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Palisades Nuclear Plant
Operated by Nuclear Management Company, LLC

March 25, 2004

10 CFR 50, Appendix H

U. S. Nuclear Regulatory Commission
ATTN: Document Control Desk
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Palisades Nuclear Power Plant
Dockets 50-255
License No. DPR-20

Reactor Pressure Vessel Surveillance Capsule W-100 Test Report

In accordance with the requirements of 10 CFR 50, Appendix H, Nuclear Management Company, LLC (NMC) is providing the reactor pressure vessel (RPV) surveillance capsule test report for the Palisades Nuclear Plant. Capsule W-100 was removed from the reactor on March 28, 2003, during the sixteenth refueling outage. Testing of the surveillance material and dosimetry analysis were performed by BWXT Services, Inc. The test report was reviewed and approved by NMC and is provided as Attachment 1, "Analysis of Capsule W-100 from the Nuclear Management Company Palisades Reactor Pressure Vessel Material Surveillance Program," dated February 2004. The neutron fluence analysis was performed by Westinghouse, documented by letter from S. Swigart (Westinghouse Electric Company) to J. Kneeland (NMC), "Fluence Analysis for Reactor Vessel Surveillance Capsule W100," dated February 11, 2004. This analysis was reviewed and approved by NMC and is provided as Attachment 2.

Attachment 2 supplements WCAP-15353, "Palisades Reactor Pressure Vessel Neutron Fluence Evaluation," dated January 2000, which was submitted to the Nuclear Regulatory Commission (NRC) by letter dated February 21, 2000. The NRC approved the methodology described in WCAP-15353, by letter dated November 14, 2000.

Enclosure 1 provides a summary of the results of the analyses.

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Summary of Commitments

This letter contains no new commitments and no revisions to existing commitments.

Daniel J. Malone
Site Vice President, Palisades Nuclear Plant
Nuclear Management Company, LLC

Enclosure (1)
Attachments (2)

CC Administrator, Region III, USNRC
Project Manager, Palisades, USNRC
Resident Inspector, Palisades, USNRC

ENCLOSURE 1
SUMMARY OF ANALYSES

Summary of Palisades Reactor Pressure Vessel Surveillance Capsule W-100 Test Report

The Palisades reactor pressure vessel (RPV) surveillance capsule W-100 was removed on March 28, 2003, during the sixteenth refueling outage. Testing of the surveillance material and dosimetry analysis were performed by BWXT Services, Inc. The test report was reviewed and approved by Nuclear Management Company, LLC (NMC) and is provided in Attachment 1, "Analysis of Capsule W-100 from the Nuclear Management Company Palisades Reactor Pressure Vessel Material Surveillance Program," dated February 2004.

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The Palisades RPV surveillance program was last submitted to the NRC by letter dated June 21, 1994 (reference 1). The charpy test results for surveillance capsules W-290, W-110 and A-240, which were previously submitted, have been reevaluated in Attachment 1 for consistency. The results of this reevaluation were reported to the NRC by letter dated December 12, 1995 (reference 2).

RPV Surveillance Capsule Best Estimate Fluence

The irradiation time and flux estimates for capsules W-290, W-110 and A-240 were supplied in WCAP-15353. The irradiation time and flux estimate for capsule W-100 is reported in Attachment 2. The revised values for best estimate fluence are used in Attachment 1.

RPV Surveillance Capsule Best Estimate Irradiation Temperature

The irradiation temperature of each RPV surveillance capsule has been estimated. The time-weighted temperature ($T_{capsule}$) of each capsule is as follows.

Capsule	$T_{capsule}$
W-290	531°F
W-110	533°F
W-100	534°F
A-240	526°F

The estimated time-weighted temperature of the RPV at the end of plant life is 535°F.

RPV Surveillance Weld Material Test Results

Charpy energy test results for the Palisades surveillance weld are summarized in Table 6-3 and on Figure 6-7 of Attachment 1.

RPV Surveillance Plate Material Test Results

Surveillance capsule W-100 contained specimens oriented in both the longitudinal (L-T) orientation and in the transverse (T-L) orientation. Charpy energy test results for L-T material are summarized in Table 6-3 and on Figure 6-4 of Attachment 1. Charpy energy test results for T-L material are summarized in Table 6-3 and on Figure 6-1 of Attachment 1.

Table 6-3 of Attachment 1 shows that measured 30 ft-lb transition temperature shifts (ΔRT_{NDT}) of both the longitudinal and transverse specimens are less than the predicted values for these materials. The predicted values remain conservative.

Table 6-3 of Attachment 1 shows that the upper shelf energy of both the longitudinal and transverse specimens are greater than the predicted values for these materials. The predicted values remain conservative.

Conclusion

Previous assessments of the Palisades reactor vessel remain unchanged. Testing of surveillance capsule W-100 demonstrates that measured change in properties of reactor vessel plate D-3803-1 is less than predicted for that material.

Previous fluence evaluations of the Palisades reactor vessel remain unchanged. The fluence accumulated by surveillance capsule W-100 is close to that anticipated.

The Palisades reactor vessel continues to be limited by the beltline axial welds fabricated with weld wire heat number W5214. The 10 CFR 50.61 pressurized thermal shock screening criterion of 270°F is not expected to be reached during plant life.

The Palisades reactor vessel continues to be limited by beltline plate D-3804-1. The 10 CFR 50 Appendix G limit of 50 ft-lbs is not expected to be reached during plant life.

References

1. Letter from D. Rogers (Consumers Power Company) to NRC, "Reactor Vessel Material Surveillance Capsule Test Report," dated June 21, 1994.

2. Letter from R. Smedley (Consumers Power Company) to NRC, "Preliminary Thermal Annealing Report, Thermal Annealing Operating Plan, Section 1.1, General Considerations, and Section 1.2, Description of the Reactor Vessel," dated December 12, 1995.

ATTACHMENT 1

REACTOR PRESSURE VESSEL SURVEILLANCE CAPSULE W-100 TEST REPORT

"ANALYSIS OF CAPSULE W-100 FROM THE NUCLEAR MANAGEMENT COMPANY PALISADES REACTOR PRESSURE VESSEL MATERIAL SURVEILLANCE PROGRAM," DATED FEBRUARY 2004

Binder

BWXT Services, Inc.

ANALYSIS OF CAPSULE W-100 FROM THE NUCLEAR MANAGEMENT COMPANY PALISADES REACTOR VESSEL MATERIAL SURVEILLANCE PROGRAM

FEBRUARY 2004

BWXT Services, Inc.
Lynchburg Technology Center

Quality Assurance
Certification of Conformance

BWXS Contract Charge No. 1295-001-03-08-00-00-0000

Nuclear Management Company (NMC) Purchase Order P035944

BWXT Services, Inc. hereby certifies that the item(s) or service(s) provided on this order are in accordance with the requirements of the above-specified NMC purchase order, dated 9/3/03 and Revision 1 to the above-specified NMC purchase order, dated 10/21/03. This project was conducted in accordance with the requirements of BWXT Services, Inc., Nuclear & Environmental Operations, Nuclear Materials Engineering Quality Assurance Plan 99001, Revision 00, dated 01/18/99, for the project titled "Analysis of Capsule W-100 from the Nuclear Management Company Palisades Reactor Vessel Material Surveillance Program."

JANUARY 21, 2004
Date

Charles C. Boyd Jr.
C.C. Boyd, Jr.
Manager, BWXS QA

ANALYSIS OF CAPSULE W-100 FROM THE NUCLEAR MANAGEMENT COMPANY PALISADES REACTOR VESSEL MATERIAL SURVEILLANCE PROGRAM

FEBRUARY 2004

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1.0 SUMMARY OF RESULTS

The analysis of the reactor vessel surveillance materials in Palisades Capsule W-100 led to the following conclusions:

Irradiation of the reactor vessel base metal (longitudinal orientation) Charpy specimens in capsule W-100 resulted in a 30 ft-lb transition temperature increase of 159.1°F and an irradiated 30 ft-lb transition temperature of 158.6°F.

Irradiation of the reactor base metal (transverse orientation) Charpy specimens in capsule W-100 resulted in a 30 ft-lb transition temperature increase of 142.5°F and an irradiated 30 ft-lb transition temperature of 160.8°F.

Irradiation of the W-100 weld metal Charpy specimens resulted in a 30 ft-lb transition temperature increase of 305.4°F and an irradiated 30 ft-lb transition temperature of 218.8°F.

Irradiation of the W-100 weld Heat-Affected-Zone (HAZ) metal Charpy specimens resulted in a 30 ft-lb transition temperature increase of 191.0°F and an irradiated 30 ft-lb transition temperature of 101.4°F.

The base metal (transverse orientation) Charpy specimens from capsule W-100 resulted in an average energy decrease of 28.6 ft-lb after irradiation and an average upper shelf energy of 73.0 ft-lb.

The base metal (longitudinal orientation) Charpy specimens from capsule W-100 resulted in an average energy decrease of 52.8 ft-lb after irradiation and an average upper shelf energy of 102.0 ft-lb.

The weld metal Charpy specimens from capsule W-100 resulted in an average energy decrease of 65.9 ft-lb after irradiation and an average upper shelf energy of 51.8 ft-lb.

The weld HAZ metal Charpy specimens from capsule W-100 resulted in an average energy decrease of 55.8 ft-lb after irradiation and an average upper shelf energy of 59.7 ft-lb.

2.0 INTRODUCTION

A reactor vessel material surveillance program (RVSP) is required by the United States Nuclear Regulatory Commission (USNRC) to monitor neutron irradiation induced changes in Charpy impact and tensile properties for reactor vessel beltline materials. Description of the RVSP and the pre-irradiation mechanical properties of the reactor vessel materials for Palisades is presented in Reference 3. As a part of the RVSP for Palisades, the reactor was shutdown on March 16, 2003, and Capsule W-100 was removed from the Palisades reactor after 16.93 EFPY of exposure. It was shipped to the BWXT Hot Cell Facility, where the postirradiation mechanical testing of the Charpy impact and tensile specimens was performed along with dosimeter counting and thermal monitor evaluation. This report presents the results of testing and the analysis of the data obtained from Palisades Capsule W-100.

3.0 BACKGROUND

The beltline region of the reactor pressure vessel is subjected to significant fast neutron fluence. Fast neutron irradiation causes an increase in hardness and yield strength and a decrease in ductility and toughness for low alloy, ferritic pressure vessel steels such as SA 302 (modified) Grade B, Class 1 plates (base material of the Palisades reactor pressure vessel beltline).

A method for ensuring the integrity of reactor pressure vessels has been presented in "Fracture Toughness Criteria for Protection Against Failure," Appendix G to Section XI of the ASME Boiler and Pressure Vessel Code [4]. The method uses fracture mechanics concepts and is based on the reference nil-ductility transition temperature (RT_{NDT}). RT_{NDT} is defined as the greater of either the drop weight nil-ductility transition temperature (NDTT per ASTM E-208 [5]) or the temperature 60°F less than the 50 ft-lb (and 35-mil lateral expansion) temperature as determined from Charpy specimens oriented perpendicular (Axial) to the major working direction of the forging. The RT_{NDT} of a given material is used to index that material to a reference stress intensity factor curve (K_{IR} curve) of Appendix G to the ASME Code [4]. When material is indexed to the K_{IR} curve, allowable stress intensity factors can be obtained for this material as a function of temperature. Allowable operating limits can then be determined using these allowable stress intensity factors.

RT_{NDT} values are adjusted to account for the effects of radiation on the reactor vessel material properties. The changes in mechanical properties of a given reactor pressure vessel steel are monitored by the RVSP. Surveillance capsules are periodically removed from the nuclear reactor and the encapsulated specimens tested. The increase in the average Charpy 30 ft-lb temperature (ΔRT_{NDT}) caused by irradiation is added to the initial RT_{NDT}, along with a margin (M) to adjust the RT_{NDT} (ART) to account for radiation embrittlement. The adjusted reference temperature (RT_{NDT} initial + M + ΔRT_{NDT}) is used to index the material to the K_{IR} curve and set operating limits to account for the effects of irradiation on the reactor vessel materials.

However, the adjusted reference temperatures (ART) RT_{NDT} comparisons are not included in this report because the neutron fluence values have not been finalized.

4.0 DESCRIPTION OF THE PALISADES REACTOR VESSEL SURVEILLANCE PROGRAM

Prior to initial plant start-up, ten surveillance capsules were inserted into the Palisades reactor vessel near the reactor vessel wall as shown in Figure 4-1. The capsules contain specimens made from intermediate shell plate D-3803-1, heat-affected-zone (HAZ) metal fabricated by welding intermediate shell plates D-3803-2 and D-3803-3 with submerged arc process using Linde 1092 flux, and weld metal fabricated by welding intermediate shell plates D-3803-1 and D-3803-2 with submerged arc process using Linde 1092 flux and a MIL-B4 electrode and a 1/16-inch diameter Nickel-200 wire feed. Capsule W-100 was removed after 16.93 effective full power years (EFPY) of plant operation. This capsule contained Charpy impact and tensile specimens made of intermediate shell plate D-3803-1, submerged arc weld metal, and HAZ metal as describe above. All test specimens were machined from material taken at least one plate thickness from any water quenched edge.

The surveillance plate material was cut directly from the intermediate shell course plate after being subjected to 1.75 hours of interstage and 30 hours of final heat treatment at 1150 ± 25°F. Charpy impact specimens from surveillance plate D-3803-1 were machined in the longitudinal orientation (longitudinal axis of the specimen longitudinal to the major working direction). The weld Charpy impact specimens were machined from the weldment such that the long dimension of each Charpy specimen was perpendicular to the weld direction. The notch of the weld metal Charpy specimens was machined such that the direction of crack propagation in the specimen was in the welding direction. Tensile specimens from surveillance plate D-3803-1 were machined with the major axis both in the tangential and longitudinal orientations. Tensile specimens from the weld metal were oriented with the long dimension of the specimen perpendicular to the weld direction.

The chemical compositions of the surveillance materials are presented in Table 4-1. The chemical analysis reported in Table 4-1 was obtained from unirradiated material used in the surveillance program [3].

Capsule W-100 contained dosimeter wires of uranium, sulfur, iron, nickel, titanium, and copper. Cadmium covers were used for materials that have competing thermal activities (i.e., uranium, nickel, and copper). Dosimeters are used to determine flux spectrum and flux attenuation through the thickness of the Charpy specimens.

The temperature monitor assemblies consist of four separate coil-shaped monitors, each of different composition and thus having different melting points. They are identified by varying capsule lengths, with melting temperatures increasing with increasing capsule length. The alloys compositions and melting points are listed as follows.

Composition	Melting Point
92.5% Pb, 5.0% Sn, 2.5% Ag	536°F
90.0% Pb, 5.0% Sn, 5.0% Ag	558°F
97.5% Pb, 2.5% Ag	580°F
97.5% Pb, 0.75% Sn, 1.75% Ag	590°F

The arrangement of the various mechanical specimens, dosimeters, and thermal monitors contained in Capsule W-100 is shown in Figure 4-2.

TABLE 4-1
Chemical Composition (wt%) of the Palisades Reactor Vessel Surveillance Materials[3]

Element	D-3803-1	D-3803-2	D-3803-3	Weld D-3803-3/ D-3803-2 Root	Weld D-3803-3/ D-3803-2 Face	Weld D-3803-2/ D-3803-2 Root	Weld D-3803-2/ D-3803-1 Face
Si	0.23	0.32	0.24	0.24	0.25	0.25	0.22
S	0.019	0.021	0.020	0.009	0.010	0.010	0.010
P	0.011	0.12	0.010	0.011	0.012	0.011	0.011
Mn	1.55	1.43	1.56	1.08	1.03	1.01	1.02
C	0.22	0.23	0.21	0.098	0.080	0.088	0.086
Cr	0.13	0.42	0.13	0.05	0.04	0.05	0.03
Ni	0.53	0.55	0.53	0.43	1.28	0.63	1.27
Mo	0.58	0.58	0.59	0.54	0.53	0.55	0.52
Al(T)	0.037	0.022	0.037	Nil	Nil	Nil	Nil
V	0.003	0.003	0.003	Nil	Nil	Nil	Nil
Cu	0.25	0.25	0.25	0.25	0.20	0.26	0.22

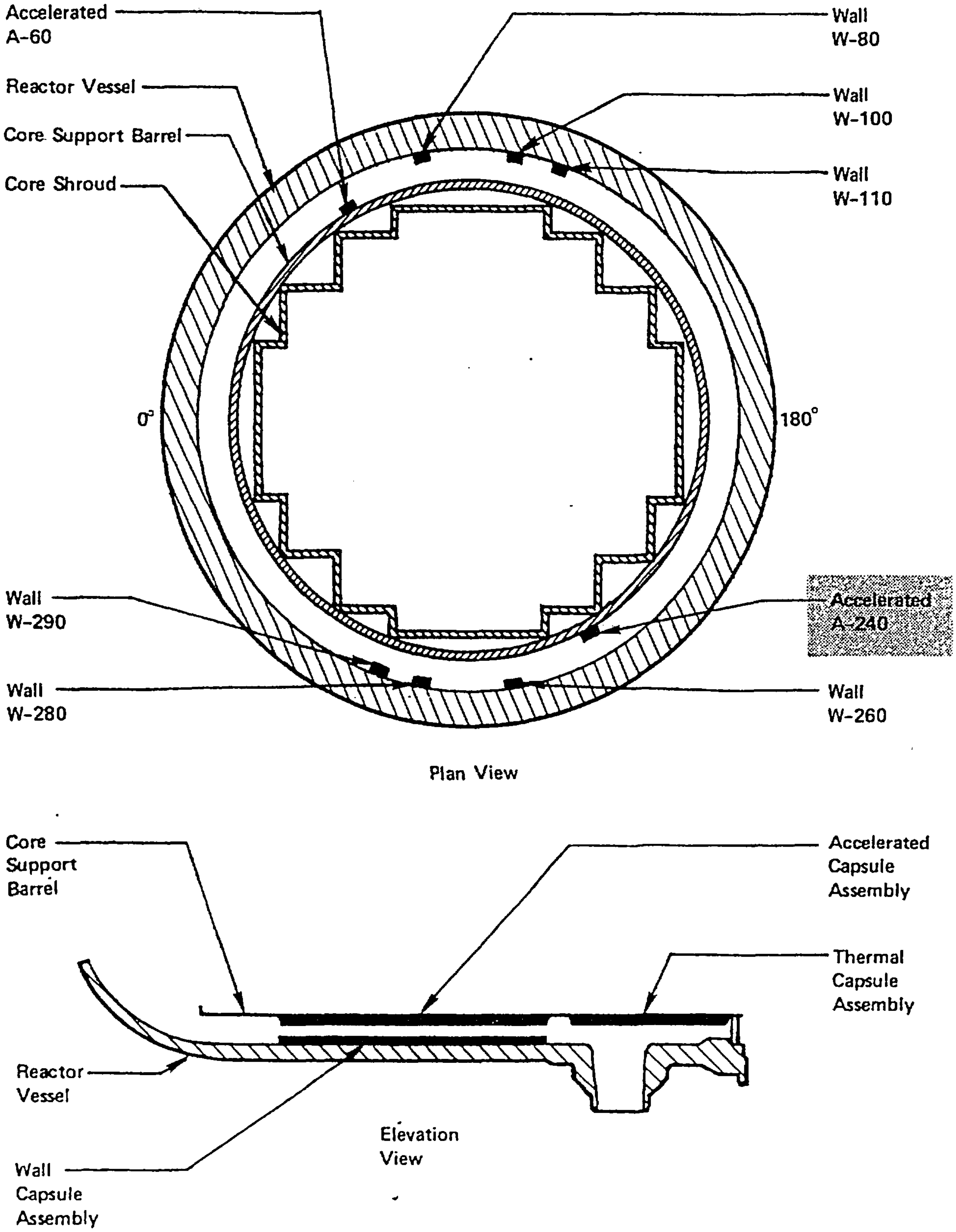


Figure 4-1. Arrangement of Surveillance Capsules in the Palisades Reactor Vessel

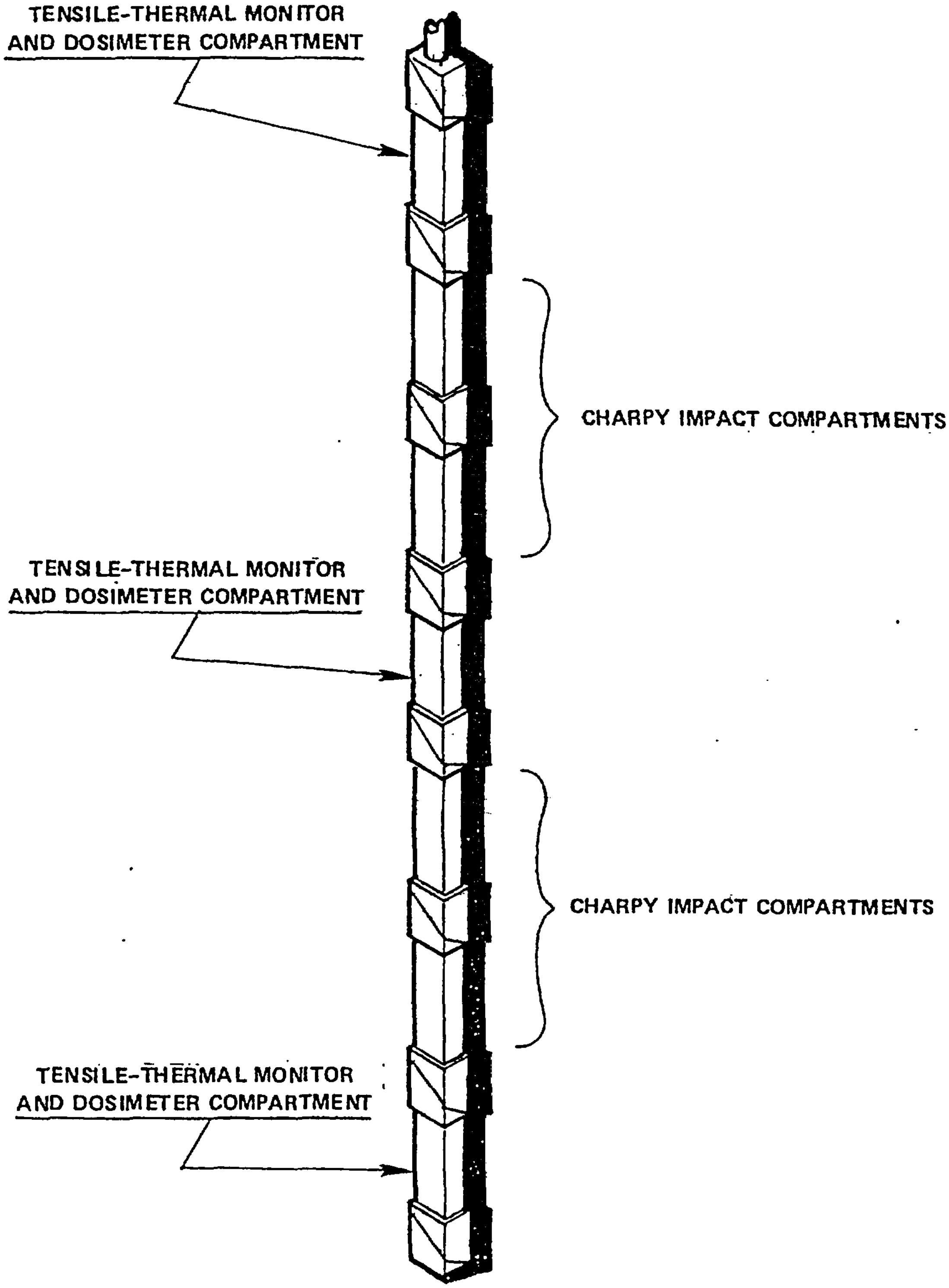


Figure 4-2. Surveillance Capsule Diagram Showing the Location of Specimens, Thermal Monitors, and Dosimeters

5.0 PROCEDURES

5.1 Visual Examination and Inventory

All specimens were visually examined after the capsule was opened for indications of abnormalities. Corroded tensile specimens were found in capsule #4 indicating this capsule suffered water ingress (See Figure 5-1). Water ingress also caused the temperature monitors in middle capsule #4 to become stuck and irretrievable (See Appendix A). The contents of capsule W-100 were inventoried and compared with the information of reference [3]. No discrepancies were found.

5.2 Thermal Monitors

Capsule W-100 contained thermal monitor coils made from four low-melting-point eutectic alloys that were sealed in Pyrex tubes. The composition of the eutectic alloys and their melting points are listed in Section 4.0. Each of the individual capsules can be identified by their length; temperatures increase with increasing capsule length

The thermal monitor coils were photographed to detect evidence of melting (See Appendix A). Three of the four Pyrex capsule tubes in top segment #1 were broken, and one of the temperature monitor coils was missing. However, the lowest melting coil in the shortest capsule was intact. None of the temperature monitor coils were melted in the bottom segment (#7). Thermal monitors from the middle segment could not be removed and therefore were not evaluated. However, based on the results from the thermal monitors from the top and bottom segments, there is reasonable assurance that none of the temperature monitors in the middle segment melted either.

5.3 Charpy Impact Testing

Charpy impact tests were conducted to meet the requirements of 10CFR50, Appendices G and H [2], ASTM Specification E185-82 [6], and BWXS Technical Procedure TP-80, Revision 12. Four groups of Charpy specimens (longitudinally and transversely oriented base metal, weld metal, and weld metal HAZ) were impact tested between -50 °F and 400 °F. Absorbed energy, percent shear fracture, and lateral expansion values were determined in accordance with ASTM E23-93.

Load-time and energy-time signals were recorded in addition to the standard measurement of Charpy energy (E_D) using an instrumented tup in accordance with BWXS Technical Procedure TP-412, Revision 3. From the load-time curves (Appendix D), the load of general yielding (P_{GY}), the time to general yielding (t_{GY}), the maximum load (P_M), the time to maximum load (t_M), the fast fracture load (P_F), the arrest load (P_A) were determined. The yield stress (σ_Y) was calculated using the following equation:

$$\sigma_Y = (P_{GY} * L) / [B * (W - a)^2 * C] \qquad (1)$$

where:
L	=	distance between the specimen supports in the impact machine
B	=	the width of the specimen measured parallel to the notch
W	=	height of the specimen, measured perpendicularly to the notch
a	=	notch depth
C	=	1.21

5.4 Tensile Testing

Tensile tests were conducted in accordance with 10CFR50, Appendices G and H [2], ASTM Specifications E8-94 [6] and E21-92 and BWXS Technical Procedure TP-78, Revision 15. The tests were conducted at a strain rate of 0.0075 inch/inch/minute until the 0.2% offset yield strength was achieved. The strain rate was then increased to 0.03 inch/inch/minute thereafter. The extensometer knife edges were spring-loaded to the specimen and operated through specimen failure. The extensometer gage length was 1.00 inch. The extensometer is rated as Class B-2 in accordance with ASTM E83-93 [11].

The yield load, ultimate load, fracture load, total elongation, and uniform elongation were determined directly from the load-extension curve. The yield strength, ultimate strength, and fracture strength were calculated using the original cross-sectional area. The final diameter and final gage length were determined from post-fracture photographs. The fracture area used to calculate the fracture stress (true stress at fracture) and percent reduction in area was computed using the final diameter measurement.

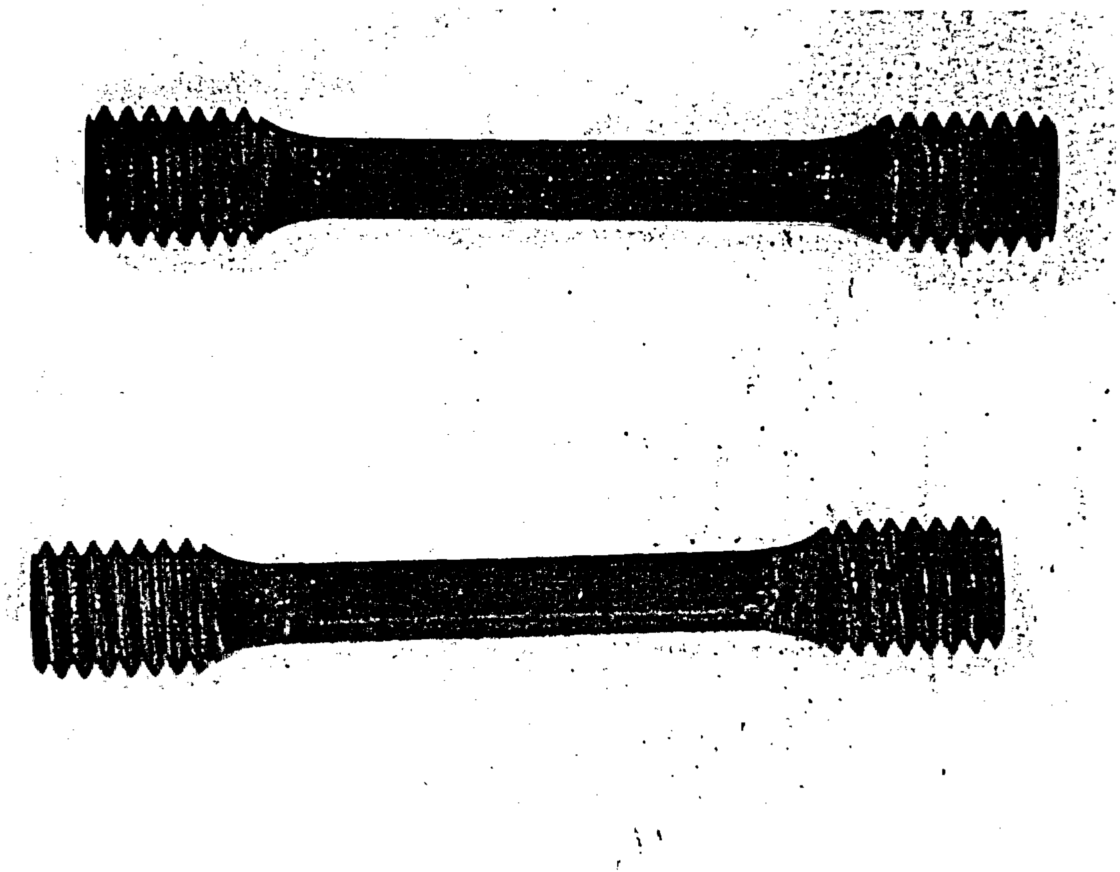


Figure 5-1. Corroded Tensile Specimens from Middle Capsule #4

6.0 MECHANICAL TEST RESULTS

6.1 Charpy Impact Test Results

The results of the Charpy impact tests performed on the various materials of Capsule W-100, which received a fluence of approximately 2.09 x 10^{19} n/cm^2 (E > 1.0 MeV) in 16.93 EFPY of operation, were analyzed using BWXS certified program CHARTEST, and the results are presented in Table 6-1, Table 6-2, and Appendix B. These results are compared with baseline results [3] and results from Capsules A-240, W-290, and W-110 in Figures 6-1 through 6-12 (these graphs were generated using certified program CVGRAPH 5.0.1). The transition temperature increases and upper shelf energy decreases for Capsule W-100 materials are summarized in Table 6-3. Note that 30 ft-lb shift values were determined using the initial 30 ft-lb transition temperatures as determined by the non-linear least squares fit of the Charpy data to the hyperbolic tangent function and not the originally reported values. A comparison of the Palisades reactor vessel beltline material test results with the Regulatory Guide 1.99, Revision 2 [1] predictions is given in Table 6-3. These prediction are based on the best estimate weight percent copper and nickel concentrations as given in a letter from John R. Kneeland, Palisades Nuclear Plant to Steve Jensen, BWX Technologies dated November 20, 2003. The measured 30 ft-lb shift in transition temperature and measured decrease in USE of all surveillance materials contained in Capsule W-100 are less than the Regulatory Guide 1.99, Revision 2 predictions except for the USE drop for the surveillance weld.

The fracture surfaces of the Charpy specimens of the various surveillance Capsule W-100 materials are shown in Appendix C. An increasingly ductile or tougher appearance with increasing test temperature can be observed.

All beltline materials are expected to have an upper shelf energy (USE) greater than 50 ft-lb through end of license (EOL, 32 EFPY) as required by 10CFR50, Appendix G [2]. The load-time records for individual instrumented Charpy specimen tests are shown in Appendix D, and a summary sheet is also provided at the beginning of this appendix. The results presented in this report are based on a regression of all capsule data using a hyperbolic tangent curve-fitting program. Appendix B presents Charpy plots and the program input data.

6.2 Tensile Test Results

All tensile tests were performed in accordance with BWXS Technical Procedure TP-78, Revision 15, and ASTM Specification E8-94 [9] and E21-92 [10]. BWXS certified program TNSLTEST was used to control the machine and acquire the data, and the data were then analyzed using BWXS certified program MTADS. All tensile tests data including engineering and true stress strain plots can be found in Appendix E.

The results of the tensile tests performed on the various materials contained in Capsule W-100 are presented in Table 6-4, and are compared with unirradiated results [3] in Figures 6-13 through 6-18. In general, strength increased and ductility decreased with increasing neutron fluence.

Photographs of the fractured tensile specimens are in Appendix F.

Table 6-1.
Charpy Impact Data for the Palisades W-100 Capsule Plate D-3803-1

Specimen Number	Temperature, °F	Impact Energy, ft-lb	Lateral Expansion, mils	Shear Fracture, %
Transverse				
213	70	9.5	2	0
255	110	14.0	7	5
25E	150	27.5	19	20
25B	200	44.0	32	40
25D	225	52.5	39	50
211	240	50.0	36	50
257	250	71.5	54	70
256	260	69.0	47	90
214	270	71.0	54	95
25A	285	77.0	56	100
25C	300	76.5	63	100
212	325	67.5	56	100
Longitudinal				
152	70	5.5	1	0
151	110	14.0	7	5
153	130	29.5	18	25
157	175	44.0	27	40
15A	200	45.0	34	45
154	225	74.4	51	70
15Y	250	86.5	50	85
156	260	73.0	50	80
15C	270	102.0	57	95
15B	280	100.5	58	100
15U	300	104.5	72	100
155	325	101.0	68	100

Table 6-2.
Charpy Impact Data for the Palisades W-100 Capsule Weld Metal and HAZ Metal

Specimen Number	Temperature, °F	Impact Energy, ft-lb	Lateral Expansion, mils	Shear Fracture, %
		Weld Metal		
35B	70	5.5	2	0
35E	150	15.5	6	0
355	200	23.0	15	20
356	225	31.0	22	45
35A	250	32.5	27	70
353	275	50.5	37	85
35C	275	37.5	21	75
352	285	55.0	41	95
35J	300	43.0	32	90
35D	325	47.0	33	95
357	350	50.0	36	100
354	400	55.0	46	100
		HAZ Metal		
414	-50	4.5	0	0
431	0	49.5	24	0
47L	0	10.0	0	0
411	40	12.0	1	0
416	70	21.0	9	40
48M	150	42.5	27	45
47P	200	65.0	39	85
412	225	52.5	31	85
415	225	42.5	26	60
413	235	53.5	40	100
47T	250	65.0	48	100
417	300	60.5	48	100

Note: Data from HAZ specimen 431 is considered nonprototypic, and was not included in the curve fitting routine in Figures 6-10 through 6-12, or in Appendix B. Results from specimen 47L are considered to be more prototypic.

Table 6-3.
Comparison of Palisades Surveillance Material (Capsule W-100) 30 ft-lb Transition Temperature Shifts (Position 2.1) and Upper Shelf Energy Decreases with Regulatory Guide 1.99 Revision 2 Predictions

Material	Unirradiated 30 ft-lb Temp. (°F)	Capsule W-100 30 ft-lb Temp. (°F)	Measured 30 ft-lb Temp. Shift (°F)	Predicted 30 ft-lb Temp. Shift (°F)	Unirradiated USE (ft-lb)	Capsule W-100 USE (ft-lb)	Predicted USE (ft-lb)
D-3803-1 Transverse	18.3	160.8	142.5	189.1	101.6	73.0	61.7
D-3803-1 Longitudinal	-0.5	158.6	159.1	189.1	154.8	102.0	93.8
Weld Metal	-86.6	218.8	305.4	*	117.7	51.8	63.7
HAZ Metal	-89.6	101.4	191.0	**	115.5	59.7	**

*Could not be calculated because RG 1.99 Rev 2 Table 2 does not provide chemistry factors for base metals with Ni content greater than 1.2 wt%.
** The RG 1.99 Rev 2 CF tables do not cover HAZ metal

Table 6-4.
Tensile Properties of the Palisades Capsule W-100 Materials

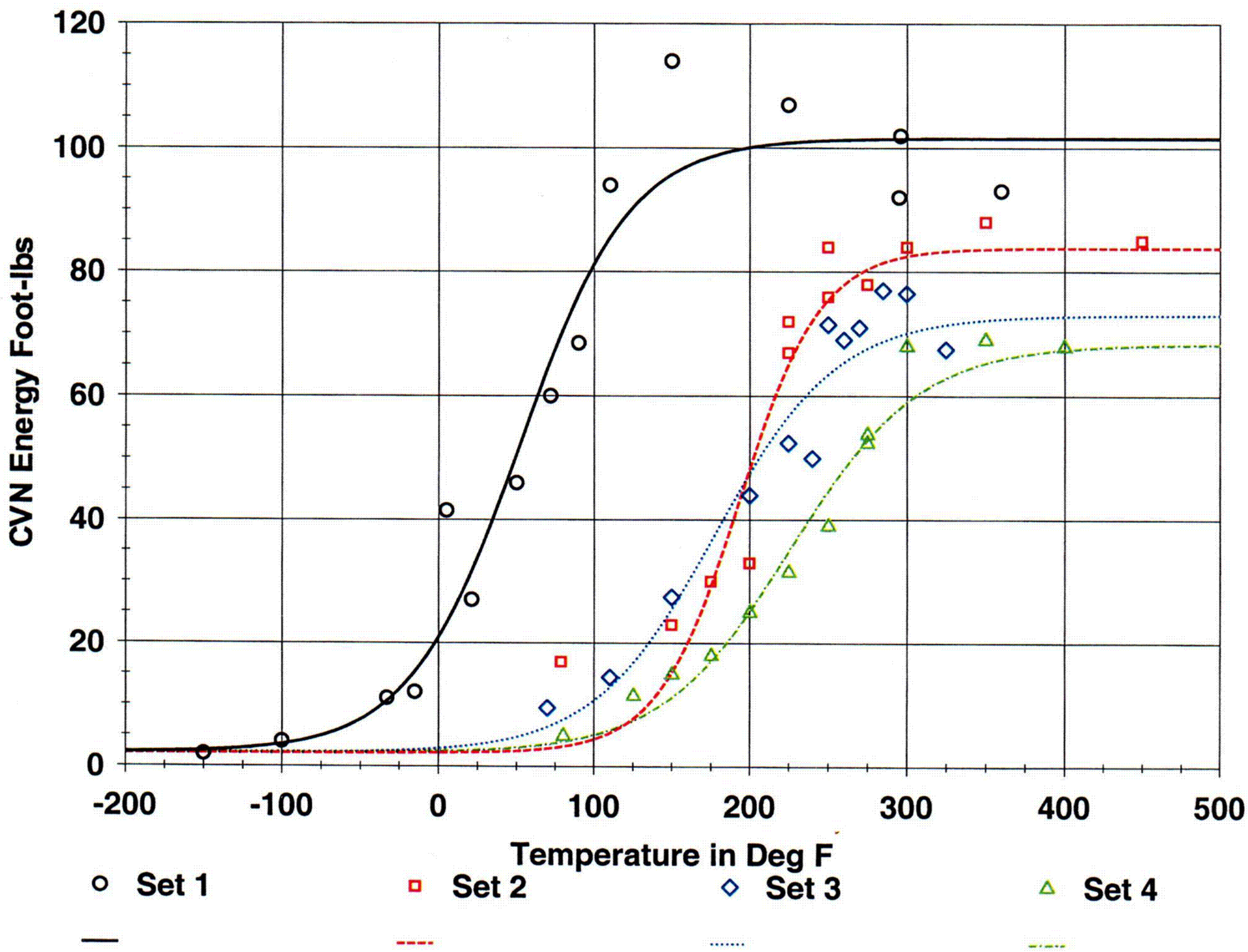
Material	Specimen Number	Test Temp. (°F)	0.2% Yield Strength (Ksi)	Ultimate Strength (Ksi)	Fracture Load (Kip)	Fracture Stress (Ksi)	Fracture Strength (Ksi)	Uniform Elongation (%)	Total Elongation (%)	Reduction in Area (%)
HAZ	4JK	70	92.0	106.3	3.60	175.9	73.4	6.0	N/A	58.3
	4JJ	200	88.6	101.3	3.47	171.4	70.7	4.9	N/A	58.8
	4JE	550	83.1	98.9	3.84	146.8	78.2	4.3	N/A	46.7
D-3803-1 (Long.)	1J1	70	89.8	108.2	3.51	190.6	71.4	10.8	23.8	62.5
	1EY	250	83.0	101.7	3.35	169.9	68.3	9.9	21.6	59.8
	1E7	550	76.7	98.3	3.53	150.1	71.9	8.8	19.2	52.1
Weld Metal	3DT	70	101.7	115.0	4.52	192.1	92.0	11.7	23.5	52.1
	3DP	300	96.4	109.7	4.59	167.1	93.5	9.4	16.6	44.0
	3DM	550	92.9	109.8	4.78	178.6	97.3	7.9	13.6	45.5

NA: Specimen failed outside the gage length.

Palisades Nuclear Plant - Base (Transverse)

CVGRAPH 5.0.1 Hyperbolic Tangent Curve Printed on 02/03/2004 10:22 AM
Data Set(s) Plotted

Curve	Plant	Capsule	Material	Ori.	Heat #
1	PALISADES	UNIRR	SA302BM	TL	C-1279-3
2	PALISADES	W-290	SA302BM	TL	C-1279-3
3	PALISADES	W-100	SA302BM	TL	C-1279-3
4	PALISADES	A-240	SA302BM	TL	C-1279-3



Results

Curve	Fluence	LSE	USE	d-USE	T @30	d-T @30	T @50	d-T @50
1	0	2.2	101.6	.0	18.3	.0	49.1	.0
2	9.26E18	2.2	83.8	-17.8	176.3	158.0	202.5	153.4
3	2.09E19	2.2	73.0	-28.6	160.8	142.5	206.3	157.2
4	4.01E19	2.2	68.4	-33.2	212.6	194.3	265.1	216.0

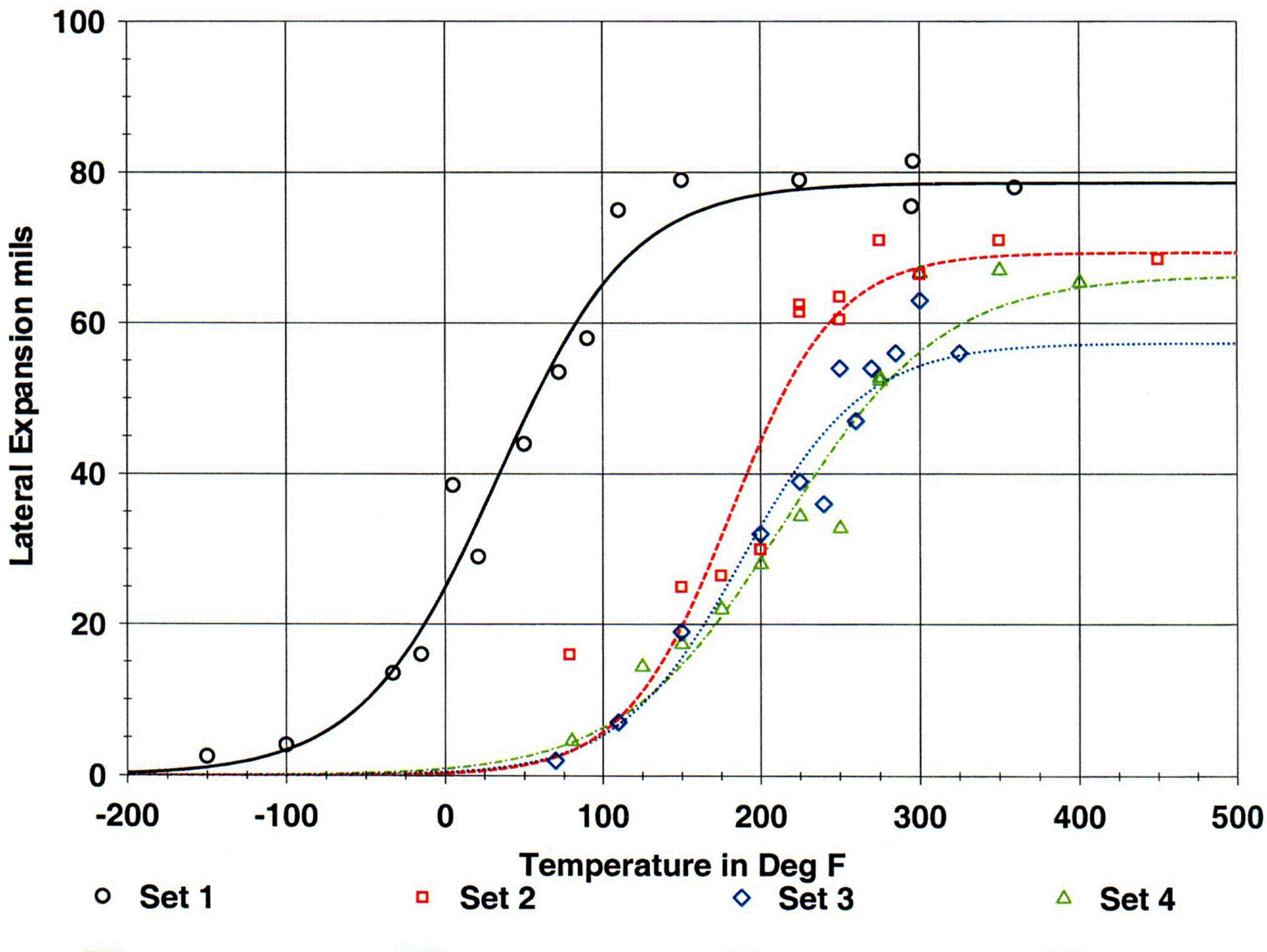
Figure 6-1. Charpy Impact Energy vs. Temperature for Palisades Surveillance Plate D-3803-1 (Transverse Orientation)

C01

Palisades Nuclear Plant - Base (Transverse)

CVGRAPH 5.0.1 Hyperbolic Tangent Curve Printed on 02/03/2004 10:25 AM
Data Set(s) Plotted

Curve	Plant	Capsule	Material	Ori.	Heat #
1	PALISADES	UNIRR	SA302BM	TL	C-1279-3
2	PALISADES	W-290	SA302BM	TL	C-1279-3
3	PALISADES	W-100	SA302BM	TL	C-1279-3
4	PALISADES	A-240	SA302BM	TL	C-1279-3



Results

Curve	Fluence	LSE	USE	d-USE	T @35	d-T @35
1	0	.0	78.6	.0	23.5	.0
2	9.26E18	.0	69.3	-9.3	181.7	158.2
3	2.09E19	.0	57.3	-21.3	205.9	182.4
4	4.01E19	.0	66.3	-12.3	219.2	195.7

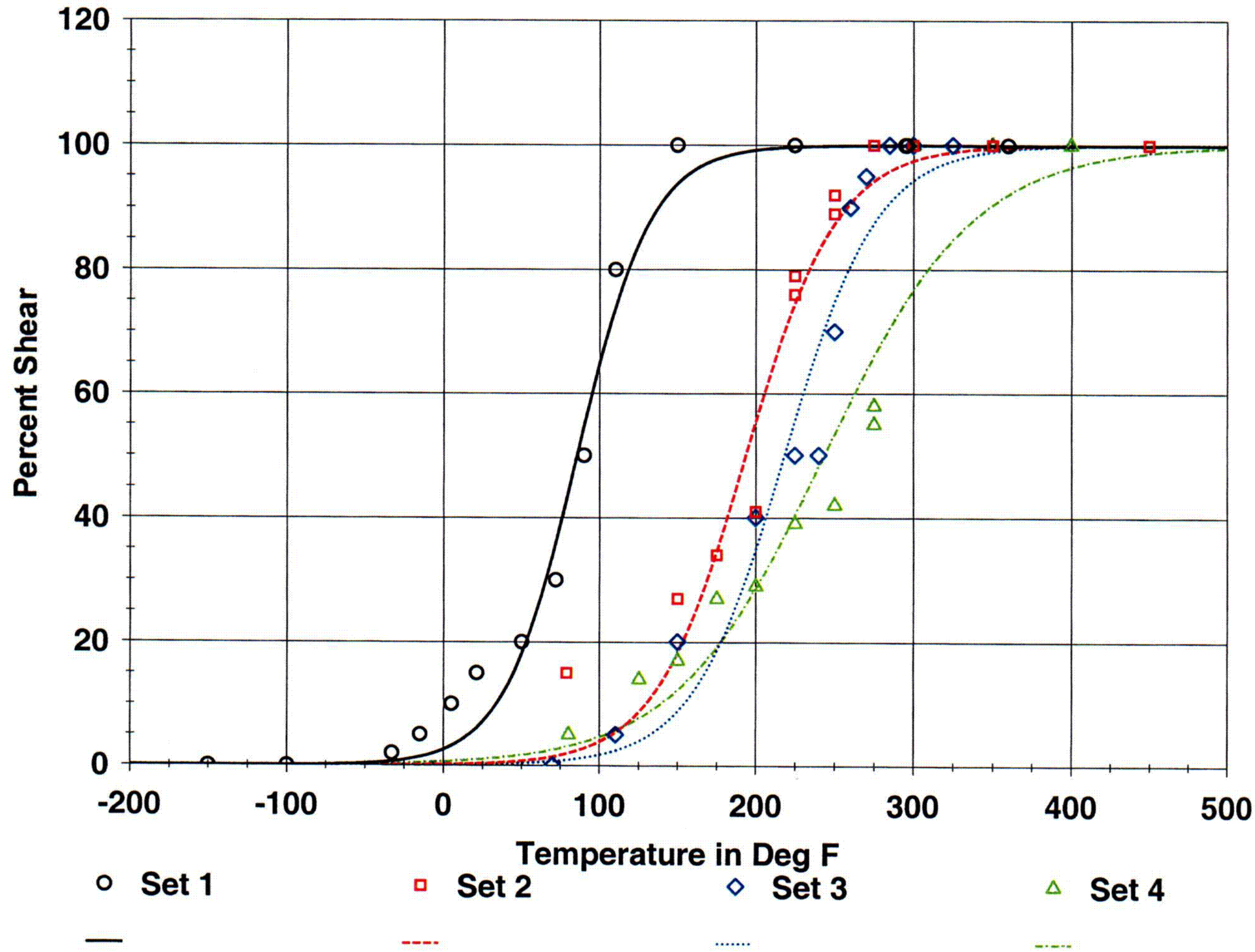
Figure 6-2. Lateral Expansion vs. Temperature for Palisades Surveillance Plate D-3803-1 (Transverse Orientation)

C02

Palisades Nuclear Plant - Base (Transverse)

CVGRAPH 5.0.1 Hyperbolic Tangent Curve Printed on 02/03/2004 10:23 AM
Data Set(s) Plotted

Curve	Plant	Capsule	Material	Ori.	Heat #
1	PALISADES	UNIRR	SA302BM	TL	C-1279-3
2	PALISADES	W-290	SA302BM	TL	C-1279-3
3	PALISADES	W-100	SA302BM	TL	C-1279-3
4	PALISADES	A-240	SA302BM	TL	C-1279-3



Results

Curve	Fluence	LSE	USE	d-USE	T @50	d-T @50
1	0	.0	100.0	.0	85.5	.0
2	9.26E18	.0	100.0	.0	193.6	108.1
3	2.09E19	.0	100.0	.0	218.7	133.2
4	4.01E19	.0	100.0	.0	243.5	158.0

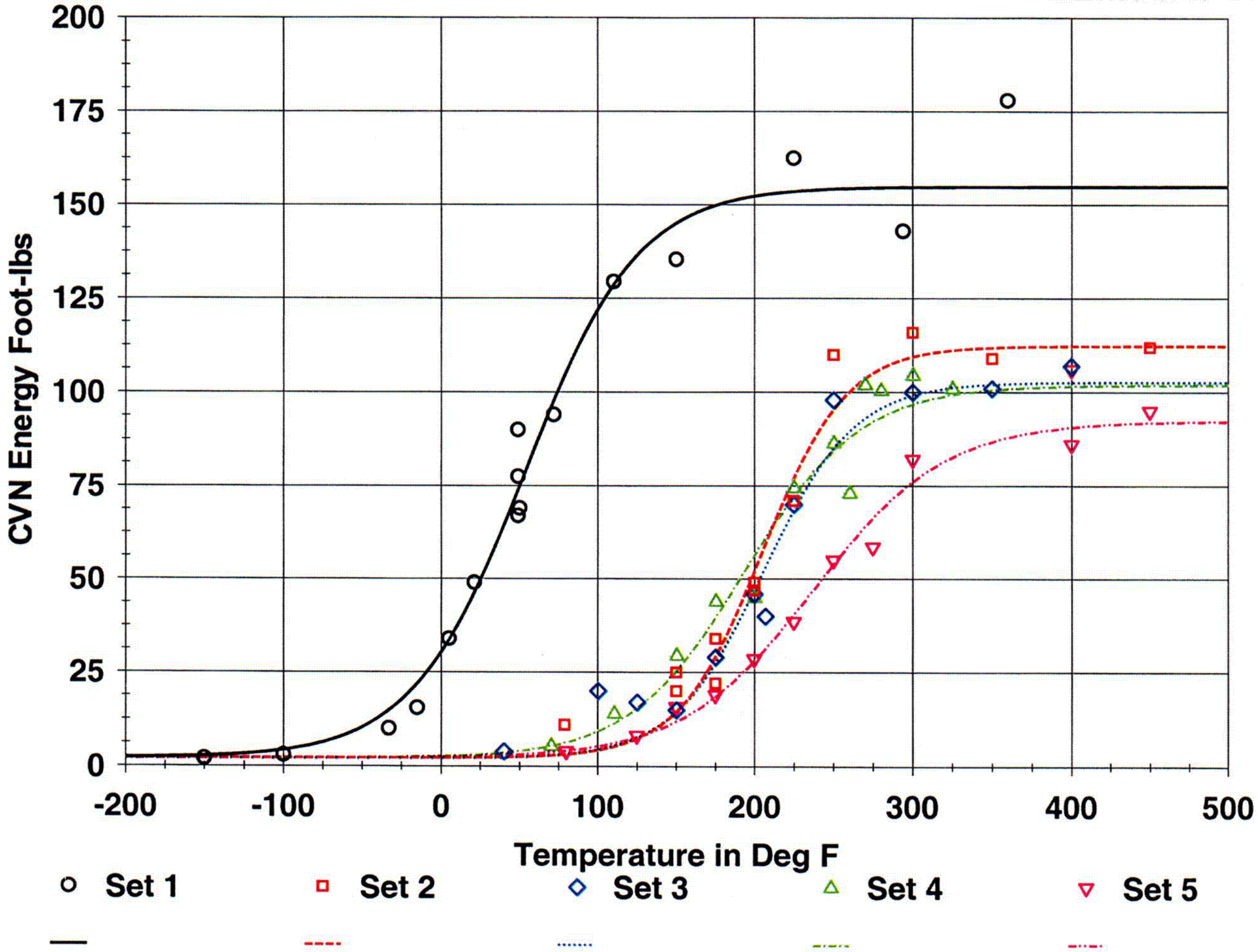
Figure 6-3. Percent Shear vs. Temperature for Palisades Surveillance Plate D-3803-1 (Transverse Orientation)

C03

Palisades Nuclear Plant - Base (Long.)

CVGRAPH 5.0.1 Hyperbolic Tangent Curve Printed on 02/03/2004 09:49 AM
Data Set(s) Plotted

Curve	Plant	Capsule	Material	Ori.	Heat #
1	PALISADES	UNIRR	SA302BM	LT	C-1279-3
2	PALISADES	W-290	SA302BM	LT	C-1279-3
3	PALISADES	W-110	SA302BM	LT	C-1279-3
4	PALISADES	W-100	SA302BM	LT	C-1279-3
5	PALISADES	A-240	SA302BM	LT	C-1279-3



Results

Curve	Fluence	LSE	USE	d-USE	T @30	d-T @30	T @50	d-T @50
1	0	2.2	154.8	.0	-.5	.0	25.3	.0
2	9.26E18	2.2	112.3	-42.5	176.3	176.8	198.0	172.7
3	1.66E19	2.1	102.7	-52.1	179.0	179.5	203.5	178.2
4	2.09E19	2.2	102.0	-52.8	158.6	159.1	190.4	165.1
5	4.01E19	2.1	92.3	-62.5	204.6	205.1	243.0	217.7

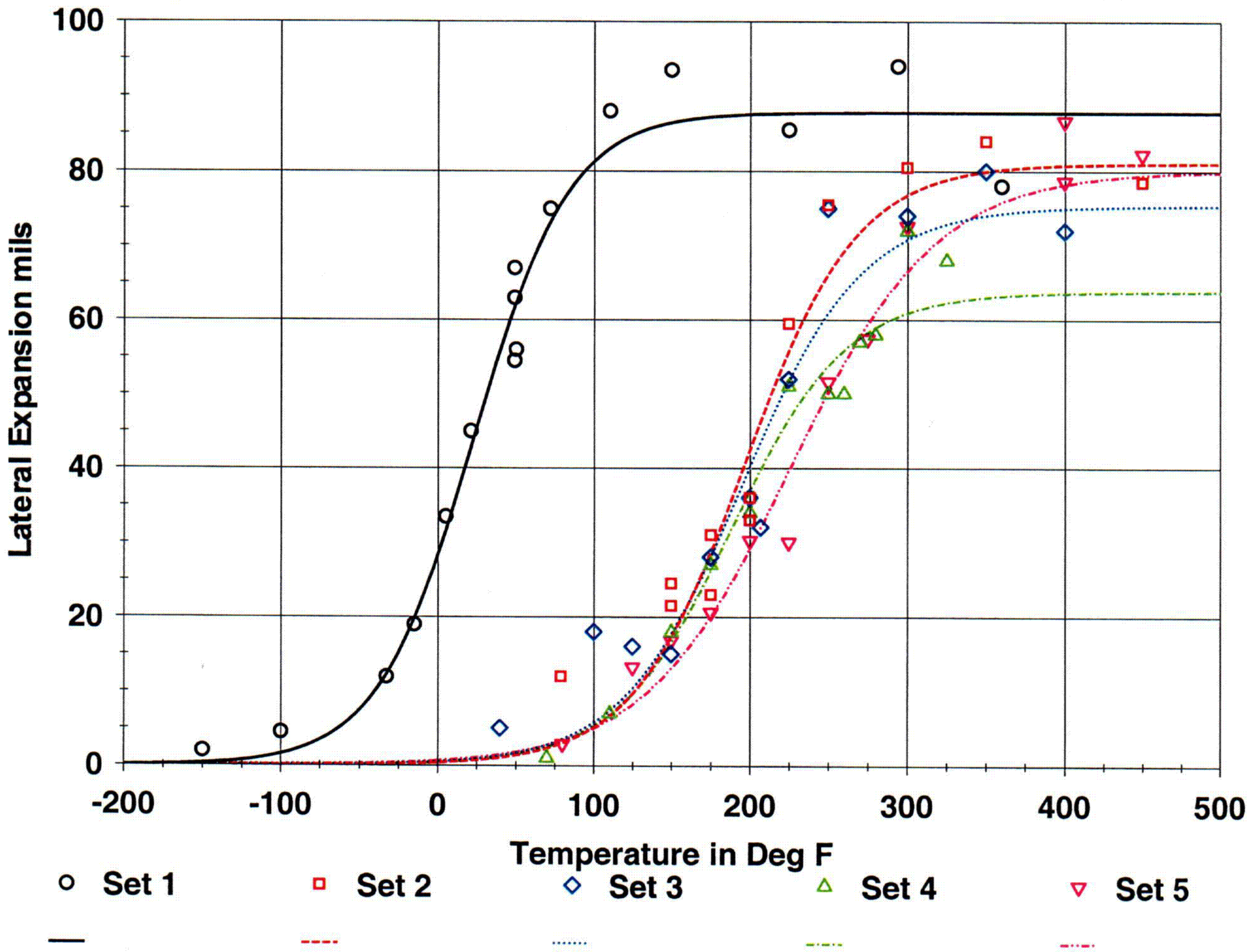
Figure 6-4. Charpy Impact Energy vs. Temperature for Palisades Surveillance Plate D-3803-1 (Longitudinal Orientation)

C04

Palisades Nuclear Plant - Base (Long.)

