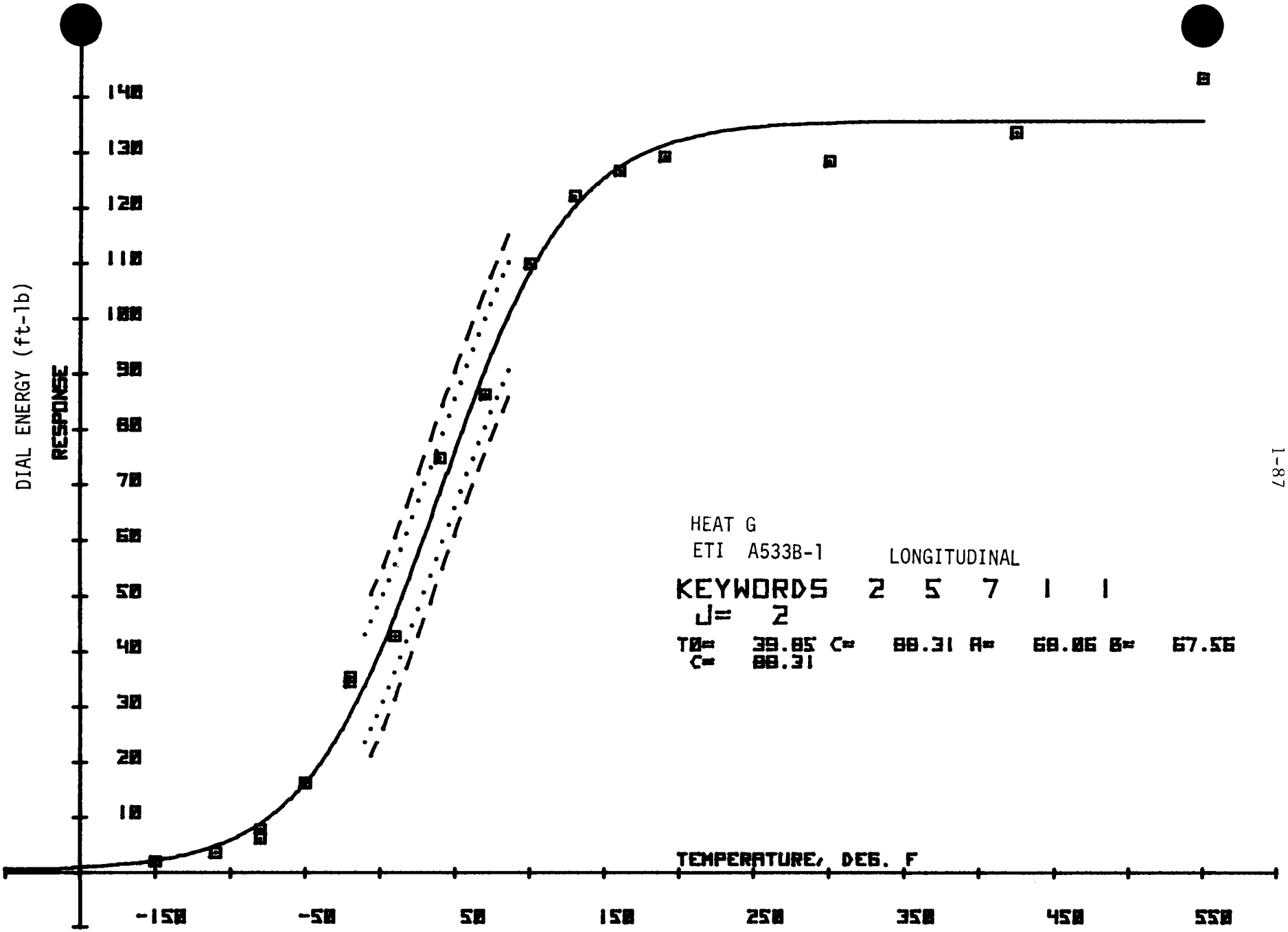

Figure 1.38 Charpy V-Notch Dial Energy for ETI Heat G (L)

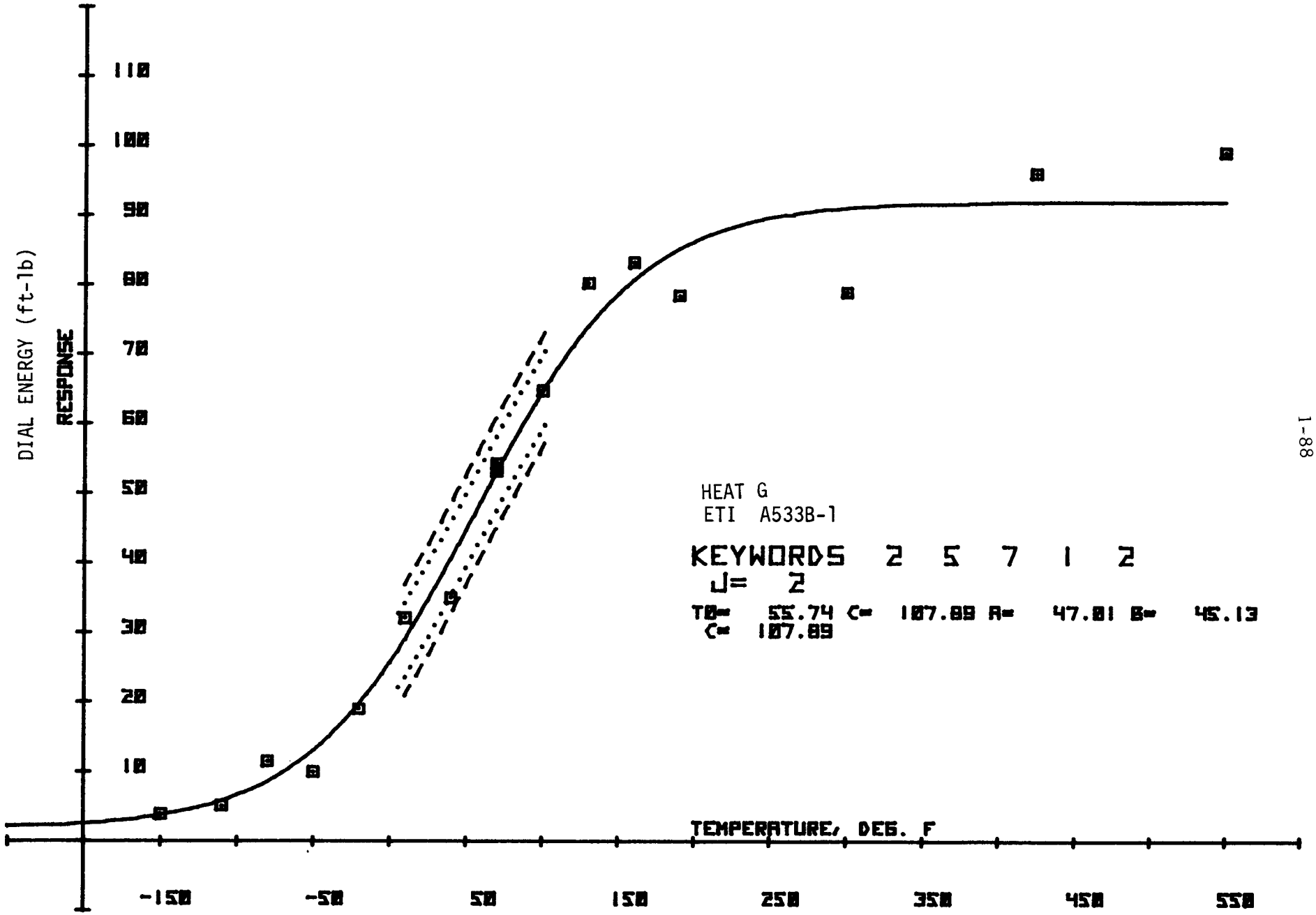

Figure 1.39 Charpy V-Notch Dial Energy for ETI Heat G (T)

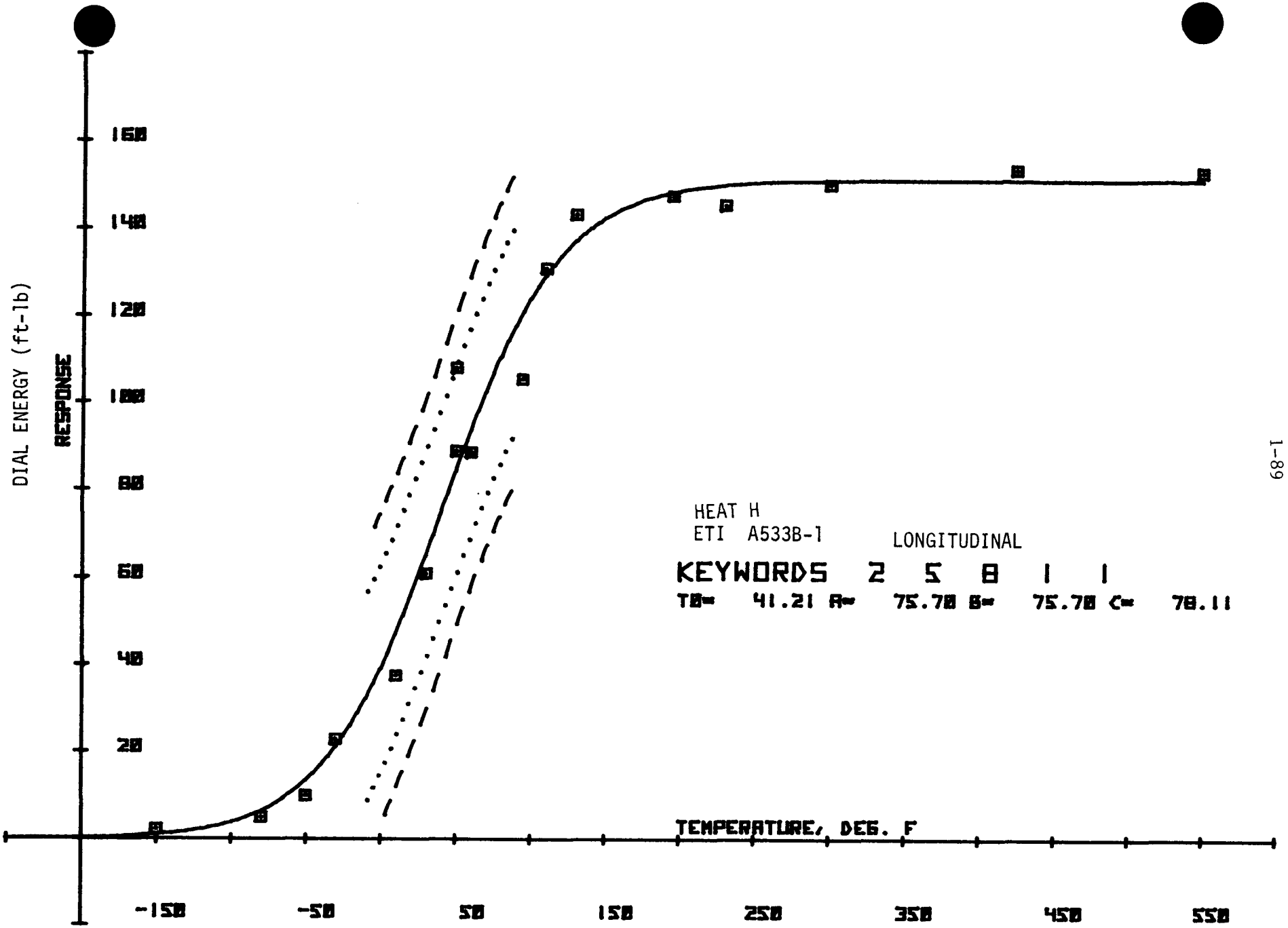

Figure 1.40 Charpy V-Notch Dial Energy for ETI Heat H (L)

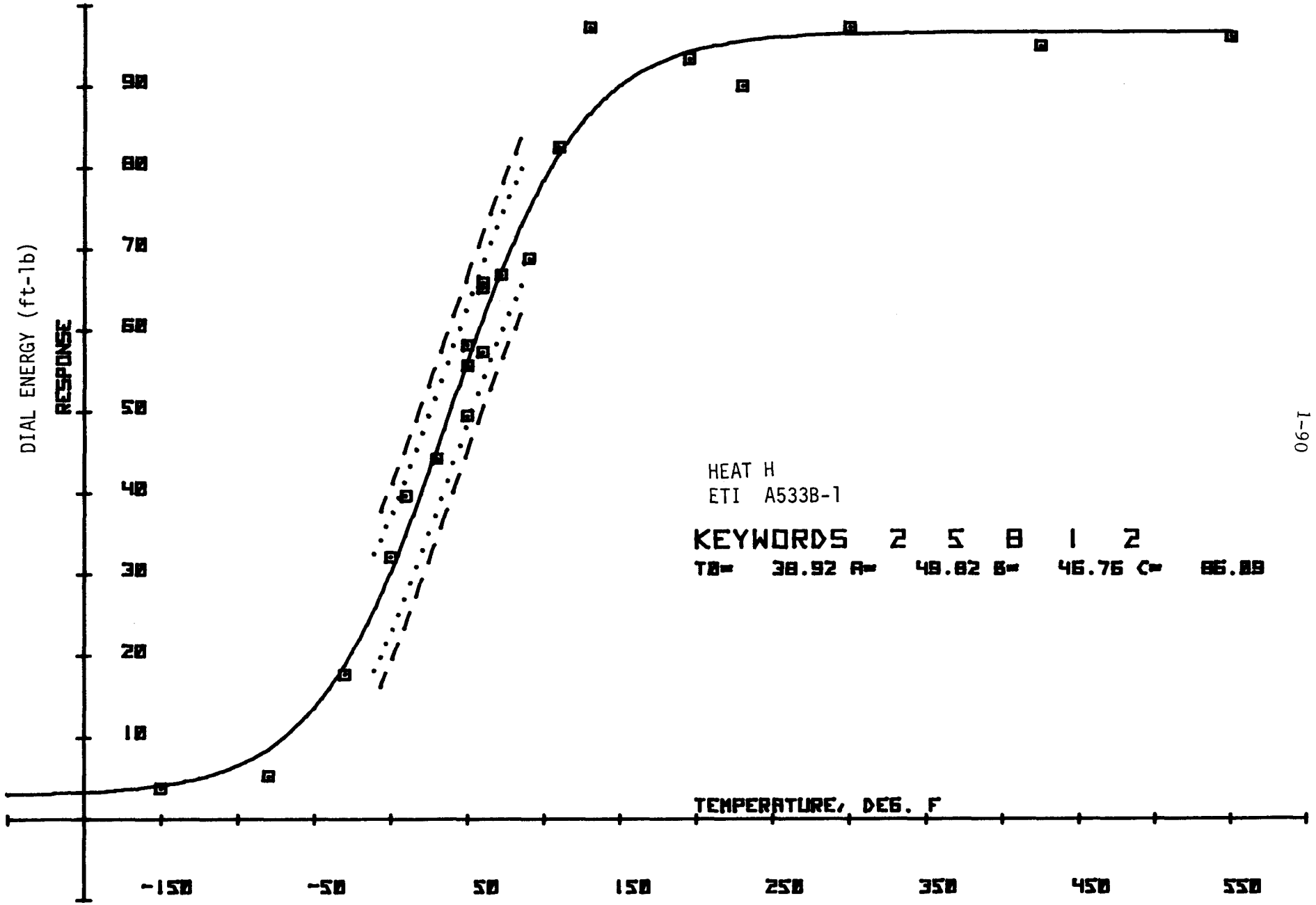

Figure 1.41 Charpy V-Notch Dial Energy for ETI Heat H (T)

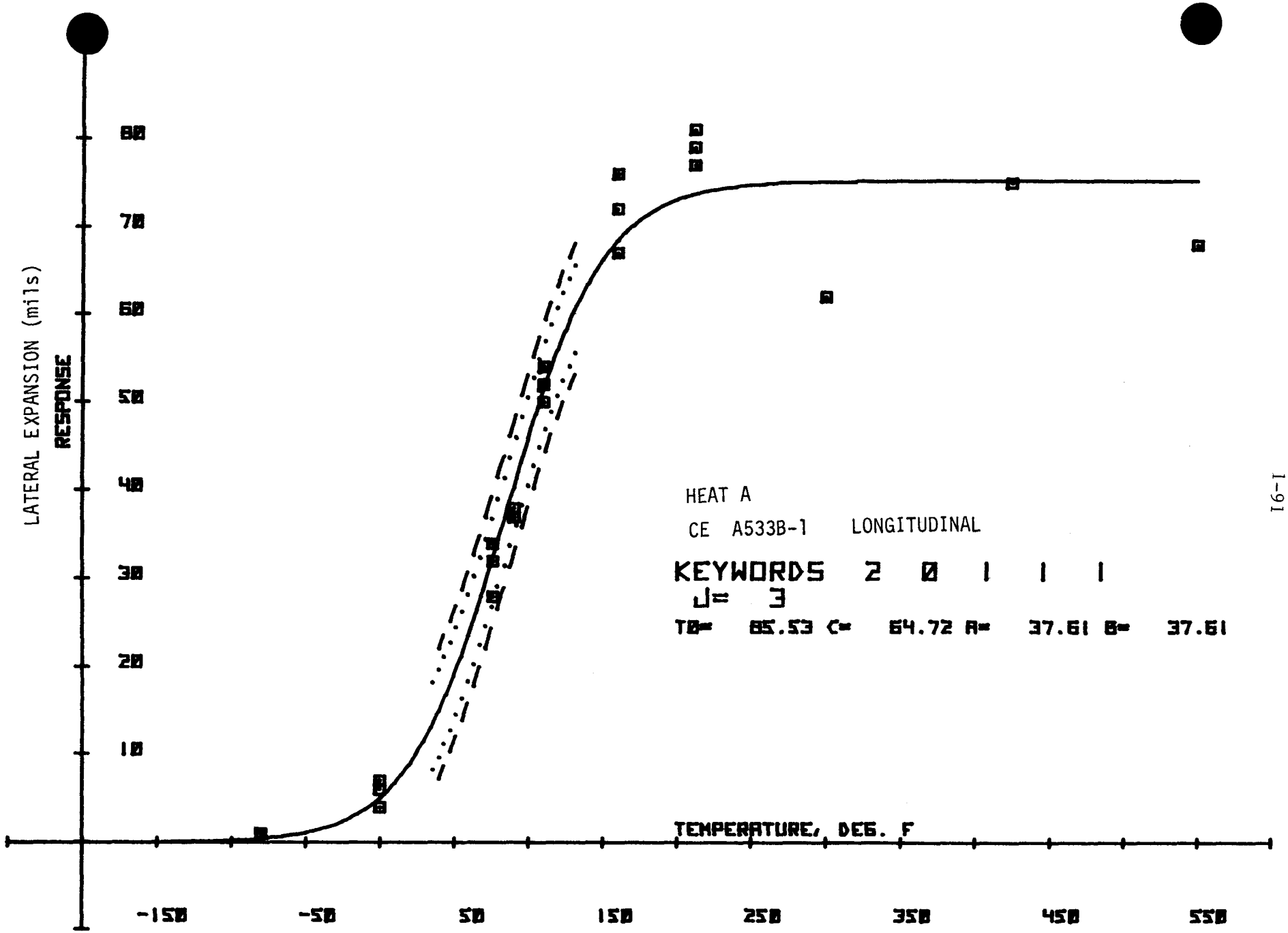

Figure 1.42 Charpy V-Notch Lateral Expansion for CE Heat A (L)

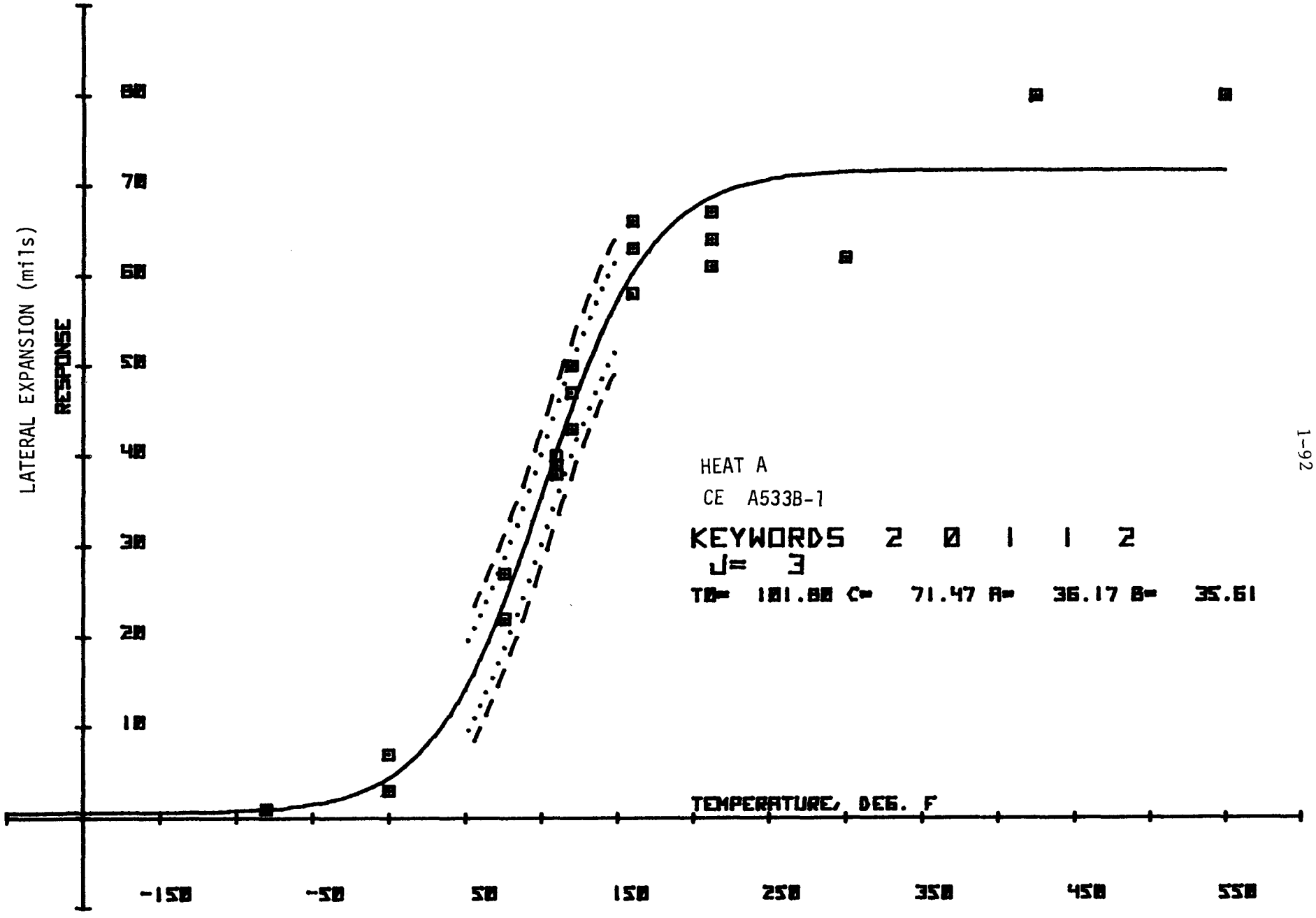

Figure 1.43 Charpy V-Notch Lateral Expansion for CE Heat A (T)

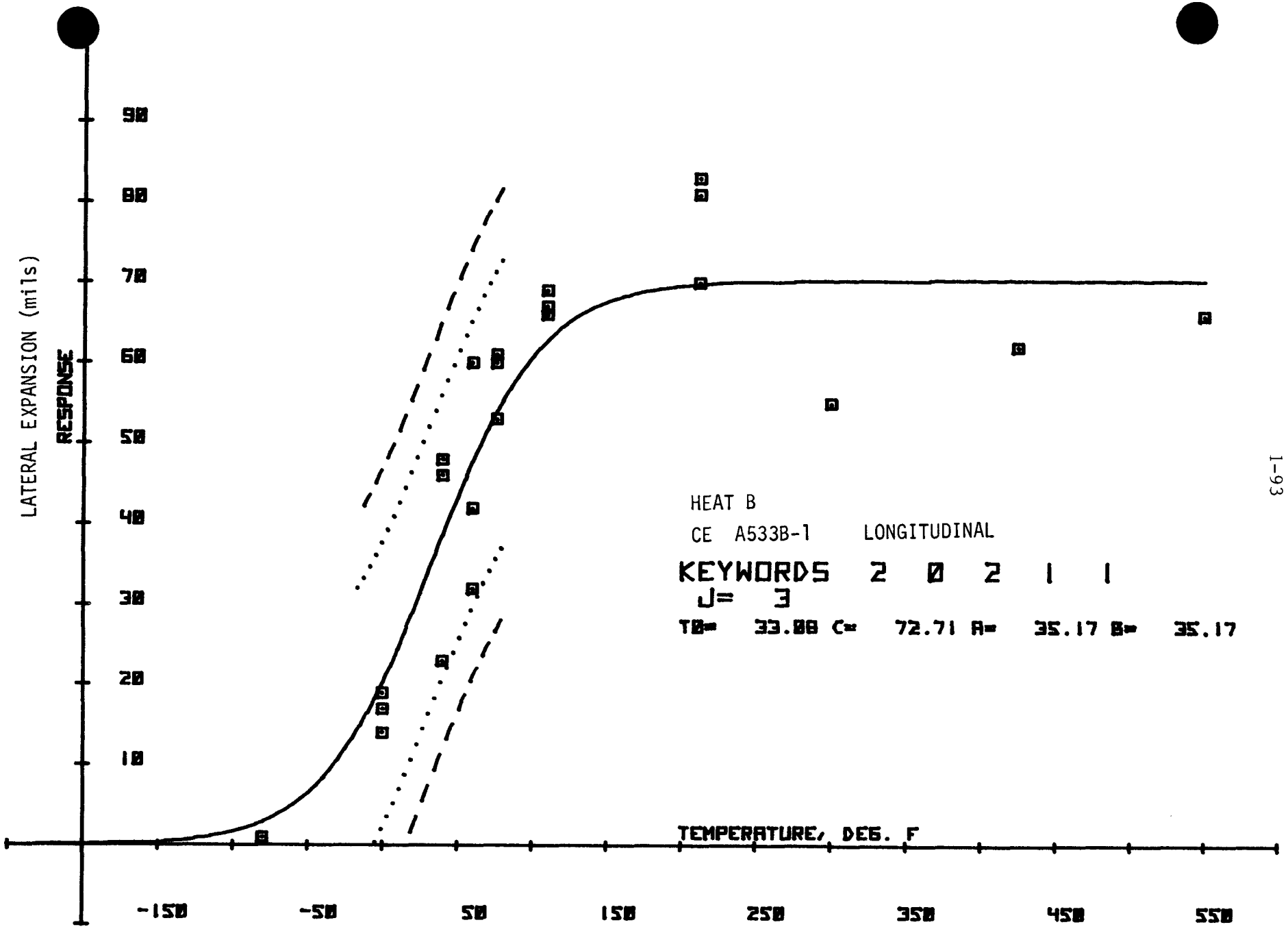

Figure 1.44 Charpy V-Notch Lateral Expansion for CE Heat B (L)

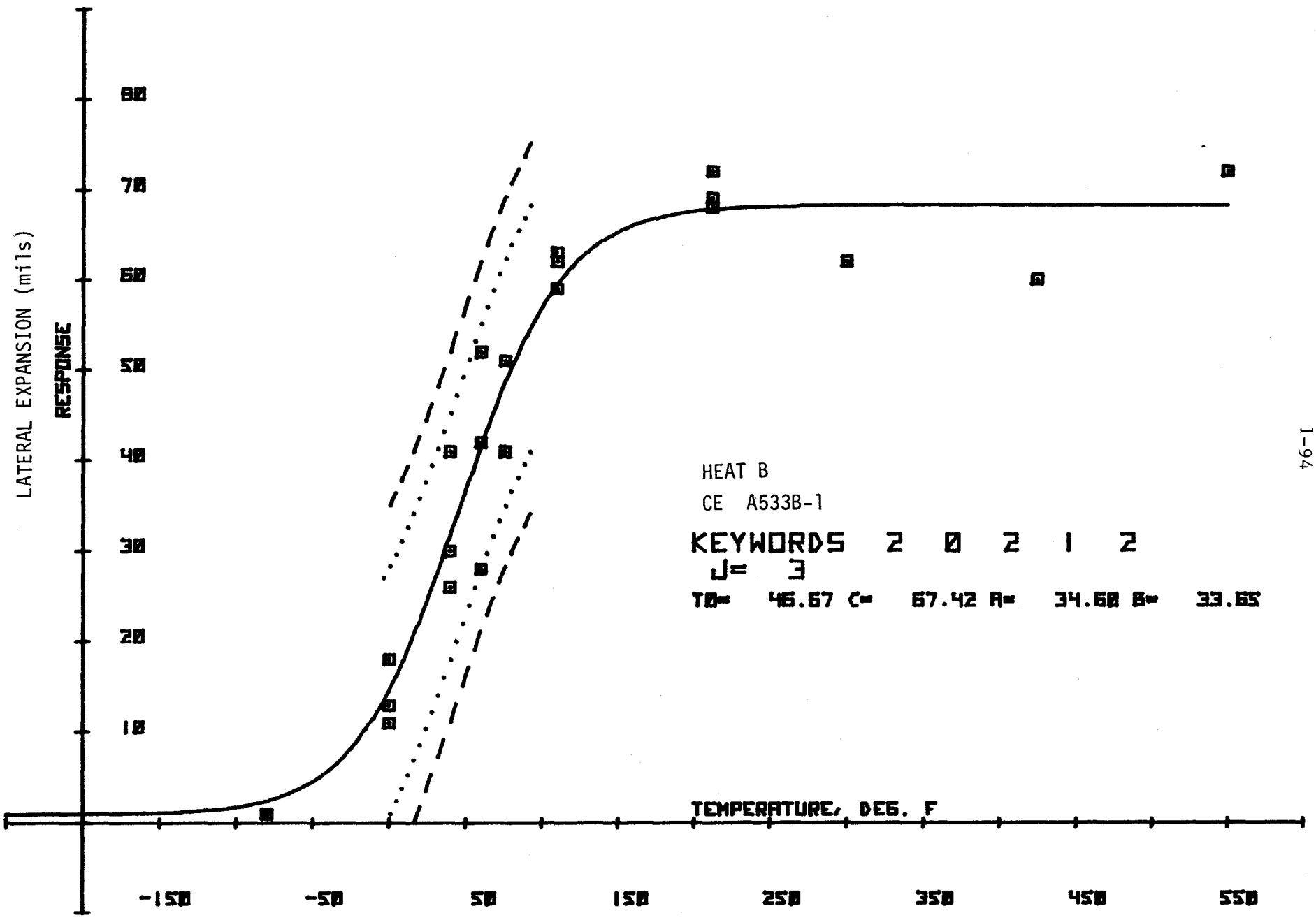

Figure 1.45 Charpy V-Notch Lateral Expansion for CE Heat B (T)

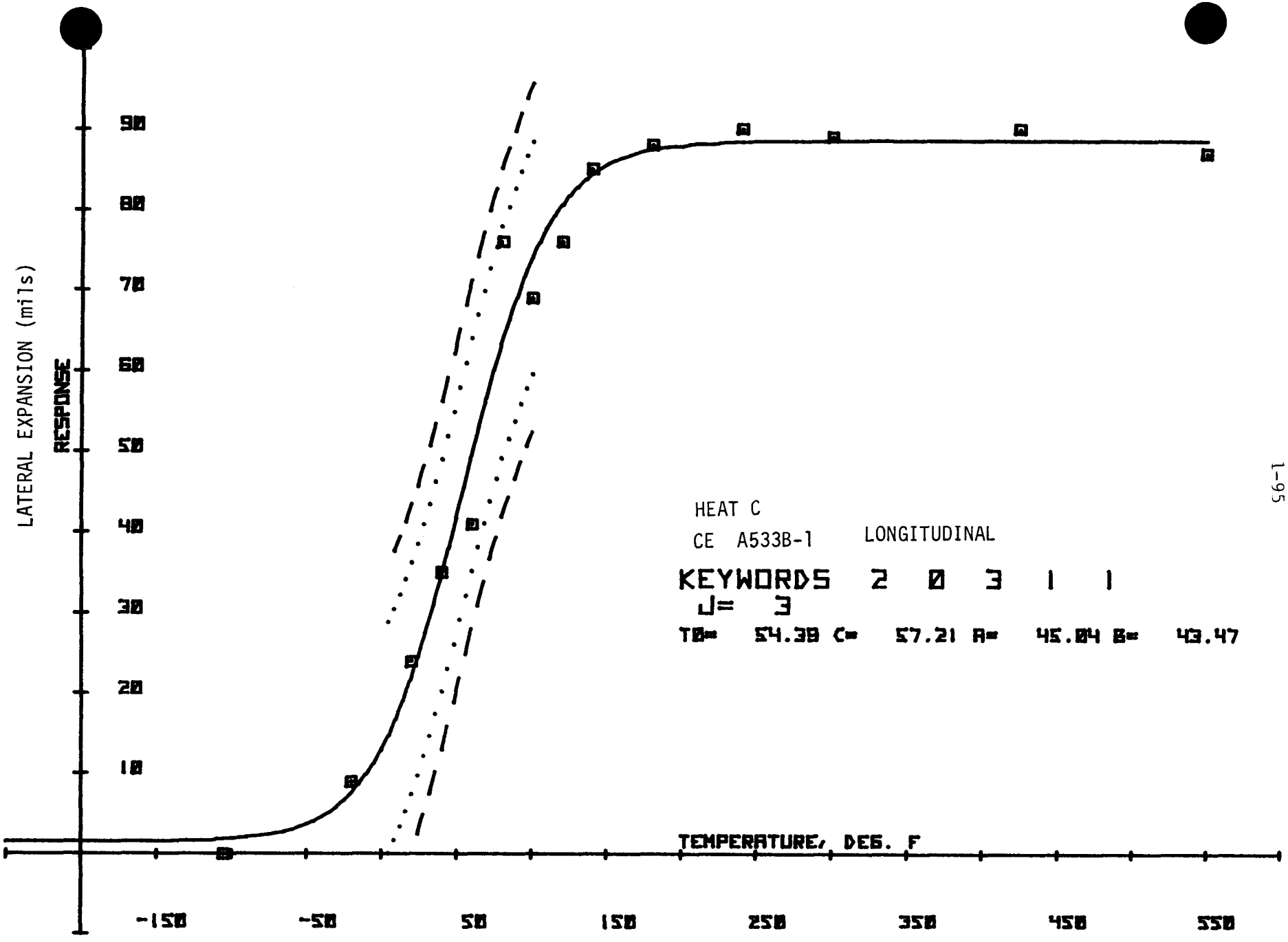

Figure 1.46 Charpy V-Notch Lateral Expansion for CE Heat C (L)

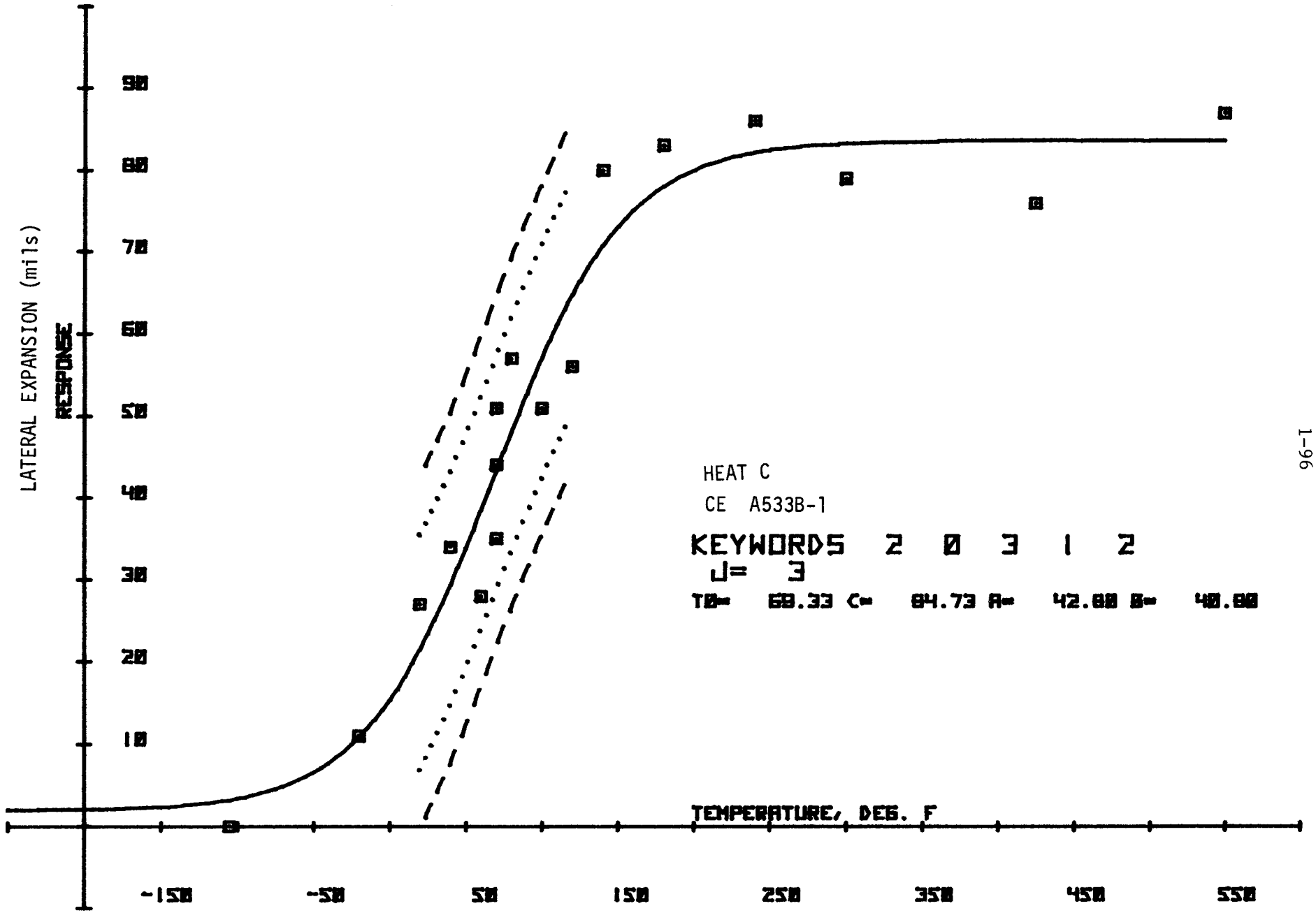

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Figure 1.47 Charpy V-Notch Lateral Expansion for CE Heat C (T)

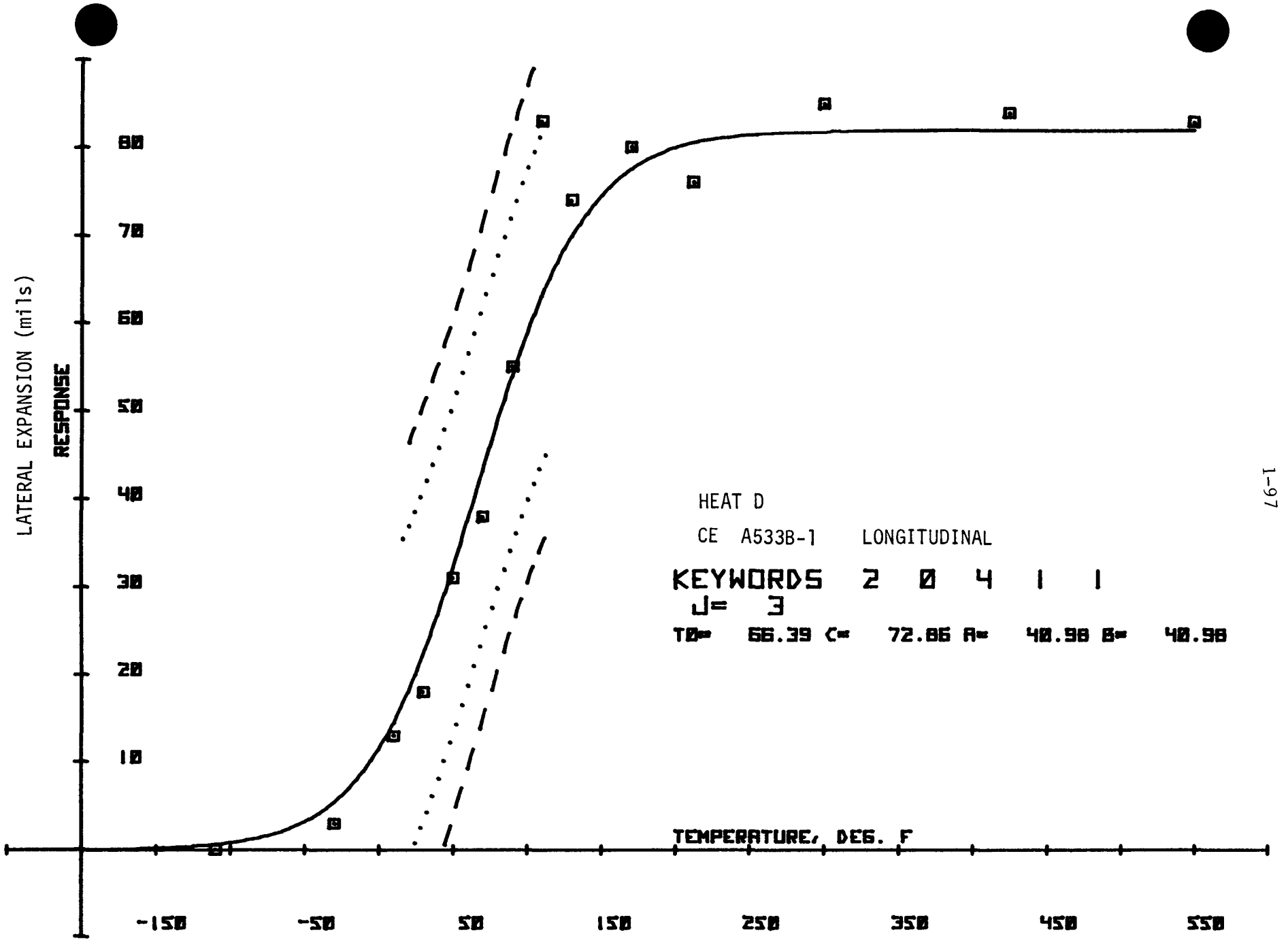

Figure 1.48 Charpy V-Notch Lateral Expansion for CE Heat D (L)

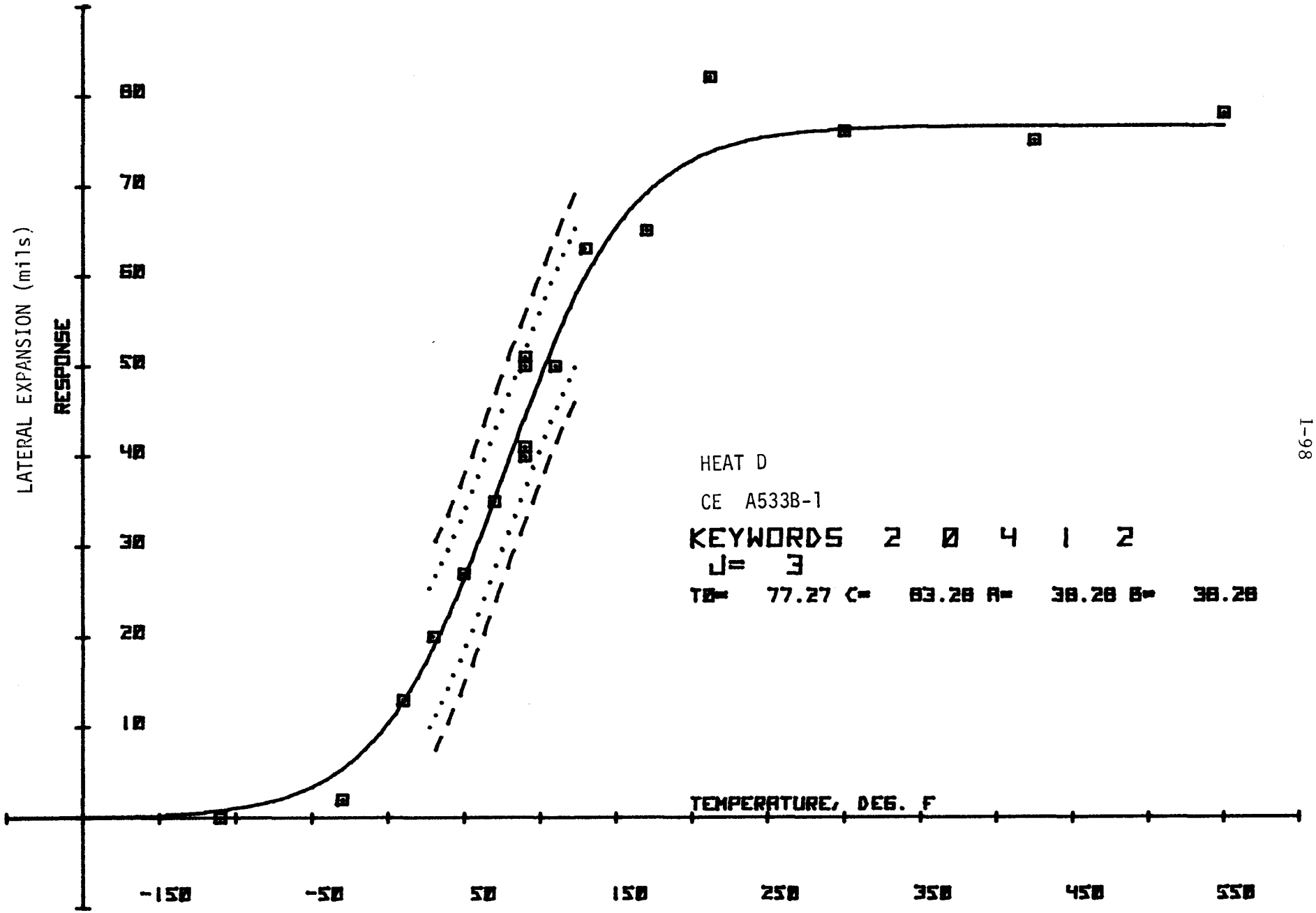

Figure 1.49 Charpy V-Notch Lateral Expansion for CE Heat D (T)

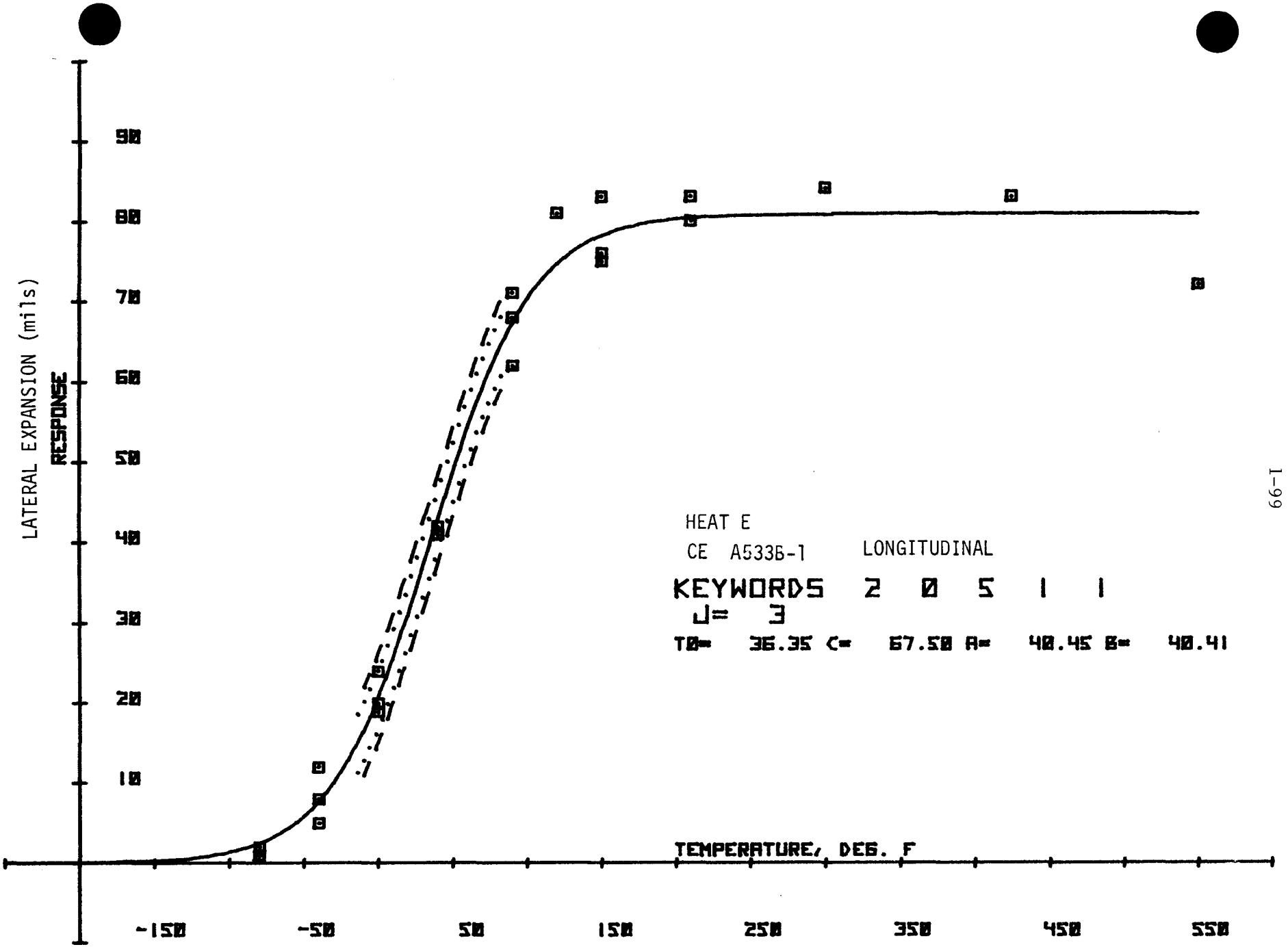

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Figure 1.50 Charpy V-Notch Lateral Expansion for CE Heat E (L)

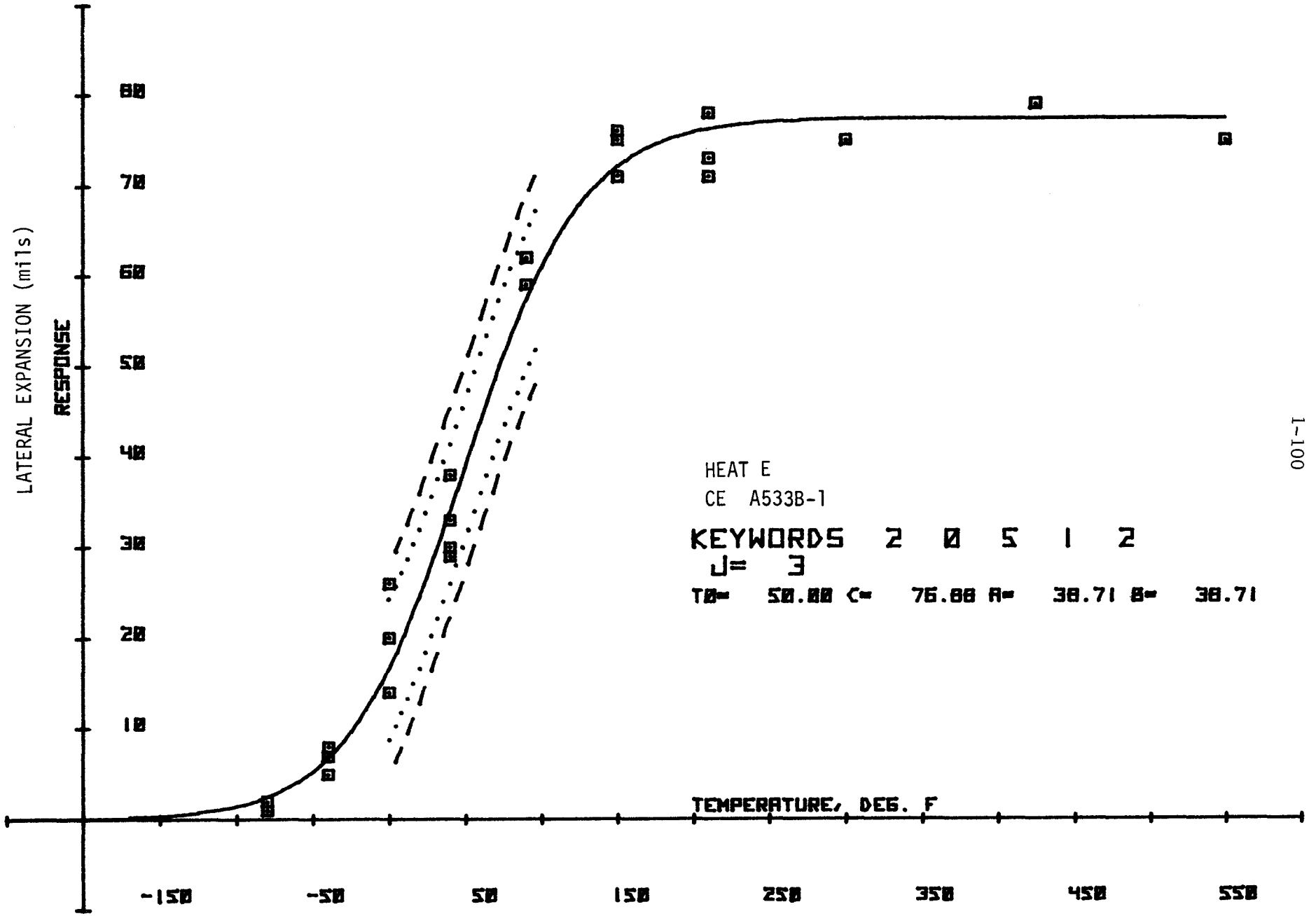


Figure 1.51 Charpy V-Notch Lateral Expansion for CE Heat E (T)

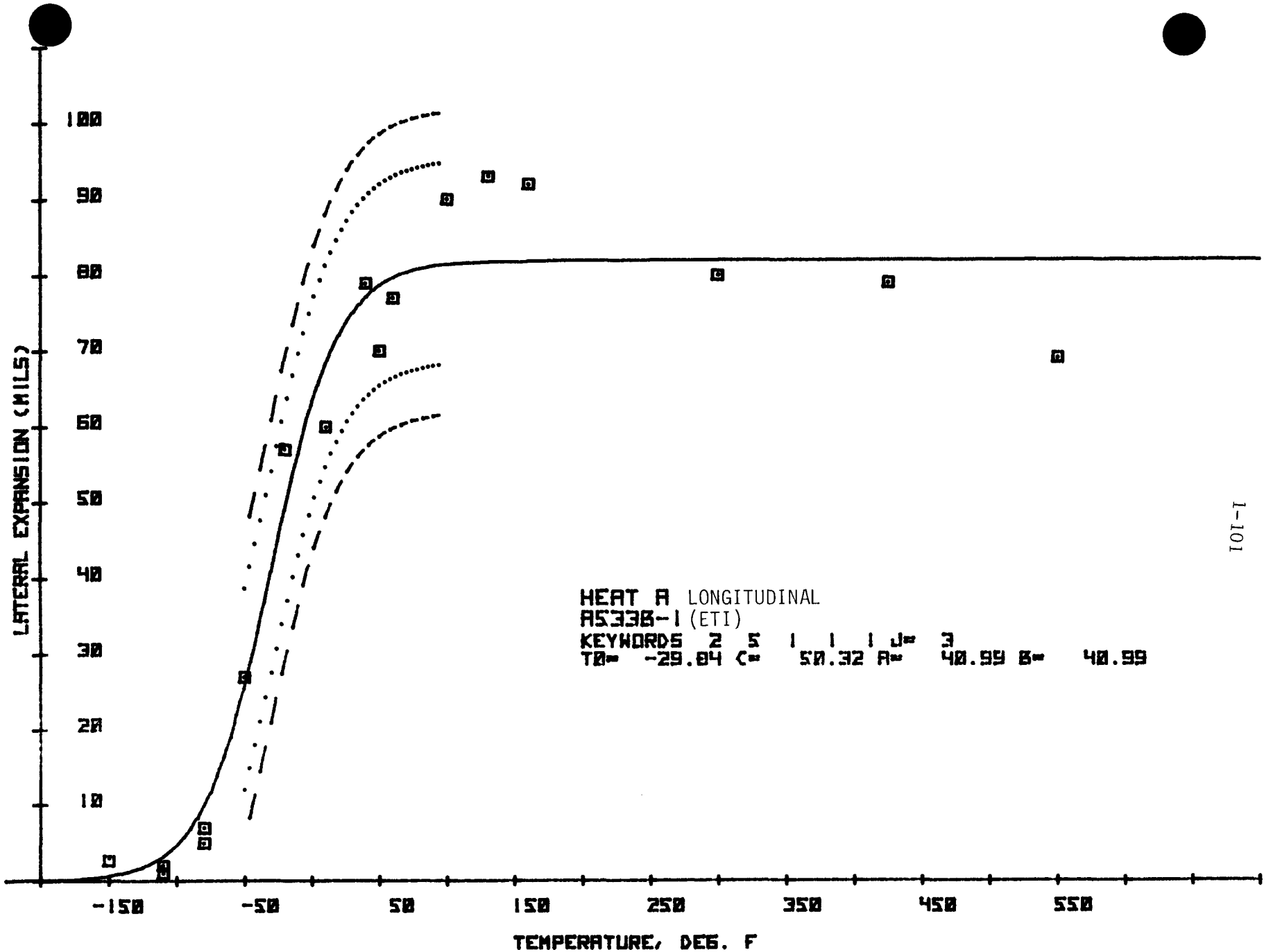


Figure 1.52. Charpy V-Notch Lateral Expansion for ETI Heat A (L)

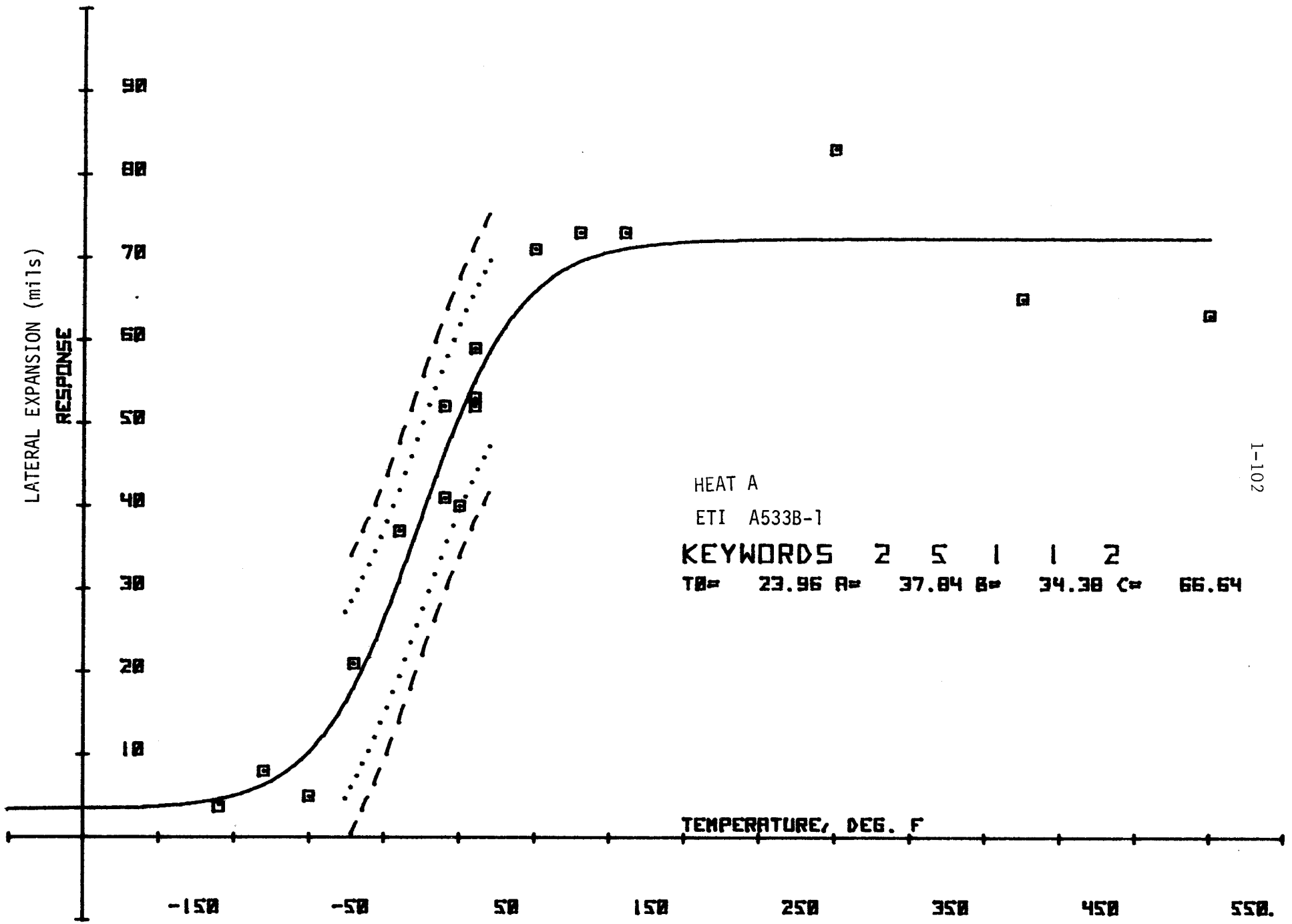


Figure 1.53 Charpy V-Notch Lateral Expansion for ETI Heat A (T)

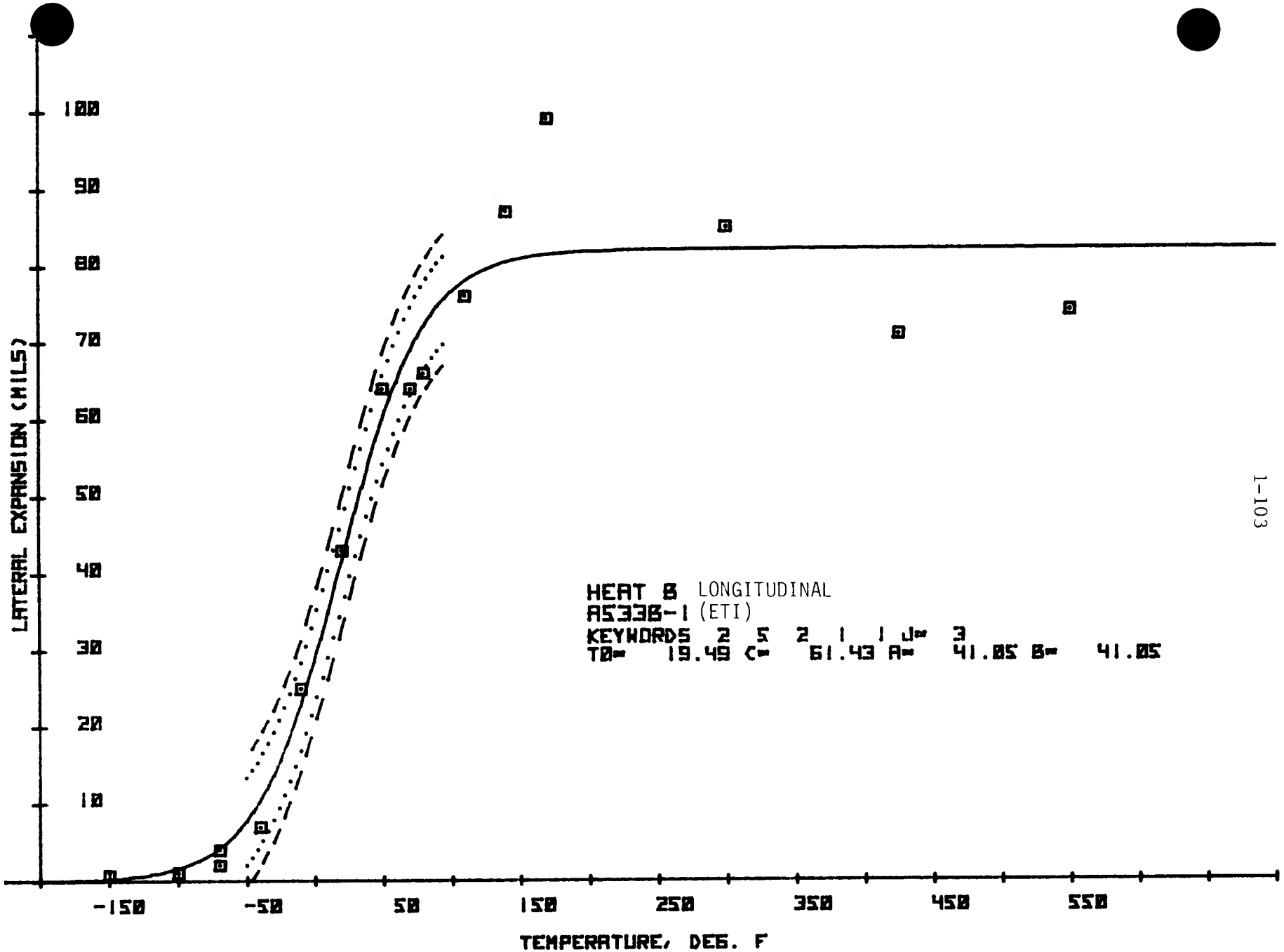


Figure 1.54. Charpy V-Notch Lateral Expansion for ETI Heat B (L)

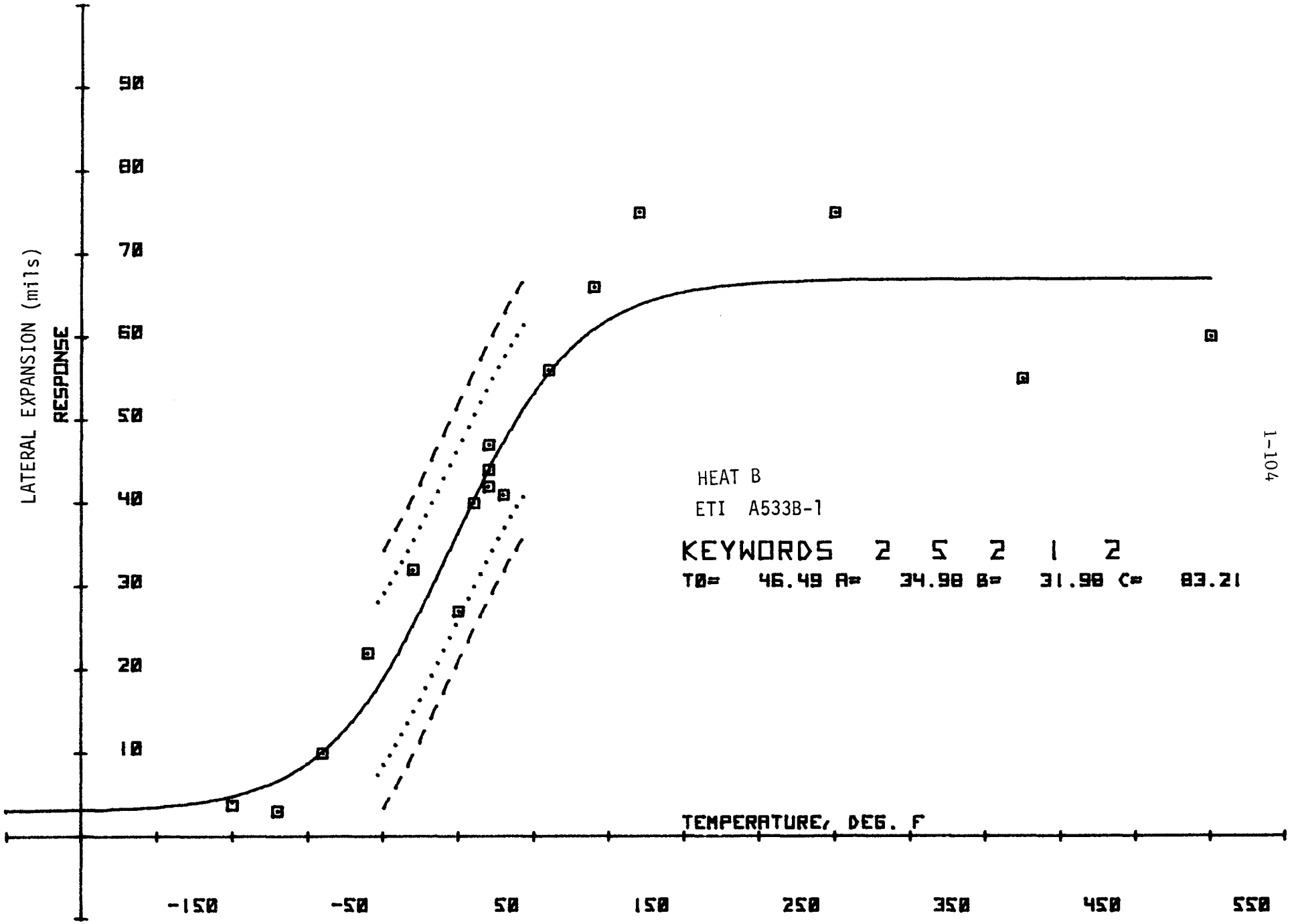


Figure 1.55 Charpy V-Notch Lateral Expansion for ETI Heat B (T)

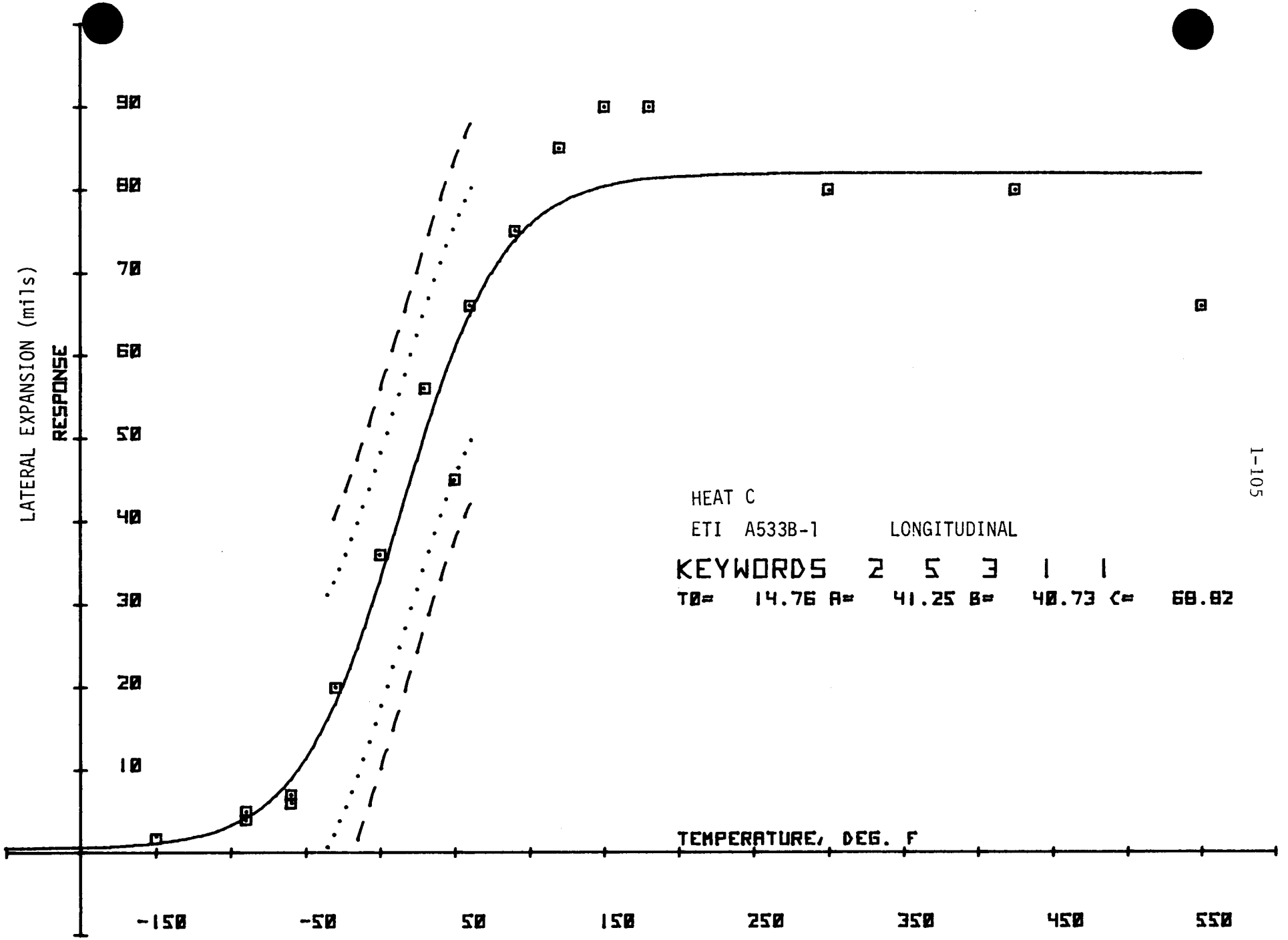
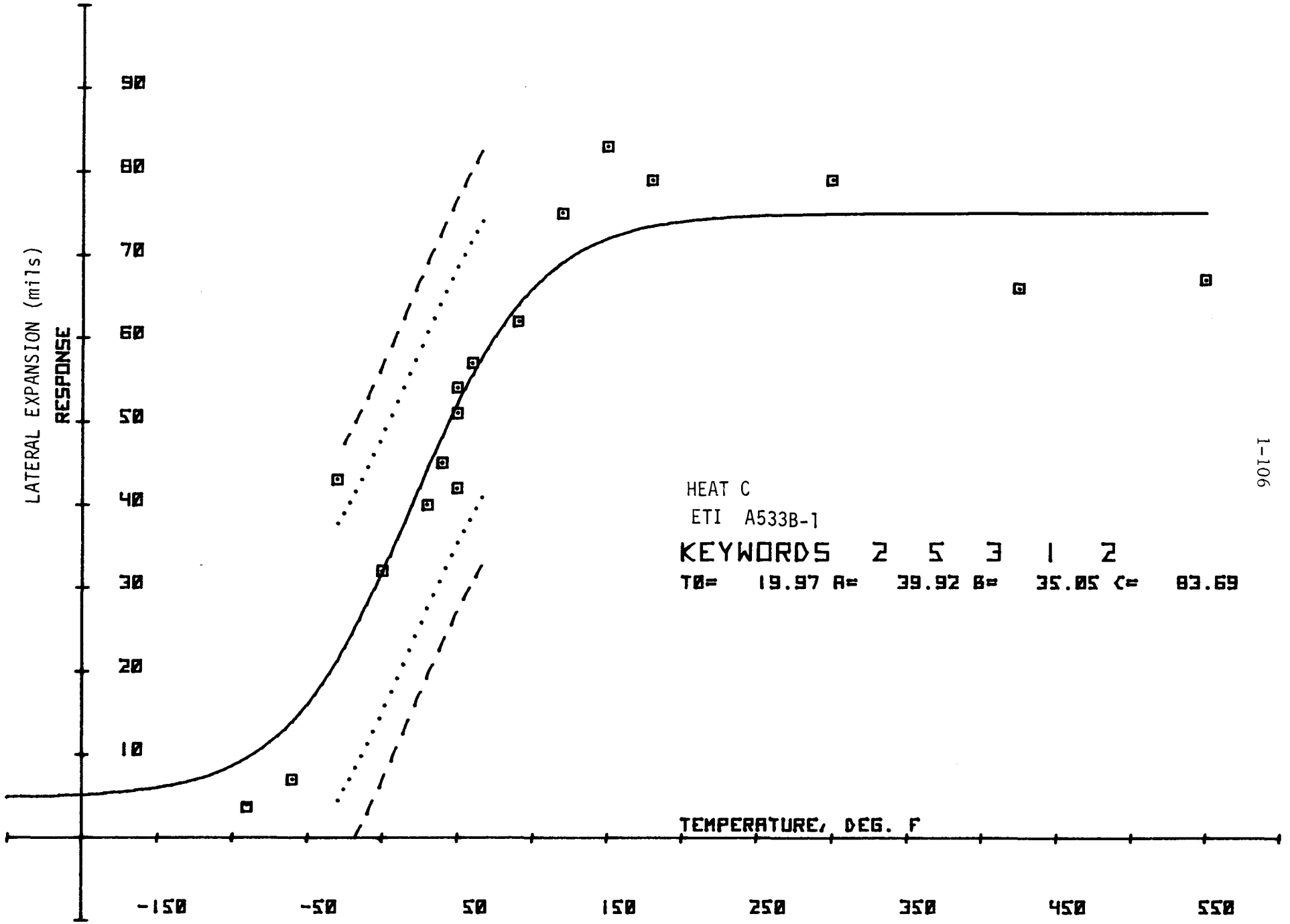


Figure 1.56 Charpy V-Notch Lateral Expansion for ETI Heat C (L)



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ure 1.57 Charpy V-Notch Lateral Expansion for ETI Heat C (T)

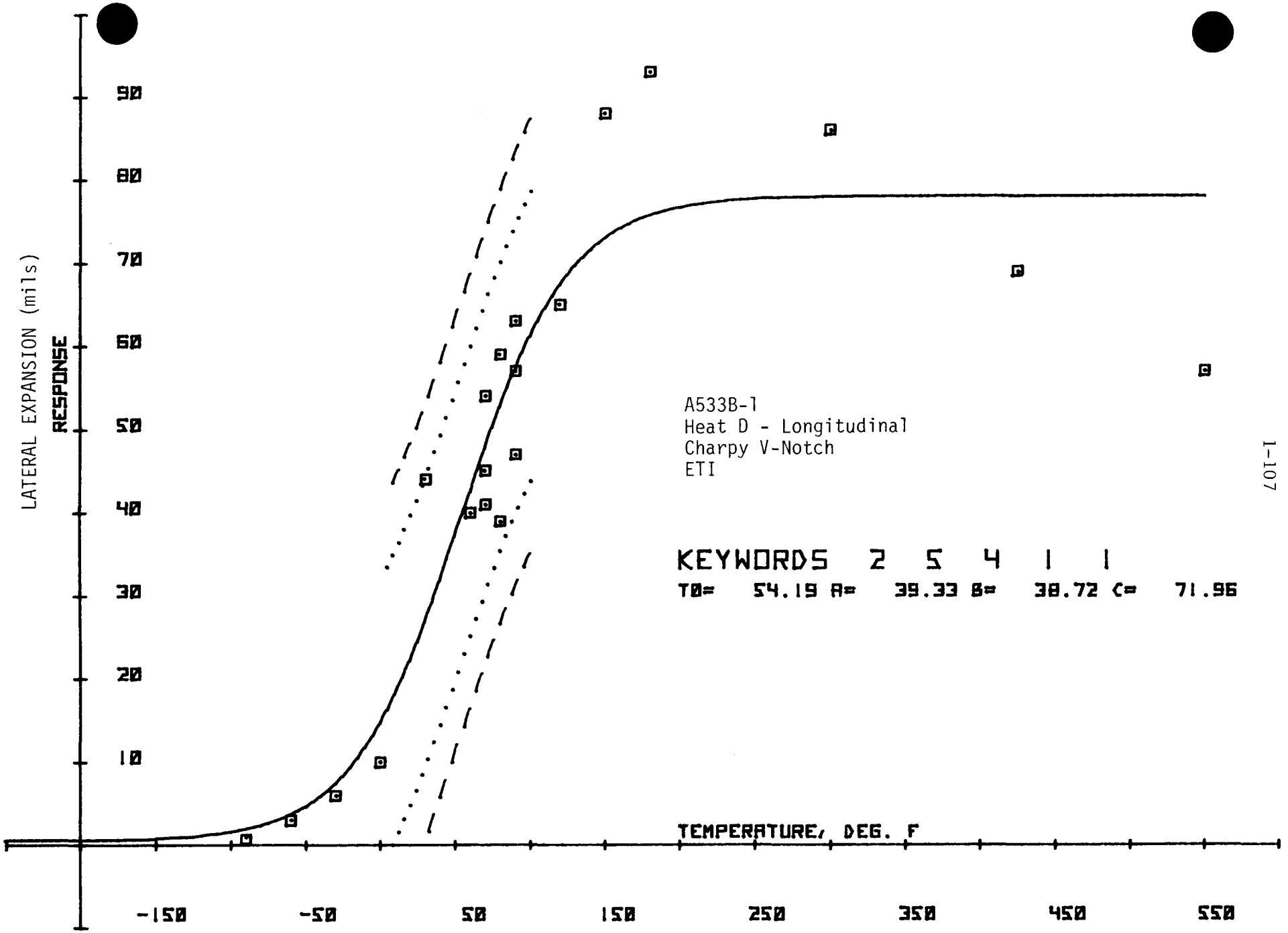

Figure 1.58 Charpy V-Notch Lateral Expansion for ETI Heat D (L)

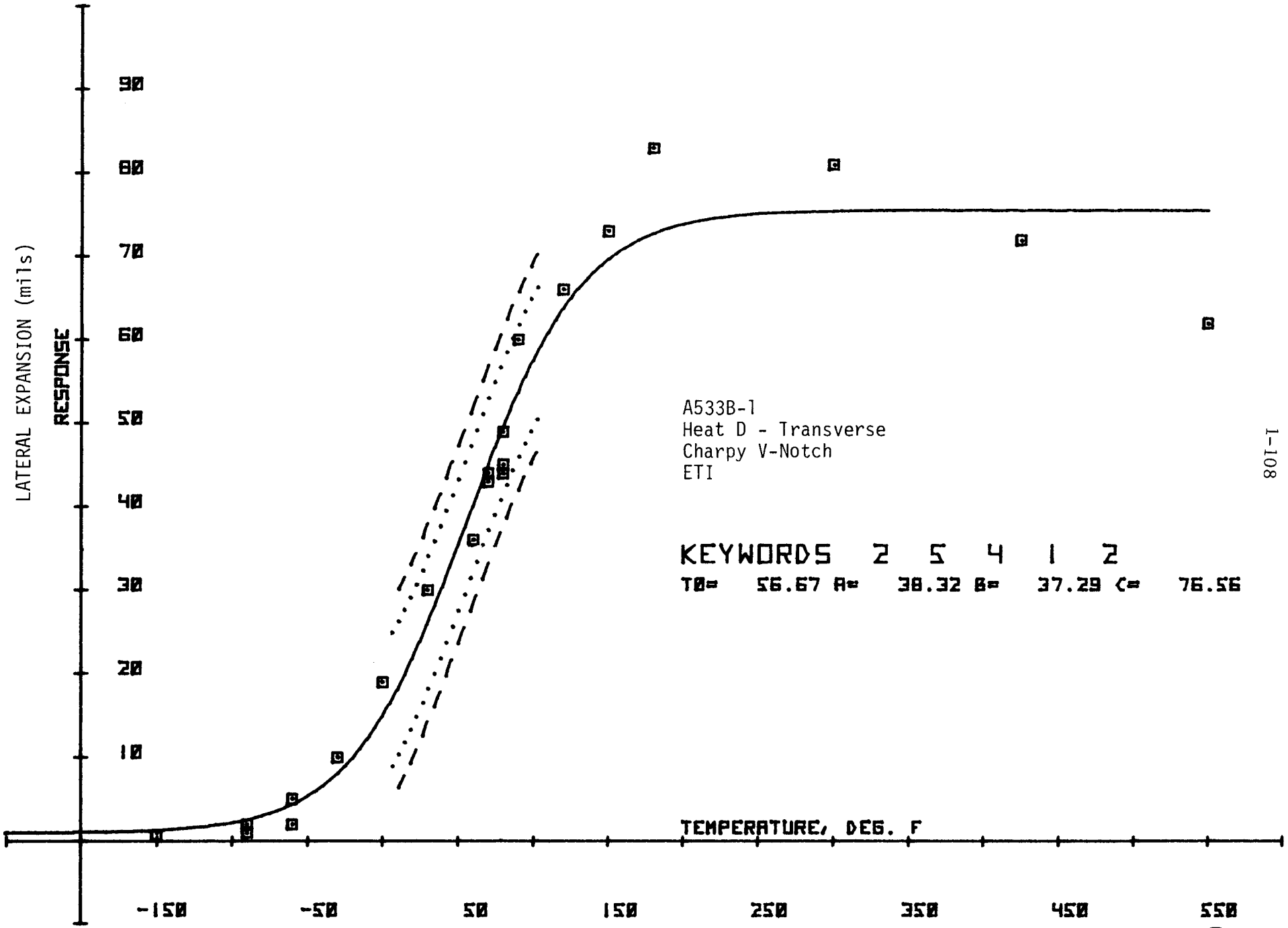

Figure 1.59 Charpy V-Notch Lateral Expansion for ETI Heat D (T)

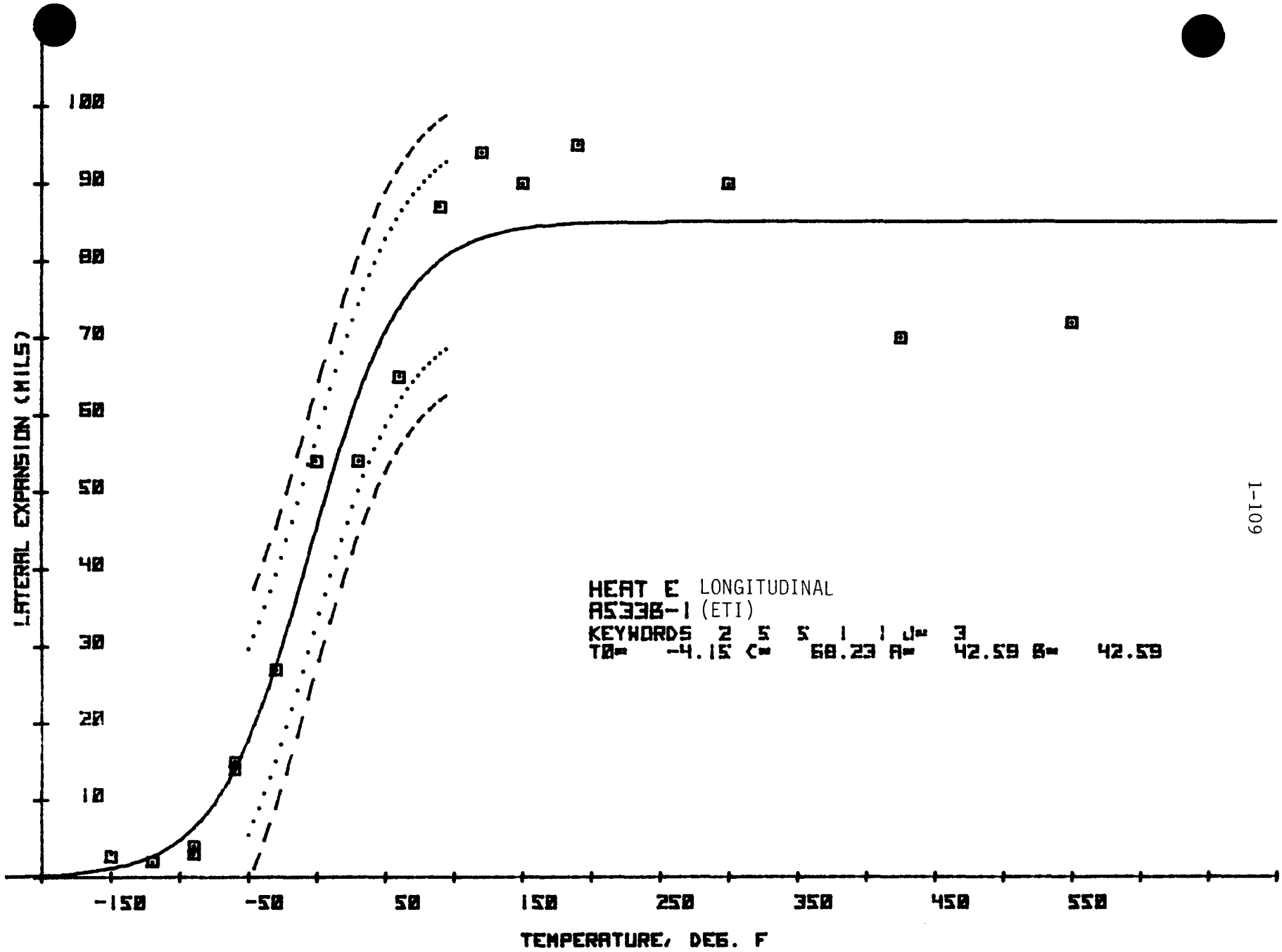

Figure 1.60. Charpy V-Notch Lateral Expansion for ETI Heat E (L)

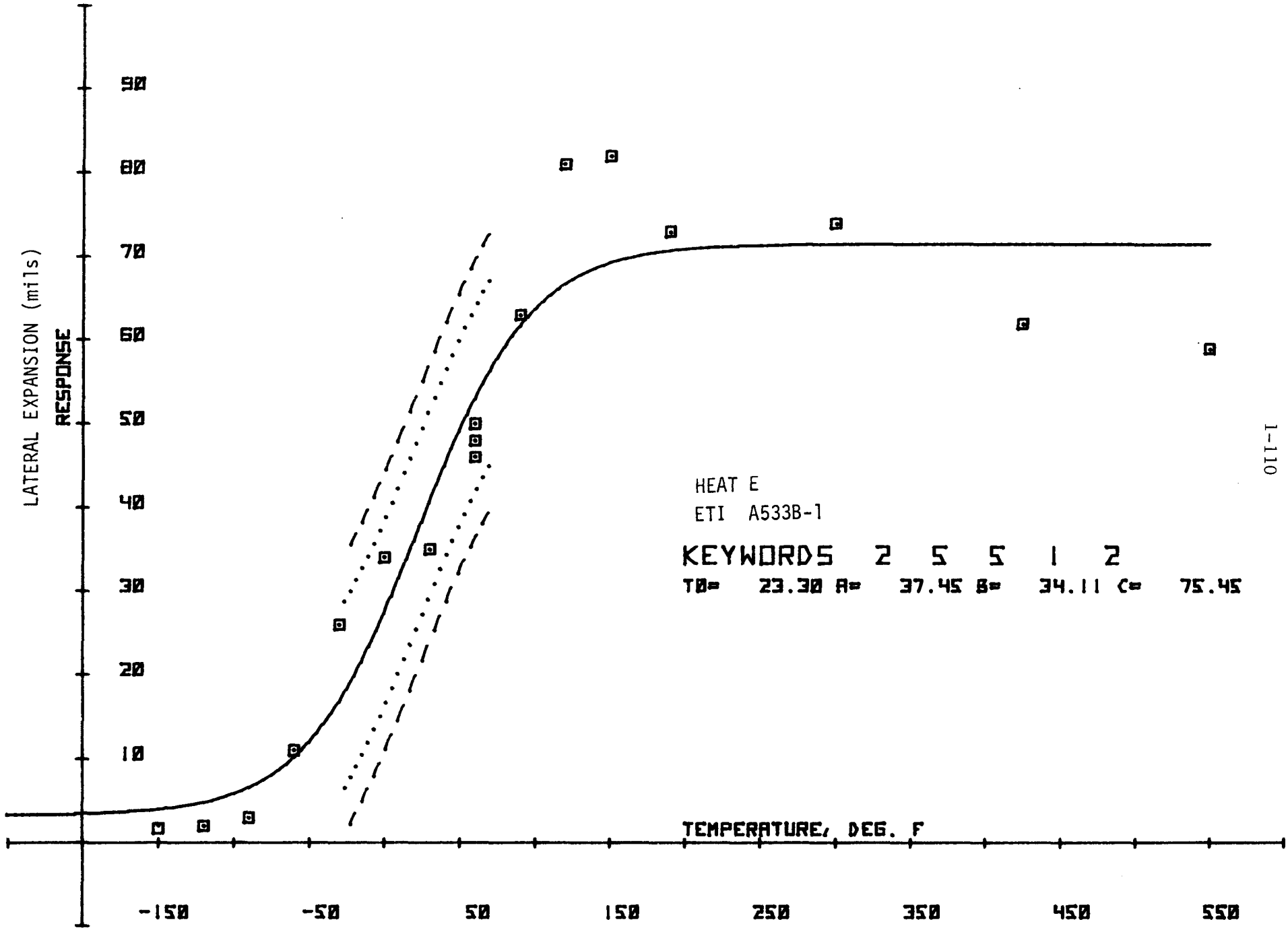

Figure 1.61 Charpy V-Notch Lateral Expansion for ETI Heat E (T)

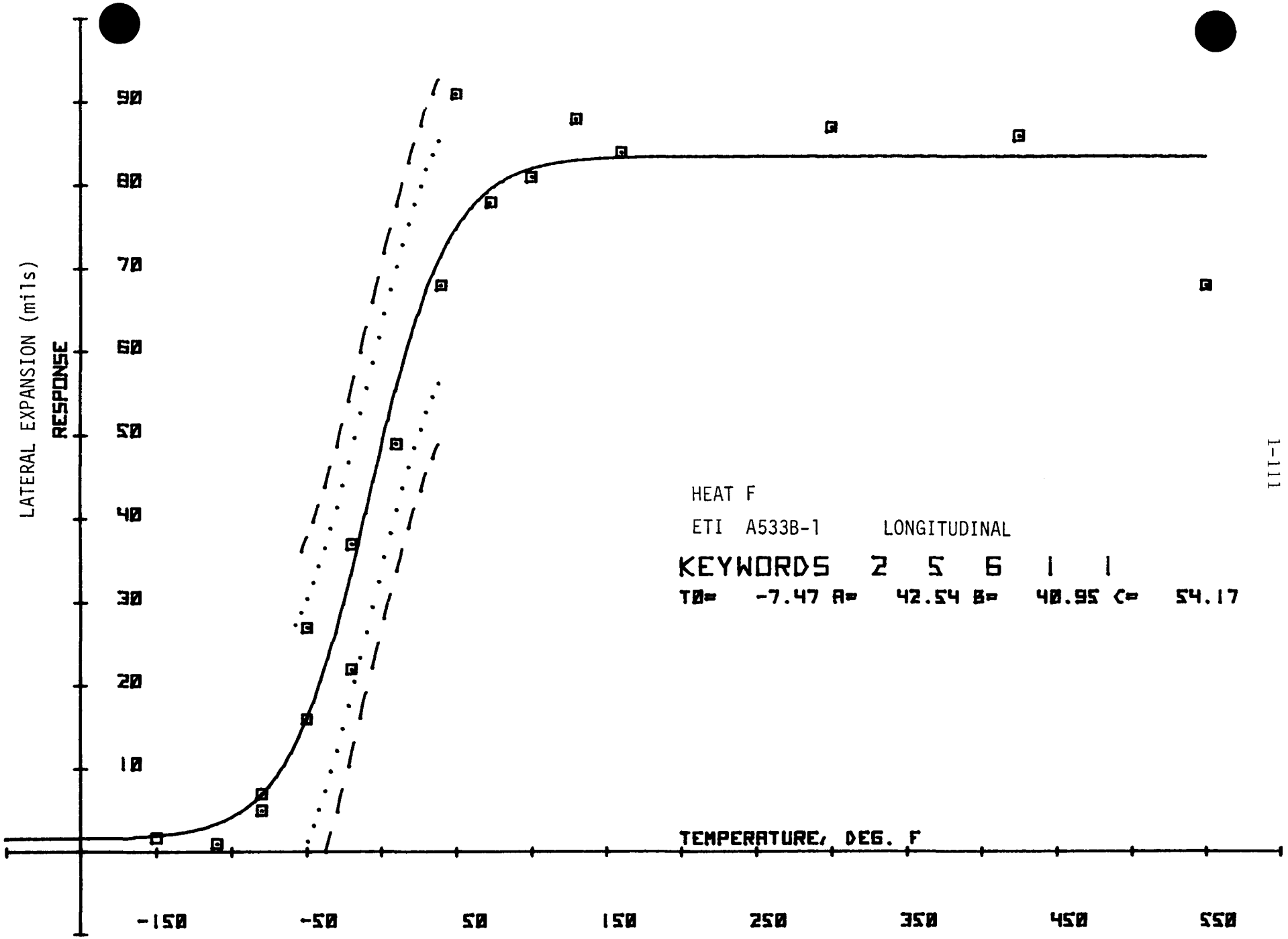

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Figure 1.62 Charpy V-Notch Lateral Expansion for ETI Heat F (L)

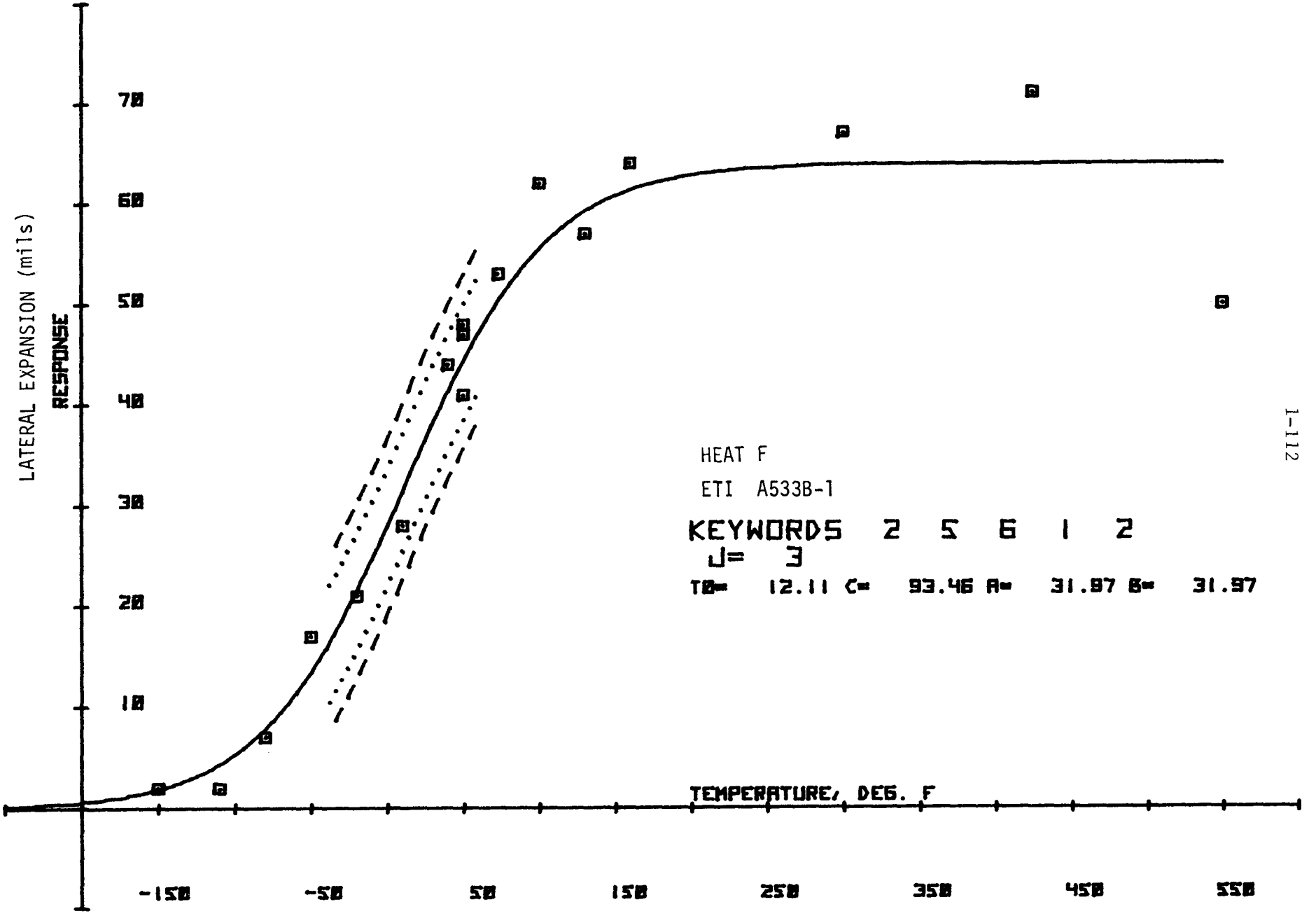

Figure 1.63 Charpy V-Notch Lateral Expansion for ETI Heat F (T)

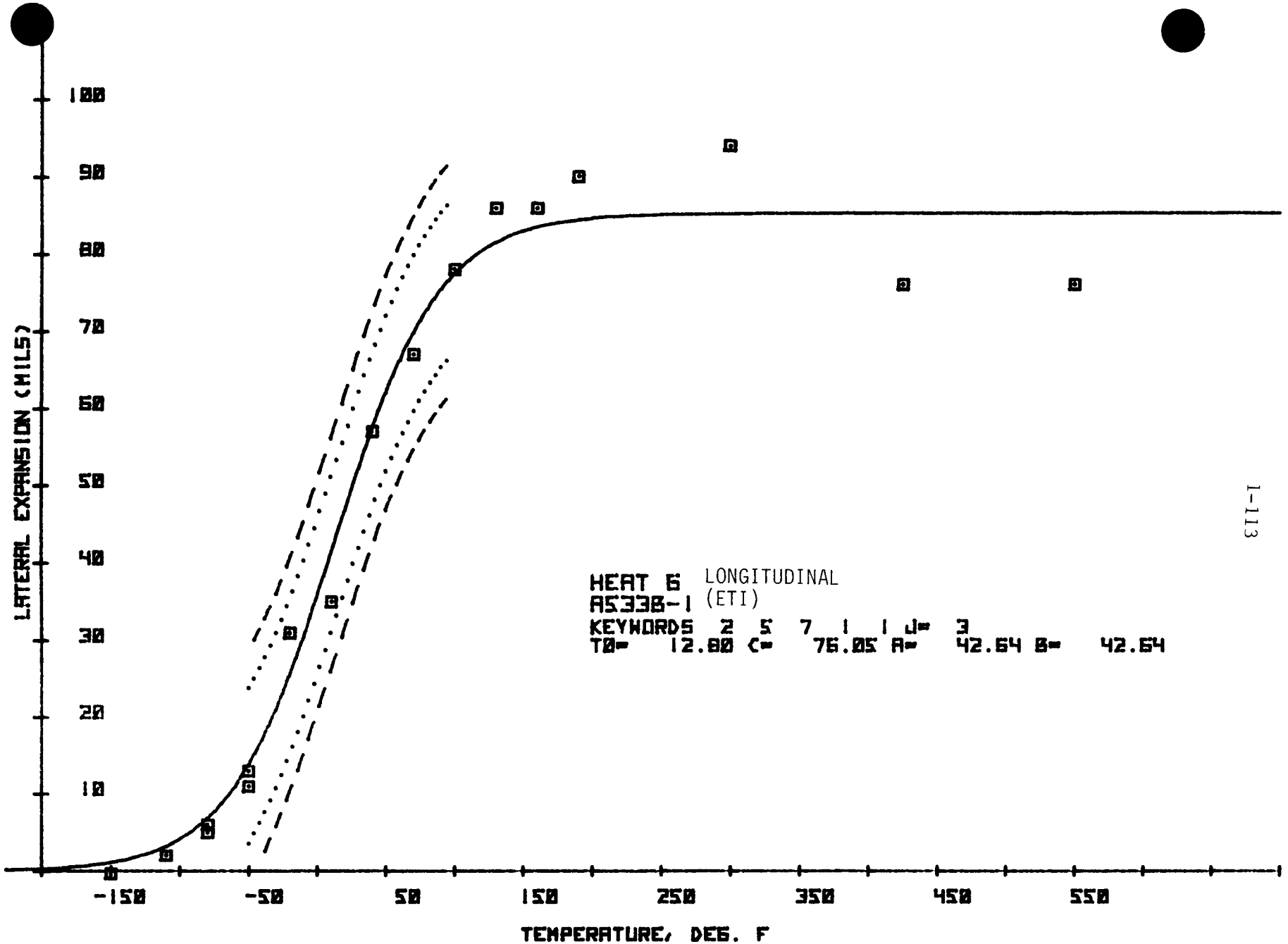

Figure 1.64. Charpy V-Notch Lateral Expansion for ETI Heat G (L)

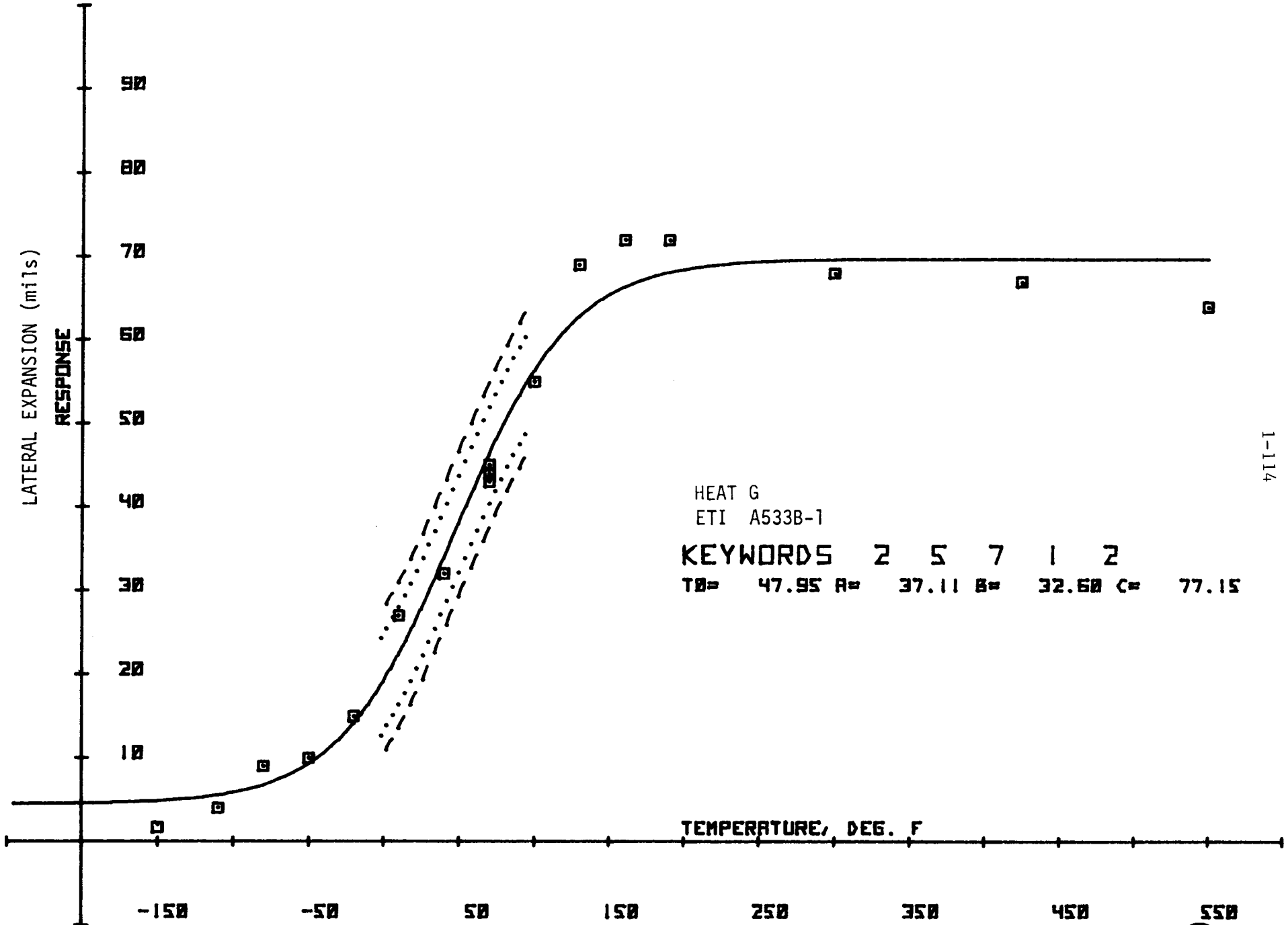

Figure 1.65 Charpy V-Notch Lateral Expansion for ETI Heat G (T)

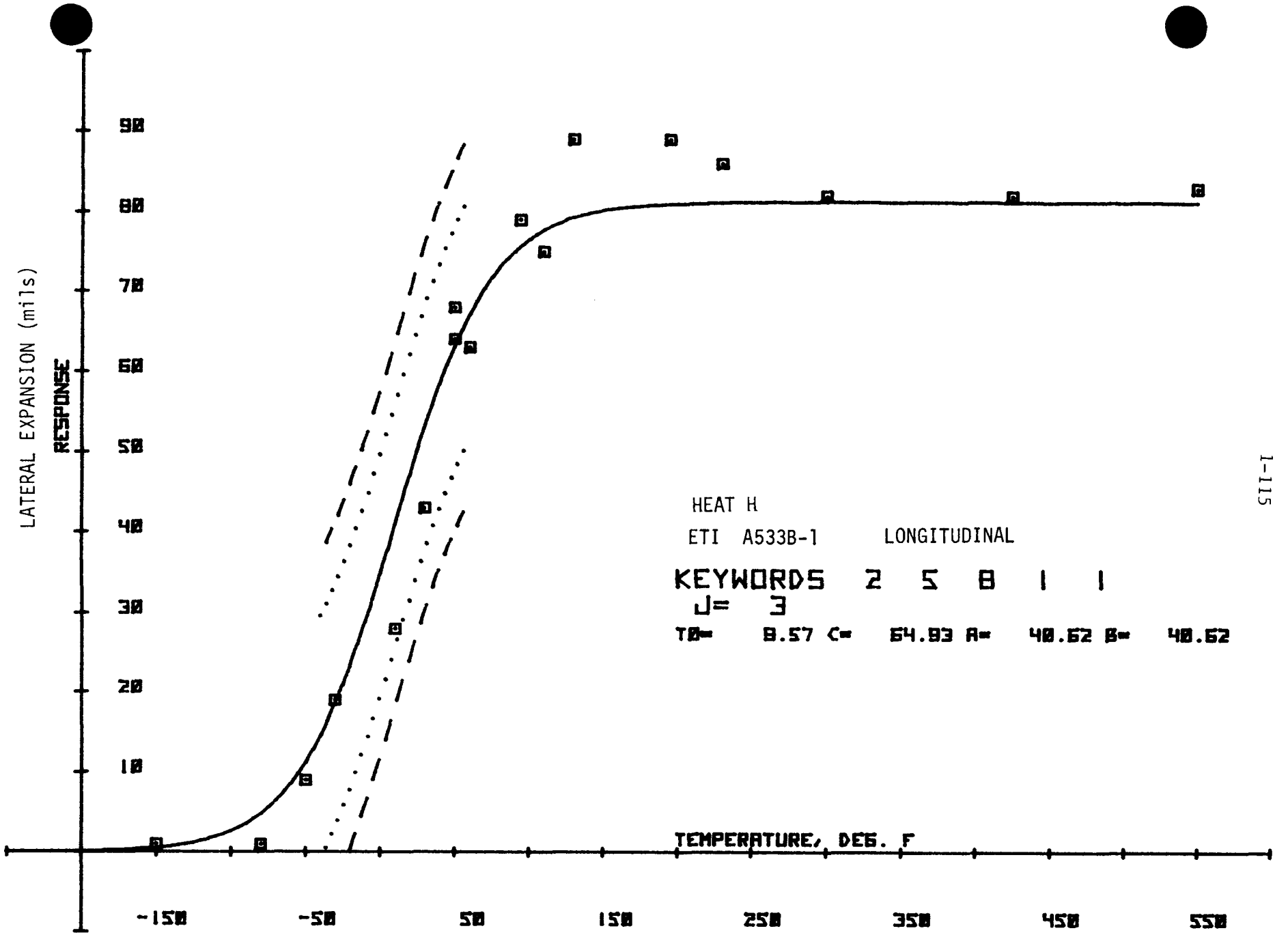

Figure 1.66 Charpy V-Notch Lateral Expansion for ETI Heat H (L)

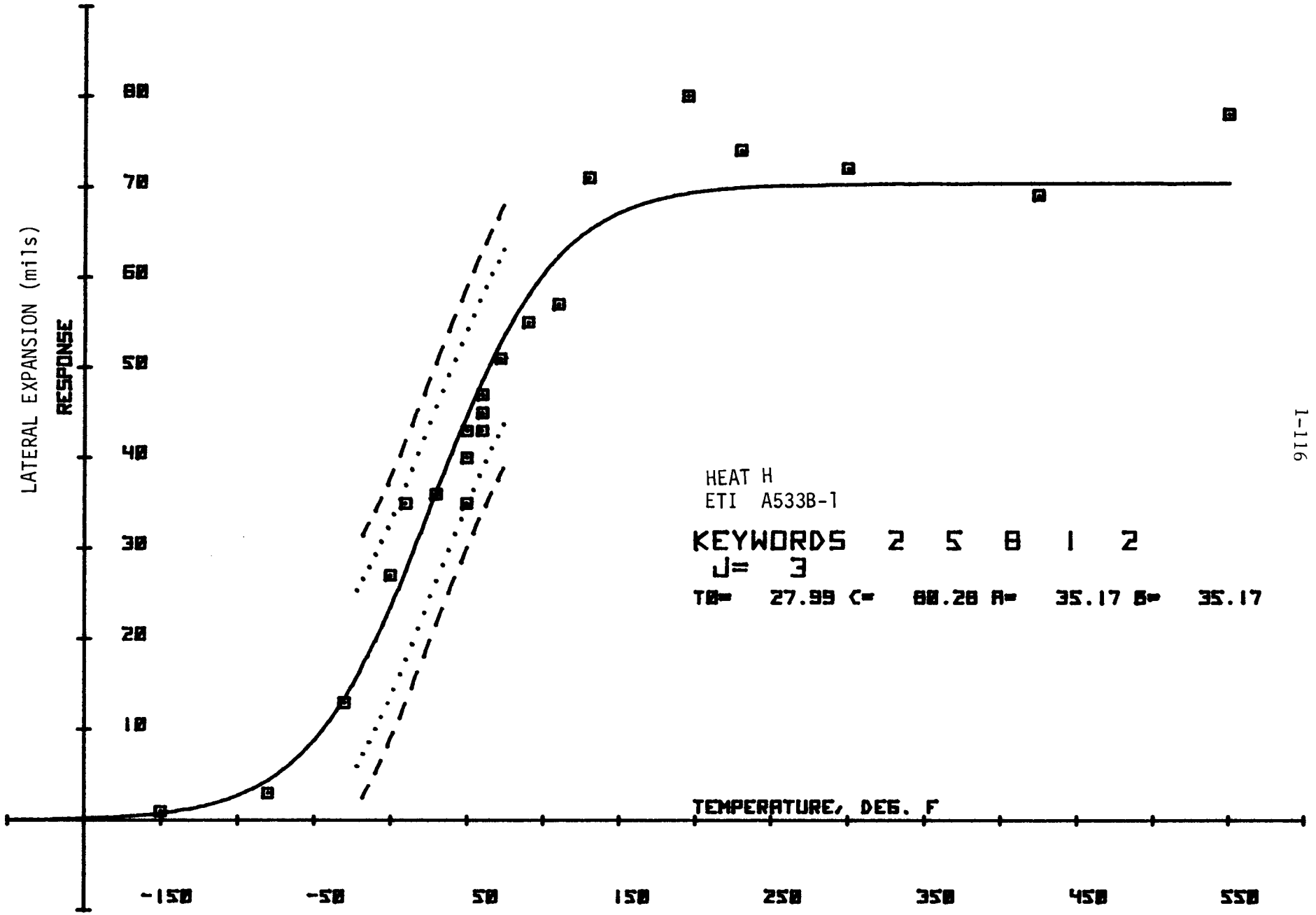

Figure 1.67 Charpy V-Notch Lateral Expansion for ETI Heat H (T)

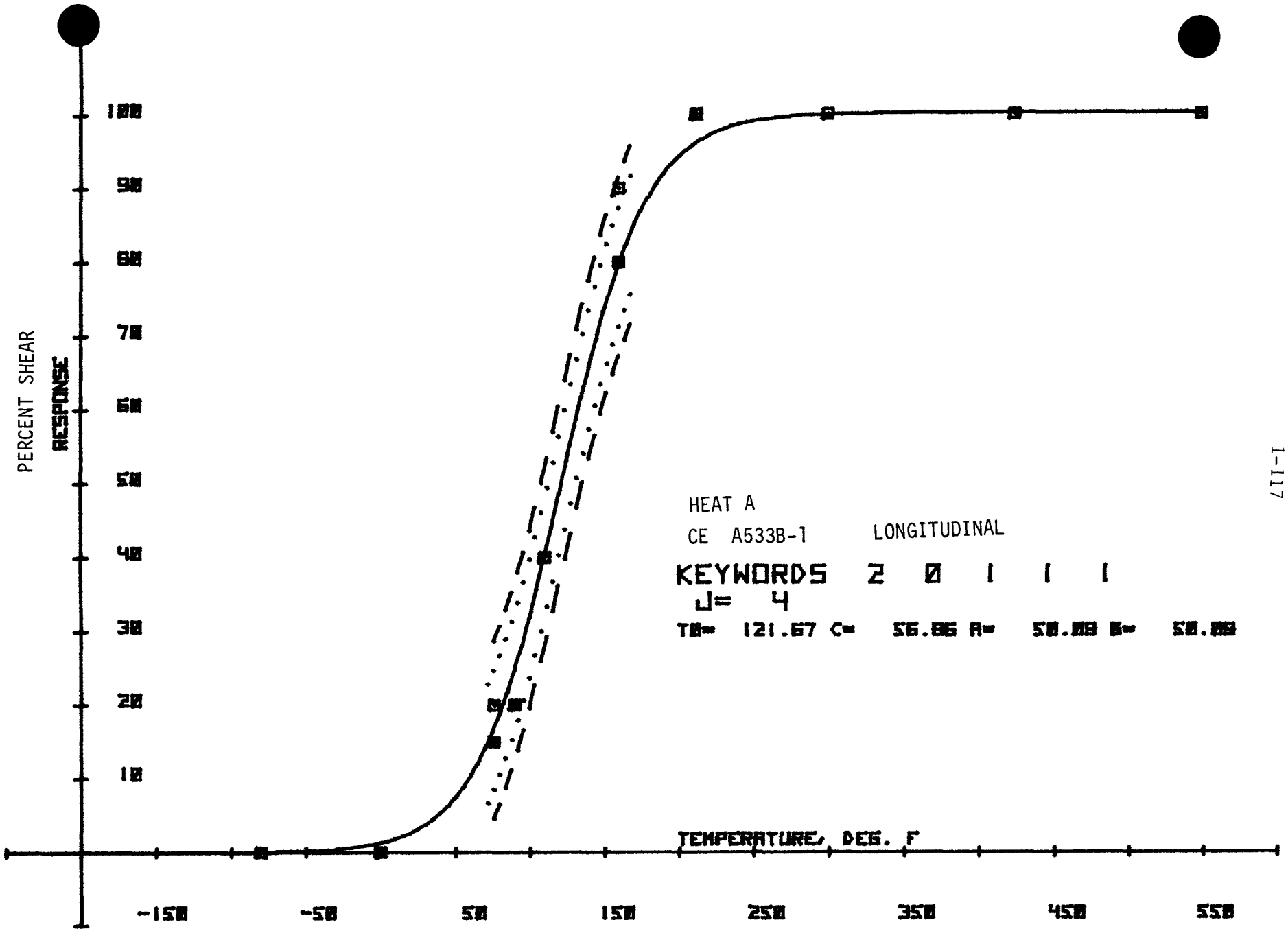

Figure 1.68 Charpy V-Notch Percent Shear for CE Heat A (L)

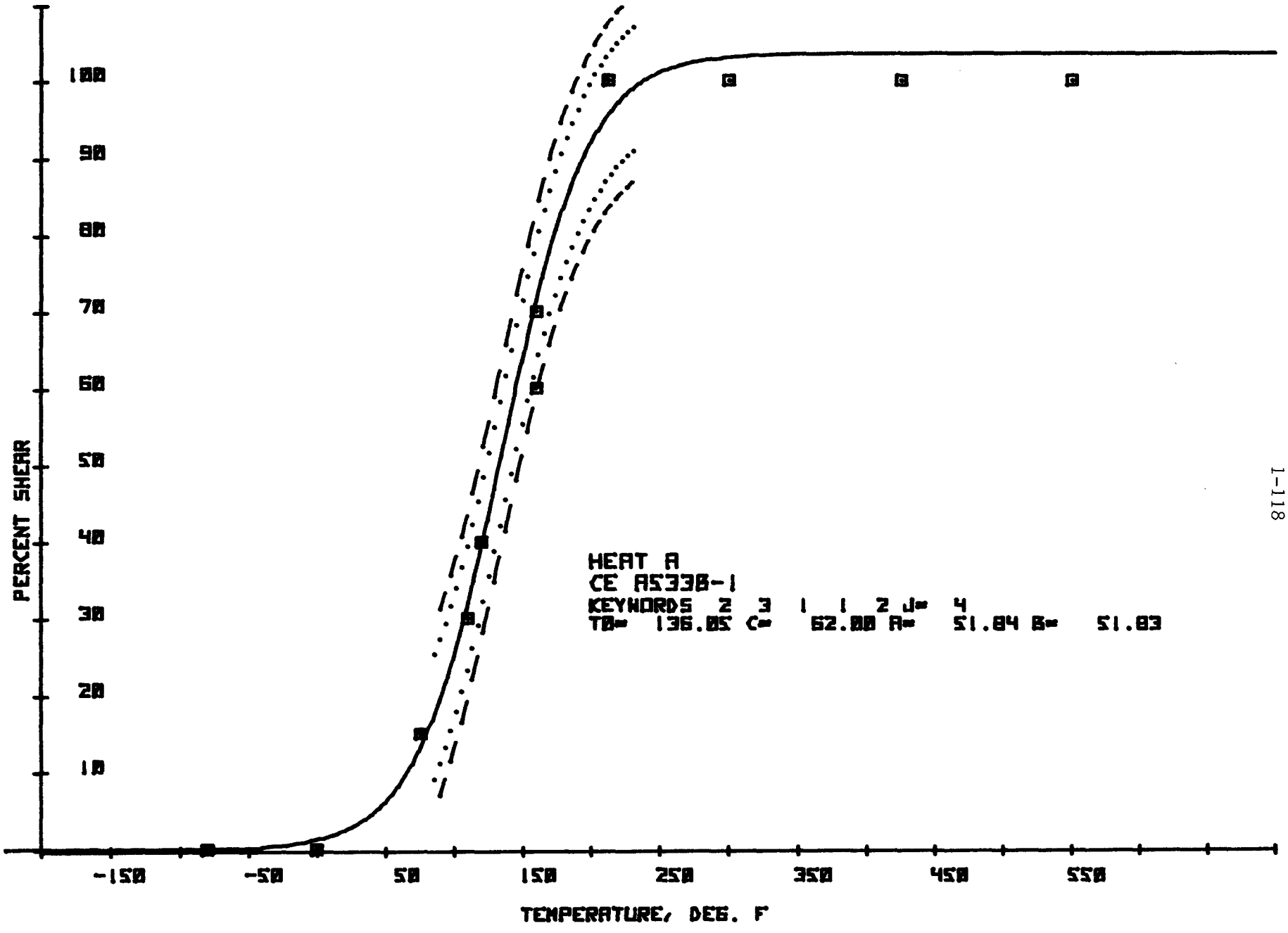

Figure 1.69 Charpy V-Notch Percent Shear for CE Heat A (T)

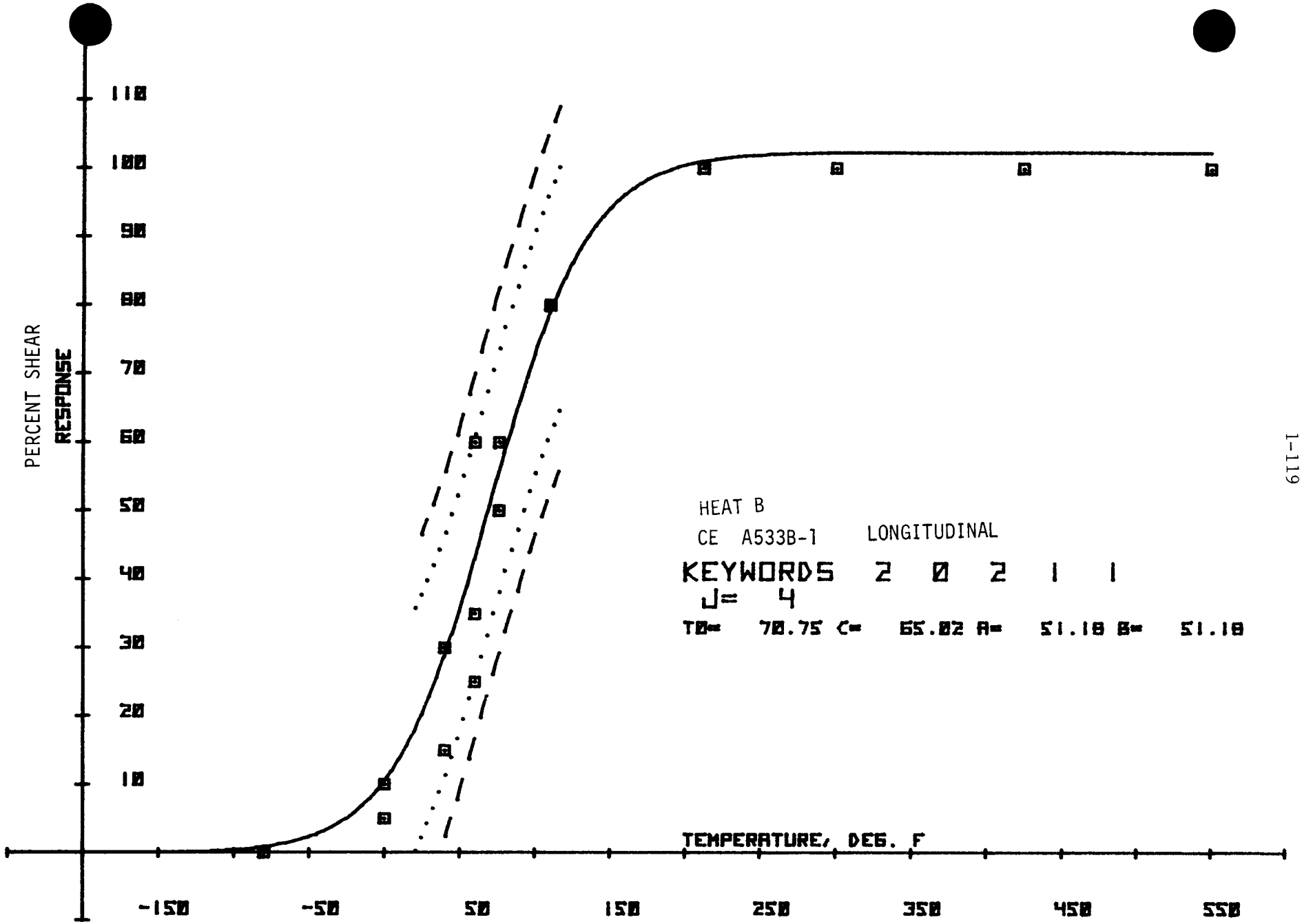

Figure 1.70 Charpy V-Notch Percent Shear for CE Heat B (L)

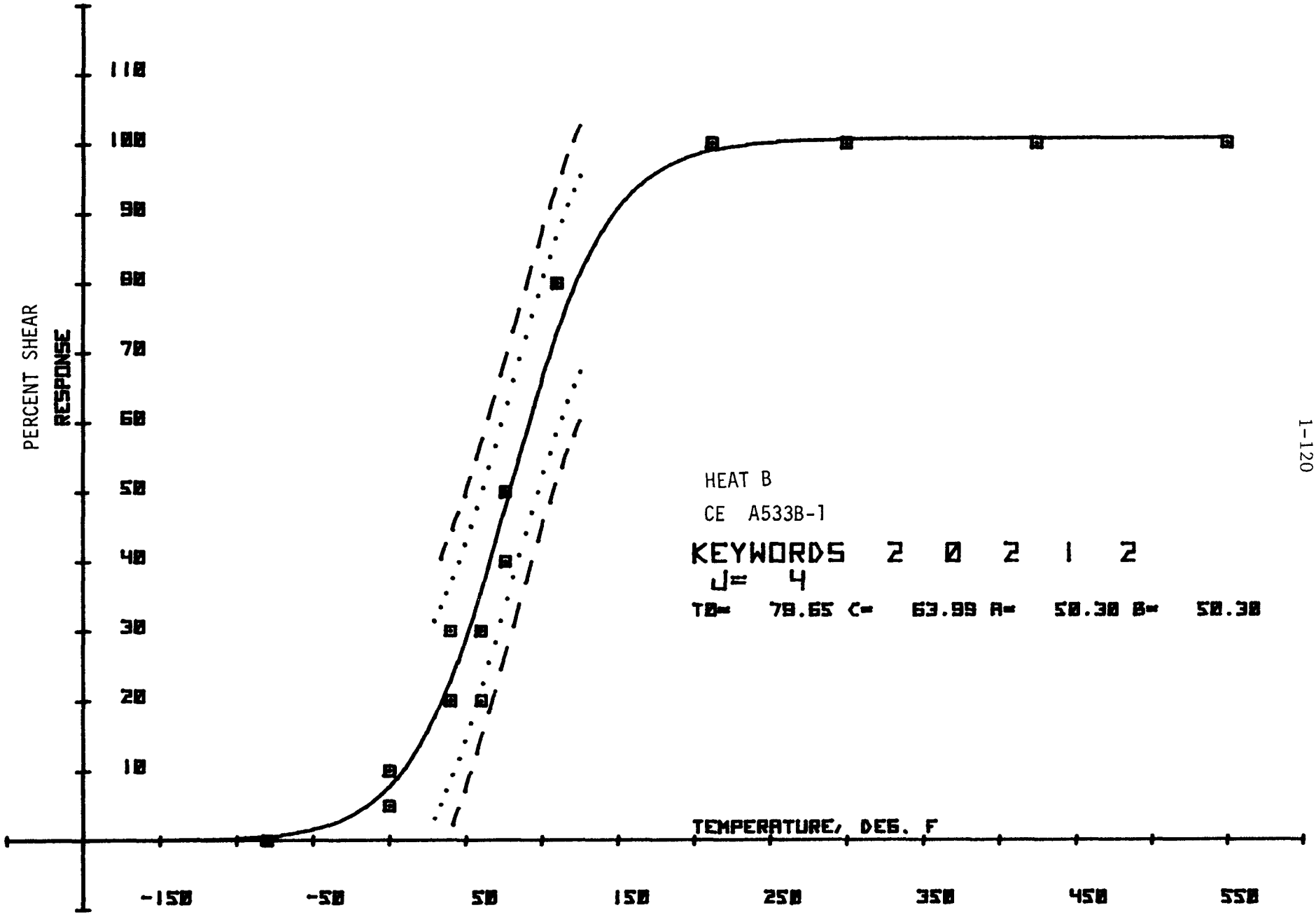

Figure 1.71 Charpy V-Notch Percent Shear for CE Heat B (T)