CVGRAPH 5.0.1 Hyperbolic Tangent Curve Printed on 02/03/2004 09:51 AM
Data Set(s) Plotted

Curve	Plant	Capsule	Material	Ori.	Heat #
1	PALISADES	UNIRR	SA302BM	LT	C-1279-3
2	PALISADES	W-290	SA302BM	LT	C-1279-3
3	PALISADES	W-110	SA302BM	LT	C-1279-3
4	PALISADES	W-100	SA302BM	LT	C-1279-3
5	PALISADES	A-240	SA302BM	LT	C-1279-3



Results

Curve	Fluence	LSE	USE	d-USE	T @35	d-T @35
1	0	.0	87.8	.0	10.0	.0
2	9.26E18	.0	81.0	-6.8	186.9	176.9
3	1.66E19	.0	75.3	-12.5	190.0	180.0
4	2.09E19	.0	63.8	-24.0	195.7	185.7
5	4.01E19	.0	80.0	-7.8	214.4	204.4

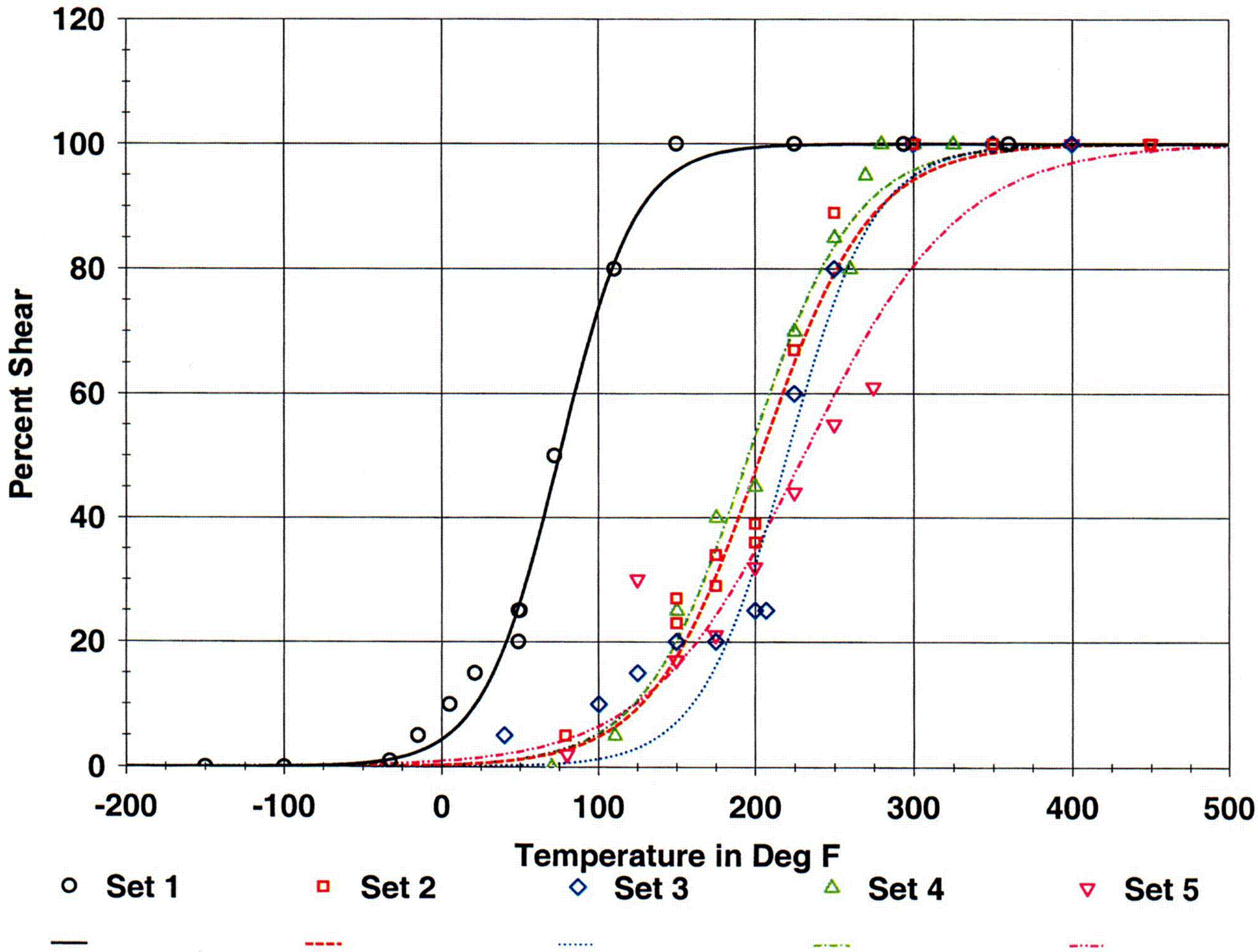
Figure 6-5. Lateral Expansion vs. Temperature for Palisades Surveillance Plate D-3803-1 (Longitudinal Orientation)

C05

Palisades Nuclear Plant - Base (Long.)

CVGRAPH 5.0.1 Hyperbolic Tangent Curve Printed on 02/03/2004 09:50 AM
Data Set(s) Plotted

Curve	Plant	Capsule	Material	Ori.	Heat #
1	PALISADES	UNIRR	SA302BM	LT	C-1279-3
2	PALISADES	W-290	SA302BM	LT	C-1279-3
3	PALISADES	W-110	SA302BM	LT	C-1279-3
4	PALISADES	W-100	SA302BM	LT	C-1279-3
5	PALISADES	A-240	SA302BM	LT	C-1279-3



Results

Curve	Fluence	LSE	USE	d-USE	T @50	d-T @50
1	0	.0	100.0	.0	75.0	.0
2	9.26E18	.0	100.0	.0	203.5	128.5
3	1.66E19	.0	100.0	.0	220.5	145.5
4	2.09E19	.0	100.0	.0	195.7	120.7
5	4.01E19	.0	100.0	.0	231.0	156.0

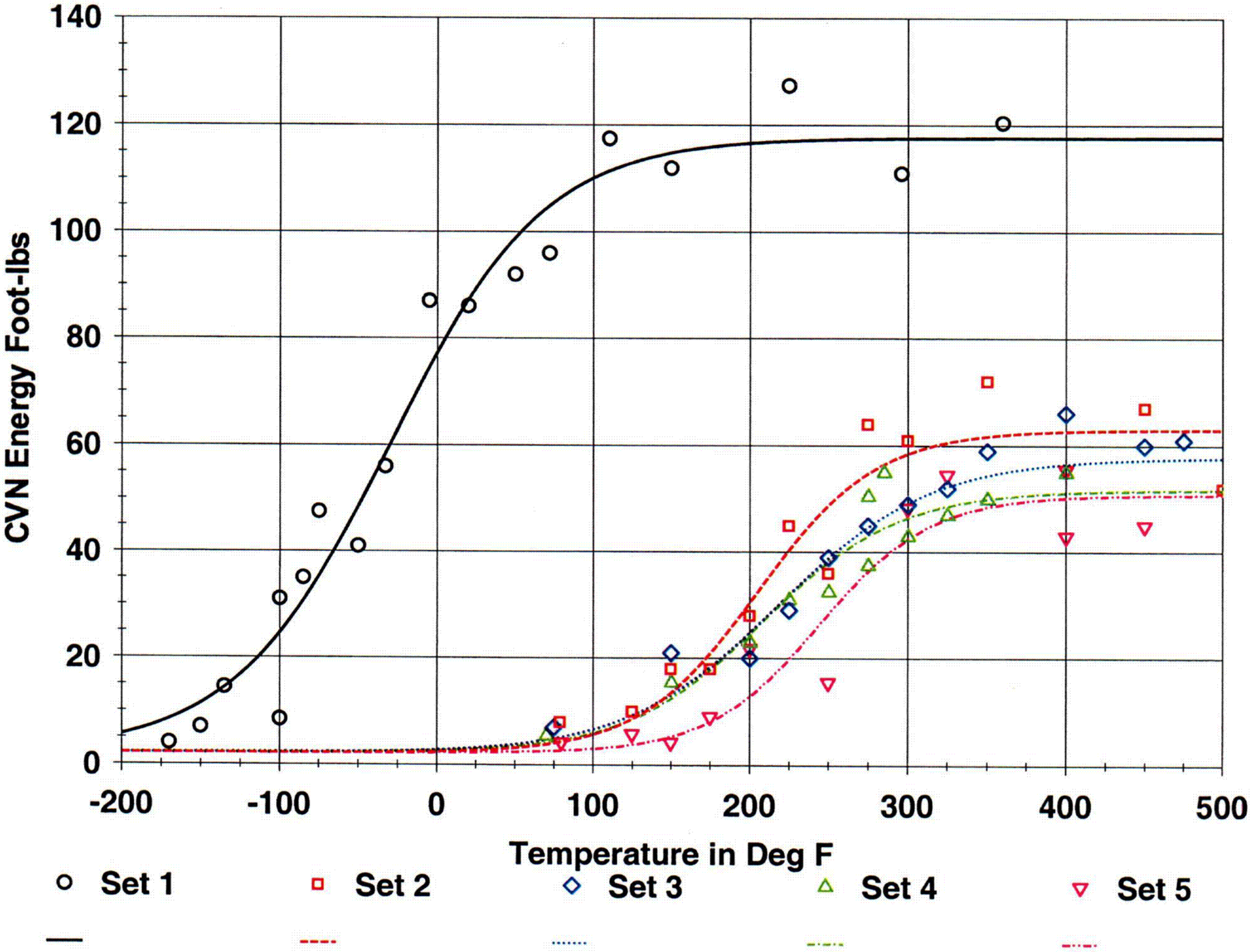
Figure 6-6. Percent Shear vs. Temperature for Palisades Surveillance Plate D-3803-1 (Longitudinal Orientation)

C06

Palisades Nuclear Plant - Weld (Heat 3277)

CVGRAPH 5.0.1 Hyperbolic Tangent Curve Printed on 02/03/2004 10:27 AM
Data Set(s) Plotted

Curve	Plant	Capsule	Material	Ori.	Heat #
1	PALISADES	UNIRR	WELD	NA	3277
2	PALISADES	W-290	WELD	NA	3277
3	PALISADES	W-110	WELD	NA	3277
4	PALISADES	W-100	WELD	NA	3277
5	PALISADES	A-240	WELD	NA	3277



Results

Curve	Fluence	LSE	USE	d-USE	T @30	d-T @30	T @50	d-T @50
1	0	2.1	117.7	.0	-86.6	.0	-47.3	.0
2	9.26E18	2.2	63.0	-54.7	199.1	285.7	254.4	301.7
3	1.66E19	2.2	57.8	-59.9	218.2	304.8	305.9	353.2
4	2.09E19	2.2	51.8	-65.9	218.8	305.4	350.1	397.4
5	4.01E19	2.2	50.8	-66.9	255.3	341.9	389.2	436.5

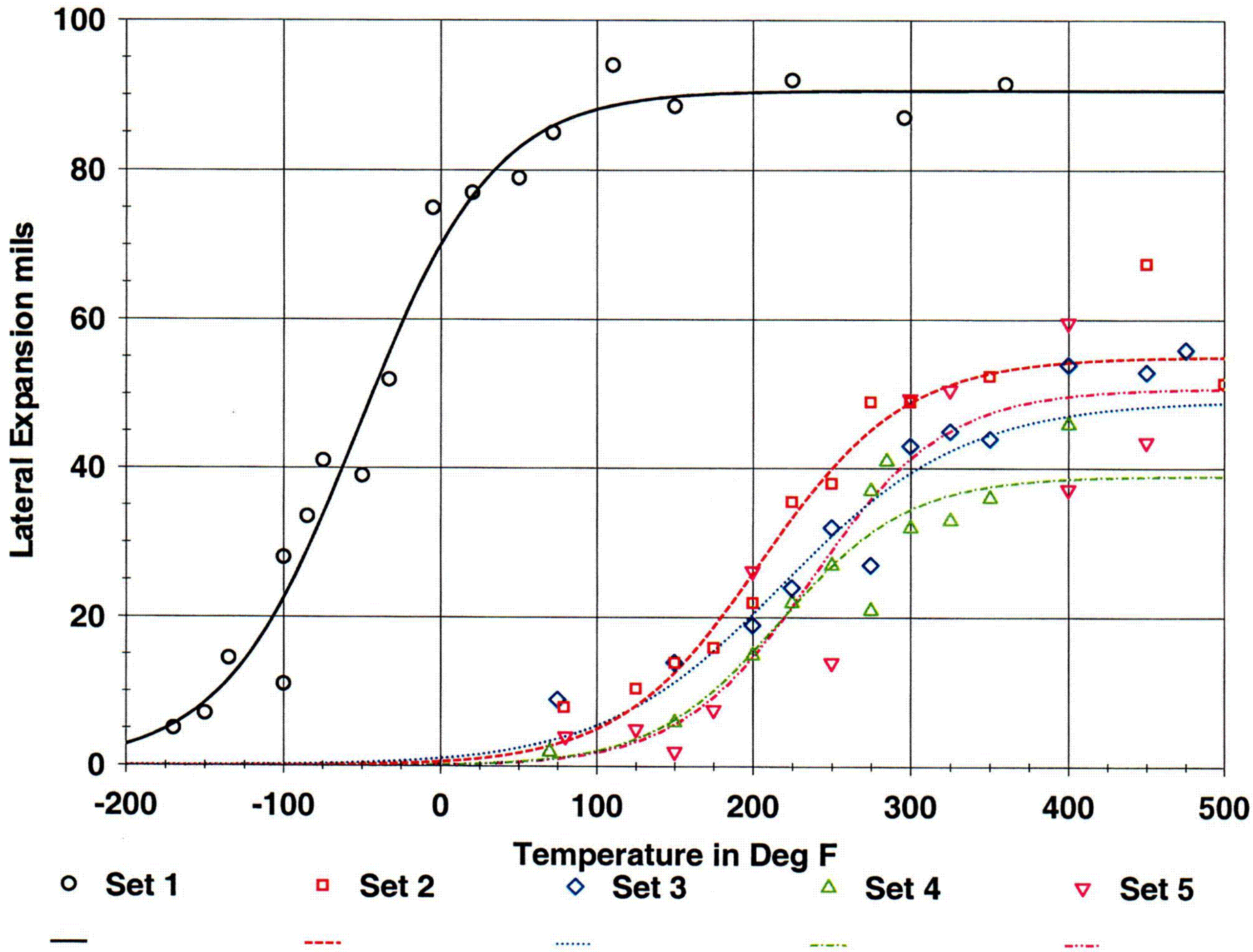
Figure 6-7. Charpy Impact Energy vs. Temperature for Palisades Surveillance Weld Metal

C07

Palisades Nuclear Plant - Weld (Heat 3277)

CVGRAPH 5.0.1 Hyperbolic Tangent Curve Printed on 02/03/2004 10:29 AM
Data Set(s) Plotted

Curve	Plant	Capsule	Material	Ori.	Heat #
1	PALISADES	UNIRR	WELD	NA	3277
2	PALISADES	W-290	WELD	NA	3277
3	PALISADES	W-110	WELD	NA	3277
4	PALISADES	W-100	WELD	NA	3277
5	PALISADES	A-240	WELD	NA	3277



Results

Curve	Fluence	LSE	USE	d-USE	T @35	d-T @35
1	0	.0	90.6	.0	-72.5	.0
2	9.26E18	.0	55.1	-35.5	231.1	303.6
3	1.66E19	.0	49.2	-41.4	272.3	344.8
4	2.09E19	.0	39.0	-51.6	306.1	378.6
5	4.01E19	.0	50.8	-39.8	272.0	344.5

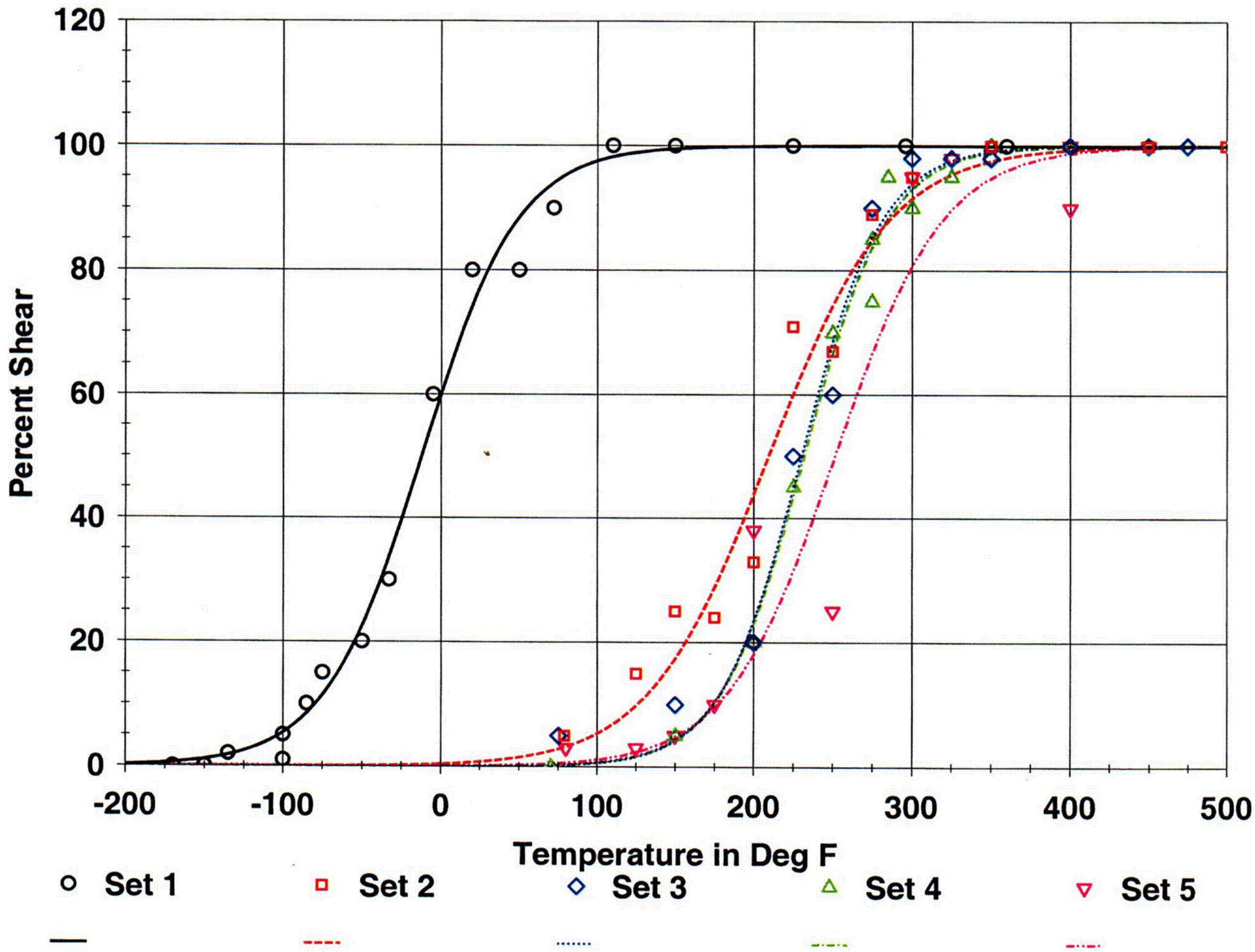
Figure 6-8. Lateral Expansion vs. Temperature for Palisades Surveillance Weld Metal

C08

Palisades Nuclear Plant - Weld (Heat 3277)

CVGRAPH 5.0.1 Hyperbolic Tangent Curve Printed on 02/03/2004 10:27 AM
Data Set(s) Plotted

Curve	Plant	Capsule	Material	Ori.	Heat #
1	PALISADES	UNIRR	WELD	NA	3277
2	PALISADES	W-290	WELD	NA	3277
3	PALISADES	W-110	WELD	NA	3277
4	PALISADES	W-100	WELD	NA	3277
5	PALISADES	A-240	WELD	NA	3277



Results

Curve	Fluence	LSE	USE	d-USE	T @50	d-T @50
1	0	.0	100.0	.0	-12.3	.0
2	9.26E18	.0	100.0	.0	209.4	221.7
3	1.66E19	.0	100.0	.0	230.4	242.7
4	2.09E19	.0	100.0	.0	231.8	244.1
5	4.01E19	.0	100.0	.0	251.6	263.9

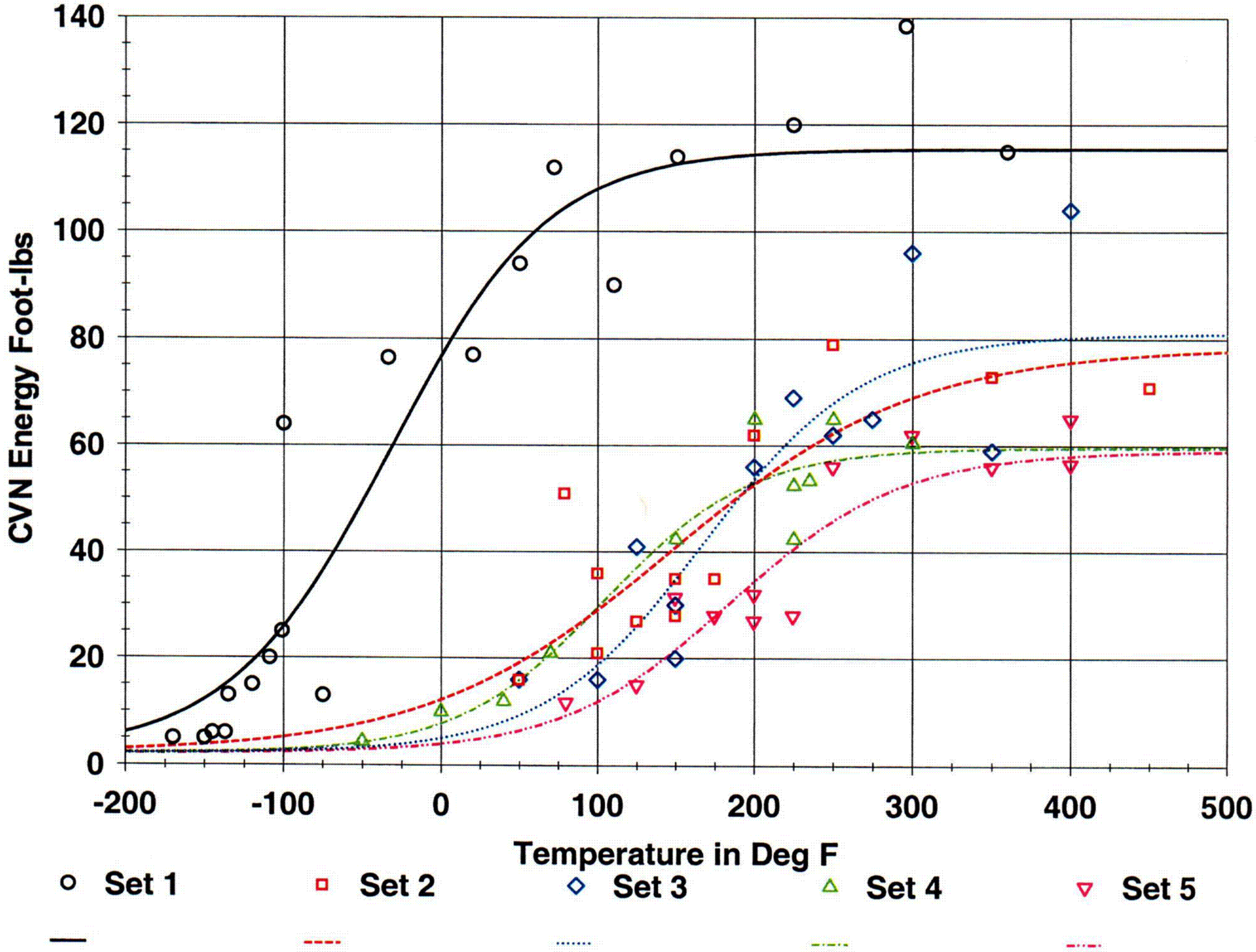
Figure 6-9. Percent Shear vs. Temperature for Palisades Surveillance Weld Metal

c09

Palisades Nuclear Plant - Heat Affected Zone

CVGRAPH 5.0.1 Hyperbolic Tangent Curve Printed on 02/03/2004 10:31 AM
Data Set(s) Plotted

Curve	Plant	Capsule	Material	Ori.	Heat #
1	PALISADES	UNIRR	SA302BM	NA	C-1279-1
2	PALISADES	W-290	SA302BM	NA	C-1279-1
3	PALISADES	W-110	SA302BM	NA	C-1279-1
4	PALISADES	W-100	SA302BM	NA	C-1279-1
5	PALISADES	A-240	SA302BM	NA	C-1279-1



Results

Curve	Fluence	LSE	USE	d-USE	T @30	d-T @30	T @50	d-T @50
1	0	2.1	115.5	.0	-89.6	.0	-48.9	.0
2	9.26E18	2.2	78.6	-36.9	104.5	194.1	188.3	237.2
3	1.66E19	2.2	81.0	-34.5	137.1	226.7	190.1	239.0
4	2.09E19	2.2	59.7	-55.8	101.4	191.0	179.2	228.1
5	4.01E19	2.2	59.1	-56.4	183.5	273.1	275.8	324.7

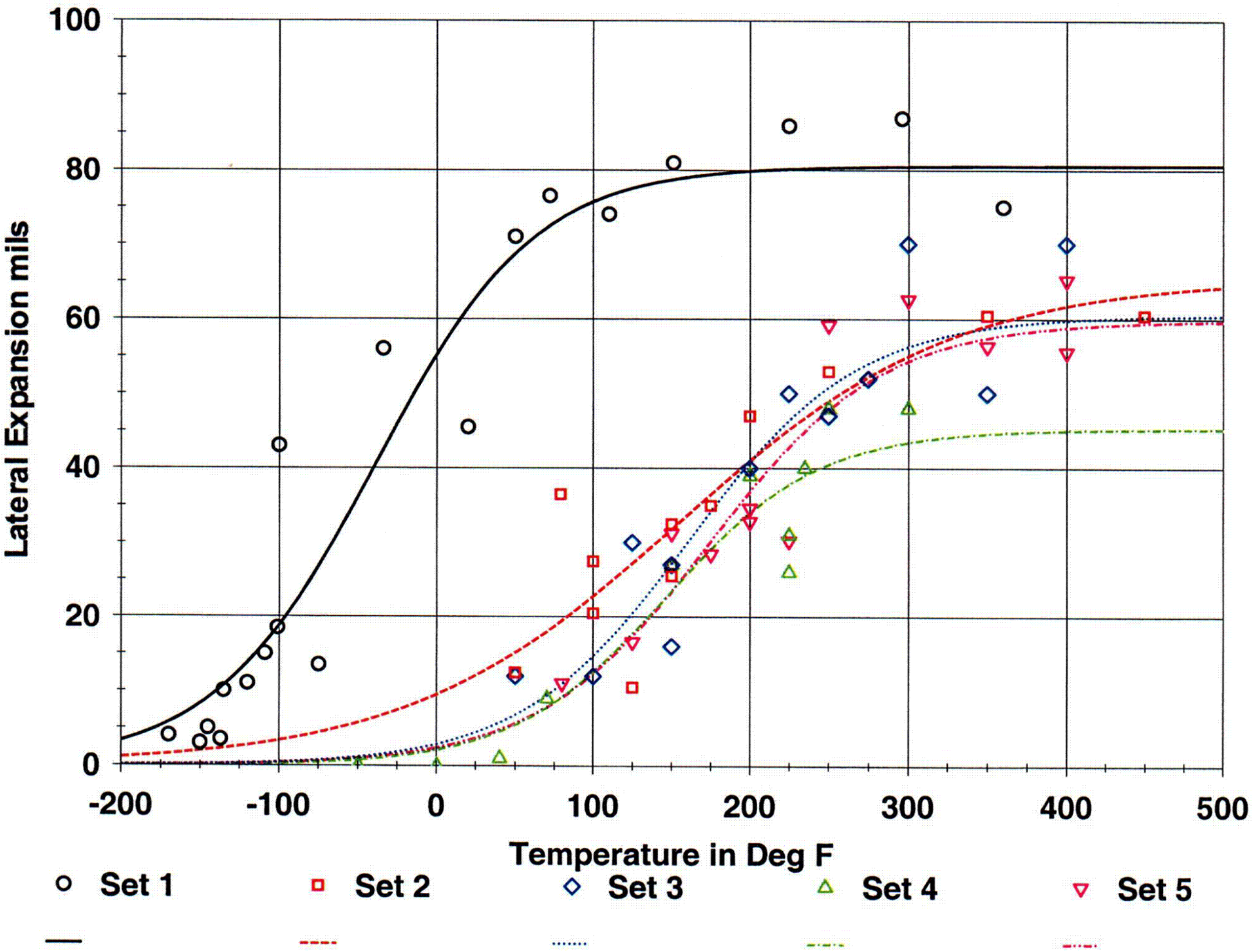
Figure 6-10. Charpy Impact Energy vs. Temperature Palisades Surveillance Heat-Affected-Zone Material

C10

Palisades Nuclear Plant - Heat Affected Zone

CVGRAPH 5.0.1 Hyperbolic Tangent Curve Printed on 02/03/2004 10:33 AM
Data Set(s) Plotted

Curve	Plant	Capsule	Material	Ori.	Heat #
1	PALISADES	UNIRR	SA302BM	NA	C-1279-1
2	PALISADES	W-290	SA302BM	NA	C-1279-1
3	PALISADES	W-110	SA302BM	NA	C-1279-1
4	PALISADES	W-100	SA302BM	NA	C-1279-1
5	PALISADES	A-240	SA302BM	NA	C-1279-1



Results

Curve	Fluence	LSE	USE	d-USE	T @35	d-T @35
1	0	.0	80.6	.0	-52.9	.0
2	9.26E18	.0	65.5	-15.1	167.0	219.9
3	1.66E19	.0	60.5	-20.1	178.4	231.3
4	2.09E19	.0	45.3	-35.3	205.9	258.8
5	4.01E19	.0	59.8	-20.8	193.1	246.0

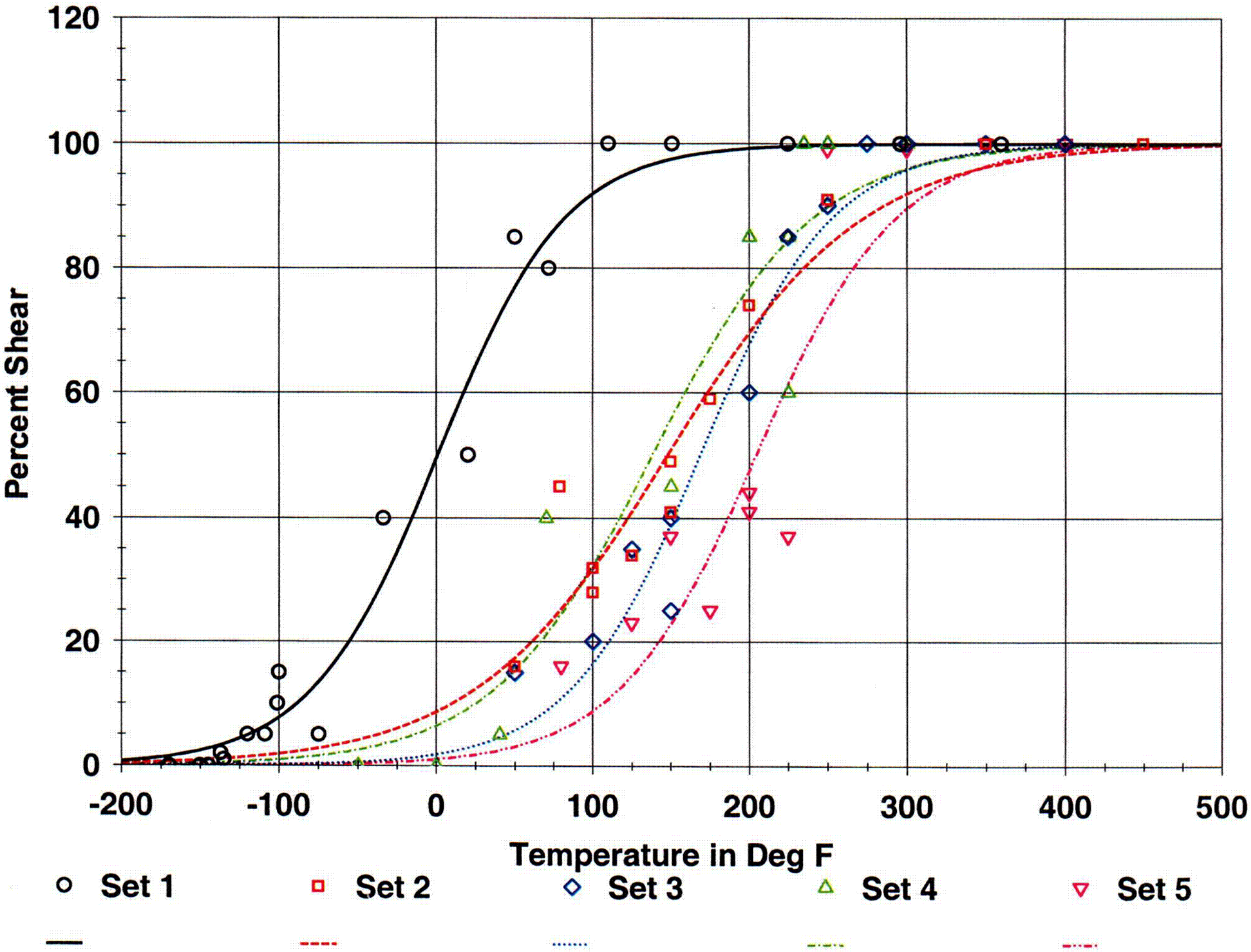
Figure 6-11. Lateral Expansion vs. Temperature for Palisades Surveillance Heat-Affected-Zone Material

C11

Palisades Nuclear Plant - Heat Affected Zone

CVGRAPH 5.0.1 Hyperbolic Tangent Curve Printed on 02/03/2004 10:31 AM
Data Set(s) Plotted

Curve	Plant	Capsule	Material	Ori.	Heat #
1	PALISADES	UNIRR	SA302BM	NA	C-1279-1
2	PALISADES	W-290	SA302BM	NA	C-1279-1
3	PALISADES	W-110	SA302BM	NA	C-1279-1
4	PALISADES	W-100	SA302BM	NA	C-1279-1
5	PALISADES	A-240	SA302BM	NA	C-1279-1



Results

Curve	Fluence	LSE	USE	d-USE	T @50	d-T @50
1	0	.0	100.0	.0	1.0	.0
2	9.26E18	.0	100.0	.0	148.1	147.1
3	1.66E19	.0	100.0	.0	169.0	168.0
4	2.09E19	.0	100.0	.0	137.9	136.9
5	4.01E19	.0	100.0	.0	204.7	203.7

Figure 6-12. Percent Shear vs. Temperature for Palisades Surveillance Heat-Affected-Zone Material

C12

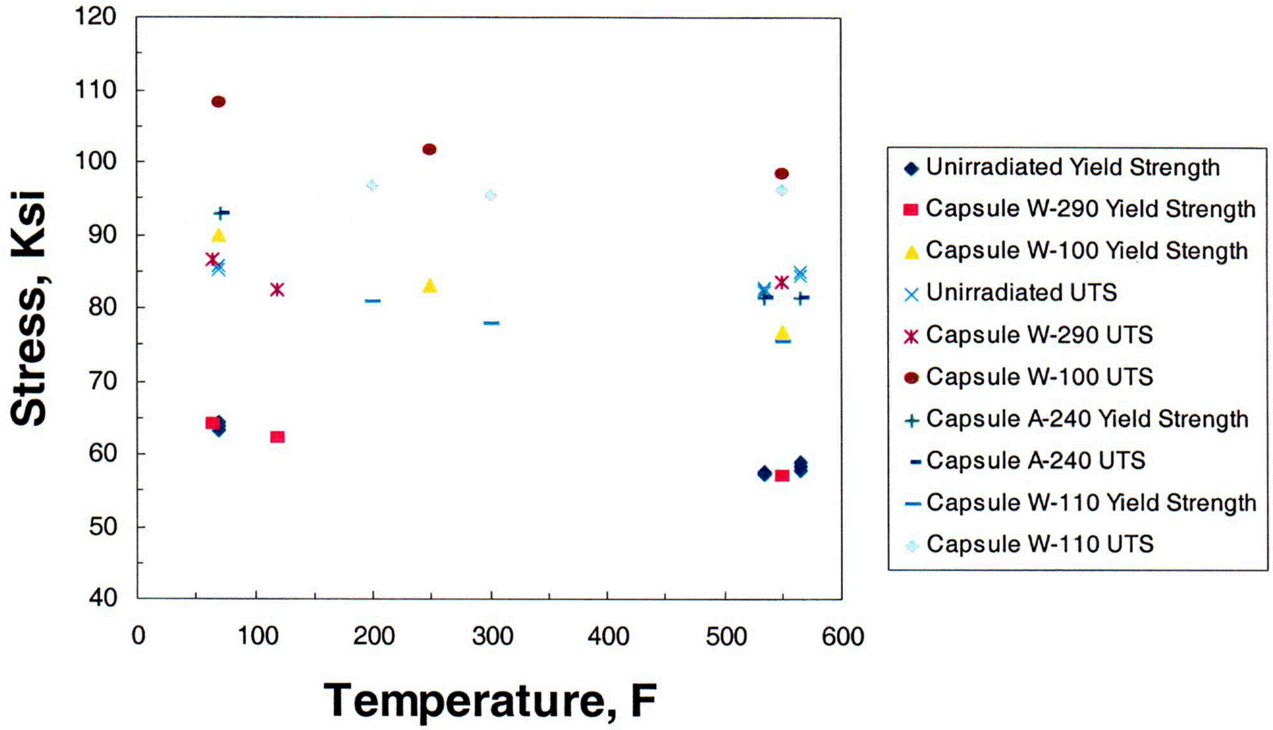


Figure 6-13. Tensile Strength Properties for Palisades Surveillance Plate D-3803-1, Longitudinal Orientation

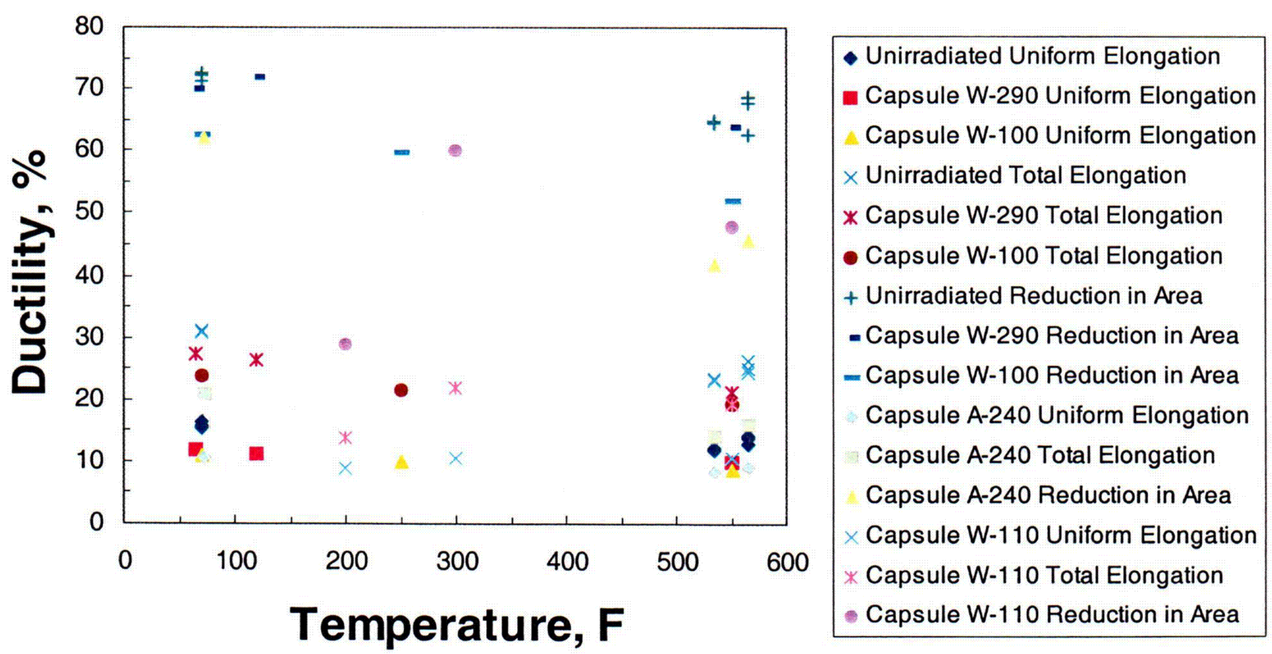


Figure 6-14. Ductility of Palisades Surveillance Plate D-3803-1, Longitudinal Orientation

C13

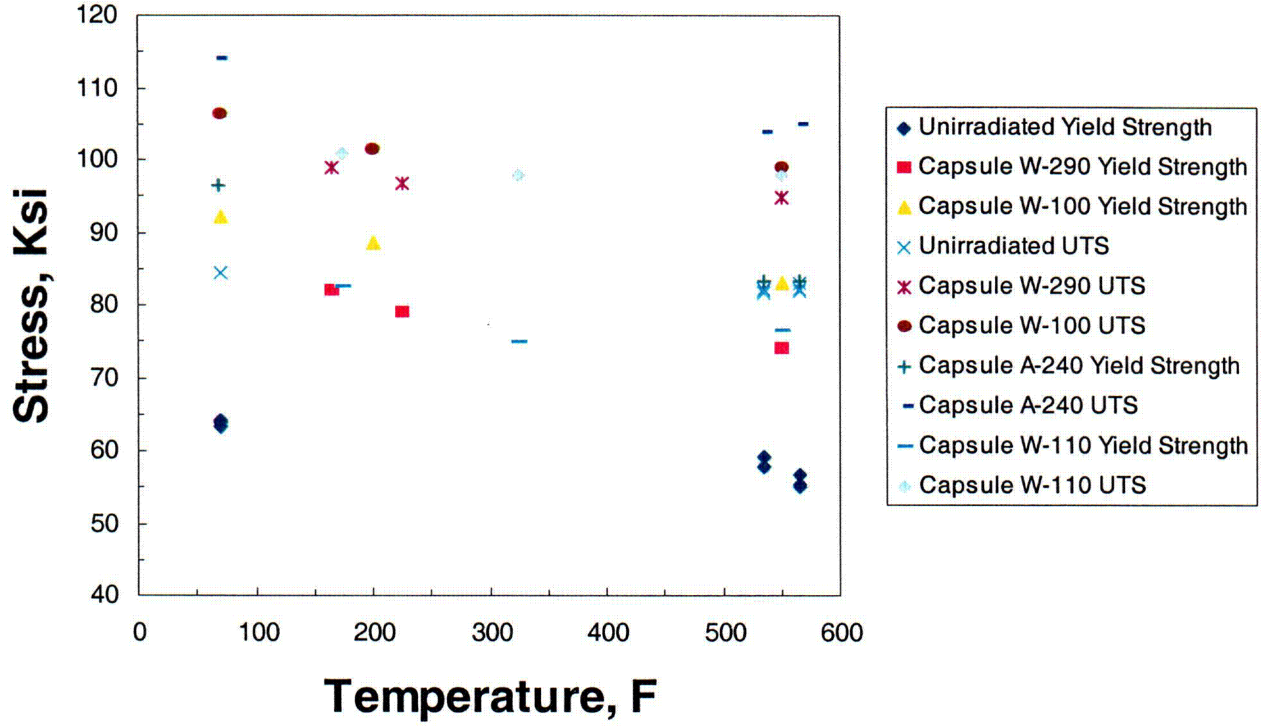


Figure 6-15. Tensile Strength Properties for Palisades Surveillance HAZ Metal

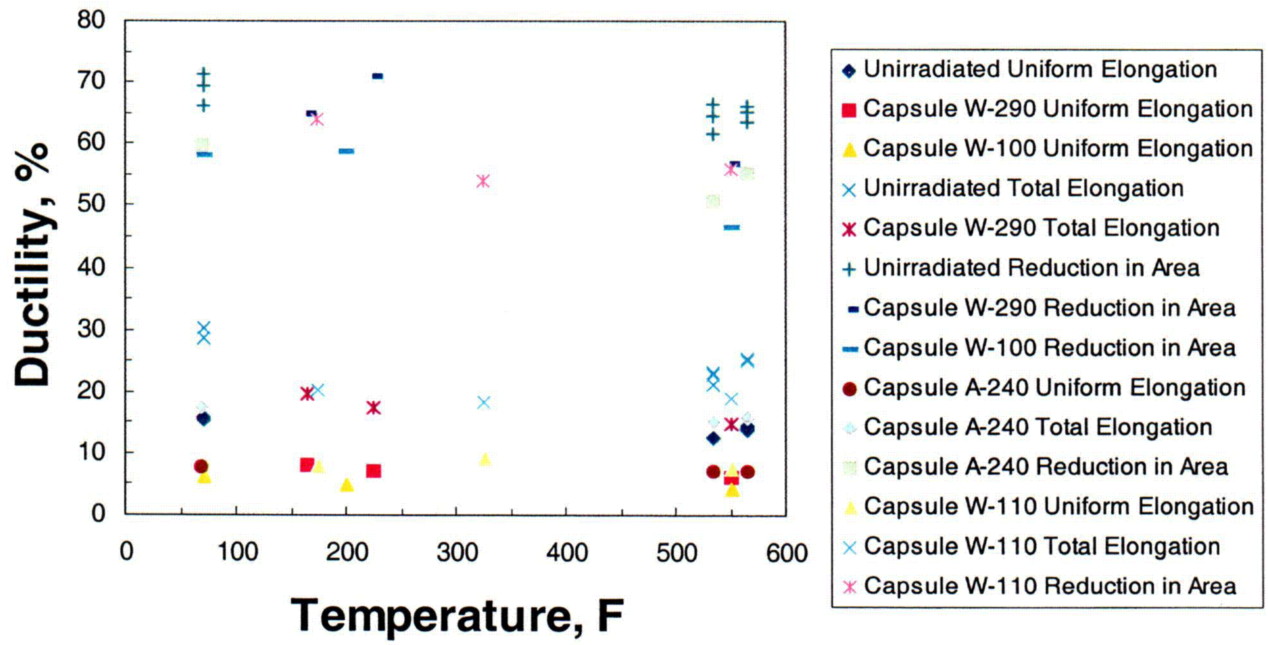


Figure 6-16. Ductility of Palisades Surveillance HAZ Metal

C14

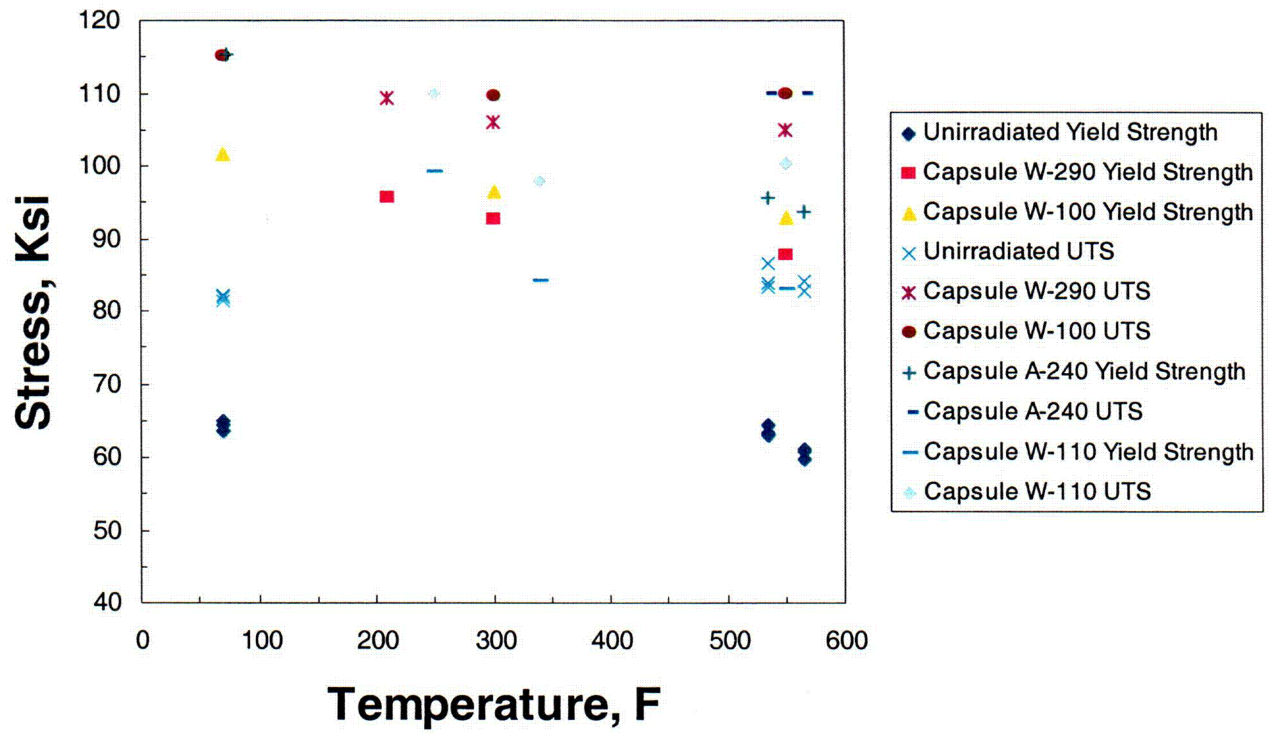


Figure 6-17. Tensile Strength Properties for Palisades Surveillance Weld Metal

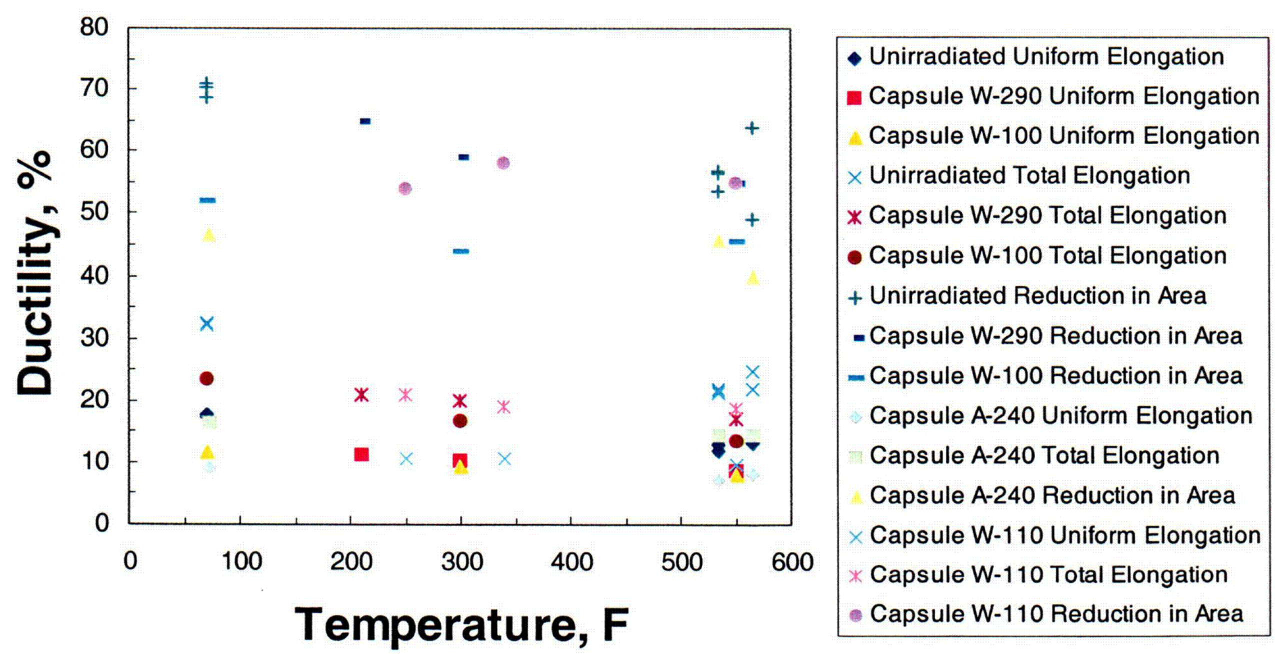


Figure 6-18. Ductility of Palisades Surveillance Weld Metal

C15

7.0 DOSIMETER ANALYSIS

There were three dosimeter sets installed in the top, middle, and bottom portion of the capsule. Included in each set were flux monitors and iron attenuation monitors. The flux monitors consisted of cadmium shielded Ni and Cu wires, as well as shielded U powder. Unshielded Ti and Fe wires were also included, along with unshielded U powder.

The flux monitors were contained in 0.125" diameter capsules, and the attenuation monitors were contained in 0.0625" diameter capsules for identification purposes. In addition, each capsule was identified by a number of grooves in the outer capsule.

During disassembly it was found that the iron flux monitors consisted of 5 wire segments that could not be laid end to end on one PetriSlide™. Consequently, three wires were counted as one set on one slide, and the other two wires were counted as another set on a second slide.

7.1 Dosimeter Preparation

The dosimeters were retrieved from the dosimeter blocks in accordance with TP-653 and stored in vials identified by the position of the dosimeter block in the assembly (Top, Middle, Bottom). The analyte nuclides were verified during gamma scanning.

The fission powder capsules were clamped in a vise mounted on two lead bricks in a hood. A flat mill-bastard file was used to file the capsules open. The fission powder was carefully collected in vials with appropriate labels.

The dosimeter wires were prepared as described in TP-115, "Neutron Flux Dosimeter Quantitative Gamma Spectrographic Analysis." Each wire was washed in reagent grade acetone, blotted dry with a laboratory towel, its diameter measured with a certified micrometer caliper, and weighed on a certified analytical balance. Each was then mounted in the center of a PetriSlide™ with double-sided tape.

The exact oxide composition of the uranium dosimeters was uncertain. It was not possible to correct for self-absorption of the powders, so it was necessary to dissolve them and put them into a geometry for which the gamma spectrometer was calibrated. This was the 20 cc liquid scintillation vial geometry. The uranium dosimeters were dissolved in 8N HNO_3 acid and diluted to 20 mL in the same acid in a pre-weighed 20 cc scintillation vial. The total uranium content was measured by inductively coupled plasma spectroscopy (ICP) per TP-781 "Operation of the Thermo Jarrell-Ash Polyscan 61E".

The cadmium shielding on the copper dosimetry could not be physically separated from the copper wire, so it was dissolved in 1 ml concentrated HNO_3 with 3 ml concentrated HCl acid, diluted to 20 ml in 8N HNO_3, and preweighed in a 20 cc scintillation vial. The total copper content was then measured by inductively coupled plasma spectroscopy.

7.2 Quantitative Gamma Spectrometry

Each of the dosimeters, in the PetriSlide™ (point source) or 20 cc vial geometry, was given a 300 second preliminary count. This provided information with which to best judge the distance at which to count the dosimeter to get a minimum of 10,000 counts in the photopeak of interest while keeping the counter dead time below 15%. It also provided qualitative identification of the dosimeters. This identification was made from the presence of the gamma rays in the table below.

Table 7-1
Table of Quantifying Gamma Rays

Dosimeter	Analyte
Iron	^{54}Mn @ 834 keV from ^{54}Fe
Nickel	^{58}Co @ 811 keV from ^{58}Ni
Copper	^{60}Co @ 1332 keV from ^{63}Cu
Titanium	^{46}Sc @1121 keV from ^{46}Ti
^{238}U	^{137}Cs @ 662 keV

The spectra were used to confirm the identities of the dosimeters.

The spectra were then measured quantitatively at the appropriate counting positions and for the appropriate count times determined from the preliminary counts.

7.3 Geometry Corrections

The detector was calibrated for the wire dosimeters with a "point source" standard and for the 20 cc vial with a 20 cc vial standard. In either case, a NIST-traceable mixed gamma standard was used. The uranium dosimeters were counted in an identical geometry to the standard, so no corrections for geometry and attenuation were required for them. The wires were not identical to the point source, so corrections for the differences between the dosimeter and the standard were required.

The point source standard was made up of a mixed gamma ray source, which was sandwiched, between two pieces of film. The source was actually a spot a few millimeters in diameter and was very thin. The calibration was performed with this source mounted against the surface of a PetriSlide™, oriented with the plane of the spot parallel to the face of the detector. The wire dosimeters were mounted on a thin piece of double-sided adhesive tape in the center of the face of a PetriSlide™. This placed the closest point on the dosimeter at the plane of the calibration source, with the bulk of it at some distance from the calibration distance.

The area covered by the dosimeter was not greatly different from that of the standard source spot. A correction was made for the slight difference in distance between the center of mass of the dosimeter wire and center of mass of the standard point source in the following manner. It was assumed that the activity was distributed uniformly throughout the dosimeter. The dosimeter wire was partitioned into four slabs parallel to the face of the detector, and a weighted average $1/r^2$ correction for the distance between the center of each slab and the plane of the calibration source was calculated. The weight factor was based on the relative mass of each slab. Since it was assumed that the wire was uniform in composition, the weight factors were proportional to the cross-sectional area of each slab.

The weighted correction factor, F_G, was given by:

$$F_G = \sum_{i=1}^{4} W_i \left(\frac{R_0}{R_i} \right)^2$$

where F_G was the weighted correction factor, W_i was the weight factor for each slab, R_0 was the distance from the detector face to the plane of the calibration standard, and R_i was the distance from the detector face to the center of each slab. The distance R_0 was measured directly for the detector/sample holder combination used. The distance R_i was the sum of this distance and the distance between the plane of the standard and the center of each slab. For a wire of diameter **D**, these are:

$$R_1 = R_0 + \frac{D}{8}$$

$$R_2 = R_0 + 3\frac{D}{8}$$

$$R_3 = R_0 + 5\frac{D}{8}$$

$$R_4 = R_0 + 7\frac{D}{8}$$

The weight factors sum to unity. In the case of a wire, the weight factors were derived from the cross-sectional area that is a circle. This circle was divided into four slabs of equal thickness, the thickness of which was **D/4=r/2**, where **r** was the radius of the wire. Two of the slabs were circular segments and the other two were slices of the circle. This is shown schematically in Figure 7-1.