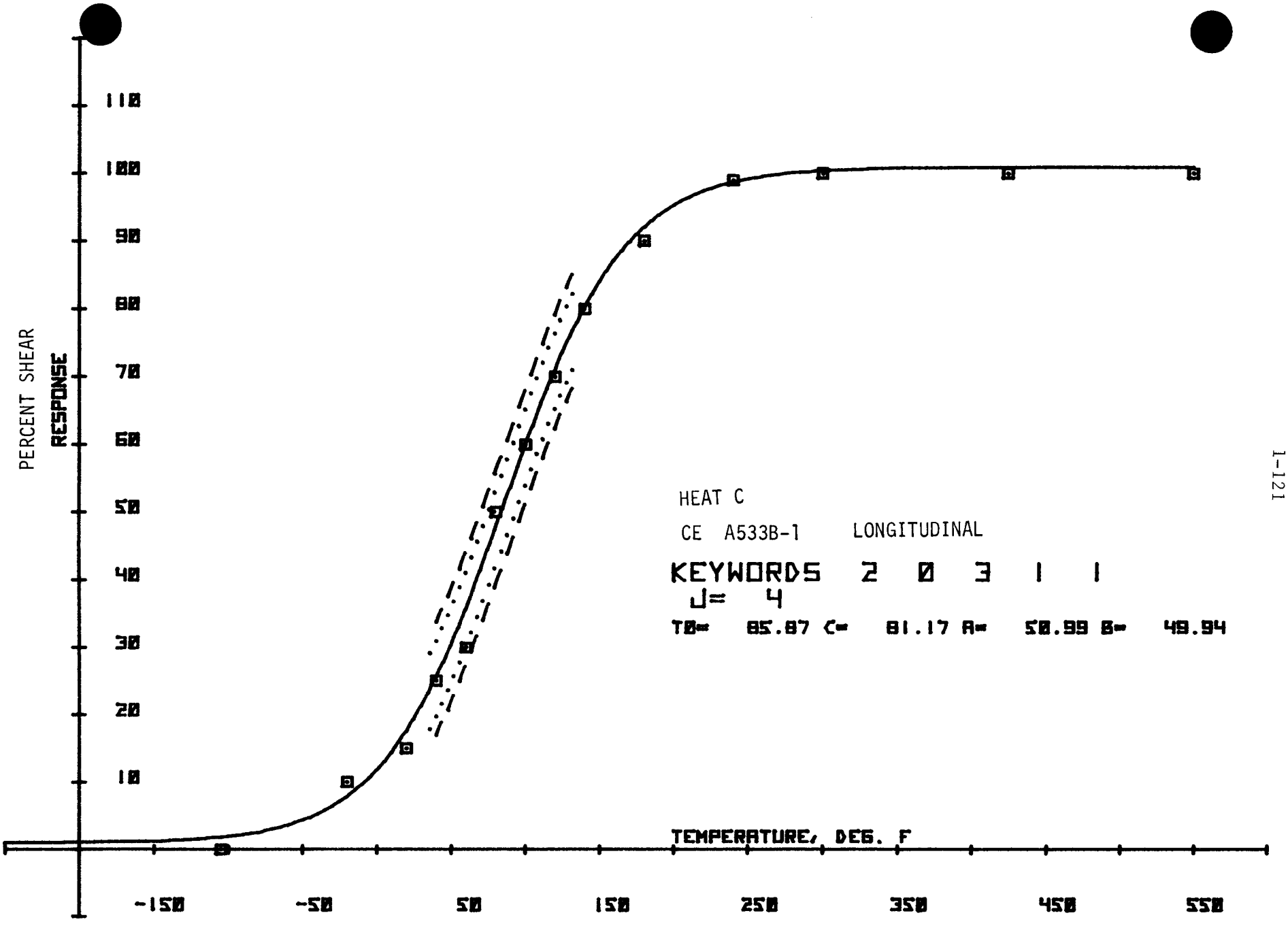

Figure 1.72 Charpy V-Notch Percent Shear for CE Heat C (L)

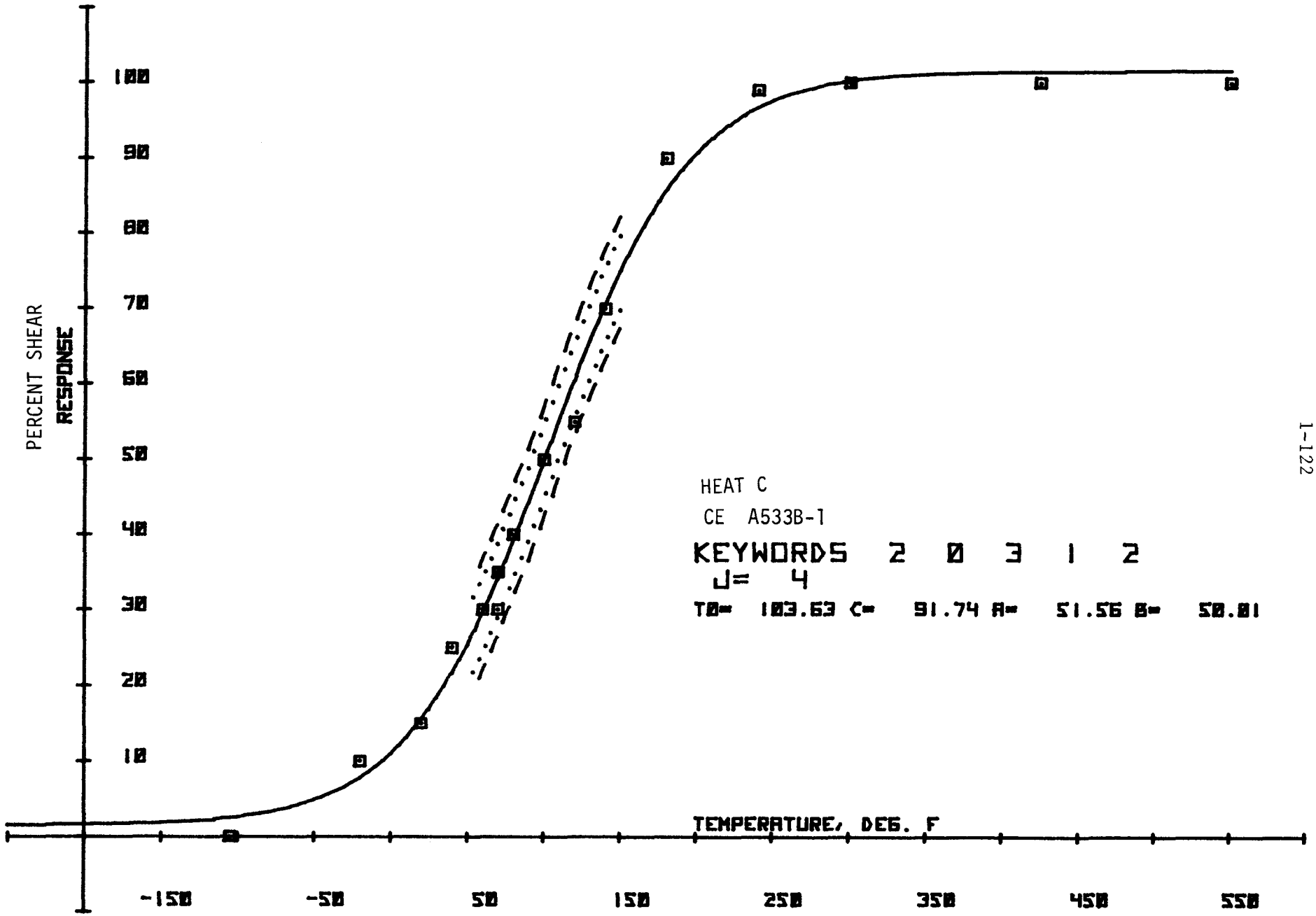

Figure 1.73 Charpy V-Notch Percent Shear for CE Heat C (T)

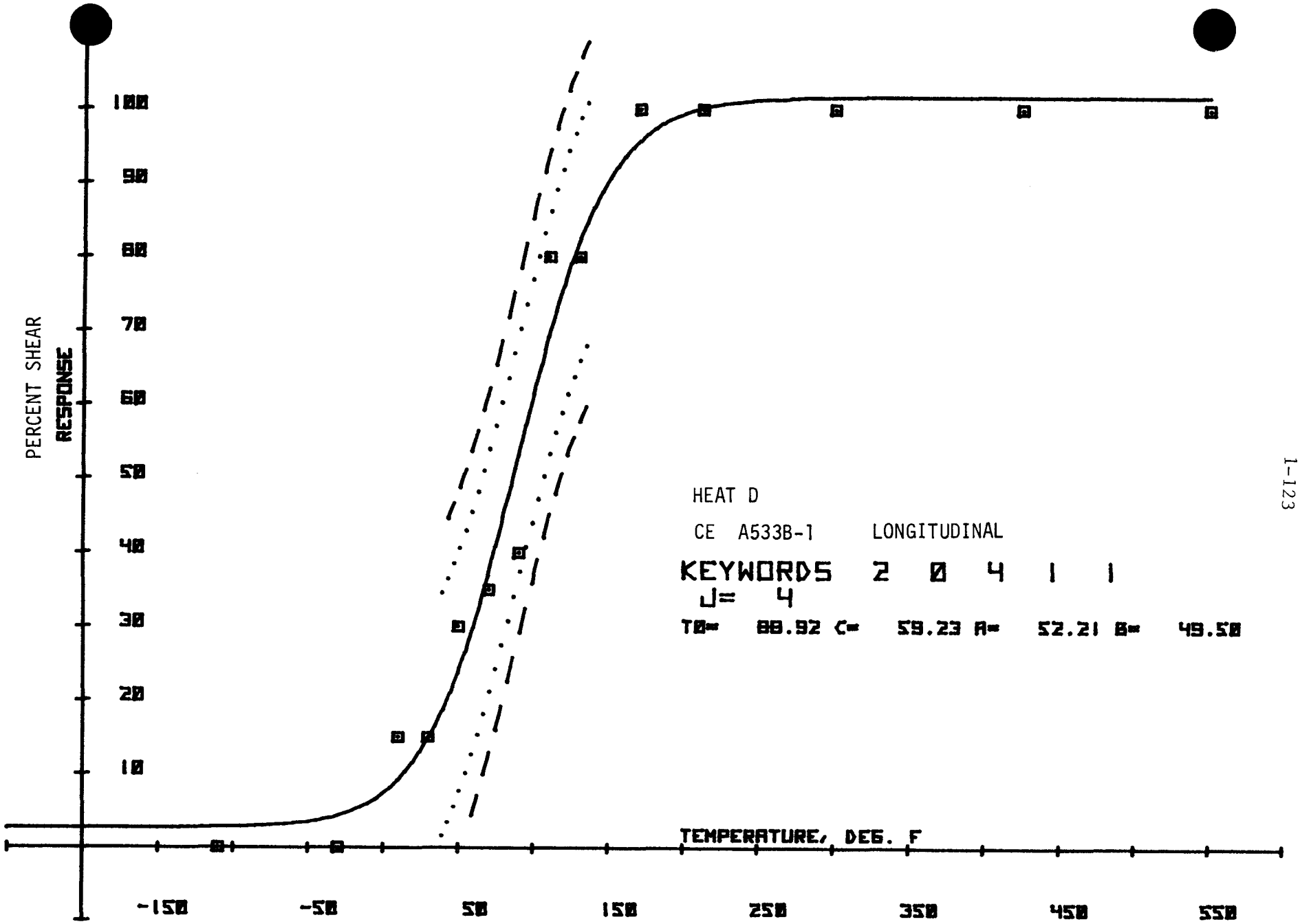

Figure 1.74 Charpy V-Notch Percent Shear for CE Heat D (L)

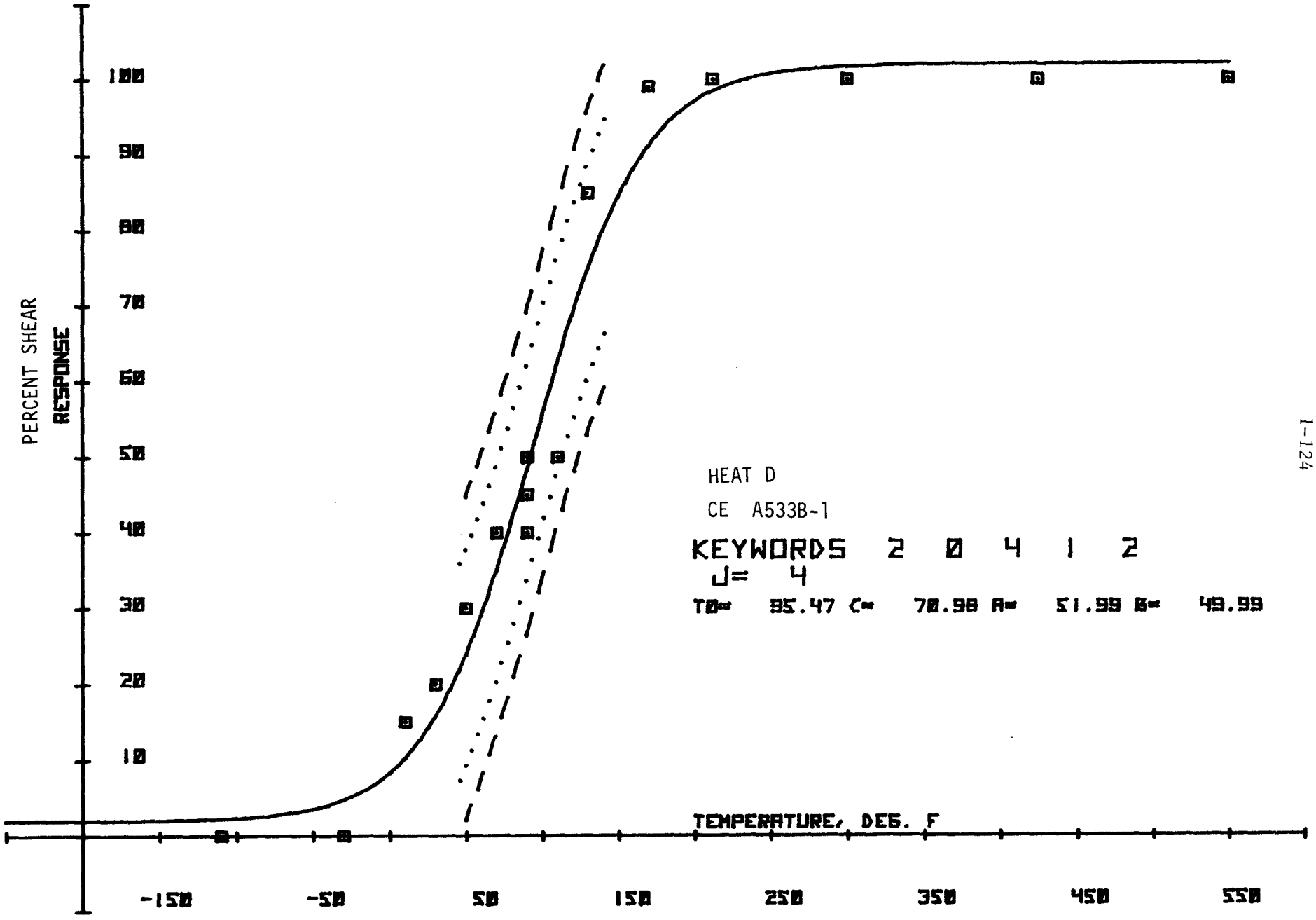

Figure 1.75 Charpy V-Notch Percent Shear for CE Heat D (T)

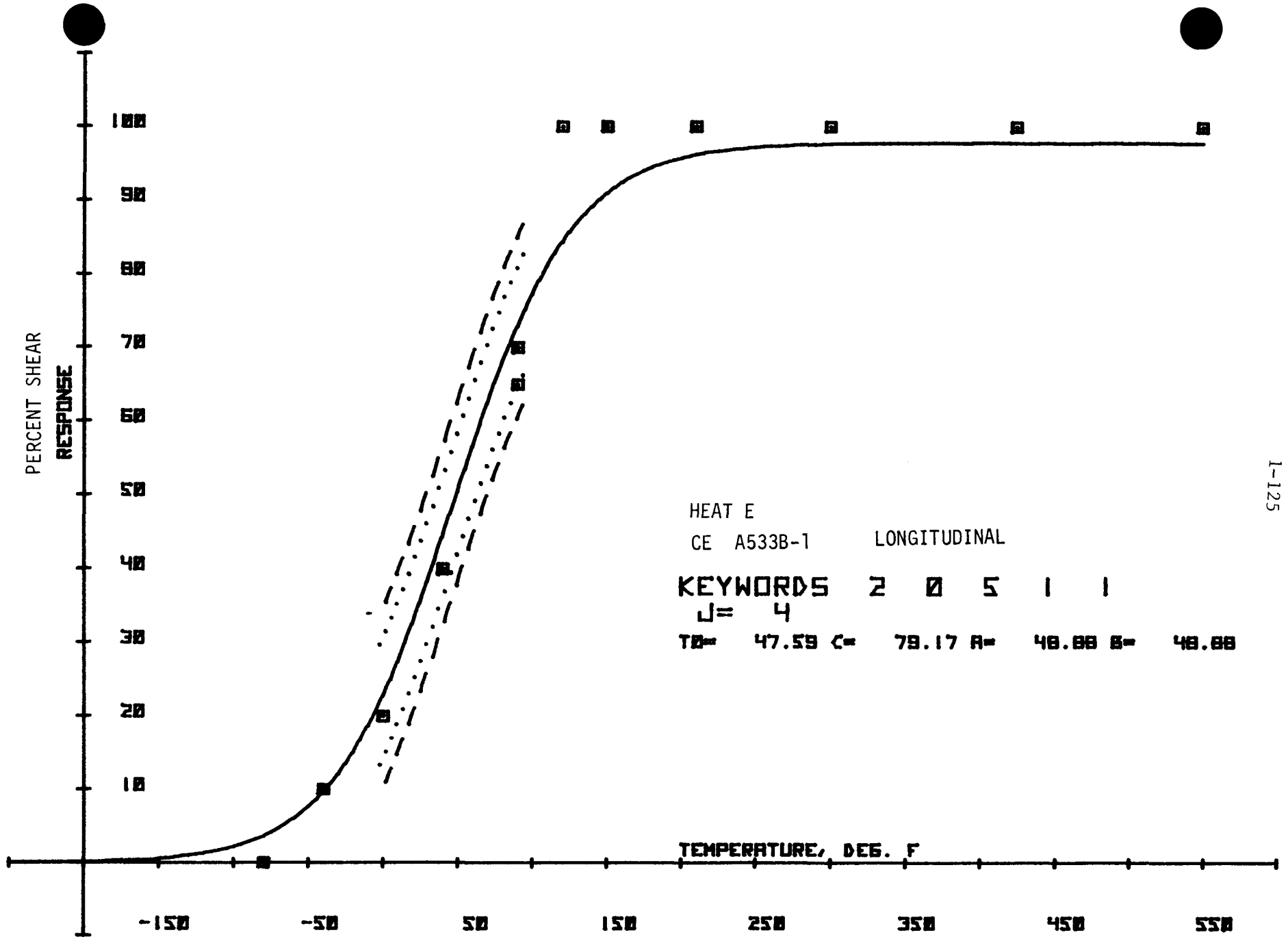

Figure 1.76 Charpy V-Notch Percent Shear for CE Heat E (L)

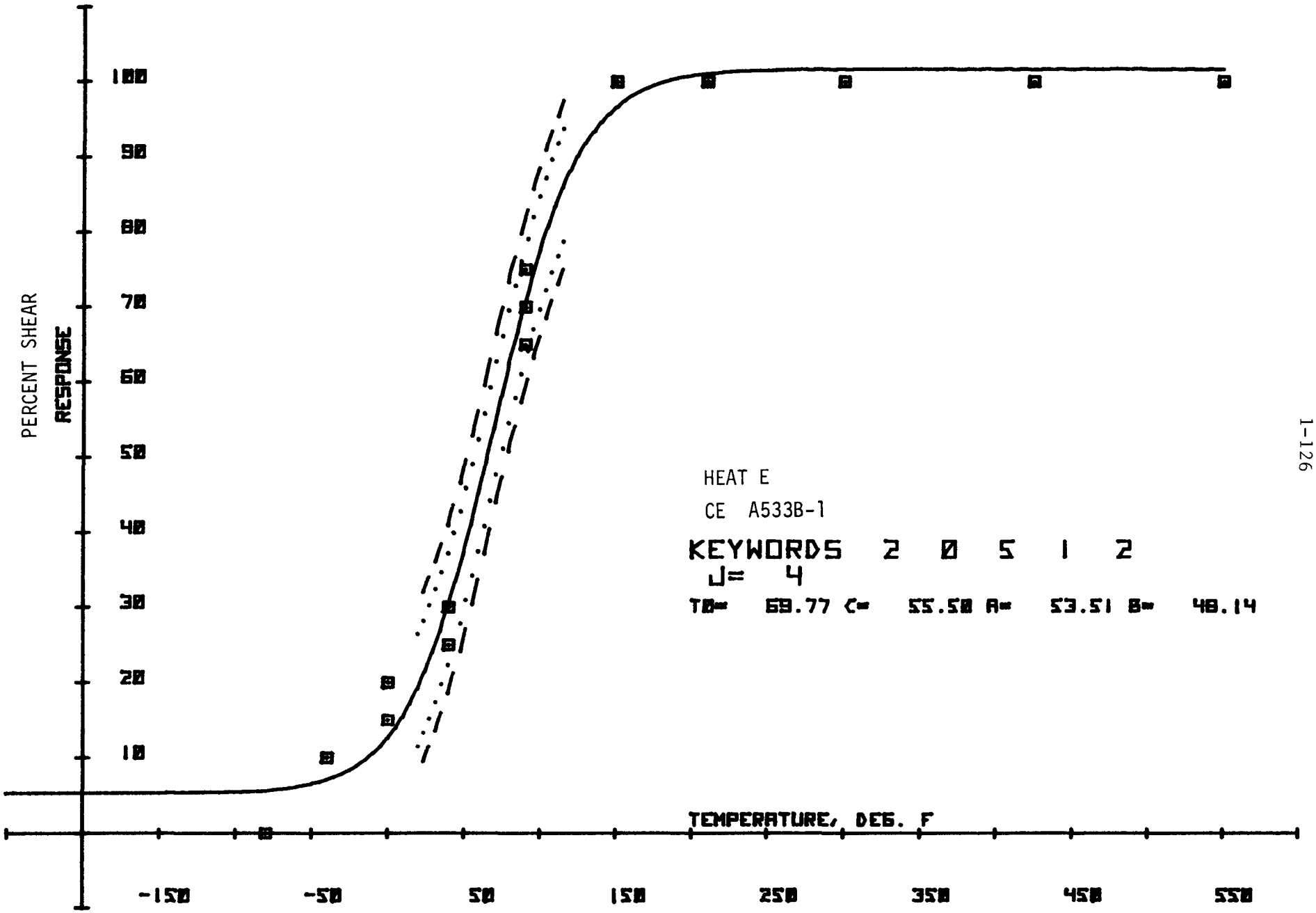

Figure 1.77 Charpy V-Notch Percent Shear for CE Heat E (T)

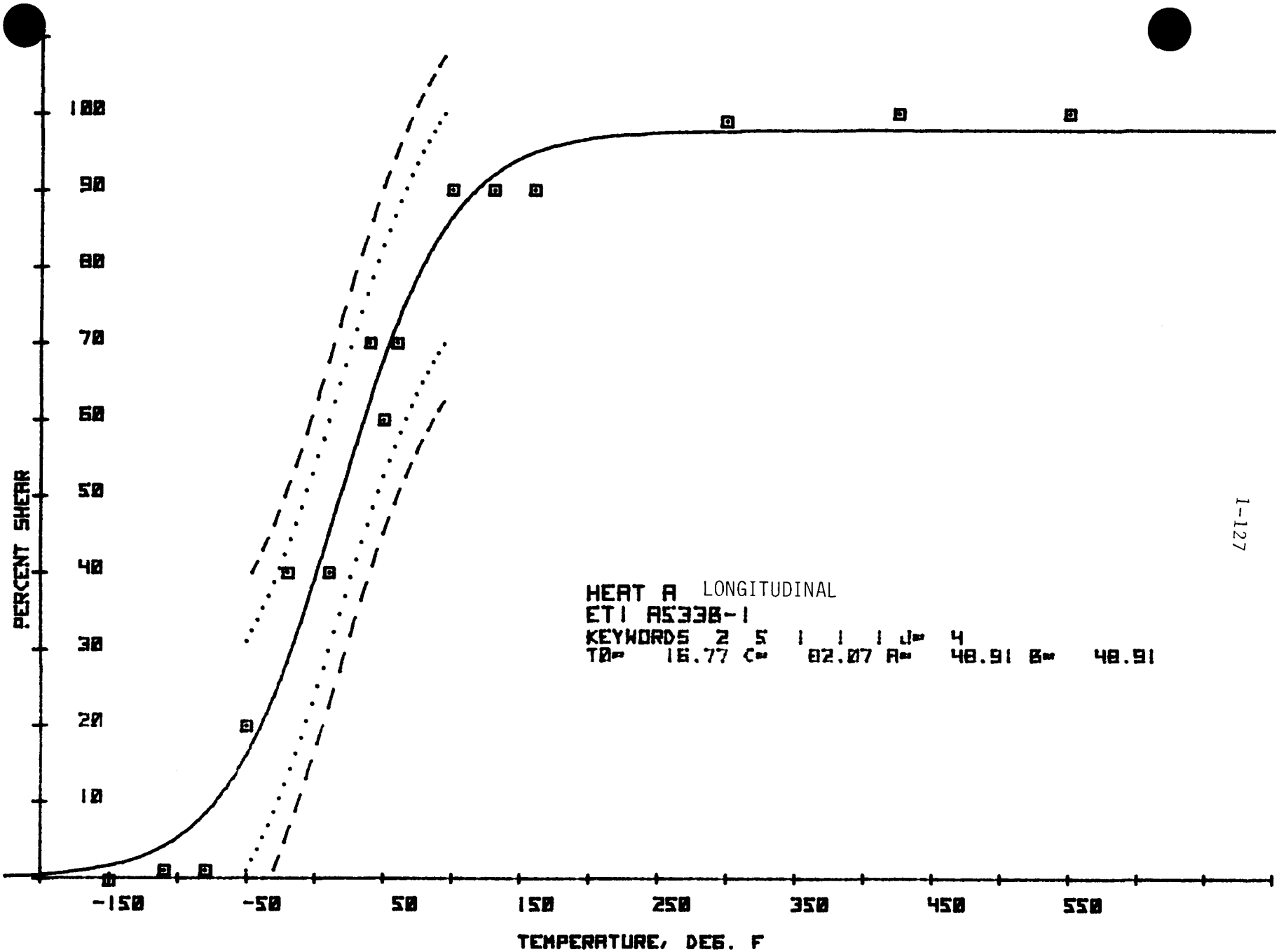

Figure 1.78. Charpy V-Notch Percent Shear for ETI Heat A (L)

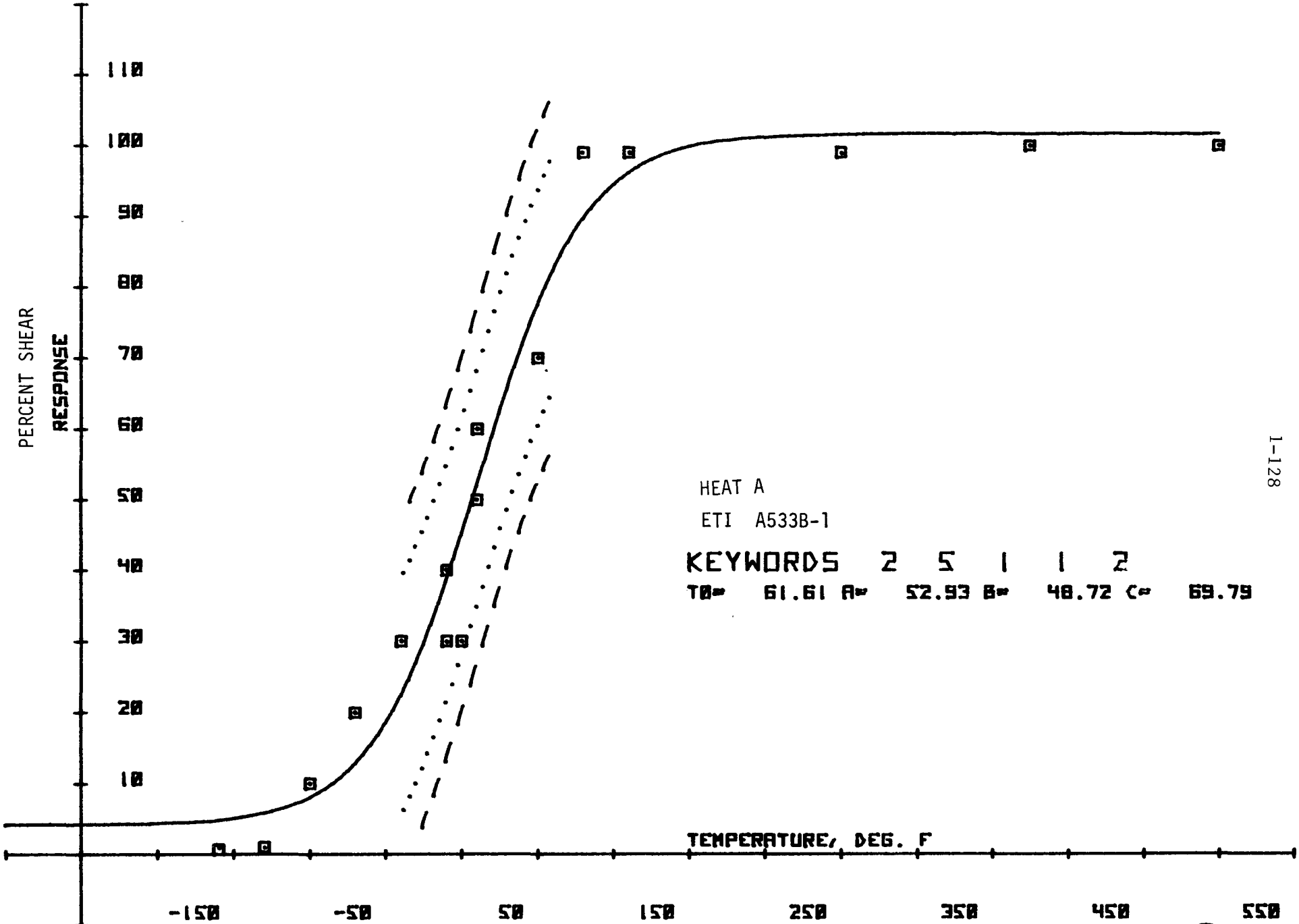

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Figure 1.79 Charpy V-Notch Percent Shear for ETI Heat A (T)

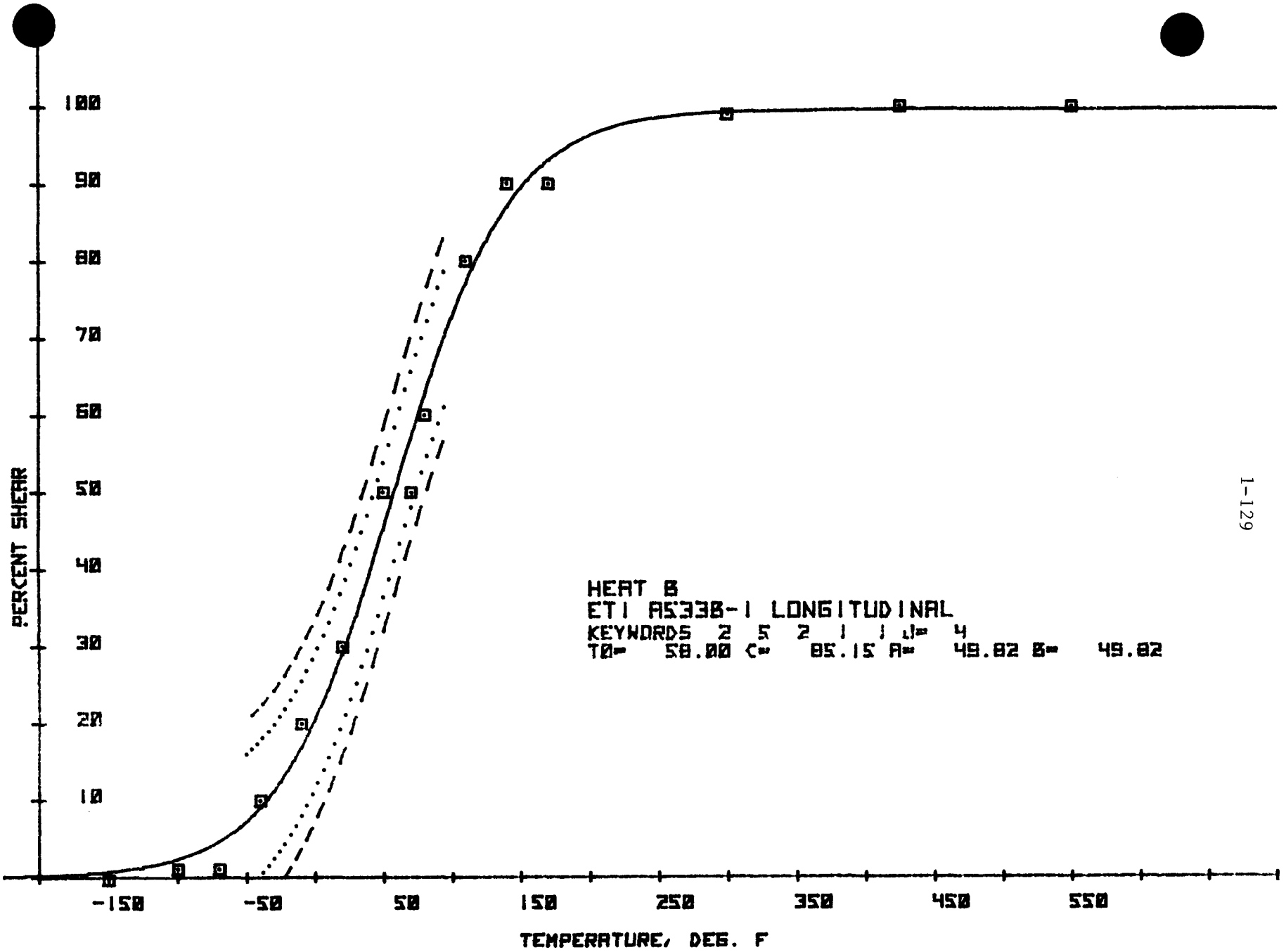

Figure 1.80. Charpy V-Notch Percent Shear for ETI Heat B (L)

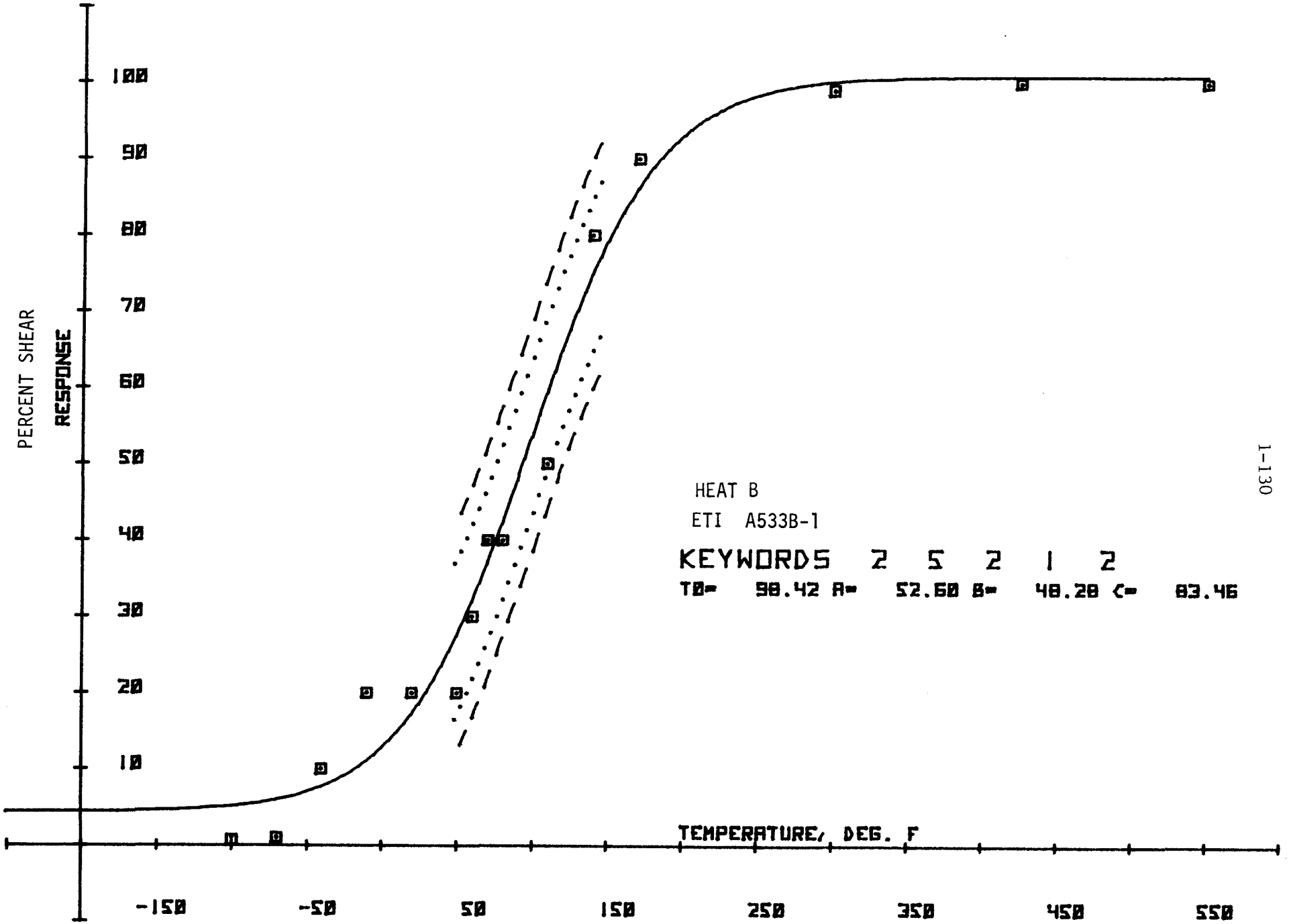

Figure 1.81 Charpy V-Notch Percent Shear for ETI Heat B (T)

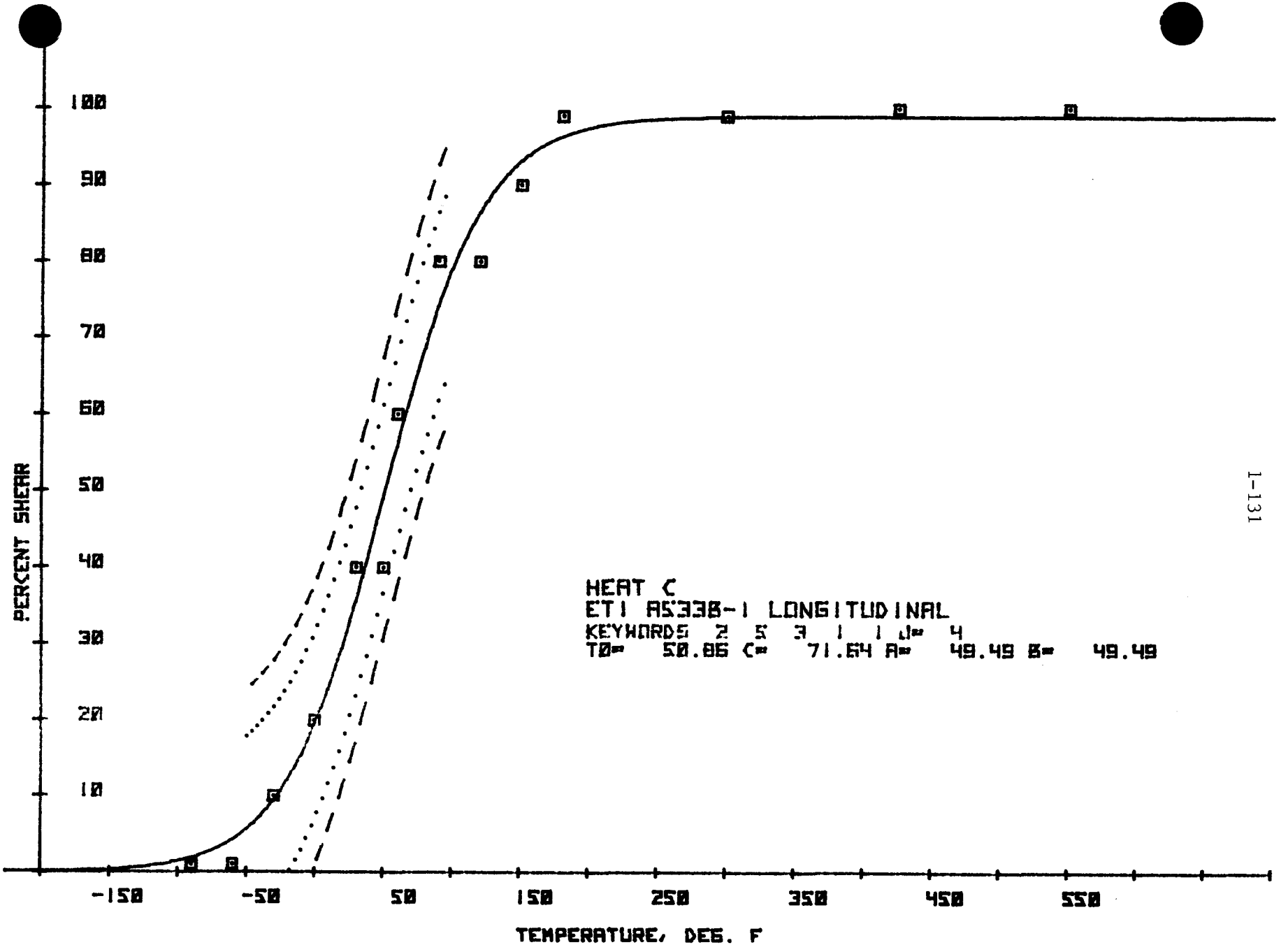

Figure 1.82. Charpy V-Notch Percent Shear for ETI Heat C (L)

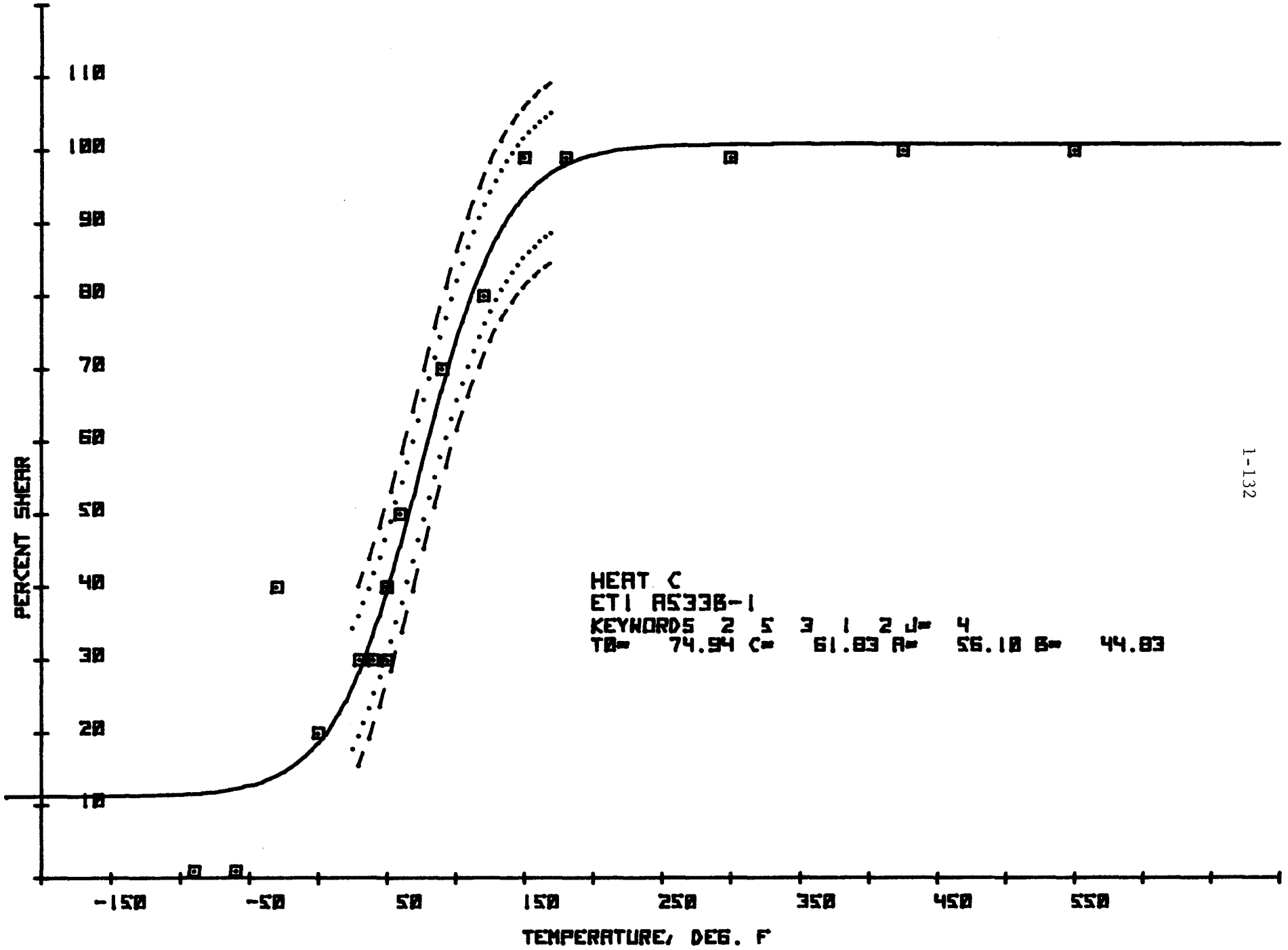

Figure 1.83. Charpy V-Notch Percent Shear for ETI Heat C (T)

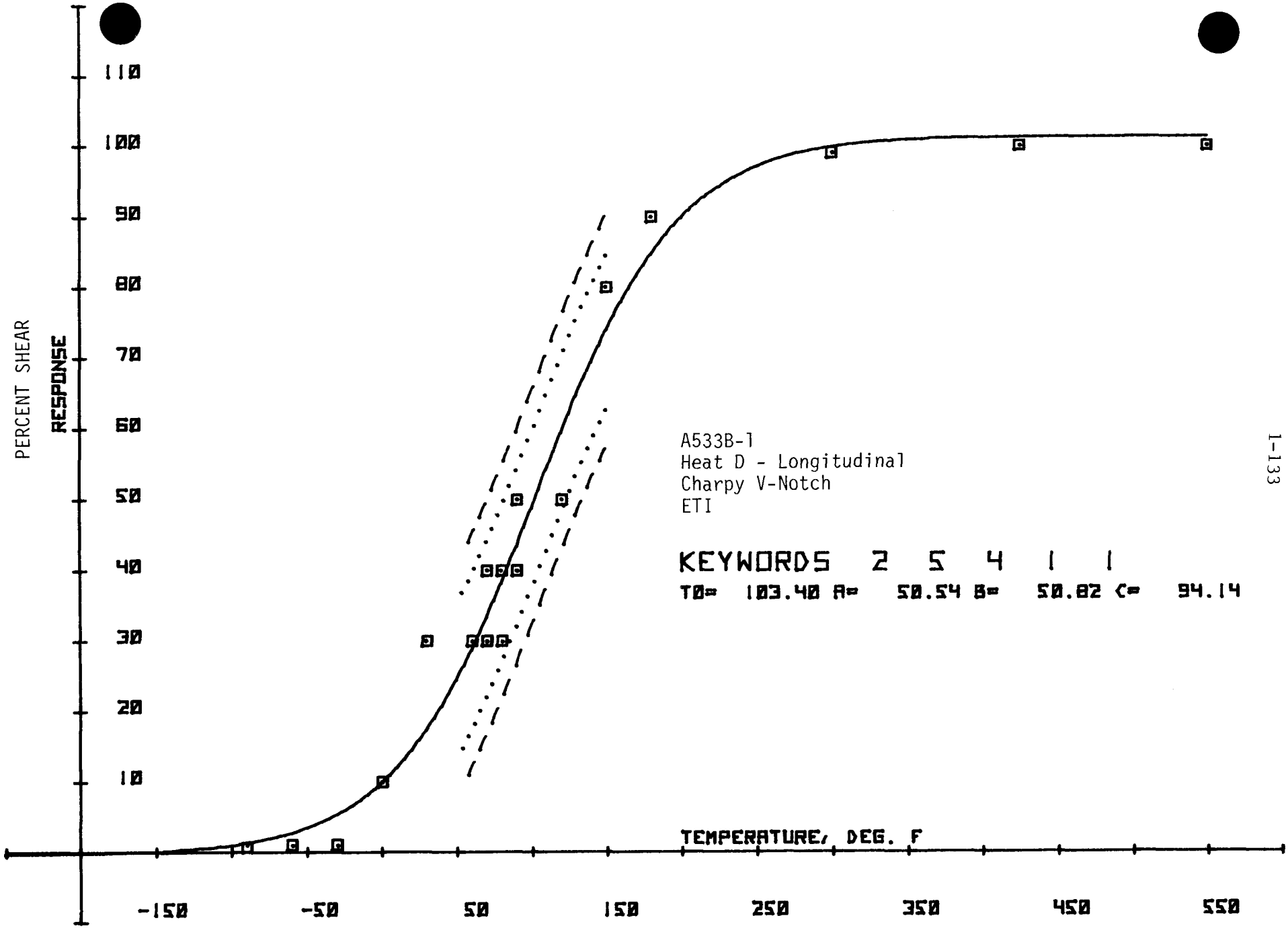

Figure 1.84 Charpy V-Notch Percent Shear for ETI Heat D (L)

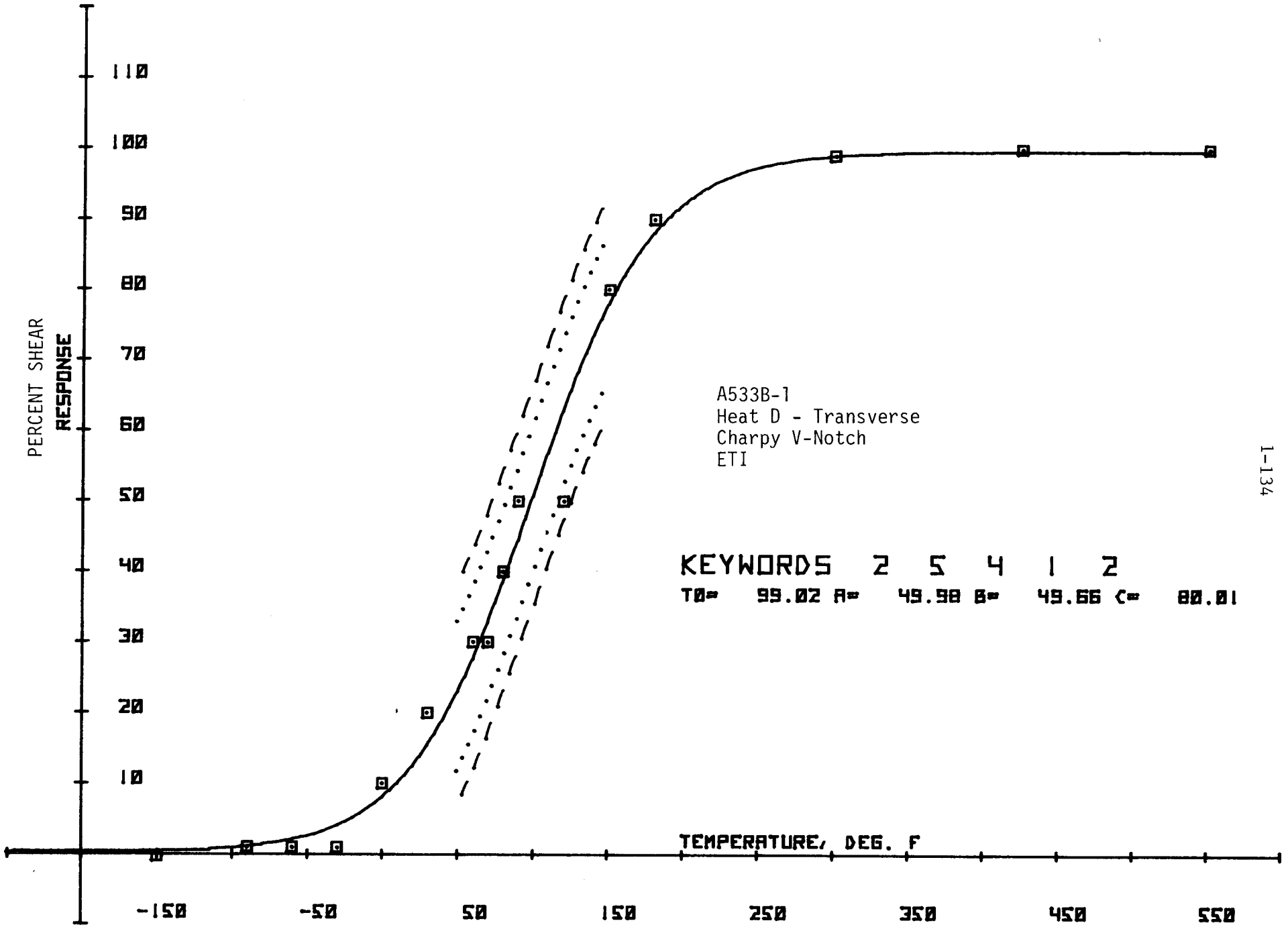

Figure 1.85 Charpy V-Notch Percent Shear for ETI Heat D (T)

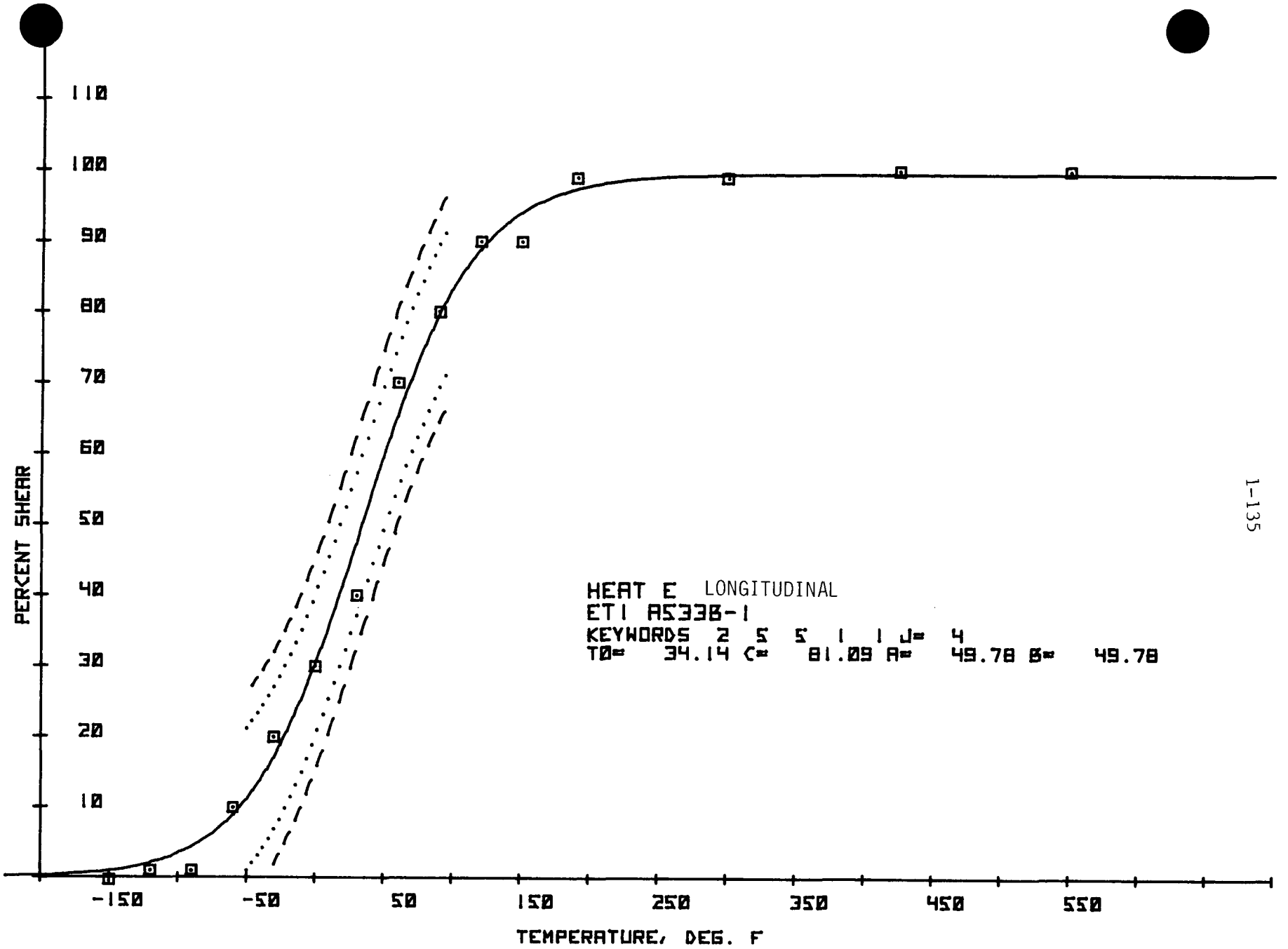

Figure 1.86. Charpy V-Notch Percent Shear for ETI Heat E (L)

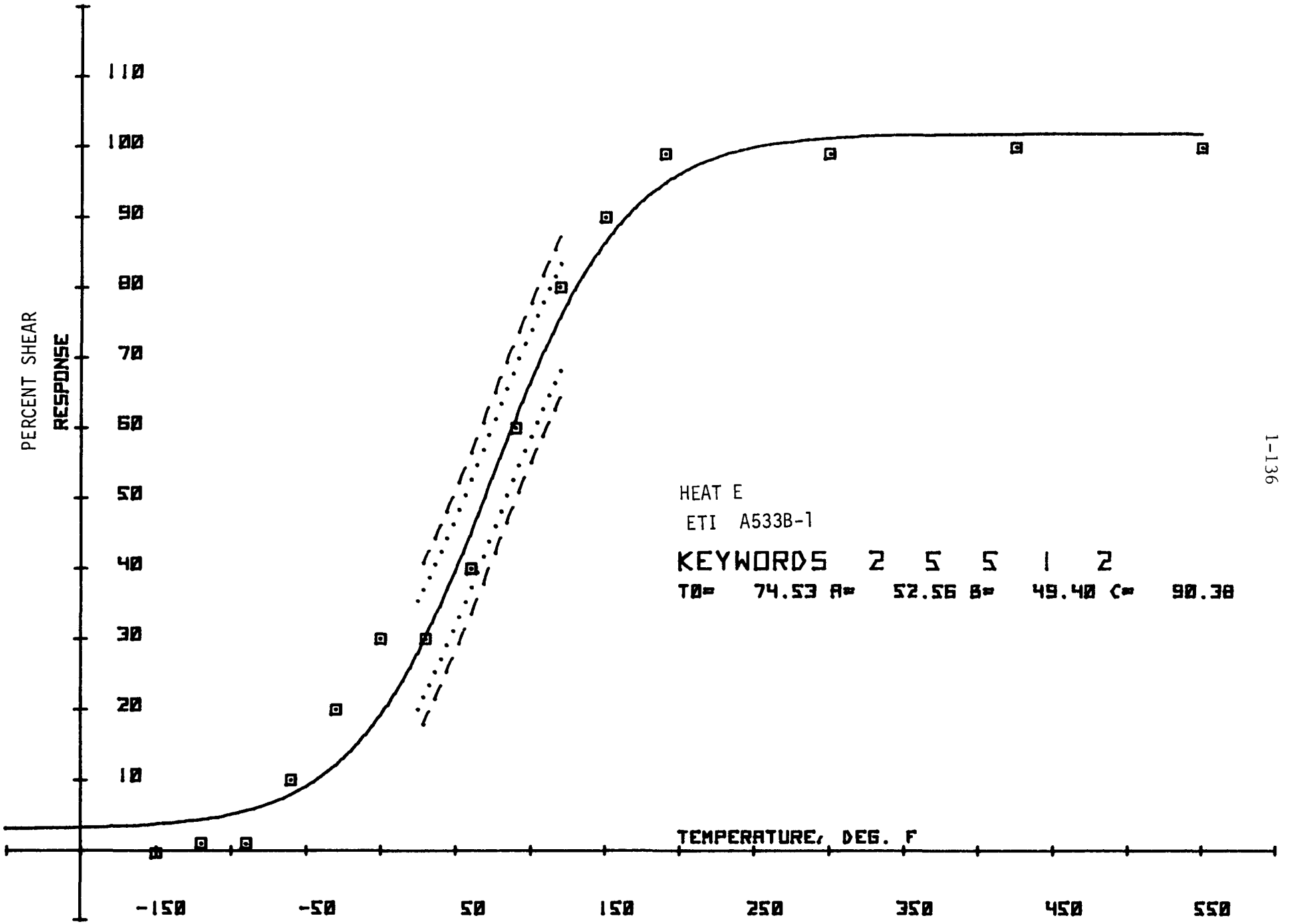

Figure 1.87 Charpy V-Notch Percent Shear for ETI Heat E (T)

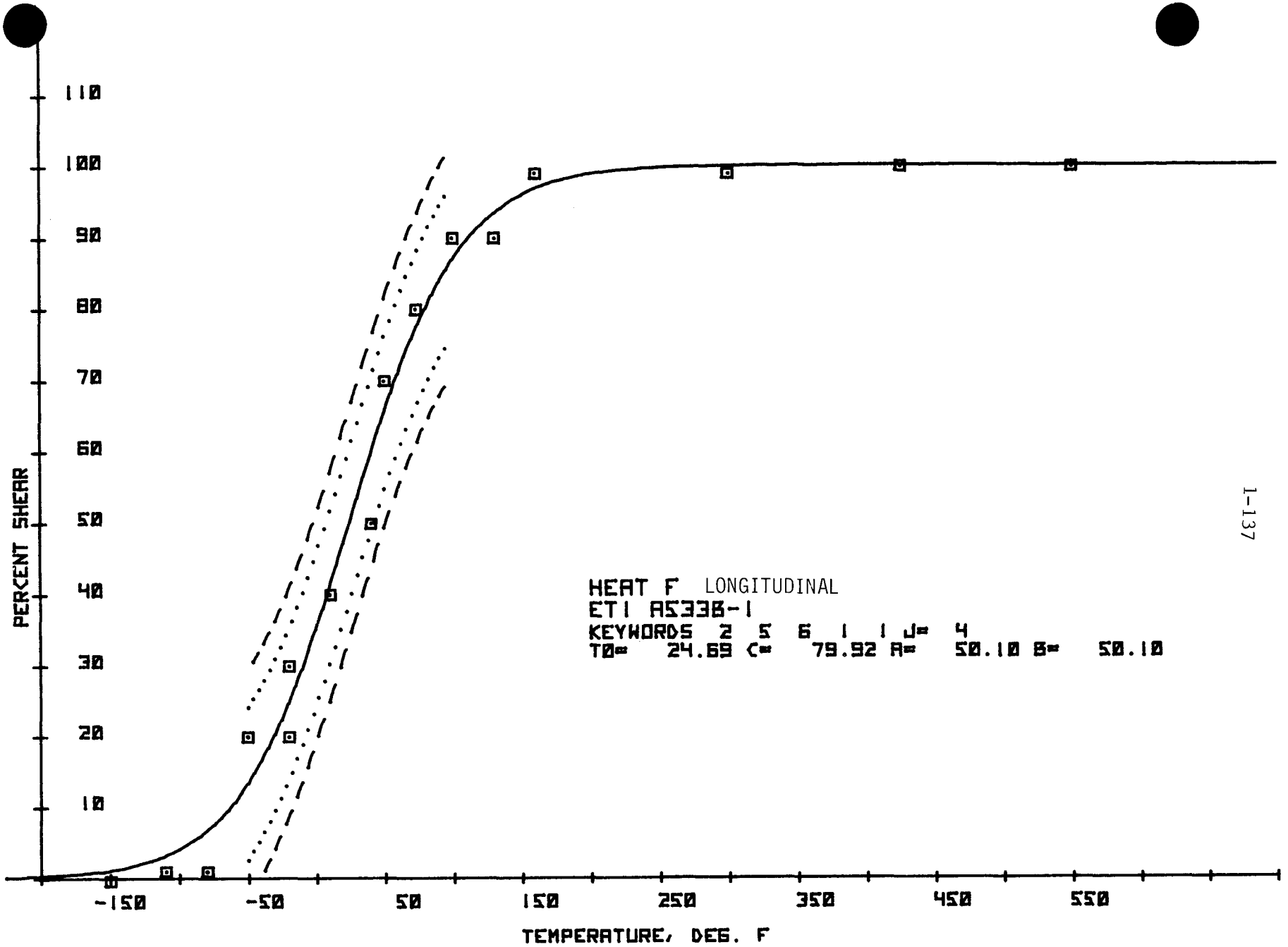

Figure 1.88. Charpy V-Notch Percent Shear for ETI Heat F (L)

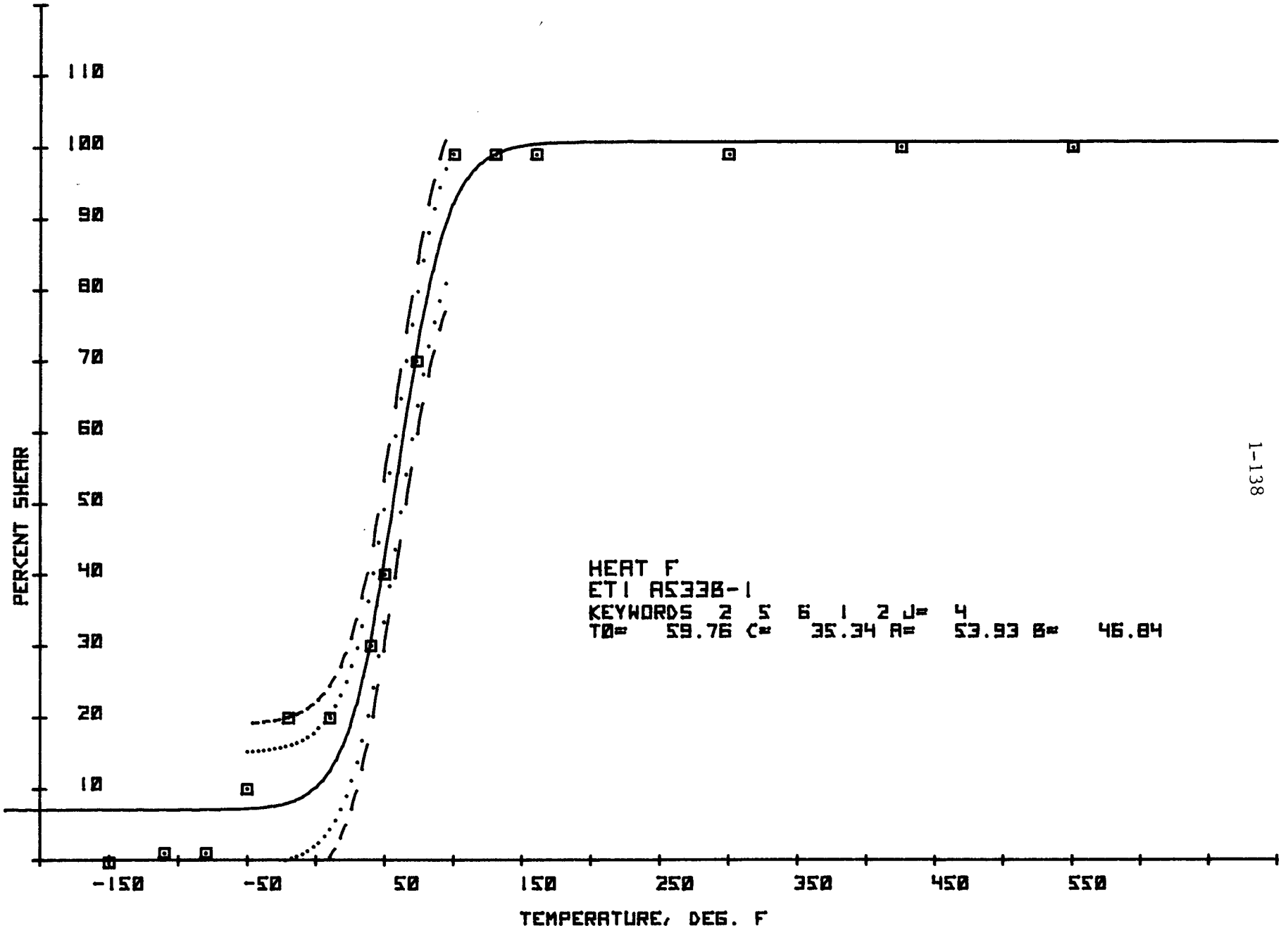

Figure 1.89. Charpy V-Notch Percent Shear for ETI Heat F (T)

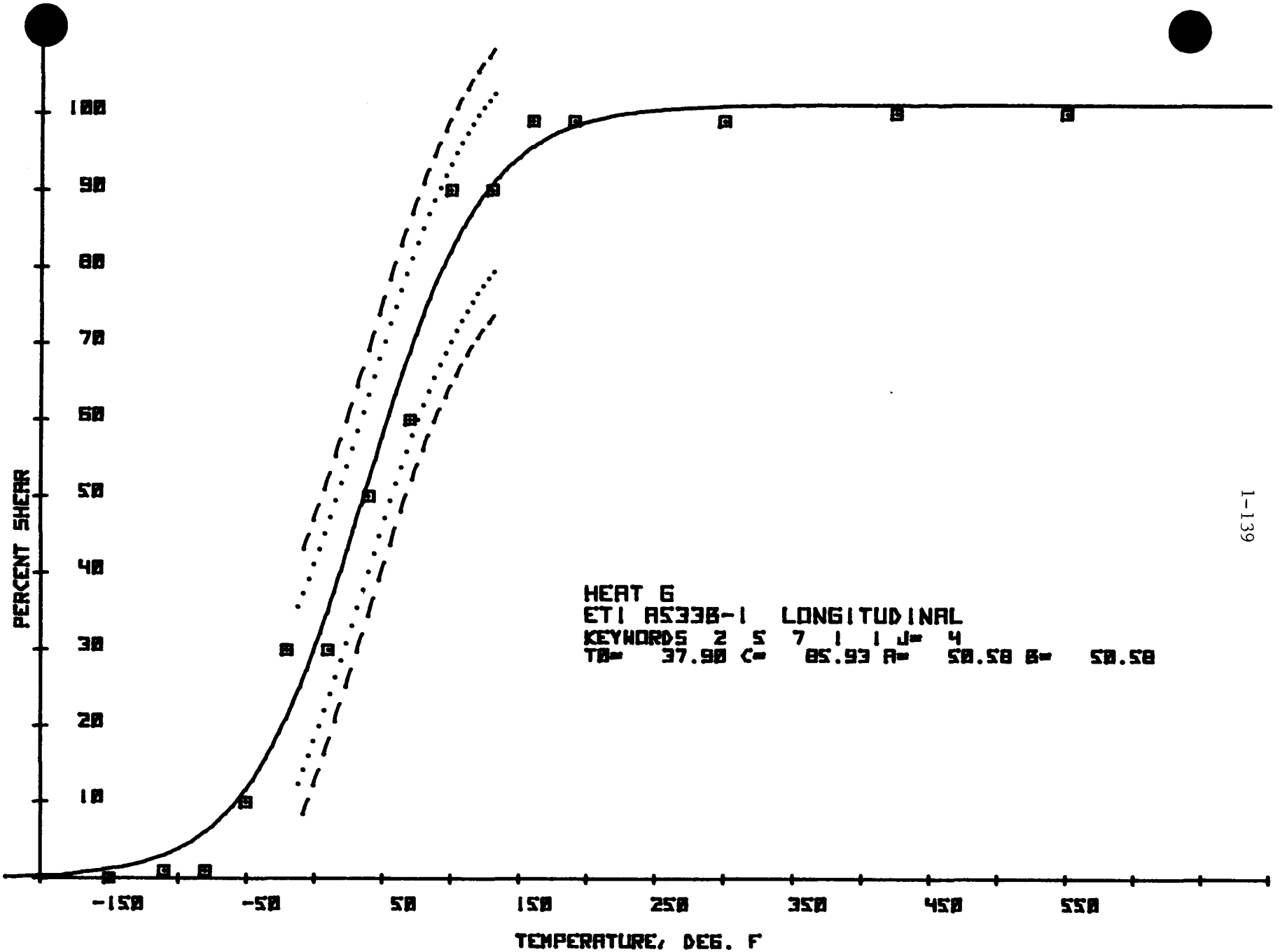

Figure 1.90 Charpy V-Notch Percent Shear for ETI Heat G (L)

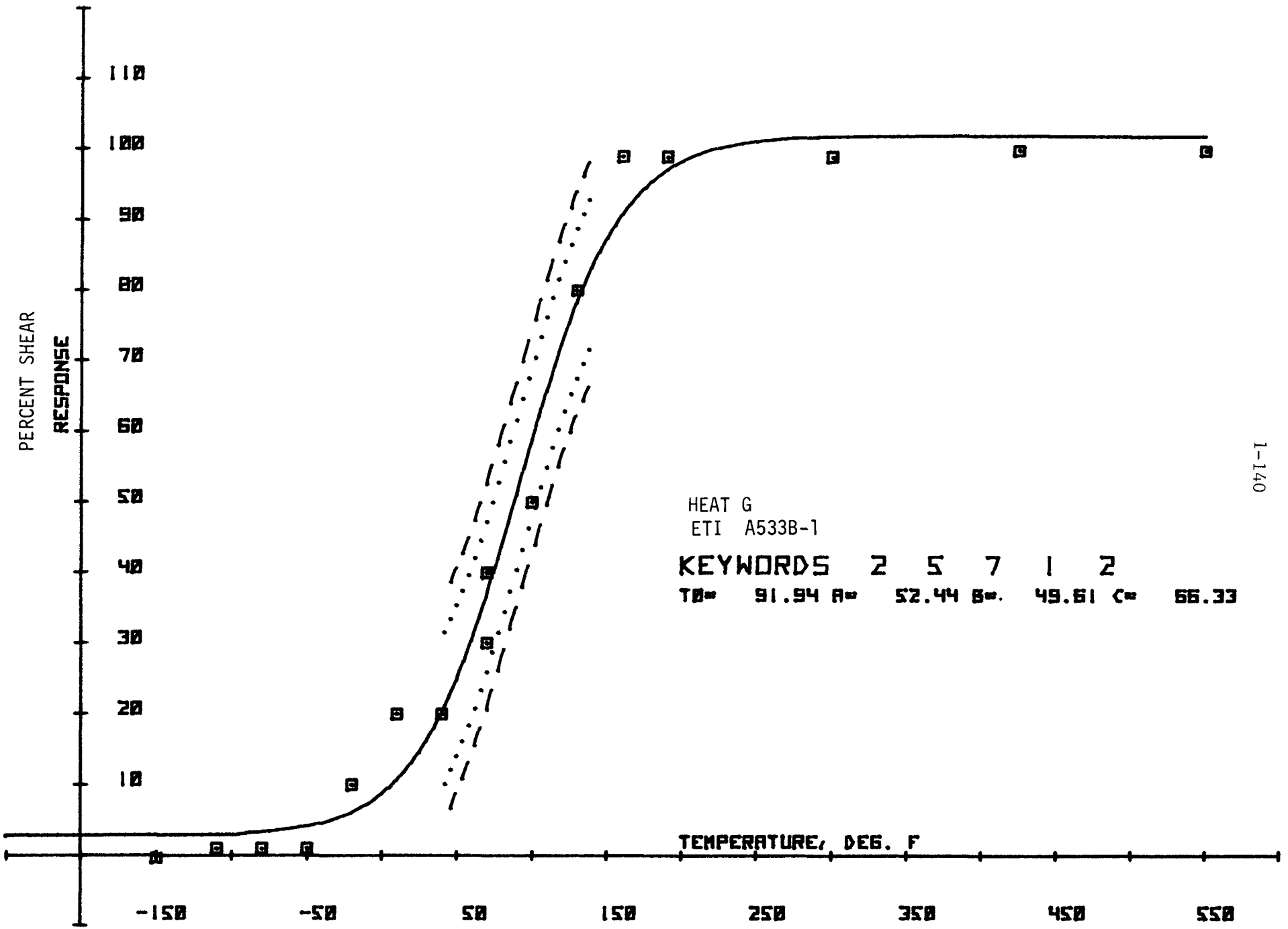

Figure 1.91 Charpy V-Notch Percent Shear for ETI Heat G (T)

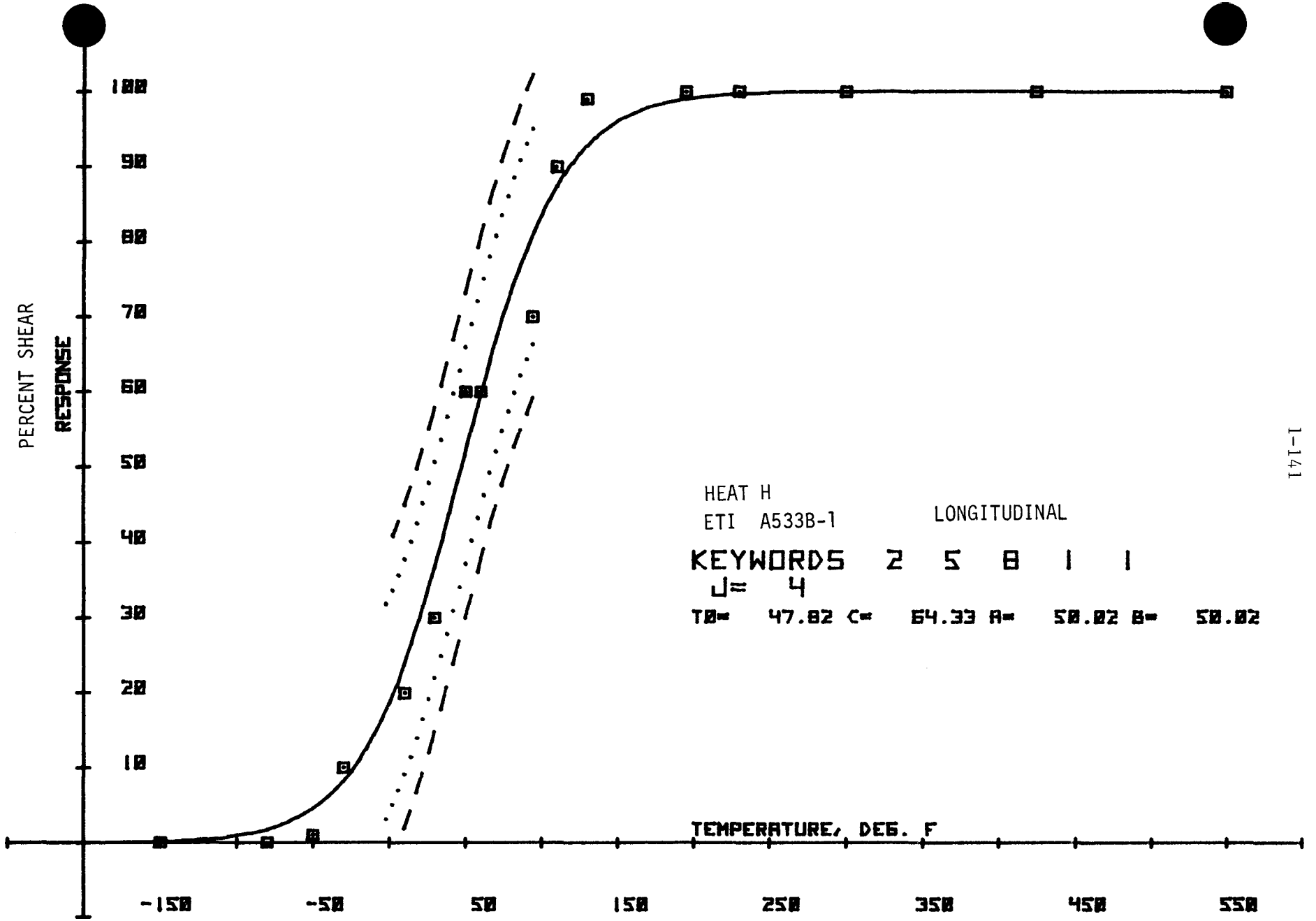

Figure 1.92 Charpy V-Notch Percent Shear for ETI Heat H (L)

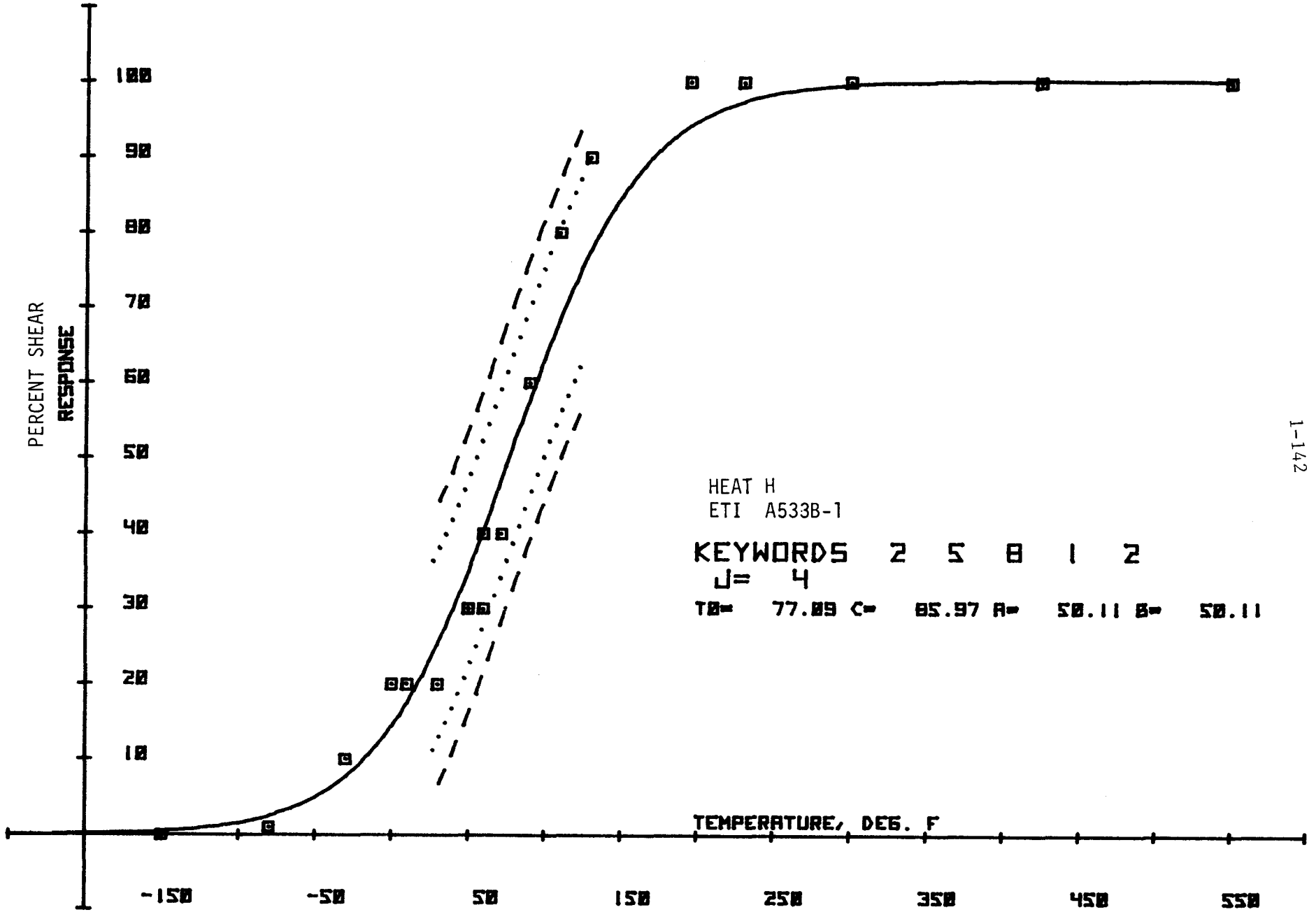

Figure 1.93 Charpy V-Notch Percent Shear for ETI Heat H (T)

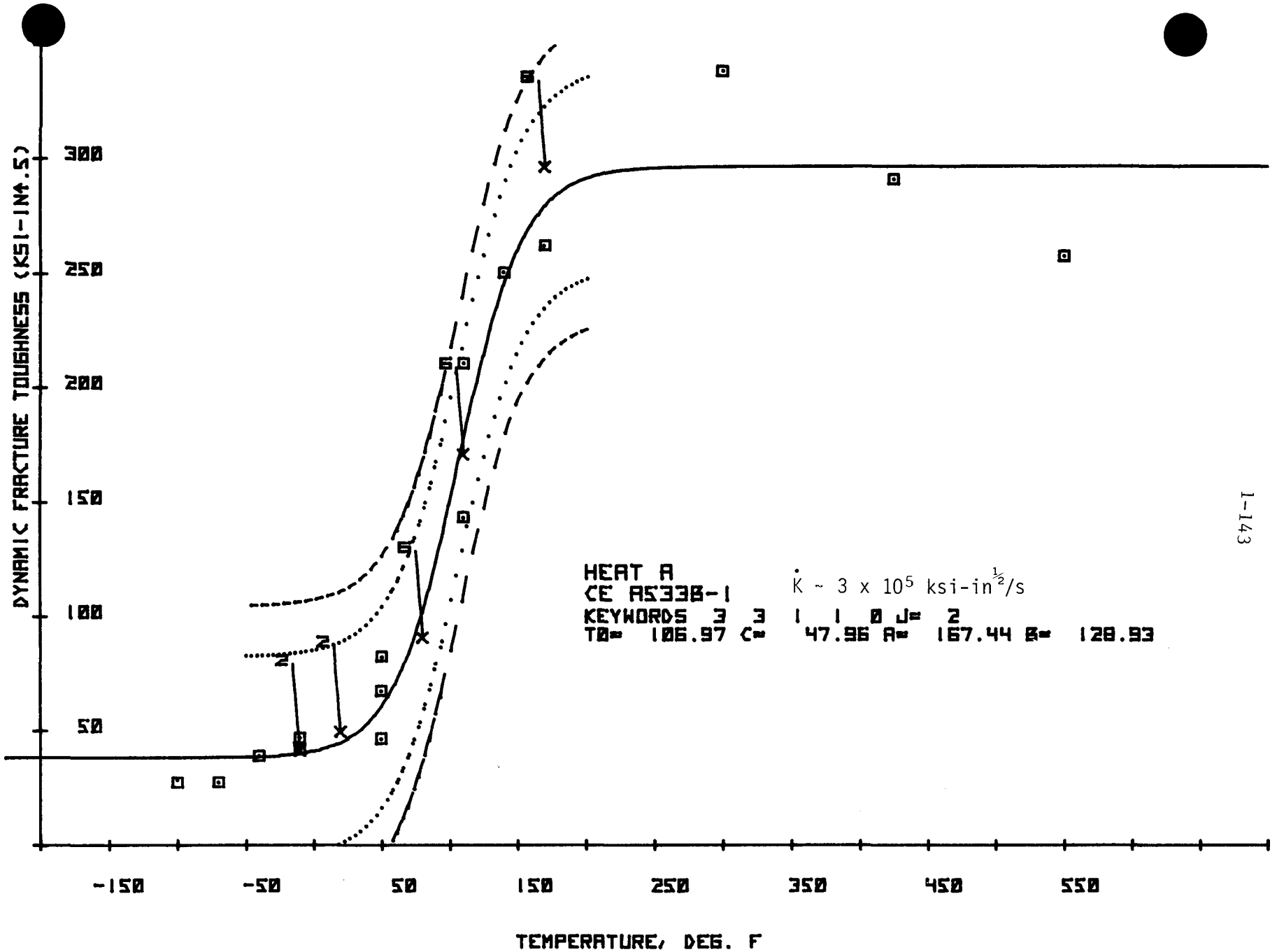

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Figure 1.94. Precracked Charpy Fracture Toughness for CE Heat A

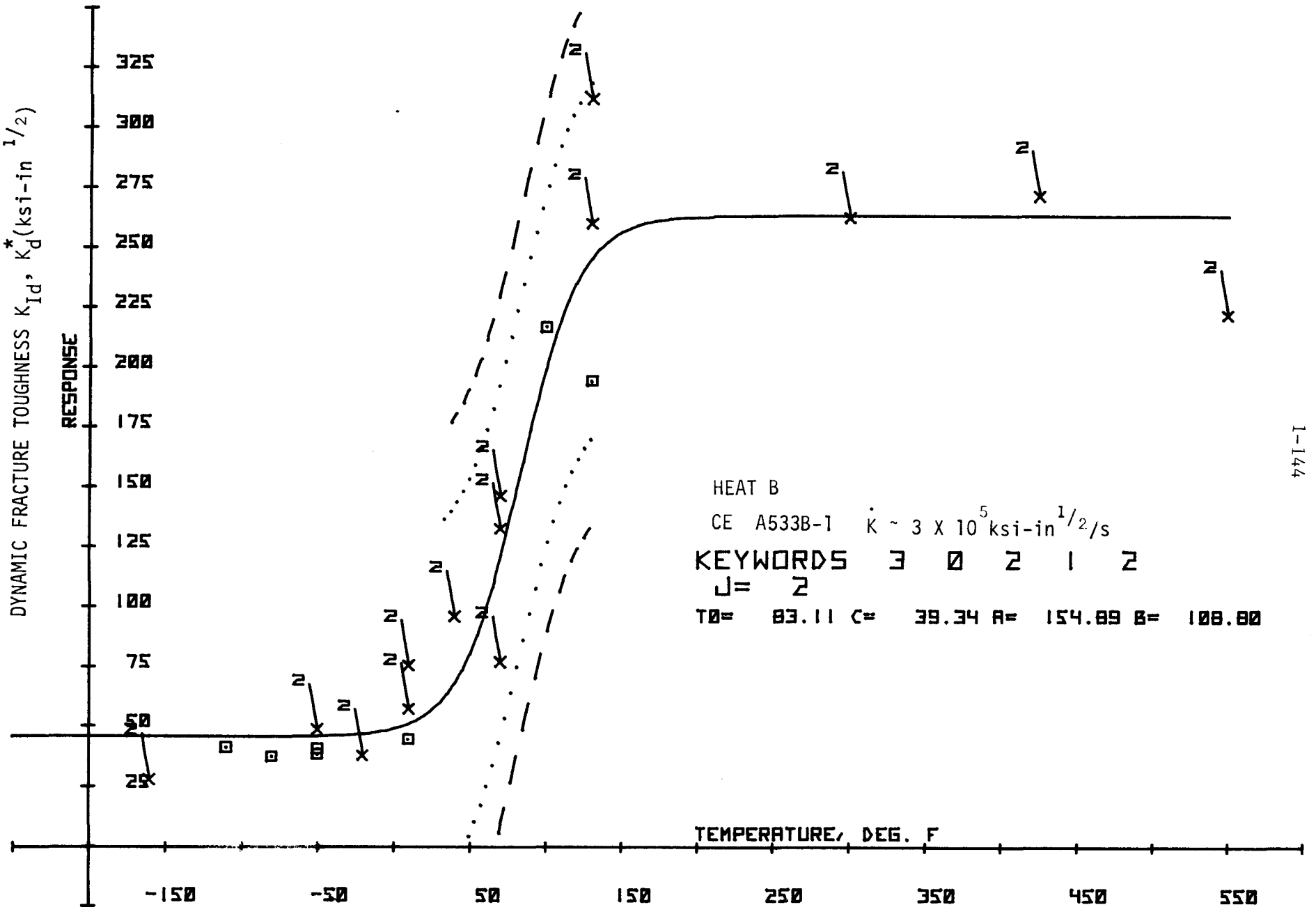

Figure 1.95 Precracked Charpy Fracture Toughness for CE Heat B

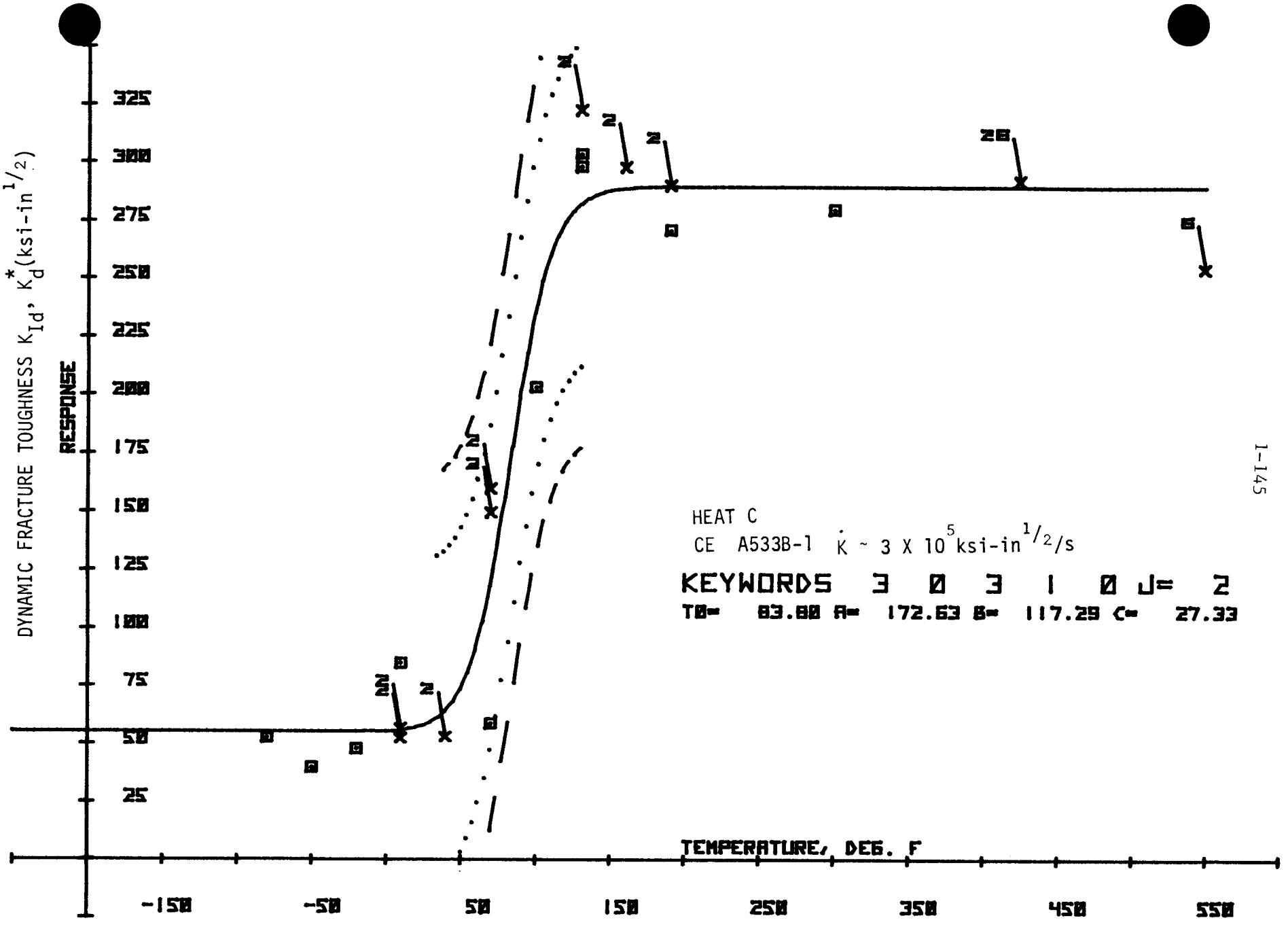

Figure 1.96 Precracked Charpy Fracture Toughness for CE Heat C

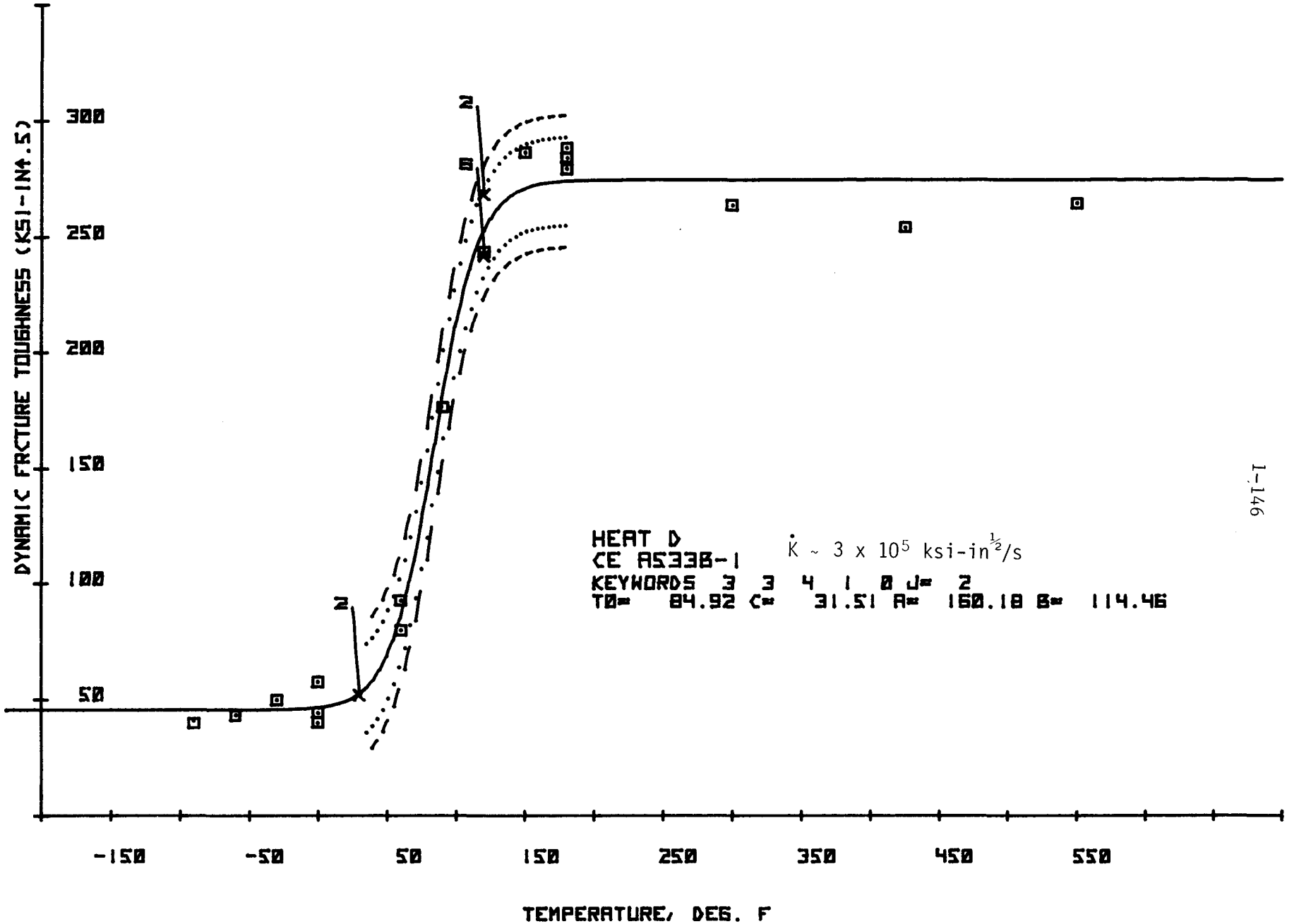

Figure 1.97. Precracked Charpy Fracture Toughness for CE Heat D

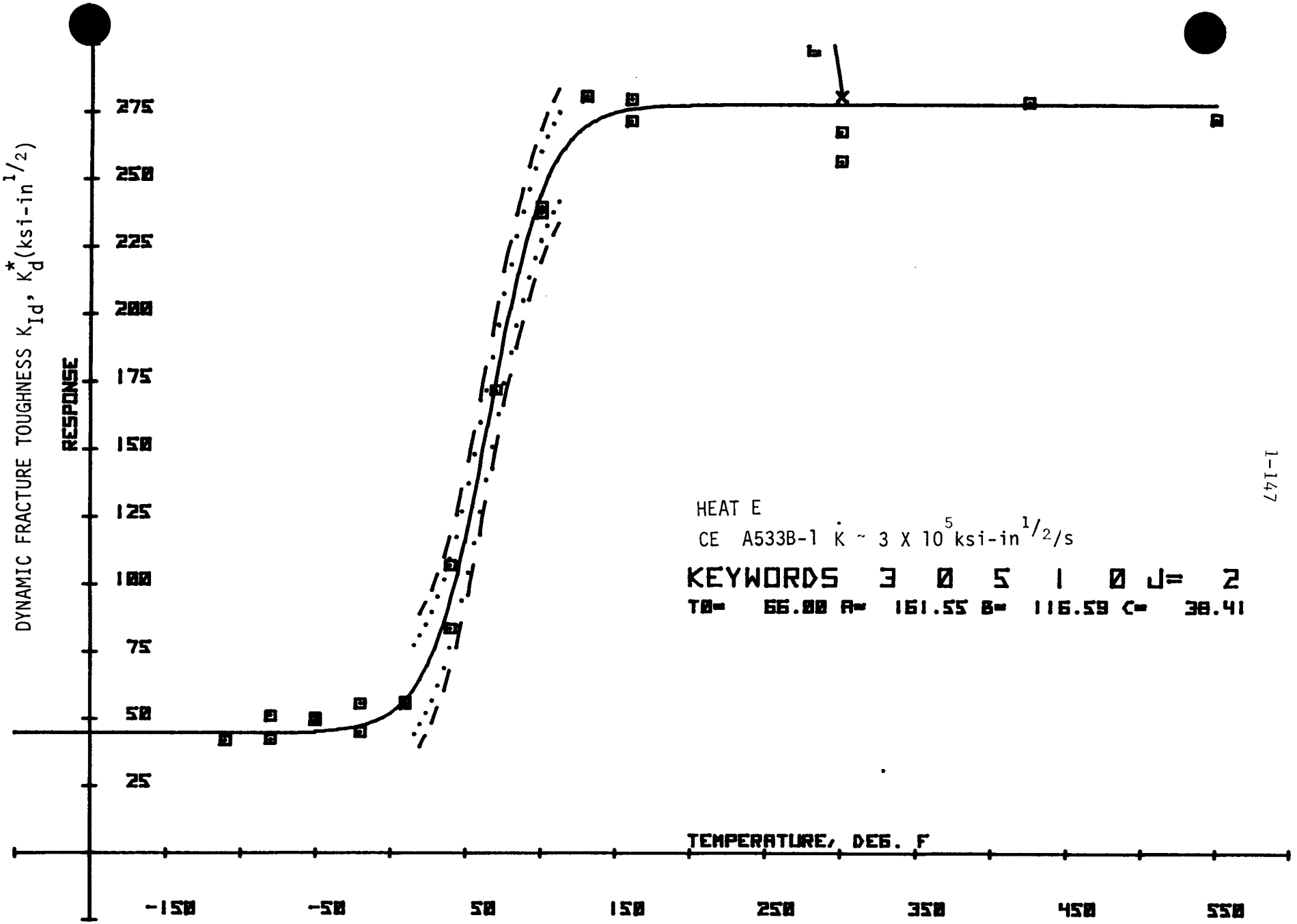

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Figure 1.98 Precracked Charpy Fracture Toughness for CE Heat E

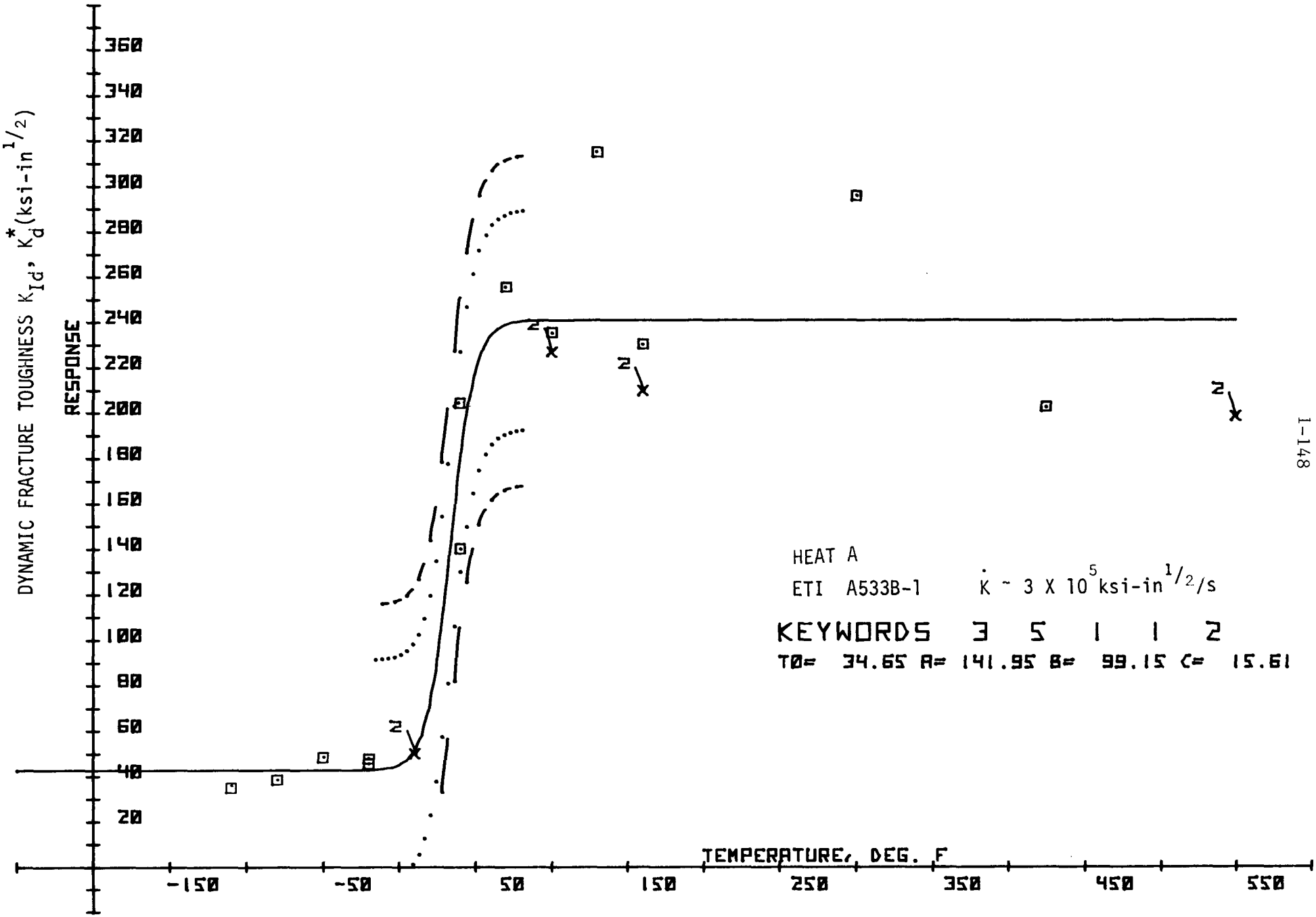

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Figure 1.99 Precracked Charpy Fracture Toughness for ETI Heat A

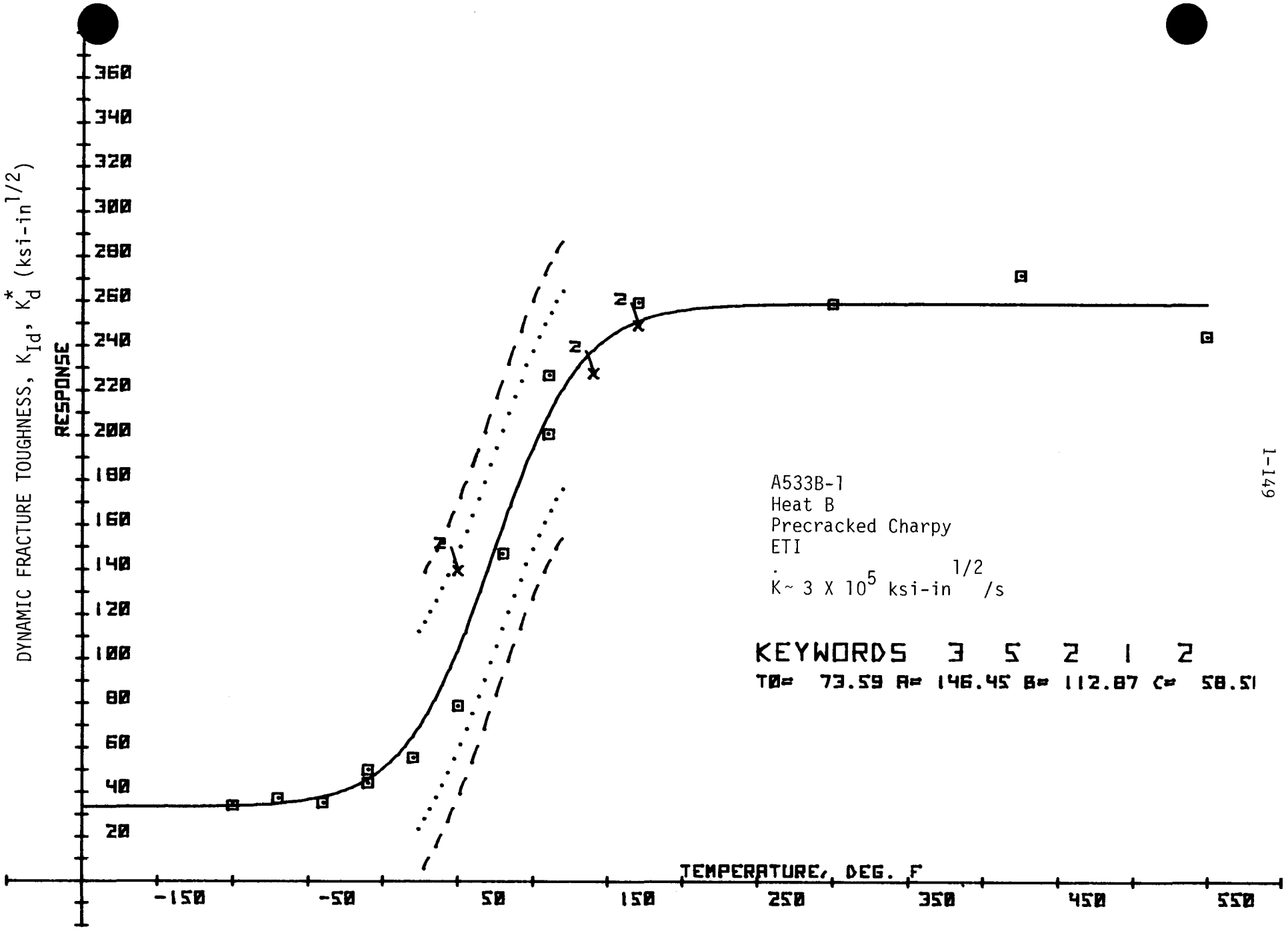

Figure 1.100. Precracked Charpy Fracture Toughness for ETI Heat B

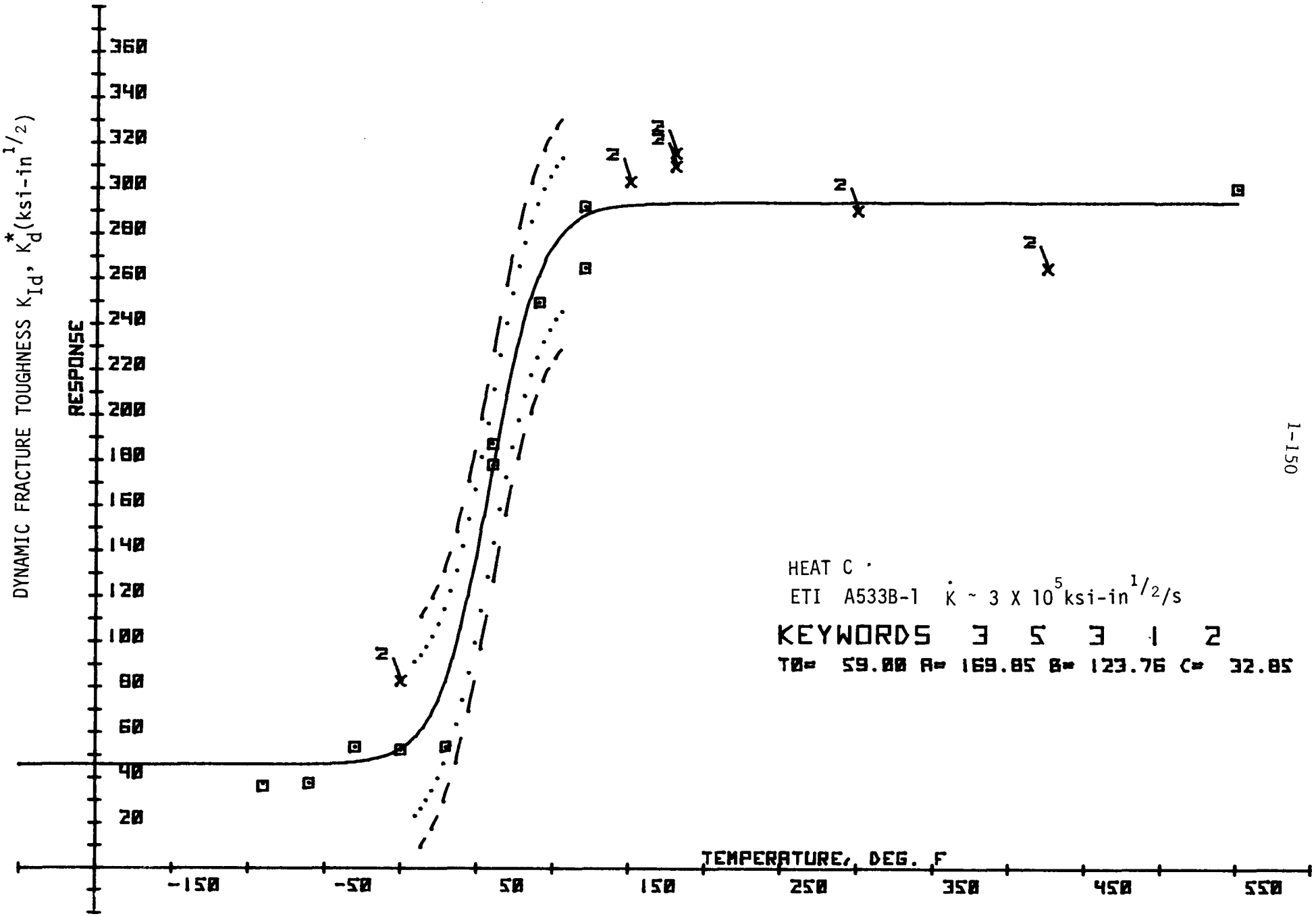

Figure 1.101 Precracked Charpy Fracture Toughness for ETI Heat C

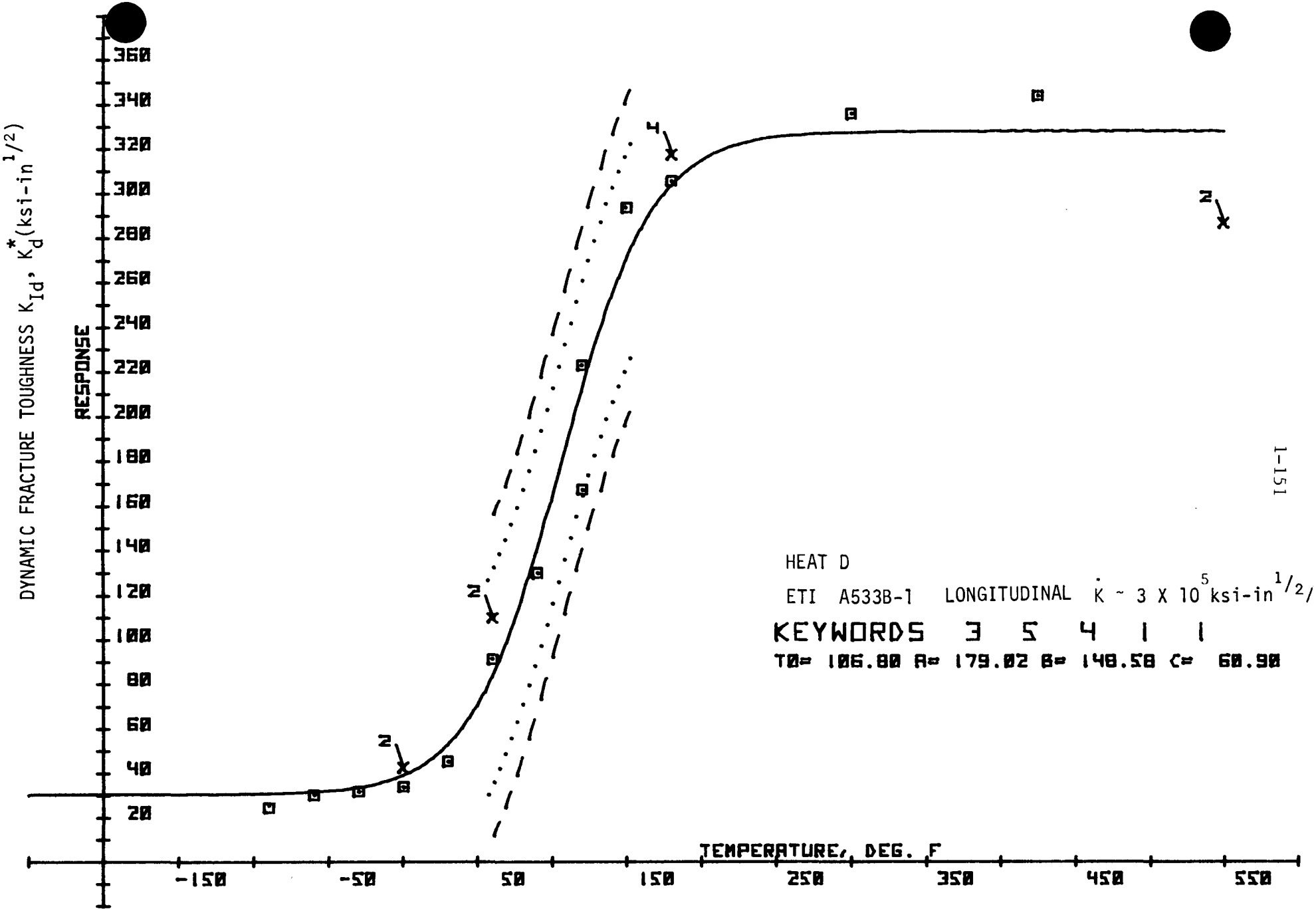

Figure 1.102 Precracked Charpy Fracture Toughness for ETI Heat D (L)

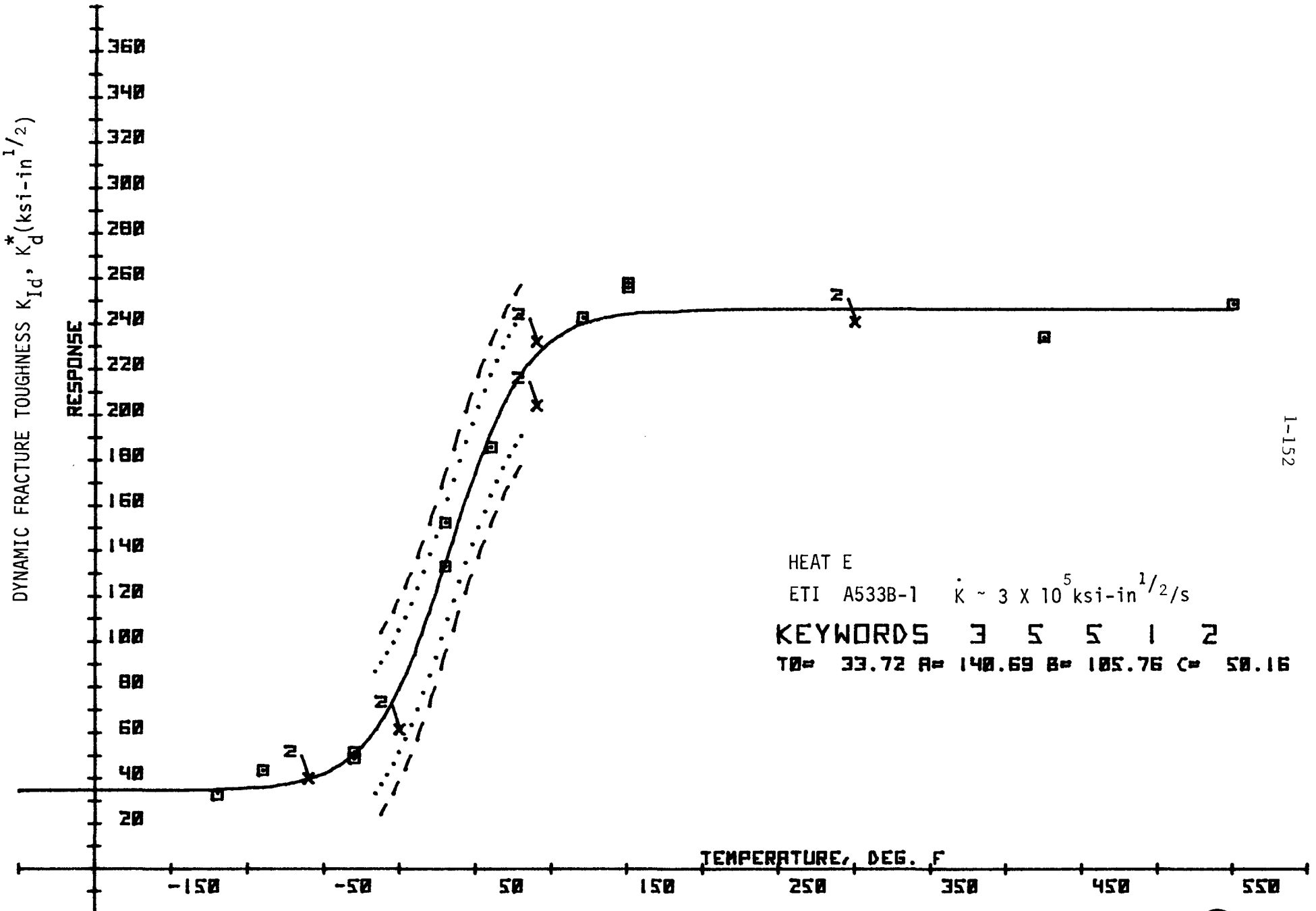

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Figure 1.103 Precracked Charpy Fracture Toughness for ETI Heat E

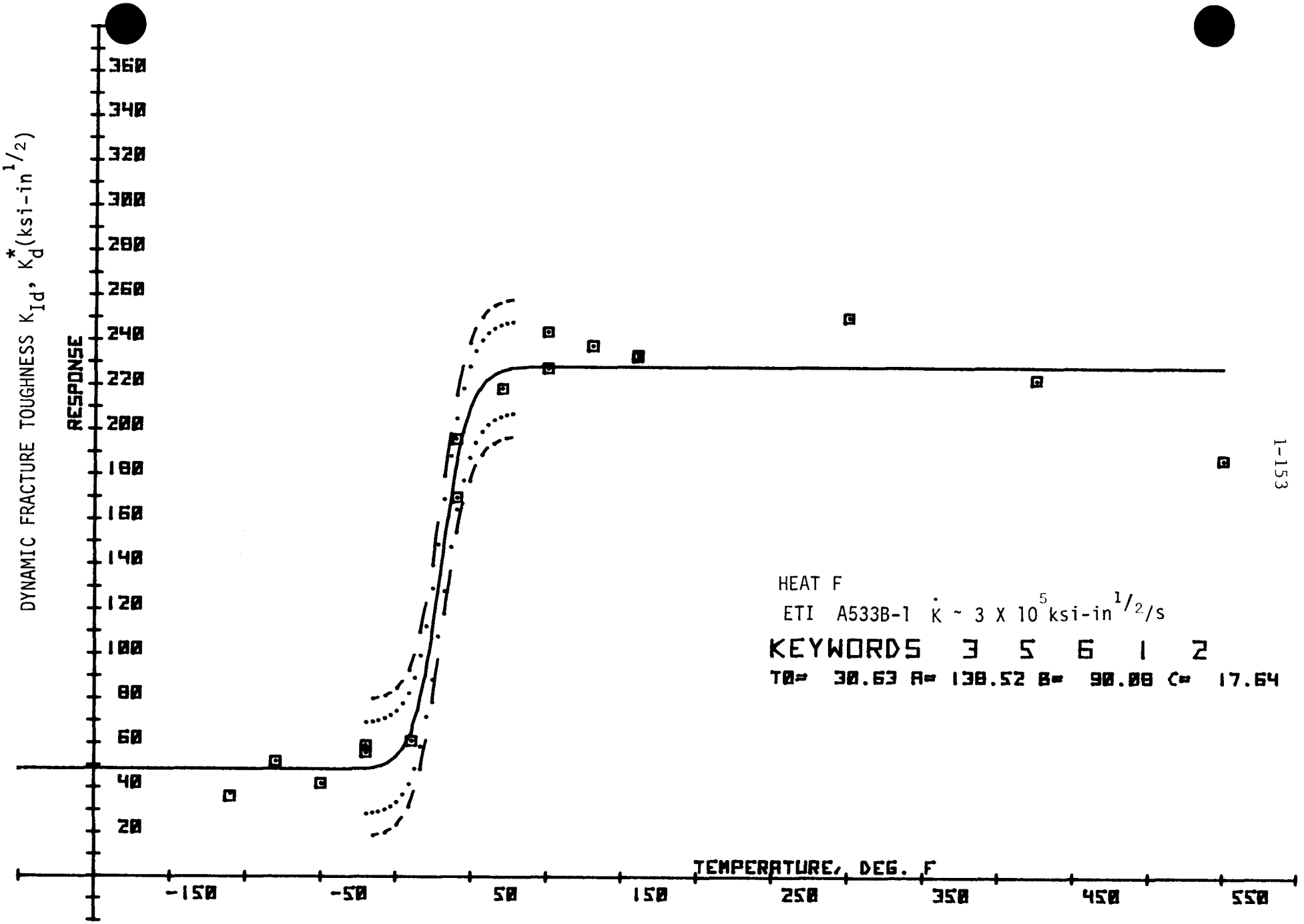

Figure 1.104 Precracked Charpy Fracture Toughness for ETI Heat F

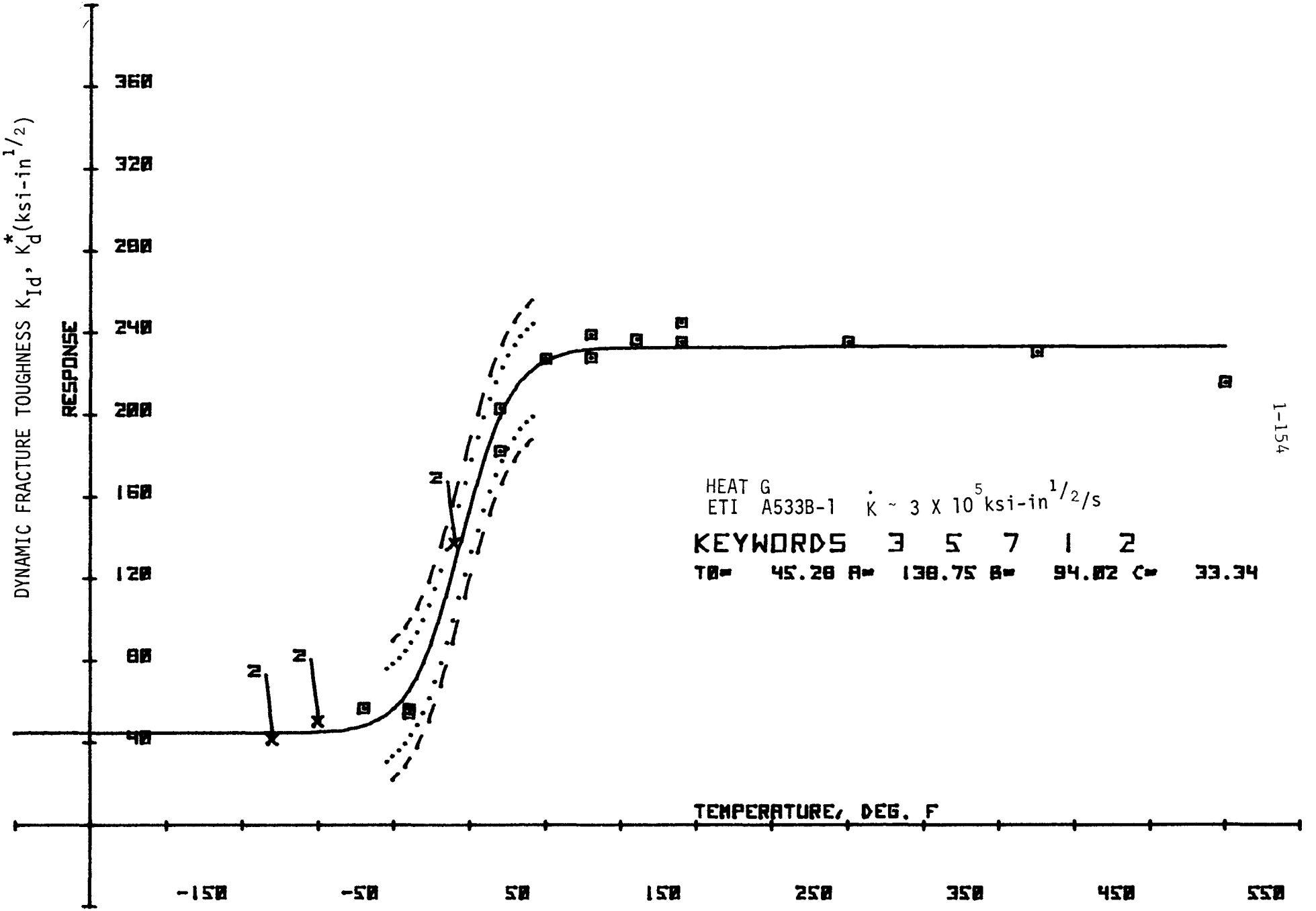

Figure 1.105 Precracked Charpy Fracture Toughness for ETI Heat G

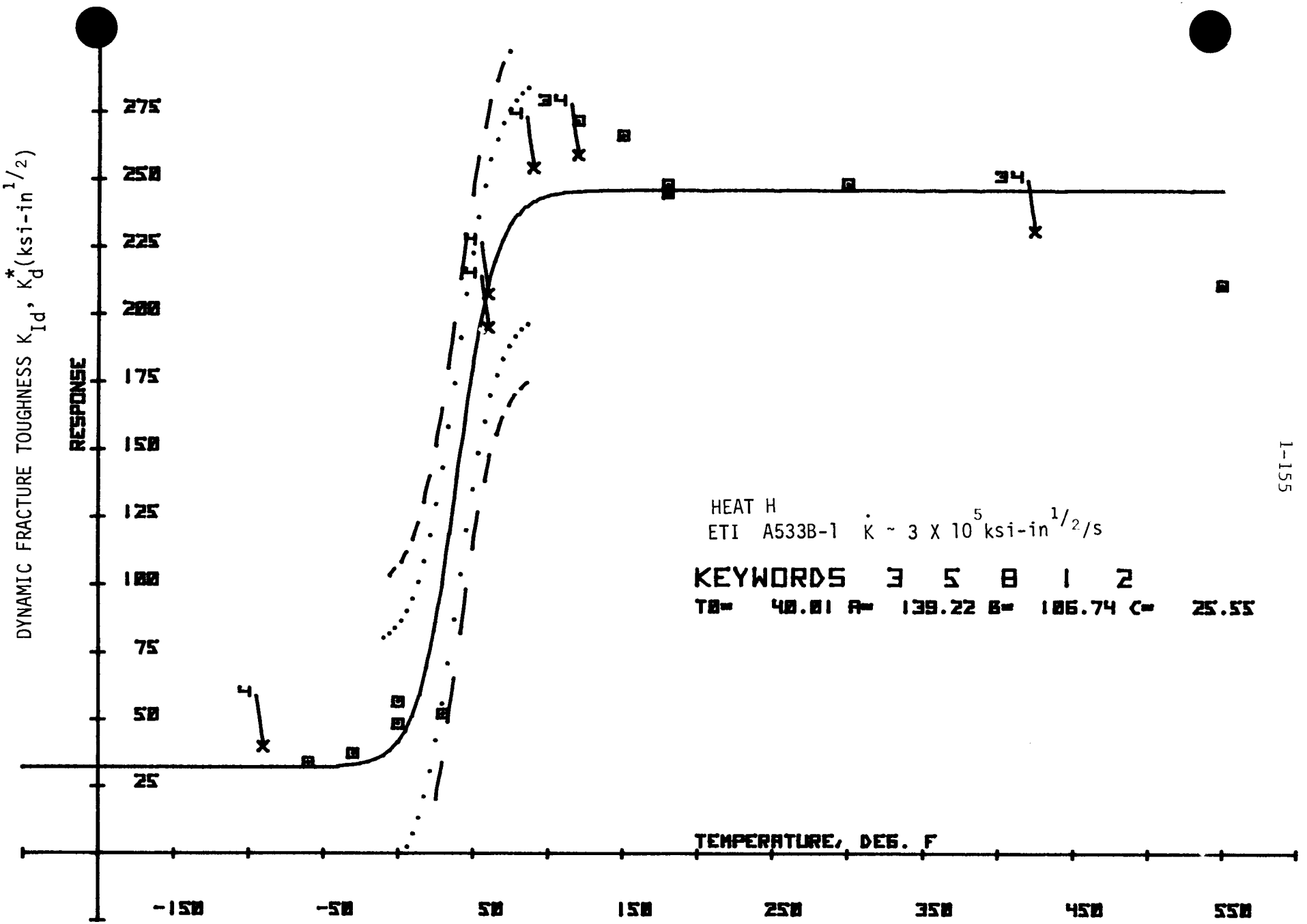

Figure 1.106 Precracked Charpy Fracture Toughness for ETI Heat H

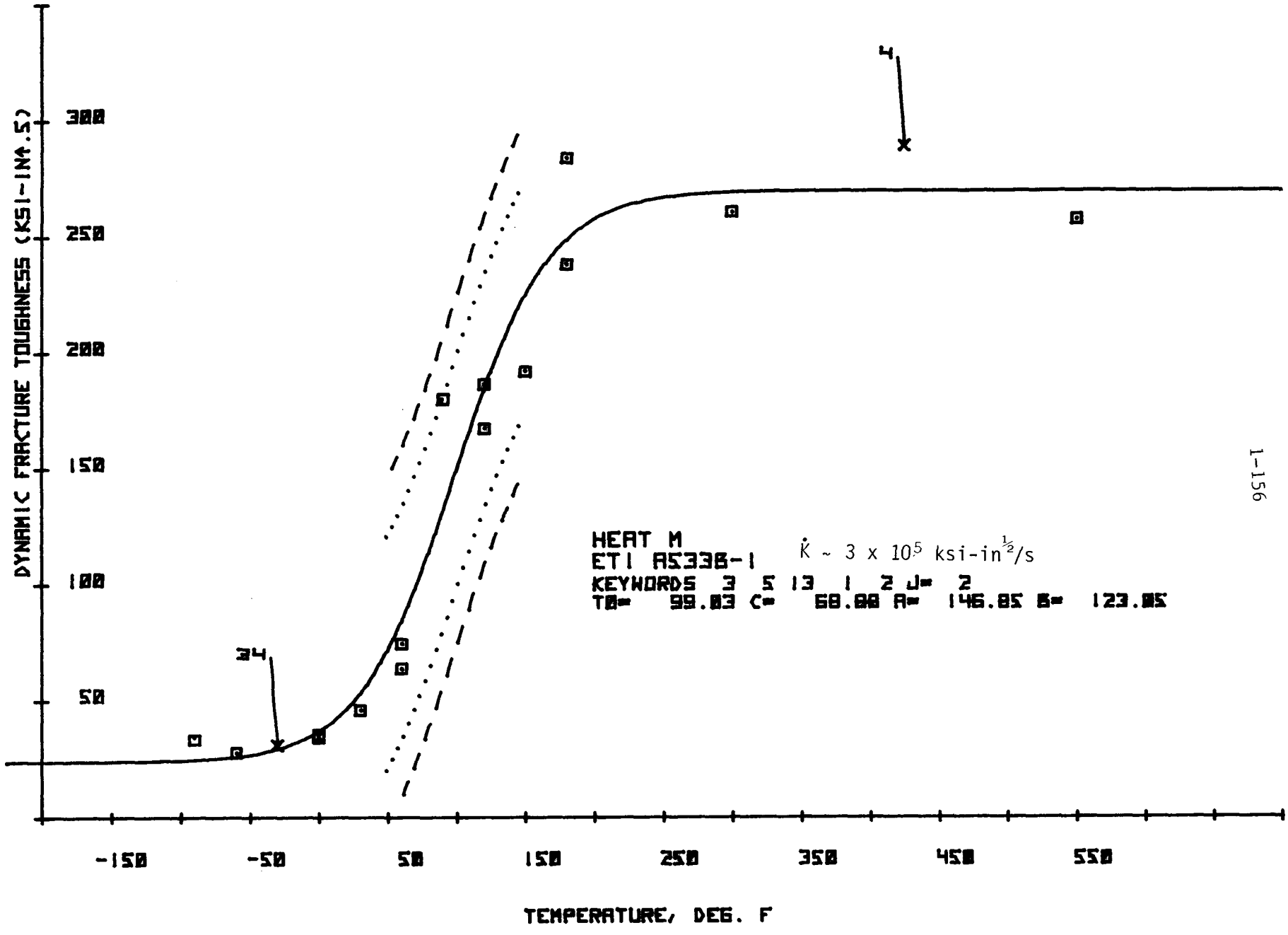

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Figure 1.107. Precracked Charpy Fracture Toughness for ETI Heat M

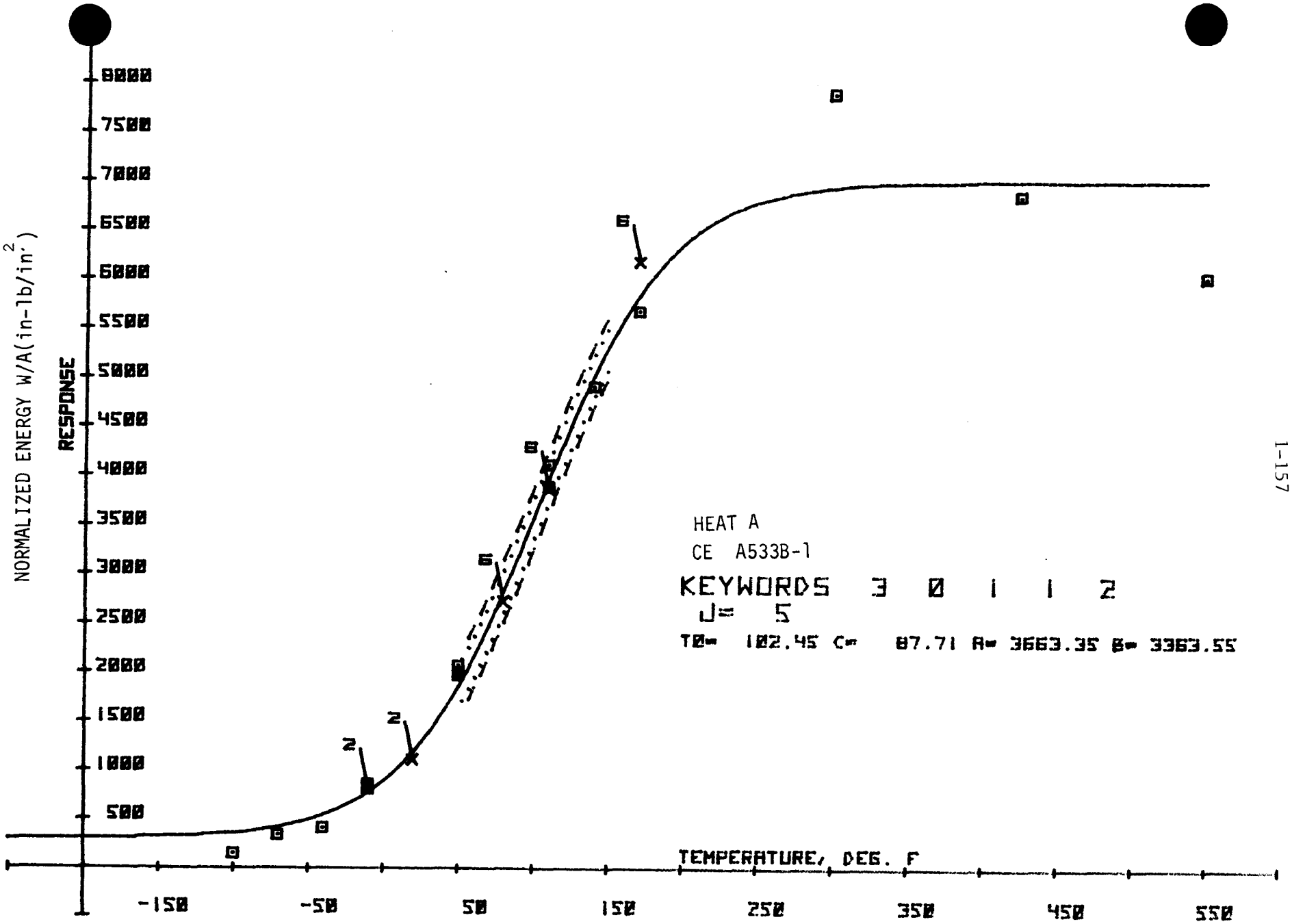


Figure 1.108 Precracked Charpy Normalized Energy for CE Heat A

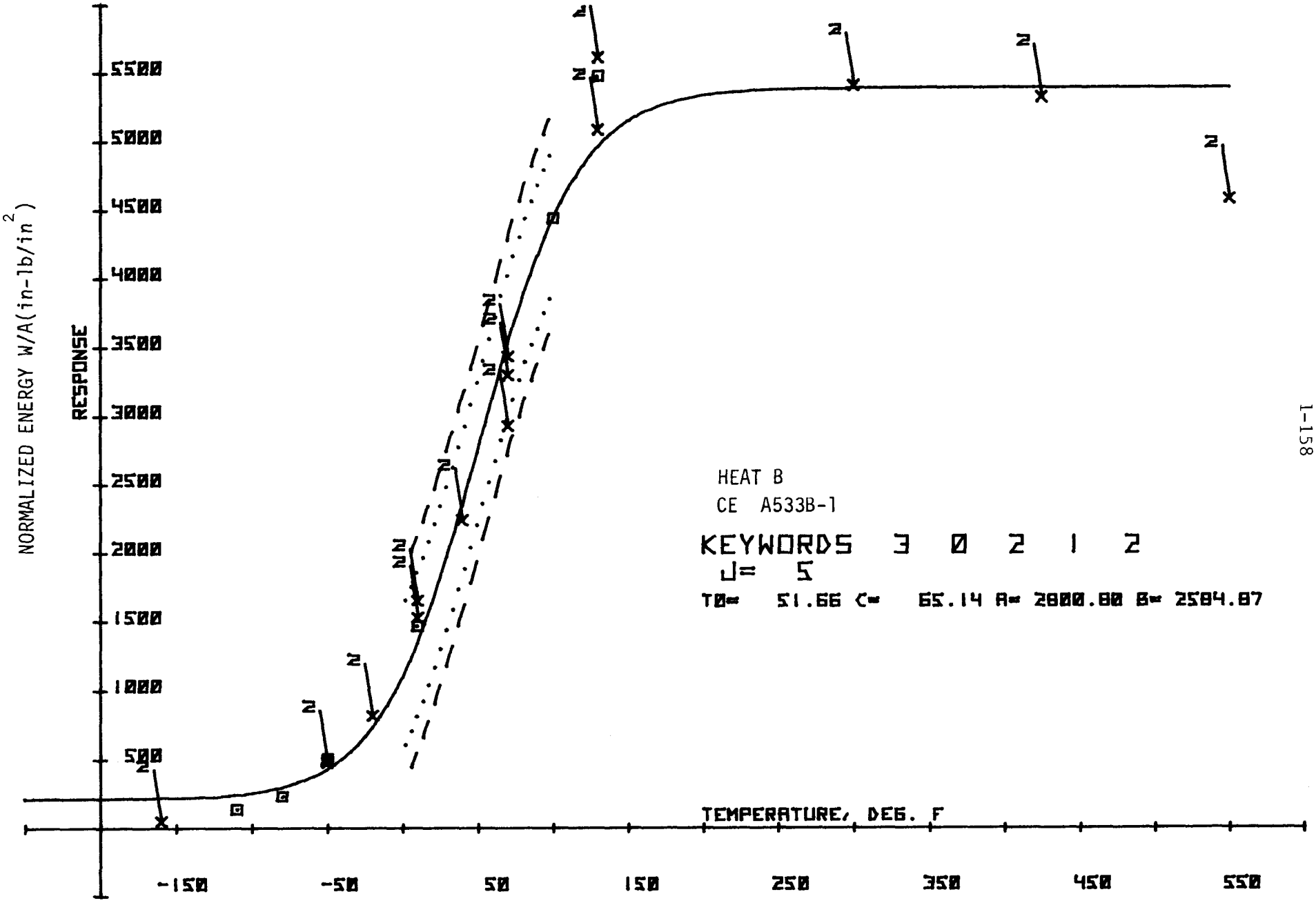


Figure 1.109 Precracked Charpy Normalized Energy for CE Heat B

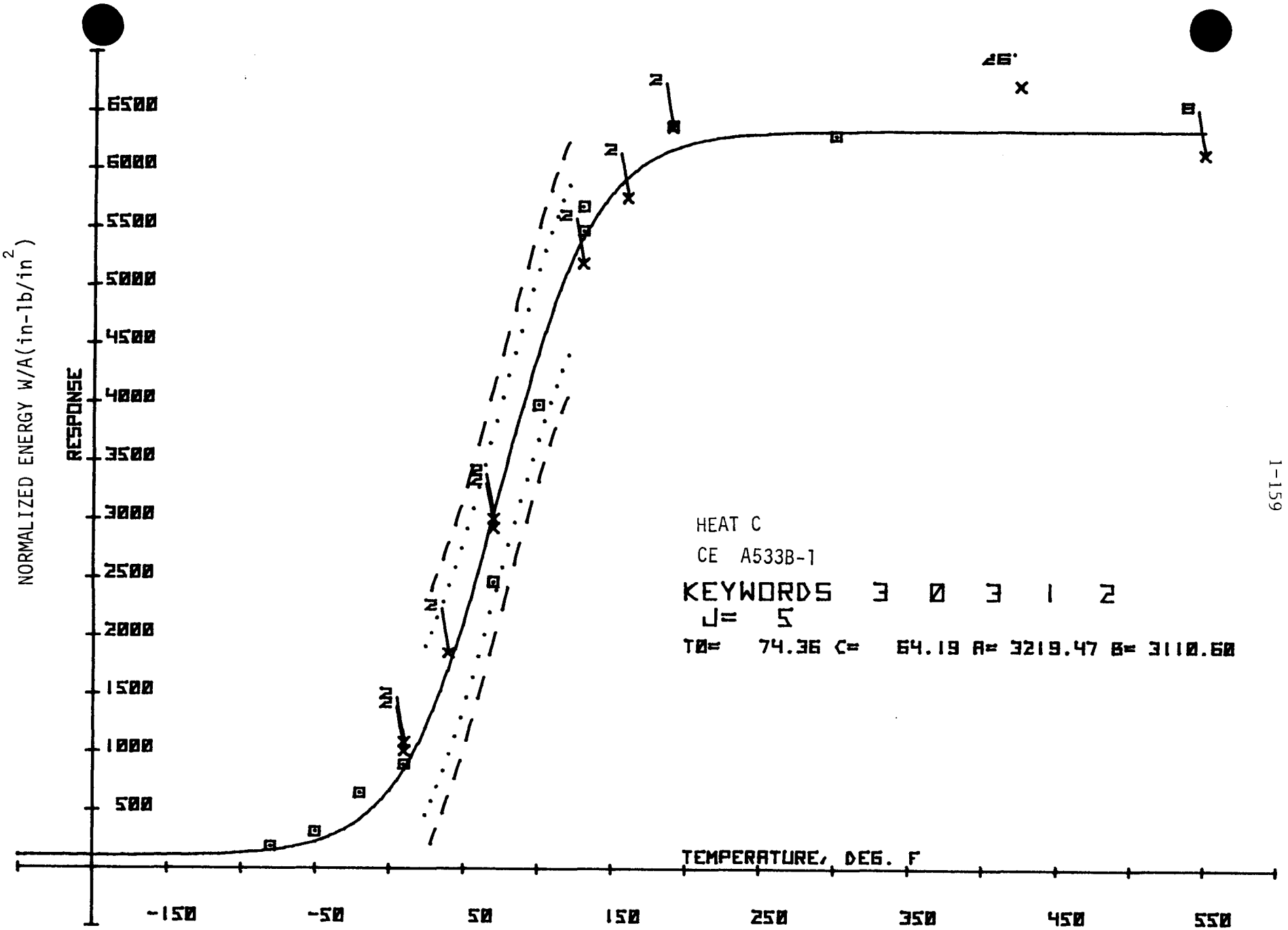
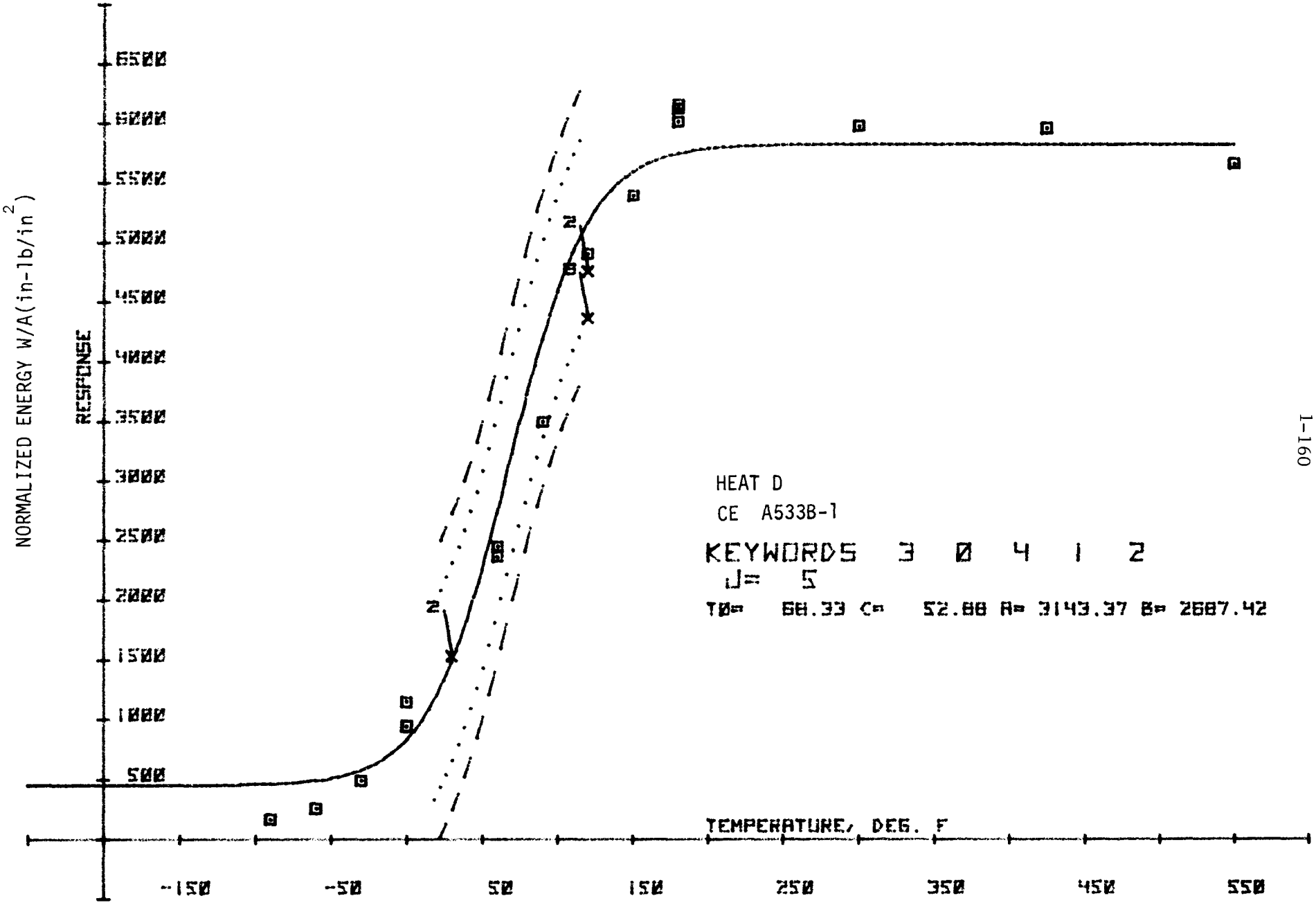


Figure 1.110 Precracked Charpy Normalized Energy for CE Heat C



ure 1.111 Precracked Charpy Normalized Energy for CE Heat D

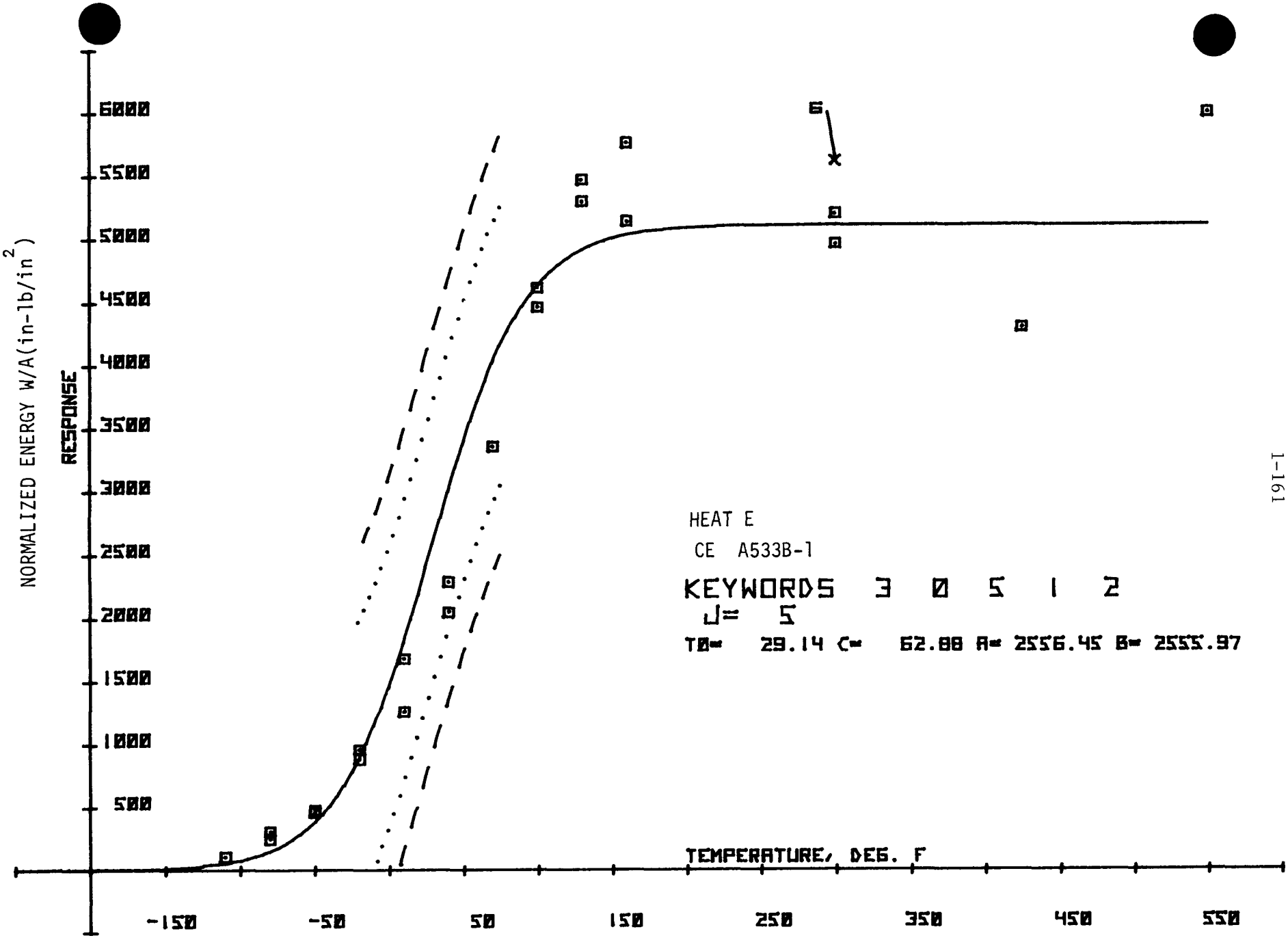


Figure 1.112 Precracked Charpy Normalized Energy for CE Heat E

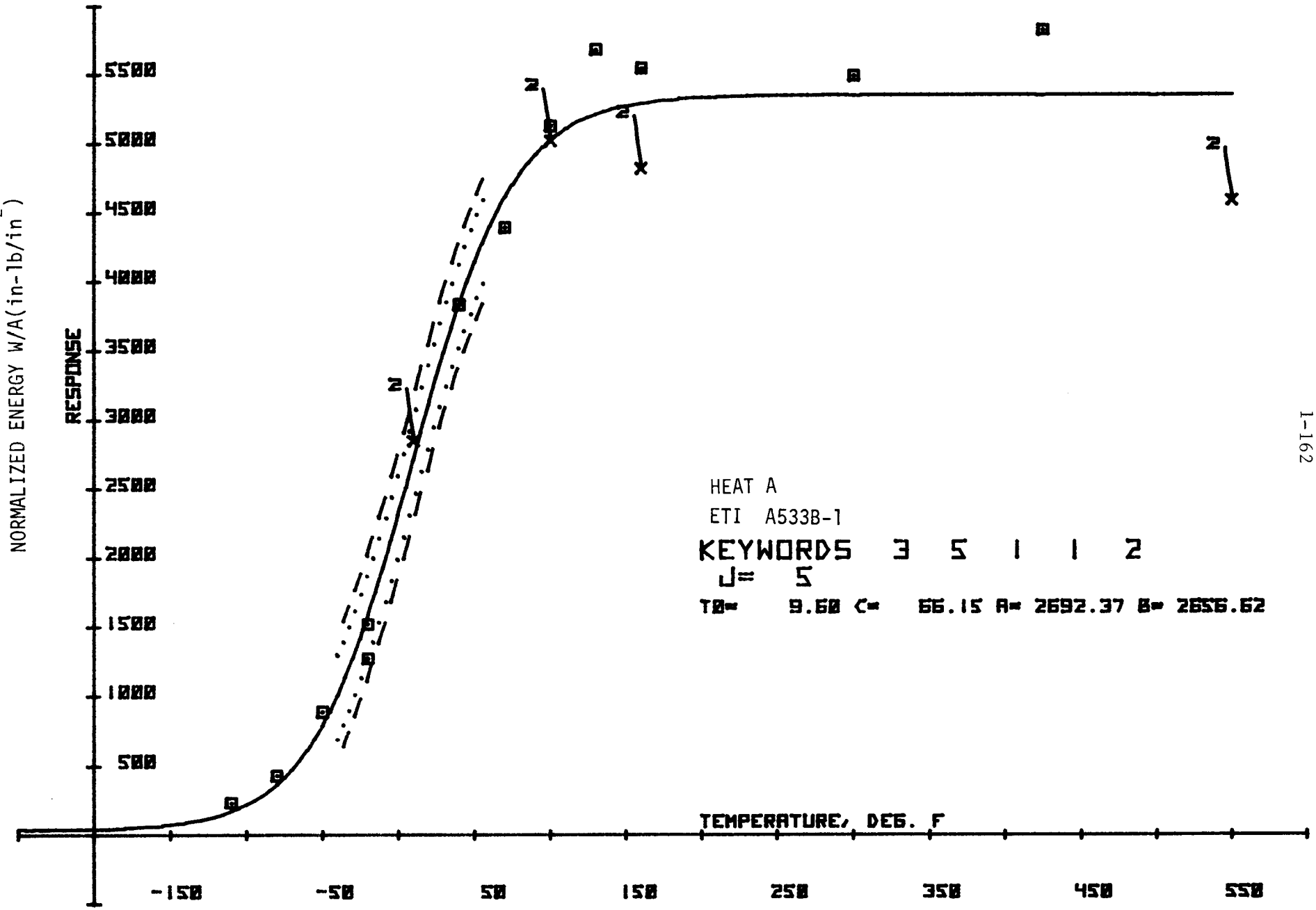


Figure 1.113 Precracked Charpy Normalized Energy for ETI Heat A

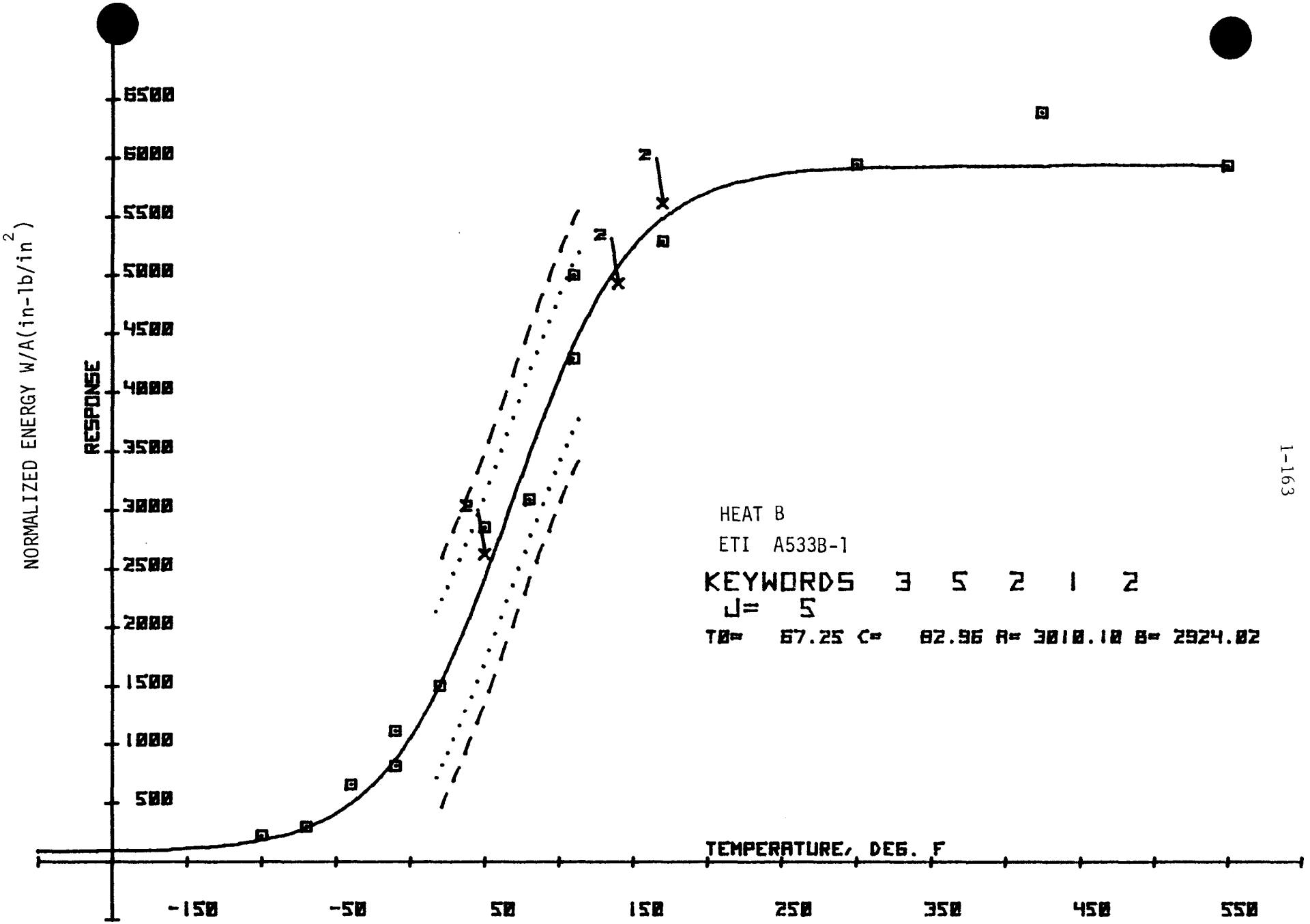


Figure 1.114 Precracked Charpy Normalized Energy for ETI Heat B

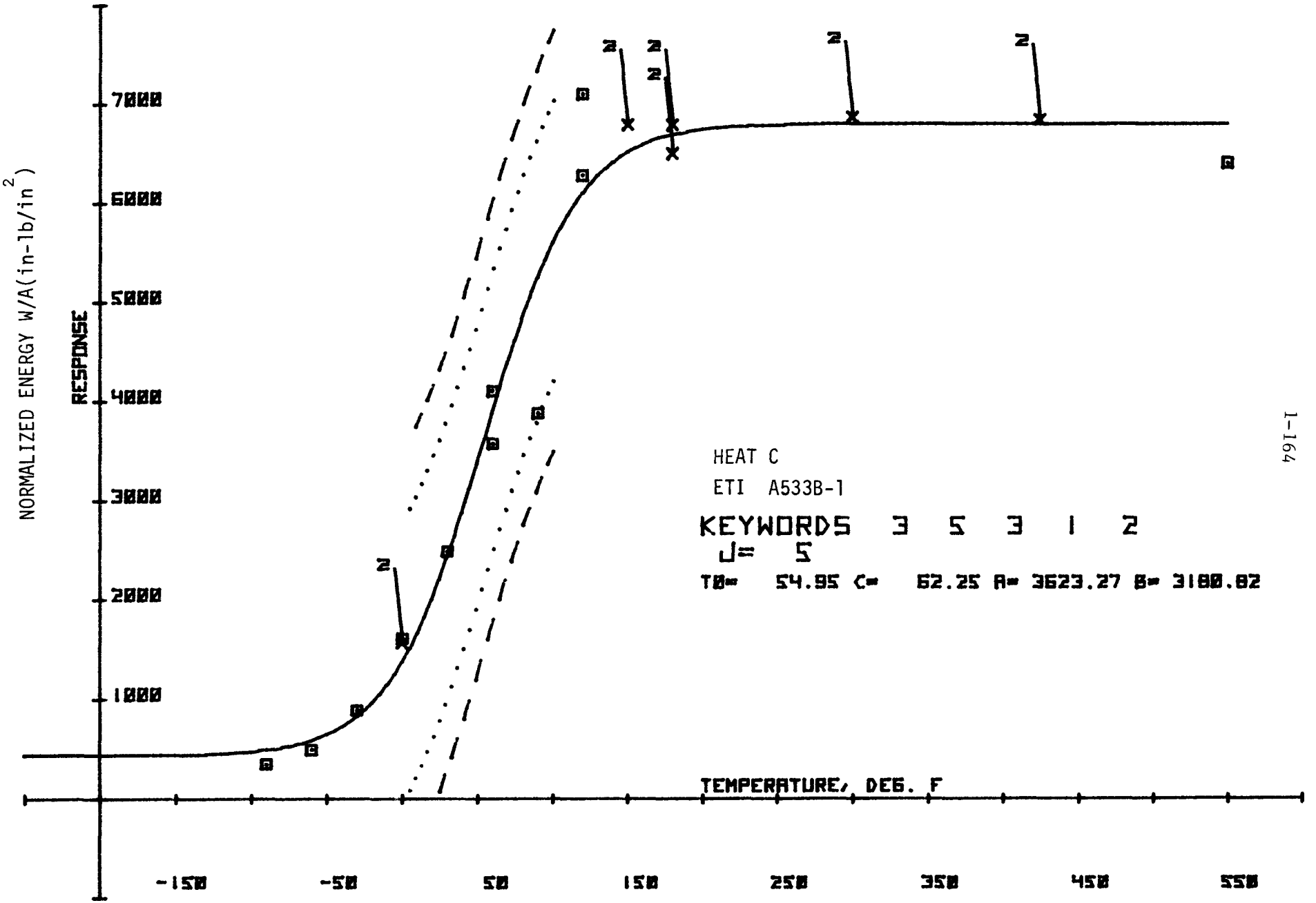


Figure I.115 Precracked Charpy Normalized Energy for ETI Heat C

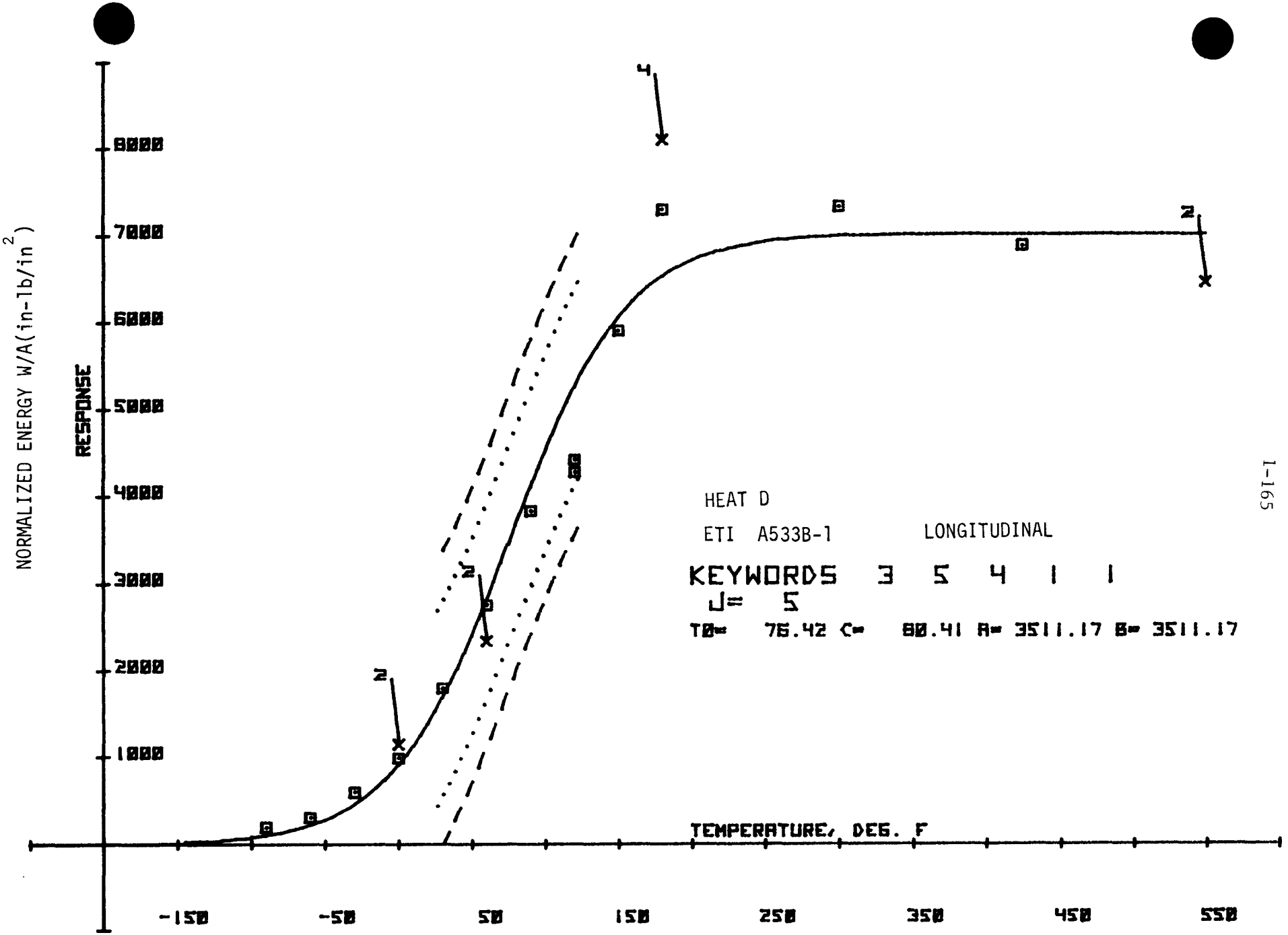


Figure 1.116 Precracked Charpy Normalized Energy for ETI Heat D(L)

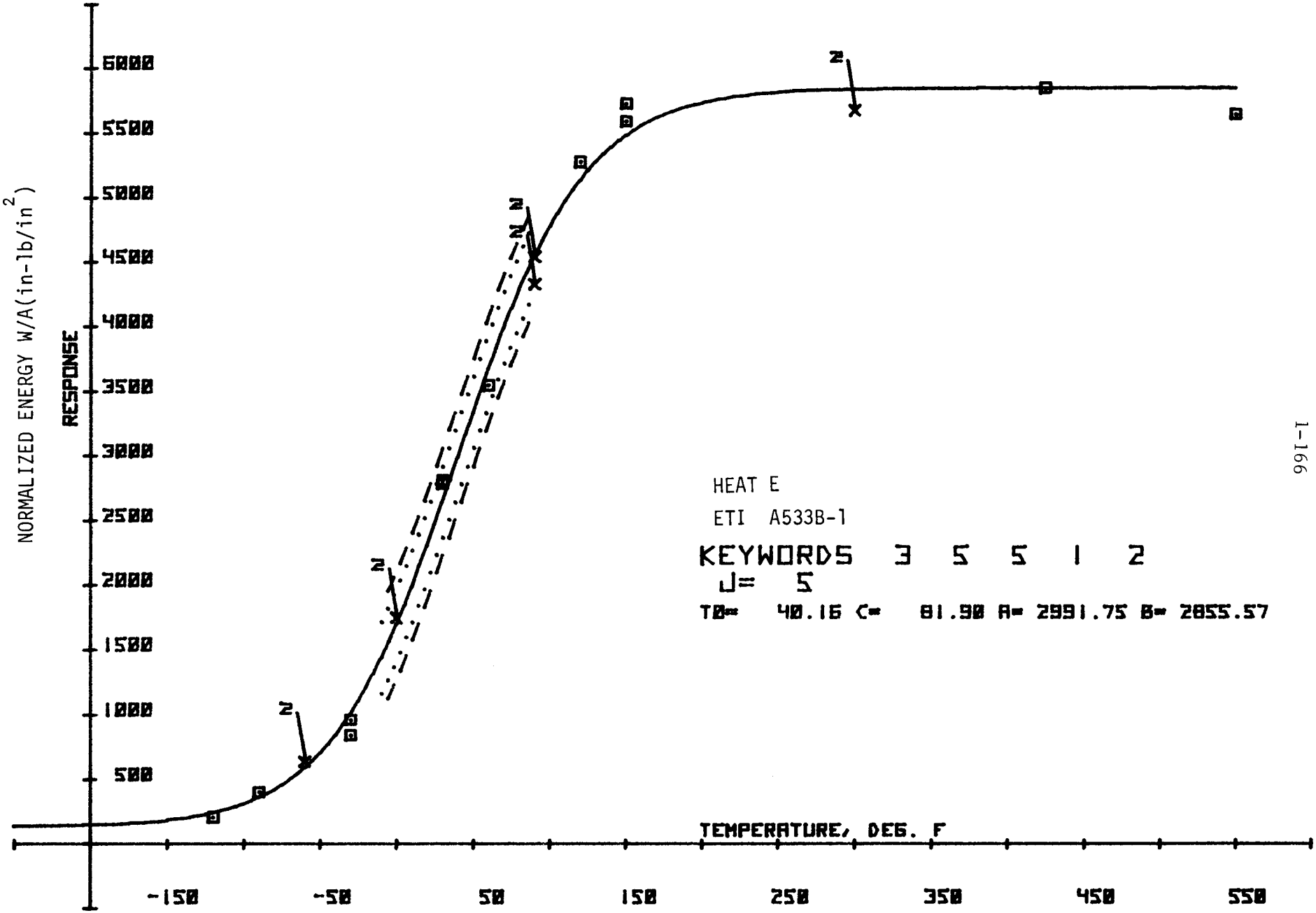


Figure 1.117 Precracked Charpy Normalized Energy for ETI Heat E

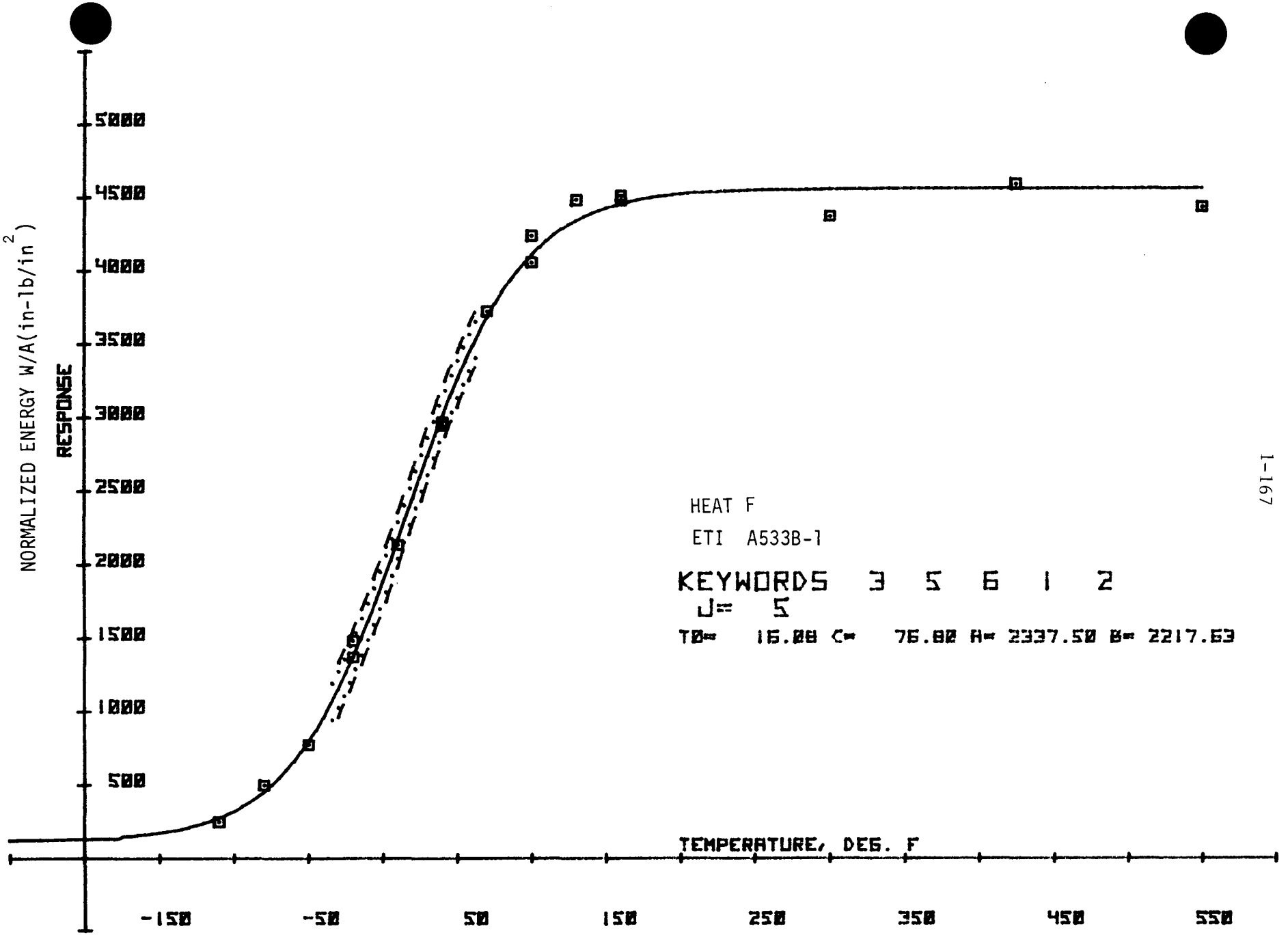


Figure 1.118 Precracked Charpy Normalized Energy for ETI Heat F

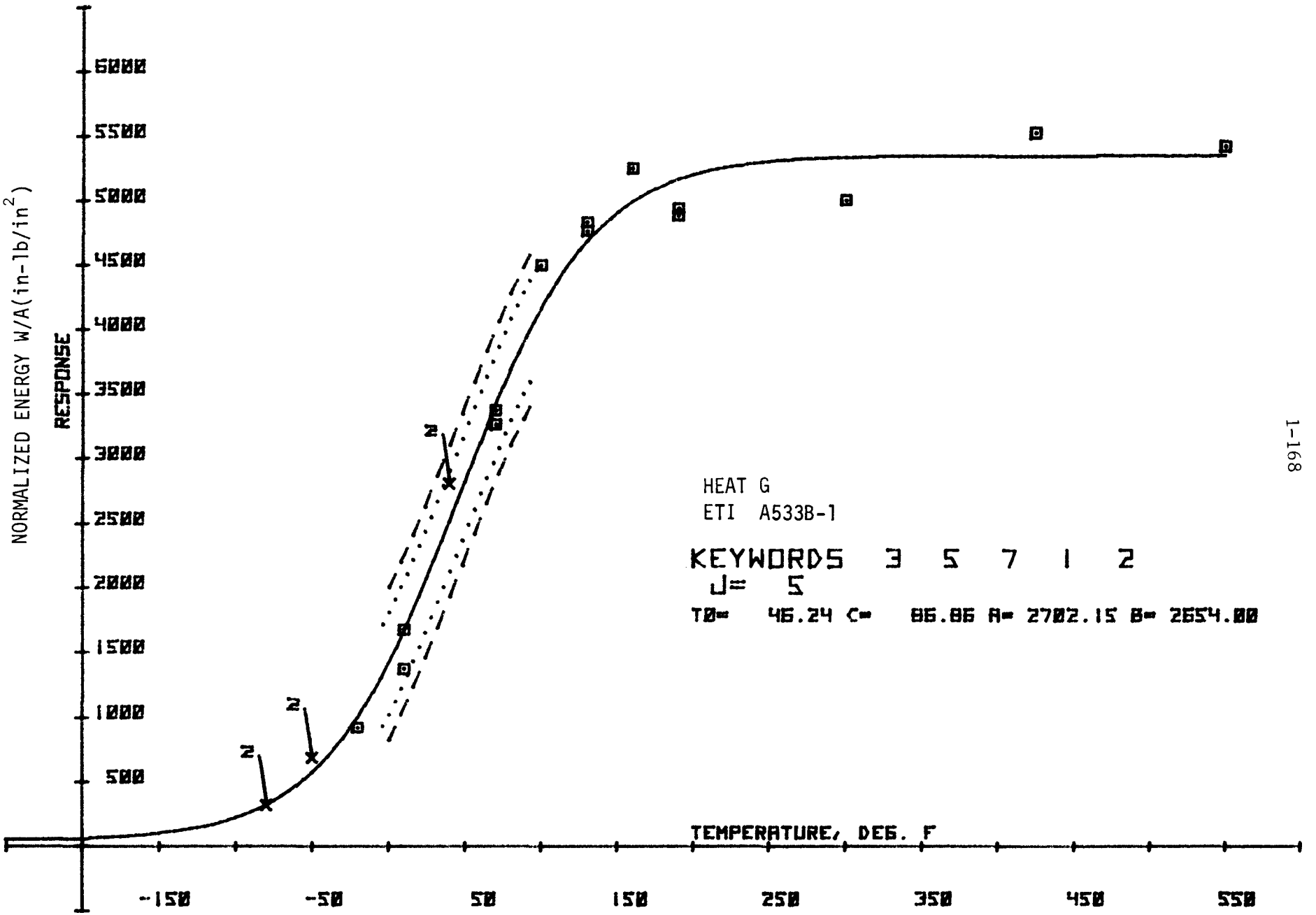


Figure 1.119 Precracked Charpy Normalized Energy for ETI Heat G

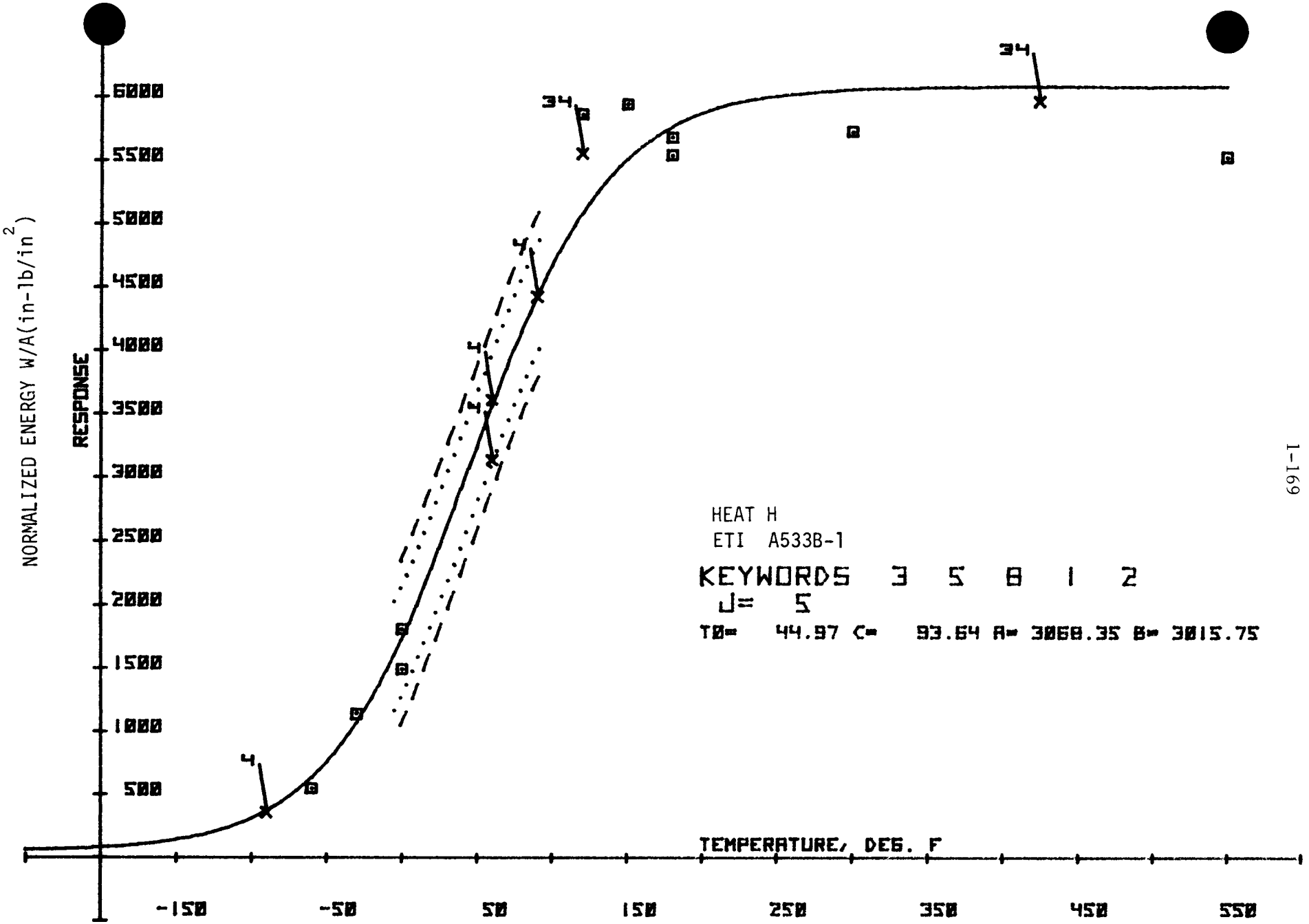


Figure 1.120 Precracked Charpy Normalized Energy for ETI Heat H

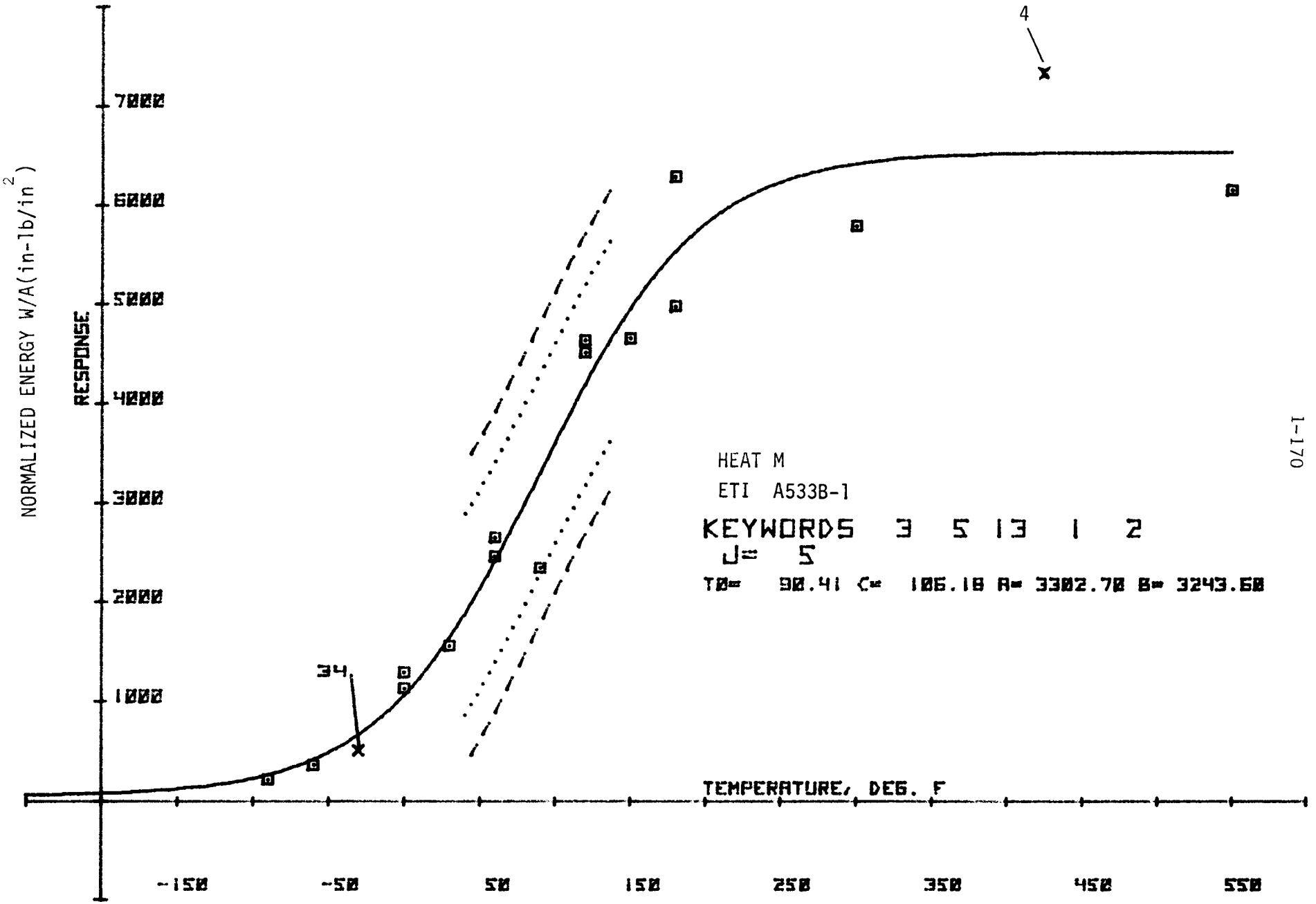


Figure 1.121 Precracked Charpy Normalized Energy for ETI Heat M

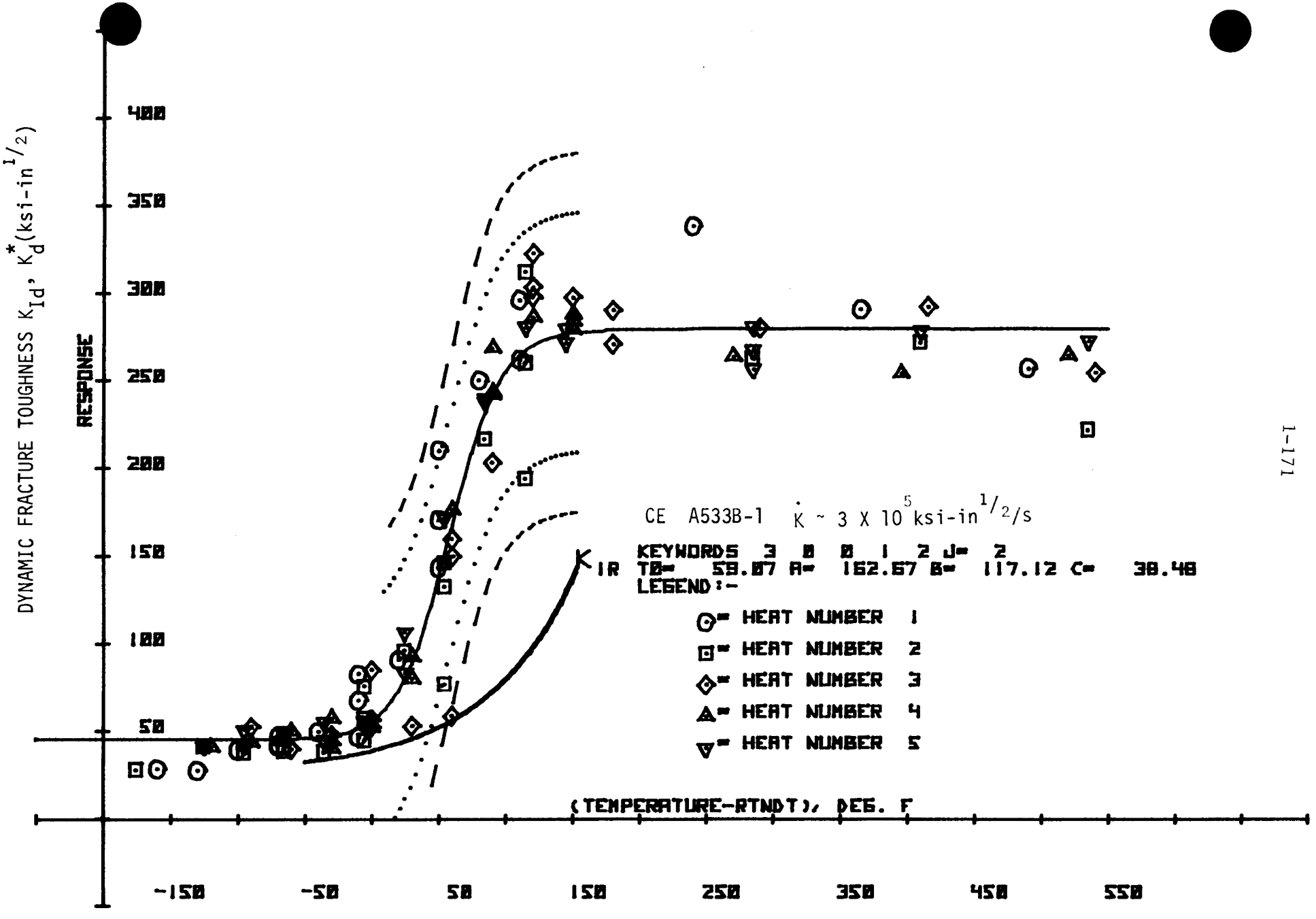


Figure 1.122 Precracked Charpy Fracture Toughness for All CE Heats

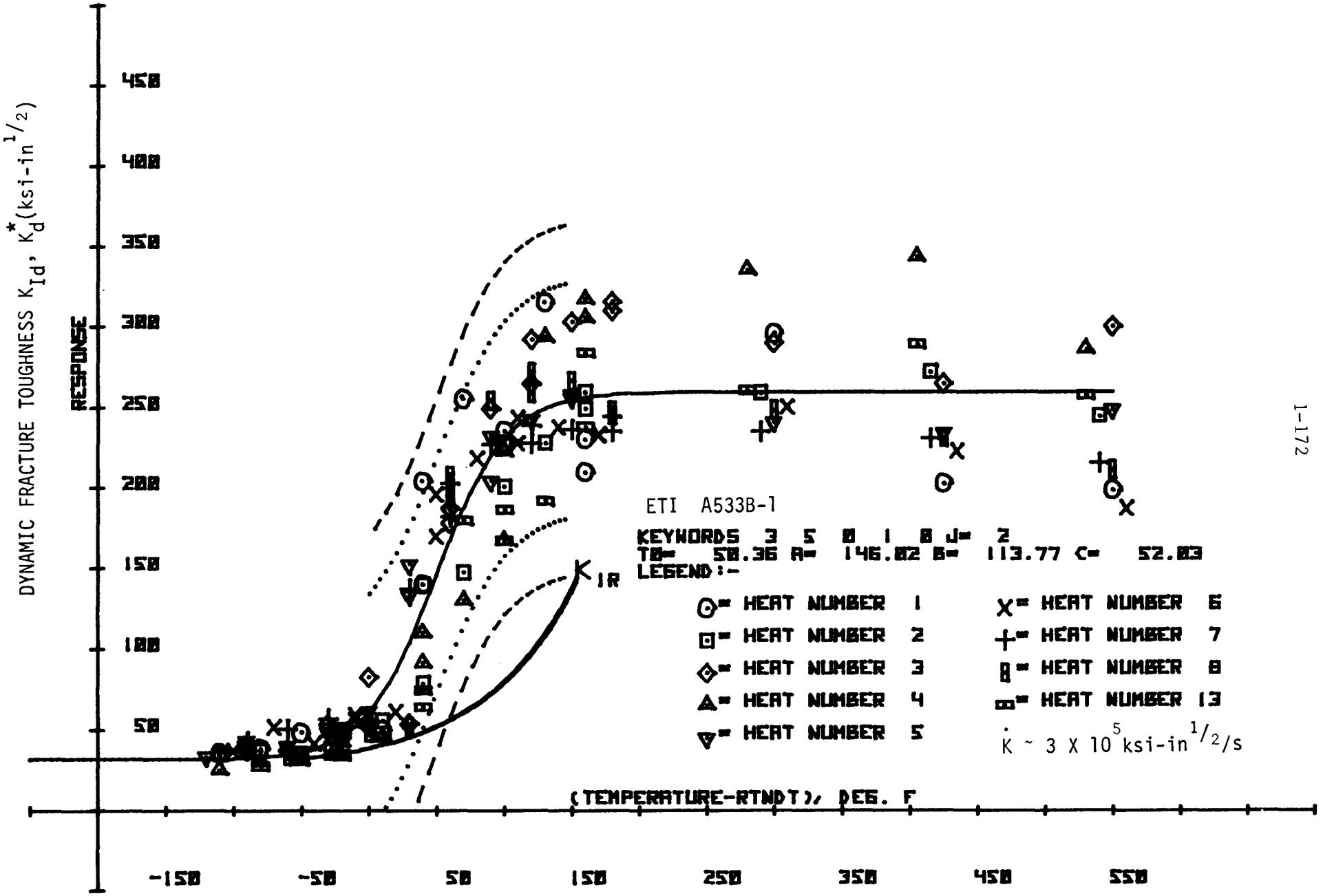


Figure 1.123 Precracked Charpy Fracture Toughness for All ETI Heats

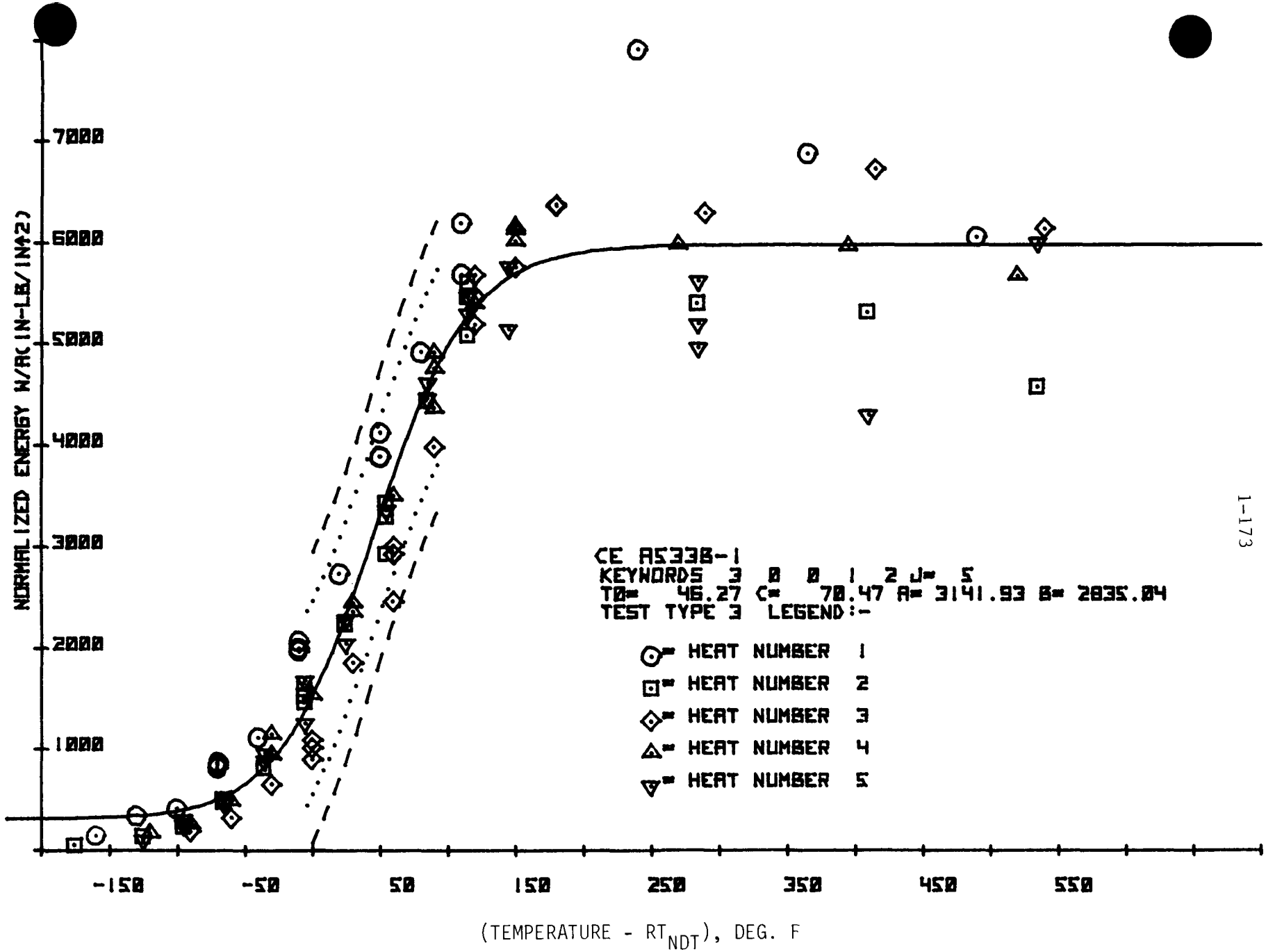


Figure 1.124. Precracked Charpy Normalized Energy for All CE Heats

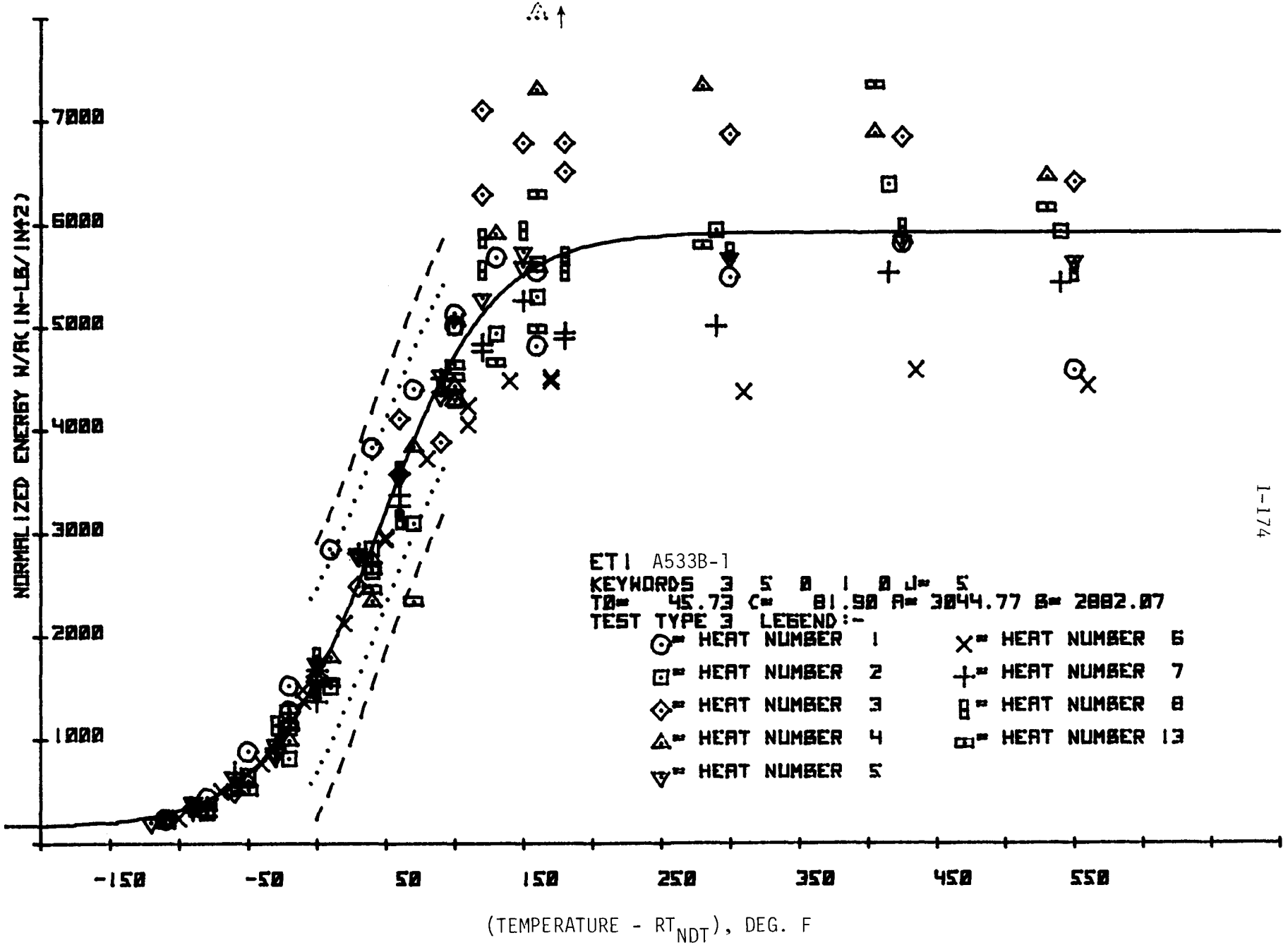


Figure 1.125. Precracked Charpy Normalized Energy for All ETI Heats

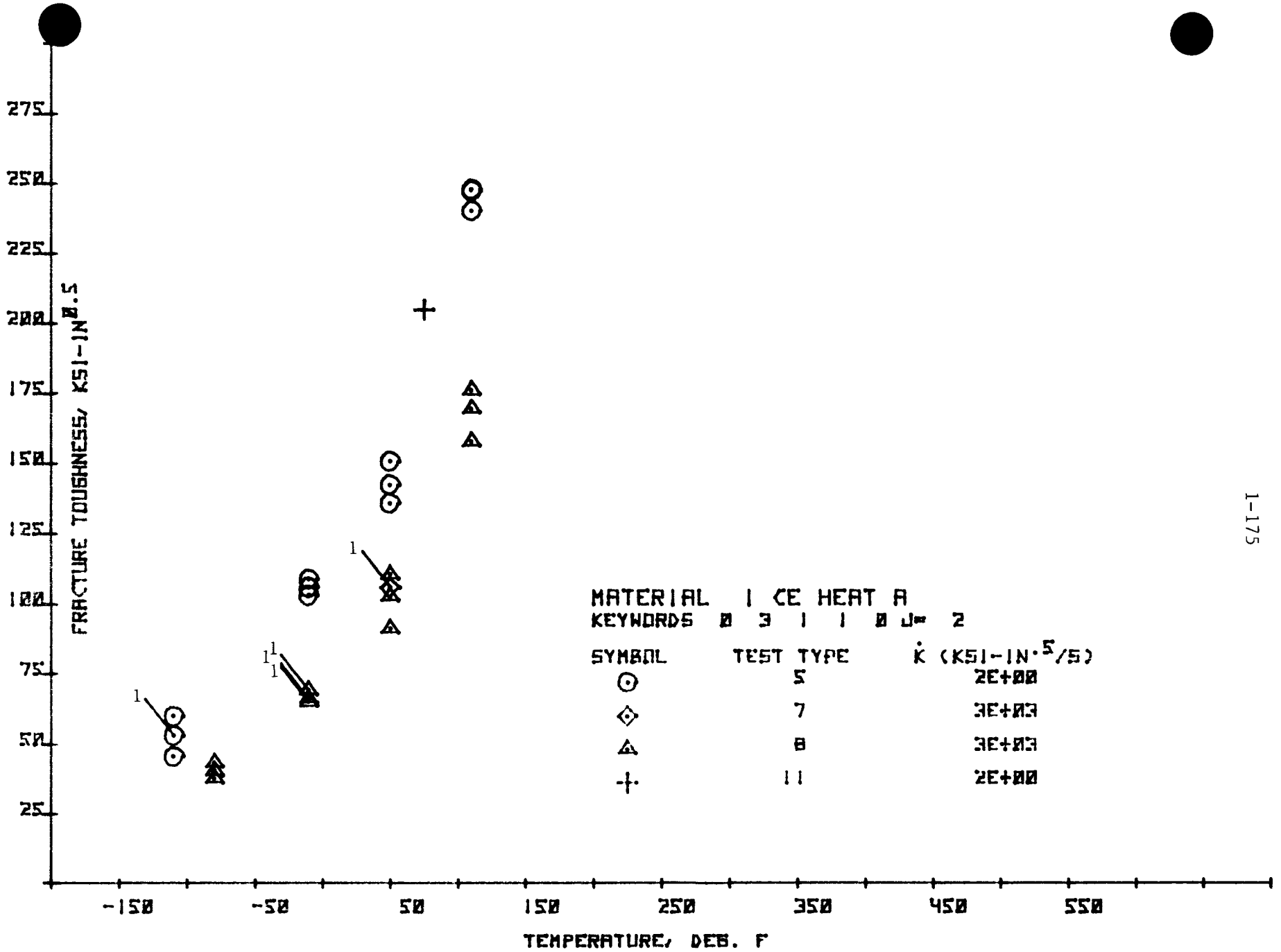


Figure 1.126. Static and Dynamic Fracture Toughness for CE Heat A

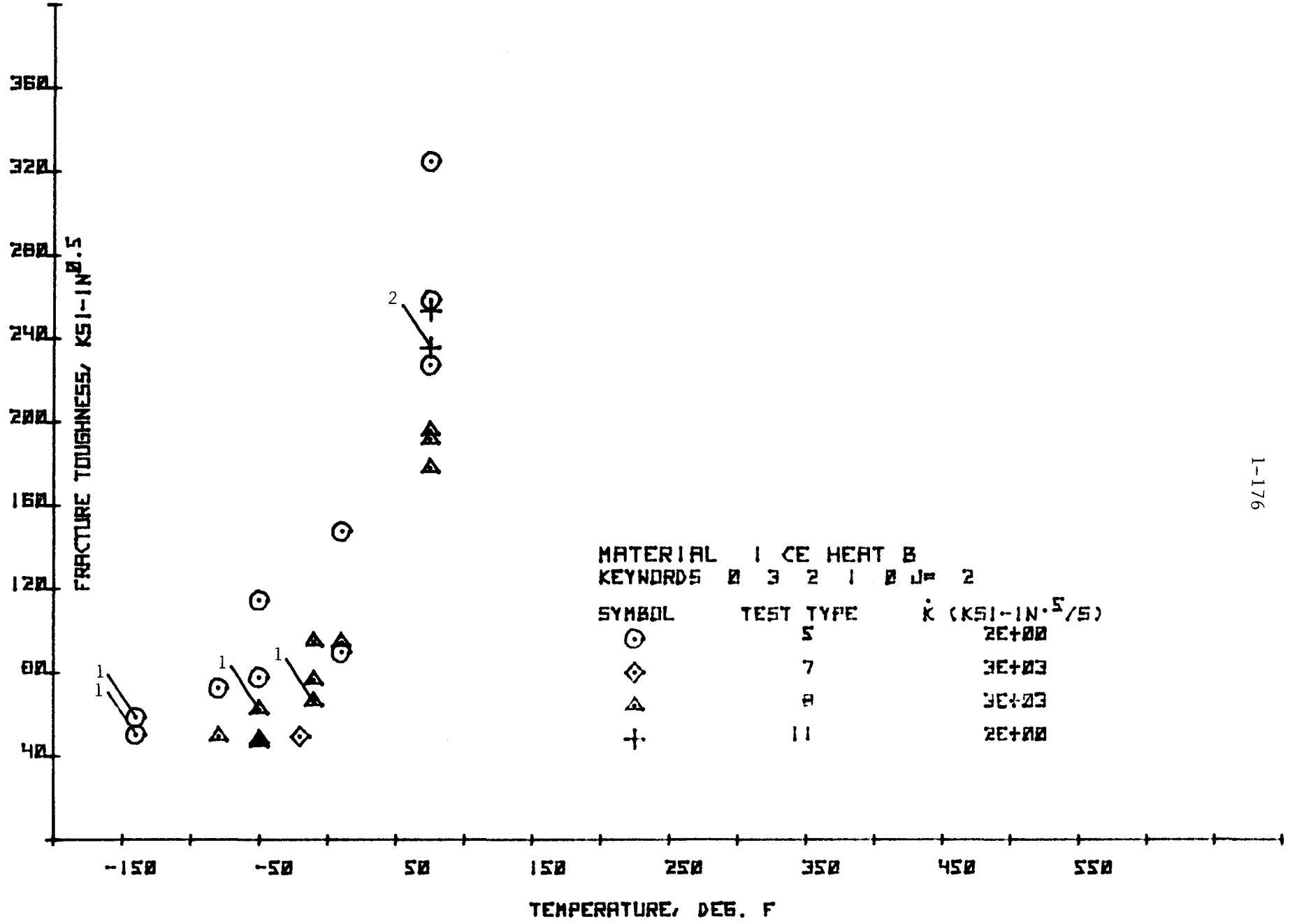


Figure 1.127. Static and Dynamic Fracture Toughness for CE Heat B

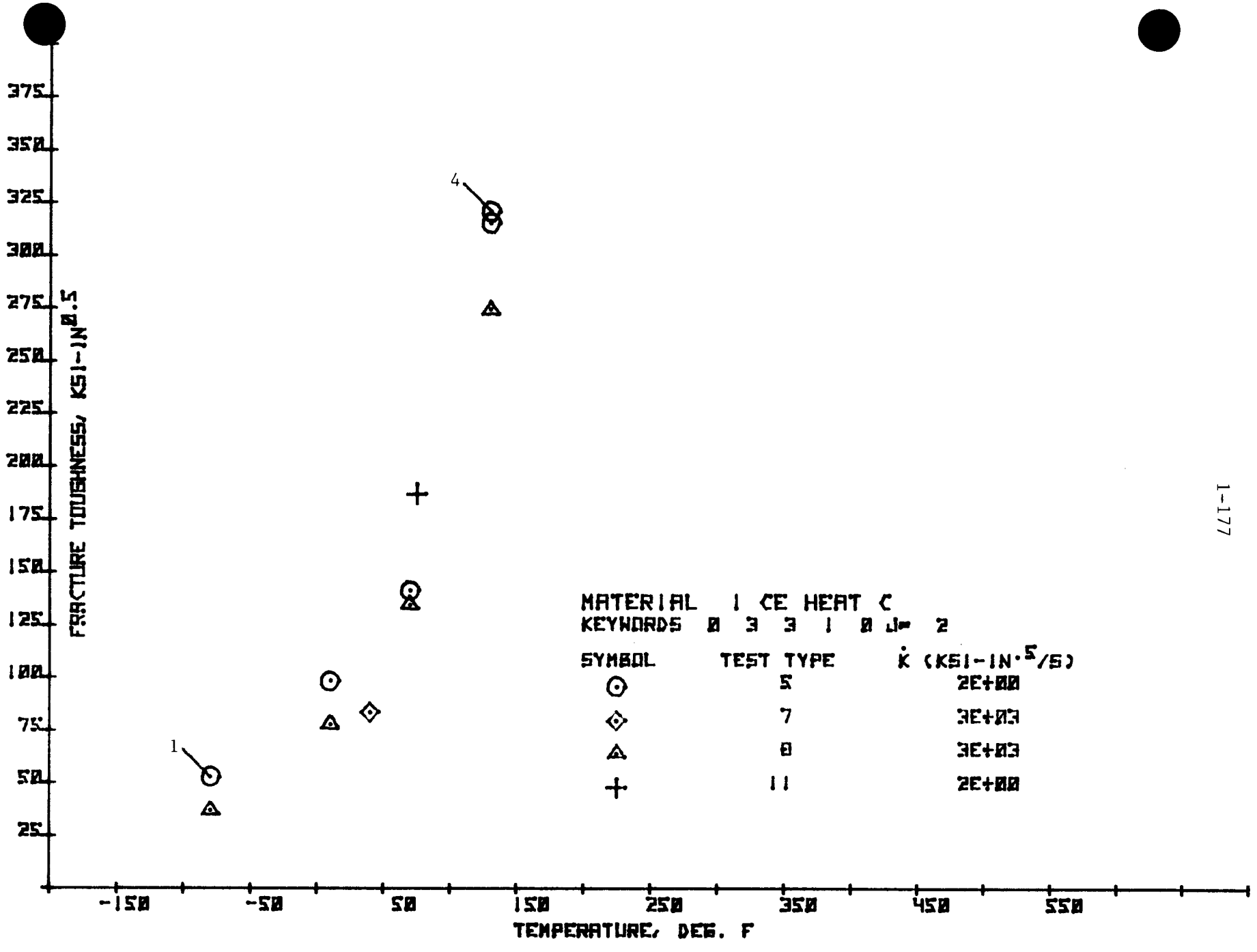


Figure 1.128. Static and Dynamic Fracture Toughness for CE Heat C

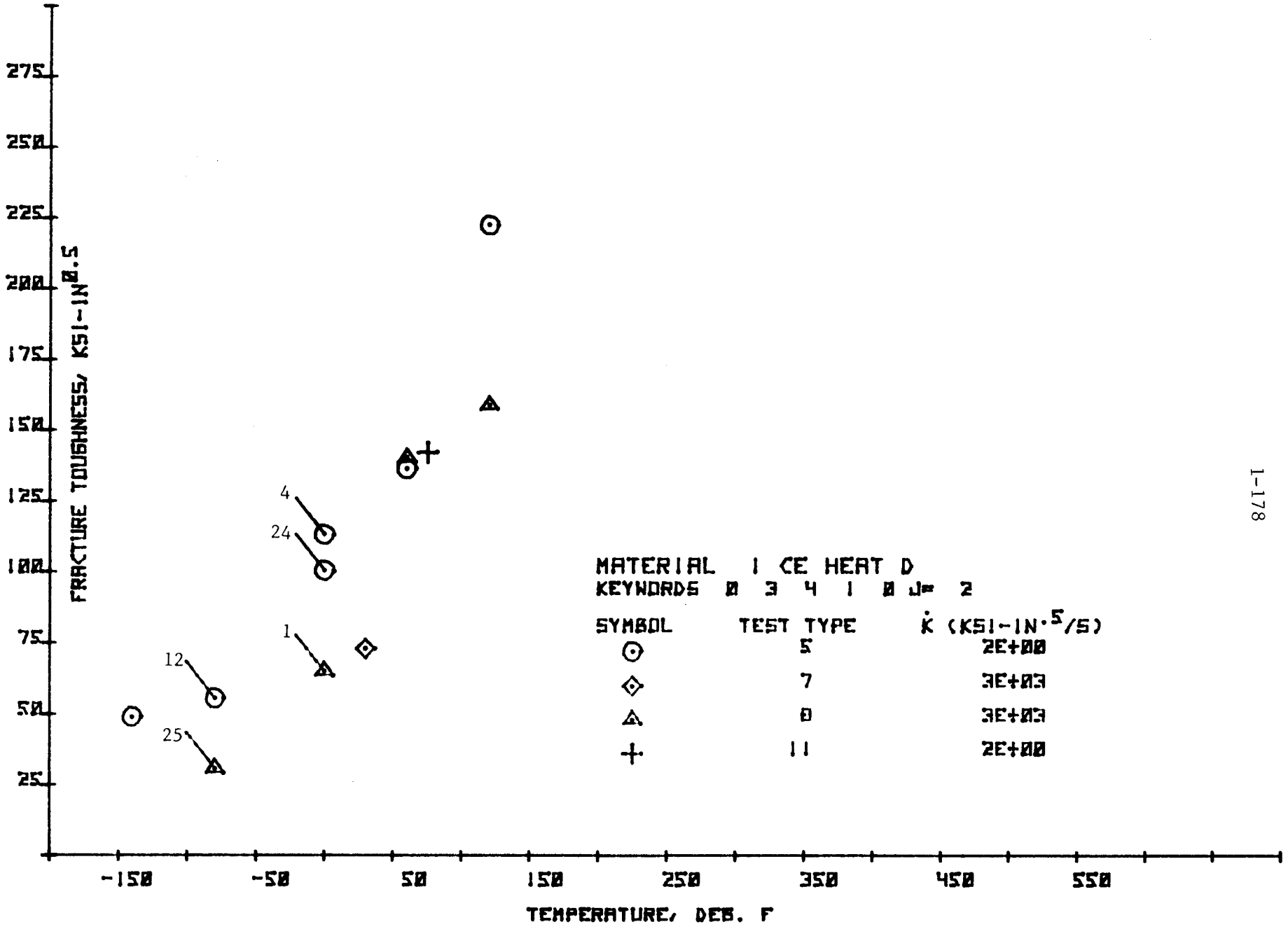


Figure 1.129. Static and Dynamic Fracture Toughness for CE Heat D

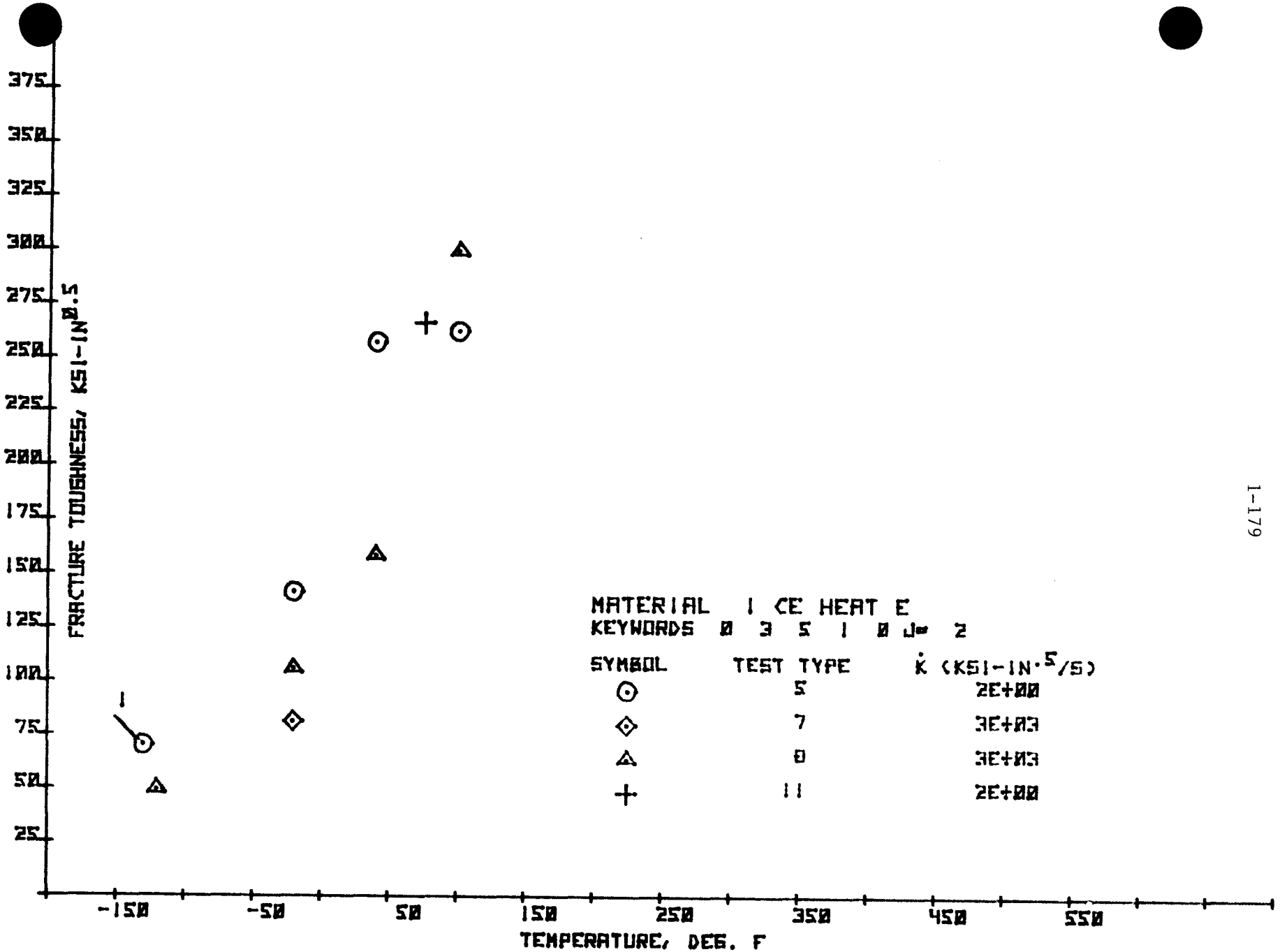


Figure 1.130. Static and Dynamic Fracture Toughness for CE Heat E

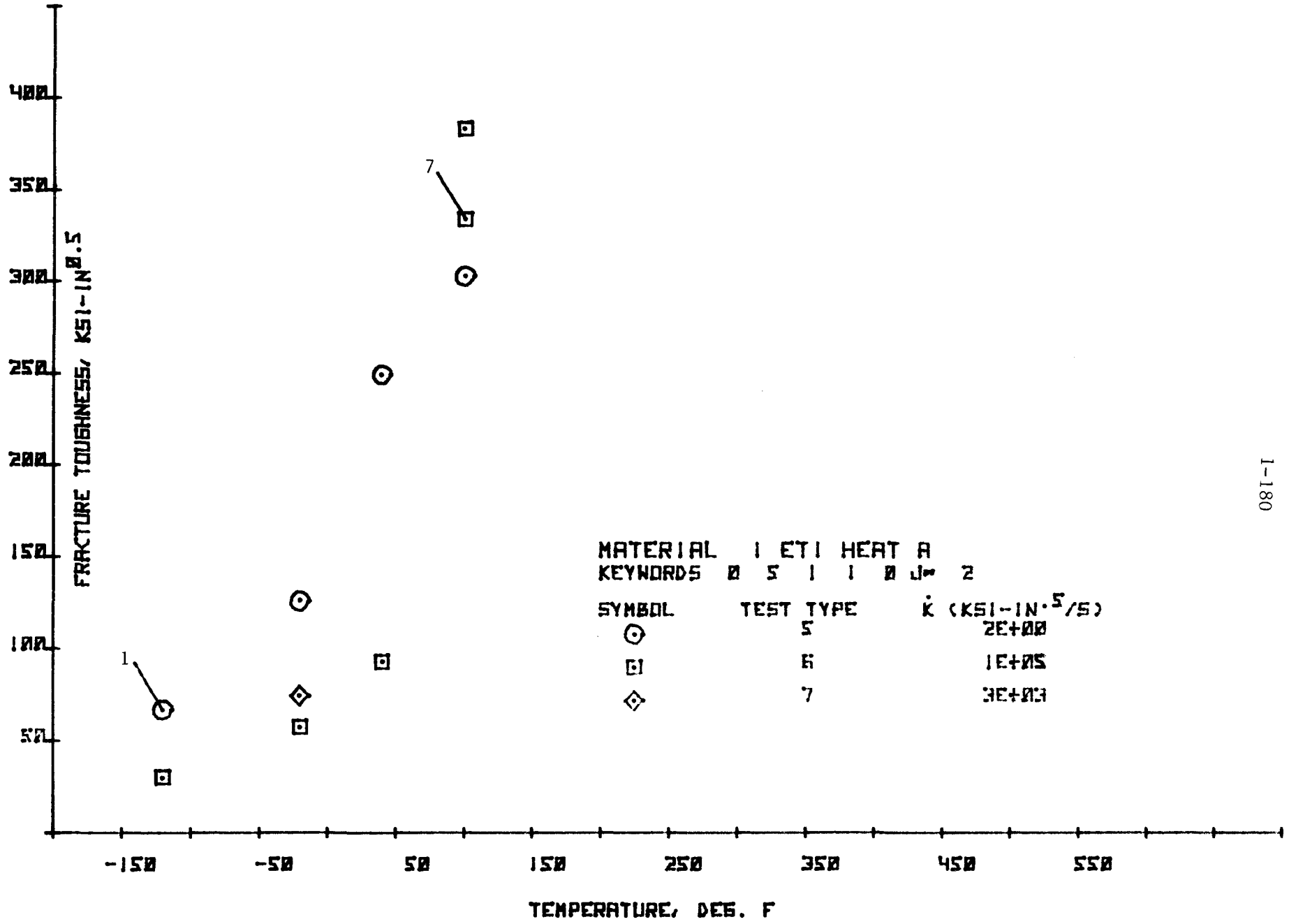


Figure 1.131. Static and Dynamic Fracture Toughness for ETI Heat A

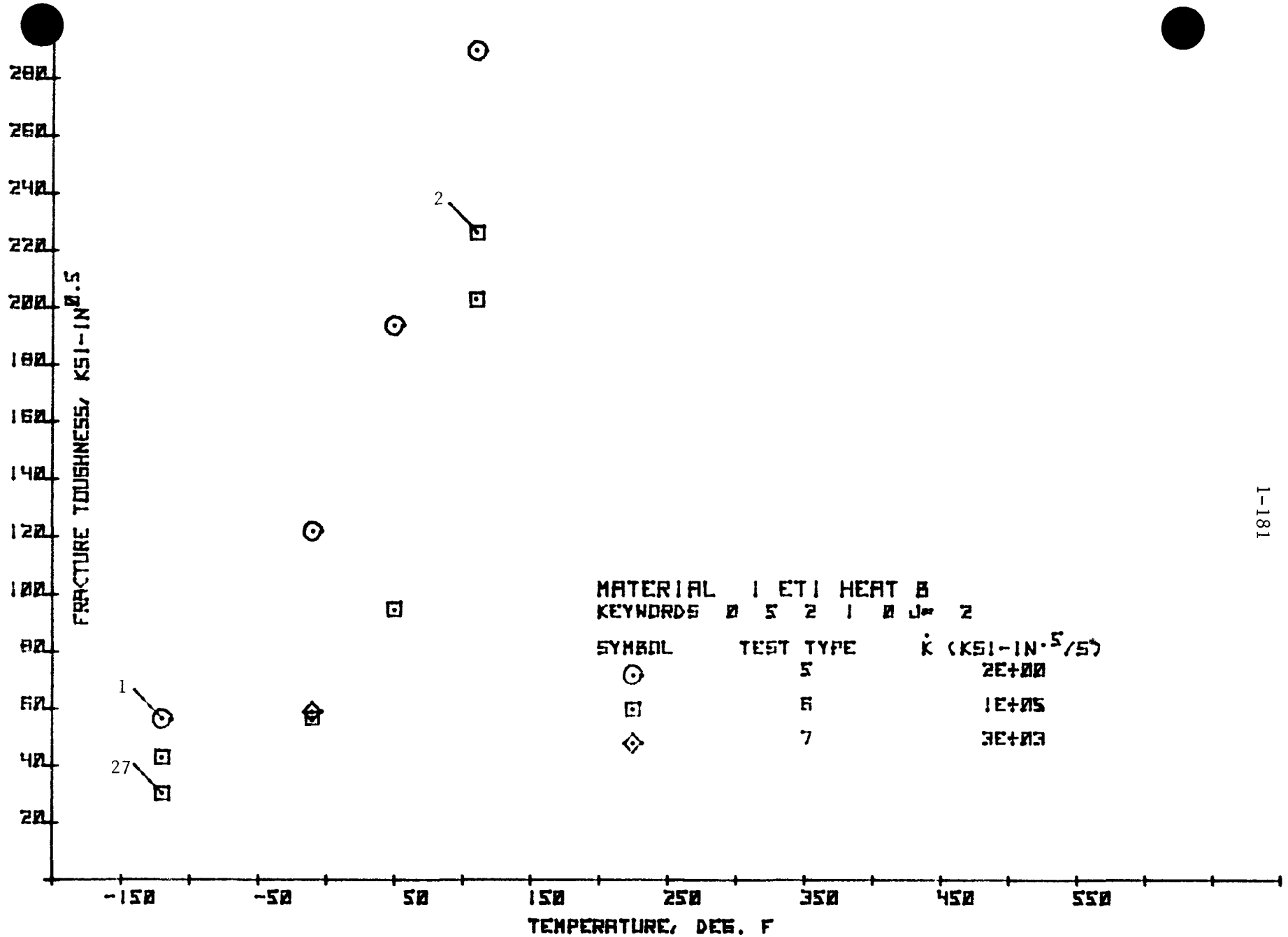


Figure 1.132. Static and Dynamic Fracture Toughness for ETI Heat B

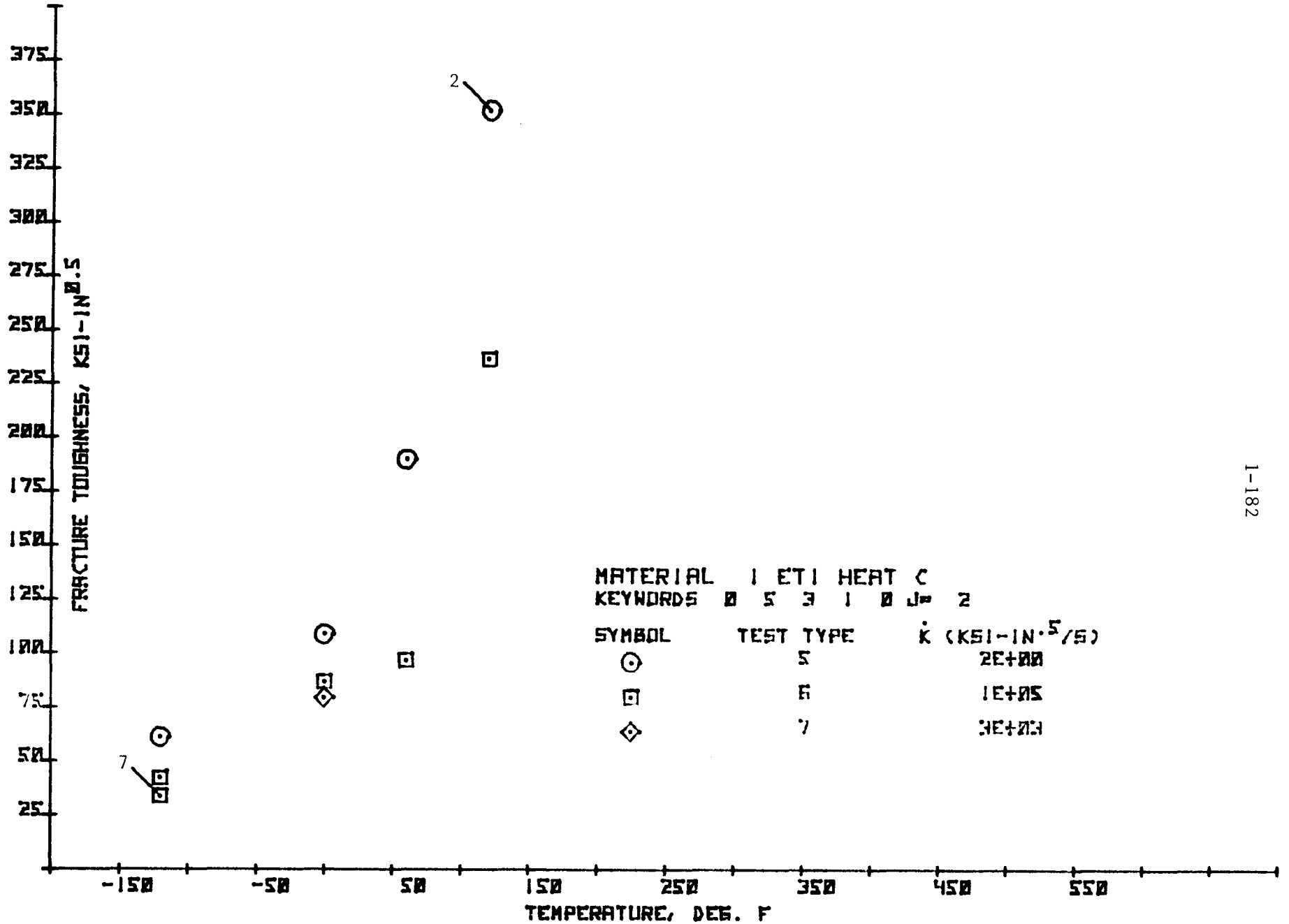


Figure 1.133. Static and Dynamic Fracture Toughness for ETI Heat C

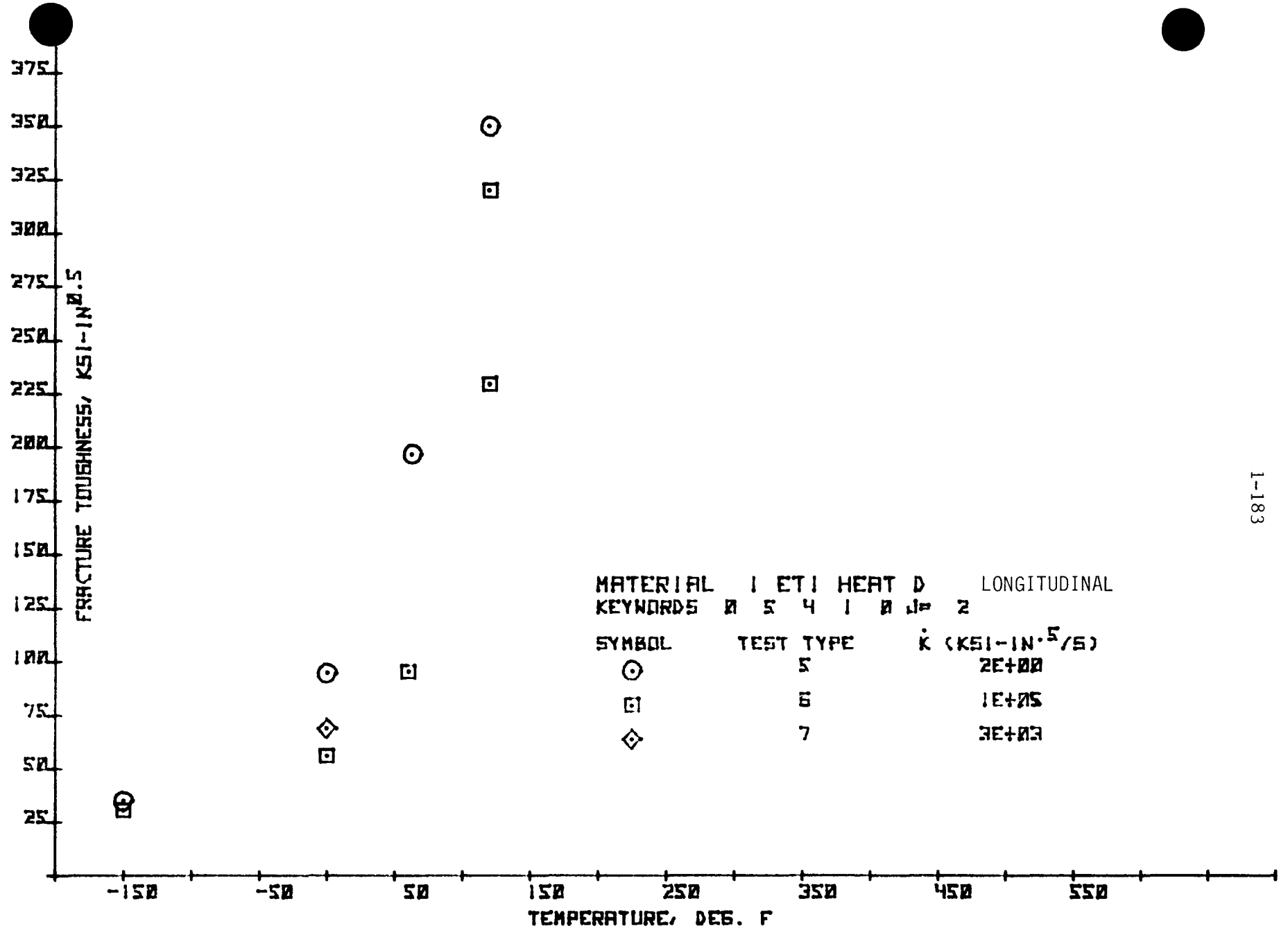


Figure 1.134. Static and Dynamic Fracture Toughness for ETI Heat D (L)

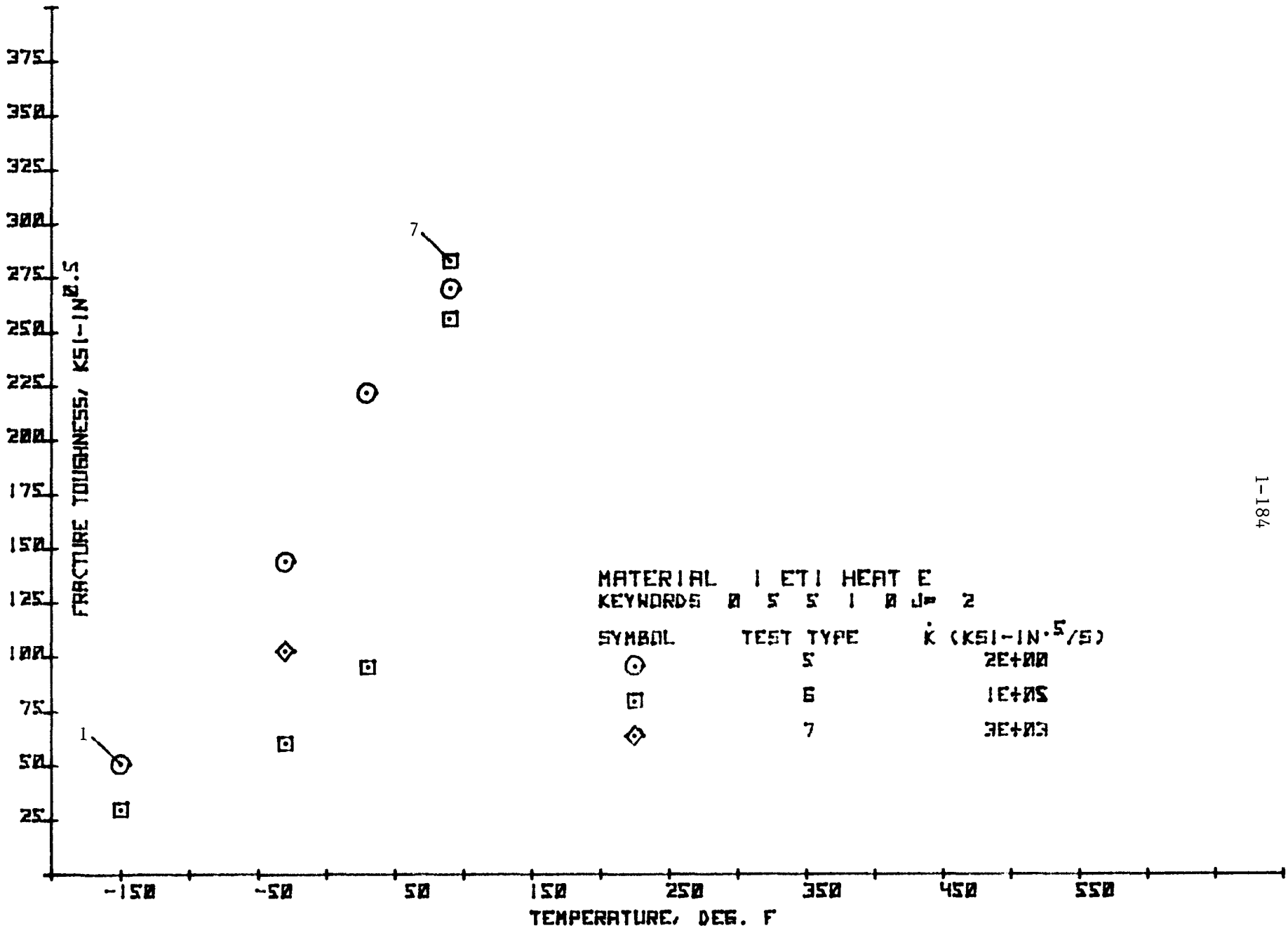


Figure 1.135. Static and Dynamic Fracture Toughness for ETI Heat E

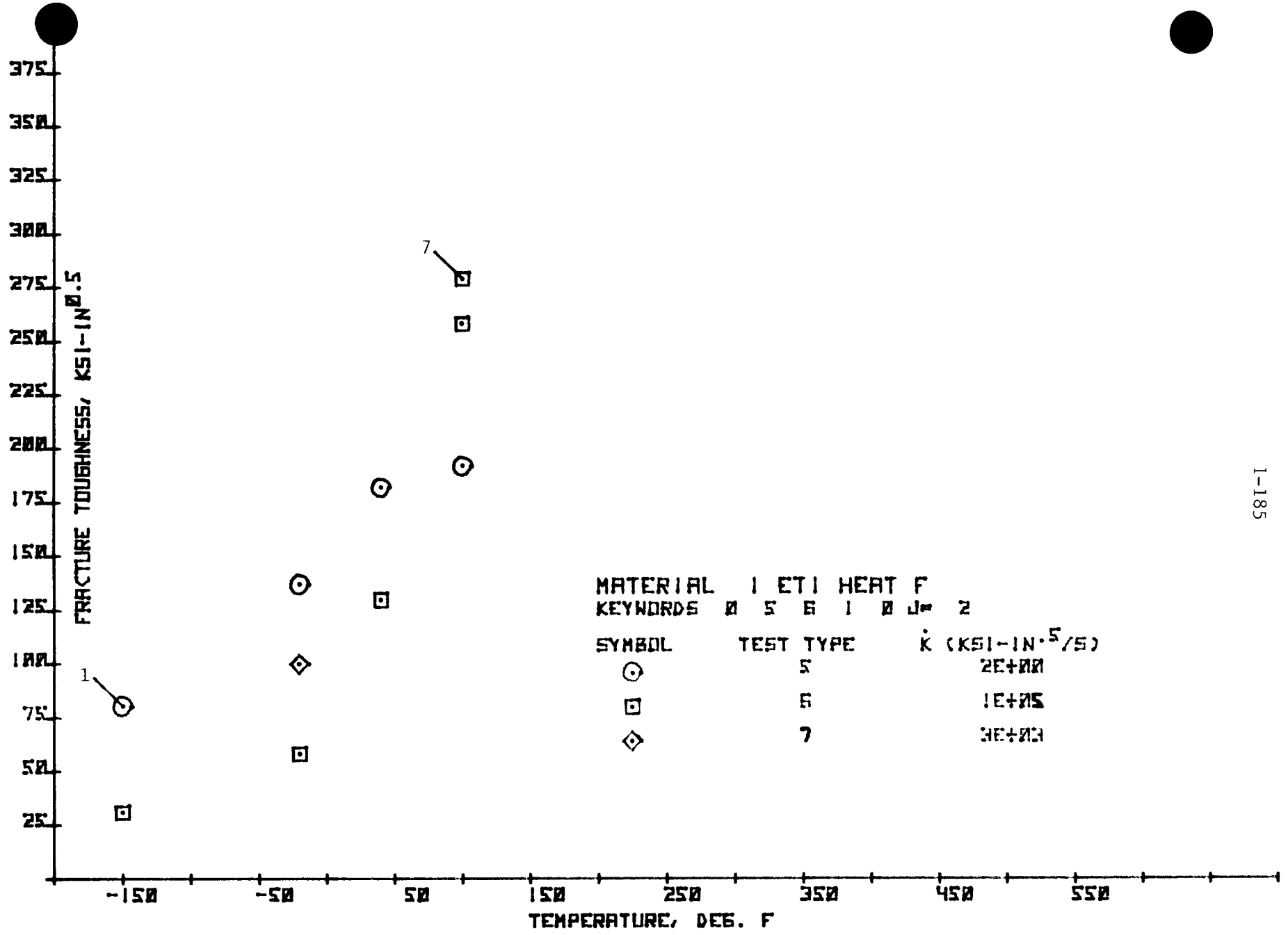
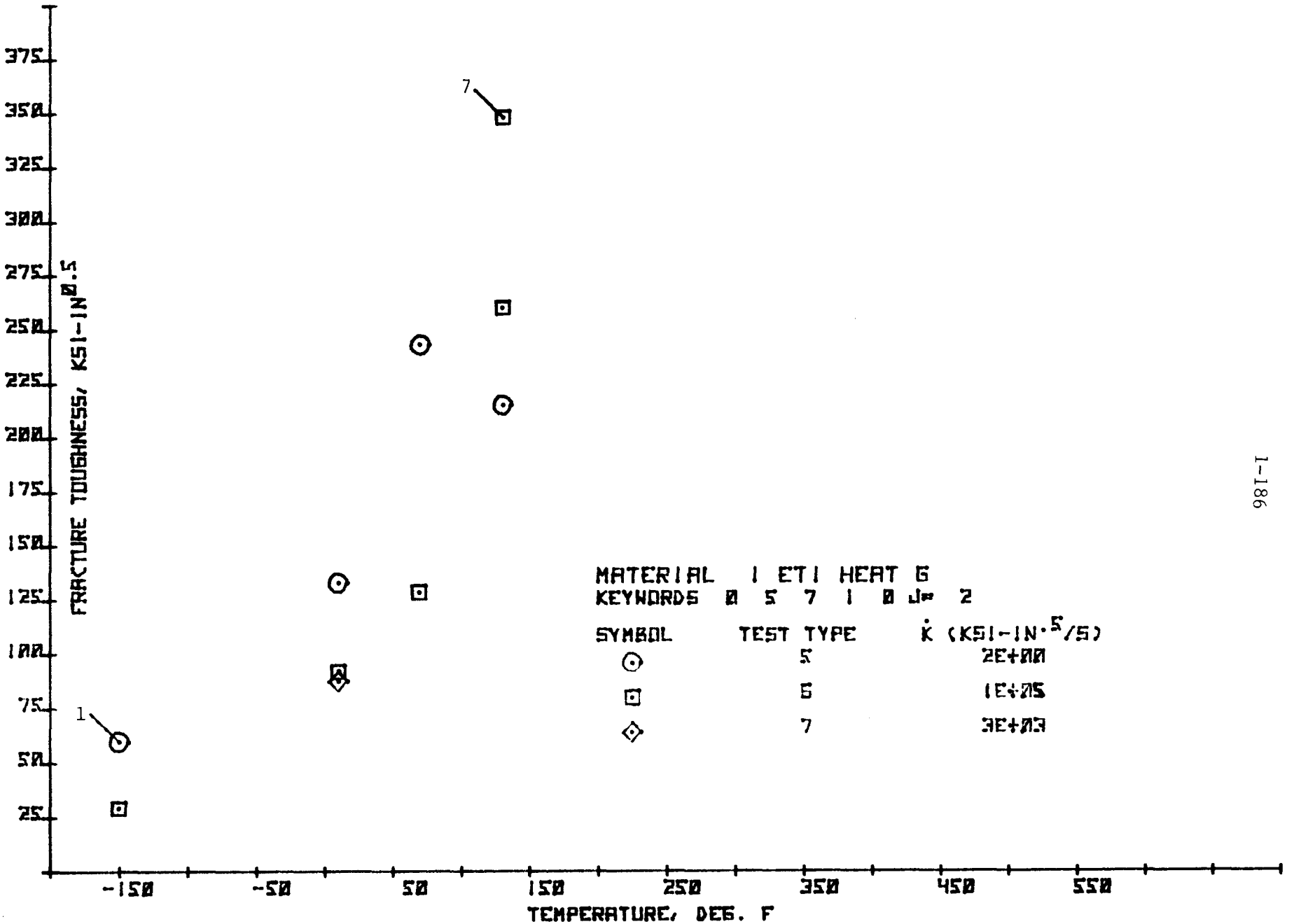


Figure 1.136. Static and Dynamic Fracture Toughness for ETI Heat F



gure 1.137. Static and Dynamic Fracture Toughness for ETI Heat G

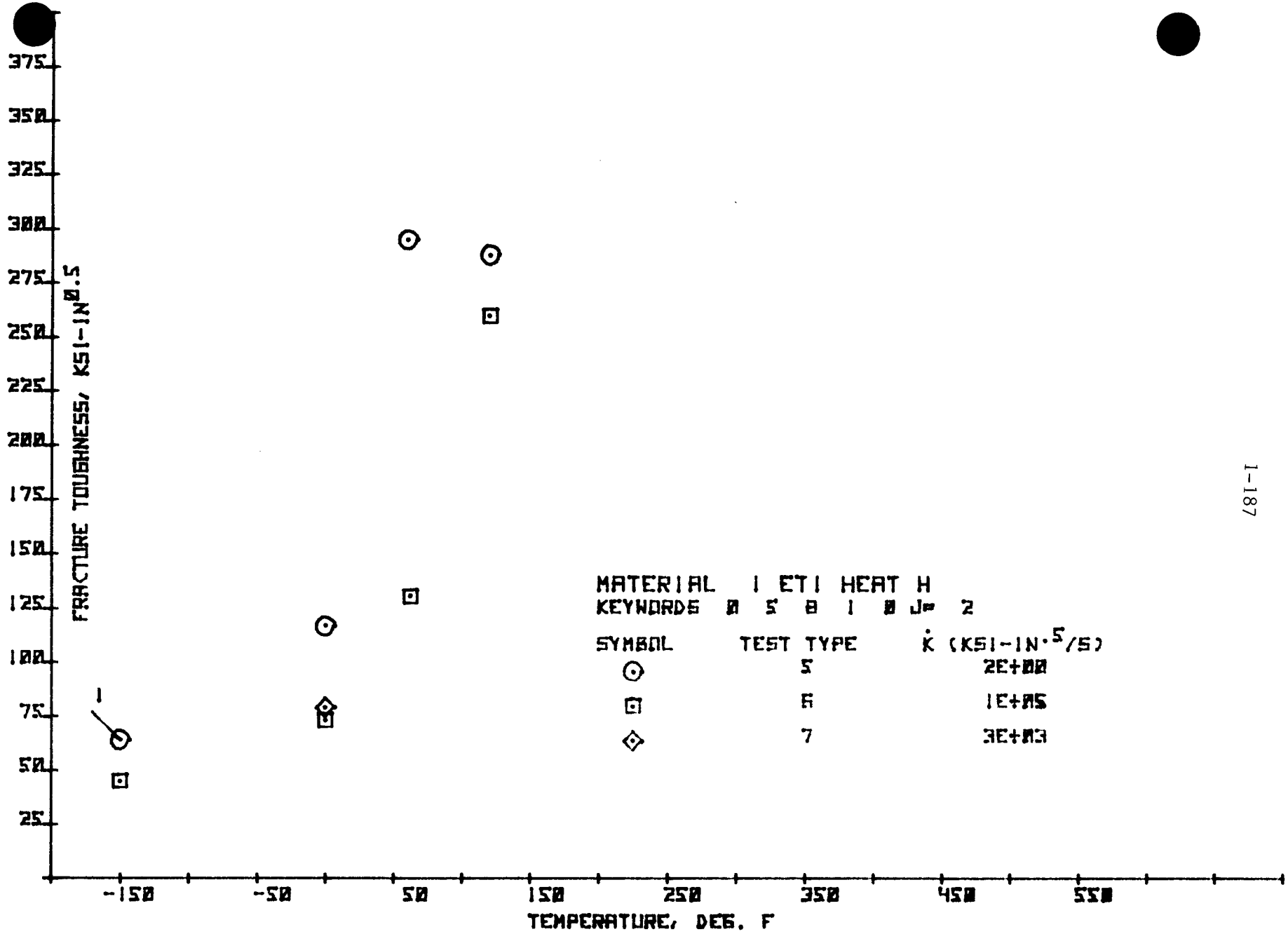
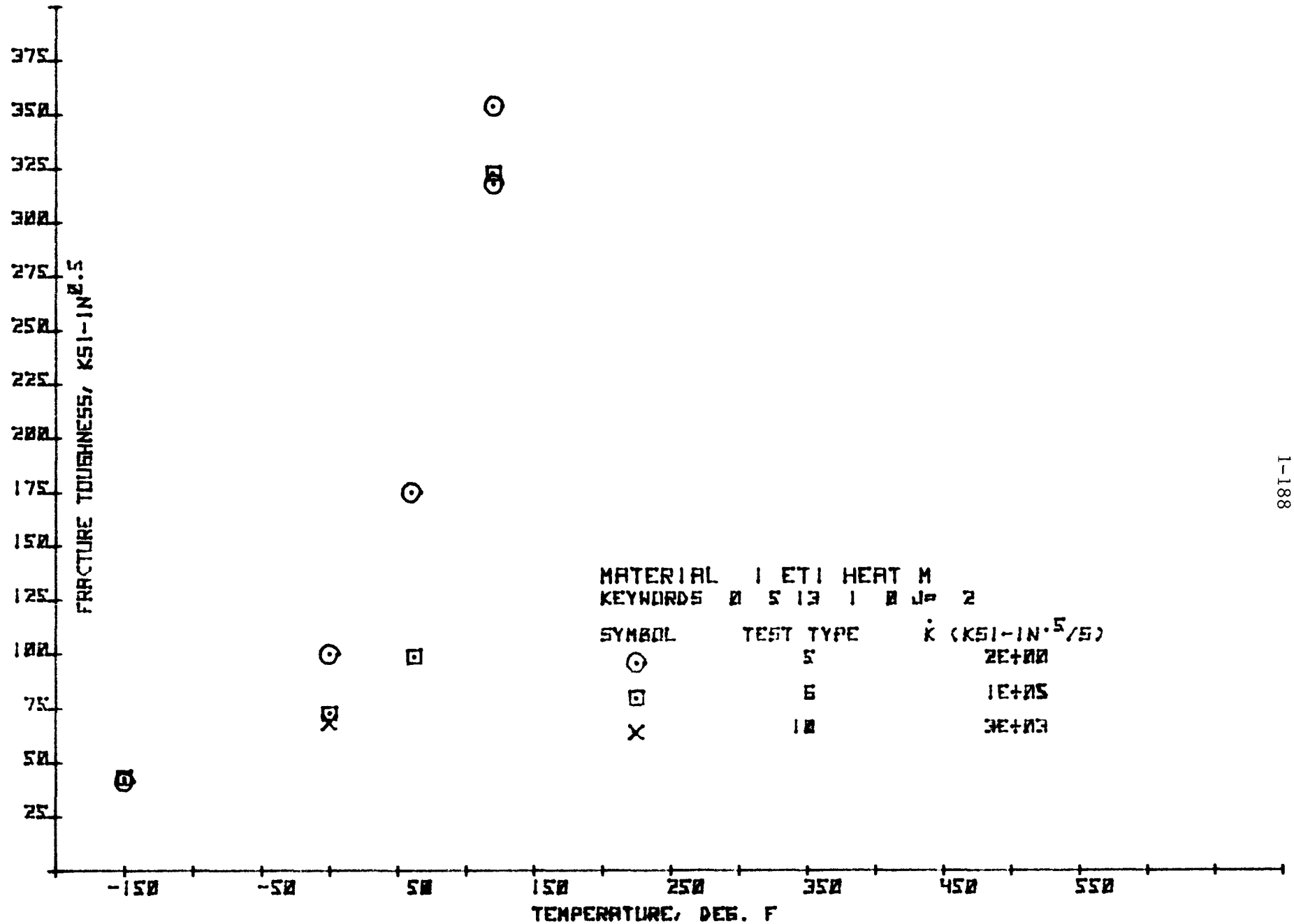