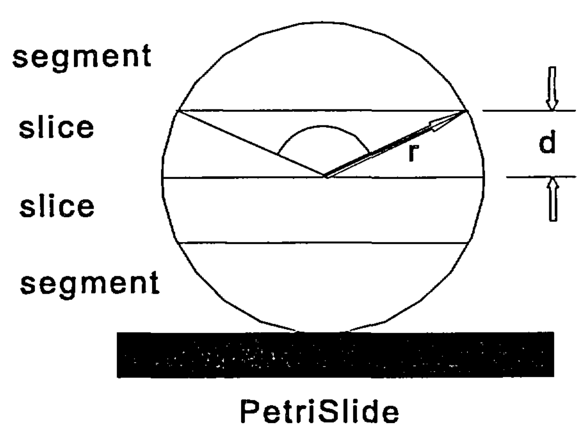


Figure 7-1 Wire on PetriSlide™

$$r = radius\ of\ wire$$

$$d = \frac{r}{2}$$

$$\theta = 2\,\mathrm{Cos}^{-1}\left(\frac{d}{r}\right)$$

$$K_{segment} = \left(\frac{1}{2}\right) r^2 (\theta - \sin(\theta))$$

$$K_{circle} = \pi r^2$$

$$K_{slice} = \left(\frac{1}{2}\right) K_{circle} - K_{segment}$$

$$W_{segment} = \frac{K_{segment}}{K_{circle}} = 0.1955$$

$$W_{slice} = 0.5 - W_{segment} = 0.3045$$

The areas **K** were calculated for a wire of unit radius. The weight factors for the slabs were calculated as the ratios of the segment or slice to the area of the circle. The measured activities were corrected for the geometry offset by dividing the activities by the weighted correction factor $\mathbf{F_G}$.

7.4 Attenuation Corrections for Wire Dosimeter

The self-absorption of low energy gamma rays in some of the dosimeters can be significant, depending on the energy of the gamma-ray photon, the wire composition, and the diameter of the wire. Self-absorption corrections were calculated for all of the gamma-ray and dosimeter combinations. The cylindrical wire source model of Evans and Evans [17] was used to compute the self-absorption factors for the wires. Equations 26 and 27 of Evans and Evans [17] were used for the calculations.

$$N_2 = N_0\left[G_2 - \left(\frac{8}{3\pi}\right)\mu r U_2 + \left(\frac{1}{2}\right)\mu^2 r^2 V_2 - \left(\frac{32}{45\pi}\right)\mu^3 r^3 W_2 + \left(\frac{1}{12}\right)\mu^4 r^4 X_2 + \mathrm{K}\right],$$

$$\textit{with:}$$

$$G_2 = 1 + \left(\frac{1}{2}\right)\left(\frac{r^2}{R_0^2}\right) + \left(\frac{5}{8}\right)\left(\frac{r^4}{R_0^4}\right) + \mathrm{K},$$

$$U_2 = 1 - \left(\frac{3\pi}{16}\right)\left(\frac{r}{R_0}\right) + \left(\frac{3}{5}\right)\left(\frac{r^2}{R_0^2}\right) - \left(\frac{5\pi}{32}\right)\left(\frac{r^3}{R_0^3}\right) + \mathrm{K},$$

$$V_2 = 1 - \left(\frac{128}{45\pi}\right)\left(\frac{r}{R_0}\right) + \left(\frac{5}{6}\right)\left(\frac{r^2}{R_0^2}\right) + \mathrm{K},$$

$$W_2 = 1 - \left(\frac{45\pi}{128}\right)\left(\frac{r}{R_0}\right) + \mathrm{K},$$

$$X_2 = 1 - \mathrm{K},$$

and,

$\mathbf{N_0}$	= the true "point source" activity,
$\mathbf{N_2}$	= self-absorption corrected activity,
r	= wire radius,
$\mathbf{R_0}$	= wire-to-detector distance, cm,
μ	= $\rho\mu_0$ = linear attenuation coefficient cm^{-1},
ρ	= density, g/cm^3,
μ_0	= mass attenuation coefficient, cm^2/g.

Values for the density of the wires were taken from the CRC Handbook of Chemistry and Physics, 63rd Edition [18]. Values for the mass attenuation coefficients were interpolated from the Storm and Israel tables [19]. The log-log polynomial technique of Hsu and Dowdy [20] was used for the interpolation.

7.5 Dosimeter Specific Activities

The isotopic fractions of the target nuclides were obtained from the CRC Handbook of Chemistry and Physics, 63rd Edition [18] and elemental weight fractions were obtained from either ICP or were based on values obtained from Palisades. Table 7-2 summarizes this information.

Table 7-2
Isotopic Fractions and Assumed Weight Fractions of Target Nuclides

Dosimeter	Target Nuclide	Isotopic Fraction of Target	Assumed Weight Fraction of Target Element
Iron	^{54}Fe	0.057	0.99865
Nickel	^{58}Ni	0.6739	0.99951
Copper	^{63}Cu	0.6850	ICP
Titanium	^{46}Ti	0.0793	0.99793
Uranium	^{238}U	1.0	ICP

The weight fraction listed in the data tables is the product of the isotopic fraction of the target and the weight fraction of the element in the dosimeter. In the case of the ^{238}U dosimeters, the total uranium content was measured by inductively coupled plasma (ICP) atomic emission spectroscopy and that value and the ^{137}Cs activity were used to calculate the specific activity. ICP was also used to determine the weight of the copper that was retrieved following dissolution of the cadmium sheathing.

The dosimeter specific activities were calculated by dividing the corrected activity of the analyte nuclide by the target nuclide mass. All results are decay corrected to the reactor shutdown date of March 16, 2003. The results are shown in Tables 7-3 through 7-5, and the detailed calculations can be found in Appendix G.

Table 7-3
Specific Activities for Top Capsule in Palisades W-100 Dosimetry
(Decay Corrected to Reactor Shutdown Date of March 16, 2003)

Flux Monitor	Specimen Identification	Shielded (Yes/No)	Target Nuclide	Analyte Nuclide	Specific Activity (μCi/gram of target)
U	T81	No	U-238	Cs-137	4.220E+01
Ti	T82	No	Ti-46	Sc-46	1.798E+02
Fe (1st set)	T83A	No	Fe-54	Mn-54	5.520E+02
Fe (2nd set)	T83B	No	Fe-54	Mn-54	5.909E+02
U	T85	Yes	U-238	Cs-137	2.109E+01
Ni	T86	Yes	Ni-58	Co-58	9.256E+02
Cu	T87	Yes	Cu-63	Co-60	5.743E+00

Attenuation Monitor (# grooves)	Specimen Identification	Shielded (Yes/No)	Target Nuclide	Analyte Nuclide	Specific Activity (μCi/gram of target)
Fe (1)	T161	No	Fe-54	Mn-54	6.068E+02
Fe (2)	T162	No	Fe-54	Mn-54	5.885E+02
Fe (3)	T163	No	Fe-54	Mn-54	6.174E+02
Fe (4)	T164	No	Fe-54	Mn-54	6.037E+02
Fe (5)	T165	No	Fe-54	Mn-54	5.735E+02

Table 7-4

Specific Activities for Middle Capsule in Palisades W-100 Dosimetry
(Decay Corrected to Reactor Shutdown Date of March 16, 2003)

Flux Monitor	Specimen Identification	Shielded (Yes/No)	Target Nuclide	Analyte Nuclide	Specific Activity (μCi/gram of target)
U	M81	No	U-238	Cs-137	3.051E+01
Ti	M82	No	Ti-46	Sc-46	1.584E+02
Fe (1st set)	M83A	No	Fe-54	Mn-54	4.822E+02
Fe (2nd set)	M83B	No	Fe-54	Mn-54	5.112E+02
U	M85	Yes	U-238	Cs-137	1.106E+01
Ni	M86	Yes	Ni-58	Co-58	8.204E+02
Cu	M87	Yes	Cu-63	Co-60	6.192E+00

Attenuation Monitor (# grooves)	Specimen Identification	Shielded (Yes/No)	Target Nuclide	Analyte Nuclide	Specific Activity (μCi/gram of target)
Fe (1)	M161	No	Fe-54	Mn-54	5.772E+02
Fe (2)	M162	No	Fe-54	Mn-54	5.857E+02
Fe (3)	M163	No	Fe-54	Mn-54	6.093E+02
Fe (4)	M164	No	Fe-54	Mn-54	5.345E+02
Fe (5)	M165	No	Fe-54	Mn-54	6.470E+02

Table 7-5
Specific Activities for Bottom Capsule in Palisades W-100 Dosimetry
(Decay Corrected to Reactor Shutdown Date of March 16, 2003)

Flux Monitor	Specimen Identification	Shielded (Yes/No)	Target Nuclide	Analyte Nuclide	Specific Activity (μCi/gram of target)
U	B81	No	U-238	Cs-137	4.641E+01
Ti	B82	No	Ti-46	Sc-46	1.800E+02
Fe (1st set)	B83A	No	Fe-54	Mn-54	5.818E+02
Fe (2nd set)	B83B	No	Fe-54	Mn-54	6.423E+02
U	B85	Yes	U-238	Cs-137	2.086E+01
Ni	B86	Yes	Ni-58	Co-58	8.137E+02
Cu	B87	Yes	Cu-63	Co-60	7.058E+00

Attenuation Monitor (# grooves)	Specimen Identification	Shielded (Yes/No)	Target Nuclide	Analyte Nuclide	Specific Activity (μCi/gram of target)
Fe (1)	B161	No	Fe-54	Mn-54	5.642E+02
Fe (2)	B162	No	Fe-54	Mn-54	6.069E+02
Fe (3)	B163	No	Fe-54	Mn-54	5.919E+02
Fe (4)	B164	No	Fe-54	Mn-54	6.192E+02
Fe (5)	B165	No	Fe-54	Mn-54	5.664E+02

8.0 REFERENCES

1. Regulatory Guide 1.99, Revision 2, Radiation Embrittlement of Reactor Vessel Materials, U.S. Nuclear Regulatory Commission, May 1988.

2. Code of Federal Regulations, 10CFR50, Appendix G, Fracture Toughness Requirements, and Appendix H, Reactor Vessel Material Surveillance Program Requirements, U.S. Nuclear Regulatory Commission, Washington, D.C.

3. Groeschel, R. C., Summary Report on Manufacture of Test specimens and Assembly of Capsules for Irradiation Surveillance of Palisades Reactor Vessel Materials, CE Report No. P-NLM-019, April 1, 1971.

4. Section XI of the ASME Boiler and Pressure Vessel Code, Appendix G, Fracture Toughness Criteria for Protection Against Failure.

5. ASTM E208, Standard Test Method for Conducting Drop-Weight Test to Determine Nil-Ductility Transition Temperature of Ferritic Steels, in ASTM Standards, Section 3, American Society for Testing and Materials, Philadelphia, PA.

6. ASTM E185-82, Standard Practice for Conducting Surveillance Tests for Light-Water Cooled Nuclear Power Reactor Vessels, E706 (IF), in ASTM Standards, Section 3, American Society for Testing and Materials, Philadelphia, PA, 1993.

7. ASTM E23-93, Standard Test Methods for Notched Bar Impact Testing of Metallic Materials, in ASTM Standards, Section 3, American Society for Testing and Materials, Philadelphia, PA, 1993.

8. ASTM A370-92, Standard Test Methods and Definitions for Mechanical Testing of Steel Products, in ASTM Standards, Section 3, American Society for Testing and Materials, Philadelphia, PA 1993.

9. ASTM E8-94, Standard Test Methods for Tension Testing of Metallic Materials, in ASTM Standards, Section 3, American Society for Testing and Materials, Philadelphia, PA 1994.

10. ASTM E21-92, Standard Test Methods for Elevated Temperature Tension Tests of Metallic Materials, in ASTM Standards, Section 3, American Society for Testing and Materials, Philadelphia, PA 1993.

11. ASTM E83-93, Standard Practice for Verification and Classification of Extensometers, in ASTM Standards, Section 3, American Society for Testing and Materials, Philadelphia, PA 1993.

12. Perrin and Fromm, "Final Report on Palisades Pressure Vessel Irradiation Program: Unirradiated Mechanical Properties to Consumers Power," August 25, 1977.

13. Perrin, Fromm, Farmelo, Denning and Jung "Final Report on Palisades Reactor Pressure Vessel Surveillance Program: Capsule A-240 to ConsumersPower," BCL-585-12, March 13, 1979.

14. Kunka and Cheney, "Analysis of Capsules T-330 and W-290 from the Consumers Power Company Reactor Vessel Radiation Surveillance Program," WCAP-10637, September 1984.

15. Peter, Lippincott, Wrights and Madeyski, "Analysis of Capsule W-110 from the Consumers Power Company Reactor Vessel Radiation Surveillance Program," WCAP-14014, May 1994.

16. Lippincott, E.P., "Consumers Power Company Palisades Nuclear Plant Reactor Vessel Fluence Analysis", WCAP-13348, May 1992.

17. R. D. Evans and R. O. Evans, "Studies of Self-Absorption in Gamma-Ray Sources," *Reviews of Modern Physics*, 20, 305-326, (January 1948).

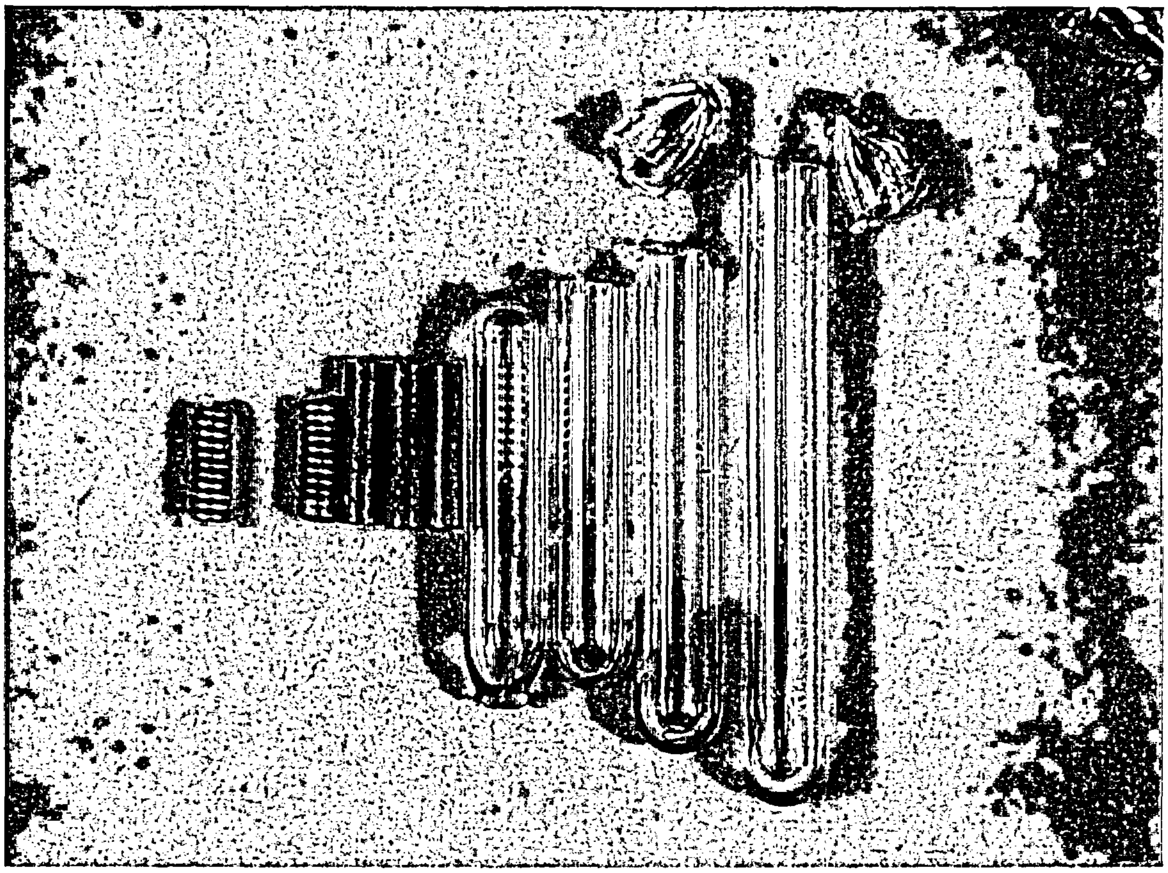
18. R. C. Weast and M. J. Astle, Eds., "CRC Handbook of Chemistry and Physics, 63rd Ed.," CRC Press, Boca Raton, FL, 1982.

19. E. Storm and H. I. Israel, "Photon Cross Sections from 0.001 to 100 MeV for Elements 1 through 100," Los Alamos Scientific Laboratory of the University of California, Los Alamos, NM, LA-3753, UC-34, PHYSICS, TID-4500, June 1967.

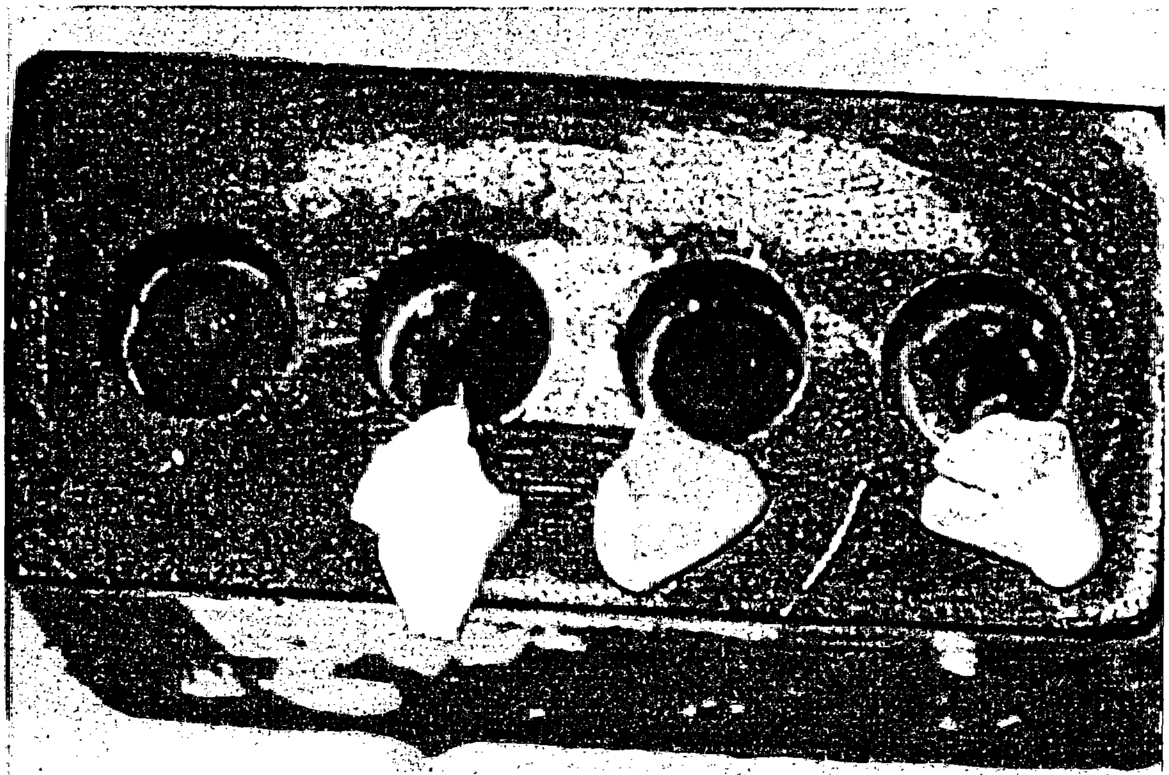
20. H.H. Hsu and E.J. Dowdy, "An Interpolation Technique for Gamma-Ray Attenuation Coefficients from 40 keV to 15 MeV,"*Nuclear Instruments and Methods*, 204, 505-509 (1983).

APPENDIX A

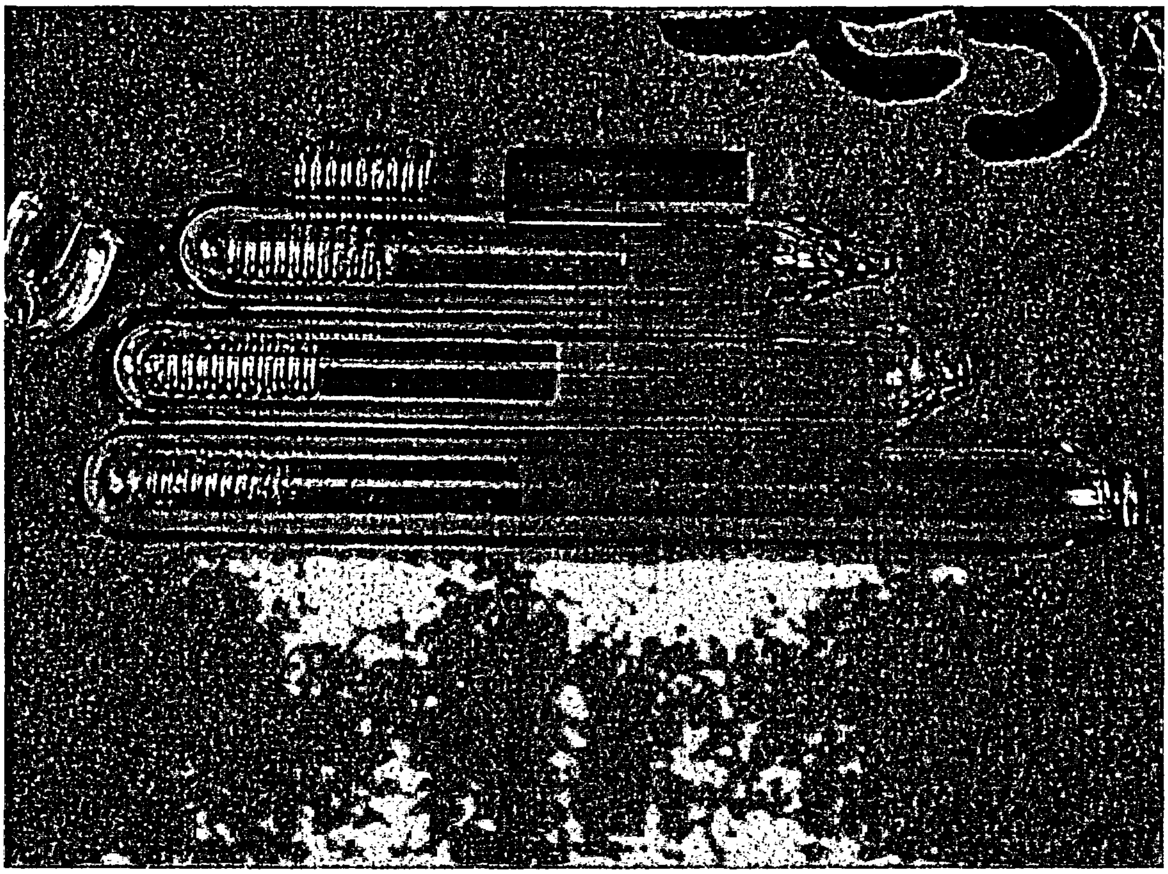
PHOTOGRAPHS OF THERMAL MONITORS PALISADES CAPSULE W-100



Unmelted temperature monitor coils in top segment #1. Melting temperatures increase with increasing capsule length.



Temperature monitors stuck in middle capsule #4, due to water ingress into capsule compartment.



Unmelted temperature monitor coils in bottom segment #7. Melting temperatures increase with increasing capsule length.

APPENDIX B

CHARPY IMPACT TEST RESULTS
PALISADES CAPSULE W-100

W-100 PLATE (LONGITUDINAL)

CVGRAPH 5.0.1 Hyperbolic Tangent Curve Printed on 01/08/2004 10:29 AM

Page 1

Coefficients of Curve 1

A = 52.1 B = 49.9 C = 73.2 T0 = 193.41 D = 0.00E+00

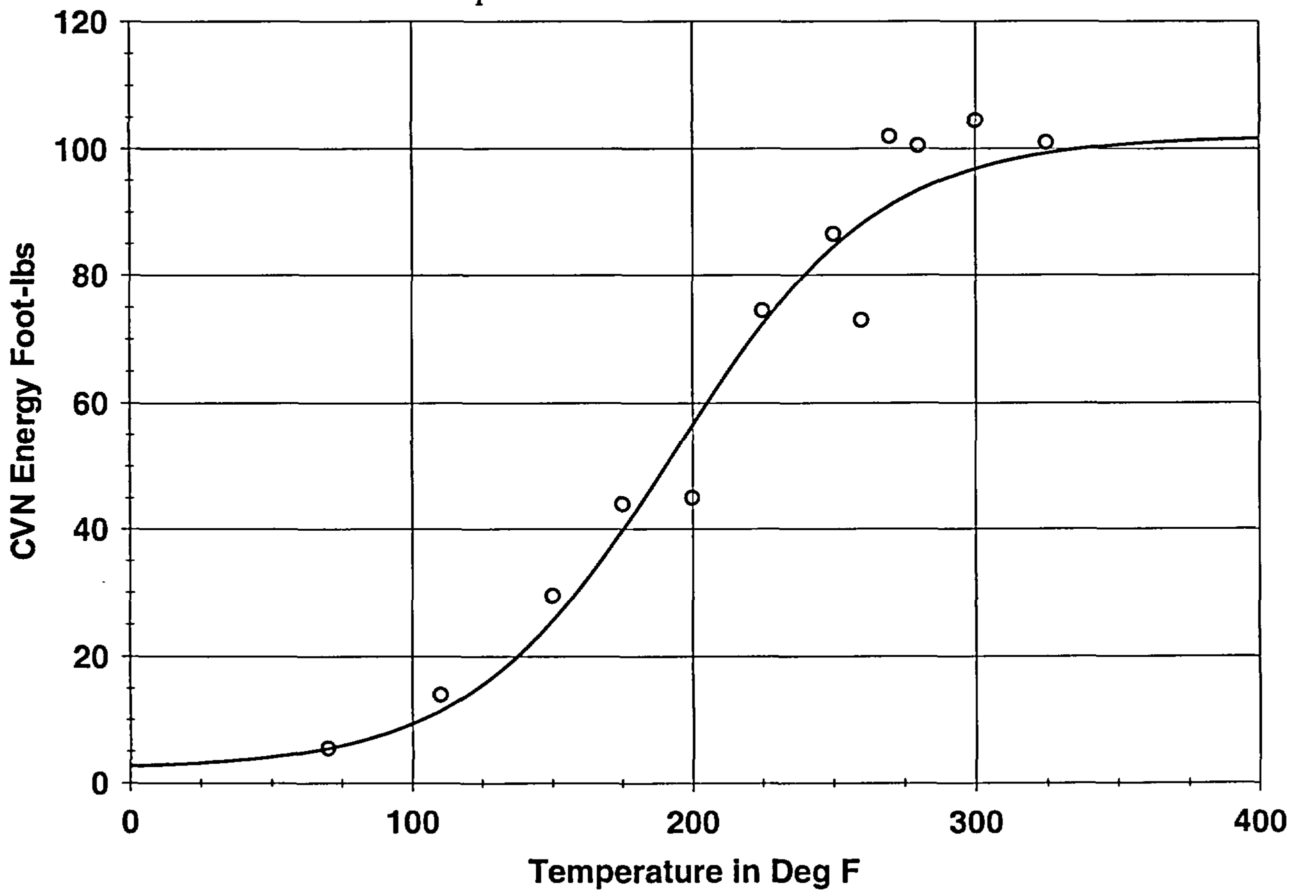
Equation is A + B * [Tanh((T-To)/(C+DT))]

Upper Shelf Energy=102.0(Fixed) Lower Shelf Energy=2.2(Fixed)

Temp@30 ft-lbs=158.6 Deg F Temp@50 ft-lbs=190.4 Deg F

Plant: PALISADES Material: D-3803-1 Heat: C-1279

Orientation: LT Capsule: W-100 Fluence: 2.09E19 n/cm^2



Charpy V-Notch Data

Temperature	Input CVN	Computed CVN	Differential
70.00	5.50	5.51	-.01
110.00	14.00	11.47	2.53
150.00	29.50	25.55	3.95
175.00	44.00	39.81	4.19
200.00	45.00	56.58	-11.58
225.00	74.50	72.39	2.11
250.00	86.50	84.47	2.03
260.00	73.00	88.08	-15.08
270.00	102.00	91.04	10.96

W-100 PLATE (LONGITUDINAL)

Plant: PALISADES Material: D-3803-1 Heat: C-1279
Orientation: LT Capsule: W-100 Fluence: 2.09E19 n/cm^2

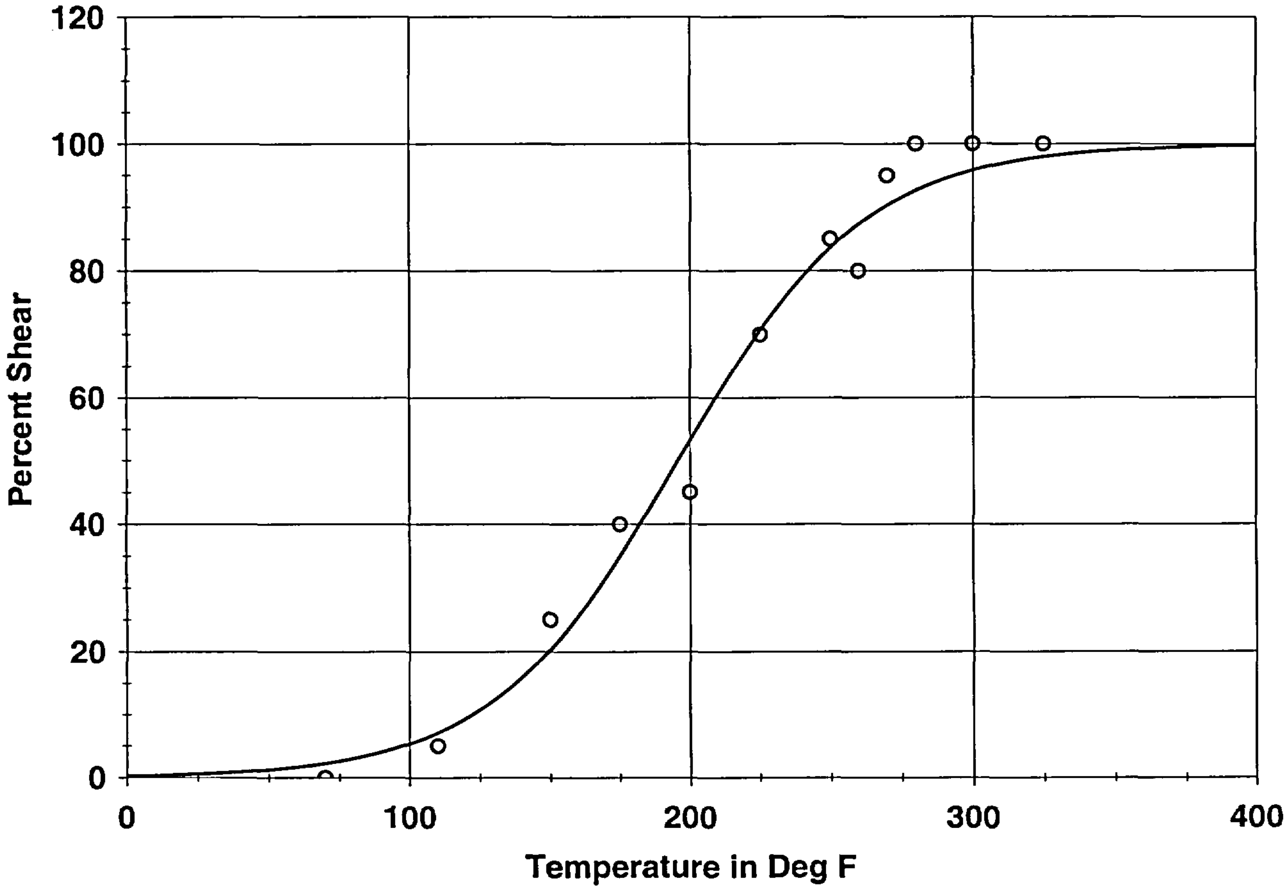
Charpy V-Notch Data

Temperature	Input CVN	Computed CVN	Differential
280.00	100.50	93.44	7.06
300.00	104.50	96.86	7.64
325.00	101.00	99.33	1.67

Correlation Coefficient = .978

W-100 PLATE (LONGITUDINAL)

CVGRAPH 5.0.1 Hyperbolic Tangent Curve Printed on 01/08/2004 10:30 AM
Page 1
Coefficients of Curve 1
A = 50. B = 50. C = 66.65 T0 = 195.62 D = 0.00E+00
Equation is A + B * [Tanh((T-To)/(C+DT))]
Temperature at 50% Shear = 195.7
Plant: PALISADES Material: D-3803-1 Heat: C-1279
Orientation: LT Capsule: W-100 Fluence: 2.09E19 n/cm^2



Charpy V-Notch Data

Temperature	Input Percent Shear	Computed Percent Shear	Differential
70.00	.00	2.25	-2.25
110.00	5.00	7.11	-2.11
150.00	25.00	20.28	4.72
175.00	40.00	35.01	4.99
200.00	45.00	53.28	-8.28
225.00	70.00	70.71	-.71
250.00	85.00	83.64	1.36
260.00	80.00	87.34	-7.34
270.00	95.00	90.31	4.69

W-100 PLATE (LONGITUDINAL)

Plant: PALISADES Material: D-3803-1 Heat: C-1279
Orientation: LT Capsule: W-100 Fluence: 2.09E19 n/cm^2

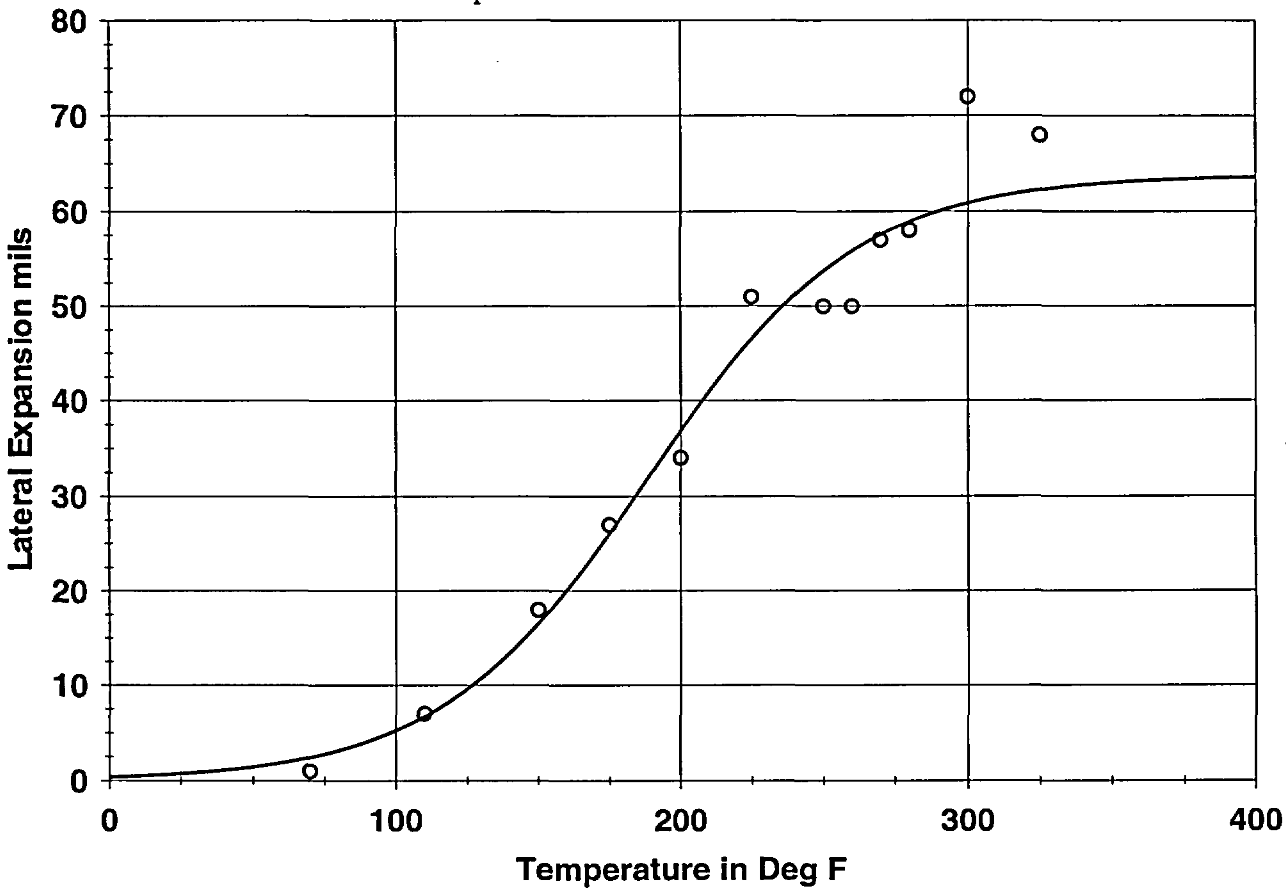
Charpy V-Notch Data

Temperature	Input Percent Shear	Computed Percent Shear	Differential
280.00	100.00	92.63	7.37
300.00	100.00	95.82	4.18
325.00	100.00	97.98	2.02

Correlation Coefficient = .992

W-100 PLATE (LONGITUDINAL)

CVGRAPH 5.0.1 Hyperbolic Tangent Curve Printed on 01/08/2004 10:35 AM
Page 1
Coefficients of Curve 1
A = 31.9 B = 31.9 C = 73.39 T0 = 188.47 D = 0.00E+00
Equation is A + B * [Tanh((T-To)/(C+DT))]
Upper Shelf L.E.=63.8(Fixed) Lower Shelf L.E.=.0(Fixed)
Temp.@L.E. 35 mils=195.7 Deg F
Plant: PALISADES Material: D-3803-1 Heat: C-1279
Orientation: LT Capsule: W-100 Fluence: 2.09E19 n/cm^2



Charpy V-Notch Data

Temperature	Input L.E.	Computed L.E.	Differential
70.00	1.00	2.43	-1.43
110.00	7.00	6.73	.27
150.00	18.00	16.56	1.44
175.00	27.00	26.11	.89
200.00	34.00	36.87	-2.87
225.00	51.00	46.59	4.41
250.00	50.00	53.75	-3.75
260.00	50.00	55.85	-5.85
270.00	57.00	57.56	-.56

W-100 PLATE (LONGITUDINAL)

Plant: PALISADES Material: D-3803-1 Heat: C-1279
Orientation: LT Capsule: W-100 Fluence: 2.09E19 n/cm^2

Charpy V-Notch Data

Temperature	Input L.E.	Computed L.E.	Differential
280.00	58.00	58.94	-.94
300.00	72.00	60.89	11.11
325.00	68.00	62.29	5.71

Correlation Coefficient = .981

W-100 PLATE (TRANSVERSE)

CVGRAPH 5.0.1 Hyperbolic Tangent Curve Printed on 01/08/2004 10:37 AM

Page 1

Coefficients of Curve 1

A = 37.6 B = 35.4 C = 77.92 T0 = 177.79 D = 0.00E+00

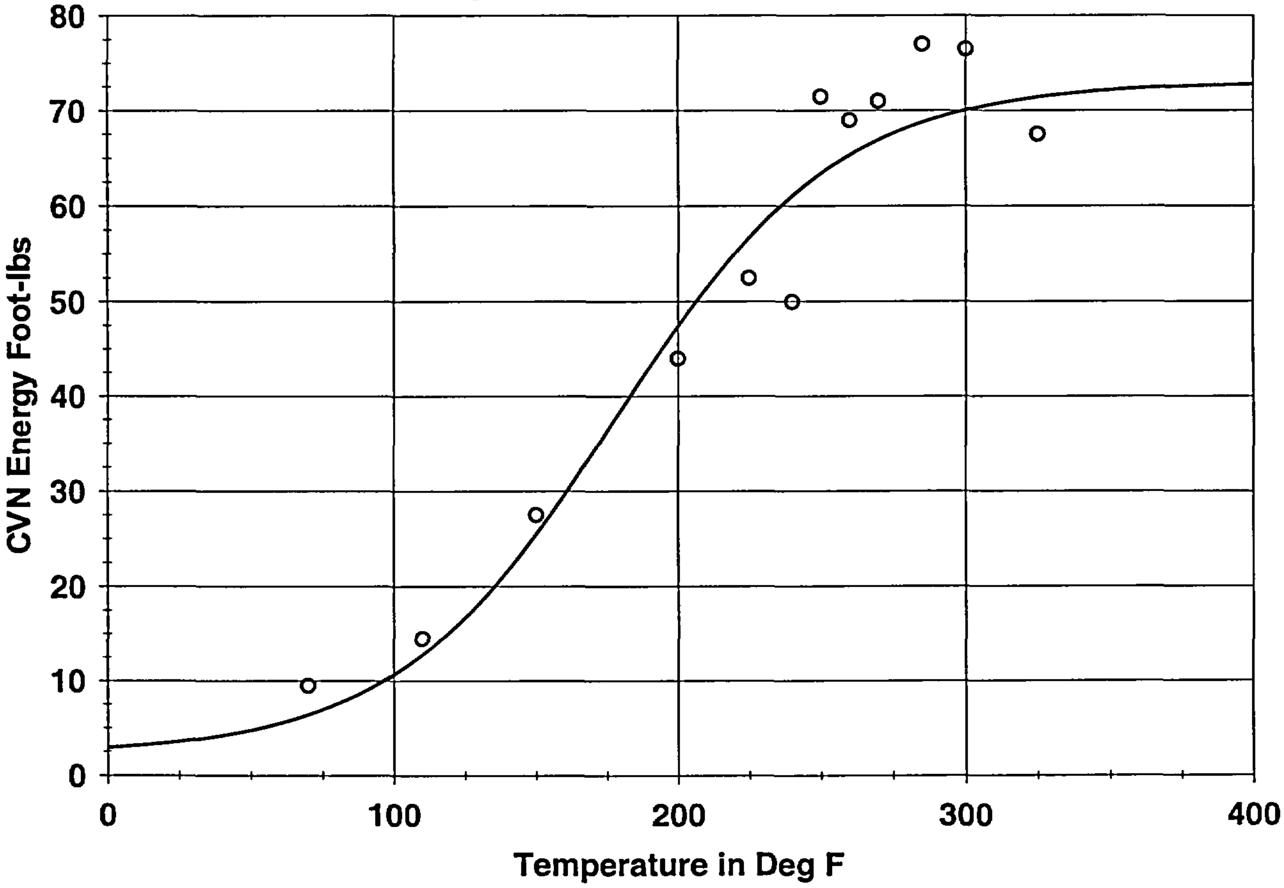
Equation is A + B * [Tanh((T-To)/(C+DT))]

Upper Shelf Energy=73.0(Fixed) Lower Shelf Energy=2.2(Fixed)

Temp@30 ft-lbs=160.8 Deg F Temp@50 ft-lbs=206.3 Deg F

Plant: PALISADES Material: D-3803-1 Heat: C-1279

Orientation: TL Capsule: W-100 Fluence: 2.09E19 n/cm^2



Charpy V-Notch Data

Temperature	Input CVN	Computed CVN	Differential
70.00	9.50	6.39	3.11
110.00	14.50	12.77	1.73
150.00	27.50	25.48	2.02
200.00	44.00	47.42	-3.42
225.00	52.50	56.76	-4.26
240.00	50.00	61.07	-11.07
250.00	71.50	63.41	8.09
260.00	69.00	65.34	3.66
270.00	71.00	66.93	4.07

W-100 PLATE (TRANSVERSE)

Plant: PALISADES Material: D-3803-1 Heat: C-1279
Orientation: TL Capsule: W-100 Fluence: 2.09E19 n/cm^2

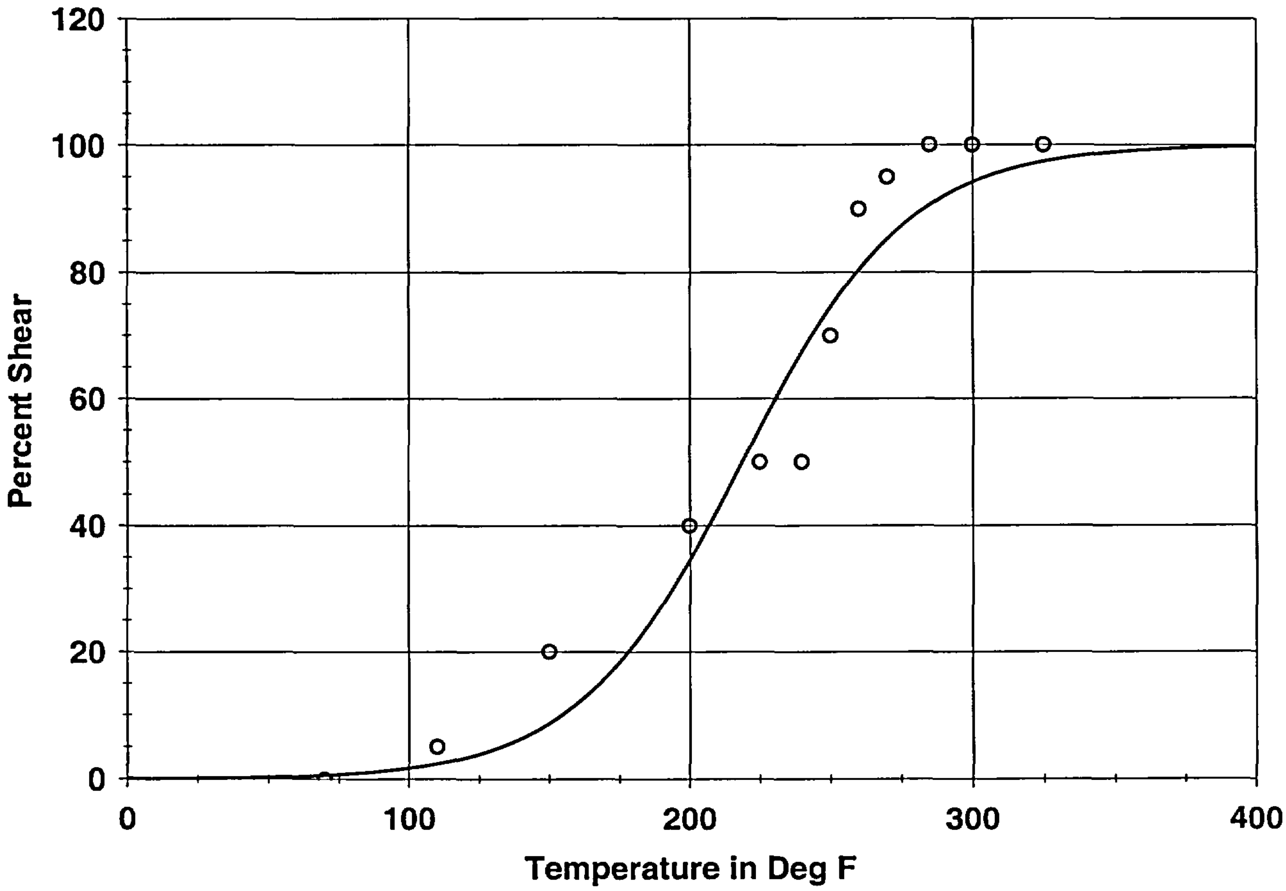
Charpy V-Notch Data

Temperature	Input CVN	Computed CVN	Differential
285.00	77.00	68.75	8.25
300.00	76.50	70.05	6.45
325.00	67.50	71.42	-3.92

Correlation Coefficient = .970

W-100 PLATE (TRANSVERSE)

CVGRAPH 5.0.1 Hyperbolic Tangent Curve Printed on 01/08/2004 10:38 AM
Page 1
Coefficients of Curve 1
A = 50. B = 50. C = 58.39 T0 = 218.6 D = 0.00E+00
Equation is A + B * [Tanh((T-To)/(C+DT))]
Temperature at 50% Shear = 218.7
Plant: PALISADES Material: D-3803-1 Heat: C-1279
Orientation: TL Capsule: W-100 Fluence: 2.09E19 n/cm^2



Charpy V-Notch Data

Temperature	Input Percent Shear	Computed Percent Shear	Differential
70.00	.00	.61	-.61
110.00	5.00	2.37	2.63
150.00	20.00	8.71	11.29
200.00	40.00	34.59	5.41
225.00	50.00	55.46	-5.46
240.00	50.00	67.55	-17.55
250.00	70.00	74.56	-4.56
260.00	90.00	80.50	9.50
270.00	95.00	85.33	9.67

W-100 PLATE (TRANSVERSE)

Plant: PALISADES Material: D-3803-1 Heat: C-1279
Orientation: TL Capsule: W-100 Fluence: 2.09E19 n/cm^2

Charpy V-Notch Data

Temperature	Input Percent Shear	Computed Percent Shear	Differential
285.00	100.00	90.67	9.33
300.00	100.00	94.20	5.80
325.00	100.00	97.45	2.55

Correlation Coefficient = .975

W-100 PLATE (TRANSVERSE)

CVGRAPH 5.0.1 Hyperbolic Tangent Curve Printed on 01/08/2004 10:39 AM

Page 1

Coefficients of Curve 1

A = 28.65 B = 28.65 C = 77.19 T0 = 188.4 D = 0.00E+00

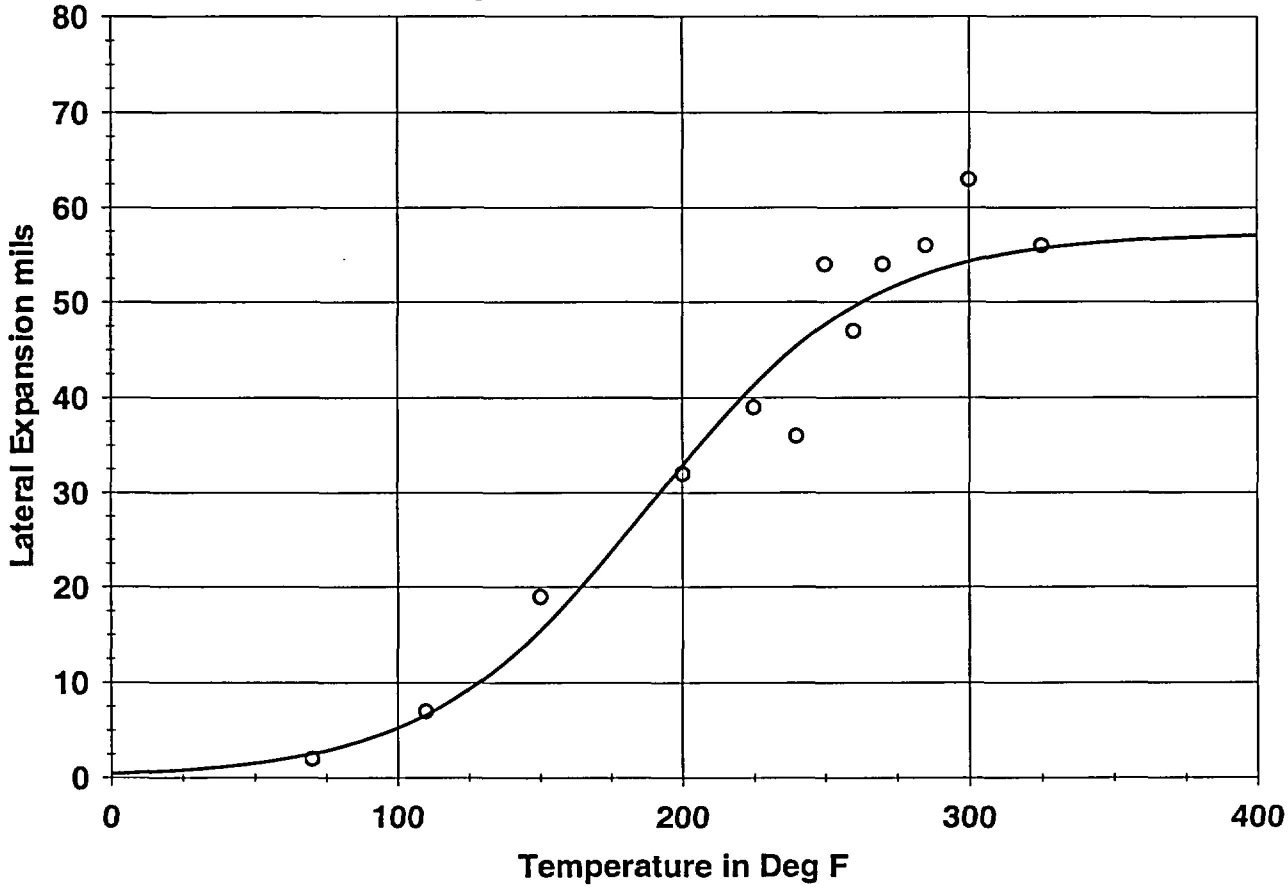
Equation is A + B * [Tanh((T-To)/(C+DT))]

Upper Shelf L.E.=57.3(Fixed) Lower Shelf L.E.=.0(Fixed)

Temp.@L.E. 35 mils=205.9 Deg F

Plant: PALISADES Material: D-3803-1 Heat: C-1279

Orientation: TL Capsule: W-100 Fluence: 2.09E19 n/cm^2



Charpy V-Notch Data

Temperature	Input L.E.	Computed L.E.	Differential
70.00	2.00	2.55	-.55
110.00	7.00	6.64	.36
150.00	19.00	15.47	3.53
200.00	32.00	32.92	-.92
225.00	39.00	41.30	-2.30
240.00	36.00	45.38	-9.38
250.00	54.00	47.64	6.36
260.00	47.00	49.55	-2.55
270.00	54.00	51.13	2.87

W-100 PLATE (TRANSVERSE)

Plant: PALISADES Material: D-3803-1 Heat: C-1279
Orientation: TL Capsule: W-100 Fluence: 2.09E19 n/cm^2

Charpy V-Notch Data

Temperature	Input L.E.	Computed L.E.	Differential
285.00	56.00	52.96	3.04
300.00	63.00	54.29	8.71
325.00	56.00	55.68	.32

Correlation Coefficient = .973

W-100 WELD

CVGRAPH 5.0.1 Hyperbolic Tangent Curve Printed on 01/08/2004 10:40 AM

Page 1

Coefficients of Curve 1

A = 27. B = 24.8 C = 86.51 T0 = 208.2 D = 0.00E+00

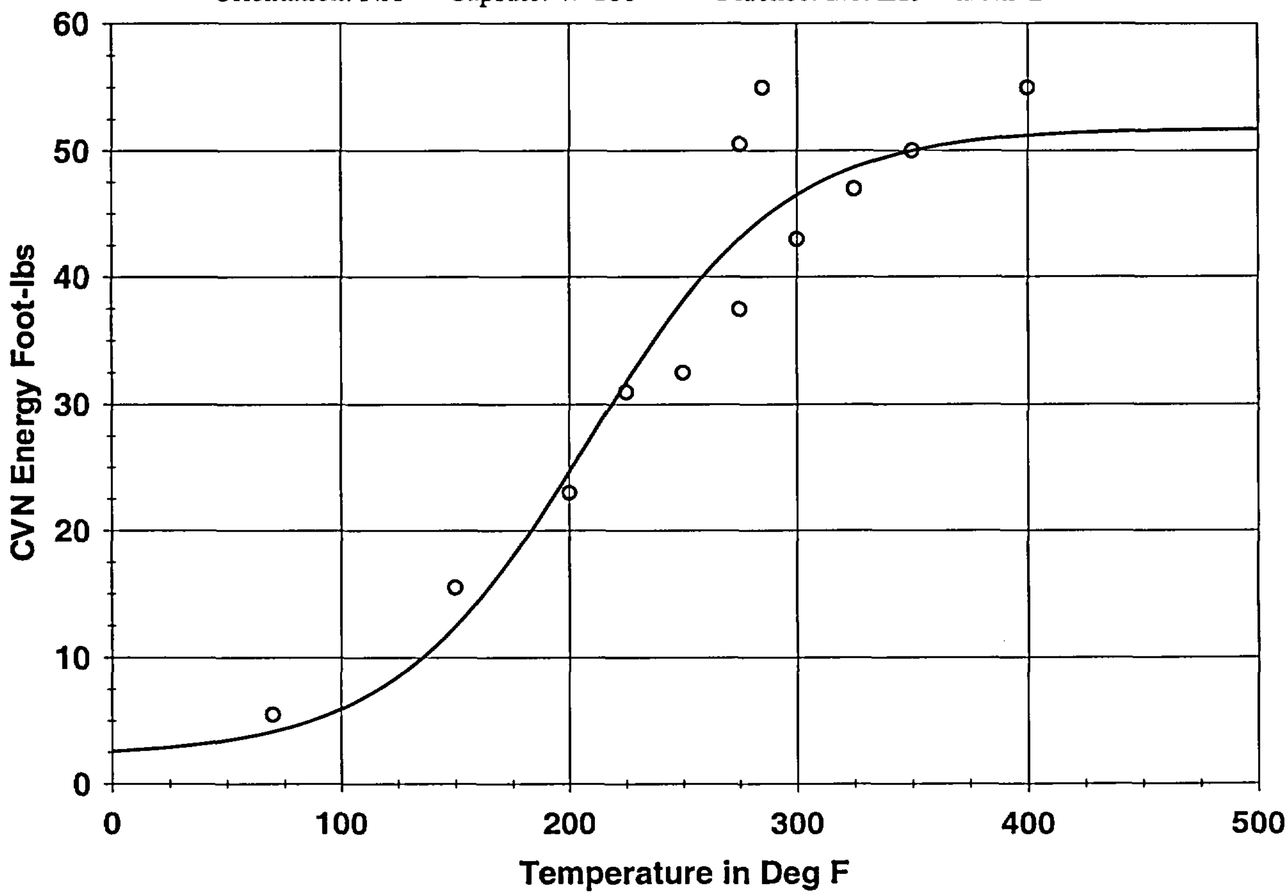
Equation is A + B * [Tanh((T-To)/(C+DT))]

Upper Shelf Energy=51.8(Fixed) Lower Shelf Energy=2.2(Fixed)

Temp@30 ft-lbs=218.8 Deg F Temp@50 ft-lbs=350.1 Deg F

Plant: PALISADES Material: D-3803-1 Heat: C-1279

Orientation: NA Capsule: W-100 Fluence: 2.09E19 n/cm^2



Charpy V-Notch Data

Temperature	Input CVN	Computed CVN	Differential
70.00	5.50	4.15	1.35
150.00	15.50	12.45	3.05
200.00	23.00	24.66	-1.66
225.00	31.00	31.76	-.76
250.00	32.50	38.13	-5.63
275.00	37.50	43.08	-5.58
275.00	50.50	43.08	7.42
285.00	55.00	44.62	10.38
300.00	43.00	46.50	-3.50

W-100 WELD

Plant: PALISADES Material: D-3803-1 Heat: C-1279
Orientation: NA Capsule: W-100 Fluence: 2.09E19 n/cm^2