Figure 1.138. Static and Dynamic Fracture Toughness for ETI Heat H



re 1.139. Static and Dynamic Fracture Toughness for ETI Heat M

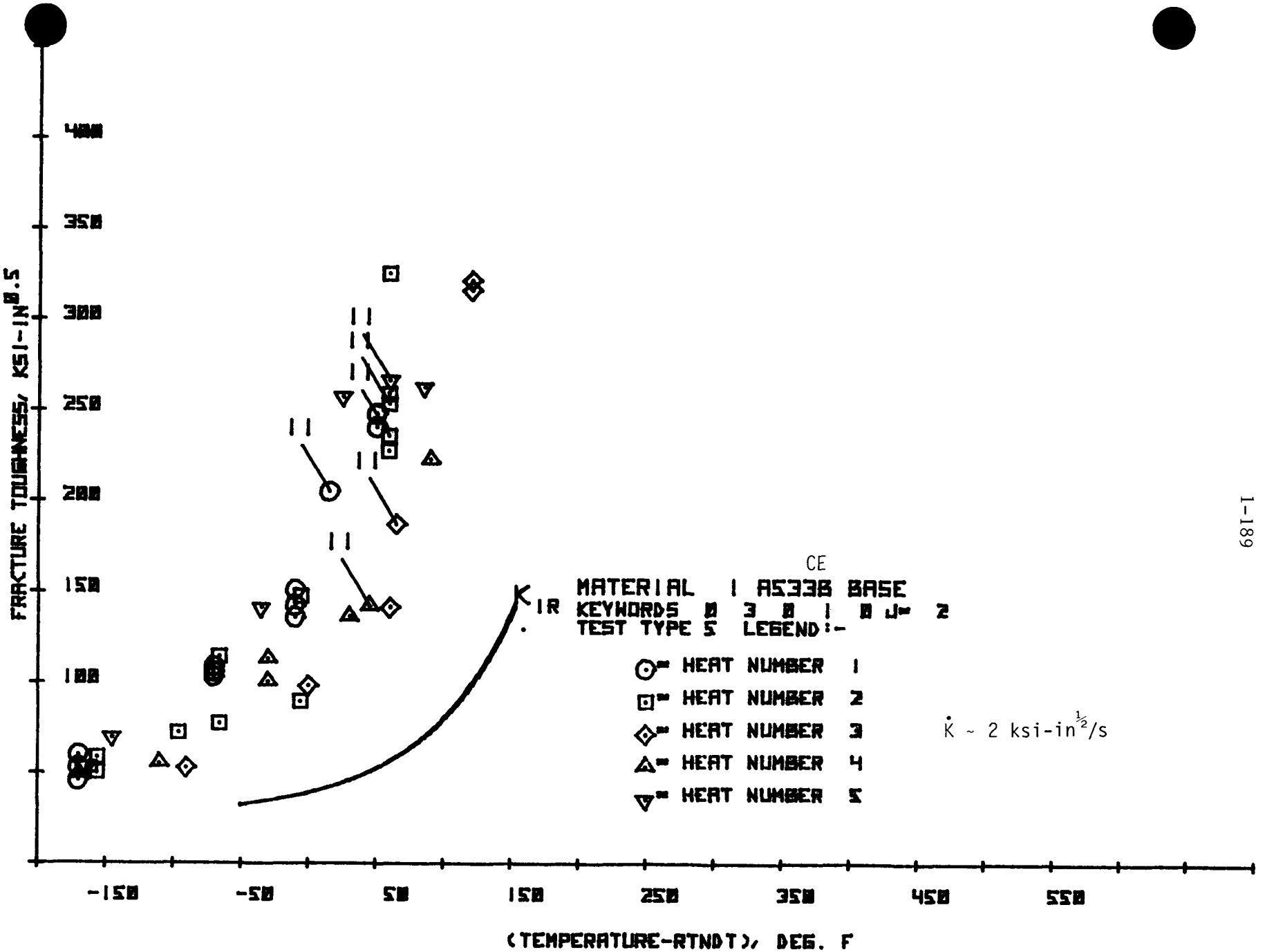


Figure 1.140. Static Fracture Toughness for All CE Heats

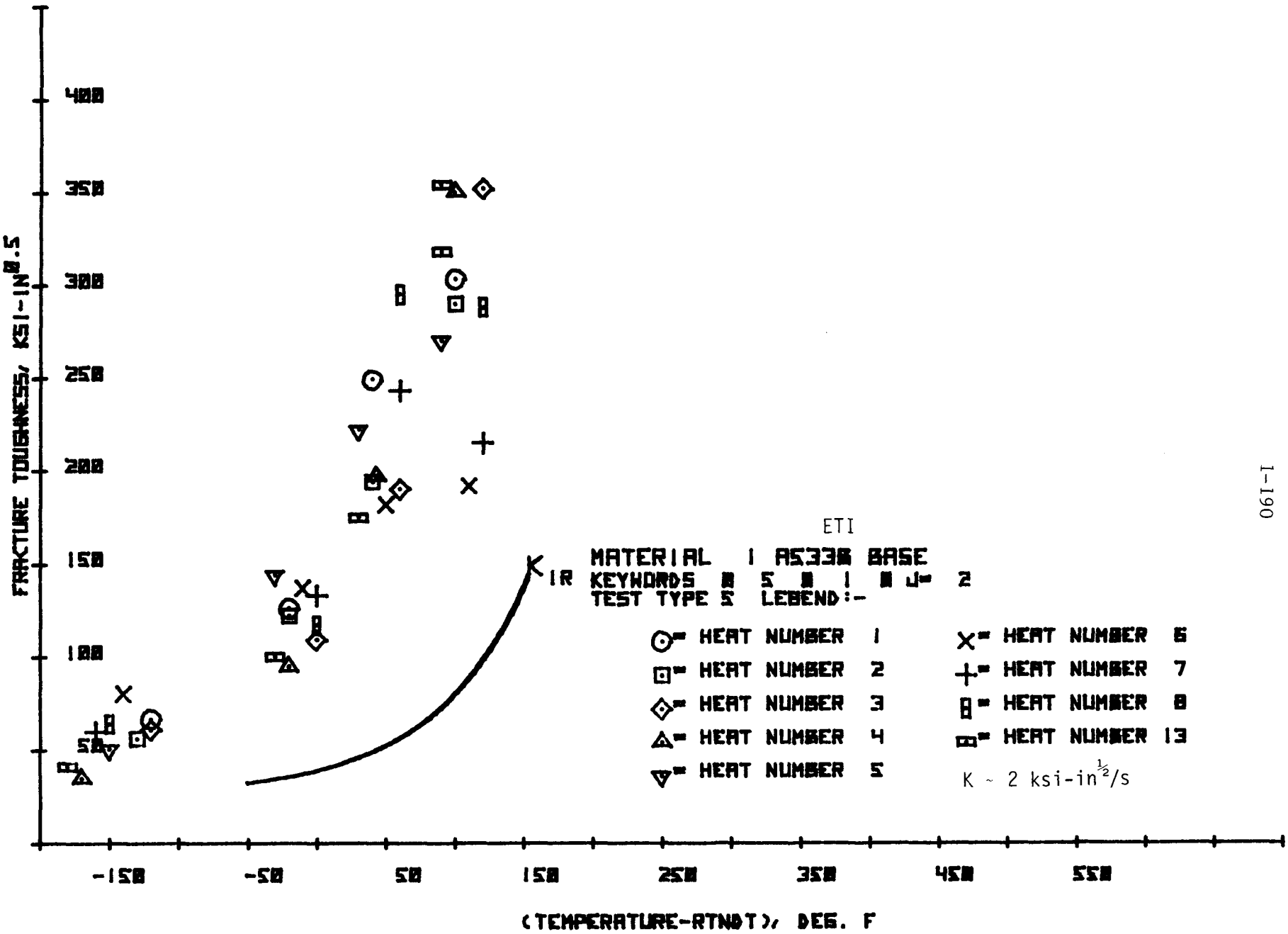


Figure 1.141. Static Fracture Toughness for All ETI Heats

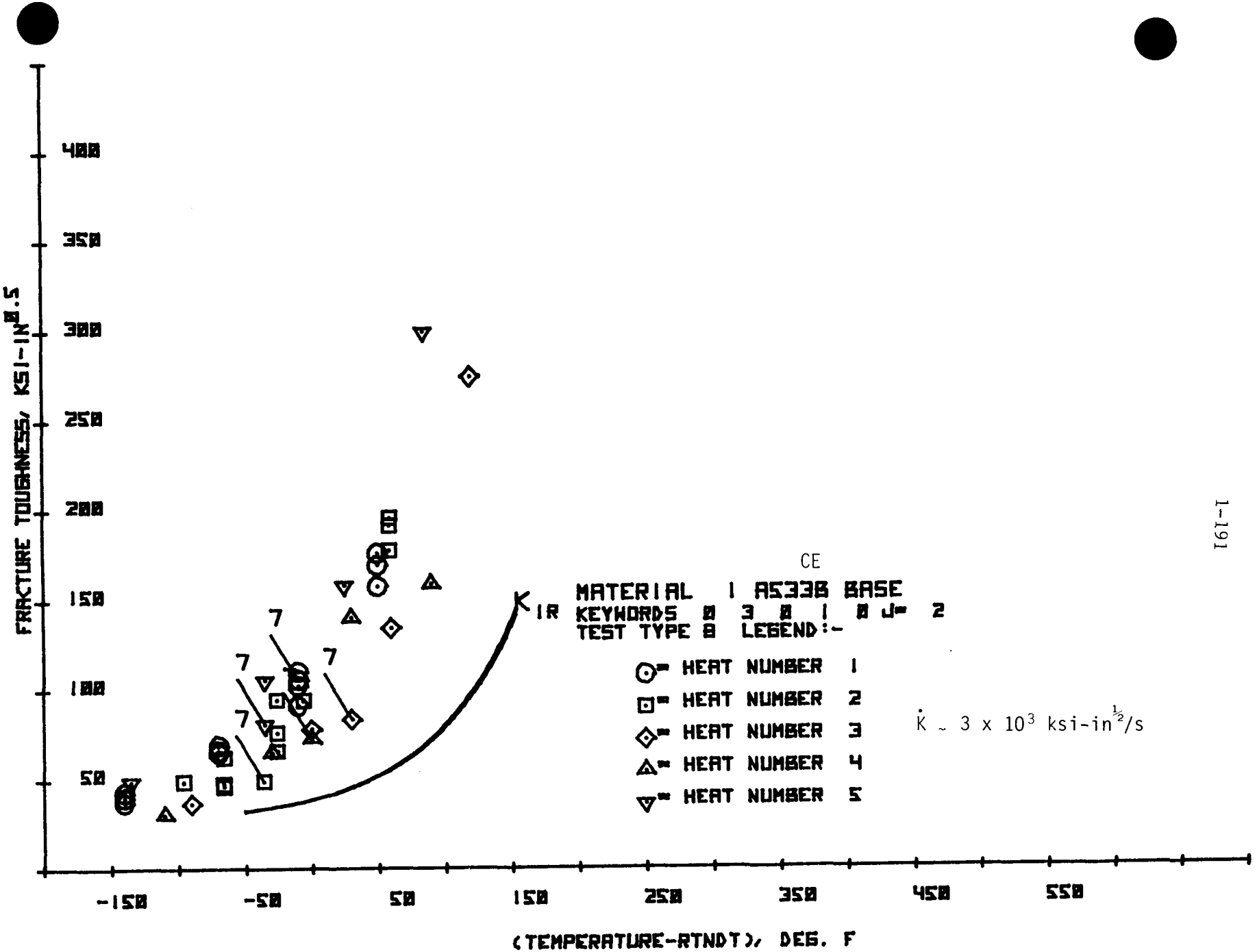


Figure 1.142. Dynamic Compact Specimen Fracture Toughness for All CE Heats

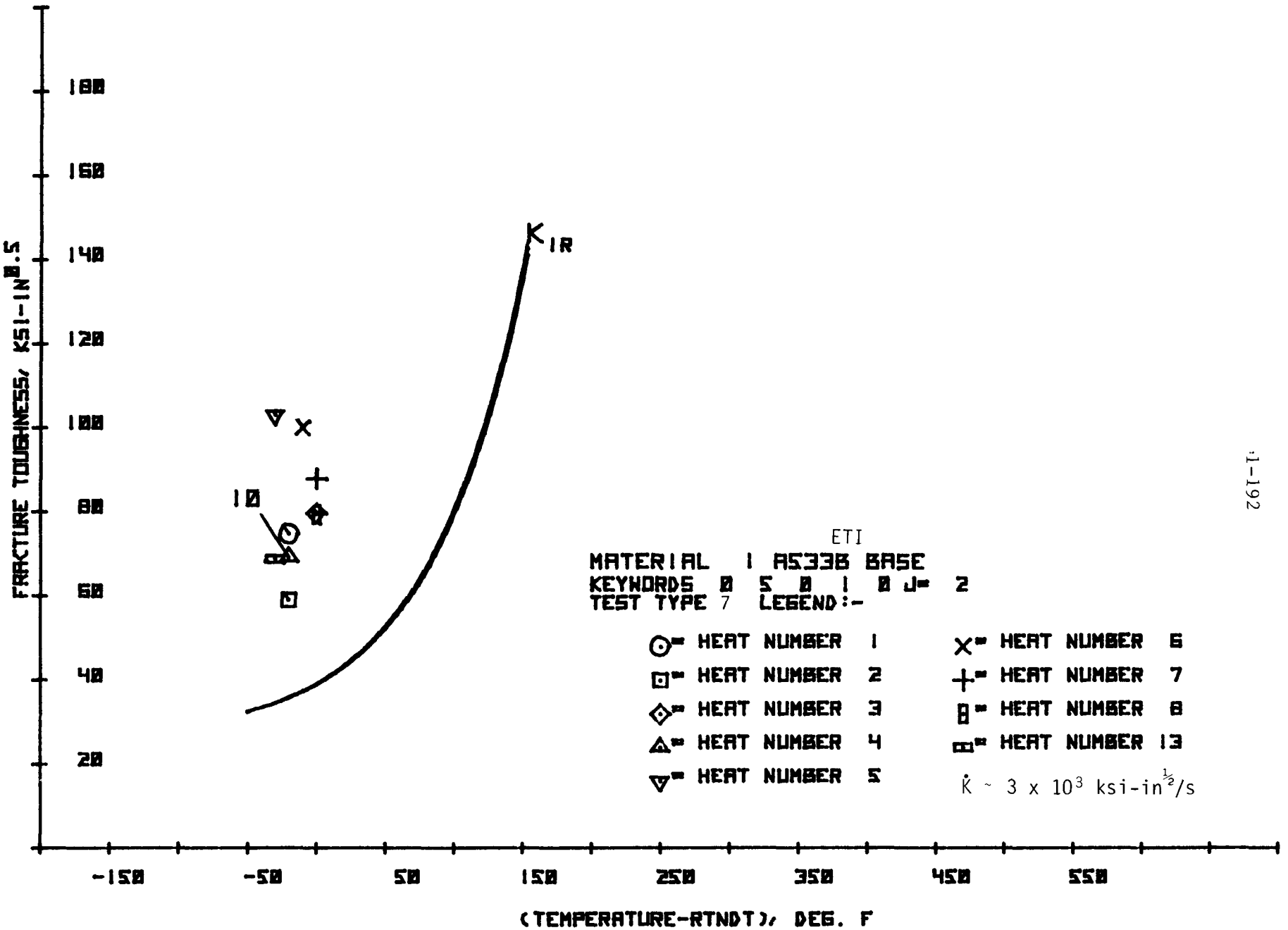


Figure 1.143. Dynamic Compact Specimen Fracture Toughness for All ETI Heats

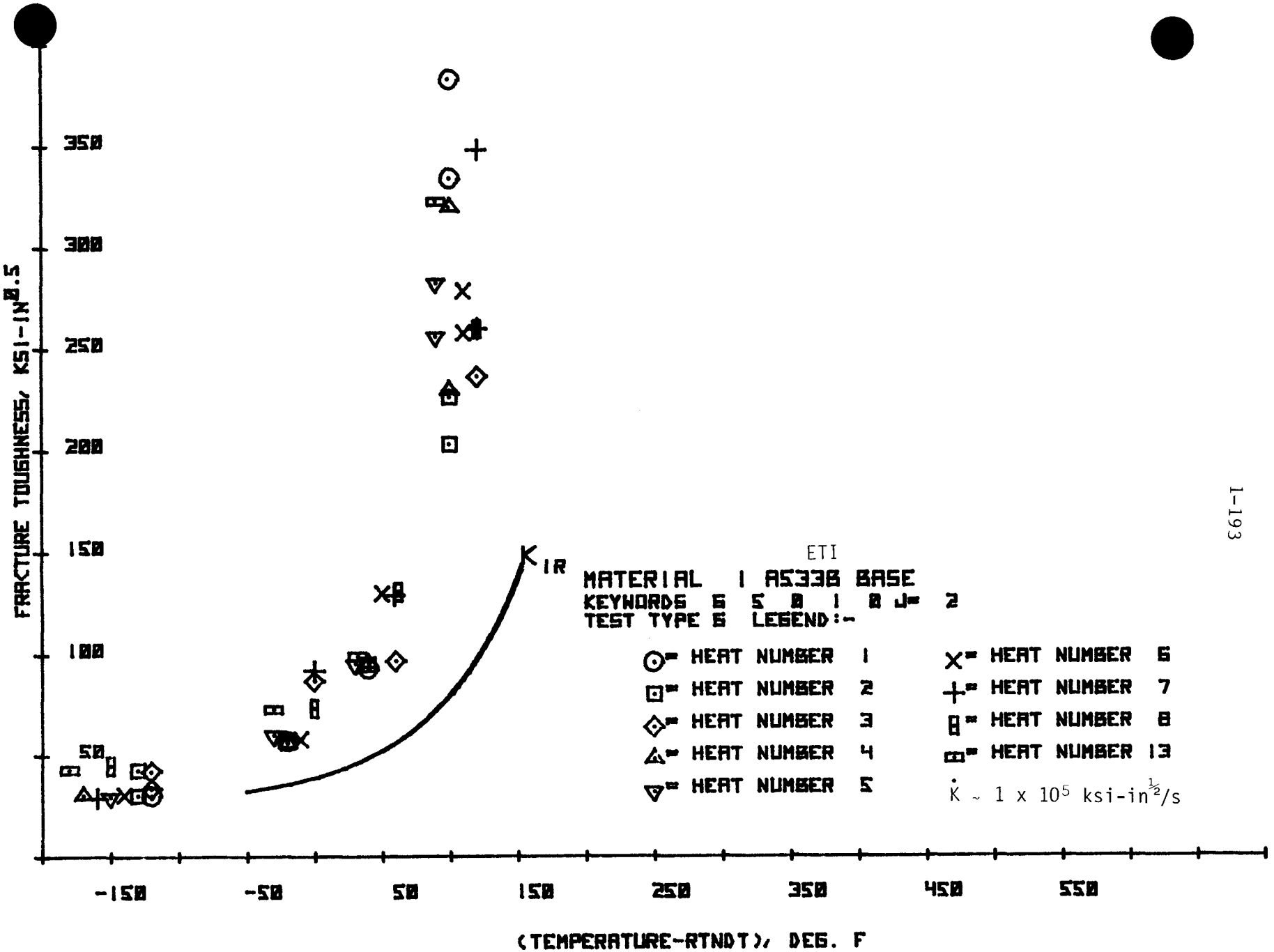


Figure 1.144. Dynamic 1T Bend Specimen Fracture Toughness for All ETI Heats

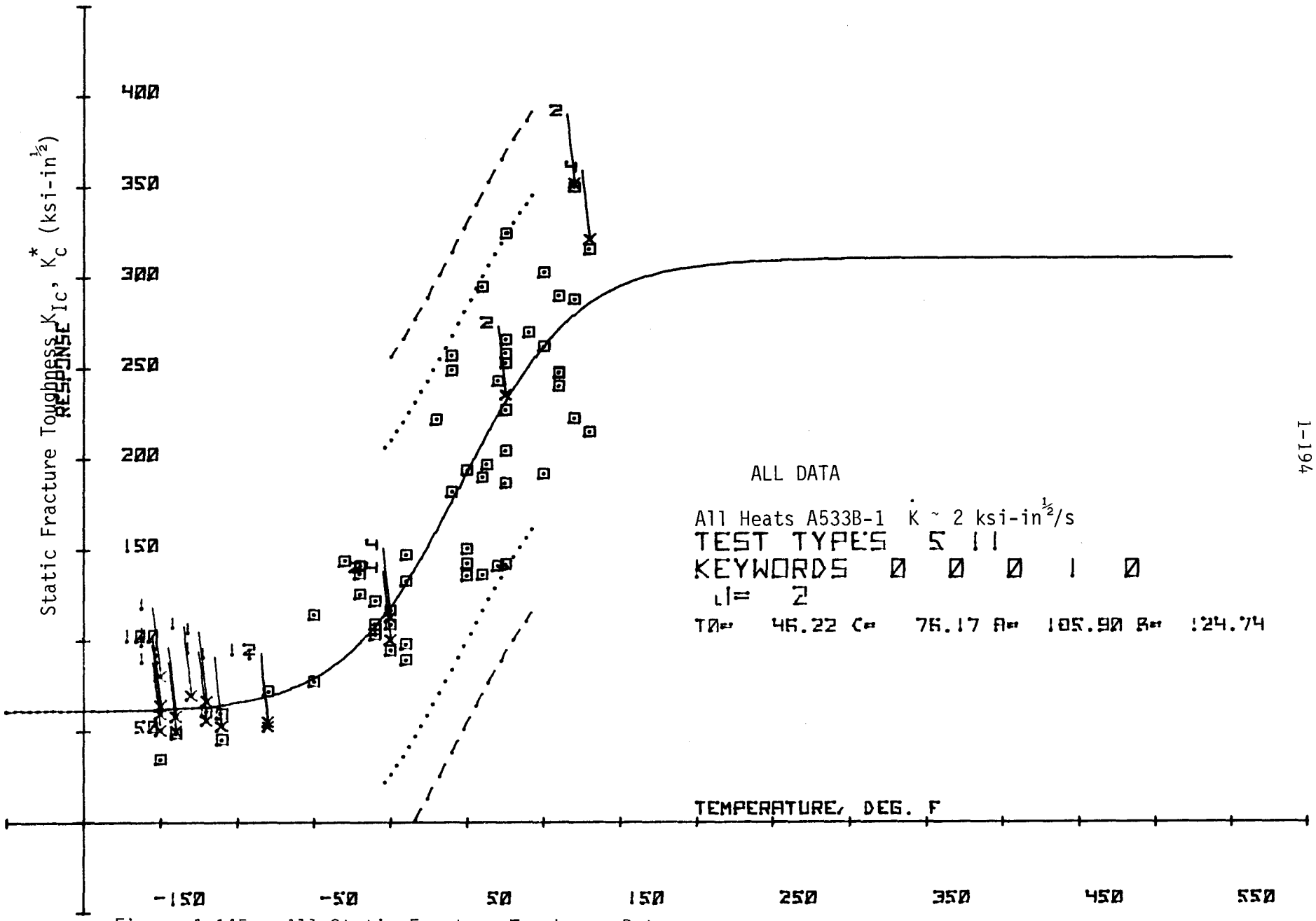


Figure 1.145. All Static Fracture Toughness Data

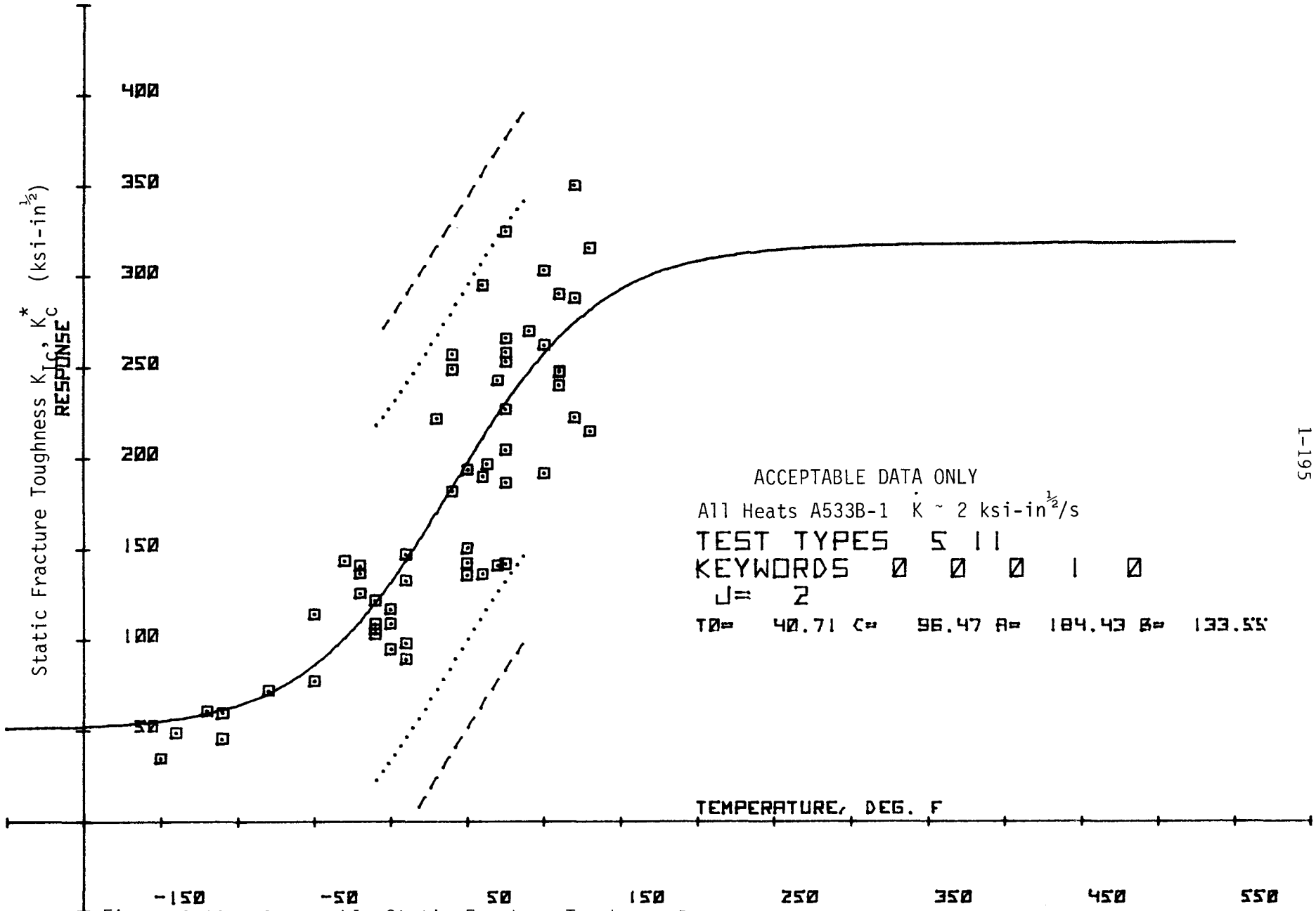


Figure 1.146. Acceptable Static Fracture Toughness Data

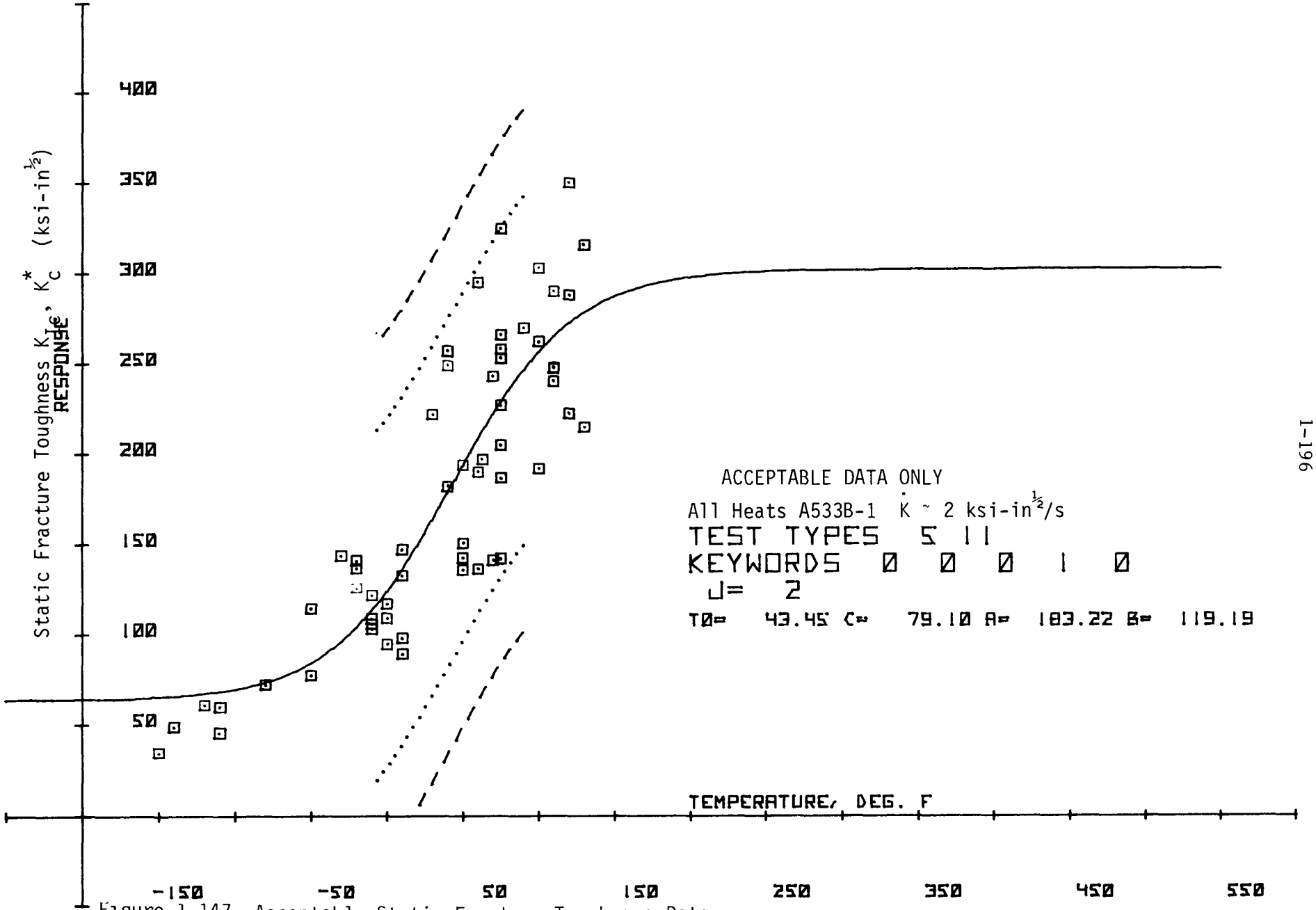


Figure 1.147 Acceptable Static Fracture Toughness Data

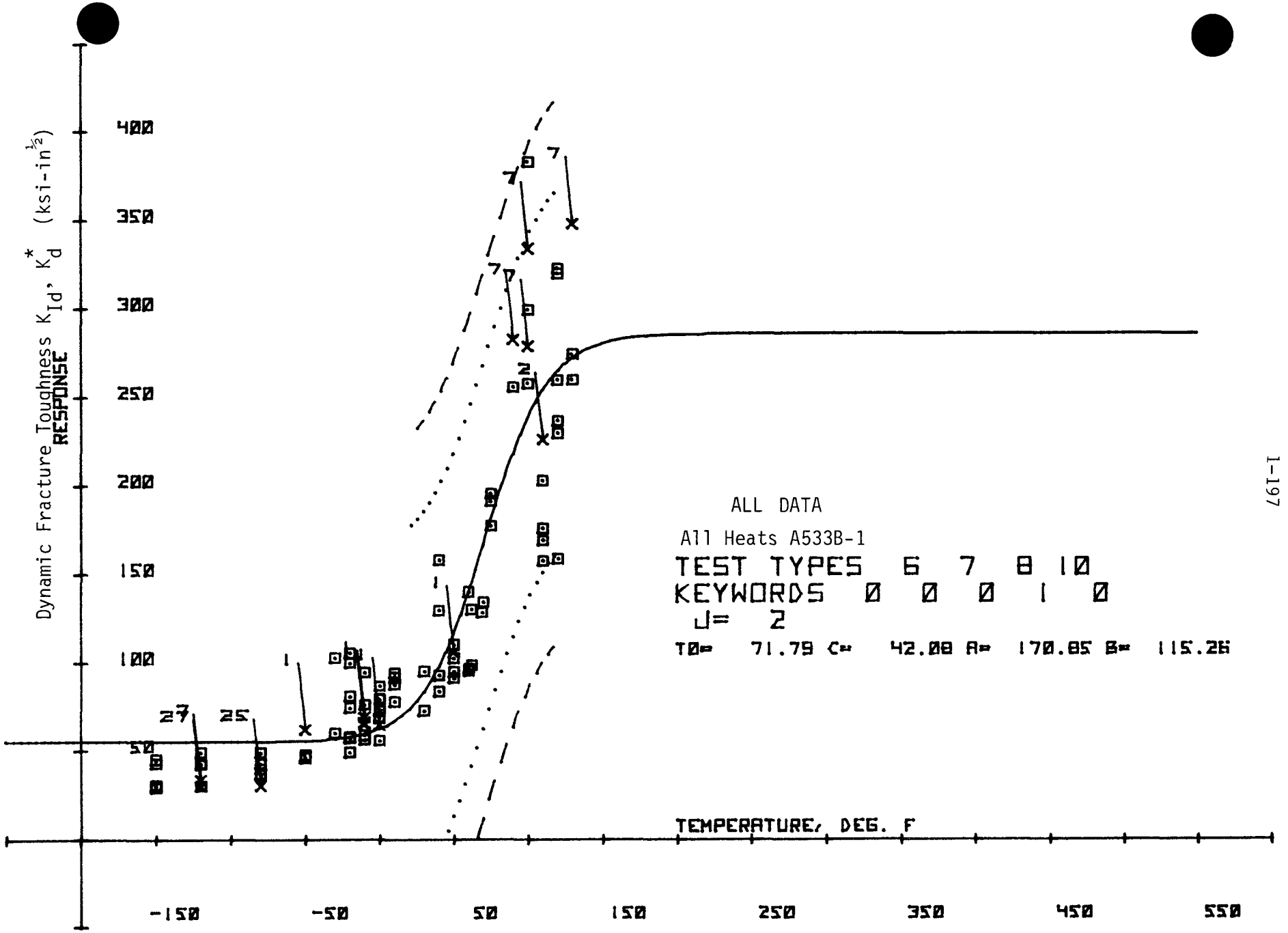


Figure 1.148. All Dynamic Fracture Toughness Data

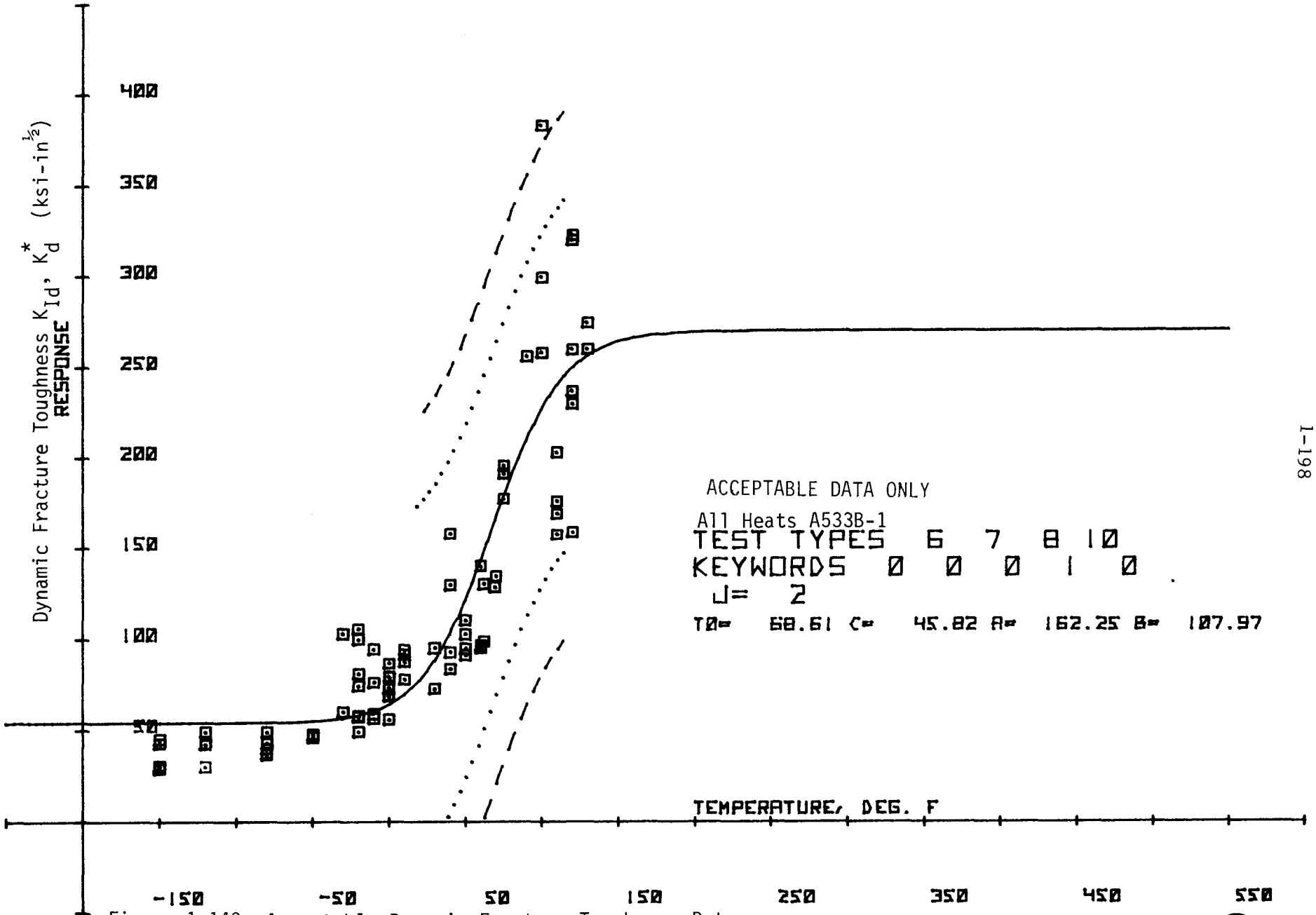


Figure 1.149. Acceptable Dynamic Fracture Toughness Data

KEYWORDS 0-0-0-1-0

MATERIAL 1 DATA BANK (A533B-1)

(0)	1-5-1-1-2-1-0	-150.00	72.10	97.50	15.20	32.60	59.70
(1)	1-5-1-1-2-6-0	-50.00	63.20	90.60	14.80	30.70	55.40
(2)	1-5-1-1-2-2-0	65.00	58.60	81.10	12.50	30.00	63.70
(3)	1-5-1-1-2-4-0	250.00	54.30	74.90	12.90	24.50	62.10
(4)	1-5-1-1-2-3-0	400.00	52.80	74.90	12.40	25.00	61.20
(5)	1-5-1-1-2-8-0	550.00	53.20	80.30	12.50	25.00	55.60
(6)	1-5-2-1-2-1-0	-150.00	76.90	102.20	14.40	32.10	57.50
(7)	1-5-2-1-2-6-0	-50.00	67.40	92.50	12.50	30.90	62.10
(8)	1-5-2-1-2-2-0	64.00	65.50	86.60	13.70	27.20	65.80
(9)	1-5-2-1-2-3-0	250.00	57.10	77.80	10.70	24.80	64.10
(10)	1-5-2-1-2-4-0	400.00	55.90	78.20	11.50	23.50	61.50
(11)	1-5-2-1-2-8-0	550.00	56.00	82.60	12.30	23.50	57.90
(12)	1-5-3-1-2-1-0	-150.00	71.90	101.00	15.10	34.20	62.80
(13)	1-5-3-1-2-8-0	-50.00	62.90	91.20	13.50	33.60	66.70
(14)	1-5-3-1-2-4-0	70.00	57.20	81.90	12.00	29.70	66.30
(15)	1-5-3-1-2-3-0	250.00	53.70	76.30	11.00	26.00	67.30
(16)	1-5-3-1-2-5-0	400.00	51.70	75.80	11.50	25.30	65.30
(17)	1-5-3-1-2-7-0	550.00	53.10	81.10	11.20	23.80	55.60
(18)	1-5-4-1-1-3-0	-150.00	68.00	96.90	17.20	35.30	63.30
(19)	1-5-4-1-1-7-0	-50.00	56.60	85.50	16.40	33.80	65.70
(20)	1-5-4-1-1-1-0	70.00	53.90	78.50	12.60	32.20	69.50
(21)	1-5-4-1-1-4-0	250.00	49.40	70.60	13.50	28.40	69.00
(22)	1-5-4-1-1-5-0	400.00	48.50	72.20	12.50	27.60	68.20
(23)	1-5-4-1-1-6-0	550.00	48.90	76.90	12.40	25.70	63.50
(24)	1-5-5-1-2-1-0	-150.00	77.40	104.20	14.80	32.10	58.20
(25)	1-5-5-1-2-6-0	-50.00	66.80	94.30	15.20	31.00	63.90
(26)	1-5-5-1-2-2-0	64.00	64.60	87.70	13.90	29.40	65.80
(27)	1-5-5-1-2-3-0	250.00	57.10	78.50	11.40	25.70	64.70
(28)	1-5-5-1-2-5-0	400.00	54.60	78.60	12.40	25.80	64.90
(29)	1-5-5-1-2-4-0	550.00	53.90	84.90	11.10	25.00	61.00
(30)	1-5-6-1-2-3-0	-150.00	80.50	107.20	12.40	31.20	55.00
(31)	1-5-6-1-2-6-0	-50.00	70.80	96.60	12.70	30.60	58.80
(32)	1-5-6-1-2-5-0	70.00	65.70	87.20	12.10	28.10	62.70
(33)	1-5-6-1-2-2-0	250.00	62.00	82.00	9.00	22.20	57.70
(34)	1-5-6-1-2-4-0	400.00	59.20	82.00	11.50	23.30	59.50
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(36)	1-5-7-1-2-3-0	-150.00	84.60	112.30	12.50	28.20	53.30
(37)	1-5-7-1-2-6-0	-50.00	75.40	102.00	12.80	27.60	56.40
(38)	1-5-7-1-2-1-0	70.00	70.50	93.50	10.70	24.80	56.90
(39)	1-5-7-1-2-4-0	250.00	65.70	87.10	8.80	18.20	58.50
(40)	1-5-7-1-2-3-0	400.00	63.10	87.40	10.80	22.50	59.00
(41)	1-5-7-1-2-5-0	550.00	63.50	91.90	12.00	23.50	56.70
(42)	2-5-1-1-1-13-0	-150.00	2.00	3.00	0.00	--	--
(43)	2-5-1-1-1-18-0	-110.00	4.30	1.00	1.00	--	--
(44)	2-5-1-1-1-3-0	-110.00	4.80	2.00	1.00	--	--
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(46)	2-5-1-1-1-8-0	-80.00	7.90	5.00	1.00	--	--
(47)	2-5-1-1-1-17-0	-50.00	32.50	27.00	20.00	--	--

(48)	2-5-1-1-1-8-0	-20.00	64.20	57.00	40.00	--	--
(49)	2-5-1-1-1-5-0	10.00	79.30	60.00	40.00	--	--
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(57)	2-5-1-1-1-14-0	425.00	152.50	79.00	100.00	--	--
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(59)	2-5-1-1-2-20-0	-110.00	5.30	4.00	1.00	--	--
(60)	2-5-1-1-2-44-0	-80.00	10.10	8.00	1.00	--	--
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(62)	2-5-1-1-2-40-0	-20.00	22.80	21.00	20.00	--	--
(63)	2-5-1-1-2-37-0	10.00	41.30	37.00	30.00	--	--
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(65)	2-5-1-1-2-43-0	40.00	60.00	52.00	40.00	--	--
(66)	2-5-1-1-2-36-0	50.00	49.70	40.00	30.00	--	--
(67)	2-5-1-1-2-26-0	60.00	65.30	53.00	60.00	--	--
(68)	2-5-1-1-2-38-0	60.00	67.30	59.00	60.00	--	--
(69)	2-5-1-1-2-39-0	60.00	61.30	52.00	50.00	--	--
(70)	2-5-1-1-2-34-0	100.00	83.10	71.00	70.00	--	--
(71)	2-5-1-1-2-45-0	130.00	89.30	73.00	99.00	--	--
(72)	2-5-1-1-2-24-0	160.00	89.50	73.00	99.00	--	--
(73)	2-5-1-1-2-25-0	300.00	93.90	88.00	99.00	--	--
(74)	2-5-1-1-2-31-0	425.00	89.50	65.00	100.00	--	--
(75)	2-5-1-1-2-33-0	550.00	83.90	63.00	100.00	--	--
(76)	2-5-2-1-1-19-0	-150.00	1.30	1.00	0.00	--	--
(77)	2-5-2-1-1-3-0	-100.00	2.30	1.00	1.00	--	--
(78)	2-5-2-1-1-18-0	-100.00	2.30	1.00	1.00	--	--
(79)	2-5-2-1-1-5-0	-70.00	3.00	2.00	1.00	--	--
(80)	2-5-2-1-1-7-0	-70.00	5.80	4.00	1.00	--	--
(81)	2-5-2-1-1-8-0	-40.00	10.30	7.00	10.00	--	--
(82)	2-5-2-1-1-15-0	-10.00	13.80	25.00	20.00	--	--
(83)	2-5-2-1-1-9-0	20.00	57.40	43.00	30.00	--	--
(84)	2-5-2-1-1-4-0	50.00	83.00	64.00	50.00	--	--
(85)	2-5-2-1-1-20-0	70.00	90.30	64.00	50.00	--	--
(86)	2-5-2-1-1-12-0	80.00	92.60	66.00	60.00	--	--
(87)	2-5-2-1-1-2-0	110.00	110.10	76.00	80.00	--	--
(88)	2-5-2-1-1-17-0	140.00	131.10	87.00	90.00	--	--
(89)	2-5-2-1-1-11-0	170.00	134.90	99.00	90.00	--	--
(90)	2-5-2-1-1-16-0	300.00	139.20	85.00	99.00	--	--
(91)	2-5-2-1-1-13-0	425.00	164.00	71.00	100.00	--	--
(92)	2-5-2-1-1-14-0	550.00	183.20	74.00	100.00	--	--
(93)	2-5-2-1-2-46-0	-100.00	4.80	4.00	1.00	--	--
(94)	2-5-2-1-2-34-0	-70.00	5.90	3.00	1.00	--	--
(95)	2-5-2-1-2-43-0	-40.00	12.40	10.00	10.00	--	--
(96)	2-5-2-1-2-21-0	-10.00	21.70	22.00	20.00	--	--
(97)	2-5-2-1-2-24-0	20.00	37.70	32.00	20.00	--	--
(98)	2-5-2-1-2-30-0	50.00	33.30	27.00	20.00	--	--

(99)	2-5-2-1-2-40-0	60.00	48.50	40.00	30.00	--	--
(100)	2-5-2-1-2-25-0	70.00	64.40	44.00	40.00	--	--
(101)	2-5-2-1-2-70-0	70.00	64.30	47.00	40.00	--	--
(102)	2-5-2-1-2-37-0	70.00	58.30	42.00	40.00	--	--
(103)	2-5-2-1-2-29-0	80.00	59.00	41.00	40.00	--	--
(104)	2-5-2-1-2-31-0	110.00	73.60	56.00	50.00	--	--
(105)	2-5-2-1-2-22-0	140.00	83.10	66.00	80.00	--	--
(106)	2-5-2-1-2-38-0	170.00	92.00	75.00	90.00	--	--
(107)	2-5-2-1-2-45-0	300.00	103.70	75.00	99.00	--	--
(108)	2-5-2-1-2-27-0	425.00	97.90	55.00	100.00	--	--
(109)	2-5-2-1-2-42-0	550.00	98.70	60.00	100.00	--	--
(110)	2-5-3-1-1-5-0	-150.00	2.00	2.00	0.00	--	--
(111)	2-5-3-1-1-20-0	-90.00	5.30	4.00	1.00	--	--
(112)	2-5-3-1-1-13-0	-90.00	5.00	5.00	1.00	--	--
(113)	2-5-3-1-1-17-0	-60.00	8.20	7.00	1.00	--	--
(114)	2-5-3-1-1-11-0	-60.00	6.30	6.00	1.00	--	--
(115)	2-5-3-1-1-10-0	-30.00	17.30	20.00	10.00	--	--
(116)	2-5-3-1-1-3-0	0.00	40.20	36.00	20.00	--	--
(117)	2-5-3-1-1-19-0	30.00	67.50	56.00	40.00	--	--
(118)	2-5-3-1-1-18-0	50.00	60.10	45.00	40.00	--	--
(119)	2-5-3-1-1-14-0	60.00	78.20	66.00	60.00	--	--
(120)	2-5-3-1-1-15-0	90.00	111.40	75.00	80.00	--	--
(121)	2-5-3-1-1-4-0	120.00	122.70	85.00	80.00	--	--
(122)	2-5-3-1-1-8-0	150.00	130.00	90.00	90.00	--	--
(123)	2-5-3-1-1-1-0	180.00	126.80	90.00	99.00	--	--
(124)	2-5-3-1-1-9-0	300.00	132.80	80.00	99.00	--	--
(125)	2-5-3-1-1-16-0	425.00	151.30	80.00	100.00	--	--
(126)	2-5-3-1-1-7-0	550.00	212.50	66.00	100.00	--	--
(127)	2-5-3-1-2-42-0	-90.00	5.20	4.00	1.00	--	--
(128)	2-5-3-1-2-28-0	-60.00	9.20	7.00	1.00	--	--
(129)	2-5-3-1-2-36-0	-30.00	45.00	43.00	40.00	--	--
(130)	2-5-3-1-2-43-0	0.00	32.90	32.00	20.00	--	--
(131)	2-5-3-1-2-25-0	30.00	46.00	40.00	30.00	--	--
(132)	2-5-3-1-2-46-0	40.00	43.70	45.00	30.00	--	--
(133)	2-5-3-1-2-26-0	40.00	58.00	45.00	30.00	--	--
(134)	2-5-3-1-2-35-0	50.00	69.50	54.00	40.00	--	--
(135)	2-5-3-1-2-29-0	50.00	63.90	51.00	40.00	--	--
(136)	2-5-3-1-2-27-0	50.00	58.10	42.00	30.00	--	--
(137)	2-5-3-1-2-37-0	60.00	67.00	57.00	50.00	--	--
(138)	2-5-3-1-2-22-0	90.00	78.40	62.00	70.00	--	--
(139)	2-5-3-1-2-39-0	120.00	90.80	75.00	80.00	--	--
(140)	2-5-3-1-2-30-0	150.00	114.30	83.00	99.00	--	--
(141)	2-5-3-1-2-38-0	180.00	112.50	79.00	99.00	--	--
(142)	2-5-3-1-2-41-0	300.00	102.20	79.00	99.00	--	--
(143)	2-5-3-1-2-33-0	425.00	119.20	66.00	100.00	--	--
(144)	2-5-3-1-2-21-0	550.00	128.00	67.00	100.00	--	--
(145)	2-5-4-1-1-35-0	-90.00	1.70	1.00	1.00	--	--
(146)	2-5-4-1-1-41-0	-60.00	3.40	3.00	1.00	--	--
(147)	2-5-4-1-1-25-0	-30.00	5.30	6.00	1.00	--	--
(148)	2-5-4-1-1-38-0	0.00	10.80	10.00	10.00	--	--
(149)	2-5-4-1-1-22-0	30.00	50.50	44.00	30.00	--	--

(150)	2-5-4-1-1-32-0	60.00	44.10	40.00	30.00	--	--
(151)	2-5-4-1-1-24-0	70.00	47.60	41.00	30.00	--	--
(152)	2-5-4-1-1-42-0	70.00	65.80	54.00	40.00	--	--
(153)	2-5-4-1-1-29-0	70.00	50.00	45.00	30.00	--	--
(154)	2-5-4-1-1-36-0	80.00	45.00	39.00	30.00	--	--
(155)	2-5-4-1-1-21-0	80.00	72.20	59.00	46.00	--	--
(156)	2-5-4-1-1-37-0	90.00	60.90	47.00	40.00	--	--
(157)	2-5-4-1-1-23-0	90.00	74.20	63.00	50.00	--	--
(158)	2-5-4-1-1-39-0	90.00	67.40	57.00	40.00	--	--
(159)	2-5-4-1-1-30-0	120.00	77.00	65.00	50.00	--	--
(160)	2-5-4-1-1-27-0	150.00	110.00	88.00	80.00	--	--
(161)	2-5-4-1-1-28-0	180.00	113.20	93.00	90.00	--	--
(162)	2-5-4-1-1-33-0	300.00	119.00	86.00	99.00	--	--
(163)	2-5-4-1-1-31-0	425.00	134.10	69.00	100.00	--	--
(164)	2-5-4-1-1-40-0	550.00	207.30	57.00	100.00	--	--
(165)	2-5-4-1-2-7-0	-150.00	1.30	1.00	0.00	--	--
(166)	2-5-4-1-2-16-0	-90.00	3.70	2.00	1.00	--	--
(167)	2-5-4-1-2-28-0	-90.00	2.50	1.00	1.00	--	--
(168)	2-5-4-1-2-22-0	-60.00	4.70	5.00	1.00	--	--
(169)	2-5-4-1-2-19-0	-60.00	4.30	2.00	1.00	--	--
(170)	2-5-4-1-2-13-0	-30.00	12.10	10.00	1.00	--	--
(171)	2-5-4-1-2-4-0	0.00	15.80	19.00	10.00	--	--
(172)	2-5-4-1-2-23-0	30.00	31.90	30.00	20.00	--	--
(173)	2-5-4-1-2-12-0	60.00	45.50	36.00	30.00	--	--
(174)	2-5-4-1-2-11-0	70.00	48.50	43.00	30.00	--	--
(175)	2-5-4-1-2-8-0	70.00	55.30	44.00	30.00	--	--
(176)	2-5-4-1-2-9-0	80.00	58.50	45.00	40.00	--	--
(177)	2-5-4-1-2-27-0	80.00	52.30	44.00	40.00	--	--
(178)	2-5-4-1-2-15-0	80.00	61.30	49.00	40.00	--	--
(179)	2-5-4-1-2-25-0	90.00	67.30	60.00	50.00	--	--
(180)	2-5-4-1-2-30-0	120.00	74.90	66.00	50.00	--	--
(181)	2-5-4-1-2-14-0	150.00	106.90	73.00	80.00	--	--
(182)	2-5-4-1-2-24-0	180.00	113.00	83.00	90.00	--	--
(183)	2-5-4-1-2-1-0	300.00	112.40	81.00	99.00	--	--
(184)	2-5-4-1-2-17-0	425.00	120.60	72.00	100.00	--	--
(185)	2-5-4-1-2-3-0	550.00	112.00	62.00	100.00	--	--
(186)	2-5-5-1-1-11-0	-150.00	0.90	3.00	0.00	--	--
(187)	2-5-5-1-1-12-0	-120.00	4.10	2.00	1.00	--	--
(188)	2-5-5-1-1-10-0	-90.00	6.90	4.00	1.00	--	--
(189)	2-5-5-1-1-2-0	-90.00	5.19	3.00	1.00	--	--
(190)	2-5-5-1-1-9-0	-60.00	12.40	14.00	10.00	--	--
(191)	2-5-5-1-1-13-0	-60.00	15.30	15.00	10.00	--	--
(192)	2-5-5-1-1-16-0	-30.00	31.30	27.00	20.00	--	--
(193)	2-5-5-1-1-3-0	-30.00	33.70	27.00	20.00	--	--
(194)	2-5-5-1-1-14-0	0.00	62.90	54.00	30.00	--	--
(195)	2-5-5-1-1-18-0	30.00	68.80	54.00	40.00	--	--
(196)	2-5-5-1-1-6-0	60.00	87.29	65.00	70.00	--	--
(197)	2-5-5-1-1-19-0	90.00	121.50	87.00	80.00	--	--
(198)	2-5-5-1-1-4-0	120.00	139.80	94.00	90.00	--	--
(199)	2-5-5-1-1-20-0	150.00	148.90	90.00	90.00	--	--
(200)	2-5-5-1-1-17-0	190.00	156.00	95.00	99.00	--	--

(201)	2-5-5-1-1-7-0	300.00	148.20	90.00	59.00	--	--
(202)	2-5-5-1-1-15-0	425.00	232.30	70.00	100.00	--	--
(203)	2-5-5-1-1-1-0	550.00	237.00	72.00	100.00	--	--
(204)	2-5-5-1-2-27-0	-150.00	2.60	2.00	0.00	--	--
(205)	2-5-5-1-2-25-0	-120.00	3.70	2.00	1.00	--	--
(206)	2-5-5-1-2-5-0	-90.00	5.00	3.00	1.00	--	--
(207)	2-5-5-1-2-36-0	-60.00	11.70	11.00	10.00	--	--
(208)	2-5-5-1-2-38-0	-30.00	24.80	26.00	20.00	--	--
(209)	2-5-5-1-2-30-0	0.00	40.40	34.00	30.00	--	--
(210)	2-5-5-1-2-28-0	30.00	43.50	35.00	30.00	--	--
(211)	2-5-5-1-2-45-0	60.00	56.10	50.00	40.00	--	--
(212)	2-5-5-1-2-41-0	60.00	53.00	48.00	40.00	--	--
(213)	2-5-5-1-2-39-0	60.00	50.00	46.00	40.00	--	--
(214)	2-5-5-1-2-42-0	90.00	70.00	63.00	60.00	--	--
(215)	2-5-5-1-2-29-0	120.00	98.60	81.00	80.00	--	--
(216)	2-5-5-1-2-21-0	150.00	99.40	82.00	90.00	--	--
(217)	2-5-5-1-2-37-0	190.00	90.20	73.00	99.00	--	--
(218)	2-5-5-1-2-46-0	300.00	93.40	74.00	99.00	--	--
(219)	2-5-5-1-2-31-0	425.00	103.00	62.00	100.00	--	--
(220)	2-5-5-1-2-34-0	550.00	102.20	59.00	100.00	--	--
(221)	2-5-6-1-1-3-0	-150.00	4.30	2.00	0.00	--	--
(222)	2-5-6-1-1-17-0	-110.00	4.10	1.00	1.00	--	--
(223)	2-5-6-1-1-11-0	-80.00	7.00	5.00	1.00	--	--
(224)	2-5-6-1-1-7-0	-80.00	7.20	7.00	1.00	--	--
(225)	2-5-6-1-1-13-0	-50.00	35.30	27.00	20.00	--	--
(226)	2-5-6-1-1-15-0	-50.00	20.10	16.00	20.00	--	--
(227)	2-5-6-1-1-18-0	-20.00	49.20	37.00	30.00	--	--
(228)	2-5-6-1-1-20-0	-20.00	21.80	22.00	20.00	--	--
(229)	2-5-6-1-1-6-0	10.00	64.40	49.00	40.00	--	--
(230)	2-5-6-1-1-19-0	40.00	86.70	68.00	50.00	--	--
(231)	2-5-6-1-1-1-0	50.00	95.10	91.00	70.00	--	--
(232)	2-5-6-1-1-2-0	73.00	108.80	78.00	80.00	--	--
(233)	2-5-6-1-1-10-0	100.00	128.80	81.00	90.00	--	--
(234)	2-5-6-1-1-8-0	130.00	131.50	88.00	90.00	--	--
(235)	2-5-6-1-1-5-0	160.00	126.00	84.00	99.00	--	--
(236)	2-5-6-1-1-16-0	300.00	135.00	87.00	99.00	--	--
(237)	2-5-6-1-1-14-0	425.00	144.90	86.00	100.00	--	--
(238)	2-5-6-1-1-4-0	550.00	201.10	68.00	100.00	--	--
(239)	2-5-6-1-2-26-0	-150.00	3.40	2.00	0.00	--	--
(240)	2-5-6-1-2-25-0	-110.00	5.80	2.00	1.00	--	--
(241)	2-5-6-1-2-24-0	-80.00	8.40	7.00	1.00	--	--
(242)	2-5-6-1-2-27-0	-50.00	20.40	17.00	10.00	--	--
(243)	2-5-6-1-2-29-0	-20.00	24.00	21.00	20.00	--	--
(244)	2-5-6-1-2-35-0	10.00	30.00	28.00	20.00	--	--
(245)	2-5-6-1-2-22-0	40.00	44.80	44.00	30.00	--	--
(246)	2-5-6-1-2-36-0	50.00	50.20	41.00	40.00	--	--
(247)	2-5-6-1-2-23-0	50.00	55.50	47.00	40.00	--	--
(248)	2-5-6-1-2-28-0	50.00	58.30	48.00	40.00	--	--
(249)	2-5-6-1-2-44-0	73.00	62.20	53.00	70.00	--	--
(250)	2-5-6-1-2-30-0	100.00	72.40	62.00	99.00	--	--
(251)	2-5-6-1-2-40-0	130.00	62.40	57.00	99.00	--	--

(252)	2-5-6-1-2-41-0	160.00	63.90	64.00	99.00	--	--	
(253)	2-5-6-1-2-34-0	300.00	70.00	67.00	99.00	--	--	
(254)	2-5-6-1-2-46-0	425.00	69.00	71.00	100.00	--	--	
(255)	2-5-6-1-2-39-0	550.00	62.80	50.00	100.00	--	--	
(256)	3-5-7-1-1-29-0	-150.00	2.00	0.00	0.00	--	--	
(257)	2-5-7-1-1-34-0	-110.00	3.60	2.00	1.00	--	--	
(258)	2-5-7-1-1-14-0	-80.00	6.20	5.00	1.00	--	--	
(259)	2-5-7-1-1-30-0	-80.00	7.90	6.00	1.00	--	--	
(260)	2-5-7-1-1-21-0	-50.00	16.20	11.00	10.00	--	--	
(261)	2-5-7-1-1-27-0	-50.00	16.30	13.00	10.00	--	--	
(262)	2-5-7-1-1-25-0	-20.00	35.40	31.00	30.00	--	--	
(263)	2-5-7-1-1-8-0	-20.00	34.50	31.00	30.00	--	--	
(264)	2-5-7-1-1-20-0	10.00	42.80	35.00	30.00	--	--	
(265)	2-5-7-1-1-6-0	40.00	74.90	57.00	50.00	--	--	
(266)	2-5-7-1-1-4-0	70.00	86.30	67.00	60.00	--	--	
(267)	2-5-7-1-1-1-0	100.00	109.90	78.00	90.00	--	--	
(268)	2-5-7-1-1-2-0	130.00	122.10	86.00	90.00	--	--	
(269)	2-5-7-1-1-10-0	160.00	126.60	86.00	99.00	--	--	
(270)	2-5-7-1-1-9-0	190.00	129.20	90.00	99.00	--	--	
(271)	2-5-7-1-1-16-0	300.00	128.30	94.00	99.00	--	--	
(272)	2-5-7-1-1-33-0	425.00	133.50	76.00	100.00	--	--	
(273)	2-5-7-1-1-7-0	550.00	143.20	76.00	100.00	--	--	
(274)	2-5-7-1-2-22-0	-150.00	3.90	2.00	0.00	--	--	
(275)	2-5-7-1-2-39-0	-110.00	5.10	4.00	1.00	--	--	
(276)	2-5-7-1-2-38-0	-80.00	11.50	9.00	1.00	--	--	
(277)	2-5-7-1-2-49-0	-50.00	10.00	10.00	1.00	--	--	
(278)	2-5-7-1-2-45-0	-20.00	19.00	15.00	10.00	--	--	
(279)	2-5-7-1-2-25-0	10.00	32.10	27.00	20.00	--	--	
(280)	2-5-7-1-2-41-0	40.00	35.00	32.00	20.00	--	--	
(281)	2-5-7-1-2-46-0	70.00	53.60	44.00	40.00	--	--	
(282)	2-5-7-1-2-26-0	70.00	54.30	45.00	40.00	--	--	
(283)	2-5-7-1-2-36-0	70.00	53.20	43.00	30.00	--	--	
(284)	2-5-7-1-2-29-0	100.00	64.80	55.00	50.00	--	--	
(285)	2-5-7-1-2-47-0	130.00	80.30	69.00	80.00	--	--	
(286)	2-5-7-1-2-37-0	160.00	83.30	72.00	99.00	--	--	
(287)	2-5-7-1-2-52-0	190.00	78.50	72.00	99.00	--	--	
(288)	2-5-7-1-2-23-0	300.00	79.00	68.00	99.00	--	--	
(289)	2-5-7-1-2-21-0	425.00	96.20	67.00	100.00	--	--	
(290)	2-5-7-1-2-32-0	550.00	99.30	64.00	100.00	--	--	
(291)	3-5-1-1-2-7-0	-110.00	35.90	--	--	234.00	2.21E+05	
(292)	3-5-1-1-2-8-0	-80.00	38.50	--	--	430.00	2.14E+05	
(293)	3-5-1-1-2-9-0	-50.00	48.40	--	--	890.00	2.44E+05	
(294)	3-5-1-1-2-14-0	-20.00	47.80	--	--	1275.00	2.66E+05	
(295)	3-5-1-1-2-3-0	-20.00	45.60	--	--	1523.00	2.00E+05	
(296)	3-5-1-1-2-18-2	10.00	50.10	--	--	2850.00	2.09E+05	
(297)	3-5-1-1-2-15-0	40.00	--	140.20	141.90	3833.00	3.89E+05	
(298)	3-5-1-1-2-13-0	40.00	--	204.40	205.30	3834.00	2.62E+05	
(299)	3-5-1-1-2-2-0	70.00	--	255.50	258.40	4393.00	2.24E+05	
(300)	3-5-1-1-2-19-2	100.00	--	226.90	225.30	5021.00	3.41E+05	
(301)	3-5-1-1-2-4-0	100.00	--	235.50	234.40	5128.00	2.79E+05	
(302)	3-5-1-1-2-16-0	130.00	--	315.00	313.60	5678.00	3.27E+05	

(303)	3-5-1-1-2-20-2	160.00	--	209.90	208.40	4824.00	3.4[illegible] 05
(304)	3-5-1-1-2-10-0	160.00	--	230.40	229.50	5544.00	3.06E+05
(305)	3-5-1-1-2-17-0	300.00	--	295.70	294.40	5489.00	2.97E+05
(306)	3-5-1-1-2-11-0	425.00	--	202.90	204.40	5820.00	3.38E+05
(307)	3-5-1-1-2-12-2	550.00	--	198.70	197.20	4588.00	3.29E+05
(308)	3-5-2-1-2-4-0	-100.00	35.30	--	--	223.00	2.10E+05
(309)	3-5-2-1-2-15-0	-70.00	37.40	--	--	300.00	2.40E+05
(310)	3-5-2-1-2-10-0	-40.00	35.40	--	--	659.00	2.27E+05
(311)	3-5-2-1-2-18-0	-10.00	44.30	--	--	1118.00	2.27E+05
(312)	3-5-2-1-2-17-0	-10.00	50.20	--	--	819.00	2.54E+05
(313)	3-5-2-1-2-1-0	20.00	55.60	--	--	1568.00	2.99E+05
(314)	3-5-2-1-2-16-0	50.00	--	79.00	80.10	2858.00	2.74E+05
(315)	3-5-2-1-2-6-2	50.00	--	139.90	138.90	2630.00	2.97E+05
(316)	3-5-2-1-2-19-0	90.00	--	147.30	146.70	3097.00	4.89E+05
(317)	3-5-2-1-2-12-0	110.00	--	227.00	229.40	5003.00	4.56E+05
(318)	3-5-2-1-2-9-0	110.00	--	200.90	200.80	4290.00	4.18E+05
(319)	3-5-2-1-2-20-2	140.00	--	227.90	226.50	4934.00	3.81E+05
(320)	3-5-2-1-2-14-0	170.00	--	259.70	259.90	5290.00	4.37E+05
(321)	3-5-2-1-2-11-2	170.00	--	249.40	247.70	5617.00	4.13E+05
(322)	3-5-2-1-2-13-0	300.00	--	259.40	262.40	5945.00	3.83E+05
(323)	3-5-2-1-2-2-0	425.00	--	272.10	275.40	6383.00	3.02E+05
(324)	3-5-2-1-2-7-0	550.00	--	244.90	245.30	5932.00	3.40E+05
(325)	3-5-3-1-2-14-0	-90.00	37.40	--	--	349.00	2.08E+05
(326)	3-5-3-1-2-5-0	-60.00	37.70	--	--	494.00	2.03E+05
(327)	3-5-3-1-2-12-0	-30.00	53.60	--	--	892.00	2.13E+05
(328)	3-5-3-1-2-11-2	0.00	--	82.70	82.20	1567.00	3.45E+05
(329)	3-5-3-1-2-2-0	0.00	32.50	--	--	1613.00	2.25E+05
(330)	3-5-3-1-2-8-0	30.00	53.80	--	--	2488.00	2.99E+05
(331)	3-5-3-1-2-19-0	60.00	--	178.10	178.70	3579.00	2.80E+05
(332)	3-5-3-1-2-13-0	60.00	--	187.20	189.10	4110.00	2.76E+05
(333)	3-5-3-1-2-16-0	90.00	--	249.50	249.60	3884.00	4.16E+05
(334)	3-5-3-1-2-17-0	120.00	--	292.00	290.90	7101.00	3.51E+05
(335)	3-5-3-1-2-6-0	120.00	--	264.70	269.50	6287.00	4.01E+05
(336)	3-5-3-1-2-3-2	150.00	--	303.00	301.10	6790.00	3.8[illegible]E+05
(337)	3-5-3-1-2-10-2	180.00	--	309.80	307.80	6506.00	4.10E+05
(338)	3-5-3-1-2-1-2	180.00	--	315.50	313.10	6791.00	3.48E+05
(339)	3-5-3-1-2-15-2	300.00	--	290.10	288.10	6871.00	3.69E+05
(340)	3-5-3-1-2-18-2	425.00	--	264.80	266.80	6847.00	2.85E+05
(341)	3-5-3-1-2-4-0	550.00	--	299.90	299.00	6411.00	2.02E+05
(342)	3-5-4-1-1-16-0	-90.00	25.50	--	--	196.00	1.70E+05
(343)	3-5-4-1-1-19-0	-60.00	30.20	--	--	305.00	1.93E+05
(344)	3-5-4-1-1-14-0	-30.00	31.80	--	--	600.00	2.21E+05
(345)	3-5-4-1-1-13-2	0.00	42.70	--	--	1153.00	2.73E+05
(346)	3-5-4-1-1-12-0	0.00	33.90	--	--	990.00	2.36E+05
(347)	3-5-4-1-1-7-0	30.00	45.40	--	--	1797.00	2.91E+05
(348)	3-5-4-1-1-4-2	60.00	--	110.00	109.20	2343.00	6.07E+05
(349)	3-5-4-1-1-3-0	60.00	--	91.30	91.90	2756.00	4.76E+05
(350)	3-5-4-1-1-8-0	90.00	--	130.00	130.80	3838.00	2.55E+05
(351)	3-5-4-1-1-6-0	120.00	--	167.40	168.10	4280.00	4.29E+05
(352)	3-5-4-1-1-5-0	120.00	--	222.80	226.00	4425.00	4.64E+05
(353)	3-5-4-1-1-10-0	150.00	--	293.40	292.30	5904.00	3.43E+05

(354)	3-5-4-1-1-18-4	180.00	--	317.10	319.80	8102.00	3.30E+05
(355)	3-5-4-1-1-15-0	180.00	--	305.30	305.90	7297.00	3.10E+05
(356)	3-5-4-1-1-17-9	300.00	--	335.30	335.40	7332.00	2.94E+05
(357)	3-5-4-1-1-34-0	425.00	--	343.40	344.10	6885.00	3.01E+05
(358)	3-5-4-1-1-20-2	550.00	--	286.10	284.00	6458.00	2.63E+05
(359)	3-5-5-1-2-15-0	-120.00	33.90	--	--	208.00	2.09E+05
(360)	3-5-5-1-2-13-6	-90.00	43.60	--	--	401.00	2.24E+05
(361)	3-5-5-1-2-12-2	-60.00	40.10	--	--	638.00	2.16E+05
(362)	3-5-5-1-2-11-0	-30.00	48.80	--	--	843.00	2.50E+05
(363)	3-5-5-1-2-10-0	-30.00	51.50	--	--	961.00	2.86E+05
(364)	3-5-5-1-2-9-2	0.00	--	61.60	61.10	1746.00	2.43E+05
(365)	3-5-5-1-2-4-0	30.00	--	152.50	152.20	2813.00	3.29E+05
(366)	3-5-5-1-2-3-0	30.00	--	133.20	133.90	2766.00	3.36E+05
(367)	3-5-5-1-2-1-0	60.00	--	185.80	186.40	3548.00	2.95E+05
(368)	3-5-5-1-2-6-2	90.00	--	232.30	230.80	4328.00	2.02E+05
(369)	3-5-5-1-2-5-2	90.00	--	204.40	202.90	4540.00	3.49E+05
(370)	3-5-5-1-2-2-0	120.00	--	242.70	244.00	5276.00	3.97E+05
(371)	3-5-5-1-2-8-0	150.00	--	258.20	257.90	5729.00	3.91E+05
(372)	3-5-5-1-2-7-0	150.00	--	256.10	258.80	5591.00	4.27E+05
(373)	3-5-5-1-2-14-2	300.00	--	241.00	239.20	5675.00	4.07E+05
(374)	3-5-5-1-2-20-0	425.00	--	234.40	235.90	5848.00	3.40E+05
(375)	3-5-5-1-2-17-0	550.00	--	248.90	250.20	5645.00	3.67E+05
(376)	3-5-6-1-2-15-0	-110.00	37.30	--	--	247.00	2.49E+05
(377)	3-5-6-1-2-13-0	-80.00	51.30	--	--	499.00	2.40E+05
(378)	3-5-6-1-2-12-0	-50.00	42.00	--	--	774.00	2.06E+05
(379)	3-5-6-1-2-9-0	-20.00	59.10	--	--	1371.00	2.43E+05
(380)	3-5-6-1-2-5-0	-20.00	56.00	--	--	1482.00	2.66E+05
(381)	3-5-6-1-2-7-0	10.00	61.10	--	--	2134.00	2.49E+05
(382)	3-5-6-1-2-4-0	40.00	--	170.00	170.50	2967.00	3.18E+05
(383)	3-5-6-1-2-3-0	40.00	--	196.10	195.60	2946.00	2.72E+05
(384)	3-5-6-1-2-1-0	70.00	--	218.50	219.10	3724.00	2.60E+05
(385)	3-5-6-1-2-6-0	100.00	--	227.70	227.30	4055.00	3.87E+05
(386)	3-5-6-1-2-5-0	100.00	--	243.80	243.70	4235.00	4.15E+05
(387)	3-5-6-1-2-2-0	130.00	--	237.70	237.40	4478.00	3.96E+05
(388)	3-5-6-1-2-11-0	160.00	--	233.50	234.50	4475.00	3.89E+05
(389)	3-5-6-1-2-10-0	160.00	--	232.80	233.80	4506.00	3.88E+05
(390)	3-5-6-1-2-14-0	300.00	--	250.40	249.80	4368.00	5.02E+05
(391)	3-5-6-1-2-16-0	425.00	--	222.90	222.70	4585.00	3.75E+05
(392)	3-5-6-1-2-19-0	550.00	--	187.30	189.50	4430.00	3.57E+05
(393)	3-5-7-1-2-12-2	-80.00	42.90	--	--	322.00	3.58E+05
(394)	3-5-7-1-2-11-2	-50.00	50.50	--	--	688.00	2.81E+05
(395)	3-5-7-1-2-9-0	-20.00	56.90	--	--	920.00	2.49E+05
(396)	3-5-7-1-2-8-0	10.00	54.30	--	--	1674.00	2.10E+05
(397)	3-5-7-1-2-7-0	10.00	56.40	--	--	1368.00	2.35E+05
(398)	3-5-7-1-2-5-2	40.00	--	137.20	136.30	2808.00	4.06E+05
(399)	3-5-7-1-2-2-0	70.00	--	182.20	183.90	3374.00	2.89E+05
(400)	3-5-7-1-2-1-0	70.00	--	203.00	205.30	3265.00	2.60E+05
(401)	3-5-7-1-2-6-0	100.00	--	226.90	228.50	4500.00	2.10E+05
(402)	3-5-7-1-2-4-0	130.00	--	227.60	226.60	4835.00	7.55E+05
(403)	3-5-7-1-2-3-0	130.00	--	238.00	240.10	4768.00	4.42E+05
(404)	3-5-7-1-2-10-0	160.00	--	236.40	237.00	5255.00	4.10E+05

(405)	3-5-7-1-2-14-0	190.00	--	244.60	243.50	4887.00	4.91E+05
(406)	3-5-7-1-2-13-0	190.00	--	235.20	235.50	4943.00	3.92E+05
(407)	3-5-7-1-2-15-0	300.00	--	235.20	235.90	5008.00	3.92E+05
(408)	3-5-7-1-2-19-0	425.00	--	230.60	231.50	5532.00	3.84E+05
(409)	3-5-7-1-2-17-0	550.00	--	215.60	217.40	5431.00	3.59E+05
(410)	4-5-1-1-2-22-0	-30.00	1.00	--	--	--	--
(411)	4-5-1-1-2-3-0	-20.00	1.00	--	--	--	--
(412)	4-5-1-1-2-4-0	-10.00	2.00	--	--	--	--
(413)	4-5-1-1-2-1-0	-10.00	2.00	--	--	--	--
(414)	4-5-2-1-2-1-0	-10.00	1.00	--	--	--	--
(415)	4-5-2-1-2-2-0	0.00	2.00	--	--	--	--
(416)	4-5-2-1-2-3-0	0.00	2.00	--	--	--	--
(417)	4-5-3-1-2-1-0	-10.00	1.00	--	--	--	--
(418)	4-5-3-1-2-3-0	0.00	1.00	--	--	--	--
(419)	4-5-3-1-2-2-0	0.00	2.00	--	--	--	--
(420)	4-5-3-1-2-6-0	10.00	2.00	--	--	--	--
(421)	4-5-3-1-2-5-0	10.00	2.00	--	--	--	--
(422)	4-5-3-1-2-4-0	10.00	3.00	--	--	--	--
(423)	4-5-4-1-1-1-0	-10.00	1.00	--	--	--	--
(424)	4-5-4-1-1-2-0	0.00	1.00	--	--	--	--
(425)	4-5-4-1-1-3-0	10.00	2.00	--	--	--	--
(426)	4-5-4-1-1-4-0	10.00	2.00	--	--	--	--
(427)	4-5-5-1-2-2-0	-30.00	1.00	--	--	--	--
(428)	4-5-5-1-2-4-0	-20.00	2.00	--	--	--	--
(429)	4-5-5-1-2-3-0	-20.00	2.00	--	--	--	--
(430)	4-5-5-1-2-1-0	-10.00	2.00	--	--	--	--
(431)	4-5-6-1-2-2-0	-30.00	1.00	--	--	--	--
(432)	4-5-6-1-2-3-0	-20.00	1.00	--	--	--	--
(433)	4-5-6-1-2-1-0	-10.00	2.00	--	--	--	--
(434)	4-5-6-1-2-4-0	-10.00	2.00	--	--	--	--
(435)	4-5-7-1-2-1-0	-10.00	1.00	--	--	--	--
(436)	4-5-7-1-2-2-0	0.00	1.00	--	--	--	--
(437)	4-5-7-1-2-3-0	10.00	1.00	--	--	--	--
(438)	4-5-7-1-2-4-0	20.00	2.00	--	--	--	--
(439)	4-5-7-1-2-5-0	20.00	2.00	--	--	--	--
(440)	5-5-1-1-2-1-1	-120.00	67.00	--	--	--	1.80
(441)	5-5-1-1-2-3-0	-20.00	--	126.00	115.00	--	2.10
(442)	5-5-1-1-2-2-0	40.00	--	249.00	221.00	--	4.30
(443)	5-5-1-1-2-4-0	100.00	--	303.00	276.00	--	4.40
(444)	5-5-2-1-2-1-1	-120.00	56.40	--	--	--	2.30
(445)	5-5-2-1-2-3-0	-10.00	--	122.00	116.00	--	4.90
(446)	5-5-2-1-2-2-0	50.00	--	194.00	176.00	--	3.80
(447)	5-5-2-1-2-4-0	110.00	--	290.00	260.00	--	4.20
(448)	5-5-3-1-2-1-0	-120.00	--	61.20	60.50	--	2.40
(449)	5-5-3-1-2-3-0	0.00	--	109.00	108.00	--	4.90
(450)	5-5-3-1-2-2-0	60.00	--	190.00	176.00	--	3.80
(451)	5-5-3-1-2-4-2	120.00	--	352.00	313.00	--	4.20
(452)	5-5-4-1-1-3-0	-150.00	35.00	--	--	--	2.30
(453)	5-5-4-1-1-2-0	0.00	--	94.80	85.70	--	3.20
(454)	5-5-4-1-1-1-0	63.00	--	197.00	178.00	--	1.30
(455)	5-5-4-1-1-4-0	120.00	--	350.00	317.00	--	4.00

(456)	5-5-5-1-2-3-1	-150.00	50.70	--	--	--	2.90
(457)	5-5-5-1-2-1-0	-30.00	--	144.00	135.00	--	3.10
(458)	5-5-5-1-2-2-0	30.00	--	222.00	204.00	--	4.20
(459)	5-5-5-1-2-4-0	90.00	--	270.00	245.00	--	3.70
(460)	5-5-6-1-2-1-1	-150.00	80.60	--	--	--	2.70
(461)	5-5-6-1-2-3-0	-20.00	--	137.00	125.00	--	3.30
(462)	5-5-6-1-2-2-0	40.00	--	182.00	162.00	--	3.60
(463)	5-5-6-1-2-4-0	100.00	--	192.00	175.00	--	2.70
(464)	5-5-7-1-2-1-1	-150.00	60.00	--	--	--	3.00
(465)	5-5-7-1-2-3-0	10.00	--	139.00	122.00	--	3.50
(466)	5-5-7-1-2-2-0	70.00	--	243.00	221.00	--	2.30
(467)	5-5-7-1-2-5-0	130.00	--	215.00	195.00	--	4.10
(468)	6-5-1-1-2-3-0	-120.00	30.30	--	--	--	560000.00
(469)	6-5-1-1-2-2-0	-20.00	57.50	--	--	569.00	1.20E+05
(470)	6-5-1-1-2-1-0	40.00	92.90	--	--	--	1.55E+05
(471)	6-5-1-1-2-5-0	100.00	--	383.00	382.00	--	1.30E+05
(472)	6-5-1-1-2-4-7	100.00	--	334.10	333.40	--	1.26E+05
(473)	6-5-2-1-2-5-0	-120.00	42.90	--	--	79.00	81000.00
(474)	6-5-2-1-2-3-27	-120.00	30.30	--	--	--	53000.00
(475)	6-5-2-1-2-2-0	-10.00	56.70	--	--	--	56000.00
(476)	6-5-2-1-2-1-0	50.00	94.90	--	--	--	1.98E+05
(477)	6-5-2-1-2-6-0	110.00	--	203.00	203.00	--	1.90E+05
(478)	6-5-2-1-2-4-2	110.00	--	226.40	224.70	--	1.50E+05
(479)	6-5-3-1-2-2-0	-120.00	42.40	--	--	95.00	71000.00
(480)	6-5-3-1-2-4-7	-120.00	33.80	--	--	--	43000.00
(481)	6-5-3-1-2-6-0	0.00	86.90	--	--	--	1.07E+05
(482)	6-5-3-1-2-5-0	60.00	96.80	--	--	--	1.61E+05
(483)	6-5-3-1-2-3-0	120.00	--	236.60	236.30	--	1.58E+05
(484)	6-5-4-1-1-3-0	-150.00	30.60	--	--	--	57000.00
(485)	6-5-4-1-1-1-0	0.00	56.10	--	--	--	1.17E+05
(486)	6-5-4-1-1-2-0	60.00	95.50	--	--	--	1.77E+05
(487)	6-5-4-1-1-5-0	120.00	--	320.00	321.00	--	1.50E+05
(488)	6-5-4-1-1-4-0	120.00	--	229.70	229.40	--	1.47E+05
(489)	6-5-5-1-2-3-0	-150.00	29.90	--	--	--	55000.00
(490)	6-5-5-1-2-2-0	-30.00	60.30	--	--	--	77000.00
(491)	6-5-5-1-2-1-0	30.00	95.30	--	--	--	1.77E+05
(492)	6-5-5-1-2-6-0	90.00	--	256.00	256.00	--	1.90E+05
(493)	6-5-5-1-2-4-7	90.00	--	282.70	282.30	--	1.57E+05
(494)	6-5-6-1-2-3-0	-150.00	30.80	--	--	--	43000.00
(495)	6-5-6-1-2-2-0	-20.00	58.10	--	--	--	1.21E+05
(496)	6-5-6-1-2-1-0	40.00	129.80	--	--	--	1.97E+05
(497)	6-5-6-1-2-5-0	100.00	--	258.00	258.00	--	2.00E+05
(498)	6-5-6-1-2-4-7	100.00	--	279.00	278.70	--	1.45E+05
(499)	6-5-7-1-2-3-0	-150.00	29.30	--	--	--	57000.00
(500)	6-5-7-1-2-2-0	10.00	91.90	--	--	--	1.09E+05
(501)	6-5-7-1-2-1-0	69.00	128.70	--	--	--	1.79E+05
(502)	6-5-7-1-2-5-0	130.00	--	260.00	260.00	--	2.00E+05
(503)	6-5-7-1-2-4-7	130.00	--	348.20	347.70	--	2.05E+05
(504)	7-5-1-1-2-1-0	-20.00	74.70	--	--	--	2200.00
(505)	7-5-2-1-2-1-0	-10.00	59.10	--	--	--	1200.00
(506)	7-5-3-1-2-1-0	0.00	79.70	--	--	--	1000.00

(507) 7-5-4-1-1-1-0	0.00	69.10	--	--	--	2200.00
(508) 7-5-5-1-2-1-0	-30.00	103.00	--	--	--	2200.00
(509) 7-5-6-1-2-1-0	-20.00	100.00	--	--	--	2100.00
(510) 7-5-7-1-2-1-0	10.00	87.80	--	--	--	2200.00
(0) 1-5-8-1-2-1-0	-150.00	78.00	105.90	14.30	32.30	61.00
(1) 1-5-8-1-2-2-0	-50.00	67.50	95.70	13.80	31.30	63.60
(2) 1-5-8-1-2-4-0	72.00	63.40	87.60	11.30	30.20	64.30
(3) 1-5-8-1-2-3-0	200.00	58.80	82.20	11.50	26.20	66.70
(4) 1-5-8-1-2-5-0	400.00	56.90	81.80	11.60	24.00	62.60
(5) 1-5-8-1-2-6-0	550.00	57.20	86.60	12.30	24.90	56.30
(30) 1-5-13-1-2-1-0	-150.00	68.20	96.60	17.10	36.20	63.60
(31) 1-5-13-1-2-2-0	-50.00	58.90	86.50	15.60	34.60	67.20
(32) 1-5-13-1-2-3-0	72.00	53.80	77.80	13.90	33.10	68.70
(33) 1-5-13-1-2-4-0	200.00	51.40	72.60	13.20	30.80	68.20
(34) 1-5-13-1-2-5-0	400.00	48.80	72.30	13.50	28.90	67.20
(35) 1-5-13-1-2-6-0	550.00	48.00	77.70	12.50	25.90	62.30
(42) 2-5-8-1-1-17-0	-150.00	2.20	1.00	0.00	--	--
(43) 2-5-8-1-2-26-0	-150.00	3.80	1.00	0.00	--	--
(44) 2-5-8-1-1-4-0	-80.00	5.00	1.00	0.00	--	--
(45) 2-5-8-1-2-31-0	-80.00	5.30	3.00	1.00	--	--
(46) 2-5-8-1-1-19-0	-50.00	9.90	9.00	1.00	--	--
(47) 2-5-8-1-1-12-0	-30.00	22.90	19.00	10.00	--	--
(48) 2-5-8-1-2-38-0	-30.00	17.70	13.00	10.00	--	--
(49) 2-5-8-1-2-34-0	0.00	32.10	27.00	20.00	--	--
(50) 2-5-8-1-1-8-0	10.00	37.50	28.00	20.00	--	--
(51) 2-5-8-1-2-46-0	10.00	39.70	35.00	20.00	--	--
(52) 2-5-8-1-1-9-0	30.00	61.00	43.00	30.00	--	--
(53) 2-5-8-1-2-40-0	30.00	44.20	36.00	20.00	--	--
(54) 2-5-8-1-1-1-0	50.00	89.00	64.00	60.00	--	--
(55) 2-5-8-1-1-13-0	50.00	108.00	68.00	60.00	--	--
(56) 2-5-8-1-2-48-0	50.00	49.50	40.00	30.00	--	--
(57) 2-5-8-1-2-29-0	50.00	55.60	35.00	30.00	--	--
(58) 2-5-8-1-2-41-0	50.00	58.20	43.00	30.00	--	--
(59) 2-5-8-1-1-14-0	60.00	88.70	63.00	60.00	--	--
(60) 2-5-8-1-2-47-0	60.00	57.30	47.00	30.00	--	--
(61) 2-5-8-1-2-44-0	60.00	65.80	45.00	40.00	--	--
(62) 2-5-8-1-2-43-0	60.00	65.20	43.00	40.00	--	--
(63) 2-5-8-1-2-45-0	72.00	66.80	51.00	40.00	--	--
(64) 2-5-8-1-2-42-0	90.00	68.80	55.00	60.00	--	--
(65) 2-5-8-1-1-7-0	94.00	105.40	79.00	70.00	--	--
(66) 2-5-8-1-1-2-0	110.00	131.00	75.00	90.00	--	--
(67) 2-5-8-1-2-36-0	110.00	82.50	57.00	80.00	--	--
(68) 2-5-8-1-1-3-0	130.00	143.30	89.00	99.00	--	--
(69) 2-5-8-1-2-35-0	130.00	97.20	71.00	90.00	--	--
(70) 2-5-8-1-1-15-0	195.00	147.60	89.00	100.00	--	--
(71) 2-5-8-1-2-30-0	195.00	93.30	80.00	100.00	--	--
(72) 2-5-8-1-1-5-0	230.00	145.60	86.00	100.00	--	--
(73) 2-5-8-1-2-32-0	230.00	90.00	74.00	100.00	--	--
(74) 2-5-8-1-1-16-0	300.00	150.30	82.00	100.00	--	--
(75) 2-5-8-1-2-27-0	300.00	97.20	72.00	100.00	--	--
(76) 2-5-8-1-1-6-0	425.00	153.80	92.00	100.00	--	--
(77) 2-5-8-1-2-28-0	425.00	94.90	69.00	100.00	--	--
(78) 2-5-8-1-1-11-0	550.00	153.30	83.00	100.00	--	--

(79)	2-5-8-1-2-33-0	550.00	96.00	78.00	100.00	--	--
(191)	3-5-8-1-2-12-4	-90.00	39.90	--	--	359.00	2.56E+05
(192)	3-5-8-1-2-1-0	-60.00	34.10	--	--	547.00	2.03E+05
(193)	3-5-8-1-2-8-0	-30.00	37.40	--	--	1137.00	2.23E+05
(194)	3-5-8-1-2-4-0	0.00	48.40	--	--	1807.00	2.12E+05
(195)	3-5-8-1-2-3-0	0.00	56.60	--	--	1491.00	2.30E+05
(196)	3-5-8-1-2-9-0	30.00	52.10	--	--	--	2.17E+05
(197)	3-5-8-1-2-7-4	60.00	--	195.20	198.50	3610.00	2.67E+05
(198)	3-5-8-1-2-6-4	60.00	--	207.60	209.90	3138.00	2.79E+05
(199)	3-5-8-1-2-5-4	90.00	--	254.30	257.50	4423.00	3.85E+05
(200)	3-5-8-1-2-11-0	120.00	--	271.90	275.90	5863.00	3.60E+05
(201)	3-5-8-1-2-10-34	120.00	--	259.10	264.40	5554.00	3.60E+05
(202)	3-5-8-1-2-2-0	150.00	--	266.50	269.00	5943.00	4.04E+05
(203)	3-5-8-1-2-17-0	180.00	--	245.20	249.50	5684.00	3.71E+05
(204)	3-5-8-1-2-16-0	180.00	--	248.30	248.50	5543.00	3.76E+05
(205)	3-5-8-1-2-13-0	300.00	--	248.60	251.80	5729.00	3.29E+05
(206)	3-5-8-1-2-14-34	425.00	--	231.00	240.90	5968.00	3.47E+05
(207)	3-5-8-1-2-15-0	550.00	--	211.20	212.80	5533.00	3.20E+05
(276)	3-5-13-1-2-17-0	-90.00	34.40	--	--	218.00	1.79E+05
(277)	3-5-13-1-2-129-0	-60.00	27.80	--	--	362.00	1.66E+05
(278)	3-5-13-1-2-21-34	-30.00	31.00	--	--	510.00	1.72E+05
(279)	3-5-13-1-2-16-0	0.00	34.30	--	--	1293.00	1.43E+05
(280)	3-5-13-1-2-110-0	0.00	35.50	--	--	1135.00	1.97E+05
(281)	3-5-13-1-2-20-0	30.00	46.10	--	--	1561.00	2.96E+05
(282)	3-5-13-1-2-126-0	60.00	--	74.60	75.10	2652.00	3.77E+05
(283)	3-5-13-1-2-120-0	60.00	--	64.00	64.70	2460.00	3.55E+05
(284)	3-5-13-1-2-15-0	90.00	--	179.90	180.60	2346.00	3.75E+05
(285)	3-5-13-1-2-19-0	120.00	--	167.30	168.90	4517.00	3.40E+05
(286)	3-5-13-1-2-18-0	120.00	--	186.30	188.90	4640.00	3.98E+05
(287)	3-5-13-1-2-105-0	150.00	--	191.80	192.90	4661.00	3.76E+05
(288)	3-5-13-1-2-118-0	180.00	--	238.00	236.50	4985.00	2.81E+05
(289)	3-5-13-1-2-11-0	180.00	--	283.90	287.90	6293.00	3.38E+05
(290)	3-5-13-1-2-12-0	300.00	--	260.70	265.30	5797.00	3.22E+05
(291)	3-5-13-1-2-13-4	425.00	--	289.30	292.60	7351.00	3.21E+05
(292)	3-5-13-1-2-14-0	550.00	--	257.70	259.50	6167.00	2.96E+05
(310)	4-5-8-1-2-6-0	-40.00	1.00	--	--	--	--
(311)	4-5-8-1-2-1-0	0.00	1.00	--	--	--	--
(312)	4-5-8-1-2-4-0	10.00	2.00	--	--	--	--
(313)	4-5-8-1-2-3-0	10.00	2.00	--	--	--	--
(314)	4-5-8-1-2-2-0	20.00	2.00	--	--	--	--
(339)	4-5-13-1-2-2-0	-10.00	1.00	--	--	--	--
(340)	4-5-13-1-2-3-0	0.00	1.00	--	--	--	--
(341)	4-5-13-1-2-1-0	0.00	2.00	--	--	--	--
(342)	4-5-13-1-2-5-0	10.00	2.00	--	--	--	--
(343)	4-5-13-1-2-4-0	10.00	2.00	--	--	--	--
(347)	5-5-8-1-2-2-1	-150.00	64.40	--	--	--	3.20
(348)	5-5-8-1-2-1-0	0.00	--	117.00	95.30	--	3.40
(349)	5-5-8-1-2-4-0	60.00	--	295.00	253.00	--	4.40
(350)	5-5-8-1-2-3-0	120.00	--	288.00	239.00	--	4.90
(367)	5-5-13-1-2-5-0	-150.00	41.30	--	--	--	3.20
(368)	5-5-13-1-2-3-0	0.00	--	100.00	88.80	--	3.00
(369)	5-5-13-1-2-2-0	60.00	--	175.00	157.00	--	4.00

(370)	5-5-13-1-2-4-0	120.00	--	354.00	299.00	--	4.00
(371)	5-5-13-1-2-1-0	120.00	--	318.00	285.00	--	4.20
(376)	6-5-8-1-2-3-0	-150.00	45.20	--	--	72.00	75000.00
(377)	6-5-8-1-2-2-0	0.00	73.40	--	--	883.00	1.11E+05
(378)	6-5-8-1-2-1-0	62.00	130.50	--	--	--	1.74E+05
(379)	6-5-8-1-2-4-0	120.00	--	259.90	261.20	--	1.52E+05
(399)	6-5-13-1-2-2-0	-150.00	43.10	--	--	75.00	80000.00
(400)	6-5-13-1-2-3-0	0.00	72.80	--	--	1098.00	1.35E+05
(401)	6-5-13-1-2-4-0	62.00	98.80	--	--	--	1.94E+05
(402)	6-5-13-1-2-1-0	120.00	--	322.80	322.30	--	1.38E+05
(408)	7-5-8-1-2-1-0	0.00	79.40	--	--	--	2100.00
(411)	10-5-13-1-2-1-0	0.00	68.70	--	--	--	2700.00
(0)	8-3-1-1-2-4-0	-80.00	43.20	--	--	--	5400.00
(1)	8-3-1-1-2-5-0	-80.00	37.50	--	--	--	--
(2)	8-3-1-1-2-6-0	-80.00	40.30	--	--	--	4900.00
(3)	8-3-1-1-2-10-1	-10.00	69.40	--	--	--	5100.00
(4)	8-3-1-1-2-11-1	-10.00	65.20	--	--	--	5500.00
(5)	8-3-1-1-2-26-1	-10.00	66.30	--	--	--	5300.00
(6)	8-3-1-1-2-16-0	50.00	--	110.40	107.70	--	5400.00
(7)	8-3-1-1-2-19-0	50.00	--	102.70	100.60	--	5200.00
(8)	8-3-1-1-2-18-0	50.00	--	91.40	90.70	--	5400.00
(9)	8-3-1-1-2-23-0	110.00	--	157.70	151.60	--	3800.00
(10)	8-3-1-1-2-24-0	110.00	--	176.00	168.20	--	4600.00
(11)	8-3-1-1-2-25-0	110.00	--	169.20	162.10	--	4100.00
(12)	8-3-2-1-2-4-0	-80.00	49.30	--	--	--	2900.00
(13)	8-3-2-1-2-10-0	-50.00	47.90	--	--	--	4900.00
(14)	8-3-2-1-2-11-1	-50.00	62.40	--	--	--	5300.00
(15)	8-3-2-1-2-12-0	-50.00	46.40	--	--	--	5500.00
(16)	8-3-2-1-2-16-0	-10.00	--	94.70	93.70	--	5400.00
(17)	8-3-2-1-2-18-0	-10.00	--	76.40	77.00	--	5500.00
(18)	8-3-2-1-2-19-1	-10.00	66.20	--	--	--	4800.00
(19)	8-3-2-1-2-27-0	10.00	--	94.40	94.70	--	4600.00
(20)	8-3-2-1-2-23-0	75.00	--	177.50	167.70	--	5000.00
(21)	8-3-2-1-2-24-0	75.00	--	191.30	183.80	--	5000.00
(22)	8-3-2-1-2-25-0	75.00	--	195.50	187.90	--	5100.00
(23)	8-3-3-1-2-9-0	-80.00	36.90	--	--	--	2500.00
(24)	8-3-3-1-2-6-0	10.00	--	78.10	73.60	--	2600.00
(25)	8-3-3-1-2-12-0	70.00	--	134.60	127.90	--	3100.00
(26)	8-3-3-1-2-19-0	130.00	--	274.30	257.90	--	3000.00
(27)	8-3-4-1-2-1-25	-80.00	30.70	--	--	--	2600.00
(28)	8-3-4-1-2-3-1	0.00	65.20	--	--	--	2600.00
(29)	8-3-4-1-2-19-0	60.00	--	140.30	132.70	--	3000.00
(30)	8-3-4-1-2-18-0	120.00	--	158.80	149.90	--	2900.00
(31)	8-3-5-1-2-22-0	-120.00	49.30	--	--	--	5800.00
(32)	8-3-5-1-2-9-0	-20.00	--	105.70	99.20	--	5100.00
(33)	8-3-5-1-2-15-0	40.00	--	158.20	157.30	--	5700.00
(34)	8-3-5-1-2-7-0	100.00	--	299.40	283.10	--	5800.00
(82)	4-3-1-1-2-2--99	-20.00	1.00	--	--	--	--
(83)	4-3-1-1-2-3-0	-10.00	1.00	--	--	--	--
(84)	4-3-1-1-2-6-0	0.00	2.00	--	--	--	--
(85)	4-3-1-1-2-8-0	0.00	2.00	--	--	--	--
(86)	4-3-2-1-2-8-0	-50.00	1.00	--	--	--	--

(87)	4-3-2-1-2-5-0	-40.00	2.00	--	--	--	--
(88)	4-3-2-1-2-4-0	-40.00	2.00	--	--	--	--
(89)	4-3-2-1-2-6-0	-20.00	2.00	--	--	--	--
(90)	4-3-2-1-2-1-0	0.00	2.00	--	--	--	--
(91)	4-23-3-1-2-3-0	0.00	1.00	--	--	--	--
(92)	4-23-3-1-2-6-0	10.00	1.00	--	--	--	--
(93)	4-23-3-1-2-4-0	20.00	2.00	--	--	--	--
(94)	4-23-3-1-2-2-0	20.00	2.00	--	--	--	--
(95)	4-23-4-1-2-2-0	0.00	1.00	--	--	--	--
(96)	4-23-4-1-2-7-0	10.00	2.00	--	--	--	--
(97)	4-23-4-1-2-4-0	10.00	2.00	--	--	--	--
(98)	4-23-5-1-2-4-0	-30.00	1.00	--	--	--	--
(99)	4-23-5-1-2-7-0	-20.00	1.00	--	--	--	--
(100)	4-23-5-1-2-3-0	-20.00	2.00	--	--	--	--
(101)	4-23-5-1-2-5-0	-10.00	2.00	--	--	--	--
(102)	4-23-5-1-2-2-0	-10.00	2.00	--	--	--	--
(103)	4-23-5-1-2-8-0	0.00	2.00	--	--	--	--
(157)	2-3-1-1-2-7-0	-80.00	4.00	1.00	0.00	--	--
(158)	2-3-1-1-2-8-0	-80.00	4.00	1.00	0.00	--	--
(159)	2-3-1-1-2-9-0	-80.00	3.50	1.00	0.00	--	--
(160)	2-3-1-1-2-19-0	0.00	11.00	3.00	0.00	--	--
(161)	2-3-1-1-2-20-0	0.00	10.50	7.00	0.00	--	--
(162)	2-3-1-1-2-21-0	0.00	10.00	3.00	0.00	--	--
(163)	2-3-1-1-2-1-0	76.00	33.00	27.00	15.00	--	--
(164)	2-3-1-1-2-2-0	76.00	29.50	22.00	15.00	--	--
(165)	2-3-1-1-2-3-0	76.00	26.50	22.00	15.00	--	--
(166)	2-3-1-1-2-10-0	110.00	51.00	40.00	30.00	--	--
(167)	2-3-1-1-2-11-0	110.00	47.50	38.00	30.00	--	--
(168)	2-3-1-1-2-12-0	110.00	50.50	39.00	30.00	--	--
(169)	2-3-1-1-2-16-0	120.00	56.00	47.00	40.00	--	--
(170)	2-3-1-1-2-17-0	120.00	53.00	50.00	40.00	--	--
(171)	2-3-1-1-2-18-0	120.00	52.00	43.00	40.00	--	--
(172)	2-3-1-1-2-13-0	160.00	72.00	58.00	60.00	--	--
(173)	2-3-1-1-2-14-0	160.00	77.00	63.00	70.00	--	--
(174)	2-3-1-1-2-15-0	160.00	70.00	66.00	60.00	--	--
(175)	2-3-1-1-2-4-0	212.00	79.00	61.00	100.00	--	--
(176)	2-3-1-1-2-5-0	212.00	90.00	67.00	100.00	--	--
(177)	2-3-1-1-2-6-0	212.00	90.00	64.00	100.00	--	--
(178)	2-3-1-1-2-22-0	300.00	146.00	62.00	100.00	--	--
(179)	2-3-1-1-2-23-0	425.00	174.00	80.00	100.00	--	--
(180)	2-3-1-1-2-24-0	550.00	132.00	80.00	100.00	--	--
(181)	2-3-1-1-1-7-0	-80.00	4.00	1.00	0.00	--	--
(182)	2-3-1-1-1-8-0	-80.00	4.00	1.00	0.00	--	--
(183)	2-3-1-1-1-9-0	-80.00	3.50	1.00	0.00	--	--
(184)	2-3-1-1-1-19-0	0.00	9.50	4.00	0.00	--	--
(185)	2-3-1-1-1-20-0	0.00	10.00	6.00	0.00	--	--
(186)	2-3-1-1-1-21-0	0.00	10.50	7.00	0.00	--	--
(187)	2-3-1-1-1-1-0	76.00	45.50	34.00	20.00	--	--
(188)	2-3-1-1-1-2-0	76.00	36.50	32.00	15.00	--	--
(189)	2-3-1-1-1-3-0	76.00	35.00	28.00	15.00	--	--
(190)	2-3-1-1-1-16-0	90.00	44.00	38.00	20.00	--	--

(191)	2-3-1-1-1-17-0	90.00	46.00	37.00	20.00	--	--
(192)	2-3-1-1-1-18-0	90.00	45.00	37.00	20.00	--	--
(193)	2-3-1-1-1-10-0	110.00	68.50	52.00	40.00	--	--
(194)	2-3-1-1-1-11-0	110.00	73.00	54.00	40.00	--	--
(195)	2-3-1-1-1-12-0	110.00	71.50	50.00	40.00	--	--
(196)	2-3-1-1-1-13-0	160.00	95.00	72.00	80.00	--	--
(197)	2-3-1-1-1-14-0	160.00	105.00	76.00	90.00	--	--
(198)	2-3-1-1-1-15-0	160.00	96.00	67.00	80.00	--	--
(199)	2-3-1-1-1-4-0	212.00	111.00	77.00	100.00	--	--
(200)	2-3-1-1-1-5-0	212.00	118.00	79.00	100.00	--	--
(201)	2-3-1-1-1-6-0	212.00	120.00	81.00	100.00	--	--
(202)	2-3-1-1-1-22-0	300.00	134.00	62.00	100.00	--	--
(203)	2-3-1-1-1-23-0	425.00	122.00	75.00	100.00	--	--
(204)	2-3-1-1-1-24-0	550.00	121.00	68.00	100.00	--	--
(205)	2-3-2-1-2-7-0	-80.00	4.00	1.00	0.00	--	--
(206)	2-3-2-1-2-8-0	-80.00	4.00	1.00	0.00	--	--
(207)	2-3-2-1-2-9-0	-80.00	3.50	1.00	0.00	--	--
(208)	2-3-2-1-2-19-0	0.00	16.00	11.00	5.00	--	--
(209)	2-3-2-1-2-20-0	0.00	22.50	13.00	10.00	--	--
(210)	2-3-2-1-2-21-0	0.00	28.00	18.00	10.00	--	--
(211)	2-3-2-1-2-13-0	40.00	38.50	30.00	20.00	--	--
(212)	2-3-2-1-2-14-0	40.00	56.50	41.00	30.00	--	--
(213)	2-3-2-1-2-15-0	40.00	38.00	26.00	20.00	--	--
(214)	2-3-2-1-2-16-0	60.00	64.00	42.00	30.00	--	--
(215)	2-3-2-1-2-17-0	60.00	41.50	28.00	20.00	--	--
(216)	2-3-2-1-2-11-0	60.00	69.00	52.00	30.00	--	--
(217)	2-3-2-1-2-1-0	76.00	51.50	41.00	50.00	--	--
(218)	2-3-2-1-2-2-0	76.00	74.50	41.00	40.00	--	--
(219)	2-3-2-1-2-3-0	76.00	54.00	51.00	50.00	--	--
(220)	2-3-2-1-2-10-0	110.00	81.00	63.00	80.00	--	--
(221)	2-3-2-1-2-11-0	110.00	79.00	59.00	80.00	--	--
(222)	2-3-2-1-2-12-0	110.00	82.00	62.00	80.00	--	--
(223)	2-3-2-1-2-4-0	212.00	92.00	68.00	100.00	--	--
(224)	2-3-2-1-2-5-0	212.00	102.50	69.00	100.00	--	--
(225)	2-3-2-1-2-6-0	212.00	107.50	72.00	100.00	--	--
(226)	2-3-2-1-2-22-0	300.00	101.00	62.00	100.00	--	--
(227)	2-3-2-1-2-23-0	425.00	102.00	60.00	100.00	--	--
(228)	2-3-2-1-2-24-0	550.00	90.00	72.00	100.00	--	--
(229)	2-3-2-1-1-7-0	-80.00	5.00	1.00	0.00	--	--
(230)	2-3-2-1-1-8-0	-80.00	4.50	1.00	0.00	--	--
(231)	2-3-2-1-1-9-0	-80.00	4.50	1.00	0.00	--	--
(232)	2-3-2-1-1-19-0	0.00	26.50	17.00	10.00	--	--
(233)	2-3-2-1-1-20-0	0.00	16.50	19.00	5.00	--	--
(234)	2-3-2-1-1-21-0	0.00	18.50	14.00	5.00	--	--
(235)	2-3-2-1-1-13-0	40.00	70.00	46.00	30.00	--	--
(236)	2-3-2-1-1-14-0	40.00	38.00	23.00	15.00	--	--
(237)	2-3-2-1-1-15-0	40.00	62.00	48.00	30.00	--	--
(238)	2-3-2-1-1-16-0	60.00	95.00	60.00	60.00	--	--
(239)	2-3-2-1-1-17-0	60.00	61.00	42.00	35.00	--	--
(240)	2-3-2-1-1-18-0	60.00	49.00	32.00	25.00	--	--
(241)	2-3-2-1-1-1-0	76.00	89.00	60.00	50.00	--	--

(242)	2-3-2-1-1-2-0	76.00	87.00	61.00	60.00	--	--
(243)	2-3-2-1-1-3-0	76.00	81.50	53.00	50.00	--	--
(244)	2-3-2-1-1-10-0	110.00	98.00	67.00	80.00	--	--
(245)	2-3-2-1-1-11-0	110.00	102.00	69.00	80.00	--	--
(246)	2-3-2-1-1-12-0	110.00	100.00	66.00	90.00	--	--
(247)	2-3-2-1-1-4-0	212.00	125.00	70.00	100.00	--	--
(248)	2-3-2-1-1-5-0	212.00	127.00	83.00	100.00	--	--
(249)	2-3-2-1-1-6-0	212.00	130.00	81.00	100.00	--	--
(250)	2-3-2-1-1-22-0	300.00	138.00	55.00	100.00	--	--
(251)	2-3-2-1-1-23-0	425.00	109.00	62.00	100.00	--	--
(252)	2-3-2-1-1-24-0	550.00	125.00	66.00	100.00	--	--
(253)	2-3-3-1-1-1-0	-105.00	2.00	0.00	0.00	--	--
(254)	2-3-3-1-1-2-0	-20.00	12.00	9.00	10.00	--	--
(255)	2-3-3-1-1-3-0	20.00	29.00	24.00	15.00	--	--
(256)	2-3-3-1-1-4-0	40.00	45.00	35.00	25.00	--	--
(257)	2-3-3-1-1-5-0	60.00	54.00	41.00	30.00	--	--
(258)	2-3-3-1-1-6-0	80.00	110.00	76.00	50.00	--	--
(259)	2-3-3-1-1-7-0	100.00	95.00	69.00	60.00	--	--
(260)	2-3-3-1-1-8-0	120.00	105.00	76.00	70.00	--	--
(261)	2-3-3-1-1-9-0	140.00	121.00	85.00	80.00	--	--
(262)	2-3-3-1-1-10-0	180.00	129.00	88.00	90.00	--	--
(263)	2-3-3-1-1-11-0	240.00	136.00	90.00	99.00	--	--
(264)	2-3-3-1-1-12-0	300.00	140.00	89.00	100.00	--	--
(265)	2-3-3-1-1-13-0	425.00	142.00	90.00	100.00	--	--
(266)	2-3-3-1-1-14-0	550.00	138.00	87.00	100.00	--	--
(267)	2-3-3-1-2-1-0	-105.00	3.00	0.00	0.00	--	--
(268)	2-3-3-1-2-2-0	-20.00	13.00	11.00	10.00	--	--
(269)	2-3-3-1-2-3-0	20.00	33.00	27.00	15.00	--	--
(270)	2-3-3-1-2-4-0	40.00	41.00	34.00	25.00	--	--
(271)	2-3-3-1-2-5-0	60.00	34.00	28.00	30.00	--	--
(272)	2-3-3-1-2-15-0	70.00	58.00	44.00	35.00	--	--
(273)	2-3-3-1-2-16-0	70.00	41.00	35.00	30.00	--	--
(274)	2-3-3-1-2-17-0	70.00	65.00	51.00	35.00	--	--
(275)	2-3-3-1-2-6-0	80.00	70.00	57.00	40.00	--	--
(276)	2-3-3-1-2-7-0	100.00	65.00	51.00	50.00	--	--
(277)	2-3-3-1-2-8-0	120.00	72.00	56.00	55.00	--	--
(278)	2-3-3-1-2-9-0	140.00	106.00	80.00	70.00	--	--
(279)	2-3-3-1-2-10-0	180.00	106.00	83.00	90.00	--	--
(280)	2-3-3-1-2-11-0	240.00	117.00	86.00	99.00	--	--
(281)	2-3-3-1-2-12-0	300.00	118.00	79.00	100.00	--	--
(282)	2-3-3-1-2-13-0	425.00	119.00	76.00	100.00	--	--
(283)	2-3-3-1-2-14-0	550.00	103.00	87.00	100.00	--	--
(284)	2-3-4-1-1-1-0	-110.00	2.00	0.00	0.00	--	--
(285)	2-3-4-1-1-2-0	-30.00	9.00	3.00	0.00	--	--
(286)	2-3-4-1-1-3-0	10.00	18.00	13.00	15.00	--	--
(287)	2-3-4-1-1-4-0	30.00	19.00	18.00	15.00	--	--
(288)	2-3-4-1-1-5-0	50.00	45.00	31.00	30.00	--	--
(289)	2-3-4-1-1-6-0	70.00	51.00	38.00	35.00	--	--
(290)	2-3-4-1-1-7-0	90.00	70.00	55.00	40.00	--	--
(291)	2-3-4-1-1-8-0	110.00	122.00	83.00	80.00	--	--
(292)	2-3-4-1-1-9-0	130.00	113.00	74.00	80.00	--	--
(293)	2-3-4-1-1-10-0	170.00	119.00	80.00	100.00	--	--

(294)	2-3-4-1-1-12-0	212.00	140.00	76.00	100.00	--	--
(295)	2-3-4-1-1-13-0	300.00	138.00	85.00	100.00	--	--
(296)	2-3-4-1-1-14-0	425.00	138.00	84.00	100.00	--	--
(297)	2-3-4-1-1-15-0	550.00	132.00	83.00	100.00	--	--
(298)	2-3-4-1-2-1-0	-110.00	3.00	0.00	0.00	--	--
(299)	2-3-4-1-2-2-0	-30.00	9.00	2.00	0.00	--	--
(300)	2-3-4-1-2-3-0	10.00	19.00	13.00	15.00	--	--
(301)	2-3-4-1-2-4-0	30.00	29.00	20.00	20.00	--	--
(302)	2-3-4-1-2-5-0	50.00	38.00	27.00	30.00	--	--
(303)	2-3-4-1-2-6-0	70.00	49.00	35.00	40.00	--	--
(304)	2-3-4-1-2-7-0	90.00	52.00	41.00	40.00	--	--
(305)	2-3-4-1-2-16-0	90.00	66.00	51.00	50.00	--	--
(306)	2-3-4-1-2-17-0	90.00	49.00	40.00	45.00	--	--
(307)	2-3-4-1-2-18-0	90.00	60.00	50.00	50.00	--	--
(308)	2-3-4-1-2-8-0	110.00	67.00	50.00	50.00	--	--
(309)	2-3-4-1-2-9-0	130.00	80.00	63.00	85.00	--	--
(310)	2-3-4-1-2-10-0	170.00	84.00	65.00	99.00	--	--
(311)	2-3-4-1-2-11-0	212.00	103.00	82.00	100.00	--	--
(312)	2-3-4-1-2-12-0	300.00	101.00	76.00	100.00	--	--
(313)	2-3-4-1-2-13-0	425.00	99.00	75.00	100.00	--	--
(314)	2-3-4-1-2-15-0	550.00	103.00	78.00	100.00	--	--
(315)	2-23-5-1-1-16-0	-80.00	5.80	1.00	0.00	--	--
(316)	2-23-5-1-1-18-0	-80.00	4.20	1.00	0.00	--	--
(317)	2-23-5-1-1-20-0	-80.00	5.80	2.00	0.00	--	--
(318)	2-23-5-1-1-2-0	-40.00	9.50	5.00	10.00	--	--
(319)	2-23-5-1-1-19-0	-40.00	11.00	8.00	10.00	--	--
(320)	2-23-5-1-1-22-0	-40.00	15.00	12.00	10.00	--	--
(321)	2-23-5-1-1-21-0	0.00	32.50	24.00	20.00	--	--
(322)	2-23-5-1-1-1-0	0.00	25.20	20.00	20.00	--	--
(323)	2-23-5-1-1-3-0	0.00	26.00	19.00	20.00	--	--
(324)	2-23-5-1-1-15-0	40.00	60.00	41.90	40.00	--	--
(325)	2-23-5-1-1-14-0	40.00	57.00	42.00	40.00	--	--
(326)	2-23-5-1-1-13-0	40.00	61.00	41.00	40.00	--	--
(327)	2-23-5-1-1-8-0	90.00	93.50	68.00	65.00	--	--
(328)	2-23-5-1-1-9-0	90.00	98.00	71.00	70.00	--	--
(329)	2-23-5-1-1-7-0	90.00	85.50	62.00	70.00	--	--
(330)	2-23-5-1-1-11-0	150.00	119.50	83.00	100.00	--	--
(331)	2-23-5-1-1-6-0	150.00	108.50	75.00	100.00	--	--
(332)	2-23-5-1-1-5-0	150.00	116.50	76.00	100.00	--	--
(333)	2-23-5-1-1-12-0	210.00	125.50	80.00	100.00	--	--
(334)	2-23-5-1-1-4-0	210.00	120.50	83.00	100.00	--	--
(335)	2-23-5-1-1-10-0	120.00	122.00	81.00	100.00	--	--
(336)	2-23-5-1-1-24-0	300.00	120.50	84.00	100.00	--	--
(337)	2-23-5-1-1-25-0	425.00	128.50	83.00	100.00	--	--
(338)	2-23-5-1-1-23-0	550.00	120.50	72.00	100.00	--	--
(339)	2-23-5-1-2-11-0	-80.00	5.40	2.00	0.00	--	--
(340)	2-23-5-1-2-9-0	-80.00	5.80	1.00	0.00	--	--
(341)	2-23-5-1-2-8-0	-80.00	5.70	1.00	0.00	--	--
(342)	2-23-5-1-2-10-0	-40.00	13.00	8.00	10.00	--	--
(343)	2-23-5-1-2-12-0	-40.00	9.20	5.00	10.00	--	--
(344)	2-23-5-1-2-13-0	-40.00	11.50	7.00	10.00	--	--

(345) 2-23-5-1-2-19-0	0.00	24.80	20.00	20.00	--	--
(346) 2-23-5-1-2-20-0	0.00	20.00	14.00	15.00	--	--
(347) 2-23-5-1-2-16-0	0.00	33.50	26.00	20.00	--	--
(348) 2-23-5-1-2-6-0	40.00	43.00	33.00	30.00	--	--
(349) 2-23-5-1-2-5-0	40.00	50.00	38.00	30.00	--	--
(350) 2-23-5-1-2-7-0	40.00	30.50	29.00	25.00	--	--
(351) 2-23-5-1-2-18-0	40.00	38.00	30.00	25.00	--	--
(352) 2-23-5-1-2-24-0	90.00	80.00	59.00	75.00	--	--
(353) 2-23-5-1-2-14-0	90.00	75.00	62.00	70.00	--	--
(354) 2-23-5-1-2-15-0	90.00	79.50	62.00	65.00	--	--
(355) 2-23-5-1-2-27-0	150.00	101.00	71.00	100.00	--	--
(356) 2-23-5-1-2-25-0	150.00	105.50	76.00	100.00	--	--
(357) 2-23-5-1-2-26-0	150.00	96.00	75.00	100.00	--	--
(358) 2-23-5-1-2-2-0	210.00	94.00	73.00	100.00	--	--
(359) 2-23-5-1-2-3-0	210.00	99.50	71.00	100.00	--	--
(360) 2-23-5-1-2-4-0	210.00	104.50	78.00	100.00	--	--
(361) 2-23-5-1-2-21-0	300.00	104.00	75.00	100.00	--	--
(362) 2-23-5-1-2-22-0	425.00	108.50	79.00	100.00	--	--
(363) 2-23-5-1-2-1-0	550.00	101.50	75.00	100.00	--	--

(82) 5-3-1-1-2-3-0	-110.00	60.10	--	--	--	1.00
(83) 5-3-1-1-2-8-1	-110.00	53.30	--	--	--	1.00
(84) 5-3-1-1-2-2-0	-110.00	45.80	--	--	--	1.00
(85) 5-3-1-1-2-1-0	-10.00	--	108.90	108.40	--	1.20
(86) 5-3-1-1-2-7-0	-10.00	--	106.00	105.50	--	1.20
(87) 5-3-1-1-2-9-0	-10.00	--	103.20	101.40	--	1.10
(88) 5-3-1-1-2-13-0	50.00	--	142.60	135.10	--	1.50
(89) 5-3-1-1-2-15-0	50.00	--	136.10	129.90	--	1.40
(90) 5-3-1-1-2-14-0	50.00	--	150.90	142.50	--	1.50
(91) 5-3-1-1-2-22-0	110.00	--	247.90	218.80	--	2.30
(92) 5-3-1-1-2-20-0	110.00	--	240.20	230.00	--	2.30
(93) 5-3-1-1-2-21-0	110.00	--	247.40	237.60	--	2.50
(94) 5-3-2-1-2-1-1	-140.00	58.60	--	--	--	1.00
(95) 5-3-2-1-2-2-1	-140.00	50.40	--	--	--	1.00
(96) 5-3-2-1-2-3-0	-80.00	--	72.60	68.90	--	1.00
(97) 5-3-2-1-2-7-0	-50.00	--	114.40	99.60	--	1.20
(98) 5-3-2-1-2-9-0	-50.00	--	77.70	80.40	--	1.10
(99) 5-3-2-1-2-13-0	10.00	--	147.30	143.20	--	1.50
(100) 5-3-2-1-2-26-0	10.00	--	89.60	91.10	--	1.10
(101) 5-3-2-1-2-22-0	75.00	--	324.60	305.20	--	2.90
(102) 5-3-2-1-2-20-0	75.00	--	227.10	213.90	--	2.30
(103) 5-3-2-1-2-21-0	75.00	--	258.20	342.60	--	2.40
(104) 5-3-3-1-2-23-1	-80.00	53.00	--	--	--	1.00
(105) 5-3-3-1-2-5-0	10.00	--	98.30	93.30	--	1.20
(106) 5-3-3-1-2-14-0	70.00	--	141.30	133.40	--	1.40
(107) 5-3-3-1-2-4-4	130.00	--	321.10	304.40	--	2.80
(108) 5-3-3-1-2-18-0	130.00	--	315.70	297.50	--	2.90
(109) 5-3-4-1-2-14-0	-140.00	49.00	--	--	--	1.00
(110) 5-3-4-1-2-12-12	-80.00	55.50	--	--	--	1.20

(111)	5-3-4-1-2-2-4	0.00	--	113.10	106.60	--		1.20
(112)	5-3-4-1-2-6-24	0.00	--	100.50	96.10	--		1.50
(113)	5-3-4-1-2-11-0	60.00	--	136.60	126.10	--		1.40
(114)	5-3-4-1-2-16-0	120.00	--	222.50	211.80	--		2.10
(115)	5-3-5-1-2-16-1	-130.00	70.10	--	--	--		1.10
(116)	5-3-5-1-2-6-0	-20.00	--	141.20	133.30	--		1.40
(117)	5-3-5-1-2-3-0	40.00	--	257.10	242.10	--		2.20
(118)	5-3-5-1-2-10-0	100.00	--	262.30	247.80	--		2.40
(164)	4-3-1-1-2-2-0	75.00	--	204.80	--	--		2.00
(165)	11-3-2-1-2-2-2	75.00	--	235.40	215.10	--		4.80
(166)	11-3-2-1-2-1-0	75.00	--	253.00	240.00	--		3.70
(167)	11-3-3-1-2-1-0	75.00	--	186.90	168.40	--		2.50
(168)	11-3-4-1-2-1-0	75.00	--	142.20	158.50	--		1.90
(170)	11-3-5-1-2-2-0	75.00	--	266.00	241.00	--		6.20
(181)	7-3-2-1-2-1-0	-20.00	49.40	--	--	--	2100.00	
(182)	7-3-3-1-2-1-0	40.00	83.80	--	--	--	2200.00	
(183)	7-3-4-1-2-1-0	30.00	73.00	--	--	--	2300.00	
(188)	1-23-1-1-2-1-0	-10.00	65.30	89.90	11.00	25.00		63.20
(189)	1-23-1-1-2-2-0	50.00	64.20	86.90	10.30	25.00		63.20
(190)	1-23-1-1-2-3-0	110.00	62.70	83.50	9.80	25.00		63.20
(191)	1-23-1-1-2-4-0	170.00	59.70	80.10	9.80	23.50		63.20
(192)	1-23-1-1-2-5-0	250.00	58.50	78.60	8.50	22.00		62.00
(193)	1-23-1-1-2-6-0	550.00	55.20	83.70	--	21.00		56.20
(194)	1-23-2-1-2-1-0	-50.00	71.30	95.50	12.20	26.50		58.20
(195)	1-23-2-1-2-2-0	10.00	67.50	90.70	11.60	27.00		61.50
(196)	1-23-2-1-2-3-0	70.00	65.20	86.20	10.90	23.00		58.70
(197)	1-23-2-1-2-4-0	130.00	62.30	83.00	11.60	26.00		62.00
(198)	1-23-2-1-2-5-0	250.00	58.20	78.40	10.40	22.00		55.70
(199)	1-23-2-1-2-6-0	550.00	55.20	81.70	9.80	19.50		42.80
(200)	1-23-3-1-2-1-0	-100.00	75.80	101.40	7.20	28.50		60.90
(201)	1-23-3-1-2-2-0	10.00	68.30	91.80	11.60	27.00		63.40
(202)	1-23-3-1-2-3-0	70.00	63.90	87.60	10.70	27.50		66.30
(203)	1-23-3-1-2-4-0	190.00	62.70	82.50	9.70	24.00		63.70
(204)	1-23-3-1-2-5-0	250.00	59.40	80.40	8.20	23.00		63.40
(205)	1-23-3-1-2-6-0	550.00	58.20	84.70	9.10	22.00		61.70
(206)	1-23-4-1-2-1-0	0.00	62.20	90.90	11.40	28.00		64.70
(207)	1-23-4-1-2-2-0	60.00	64.60	87.30	11.60	26.00		65.30
(208)	1-23-4-1-2-3-0	120.00	63.40	83.80	10.30	24.50		65.20
(209)	1-23-4-1-2-4-0	180.00	61.90	82.00	9.70	24.50		60.20
(210)	1-23-4-1-2-5-0	250.00	59.70	80.50	9.10	22.50		65.20
(211)	1-23-4-1-2-6-0	550.00	57.70	82.90	9.00	20.50		56.70
(212)	1-23-5-1-2-1-0	-100.00	75.70	99.40	12.20	29.50		59.90
(213)	1-23-5-1-2-2-0	-20.00	67.90	91.40	--	27.00		63.20
(214)	1-23-5-1-2-3-0	40.00	65.70	88.20	11.00	27.50		65.70
(215)	1-23-5-1-2-4-0	160.00	61.20	81.40	10.40	25.50		64.20
(216)	1-23-5-1-2-5-0	250.00	59.70	79.70	9.80	24.50		63.70
(217)	1-23-5-1-2-6-0	550.00	56.40	84.00	12.10	26.00		62.90
(279)	3-3-1-1-2-1-0	-100.00	28.50	--	--	145.00	3.00E+05	
(280)	3-3-1-1-2-2-0	-70.00	27.60	--	--	340.00	1.50E+05	
(281)	3-3-1-1-2-3-0	-40.00	39.30	--	--	412.00	1.40E+05	
(282)	3-3-1-1-2-4-0	-10.00	47.00	--	--	869.00	2.50E+05	

(283)	3-3-1-1-2-5-0	-10.00	42.30	--	--	814.00	2.30E+05
(284)	3-3-1-1-2-6-2	-10.00	41.60	--	--	843.00	2.00E+05
(285)	3-3-1-1-2-7-2	20.00	49.80	--	--	1117.00	3.10E+05
(286)	3-3-1-1-2-8-0	50.00	46.80	--	--	2003.00	2.90E+05
(287)	3-3-1-1-2-9-0	50.00	--	67.70	67.50	1977.00	3.00E+05
(288)	3-3-1-1-2-10-0	50.00	--	82.70	82.30	2072.00	2.90E+05
(289)	3-3-1-1-2-11-6	80.00	--	91.00	89.60	2736.00	1.09E+06
(290)	3-3-1-1-2-12-0	110.00	--	143.50	143.20	4121.00	4.40E+05
(291)	3-3-1-1-2-13-0	110.00	--	210.60	210.90	3892.00	5.10E+05
(292)	3-3-1-1-2-14-6	110.00	--	171.00	168.70	3883.00	7.50E+05
(293)	3-3-1-1-2-15-0	140.00	--	250.30	249.80	4914.00	4.50E+05
(294)	3-3-1-1-2-16-0	170.00	--	262.20	260.50	5686.00	4.80E+05
(295)	3-3-1-1-2-18-6	170.00	--	296.20	295.70	6188.00	6.50E+05
(296)	3-3-1-1-2-19-0	300.00	--	338.00	335.00	7908.00	2.80E+05
(297)	3-3-1-1-2-21-0	425.00	--	290.70	285.60	6874.00	3.10E+05
(298)	3-3-1-1-2-22-0	550.00	--	257.30	253.80	6056.00	3.30E+05
(299)	3-3-2-1-2-1-2	-160.00	28.10	--	--	52.00	1.90E+05
(300)	3-3-2-1-2-2-0	-110.00	41.50	--	--	140.00	2.00E+05
(301)	3-3-2-1-2-3-0	-80.00	37.80	--	--	235.00	1.70E+05
(302)	3-3-2-1-2-4-0	-50.00	40.90	--	--	508.00	1.40E+05
(303)	3-3-2-1-2-5-2	-50.00	48.80	--	--	481.00	1.50E+05
(304)	3-3-2-1-2-6-0	-50.00	38.70	--	--	497.00	1.80E+05
(305)	3-3-2-1-2-7-2	-20.00	38.20	--	--	819.00	1.80E+05
(306)	3-3-2-1-2-8-2	10.00	--	57.50	56.30	1532.00	1.60E+05
(307)	3-3-2-1-2-9-0	10.00	44.90	--	--	1468.00	1.60E+05
(308)	3-3-2-1-2-10-2	10.00	--	75.70	74.30	1653.00	1.80E+05
(309)	3-3-2-1-2-11-2	40.00	--	96.10	94.30	2241.00	3.30E+05
(310)	3-3-2-1-2-13-2	70.00	--	132.80	129.70	3435.00	4.30E+05
(311)	3-3-2-1-2-14-2	70.00	--	146.50	143.80	2932.00	4.70E+05
(312)	3-3-2-1-2-15-0	100.00	--	217.00	214.50	4440.00	3.40E+05
(313)	3-3-2-1-2-16-2	130.00	--	260.20	254.30	5082.00	4.10E+05
(314)	3-3-2-1-2-17-2	130.00	--	312.20	306.70	5607.00	3.90E+05
(315)	3-3-2-1-2-18-0	130.00	--	194.50	192.00	5472.00	3.10E+05
(316)	3-3-2-1-2-19-2	300.00	--	263.00	258.00	5403.00	3.20E+05
(317)	3-3-2-1-2-20-2	425.00	--	272.10	265.60	5320.00	3.00E+05
(318)	3-3-2-1-2-22-2	550.00	--	222.20	217.50	4578.00	3.20E+05
(319)	3-3-3-1-2-1-0	-80.00	52.50	--	--	192.00	2.20E+05
(320)	3-3-3-1-2-2-0	-50.00	39.80	--	--	320.00	4.00E+05
(321)	3-3-3-1-2-3-0	-20.00	47.80	--	--	653.00	2.30E+05
(322)	3-3-3-1-2-4-2	10.00	56.80	--	--	1093.00	2.40E+05
(323)	3-3-3-1-2-5-0	10.00	--	85.10	83.80	900.00	2.30E+05
(324)	3-3-3-1-2-6-2	10.00	52.60	--	--	1015.00	2.50E+05
(325)	3-3-3-1-2-7-2	40.00	53.20	--	--	1858.00	3.80E+05
(326)	3-3-3-1-2-10-2	70.00	--	160.00	157.50	3009.00	4.90E+05
(327)	3-3-3-1-2-11-0	100.00	--	203.50	201.20	3981.00	2.90E+05
(328)	3-3-3-1-2-12-0	130.00	--	298.10	295.60	5680.00	2.10E+05
(329)	3-3-3-1-2-13-2	130.00	--	322.80	316.10	5193.00	3.40E+05
(330)	3-3-3-1-2-14-0	130.00	--	303.70	299.40	5472.00	3.40E+05
(331)	3-3-3-1-2-15-2	160.00	--	298.00	293.00	5756.00	2.10E+05
(332)	3-3-3-1-2-17-0	190.00	--	271.00	267.70	6373.00	2.60E+05
(333)	3-3-3-1-2-18-2	190.00	--	290.30	285.80	6360.00	2.30E+05

(334)	3-3-3-1-2-23-0	300.00	--	280.20	276.00	6289.00	1.90E+05
(335)	3-3-3-1-2-20-26	425.00	--	292.50	288.00	6721.00	5.80E+05
(336)	3-3-3-1-2-21-6	550.00	--	254.90	250.80	6137.00	3.70E+05
(337)	3-3-4-1-2-1-0	-90.00	41.00	--	--	169.00	1.70E+05
(338)	3-3-4-1-2-2-0	-60.00	43.30	--	--	260.00	1.70E+05
(339)	3-3-4-1-2-3-0	-30.00	49.90	--	--	492.00	2.40E+05
(340)	3-3-4-1-2-5-0	0.00	40.20	--	--	1150.00	1.70E+05
(341)	3-3-4-1-2-6-0	0.00	57.50	--	--	947.00	2.50E+05
(342)	3-3-4-1-2-7-0	0.00	44.50	--	--	949.00	3.80E+05
(343)	3-3-4-1-2-8-2	30.00	52.00	--	--	1534.00	3.20E+05
(344)	3-3-4-1-2-10-0	60.00	--	79.90	79.10	2452.00	4.50E+05
(345)	3-3-4-1-2-11-0	60.00	--	92.70	91.50	2365.00	2.80E+05
(346)	3-3-4-1-2-13-0	90.00	--	176.50	175.50	3497.00	2.90E+05
(347)	3-3-4-1-2-14-2	120.00	--	268.60	263.00	4760.00	5.10E+05
(348)	3-3-4-1-2-15-0	120.00	--	243.60	240.30	4906.00	3.30E+05
(349)	3-3-4-1-2-16-6	120.00	--	242.00	239.00	4365.00	6.70E+05
(350)	3-3-4-1-2-17-0	150.00	--	286.40	283.10	5395.00	4.70E+05
(351)	3-3-4-1-2-18-0	180.00	--	279.30	279.40	6013.00	3.50E+05
(352)	3-3-4-1-2-19-0	180.00	--	288.30	285.80	6126.00	3.30E+05
(353)	3-3-4-1-2-20-0	180.00	--	284.30	284.10	6160.00	5.10E+05
(354)	3-3-4-1-2-21-0	300.00	--	263.80	261.20	5979.00	2.20E+05
(355)	3-3-4-1-2-22-0	425.00	--	254.20	251.80	5962.00	2.90E+05
(356)	3-3-4-1-2-23-0	550.00	--	264.50	260.80	5671.00	2.90E+05
(357)	3-23-5-1-2-14-0	-110.00	41.90	--	--	106.00	2.20E+05
(358)	3-23-5-1-2-7-0	-80.00	42.30	--	--	308.00	2.40E+05
(359)	3-23-5-1-2-9-0	-80.00	51.10	--	--	249.00	2.40E+05
(360)	3-23-5-1-2-8-0	-50.00	50.30	--	--	480.00	2.20E+05
(361)	3-23-5-1-2-12-0	-50.00	49.40	--	--	462.00	2.30E+05
(362)	3-23-5-1-2-4-0	-20.00	55.70	--	--	960.00	3.30E+05
(363)	3-23-5-1-2-22-0	-20.00	45.10	--	--	889.00	2.80E+05
(364)	3-23-5-1-2-16-0	10.00	55.70	--	--	1261.00	4.00E+05
(365)	3-23-5-1-2-1-0	10.00	56.50	--	--	1680.00	3.10E+05
(366)	3-23-5-1-2-20-0	40.00	--	107.00	107.00	2051.00	4.30E+05
(367)	3-23-5-1-2-13-0	70.00	--	172.00	173.00	3360.00	3.80E+05
(368)	3-23-5-1-2-15-0	100.00	--	238.00	241.00	4615.00	3.00E+05
(369)	3-23-5-1-2-17-0	100.00	--	240.00	240.00	4462.00	3.40E+05
(370)	3-23-5-1-2-3-0	130.00	--	281.00	282.00	5470.00	3.10E+05
(371)	3-23-5-1-2-5-0	130.00	--	281.00	280.00	5300.00	3.50E+05
(372)	3-23-5-1-2-11-0	160.00	--	280.00	280.00	5143.00	3.10E+05
(373)	3-23-5-1-2-19-0	160.00	--	272.00	274.00	5763.00	3.00E+05
(374)	3-23-5-1-2-23-0	300.00	--	257.00	258.00	4960.00	3.20E+05
(375)	3-23-5-1-2-6-6	300.00	--	281.00	281.00	5620.00	3.10E+05
(376)	3-23-5-1-2-2-0	300.00	--	268.00	270.00	5200.00	3.40E+05
(377)	3-23-5-1-2-18-0	425.00	--	279.00	280.00	4300.00	2.80E+05
(378)	3-23-5-1-2-21-0	550.00	--	273.00	275.00	6000.00	2.70E+05
(5)	7-3-1-1-2-1-1	50.00	106.00	--	--	--	--
(6)	7-3-5-1-2-1-0	-20.00	81.20	--	--	--	2000.00
(11)	3-3-2-1-2-12-2	70.00	--	77.20	70.40	3299.00	5.20E+05
(12)	3-3-3-1-2-8-0	70.00	59.00	--	--	2469.00	5.60E+05
(13)	3-3-3-1-2-9-2	70.00	--	149.90	147.00	2928.00	3.40E+05
(14)	3-3-5-1-2-10-0	40.00	--	83.80	83.30	2290.00	4.70E+05

APPENDIX 2

MATERIAL 2

A508 CLASS 2 FORGING STEEL

MATERIAL TYPE 2
A508, CLASS 2 FORGING STEEL

INTRODUCTION

Five different heats of A508-2 forging material were studied by Babcock and Wilcox. A description of each heat is given in Table 2.1. This table also lists the NDTT and RT_{NDT} values for each heat. It is interesting to note the RT_{NDT} was always determined by the NDTT. The test results for the A508-2 material are summarized in the extract from the data bank included at the end of this section. More details on the materials and the test program on the A508-2 material can be found in reference 11.

TENSILE TESTS RESULTS

For each 2-in. gage section tensile test the yield strength, ultimate tensile strength, uniform elongation, total elongation, and reduction in area data as a function of temperature were fitted using a third order polynomial regression curve. The curve fit coefficients for each of the five heats are listed in Table 2.2, along with the variance, degrees of freedom and standard deviation. The curve fits for the various tensile data are shown in Figures 2.1 - 2.5.

CHARPY V-NOTCH RESULTS

Impact Energy

The impact energy results for A508-2 using the tanh regression analysis are summarized in Table 2.3, which shows the coefficients of the tanh equation for each set of data. The curves fit to the Charpy impact energy data are shown in Figures 2.6 through 2.15. Table 2.4 shows the deviation and the normalized deviation for the various parameters listed in Table 2.3. Heat A exhibited a significantly higher upper shelf (particularly longitudinal), and the variance value for set 22421 (heat D) was high. The deviation from the mean value for the other heats did not reach the 95% confidence level.

Lateral Expansion

The lateral expansion results are summarized in Table 2.5, which shows the curve fit coefficients for tanh curves fitted to the test data. The curves are shown in Figures 2.16 - 2.25. Each coefficient was examined as for the impact energy results in the previous section. The results are summarized in Table 2.6. The variance estimate for the set 22421 (heat D) had an exceptionally high variance. This resulted from unduly high scatter of two data values at the upper shelf end of the transition range (Figure 2.22).

Percent Shear

The tanh coefficients for the percent shear data are summarized in Table 2.7 and the data are shown graphically in Figures 2.26 - 2.35. Each column of Table 2.7 has been analyzed for deviation from the mean, and the results are shown in Table 2.8. Again, the variance of set 22421 was high.

Summary of Charpy Impact Test Data

Table 2.9 shows the quantity T_o - C, a measure of the ductile-brittle transition temperature, for all the impact test quantities compared to RT_{NDT} and NDTT. There seems little correlation between these various measures of the ductile-brittle transition temperature.

The good agreement between the ductile-brittle transition for the percent shear of the A533B-1 heats and the RT_{NDT} was notably absent for the A508-2 heats. Two heats showed deviations of more than $100^{o}F$ between the T_o - C value and the RT_{NDT}.

INSTRUMENTED PRECRACKED CHARPY RESULTS

Dynamic Fracture Toughness, K_{Id}, K_d^*

The tanh curve fit coefficients for the A508-2 heats are summarized in Table 2.10. The deviation from the mean values for the various parameters in Table 2.10 are given in Table 2.11. No statistically significant differences were observed between the various parameters. From the mean estimates of A and B, the lower and upper shelves were estimated as 38 and 293 ksi-in$^{\frac{1}{2}}$. The curves fitted to the data are shown in Figures 2.36 - 2.40.

Normalized Energy, W/A

Table 2.12 summarizes the statistics for curves fitted to the test data. There were again no important deviations for any of the parameters from the mean value (Table 2.13). The curves fitted to the test data are shown in Figures 2.41 - 2.45.

Summary of Precracked Charpy Results

Table 2.14 shows the ductile-brittle transition for the K values and the W/A values, as estimated by T_0 - C. There was reasonable agreement between the W/A data and RT_{NDT}. (Note again that RT_{NDT} = NDTT for all heats of A508-2).

After normalizing the temperatures by subtracting RT_{NDT} from the test temperature, the data were combined into single plots for K and W/A data. The K values are shown in Figure 2.46. The K_{TR} curve lies between the 95 and 97.5% confidence lines. The upper and lower shelves were at 282 and 45 ksi-in$^{\frac{1}{2}}$, while the ductile-brittle transition, T_0 - C, was at 14^{o}F compared to the expected value of 0^{o}F.

The normalized energy values, W/A, are summarized in Figure 2.47. There was much less scatter on this figure than there was for the K data. The overall transition estimate was -9.6^{o}F compared to the expected value of 0^{o}F.

STATIC AND DYNAMIC COMPACT FRACTURE TOUGHNESS RESULTS

For the A508-2 forging material, 1-in. compact fracture specimens (test type 5) were used to measure static fracture toughness. However, as in other materials, there were only a few (4 or 5) data points for each heat, so that a tanh curve would have little meaning. As for the static compact fracture test, there were few data points for the dynamic compact specimen tests (test types 7 and 8) for each heat. These fracture toughness results for each heat are shown in Figures 2.48 - 2.52. Group plots by test type are shown in Figures 2.53 - 2.54 referenced by the RT_{NDT} and compared to the K_{IR} curve.

EFFECT OF ERROR CODES

The static and dynamic fracture toughness results for material 2 were statistically analyzed with and without the data points which did not meet the EPRI procedures. Tanh curve fits to the total data and acceptable data only are shown in Figures 2.55 to 2.58. The influence of the error code data on shelf properties and variance was determined. Both the overall variance and the variance in the transition temperature region ($T_0 \pm 50^{\circ}F$) were compared. A summary of the error code analysis is given in Table 2.15. The variance ratio (F) was calculated for the static and dynamic fracture toughness results. The ratios shown in Table 2.15 had a high probability of occurring by chance, and it is concluded that the effect of the error codes on the data was not significant.

Table 2.1. Summary of A508-2 Heats (Material 2)

TEST LABORATORY	HEAT CODE	FORGING THICKNESS (in.)	NDTT (^{o}F)	RT_{NDT} (^{o}F)
B & W	A(1)	(Ref. 11)	20	20
	B(2)		20	20
	C(3)		30	30
	D(4)		40	40
	K(11)		20	20

Table 2.2 Summary of the Regression Analysis of the Tensile Test Data (A508-2)

Property	A	B	C	D	Variance, σ^2	Degrees of Freedom ϕ	Standard Deviation σ
Yield Stress	68.58	-8.653×10^{-2}	2.769×10^{-4}	-2.846×10^{-7}	14.17	26.00	3.76
Ultimate Tensile Stress	91.46	-7.710×10^{-2}	1.474×10^{-4}	-5.312×10^{-8}	8.12	26.00	2.85
Uniform Elongation	11.34	-1.078×10^{-2}	2.184×10^{-5}	-1.103×10^{-8}	.91	26.00	.954
Total Elongation	28.82	-1.226×10^{-2}	-4.491×10^{-5}	9.462×10^{-8}	1.36	26.00	1.17
Reduction In Area	69.32	1.571×10^{-2}	-8.284×10^{-5}	8.238×10^{-8}	2.05	26.00	1.43

Table 2.3. Tanh Fit Parameters for Charpy Impact Energy Data (A508-2)

KEY	J	A	B	T0	C	PHI	VAR
22121	2	108.15	103.61	61.22	108.08	6	129.90
22122	2	94.36	94.36	67.82	121.32	8	387.04
22221	2	66.72	66.99	47.91	80.61	7	40.21
22222	2	58.12	54.55	46.20	67.84	7	170.63
22321	2	81.70	81.70	38.73	96.22	4	93.14
22322	2	67.41	66.19	35.31	64.09	4	135.89
22421	2	78.69	78.69	37.51	91.96	4	512.31
22422	2	71.69	71.69	36.62	97.49	4	93.04
221121	2	77.01	77.01	51.87	112.13	6	83.31
221122	2	67.11	67.11	53.62	84.35	6	52.94

Table 2.4. Deviation of Charpy Impact Energy Curve Fit Parameters from Mean Value (A508-2)

A

TOTAL	770.96
MEAN	77.096
ST. DEV	14.81986370

KEY	VAL	DEV	NORMALIZED DEV
22121	108.15	31.05	2.10
22122	94.36	17.26	1.16
22221	66.72	-10.38	-0.70
22222	58.12	-18.98	-1.28
22321	81.70	4.60	0.31
22322	67.41	-9.69	-0.65
22421	78.69	1.59	0.11
22422	71.69	-5.41	-0.36
221121	77.01	-0.09	-0.01
221122	67.11	-9.99	-0.67

B

TOTAL	761.9
MEAN	76.19
ST. DEV	14.43342494

KEY	VAL	DEV	NORMALIZED DEV
22121	103.61	27.42	1.90
22122	94.36	18.17	1.26
22221	66.99	-9.20	-0.64
22222	54.55	-21.64	-1.50
22321	81.70	5.51	0.38
22322	66.19	-10.00	-0.69
22421	78.69	2.50	0.17
22422	71.69	-4.50	-0.31
221121	77.01	0.82	0.06
221122	67.11	-9.08	-0.63

Table 2.4. (continued)

T_0

TOTAL	476.81
MEAN	47.681
ST. DEV	11.07000999

KEY	VAL	DEV	NORMALIZED DEV
22121	61.22	13.54	1.22
22122	67.82	20.14	1.82
22221	47.91	0.23	0.02
22222	46.20	-1.48	-0.13
22321	38.73	-8.95	-0.81
22322	35.31	-12.37	-1.12
22421	37.51	-10.17	-0.92
22422	36.62	-11.06	-1.00
221121	51.87	4.19	0.38
221122	53.62	5.94	0.54

C

TOTAL	924.09
MEAN	92.409
ST. DEV	18.62092995

KEY	VAL	DEV	NORMALIZED DEV
22121	108.08	15.67	0.84
22122	121.32	28.91	1.55
22221	80.61	-11.80	-0.63
22222	67.84	-24.57	-1.32
22321	96.22	3.81	0.20
22322	64.09	-28.32	-1.52
22421	91.96	-0.45	-0.02
22422	97.49	5.08	0.27
221121	112.13	19.72	1.06
221122	84.35	-8.06	-0.43

Table 2.4. (continued)

PHI

TOTAL	56
MEAN	5.6
ST. DEV	1.505545305

KEY	VAL	DEV	NORMALIZED DEV
22121	6.00	0.40	0.27
22122	8.00	2.40	1.59
22221	7.00	1.40	0.93
22222	7.00	1.40	0.93
22321	4.00	-1.60	-1.06
22322	4.00	-1.60	-1.06
22421	4.00	-1.60	-1.06
22422	4.00	-1.60	-1.06
221121	6.00	0.40	0.27
221122	6.00	0.40	0.27

VARIANCE

TOTAL	1698.41
MEAN	169.841
ST. DEV	155.2589553

KEY	VAL	DEV	NORMALIZED DEV
22121	129.90	-39.94	-0.26
22122	387.04	217.20	1.40
22221	40.21	-129.63	-0.83
22222	170.63	0.79	0.01
22321	93.14	-76.70	-0.49
22322	135.89	-33.95	-0.22
22421	512.31	342.47	2.21
22422	93.04	-76.80	-0.49
221121	83.31	-86.53	-0.56
221122	52.94	-116.90	-0.75

Table 2.5. Tanh Fit Parameters for Charpy Impact Lateral Expansion Data (A508-2)

KEY	J	A	B	T0	C	PHI	VAR
22121	3	36.89	36.89	-12.31	40.11	3	51.59
22122	3	34.78	34.78	-16.78	66.73	3	112.60
22221	3	41.25	40.37	44.24	71.17	7	15.89
22222	3	40.31	40.31	54.86	112.02	6	96.25
22321	3	38.24	37.17	-11.16	36.42	3	34.40
22322	3	42.27	39.90	27.66	50.71	3	93.74
22421	3	40.46	35.36	19.98	32.97	3	564.31
22422	3	37.94	37.94	9.20	83.56	3	45.19
221121	3	42.70	39.51	15.01	50.87	3	46.75
221122	3	42.78	42.78	45.93	91.65	7	37.69

Table 2.6. Deviation of Charpy Impact Lateral Expansion Curve Fit Parameters from Mean Value (A508-2)

A

TOTAL	397.62
MEAN	39.762
ST. DEV	2.702606972

KEY	VAL	DEV	NORMALIZED DEV
22121	36.89	-2.87	-1.06
22122	34.78	-4.98	-1.84
22221	41.25	1.49	0.55
22222	40.31	0.55	0.20
22321	38.24	-1.52	-0.56
22322	42.27	2.51	0.93
22421	40.46	0.70	0.26
22422	37.94	-1.82	-0.67
221121	42.70	2.94	1.09
221122	42.78	3.02	1.12

B

TOTAL	385.01
MEAN	38.501
ST. DEV	2.504309397

KEY	VAL	DEV	NORMALIZED DEV
22121	36.89	-1.61	-0.64
22122	34.78	-3.72	-1.49
22221	40.37	1.87	0.75
22222	40.31	1.81	0.72
22321	37.17	-1.33	-0.53
22322	39.90	1.40	0.56
22421	35.36	-3.14	-1.25
22422	37.94	-0.56	-0.22
221121	39.51	1.01	0.40
221122	42.78	4.28	1.71

Table 2.6. (continued)

T_0

TOTAL	176.63
MEAN	17.663
ST. DEV	25.79494483

KEY	VAL	DEV	NORMALIZED DEV
22121	-12.31	-29.97	-1.16
22122	-16.78	-34.44	-1.34
22221	44.24	26.58	1.03
22222	54.86	37.20	1.44
22321	-11.16	-28.82	-1.12
22322	27.66	10.00	0.39
22421	19.98	2.32	0.09
22422	9.20	-8.46	-0.33
221121	15.01	-2.65	-0.10
221122	45.93	28.27	1.10

C

TOTAL	636.41
MEAN	63.641
ST. DEV	26.17246197

KEY	VAL	DEV	NORMALIZED DEV
22121	40.11	-23.53	-0.90
22122	66.73	3.09	0.12
22221	71.17	7.53	0.29
22222	112.02	48.38	1.85
22321	36.42	-27.22	-1.04
22322	50.71	-12.93	-0.49
22421	32.97	-30.67	-1.17
22422	83.56	19.92	0.76
221121	50.87	-12.77	-0.49
221122	91.85	28.21	1.08

Table 2.6. (continued)

PHI

TOTAL	41
MEAN	4.1
ST. DEV	1.79195734

KEY	VAL	DEV	NORMALIZED DEV
22121	3.00	-1.10	-0.61
22122	3.00	-1.10	-0.61
22221	7.00	2.90	1.62
22222	6.00	1.90	1.06
22321	3.00	-1.10	-0.61
22322	3.00	-1.10	-0.61
22421	3.00	-1.10	-0.61
22422	3.00	-1.10	-0.61
221121	3.00	-1.10	-0.61
221122	7.00	2.90	1.62

VARIANCE

TOTAL	1090.41
MEAN	109.041
ST. DEV	162.7100175

KEY	VAL	DEV	NORMALIZED DEV
22121	51.59	-58.25	-0.36
22122	112.60	2.76	0.02
22221	15.89	-93.95	-0.58
22222	96.25	-13.59	-0.08
22321	34.40	-75.44	-0.46
22322	93.74	-16.10	-0.10
22421	564.31	454.47	2.79
22422	45.19	-64.65	-0.40
221121	46.75	-63.09	-0.39
221122	37.69	-72.15	-0.44

Table 2.7. Tanh Fit Parameters for Charpy Impact Percent Shear Data (A508-2)

KEY	J	A	B	T0	C	PHI	VAR
22121	4	50.12	48.78	57.84	50.80	6	125.77
22122	4	50.22	49.56	65.39	65.64	8	117.31
22221	4	49.18	49.18	74.48	55.15	5	102.20
22222	4	52.00	47.46	104.02	46.41	5	81.57
22321	4	41.69	41.69	28.17	102.86	3	218.43
22322	4	39.34	37.38	36.66	70.56	4	329.06
22421	4	52.73	42.60	80.48	41.69	5	777.05
22422	4	51.37	50.40	82.61	98.04	5	195.85
221121	4	31.59	31.59	53.70	116.37	6	137.58
221122	4	31.50	29.42	54.09	139.31	6	84.13

Table 2.8. Deviation of Charpy Impact Percent Shear Curve Fit Parameters from Mean Value (A508-2)

A

TOTAL	449.74
MEAN	44.974
ST. DEV	8.335519980

KEY	VAL	DEV	NORMALIZED DEV
22121	50.12	5.15	0.62
22122	50.22	5.25	0.63
22221	49.18	4.21	0.50
22222	52.00	7.03	0.84
22321	41.69	-3.28	-0.39
22322	39.34	-5.63	-0.68
22421	52.73	7.76	0.93
22422	51.37	6.40	0.77
221121	31.59	-13.38	-1.61
221122	31.50	-13.47	-1.62

B

TOTAL	428.06
MEAN	42.806
ST. DEV	7.724237755

KEY	VAL	DEV	NORMALIZED DEV
22121	46.78	5.97	0.77
22122	49.56	6.75	0.87
22221	49.18	6.37	0.83
22222	47.46	4.65	0.60
22321	41.69	-1.12	-0.14
22322	37.38	-5.43	-0.70
22421	42.60	-0.21	-0.03
22422	50.40	7.59	0.98
221121	31.59	-11.22	-1.45
221122	29.42	-13.39	-1.73

Table 2.8. (continued)

T_0

TOTAL	637.44
MEAN	63.744
ST. DEV	22.61793349

KEY	VAL	DEV	NORMALIZED DEV
22121	57.84	-5.90	-0.26
22122	65.39	1.65	0.07
22221	74.48	10.74	0.47
22222	104.02	40.28	1.78
22321	28.17	-35.57	-1.57
22322	36.66	-27.08	-1.20
22421	80.48	16.74	0.74
22422	82.61	18.87	0.83
221121	53.70	-10.04	-0.44
221122	54.09	-9.65	-0.43

C

TOTAL	776.83
MEAN	77.683
ST. DEV	32.38940932

KEY	VAL	DEV	NORMALIZED DEV
22121	50.80	-26.88	-0.82
22122	65.64	-12.04	-0.37
22221	55.15	-22.53	-0.69
22222	46.41	-31.27	-0.95
22321	102.86	25.18	0.77
22322	70.56	-7.12	-0.22
22421	41.69	-35.99	-1.09
22422	88.04	10.36	0.31
221121	116.37	38.69	1.18
221122	139.31	61.63	1.87

Table 2.8. (continued)

PHI

TOTAL	53
MEAN	5.3
ST. DEV	1.337493510

KEY	VAL	DEV	NORMALIZED DEV
22121	6.00	0.70	0.52
22122	8.00	2.70	2.02
22221	5.00	-0.30	-0.22
22222	5.00	-0.30	-0.22
22321	3.00	-2.30	-1.72
22322	4.00	-1.30	-0.97
22421	5.00	-0.30	-0.22
22422	5.00	-0.30	-0.22
221121	6.00	0.70	0.52
221122	6.00	0.70	0.52

VARIANCE

TOTAL	2168.95
MEAN	216.895
ST. DEV	210.9254767

KEY	VAL	DEV	NORMALIZED DEV
22121	125.77	-91.13	-0.43
22122	117.31	-99.59	-0.47
22221	102.20	-114.70	-0.54
22222	81.57	-135.33	-0.64
22321	218.43	1.54	0.01
22322	329.06	112.17	0.53
22421	777.05	560.16	2.66
22422	195.85	-21.05	-0.10
221121	137.58	-79.32	-0.38
221122	84.13	-132.77	-0.63

Table 2.9. Comparison of To - C from Impact Test Measurements with RT_{NDT} and NDTT (A508-2).

KEY	To - C (^{o}F) IMPACT ENERGY	LATERAL EXPANSION	PERCENT SHEAR	RT_{NDT} (^{o}F)	NDTT (^{o}F)
22121	-47	-52	7	20	20
22122	-54	-84	0		
22221	-33	-27	19	20	20
22222	-22	-57	58		
22321	-57	-48	-75	30	30
22322	-29	-23	-34		
22421	-76	-13	38	40	40
22422	-54	-74	-5		
221121	-60	-36	-63	20	20
221122	-31	-46	-85		

Table 2.10. Tanh Fit Parameters for Precracked Charpy Toughness Data (A508-2)

KEY	J	A	B	T0	C	PHI	VAR
32122	2	165.49	132.05	100.85	90.39	3	962.00
32222	2	148.77	113.39	90.56	56.13	6	2002.52
32322	2	155.69	136.93	52.78	79.95	3	7161.33
32422	2	172.31	121.78	76.77	4.45	5	144.35
321122	2	165.00	131.88	90.00	16.31	4	341.23

Table 2.11. Deviation of Precracked Charpy Fracture Toughness Curve Fit Parameters from Mean Value (A508-2)

A

TOTAL	827.26
MEAN	165.452
ST. DEV	14.1663658

KEY	VAL	DEV	NORMALIZED DEV
32122	165.49	0.04	0.00
32222	148.77	-16.68	-1.18
32322	155.69	-9.76	-0.69
32422	172.31	6.86	0.48
321122	185.00	19.55	1.38

B

TOTAL	636.03
MEAN	127.206
ST. DEV	9.4893377

KEY	VAL	DEV	NORMALIZED DEV
32122	132.05	4.84	0.51
32222	113.39	-13.82	-1.46
32322	136.93	9.72	1.02
32422	121.78	-5.43	-0.57
321122	131.88	4.67	0.49

Table 2.11. (continued)

T_0

TOTAL	412.96
MEAN	82.592
ST. DEV	18.40574014

KEY	VAL	DEV	NORMALIZED DEV
32122	100.85	18.26	0.99
32222	90.56	7.97	0.43
32322	52.78	-29.81	-1.62
32422	78.77	-3.82	-0.21
21122	90.00	7.41	0.40

C

TOTAL	247.23
MEAN	49.446
ST. DEV	37.99412955

KEY	VAL	DEV	NORMALIZED DEV
32122	90.39	40.94	1.08
32222	56.13	6.68	0.18
32322	79.95	30.50	0.80
32422	4.45	-45.00	-1.18
321122	16.31	-33.14	-0.87

Table 2.11. (continued)

PHI

TOTAL	21
MEAN	4.2
ST. DEV	1.303840481

KEY	VAL	DEV	NORMALIZED DEV
32122	3.00	-1.20	-0.92
32222	6.00	1.80	1.38
32322	3.00	-1.20	-0.92
32422	5.00	0.80	0.61
321122	4.00	-0.20	-0.15

VARIANCE

TOTAL	10611.43
MEAN	2122.286
ST. DEV	2908.477403

KEY	VAL	DEV	NORMALIZED DEV
32122	962.00	-1160.29	-0.40
32222	2002.52	-119.77	-0.04
32322	7161.33	5039.04	1.73
32422	144.35	-1977.94	-0.68
321122	341.23	-1781.06	-0.61

Table 2.12. Tanh Fit Parameters for Precracked Charpy W/A Data (A508-2)

KEY	J	A	B	T0	C	PHI	VAR
32122	5	4220.47	4049.72	90.73	95.47	4	3.56E+05
32222	5	3241.67	2754.97	86.99	54.82	4	2.65E+05
32322	5	4109.82	3875.72	115.06	93.72	3	2.96E+05
32422	5	4362.35	3599.22	110.36	71.32	6	3.43E+05
321122	5	4713.77	4012.70	102.51	58.17	5	1.50E+05

Table 2.13. Deviation of Precracked Charpy W/A Curve Fit Parameters from Mean Values (A508-2)

A

TOTAL	20648.08
MEAN	4129.616
ST. DEV	546.0071978

KEY	VAL	DEV	NORMALIZED DEV
32122	4220.47	90.85	0.17
32222	3241.67	-887.95	-1.63
32322	4109.82	-19.80	-0.04
32422	4362.35	232.73	0.43
321122	4713.77	584.15	1.07

B

TOTAL	18292.33
MEAN	3658.466
ST. DEV	535.157881

KEY	VAL	DEV	NORMALIZED DEV
32122	4049.72	391.25	0.73
32222	2754.97	-903.50	-1.69
32322	3875.72	217.25	0.41
32422	3599.22	-59.25	-0.11
321122	4012.70	354.23	0.66

Table 2.13. (continued)

T_0

TOTAL	505.65
MEAN	101.13
ST. DEV	12.13715164

KEY	VAL	DEV	NORMALIZED DEV
32122	90.73	-10.40	-0.86
32222	86.99	-14.14	-1.17
32322	115.06	13.93	1.15
32422	110.36	9.23	0.76
31122	102.51	1.38	0.11

C

TAL	373.5
MEAN	74.7
ST. DEV	19.19005602

KEY	VAL	DEV	NORMALIZED DEV
32122	95.47	20.77	1.08
32222	54.82	-19.88	-1.04
32322	93.72	19.02	0.99
32422	71.32	-3.38	-0.18
31122	58.17	-16.53	-0.86

Table 2.13. (continued)

PHI

TOTAL	22
MEAN	4.4
ST. DEV	1.140175425

KEY	VAL	DEV	NORMALIZED DEV
32122	4.00	-0.40	-0.35
32222	4.00	-0.40	-0.35
32322	3.00	-1.40	-1.23
32422	6.00	1.60	1.40
321122	5.00	0.60	0.53

VARIANCE

TOTAL	1409160
MEAN	281832
ST. DEV	82422.18664

KEY	VAL	DEV	NORMALIZED DEV
32122	3.56E+05	73680.00	0.89
32222	2.65E+05	-16650.00	-0.20
32322	2.96E+05	13706.00	0.17
32422	3.43E+05	61529.00	0.75
^21122	1.50E+05	-1.32E+05	-1.60

Table 2.14. Comparison of Precracked Charpy Transition Behavior with NDTT and RT_{NDT} (A508-2)

KEY	$T_0 - C$ (^oF) K_{Id}, K_d^*	W/A	RT_{NDT}(^oF)	NDTT(^oF)
32122	10	-5	20	20
32222	34	32	20	20
32322	-27	21	30	30
32422	74	40	40	40
321122	74	44	20	20

Table 2.15. Summary of Error Code Analysis for Material 2 (A508-2)

TEST TYPE	INCLUDES ERROR CODES	NO. OF POINTS	SHELF(Ft-Lb) LOWER	SHELF(Ft-Lb) UPPER	VARIANCE OVERALL	VARIANCE TRANSITION REGION	VARIANCE RATIO F OVERALL	VARIANCE RATIO F TRANSITION REGION
Static (5)	Yes	25	97	--	2626	3098		
							0.814	1.230
	No	19	8	--	3228	2519		
Dynamic (7,8)	Yes	30	31	--	2031	3392		
							1.098	1.051
	No	26	28	--	1850	3226		

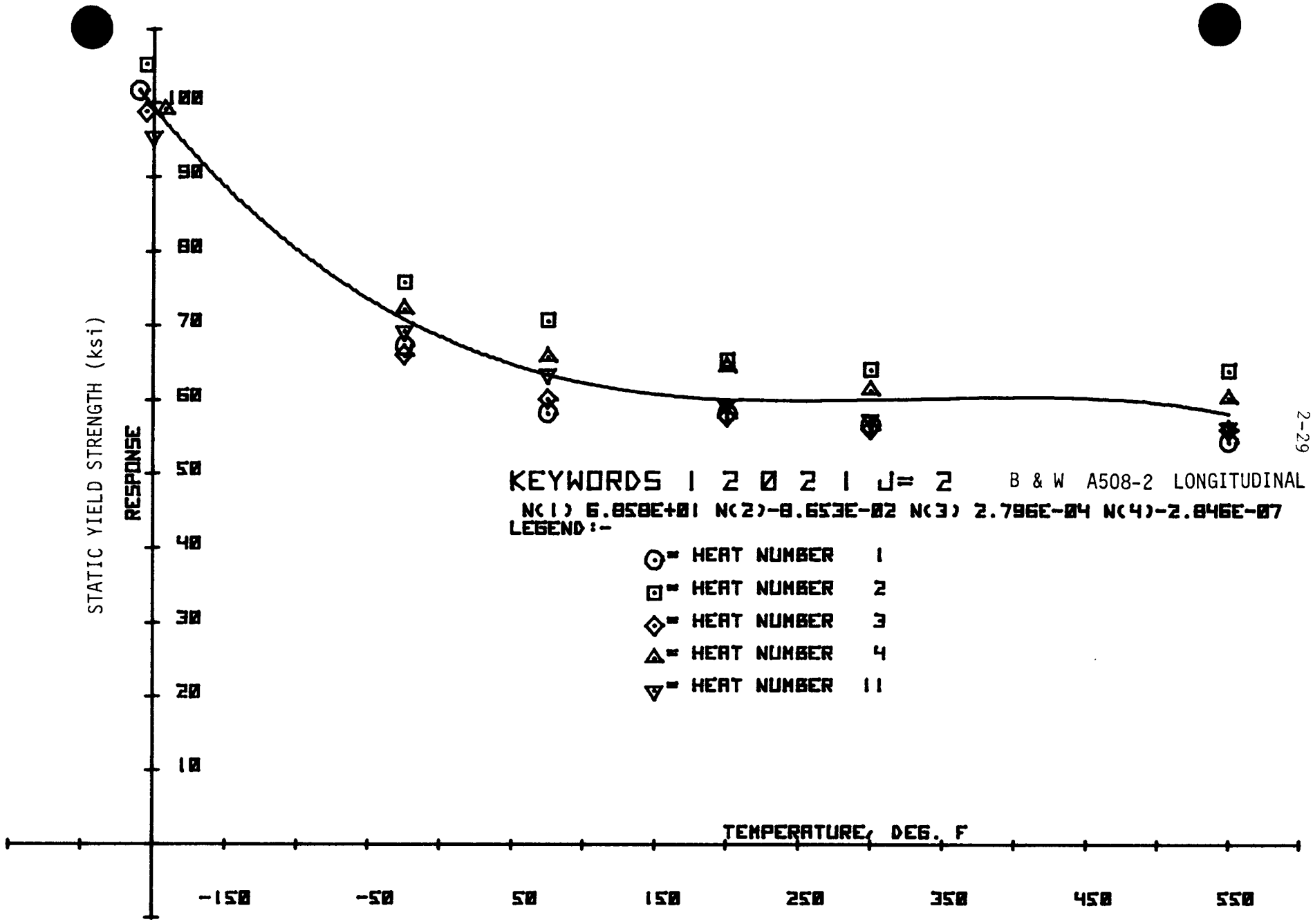


Figure 2.1 Tensile Static Yield Strength for B&W Heats (L)

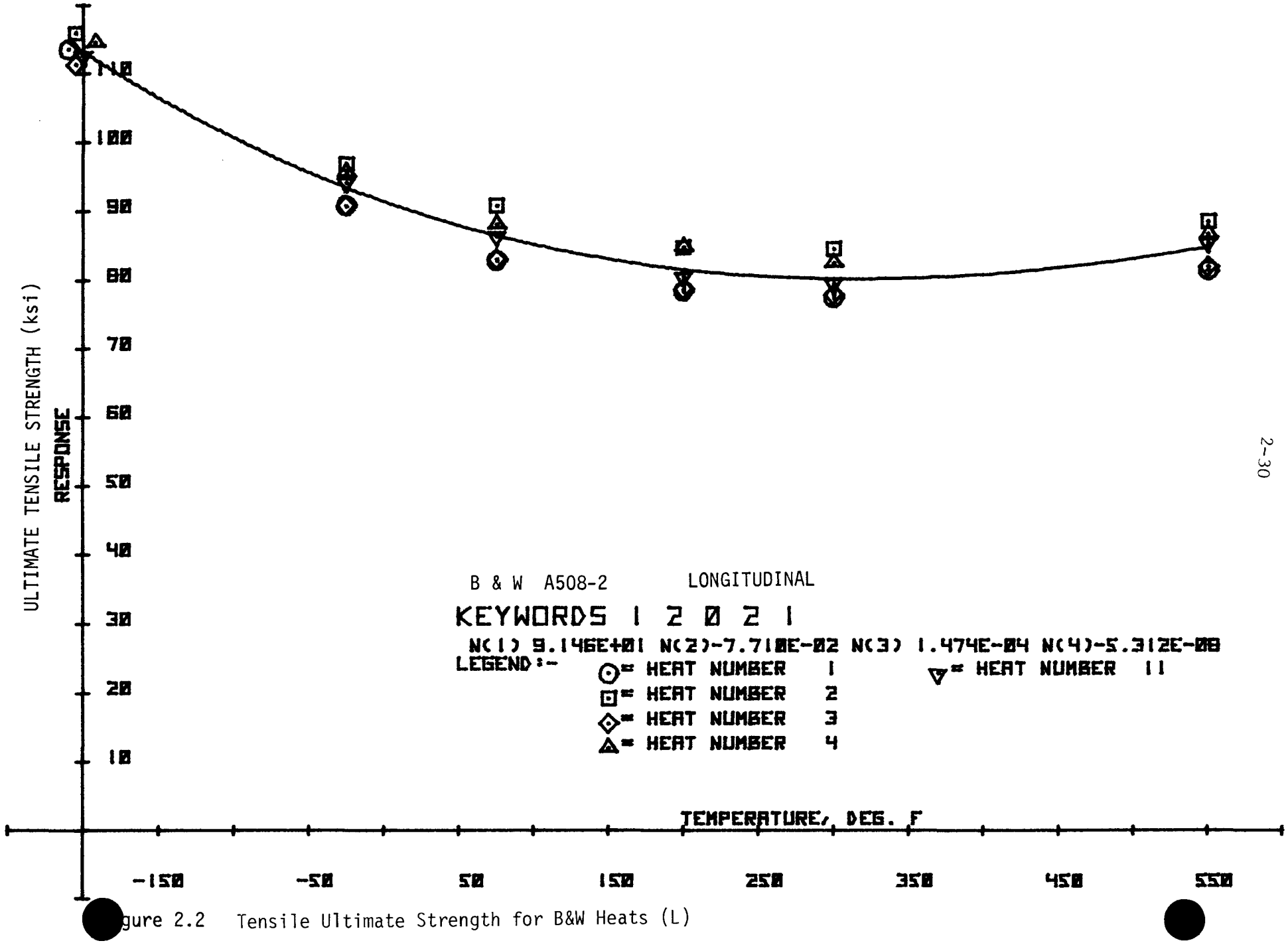


Figure 2.2 Tensile Ultimate Strength for B&W Heats (L)

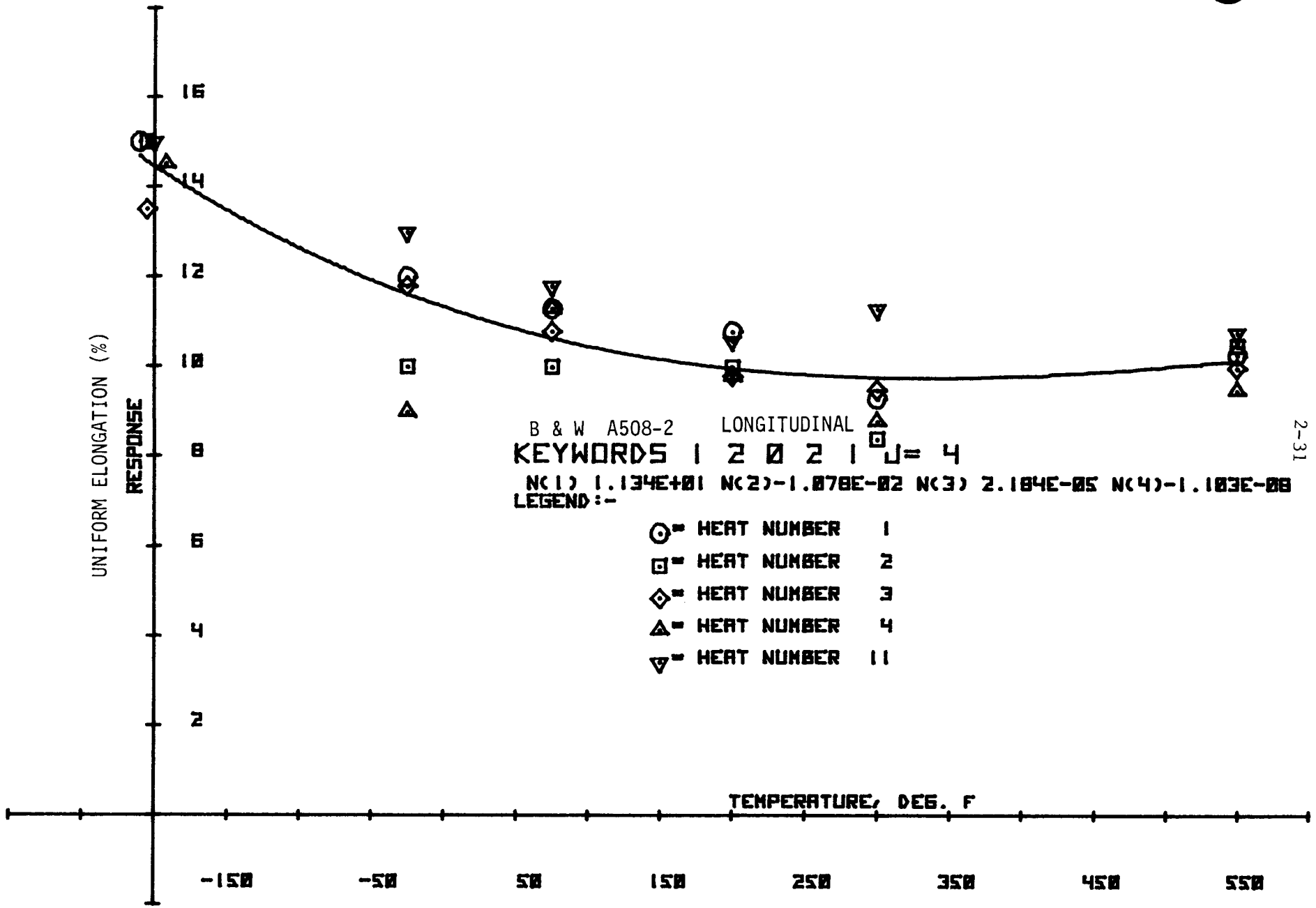
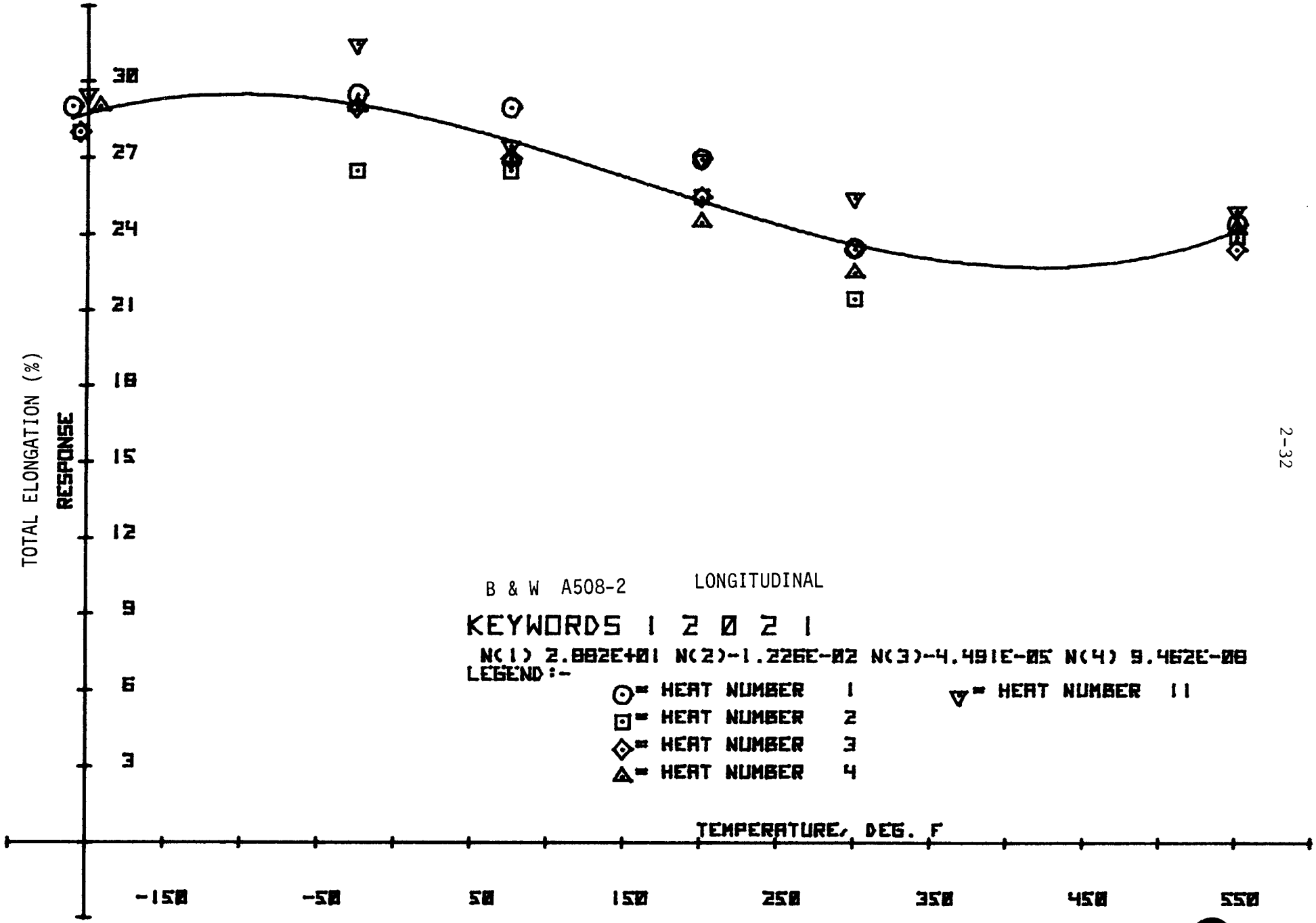


Figure 2.3 Tensile Uniform Elongation for B&W Heats (L)



ure 2.4 Tensile Total Elongation for B&W Heats (L)

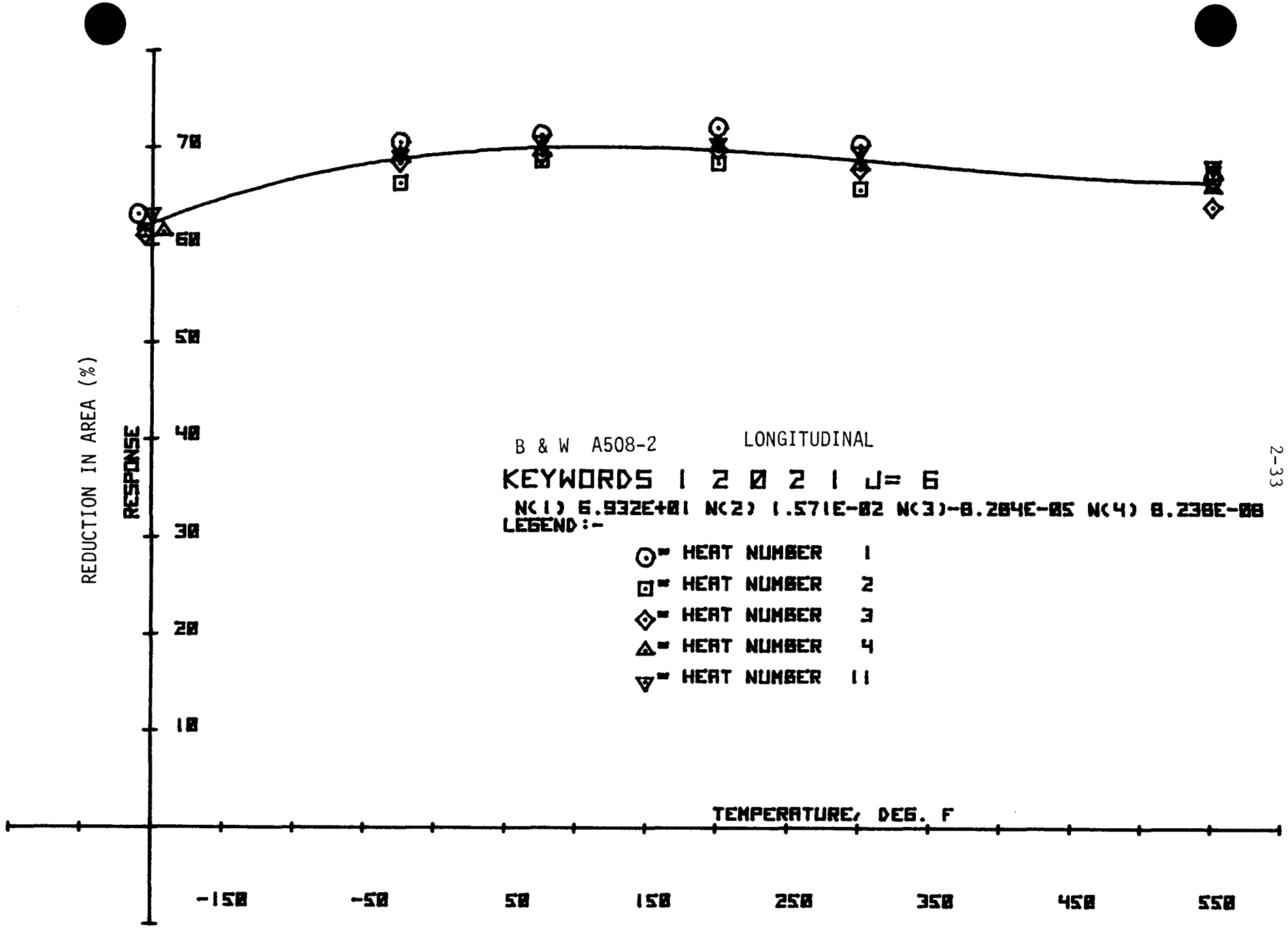


Figure 2.5 Tensile Reduction in Area for B&W Heats (L)

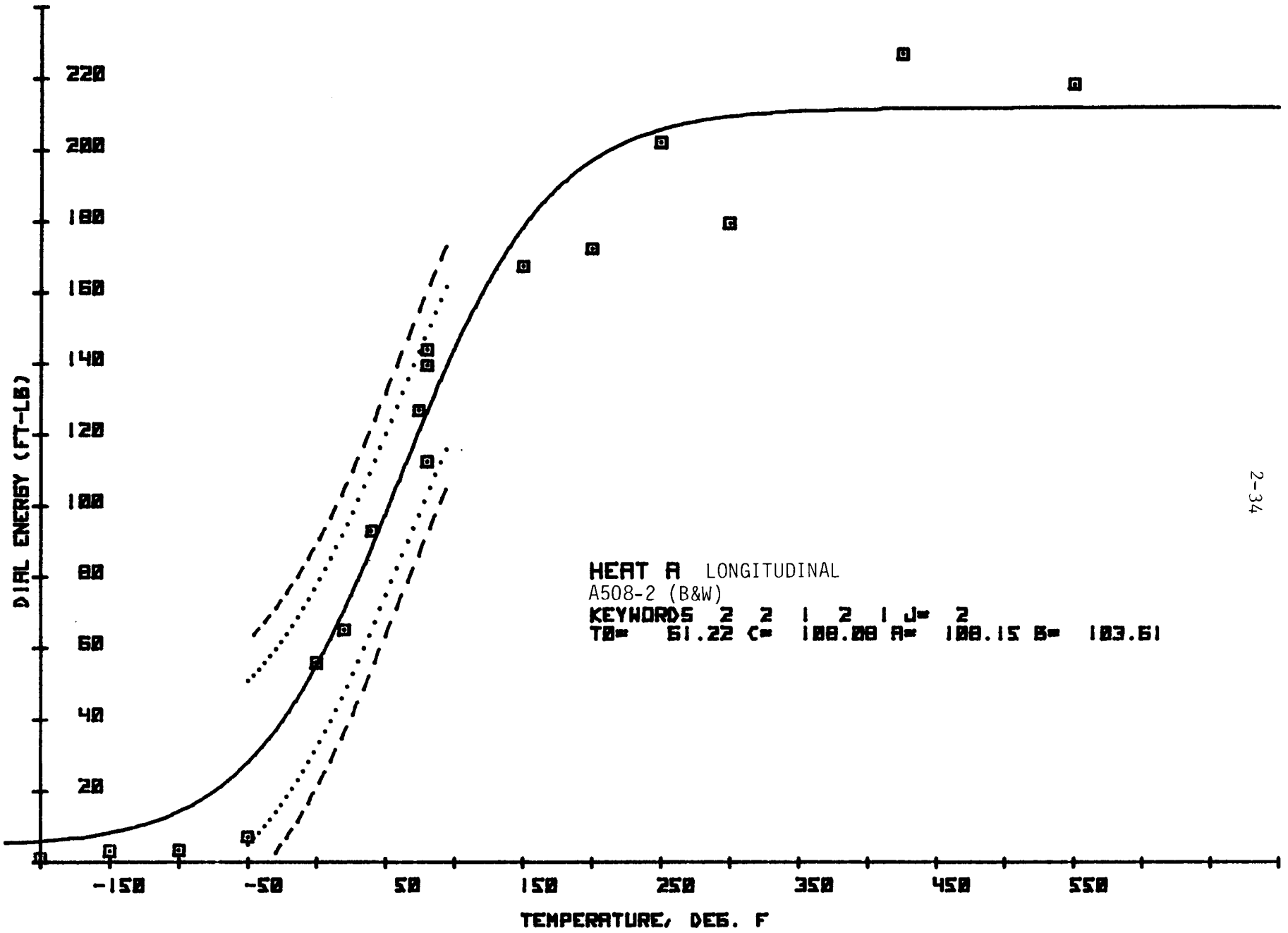


Figure 2.6. Charpy V-Notch Dial Energy for B&W Heat A (L)

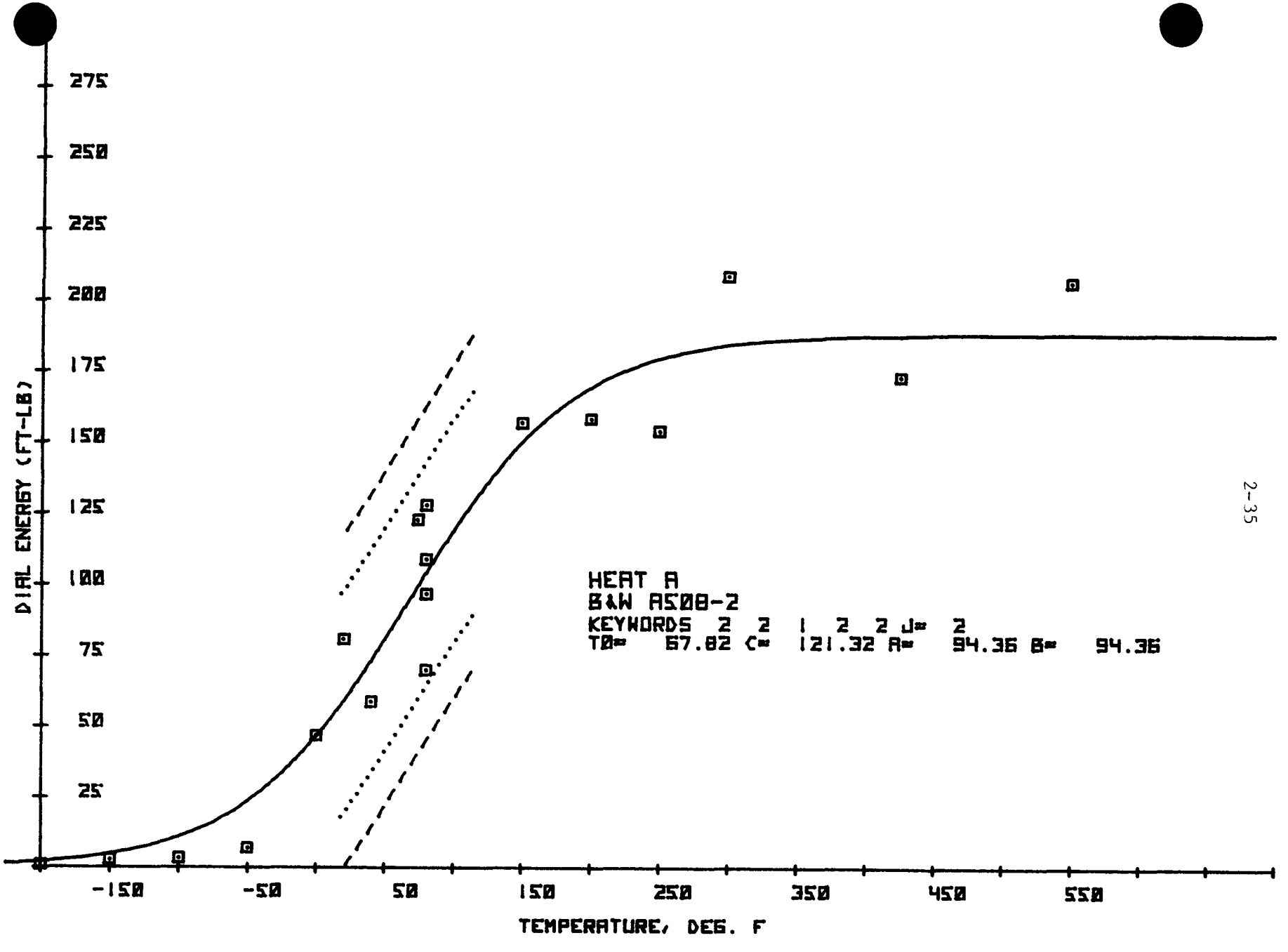


Figure 2.7. Charpy V-Notch Dial Energy for B&W Heat A (T)

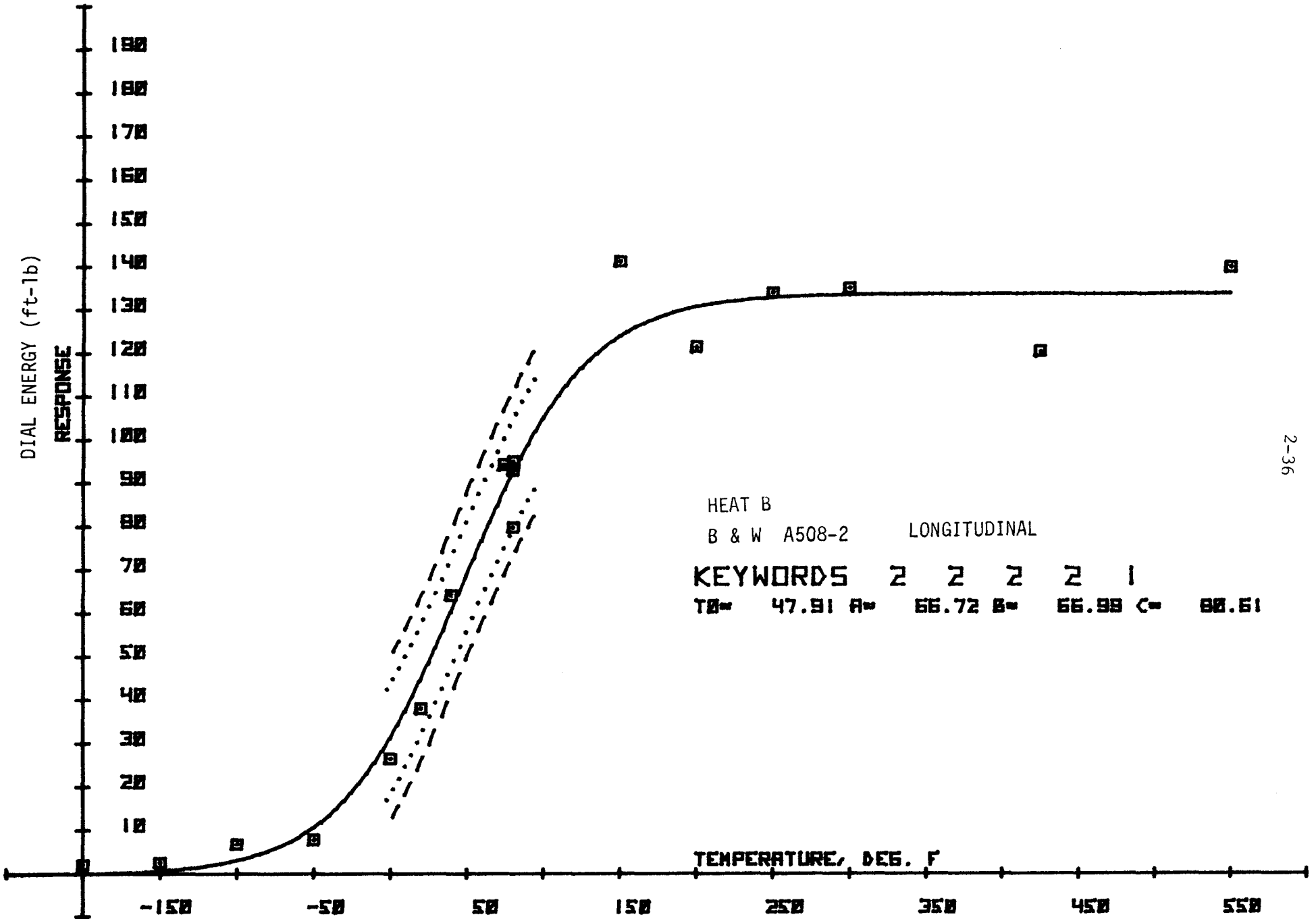


Figure 2.8 Charpy V-Notch Dial Energy for B&W Heat B (L)

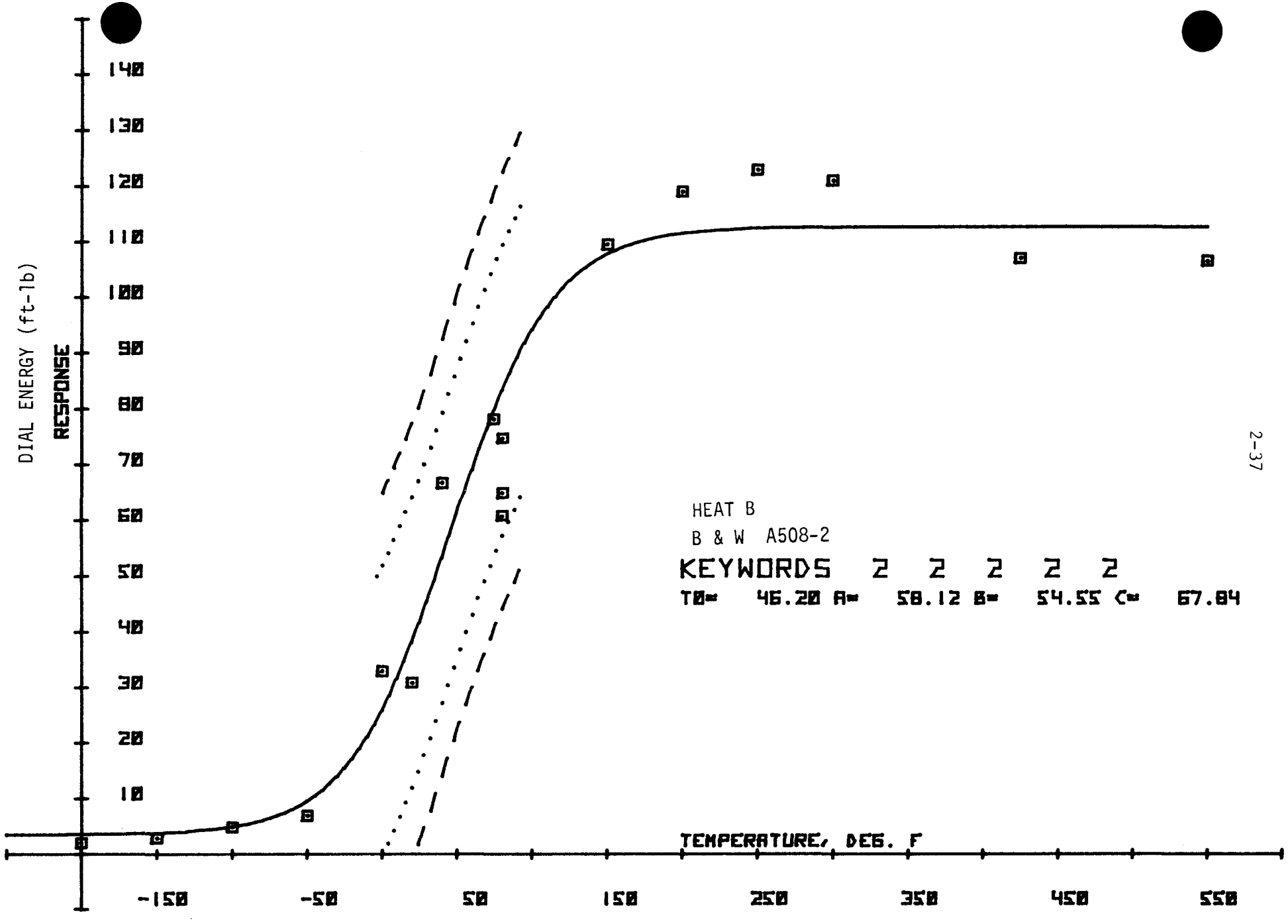
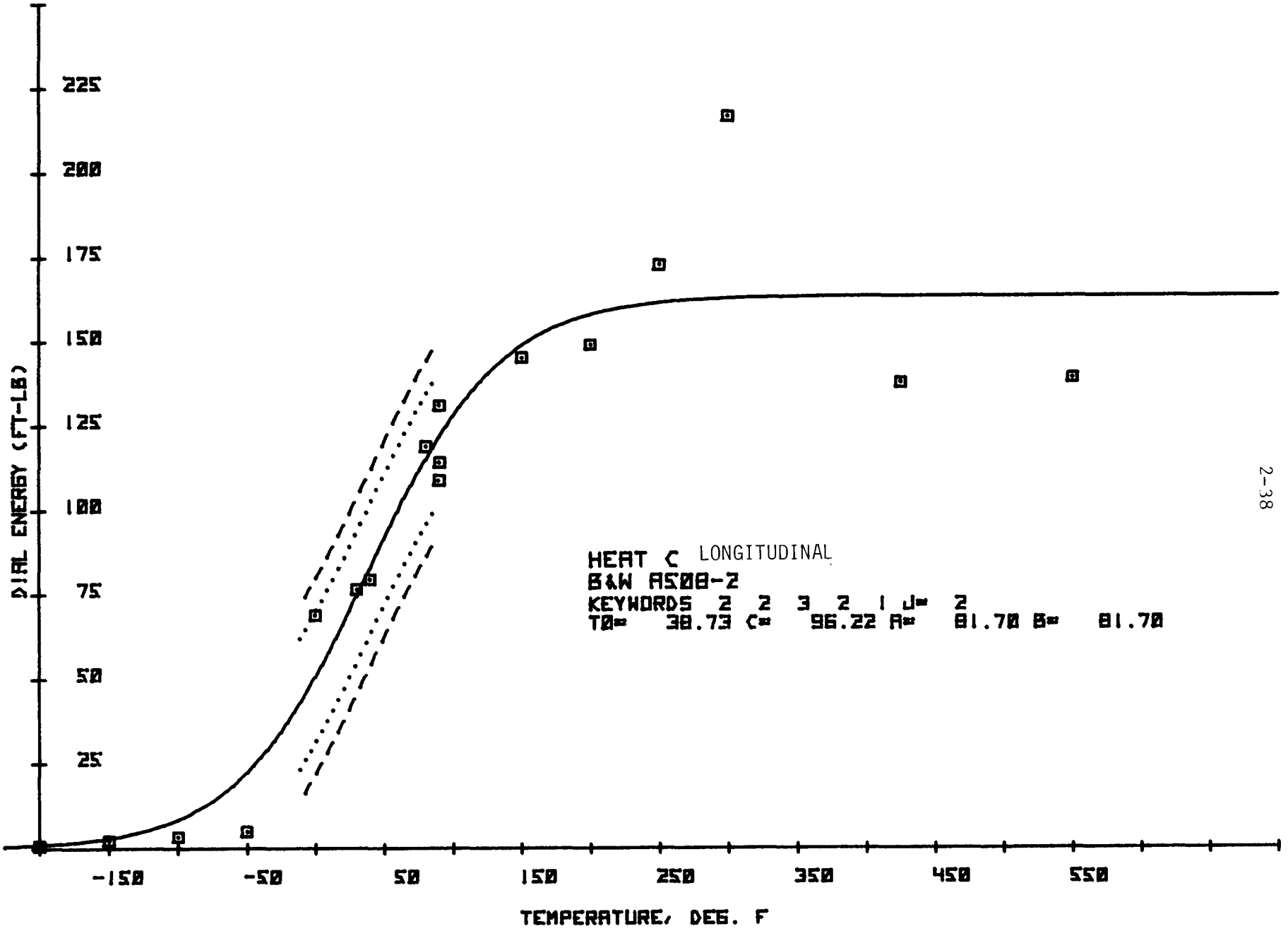


Figure 2.9 Charpy V-Notch Dial Energy for B&W Heat B (T)



ure 2.10. Charpy V-Notch Dial Energy for B&W Heat C (L)

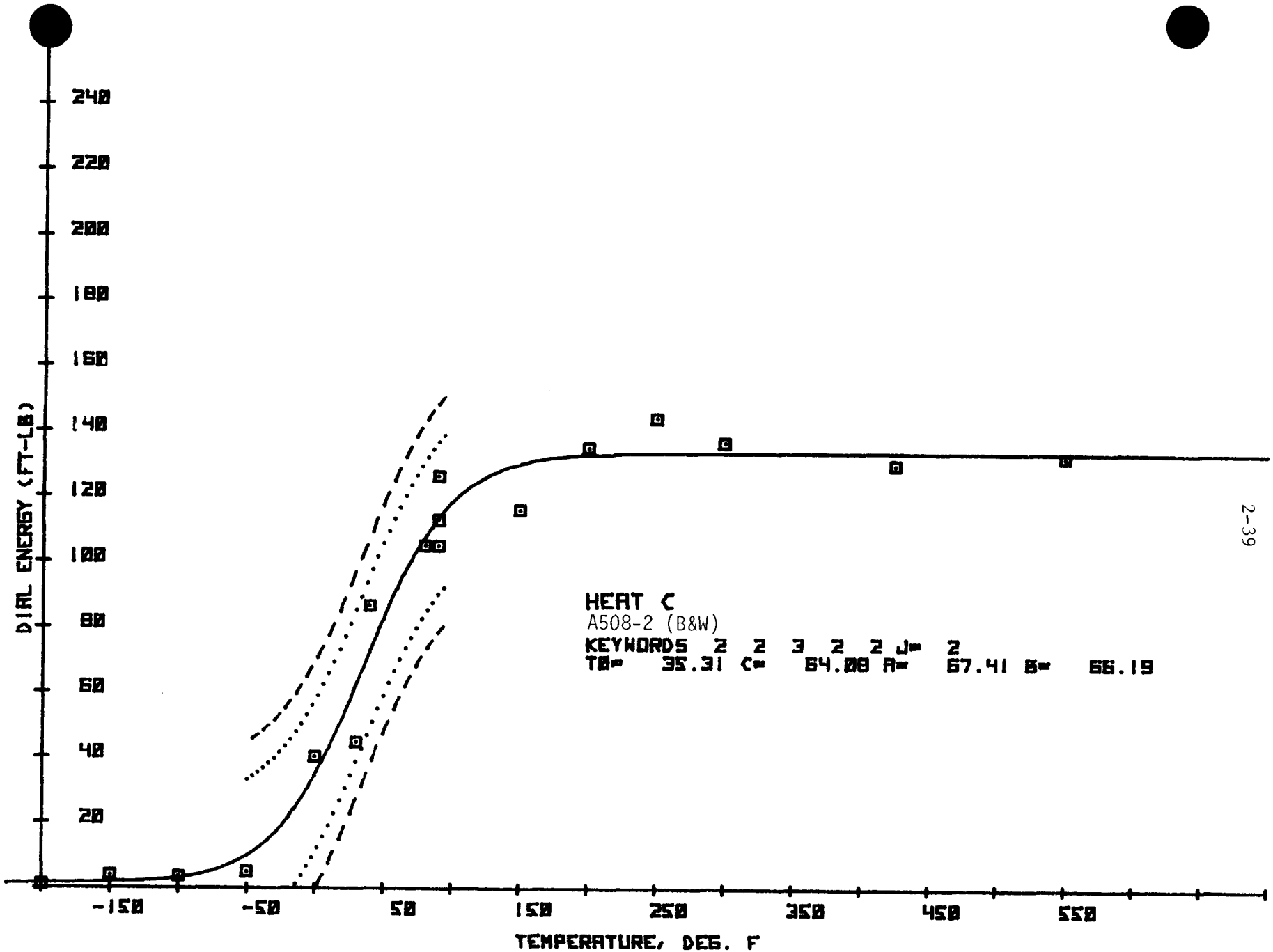


Figure 2.11. Charpy V-Notch Dial Energy for B&W Heat C (T)

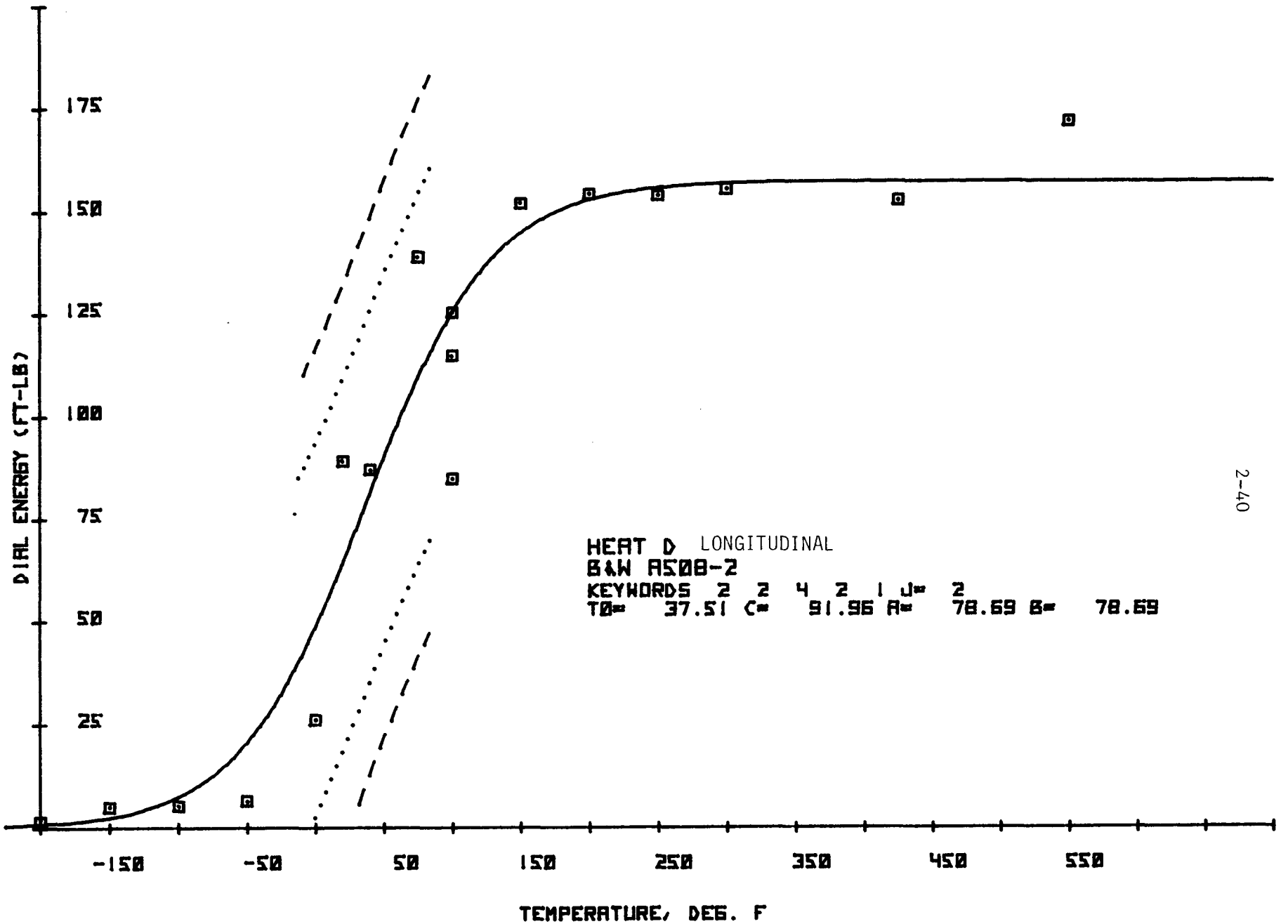


Figure 2.12. Charpy V-Notch Dial Energy for B&W Heat D (L)

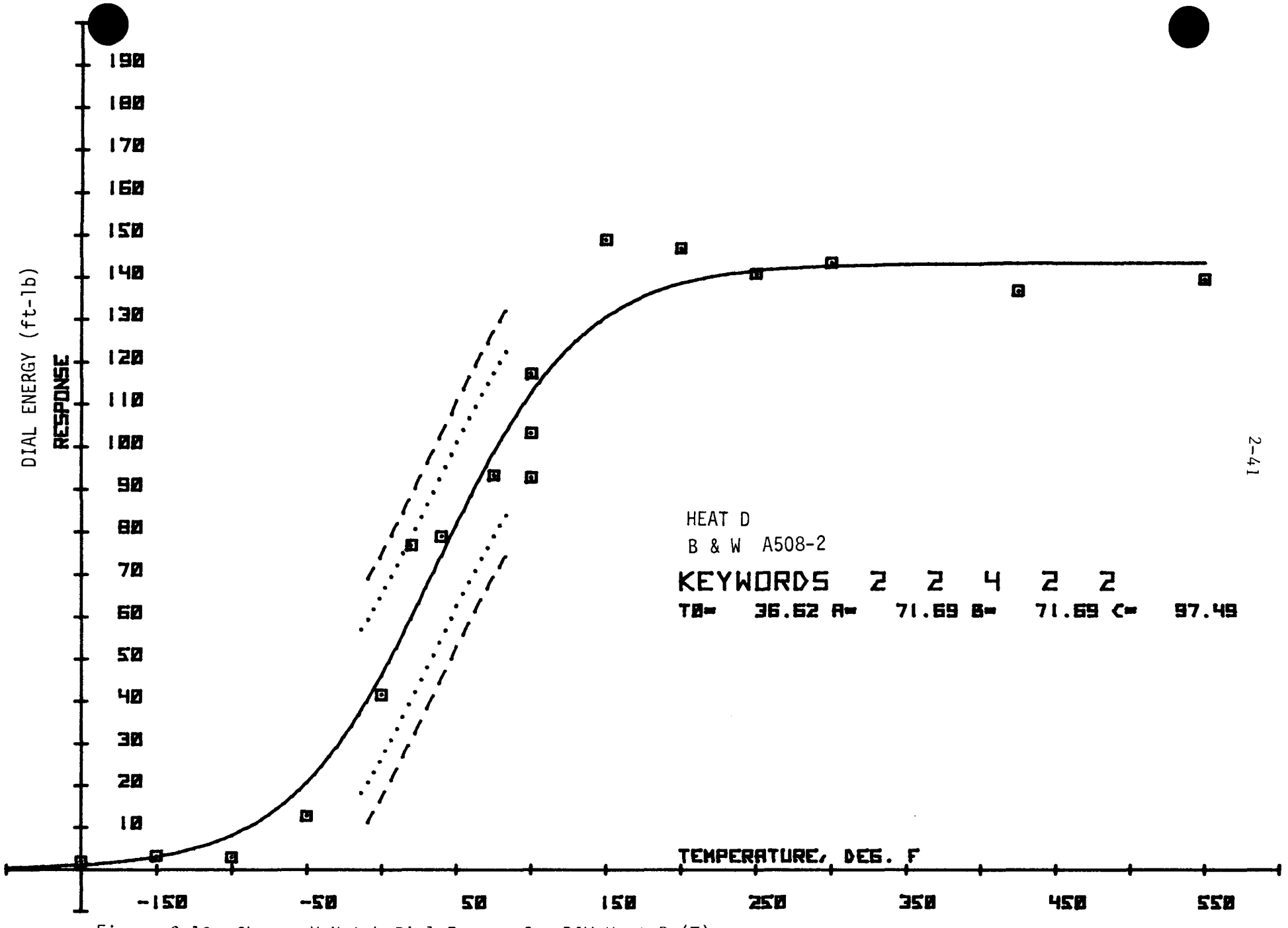


Figure 2.13 Charpy V-Notch Dial Energy for B&W Heat D (T)

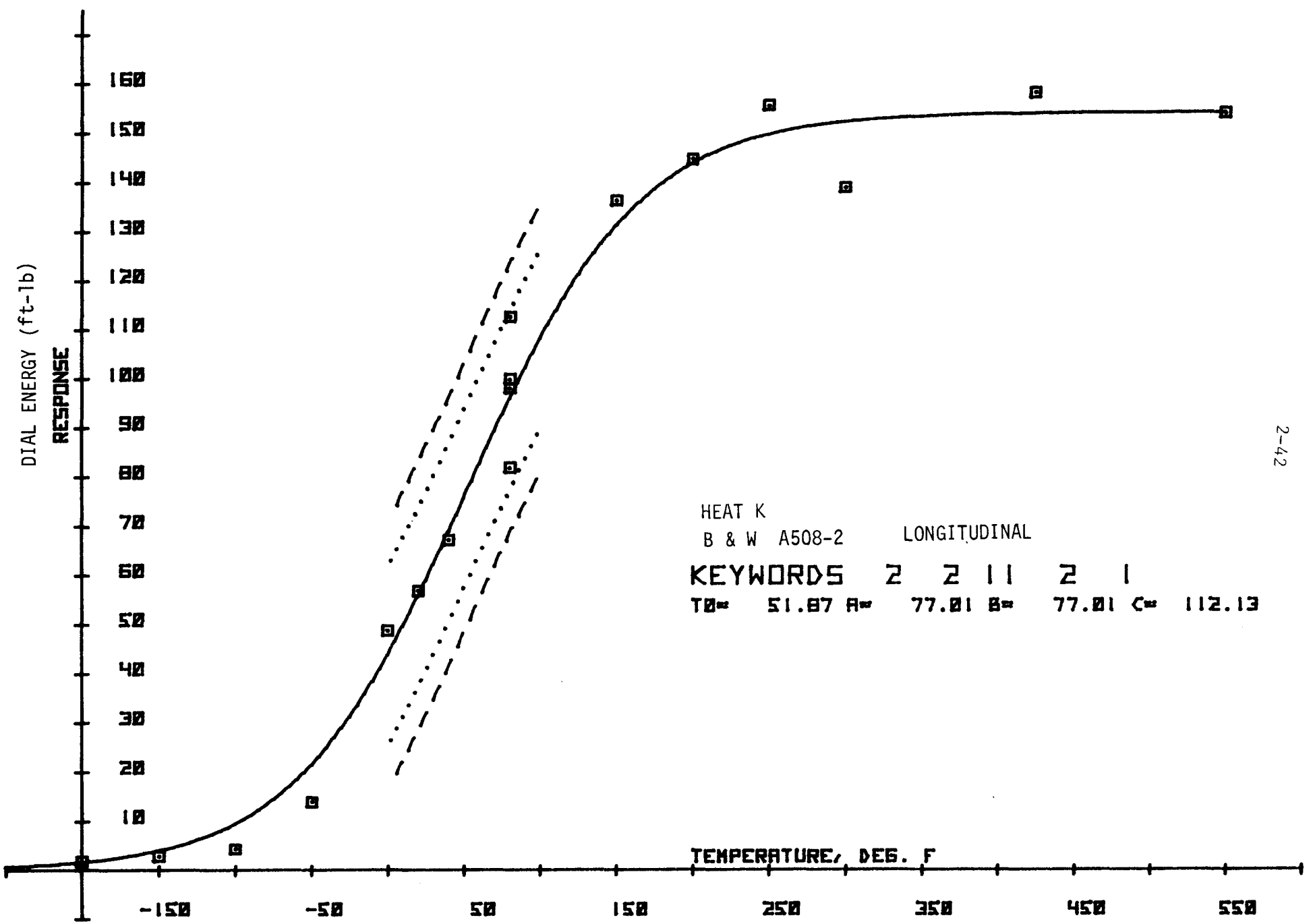


Figure 2.14 Charpy V-Notch Dial Energy for B&W Heat K (L)

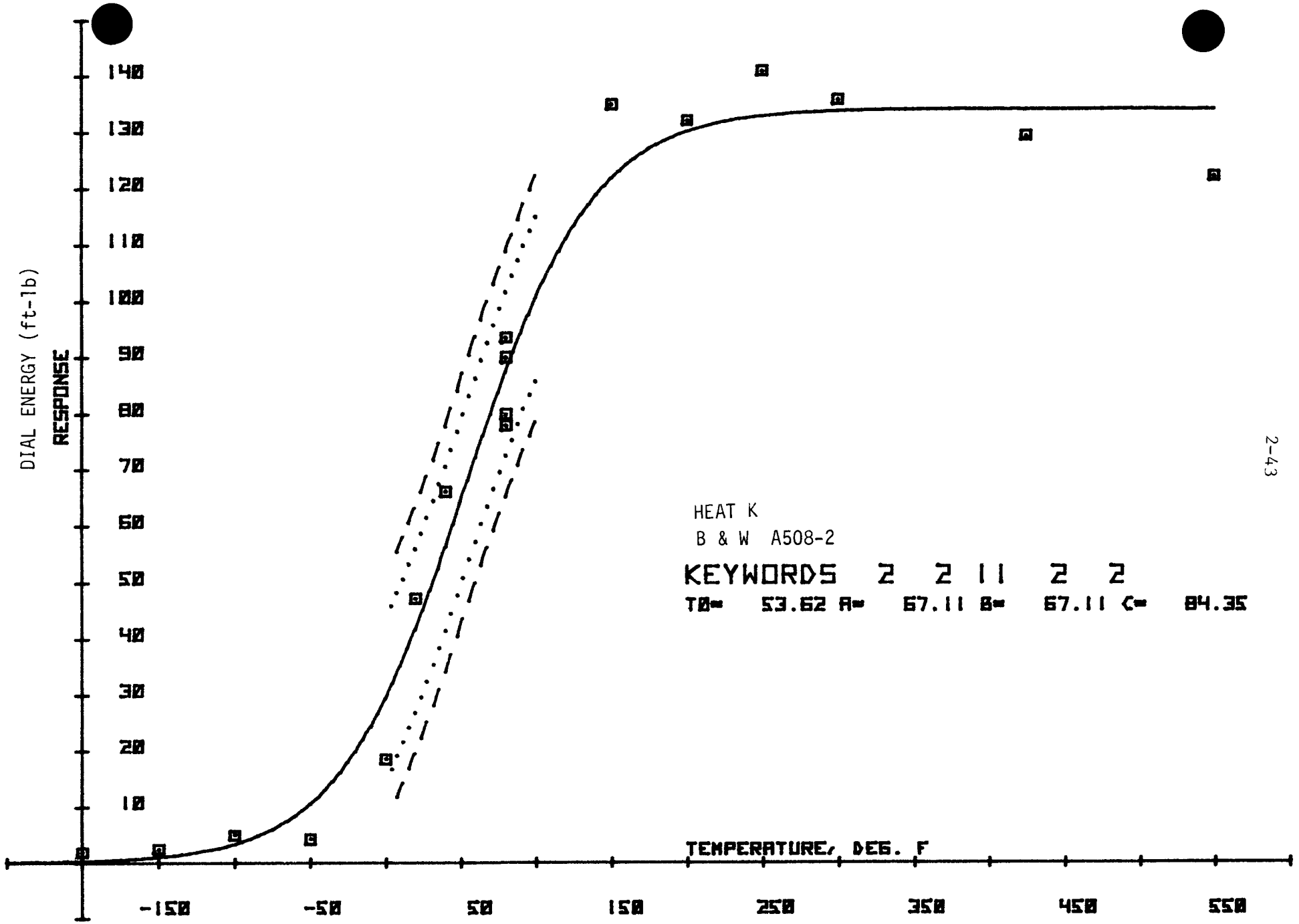


Figure 2.15 Charpy V-Notch Dial Energy for B&W Heat K (T)

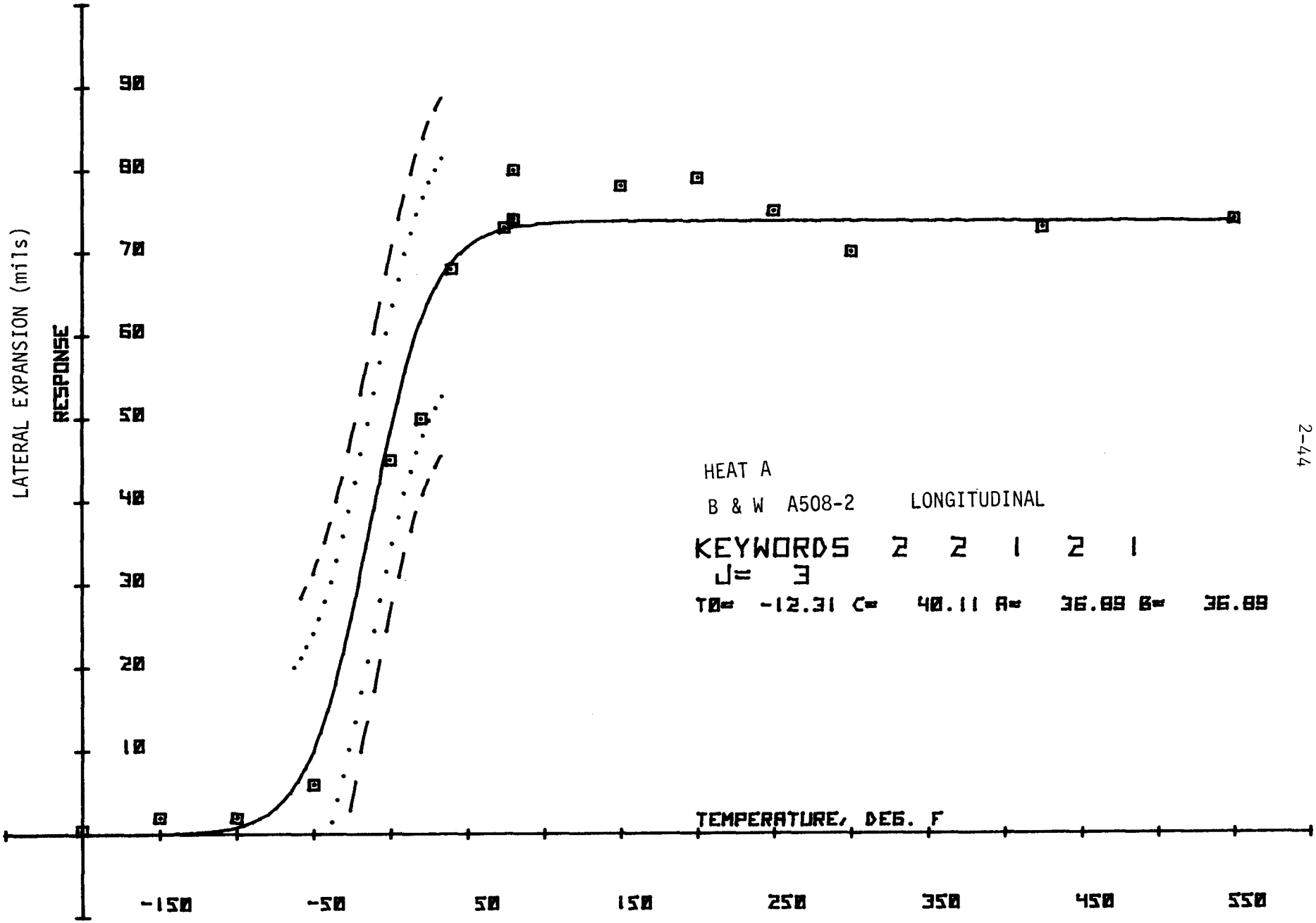


Figure 2.16 Charpy V-Notch Lateral Expansion for B&W Heat A (L)

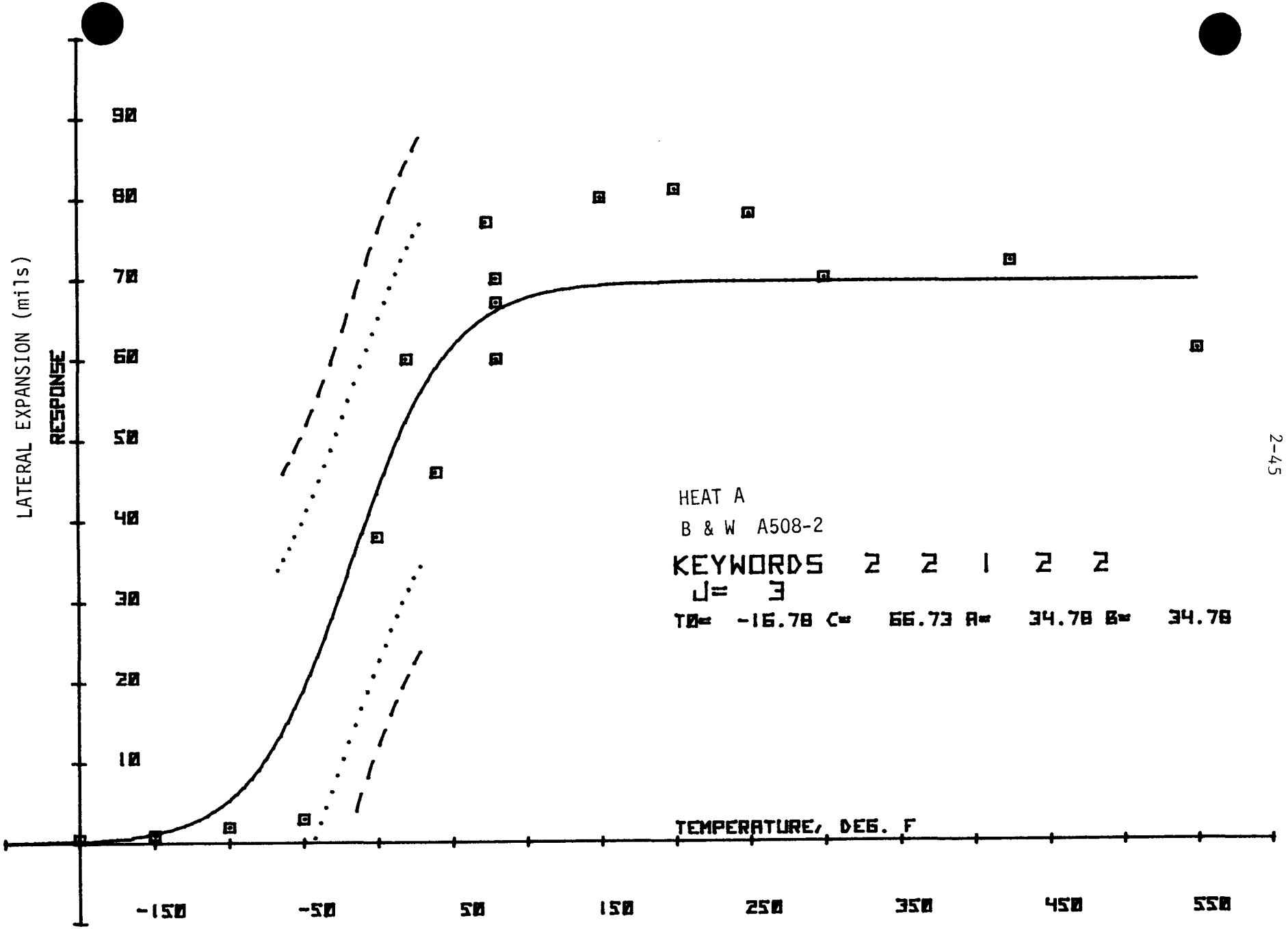
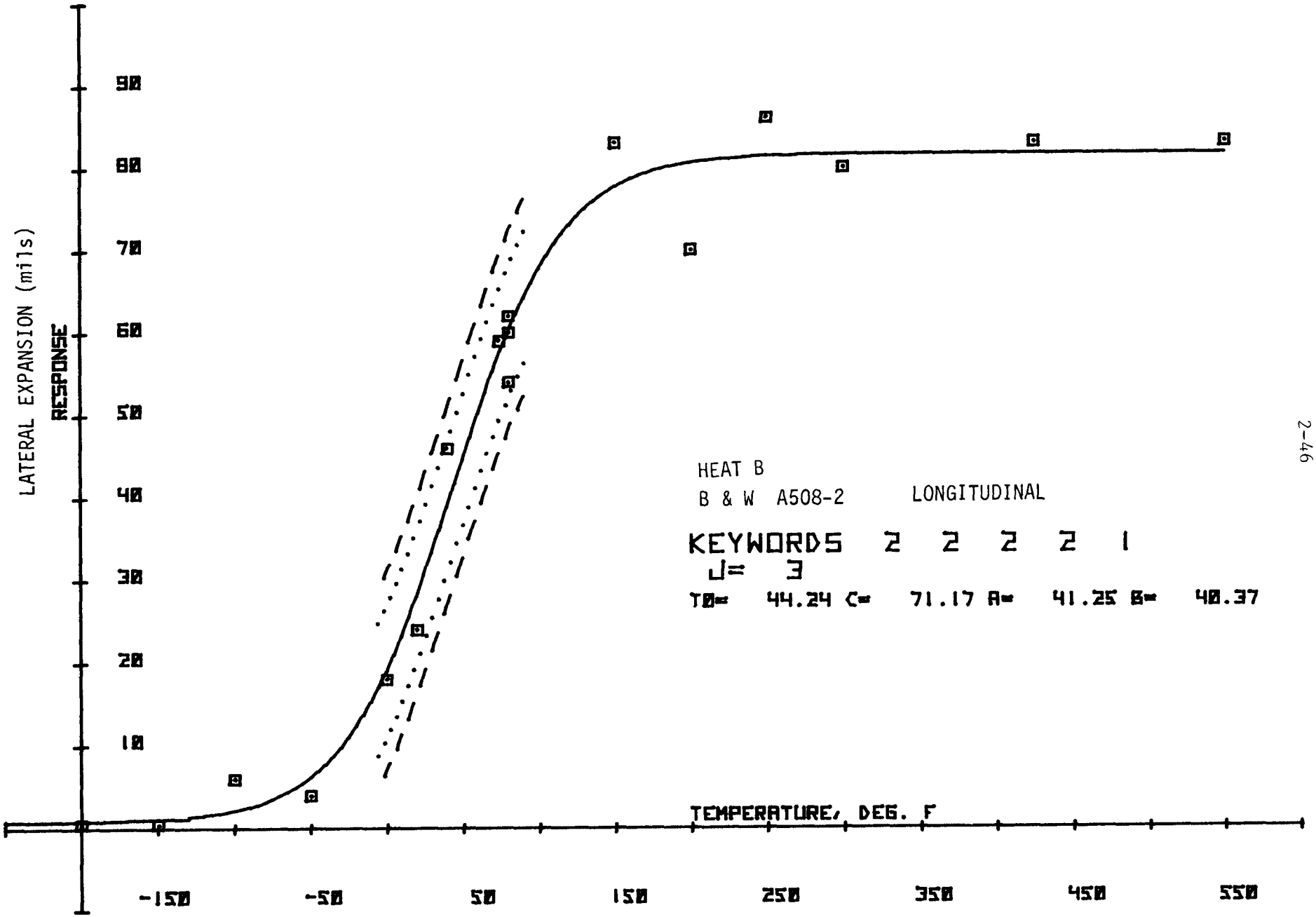


Figure 2.17 Charpy V-Notch Lateral Expansion for B&W Heat A (T)



ure 2.18 Charpy V-Notch Lateral Expansion for B&W Heat B (L)

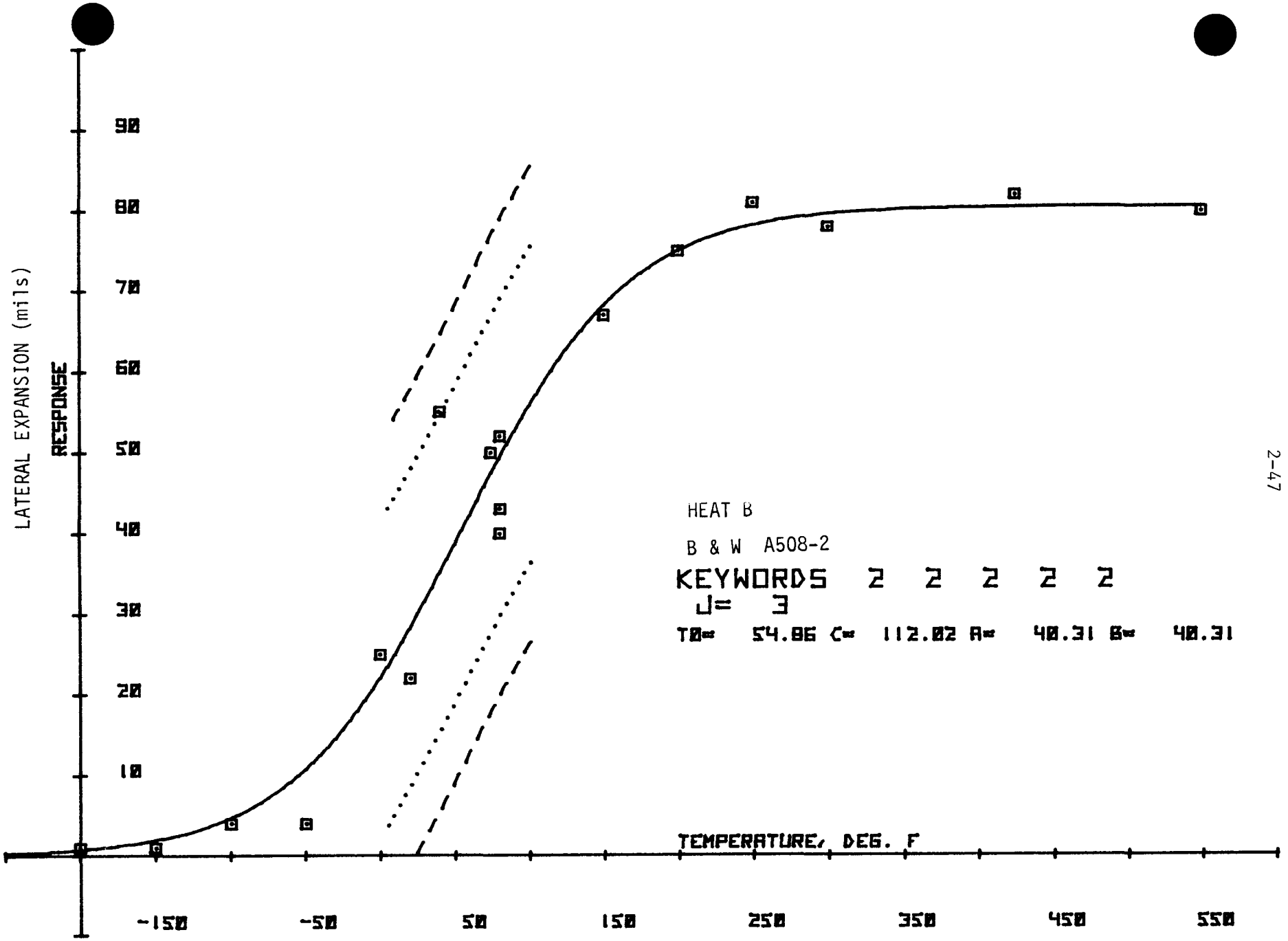


Figure 2.19 Charpy V-Notch Lateral Expansion for B&W Heat B (T)

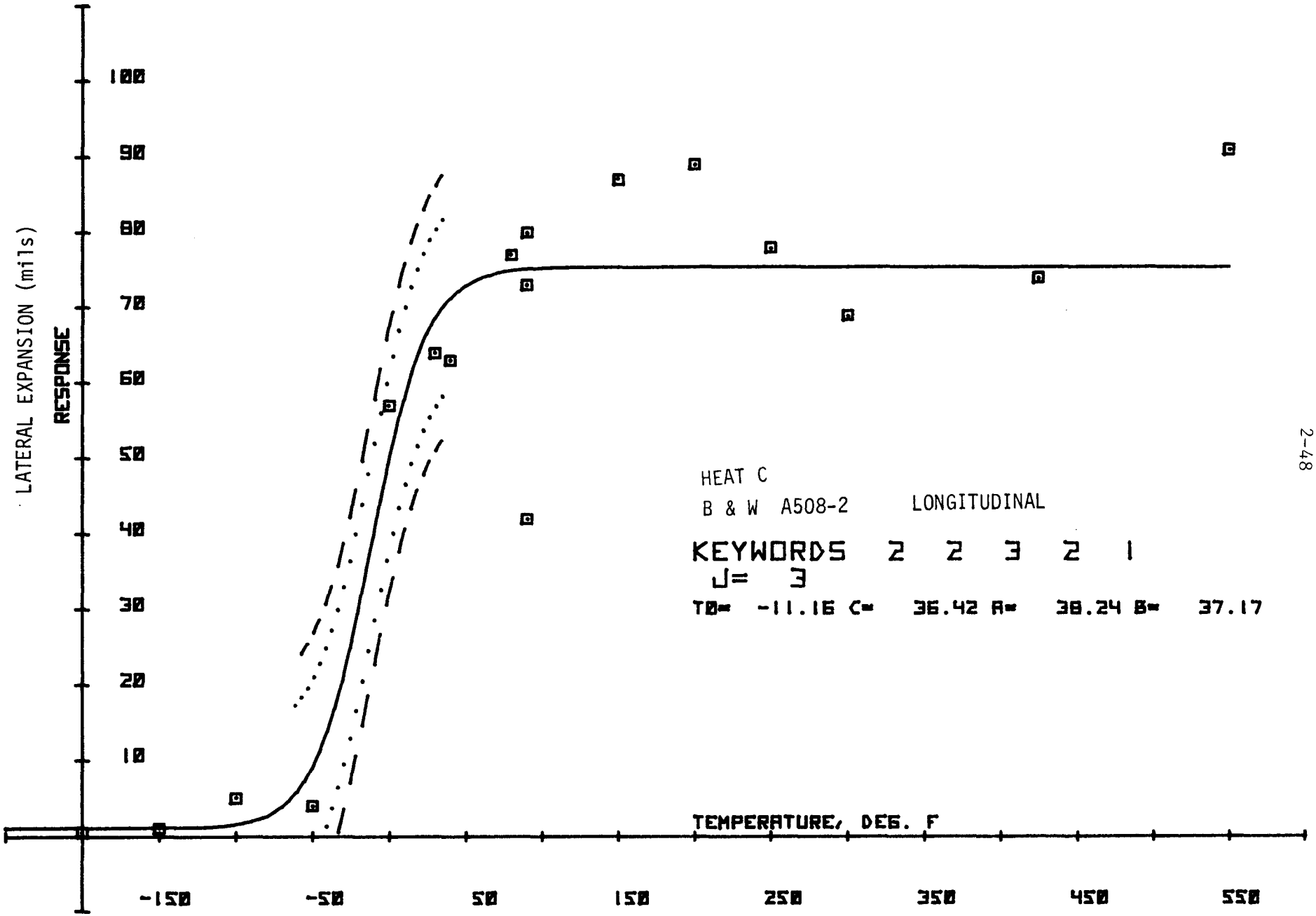


Figure 2.20 Charpy V-Notch Lateral Expansion for B&W Heat C (L)

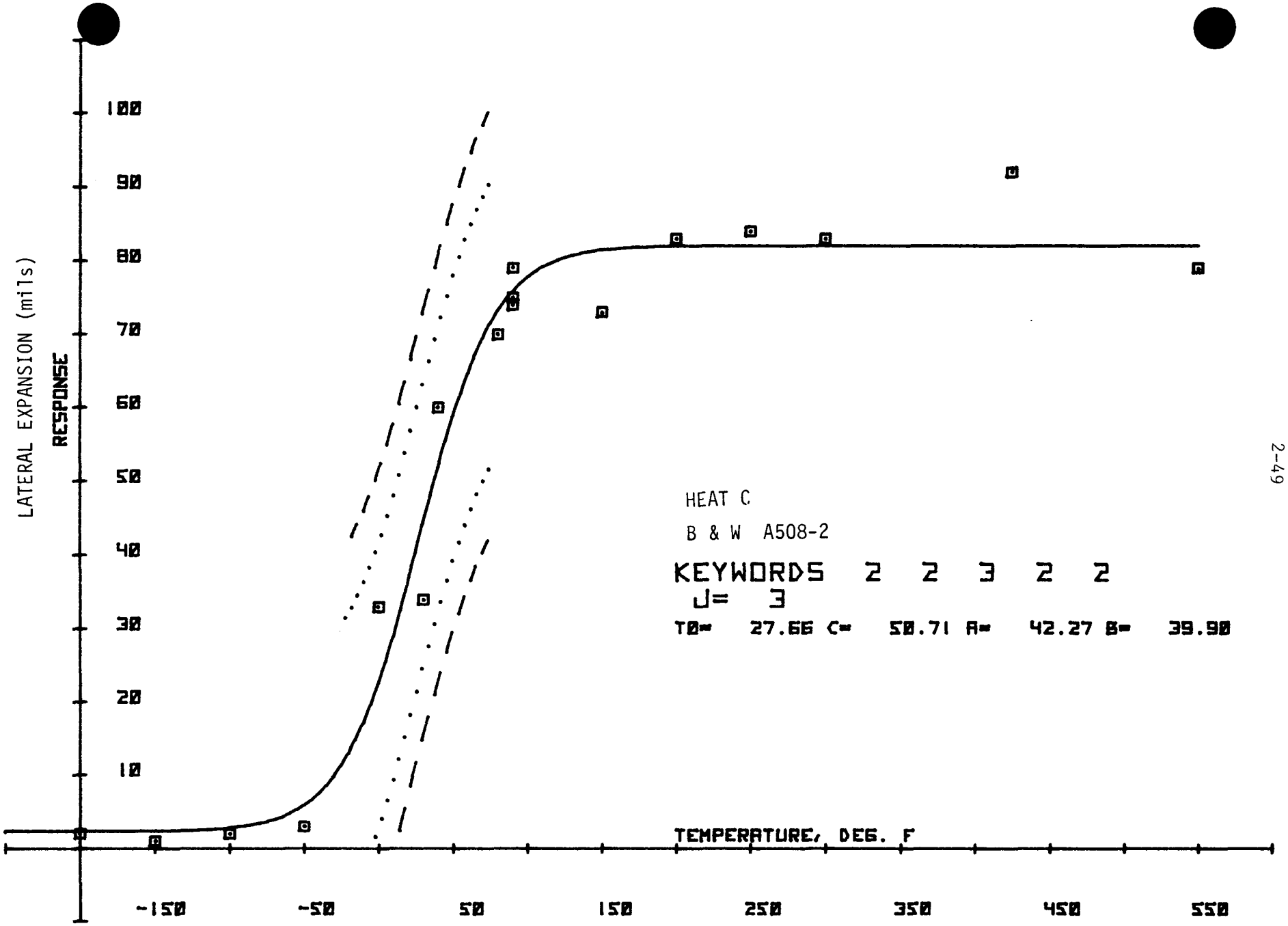


Figure 2.21 Charpy V-Notch Lateral Expansion for B&W Heat C (T)

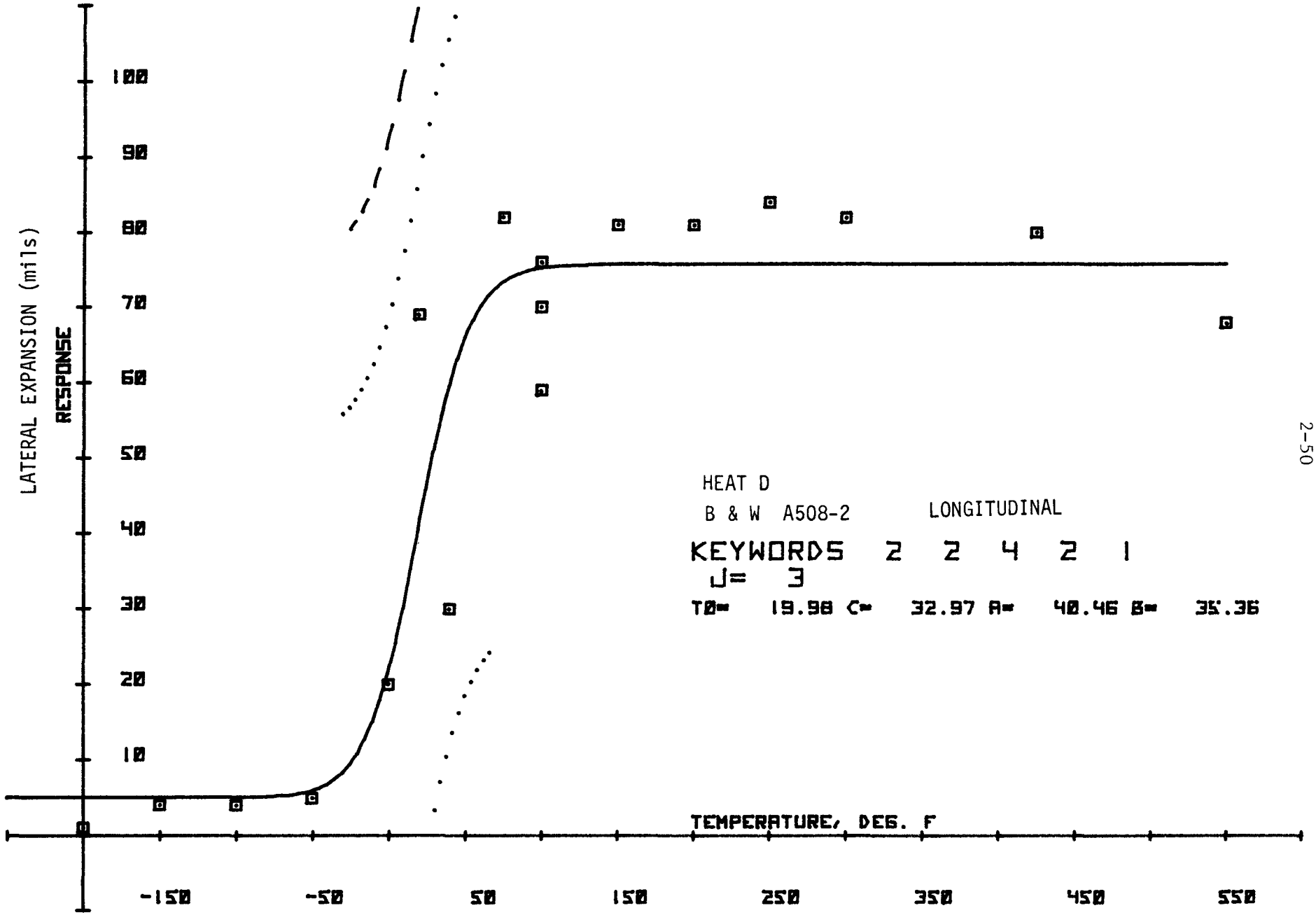


Figure 2.22 Charpy V-Notch Lateral Expansion for B&W Heat D (L)

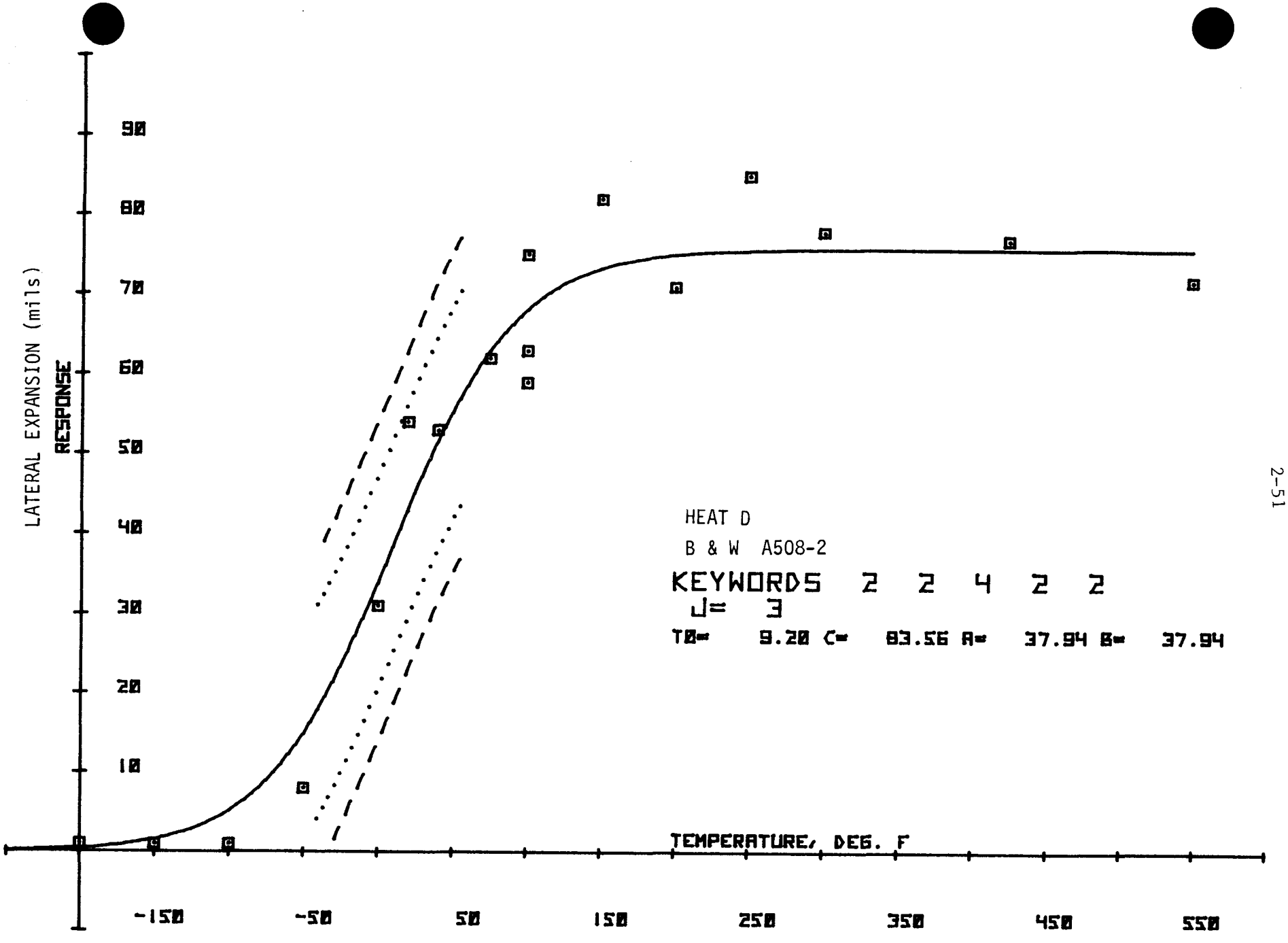


Figure 2.23 Charpy V-Notch Lateral Expansion for B&W Heat D (T)

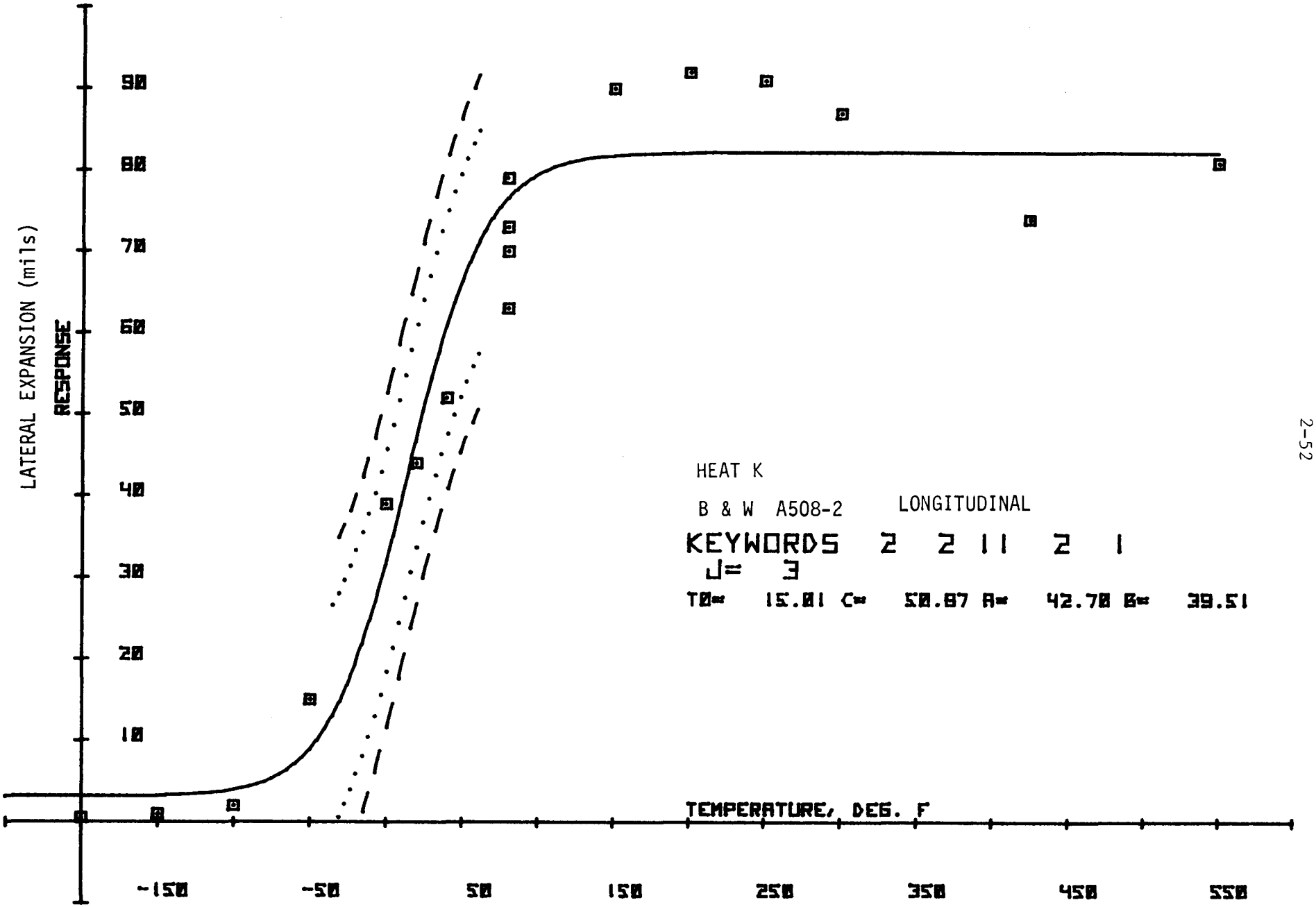


Figure 2.24 Charpy V-Notch Lateral Expansion for B&W Heat K (L)

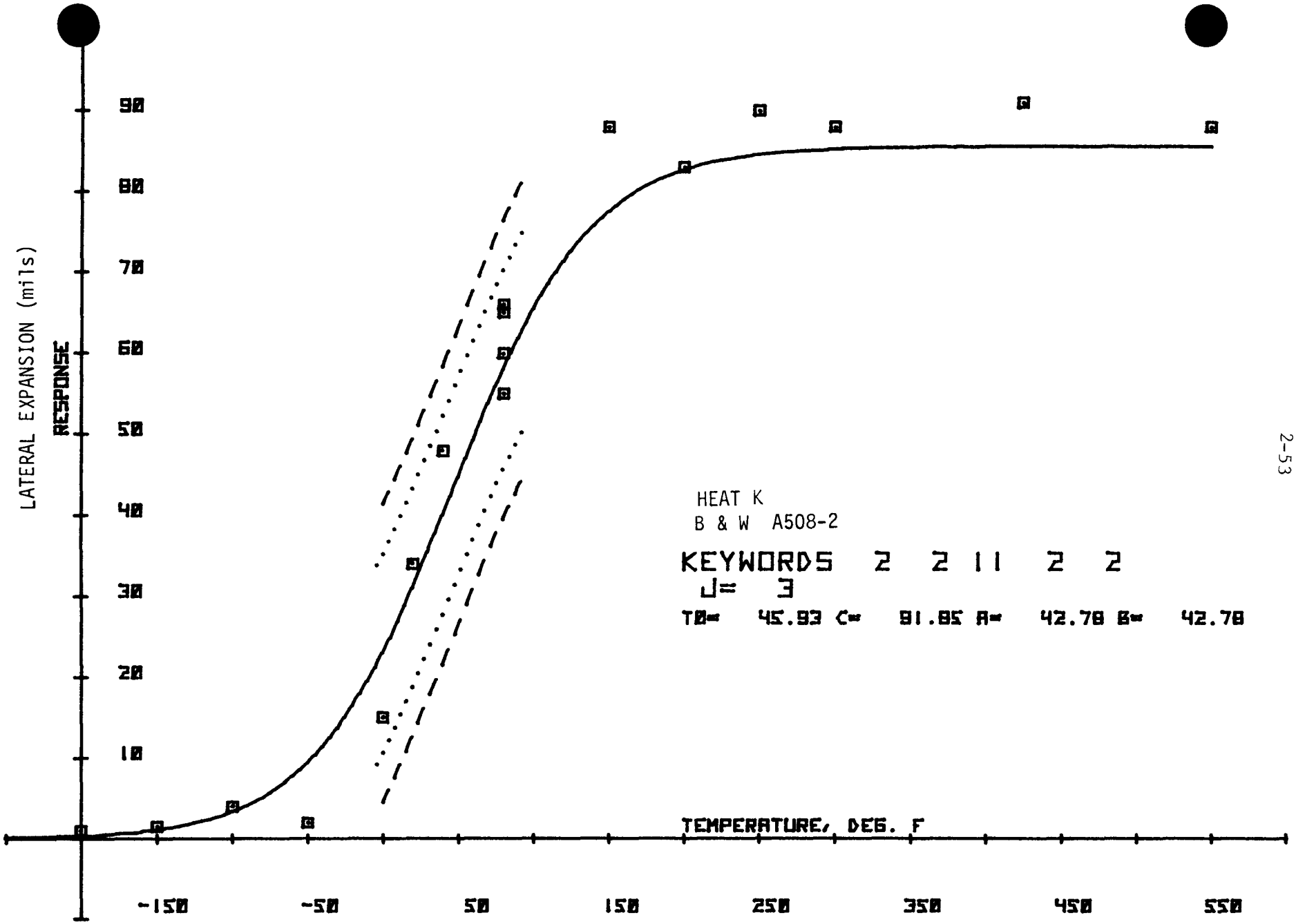


Figure 2.25 Charpy V-Notch Lateral Expansion for B&W Heat K (T)

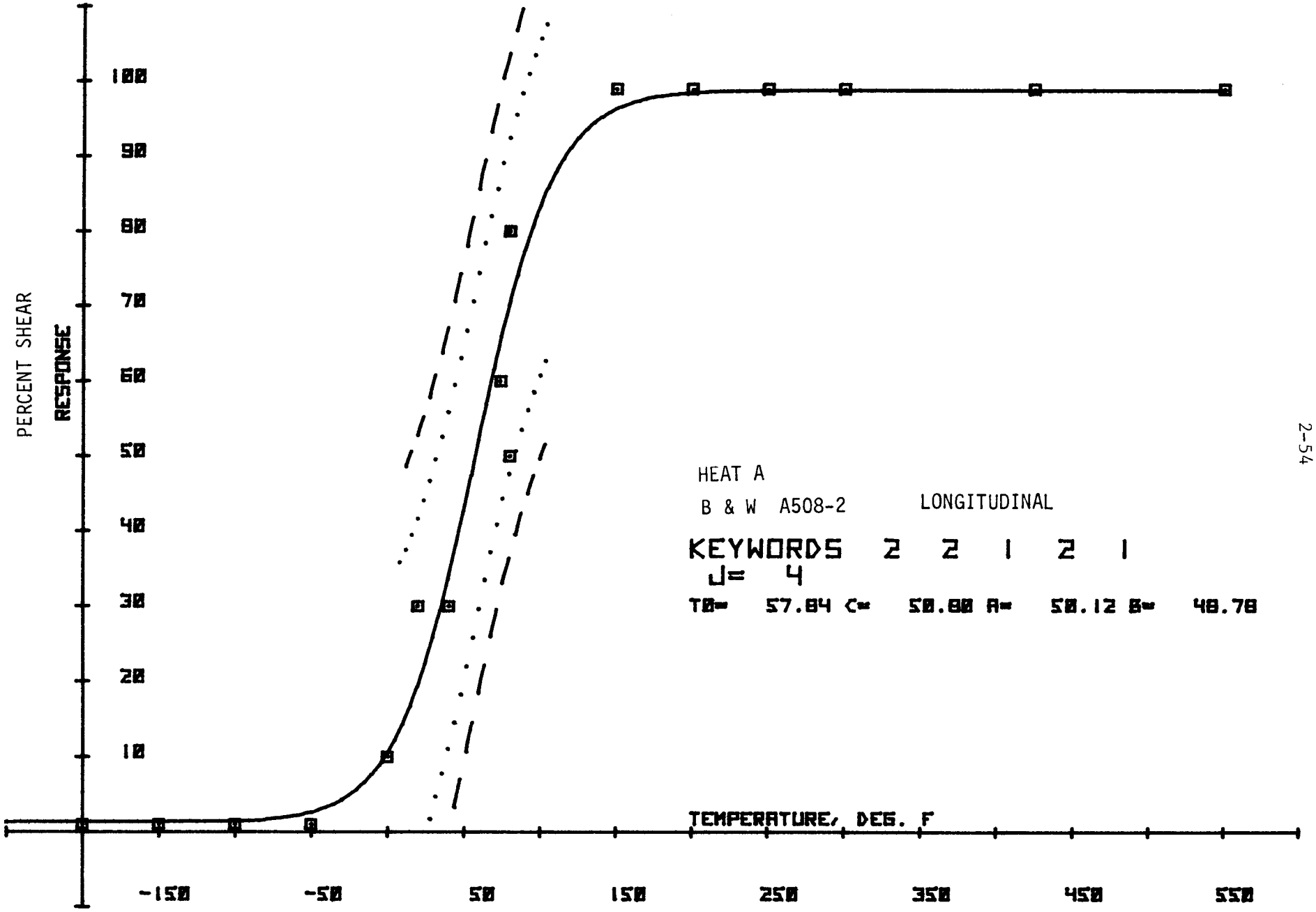


Figure 2.26 Charpy V-Notch Percent Shear for B&W Heat A (L)