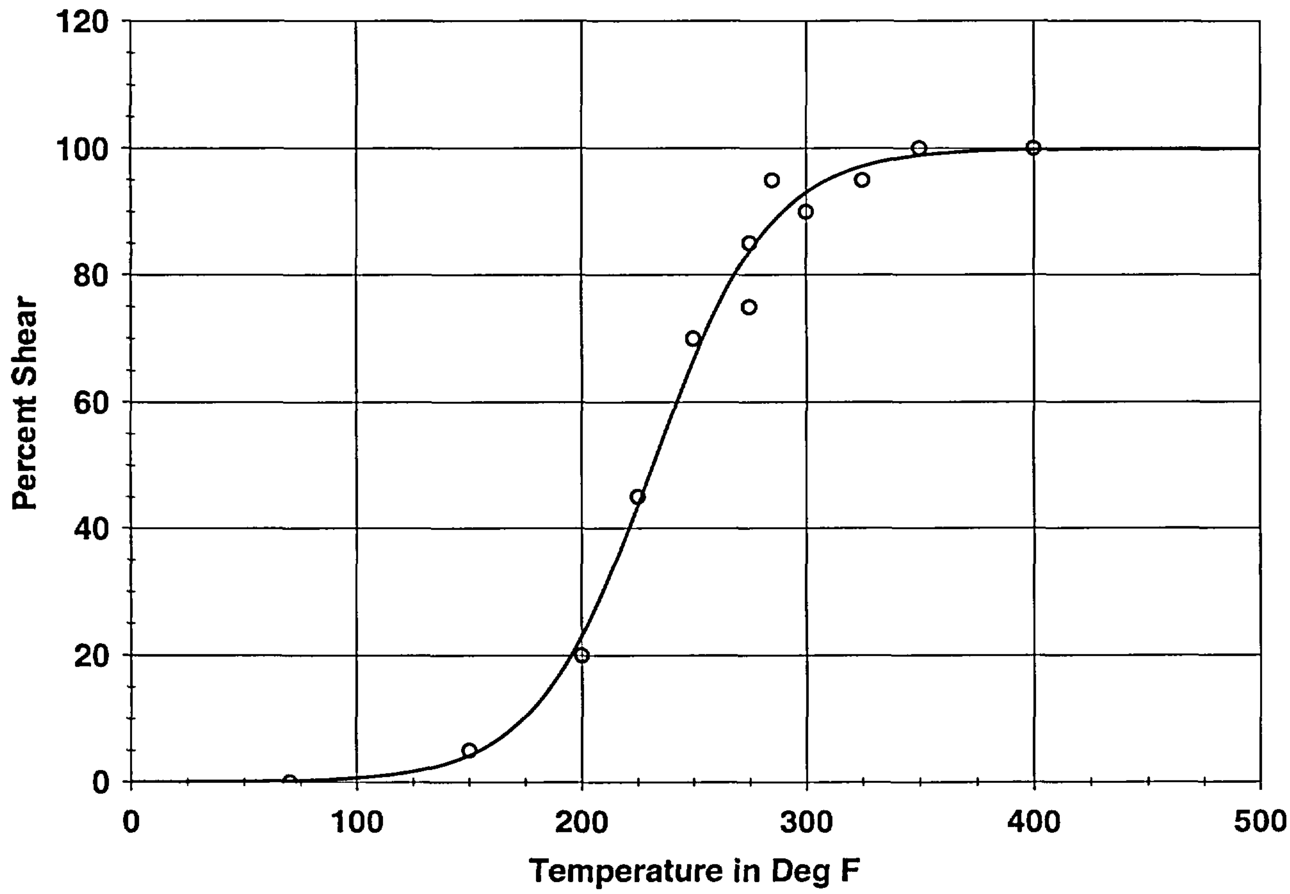
Charpy V-Notch Data

Temperature	Input CVN	Computed CVN	Differential
325.00	47.00	48.68	-1.68
350.00	50.00	50.00	.00
400.00	55.00	51.22	3.78

Correlation Coefficient = .952

W-100 WELD

CVGRAPH 5.0.1 Hyperbolic Tangent Curve Printed on 01/08/2004 10:41 AM
Page 1
Coefficients of Curve 1
A = 50. B = 50. C = 52.59 T0 = 231.78 D = 0.00E+00
Equation is A + B * [Tanh((T-To)/(C+DT))]
Temperature at 50% Shear = 231.8
Plant: PALISADES Material: D-3803-1 Heat: C-1279
Orientation: NA Capsule: W-100 Fluence: 2.09E19 n/cm^2



Charpy V-Notch Data

Temperature	Input Percent Shear	Computed Percent Shear	Differential
70.00	.00	.21	-.21
150.00	5.00	4.27	.73
200.00	20.00	23.00	-3.00
225.00	45.00	43.59	1.41
250.00	70.00	66.66	3.34
275.00	75.00	83.80	-8.80
275.00	85.00	83.80	1.20
285.00	95.00	88.33	6.67
300.00	90.00	93.05	-3.05

W-100 WELD

Page 2
Plant: PALISADES   Material: D-3803-1   Heat: C-1279
Orientation: NA   Capsule: W-100   Fluence: 2.09E19   n/cm^2

Charpy V-Notch Data

Temperature	Input Percent Shear	Computed Percent Shear	Differential
325.00	95.00	97.19	-2.19
350.00	100.00	98.90	1.10
400.00	100.00	99.83	.17

Correlation Coefficient = .995

W-100 WELD

CVGRAPH 5.0.1 Hyperbolic Tangent Curve Printed on 01/08/2004 10:42 AM
Page 1
Coefficients of Curve 1

A = 19.5 B = 19.5 C = 81.87 T0 = 217.28 D = 0.00E+00

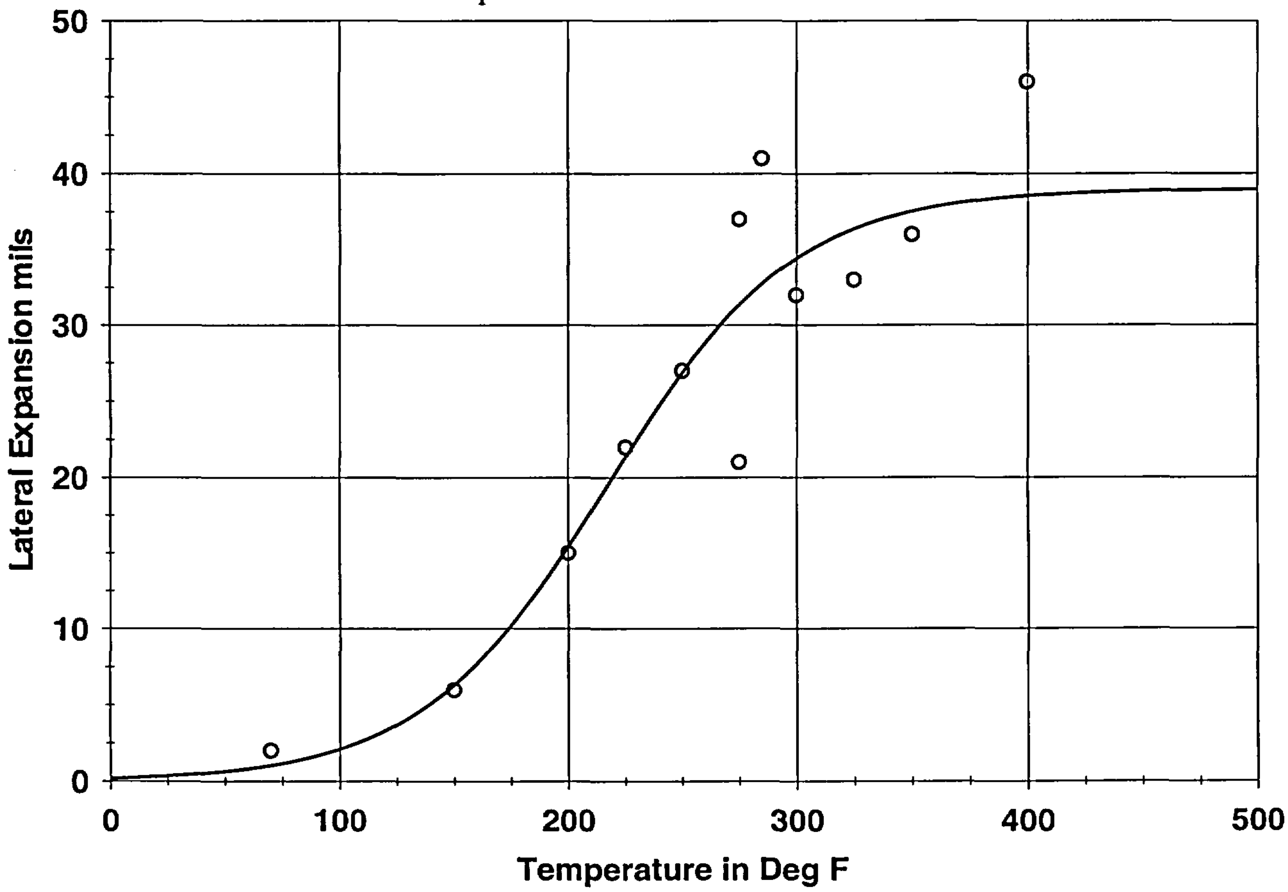
Equation is A + B * [Tanh((T-To)/(C+DT))]

Upper Shelf L.E.=39.0(Fixed) Lower Shelf L.E.=.0(Fixed)

Temp.@L.E. 35 mils=306.1 Deg F

Plant: PALISADES Material: D-3803-1 Heat: C-1279

Orientation: NA Capsule: W-100 Fluence: 2.09E19 n/cm^2



Charpy V-Notch Data

Temperature	Input L.E.	Computed L.E.	Differential
70.00	2.00	1.04	.96
150.00	6.00	6.32	-.32
200.00	15.00	15.44	-.44
225.00	22.00	21.33	.67
250.00	27.00	26.90	.10
275.00	21.00	31.35	-10.35
275.00	37.00	31.35	5.65
285.00	41.00	32.74	8.26
300.00	32.00	34.44	-2.44

W-100 WELD

Plant: PALISADES Material: D-3803-1 Heat: C-1279
Orientation: NA Capsule: W-100 Fluence: 2.09E19 n/cm^2

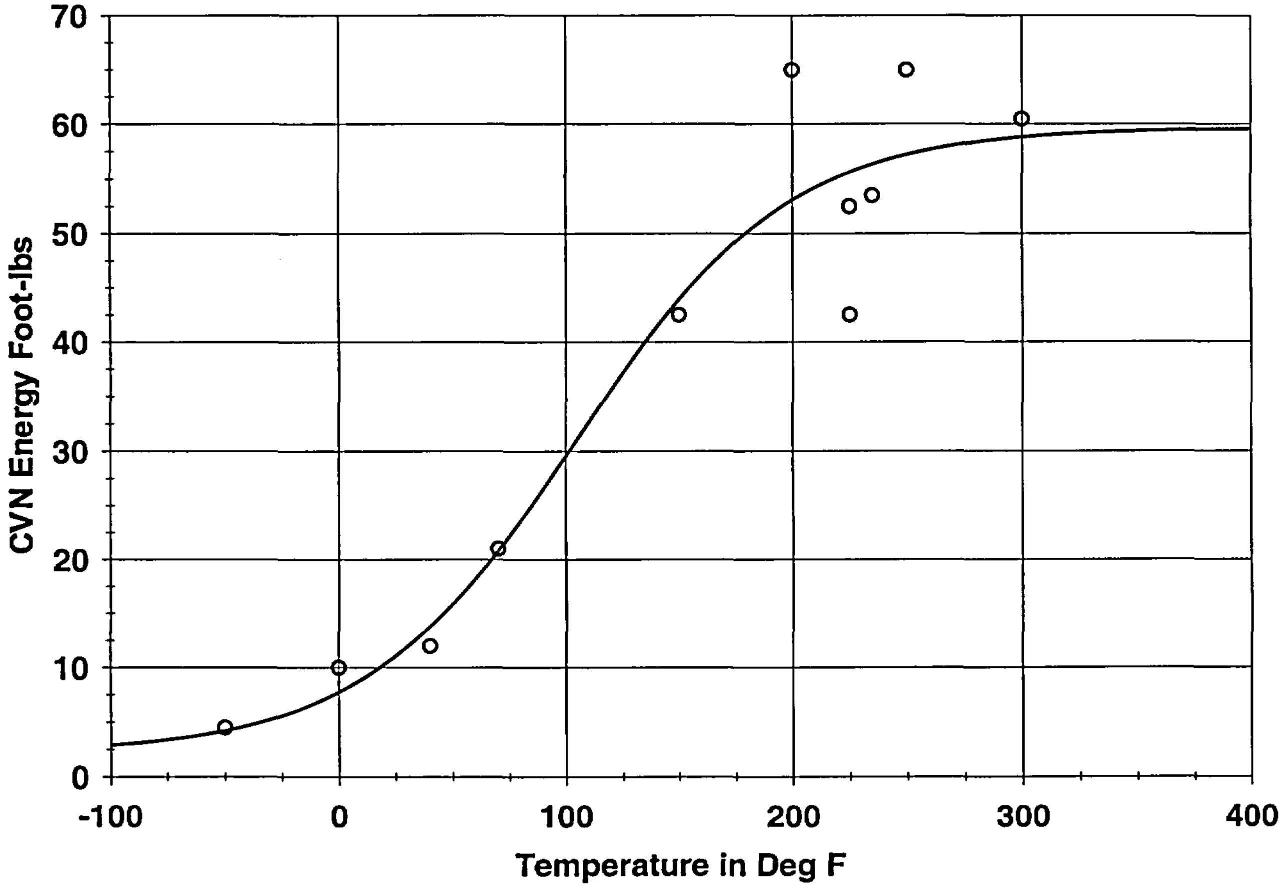
Charpy V-Notch Data

Temperature	Input L.E.	Computed L.E.	Differential
325.00	33.00	36.38	-3.38
350.00	36.00	37.53	-1.53
400.00	46.00	38.56	7.44

Correlation Coefficient = .929

W-100 HEAT AFFECTED ZONE

CVGRAPH 5.0.1 Hyperbolic Tangent Curve Printed on 01/08/2004 10:24 AM
Page 1
Coefficients of Curve 1
A = 30.95 B = 28.75 C = 93.62 T0 = 104.46 D = 0.00E+00
Equation is A + B * [Tanh((T-To)/(C+DT))]
Upper Shelf Energy=59.7(Fixed)   Lower Shelf Energy=2.2(Fixed)
Temp@30 ft-lbs=101.4 Deg F   Temp@50 ft-lbs=179.2 Deg F
Plant: PALISADES   Material: D-3803-1   Heat: C-1279
Orientation: NA   Capsule: W-100   Fluence: 2.09E19 n/cm^2



Charpy V-Notch Data

Temperature	Input CVN	Computed CVN	Differential
-50.00	4.50	4.25	.25
.00	10.00	7.77	2.23
40.00	12.00	13.78	-1.78
70.00	21.00	20.82	.18
150.00	42.50	43.93	-1.43
200.00	65.00	53.09	11.91
225.00	42.50	55.63	-13.13
225.00	52.50	55.63	-3.13
235.00	53.50	56.37	-2.87

W-100 HEAT AFFECTED ZONE

Plant: PALISADES Material: D-3803-1 Heat: C-1279
Orientation: NA Capsule: W-100 Fluence: 2.09E19 n/cm^2

Charpy V-Notch Data

Temperature	Input CVN	Computed CVN	Differential
250.00	65.00	57.24	7.76
300.00	60.50	58.83	1.67

Correlation Coefficient = .961

W-100 HEAT AFFECTED ZONE

CVGRAPH 5.0.1 Hyperbolic Tangent Curve Printed on 01/08/2004 10:25 AM

Page 1

Coefficients of Curve 1

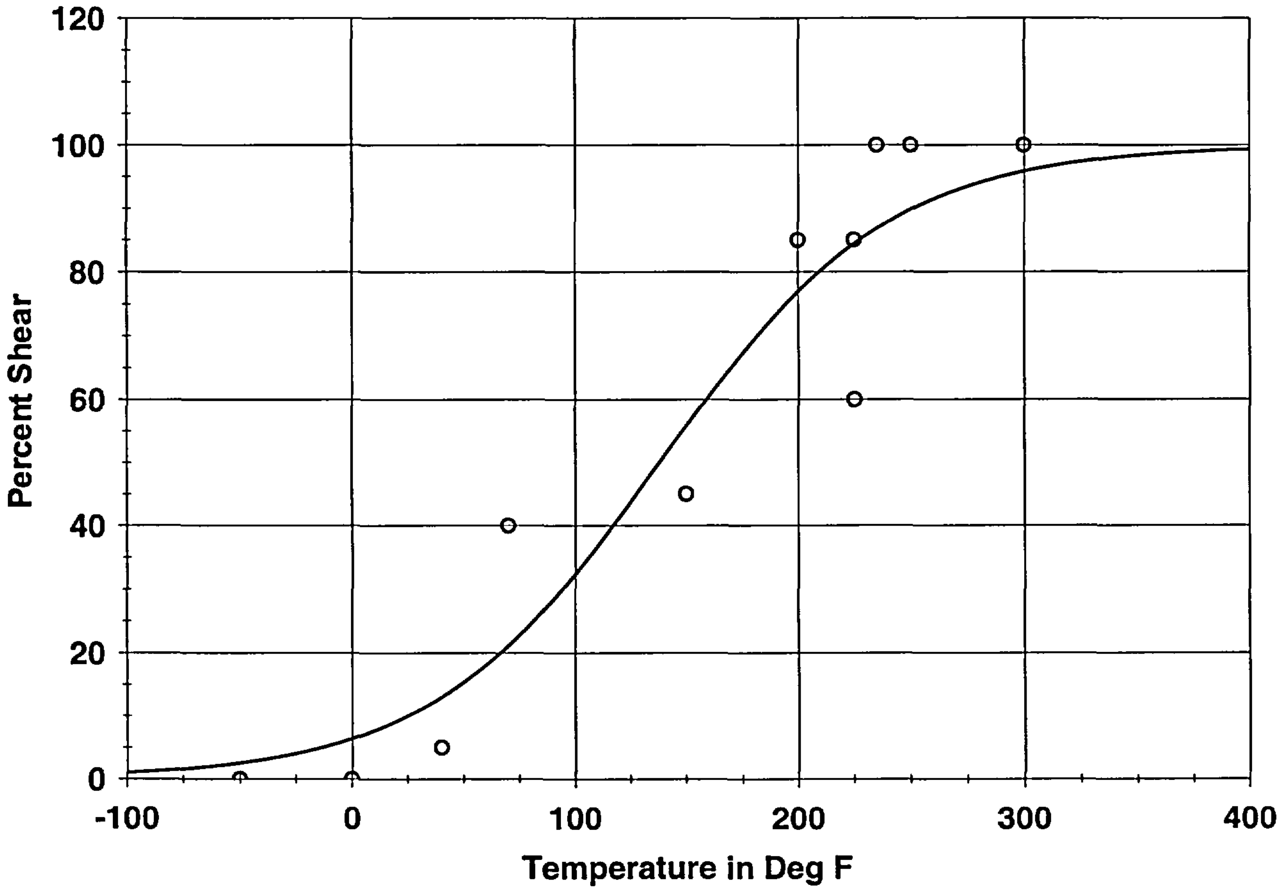
A = 50. B = 50. C = 103. T0 = 137.88 D = 0.00E+00

Equation is A + B * [Tanh((T-To)/(C+DT))]

Temperature at 50% Shear = 137.9

Plant: PALISADES Material: D-3803-1 Heat: C-1279

Orientation: NA Capsule: W-100 Fluence: 2.09E19 n/cm^2



Charpy V-Notch Data

Temperature	Input Percent Shear	Computed Percent Shear	Differential
-50.00	.00	2.54	-2.54
.00	.00	6.43	-6.43
40.00	5.00	13.00	-8.00
70.00	40.00	21.11	18.89
150.00	45.00	55.86	-10.86
200.00	85.00	76.96	8.04
225.00	60.00	84.45	-24.45
225.00	85.00	84.45	.55
235.00	100.00	86.83	13.17

W-100 HEAT AFFECTED ZONE

Plant: PALISADES Material: D-3803-1 Heat: C-1279
Orientation: NA Capsule: W-100 Fluence: 2.09E19 n/cm^2

Charpy V-Notch Data

Temperature	Input Percent Shear	Computed Percent Shear	Differential
250.00	100.00	89.82	10.18
300.00	100.00	95.88	4.12

Correlation Coefficient = .954

W-100 HEAT AFFECTED ZONE

CVGRAPH 5.0.1 Hyperbolic Tangent Curve Printed on 01/08/2004 10:27 AM

Page 1

Coefficients of Curve 1

A = 22.65 B = 22.65 C = 97.13 T0 = 146.47 D = 0.00E+00

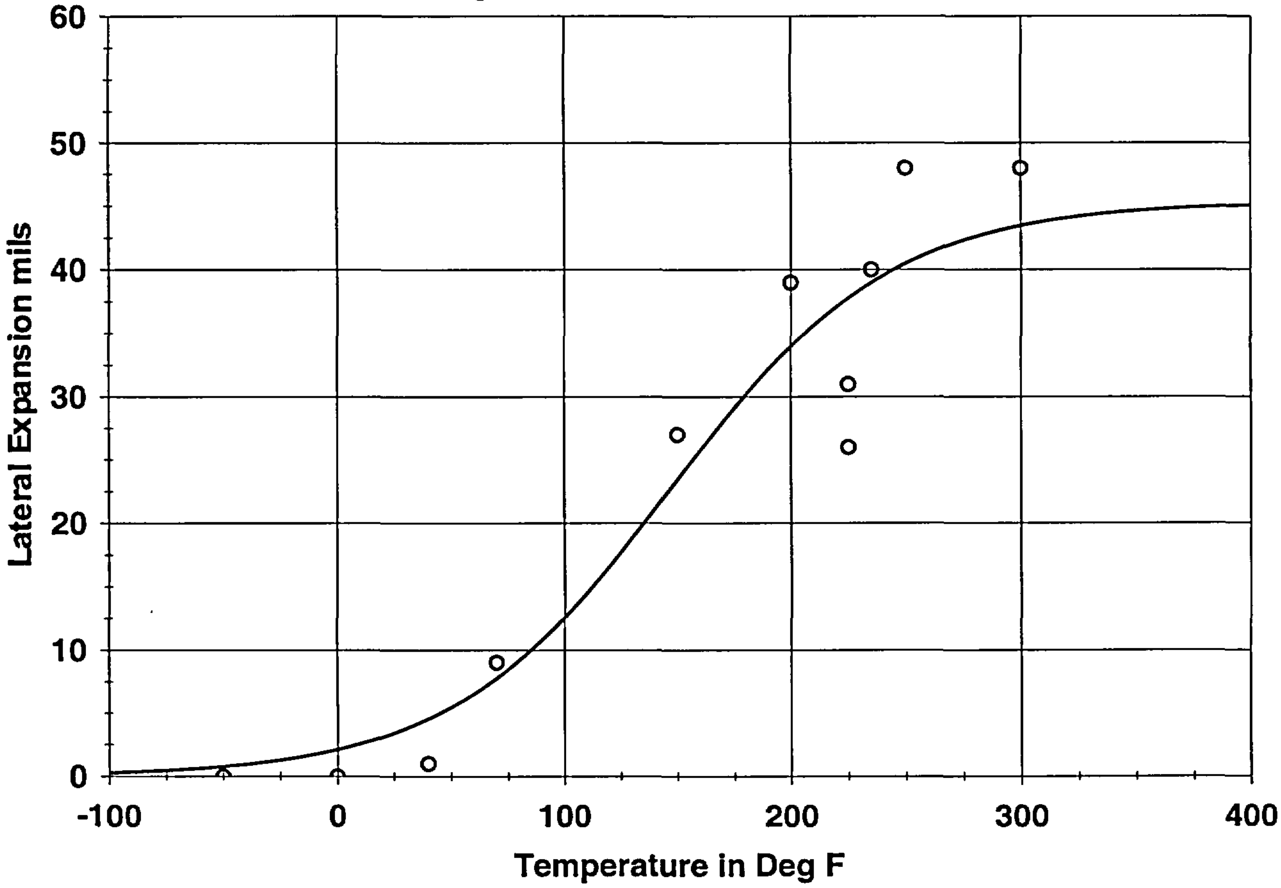
Equation is A + B * [Tanh((T-To)/(C+DT))]

Upper Shelf L.E.=45.3(Fixed) Lower Shelf L.E.=.0(Fixed)

Temp.@L.E. 35 mils=205.9 Deg F

Plant: PALISADES Material: D-3803-1 Heat: C-1279

Orientation: NA Capsule: W-100 Fluence: 2.09E19 n/cm^2



Charpy V-Notch Data

Temperature	Input L.E.	Computed L.E.	Differential
-50.00	.00	.78	-.78
.00	.00	2.12	-2.12
40.00	1.00	4.55	-3.55
70.00	9.00	7.77	1.23
150.00	27.00	23.47	3.53
200.00	39.00	34.01	4.99
225.00	26.00	37.80	-11.80
225.00	31.00	37.80	-6.80
235.00	40.00	39.00	1.00

W-100 HEAT AFFECTED ZONE

Plant: PALISADES Material: D-3803-1 Heat: C-1279
Orientation: NA Capsule: W-100 Fluence: 2.09E19 n/cm^2

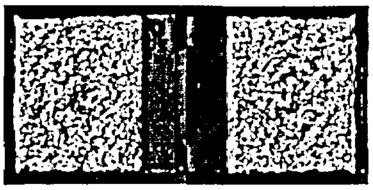
Charpy V-Notch Data

Temperature	Input L.E.	Computed L.E.	Differential
250.00	48.00	40.50	7.50
300.00	48.00	43.46	4.54

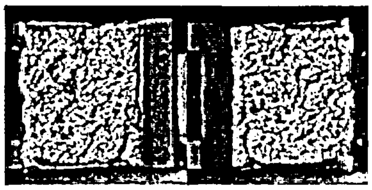
Correlation Coefficient = .955

APPENDIX C

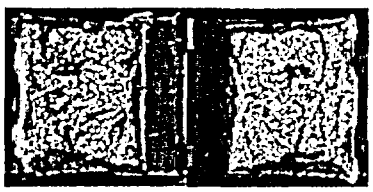
FRACTURE SURFACES OF CHARPY IMPACT SPECIMENS PALISADES CAPSULE W-100



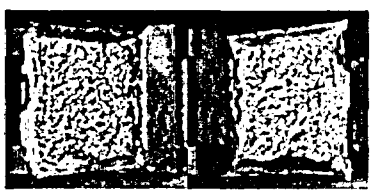
152 70°F



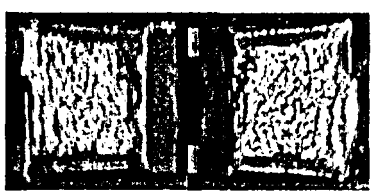
151 110°F



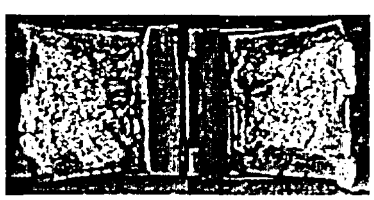
153 150°F



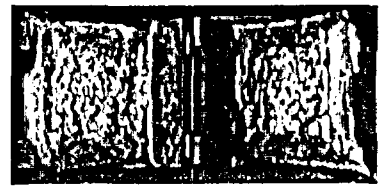
157 175°F



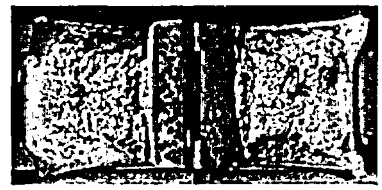
15A 200°F



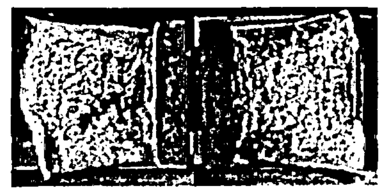
154 225°F



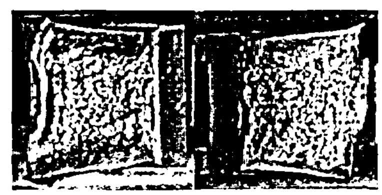
15Y 250°F



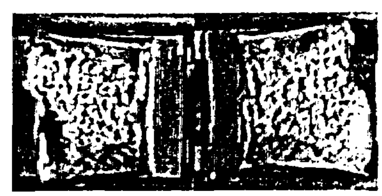
156 260°F



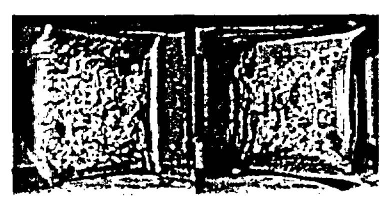
15C 270°F



15B 280°F

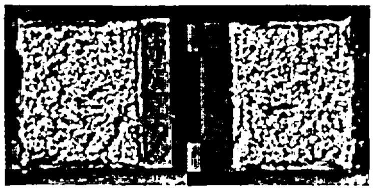


15U 300°F

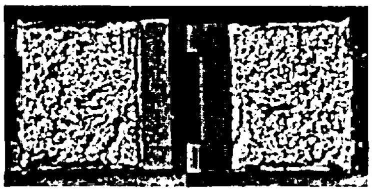


155 325°F

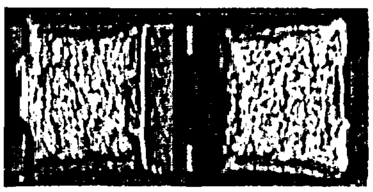
Base Metal (Longitudinal) Charpy Samples



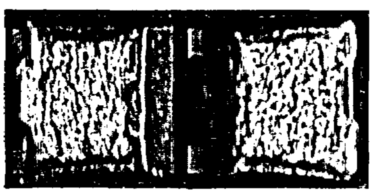
213 70°F



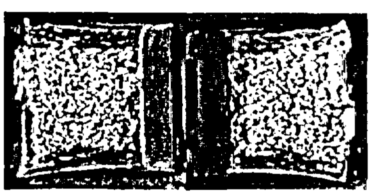
255 110°F



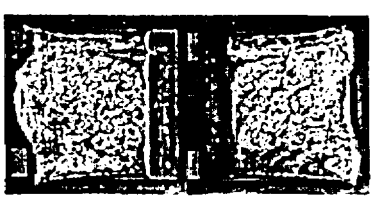
25E 150°F



25B 200°F

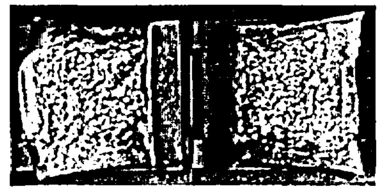


25D 225°F

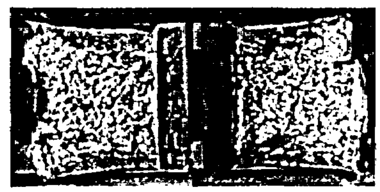


211 240°F

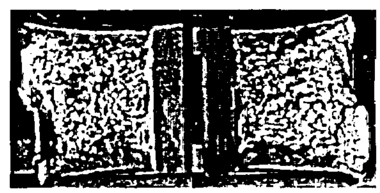
257 250°F



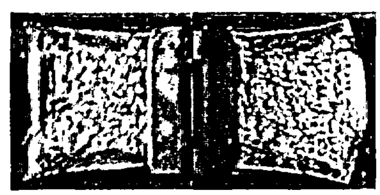
256 260°F



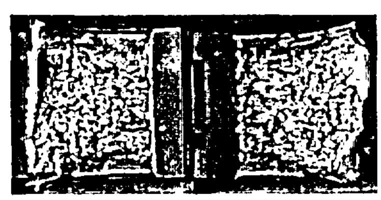
214 270°F



25A 285°F

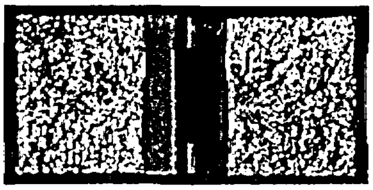


25C 300°F

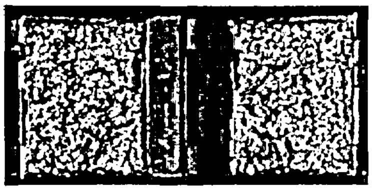


212 325°F

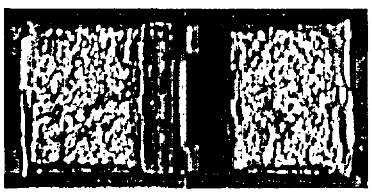
Base Metal (Transverse) Charpy Samples



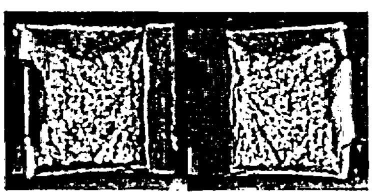
35B 70°F



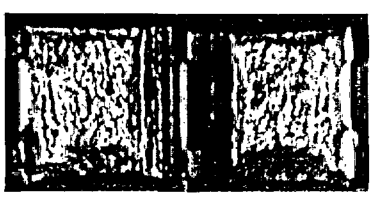
35E 150°F



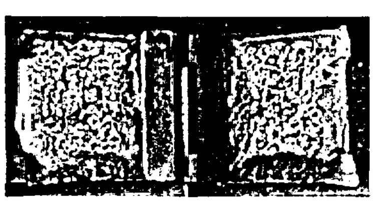
355 200°F



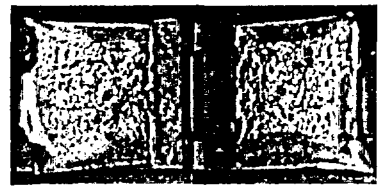
356 225°F



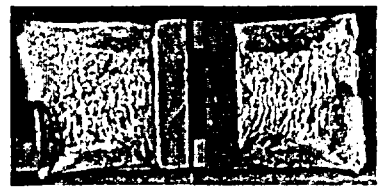
35A 250°F



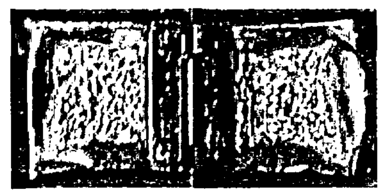
35C 275°F



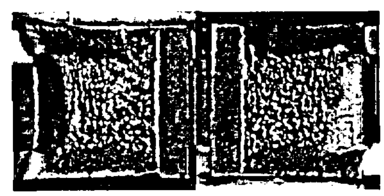
353 275°F



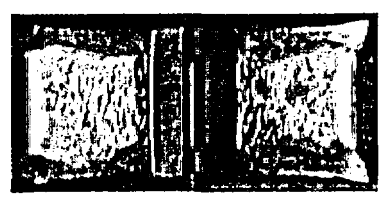
352 285°F



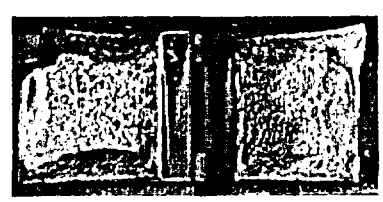
35J 300°F



35D 325°F

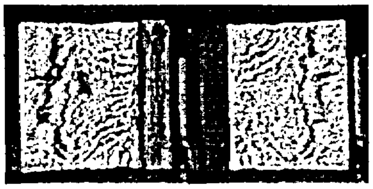


357 350°F

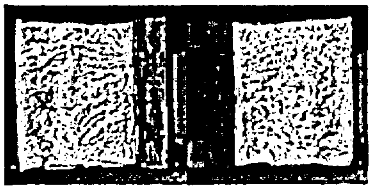


354 400°F

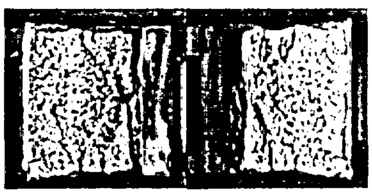
Weld Charpy Samples



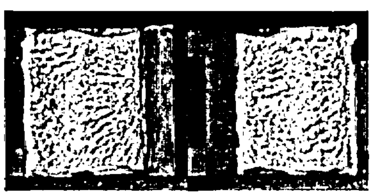
414 -50°F



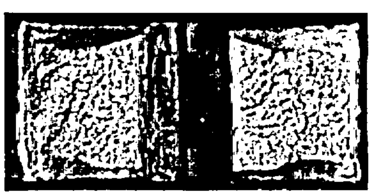
47L 0°F



431 0°F

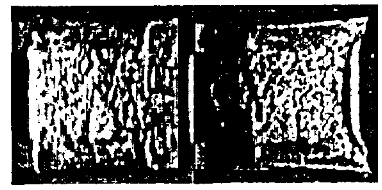


411 40°F

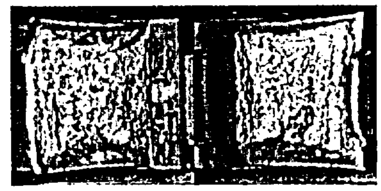


416 70°F

47M 150°F

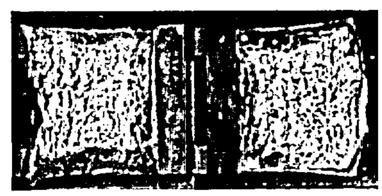


47P 200°F

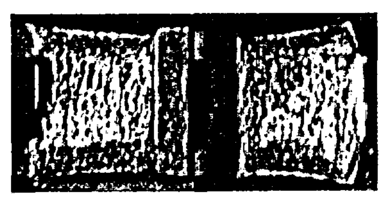


415 225°F

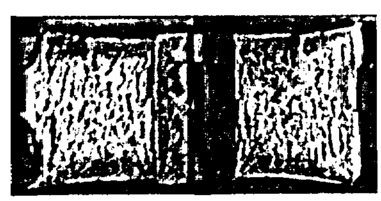
412 225°F



413 235°F



47T 250°F



417 300°F

HAZ Charpy Samples

APPENDIX D

INSTRUMENTED CHARPY IMPACT TEST RESULTS
PALISADES CAPSULE W-100

Specimen ID	Yield Properties			Maximum Load Properties			Fast Fracture Properties			Crack Arrest Properties			Propagation Load Properties		Total Energy Properties		Shear Lip Properties	Dynamic Yield Strength
	Time (μs)	Load (lbf)	Energy (ft-lbf)	Time (μs)	Load (lbf)	Energy (ft-lbf)	Time (μs)	Load (lbf)	Energy (ft-lbf)	Time (μs)	Load (lbf)	Energy (ft-lbf)	Load (lbf)	Energy (ft-lbf)	Time (μs)	Energy (ft-lbf)	Energy (ft-lbf)	(ksi)
152	117	3137	2.9	117	3137	2.9	117	3137	2.9	163	0	4.3	3156	1.3	163	4.3	1.3	90
151	166	3376	4.7	244	3678	9.2	244	3678	9.2	350	582	11.3	3096	3.3	894	12.5	3.3	97
153	162	3232	4.8	406	4000	19.6	406	4000	19.6	526	1327	23.2	2673	7.7	1610	27.3	7.7	93
157	198	3215	5.0	634	4301	32.7	634	4301	32.7	752	1619	37.1	2682	9.3	1834	42.0	9.3	92
15A	174	3149	4.8	544	4080	27.3	580	4014	29.6	706	2006	34.8	2008	14.3	1800	41.6	12.0	90
154	160	3091	5.0	698	4147	38.5	958	3560	53.9	1080	2006	59.1	1555	31.4	3194	69.9	16.0	89
15Y	174	3054	4.6	718	4147	37.9	1098	3611	60.5	1204	2335	64.8	1277	42.6	3198	80.5	20.0	88
156	174	3059	5.1	622	4110	32.4	714	4071	38.3	834	3050	44.5	1021	36.9	3022	69.3	31.0	88
15C	166	3018	4.8	706	4103	37.7	1274	2866	68.8	1354	2525	71.9	340	57.1	4076	94.8	25.9	87
15B	168	3002	4.9	706	4078	37.5	NA	NA	NA	NA	NA	NA	4044	54.3	4044	91.8	0.0	86
15U	158	2967	4.7	700	4037	37.2	3902	2.3	96.3	3902	2.3	96.3	0	59.1	3902	96.3	0.0	85
155	150	2930	4.4	704	4030	37.6	3536	2.3	94	3536	2.3	94	0	56.5	3536	94.0	0.0	84
213	172	3531	4.9	172	3531	4.9	172	3531	4.9	251	0	8.2	3531	3.3	251	8.2	3.3	101
255	182	3367	5.1	252	3664	9.2	252	3664	9.2	360	593	11.4	3071	4.1	1166	13.2	4.1	97
25E	176	3259	4.9	406	3974	18.9	406	3974	18.9	530	1005	22.1	2969	6.4	1616	25.2	6.4	94
25B	168	3151	4.7	540	4115	27.4	578	4066	29.9	696	2040	34.7	2026	13.5	1780	40.9	11.0	91
25D	158	3128	4.7	530	4115	27.3	640	3993	34.4	746	2330	39	1663	22.0	2622	49.3	15.0	90
211	148	3004	3.9	440	3813	20.7	440	3813	20.7	564	2673	26.6	1141	26.3	3114	46.9	26.3	86
257	158	3061	4.4	614	4089	32.0	808	3696	43.8	940	2210	49.6	1486	34.8	3068	66.7	22.9	88
256	164	3054	4.9	534	4085	27.2	808	3360	43.7	878	2477	46.7	883	37.7	3006	64.9	21.2	88
214	158	3013	4.7	532	3968	26.8	668	3733	35.2	778	2956	40.8	777	39.5	3474	66.4	31.2	87
25A	168	3015	4.6	540	4034	26.7	3448	2.3	72.1	3448	2.3	72.1	0	45.4	3448	72.1	0.0	87
25C	158	2988	4.7	532	4004	26.7	NA	NA	NA	NA	NA	NA	0	44.5	3142	71.2	0.0	86
212	166	2939	4.9	438	3634	20.1	NA	NA	NA	NA	NA	NA	0	41.7	3182	61.7	0.0	84
35B	129	3570	3.5	129	3570	3.5	129	3570	3.5	176	0	5	3609	1.5	176	5.0	1.5	103
35E	166	3659	5.2	262	4032	11.4	268	4030	11.8	338	0	14.4	4073	3.0	338	14.4	2.6	105
355	164	3462	5.1	342	3991	16.2	368	3977	17.9	496	554	20.5	3422	5.5	1024	21.6	3.8	99
356	162	3478	5.4	340	4046	16.6	374	4025	18.9	496	1679	23.5	2346	12.8	1570	29.4	10.5	100
35A	158	3388	5.0	336	3940	15.9	380	3901	18.8	486	1923	22.9	1978	15.5	1474	31.4	12.7	97
35C	154	3418	4.7	428	4041	21.8	496	3896	26.2	608	1888	30.4	2008	14.3	1576	36.2	10.0	98
353	162	3294	5.2	430	3968	21.5	608	3669	32.6	706	2314	36.8	1355	27.3	1980	48.9	16.3	95
352	206	3186	4.3	508	3859	22.4	776	2990	37.6	854	2360	40.7	630	30.6	2258	53.1	15.5	91
35J	162	3388	5.3	420	3951	21.3	546	3356	28.9	640	2243	32.8	1113	19.8	1648	41.1	12.1	97
35D	158	3351	5.0	430	3961	21.8	514	3742	27	594	2942	31.1	800	23.7	1832	45.5	18.5	96
357	154	3234	5.0	428	3820	21.3	NA	NA	NA	NA	NA	NA	0	26.8	1832	48.1	0.0	93
354	156	3123	5.0	428	3818	20.9	NA	NA	NA	NA	NA	NA	0	31.0	1968	51.9	0.0	90
414	124	3869	3.7	124	3869	3.7	124	3869	3.7	172	0	5.4	3908	1.7	172	5.4	1.7	111
47L	150	3882	5.5	150	3882	5.5	179	3876	7.4	232	0	9.3	3910	3.8	232	9.3	1.9	112
431	147	3728	4.9	699	4425	42.2	740	4317	44.9	804	0	47.3	4324	5.1	804	47.3	2.4	107
411	153	3839	5.3	187	3850	7.5	187	3850	7.5	247	0	9.5	3855	2.0	247	9.5	2.0	110
416	153	3784	5.3	239	4119	10.9	243	4110	11.2	356	1463	15	2647	8.2	880	19.1	7.9	109
47M	156	3397	5.2	522	4234	28.9	560	4115	31.4	678	1826	35.9	2289	11.2	1482	40.0	8.7	98
47P	156	3294	5.1	524	4248	28.6	778	3912	45	872	1957	49	1955	32.5	2914	61.1	16.1	95
415	158	3353	5.2	408	3901	20.6	414	3894	21	524	2698	26.3	1196	19.4	2220	40.0	19.1	96
412	168	3353	5.5	436	4050	22.3	544	3910	29.2	658	2551	35	1359	28.2	2632	50.5	21.3	96
413	162	3330	5.3	522	4204	28.4	NA	NA	NA	NA	NA	NA	0	22.7	2634	51.1	0.0	96
47T	166	3211	5.1	434	3928	21.3	NA	NA	NA	NA	NA	NA	0	40.5	2938	61.8	0.0	92
417	172	3188	5.0	422	3811	19.9	NA	NA	NA	NA	NA	NA	0	36.8	2648	56.6	0.0	92

CHARTEST.R00 --- 04/10/91
ANALYZE.R00 --- 04/10/91

INSTRUMENTED IMPACT TEST RESULTS

ANALYSIS DATE: 11/24/2003
MATERIAL: BASE (LONG)
INITIAL HAMMER ENERGY, FT-LBS: 240
INITIAL HAMMER VELOCITY, FT/SEC: 17
LOAD CALIBRATION, LBS/VOLT: 1150
SPECIMEN WIDTH, INCH: .394
NOTCH DEPTH, INCH: 7.900001E-02
RESPONSE TIME, MSEC: .0519
TECHNICAL PROCEDURE(S): TP-80 TP-412

ANALYSIS BY: BJV
TEST DATE: 10/31/2003
SPEC. ID: P152
PROJ. NO.: 1295-001-03-08
QA NO.: 99001
TEST TEMP (F): 70
OPERATOR: BJV

PROPERTY	ENERGY, FT-LBS		LOAD POUNDS	TIME MSEC
	UNCORRECTED	CORRECTED		
GENERAL YIELD	2.946381	2.937338	3137.2	.117
FLOW LOAD	2.946381	2.937338	3137.2	.117
MAXIMUM LOAD	2.946381	2.937338	3137.2	.117
FAST FRACTURE LOAD	2.946381	2.937338	3137.2	.117
ARREST LOAD	4.28239	4.263287	-18.40015	.163
PROPAGATION LOAD	1.336322	1.326259	3155.6	0
TOTAL ENERGY	4.282703	4.263597	0	0
SHEAR LIP ENERGY	1.336322	1.326259	0	0
TOTAL EVENT TIME	0	0	0	.163

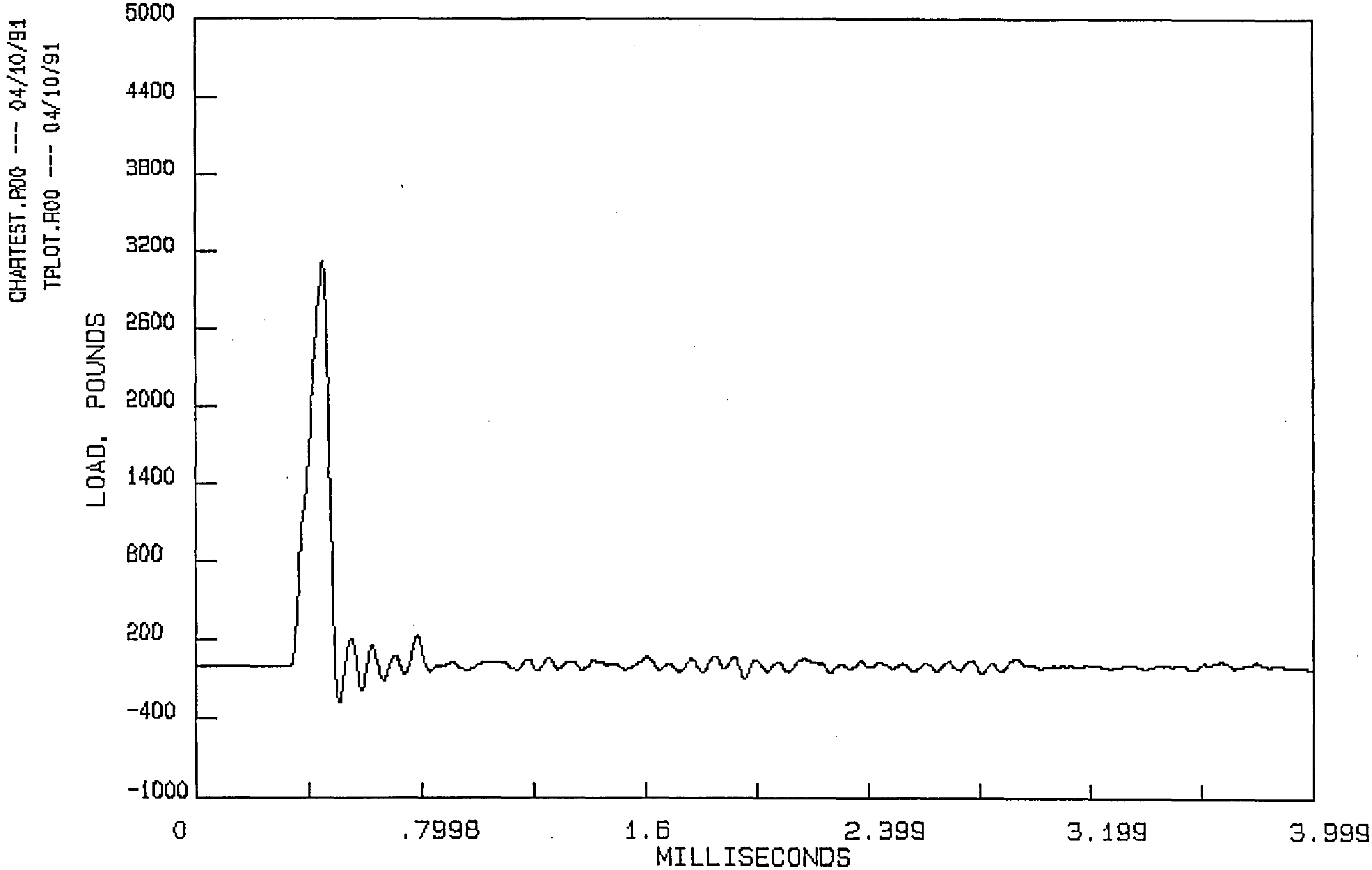
DYNAMIC YIELD STRENGTH (KSI) = 90
DYNAMIC FLOW STRENGTH (KSI) = 90
DIAL ENERGY READING (FT-LBS) = 5.5

TEST VIOLATIONS

********* NO VIOLATIONS *********

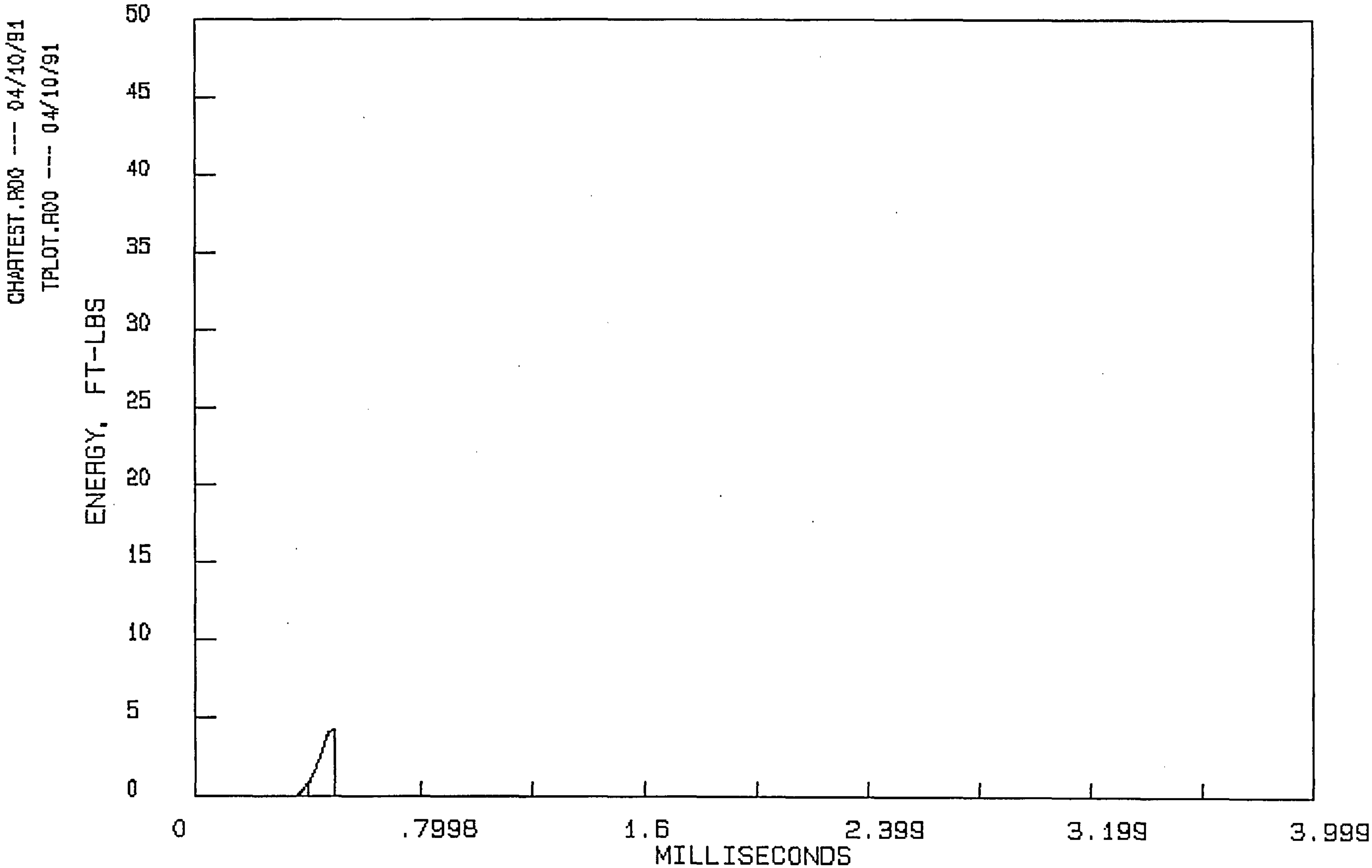
PROJ. NO. 1295-001-03-08 QA NO. 99001

LOAD - TIME TRACE FOR SPECIMEN P152



PROJ. NO. 1295-001-03-08 QA NO. 99001

ENERGY - TIME TRACE FOR SPECIMEN P152



INSTRUMENTED IMPACT TEST RESULTS

ANALYSIS DATE: 11/24/2003
MATERIAL: BASE (LONG)
INITIAL HAMMER ENERGY, FT-LBS: 240
INITIAL HAMMER VELOCITY, FT/SEC: 17
LOAD CALIBRATION, LBS/VOLT: 1150
SPECIMEN WIDTH, INCH: .394
NOTCH DEPTH, INCH: 7.900001E-02
RESPONSE TIME, MSEC: .0519
TECHNICAL PROCEDURE(S): TP-80 TP-412

ANALYSIS BY: BJV
TEST DATE: 11/10/2003
SPEC. ID: P151
PROJ. NO.: 1295-001-03-08
QA NO.: 99001
TEST TEMP (F): 110
OPERATOR: BJV

PROPERTY	ENERGY, FT-LBS		LOAD POUNDS	TIME MSEC
	UNCORRECTED	CORRECTED		
GENERAL YIELD	4.706546	4.683471	3376.4	.1660001
FLOW LOAD	6.294865	6.253589	3527.05	.1940001
MAXIMUM LOAD	9.279367	9.189673	3677.7	.2440001
FAST FRACTURE LOAD	9.279367	9.189673	3677.7	.2440001
ARREST LOAD	11.39389	11.25866	581.8997	.35
PROPAGATION LOAD	3.407562	3.329597	3095.8	0
TOTAL ENERGY	12.68693	12.51927	0	0
SHEAR LIP ENERGY	3.407562	3.329597	0	0
TOTAL EVENT TIME	0	0	0	.8940001

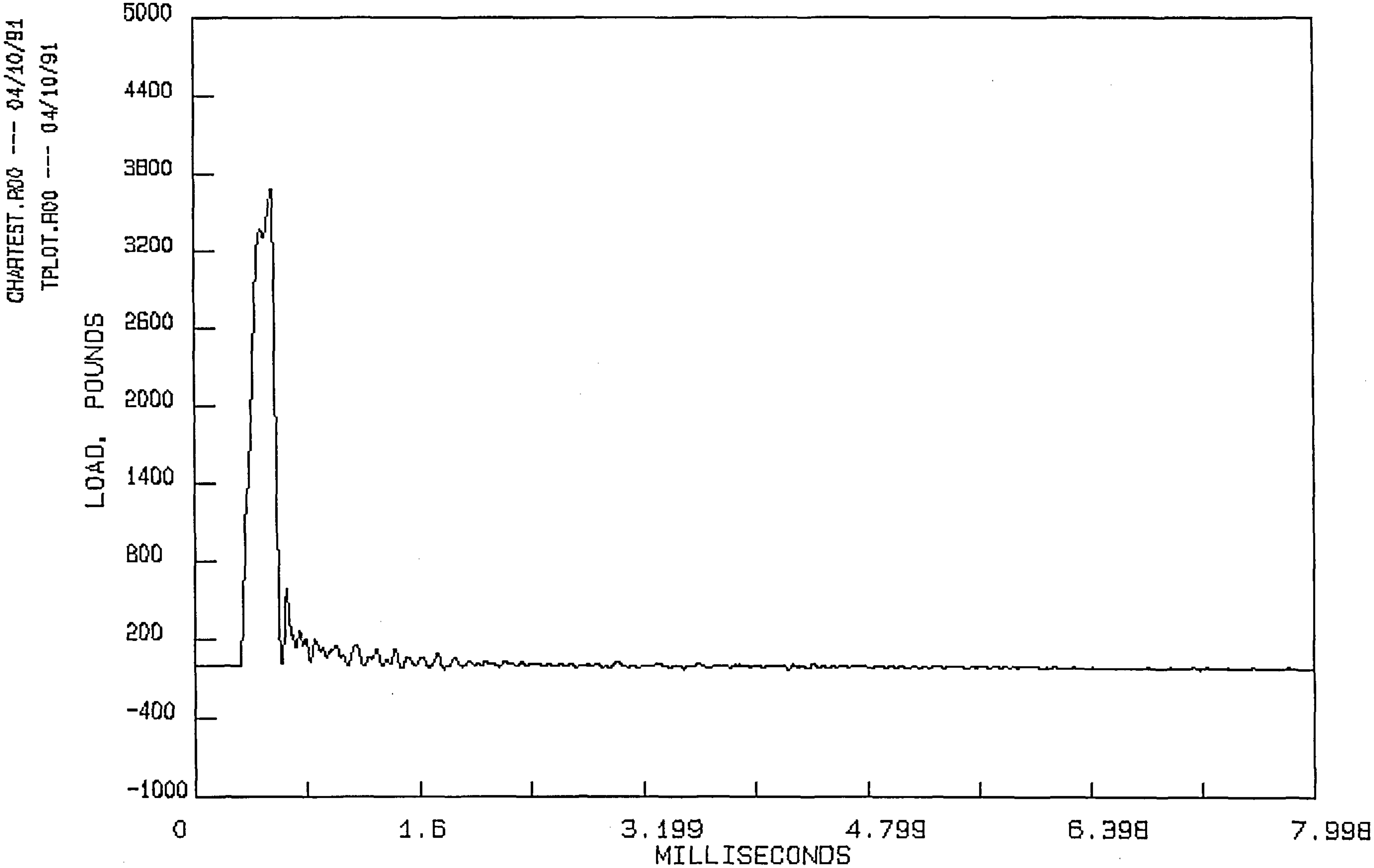
DYNAMIC YIELD STRENGTH (KSI) = 97
DYNAMIC FLOW STRENGTH (KSI) = 101
DIAL ENERGY READING (FT-LBS) = 14