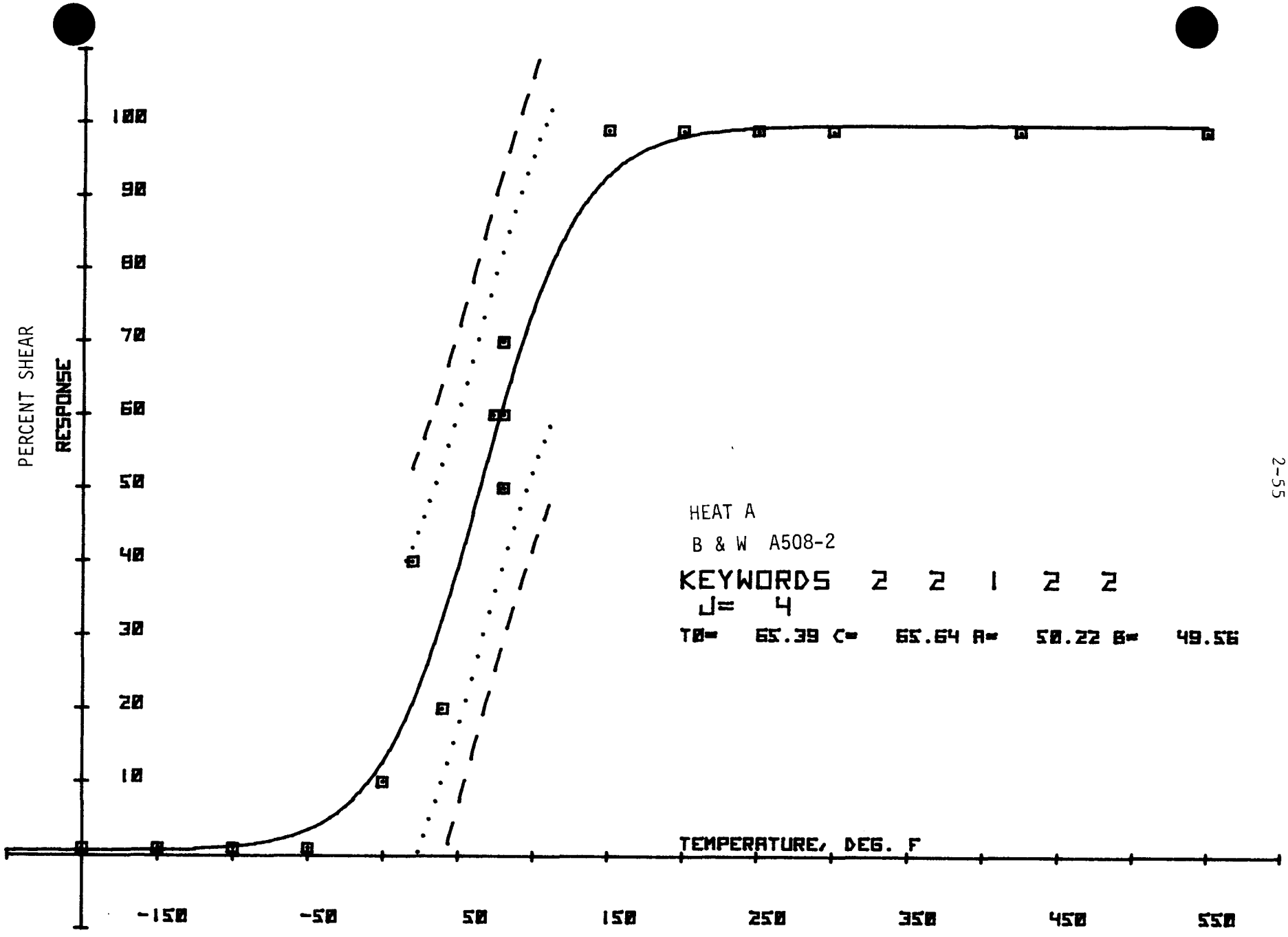


Figure 2.27 Charpy V-Notch Percent Shear for B&W Heat A (T)

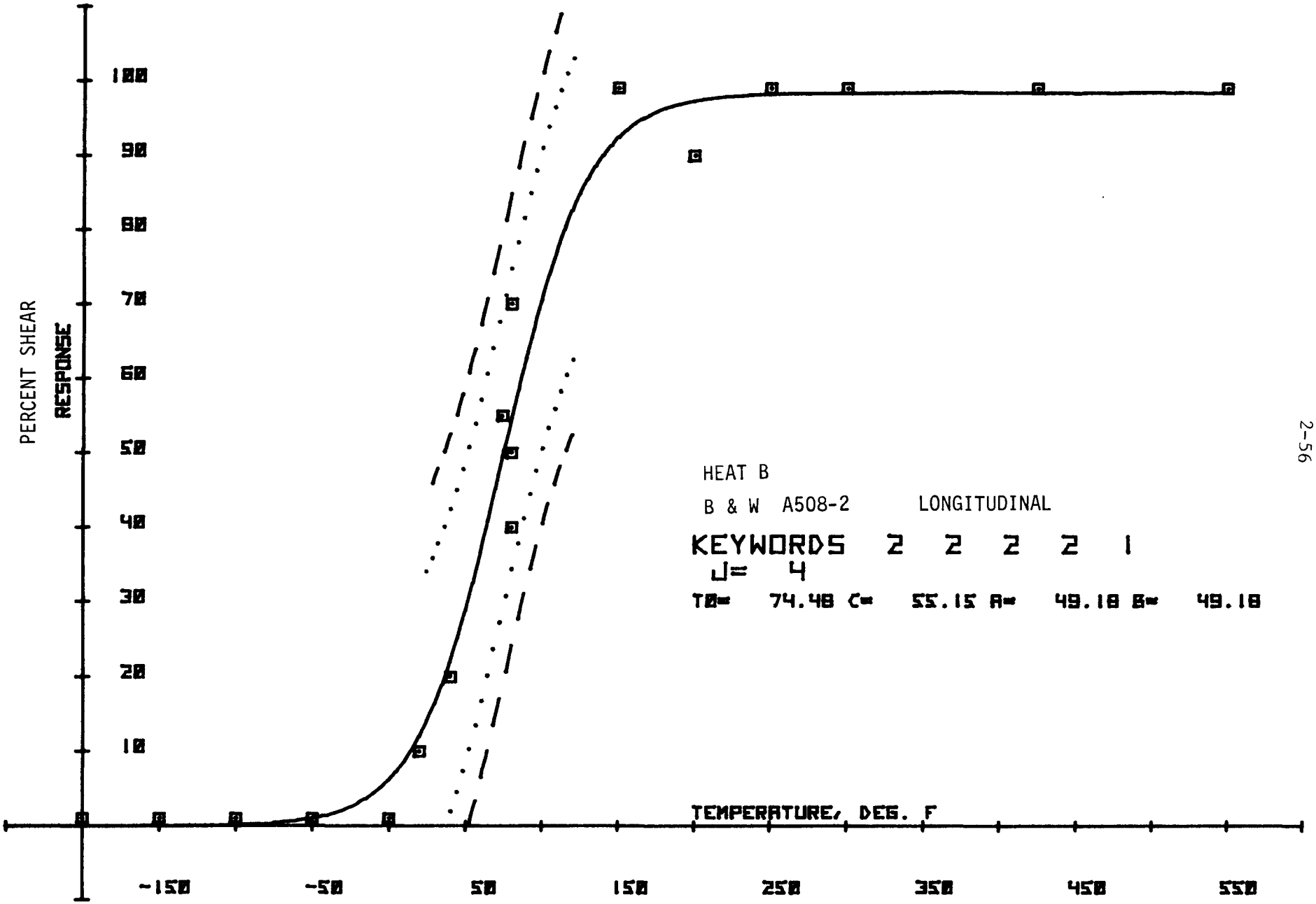


Figure 2.28 Charpy V-Notch Percent Shear for B&W Heat B (L)

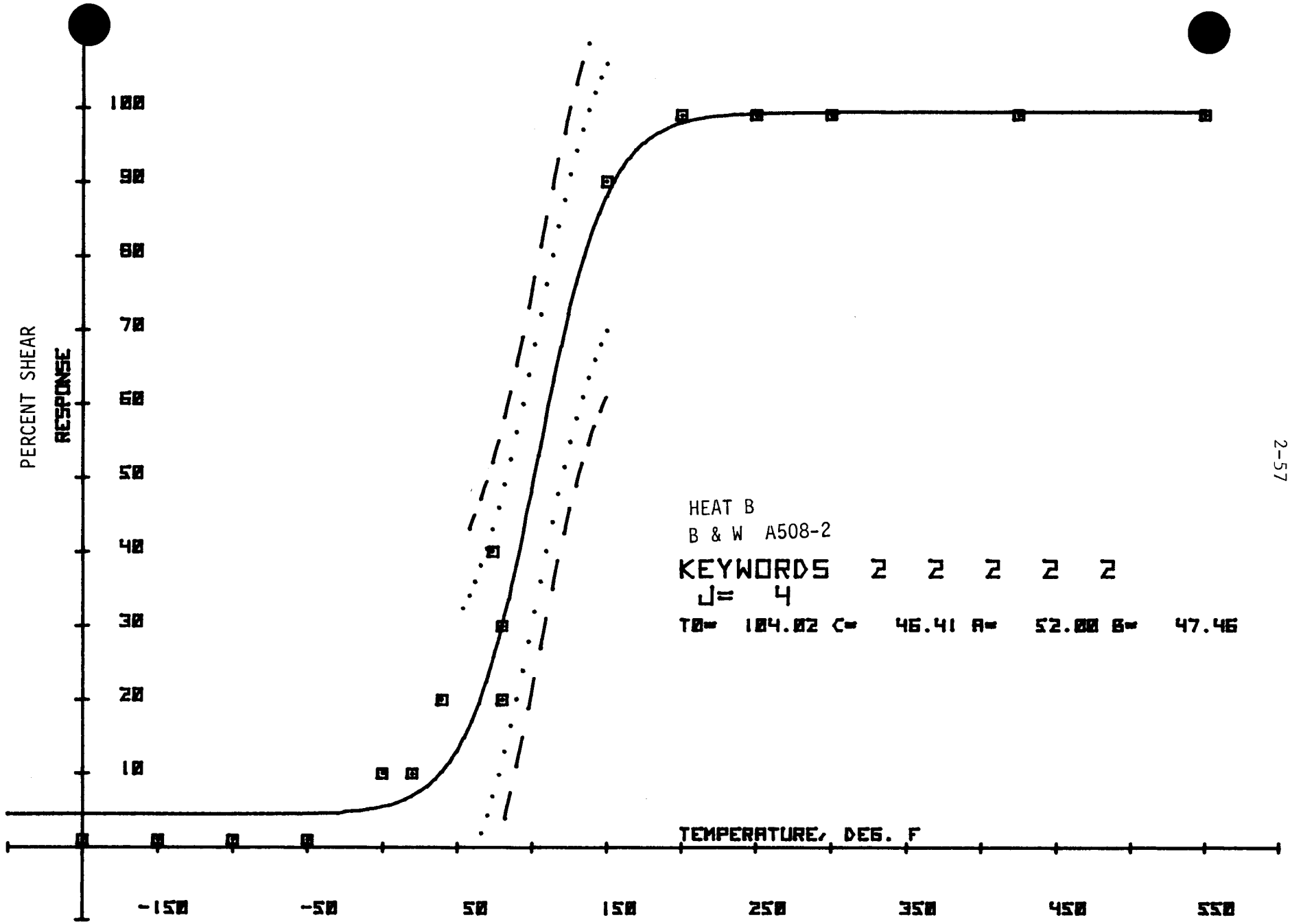
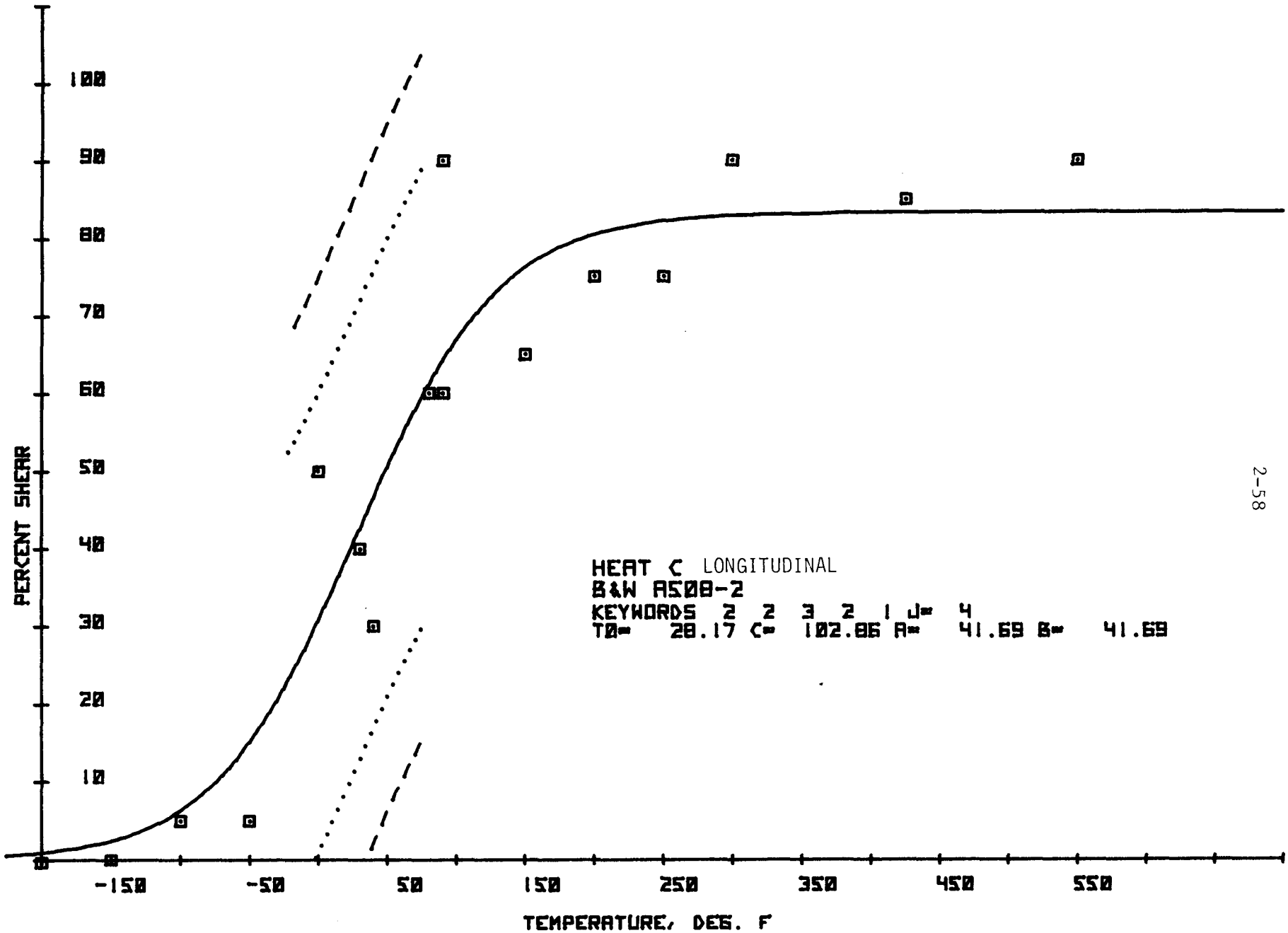


Figure 2.29 Charpy V-Notch Percent Shear for B&W Heat B (T)



gure 2.30. Charpy V-Notch Percent Shear for B&W Heat C (L)

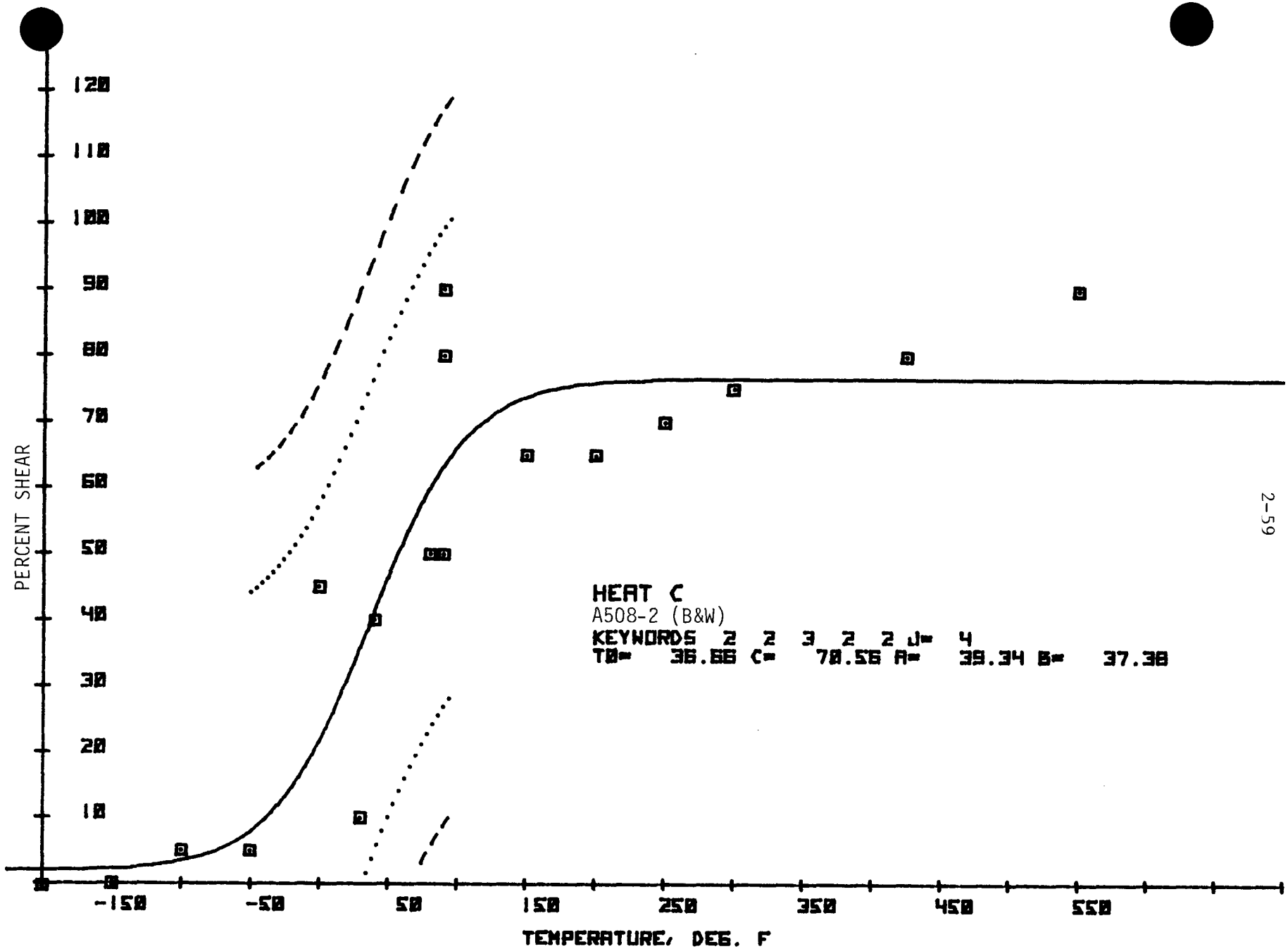


Figure 2.31. Charpy V-Notch Percent Shear for B&W Heat C (T)

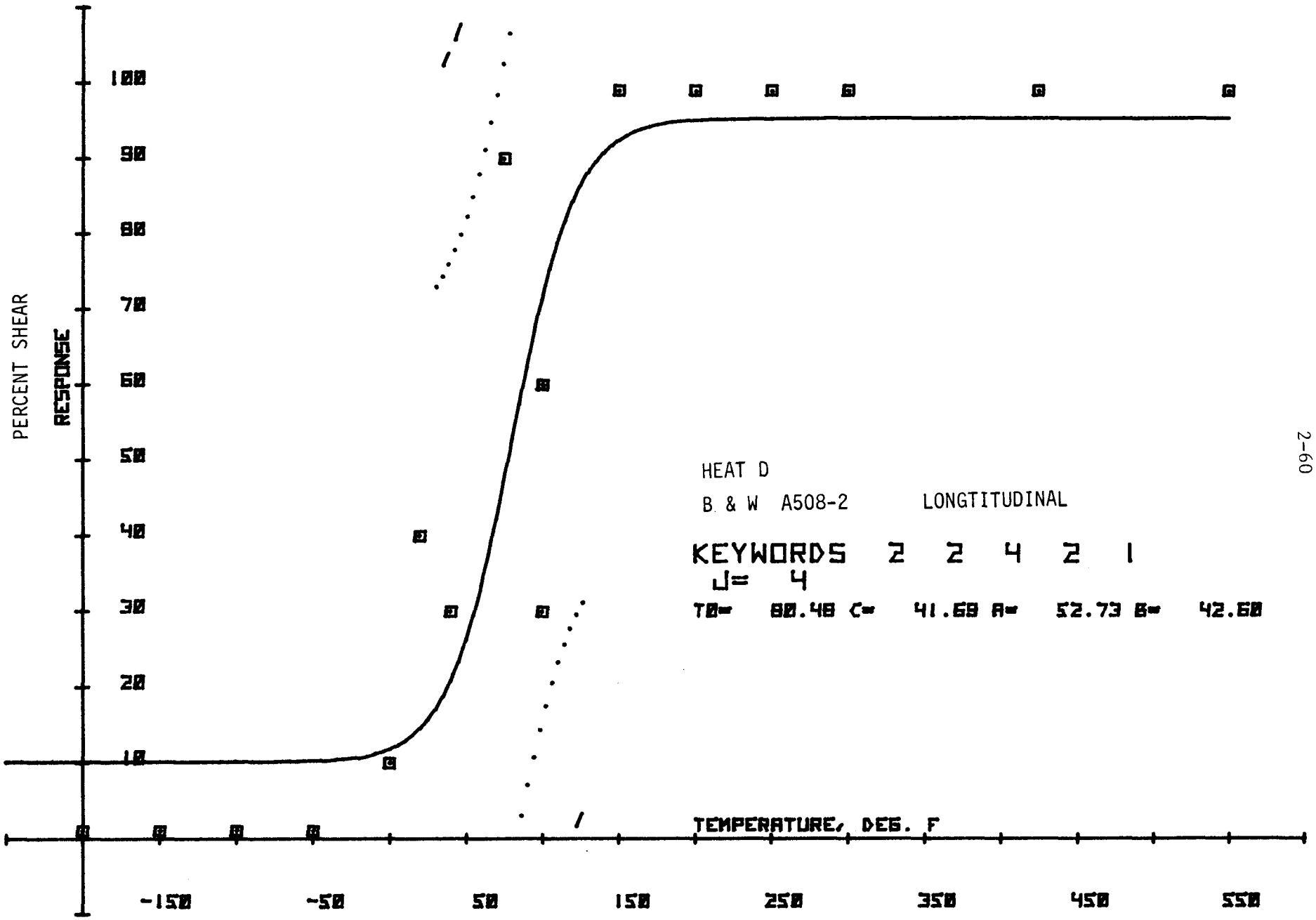


Figure 2.32 Charpy V-Notch Percent Shear for B&W Heat D (L)

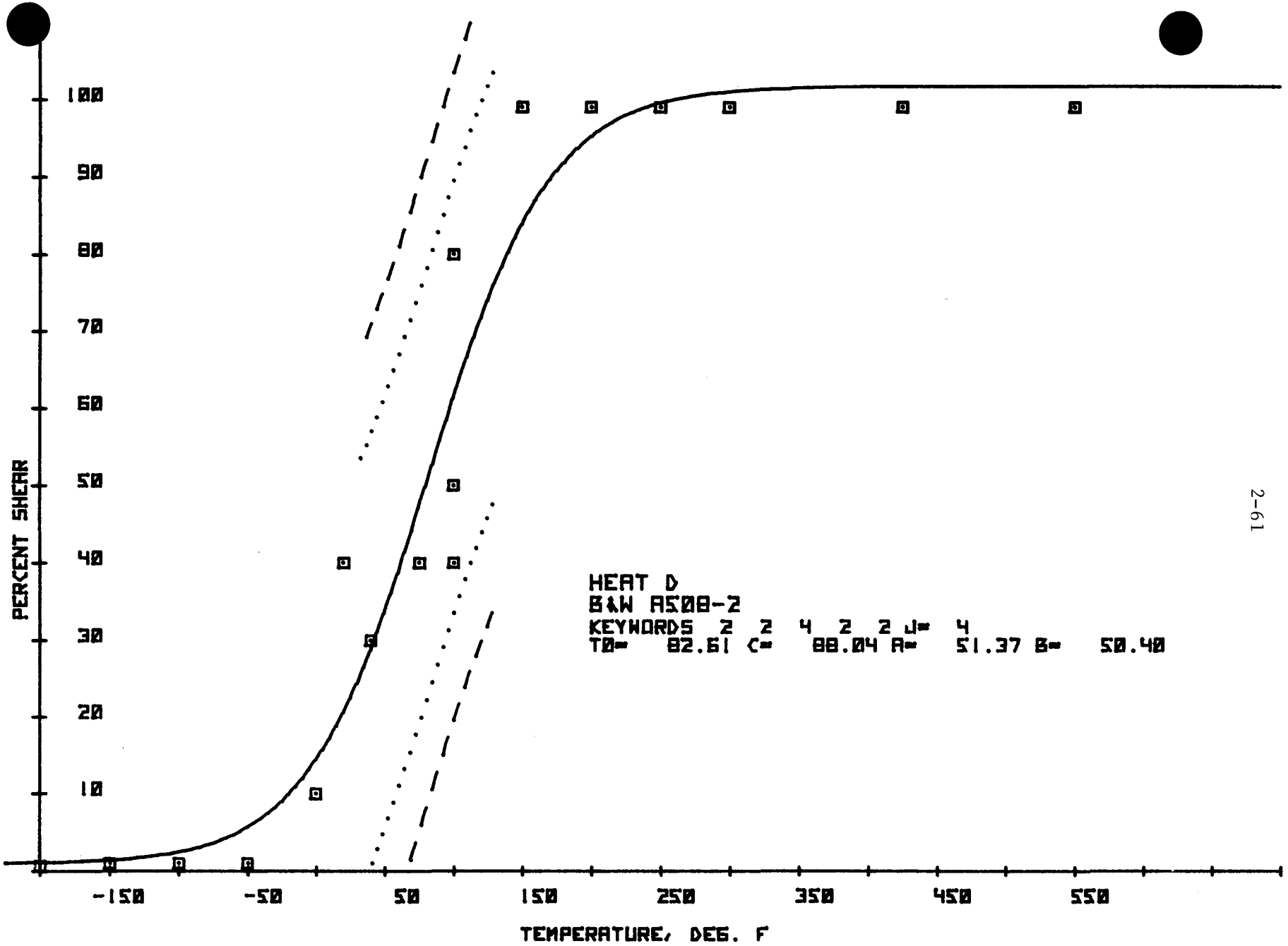


Figure 2.33. Charpy V-Notch Percent Shear for B&W Heat D (T)

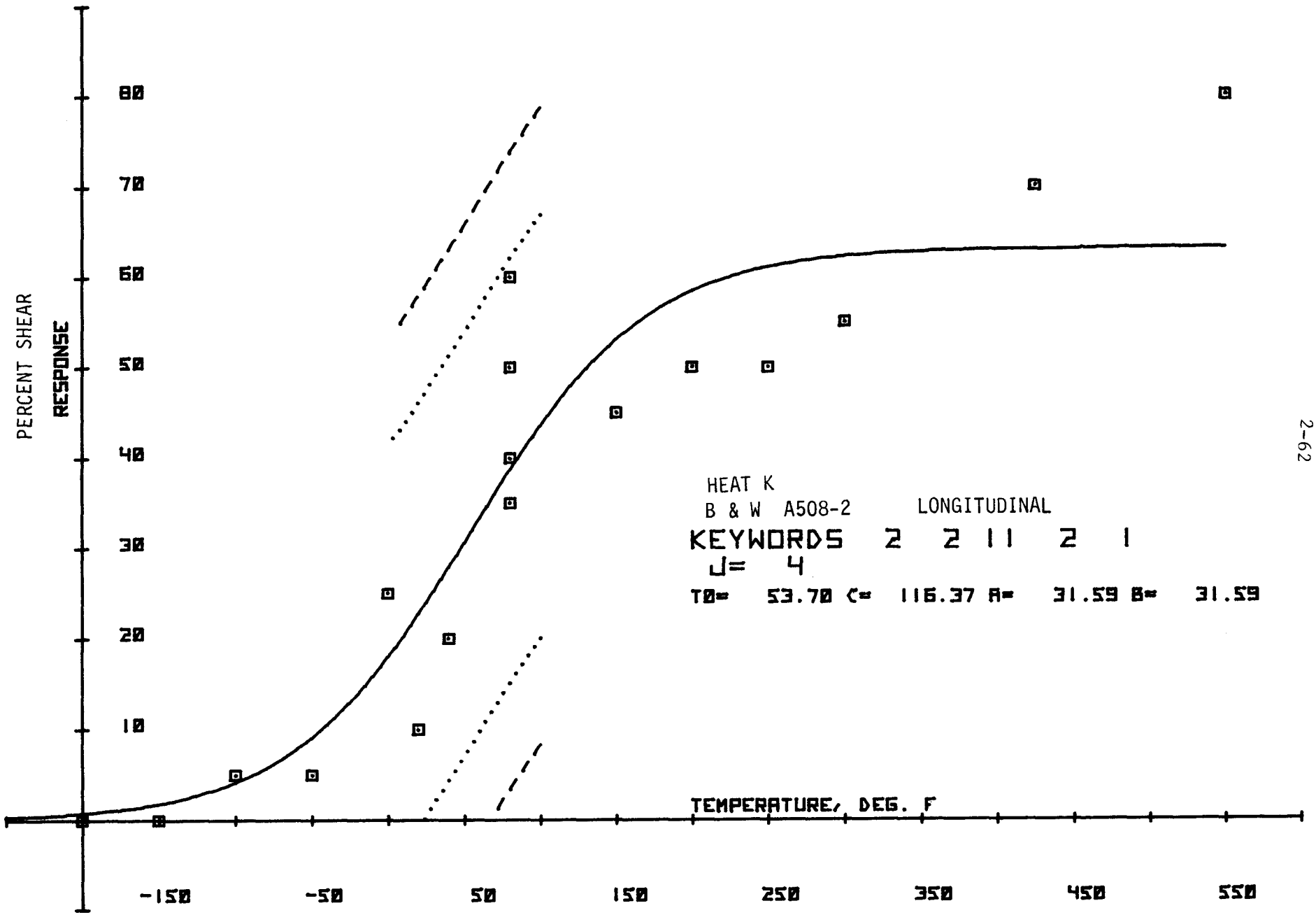


Figure 2.34 Charpy V-Notch Percent Shear for B&W Heat K (L)

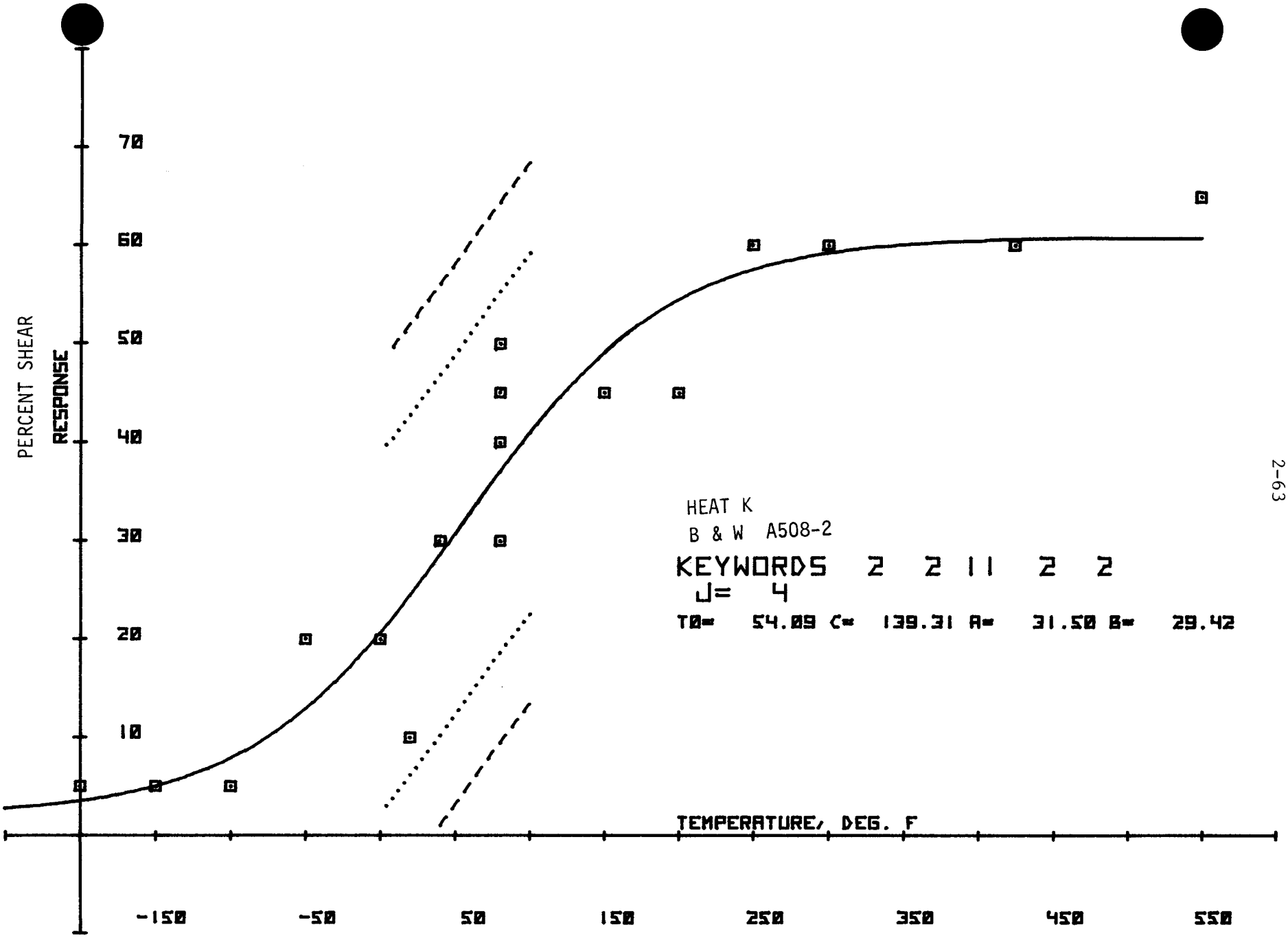


Figure 2.35 Charpy V-Notch Percent Shear for B&W Heat K (T)

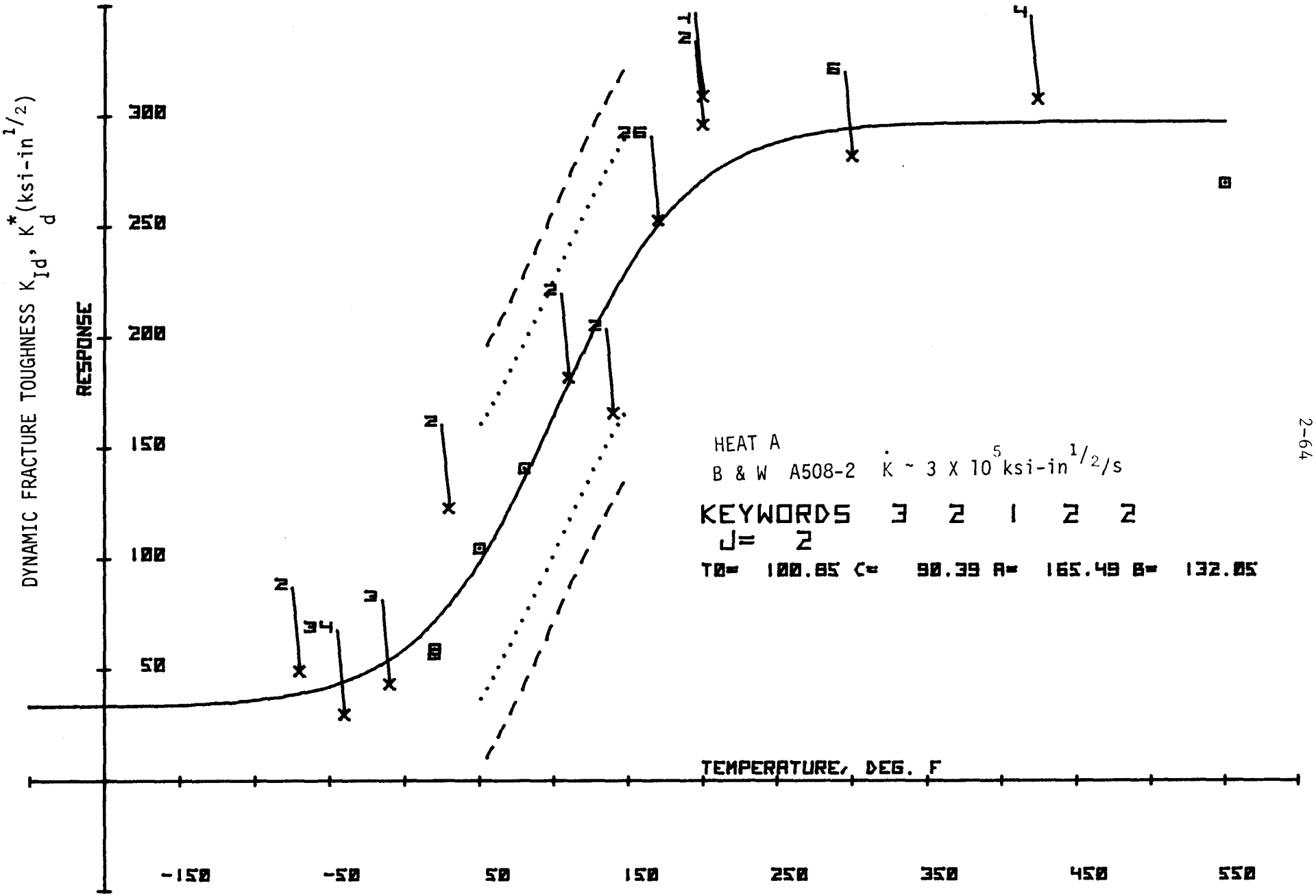


Figure 2.36 Precracked Charpy Fracture Toughness for B&W Heat A

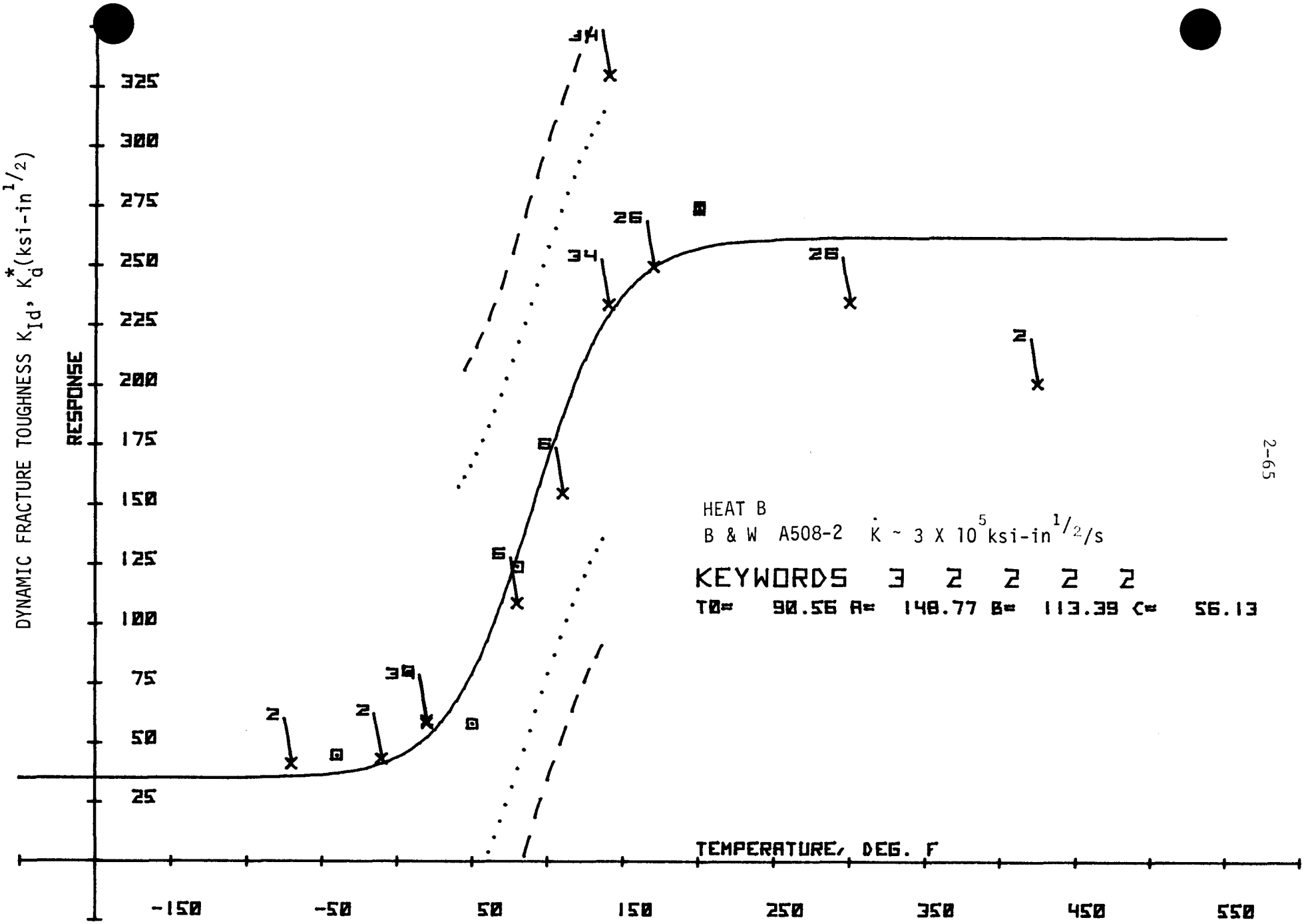


Figure 2.37 Precracked Charpy Fracture Toughness for B&W Heat B

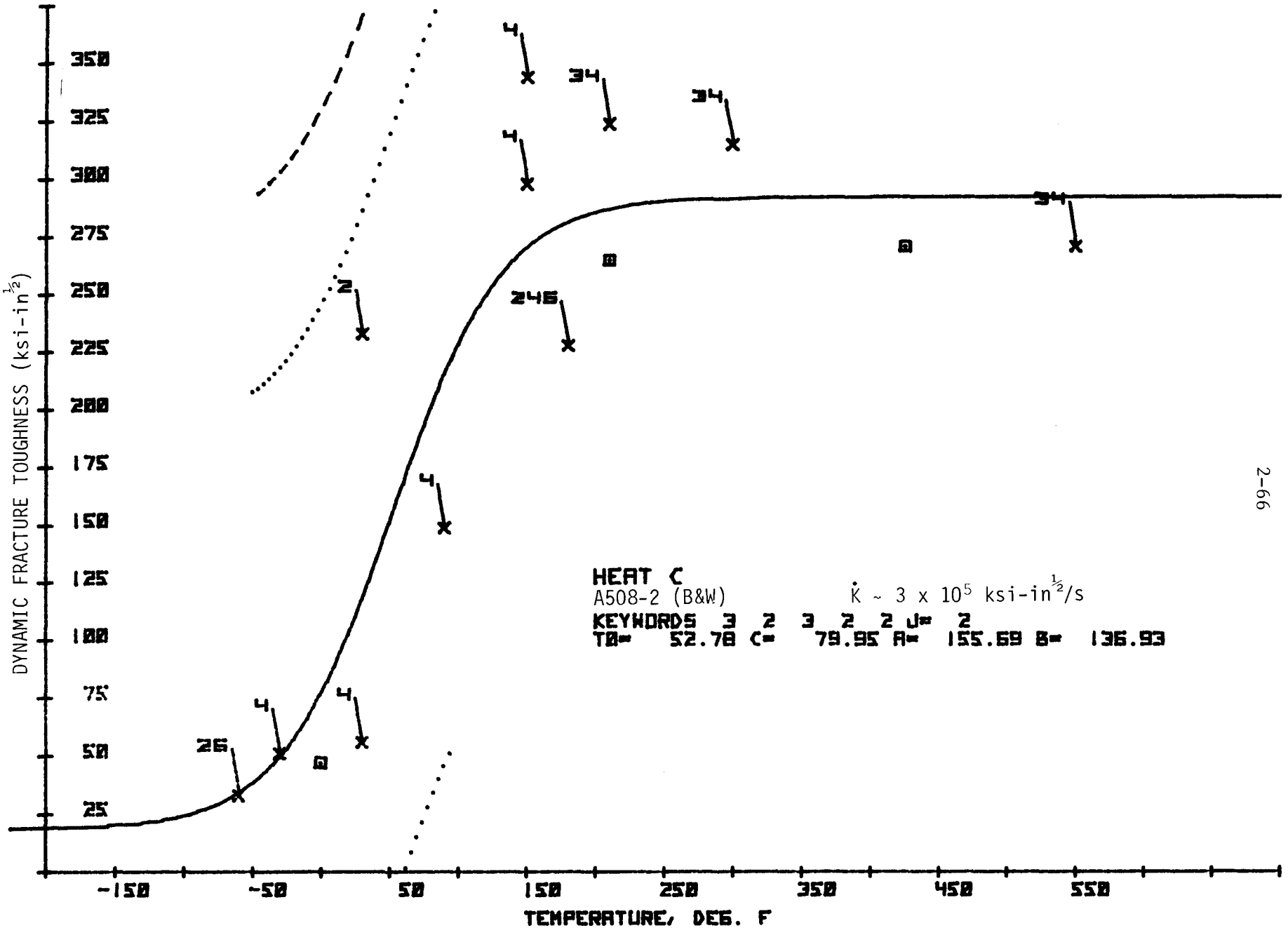


Figure 2.38. Precracked Charpy Fracture Toughness for B&W Heat C

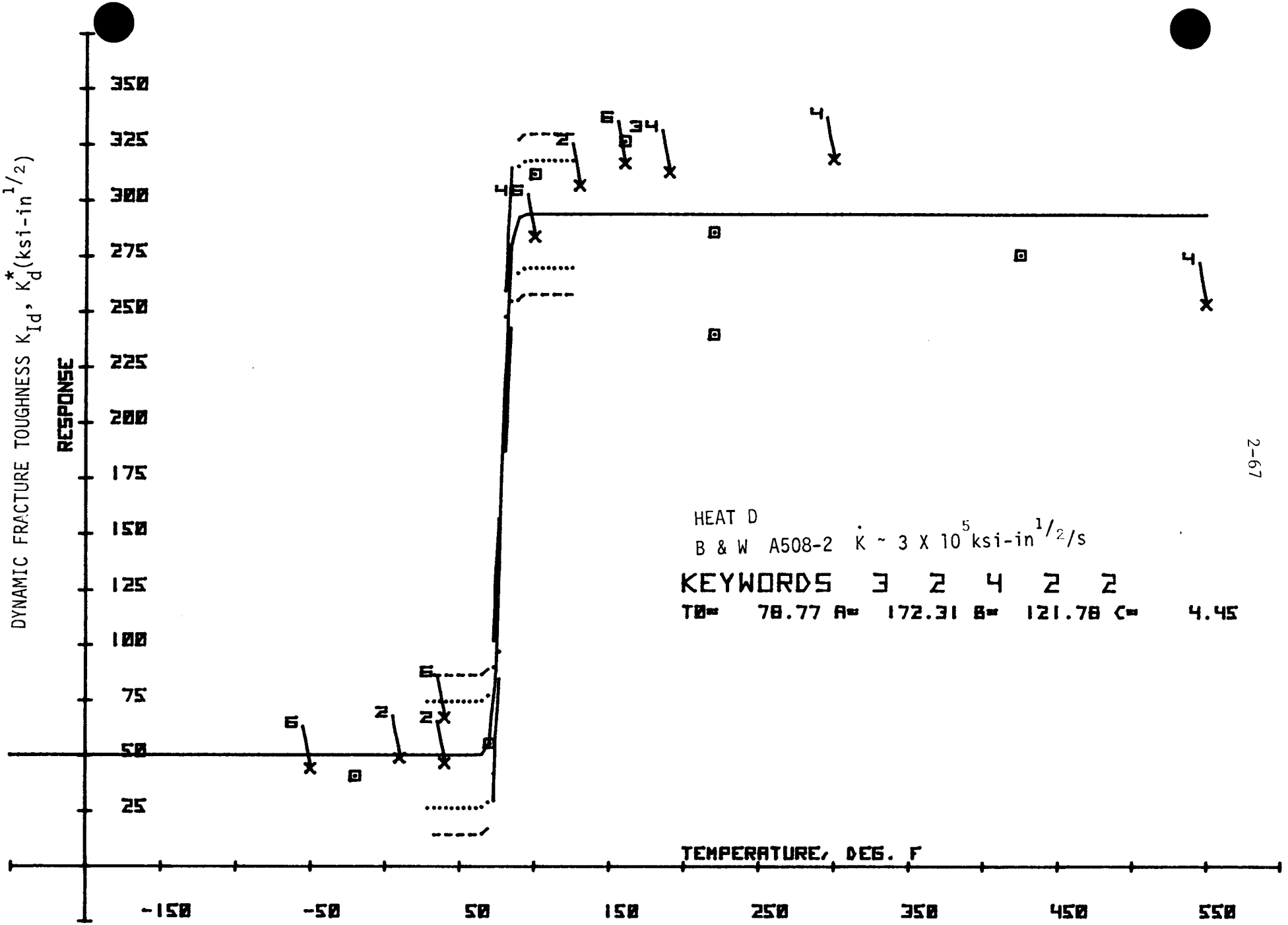


Figure 2.39 Precracked Charpy Fracture Toughness for B&W Heat D

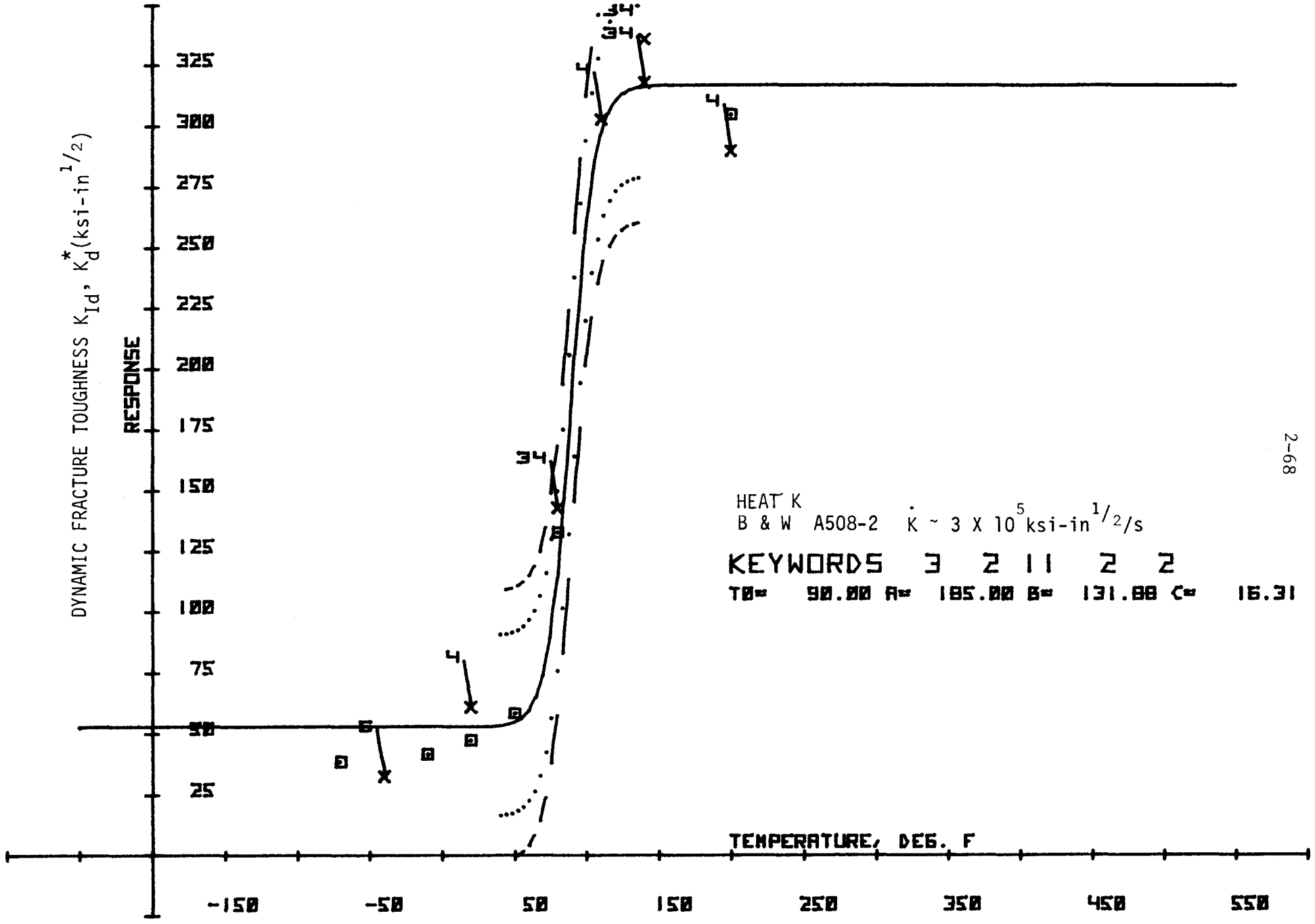


Figure 2.40 Precracked Charpy Fracture Toughness for B&W Heat K

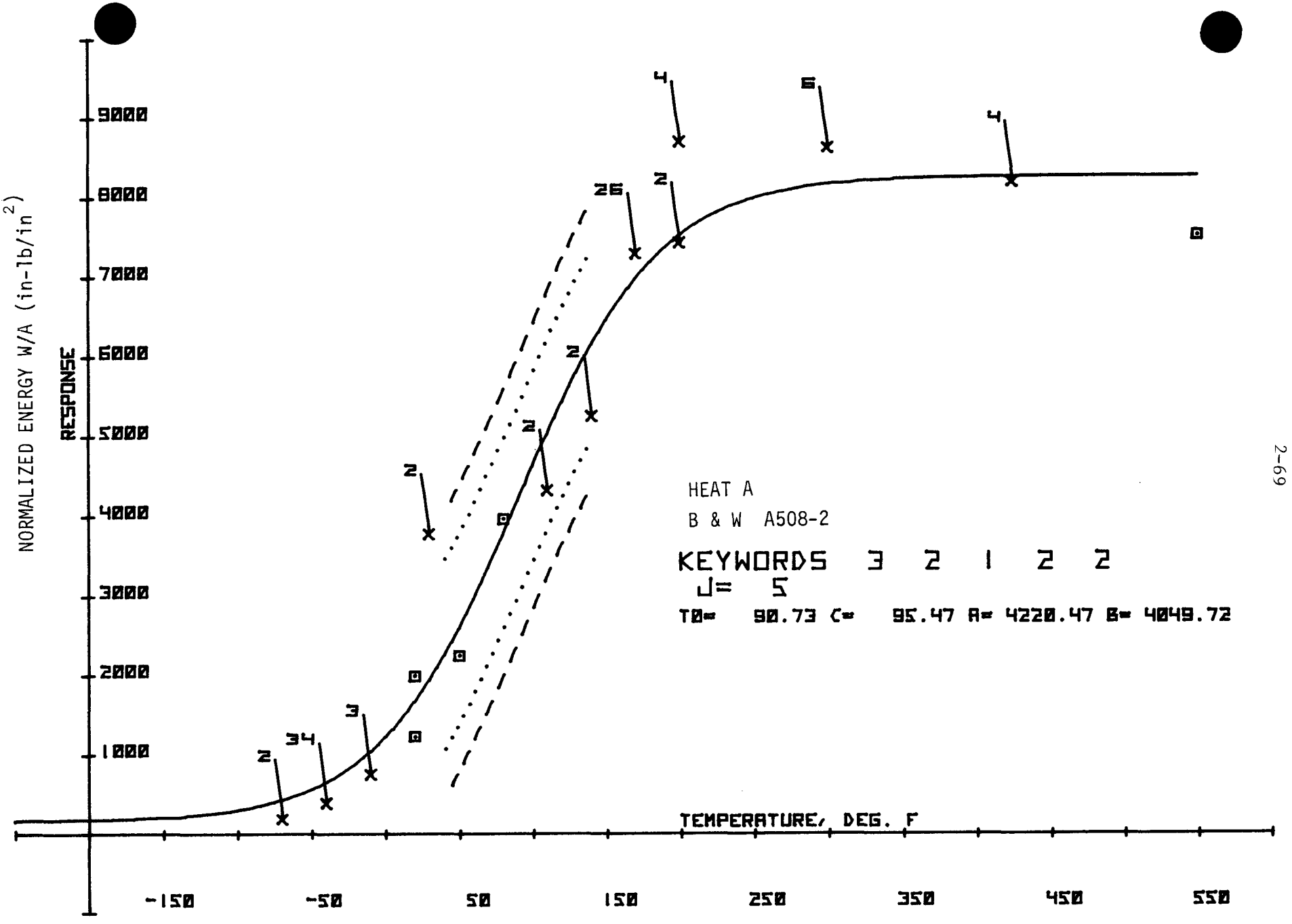


Figure 2.41 Precracked Charpy Normalized Energy for B&W Heat A

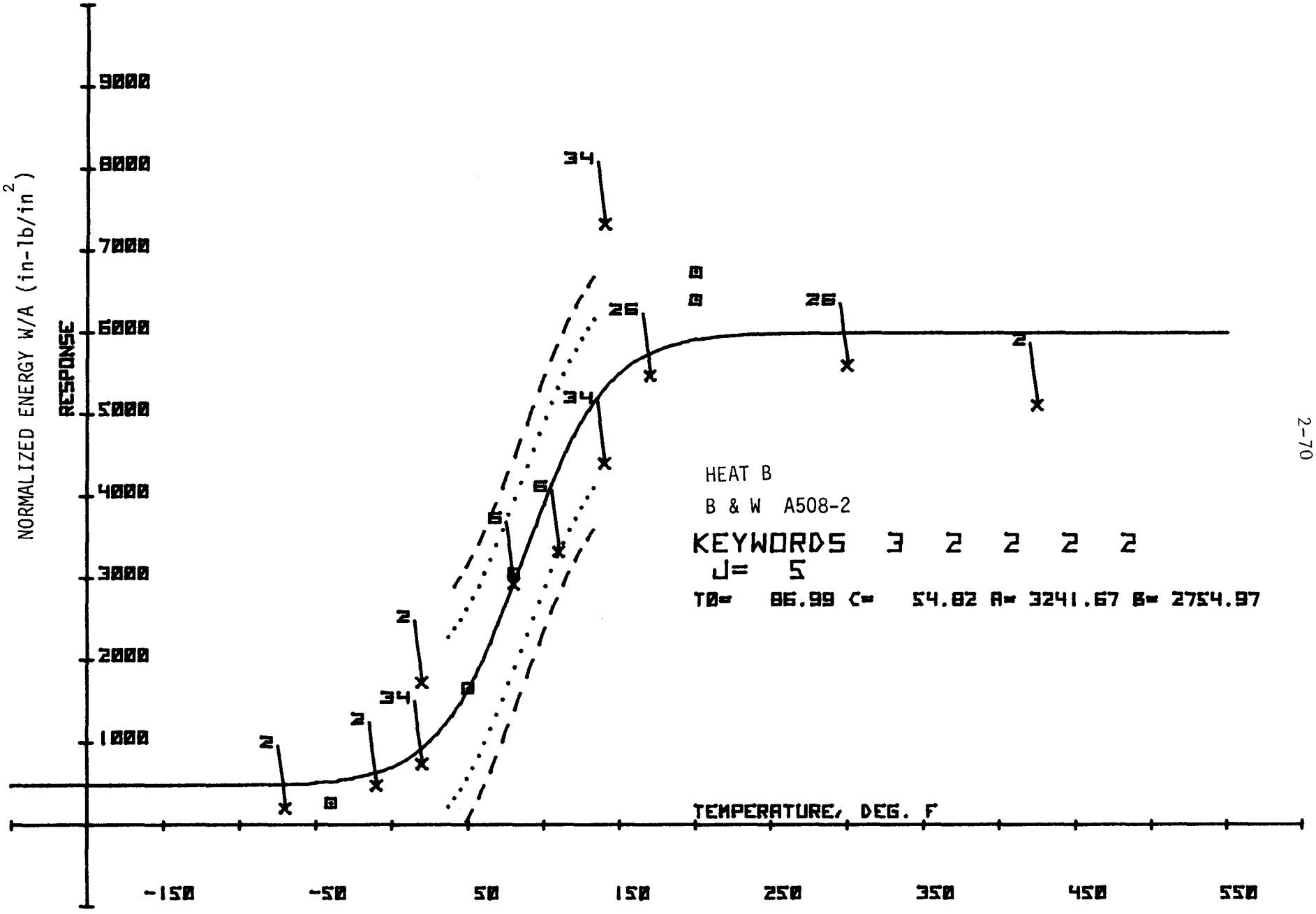


Figure 2.42 Precracked Charpy Normalized Energy for B&W Heat B

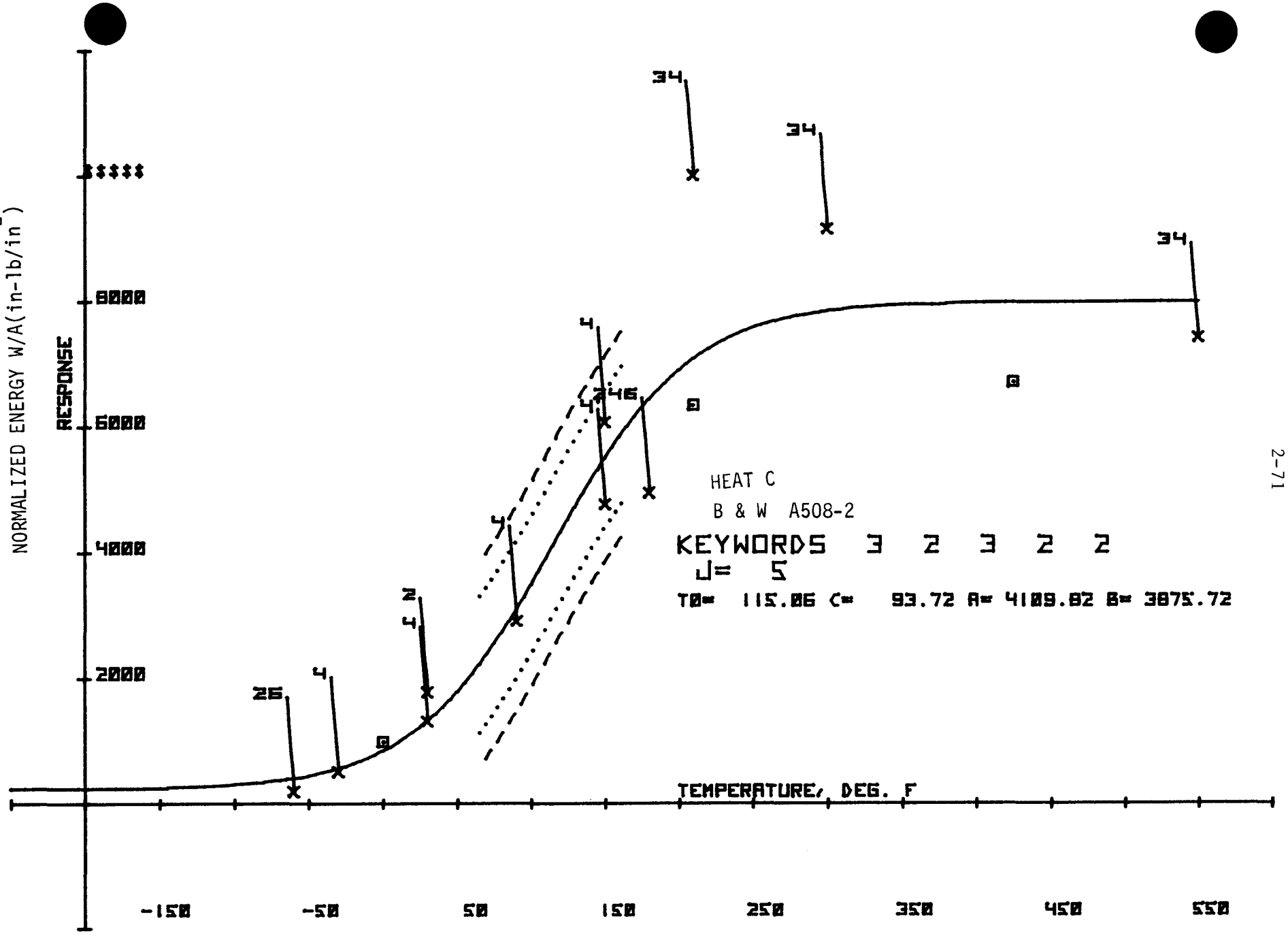


Figure 2.43 Precracked Charpy Normalized Energy for B&W Heat C

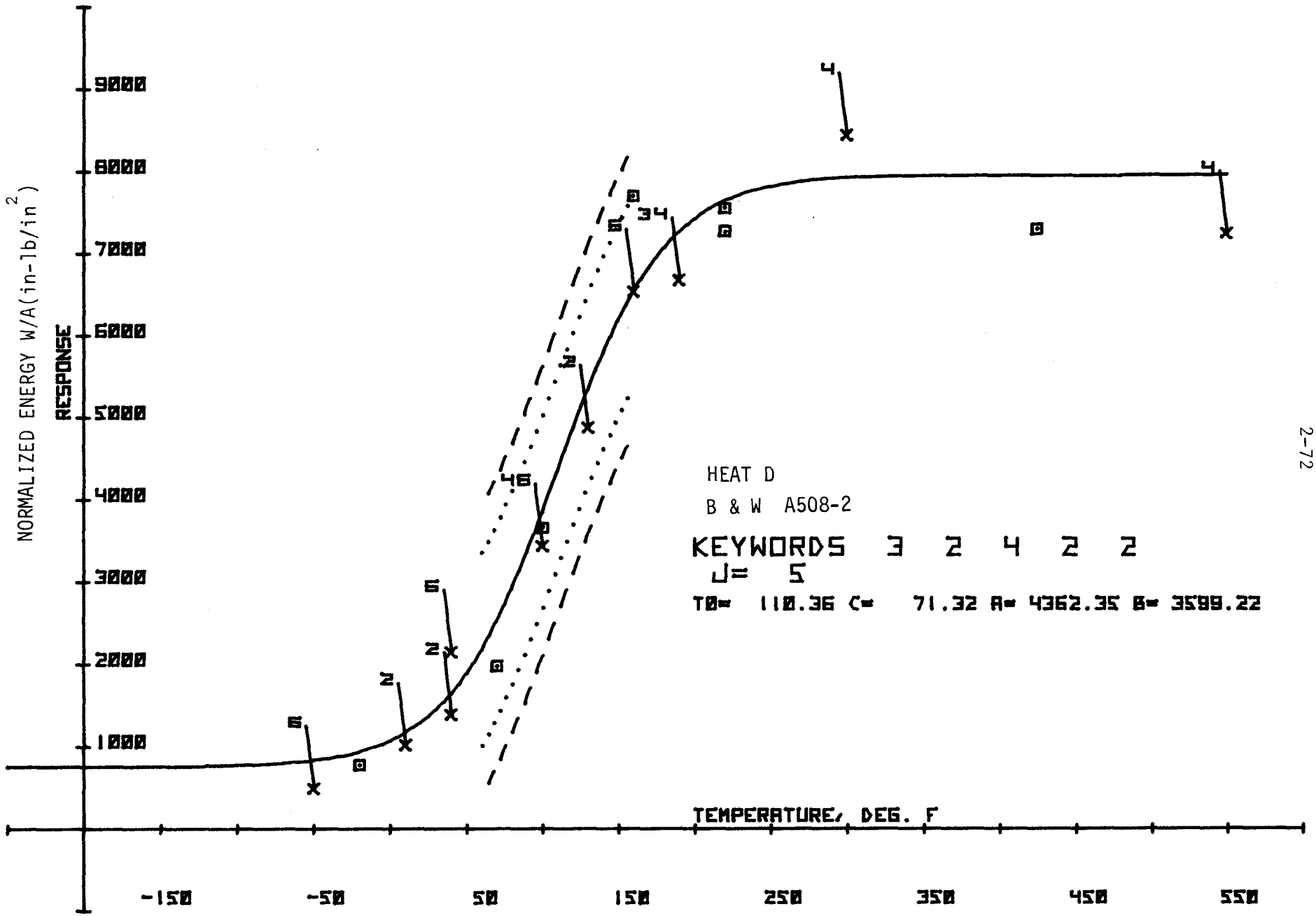


Figure 2.44 Precracked Charpy Normalized Energy for B&W Heat D

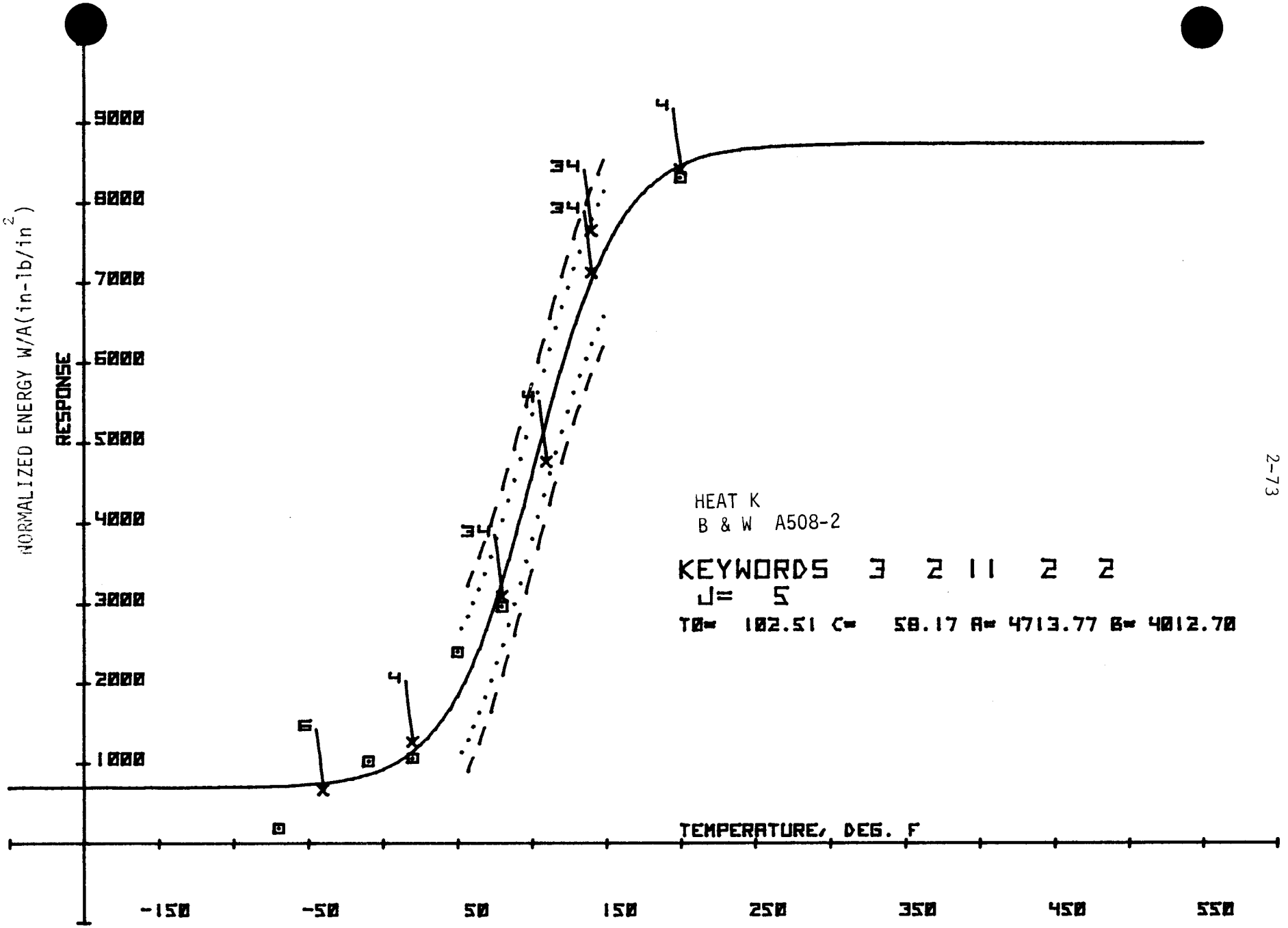
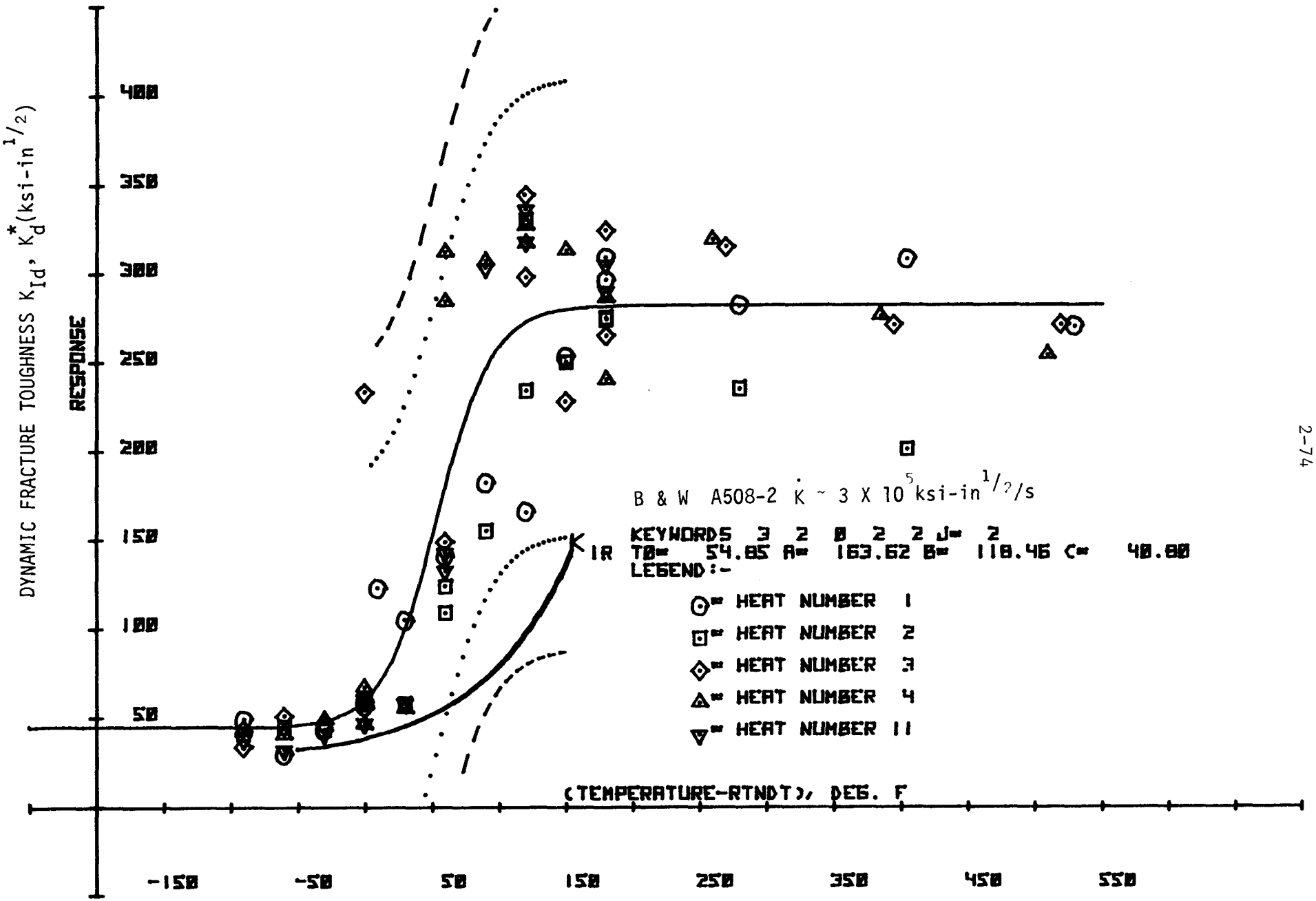


Figure 2.45 Precracked Charpy Normalized Energy for B&W Heat K



ure 2.46 Precracked Charpy Fracture Toughness for All B&W Heats

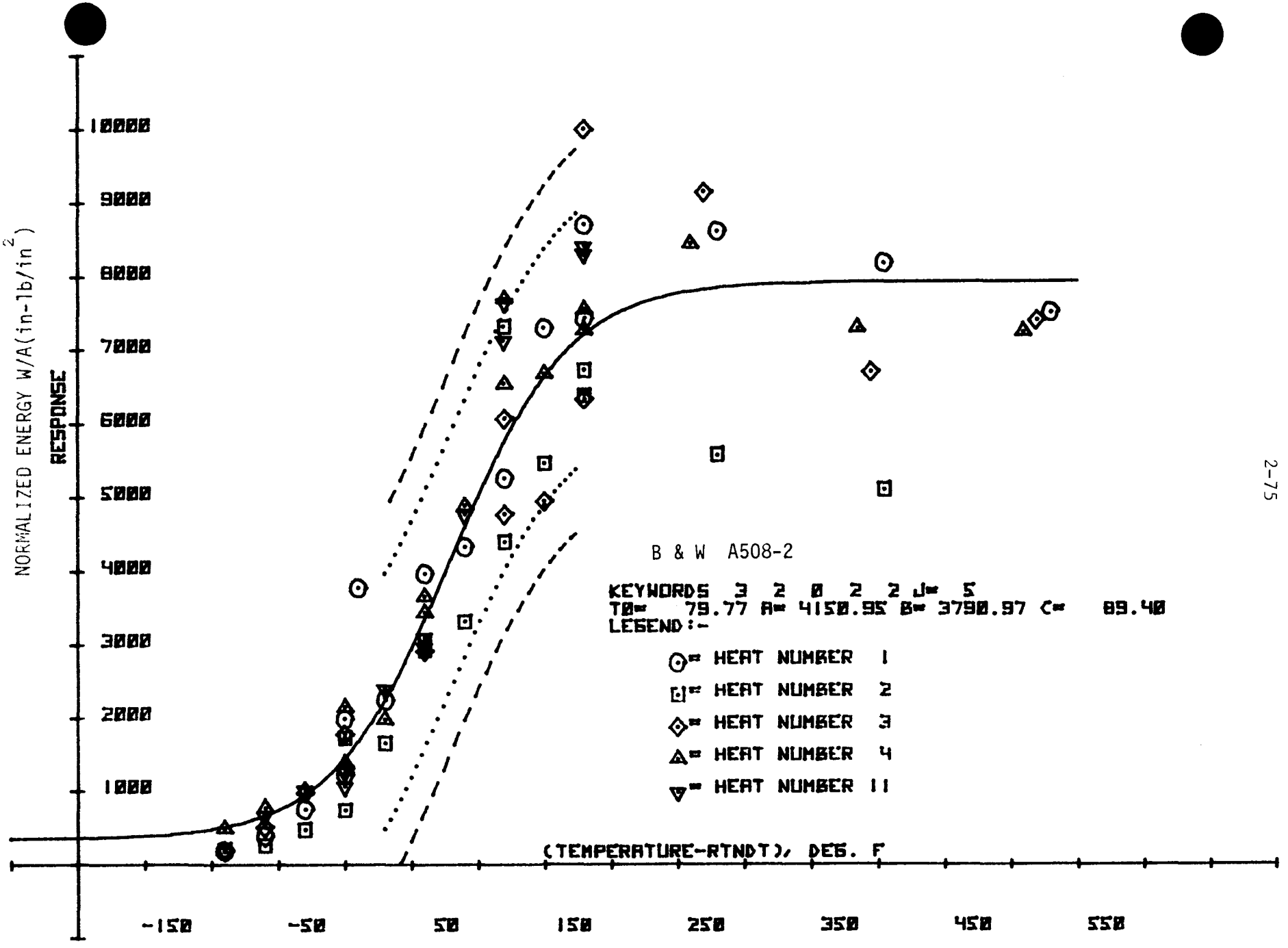


Figure 2.47 Precracked Charpy Normalized Energy for All B&W Heats

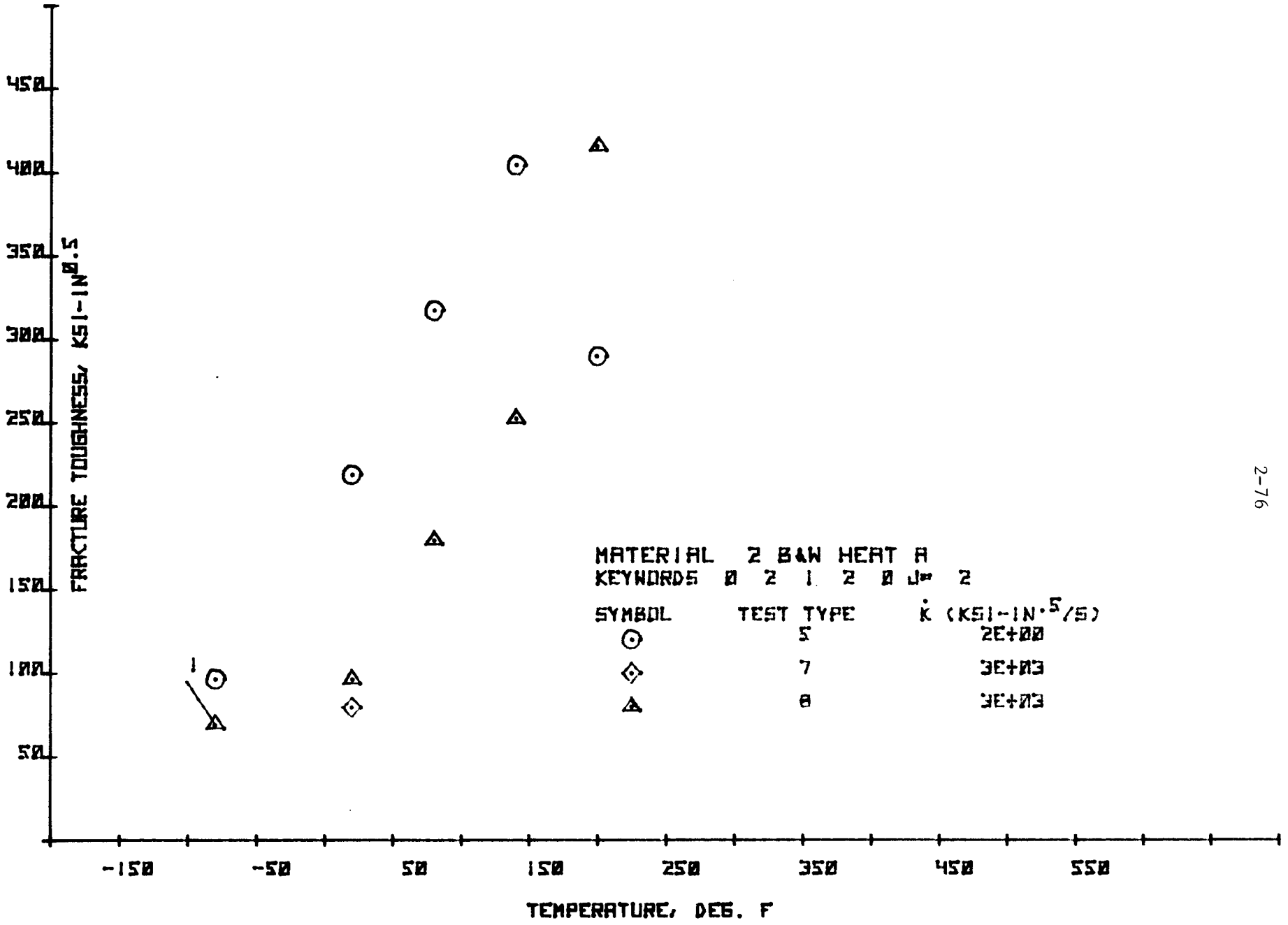


Figure 2.48. Static and Dynamic Fracture Toughness for B&W Heat A

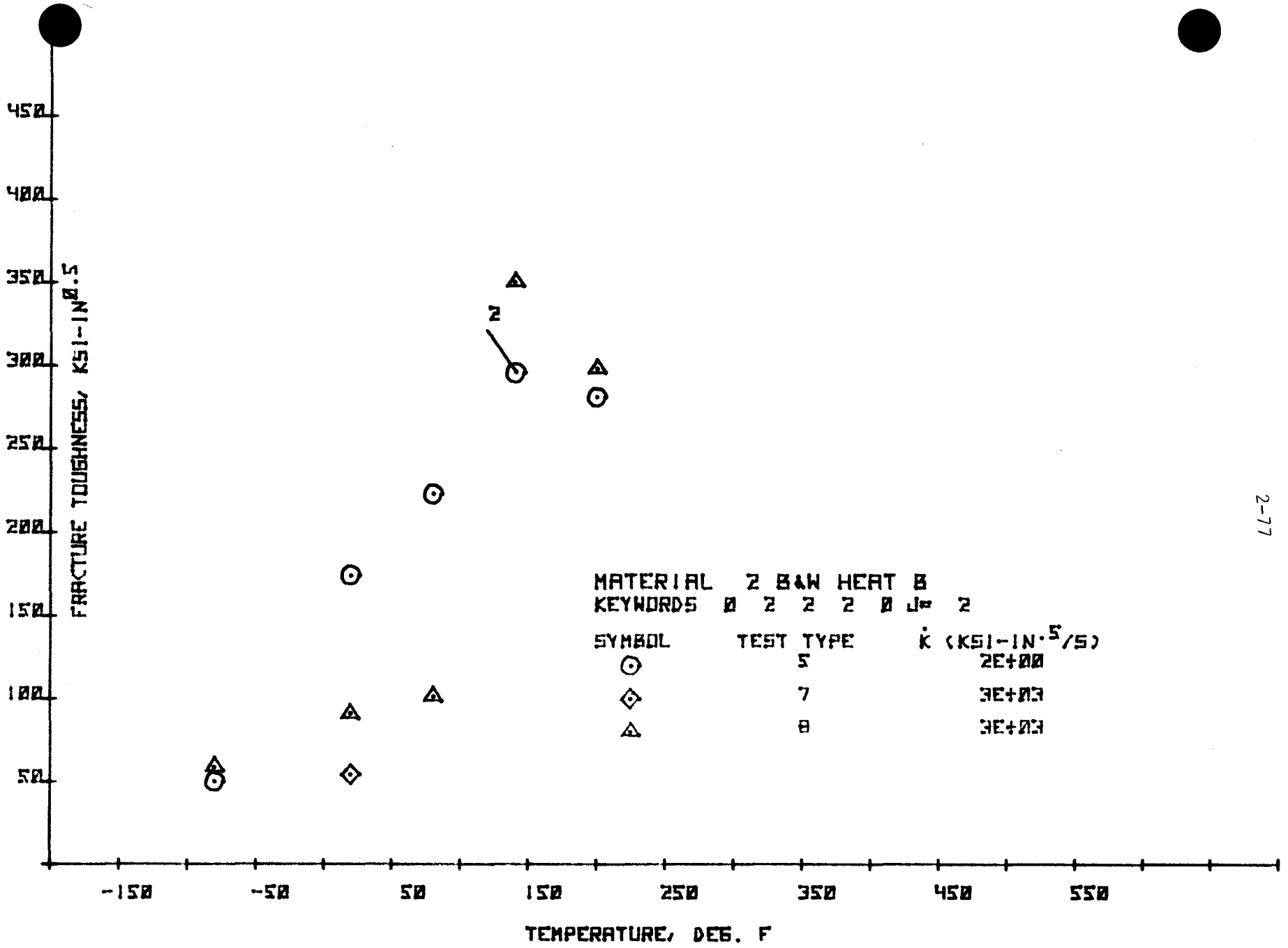


Figure 2.49. Static and Dynamic Fracture Toughness for B&W Heat B

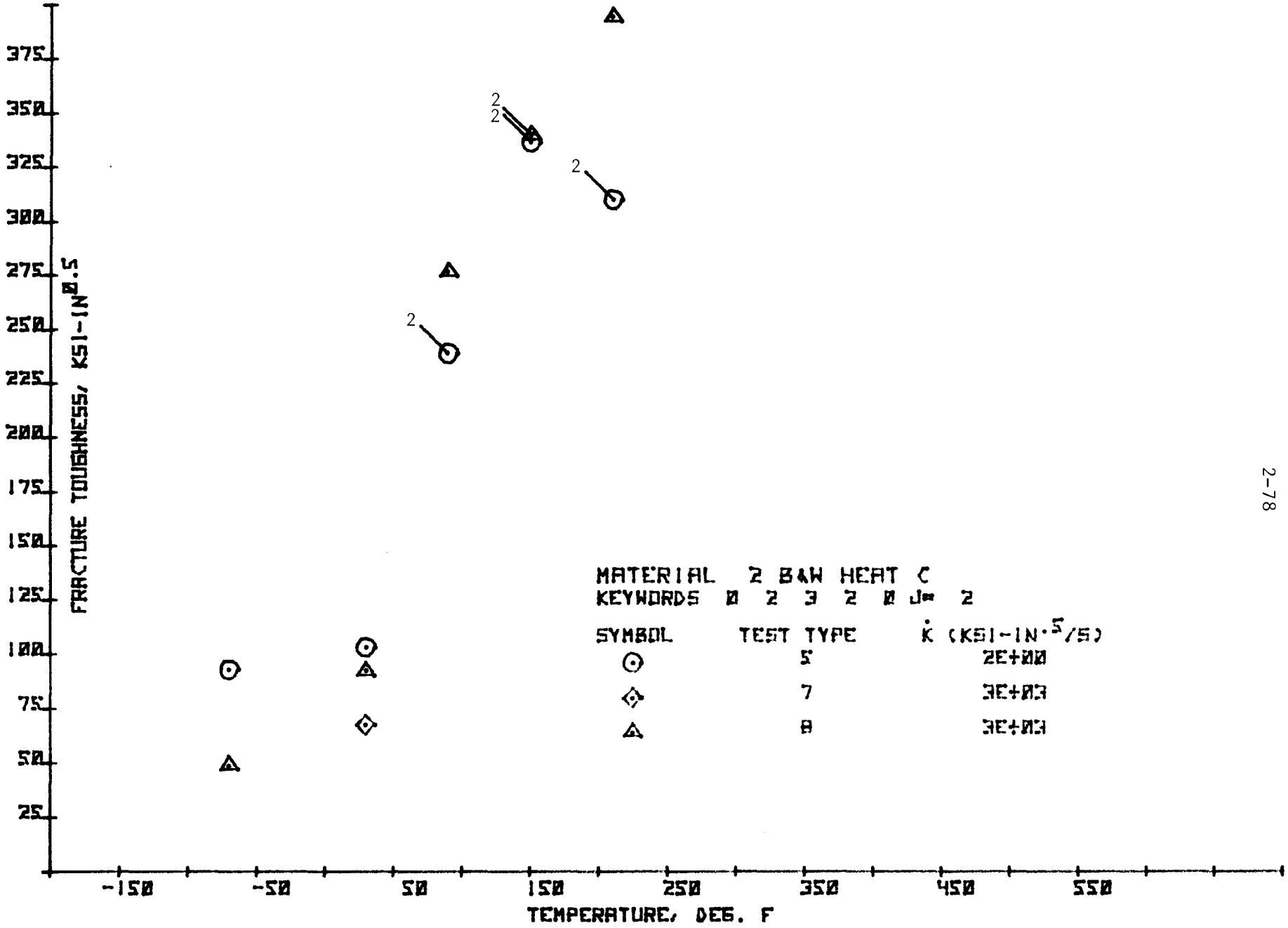


Figure 2.50. Static and Dynamic Fracture Toughness for B&W Heat C

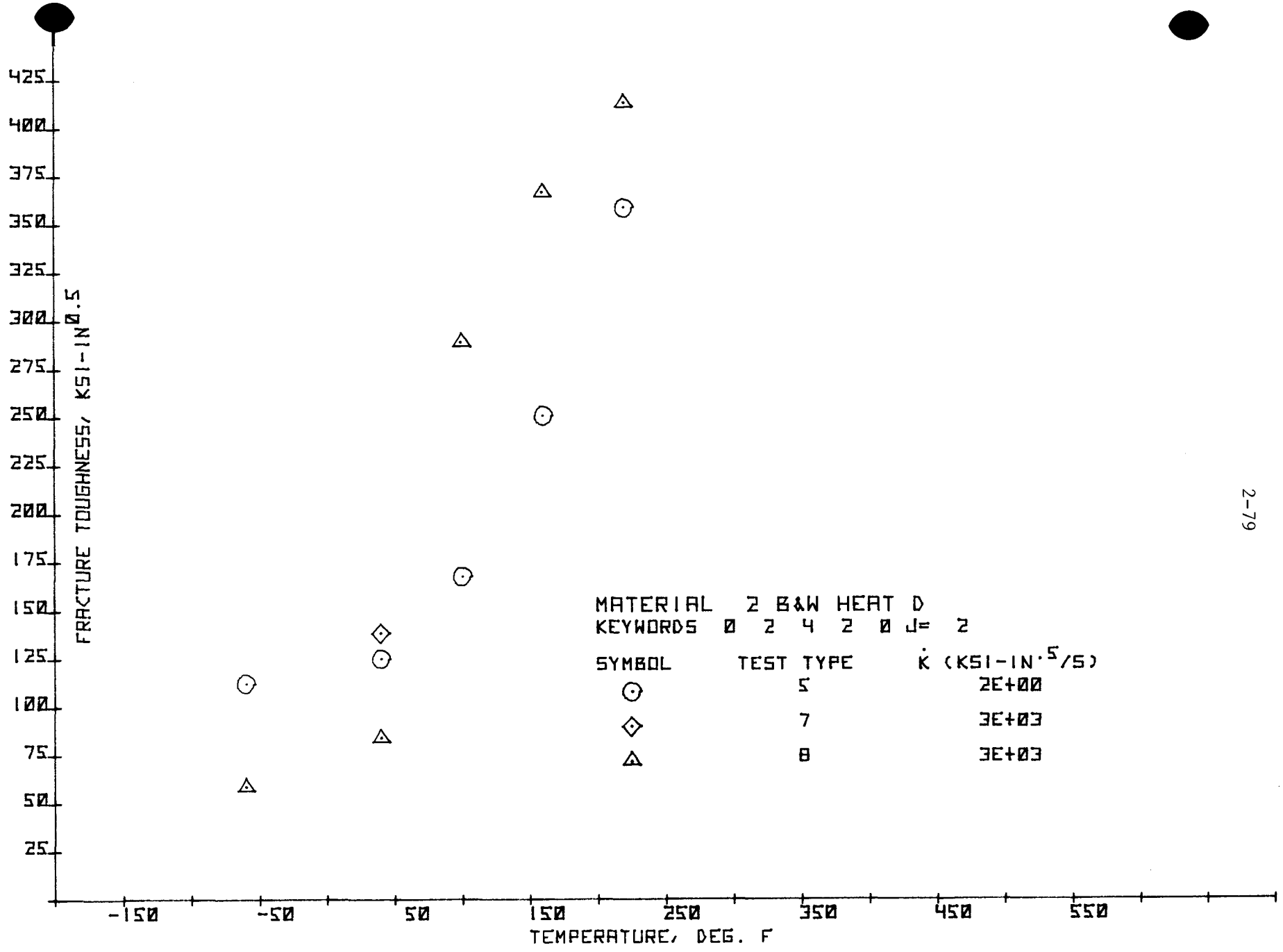


Figure 2.51. Static and Dynamic Fracture Toughness for B&W Heat D

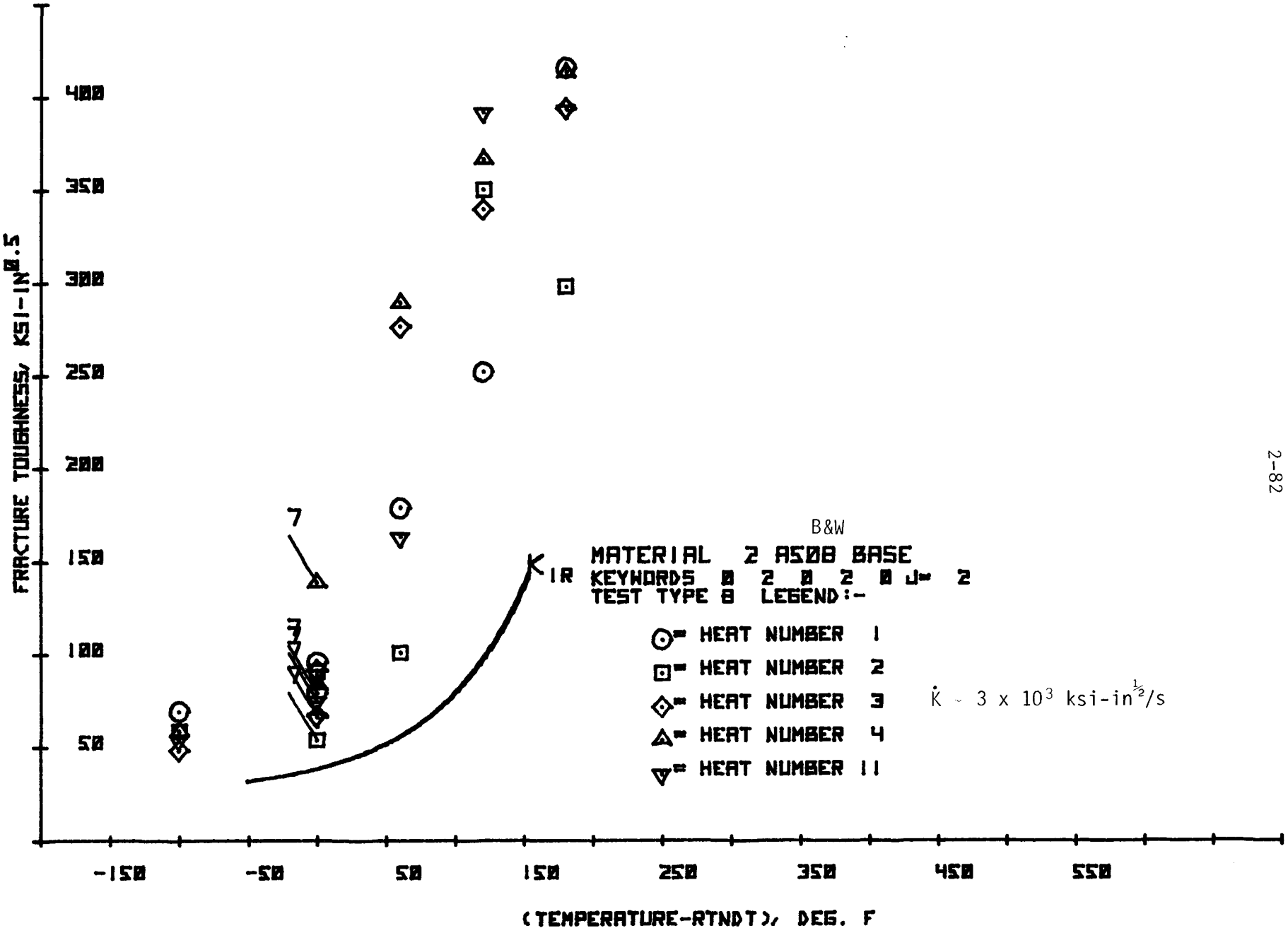


Figure 2.54. Dynamic Compact Specimen Fracture Toughness Data for All B&W Heats

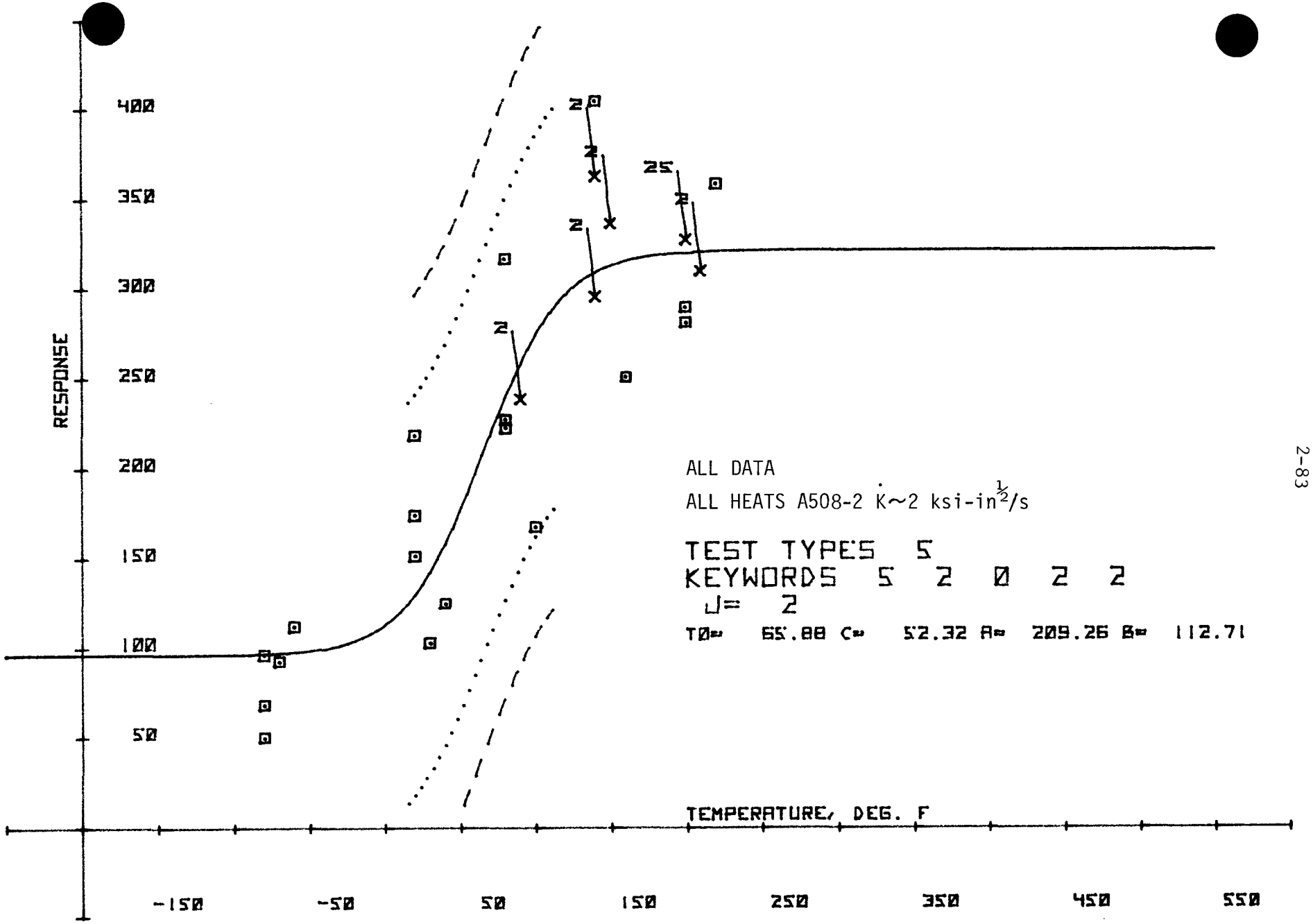


Figure 2.55 All Static Fracture Toughness Data

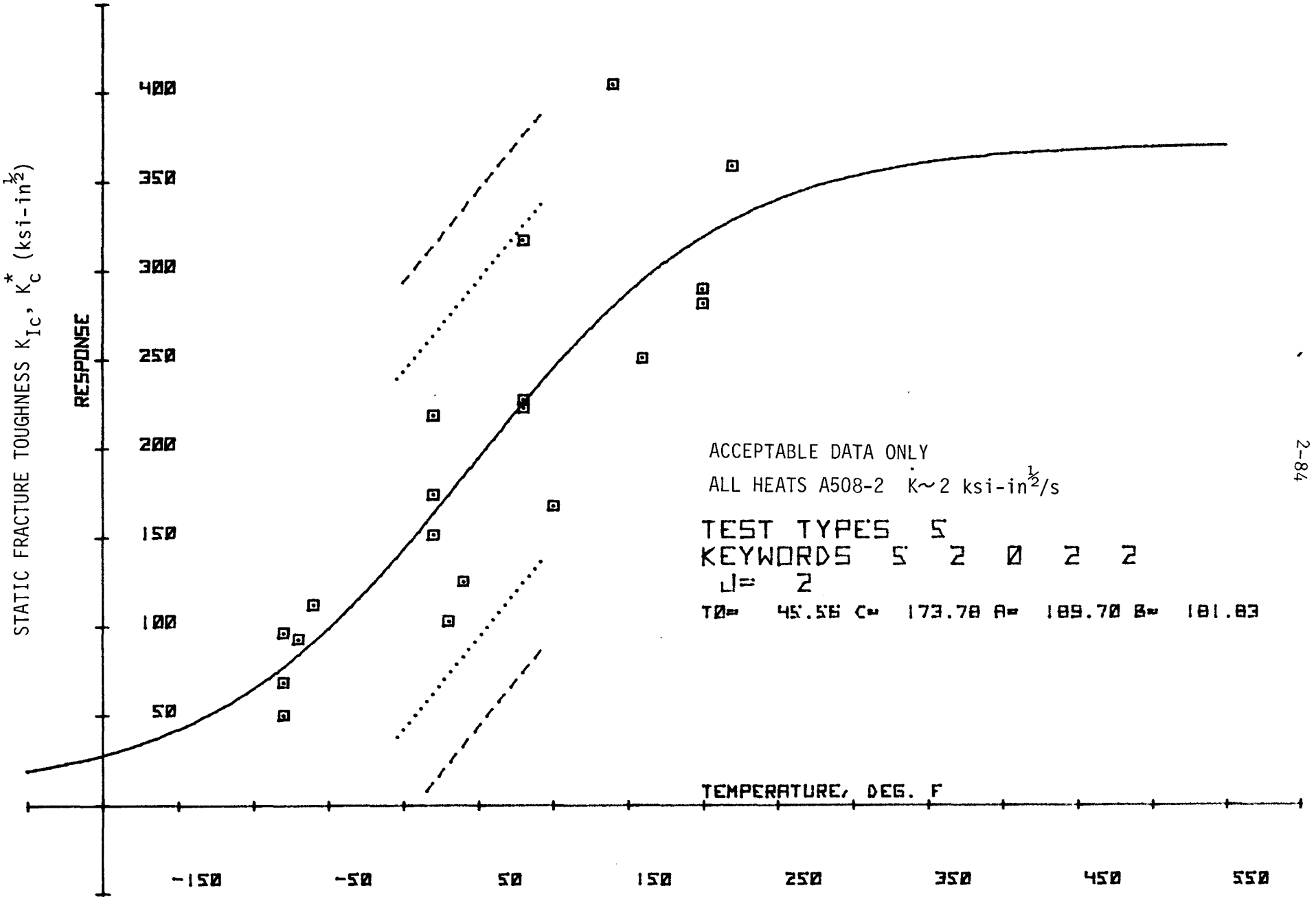


Figure 2.56 Acceptable Static Fracture Toughness Data

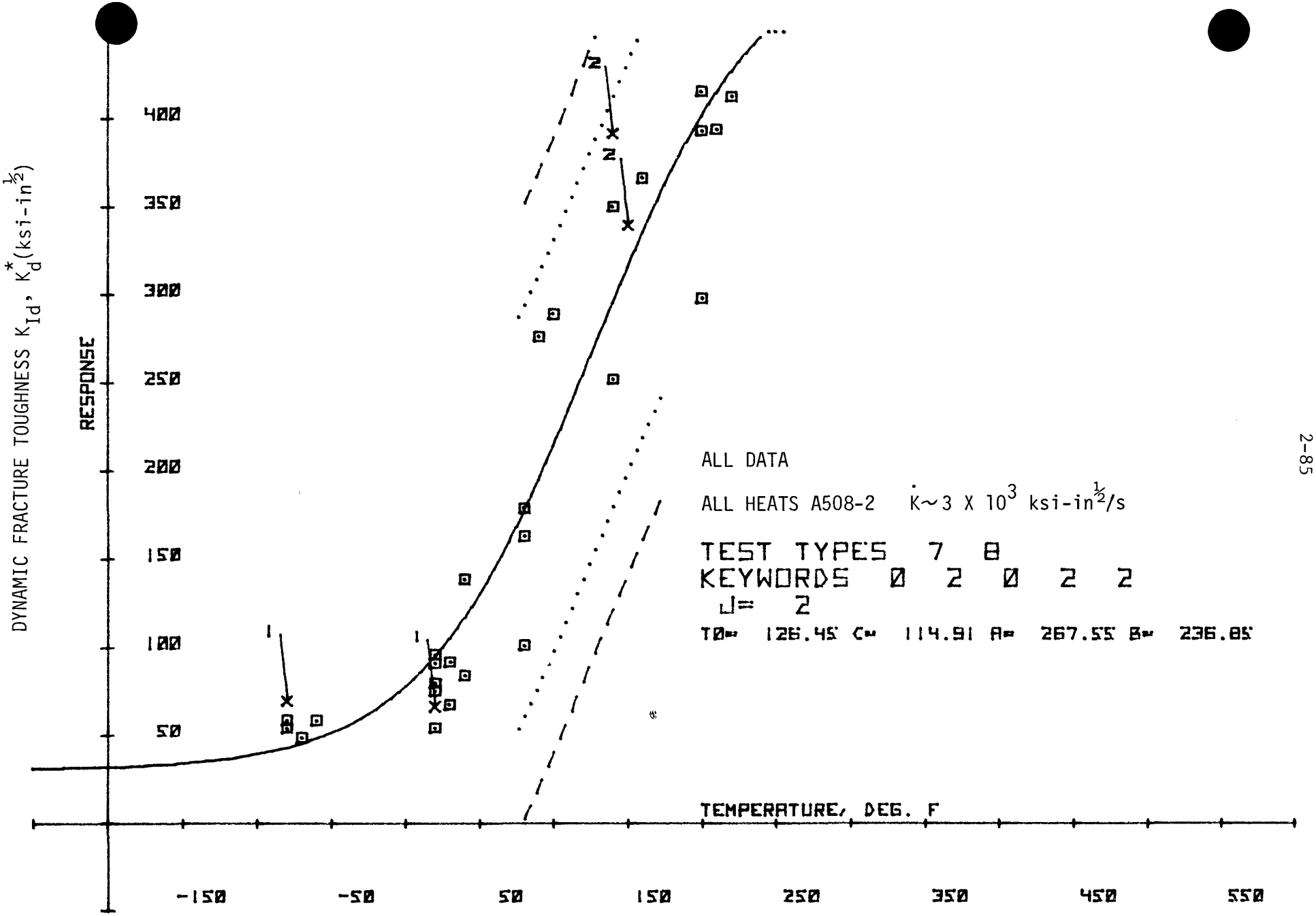


Figure 2.57 All Dynamic Fracture Toughness Data

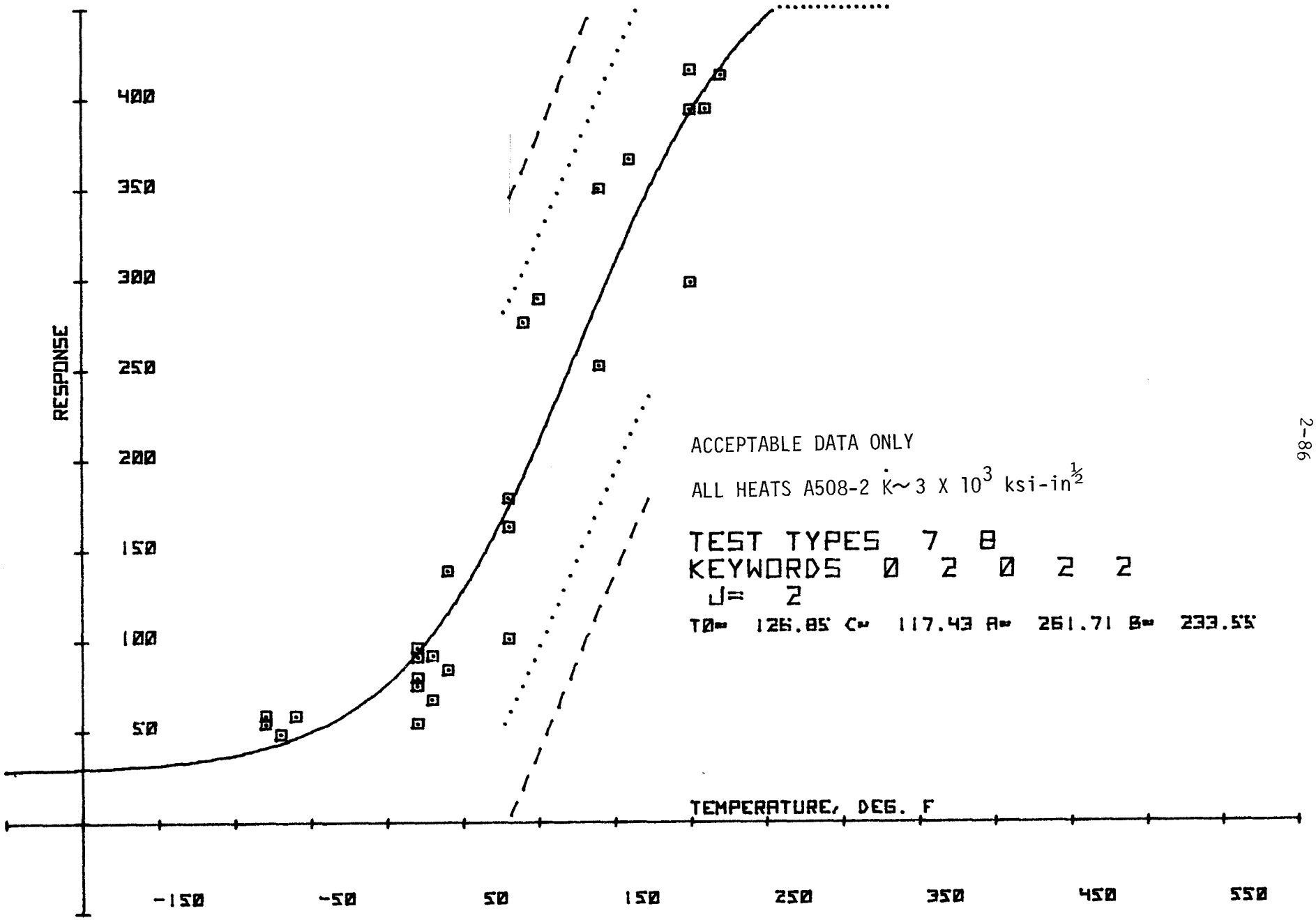


Figure 2.58 Acceptable Dynamic Fracture Toughness Data

KEYWORDS 0-0-0-2-0

MATERIAL 2 DATA BANK (A508-2)

(0) 4-2-1-2-2-1-0	0.00	1.00	--	--	--	--	
(1) 4-2-1-2-2-3-0	20.00	1.00	--	--	--	--	
(2) 4-2-1-2-2-4-0	30.00	2.00	--	--	--	--	
(3) 4-2-1-2-2-5-0	30.00	2.00	--	--	--	--	
(4) 4-2-1-2-2-2-0	40.00	2.00	--	--	--	--	
(17) 4-2-2-2-2-1-0	0.00	1.00	--	--	--	--	
(18) 4-2-2-2-2-3-0	20.00	1.00	--	--	--	--	
(19) 4-2-2-2-2-4-0	30.00	2.00	--	--	--	--	
(20) 4-2-2-2-2-5-0	30.00	2.00	--	--	--	--	
(21) 4-2-2-2-2-2-0	40.00	2.00	--	--	--	--	
(33) 4-2-3-2-2-1-0	0.00	1.00	--	--	--	--	
(34) 4-2-3-2-2-3-0	20.00	1.00	--	--	--	--	
(35) 4-2-3-2-2-4-0	30.00	1.00	--	--	--	--	
(36) 4-2-3-2-2-2-0	40.00	2.00	--	--	--	--	
(37) 4-2-3-2-2-5-0	40.00	2.00	--	--	--	--	
(52) 4-2-4-2-2-1-0	0.00	1.00	--	--	--	--	
(53) 4-2-4-2-2-2-0	40.00	1.00	--	--	--	--	
(54) 4-2-4-2-2-5-0	50.00	2.00	--	--	--	--	
(55) 4-2-4-2-2-6-0	50.00	2.00	--	--	--	--	
(56) 4-2-4-2-2-4-0	60.00	2.00	--	--	--	--	
(57) 4-2-4-2-2-3-0	80.00	2.00	--	--	--	--	
(93) 4-2-11-2-2-1-0	0.00	1.00	--	--	--	--	
(94) 4-2-11-2-2-4-0	10.00	1.00	--	--	--	--	
(95) 4-2-11-2-2-3-0	20.00	1.00	--	--	--	--	
(96) 4-2-11-2-2-5-0	20.00	2.00	--	--	--	--	
(97) 4-2-11-2-2-6-0	30.00	2.00	--	--	--	--	
(98) 4-2-11-2-2-7-0	30.00	2.00	--	--	--	--	
(99) 4-2-11-2-2-2-0	40.00	2.00	--	--	--	--	
(115) 3-2-1-2-2-26-2	-70.00	49.30	--	--	192.00	2.90E+05	
(116) 3-2-1-2-2-22-34	-40.00	29.80	--	--	398.00	2.60E+05	
(117) 3-2-1-2-2-23-3	-10.00	43.60	--	--	761.00	4.10E+05	
(118) 3-2-1-2-2-24-0	20.00	57.00	--	--	1230.00	4.30E+05	
(119) 3-2-1-2-2-25-0	20.00	59.20	--	--	1990.00	4.30E+05	
(120) 3-2-1-2-2-21-0	50.00	--	104.80	104.40	2250.00	4.10E+05	
(121) 3-2-1-2-2-27-2	30.00	--	123.00	123.00	3780.00	3.70E+05	
(122) 3-2-1-2-2-28-0	80.00	--	141.00	142.00	3970.00	4.40E+05	
(123) 3-2-1-2-2-29-2	110.00	--	182.00	181.00	4330.00	3.50E+05	
(124) 3-2-1-2-2-30-2	140.00	--	166.00	165.00	5260.00	1.80E+05	
(125) 3-2-1-2-2-32-26	170.00	--	253.00	251.00	7300.00	4.10E+05	
(126) 3-2-1-2-2-33-2	200.00	--	296.00	294.00	7430.00	3.70E+05	
(127) 3-2-1-2-2-34-4	200.00	--	309.00	312.00	8700.00	4.00E+05	
(128) 3-2-1-2-2-35-6	300.00	--	282.00	281.00	8620.00	3.90E+05	
(129) 3-2-1-2-2-36-4	425.00	--	308.00	310.00	8190.00	3.50E+05	
(130) 3-2-1-2-2-37-0	550.00	--	270.00	270.00	7520.00	3.40E+05	
(164) 3-2-2-2-2-21-2	-70.00	41.40	--	--	205.00	2.20E+05	
(165) 3-2-2-2-2-22-0	-40.00	45.10	--	--	268.00	4.40E+05	
(166) 3-2-2-2-2-23-2	-10.00	43.40	--	--	482.00	3.60E+05	
(167) 3-2-2-2-2-24-34	20.00	58.50	--	--	745.00	5.00E+05	

(168)	3-2-2-2-2-2-2	20.00	59.60	--	--	1730.00	5.40E+05
(169)	3-2-2-2-2-26-0	50.00	58.30	--	--	1660.00	4.50E+05
(170)	3-2-2-2-2-27-6	80.00	--	109.00	109.00	2930.00	6.00E+05
(171)	3-2-2-2-2-28-0	80.00	--	124.00	123.00	3060.00	5.20E+05
(172)	3-2-2-2-2-29-6	110.00	--	155.00	156.00	3320.00	5.20E+05
(173)	3-2-2-2-2-30-34	140.00	--	330.00	339.00	7320.00	2.80E+05
(174)	3-2-2-2-2-31-34	140.00	--	234.00	247.00	4400.00	2.60E+05
(175)	3-2-2-2-2-32-26	170.00	--	250.00	262.00	5470.00	4.30E+05
(176)	3-2-2-2-2-33-0	200.00	--	274.00	274.00	6390.00	4.40E+05
(177)	3-2-2-2-2-34-0	200.00	--	275.00	278.00	6730.00	4.20E+05
(178)	3-2-2-2-2-35-26	300.00	--	235.00	233.00	5590.00	1.80E+05
(179)	3-2-2-2-2-36-2	425.00	--	201.00	199.00	5110.00	3.30E+05
(212)	3-2-3-2-2-21-26	-60.00	34.10	--	--	196.00	5.50E+05
(213)	3-2-3-2-2-39-4	-30.00	51.30	--	--	514.00	4.20E+05
(214)	3-2-3-2-2-23-0	0.00	47.30	--	--	986.00	4.20E+05
(215)	3-2-3-2-2-24-4	30.00	56.00	--	--	1320.00	3.90E+05
(216)	3-2-3-2-2-25-2	30.00	--	233.00	231.00	1780.00	3.30E+05
(217)	3-2-3-2-2-27-4	90.00	--	149.00	150.00	2920.00	4.70E+05
(218)	3-2-3-2-2-30-4	150.00	--	344.00	347.00	4770.00	3.80E+05
(219)	3-2-3-2-2-31-4	150.00	--	298.00	297.00	6070.00	2.90E+05
(220)	3-2-3-2-2-32-246	180.00	--	228.00	226.00	4950.00	4.40E+05
(221)	3-2-3-2-2-33-34	210.00	--	324.00	359.00	10000.00	3.60E+05
(222)	3-2-3-2-2-34-0	210.00	--	265.00	264.00	6340.00	3.90E+05
(223)	3-2-3-2-2-5-34	300.00	--	315.00	342.00	9150.00	3.60E+05
(224)	3-2-3-2-2-36-0	425.00	--	271.00	271.00	6710.00	3.70E+05
(225)	3-2-3-2-2-37-34	550.00	--	271.00	277.00	7410.00	3.70E+05
(260)	3-2-4-2-2-21-6	-50.00	44.40	--	--	494.00	4.60E+05
(261)	3-2-4-2-2-22-0	-20.00	41.00	--	--	779.00	3.60E+05
(262)	3-2-4-2-2-23-2	10.00	49.20	--	--	1020.00	4.30E+05
(263)	3-2-4-2-2-24-2	40.00	46.80	--	--	1390.00	4.20E+05
(264)	3-2-4-2-2-5-6	40.00	67.40	--	--	2150.00	7.20E+05
(265)	3-2-4-2-2-26-0	70.00	55.70	--	--	1980.00	4.20E+05
(266)	3-2-4-2-2-27-0	100.00	--	312.00	311.00	3660.00	2.80E+05
(267)	3-2-4-2-2-28-46	100.00	--	284.00	286.00	3440.00	3.80E+05
(268)	3-2-4-2-2-29-2	130.00	--	307.00	305.00	4880.00	2.80E+05
(269)	3-2-4-2-2-30-6	160.00	--	317.00	316.00	6540.00	2.80E+05
(270)	3-2-4-2-2-31-0	160.00	--	327.00	332.00	7700.00	2.90E+05
(271)	3-2-4-2-2-32-34	190.00	--	313.00	319.00	6680.00	4.10E+05
(272)	3-2-4-2-2-33-0	220.00	--	286.00	285.00	7270.00	4.30E+05
(273)	3-2-4-2-2-34-0	220.00	--	240.00	241.00	7550.00	4.50E+05
(274)	3-2-4-2-2-35-4	300.00	--	319.00	323.00	8440.00	4.00E+05
(275)	3-2-4-2-2-36-0	425.00	--	276.00	278.00	7300.00	3.90E+05
(276)	3-2-4-2-2-37-4	550.00	--	254.00	255.00	7250.00	3.40E+05
(368)	3-2-11-2-2-21-0	-70.00	38.70	--	--	192.00	2.60E+05
(369)	3-2-11-2-2-22-6	-40.00	32.70	--	--	672.00	5.30E+05
(370)	3-2-11-2-2-23-0	-10.00	41.70	--	--	1030.00	3.70E+05
(371)	3-2-11-2-2-24-4	20.00	61.20	--	--	1270.00	4.90E+05
(372)	3-2-11-2-2-25-0	20.00	47.40	--	--	1070.00	4.10E+05
(373)	3-2-11-2-2-26-0	50.00	58.60	--	--	2400.00	4.30E+05
(374)	3-2-11-2-2-27-34	80.00	--	143.00	146.00	3100.00	5.20E+05
(375)	3-2-11-2-2-28-0	80.00	--	133.00	133.00	2970.00	4.80E+05

(376)	3-2-11-2-2-29-4	110.00	--	303.00	303.00	4770.00	3.26E+05
(377)	3-2-11-2-2-31-34	140.00	--	336.00	355.00	7130.00	2.90E+05
(378)	3-2-11-2-2-33-34	140.00	--	318.00	327.00	7650.00	3.00E+05
(379)	3-2-11-2-2-36-4	200.00	--	290.00	290.00	8410.00	4.00E+05
(380)	3-2-11-2-2-37-0	200.00	--	305.00	308.00	8310.00	4.20E+05
(415)	2-2-1-2-1-1-0	-200.00	2.00	0.50	1.00	--	--
(416)	2-2-1-2-1-2-0	-150.00	3.20	2.00	1.00	--	--
(417)	2-2-1-2-1-3-0	-100.00	3.50	2.00	1.00	--	--
(418)	2-2-1-2-1-4-0	-50.00	7.30	6.00	1.00	--	--
(419)	2-2-1-2-1-5-0	0.00	55.90	45.00	10.00	--	--
(420)	2-2-1-2-1-16-0	20.00	65.20	50.00	30.00	--	--
(421)	2-2-1-2-1-17-0	40.00	93.00	68.00	30.00	--	--
(422)	2-2-1-2-1-6-0	74.00	126.80	73.00	60.00	--	--
(423)	2-2-1-2-1-15-0	80.00	143.90	74.00	80.00	--	--
(424)	2-2-1-2-1-14-0	80.00	139.50	80.00	80.00	--	--
(425)	2-2-1-2-1-13-0	80.00	112.50	74.00	50.00	--	--
(426)	2-2-1-2-1-7-0	150.00	167.30	78.00	99.00	--	--
(427)	2-2-1-2-1-8-0	200.00	172.20	79.00	99.00	--	--
(428)	2-2-1-2-1-9-0	250.00	202.00	75.00	99.00	--	--
(429)	2-2-1-2-1-10-0	300.00	179.50	70.00	99.00	--	--
(430)	2-2-1-2-1-11-0	425.00	226.50	73.00	99.00	--	--
(431)	2-2-1-2-1-12-0	550.00	218.20	74.00	99.00	--	--
(432)	2-2-1-2-2-1-0	-200.00	2.00	0.50	1.00	--	--
(433)	2-2-1-2-2-2-0	-150.00	2.90	1.00	1.00	--	--
(434)	2-2-1-2-2-3-0	-100.00	3.40	2.00	1.00	--	--
(435)	2-2-1-2-2-4-0	-50.00	7.00	3.00	1.00	--	--
(436)	2-2-1-2-2-5-0	0.00	47.00	38.00	10.00	--	--
(437)	2-2-1-2-2-16-0	20.00	61.00	60.00	40.00	--	--
(438)	2-2-1-2-2-17-0	40.00	59.00	46.00	20.00	--	--
(439)	2-2-1-2-2-6-0	74.00	122.90	77.00	60.00	--	--
(440)	2-2-1-2-2-13-0	80.00	--	70.00	70.00	--	--
(441)	2-2-1-2-2-14-0	80.00	128.00	70.00	70.00	--	--
(442)	2-2-1-2-2-15-0	80.00	96.90	60.00	50.00	--	--
(443)	2-2-1-2-2-15-0	80.00	96.90	60.00	50.00	--	--
(444)	2-2-1-2-2-18-0	80.00	108.90	67.00	60.00	--	--
(445)	2-2-1-2-2-7-0	150.00	157.00	80.00	99.00	--	--
(446)	2-2-1-2-2-8-0	200.00	158.50	81.00	99.00	--	--
(447)	2-2-1-2-2-9-0	250.00	154.30	78.00	99.00	--	--
(448)	2-2-1-2-2-10-0	300.00	209.00	70.00	99.00	--	--
(449)	2-2-1-2-2-11-0	425.00	173.50	72.00	99.00	--	--
(450)	2-2-1-2-2-12-0	550.00	206.90	61.00	99.00	--	--
(507)	2-2-2-2-1-1-0	-200.00	2.00	0.50	1.00	--	--
(508)	2-2-2-2-1-2-0	-150.00	2.50	0.50	1.00	--	--
(509)	2-2-2-2-1-3-0	-100.00	6.80	6.00	1.00	--	--
(510)	2-2-2-2-1-4-0	-50.00	7.80	4.00	1.00	--	--
(511)	2-2-2-2-1-5-0	0.00	26.50	18.00	1.00	--	--
(512)	2-2-2-2-1-16-0	20.00	38.00	24.00	10.00	--	--
(513)	2-2-2-2-1-17-0	40.00	64.20	46.00	20.00	--	--
(514)	2-2-2-2-1-6-0	74.00	94.30	59.00	55.00	--	--
(515)	2-2-2-2-1-13-0	80.00	95.00	62.00	40.00	--	--

(516)	2-2-2-2-1-14-0	80.00	79.80	54.00	50.00	--	--
(517)	2-2-2-2-1-15-0	80.00	93.00	60.00	70.00	--	--
(518)	2-2-2-2-1-7-0	150.00	141.20	83.00	99.00	--	--
(519)	2-2-2-2-1-8-0	200.00	121.50	70.00	90.00	--	--
(520)	2-2-2-2-1-9-0	250.00	134.00	86.00	99.00	--	--
(521)	2-2-2-2-1-10-0	300.00	135.90	80.00	99.00	--	--
(522)	2-2-2-2-1-11-0	425.00	120.50	83.00	99.00	--	--
(523)	2-2-2-2-1-12-0	550.00	139.90	83.00	99.00	--	--
(524)	2-2-2-2-2-1-0	-200.00	2.00	1.00	1.00	--	--
(525)	2-2-2-2-2-2-0	-150.00	2.90	1.00	1.00	--	--
(526)	2-2-2-2-2-3-0	-100.00	4.90	4.00	1.00	--	--
(527)	2-2-2-2-2-4-0	-50.00	7.00	4.00	1.00	--	--
(528)	2-2-2-2-2-5-0	0.00	33.00	25.00	10.00	--	--
(529)	2-2-2-2-2-16-0	20.00	30.90	22.00	10.00	--	--
(530)	2-2-2-2-2-17-0	40.00	66.80	55.00	20.00	--	--
(531)	2-2-2-2-2-6-0	74.00	78.20	50.00	40.00	--	--
(532)	2-2-2-2-2-13-0	80.00	74.80	52.00	30.00	--	--
(533)	2-2-2-2-2-14-0	80.00	60.90	40.00	20.00	--	--
(534)	2-2-2-2-2-15-0	80.00	65.00	43.00	20.00	--	--
(535)	2-2-2-2-2-7-0	150.00	109.50	67.00	90.00	--	--
(536)	2-2-2-2-2-8-0	200.00	119.00	75.00	99.00	--	--
(537)	2-2-2-2-2-9-0	250.00	122.90	81.00	99.00	--	--
(538)	2-2-2-2-2-10-0	300.00	121.00	78.00	99.00	--	--
(539)	2-2-2-2-2-11-0	425.00	107.00	82.00	99.00	--	--
(540)	2-2-2-2-2-12-0	550.00	106.50	80.00	99.00	--	--
(28)	2-2-3-2-1-1-0	-200.00	1.50	0.50	0.00	--	--
(29)	2-2-3-2-1-2-0	-150.00	2.30	1.00	0.00	--	--
(30)	2-2-3-2-1-3-0	-100.00	3.50	5.00	5.00	--	--
(31)	2-2-3-2-1-4-0	-50.00	5.00	4.00	5.00	--	--
(32)	2-2-3-2-1-5-0	0.00	68.90	57.00	50.00	--	--
(33)	2-2-3-2-1-16-0	30.00	76.60	64.00	40.00	--	--
(34)	2-2-3-2-1-17-0	40.00	79.50	63.00	30.00	--	--
(35)	2-2-3-2-1-6-0	80.00	118.90	77.00	60.00	--	--
(36)	2-2-3-2-1-13-0	90.00	114.20	73.00	60.00	--	--
(37)	2-2-3-2-1-14-0	90.00	131.00	80.00	90.00	--	--
(38)	2-2-3-2-1-15-0	90.00	108.80	42.00	60.00	--	--
(39)	2-2-3-2-1-7-0	150.00	145.20	87.00	65.00	--	--
(40)	2-2-3-2-1-8-0	200.00	148.90	89.00	75.00	--	--
(41)	2-2-3-2-1-9-0	250.00	172.50	78.00	75.00	--	--
(42)	2-2-3-2-1-10-0	300.00	216.50	69.00	90.00	--	--
(43)	2-2-3-2-1-11-0	425.00	137.60	74.00	85.00	--	--
(44)	2-2-3-2-1-12-0	550.00	139.00	91.00	90.00	--	--
(45)	2-2-3-2-2-1-0	-200.00	1.60	2.00	0.00	--	--
(46)	2-2-3-2-2-2-0	-150.00	3.90	1.00	0.00	--	--
(47)	2-2-3-2-2-3-0	-100.00	3.50	2.00	5.00	--	--
(48)	2-2-3-2-2-4-0	-50.00	4.90	3.00	5.00	--	--
(49)	2-2-3-2-2-5-0	0.00	40.20	33.00	45.00	--	--
(50)	2-2-3-2-2-16-0	30.00	44.80	34.00	10.00	--	--
(51)	2-2-3-2-2-17-0	40.00	86.70	60.00	40.00	--	--
(52)	2-2-3-2-2-6-0	80.00	105.00	70.00	50.00	--	--
(53)	2-2-3-2-2-13-0	90.00	105.00	75.00	50.00	--	--

(54)	2-2-3-2-2-14-0	90.00	112.90	74.00	80.00	--
(55)	2-2-3-2-2-15-0	90.00	126.20	79.00	90.00	--
(56)	2-2-3-2-2-7-0	150.00	115.90	73.00	65.00	--
(57)	2-2-3-2-2-8-0	200.00	135.00	83.00	65.00	--
(58)	2-2-3-2-2-9-0	250.00	144.00	84.00	70.00	--
(59)	2-2-3-2-2-10-0	300.00	136.70	83.00	75.00	--
(60)	2-2-3-2-2-11-0	425.00	129.90	92.00	80.00	--
(61)	2-2-3-2-2-12-0	550.00	132.40	79.00	90.00	--
(121)	2-2-4-2-1-1-0	-200.00	2.10	1.00	1.00	--
(122)	2-2-4-2-1-2-0	-150.00	5.00	4.00	1.00	--
(123)	2-2-4-2-1-3-0	-100.00	5.30	4.00	1.00	--
(124)	2-2-4-2-1-4-0	-50.00	6.50	5.00	1.00	--
(125)	2-2-4-2-1-5-0	0.00	26.20	20.00	10.00	--
(126)	2-2-4-2-1-17-0	20.00	89.10	69.00	40.00	--
(127)	2-2-4-2-1-16-0	40.00	87.10	30.00	30.00	--
(128)	2-2-4-2-1-6-0	75.00	138.90	82.00	90.00	--
(129)	2-2-4-2-1-15-0	100.00	84.90	59.00	30.00	--
(130)	2-2-4-2-1-14-0	100.00	125.40	76.00	60.00	--
(131)	2-2-4-2-1-13-0	100.00	114.90	70.00	60.00	--
(132)	2-2-4-2-1-7-0	150.00	152.00	81.00	99.00	--
(133)	2-2-4-2-1-8-0	200.00	154.30	81.00	99.00	--
(134)	2-2-4-2-1-9-0	250.00	153.90	84.00	99.00	--
(135)	2-2-4-2-1-10-0	300.00	155.50	82.00	99.00	--
(136)	2-2-4-2-1-11-0	425.00	152.80	80.00	99.00	--
(137)	2-2-4-2-1-12-0	550.00	172.00	68.00	99.00	--
(138)	2-2-4-2-2-1-0	-200.00	1.90	1.00	1.00	--
(139)	2-2-4-2-2-2-0	-150.00	3.20	1.00	1.00	--
(140)	2-2-4-2-2-3-0	-100.00	2.90	1.00	1.00	--
(141)	2-2-4-2-2-20-0	-50.00	12.90	8.00	1.00	--
(142)	2-2-4-2-2-18-0	0.00	41.60	31.00	10.00	--
(143)	2-2-4-2-2-19-0	20.00	77.00	54.00	40.00	--
(144)	2-2-4-2-2-16-0	40.00	79.00	53.00	30.00	--
(145)	2-2-4-2-2-17-0	75.00	93.40	62.00	40.00	--
(146)	2-2-4-2-2-13-0	100.00	92.90	59.00	50.00	--
(147)	2-2-4-2-2-14-0	100.00	117.40	75.00	80.00	--
(148)	2-2-4-2-2-15-0	100.00	103.30	63.00	40.00	--
(149)	2-2-4-2-2-7-0	150.00	149.00	82.00	99.00	--
(150)	2-2-4-2-2-8-0	200.00	147.00	71.00	99.00	--
(151)	2-2-4-2-2-9-0	250.00	140.90	85.00	99.00	--
(152)	2-2-4-2-2-10-0	300.00	143.50	78.00	99.00	--
(153)	2-2-4-2-2-11-0	425.00	136.80	77.00	99.00	--
(154)	2-2-4-2-2-12-0	550.00	139.50	72.00	99.00	--
(231)	2-2-11-2-1-1-0	-200.00	1.80	0.50	0.00	--
(282)	2-2-11-2-1-2-0	-150.00	2.90	1.00	0.00	--
(283)	2-2-11-2-1-3-0	-100.00	4.40	2.00	5.00	--
(284)	2-2-11-2-1-4-0	-50.00	14.00	15.00	5.00	--
(285)	2-2-11-2-1-5-0	0.00	48.80	39.00	25.00	--
(286)	2-2-11-2-1-17-0	20.00	56.90	44.00	10.00	--
(287)	2-2-11-2-1-16-0	40.00	67.20	52.00	20.00	--
(288)	2-2-11-2-1-15-0	80.00	112.60	79.00	50.00	--

(289)	2-2-11-2-1-14-0	80.00	100.00	73.00	60.00	--	--
(290)	2-2-11-2-1-13-0	80.00	81.90	63.00	40.00	--	--
(291)	2-2-11-2-1-6-0	80.00	98.00	70.00	35.00	--	--
(292)	2-2-11-2-1-7-0	150.00	136.30	90.00	45.00	--	--
(293)	2-2-11-2-1-8-0	200.00	144.60	92.00	50.00	--	--
(294)	2-2-11-2-1-9-0	250.00	155.50	91.00	50.00	--	--
(295)	2-2-11-2-1-10-0	300.00	138.90	87.00	55.00	--	--
(296)	2-2-11-2-1-11-0	425.00	158.00	74.00	70.00	--	--
(297)	2-2-11-2-1-12-0	550.00	153.90	81.00	80.00	--	--
(298)	2-2-11-2-2-1-0	-200.00	1.90	1.00	5.00	--	--
(299)	2-2-11-2-2-2-0	-150.00	2.50	1.50	5.00	--	--
(300)	2-2-11-2-2-3-0	-100.00	5.00	4.00	5.00	--	--
(301)	2-2-11-2-2-4-0	-50.00	4.30	2.00	20.00	--	--
(302)	2-2-11-2-2-5-0	0.00	18.60	15.00	20.00	--	--
(303)	2-2-11-2-2-17-0	20.00	47.30	34.00	10.00	--	--
(304)	2-2-11-2-2-16-0	40.00	66.20	48.00	30.00	--	--
(305)	2-2-11-2-2-15-0	80.00	78.00	55.00	30.00	--	--
(306)	2-2-11-2-2-14-0	80.00	90.10	65.00	50.00	--	--
(307)	2-2-11-2-2-13-0	80.00	93.60	66.00	40.00	--	--
(308)	2-2-11-2-2-6-0	80.00	80.00	60.00	45.00	--	--
(309)	2-2-11-2-2-7-0	150.00	135.00	88.00	45.00	--	--
(310)	2-2-11-2-2-8-0	200.00	132.20	83.00	45.00	--	--
(311)	2-2-11-2-2-3-0	250.00	141.00	90.00	60.00	--	--
(312)	2-2-11-2-2-10-0	300.00	135.90	88.00	60.00	--	--
(313)	2-2-11-2-2-11-0	425.00	129.50	91.00	60.00	--	--
(314)	2-2-11-2-2-12-0	550.00	122.30	88.00	65.00	--	--
(380)	1-2-1-2-1-1-0	-210.00	101.70	113.50	15.00	29.00	63.20
(381)	1-2-1-2-1-2-0	-25.00	67.40	90.80	12.00	29.50	70.60
(382)	1-2-1-2-1-3-0	75.00	58.40	82.80	11.30	29.00	71.40
(383)	1-2-1-2-1-4-0	200.00	58.40	78.40	10.80	27.00	72.20
(384)	1-2-1-2-1-5-0	300.00	56.80	77.40	9.30	23.50	70.40
(385)	1-2-1-2-1-6-0	550.00	54.50	81.40	10.30	24.50	67.00
(398)	1-2-2-2-1-1-0	-205.00	105.20	115.90	15.00	28.00	61.50
(399)	1-2-2-2-1-2-0	-25.00	75.90	96.90	10.00	26.50	66.40
(400)	1-2-2-2-1-3-0	75.00	70.80	90.80	10.00	26.50	68.70
(401)	1-2-2-2-1-4-0	200.00	65.50	84.70	10.00	25.50	68.50
(402)	1-2-2-2-1-5-0	300.00	64.20	84.50	8.40	21.50	65.90
(403)	1-2-2-2-1-6-0	550.00	64.10	88.50	10.50	24.00	67.60
(416)	1-2-3-2-1-1-0	-205.00	98.80	111.30	13.50	28.00	61.00
(417)	1-2-3-2-1-2-0	-25.00	66.20	90.80	11.80	29.00	68.50
(418)	1-2-3-2-1-3-0	75.00	60.30	83.00	10.80	27.00	69.30
(419)	1-2-3-2-1-4-0	200.00	57.90	78.70	9.80	25.50	69.80
(420)	1-2-3-2-1-5-0	300.00	56.20	77.90	9.50	23.50	67.90
(421)	1-2-3-2-1-6-0	550.00	56.10	81.90	10.00	23.50	64.10
(434)	1-2-4-2-1-1-0	-192.00	99.10	114.50	14.50	29.00	61.30
(435)	1-2-4-2-1-2-0	-25.00	72.30	95.70	9.00	29.00	69.20
(436)	1-2-4-2-1-3-0	75.00	65.90	88.10	11.30	27.00	69.70
(437)	1-2-4-2-1-4-0	200.00	64.60	84.80	9.80	24.50	70.20
(438)	1-2-4-2-1-5-0	300.00	61.40	82.40	8.80	22.50	68.30
(439)	1-2-4-2-1-6-0	550.00	60.30	86.70	9.50	24.30	66.10
(476)	1-2-11-2-1-1-0	-200.00	95.60	112.60	15.00	29.50	63.30

(477)	1-2-11-2-1-2-0	-25.00	69.40	94.20	13.00	31.50	69.30
(478)	1-2-11-2-1-3-0	75.00	63.70	86.40	11.80	27.50	70.80
(479)	1-2-11-2-1-4-0	200.00	59.50	80.50	10.60	27.00	70.60
(480)	1-2-11-2-1-5-0	300.00	57.50	79.50	11.30	25.50	69.80
(481)	1-2-11-2-1-6-0	550.00	56.50	85.40	10.80	25.00	68.40
(494)	5-2-1-2-2-9-0	-80.00	--	96.60	85.80	--	1.70
(495)	5-2-1-2-2-10-0	20.00	--	218.60	199.00	--	1.20
(496)	5-2-1-2-2-5-0	80.00	--	317.20	299.60	--	1.50
(497)	5-2-1-2-2-4-0	140.00	--	404.50	370.80	--	1.20
(498)	5-2-1-2-2-3-0	200.00	--	289.90	279.20	--	1.70
(508)	5-2-2-2-2-5-0	-80.00	50.30	--	--	--	1.50
(509)	5-2-2-2-2-6-0	20.00	--	174.20	154.50	--	2.20
(510)	5-2-2-2-2-4-0	80.00	--	222.90	208.70	--	2.70
(511)	5-2-2-2-2-3-2	140.00	--	296.00	268.60	--	1.70
(512)	5-2-2-2-2-2-0	200.00	--	281.40	254.50	--	1.80
(523)	5-2-3-2-2-5-0	-70.00	--	93.00	82.40	--	1.80
(524)	5-2-3-2-2-9-0	30.00	--	103.20	91.40	--	1.40
(525)	5-2-3-2-2-4-2	90.00	--	238.90	230.90	--	1.10
(526)	5-2-3-2-2-3-2	150.00	--	336.60	309.10	--	--
(527)	5-2-3-2-2-2-2	210.00	--	310.30	308.20	--	1.80
(538)	5-2-4-2-2-4-0	-60.00	--	112.40	103.30	--	1.70
(539)	5-2-4-2-2-10-0	40.00	--	125.40	111.30	--	1.70
(540)	5-2-4-2-2-5-0	100.00	--	167.90	150.30	--	1.60
(541)	5-2-4-2-2-3-0	160.00	--	250.80	321.90	--	1.60
(542)	5-2-4-2-2-2-0	220.00	--	358.70	303.60	--	--
(6)	5-2-11-2-2-9-0	-80.00	--	68.80	58.80	--	1.60
(7)	5-2-11-2-2-5-0	20.00	--	151.60	137.20	--	1.70
(8)	5-2-11-2-2-4-0	80.00	--	227.50	220.10	--	1.60
(9)	5-2-11-2-2-2-2	140.00	--	363.00	342.80	--	1.50
(10)	5-2-11-2-2-3-25	200.00	--	327.80	284.50	--	1.70
(22)	7-2-1-2-2-1-0	20.00	79.90	--	--	--	2500.00
(25)	7-2-2-2-2-1-0	20.00	54.50	--	--	--	2700.00
(27)	7-2-3-2-2-1-0	30.00	67.60	--	--	--	2600.00
(30)	7-2-4-2-2-1-0	40.00	--	138.80	121.40	--	2900.00
(32)	7-2-11-2-2-1-0	20.00	75.60	--	--	--	2600.00
(40)	8-2-1-2-2-11-1	-80.00	69.80	--	--	--	--
(41)	8-2-1-2-2-8-0	20.00	--	96.20	89.70	--	3000.00
(42)	8-2-1-2-2-7-0	80.00	--	178.90	154.40	--	2900.00
(43)	8-2-1-2-2-2-0	140.00	--	252.10	233.40	--	1700.00
(44)	8-2-1-2-2-6-0	200.00	--	415.60	381.80	--	2800.00
(55)	8-2-2-2-2-9-0	-80.00	59.00	--	--	--	3200.00
(56)	8-2-2-2-2-10-0	20.00	--	91.20	86.20	--	3200.00
(57)	8-2-2-2-2-11-0	80.00	--	101.30	92.80	--	3100.00
(58)	8-2-2-2-2-8-0	140.00	--	350.20	338.30	--	1900.00
(59)	8-2-2-2-2-7-0	200.00	--	298.20	306.50	--	3100.00
(70)	8-2-3-2-2-11-0	-70.00	48.80	--	--	--	3100.00
(71)	8-2-3-2-2-10-0	30.00	--	92.00	82.70	--	3000.00
(72)	8-2-3-2-2-8-0	90.00	--	276.20	212.30	--	2900.00
(73)	8-2-3-2-2-7-2	150.00	--	339.70	320.20	--	2600.00
(74)	8-2-3-2-2-6-0	210.00	--	394.20	376.50	--	2900.00

(85) 8-2-4-2-2-11-0	-60.00	58.80	--	--	--	3200.00
(86) 8-2-4-2-2-9-0	40.00	--	84.20	74.60	--	3000.00
(87) 8-2-4-2-2-8-0	100.00	--	289.20	265.20	--	3100.00
(88) 8-2-4-2-2-7-0	160.00	--	366.40	339.50	--	2400.00
(89) 8-2-4-2-2-6-0	220.00	--	412.80	354.40	--	3000.00
(119) 8-2-11-2-2-10-0	-80.00	54.40	--	--	--	3300.00
(120) 8-2-11-2-2-11-1	20.00	66.70	--	--	--	3200.00
(121) 8-2-11-2-2-8-0	80.00	--	163.10	147.50	--	3000.00
(122) 8-2-11-2-2-7-2	140.00	--	391.80	359.30	--	3300.00
(123) 8-2-11-2-2-6-0	200.00	--	393.50	349.80	--	3200.00

APPENDIX 3

MATERIAL 3

A540 GRADE B-23 AND B-24 BOLTING STEELS

MATERIAL TYPE 3
A540 BOLTING STEEL

INTRODUCTION

Babcock and Wilcox performed a special test matrix on five heats of A540 bolting material. Differences in the test matrix included: (1) all specimens were machined in the longitudinal orientation, and (2) the testing temperature matrix was altered due to the low NDTT values[11]. The high yield strength of A540 (approximately 140,000 psi) makes this material substantially different from the other materials studied in this program and excludes this material from meeting the K_{IR} Code requirements. The Charpy V-notch upper shelf energy of A540 is low, sometimes falling below 50 ft-lb. Table 3.1 provides a brief description of the various heats of material 3. More detailed information on the material and test results can be obtained from reference 11. The test results contained in the data bank are given in the extract at the end of this section.

TENSILE TESTS RESULTS

The 2-in. gage section tensile properties of A540 bolting material were determined over a range of temperatures as specified by the Program Office. Third order polynomial curve fits to the data for each heat are shown in Figures 3.1 - 3.5. The curve fit coefficients and the statistical data for each curve are summarized in Table 3.2.

CHARPY V-NOTCH RESULTS

Impact Energy

The impact energy results for A540 steel are shown graphically in Figures 3.6 - 3.10 and summarized in Table 3.3. The columns in Table 3.3 show the keywords, the column of the data bank record in which the data is filed (J value), the tanh coefficients (A, B, T_0 and C) of the tanh curve, PHI (the number of degrees of freedom), and VAR (the variance

of data in a ±50°F temperature range about T_0). Table 3.4 provides a comparison of each quantity to the mean. Although the variance of data set 22631 (heat F) was high, it did not deviate significantly from the results for the other sets. Both A and B values for data set 22531 (heat E) were high, indicating a high upper shelf.

Lateral Expansion

The curve fit results for the Charpy lateral expansion data are summarized in Table 3.5. The individual curve fit parameters are analyzed in Table 3.6. The data are shown graphically in Figures 3.11 - 3.15. Table 3.6 again shows high A and B values for data set 22531 (heat E) indicating a high upper shelf value.

Percent Shear

The statistics for the curves fitted to the percent shear results for A540 are summarized in Table 3.7 and the statistical parameters are compared in Table 3.8. The curves are shown in Figures 3.16 to 3.20.

Summary of Charpy Impact Data

Table 3.9 compares the T_0 - C estimate of a transition temperature from the three impact test quantities to NDTT. T_0 - C from the impact energy curves appears to give the best correlation with NDTT.

INSTRUMENTED PRECRACKED CHARPY RESULTS

Dynamic Fracture Toughness K_{Id}, K_d^*

The elastic and elastic-plastic fracture toughness results for A540 are shown in Figures 3.21 - 3.25. The curve statistics are summarized in Table 3.10. The various statistical parameters are analyzed in Table 3.11. The mean upper shelf was 156 ksi-$in^{\frac{1}{2}}$. The mean lower shelf was 41 ksi-$in^{\frac{1}{2}}$. Material from heat E (data set 32531) had a higher than average upper shelf.

Normalized Energy, W/A

The normalized energy results for the precracked Charpy tests on A540 are shown fitted to tanh curves in Figures 3.26 - 3.30. The parameters of the curve are summarized in Table 3.12. Each parameter is analyzed separately in Table 3.13. For W/A measurements, data set 321231 (heat L) exhibited the largest deviation from the mean for upper shelf values.

Summary of Precracked Charpy Results

T_0 - C data from both the fracture toughness and W/A curves are compared to NDTT in Table 3.14. The normalized energy results show the best agreement with NDTT. None the less, heats H (32831) and L (321231) differ by $41^{o}F$ and $54^{o}F$, respectively.

The toughness and W/A data are summarized in Figures 3.31 and 3.32. These figures use NDTT to normalize the test temperature.

STATIC AND DYNAMIC COMPACT FRACTURE RESULTS

Although there were upper shelf data for the compact fracture toughness tests enabling tanh curve fits, there were too few data points to make statistical comparisons. The 1-in. static test results (test type 5) for A540 are shown in Figures 3.33 - 3.37. Table 3.15 gives estimates of the upper shelf toughnesses (A + B), T_0, and T_0 - C based on the tanh fit curves, and compares the tanh transition temperature parameters to the NDTT. Static toughness results for all five heats of A540 are summarized in Figure 3.38. The shelves were at 54 ksi-$in^{\frac{1}{2}}$ and 220 ksi-$in^{\frac{1}{2}}$. The ductile-brittle transition (T_0 - C) was at $-83^{o}F$.

The dynamic one-inch and two-inch compact fracture results (test types 8 and 9) for A540 are shown in Figures 3.39 to 3.43. There were again too few points on each graph to allow statistical analysis. The upper shelf and transition temperature parameter for each heat are listed in Table 3.16. The toughness results are combined and referenced to NDTT in Figure 3.44.

EFFECT OF ERROR CODES

The static and dynamic fracture toughness results for material 3 were statistically analyzed with and without the data points which did not meet the EPRI procedures. Tanh curve fits to the total data and acceptable data only are shown in Figures 3.45 to 3.48. The influence of the error code data on shelf properties and variance was determined. Both the overall variance and the variance in the transition temperature region ($T_0 \pm 50^{\circ}F$) were compared. A summary of the error code analysis is given in Table 3.17. The variance ratio (F) was calculated for the static and dynamic fracture toughness results. The ratios shown in Table 3.17 had a high probability of occurring by chance, and it is concluded that the effect of the error codes on the data was not significant.

Table 3.1. Summary of A540 Heats (Material 3)

TEST LABORATORY	HEAT CODE	THICKNESS DIAMETER (in.)	NDTT (^{o}F)	COMMENTS
	E(5)		-170	B-23
	F(6)		-150	B-23
B & W	G(7)	(Ref. 11)	-140	B-24
	H(8)		-160	B-23
	L(12)		~-200	B-23

Table 3.2. Summary of the Regression Analysis of the Tensile Test Data.(A540)

Property	A	B	C	D	Variance, σ^2	Degrees of Freedom ϕ	Standard Deviation σ
Yield Stress	150.7	$-7.590X10^{-2}$	$1.210X10^{-4}$	$-1.187X10^{-7}$	84.27	26.00	9.17
Ultimate Tensile Stress	169.3	$-7.739X10^{-2}$	$1.138X10^{-4}$	$-5.171X10^{-8}$	42.21	26.00	6.49
Uniform Elongation	6.545	$-6.37X10^{-3}$	$5.372X10^{-6}$	$1.149X10^{-8}$	.54	16.00	.734
Total Elongation	17.13	$-7.374X10^{-3}$	$-2.215X10^{-5}$	$8.006X10^{-8}$	1.11	26.00	1.053
Reduction In Area	53.41	$-1.402X10^{-3}$	$-7.853X10^{-5}$	$1.934X10^{-7}$	10.12	26.00	3.181

Table 3.3. Tanh Fit Parameters for Charpy Impact Energy Data (A540)

KEY	J	A	B	T0	C	PHI	VAR
22531	2	36.86	25.98	-67.59	94.24	4	9.57
22631	2	27.89	20.75	-35.85	85.06	5	24.10
22731	2	27.40	18.40	-31.91	138.51	4	6.16
22831	2	30.11	18.94	-70.67	92.14	4	7.88
221231	2	33.05	22.44	-68.97	71.14	4	2.53

Table 3.4. Deviation of Charpy Impact Energy Curve Fit Parameters from Mean Values (A540)

A

TOTAL	155.31
MEAN	31.062
ST. DEV	3.935323367

KEY	VAL	DEV	NORMALIZED DEV
22531	36.86	5.80	1.47
22631	27.89	-3.17	-0.81
22731	27.40	-3.66	-0.93
22831	30.11	-0.95	-0.24
221231	33.05	1.99	0.51

B

TOTAL	106.51
MEAN	21.302
ST. DEV	3.061212178

KEY	VAL	DEV	NORMALIZED DEV
22531	25.98	4.68	1.53
22631	20.75	-0.55	-0.18
22731	18.40	-2.90	-0.95
22831	18.94	-2.36	-0.77
1231	22.44	1.14	0.37

Table 3.4. (continued)

T_0

TOTAL	-275.02
MEAN	-55.004
ST. DEV	19.35161699

KEY	VAL	DEV	NORMALIZED DEV
22531	-67.59	-12.59	-0.65
22631	-35.88	19.12	0.99
22731	-31.91	23.09	1.19
22831	-70.67	-15.67	-0.81
221231	-68.97	-13.97	-0.72

C

TOTAL	481.09
MEAN	96.218
ST. DEV	25.31088145

KEY	VAL	DEV	NORMALIZED DEV
22531	94.24	-1.98	-0.08
22631	85.06	-11.16	-0.44
22731	138.51	42.29	1.67
22831	92.14	-4.08	-0.16
221231	71.14	-25.08	-0.99

Table 3.4. (continued)

PHI

TOTAL	21
MEAN	4.2
ST. DEV	0.4472135595

KEY	VAL	DEV	NORMALIZED DEV
22531	4.00	-0.20	-0.45
22631	5.00	0.80	1.79
22731	4.00	-0.20	-0.45
22831	4.00	-0.20	-0.45
221231	4.00	-0.20	-0.45

VARIANCE

TOTAL	50.32
MEAN	10.064
ST. DEV	8.310802007

KEY	VAL	DEV	NORMALIZED DEV
22531	9.57	-0.49	-0.06
22631	24.18	14.12	1.70
22731	6.16	-3.90	-0.47
22831	7.08	-2.18	-0.26
221231	2.53	-7.53	-0.91

Table 3.5. Tanh Fit Parameters for Charpy Impact Lateral Expansion Data (A540)

KEY	J	A	B	T0	C	PHI	VAR
22531	3	22.02	20.80	-63.61	128.52	4	7.59
22631	3	17.20	15.59	-20.29	122.51	4	2.83
22731	3	16.38	16.33	-13.17	150.90	3	3.55
22831	3	18.70	18.66	-37.27	200.11	4	7.70
221231	3	18.42	18.42	-63.73	185.82	4	5.83

Table 3.6. Deviation of Charpy Impact Lateral Expansion Curve Fit Parameters From Mean Values (A540)

A

TOTAL	92.72
MEAN	18.544
ST. DEV	2.157053546

KEY	VAL	DEV	NORMALIZED DEV
22531	22.02	3.48	1.61
22631	17.20	-1.34	-0.62
22731	16.38	-2.16	-1.00
22831	18.70	0.16	0.07
221231	18.42	-0.12	-0.06

B

TOTAL	89.8
MEAN	17.96
ST. DEV	2.064037306

KEY	VAL	DEV	NORMALIZED DEV
22531	20.80	2.84	1.38
22631	15.59	-2.37	-1.15
22731	16.33	-1.63	-0.79
22831	18.66	0.70	0.34
221231	18.42	0.46	0.22

T_0

TOTAL	-198.07
MEAN	-39.614
ST. DEV	23.64099152

KEY	VAL	DEV	NORMALIZED DEV
22531	-63.61	-24.00	-1.02
22631	-20.29	19.32	0.82
22731	-13.17	26.44	1.12
22831	-37.27	2.34	0.10
221231	-63.73	-24.12	-1.02

Table 3.6. (continued)

C

TOTAL	707.86
MEAN	141.572
ST. DEV	36.48845393

KEY	VAL	DEV	NORMALIZED DEV
22531	128.52	-13.05	-0.36
22631	122.51	-19.06	-0.52
22731	150.90	9.33	0.26
22831	200.11	58.54	1.60
221231	105.82	-35.75	-0.98

PHI

TOTAL	19
MEAN	3.8
ST. DEV	0.447213595

KEY	VAL	DEV	NORMALIZED DEV
22531	4.00	0.20	0.45
22631	4.00	0.20	0.45
22731	3.00	-0.80	-1.79
22831	4.00	0.20	0.45
221231	4.00	0.20	0.45

VARIANCE

TOTAL	26.5
MEAN	5.3
ST. DEV	2.497418667

KEY	VAL	DEV	NORMALIZED DEV
22531	7.59	2.29	0.92
22631	2.83	-2.47	-0.99
22731	2.55	-2.75	-1.10
22831	7.70	2.40	0.96
221231	5.83	0.53	0.21

Table 3.7. Tanh Fit Parameters for Charpy Impact Percent Shear Data (A540)

KEY	J	A	B	T0	C	PHI	VAR
22531	4	55.31	44.15	-73.83	18.07	4	13.34
22631	4	52.29	47.87	-30.80	38.20	5	455.54
22731	4	51.38	46.91	-72.46	10.45	4	7.47
22831	4	55.72	43.33	-69.68	7.30	4	14.42
221231	4	51.79	47.39	-72.13	11.68	4	6.74

Table 3.8. Deviation of Charpy Impact Percent Shear Curve Fit Parameters From Mean Values (A540)

A

TOTAL	266.49
MEAN	53.298
ST. DEV	2.054451265

KEY	VAL	DEV	NORMALIZED DEV
22531	55.31	2.01	0.98
22631	52.29	-1.01	-0.49
22731	51.38	-1.92	-0.93
22831	55.72	2.42	1.18
221231	51.79	-1.51	-0.73

B

TOTAL	229.65
MEAN	45.93
ST. DEV	2.04841402

KEY	VAL	DEV	NORMALIZED DEV
22531	44.15	-1.78	-0.87
22631	47.87	1.94	0.95
22731	46.91	0.98	0.48
22831	43.33	-2.60	-1.27
221231	47.39	1.46	0.71

Table 3.8. (continued)

T_0

TOTAL	-318.9
MEAN	-63.78
ST. DEV	18.49701192

KEY	VAL	DEV	NORMALIZED DEV
22531	-73.83	-10.05	-0.54
22631	-30.80	32.98	1.78
22731	-72.46	-8.68	-0.47
22831	-59.68	-5.90	-0.32
221231	-72.13	-8.35	-0.45

C

TOTAL	86.2
MEAN	17.24
ST. DEV	12.30997360

KEY	VAL	DEV	NORMALIZED DEV
22531	18.07	0.83	0.07
22631	38.20	20.96	1.70
22731	10.45	-6.79	-0.55
22831	7.80	-9.44	-0.77
221231	11.68	-5.56	-0.45

PHI

TOTAL	21
MEAN	4.2
ST. DEV	0.447213595

KEY	VAL	DEV	NORMALIZED DEV
22531	4.00	-0.20	-0.45
22631	5.00	0.80	1.79
22731	4.00	-0.20	-0.45
22831	4.00	-0.20	-0.45
221231	4.00	-0.20	-0.45

Table 3.8. (continued)

VARIANCE

TOTAL	497.51
MEAN	99.502
ST. DEV	199.0606516

KEY	VAL	DEV	NORMALIZED DEV
22531	13.34	-86.16	-0.43
22631	455.54	356.04	1.79
22731	7.47	-92.03	-0.46
22831	14.42	-85.08	-0.43
221231	6.74	-92.76	-0.47

Table 3.9. Comparison of To - C from Impact Test Measurements with NDTT (A540)

	To - C (^{o}F)			
KEY	IMPACT ENERGY	LATERAL EXPANSION	PERCENT SHEAR	NDTT(^{o}F)
22531	-162	-192	-92	-170
22631	-121	-143	-69	-150
22731	-170	-165	-83	-140
22831	-163	-237	-77	-160
221231	-140	-170	-84	-200

Table 3.10. Tanh Fit Parameters for Precracked Charpy Toughness Data (A540)

KEY	J	A	B	T0	C	PHI	VAR
32531	2	100.35	61.02	-87.96	70.60	4	368.68
32631	2	105.65	59.62	-83.11	90.54	3	229.23
32731	2	82.33	53.74	-126.10	122.39	3	207.49
32831	2	98.78	54.76	-106.30	100.22	4	59.45
321231	2	97.89	60.33	-135.24	54.27	4	59.51

Table 3.11. Deviation of Precracked Charpy Fracture Toughness Curve Fit Parameters From Mean Values (A540)

A

TOTAL	493
MEAN	98.6
ST. DEV	10.12440616

KEY	VAL	DEV	NORMALIZED DEV
32531	108.35	9.75	0.96
32631	105.65	7.05	0.70
32731	82.33	-16.27	-1.61
32831	98.78	0.18	0.02
321231	97.89	-0.71	-0.07

B

TOTAL	290.27
MEAN	58.054
ST. DEV	3.580374282

KEY	VAL	DEV	NORMALIZED DEV
32531	61.82	3.77	1.05
32631	59.62	1.57	0.44
32731	53.74	-4.31	-1.20
32831	54.76	-3.29	-0.92
321231	60.33	2.28	0.64

T_0

TOTAL	-538.71
MEAN	-107.742
ST. DEV	22.87629947

KEY	VAL	DEV	NORMALIZED DEV
32531	-87.96	19.78	0.86
32631	-83.11	24.63	1.08
32731	-126.10	-18.36	-0.80
32831	-106.30	1.44	0.06
321231	-135.24	-27.50	-1.20

Table 3.11. (continued)

C

TOTAL	438.01
MEAN	87.602
ST. DEV	26.35073661

KEY	VAL	DEV	NORMALIZED DEV
32531	70.60	-17.00	-0.65
32631	90.54	2.94	0.11
32731	122.38	34.78	1.32
32831	100.22	12.62	0.48
321231	54.27	-33.33	-1.26

PHI

TOTAL	18
MEAN	3.6
ST. DEV	0.547722558

KEY	VAL	DEV	NORMALIZED DEV
32531	4.00	0.40	0.73
32631	3.00	-0.60	-1.10
32731	3.00	-0.60	-1.10
32831	4.00	0.40	0.73
321231	4.00	0.40	0.73

VARIANCE

TOTAL	924.36
MEAN	184.872
ST. DEV	130.1065872

KEY	VAL	DEV	NORMALIZED DEV
32531	368.68	183.81	1.41
32631	229.23	44.36	0.34
32731	207.49	22.62	0.17
32831	59.45	-125.42	-0.96
321231	59.51	-125.36	-0.96

Table 3.12. Tanh Fit Parameters for Precracked Charpy W/A Data (A540)

KEY	J	A	B	T0	C	PHI	VAR
32531	5	1580.99	1548.82	-113.76	71.45	2	97678.90
32631	5	1489.07	1168.54	-92.84	58.13	3	11026.80
32731	5	1351.53	1115.24	-76.80	62.96	3	3976.02
32831	5	1297.93	1297.93	-125.42	75.58	5	54525.50
321231	5	1827.14	1591.76	-104.82	41.41	5	10039.90

Table 3.13. Deviation of Precracked Charpy W/A Curve Fit Parameters from Mean Values (A540)

A

TOTAL	7546.66
MEAN	1509.332
ST. DEV	209.8449543

KEY	VAL	DEV	NORMALIZED DEV
32531	1580.99	71.66	0.34
32631	1489.07	-20.26	-0.10
32731	1351.53	-157.80	-0.75
32831	1297.93	-211.40	-1.01
321231	1827.14	317.81	1.51

B

TOTAL	6722.29
MEAN	1344.458
ST. DEV	217.1261127

KEY	VAL	DEV	NORMALIZED DEV
32531	1548.82	204.36	0.94
32631	1168.54	-175.92	-0.81
32731	1115.24	-229.22	-1.06
32831	1297.93	-46.53	-0.21
321231	1591.76	247.30	1.14

Table 3.13. (continued)

T_0

TOTAL	-513.72
MEAN	-102.744
ST. DEV	18.7543243

KEY	VAL	DEV	NORMALIZED DEV
32531	-113.76	-11.02	-0.59
32631	-92.84	9.90	0.53
32731	-76.88	25.86	1.38
32831	-125.42	-22.68	-1.21
321231	-104.82	-2.08	-0.11

C

TOTAL	309.53
MEAN	61.906
ST. DEV	13.35590993

KEY	VAL	DEV	NORMALIZED DEV
32531	71.45	9.54	0.71
32631	58.13	-3.78	-0.28
32731	62.96	1.05	0.08
32831	75.58	13.67	1.02
321231	41.41	-20.50	-1.53

Table 3.13. (continued)

PHI

TOTAL	18
MEAN	3.6
ST. DEV	1.341640786

KEY	VAL	DEV	NORMALIZED DEV
32531	2.00	-1.60	-1.19
32631	3.00	-0.60	-0.45
32731	3.00	-0.60	-0.45
32831	5.00	1.40	1.04
321231	5.00	1.40	1.04

VARIANCE

TOTAL	177246.32
MEAN	35449.264
ST. DEV	40215.44190

KEY	VAL	DEV	NORMALIZED DEV
32531	97678.90	62229.64	1.55
32631	11026.00	-24423.26	-0.61
32731	3976.02	-31473.24	-0.78
32831	54525.50	19076.24	0.47
321231	10039.90	-25409.36	-0.63

Table 3.14. Comparison of Precracked Charpy Transition Behavior with NDTT (A540)

	$T_0 - C$ (^oF)		
KEY	K_{Id}, K_d^*	W/A	NDTT (^oF)
32531	-159	-185	-170
32631	-174	-151	-150
32731	-248	-140	-140
32831	-207	-201	-160
321231	-190	-146	-200

Table 3.15. Static Compact Specimen Upper Shelf and Transition Temperature Behavior (A540)

KEY	A+B (ksi-in$^{1/2}$)	T_0 (^oF)	T_0 - C (^oF)	RT_{NDT} (^oF)	NDTT (^oF)
52531	237	-70	-130	---	-170
52631	218	-175	-242	---	-150
52731	216	-177	-279	---	-140
52831	213	-101	-155	---	-160
521231	242	-80	-157	---	-200

Table 3.16. Dynamic Compact Specimen Upper Shelf and Transition Temperature Behavior (A540)

KEY	A+B (ksi-in$^{1/2}$)	T_0 (^oF)	T_0 - C (^oF)	RT_{NDT} (^oF)	NDTT (^oF)
02531	253	-33	-84	---	-170
02631	231	-16	-47	---	-150
02731	239	-16	-39	---	-140
02831	238	-32	-63	---	-160
021231	266	-51	-82	---	-200

Table 3.17. Summary of Error Code Analysis for Material 3 (A540)

TEST TYPE	INCLUDES ERROR CODES	NO. OF POINTS	SHELF(Ft-Lb) LOWER	SHELF(Ft-Lb) UPPER	VARIANCE OVERALL	VARIANCE TRANSITION REGION	VARIANCE RATIO F OVERALL	VARIANCE RATIO F TRANSITION REGION
Static (5)	Yes	24	56	247	391	711		
							1.35	5.12*
	No	23	56	230	290	139		
Dynamic (8,9)	Yes	26	57	240	1918	3692		
							0.98	0.63
	No	20	48	240	1955	5858		

* Possibly significant, with between a 5 and 10 percent probability of chance occurrence. Since there were no "error code" points in this range, this result is a chance occurrence.