TEST VIOLATIONS

********* NO VIOLATIONS *********

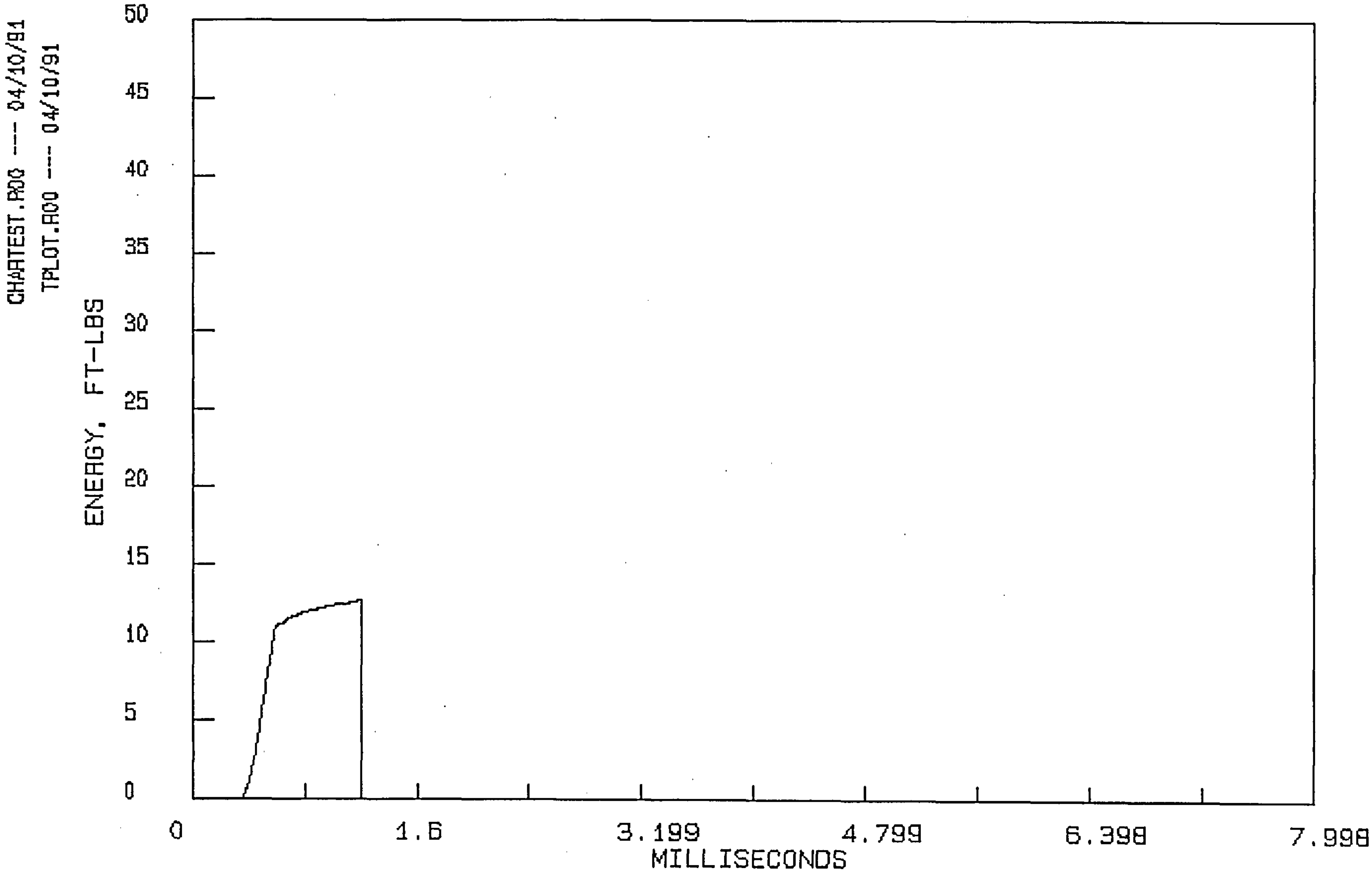
PROJ. NO. 1295-001-03-08 QA NO. 99001

LOAD - TIME TRACE FOR SPECIMEN P151



PROJ. NO. 1295-001-03-08   QA NO. 99001

ENERGY - TIME TRACE FOR SPECIMEN P151



CHARTEST.R00 --- 04/10/91
ANALYZE.R00 --- 04/10/91

INSTRUMENTED IMPACT TEST RESULTS

ANALYSIS DATE: 12/03/2003
MATERIAL: BASE (LONG)
INITIAL HAMMER ENERGY, FT-LBS: 240
INITIAL HAMMER VELOCITY, FT/SEC: 17
LOAD CALIBRATION, LBS/VOLT: 1150
SPECIMEN WIDTH, INCH: .394
NOTCH DEPTH, INCH: 7.900001E-02
RESPONSE TIME, MSEC: .0519
TECHNICAL PROCEDURE(S): TP-80 TP-412

ANALYSIS BY: BJV
TEST DATE: 11/05/2003
SPEC. ID: P153
PROJ. NO.: 1295-001-03-08
QA NO.: 99001
TEST TEMP (F): 150
OPERATOR: BJV

PROPERTY	ENERGY, FT-LBS		LOAD POUNDS	TIME MSEC
	UNCORRECTED	CORRECTED		
GENERAL YIELD	4.798901	4.774912	3231.5	.1619999
FLOW LOAD	10.60212	10.48503	3615.6	.262
MAXIMUM LOAD	19.9862	19.57011	3999.7	.406
FAST FRACTURE LOAD	19.9862	19.57011	3999.7	.406
ARREST LOAD	23.7627	23.17451	1327.1	.526
PROPAGATION LOAD	8.132139	7.724649	2672.6	0
TOTAL ENERGY	28.11834	27.29476	0	0
SHEAR LIP ENERGY	8.132139	7.724649	0	0
TOTAL EVENT TIME	0	0	0	1.61

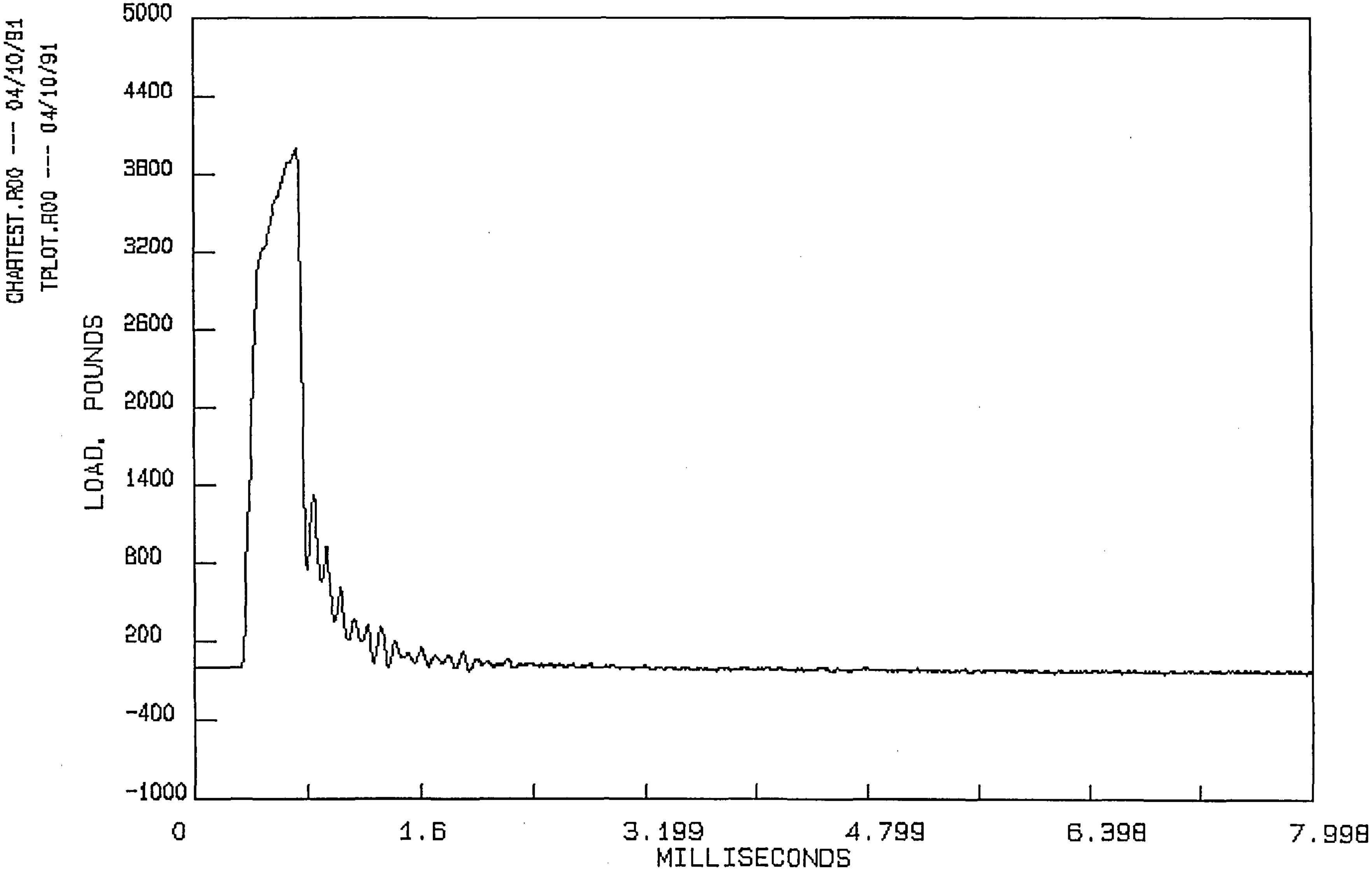
DYNAMIC YIELD STRENGTH (KSI) = 93
DYNAMIC FLOW STRENGTH (KSI) = 104
DIAL ENERGY READING (FT-LBS) = 29.5

TEST VIOLATIONS

********* NO VIOLATIONS *********

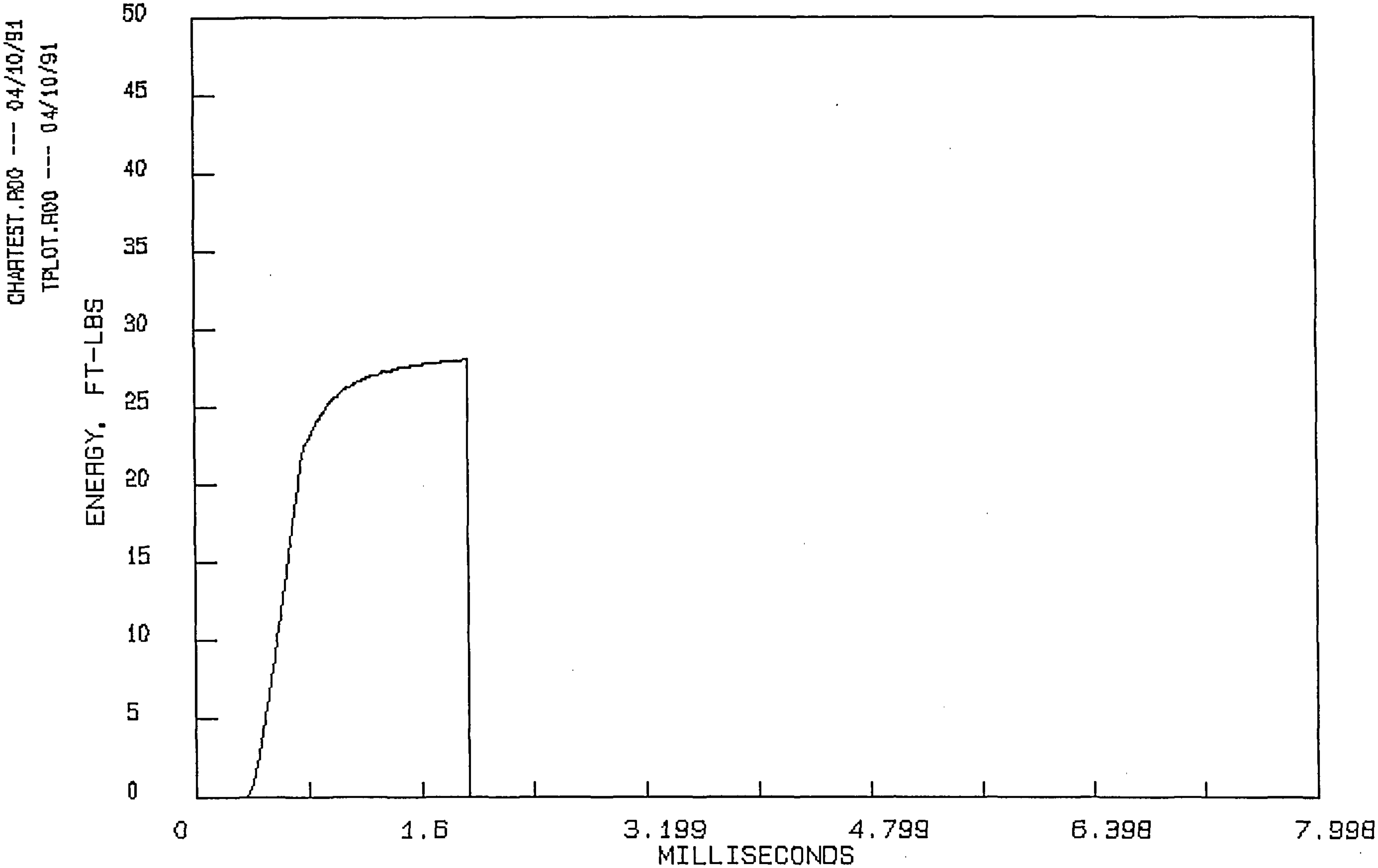
PROJ. NO. 1295-001-03-08 QA NO. 99001

LOAD - TIME TRACE FOR SPECIMEN P153



PROJ. NO. 1295-001-03-08 QA NO. 99001

ENERGY - TIME TRACE FOR SPECIMEN P153



CHARTEST.R00 --- 04/10/91
ANALYZE.R00 --- 04/10/91

INSTRUMENTED IMPACT TEST RESULTS

ANALYSIS DATE: 12/03/2003
MATERIAL: BASE (LONG)
INITIAL HAMMER ENERGY, FT-LBS: 240
INITIAL HAMMER VELOCITY, FT/SEC: 17
LOAD CALIBRATION, LBS/VOLT: 1150
SPECIMEN WIDTH, INCH: .394
NOTCH DEPTH, INCH: 7.900001E-02
RESPONSE TIME, MSEC: .0519
TECHNICAL PROCEDURE(S): TP-80 TP-412

ANALYSIS BY: BJV
TEST DATE: 11/10/2003
SPEC. ID: P157
PROJ. NO.: 1295-001-03-08
QA NO.: 99001
TEST TEMP (F): 175
OPERATOR: BJV

PROPERTY	ENERGY, FT-LBS		LOAD POUNDS	TIME MSEC
	UNCORRECTED	CORRECTED		
GENERAL YIELD	5.003392	4.977315	3215.4	.1979999
FLOW LOAD	13.3098	13.12527	3758.2	.3379999
MAXIMUM LOAD	33.86842	32.67355	4301	.6339999
FAST FRACTURE LOAD	33.86842	32.67355	4301	.6339999
ARREST LOAD	38.64707	37.09124	1619.2	.752
PROPAGATION LOAD	10.1312	9.309441	2681.8	0
TOTAL ENERGY	43.99962	41.98299	0	0
SHEAR LIP ENERGY	10.1312	9.309441	0	0
TOTAL EVENT TIME	0	0	0	1.834

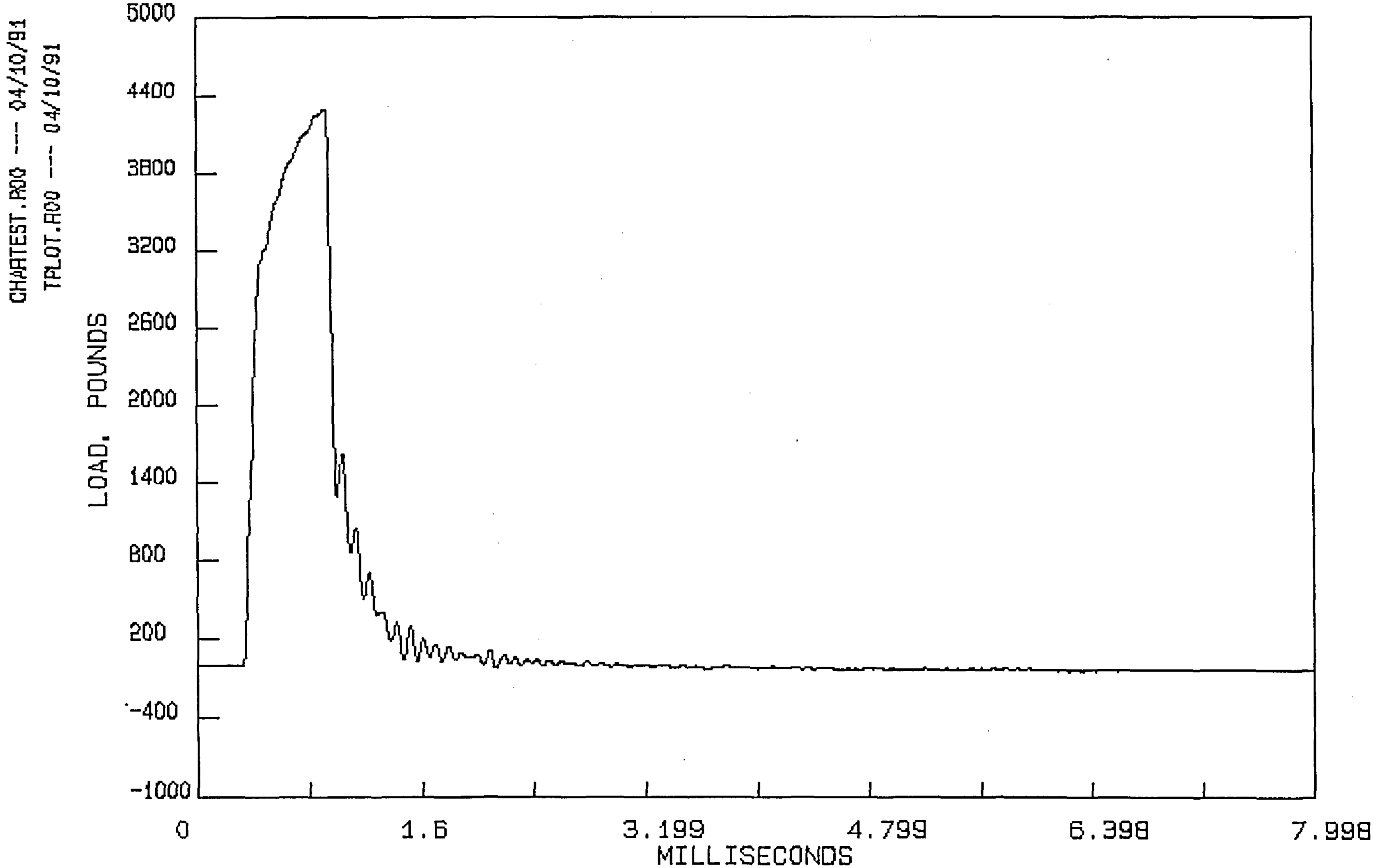
DYNAMIC YIELD STRENGTH (KSI) = 92
DYNAMIC FLOW STRENGTH (KSI) = 108
DIAL ENERGY READING (FT-LBS) = 44

TEST VIOLATIONS

********* NO VIOLATIONS *********

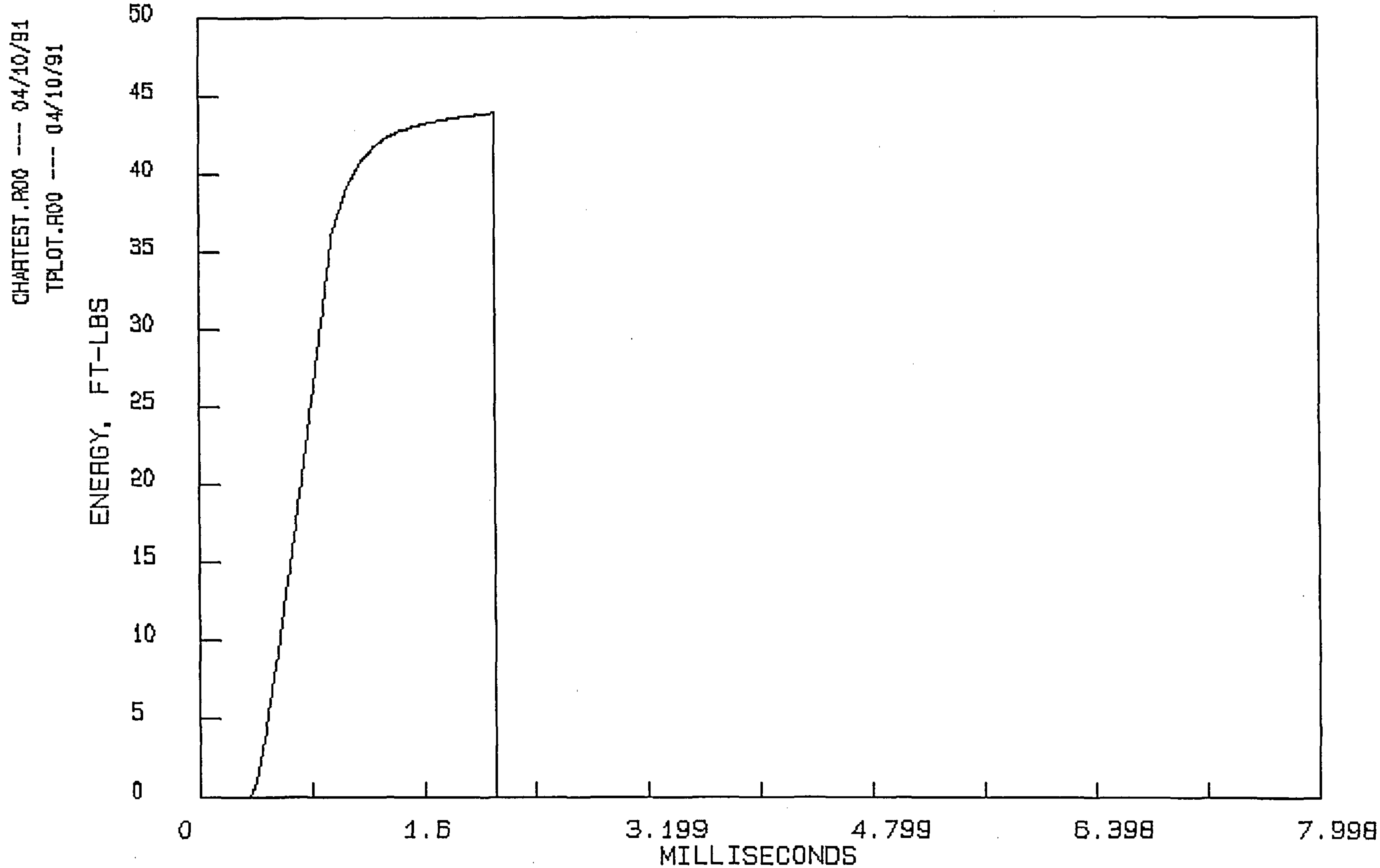
PROJ. NO. 1295-001-03-08 QA NO. 99001

LOAD - TIME TRACE FOR SPECIMEN P157



PROJ. NO. 1295-001-03-08 QA NO. 99001

ENERGY - TIME TRACE FOR SPECIMEN P157



CHARTEST.R00 --- 04/10/91
ANALYZE.R00 --- 04/10/91

INSTRUMENTED IMPACT TEST RESULTS

ANALYSIS DATE: 12/03/2003
MATERIAL: BASE (LONG)
INITIAL HAMMER ENERGY, FT-LBS: 240
INITIAL HAMMER VELOCITY, FT/SEC: 17
LOAD CALIBRATION, LBS/VOLT: 1150
SPECIMEN WIDTH, INCH: .394
NOTCH DEPTH, INCH: 7.900001E-02
RESPONSE TIME, MSEC: .0519
TECHNICAL PROCEDURE(S): TP-80 TP-412

ANALYSIS BY: BJV
TEST DATE: 11/05/2003
SPEC. ID: P15A
PROJ. NO.: 1295-001-03-08
QA NO.: 99001
TEST TEMP (F): 200
OPERATOR: BJV

PROPERTY	ENERGY, FT-LBS		LOAD POUNDS	TIME MSEC
	UNCORRECTED	CORRECTED		
GENERAL YIELD	4.793738	4.769801	3148.7	.1739999
FLOW LOAD	12.62914	12.463	3614.45	.3099999
MAXIMUM LOAD	28.12276	27.29892	4080.2	.544
FAST FRACTURE LOAD	30.5985	29.62322	4013.5	.58
ARREST LOAD	36.18393	34.8201	2005.6	.706
PROPAGATION LOAD	15.50552	14.34663	2007.9	0
TOTAL ENERGY	43.62828	41.64555	0	0
SHEAR LIP ENERGY	13.02978	12.02233	0	0
TOTAL EVENT TIME	0	0	0	1.8

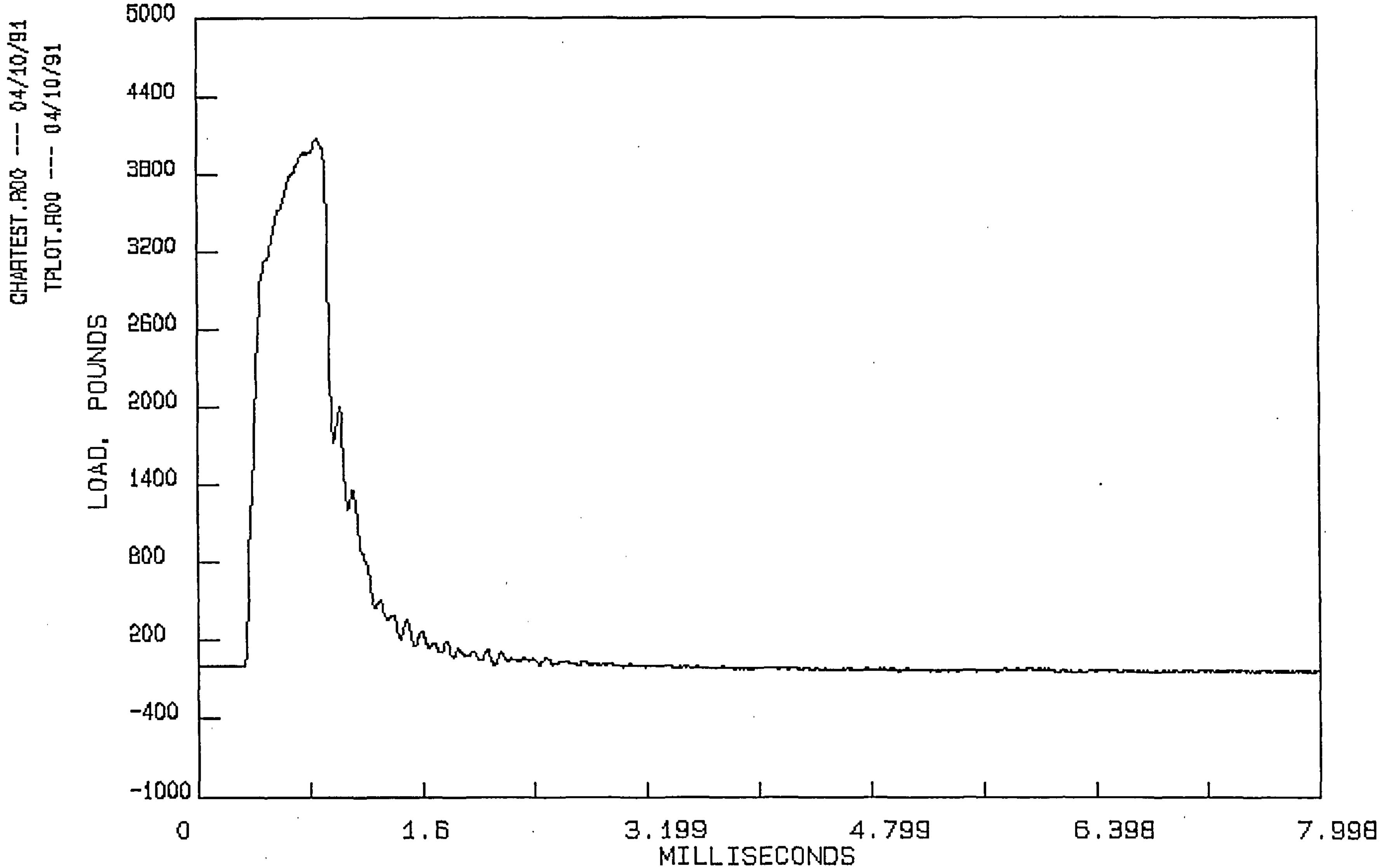
DYNAMIC YIELD STRENGTH (KSI) = 90
DYNAMIC FLOW STRENGTH (KSI) = 104
DIAL ENERGY READING (FT-LBS) = 45

TEST VIOLATIONS

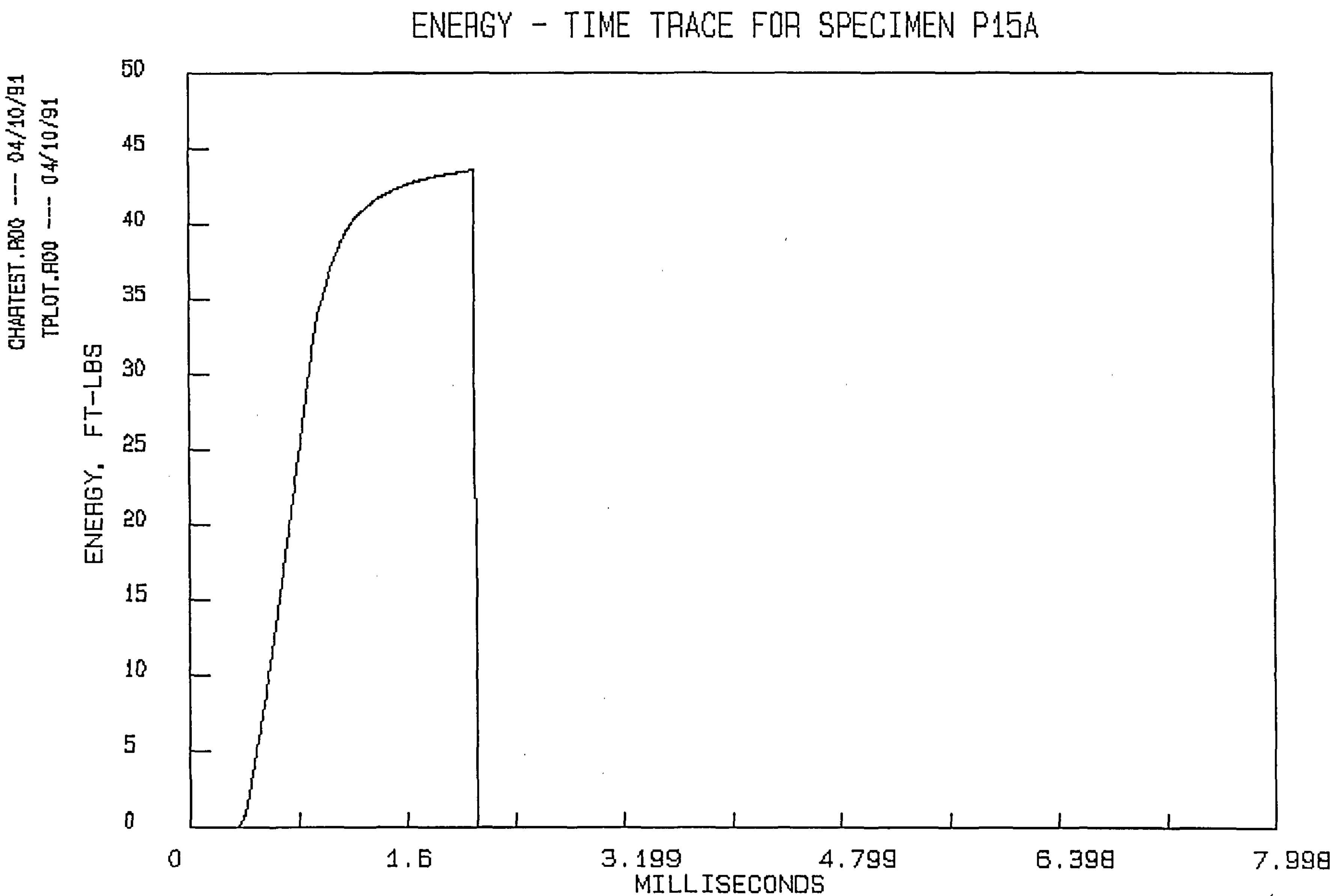
********* NO VIOLATIONS *********

PROJ. NO. 1295-001-03-08   QA NO. 99001

LOAD - TIME TRACE FOR SPECIMEN P15A



PROJ. NO. 1295-001-03-08 QA NO. 99001



CHARTEST.R00 --- 04/10/91
ANALYZE.R00 --- 04/10/91

INSTRUMENTED IMPACT TEST RESULTS

ANALYSIS DATE: 12/03/2003
MATERIAL: BASE (LONG)
INITIAL HAMMER ENERGY, FT-LBS: 240
INITIAL HAMMER VELOCITY, FT/SEC: 17
LOAD CALIBRATION, LBS/VOLT: 1150
SPECIMEN WIDTH, INCH: .394
NOTCH DEPTH, INCH: 7.900001E-02
RESPONSE TIME, MSEC: .0519
TECHNICAL PROCEDURE(S): TP-80 TP-412

ANALYSIS BY: BJV
TEST DATE: 11/06/2003
SPEC. ID: P154
PROJ. NO.: 1295-001-03-08
QA NO.: 99001
TEST TEMP (F): 225
OPERATOR: BJV

PROPERTY	ENERGY, FT-LBS UNCORRECTED	ENERGY, FT-LBS CORRECTED	LOAD POUNDS	TIME MSEC
GENERAL YIELD	5.067596	5.040845	3091.2	.1600001
FLOW LOAD	12.86468	12.69228	3619.05	.2960001
MAXIMUM LOAD	40.15618	38.47648	4146.9	.6980001
FAST FRACTURE LOAD	57.33094	53.90715	3560.4	.9580001
ARREST LOAD	63.22268	59.05903	2005.6	1.08
PROPAGATION LOAD	35.72489	31.40674	1554.8	0
TOTAL ENERGY	75.88107	69.88322	0	0
SHEAR LIP ENERGY	18.55013	15.97607	0	0
TOTAL EVENT TIME	0	0	0	3.194

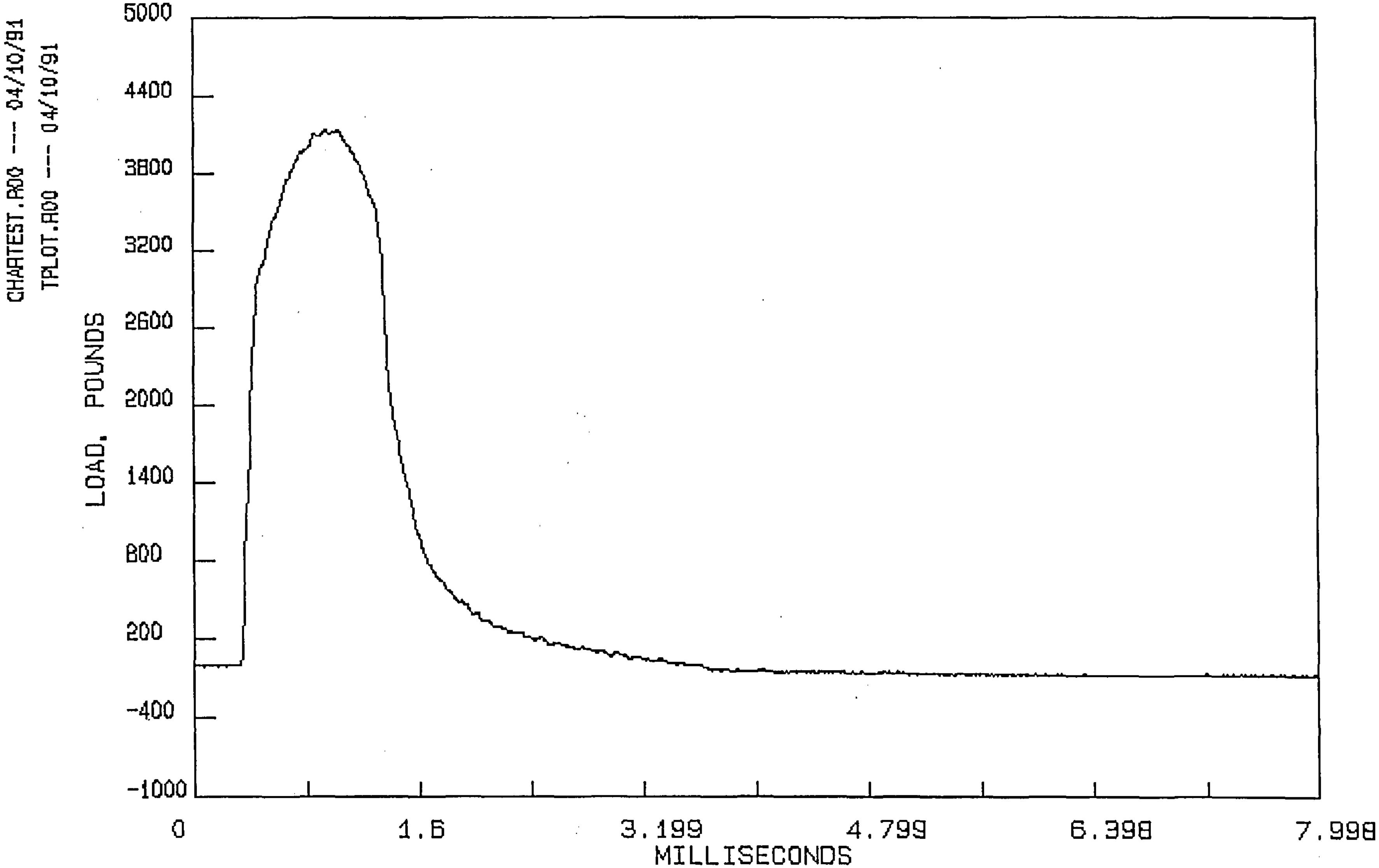
DYNAMIC YIELD STRENGTH (KSI) = 89
DYNAMIC FLOW STRENGTH (KSI) = 104
DIAL ENERGY READING (FT-LBS) = 74.5

TEST VIOLATIONS

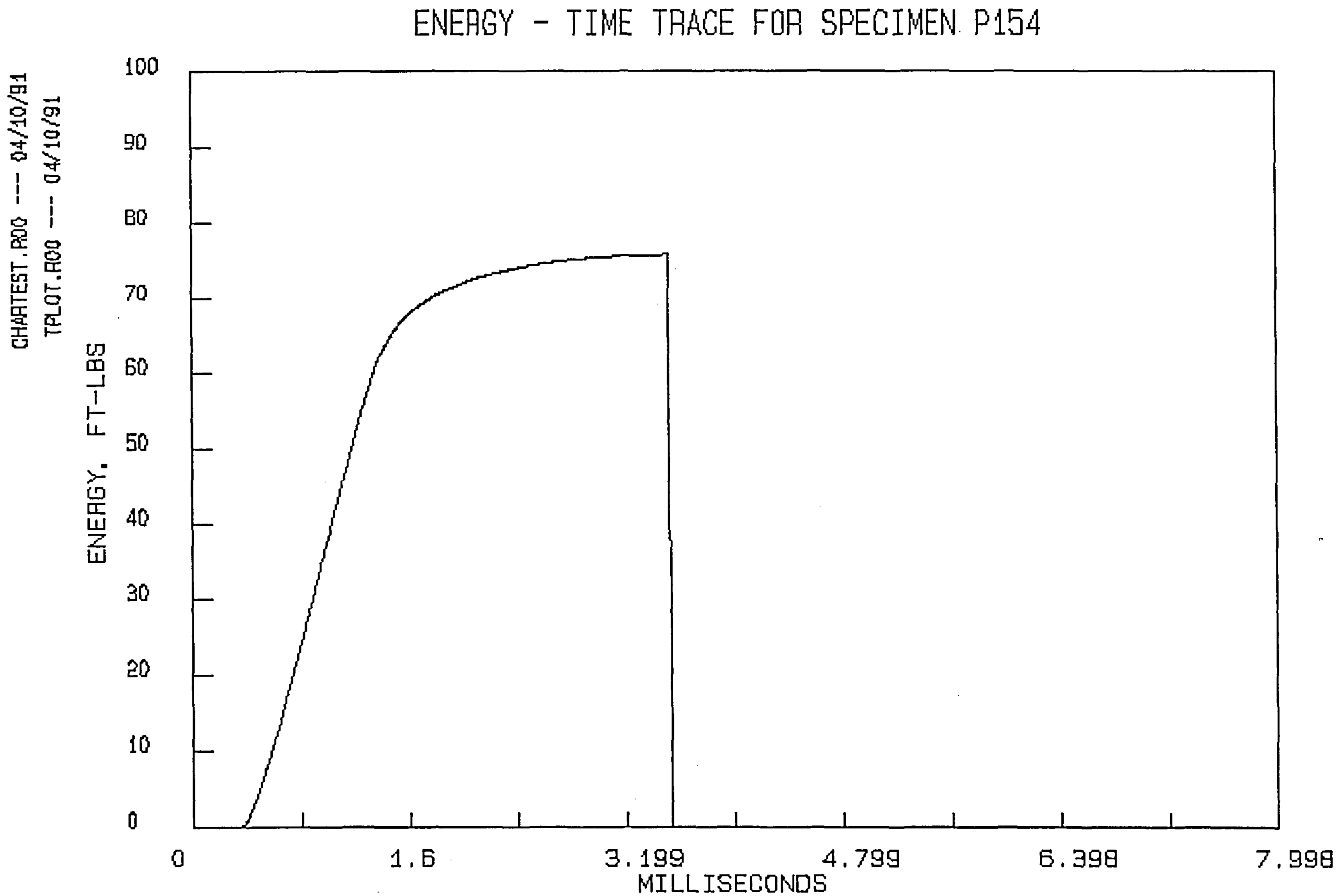
********* NO VIOLATIONS *********

PROJ. NO. 1295-001-03-08 QA NO. 99001

LOAD - TIME TRACE FOR SPECIMEN P154



PROJ. NO. 1295-001-03-08   QA NO. 99001



CHARTEST.R00 --- 04/10/91
ANALYZE.R00 --- 04/10/91

INSTRUMENTED IMPACT TEST RESULTS

ANALYSIS DATE: 12/03/2003
MATERIAL: BASE (LONG)
INITIAL HAMMER ENERGY, FT-LBS: 240
INITIAL HAMMER VELOCITY, FT/SEC: 17
LOAD CALIBRATION, LBS/VOLT: 1150
SPECIMEN WIDTH, INCH: .394
NOTCH DEPTH, INCH: 7.900001E-02
RESPONSE TIME, MSEC: .0519
TECHNICAL PROCEDURE(S): TP-80 TP-412

ANALYSIS BY: BJV
TEST DATE: 11/05/2003
SPEC. ID: P15Y
PROJ. NO.: 1295-001-03-08
QA NO.: 99001
TEST TEMP (F): 250
OPERATOR: BJV

PROPERTY	ENERGY, FT-LBS		LOAD POUNDS	TIME MSEC
	UNCORRECTED	CORRECTED		
GENERAL YIELD	4.649538	4.627019	3054.4	.1739999
FLOW LOAD	13.45736	13.26871	3600.65	.33
MAXIMUM LOAD	39.56795	37.9371	4146.9	.7179999
FAST FRACTURE LOAD	64.93955	60.54669	3611	1.098
ARREST LOAD	69.90434	64.81412	2334.5	1.204
PROPAGATION LOAD	49.16261	42.5923	1276.5	0
TOTAL ENERGY	88.73056	80.5294	0	0
SHEAR LIP ENERGY	23.79101	19.98271	0	0
TOTAL EVENT TIME	0	0	0	3.198

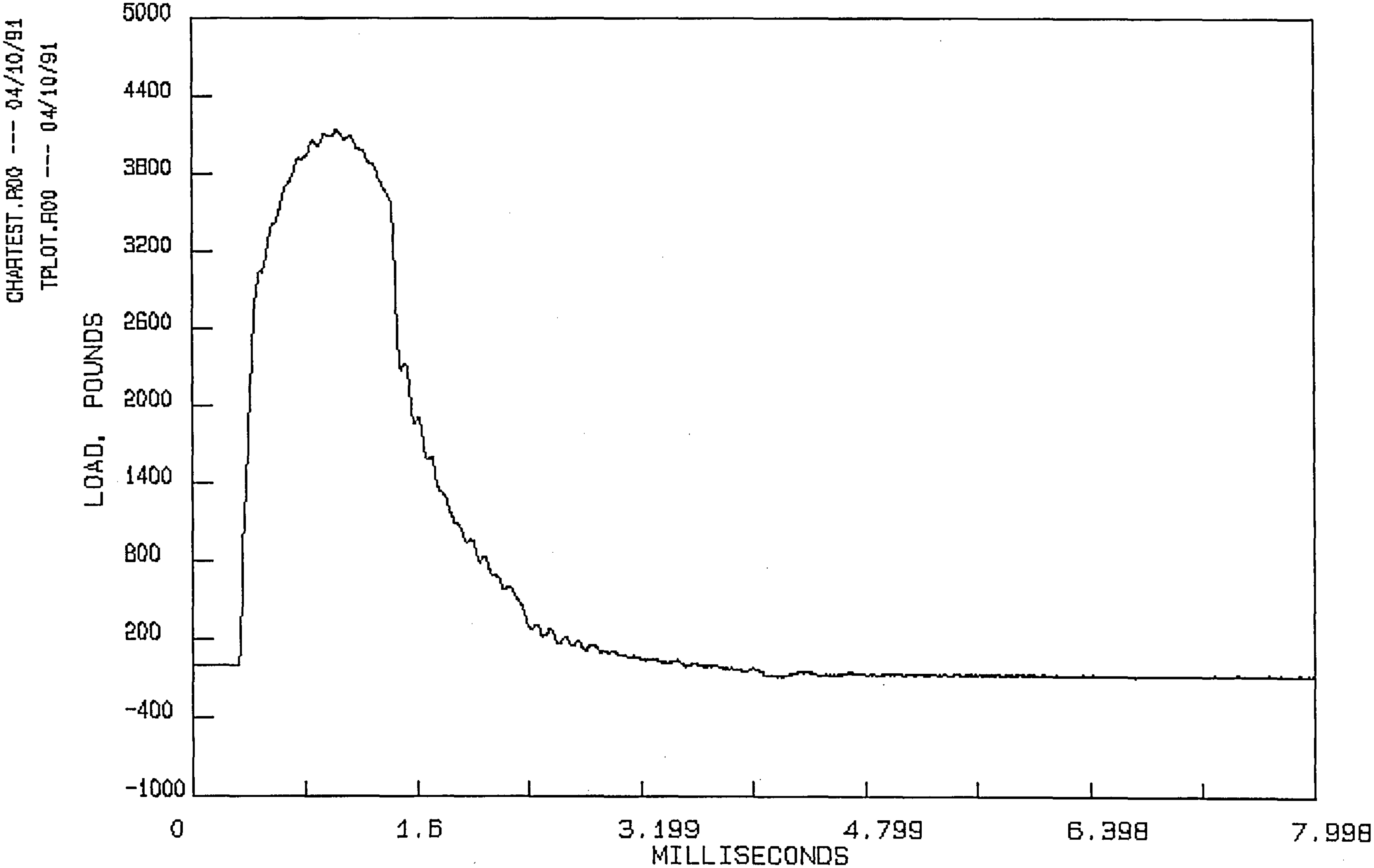
DYNAMIC YIELD STRENGTH (KSI) = 88
DYNAMIC FLOW STRENGTH (KSI) = 103
DIAL ENERGY READING (FT-LBS) = 86.5

TEST VIOLATIONS

********* NO VIOLATIONS *********

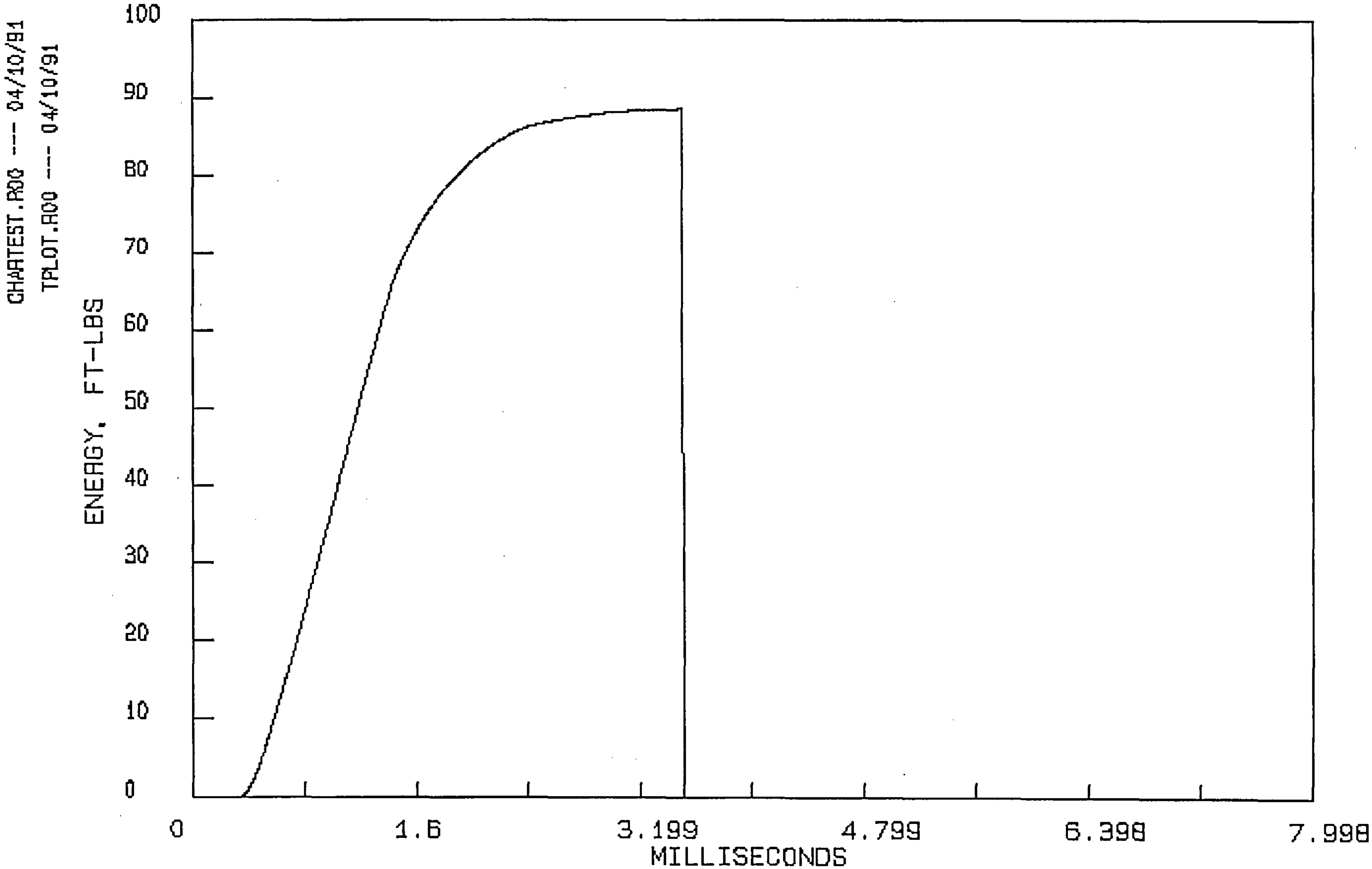
PROJ. NO. 1295-001-03-08 QA NO. 99001

LOAD - TIME TRACE FOR SPECIMEN P15Y



PROJ. NO. 1295-001-03-08 QA NO. 99001

ENERGY - TIME TRACE FOR SPECIMEN P15Y



CHARTEST.R00 --- 04/10/91
ANALYZE.R00 --- 04/10/91

INSTRUMENTED IMPACT TEST RESULTS

ANALYSIS DATE: 12/03/2003
MATERIAL: BASE (LONG)
INITIAL HAMMER ENERGY, FT-LBS: 240
INITIAL HAMMER VELOCITY, FT/SEC: 17
LOAD CALIBRATION, LBS/VOLT: 1150
SPECIMEN WIDTH, INCH: .394
NOTCH DEPTH, INCH: 7.900001E-02
RESPONSE TIME, MSEC: .0519
TECHNICAL PROCEDURE(S): TP-80 TP-412

ANALYSIS BY: BJV
TEST DATE: 11/10/2003
SPEC. ID: P156
PROJ. NO.: 1295-001-03-08
QA NO.: 99001
TEST TEMP (F): 260
OPERATOR: BJV

PROPERTY	ENERGY, FT-LBS		LOAD POUNDS	TIME MSEC
	UNCORRECTED	CORRECTED		
GENERAL YIELD	5.116392	5.089124	3059	.174
FLOW LOAD	12.95485	12.78003	3584.55	.312
MAXIMUM LOAD	33.6153	32.43823	4110.1	.622
FAST FRACTURE LOAD	39.99152	38.32556	4071	.714
ARREST LOAD	46.82799	44.54376	3049.8	.834
PROPAGATION LOAD	41.62641	36.90628	1021.2	0
TOTAL ENERGY	75.24171	69.34451	0	0
SHEAR LIP ENERGY	35.25019	31.01895	0	0
TOTAL EVENT TIME	0	0	0	3.022

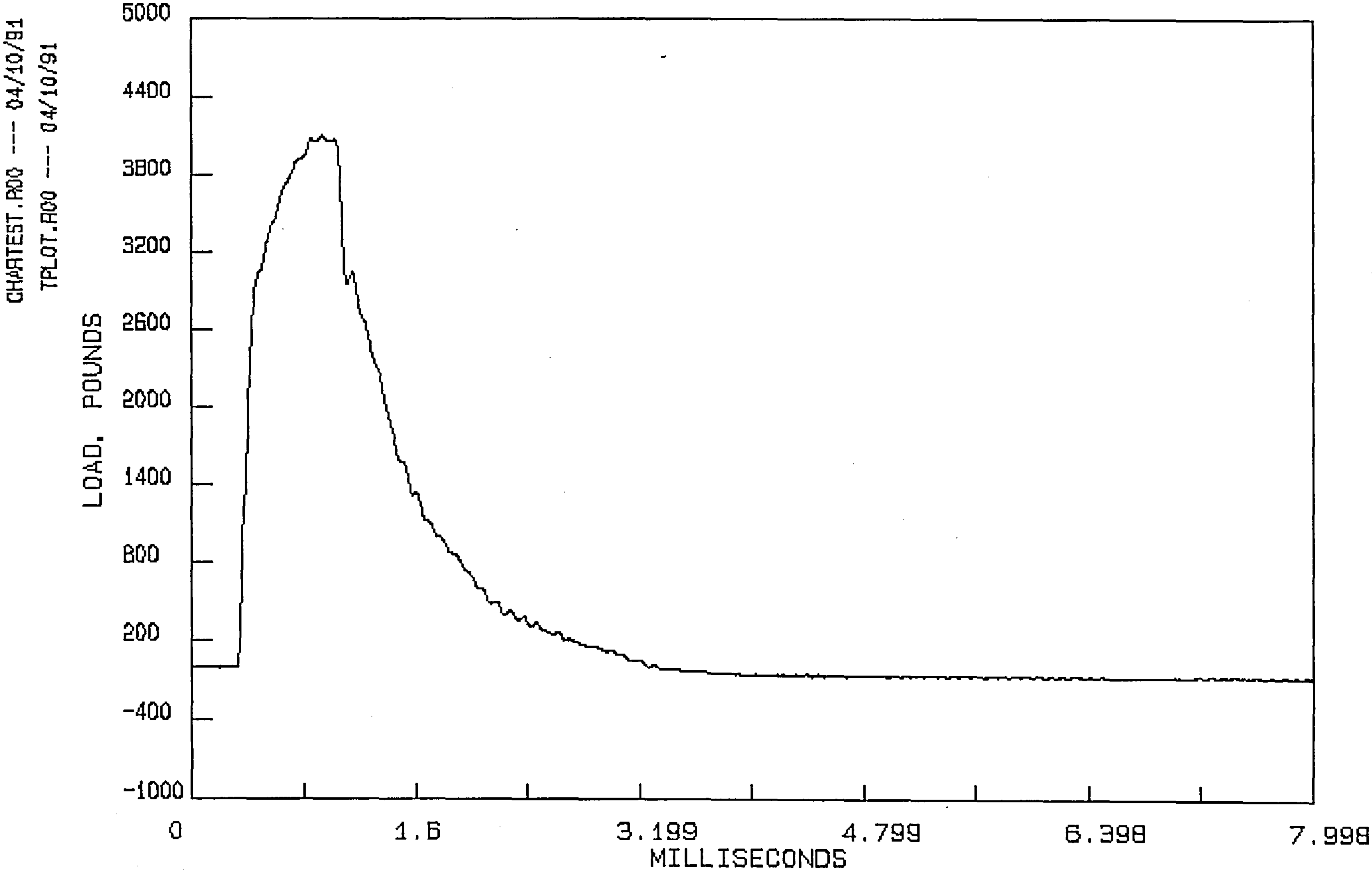
DYNAMIC YIELD STRENGTH (KSI) = 88
DYNAMIC FLOW STRENGTH (KSI) = 103
DIAL ENERGY READING (FT-LBS) = 73

TEST VIOLATIONS

********* NO VIOLATIONS *********

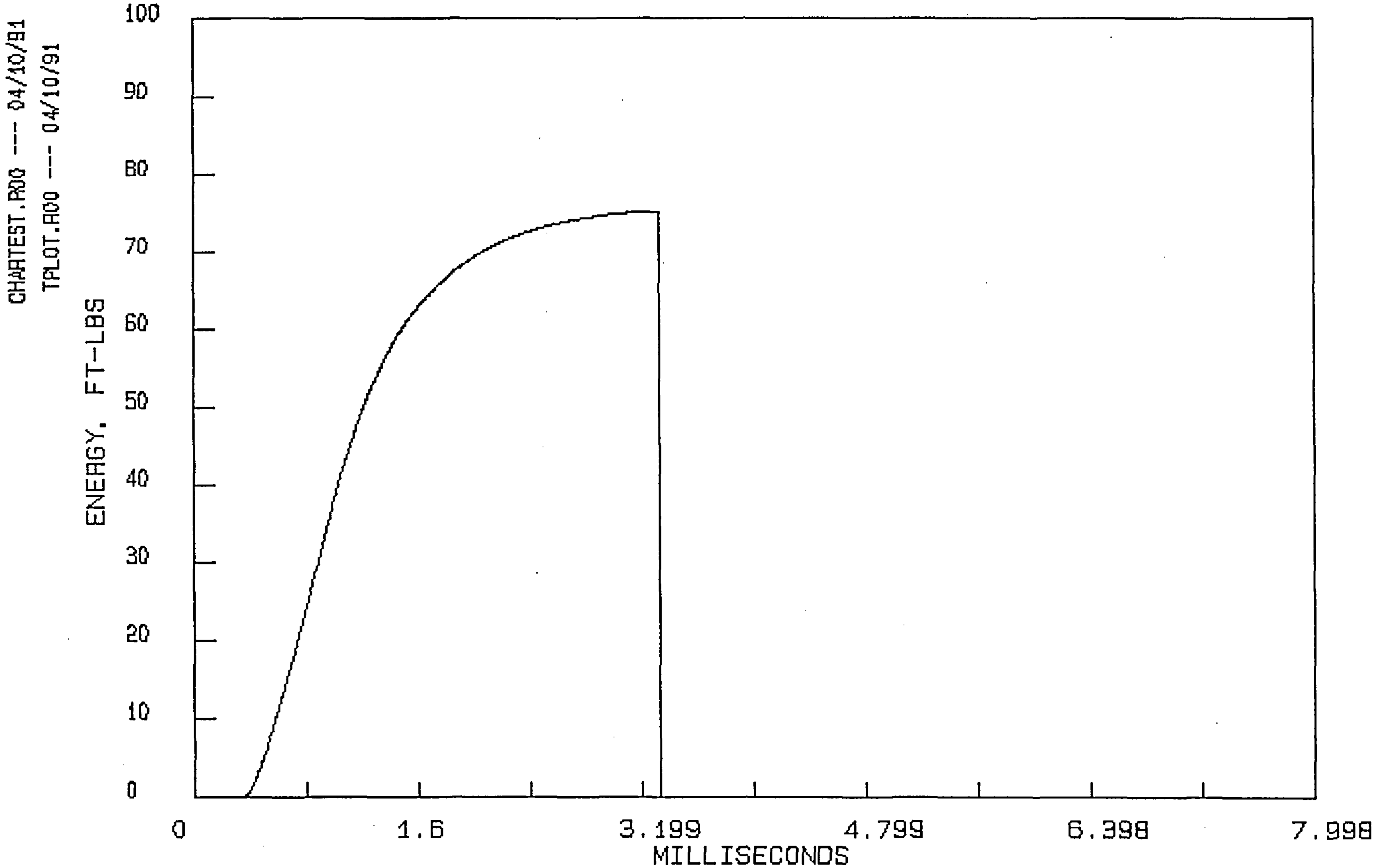
PROJ. NO. 1295-001-03-08   QA NO. 99001

LOAD - TIME TRACE FOR SPECIMEN P156



PROJ. NO. 1295-001-03-08 QA NO. 99001

ENERGY - TIME TRACE FOR SPECIMEN P156



CHARTEST.R00 --- 04/10/91
ANALYZE.R00 --- 04/10/91

INSTRUMENTED IMPACT TEST RESULTS

ANALYSIS DATE: 12/03/2003
MATERIAL: BASE (LONG)
INITIAL HAMMER ENERGY, FT-LBS: 240
INITIAL HAMMER VELOCITY, FT/SEC: 17
LOAD CALIBRATION, LBS/VOLT: 1150
SPECIMEN WIDTH, INCH: .394
NOTCH DEPTH, INCH: 7.900001E-02
RESPONSE TIME, MSEC: .0519
TECHNICAL PROCEDURE(S): TP-80 TP-412