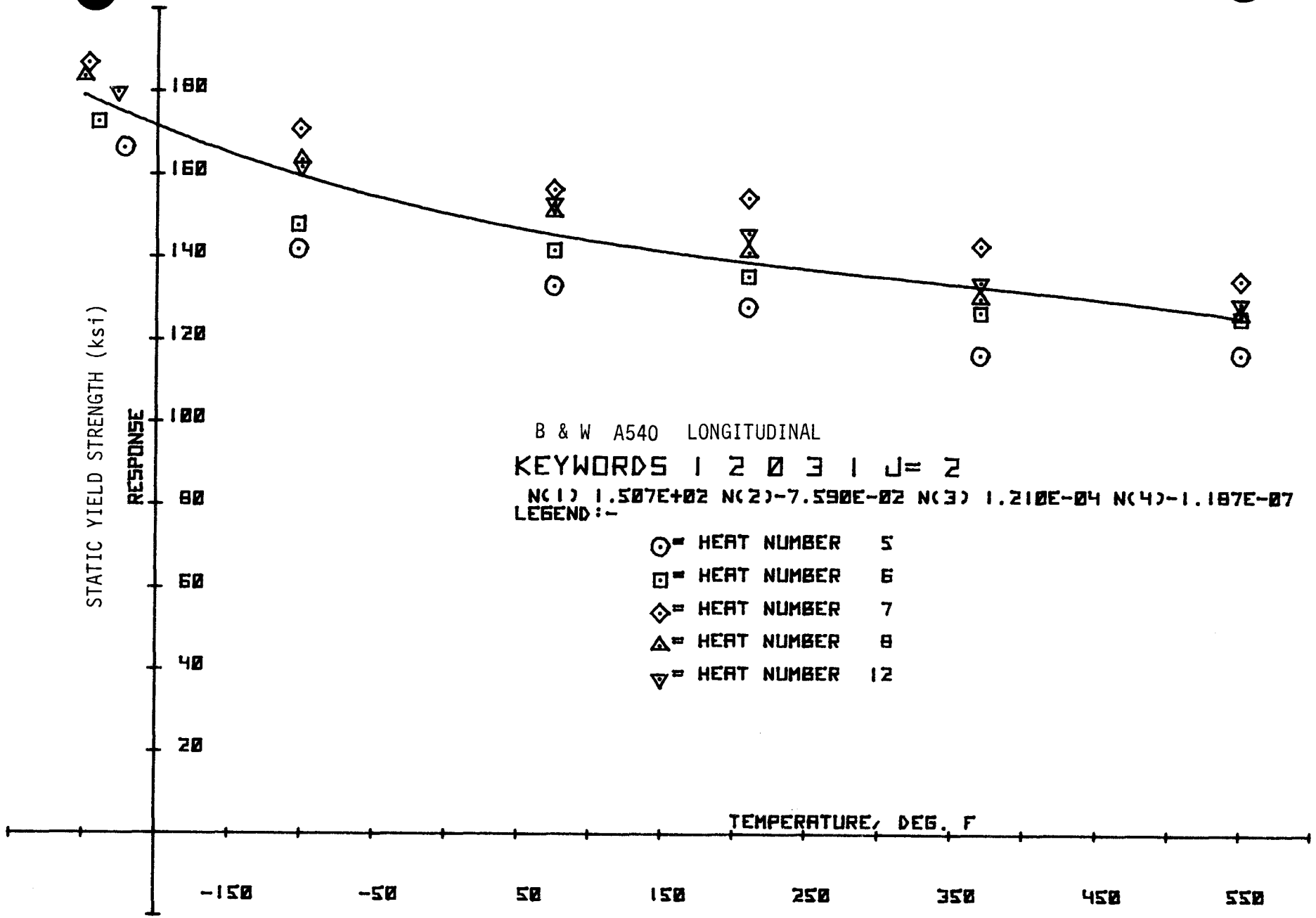


Figure 3.1 Tensile Static Yield Strength for All B&W Heats

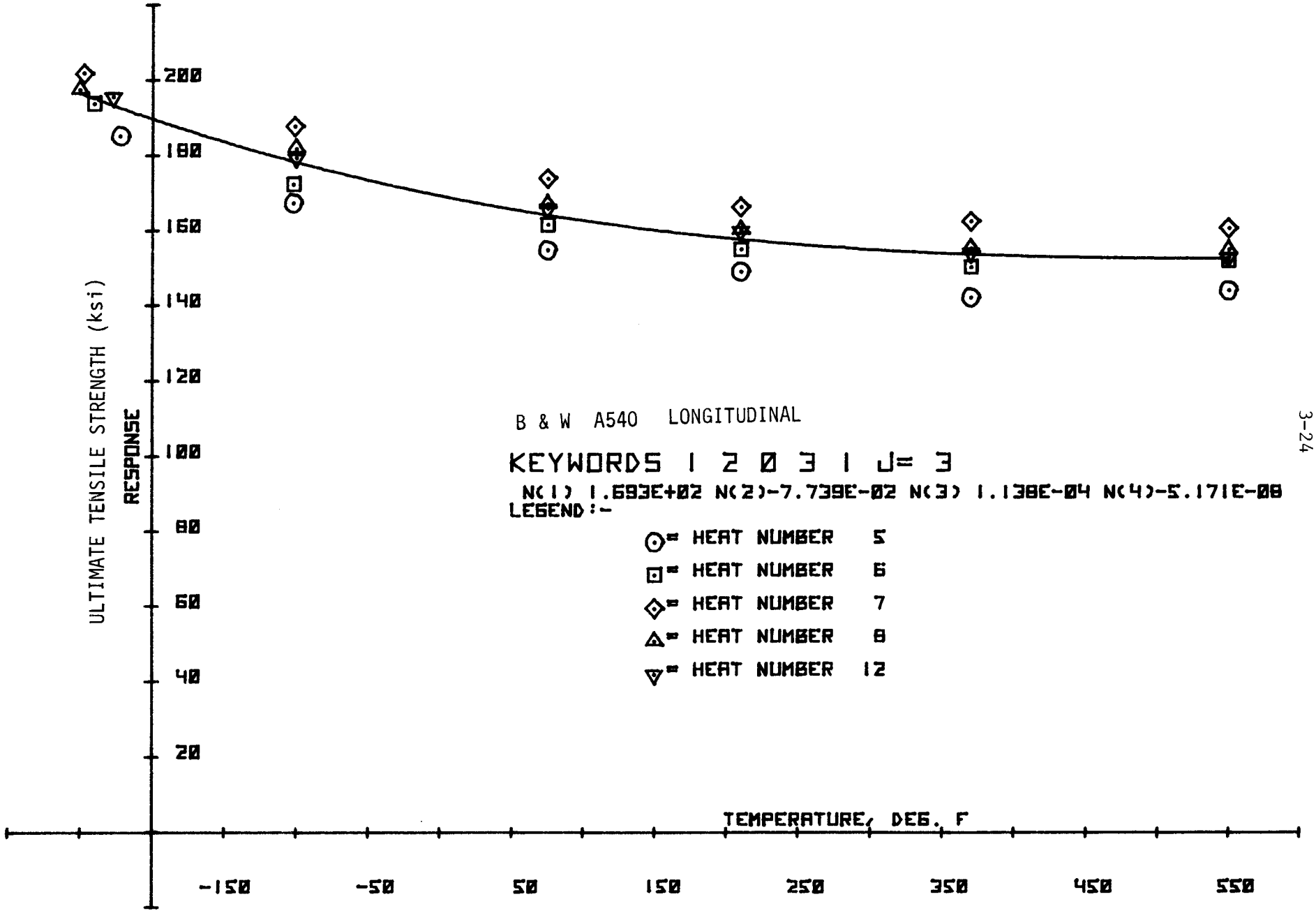


Figure 3.2 Tensile Ultimate Strength for All B&W Heats

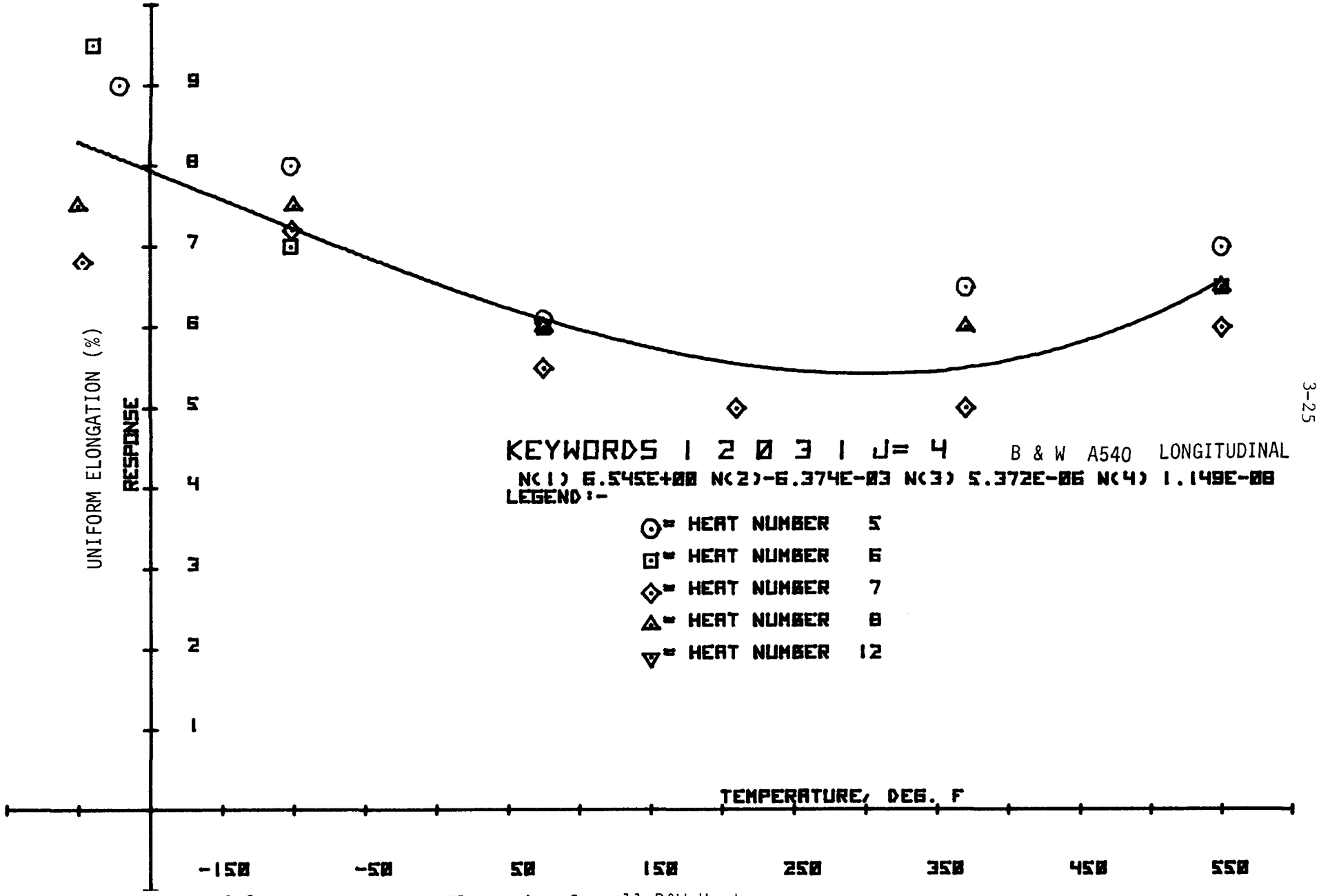


Figure 3.3 Tensile Uniform Elongation for all B&W Heats

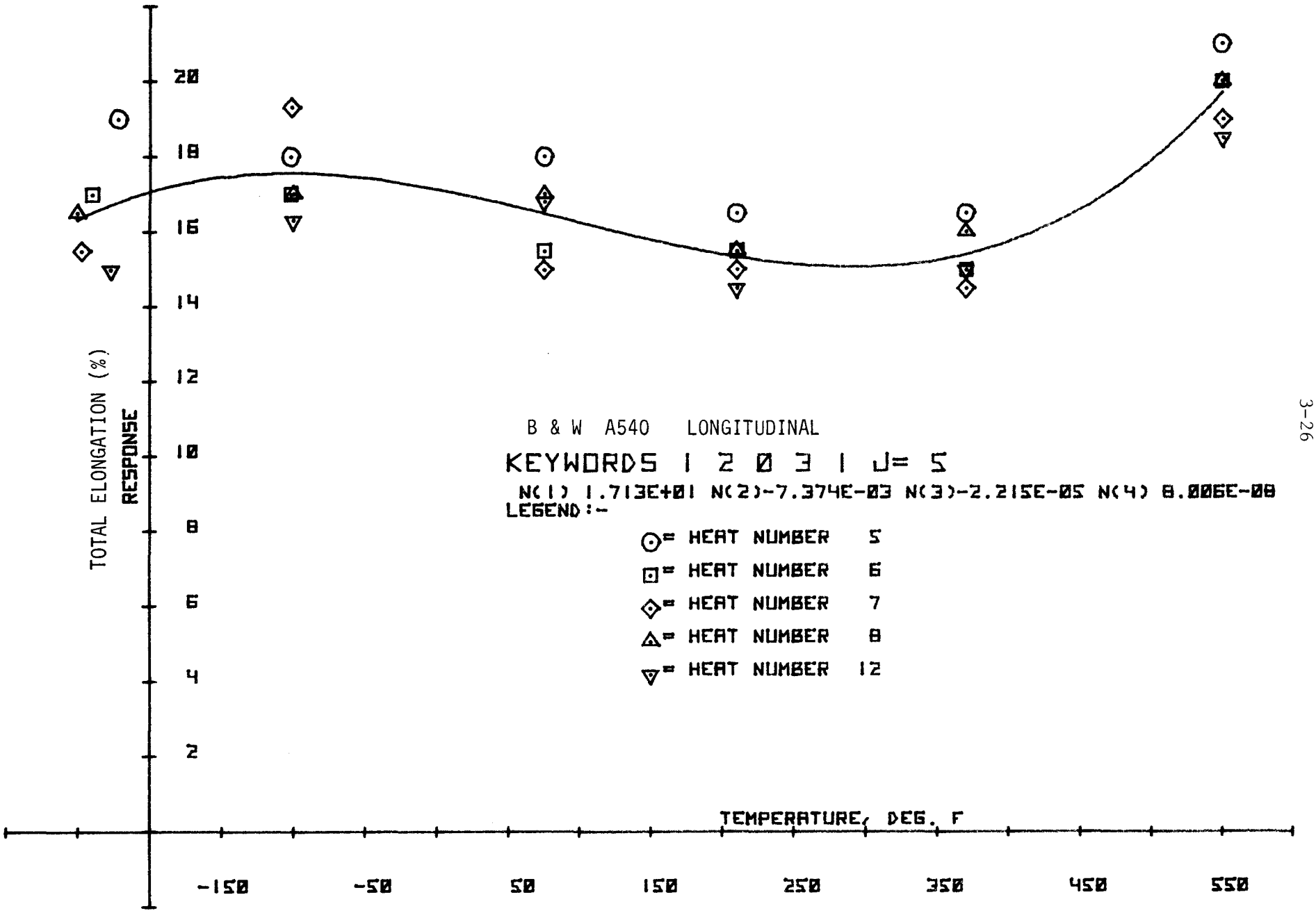


Figure 3.4 Tensile Total Elongation for All B&W Heats

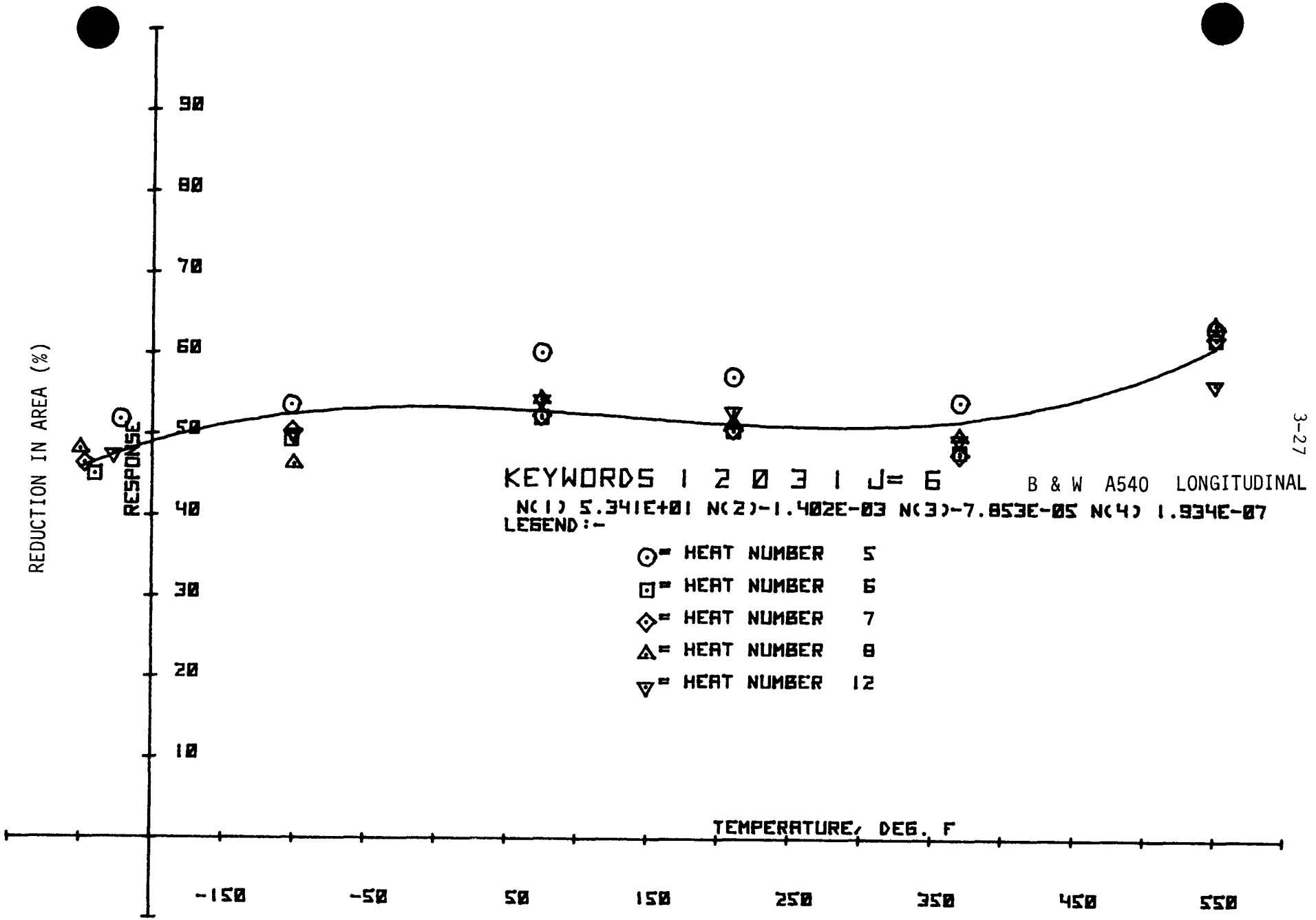


Figure 3.5 Tensile Reduction in Area for All B&W Heats

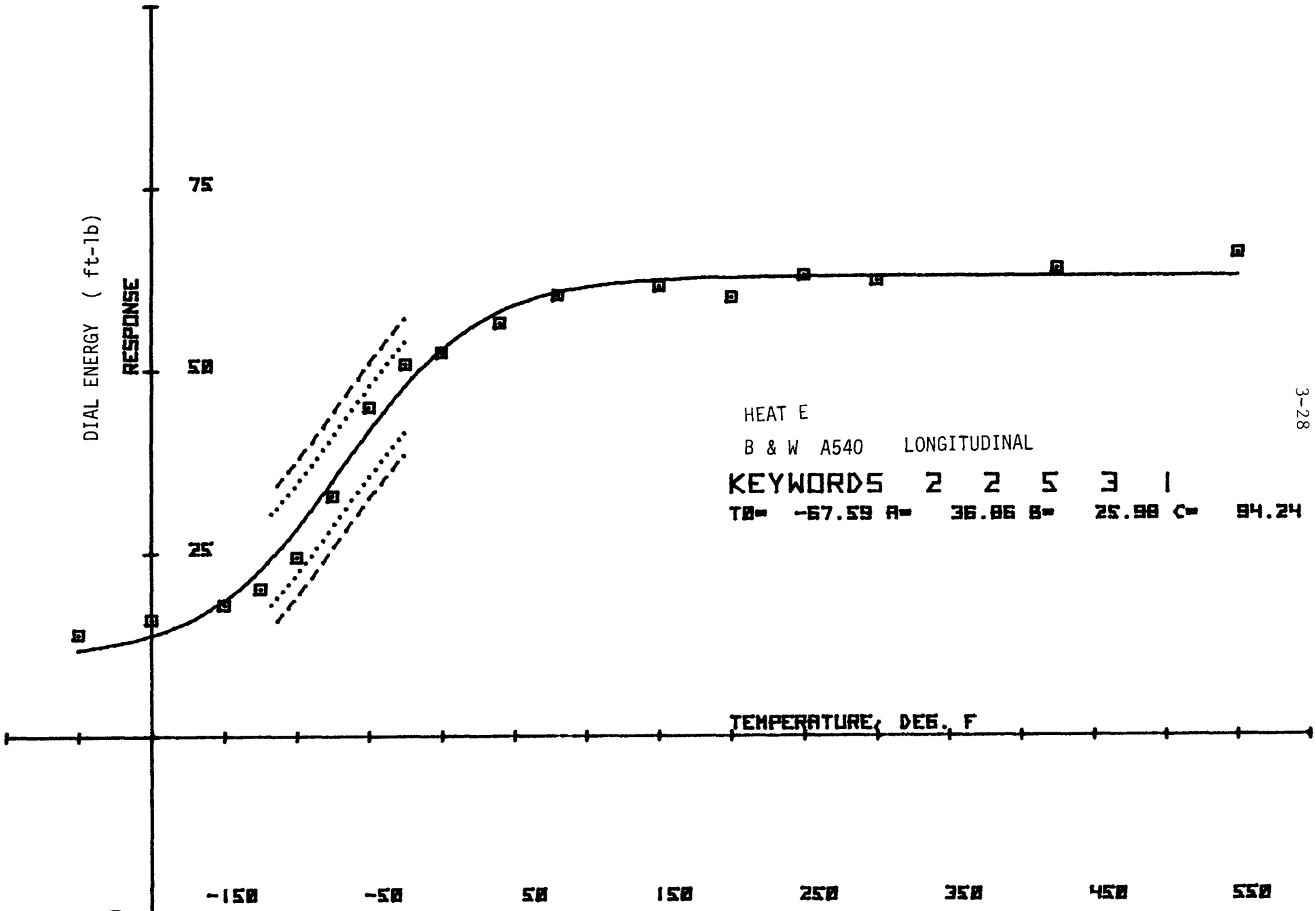


Figure 3.6. Charpy V-Notch Dial Energy for B&W Heat E

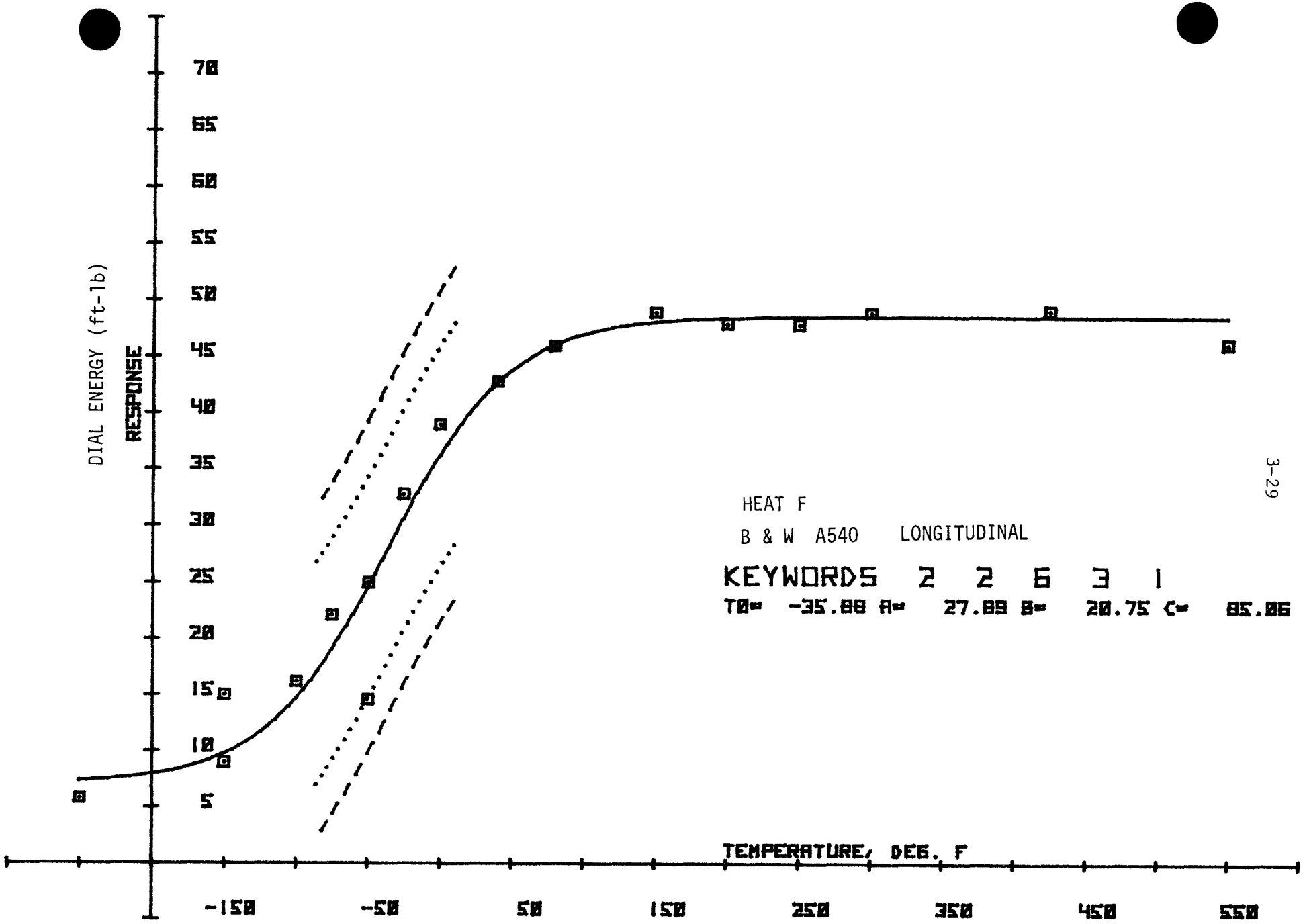


Figure 3.7 Charpy V-Notch Dial Energy for B&W Heat F

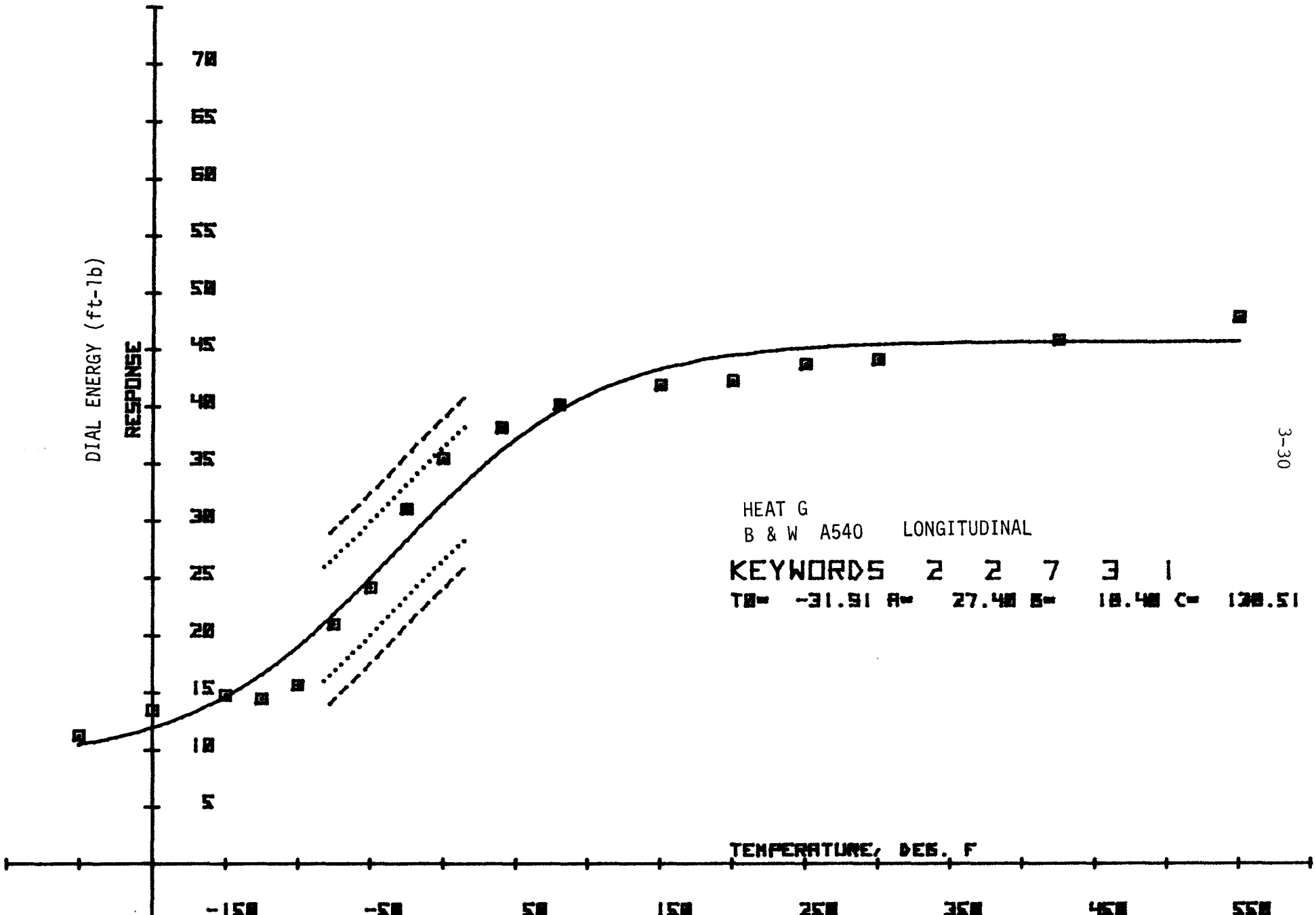


Figure 3.8 Charpy V-Notch Dial Energy for B&W Heat G

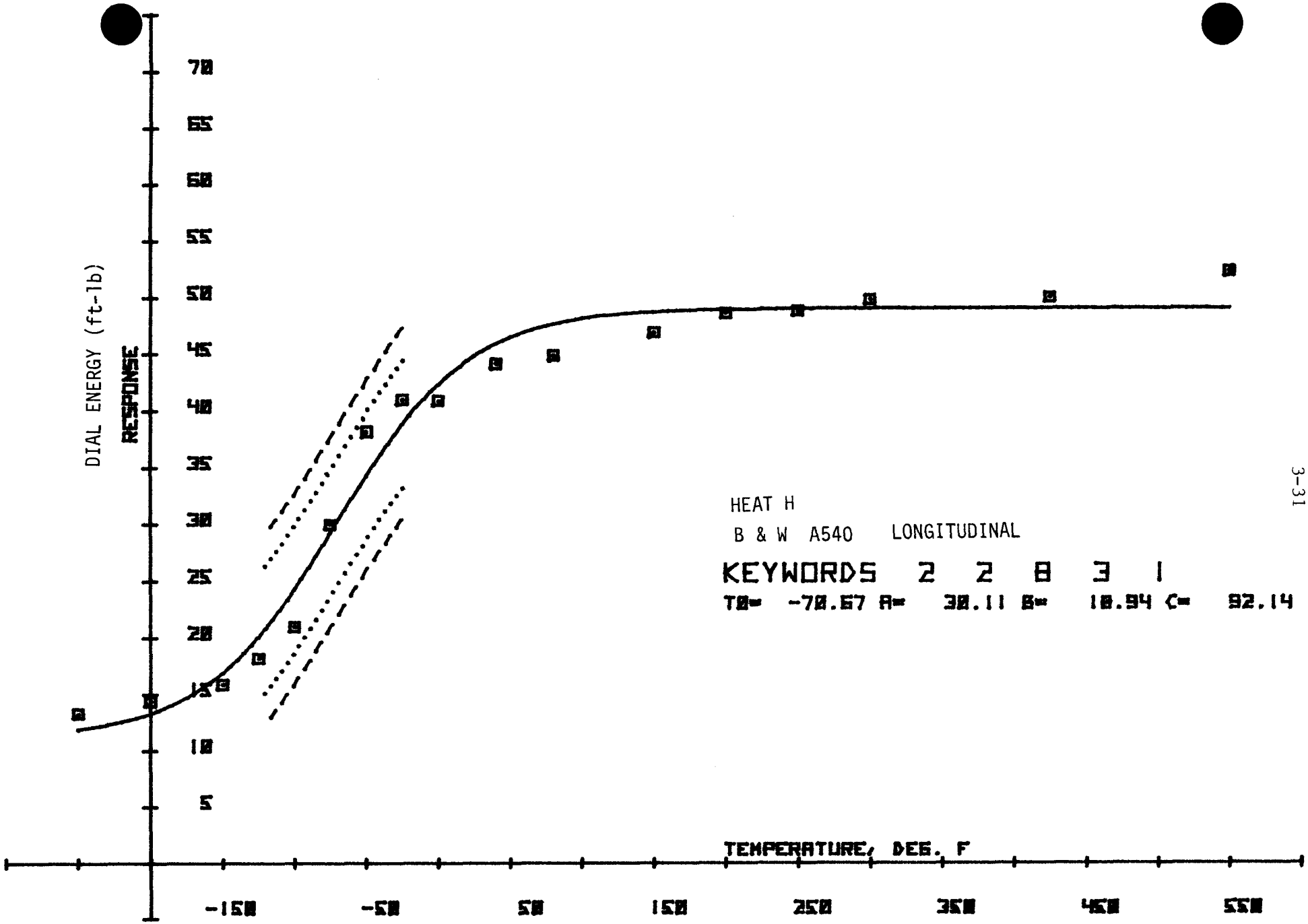


Figure 3.9 Charpy V-Notch Dial Energy for B&W Heat H

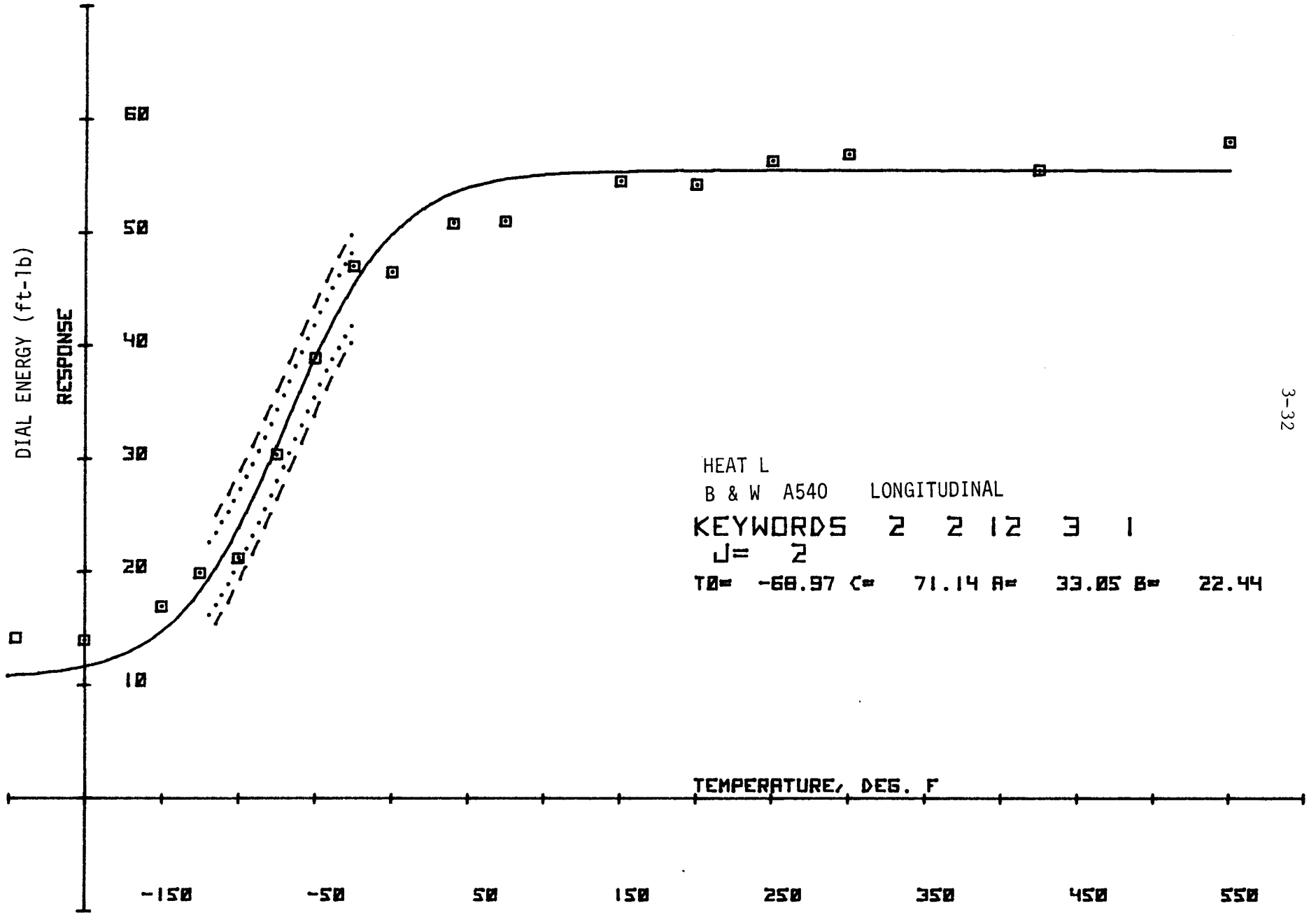


Figure 3.10 Charpy V-Notch Dial Energy for B&W Heat L

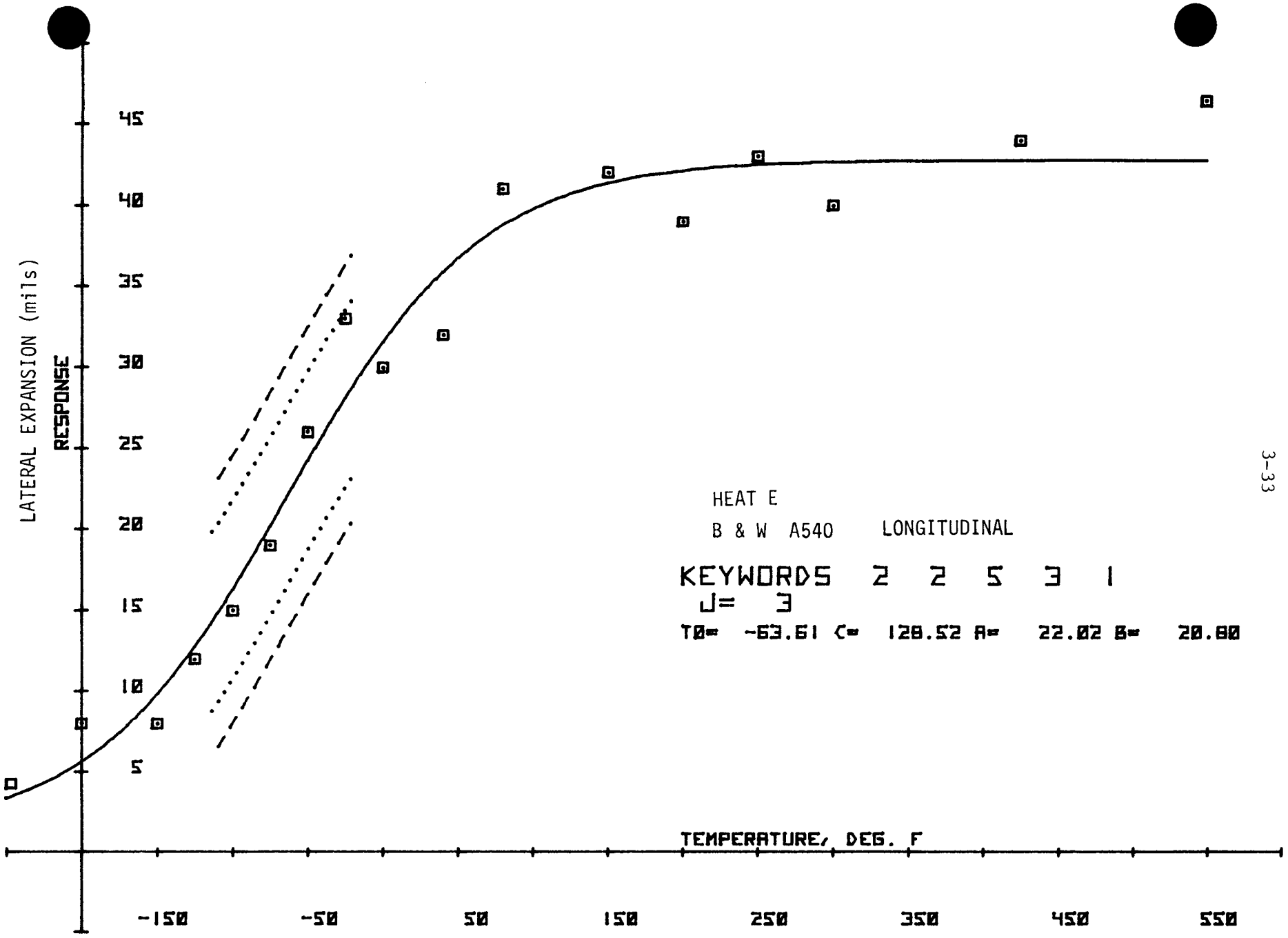


Figure 3.11 Charpy V-Notch Lateral Expansion for B&W Heat E

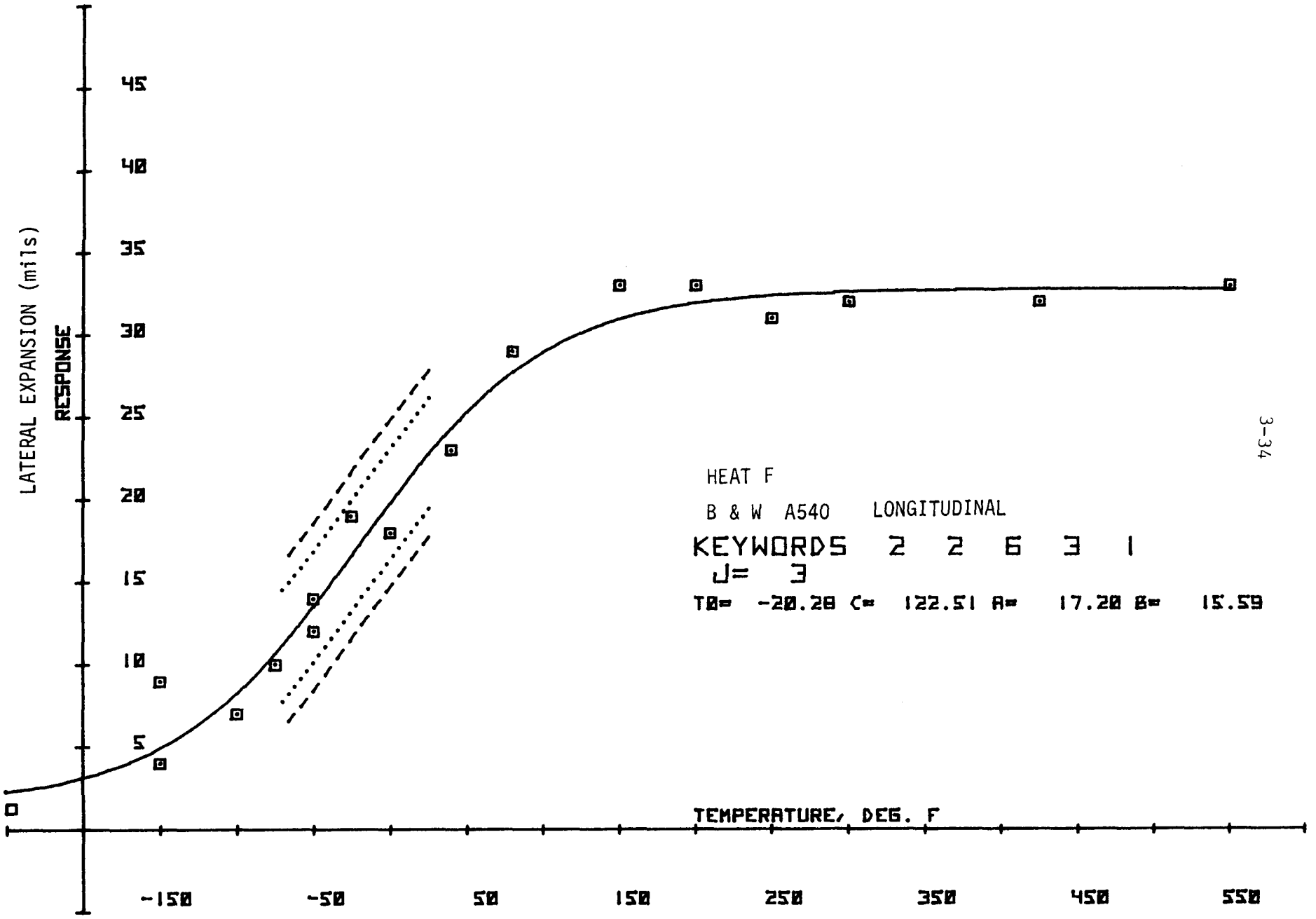


Figure 3.12 Charpy V-Notch Lateral Expansion for B&W Heat F

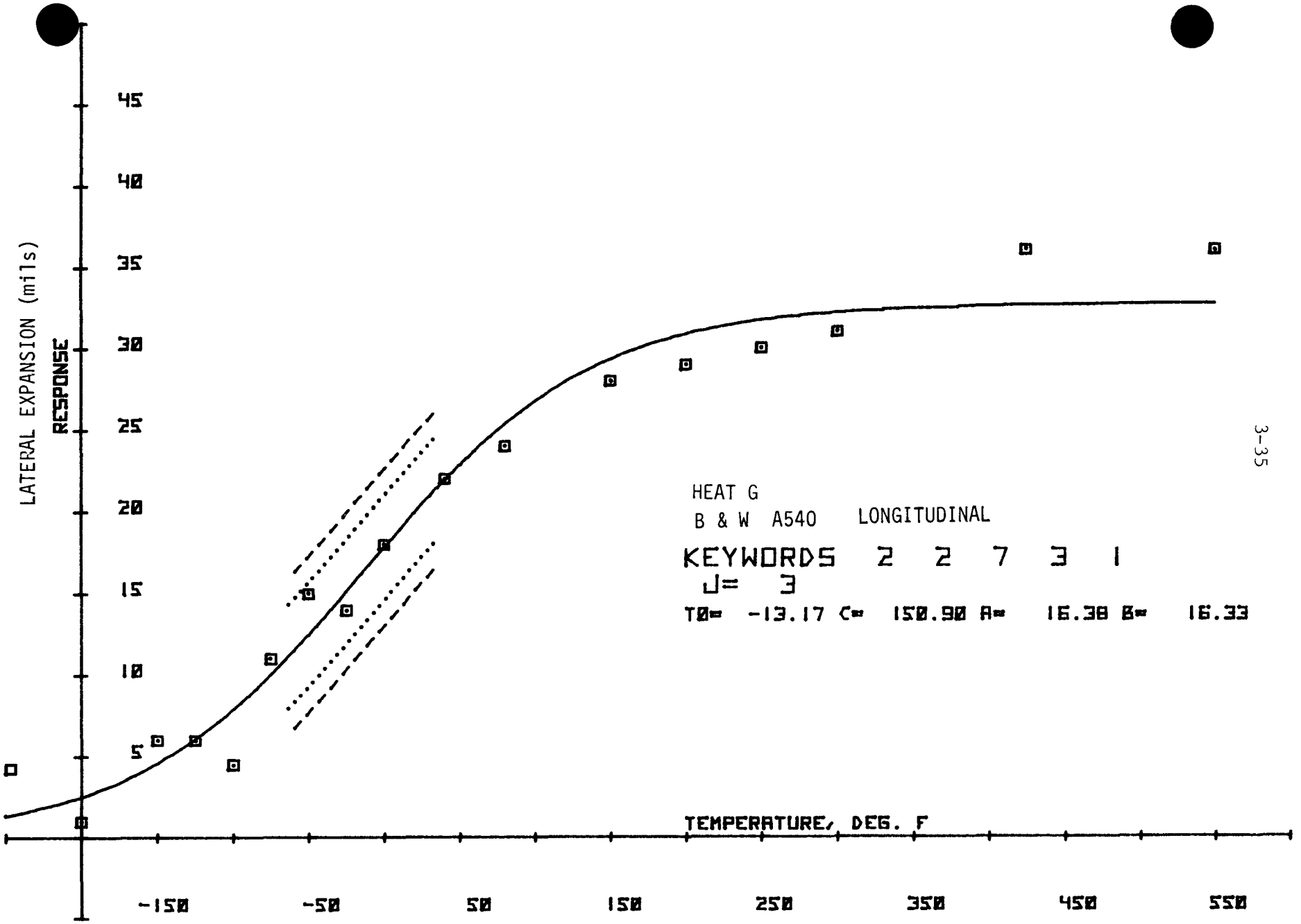


Figure 3.13 Charpy V-Notch Lateral Expansion for B&W Heat G

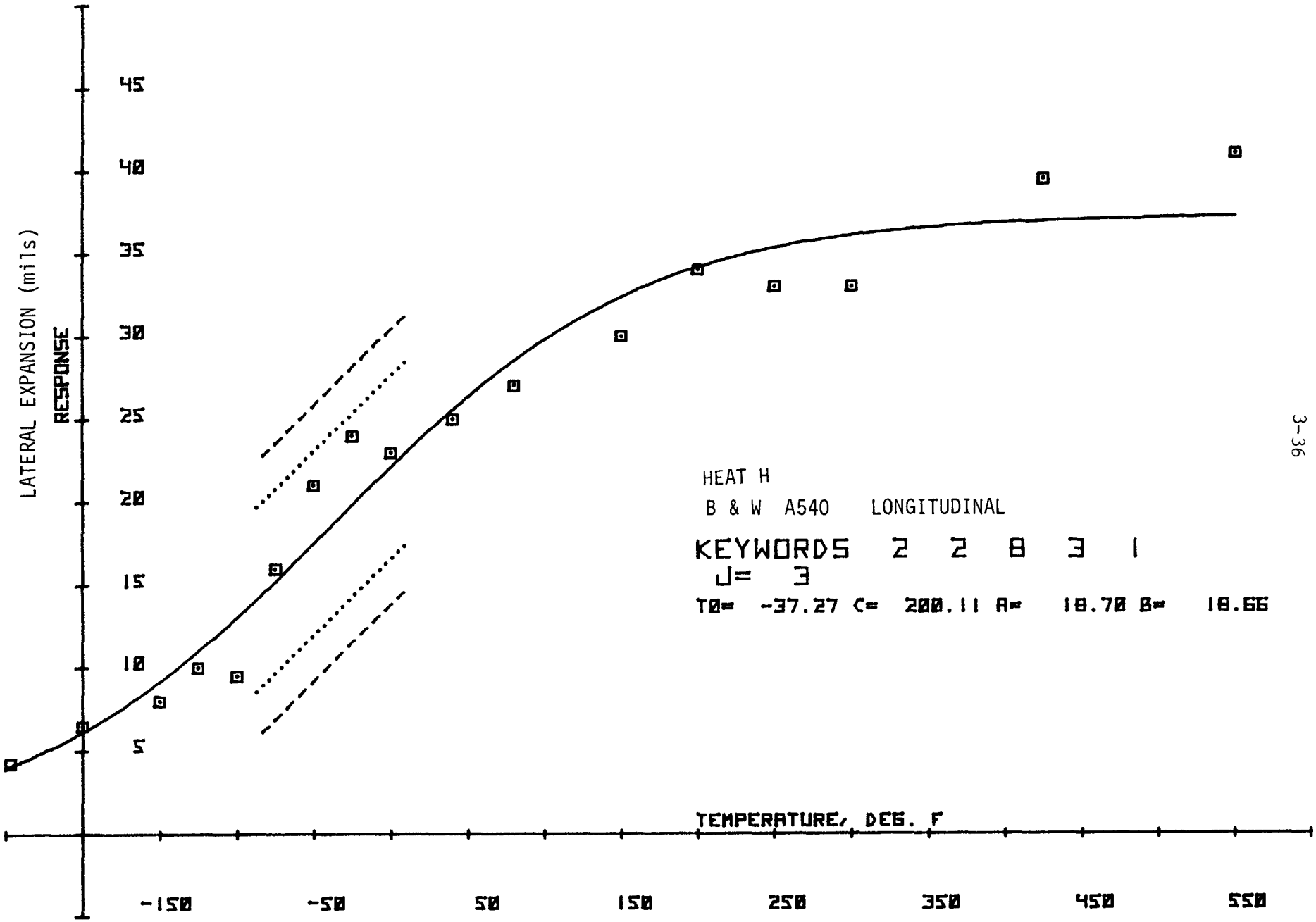


Figure 3.14 Charpy V-Notch Lateral Expansion for B&W Heat H

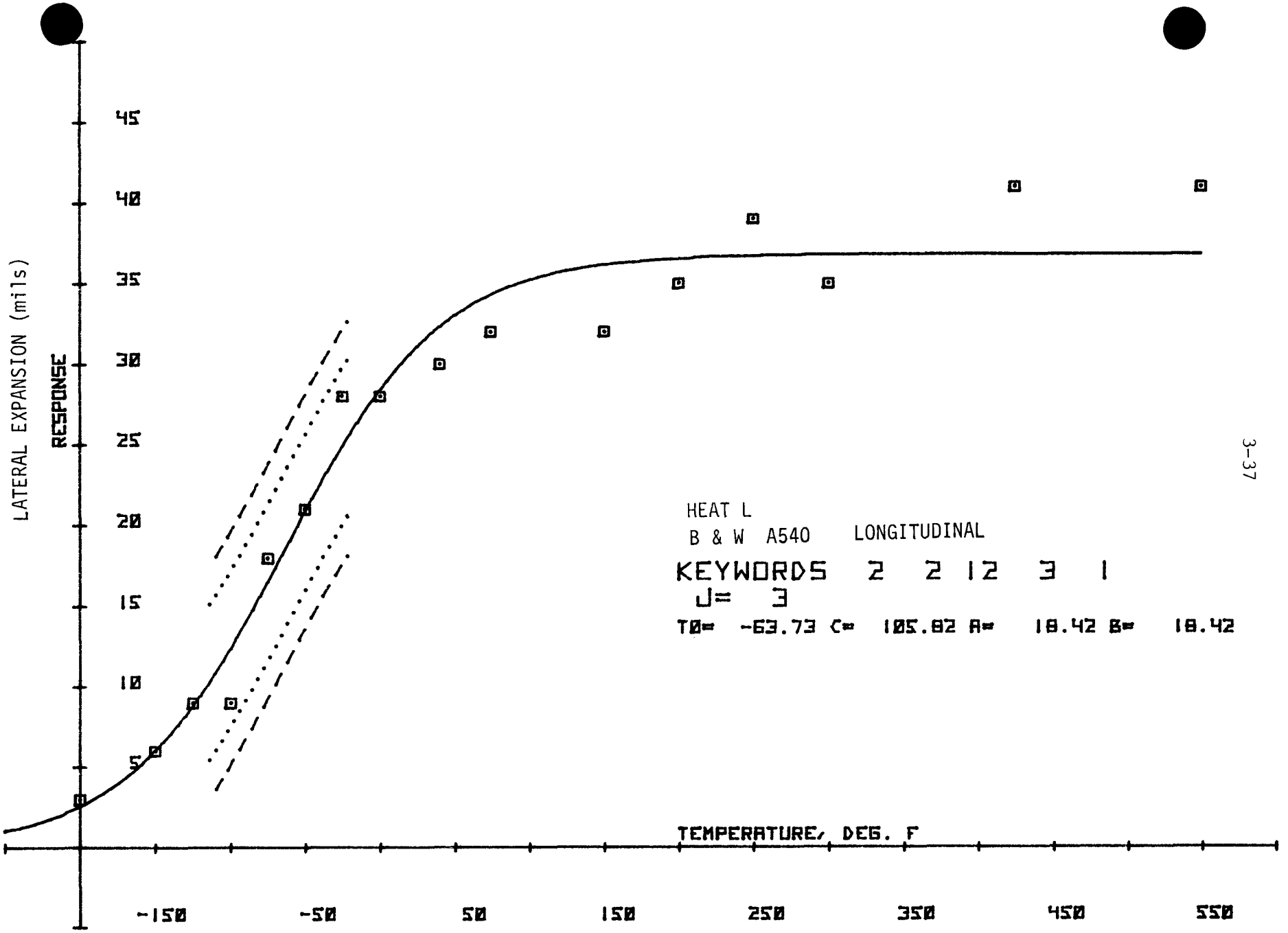


Figure 3.15 Charpy V-Notch Lateral Expansion for B&W Heat L

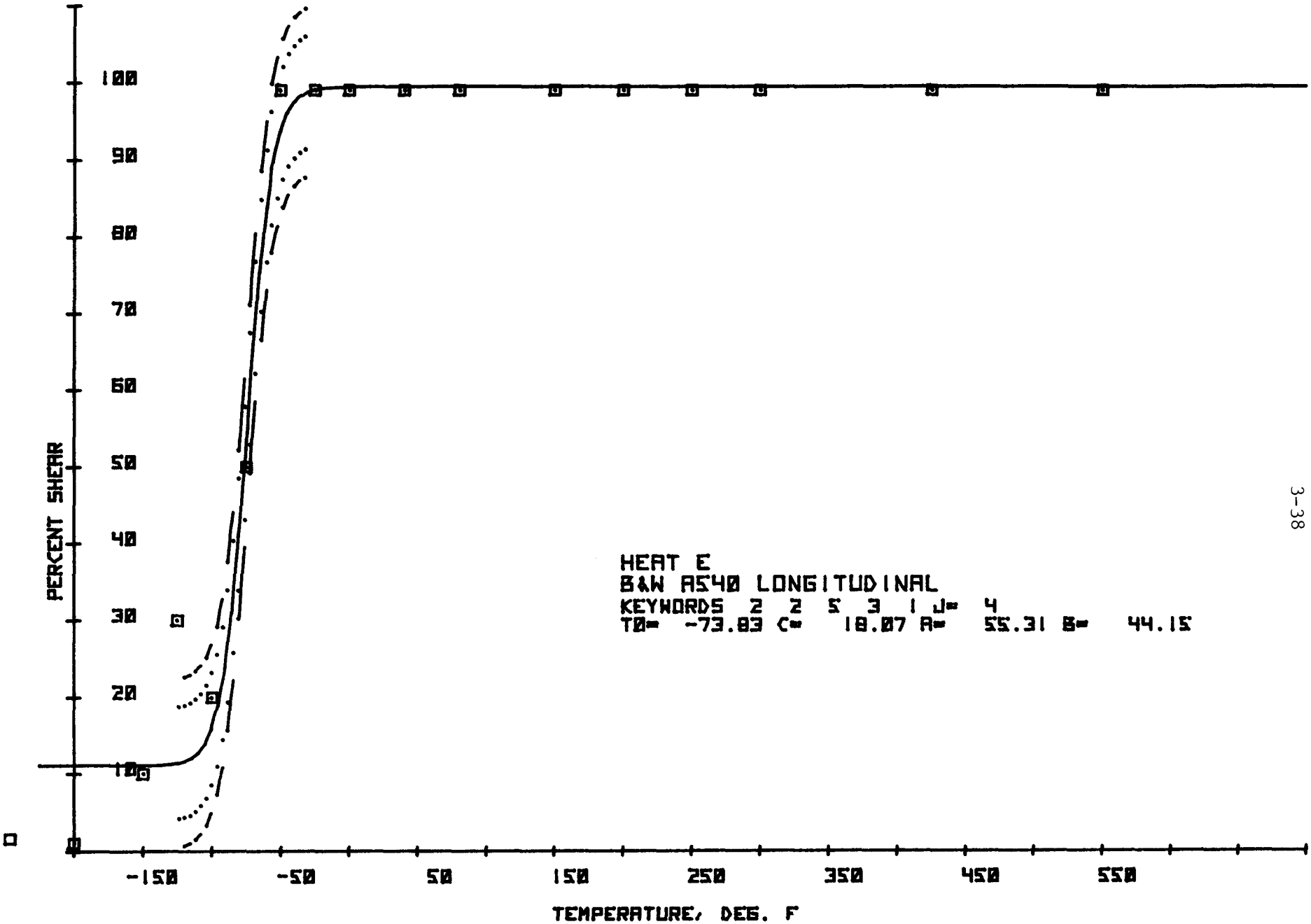


Figure 3.16 Charpy V-Notch Percent Shear for B&W Heat E

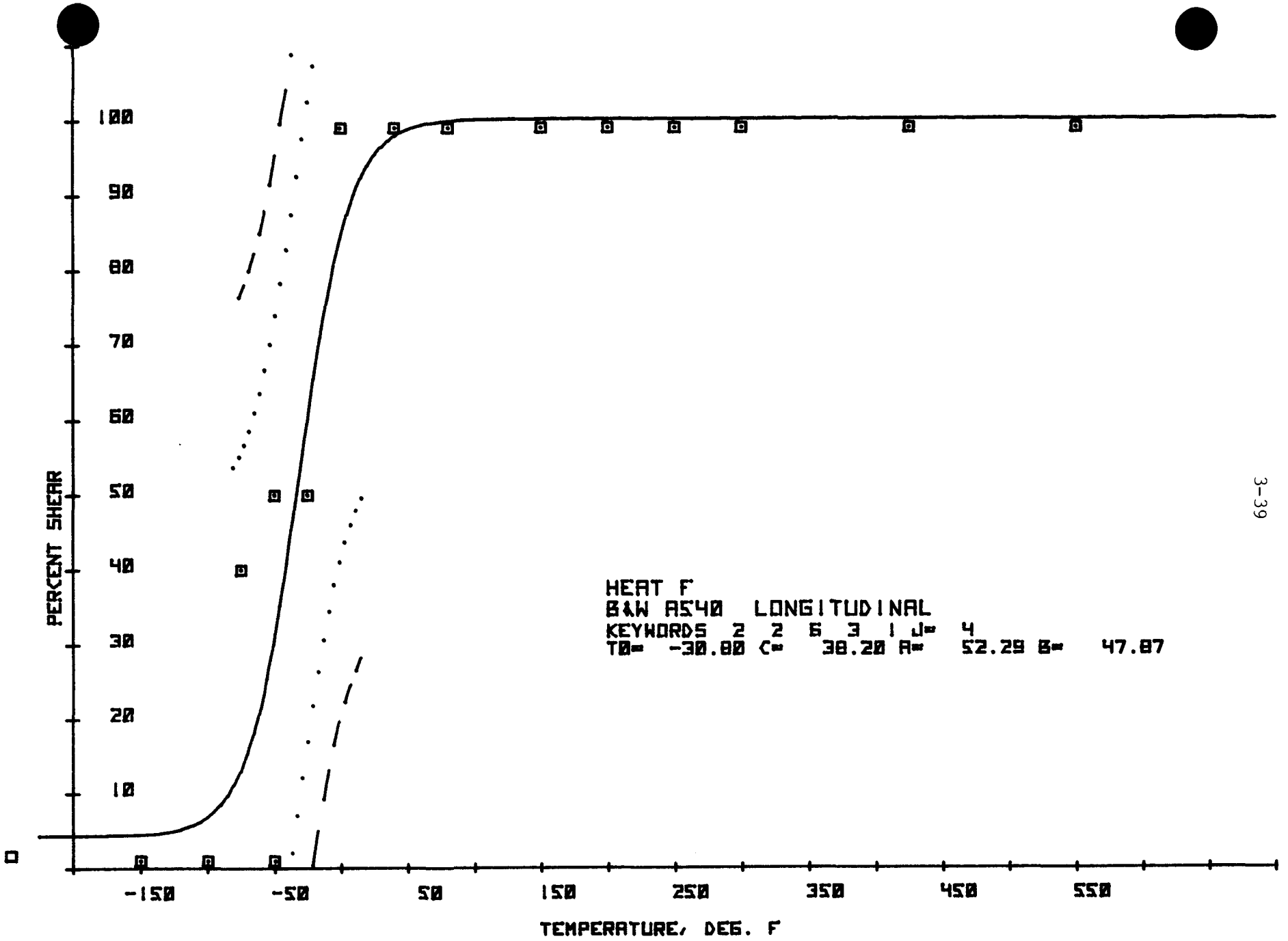


Figure 3.17 Charpy V-Notch Percent Shear for B&W Heat F

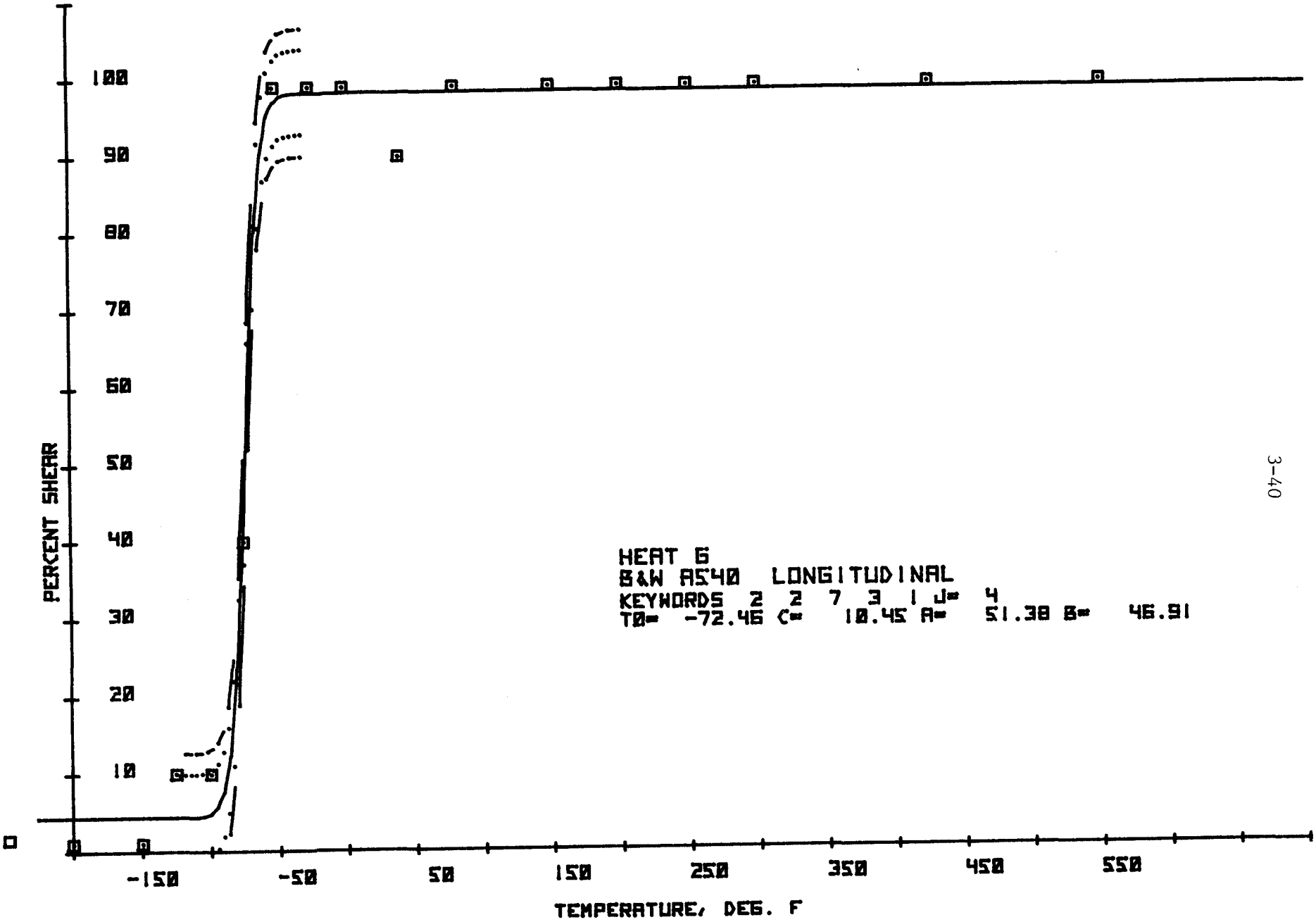


Figure 3.18 Charpy V-Notch Percent Shear for B&W Heat G

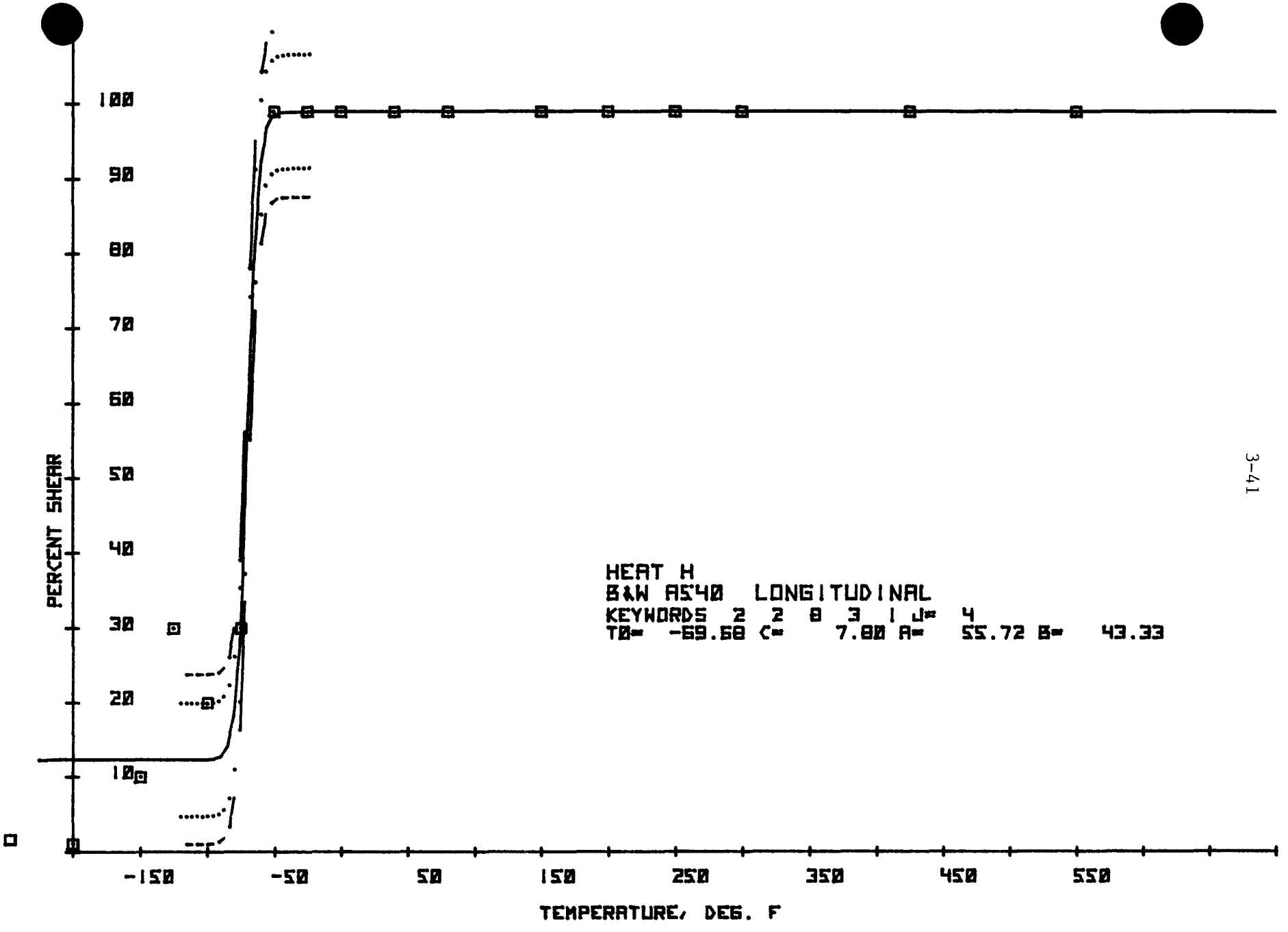


Figure 3.19 Charpy V-Notch Percent Shear for B&W Heat H

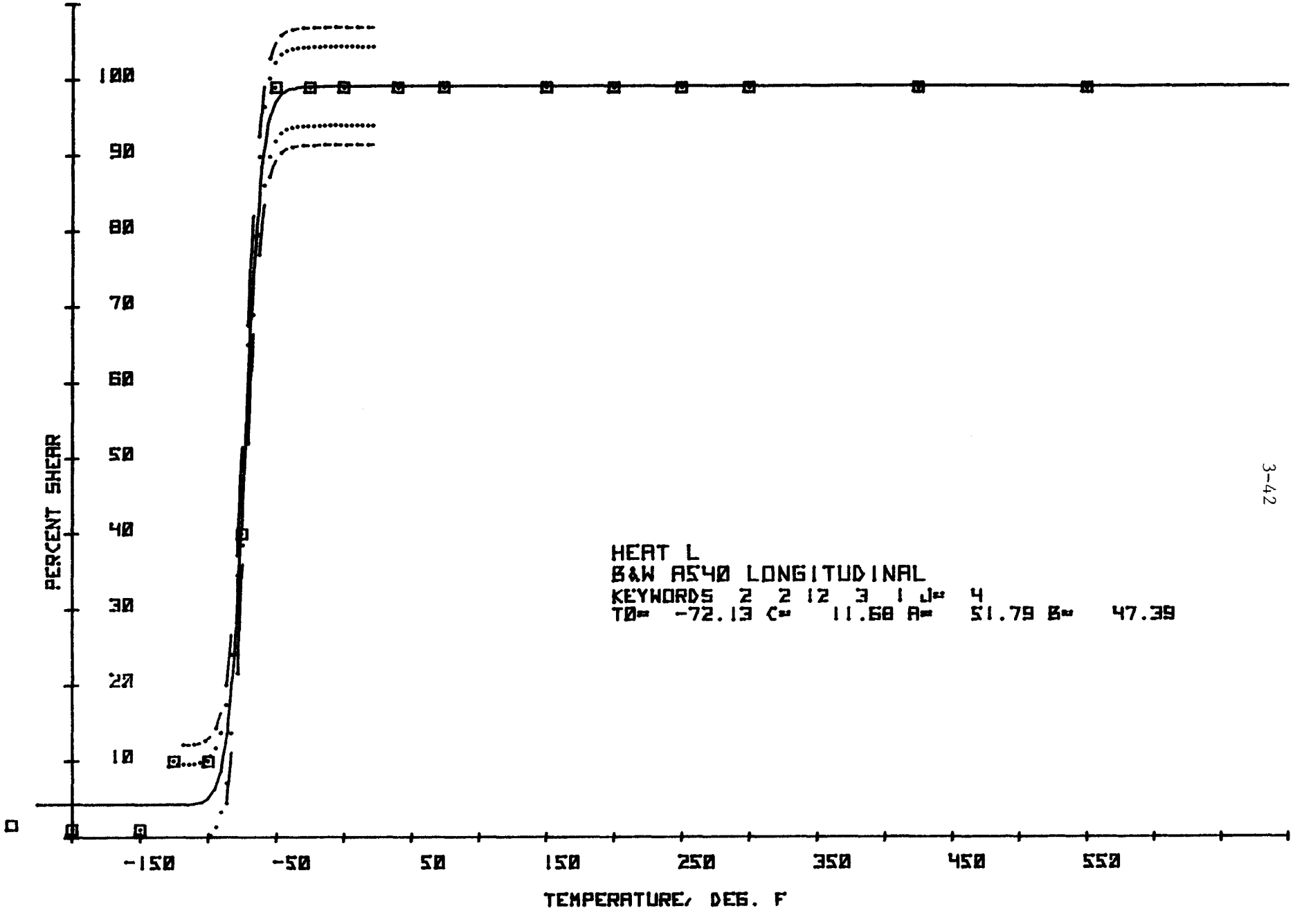


Figure 3.20 Charpy V-Notch Percent Shear for B&W Heat L

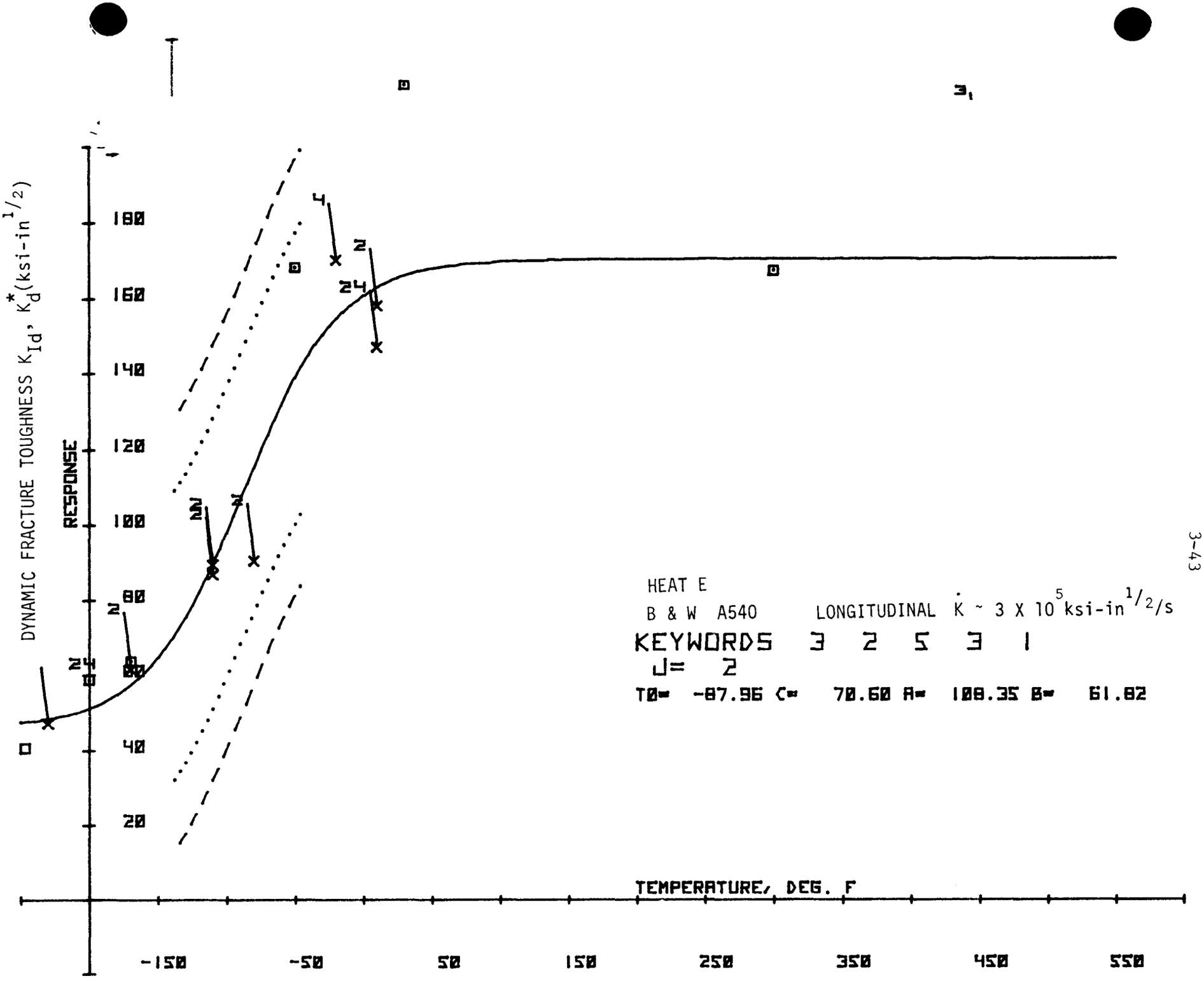


Figure 3.21 Precracked Charpy Fracture Toughness for B&W Heat E

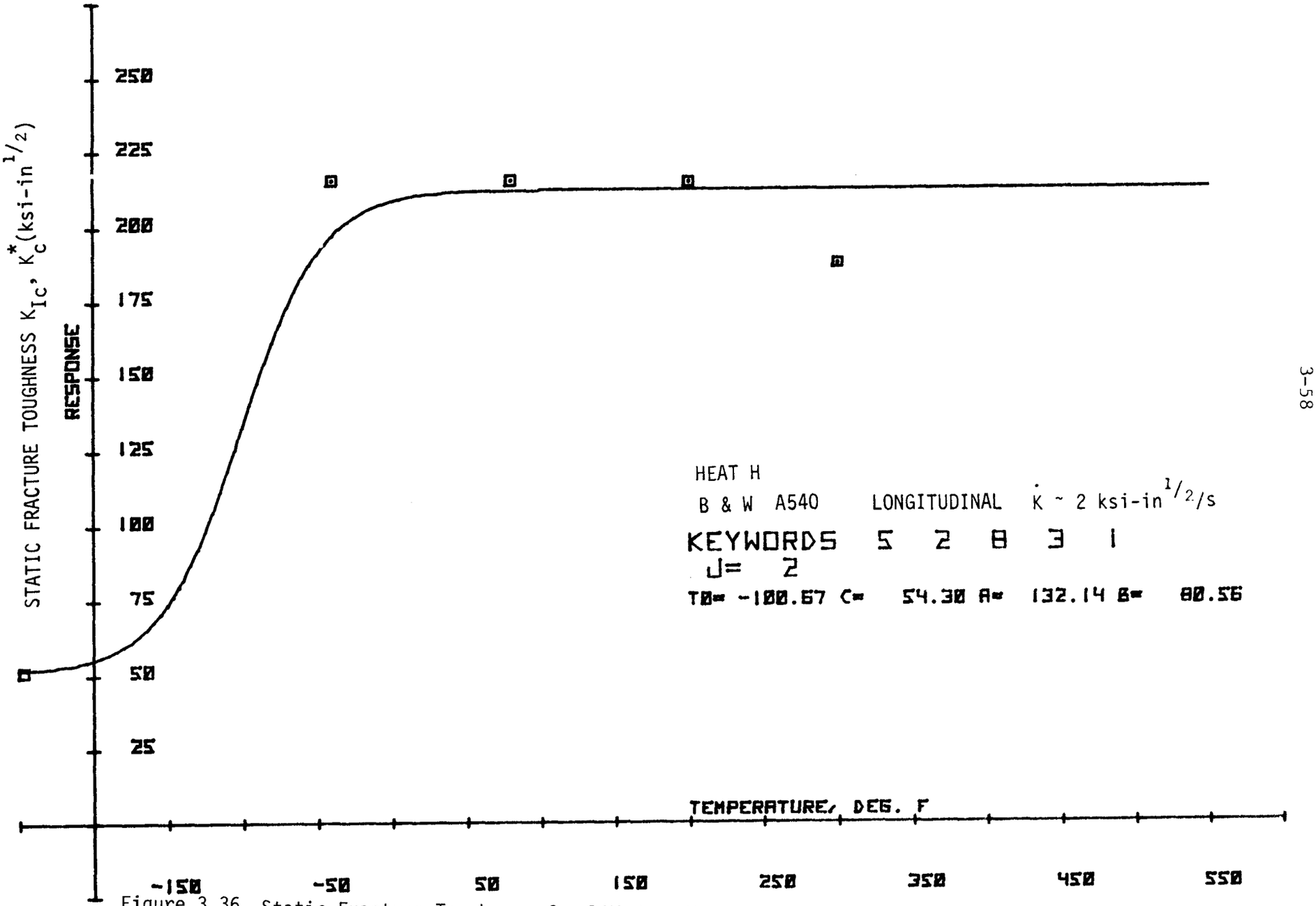


Figure 3.36. Static Fracture Toughness for B&W Heat H

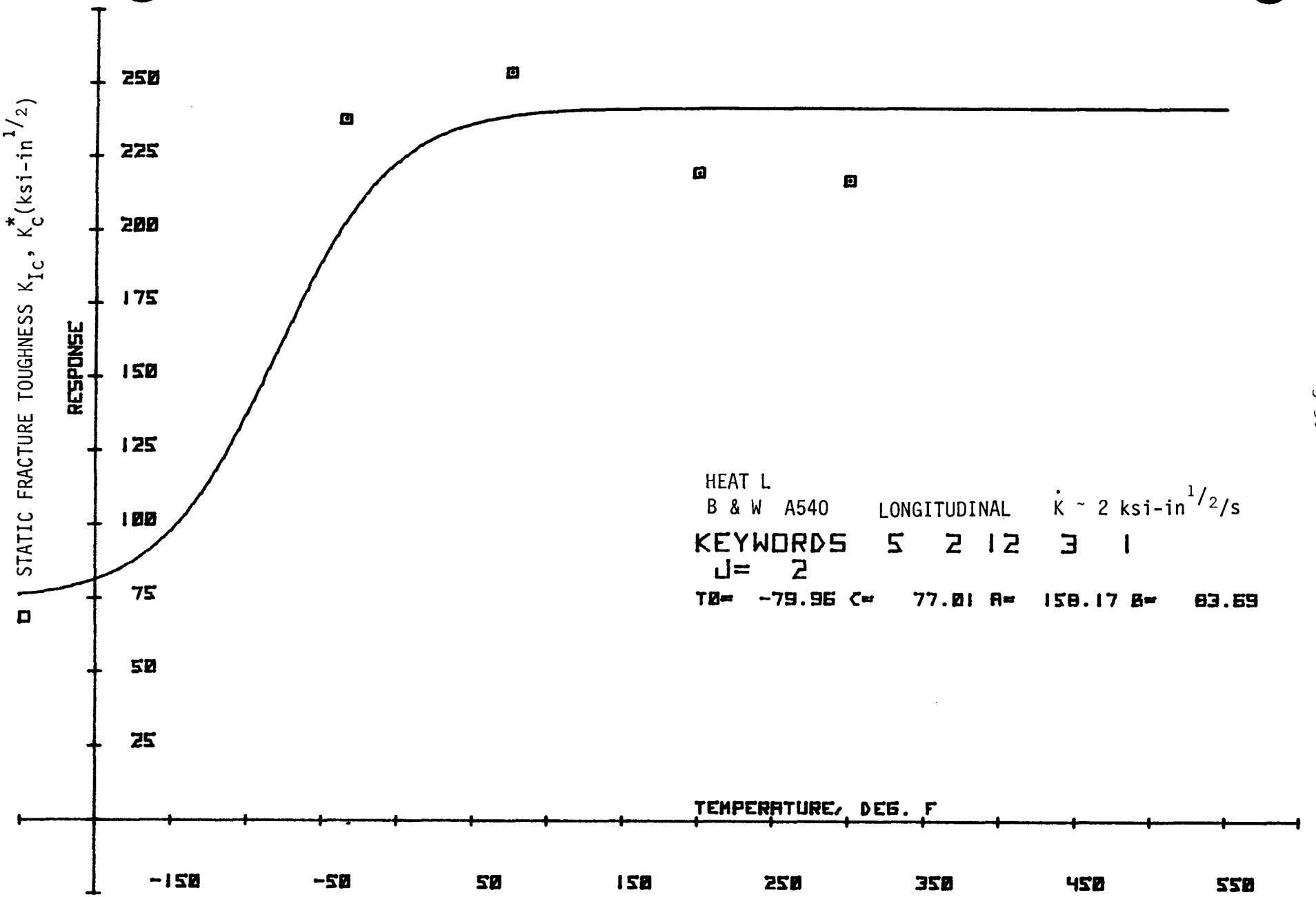


Figure 3.37. Static Fracture Toughness for B&W Heat L

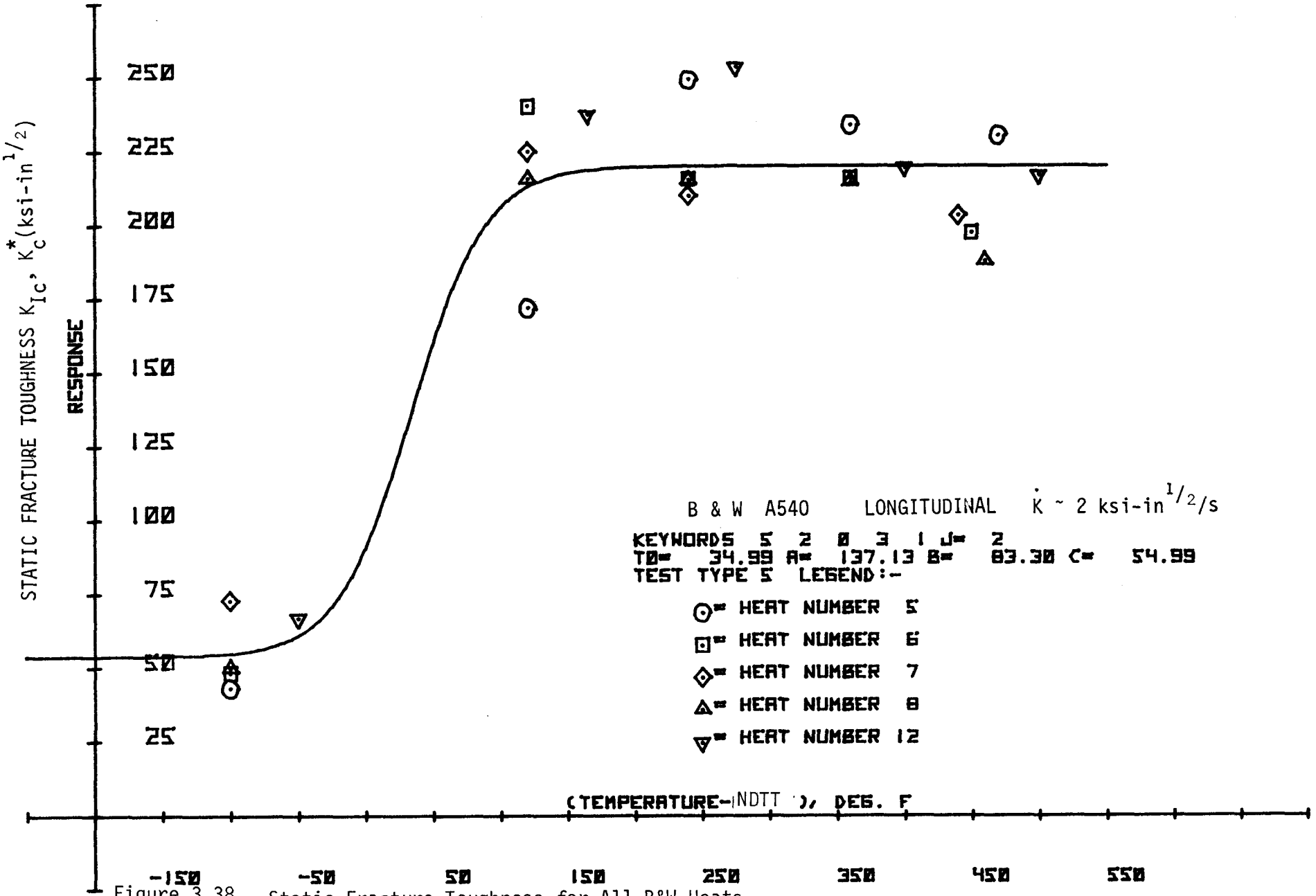


Figure 3.38. Static Fracture Toughness for All B&W Heats

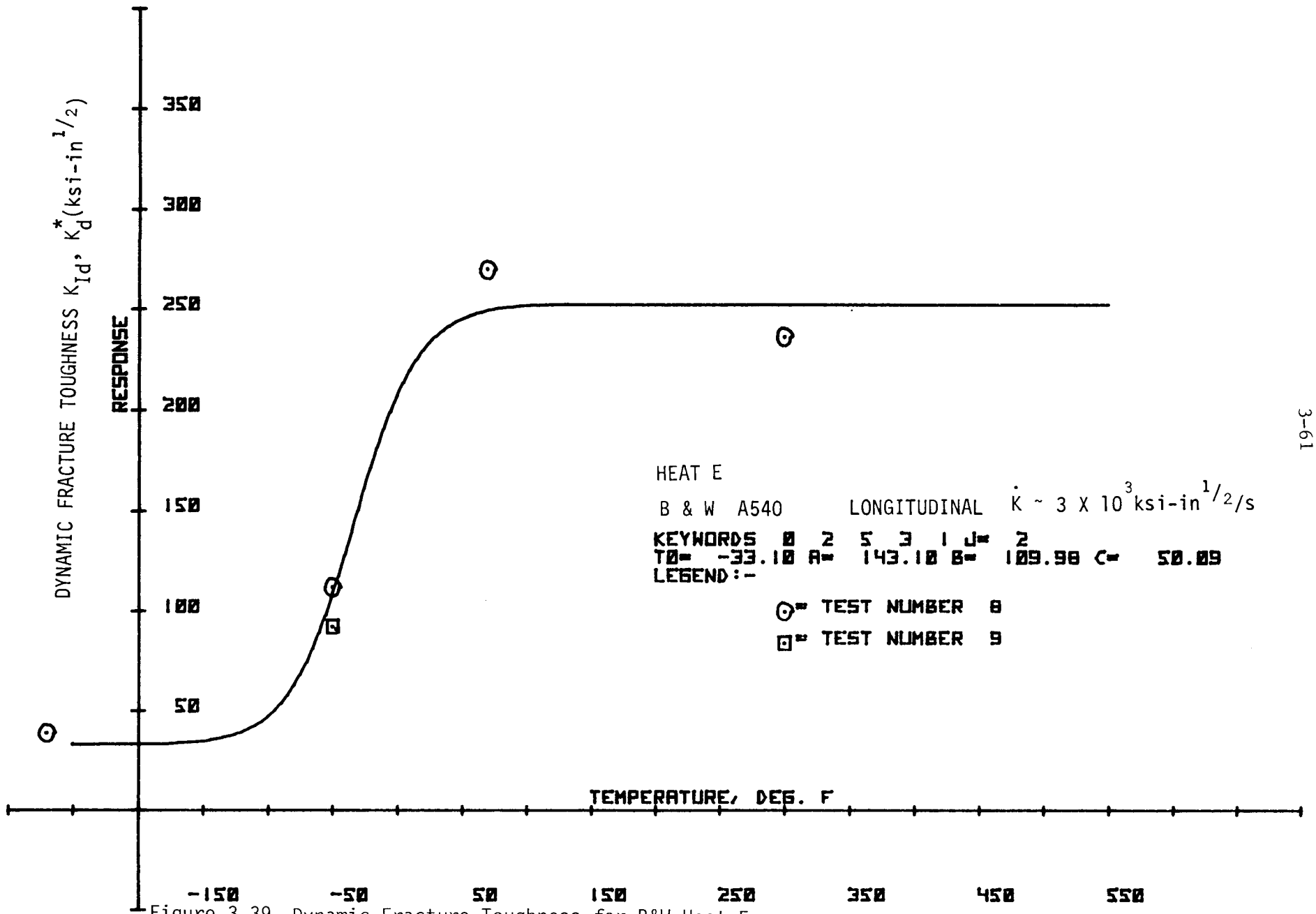


Figure 3.39. Dynamic Fracture Toughness for B&W Heat E

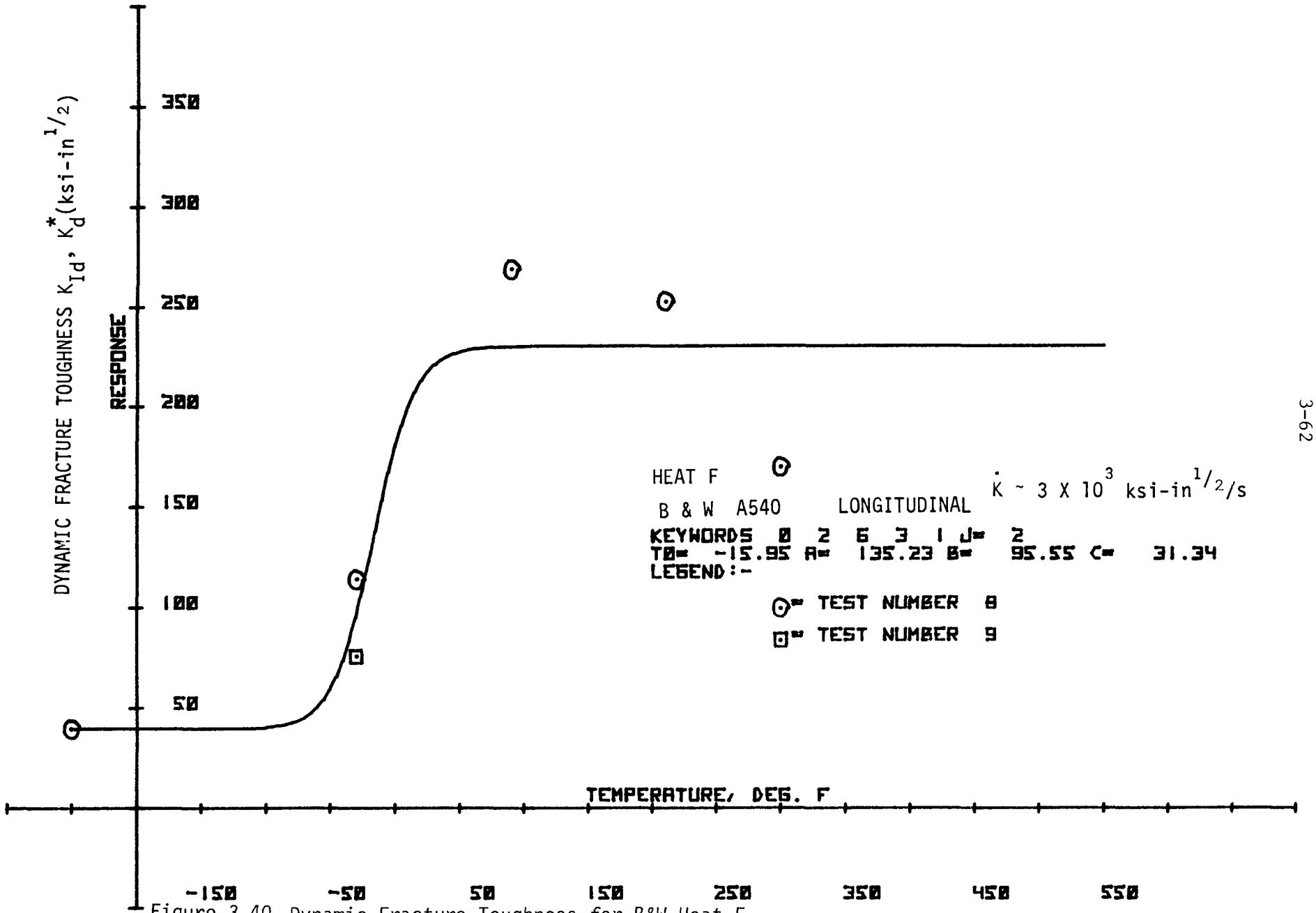


Figure 3.40. Dynamic Fracture Toughness for B&W Heat F

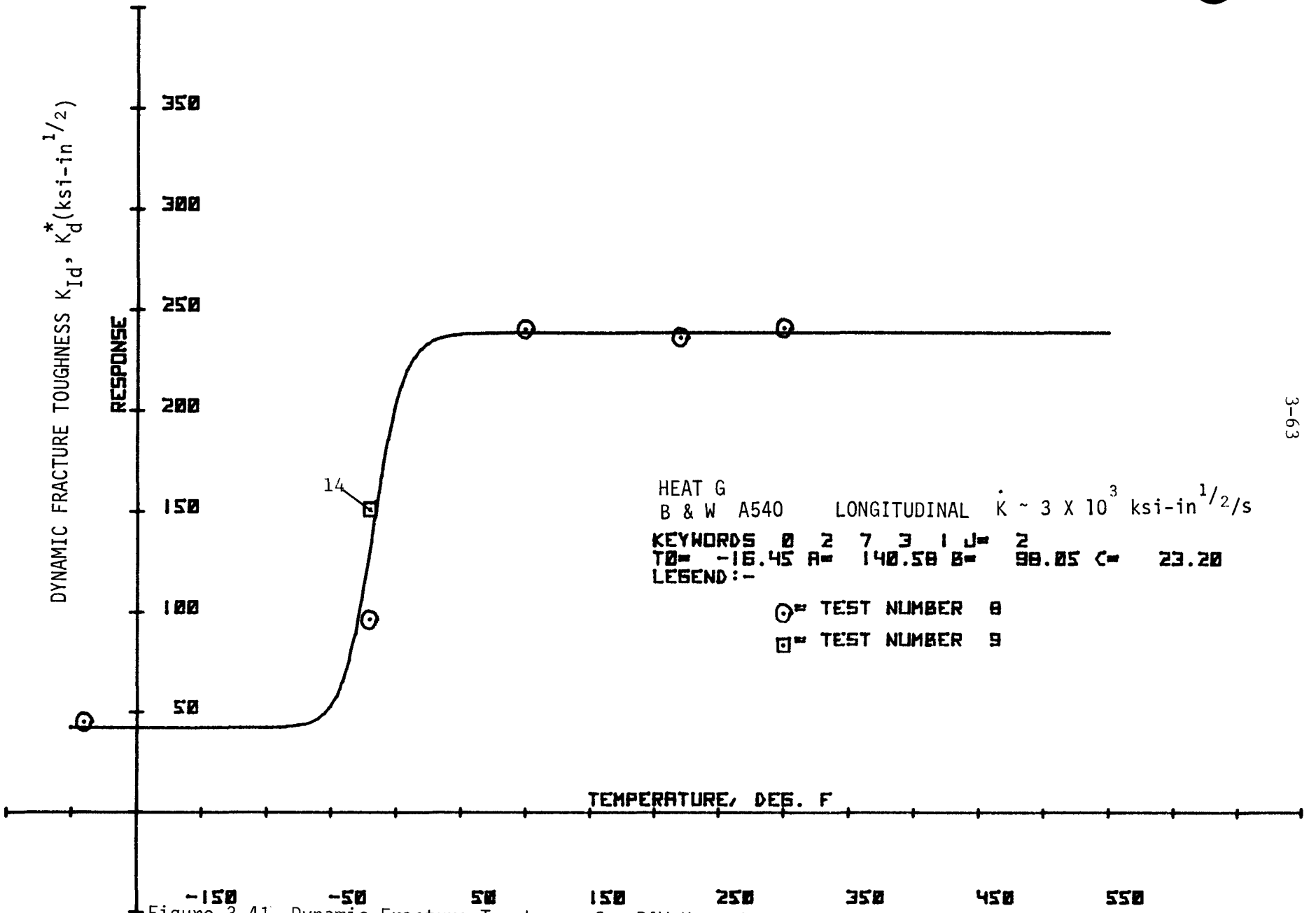


Figure 3.41. Dynamic Fracture Toughness for B&W Heat G

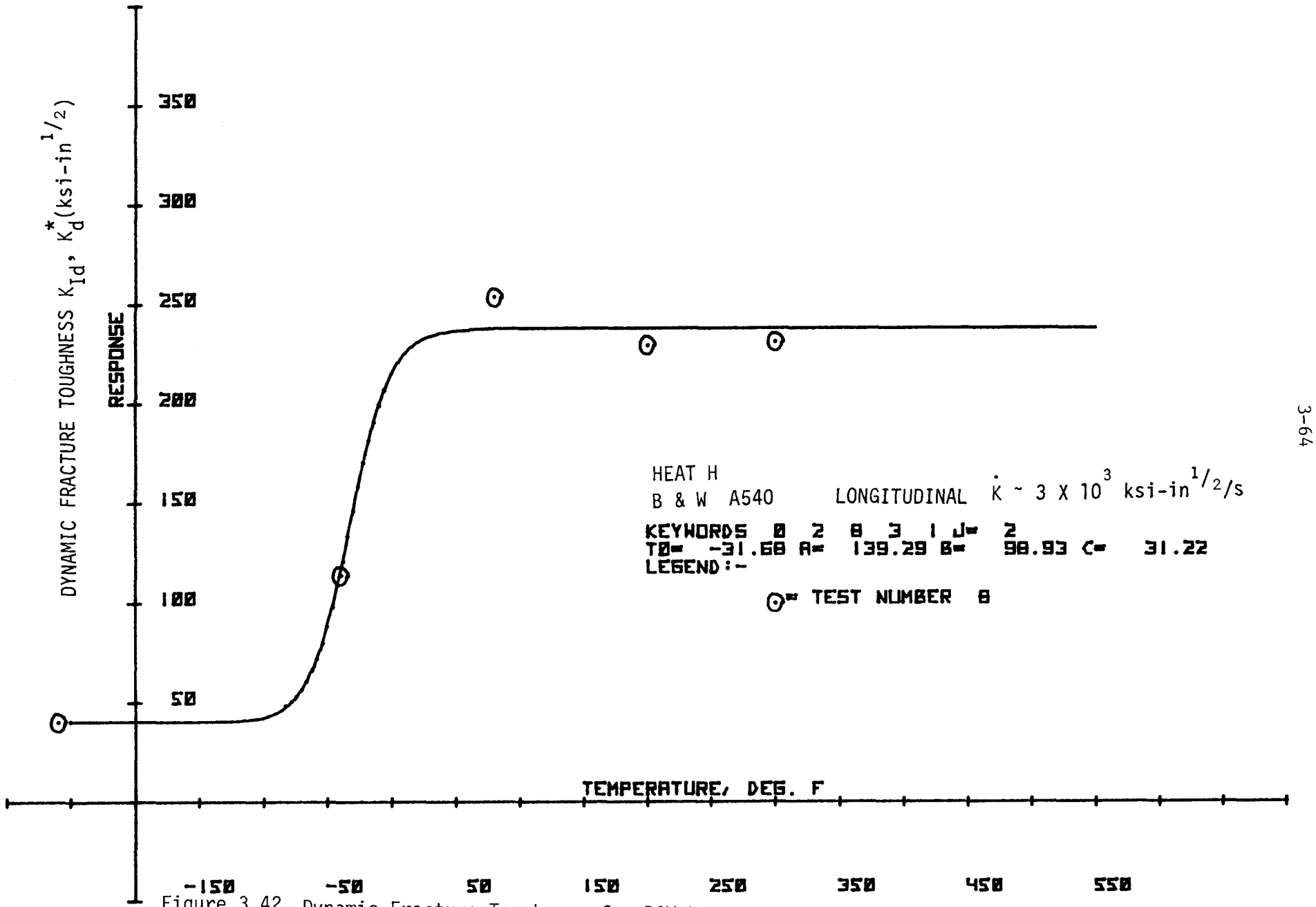


Figure 3.42. Dynamic Fracture Toughness for B&W Heat H

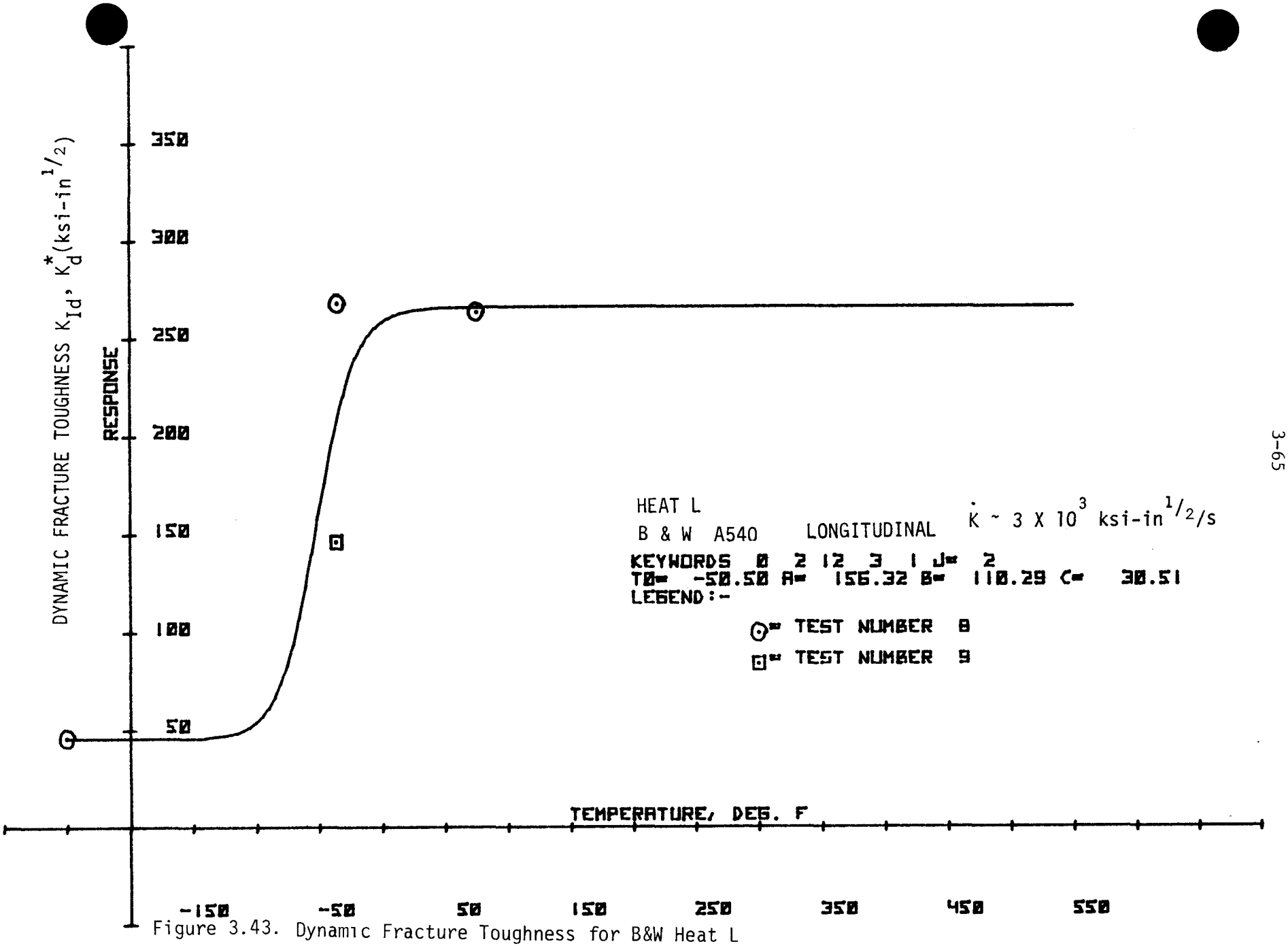


Figure 3.43. Dynamic Fracture Toughness for B&W Heat L

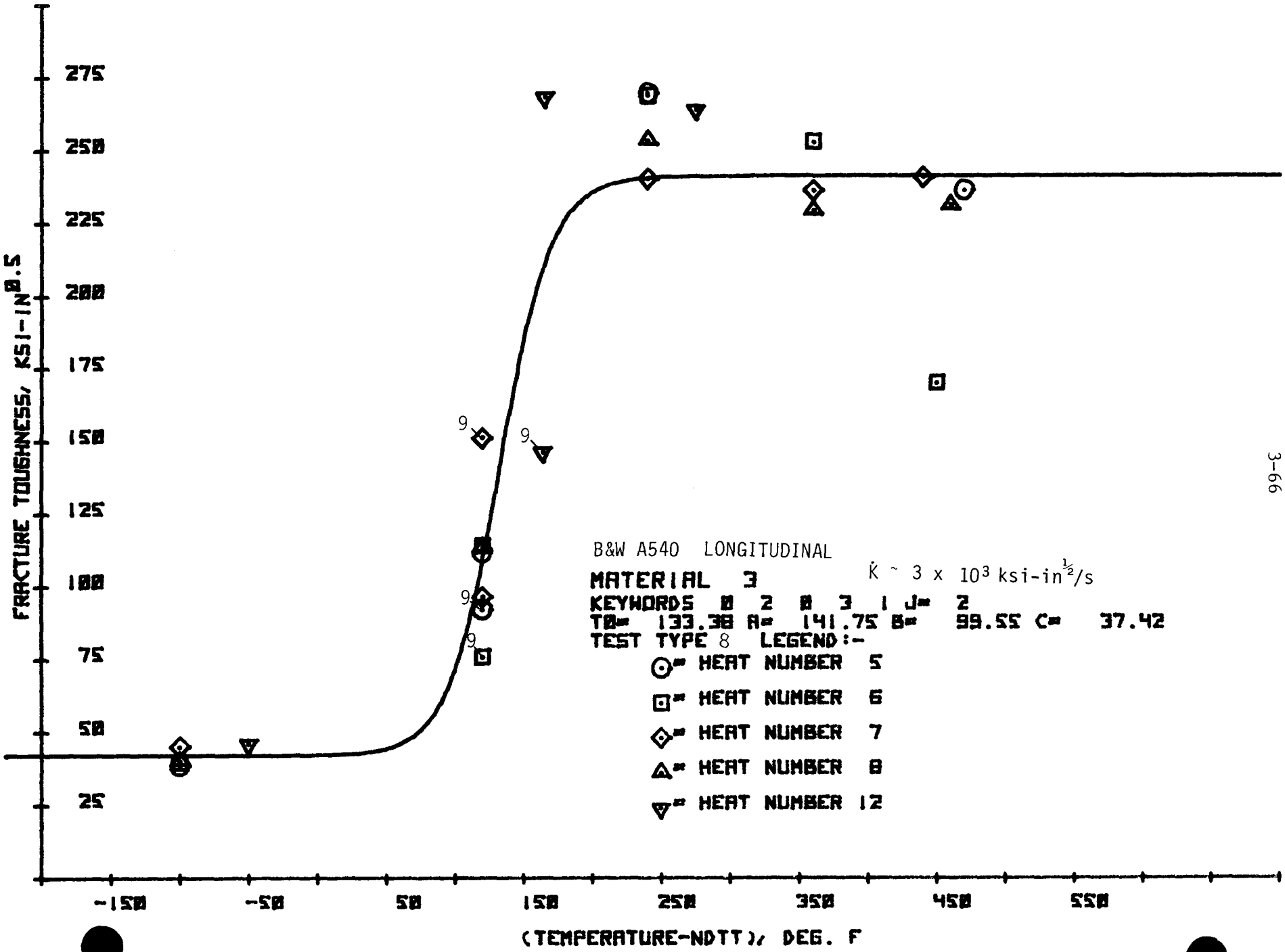


Figure 3.44. Dynamic Compact Specimen Fracture Toughness for All B&W Heats

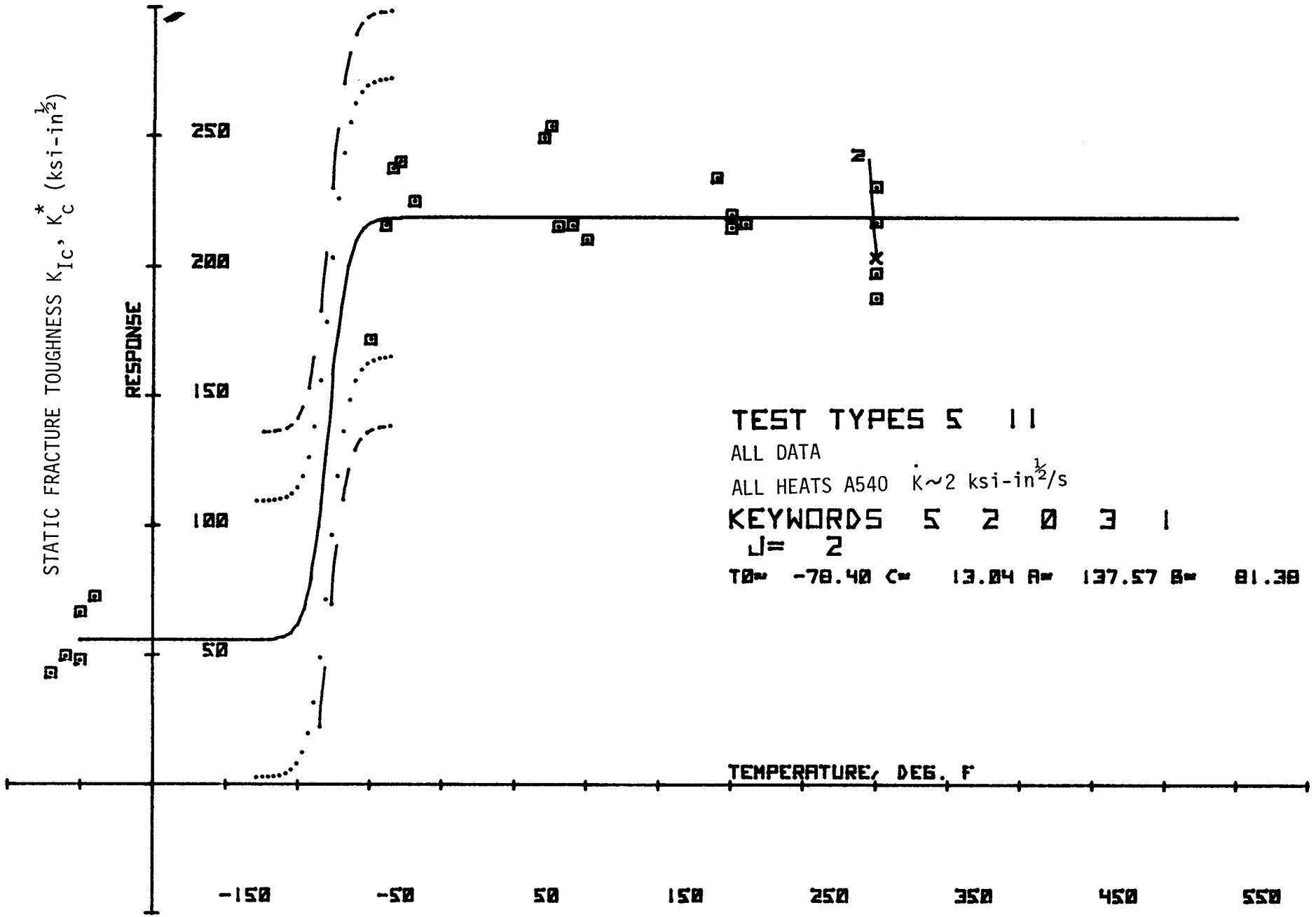


Figure 3.45 All Static Fracture Toughness Data

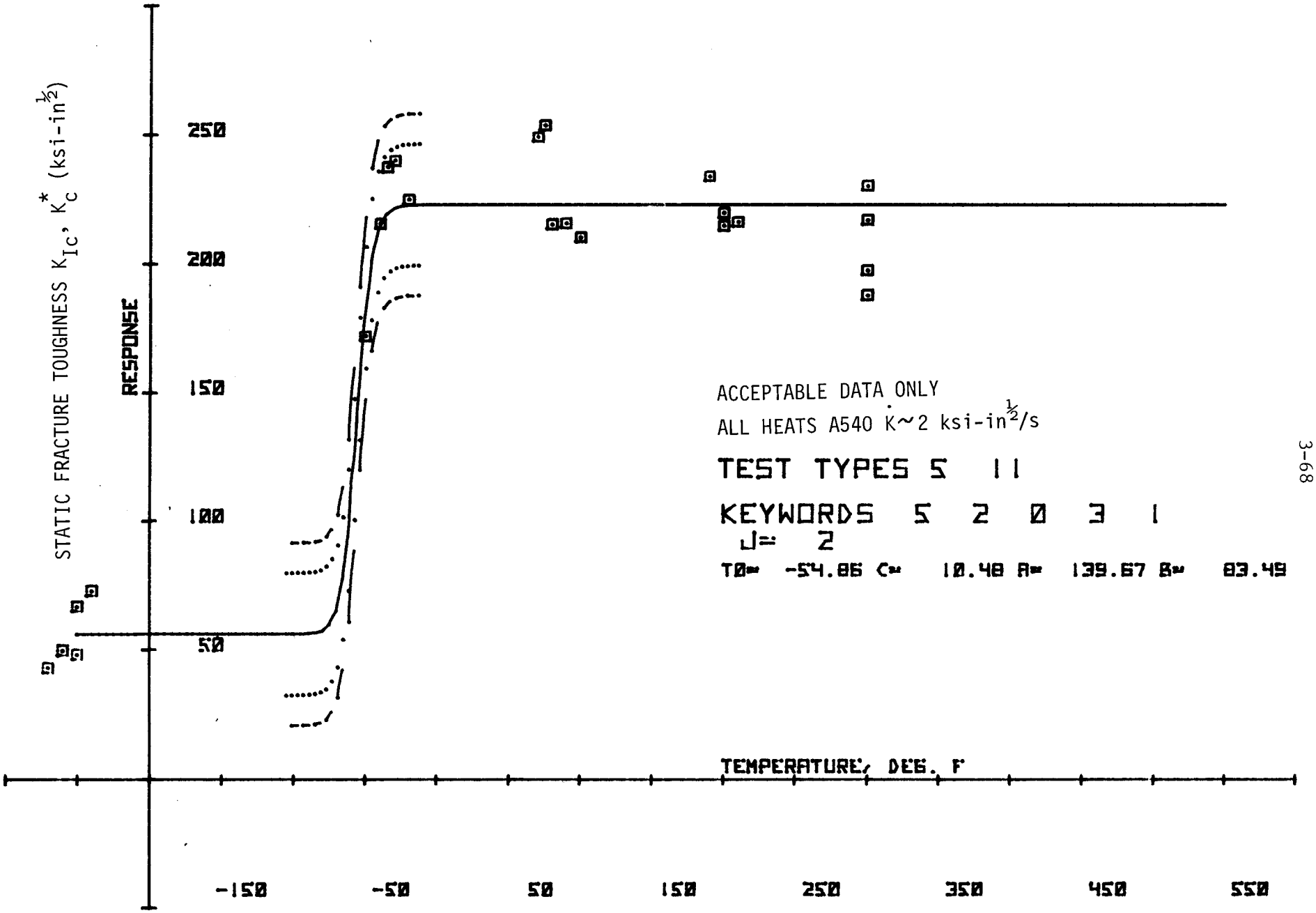


Figure 3.46 Acceptable Static Fracture Toughness Data

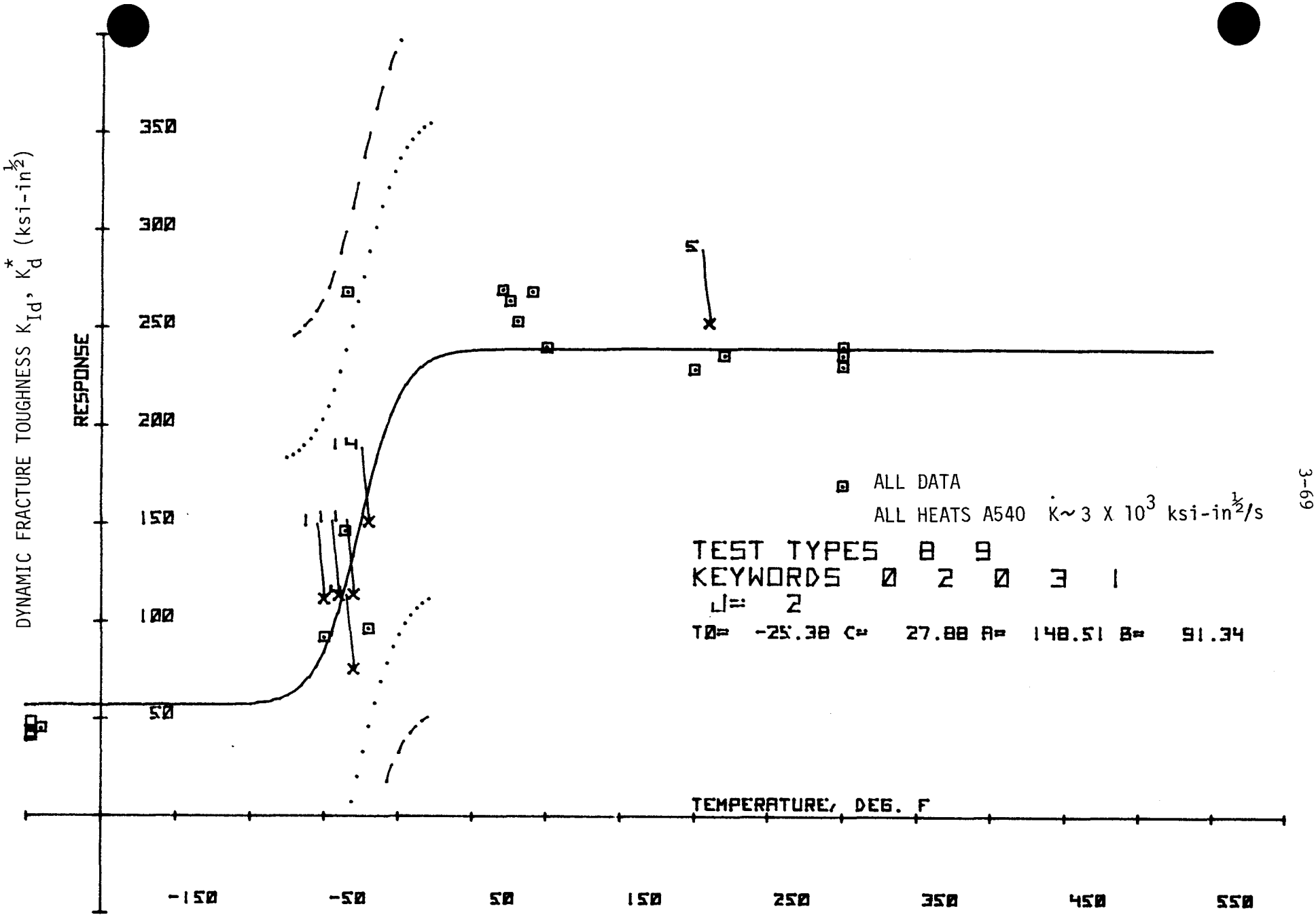


Figure 3.47 All Dynamic Fracture Toughness Data

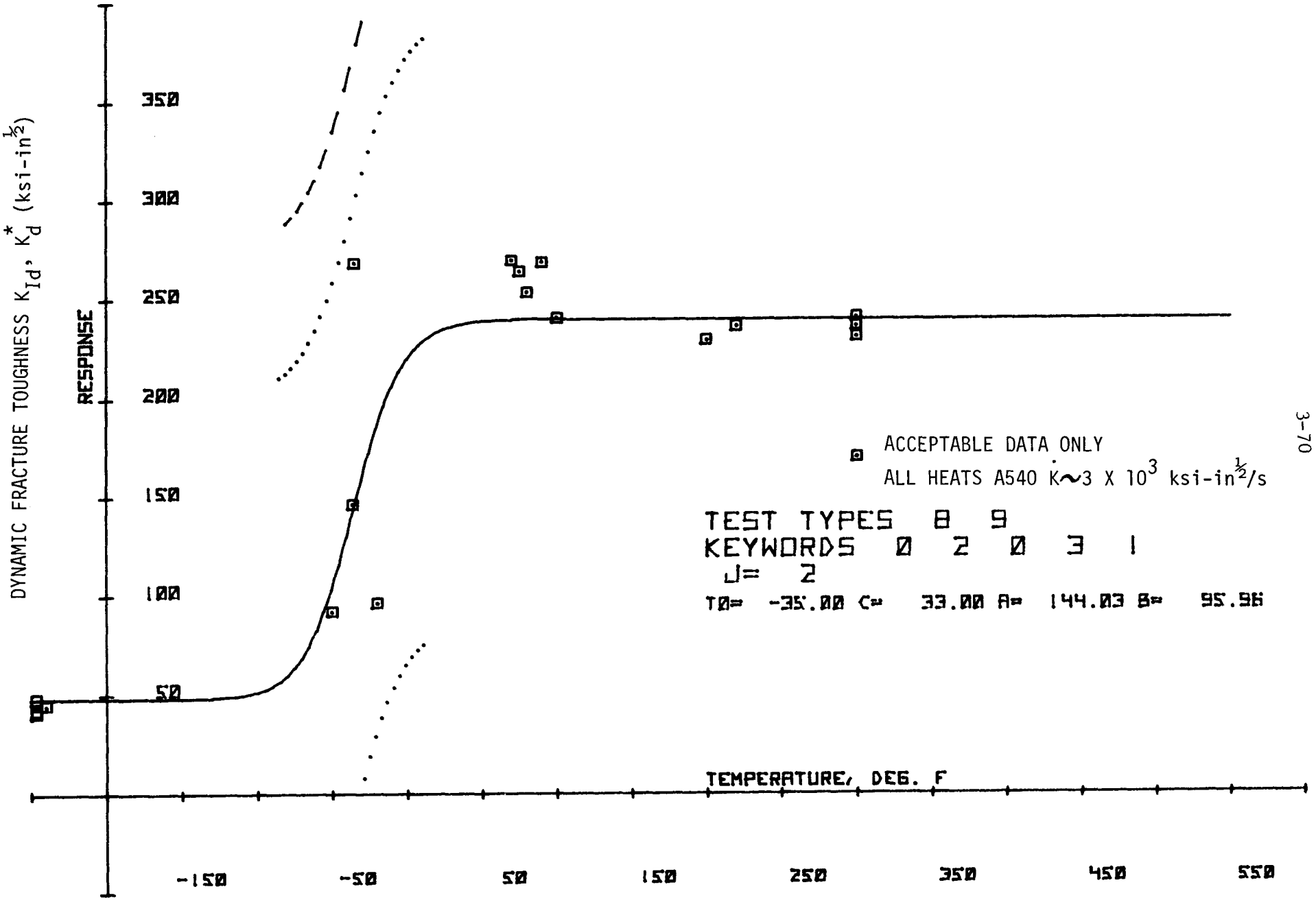


Figure 3.48 Acceptable Dynamic Fracture Toughness Dat

KEYWORDS 0-2-0-3-0

MATERIAL 3 DATA BANK (A540)

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(69)	4-2-5-3-2-4-0	-170.00	1.00	--	--	--	--
(70)	4-2-5-3-2-5-0	-160.00	2.00	--	--	--	--
(71)	4-2-5-3-2-6-0	-160.00	2.00	--	--	--	--
(72)	4-2-5-3-2-2-0	-150.00	2.00	--	--	--	--
(73)	4-2-5-3-2-1-0	-110.00	2.00	--	--	--	--
(74)	4-2-6-3-2-2-0	-150.00	1.00	--	--	--	--
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(78)	4-2-6-3-2-1-0	-110.00	2.00	--	--	--	--
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(85)	4-2-7-3-2-8-0	-120.00	2.00	--	--	--	--
(86)	4-2-7-3-2-1-0	-110.00	2.00	--	--	--	--
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(310)	3-2-5-3-1-18-0	-260.00	39.70	--	--	158.00	2.30E+05
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(320)	3-2-5-3-1-33-24	10.00	--	147.00	146.00	2830.00	6.70E+05
(321)	3-2-5-3-1-34-0	300.00	--	167.00	167.00	3320.00	6.70E+05
(322)	3-2-6-3-1-28-2	-240.00	46.10	--	--	218.00	2.20E+05
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(325)	3-2-6-3-1-21-0	-150.00	75.40	--	--	595.00	5.00E+05
(326)	3-2-6-3-1-22-4	-150.00	76.50	--	--	587.00	5.20E+05
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(329)	3-2-6-3-1-26-0	-60.00	101.00	--	--	1950.00	4.50E+05
(330)	3-2-6-3-1-27-34	-30.00	--	149.00	153.00	2200.00	5.30E+05
(331)	3-2-6-3-1-18-34	-30.00	--	167.00	171.00	2680.00	5.60E+05
(332)	3-2-6-3-1-29-0	0.00	--	141.00	141.00	2530.00	4.70E+05
(333)	3-2-6-3-1-30-0	30.00	--	155.00	157.00	2750.00	5.20E+05
(334)	3-2-6-3-1-31-0	30.00	--	186.00	188.00	2830.00	3.40E+05

(335)	3-2-6-3-1-32-4	300.00	--	156.00	156.00	2750.00	6.80E+05
(336)	3-2-6-3-1-33-2	425.00	--	159.00	158.00	2480.00	6.50E+05
(337)	3-2-6-3-1-34-2	550.00	--	147.00	146.00	2340.00	5.30E+05
(338)	3-2-7-3-1-18-0	-230.00	45.50	--	--	146.00	2.30E+05
(339)	3-2-7-3-1-19-0	-200.00	48.10	--	--	247.00	3.10E+05
(340)	3-2-7-3-1-21-0	-140.00	73.20	--	--	573.00	5.10E+05
(341)	3-2-7-3-1-23-2	-110.00	114.00	--	--	921.00	5.30E+05
(342)	3-2-7-3-1-24-2	-80.00	99.20	--	--	1300.00	4.00E+05
(343)	3-2-7-3-1-26-0	-50.00	102.00	--	--	1820.00	2.90E+05
(344)	3-2-7-3-1-27-24	-20.00	--	126.00	125.00	2060.00	5.50E+05
(345)	3-2-7-3-1-28-0	-20.00	--	104.00	104.00	2160.00	4.90E+05
(346)	3-2-7-3-1-29-0	10.00	--	104.00	104.00	2210.00	4.80E+05
(347)	3-2-7-3-1-30-0	40.00	--	115.00	116.00	2530.00	3.50E+05
(348)	3-2-7-3-1-31-34	40.00	--	159.00	163.00	2580.00	5.60E+05
(349)	3-2-7-3-1-32-0	300.00	--	131.00	130.00	2790.00	6.40E+05
(350)	3-2-7-3-1-33-2	425.00	--	159.00	168.00	2730.00	7.20E+05
(351)	3-2-7-3-1-34-24	550.00	--	129.00	131.00	1760.00	5.50E+05
(352)	3-2-8-3-1-32-2	-250.00	52.00	--	--	175.00	2.30E+05
(353)	3-2-8-3-1-31-2	-220.00	52.20	--	--	124.00	2.10E+05
(354)	3-2-8-3-1-21-2	-190.00	60.10	--	--	383.00	4.20E+05
(355)	3-2-8-3-1-22-2	-160.00	66.80	--	--	648.00	5.40E+05
(356)	3-2-8-3-1-23-24	-160.00	74.70	--	--	637.00	5.50E+05
(357)	3-2-8-3-1-24-0	-130.00	94.30	--	--	847.00	4.60E+05
(358)	3-2-8-3-1-25-2	-100.00	99.80	--	--	1480.00	4.40E+05
(359)	3-2-8-3-1-26-0	-100.00	103.00	--	--	1480.00	4.20E+05
(360)	3-2-8-3-1-27-0	-70.00	--	105.00	106.00	2390.00	4.80E+05
(361)	3-2-8-3-1-29-0	-40.00	--	149.00	151.00	2450.00	5.50E+05
(362)	3-2-8-3-1-28-0	-40.00	--	159.00	159.00	2400.00	5.70E+05
(363)	3-2-8-3-1-20-0	-10.00	--	110.00	110.00	2550.00	4.60E+05
(364)	3-2-8-3-1-19-34	20.00	--	162.00	165.00	2900.00	5.50E+05
(365)	3-2-8-3-1-33-0	20.00	--	125.00	126.00	2780.00	5.20E+05
(366)	3-2-8-3-1-34-24	300.00	--	154.00	153.00	2310.00	6.50E+05
(367)	3-2-8-3-1-35-0	425.00	--	154.00	154.00	2820.00	6.50E+05
(407)	3-2-5-3-1-27-2	-110.00	86.90	--	--	1410.00	4.50E+05
327	2-2-5-3-1-1-0	-250.00	14.00	4.00	1.00	--	--
328	2-2-5-3-1-2-0	-200.00	16.00	8.00	1.00	--	--
329	2-2-5-3-1-3-0	-150.00	18.00	8.00	10.00	--	--
330	2-2-5-3-1-14-0	-125.00	20.20	12.00	30.00	--	--
331	2-2-5-3-1-4-0	-100.00	24.50	15.00	20.00	--	--
332	2-2-5-3-1-15-0	-75.00	32.90	19.00	50.00	--	--
333	2-2-5-3-1-13-0	-50.00	45.00	26.00	99.00	--	--
334	2-2-5-3-1-16-0	-25.00	50.90	33.00	99.00	--	--
335	2-2-5-3-1-5-0	0.00	52.50	30.00	99.00	--	--
336	2-2-5-3-1-17-0	40.00	56.50	32.00	99.00	--	--
337	2-2-5-3-1-6-0	80.00	60.30	41.00	99.00	--	--
338	2-2-5-3-1-7-0	150.00	61.50	42.00	99.00	--	--
339	2-2-5-3-1-8-0	200.00	60.00	39.00	99.00	--	--
340	2-2-5-3-1-9-0	250.00	63.00	43.00	99.00	--	--
341	2-2-5-3-1-10-0	300.00	62.30	40.00	99.00	--	--
342	2-2-5-3-1-11-0	425.00	63.90	44.00	99.00	--	--
343	2-2-5-3-1-12-0	550.00	66.00	46.50	99.00	--	

344	2-2-6-3-1-1-0	-250.00	5.80	1.00	1.00	--	--
345	2-2-6-3-1-3-0	-150.00	15.00	9.00	1.00	--	--
346	2-2-6-3-1-14-0	-150.00	9.00	4.00	1.00	--	--
347	2-2-6-3-1-4-0	-100.00	16.20	7.00	1.00	--	--
348	2-2-6-3-1-15-0	-75.00	22.10	10.00	40.00	--	
349	2-2-6-3-1-13-0	-50.00	25.00	14.00	50.00	--	
350	2-2-6-3-1-2-0	-50.00	14.60	12.00	1.00	--	--
351	2-2-6-3-1-16-0	-25.00	32.80	19.00	50.00	--	--
352	2-2-6-3-1-5-0	0.00	39.00	18.00	99.00	--	--
353	2-2-6-3-1-17-0	40.00	42.80	23.00	99.00	--	--
354	2-2-6-3-1-6-0	80.00	46.00	29.00	99.00	--	--
355	2-2-6-3-1-7-0	150.00	49.00	33.00	99.00	--	--
356	2-2-6-3-1-8-0	200.00	48.00	33.00	99.00	--	--
357	2-2-6-3-1-9-0	250.00	47.90	31.00	99.00	--	--
358	2-2-6-3-1-10-0	300.00	49.00	32.00	99.00	--	--
359	2-2-6-3-1-11-0	425.00	49.20	32.00	99.00	--	--
360	2-2-6-3-1-12-0	550.00	46.30	33.00	99.00	--	--
361	2-2-7-3-1-1-0	-250.00	11.30	4.00	1.00	--	--
362	2-2-7-3-1-2-0	-200.00	13.50	1.00	1.00	--	--
363	2-2-7-3-1-3-0	-150.00	14.80	6.00	1.00	--	--
364	2-2-7-3-1-14-0	-125.00	14.50	6.00	10.00	--	--
365	2-2-7-3-1-4-0	-100.00	15.70	4.50	10.00	--	--
366	2-2-7-3-1-15-0	-75.00	21.00	11.00	40.00	--	--
367	2-2-7-3-1-13-0	-50.00	24.20	15.00	99.00	--	--
368	2-2-7-3-1-16-0	-25.00	31.10	14.00	99.00	--	--
369	2-2-7-3-1-5-0	0.00	35.50	18.00	99.00	--	--
370	2-2-7-3-1-17-0	40.00	38.20	22.00	90.00	--	--
371	2-2-7-3-1-6-0	80.00	40.20	24.00	99.00	--	--
372	2-2-7-3-1-7-0	150.00	41.90	28.00	99.00	--	--
373	2-2-7-3-1-8-0	200.00	42.30	29.00	99.00	--	--
374	2-2-7-3-1-9-0	250.00	43.80	30.00	99.00	--	--
375	2-2-7-3-1-10-0	300.00	44.20	31.00	99.00	--	--
376	2-2-7-3-1-11-0	425.00	45.90	36.00	99.00	--	--
377	2-2-7-3-1-12-0	550.00	47.90	36.00	99.00	--	--
378	2-2-8-3-1-1-0	-250.00	13.30	4.00	1.00	--	--
379	2-2-8-3-1-2-0	-200.00	14.40	6.50	1.00	--	--
380	2-2-8-3-1-3-0	-150.00	15.90	8.00	10.00	--	--
381	2-2-8-3-1-14-0	-125.00	18.20	10.00	30.00	--	--
382	2-2-8-3-1-4-0	-100.00	21.00	9.50	20.00	--	--
383	2-2-8-3-1-15-0	-75.00	30.00	16.00	30.00	--	--
384	2-2-8-3-1-13-0	-50.00	38.20	21.00	99.00	--	--
385	2-2-8-3-1-16-0	-25.00	41.00	24.00	99.00	--	--
386	2-2-8-3-1-5-0	0.00	40.90	23.00	99.00	--	--
387	2-2-8-3-1-17-0	40.00	44.20	25.00	99.00	--	--
388	2-2-8-3-1-6-0	80.00	44.90	27.00	99.00	--	--
389	2-2-8-3-1-7-0	150.00	46.90	30.00	99.00	--	--
390	2-2-8-3-1-8-0	200.00	48.60	34.00	99.00	--	--
391	2-2-8-3-1-9-0	250.00	48.80	33.00	99.00	--	--
392	2-2-8-3-1-10-0	300.00	49.80	33.00	99.00	--	--
393	2-2-8-3-1-11-0	425.00	50.00	39.50	99.00	--	--
394	2-2-8-3-1-12-0	550.00	52.30	41.00	99.00	--	--

(280) 2-2-8-3-1-12-0	550.00	52.30	41.00	50.00	--	
(452) 1-2-5-3-1-1-0	-222.00	166.50	185.20	9.00	19.00	51.80
(453) 1-2-5-3-1-2-0	-102.00	142.00	167.40	8.00	18.00	53.60
(454) 1-2-5-3-1-3-0	75.00	133.30	154.80	6.10	18.00	60.20
(455) 1-2-5-3-1-4-0	210.00	128.20	149.00	--	16.50	57.30
(456) 1-2-5-3-1-5-0	370.00	116.70	142.00	6.50	16.50	54.20
(457) 1-2-5-3-1-6-0	550.00	116.90	143.90	7.00	21.00	63.40
(458) 1-2-6-3-1-1-0	-240.00	172.60	193.80	9.50	17.00	45.00
(459) 1-2-6-3-1-2-0	-102.00	147.90	172.40	7.00	17.00	49.30
(460) 1-2-6-3-1-3-0	75.00	141.80	161.60	6.00	15.50	52.20
(461) 1-2-6-3-1-4-0	210.00	135.60	155.00	--	15.50	50.60
(462) 1-2-6-3-1-5-0	370.00	126.90	150.20	--	15.00	48.10
(463) 1-2-6-3-1-6-0	550.00	125.60	151.90	6.50	20.00	62.10
(464) 1-2-7-3-1-1-0	-247.00	186.90	201.80	6.80	15.50	46.40
(465) 1-2-7-3-1-2-0	-101.00	170.90	187.70	7.20	19.30	50.40
(466) 1-2-7-3-1-3-0	75.00	156.60	173.90	5.50	15.00	52.40
(467) 1-2-7-3-1-4-0	210.00	154.50	166.30	5.00	15.00	50.80
(468) 1-2-7-3-1-5-0	370.00	143.00	162.40	5.00	14.50	47.80
(469) 1-2-7-3-1-6-0	550.00	134.80	160.60	6.00	19.00	62.30
(470) 1-2-8-3-1-1-0	-250.00	183.50	197.60	7.50	16.50	48.10
(471) 1-2-8-3-1-2-0	-100.00	163.50	181.90	7.50	17.00	46.30
(472) 1-2-8-3-1-3-0	75.00	150.90	167.10	6.00	17.00	54.40
(473) 1-2-8-3-1-4-0	210.00	141.40	160.20	--	15.50	51.50
(474) 1-2-8-3-1-5-0	370.00	130.30	155.20	6.00	16.00	50.00
(475) 1-2-8-3-1-6-0	550.00	126.40	154.00	6.50	20.00	63.90
(553) 5-2-5-3-1-8-0	-270.00	43.10	--	--	--	1.70
(554) 5-2-5-3-1-5-0	-50.00	--	171.90	154.60	--	--
(555) 5-2-5-3-1-9-0	70.00	--	249.40	231.00	--	--
(556) 5-2-5-3-1-3-0	190.00	--	234.20	213.90	--	1.90
(557) 5-2-5-3-1-2-0	300.00	--	230.60	206.90	--	--
(558) 5-2-6-3-1-8-0	-250.00	48.30	--	--	--	1.20
(559) 5-2-6-3-1-9-0	-30.00	--	240.20	214.50	--	--
(560) 5-2-6-3-1-4-0	90.00	--	215.90	197.00	--	--
(561) 5-2-6-3-1-3-0	210.00	--	216.40	184.20	--	--
(562) 5-2-6-3-1-2-0	300.00	--	197.70	172.90	--	--
(563) 5-2-7-3-1-8-0	-240.00	73.00	--	--	--	--
(564) 5-2-7-3-1-4-0	-20.00	--	225.00	196.90	--	--
(565) 5-2-7-3-1-9-0	100.00	--	210.40	192.70	--	--
(0) 5-2-7-3-1-2-2	300.00	--	203.60	176.40	--	--
(1) 5-2-8-3-1-8-0	-260.00	49.90	--	--	--	1.80
(2) 5-2-8-3-1-9-0	-40.00	--	215.70	193.90	--	--
(3) 5-2-8-3-1-5-0	80.00	--	215.50	190.80	--	--
(4) 5-2-8-3-1-4-0	200.00	--	214.90	191.70	--	--
(5) 5-2-8-3-1-3-0	300.00	--	187.90	178.90	--	--
(35) 9-2-5-3-1-1-0	-50.00	92.30	--	--	--	1600.00
(36) 9-2-6-3-1-1-4	-30.00	75.90	--	--	--	2400.00
(37) 9-2-7-3-1-1-14	-20.00	151.20	--	--	--	3200.00
(100) 8-2-5-3-1-9-0	-270.00	38.80	--	--	--	2700.00
(101) 8-2-5-3-1-4-1	-50.00	112.00	--	--	--	1500.00
(102) 8-2-5-3-1-10-0	70.00	--	269.80	247.20	--	3500.00
(103) 8-2-5-3-1-7-0	300.00	--	236.70	200.60	--	3200.00

(104)	8-2-6-3-1-5-0	-250.00	39.70	--	--	--	2900.00
(105)	8-2-6-3-1-9-1	-30.00	114.20	--	--	--	3800.00
(106)	8-2-6-3-1-10-0	90.00	--	268.90	240.80	--	3500.00
(107)	8-2-6-3-1-6-5	210.00	--	253.10	218.00	--	3700.00
(108)	8-2-6-3-1-7-0	300.00	--	170.20	210.20	--	2200.00
(109)	8-2-7-3-1-9-0	-240.00	45.20	--	--	--	3000.00
(110)	8-2-7-3-1-5-0	-20.00	96.60	--	--	--	2800.00
(111)	8-2-7-3-1-10-0	100.00	--	240.40	219.50	--	3500.00
(112)	8-2-7-3-1-6-0	220.00	--	236.50	218.30	--	2900.00
(113)	8-2-7-3-1-7-0	300.00	--	241.00	212.10	--	2600.00
(114)	8-2-8-3-1-9-0	-260.00	40.10	--	--	--	2900.00
(115)	8-2-8-3-1-2-1	-40.00	113.70	--	--	--	3700.00
(116)	8-2-8-3-1-10-0	80.00	--	253.50	227.70	--	3600.00
(117)	8-2-8-3-1-6-0	200.00	--	229.60	217.70	--	3600.00
(118)	8-2-8-3-1-7-0	300.00	--	231.30	211.10	--	2000.00
(134)	3-2-12-3-1-18-0	-290.00	33.50	--	--	120.00	2.20E+05
(135)	3-2-12-3-1-20-4	-230.00	38.00	--	--	157.00	2.50E+05
(136)	3-2-12-3-1-21-0	-200.00	54.80	--	--	325.00	3.80E+05
(137)	3-2-12-3-1-22-0	-200.00	57.90	--	--	371.00	4.30E+05
(138)	3-2-12-3-1-23-0	-170.00	59.60	--	--	470.00	3.50E+05
(139)	3-2-12-3-1-24-0	-140.00	79.30	--	--	714.00	3.20E+05
(140)	3-2-12-3-1-25-3	-140.00	95.50	--	--	707.00	3.60E+05
(141)	3-2-12-3-1-26-0	-110.00	--	130.00	130.00	1570.00	3.90E+05
(142)	3-2-12-3-1-27-2	-80.00	--	142.00	141.00	2600.00	3.90E+05
(143)	3-2-12-3-1-28-0	-80.00	--	144.00	145.00	2880.00	4.00E+05
(144)	3-2-12-3-1-29-0	-50.00	--	135.00	135.00	3000.00	3.70E+05
(145)	3-2-12-3-1-30-0	-20.00	--	188.00	189.00	3240.00	3.90E+05
(146)	3-2-12-3-1-31-0	-20.00	--	164.00	165.00	3190.00	3.80E+05
(147)	3-2-12-3-1-32-0	300.00	--	172.00	174.00	3800.00	3.40E+05
(148)	3-2-12-3-1-33-3	425.00	--	171.00	174.00	3870.00	4.70E+05
(149)	3-2-12-3-1-34-2	550.00	--	118.00	117.00	3000.00	3.90E+05
(150)	5-2-12-3-1-2-0	-250.00	67.00	--	--	--	3.80
(151)	5-2-12-3-1-4-0	-35.00	--	237.70	232.00	--	2.60
(152)	5-2-12-3-1-5-0	75.00	--	253.80	270.60	--	--
(153)	5-2-12-3-1-6-0	200.00	--	219.90	210.40	--	2.00
(154)	5-2-12-3-1-3-0	300.00	--	217.20	210.70	--	1.90
(155)	8-2-12-3-1-7-0	-250.00	46.20	--	--	--	3400.00
(156)	8-2-12-3-1-9-0	-35.00	--	268.50	254.60	--	4300.00
(157)	8-2-12-3-1-10-0	75.00	--	264.20	245.70	--	7400.00
(158)	9-2-12-3-1-1-0	-36.00	146.50	--	--	--	2900.00
(159)	4-2-12-3-2-1-0	-320.00	1.00	--	--	--	--
(160)	4-2-12-3-2-2-0	-240.00	1.00	--	--	--	--
(161)	4-2-12-3-2-3-0	-230.00	2.00	--	--	--	--
(162)	4-2-12-3-2-4-0	-200.00	1.00	--	--	--	--
(163)	4-2-12-3-2-5-0	-190.00	2.00	--	--	--	--
(164)	4-2-12-3-2-6-0	-170.00	2.00	--	--	--	--
(165)	4-2-12-3-2-7-0	-150.00	2.00	--	--	--	--
6	2-2-12-3-1-1-0	-248.00	13.80	3.00	1.00	--	--
7	2-2-12-3-1-2-0	-200.00	14.00	3.00	1.00	--	--
8	2-2-12-3-1-3-0	-150.00	17.00	6.00	1.00	--	--
9	2-2-12-3-1-14-0	-125.00	19.90	9.00	10.00	--	--

10	2-2-12-3-1-4-0	-100.00	21.20	9.00	10.00	--	--
11	2-2-12-3-1-15-0	-75.00	30.40	18.00	40.00	--	--
12	2-2-12-3-1-13-0	-50.00	38.90	21.00	99.00	--	--
13	2-2-12-3-1-16-0	-25.00	47.00	28.00	99.00	--	--
14	2-2-12-3-1-5-0	0.00	46.50	28.00	99.00	--	--
15	2-2-12-3-1-17-0	40.00	50.80	30.00	99.00	--	--
16	2-2-12-3-1-6-0	74.00	51.00	32.00	99.00	--	--
17	2-2-12-3-1-7-0	150.00	54.50	32.00	99.00	--	--
18	2-2-12-3-1-8-0	200.00	54.20	35.00	99.00	--	--
19	2-2-12-3-1-9-0	250.00	56.30	39.00	99.00	--	--
20	2-2-12-3-1-10-0	300.00	56.90	35.00	99.00	--	--
21	2-2-12-3-1-11-0	425.00	55.50	41.00	99.00	--	--
22	2-2-12-3-1-12-0	550.00	58.00	41.00	99.00	--	--
(183)	1-2-12-3-1-1-0	-227.00	179.80	195.60	7.50	15.00	47.50
(184)	1-2-12-3-1-2-0	-100.00	161.80	179.40	6.50	16.30	50.10
(185)	1-2-12-3-1-3-0	75.00	153.30	165.90	6.30	16.80	54.40
(186)	1-2-12-3-1-4-0	210.00	146.00	159.90	5.70	14.50	53.00
(187)	1-2-12-3-1-5-0	370.00	134.30	154.10	6.00	15.00	49.70
(188)	1-2-12-3-1-6-0	550.00	129.40	152.70	6.50	18.50	56.60

APPENDIX 4

MATERIAL 4

A302 GRADE B STEEL

MATERIAL TYPE 4
A302 GRADE B STEEL

INTRODUCTION

One heat (heat N) of A302B steel was studied by Effects Technology, Inc. This heat was formerly used as a reactor surveillance correlation material. The A302B steel was included in the present program to represent the properties of the older nuclear pressure vessels. Table 4.1 provides a brief description of material 4. A complete history of the material and test results can be found in reference 13. The test results for material 4 extracted from the data bank are at the end of this section.

TENSILE TESTS RESULTS

The tensile test results on heat N are shown graphically in Figures 4.1 to 4.5. Cubic polynomial equations were fitted to the data. A summary of the statistical parameters for the tensile data is given in Table 4.2.

CHARPY V-NOTCH RESULTS

Impact Energy

The impact energy data for the longitudinally oriented material are shown graphically in Figure 4.6. The upper and lower shelves are 82 and 5 ft-lb, while the ductile-brittle transition temperature, T_0 - C, was $-25.4^{o}F$. The variance about the transition portion of the curve was 69 with 6 degrees of freedom. The transverse data are shown in Figure 4.7. The upper and lower shelves were 45 and 4 ft-lb. The variance in the transition range was 8.7 with 6 degrees of freedom. The results are summarized in Table 4.3.

Lateral Expansion

The results for longitudinal specimens are shown in Figure 4.8, while the transverse results are shown in Figure 4.9. The major features of the data are summarized in Table 4.3.

Percent Shear

The percent shear data are summarized in Figure 4.10 (longitudinal) and 4.11 (transverse). The major features of the curves are extracted and summarized in Table 4.3.

Summary of Charpy Impact Test Data

Table 4.3 summarizes the tanh and transition temperature parameters for the three different types of Charpy measurements. Note that T_o - C from the tanh fit to the percent shear data correlated well with the NDTT. The upper shelf energy for the transverse orientation of the A302B steel was less the 50 ft-lb, so the RT_{NDT} could not be established. However, the 35 mil lateral expansion criterion was reached at 60^oF for the transverse material (Figure 4.9). Based on lateral expansion, RT_{NDT} would be 0^oF, which is the NDT temperature.

INSTRUMENTED PRECRACKED CHARPY RESULTS

Dynamic Fracture Toughness, K_{Id}, K_d^*

The tanh curve fit to the data for heat N is shown in Figure 4.12. The K_{IR} curve is shown superimposed by assuming that NDTT is an RT_{NDT} for this material. The curve parameters are summarized in Table 4.4. The value of T_o - C was -6^oF, in good agreement with the expected value of 0^oF.

Normalized Energy, W/A

Figure 4.13 shows the test data for heat N with a fitted tanh curve. The fitted curve had the properties listed in Table 4.4. Note the large difference between T_o - C and NDTT.

STATIC COMPACT AND DYNAMIC ONE-INCH AND FOUR-INCH FRACTURE TOUGHNESS RESULTS

There were again too few data points for adequate analysis. The results for heat N are shown in Figure 4.14 with the K_{IR} curve added for comparison in Figure 4.15 (using NDTT). Note that error code type markings

are used to indicate test types other than type 5 in Figure 4.15. Only one dynamic 4-in. compact fracture test was performed on the A302B steel. The 4-in. data point was in good agreement with the bend data even though there is a difference in stress intensity rates.

EFFECT OF ERROR CODES

The effect of error codes was not performed since the data obtained was for only one heat of material. The general effect can be observed by looking at the curves with the error codes identified. As in the other materials, the effect of error codes is minimal.

Table 4.1. Summary of A302B Heats (Material 4)

TEST LABORATORY	HEAT CODE	PLATE THICKNESS (in.)	NDTT (^{o}F)	RT_{NDT} (^{o}F)	COMMENTS
ETI	N(14)	6	0	---*	ASTM Surveillance Correlation Heat

* RT_{NDT} could not be determined because the Charpy V-notch upper shelf energy was less than 50 ft-lb.

Table 4.2. Summary of the Regression Analysis of the Tensile Test Data (A302B)

Property	A	B	C	D	Variance, σ^2	Degrees of Freedom ϕ	Standard Deviation σ
Yield Strength	70.12	-5.324×10^{-2}	9.64×10^{-5}	-5.202×10^{-8}	1.12	2.00	1.05
Ultimate Tensile Strength	95.25	-7.183×10^{-2}	1.187×10^{-4}	-1.116×10^{-8}	0.18	2.00	0.424
Uniform Elongation	11.75	-1.036×10^{-2}	2.581×10^{-5}	-2.059×10^{-8}	0.12	2.00	0.346
Total Elongation	25.76	-1.648×10^{-2}	-2.052×10^{-5}	5.398×10^{-8}	0.91	2.00	0.954
Reduction In Area	48.19	4.859×10^{-3}	1.453×10^{-5}	-1.080×10^{-7}	2.70	2.00	1.64

Table 4.3. Summary of Charpy Impact Tanh and Transition Temperature Parameters (A302B)

	Key	J	A	B	T_0	C	PHI	VAR	T_0 - C	NDTT
Energy	251441	2	43.55	38.54	39.87	65.33	6	69.2	-25	0
	251442	2	24.73	20.50	33.48	53.99	6	8.68	-21	
Lateral Expansion	251441	3	32.16	32.16	22.92	75.02	6	34.2	-52	0
	251442	3	24.23	24.23	36.33	70.77	6	1.59	-34	
Percent Shear	251441	4	53.27	48.03	50.87	52.69	6	85.4	-2	0
	251442	4	51.76	49.47	45.79	49.79	6	22.5	-4	

Table 4.4. Summary of Statistical Data for Precracked Charpy Fracture Toughness Tests (A302B)

TEST	KEY	A-B ($ksi\text{-}in^{1/2}$)	A+B ($ksi\text{-}in^{1/2}$)	T_o (^oF)	$T_o - C$ (^oF)	NDTT (^oF)	PHI	VAR
K_{Id}, K_d^*	351442	42	170	30	-6	0	5	127
W/A	351442	281 ($in\text{-}lb/in^2$)	2685 ($in\text{-}lb/in^2$)	5	-77	0	4	9224

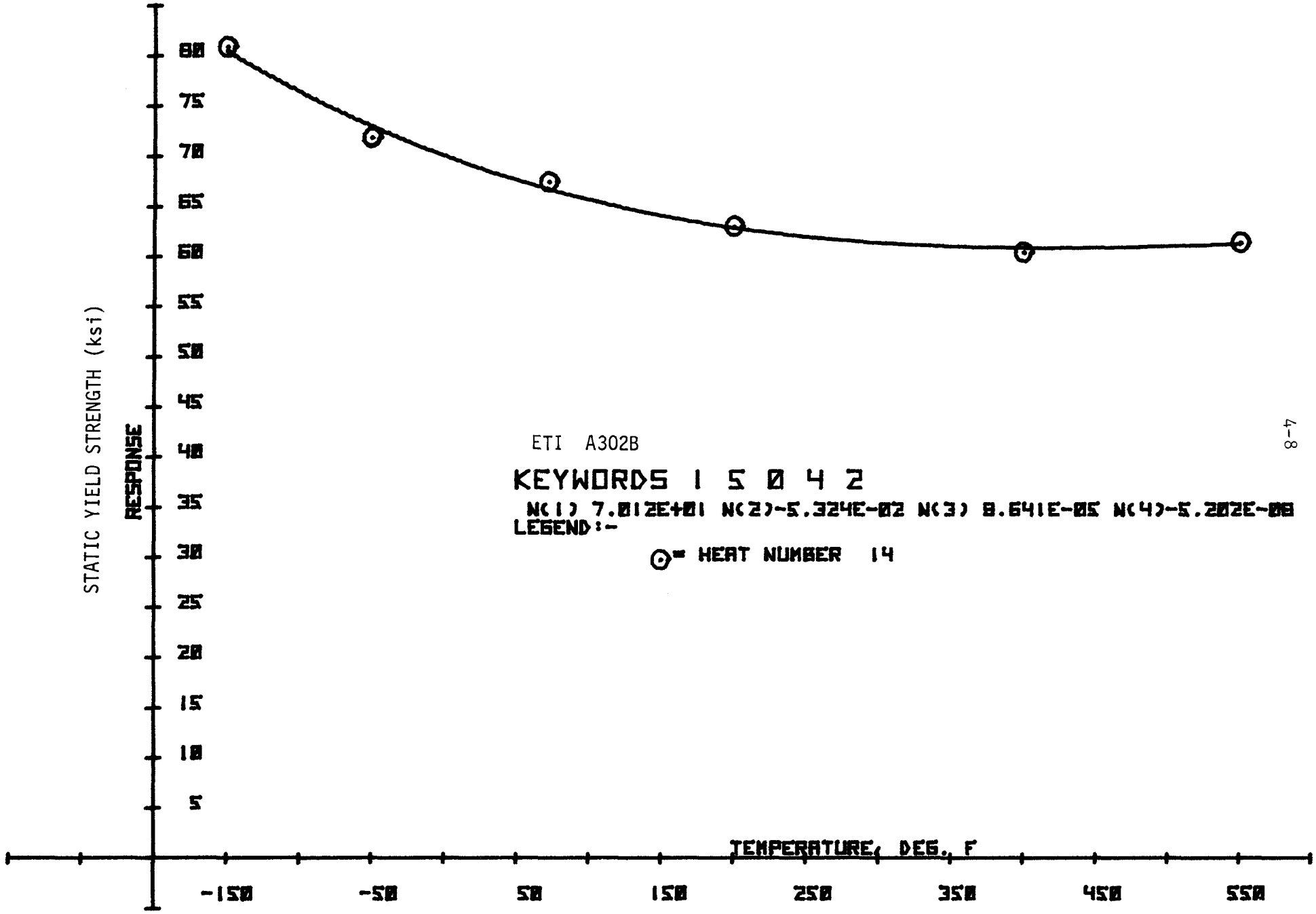


Figure 4.1 Tensile Static Yield Strength for ETI Heat N

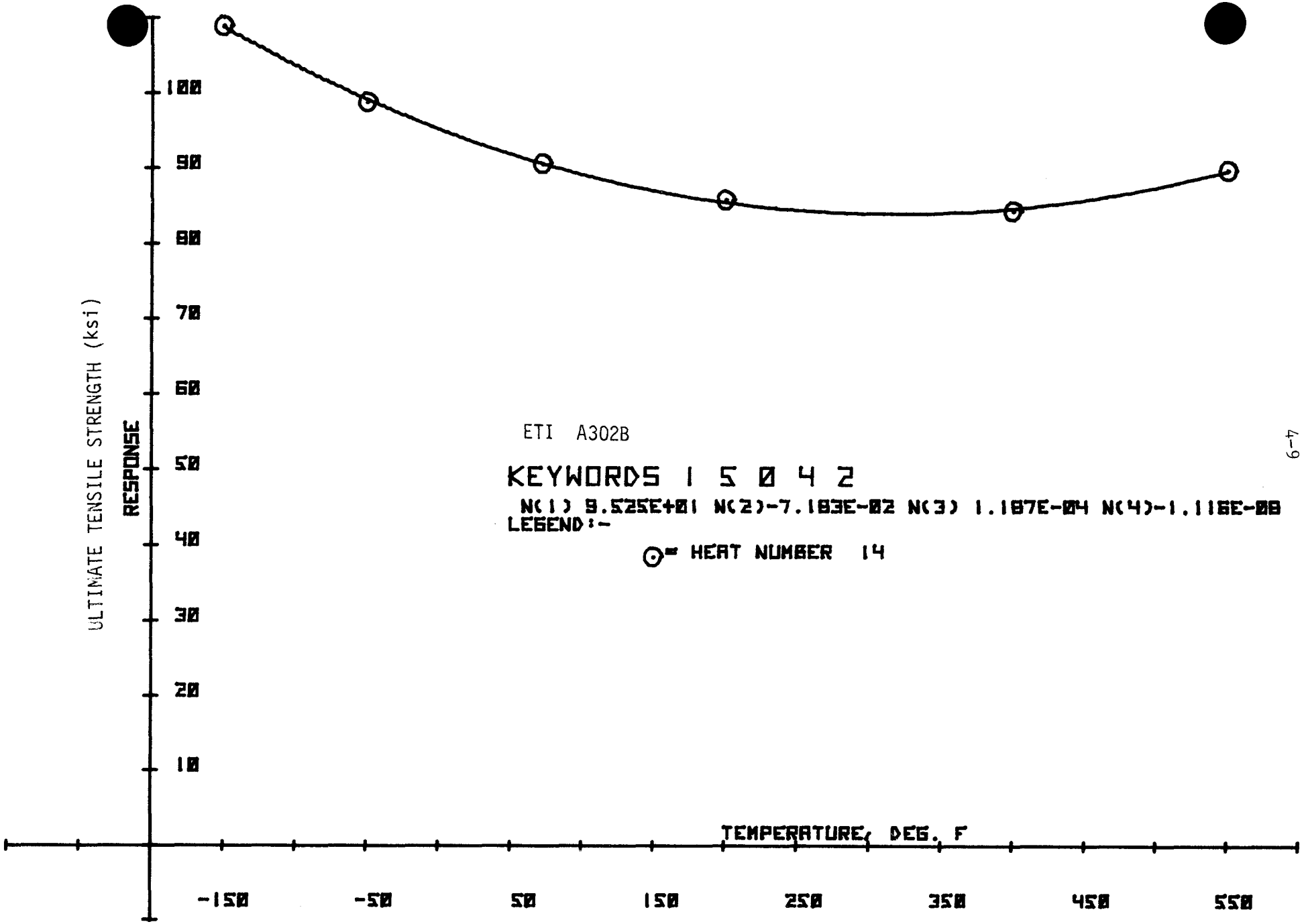


Figure 4.2 Tensile Ultimate Strength for ETI Heat N

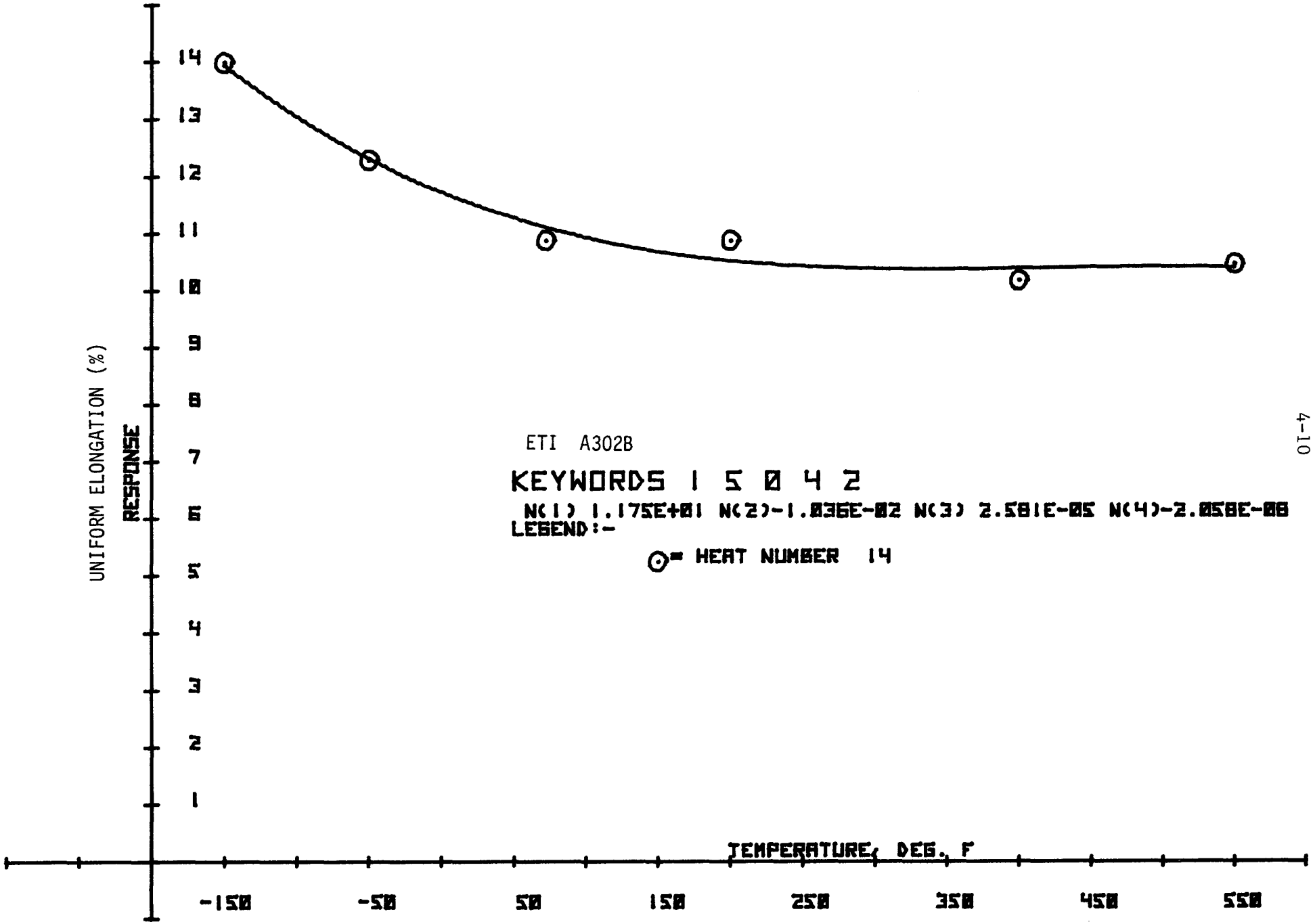


Figure 4.3 Tensile Uniform Elongation for ETI Heat N

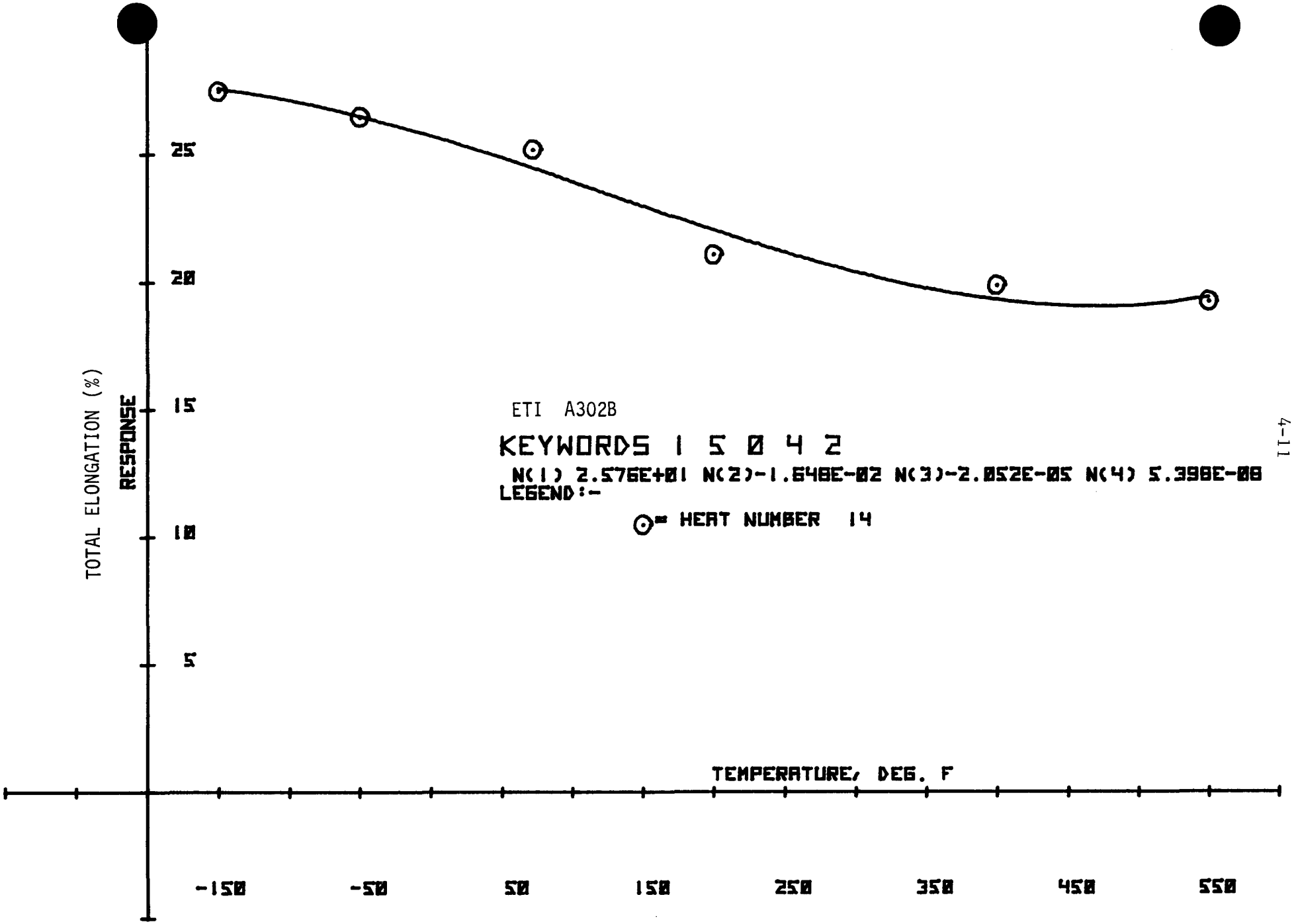


Figure 4.4 Tensile Total Elongation for ETI Heat N

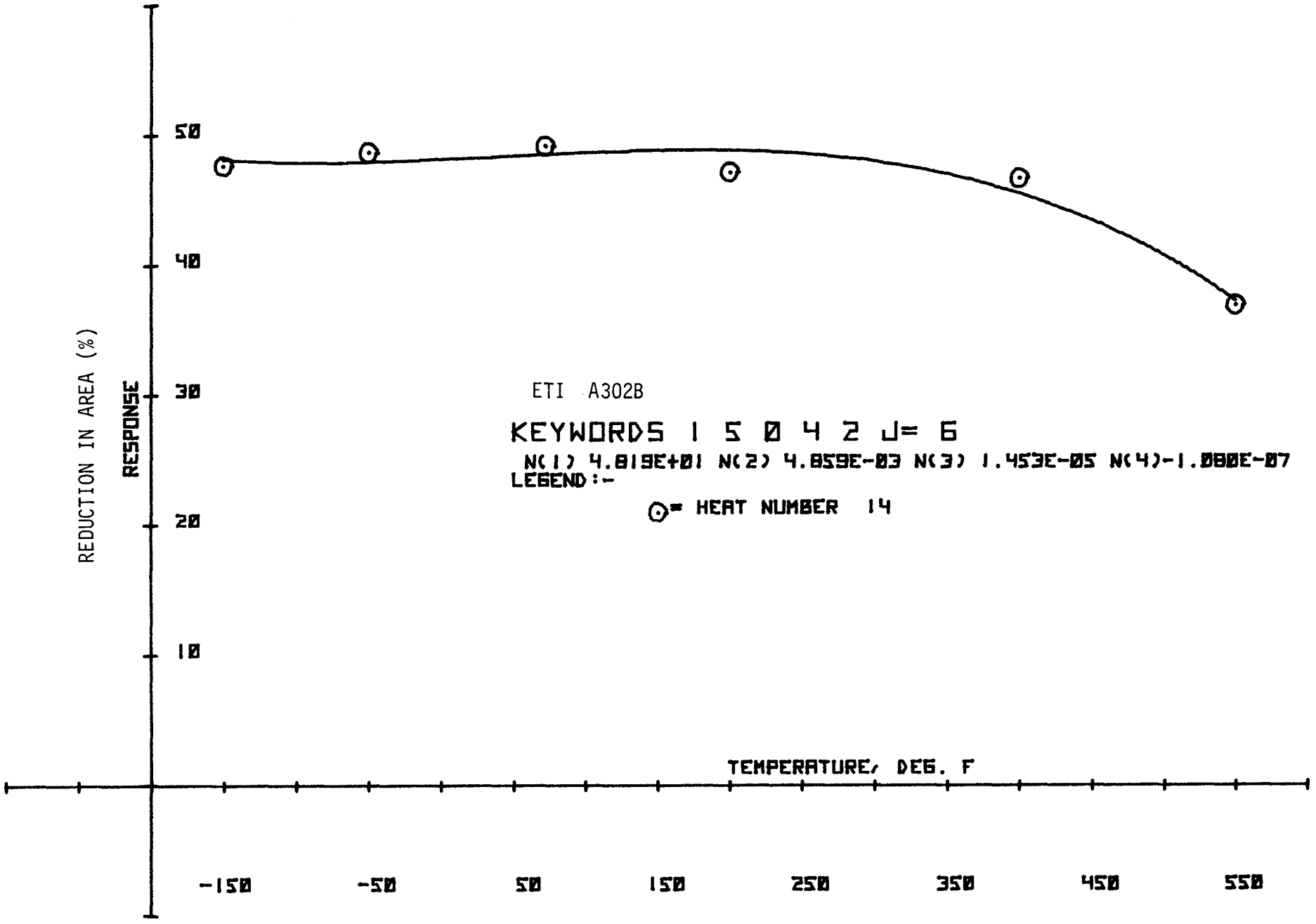


Figure 4.5 Tensile Reduction in Area for ETI Heat N

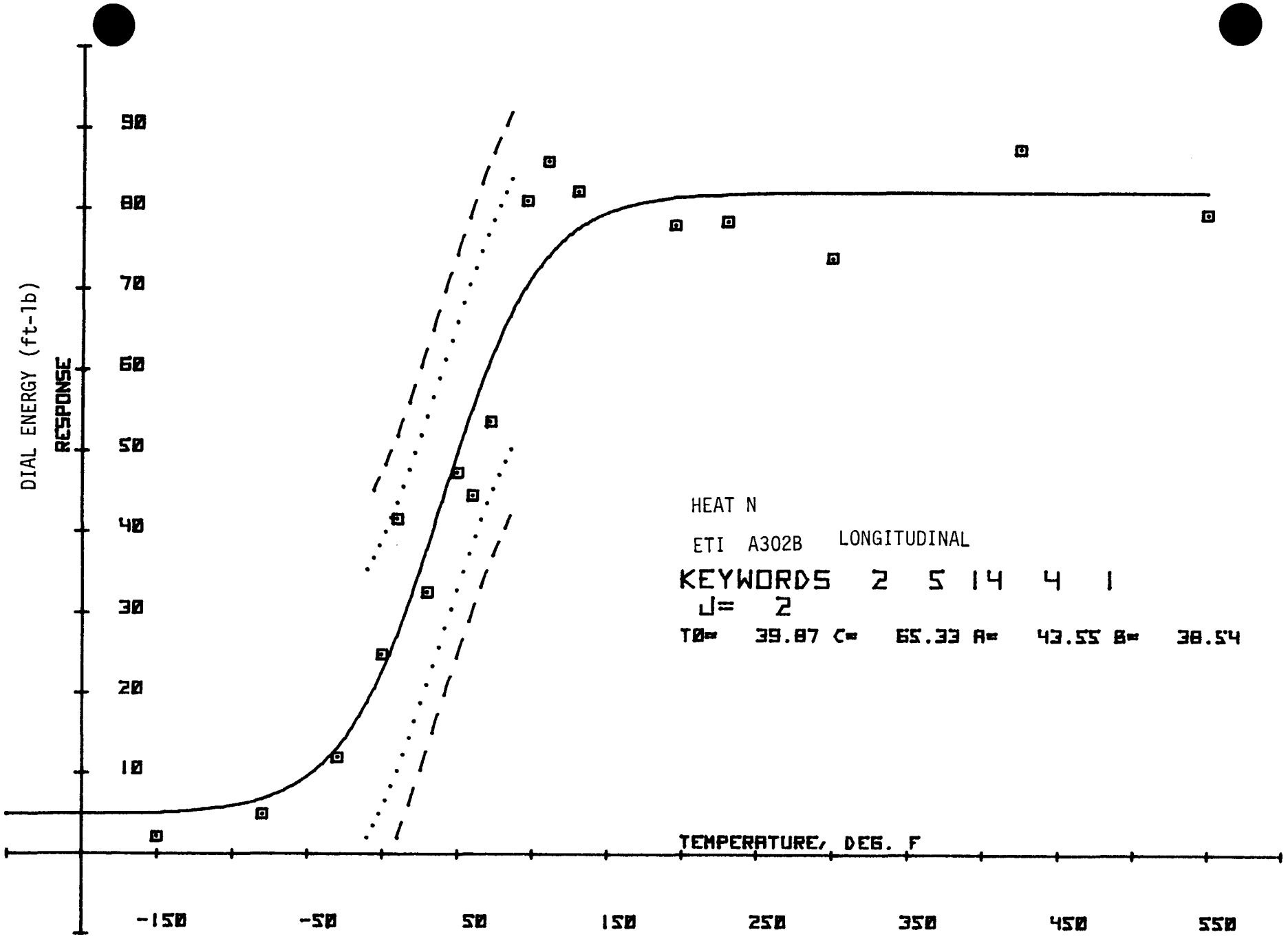


Figure 4.6 Charpy V-Notch Dial Energy for ETI Heat N (L)

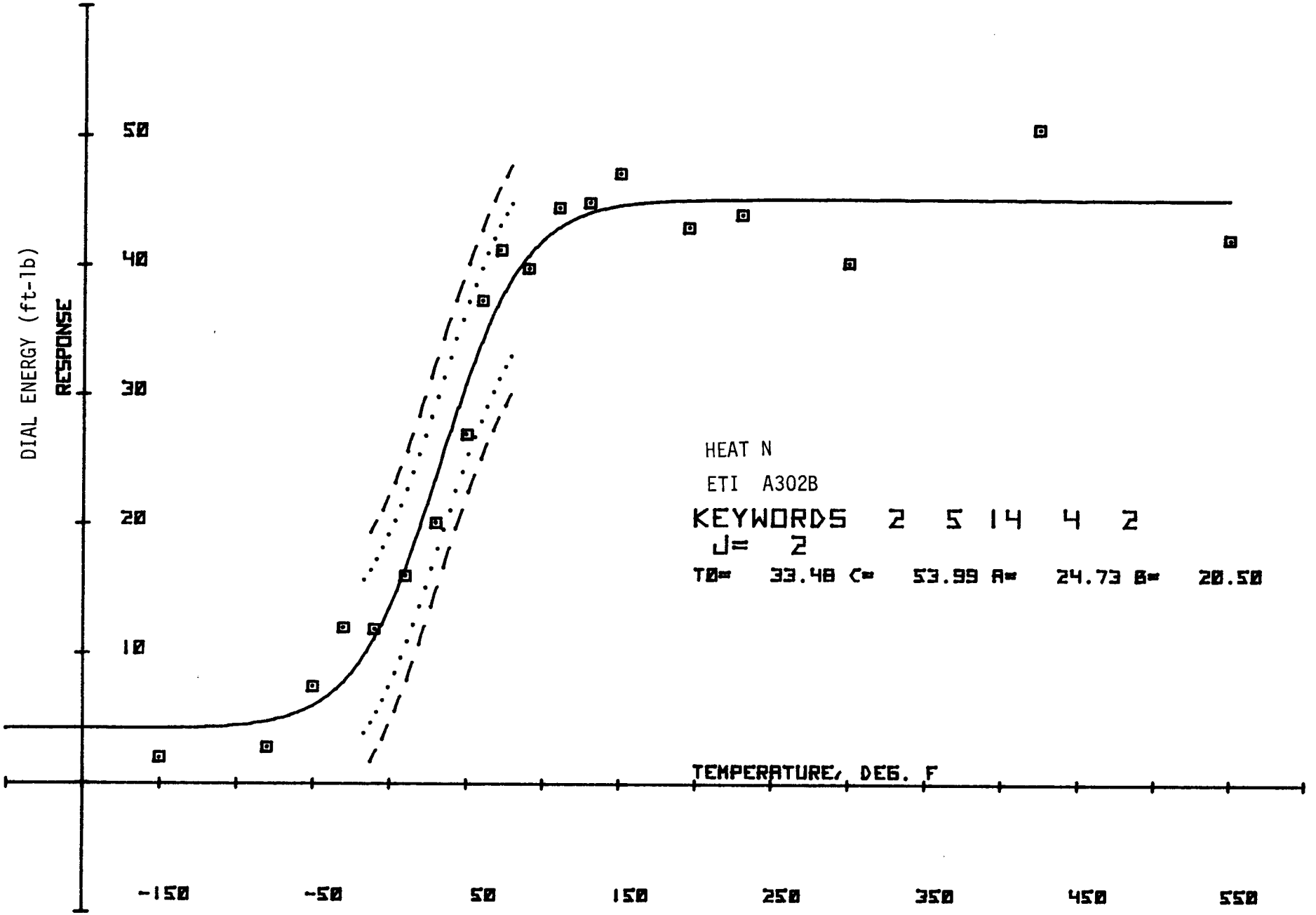


Figure 4.7 Charpy V-Notch Dial Energy for ETI Heat N (T)

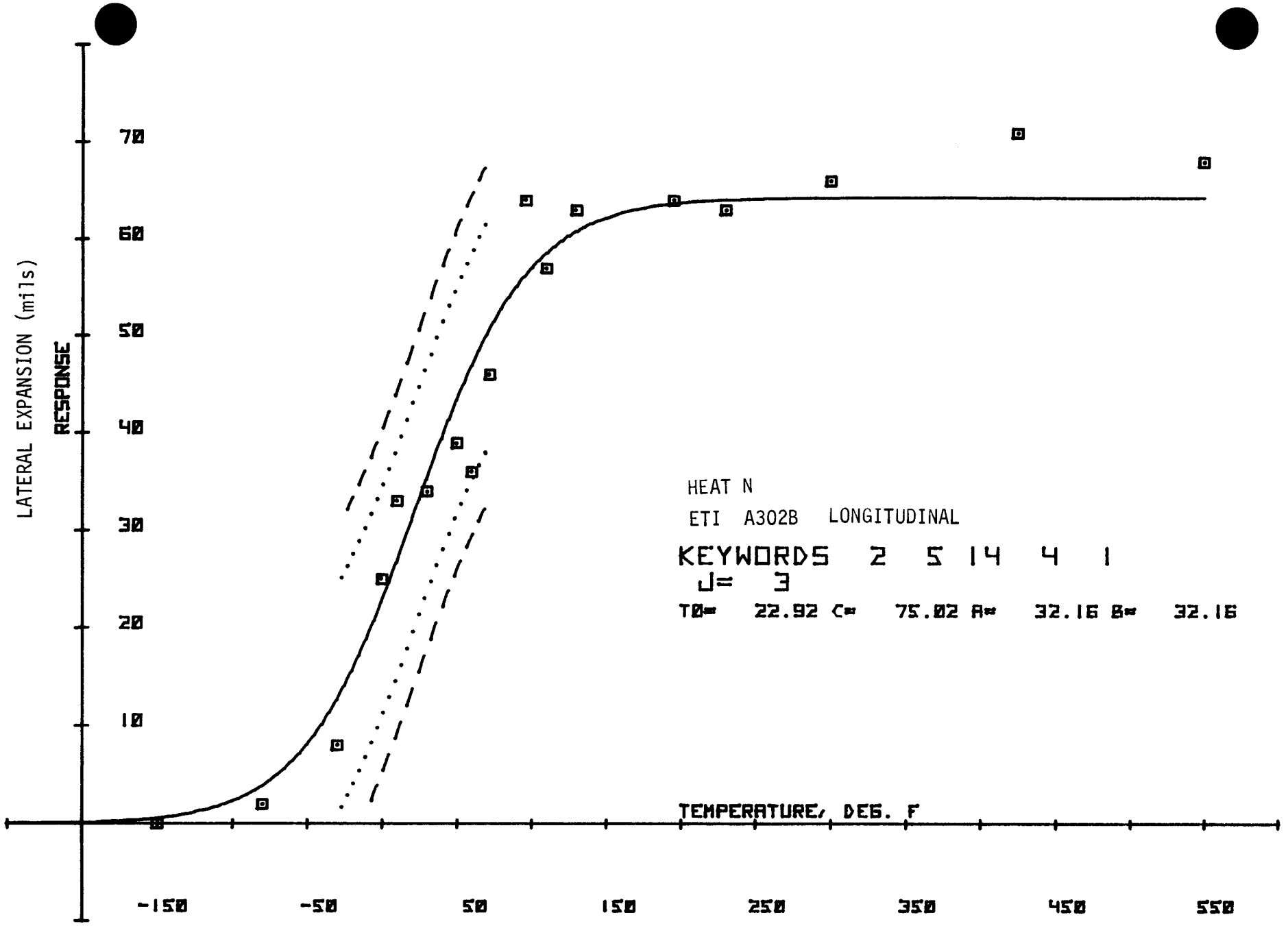


Figure 4.8 Charpy V-Notch Lateral Expansion for ETI Heat N (L)

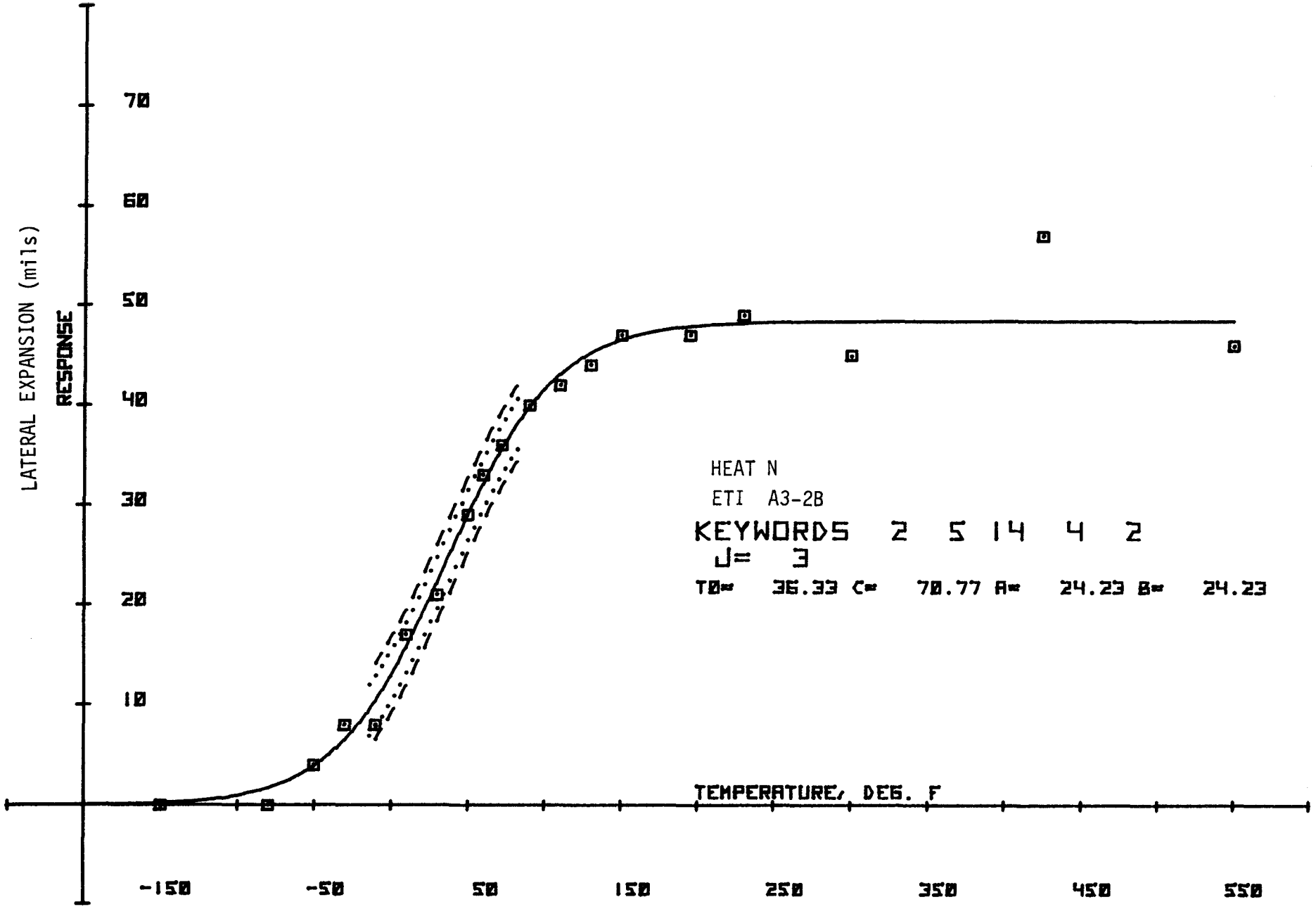


Figure 4.9 Charpy V-Notch Lateral Expansion for ETI Heat N (T)

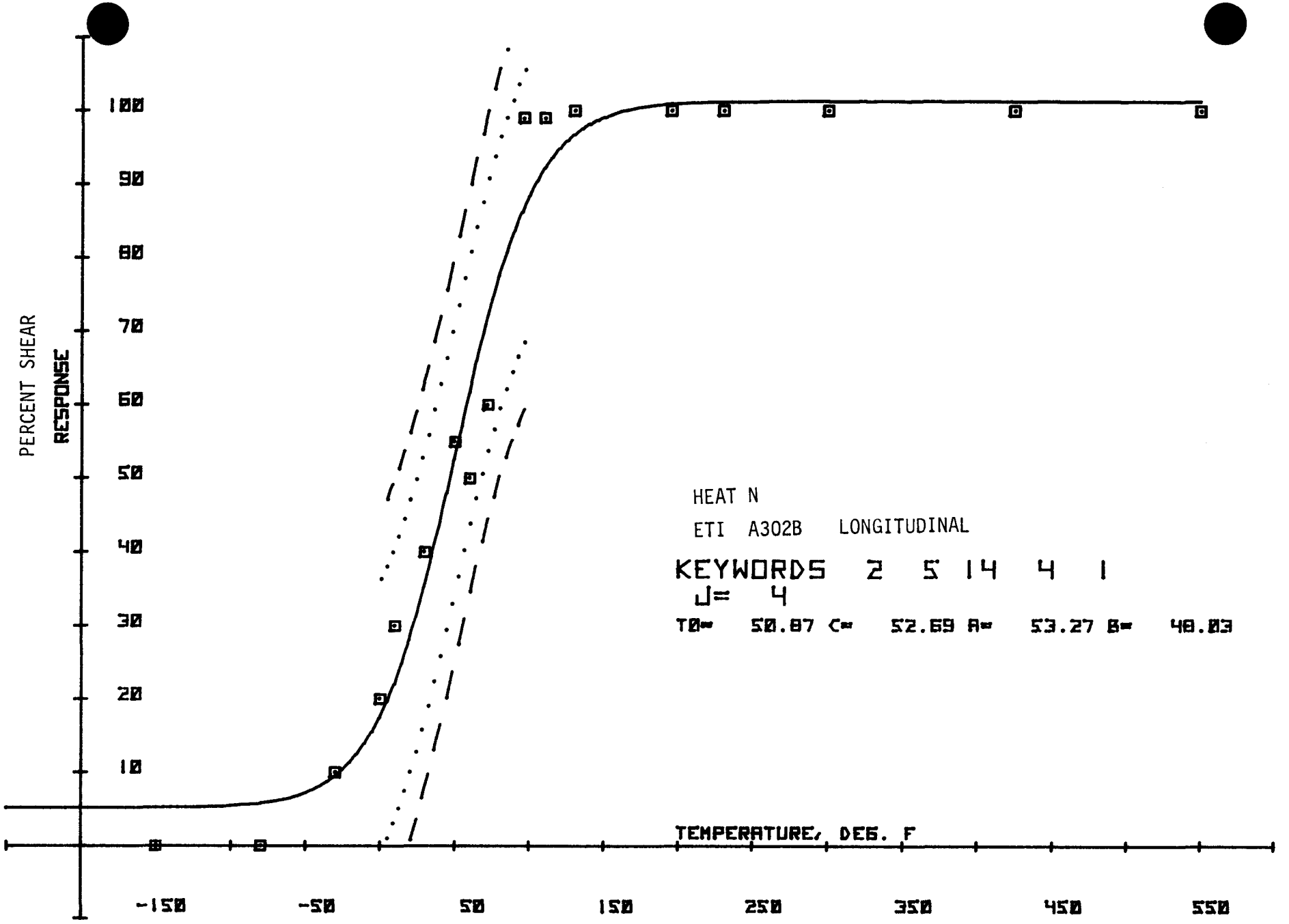
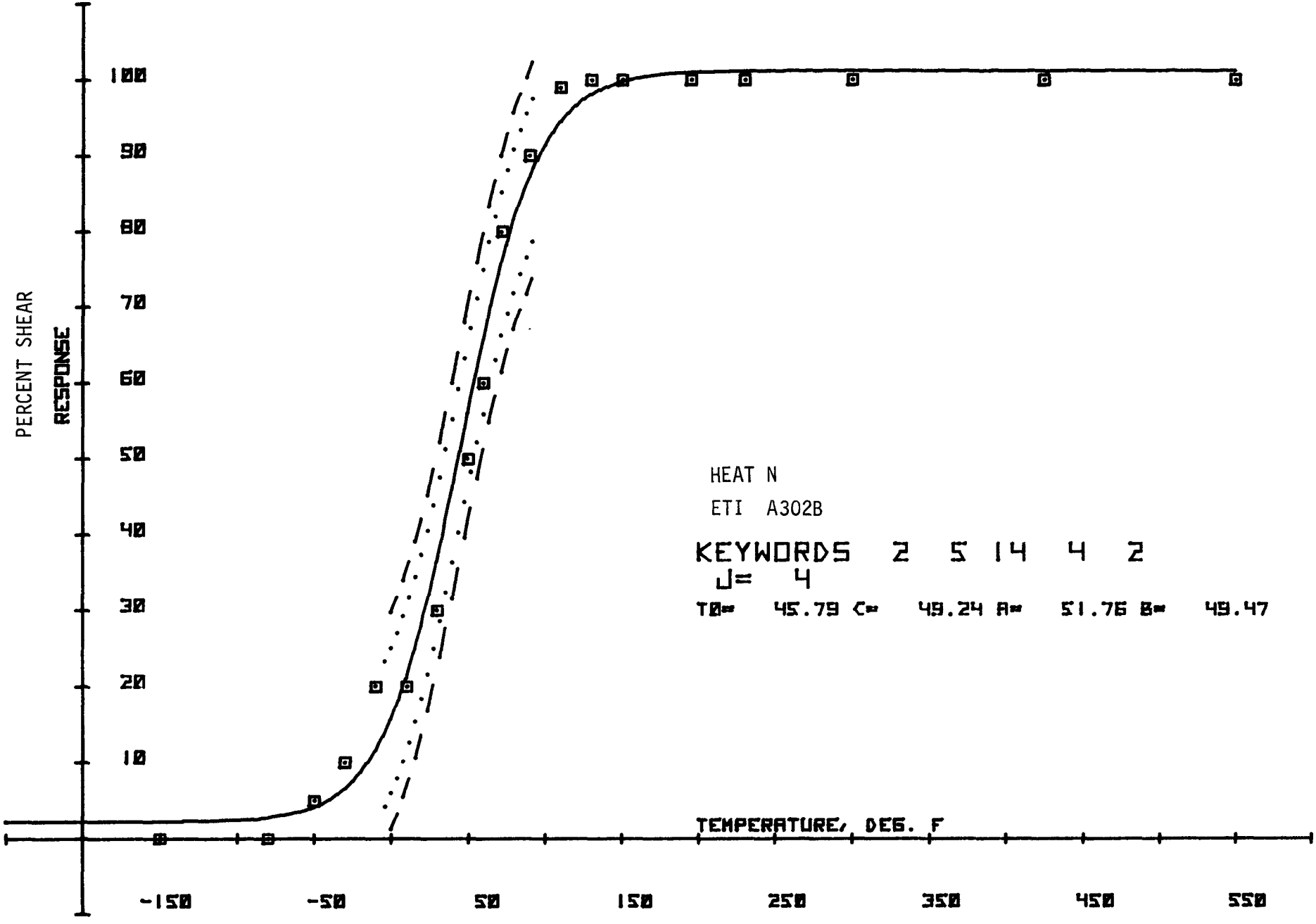


Figure 4.10 Charpy V-Notch Percent Shear for ETI Heat N (L)



ure 4.11 Charpy V-Notch Percent Shear for ETI Heat N (T)

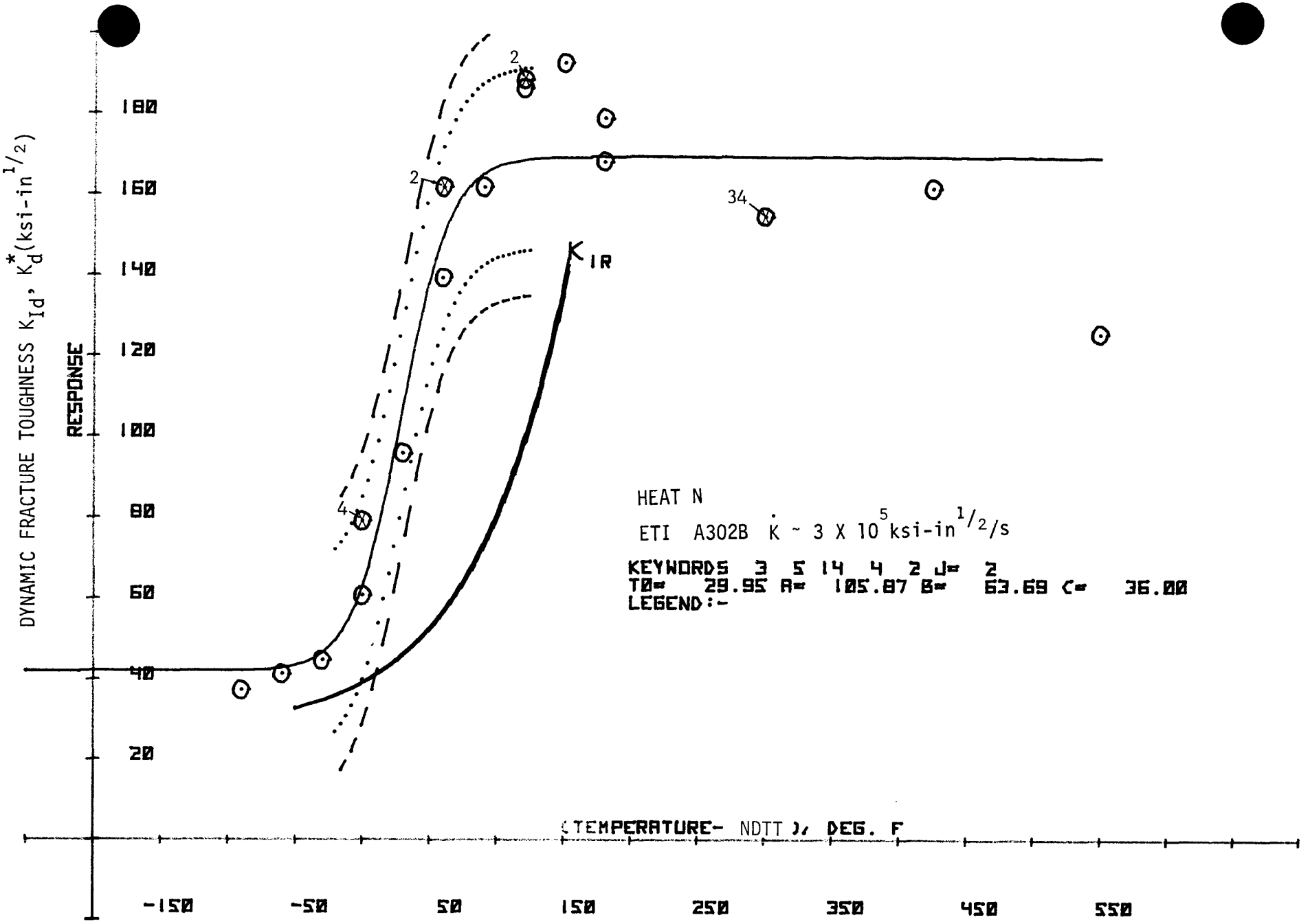


Figure 4.12 Precracked Charpy Fracture Toughness for ETI Heat N

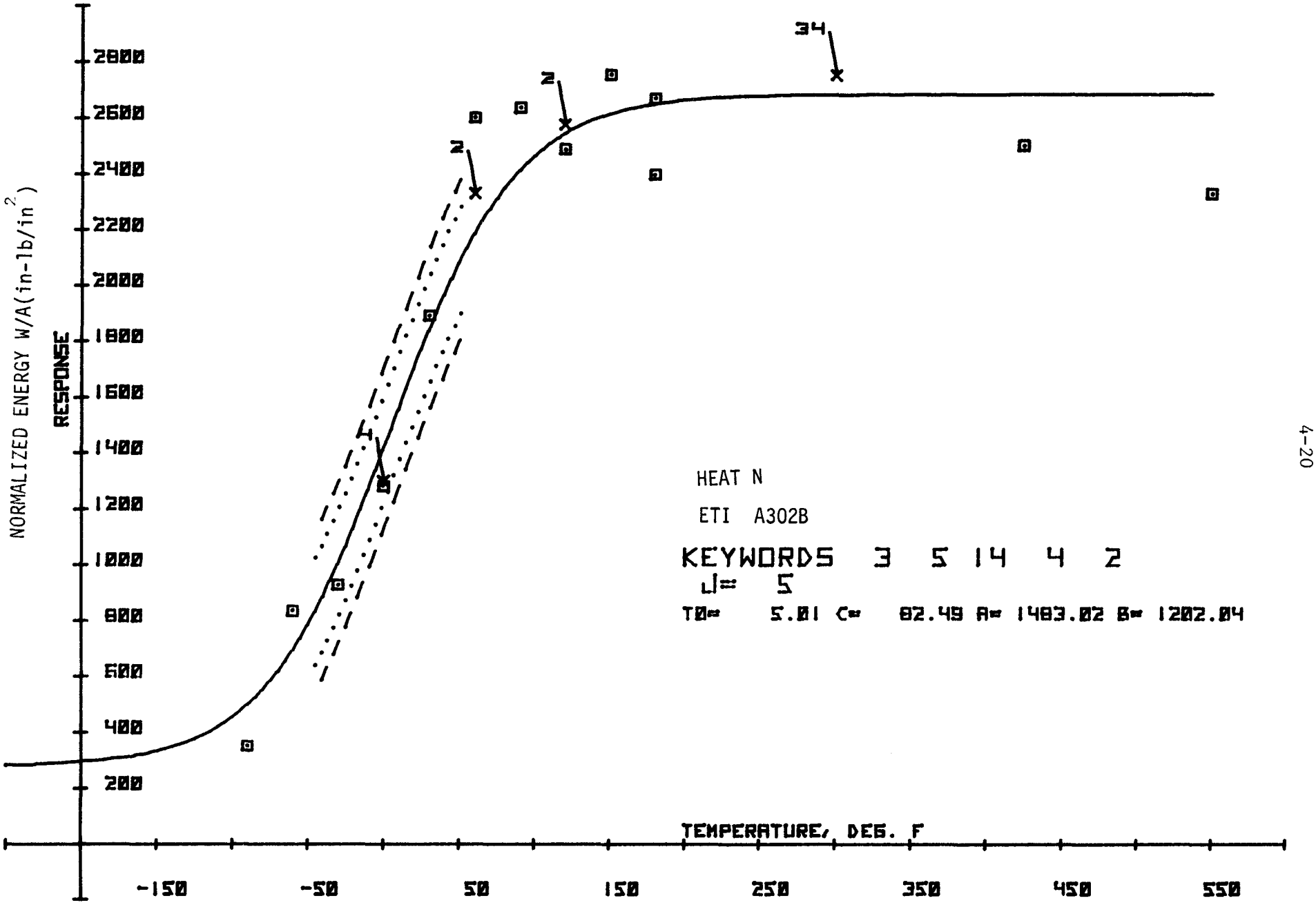


Figure 4.13 Precracked Charpy Normalized Energy for ETI Heat N

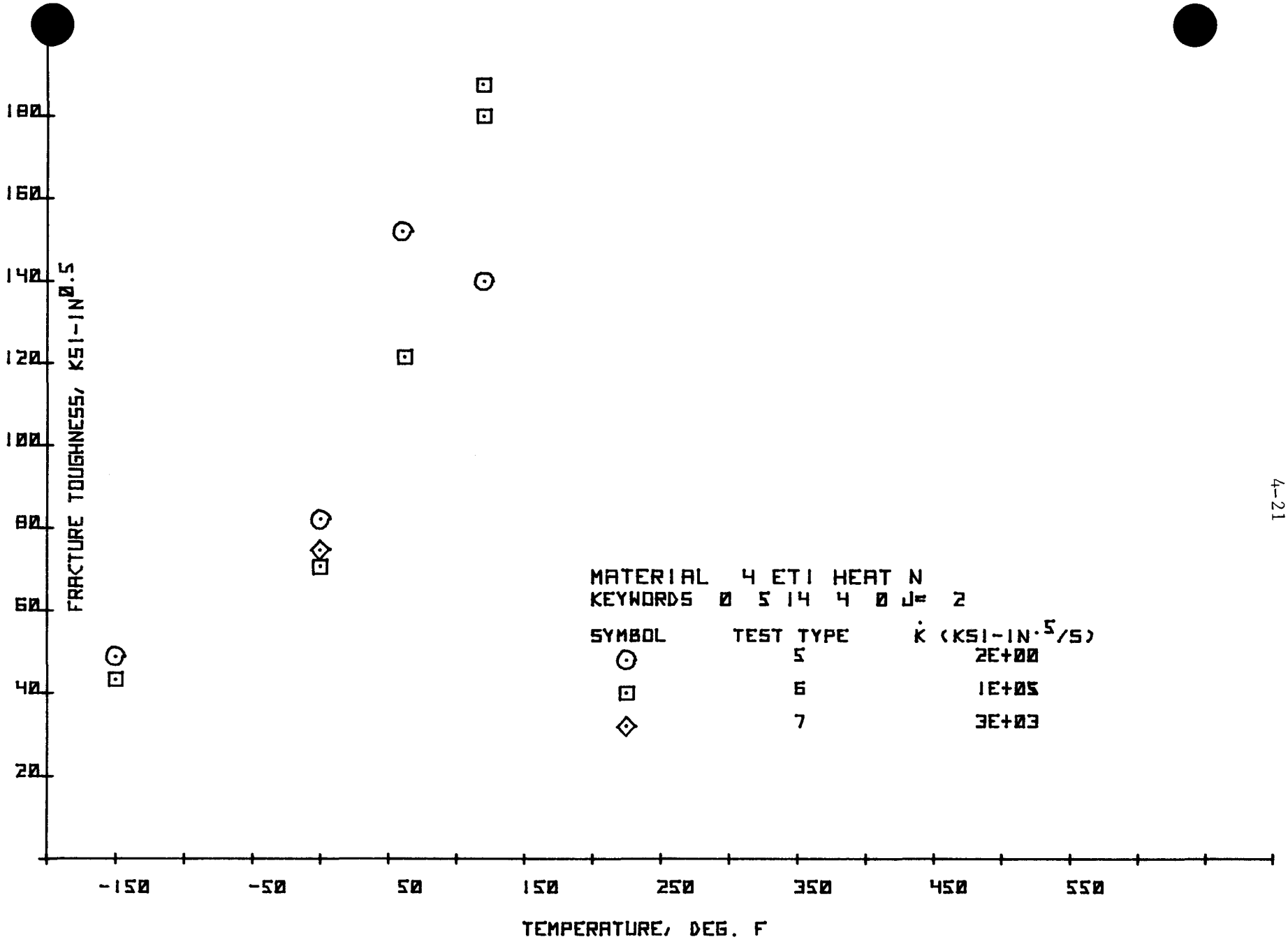
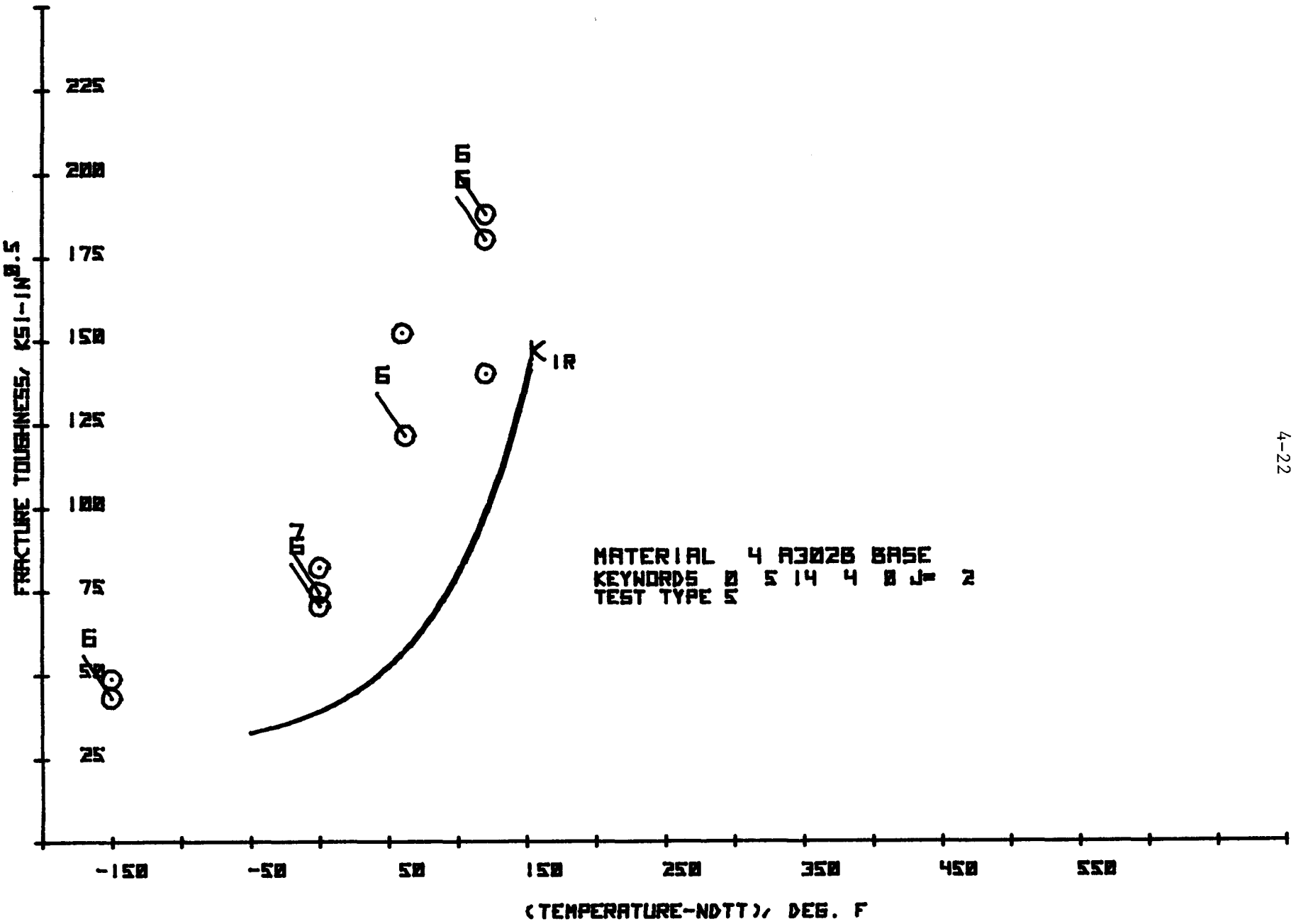


Figure 4.14. Static and Dynamic Fracture Toughness for ETI Heat N



ure 4.15. Fracture Toughness Data for ETI Heat N

KEYWORDS 0-0-M-4-0

MATERIAL 4 DATA BANK (A302B)

(36) 1-5-14-4-2-1-0	-150.00	80.90	108.90	14.00	27.50	47.70	
(37) 1-5-14-4-2-2-0	-50.00	71.90	98.80	12.30	26.50	48.70	
(38) 1-5-14-4-2-3-0	72.00	67.50	90.70	10.90	25.20	49.20	
(39) 1-5-14-4-2-4-0	200.00	63.10	85.90	10.90	21.10	47.20	
(40) 1-5-14-4-2-5-0	400.00	60.50	84.50	10.20	19.90	46.70	
(41) 1-5-14-4-2-6-0	550.00	61.50	89.90	10.50	19.30	36.90	
(155) 2-5-14-4-1-3-0	-150.00	2.20	0.00	0.00	--	--	
(156) 2-5-14-4-2-48-0	-150.00	2.00	0.00	0.00	--	--	
(157) 2-5-14-4-1-10-0	-80.00	5.00	2.00	0.00	--	--	
(158) 2-5-14-4-2-27-0	-80.00	2.80	0.00	0.00	--	--	
(159) 2-5-14-4-2-50-0	-50.00	7.50	4.00	5.00	--	--	
(160) 2-5-14-4-1-14-0	-30.00	12.00	8.00	10.00	--	--	
(161) 2-5-14-4-2-24-0	-30.00	12.00	8.00	10.00	--	--	
(162) 2-5-14-4-2-46-0	-10.00	11.90	8.00	20.00	--	--	
(163) 2-5-14-4-1-4-0	0.00	24.90	25.00	20.00	--	--	
(164) 2-5-14-4-1-9-0	10.00	41.60	33.00	30.00	--	--	
(165) 2-5-14-4-2-33-0	10.00	16.00	17.00	20.00	--	--	
(166) 2-5-14-4-1-13-0	30.00	32.60	34.00	40.00	--	--	
(167) 2-5-14-4-2-53-0	30.00	20.10	21.00	30.00	--	--	
(168) 2-5-14-4-1-7-0	50.00	47.30	39.00	55.00	--	--	
(169) 2-5-14-4-2-51-0	50.00	27.00	29.00	50.00	--	--	
(170) 2-5-14-4-1-12-0	60.00	44.50	36.00	50.00	--	--	
(171) 2-5-14-4-2-54-0	60.00	37.30	33.00	60.00	--	--	
(172) 2-5-14-4-1-10-0	72.00	53.70	46.00	60.00	--	--	
(173) 2-5-14-4-2-52-0	72.00	41.20	36.00	80.00	--	--	
(174) 2-5-14-4-2-21-0	90.00	39.80	40.00	90.00	--	--	
(175) 2-5-14-4-1-9-0	96.00	81.00	64.00	99.00	--	--	
(176) 2-5-14-4-1-16-0	110.00	85.80	57.00	99.00	--	--	
(177) 2-5-14-4-2-23-0	110.00	44.50	42.00	99.00	--	--	
(178) 2-5-14-4-1-17-0	130.00	82.20	63.00	100.00	--	--	
(179) 2-5-14-4-2-26-0	130.00	44.90	44.00	100.00	--	--	
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(181) 2-5-14-4-1-15-0	195.00	78.00	64.00	100.00	--	--	
(182) 2-5-14-4-2-22-0	195.00	43.00	47.00	100.00	--	--	
(183) 2-5-14-4-1-19-0	230.00	78.40	63.00	100.00	--	--	
(184) 2-5-14-4-2-25-0	230.00	44.00	49.00	100.00	--	--	
(185) 2-5-14-4-1-5-0	300.00	74.00	66.00	100.00	--	--	
(186) 2-5-14-4-2-45-0	300.00	40.30	45.00	100.00	--	--	
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(189) 2-5-14-4-1-6-0	550.00	79.40	68.00	100.00	--	--	
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(297) 3-5-14-4-2-3-4	0.00	--	79.20	79.70	1301.00	2.40E+05	
(298) 3-5-14-4-2-10-0	30.00	--	96.00	97.20	1894.00	2.58E+05	
(299) 3-5-14-4-2-8-0	60.00	--	139.60	141.10	2602.00	3.06E+05	

(300)	3-5-14-4-2-7-2	60.00	--	162.00	161.30	2332.00	2.59E+05
(301)	3-5-14-4-2-6-0	90.00	--	162.00	164.00	2638.00	4.22E+05
(302)	3-5-14-4-2-12-0	120.00	--	186.50	185.90	2490.00	1.94E+05
(303)	3-5-14-4-2-11-2	120.00	--	188.70	188.00	2577.00	3.64E+05
(304)	3-5-14-4-2-2-0	150.00	--	192.70	195.10	2756.00	5.18E+05
(305)	3-5-14-4-2-19-0	180.00	--	168.40	168.10	2400.00	4.31E+05
(306)	3-5-14-4-2-14-0	180.00	--	179.10	180.50	2669.00	4.66E+05
(307)	3-5-14-4-2-15-34	300.00	--	154.90	159.20	2754.00	3.97E+05
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(344)	4-5-14-4-2-1-0	0.00	1.00	--	--	--	--
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(346)	4-5-14-4-2-2-0	10.00	2.00	--	--	--	--
(372)	5-5-14-4-2-4-0	-150.00	48.90	--	--	--	3.30
(373)	5-5-14-4-2-1-0	0.00	--	82.00	78.50	--	3.00
(374)	5-5-14-4-2-2-0	60.00	--	152.00	132.00	--	3.50
(375)	5-5-14-4-2-6-0	120.00	--	140.00	114.00	--	4.00
(403)	6-5-14-4-2-4-0	-150.00	43.30	--	--	58.00	850000.00
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(405)	6-5-14-4-2-6-0	62.00	121.50	--	--	2540.00	1.69E+05
(406)	6-5-14-4-2-3-0	120.00	--	187.80	187.80	4686.00	2.41E+05
(407)	6-5-14-4-2-2-0	120.00	--	180.20	180.00	--	1.76E+05
(410)	7-5-14-4-2-1-0	0.00	74.60	--	--	--	2300.00