ANALYSIS BY: BJV
TEST DATE: 11/10/2003
SPEC. ID: P15C
PROJ. NO.: 1295-001-03-08
QA NO.: 99001
TEST TEMP (F): 270
OPERATOR: BJV

PROPERTY	ENERGY, FT-LBS		LOAD POUNDS	TIME MSEC
	UNCORRECTED	CORRECTED		
GENERAL YIELD	4.869123	4.844427	3017.6	.166
FLOW LOAD	13.16043	12.98002	3560.4	.314
MAXIMUM LOAD	39.29213	37.68393	4103.2	.706
FAST FRACTURE LOAD	74.64564	68.8415	2865.8	1.274
ARREST LOAD	78.24316	71.86608	2525.4	1.354
PROPAGATION LOAD	67.33647	57.10128	340.4002	0
TOTAL ENERGY	106.6286	94.78521	0	0
SHEAR LIP ENERGY	31.98296	25.94371	0	0
TOTAL EVENT TIME	0	0	0	4.076

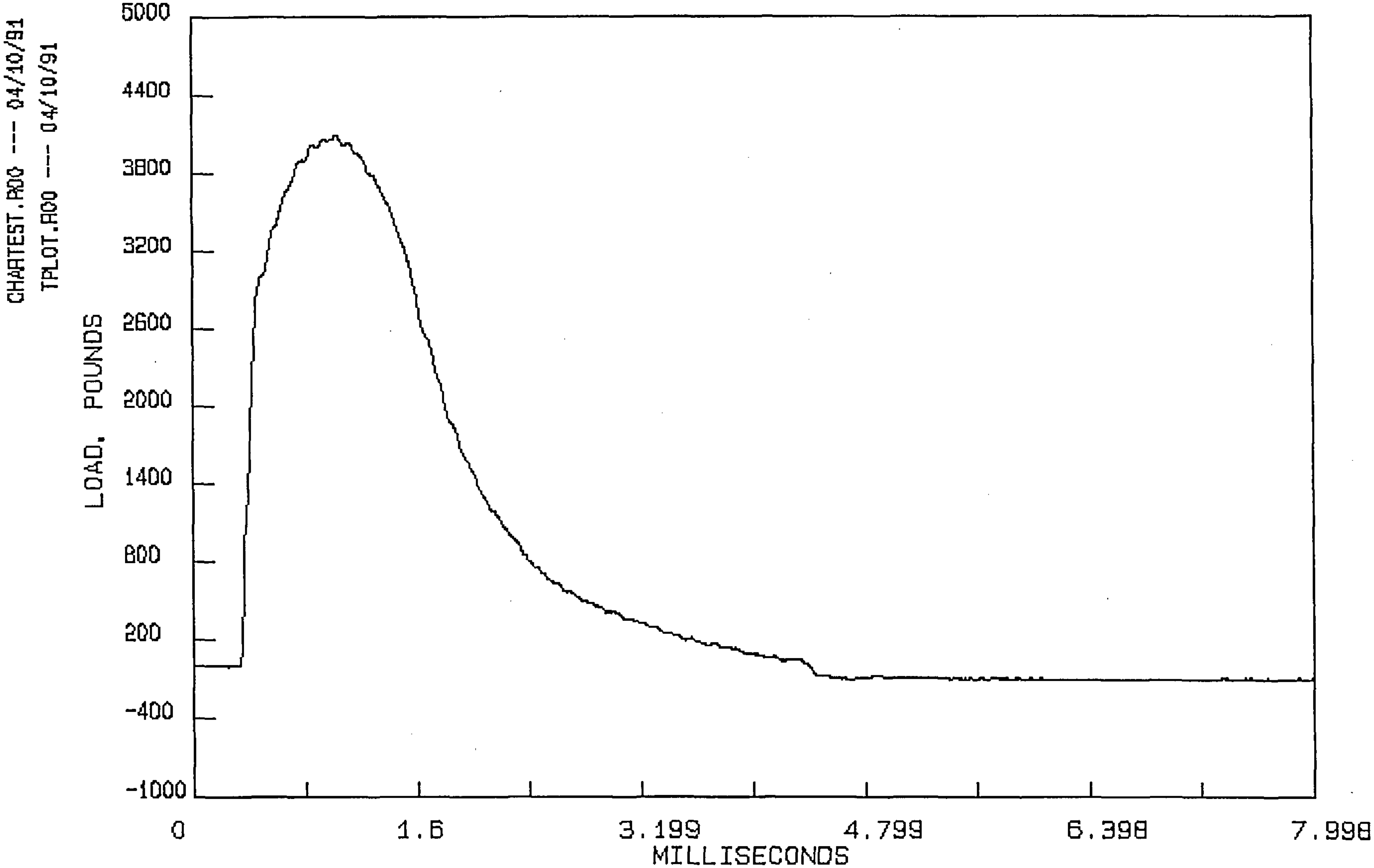
DYNAMIC YIELD STRENGTH (KSI) = 87
DYNAMIC FLOW STRENGTH (KSI) = 102
DIAL ENERGY READING (FT-LBS) = 102

TEST VIOLATIONS

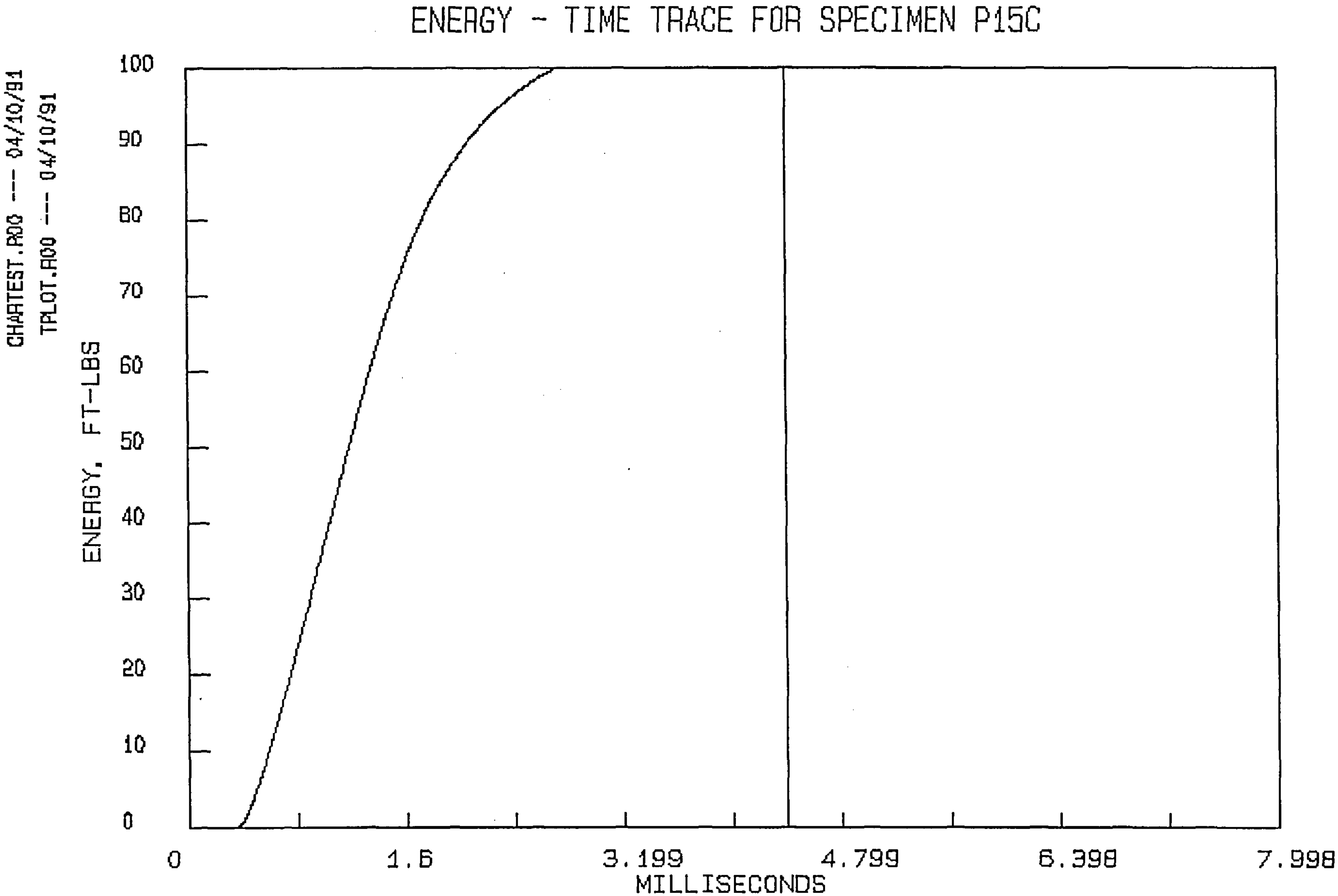
********* NO VIOLATIONS *********

PROJ. NO. 1295-001-03-08 QA NO. 99001

LOAD - TIME TRACE FOR SPECIMEN P15C



PROJ. NO. 1295-001-03-08 QA NO. 99001



CHARTEST.R00 --- 04/10/91
ANALYZE.R00 --- 04/10/91

INSTRUMENTED IMPACT TEST RESULTS

ANALYSIS DATE: 12/03/2003
MATERIAL: BASE (LONG)
INITIAL HAMMER ENERGY, FT-LBS: 240
INITIAL HAMMER VELOCITY, FT/SEC: 17
LOAD CALIBRATION, LBS/VOLT: 1150
SPECIMEN WIDTH, INCH: .394
NOTCH DEPTH, INCH: 7.900001E-02
RESPONSE TIME, MSEC: .0519
TECHNICAL PROCEDURE(S): TP-80 TP-412

ANALYSIS BY: BJV
TEST DATE: 11/06/2003
SPEC. ID: P15B
PROJ. NO.: 1295-001-03-08
QA NO.: 99001
TEST TEMP (F): 280
OPERATOR: BJV

PROPERTY	ENERGY, FT-LBS		LOAD POUNDS	TIME MSEC
	UNCORRECTED	CORRECTED		
GENERAL YIELD	4.88273	4.857895	3001.5	.1680001
FLOW LOAD	12.92317	12.7492	3539.7	.312
MAXIMUM LOAD	39.08757	37.49607	4077.9	.7060001
FAST FRACTURE LOAD	102.7889	91.78311	-2.441406E-04	4.044
ARREST LOAD	102.7889	91.78311	-2.441406E-04	4.044
PROPAGATION LOAD	63.70133	54.28704	0	0
TOTAL ENERGY	102.7889	91.78311	0	0
SHEAR LIP ENERGY	0	0	0	0
TOTAL EVENT TIME	0	0	0	4.044

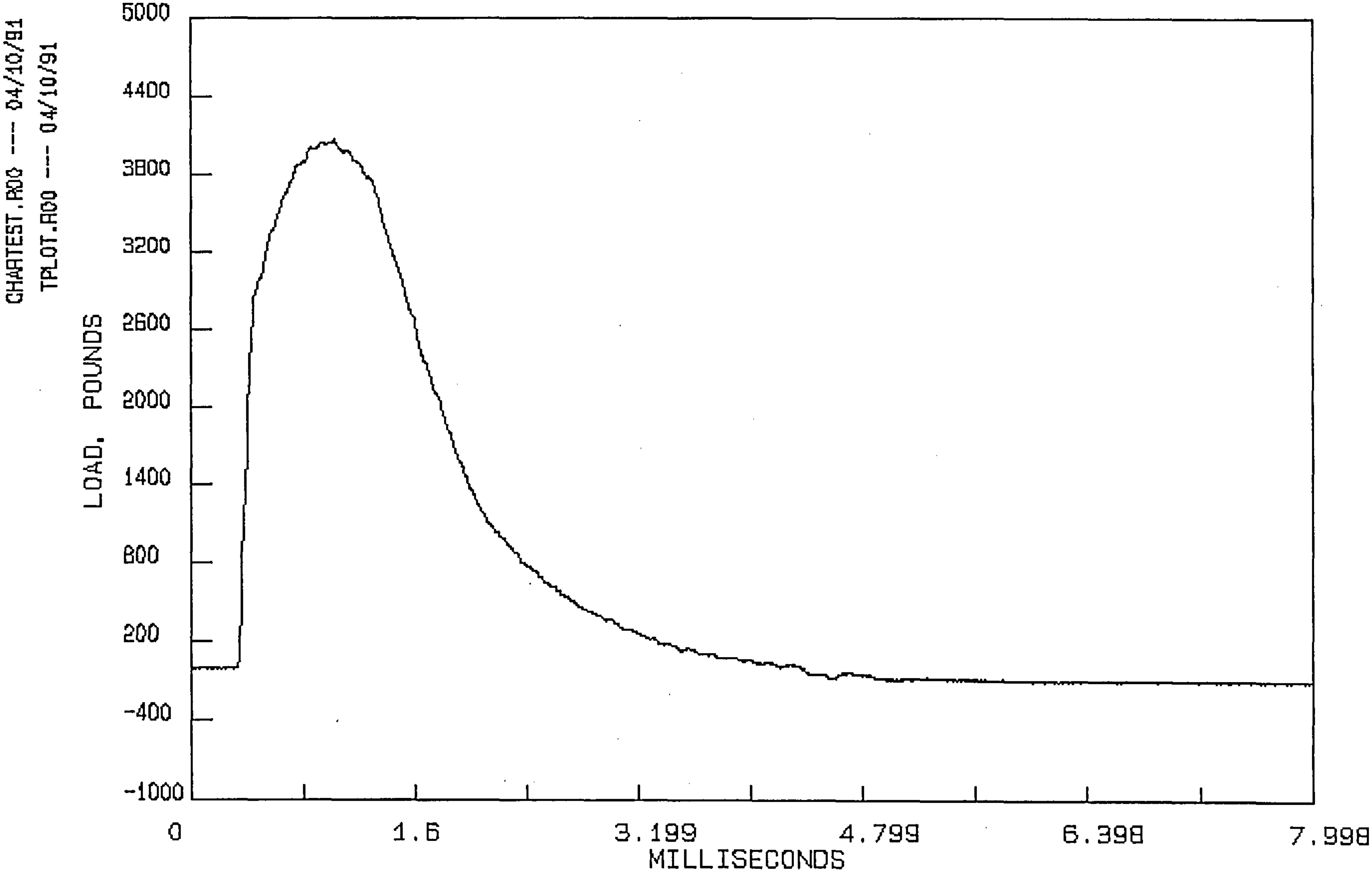
DYNAMIC YIELD STRENGTH (KSI) = 86
DYNAMIC FLOW STRENGTH (KSI) = 102
DIAL ENERGY READING (FT-LBS) = 100.5

TEST VIOLATIONS

********* NO VIOLATIONS *********

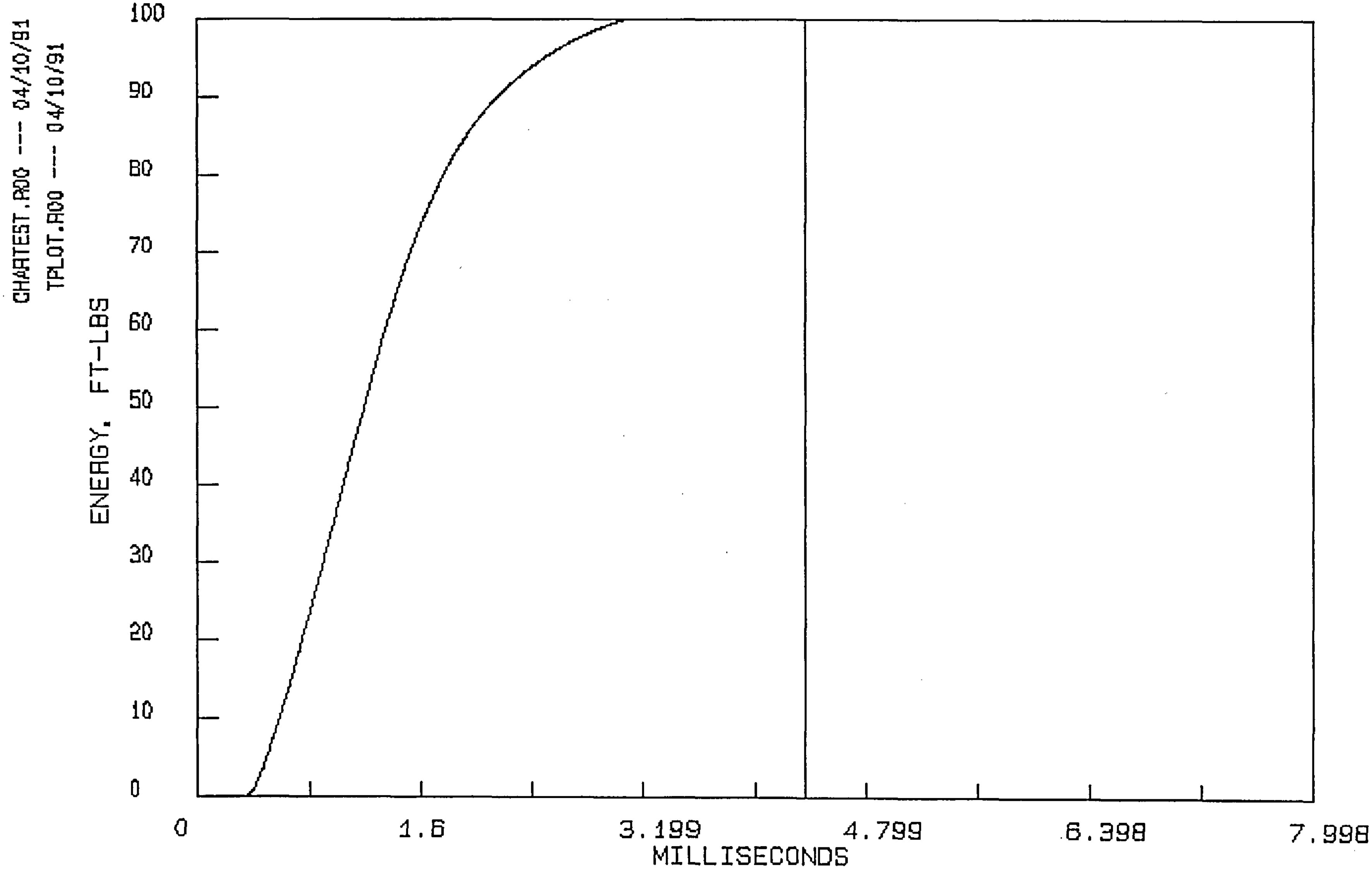
PROJ. NO. 1295-001-03-08 QA NO. 99001

LOAD - TIME TRACE FOR SPECIMEN P15B



PROJ. NO. 1295-001-03-08   QA NO. 99001

ENERGY - TIME TRACE FOR SPECIMEN P15B



CHARTEST.R00 --- 04/10/91
ANALYZE.R00 --- 04/10/91

INSTRUMENTED IMPACT TEST RESULTS

ANALYSIS DATE: 12/03/2003
MATERIAL: BASE (LONG)
INITIAL HAMMER ENERGY, FT-LBS: 240
INITIAL HAMMER VELOCITY, FT/SEC: 17
LOAD CALIBRATION, LBS/VOLT: 1150
SPECIMEN WIDTH, INCH: .394
NOTCH DEPTH, INCH: 7.900001E-02
RESPONSE TIME, MSEC: .0519
TECHNICAL PROCEDURE(S): TP-80 TP-412

ANALYSIS BY: BJV
TEST DATE: 11/05/2003
SPEC. ID: P15U
PROJ. NO.: 1295-001-03-08
QA NO.: 99001
TEST TEMP (F): 300
OPERATOR: BJV

PROPERTY	ENERGY, FT-LBS		LOAD POUNDS	TIME MSEC
	UNCORRECTED	CORRECTED		
GENERAL YIELD	4.737825	4.714443	2967	.158
FLOW LOAD	12.78484	12.61458	3501.75	.304
MAXIMUM LOAD	38.77205	37.20614	4036.5	.7000001
FAST FRACTURE LOAD	108.6024	96.31648	2.299805	3.902
ARREST LOAD	108.6024	96.31648	2.299805	3.902
PROPAGATION LOAD	69.83035	59.11034	0	0
TOTAL ENERGY	108.6024	96.31648	0	0
SHEAR LIP ENERGY	0	0	0	0
TOTAL EVENT TIME	0	0	0	3.902

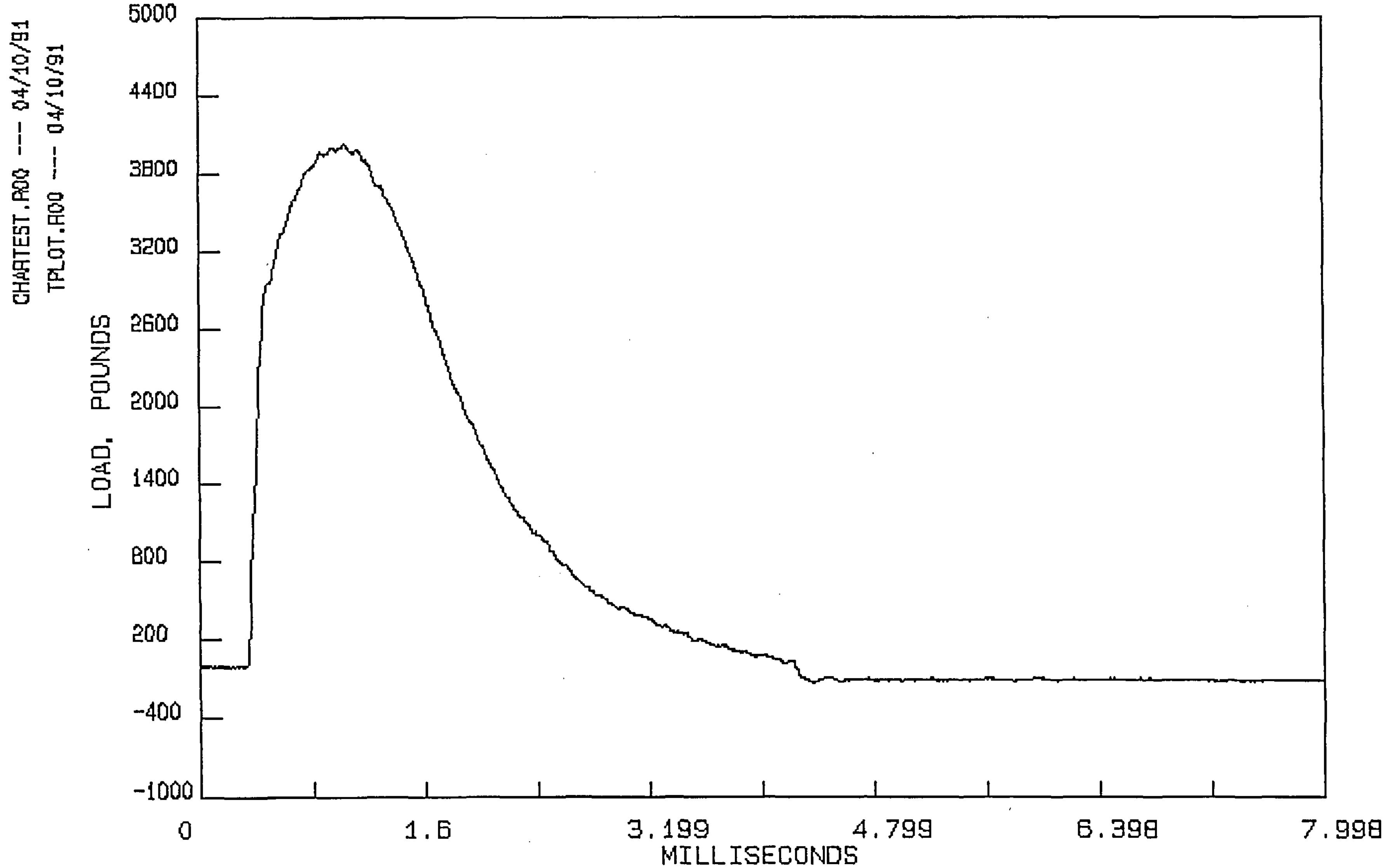
DYNAMIC YIELD STRENGTH (KSI) = 85
DYNAMIC FLOW STRENGTH (KSI) = 101
DIAL ENERGY READING (FT-LBS) = 104.5

TEST VIOLATIONS

********* NO VIOLATIONS *********

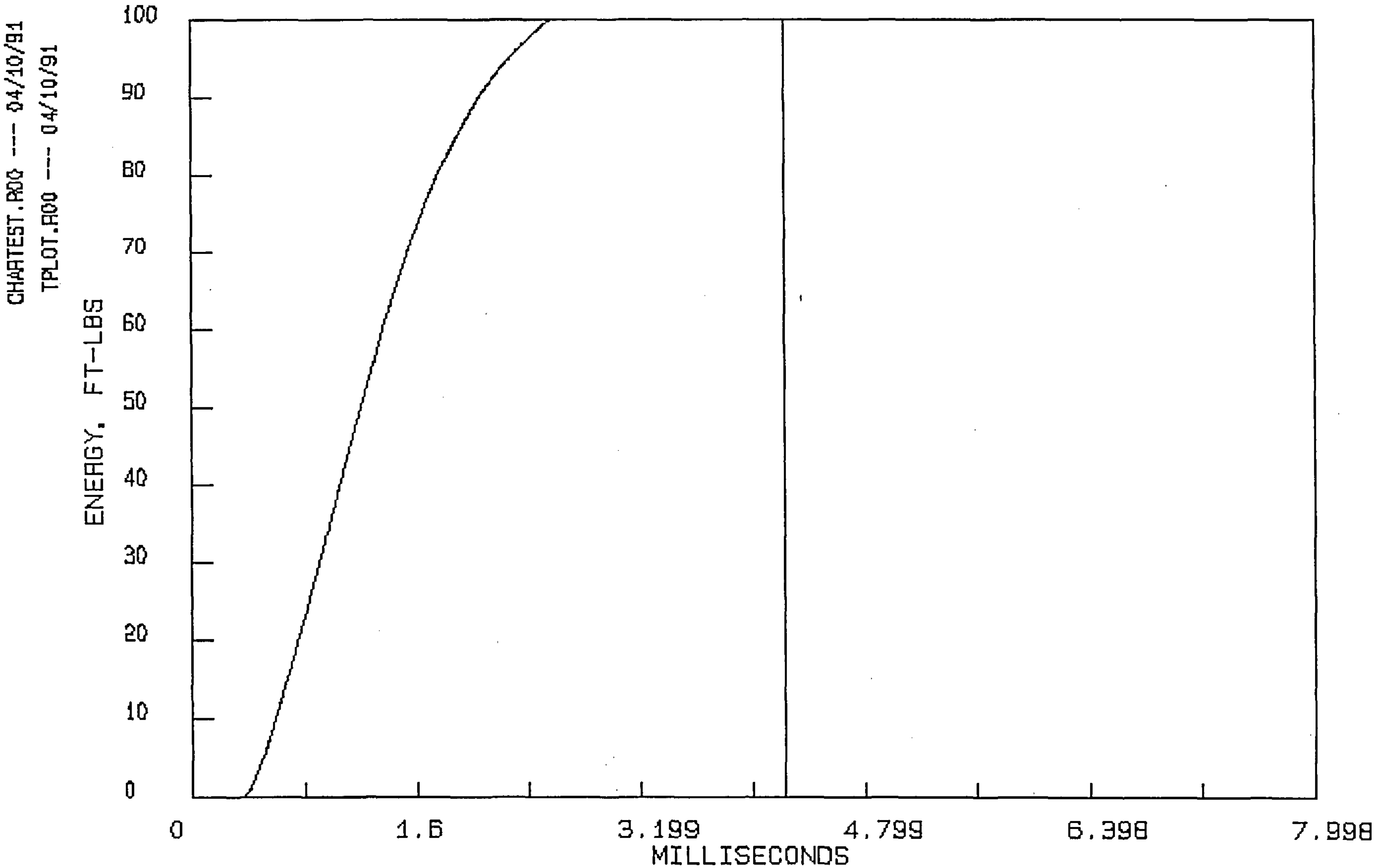
PROJ. NO. 1295-001-03-08   QA NO. 99001

LOAD - TIME TRACE FOR SPECIMEN P15U



PROJ. NO. 1295-001-03-08 QA NO. 99001

ENERGY - TIME TRACE FOR SPECIMEN P15U



CHARTEST.R00 --- 04/10/91
ANALYZE.R00 --- 04/10/91

INSTRUMENTED IMPACT TEST RESULTS

ANALYSIS DATE: 12/03/2003
MATERIAL: BASE (LONG)
INITIAL HAMMER ENERGY, FT-LBS: 240
INITIAL HAMMER VELOCITY, FT/SEC: 17
LOAD CALIBRATION, LBS/VOLT: 1150
SPECIMEN WIDTH, INCH: .394
NOTCH DEPTH, INCH: 7.900001E-02
RESPONSE TIME, MSEC: .0519
TECHNICAL PROCEDURE(S): TP-80 TP-412

ANALYSIS BY: BJV
TEST DATE: 11/06/2003
SPEC. ID: P155
PROJ. NO.: 1295-001-03-08
QA NO.: 99001
TEST TEMP (F): 325
OPERATOR: BJV

PROPERTY	ENERGY, FT-LBS		LOAD POUNDS	TIME MSEC
	UNCORRECTED	CORRECTED		
GENERAL YIELD	4.41572	4.395409	2930.2	.15
FLOW LOAD	12.71634	12.5479	3479.9	.302
MAXIMUM LOAD	39.15889	37.56158	4029.6	.7040001
FAST FRACTURE LOAD	105.6571	94.02853	2.299805	3.536
ARREST LOAD	105.6571	94.02853	2.299805	3.536
PROPAGATION LOAD	66.49821	56.46695	0	0
TOTAL ENERGY	105.6571	94.02853	0	0
SHEAR LIP ENERGY	0	0	0	0
TOTAL EVENT TIME	0	0	0	3.536

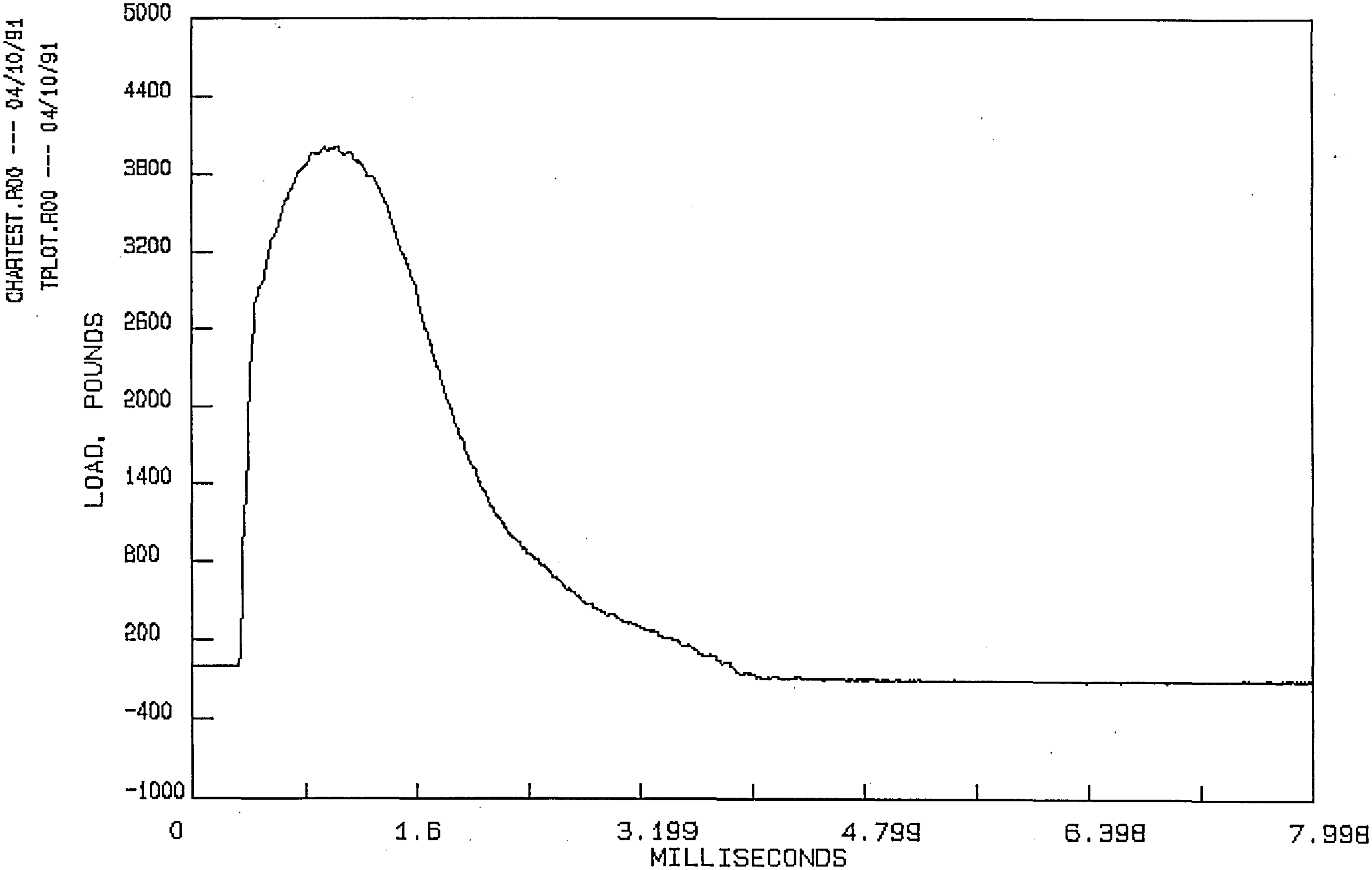
DYNAMIC YIELD STRENGTH (KSI) = 84
DYNAMIC FLOW STRENGTH (KSI) = 100
DIAL ENERGY READING (FT-LBS) = 101

TEST VIOLATIONS

********* NO VIOLATIONS *********

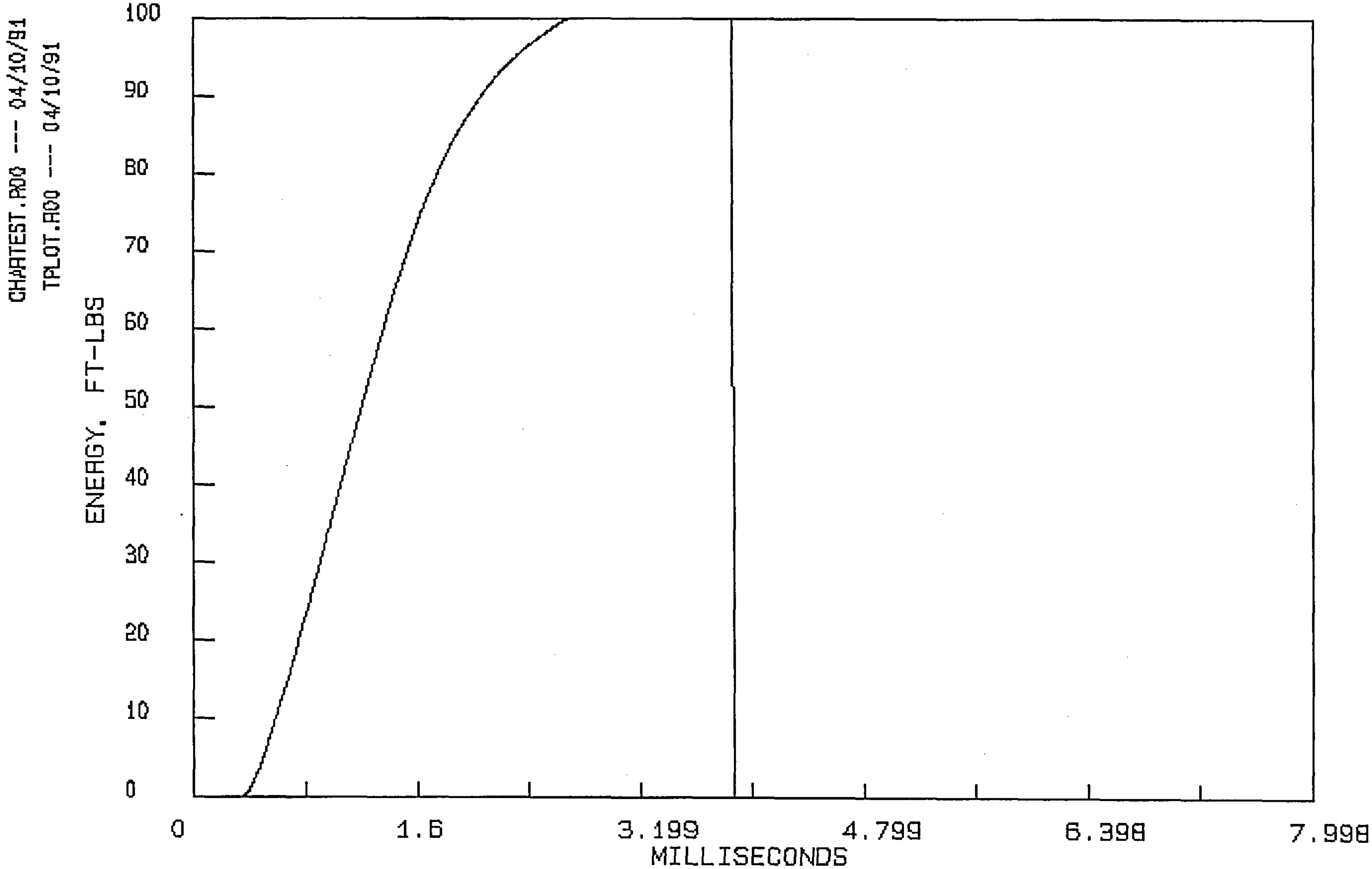
PROJ. NO. 1295-001-03-08 QA NO. 99001

LOAD - TIME TRACE FOR SPECIMEN P155



PROJ. NO. 1295-001-03-08   QA NO. 99001

ENERGY - TIME TRACE FOR SPECIMEN P155



INSTRUMENTED IMPACT TEST RESULTS

ANALYSIS DATE: 12/03/2003
MATERIAL: BASE (TRANSVERSE)
INITIAL HAMMER ENERGY, FT-LBS: 240
INITIAL HAMMER VELOCITY, FT/SEC: 17
LOAD CALIBRATION, LBS/VOLT: 1150
SPECIMEN WIDTH, INCH: .394
NOTCH DEPTH, INCH: 7.900001E-02
RESPONSE TIME, MSEC: .0519
TECHNICAL PROCEDURE(S): TP-80 TP-412

ANALYSIS BY: BJV
TEST DATE: 11/05/2003
SPEC. ID: P213
PROJ. NO.: 1295-001-03-08
QA NO.: 99001
TEST TEMP (F): 70
OPERATOR: BJV

PROPERTY	ENERGY, FT-LBS UNCORRECTED	ENERGY, FT-LBS CORRECTED	LOAD POUNDS	TIME MSEC
GENERAL YIELD	4.969924	4.944195	3530.5	.172
FLOW LOAD	4.969924	4.944195	3530.5	.172
MAXIMUM LOAD	4.969924	4.944195	3530.5	.172
FAST FRACTURE LOAD	4.969924	4.944195	3530.5	.172
ARREST LOAD	8.271058	8.199798	0	.2509999
PROPAGATION LOAD	3.301134	3.255603	3530.5	0
TOTAL ENERGY	8.271058	8.199798	0	0
SHEAR LIP ENERGY	3.301134	3.255603	0	0
TOTAL EVENT TIME	0	0	0	.2509999

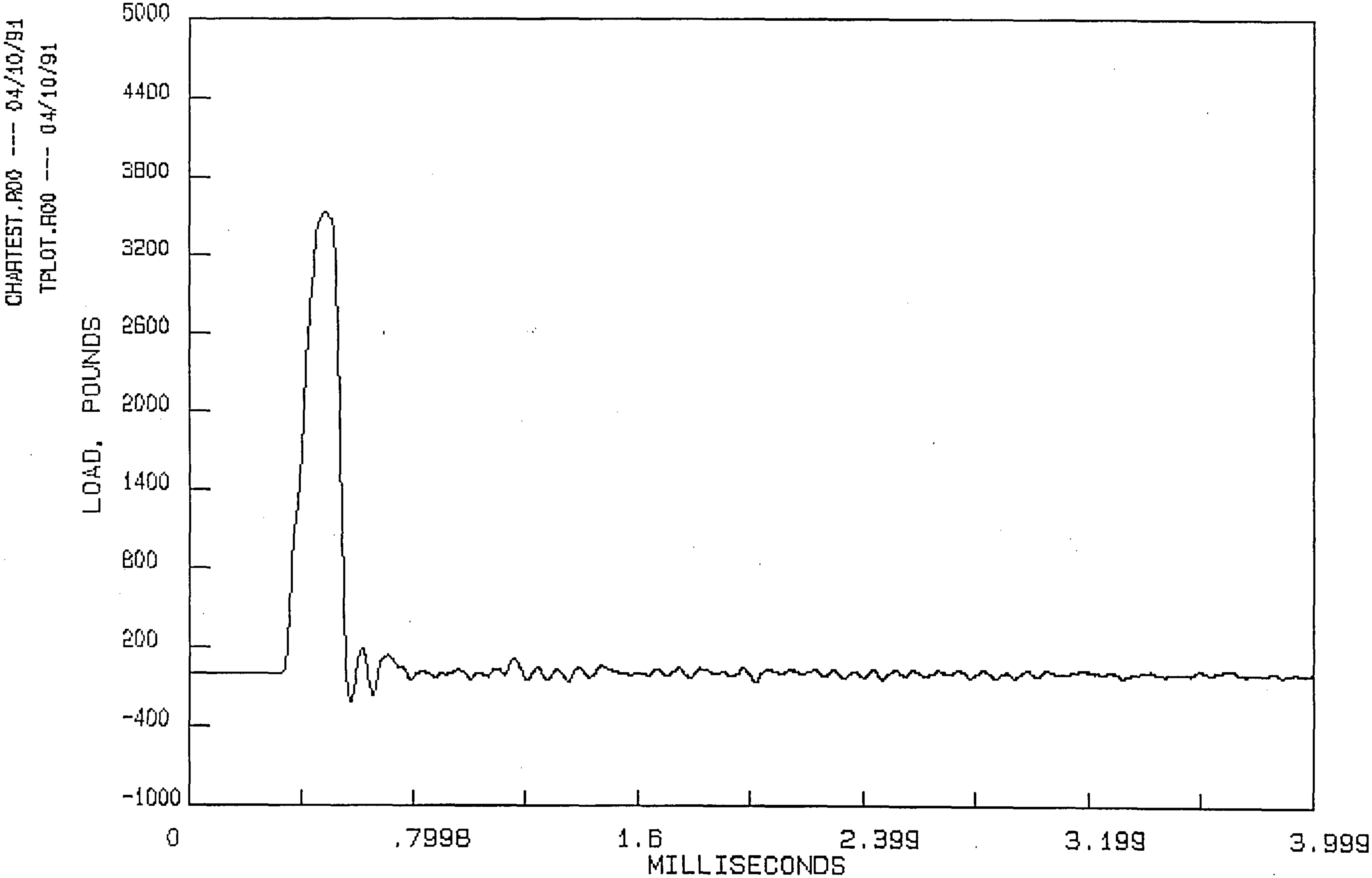
DYNAMIC YIELD STRENGTH (KSI) = 101
DYNAMIC FLOW STRENGTH (KSI) = 101
DIAL ENERGY READING (FT-LBS) = 9.5

TEST VIOLATIONS

********* NO VIOLATIONS *********

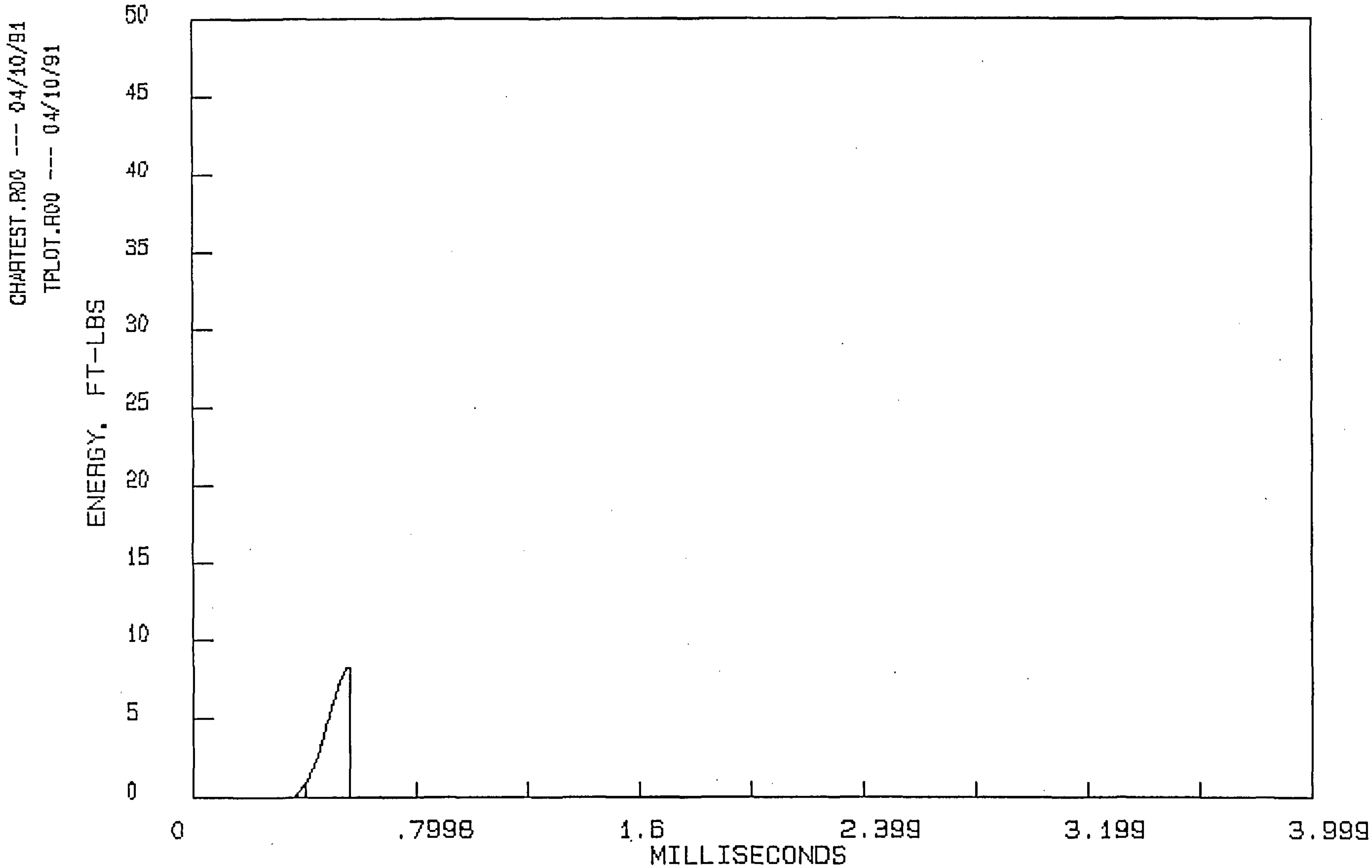
PROJ. NO. 1295-001-03-08 QA NO. 99001

LOAD - TIME TRACE FOR SPECIMEN P213



PROJ. NO. 1295-001-03-08   QA NO. 99001

ENERGY - TIME TRACE FOR SPECIMEN P213



CHARTEST.R00 --- 04/10/91
ANALYZE.R00 --- 04/10/91

INSTRUMENTED IMPACT TEST RESULTS

ANALYSIS DATE: 12/03/2003
MATERIAL: BASE (TRANSVERSE)
INITIAL HAMMER ENERGY, FT-LBS: 240
INITIAL HAMMER VELOCITY, FT/SEC: 17
LOAD CALIBRATION, LBS/VOLT: 1150
SPECIMEN WIDTH, INCH: .394
NOTCH DEPTH, INCH: 7.900001E-02
RESPONSE TIME, MSEC: .0519
TECHNICAL PROCEDURE(S): TP-80 TP-412

ANALYSIS BY: BJV
TEST DATE: 11/10/2003
SPEC. ID: P255
PROJ. NO.: 1295-001-03-08
QA NO.: 99001
TEST TEMP (F): 110
OPERATOR: BJV

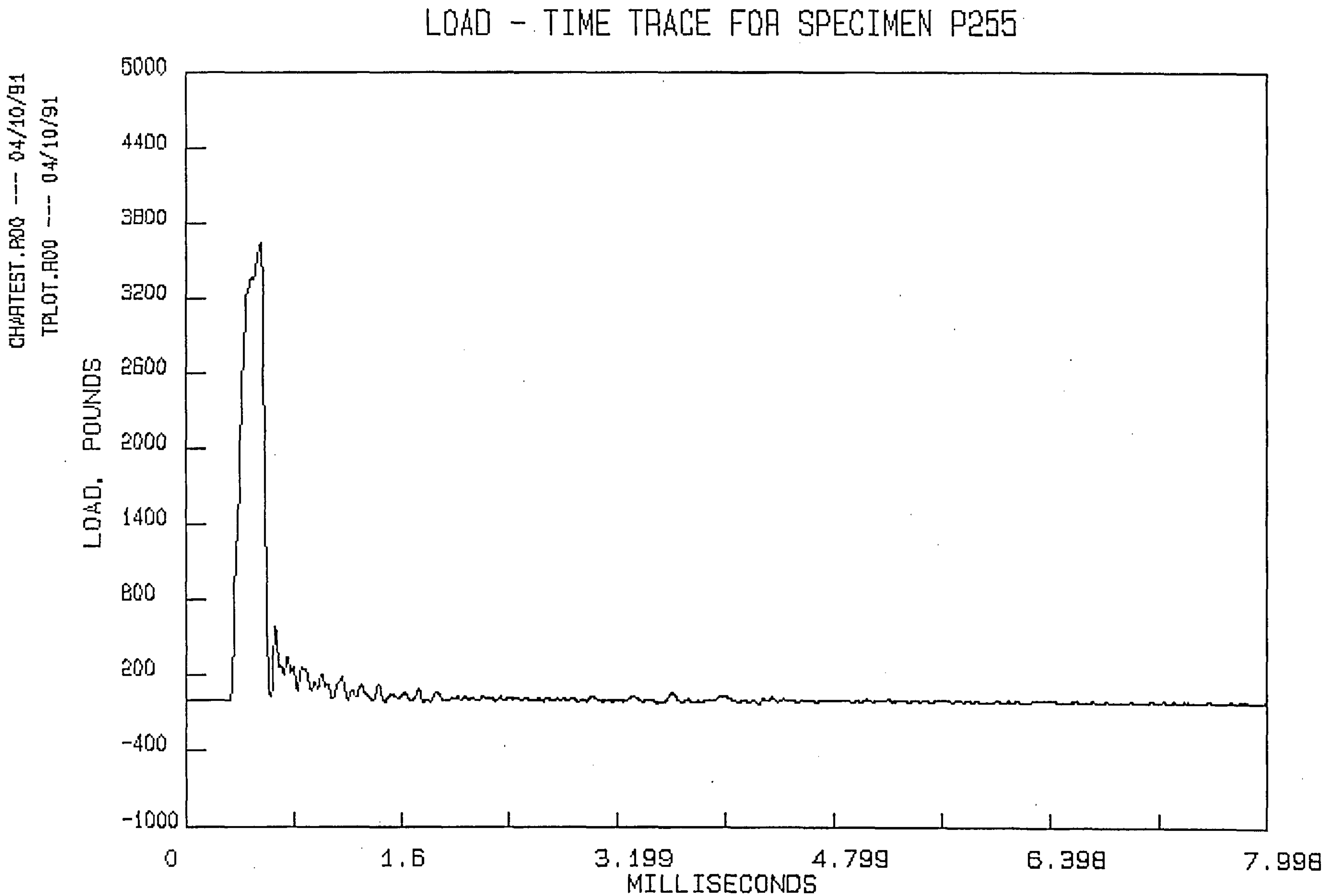
PROPERTY	ENERGY, FT-LBS UNCORRECTED	ENERGY, FT-LBS CORRECTED	LOAD POUNDS	TIME MSEC
GENERAL YIELD	5.118346	5.091057	3367.2	.182
FLOW LOAD	7.783638	7.720529	3515.55	.2280001
MAXIMUM LOAD	9.253954	9.16475	3663.9	.2520001
FAST FRACTURE LOAD	9.253954	9.16475	3663.9	.2520001
ARREST LOAD	11.51948	11.38125	593.3999	.36
PROPAGATION LOAD	4.175326	4.07667	3070.5	0
TOTAL ENERGY	13.42928	13.24142	0	0
SHEAR LIP ENERGY	4.175326	4.07667	0	0
TOTAL EVENT TIME	0	0	0	1.166

DYNAMIC YIELD STRENGTH (KSI) = 97
DYNAMIC FLOW STRENGTH (KSI) = 101
DIAL ENERGY READING (FT-LBS) = 14.5

TEST VIOLATIONS

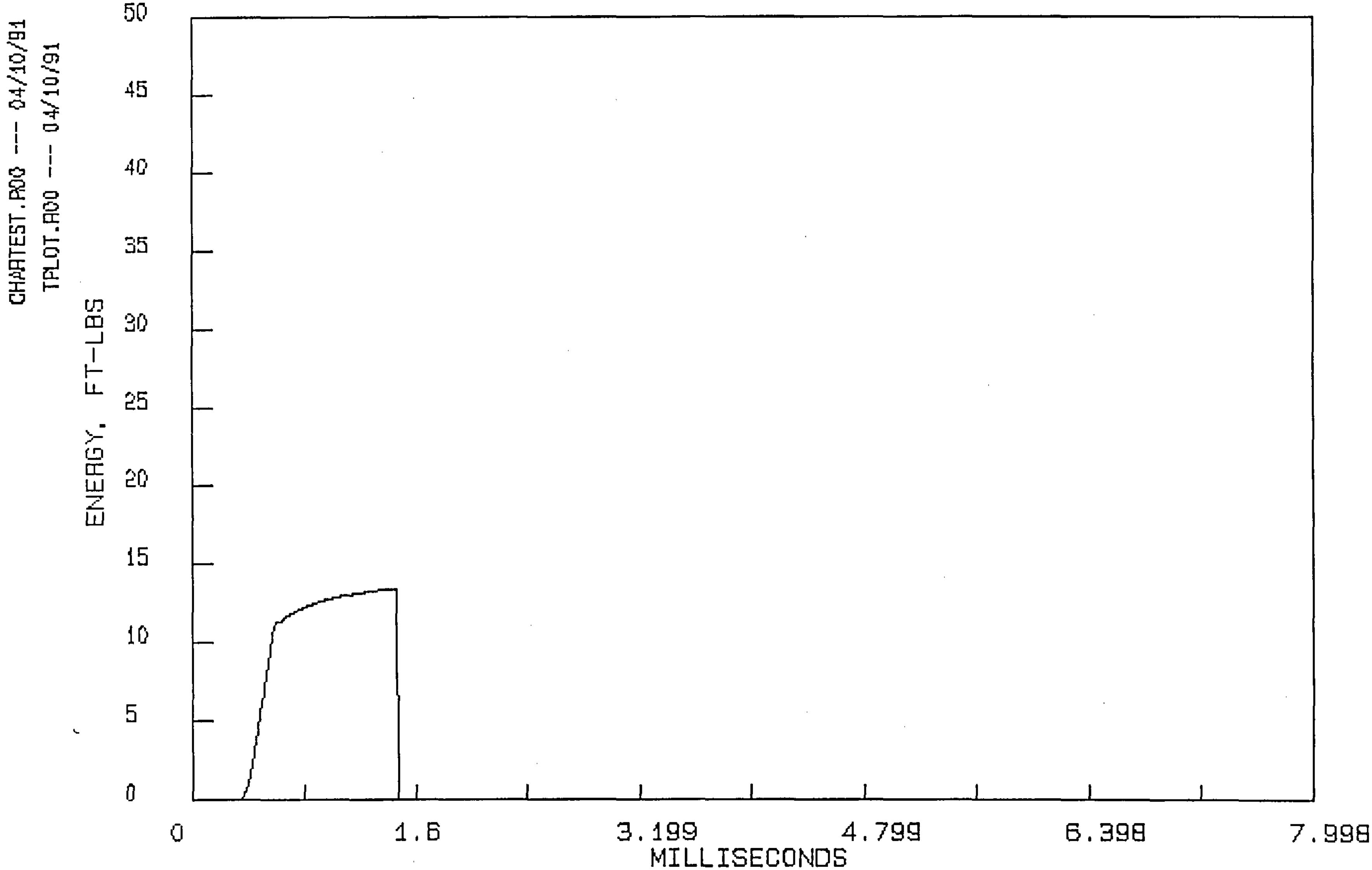
********* NO VIOLATIONS *********

PROJ. NO. 1295-001-03-08 QA NO. 99001



PROJ. NO. 1295-001-03-08 QA NO. 99001

ENERGY - TIME TRACE FOR SPECIMEN P255



CHARTEST.R00 --- 04/10/91
ANALYZE.R00 --- 04/10/91

INSTRUMENTED IMPACT TEST RESULTS

ANALYSIS DATE: 12/03/2003
MATERIAL: BASE (TRANSVERSE)
INITIAL HAMMER ENERGY, FT-LBS: 240
INITIAL HAMMER VELOCITY, FT/SEC: 17
LOAD CALIBRATION, LBS/VOLT: 1150
SPECIMEN WIDTH, INCH: .394
NOTCH DEPTH, INCH: 7.900001E-02
RESPONSE TIME, MSEC: .0519
TECHNICAL PROCEDURE(S): TP-80 TP-412

ANALYSIS BY: BJV
TEST DATE: 11/05/2003
SPEC. ID: P25E
PROJ. NO.: 1295-001-03-08
QA NO.: 99001
TEST TEMP (F): 150
OPERATOR: BJV

PROPERTY	ENERGY, FT-LBS		LOAD POUNDS	TIME MSEC
	UNCORRECTED	CORRECTED		
GENERAL YIELD	4.93059	4.905266	3259.1	.176
FLOW LOAD	9.659423	9.562231	3616.75	.2580001
MAXIMUM LOAD	19.25621	18.86996	3974.4	.4060001
FAST FRACTURE LOAD	19.25621	18.86996	3974.4	.4060001
ARREST LOAD	22.6468	22.11255	1005.1	.5300001
PROPAGATION LOAD	6.66671	6.352959	2969.3	0
TOTAL ENERGY	25.92292	25.22292	0	0
SHEAR LIP ENERGY	6.66671	6.352959	0	0
TOTAL EVENT TIME	0	0	0	1.616

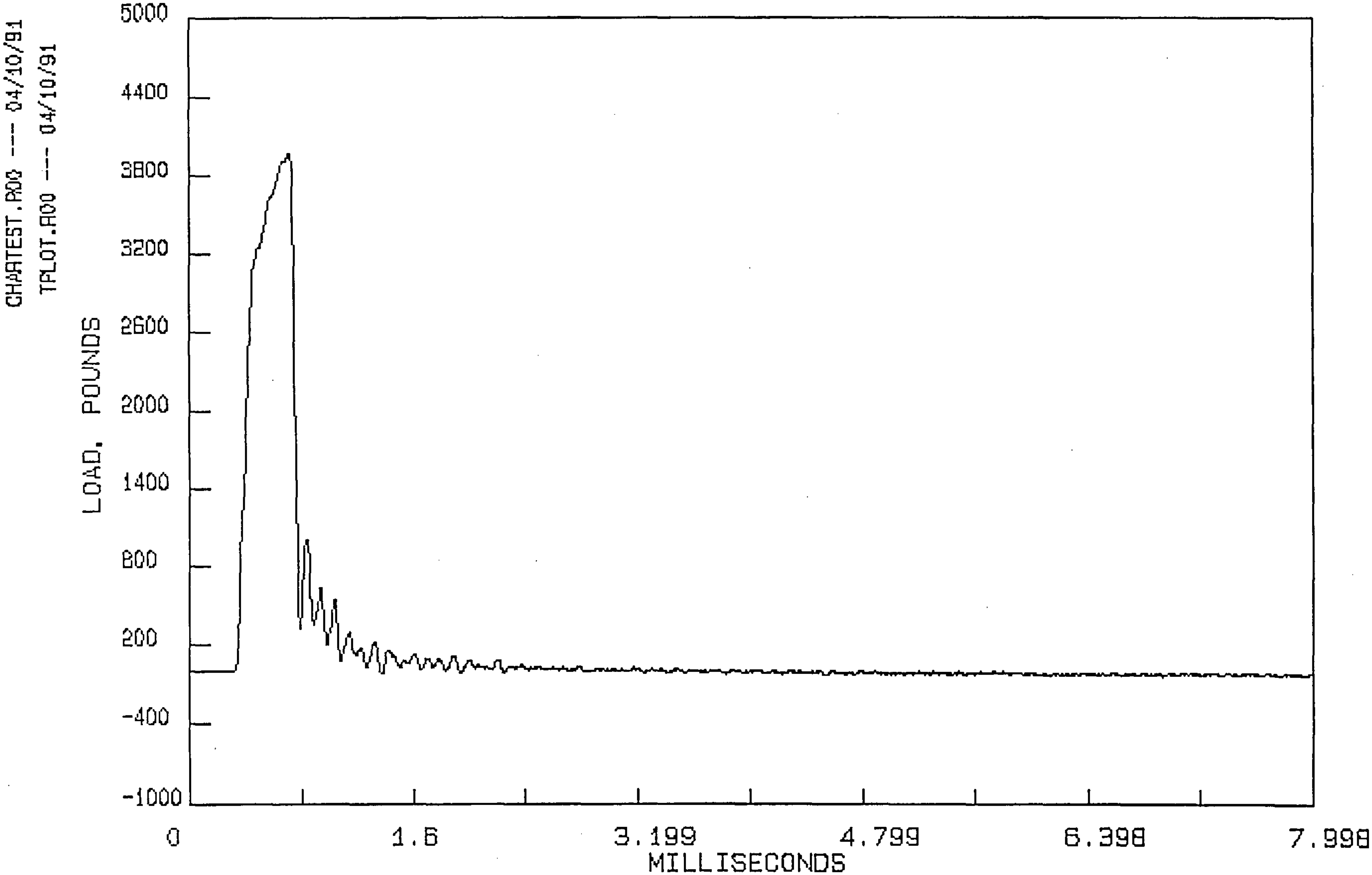
DYNAMIC YIELD STRENGTH (KSI) = 94
DYNAMIC FLOW STRENGTH (KSI) = 104
DIAL ENERGY READING (FT-LBS) = 27.5

TEST VIOLATIONS

********* NO VIOLATIONS *********

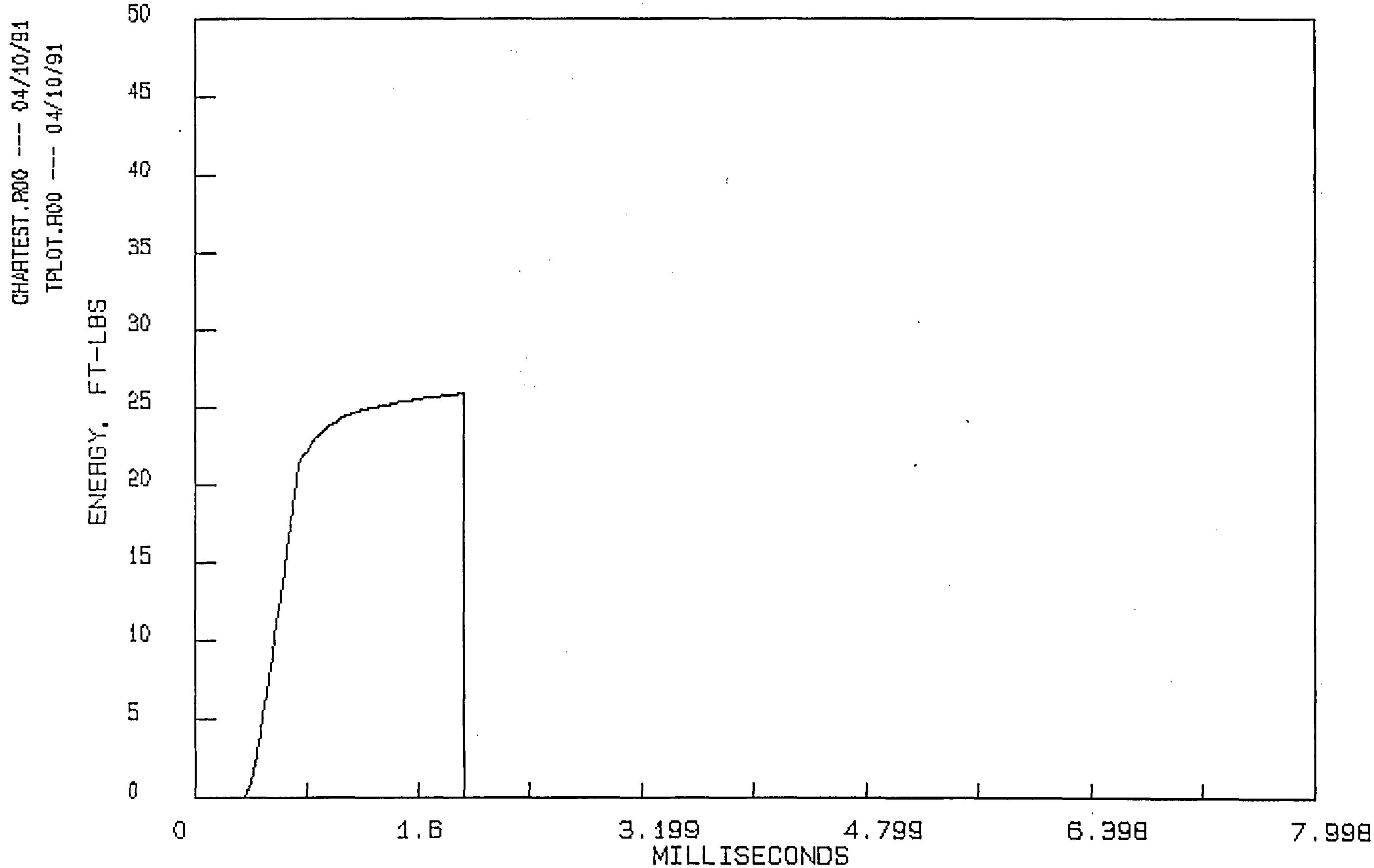
PROJ. NO. 1295-001-03-08 QA NO. 99001

LOAD - TIME TRACE FOR SPECIMEN P25E



PROJ. NO. 1295-001-03-08 QA NO. 99001

ENERGY - TIME TRACE FOR SPECIMEN P25E



CHARTEST.R00 --- 04/10/91
ANALYZE.R00 --- 04/10/91

INSTRUMENTED IMPACT TEST RESULTS

ANALYSIS DATE: 12/03/2003
MATERIAL: BASE (TRANSVERSE)
INITIAL HAMMER ENERGY, FT-LBS: 240
INITIAL HAMMER VELOCITY, FT/SEC: 17
LOAD CALIBRATION, LBS/VOLT: 1150
SPECIMEN WIDTH, INCH: .394
NOTCH DEPTH, INCH: 7.900001E-02
RESPONSE TIME, MSEC: .0519
TECHNICAL PROCEDURE(S): TP-80 TP-412

ANALYSIS BY: BJV
TEST DATE: 11/05/2003
SPEC. ID: P25B
PROJ. NO.: 1295-001-03-08
QA NO.: 99001
TEST TEMP (F): 200
OPERATOR: BJV

PROPERTY	ENERGY, FT-LBS		LOAD POUNDS	TIME MSEC
	UNCORRECTED	CORRECTED		
GENERAL YIELD	4.730475	4.707165	3151	.1679999
FLOW LOAD	12.91708	12.74328	3632.85	.3099999
MAXIMUM LOAD	28.27784	27.44489	4114.7	.54
FAST FRACTURE LOAD	30.91794	29.92219	4066.4	.578
ARREST LOAD	36.09134	34.73448	2040.1	.696
PROPAGATION LOAD	14.54778	13.47028	2026.3	0
TOTAL ENERGY	42.82562	40.91517	0	0
SHEAR LIP ENERGY	11.90768	10.99298	0	0
TOTAL EVENT TIME	0	0	0	1.78

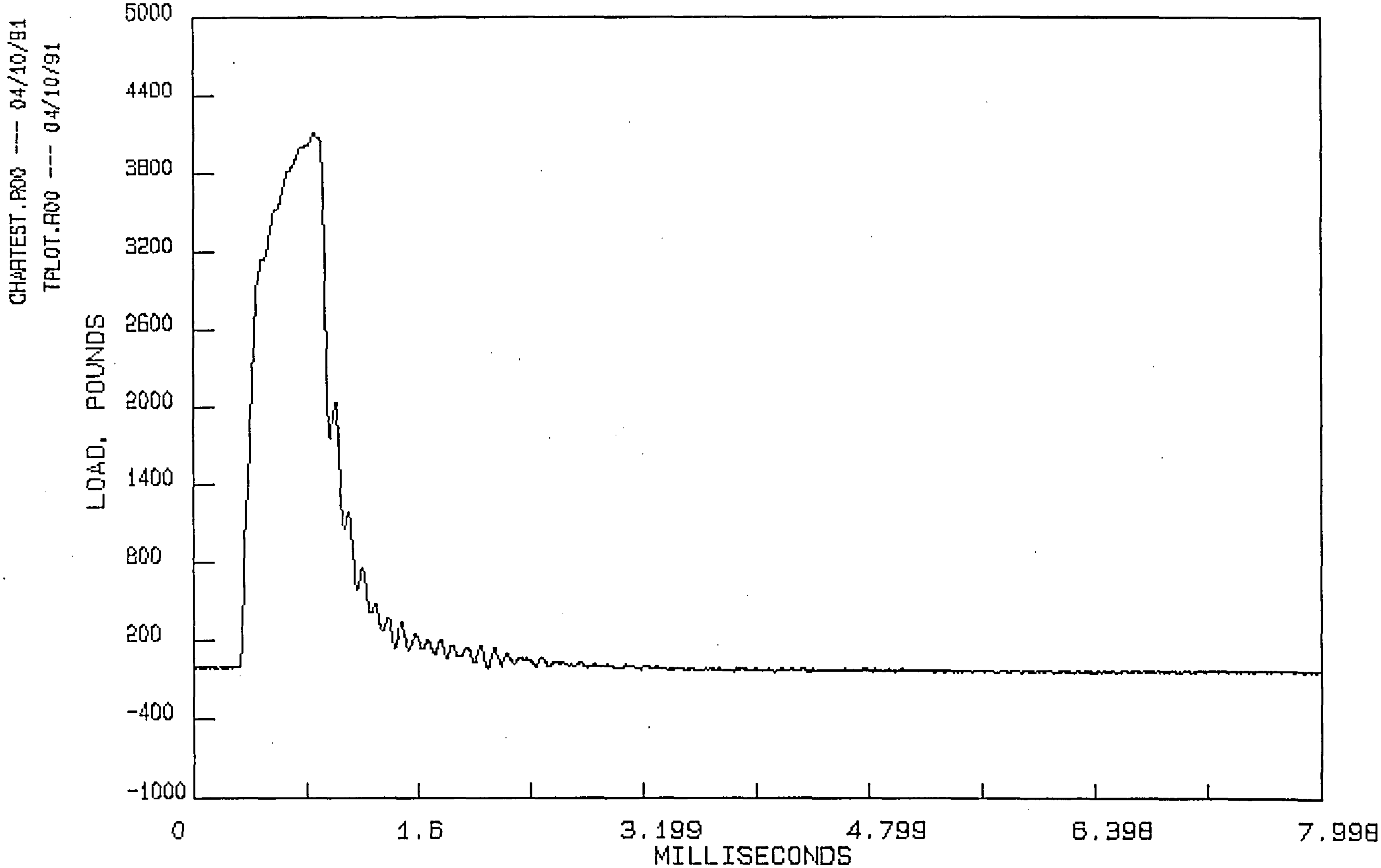
DYNAMIC YIELD STRENGTH (KSI) = 91
DYNAMIC FLOW STRENGTH (KSI) = 104
DIAL ENERGY READING (FT-LBS) = 44

TEST VIOLATIONS

********* NO VIOLATIONS *********

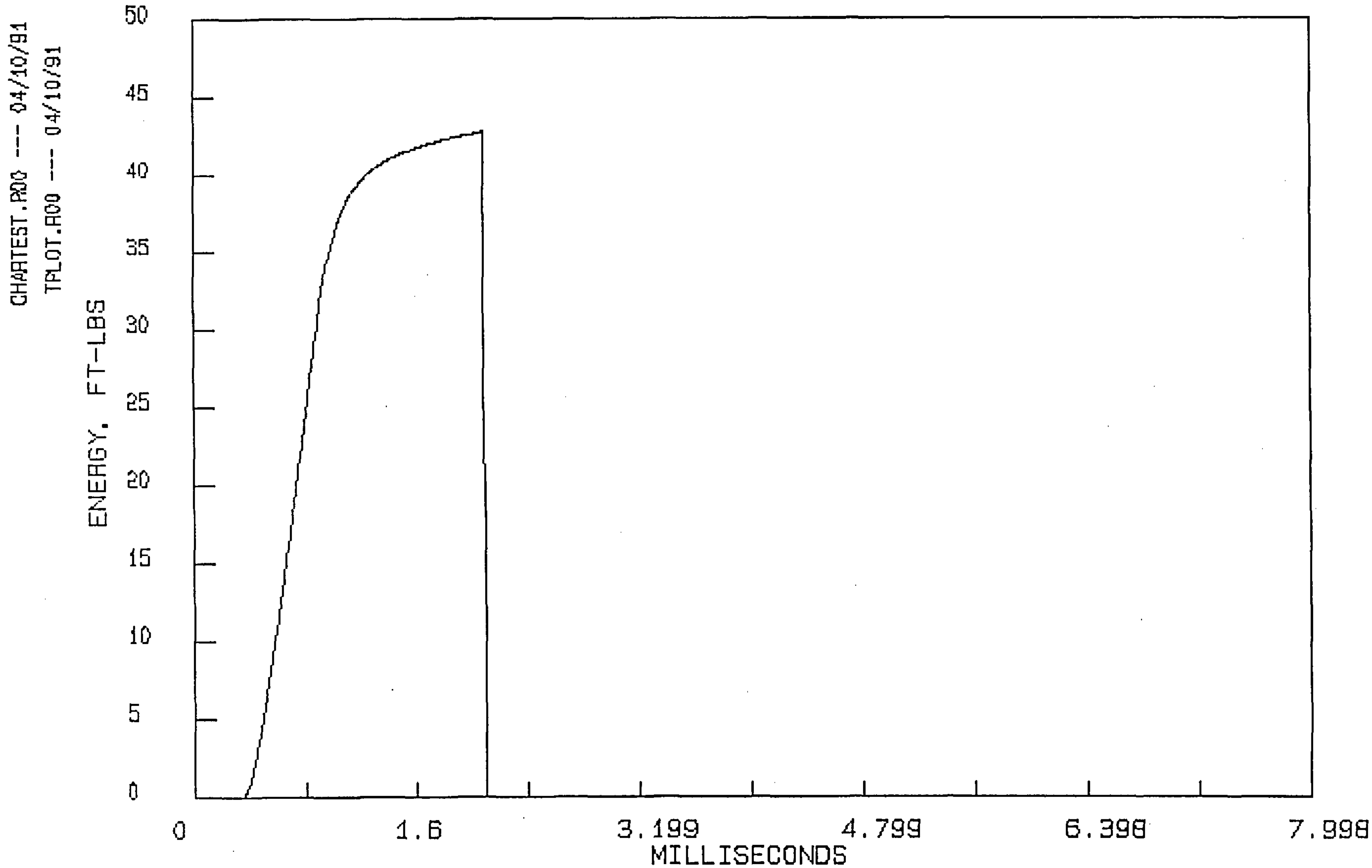
PROJ. NO. 1295-001-03-08 QA NO. 99001

LOAD - TIME TRACE FOR SPECIMEN P25B



PROJ. NO. 1295-001-03-08 QA NO. 99001

ENERGY - TIME TRACE FOR SPECIMEN P25B



CHARTEST.R00 --- 04/10/91
ANALYZE.R00 --- 04/10/91

INSTRUMENTED IMPACT TEST RESULTS

ANALYSIS DATE: 12/04/2003
MATERIAL: BASE (TRANSVERSE)
INITIAL HAMMER ENERGY, FT-LBS: 240
INITIAL HAMMER VELOCITY, FT/SEC: 17
LOAD CALIBRATION, LBS/VOLT: 1150
SPECIMEN WIDTH, INCH: .394
NOTCH DEPTH, INCH: 7.900001E-02
RESPONSE TIME, MSEC: .0519
TECHNICAL PROCEDURE(S): TP-80 TP-412

ANALYSIS BY: BJV
TEST DATE: 11/06/2003
SPEC. ID: P25D
PROJ. NO.: 1295-001-03-08
QA NO.: 99001
TEST TEMP (F): 225
OPERATOR: BJV

PROPERTY	ENERGY, FT-LBS UNCORRECTED	ENERGY, FT-LBS CORRECTED	LOAD POUNDS	TIME MSEC
GENERAL YIELD	4.69372	4.670771	3128	.1579999
FLOW LOAD	12.84662	12.67471	3621.35	.2999999
MAXIMUM LOAD	28.13262	27.3082	4114.7	.53
FAST FRACTURE LOAD	35.72217	34.39293	3992.8	.64
ARREST LOAD	40.69303	38.96811	2329.9	.7460001
PROPAGATION LOAD	24.05275	22.04039	1662.9	0
TOTAL ENERGY	52.18537	49.34859	0	0
SHEAR LIP ENERGY	16.4632	14.95566	0	0
TOTAL EVENT TIME	0	0	0	2.622

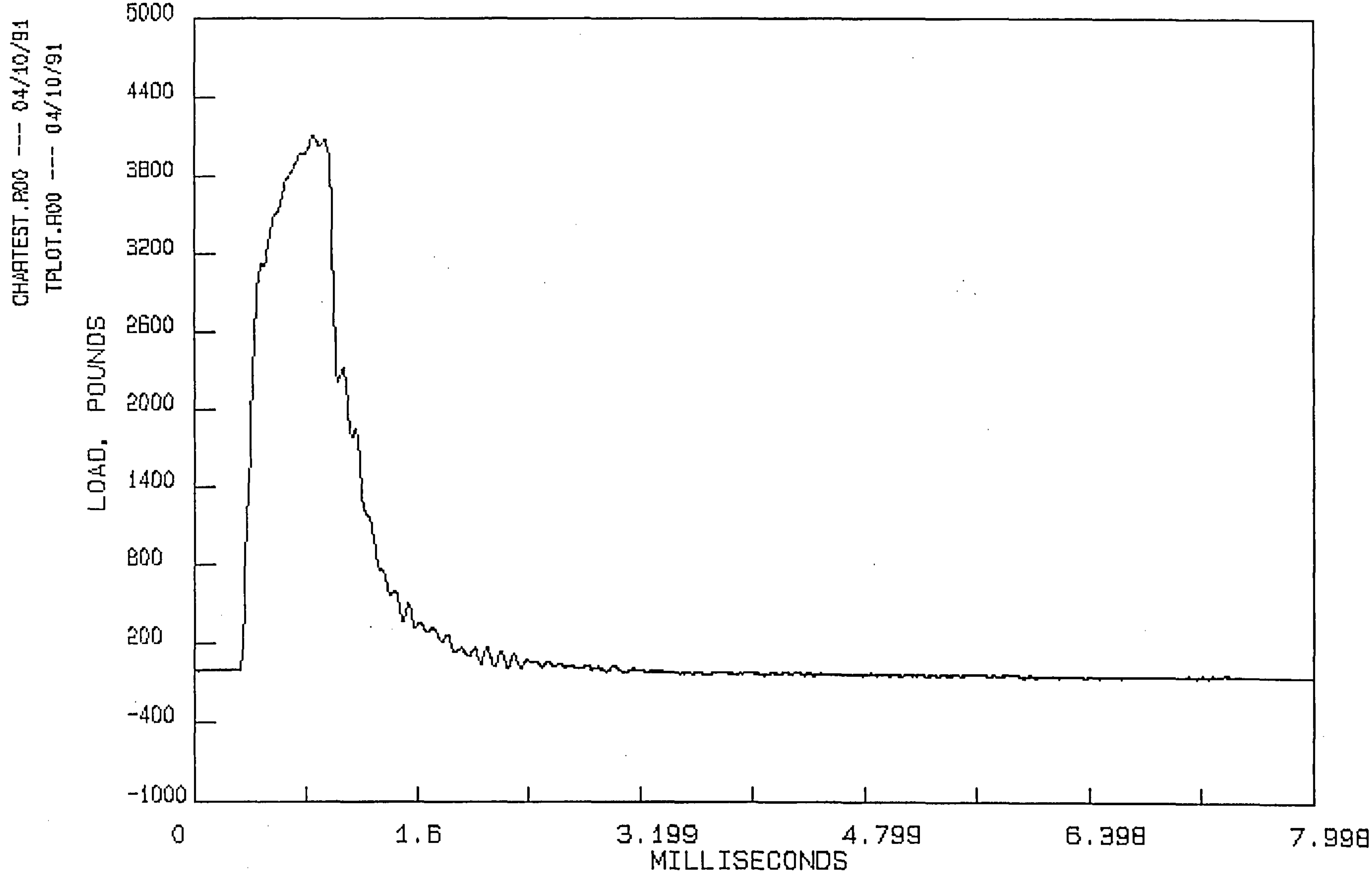
DYNAMIC YIELD STRENGTH (KSI) = 90
DYNAMIC FLOW STRENGTH (KSI) = 104
DIAL ENERGY READING (FT-LBS) = 52.5

TEST VIOLATIONS

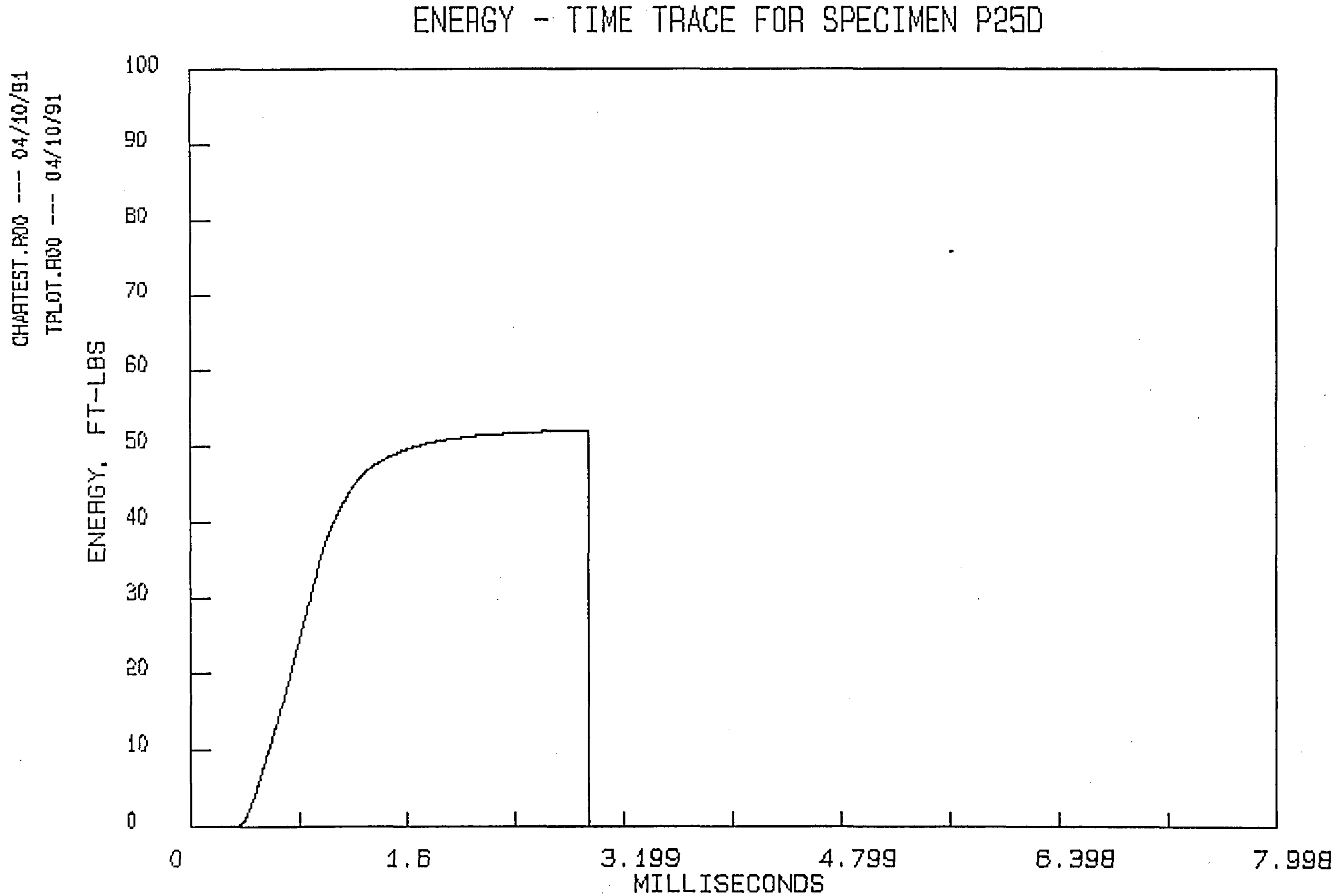
********* NO VIOLATIONS *********

PROJ. NO. 1295-001-03-08 QA NO. 99001

LOAD - TIME TRACE FOR SPECIMEN P25D



PROJ. NO. 1295-001-03-08 QA NO. 99001



CHARTEST.R00 --- 04/10/91
ANALYZE.R00 --- 04/10/91

INSTRUMENTED IMPACT TEST RESULTS

ANALYSIS DATE: 12/04/2003
MATERIAL: BASE (TRANSVERSE)
INITIAL HAMMER ENERGY, FT-LBS: 240
INITIAL HAMMER VELOCITY, FT/SEC: 17
LOAD CALIBRATION, LBS/VOLT: 1150
SPECIMEN WIDTH, INCH: .394
NOTCH DEPTH, INCH: 7.900001E-02
RESPONSE TIME, MSEC: .0519
TECHNICAL PROCEDURE(S): TP-80 TP-412

ANALYSIS BY: BJV
TEST DATE: 11/10/2003
SPEC. ID: P211
PROJ. NO.: 1295-001-03-08
QA NO.: 99001
TEST TEMP (F): 240
OPERATOR: BJV

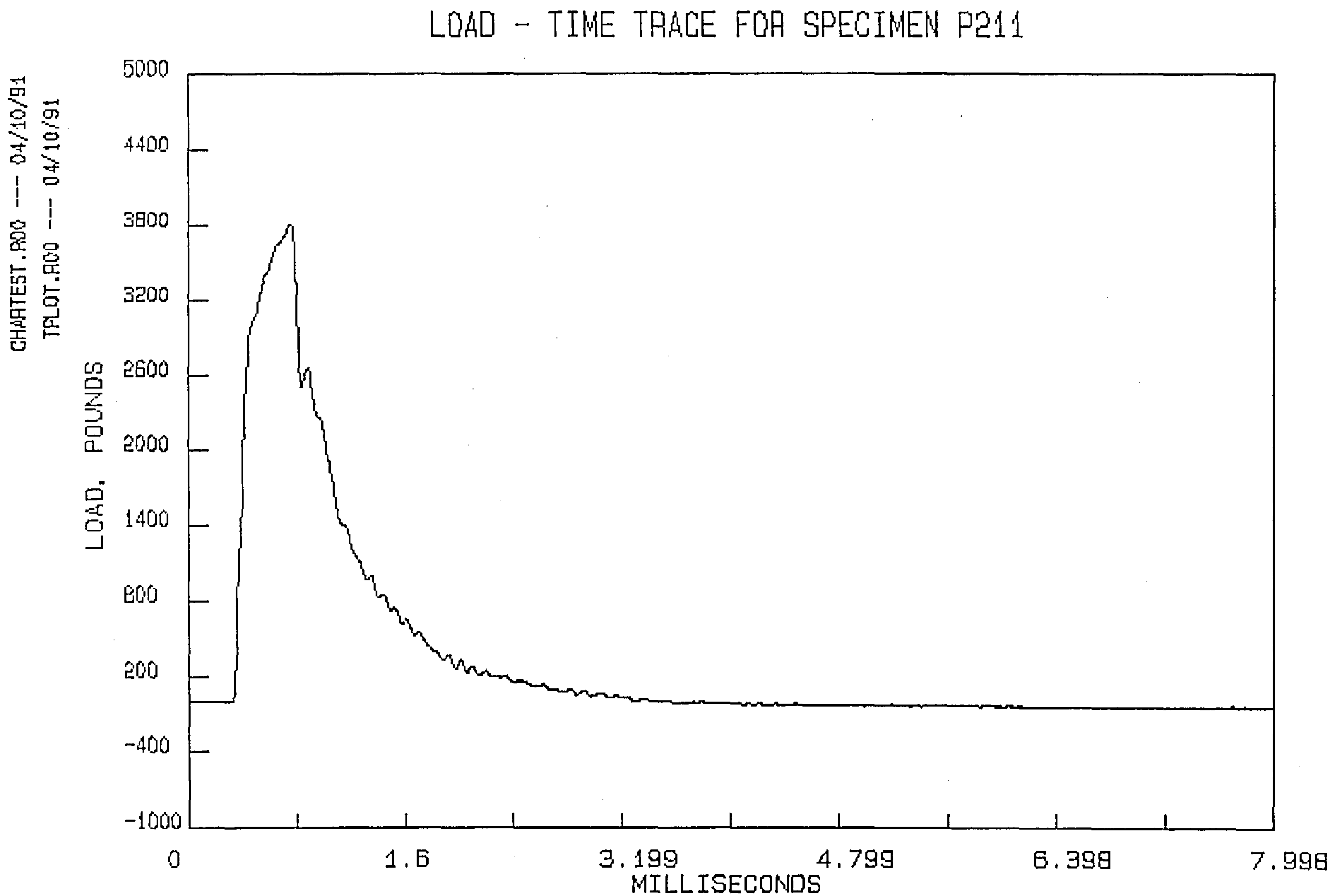
PROPERTY	ENERGY, FT-LBS UNCORRECTED	ENERGY, FT-LBS CORRECTED	LOAD POUNDS	TIME MSEC
GENERAL YIELD	3.87004	3.854439	3003.8	.1480001
FLOW LOAD	9.287659	9.197805	3408.6	.248
MAXIMUM LOAD	21.12886	20.66383	3813.4	.44
FAST FRACTURE LOAD	21.12886	20.66383	3813.4	.44
ARREST LOAD	27.41161	26.6289	2672.6	.564
PROPAGATION LOAD	28.36879	26.28172	1140.8	0
TOTAL ENERGY	49.49765	46.94555	0	0
SHEAR LIP ENERGY	28.36879	26.28172	0	0
TOTAL EVENT TIME	0	0	0	3.114

DYNAMIC YIELD STRENGTH (KSI) = 86
DYNAMIC FLOW STRENGTH (KSI) = 98
DIAL ENERGY READING (FT-LBS) = 50

TEST VIOLATIONS

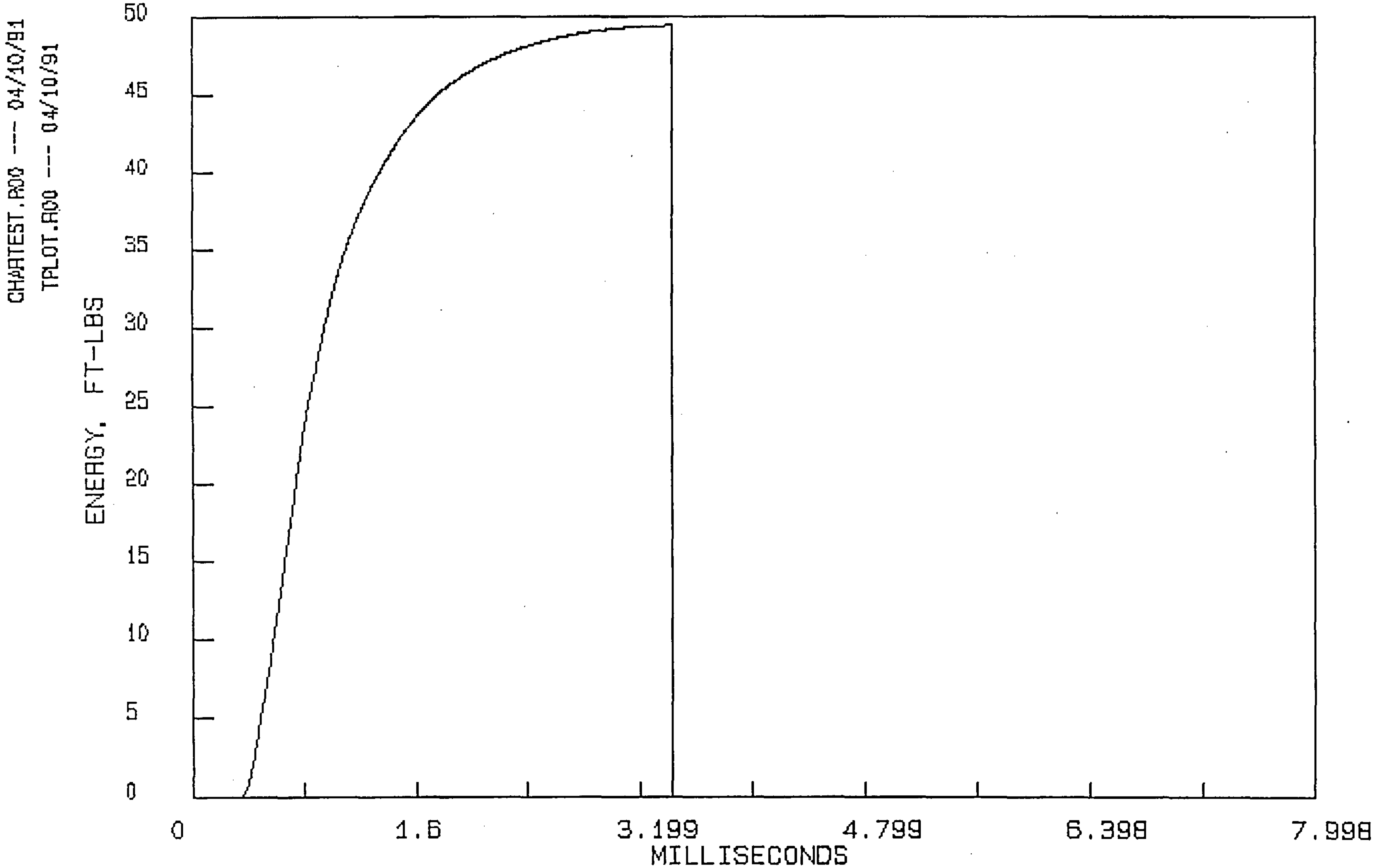
********* NO VIOLATIONS *********

PROJ. NO. 1295-001-03-08 QA NO. 99001



PROJ. NO. 1295-001-03-08   QA NO. 99001

ENERGY - TIME TRACE FOR SPECIMEN P211



CHARTEST.R00 --- 04/10/91
ANALYZE.R00 --- 04/10/91

INSTRUMENTED IMPACT TEST RESULTS

ANALYSIS DATE: 12/04/2003
MATERIAL: BASE (TRANSVERSE)
INITIAL HAMMER ENERGY, FT-LBS: 240
INITIAL HAMMER VELOCITY, FT/SEC: 17
LOAD CALIBRATION, LBS/VOLT: 1150
SPECIMEN WIDTH, INCH: .394
NOTCH DEPTH, INCH: 7.900001E-02
RESPONSE TIME, MSEC: .0519
TECHNICAL PROCEDURE(S): TP-80 TP-412

ANALYSIS BY: BJV
TEST DATE: 11/05/2003
SPEC. ID: P257
PROJ. NO.: 1295-001-03-08
QA NO.: 99001
TEST TEMP (F): 250
OPERATOR: BJV

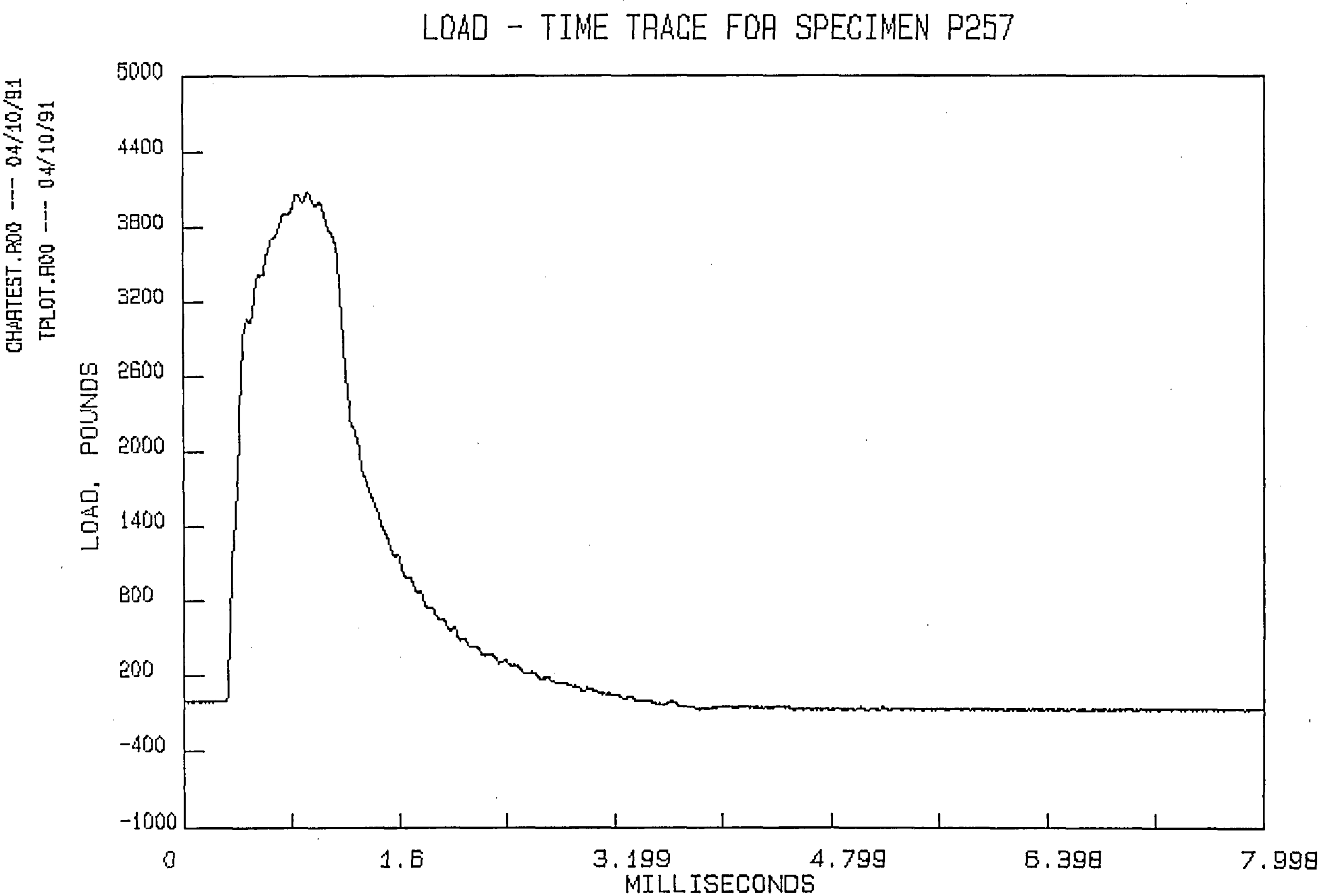
PROPERTY	ENERGY, FT-LBS		LOAD POUNDS	TIME MSEC
	UNCORRECTED	CORRECTED		
GENERAL YIELD	4.427372	4.406954	3061.3	.158
FLOW LOAD	12.82159	12.65035	3575.35	.308
MAXIMUM LOAD	33.11754	31.97507	4089.4	.614
FAST FRACTURE LOAD	46.02677	43.82004	3696.1	.808
ARREST LOAD	52.51761	49.64459	2210.3	.9400001
PROPAGATION LOAD	39.03938	34.75828	1485.8	0
TOTAL ENERGY	72.15691	66.73335	0	0
SHEAR LIP ENERGY	26.13014	22.91331	0	0
TOTAL EVENT TIME	0	0	0	3.068

DYNAMIC YIELD STRENGTH (KSI) = 88
DYNAMIC FLOW STRENGTH (KSI) = 103
DIAL ENERGY READING (FT-LBS) = 71.5

TEST VIOLATIONS

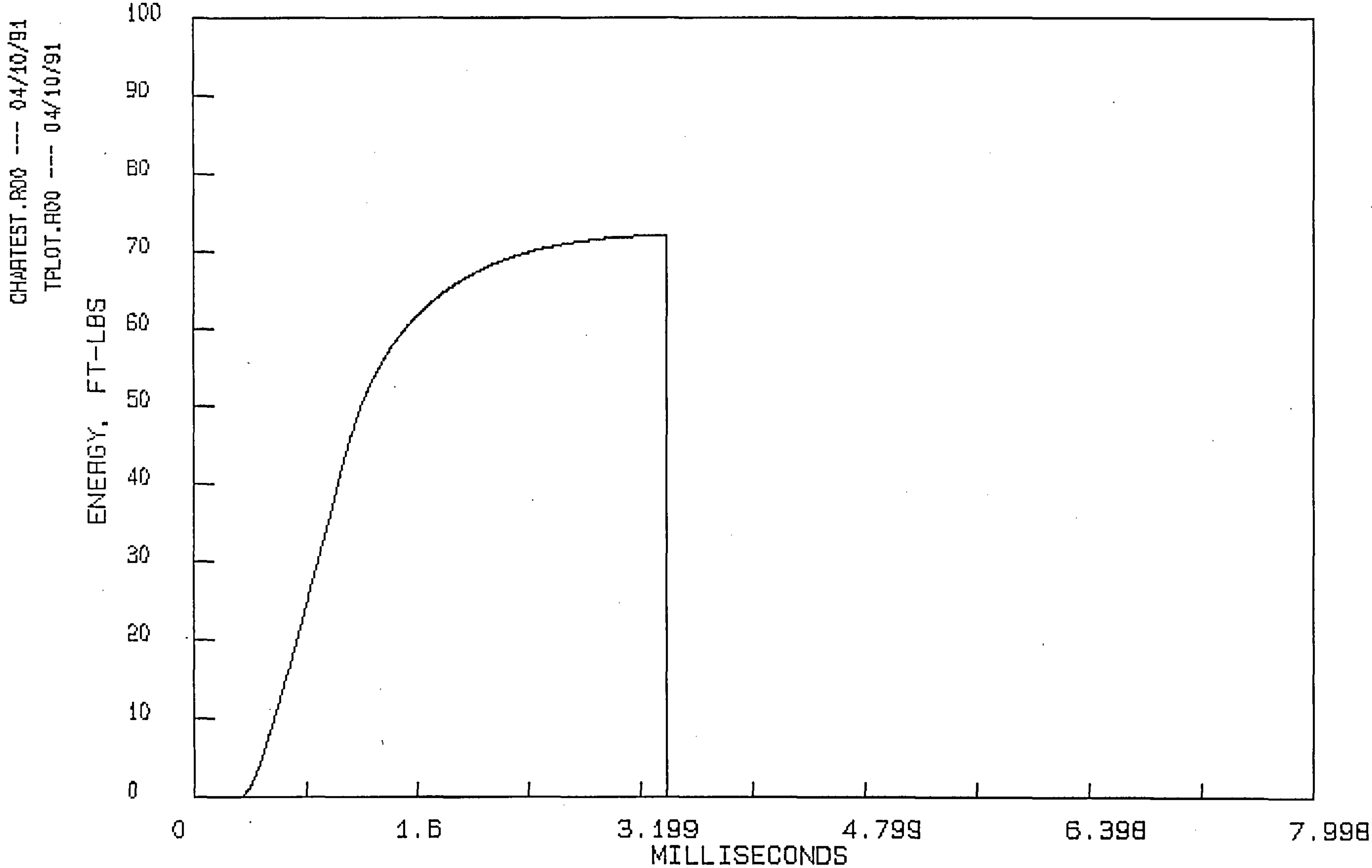
********* NO VIOLATIONS *********

PROJ. NO. 1295-001-03-08 QA NO. 99001



PROJ. NO. 1295-001-03-08 QA NO. 99001

ENERGY - TIME TRACE FOR SPECIMEN P257



CHARTEST.R00 --- 04/10/91
ANALYZE.R00 --- 04/10/91

INSTRUMENTED IMPACT TEST RESULTS

ANALYSIS DATE: 12/04/2003
MATERIAL: BASE (TRANSVERSE)
INITIAL HAMMER ENERGY, FT-LBS: 240
INITIAL HAMMER VELOCITY, FT/SEC: 17
LOAD CALIBRATION, LBS/VOLT: 1150
SPECIMEN WIDTH, INCH: .394
NOTCH DEPTH, INCH: 7.900001E-02
RESPONSE TIME, MSEC: .0519
TECHNICAL PROCEDURE(S): TP-80 TP-412

ANALYSIS BY: BJV
TEST DATE: 11/10/2003
SPEC. ID: P256
PROJ. NO.: 1295-001-03-08
QA NO.: 99001
TEST TEMP (F): 260
OPERATOR: BJV

PROPERTY	ENERGY, FT-LBS		LOAD POUNDS	TIME MSEC
	UNCORRECTED	CORRECTED		
GENERAL YIELD	4.896337	4.871364	3054.4	.164
FLOW LOAD	12.57918	12.41435	3569.6	.3000001
MAXIMUM LOAD	27.98325	27.16756	4084.8	.5340001
FAST FRACTURE LOAD	45.906	43.71083	3360.3	.8080001
ARREST LOAD	49.25709	46.72974	2477.1	.8780001
PROPAGATION LOAD	41.98051	37.69732	883.2	0
TOTAL ENERGY	69.96376	64.86488	0	0
SHEAR LIP ENERGY	24.05776	21.15405	0	0
TOTAL EVENT TIME	0	0	0	3.006

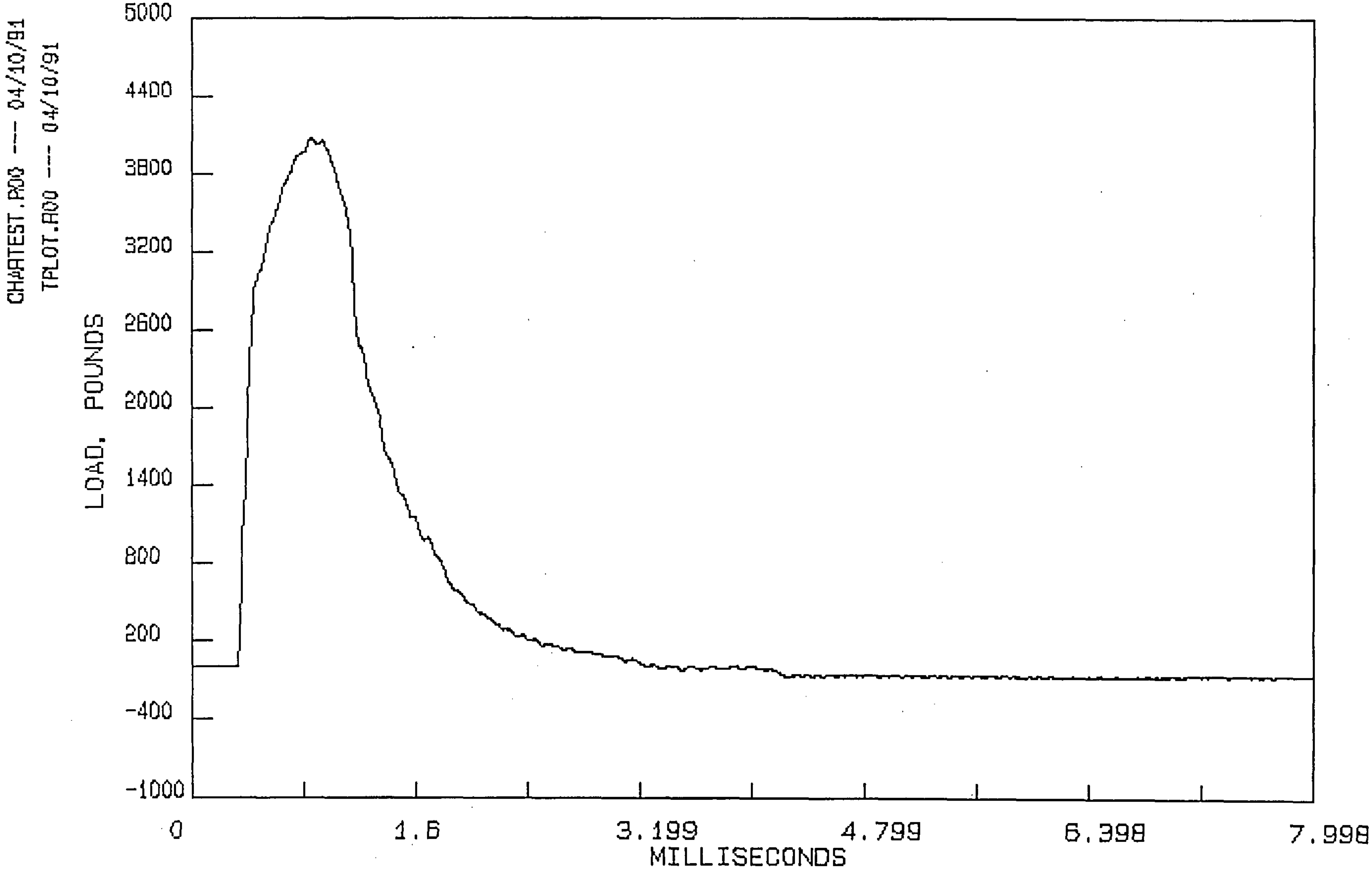
DYNAMIC YIELD STRENGTH (KSI) = 88
DYNAMIC FLOW STRENGTH (KSI) = 103
DIAL ENERGY READING (FT-LBS) = 69

TEST VIOLATIONS

********* NO VIOLATIONS *********

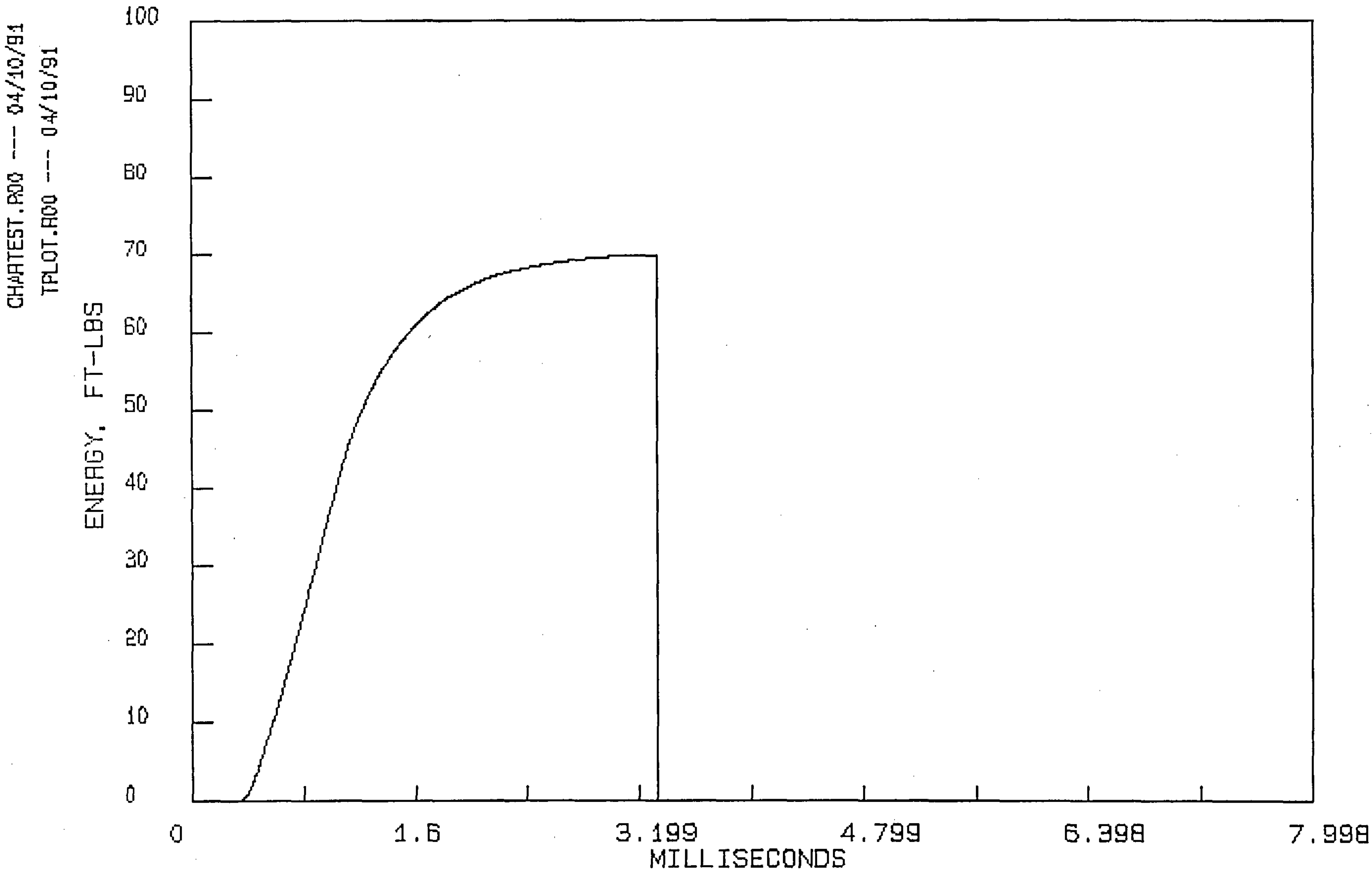
PROJ. NO. 1295-001-03-08 QA NO. 99001

LOAD - TIME TRACE FOR SPECIMEN P256



PROJ. NO. 1295-001-03-08 QA NO. 99001

ENERGY - TIME TRACE FOR SPECIMEN P256



CHARTEST.R00 --- 04/10/91
ANALYZE.R00 --- 04/10/91

INSTRUMENTED IMPACT TEST RESULTS

ANALYSIS DATE: 12/04/2003
MATERIAL: BASE (TRANSVERSE)
INITIAL HAMMER ENERGY, FT-LBS: 240
INITIAL HAMMER VELOCITY, FT/SEC: 17
LOAD CALIBRATION, LBS/VOLT: 1150
SPECIMEN WIDTH, INCH: .394
NOTCH DEPTH, INCH: 7.900001E-02
RESPONSE TIME, MSEC: .0519
TECHNICAL PROCEDURE(S): TP-80 TP-412

ANALYSIS BY: BJV
TEST DATE: 11/06/2003
SPEC. ID: P214
PROJ. NO.: 1295-001-03-08
QA NO.: 99001
TEST TEMP (F): 270
OPERATOR: BJV

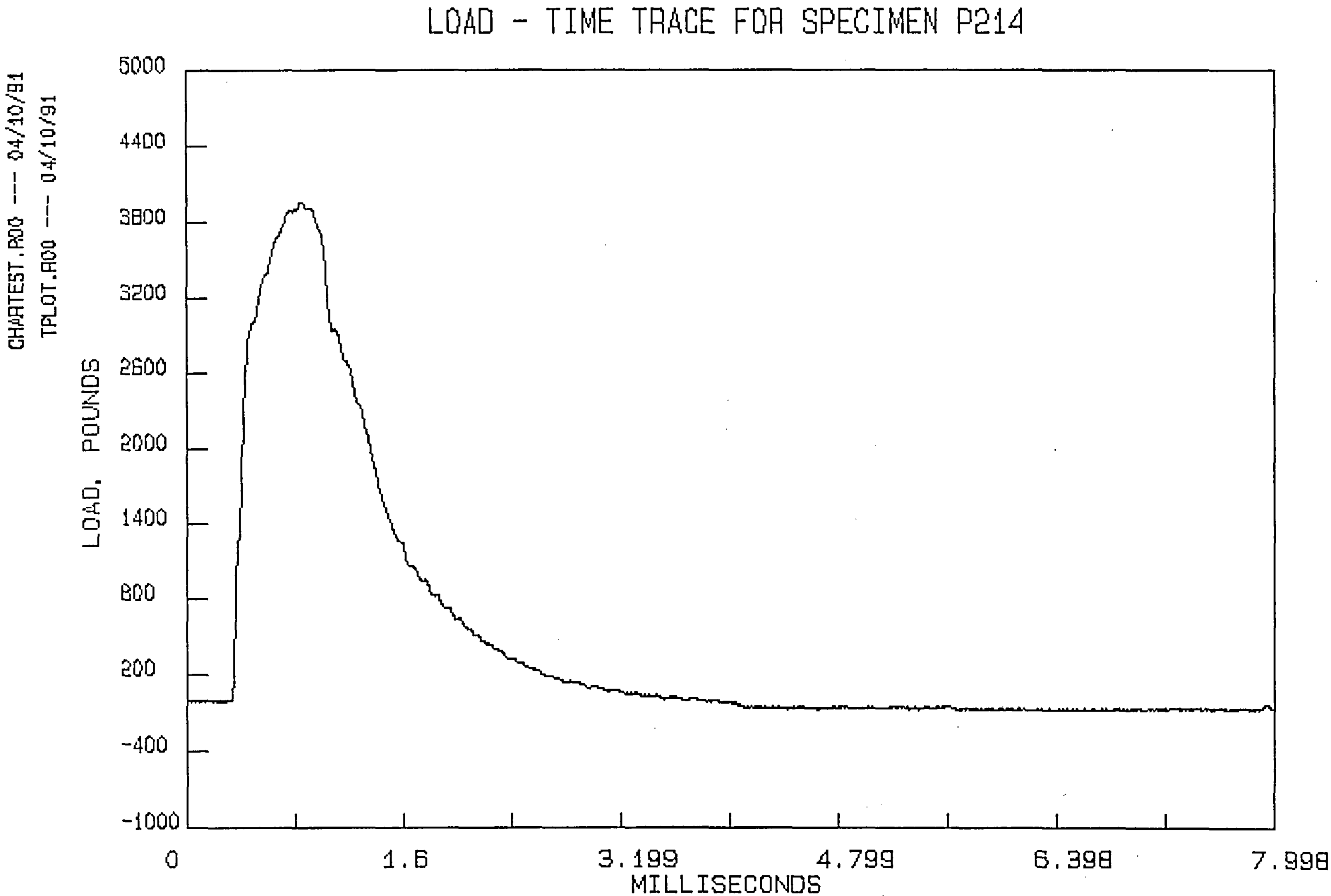
PROPERTY	ENERGY, FT-LBS		LOAD POUNDS	TIME MSEC
	UNCORRECTED	CORRECTED		
GENERAL YIELD	4.683632	4.660781	3013	.1579999
FLOW LOAD	11.98955	11.83981	3490.25	.2899999
MAXIMUM LOAD	27.62399	26.82911	3967.5	.532
FAST FRACTURE LOAD	36.58336	35.18925	3732.9	.668
ARREST LOAD	42.67617	40.77903	2955.5	.778
PROPAGATION LOAD	44.10367	39.53932	777.3999	0
TOTAL ENERGY	71.72766	66.36843	0	0
SHEAR LIP ENERGY	35.1443	31.17918	0	0
TOTAL EVENT TIME	0	0	0	3.474

DYNAMIC YIELD STRENGTH (KSI) = 87
DYNAMIC FLOW STRENGTH (KSI) = 100
DIAL ENERGY READING (FT-LBS) = 71

TEST VIOLATIONS

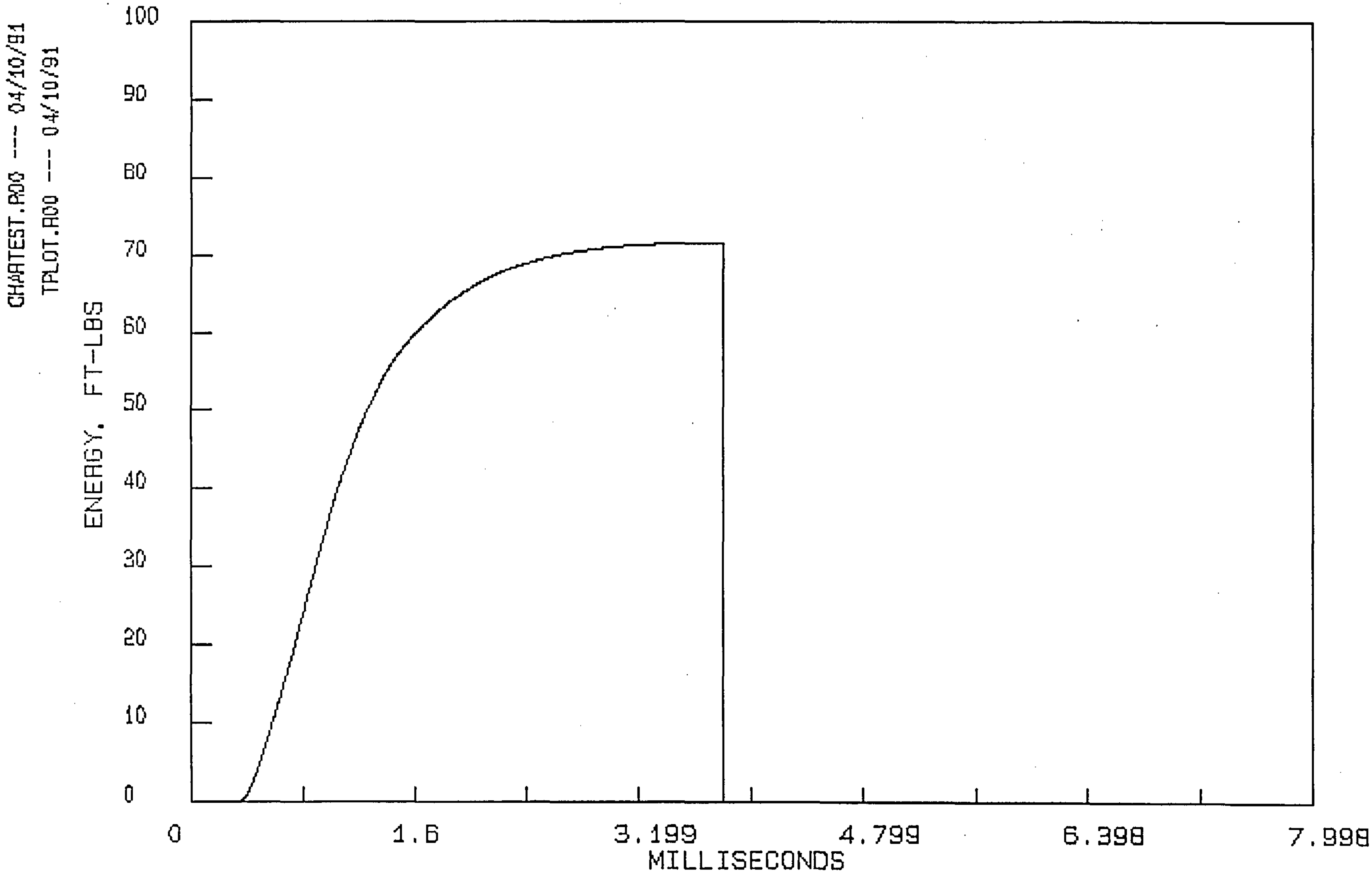
********* NO VIOLATIONS *********

PROJ. NO. 1295-001-03-08 QA NO. 99001



PROJ. NO. 1295-001-03-08 QA NO. 99001

ENERGY - TIME TRACE FOR SPECIMEN P214



CHARTEST.R00 --- 04/10/91
ANALYZE.R00 --- 04/10/91

INSTRUMENTED IMPACT TEST RESULTS

ANALYSIS DATE: 12/04/2003
MATERIAL: BASE (TRANSVERSE)
INITIAL HAMMER ENERGY, FT-LBS: 240
INITIAL HAMMER VELOCITY, FT/SEC: 17
LOAD CALIBRATION, LBS/VOLT: 1150
SPECIMEN WIDTH, INCH: .394
NOTCH DEPTH, INCH: 7.900001E-02
RESPONSE TIME, MSEC: .0519
TECHNICAL PROCEDURE(S): TP-80 TP-412

ANALYSIS BY: BJV
TEST DATE: 11/06/2003
SPEC. ID: P25A
PROJ. NO.: 1295-001-03-08
QA NO.: 99001
TEST TEMP (F): 285
OPERATOR: BJV

PROPERTY	ENERGY, FT-LBS UNCORRECTED	ENERGY, FT-LBS CORRECTED	LOAD POUNDS	TIME MSEC
GENERAL YIELD	4.653682	4.631123	3015.3	.1679999
FLOW LOAD	12.55313	12.38898	3524.75	.31
MAXIMUM LOAD	27.53813	26.74818	4034.2	.5399999
FAST FRACTURE LOAD	78.53216	72.10789	2.299805	3.448
ARREST LOAD	78.53216	72.10789	2.299805	3.448
PROPAGATION LOAD	50.99403	45.35971	0	0
TOTAL ENERGY	78.53216	72.10789	0	0
SHEAR LIP ENERGY	0	0	0	0
TOTAL EVENT TIME	0	0	0	3.448

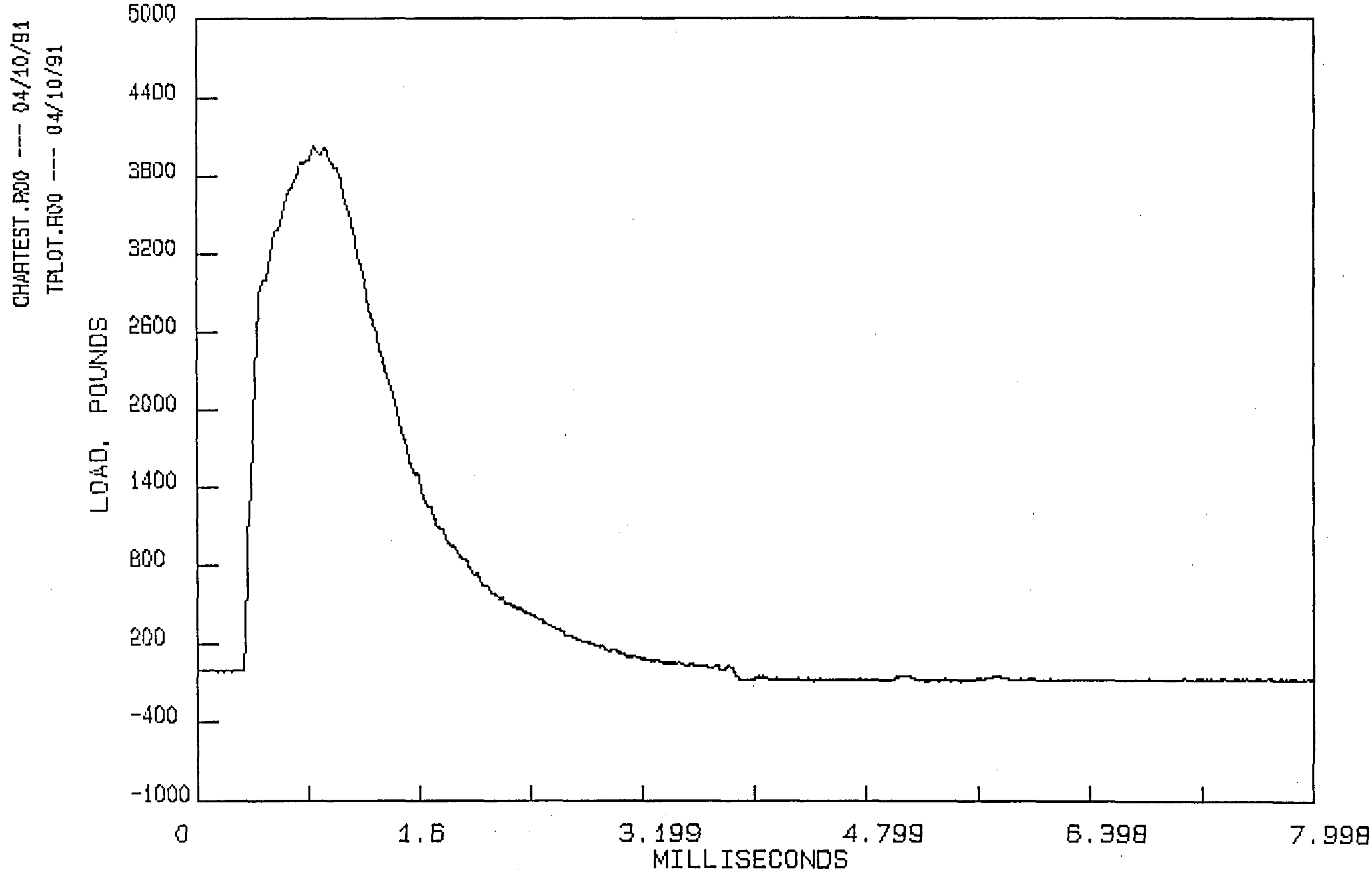
DYNAMIC YIELD STRENGTH (KSI) = 87
DYNAMIC FLOW STRENGTH (KSI) = 101
DIAL ENERGY READING (FT-LBS) = 77

TEST VIOLATIONS

********* NO VIOLATIONS *********

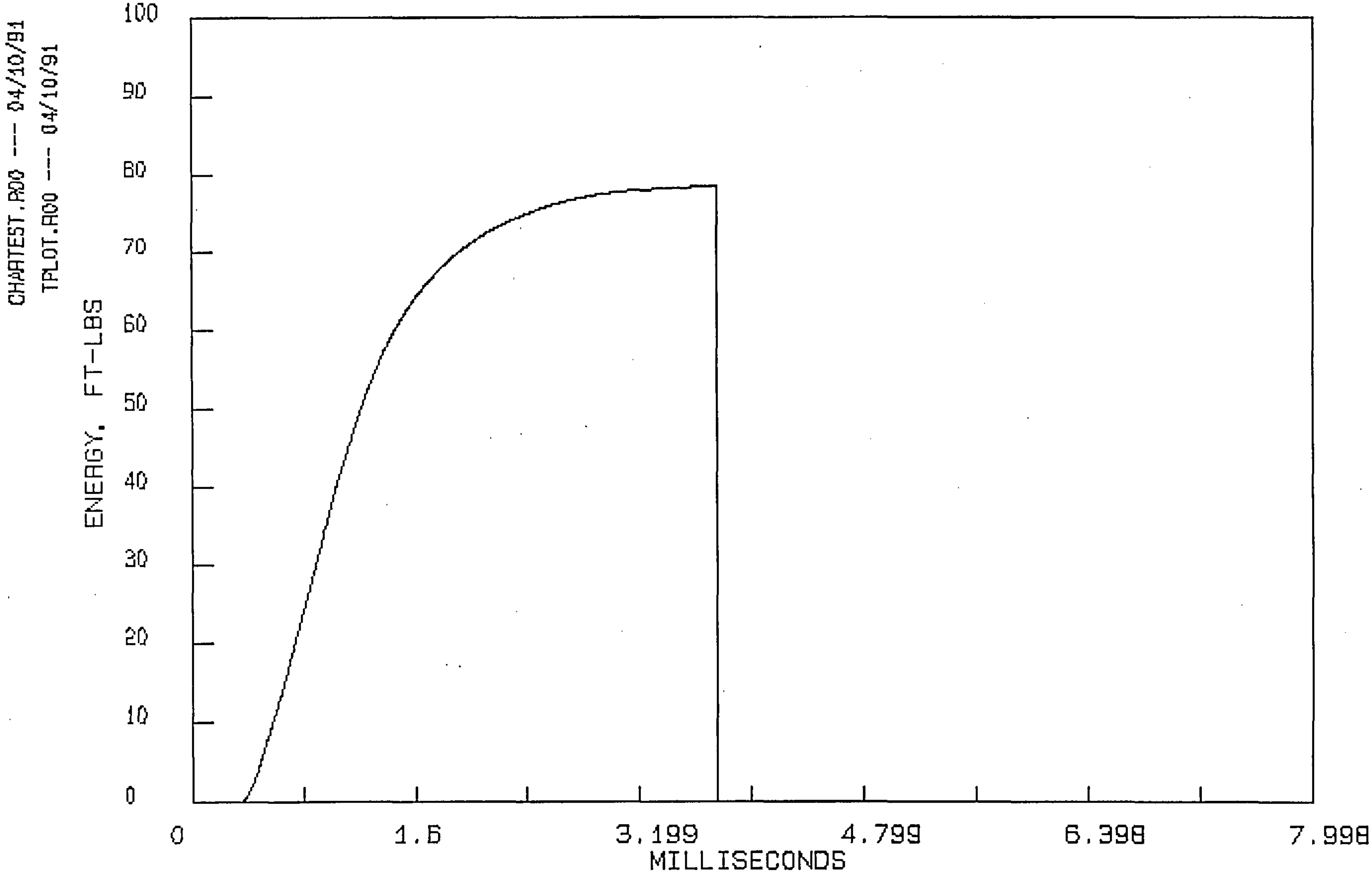
PROJ. NO. 1295-001-03-08 QA NO. 99001

LOAD - TIME TRACE FOR SPECIMEN P25A



PROJ. NO. 1295-001-03-08   QA NO. 99001

ENERGY - TIME TRACE FOR SPECIMEN P25A



CHARTEST.R00 --- 04/10/91
ANALYZE.R00 --- 04/10/91

INSTRUMENTED IMPACT TEST RESULTS

ANALYSIS DATE: 12/04/2003
MATERIAL: BASE (TRANSVERSE)
INITIAL HAMMER ENERGY, FT-LBS: 240
INITIAL HAMMER VELOCITY, FT/SEC: 17
LOAD CALIBRATION, LBS/VOLT: 1150
SPECIMEN WIDTH, INCH: .394
NOTCH DEPTH, INCH: 7.900001E-02
RESPONSE TIME, MSEC: .0519
TECHNICAL PROCEDURE(S): TP-80 TP-412

ANALYSIS BY: BJV
TEST DATE: 11/05/2003
SPEC. ID: P25C
PROJ. NO.: 1295-001-03-08
QA NO.: 99001
TEST TEMP (F): 300
OPERATOR: BJV

PROPERTY	ENERGY, FT-LBS UNCORRECTED	ENERGY, FT-LBS CORRECTED	LOAD POUNDS	TIME MSEC
GENERAL YIELD	4.676282	4.653503	2987.7	.1579999
FLOW LOAD	12.50074	12.33796	3496	.3
MAXIMUM LOAD	27.46925	26.68325	4004.3	.532
FAST FRACTURE LOAD	77.48089	71.22746	-2.441406E-04142	
ARREST LOAD	77.48089	71.22746	-2.441406E-04142	
PROPAGATION LOAD	50.01164	44.54421	0	0
TOTAL ENERGY	77.48089	71.22746	0	0
SHEAR LIP ENERGY	0	0	0	0
TOTAL EVENT TIME	0	0	0	3.142

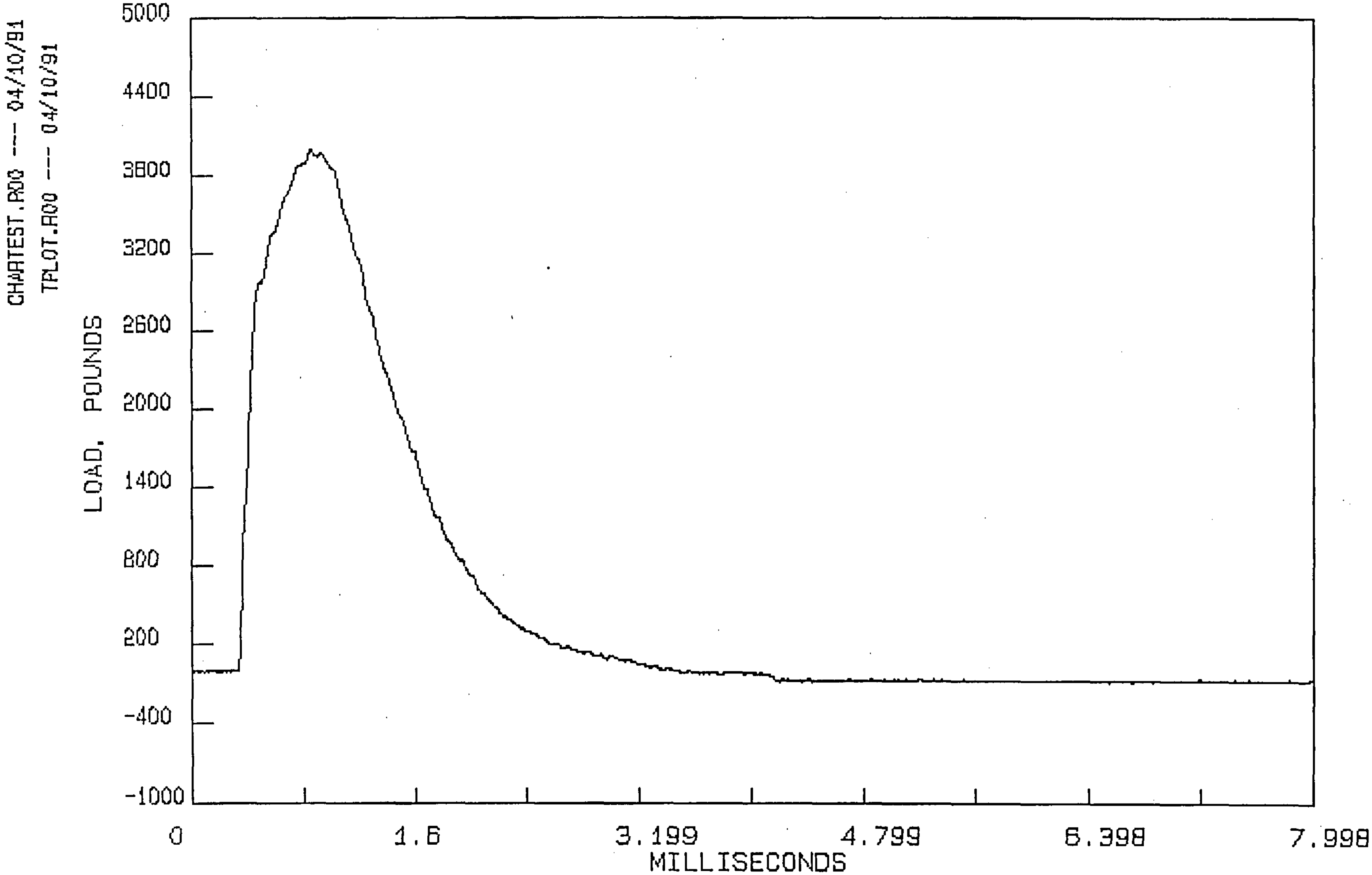
DYNAMIC YIELD STRENGTH (KSI) = 86
DYNAMIC FLOW STRENGTH (KSI) = 100
DIAL ENERGY READING (FT-LBS) = 76.5

TEST VIOLATIONS

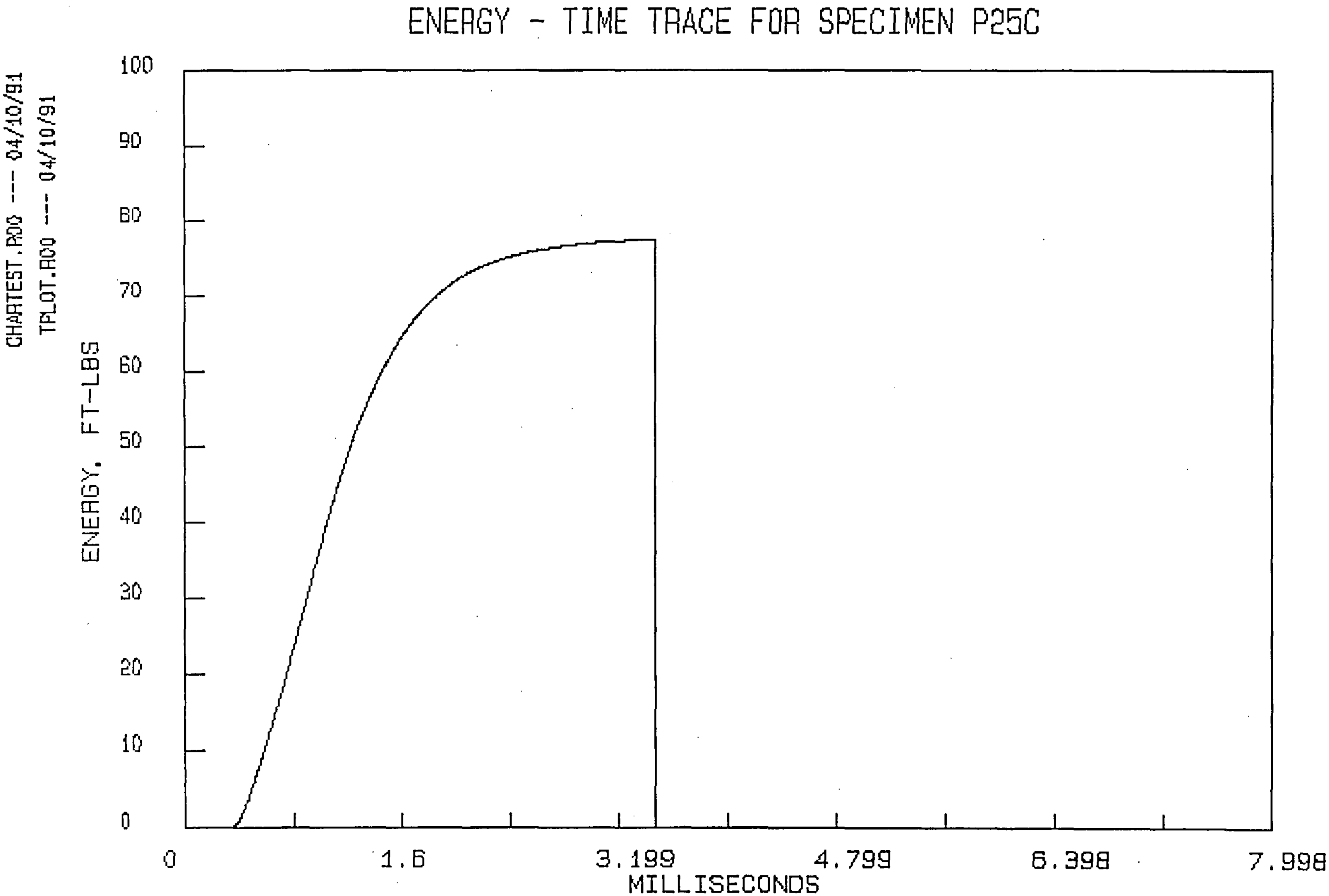
********* NO VIOLATIONS *********

PROJ. NO. 1295-001-03-08 QA NO. 99001

LOAD - TIME TRACE FOR SPECIMEN P25C



PROJ. NO. 1295-001-03-08   QA NO. 99001



CHARTEST.R00 --- 04/10/91
ANALYZE.R00 --- 04/10/91

INSTRUMENTED IMPACT TEST RESULTS

ANALYSIS DATE: 12/04/2003
MATERIAL: BASE (TRANSVERSE)
INITIAL HAMMER ENERGY, FT-LBS: 240
INITIAL HAMMER VELOCITY, FT/SEC: 17
LOAD CALIBRATION, LBS/VOLT: 1150
SPECIMEN WIDTH, INCH: .394
NOTCH DEPTH, INCH: 7.900001E-02
RESPONSE TIME, MSEC: .0519
TECHNICAL PROCEDURE(S): TP-80 TP-412

ANALYSIS BY: BJV
TEST DATE: 11/06/2003
SPEC. ID: P212
PROJ. NO.: 1295-001-03-08
QA NO.: 99001
TEST TEMP (F): 325
OPERATOR: BJV

PROPERTY	ENERGY, FT-LBS		LOAD POUNDS	TIME MSEC
	UNCORRECTED	CORRECTED		
GENERAL YIELD	4.887344	4.862463	2939.4	.166
FLOW LOAD	9.10811	9.021696	3286.7	.2459999
MAXIMUM LOAD	20.50318	20.06528	3634	.4379999
FAST FRACTURE LOAD	66.32093	61.7392	-2.441406E-B4182	
ARREST LOAD	66.32093	61.7392	-2.441406E-B4182	
PROPAGATION LOAD	45.81775	41.67392	0	0
TOTAL ENERGY	66.32093	61.7392	0	0
SHEAR LIP ENERGY	0	0	0	0
TOTAL EVENT TIME	0	0	0	3.182

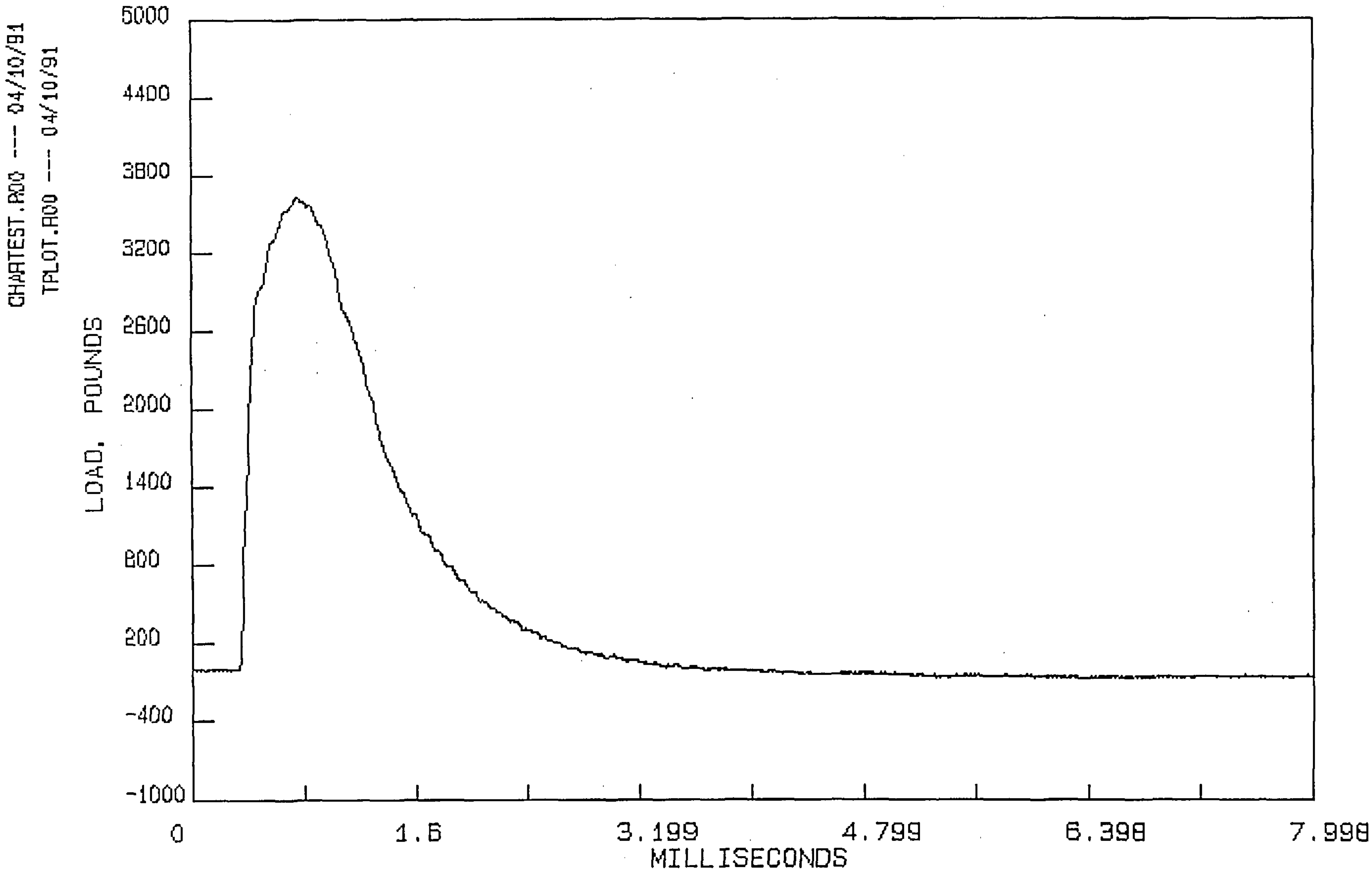
DYNAMIC YIELD STRENGTH (KSI) = 84
DYNAMIC FLOW STRENGTH (KSI) = 94
DIAL ENERGY READING (FT-LBS) = 67.5

TEST VIOLATIONS

********* NO VIOLATIONS *********

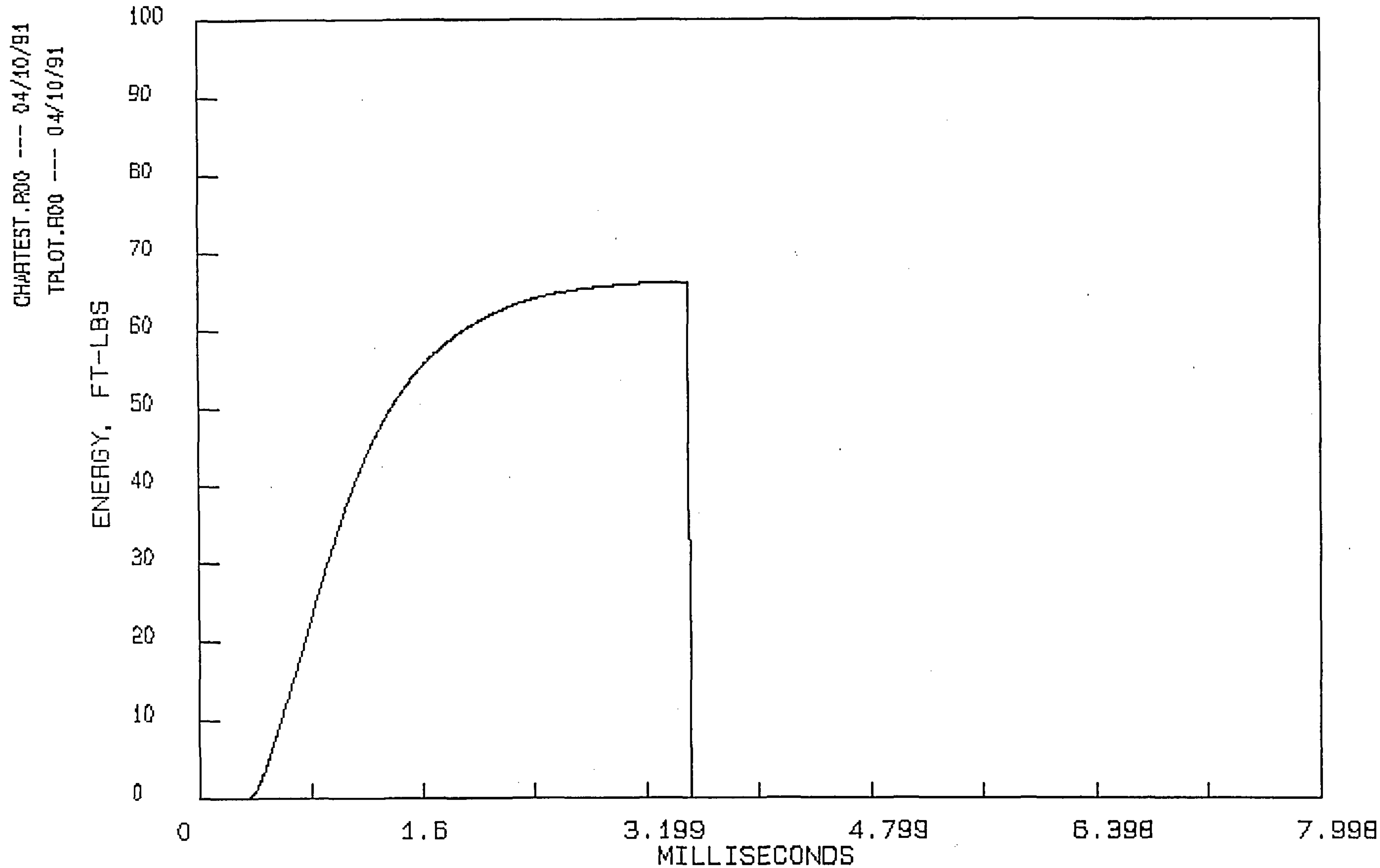
PROJ. NO. 1295-001-03-08 QA NO. 99001

LOAD - TIME TRACE FOR SPECIMEN P212



PROJ. NO. 1295-001-03-08 QA NO. 99001

ENERGY - TIME TRACE FOR SPECIMEN P212



CHARTEST.R00 --- 04/10/91
ANALYZE.R00 --- 04/10/91

INSTRUMENTED IMPACT TEST RESULTS

ANALYSIS DATE: 12/04/2003
MATERIAL: WELD
INITIAL HAMMER ENERGY, FT-LBS: 240
INITIAL HAMMER VELOCITY, FT/SEC: 17
LOAD CALIBRATION, LBS/VOLT: 1150
SPECIMEN WIDTH, INCH: .394
NOTCH DEPTH, INCH: 7.900001E-02
RESPONSE TIME, MSEC: .0519
TECHNICAL PROCEDURE(S): TP-80 TP-412

ANALYSIS BY: BJV
TEST DATE: 11/05/2003
SPEC. ID: P35B
PROJ. NO.: 1295-001-03-08
QA NO.: 99001
TEST TEMP (F): 70
OPERATOR: BJV

PROPERTY	ENERGY, FT-LBS		LOAD POUNDS	TIME MSEC
	UNCORRECTED	CORRECTED		
GENERAL YIELD	3.527954	3.514989	3569.6	.129
FLOW LOAD	3.527954	3.514989	3569.6	.129
MAXIMUM LOAD	3.527954	3.514989	3569.6	.129
FAST FRACTURE LOAD	3.527954	3.514989	3569.6	.129
ARREST LOAD	5.061339	5.034654	-39.10034	.176
PROPAGATION LOAD	1.53405	1.520324	3608.7	0
TOTAL ENERGY	5.062004	5.035313	0	0
SHEAR LIP ENERGY	1.53405	1.520324	0	0
TOTAL EVENT TIME	0	0	0	.176

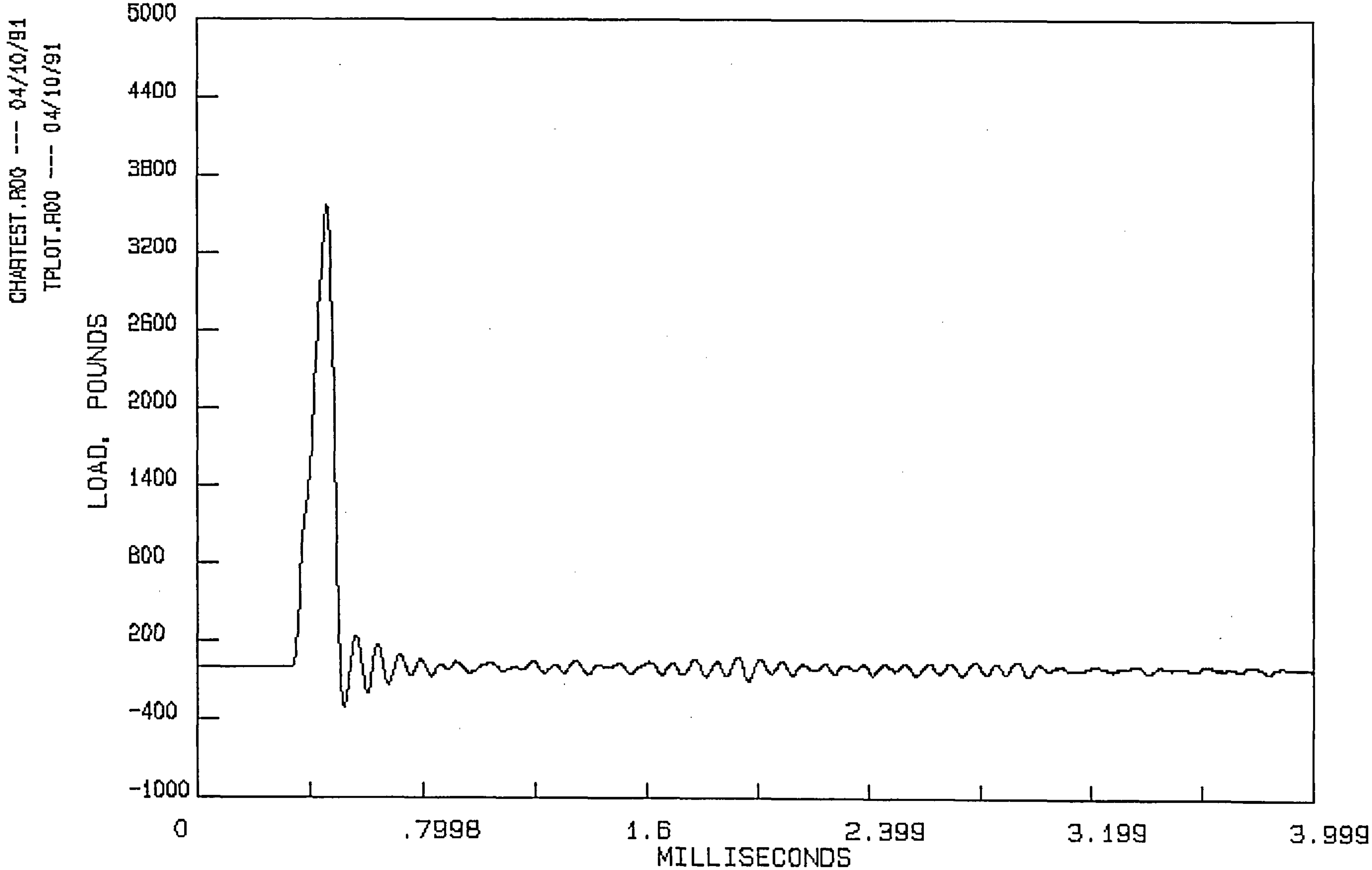
DYNAMIC YIELD STRENGTH (KSI) = 103
DYNAMIC FLOW STRENGTH (KSI) = 103
DIAL ENERGY READING (FT-LBS) = 5.5

TEST VIOLATIONS

********* NO VIOLATIONS *********

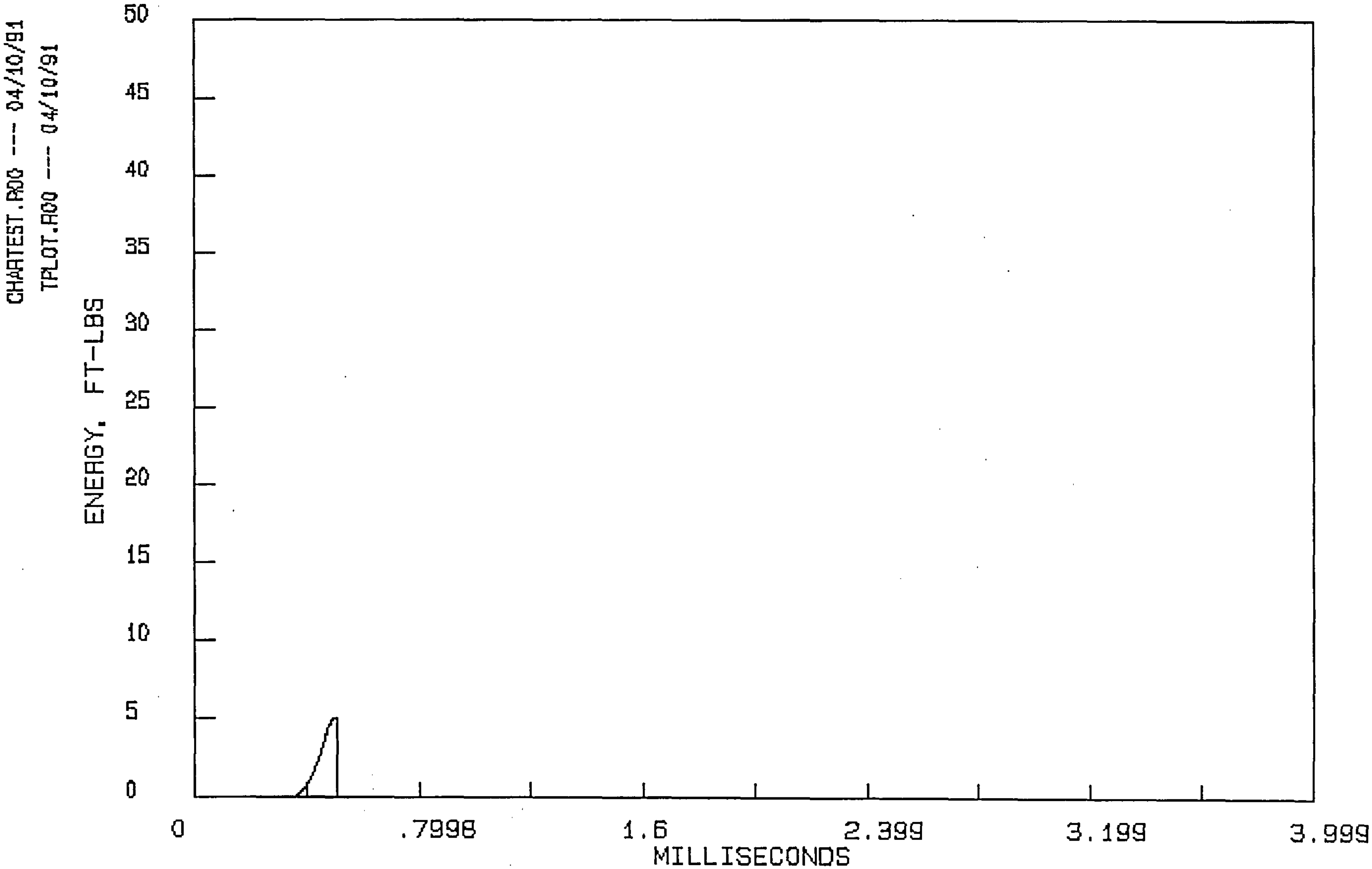
PROJ. NO. 1295-001-03-08 QA NO. 99001

LOAD - TIME TRACE FOR SPECIMEN P35B



PROJ. NO. 1295-001-03-08   QA NO. 99001

ENERGY - TIME TRACE FOR SPECIMEN P35B



CHARTEST.R00 --- 04/10/91
ANALYZE.R00 --- 04/10/91

INSTRUMENTED IMPACT TEST RESULTS

ANALYSIS DATE: 12/08/2003
MATERIAL: WELD
INITIAL HAMMER ENERGY, FT-LBS: 240
INITIAL HAMMER VELOCITY, FT/SEC: 17
LOAD CALIBRATION, LBS/VOLT: 1150
SPECIMEN WIDTH, INCH: .394
NOTCH DEPTH, INCH: 7.900001E-02
RESPONSE TIME, MSEC: .0519
TECHNICAL PROCEDURE(S): TP-80 TP-412

ANALYSIS BY: BJV
TEST DATE: 11/05/2003
SPEC. ID: P35E
PROJ. NO.: 1295-001-03-08
QA NO.: 99001
TEST TEMP (F): 150
OPERATOR: BJV

PROPERTY	ENERGY, FT-LBS		LOAD POUNDS	TIME MSEC
	UNCORRECTED	CORRECTED		
GENERAL YIELD	5.263641	5.234781	3659.3	.166
FLOW LOAD	8.544992	8.468933	3845.6	.218
MAXIMUM LOAD	11.51682	11.37866	4031.9	.262
FAST FRACTURE LOAD	11.92769	11.77949	4029.6	.268
ARREST LOAD	14.63177	14.40876	-43.7002	.3379999
PROPAGATION LOAD	3.11643	3.03154	4073.3	0
TOTAL ENERGY	14.63325	14.4102	0	0
SHEAR LIP ENERGY	2.705561	2.63071	0	0
TOTAL EVENT TIME	0	0	0	.3379999

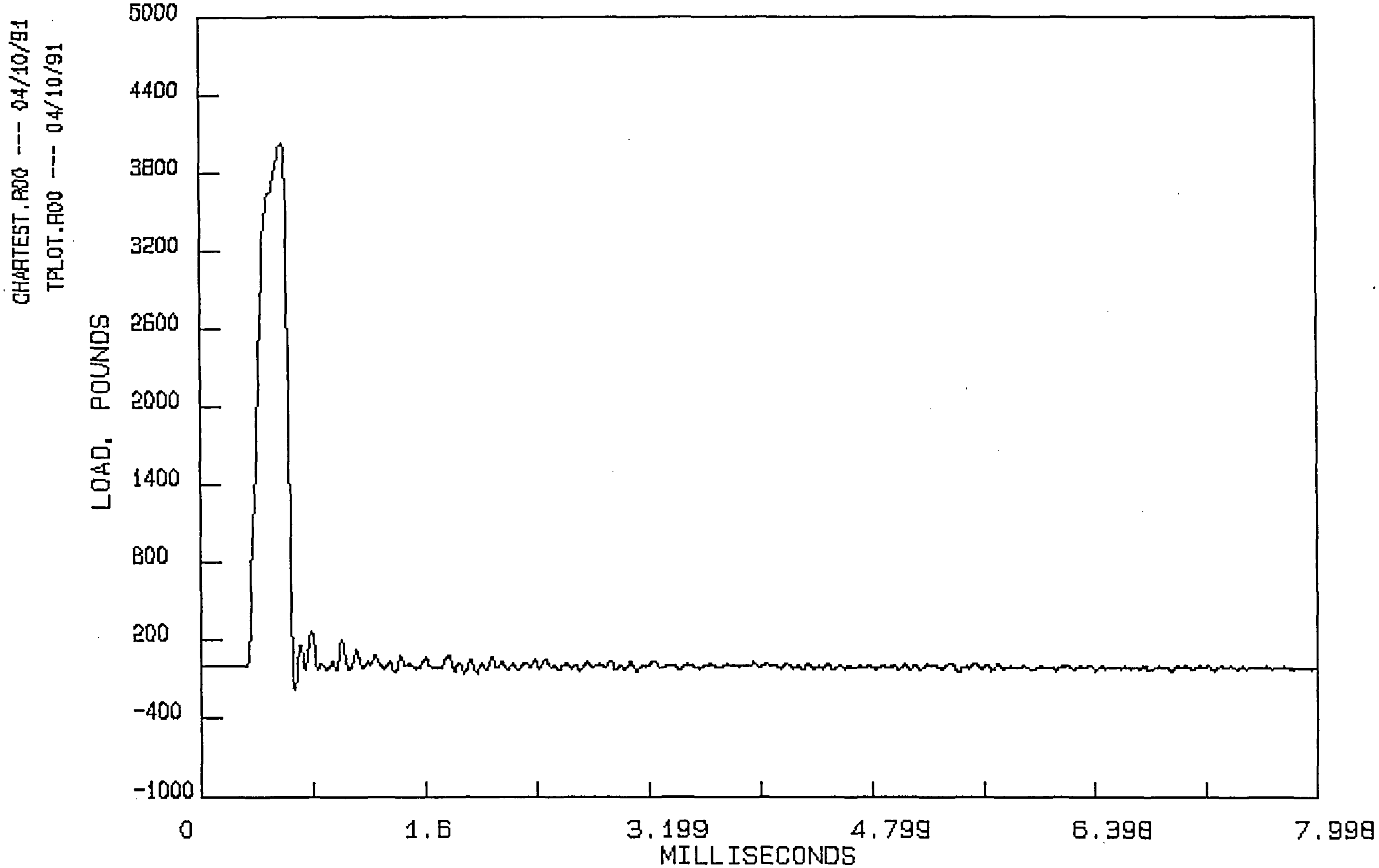
DYNAMIC YIELD STRENGTH (KSI) = 105
DYNAMIC FLOW STRENGTH (KSI) = 110
DIAL ENERGY READING (FT-LBS) = 15.5

TEST VIOLATIONS

********* NO VIOLATIONS *********

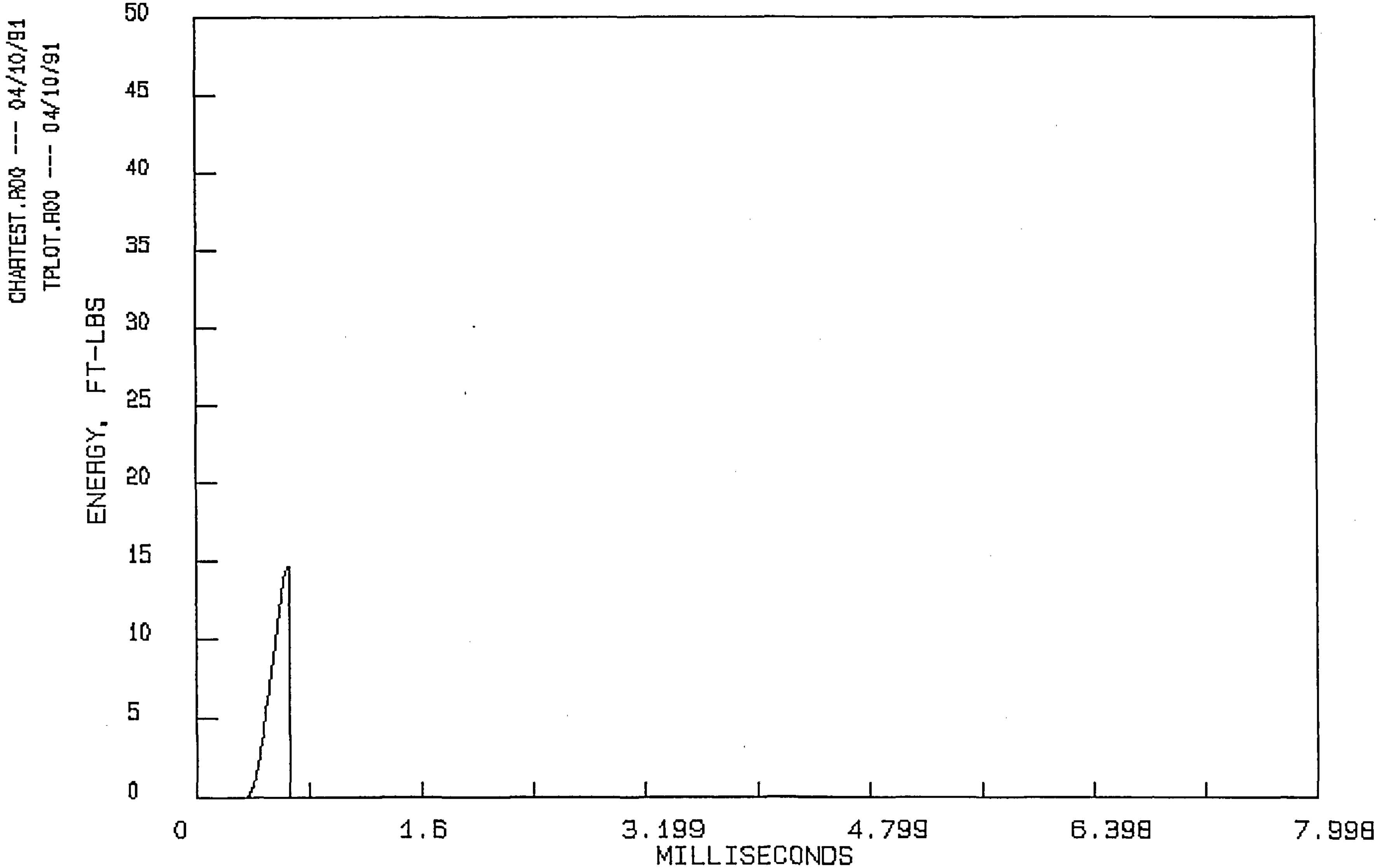
PROJ. NO. 1295-001-03-08 QA NO. 99001

LOAD - TIME TRACE FOR SPECIMEN P35E



PROJ. NO. 1295-001-03-08   QA NO. 99001

ENERGY - TIME TRACE FOR SPECIMEN P35E



CHARTEST.R00 --- 04/10/91
ANALYZE.R00 --- 04/10/91

INSTRUMENTED IMPACT TEST RESULTS

ANALYSIS DATE: 12/08/2003
MATERIAL: WELD
INITIAL HAMMER ENERGY, FT-LBS: 240
INITIAL HAMMER VELOCITY, FT/SEC: 17
LOAD CALIBRATION, LBS/VOLT: 1150
SPECIMEN WIDTH, INCH: .394
NOTCH DEPTH, INCH: 7.900001E-02
RESPONSE TIME, MSEC: .0519
TECHNICAL PROCEDURE(S): TP-80 TP-412

ANALYSIS BY: BJV
TEST DATE: 11/05/2003
SPEC. ID: P355
PROJ. NO.: 1295-001-03-08
QA NO.: 99001
TEST TEMP (F): 200
OPERATOR: BJV

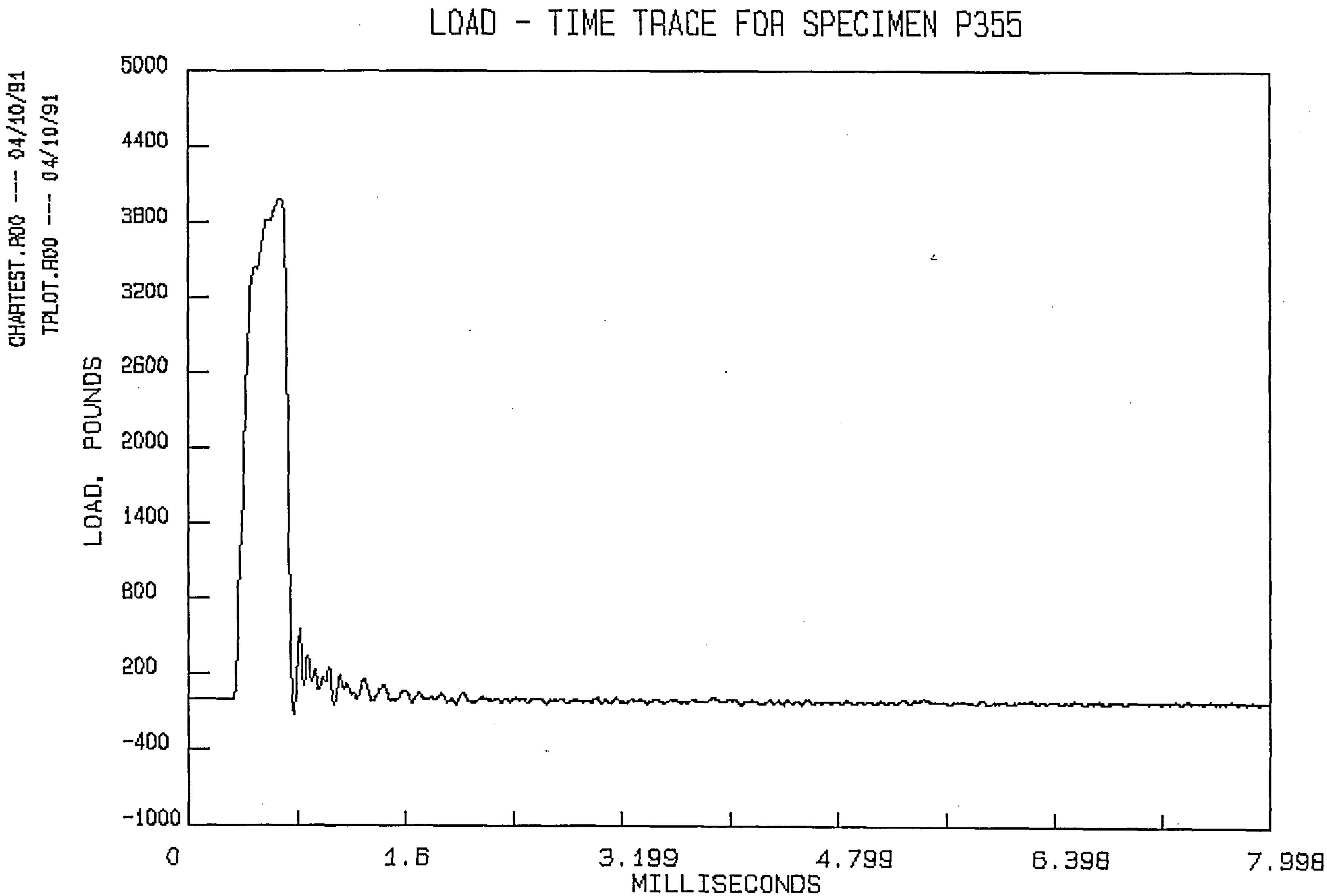
PROPERTY	ENERGY, FT-LBS		LOAD POUNDS	TIME MSEC
	UNCORRECTED	CORRECTED		
GENERAL YIELD	5.089726	5.062741	3461.5	.164
FLOW LOAD	8.941625	8.85834	3726	.2280001
MAXIMUM LOAD	16.44335	16.1617	3990.5	.342
FAST FRACTURE LOAD	18.20441	17.8592	3976.7	.368
ARREST LOAD	20.94305	20.48616	554.3001	.496
PROPAGATION LOAD	5.6884	5.459831	3422.4	0
TOTAL ENERGY	22.13175	21.62153	0	0
SHEAR LIP ENERGY	3.92734	3.762331	0	0
TOTAL EVENT TIME	0	0	0	1.024

DYNAMIC YIELD STRENGTH (KSI) = 99
DYNAMIC FLOW STRENGTH (KSI) = 107
DIAL ENERGY READING (FT-LBS) = 23

TEST VIOLATIONS

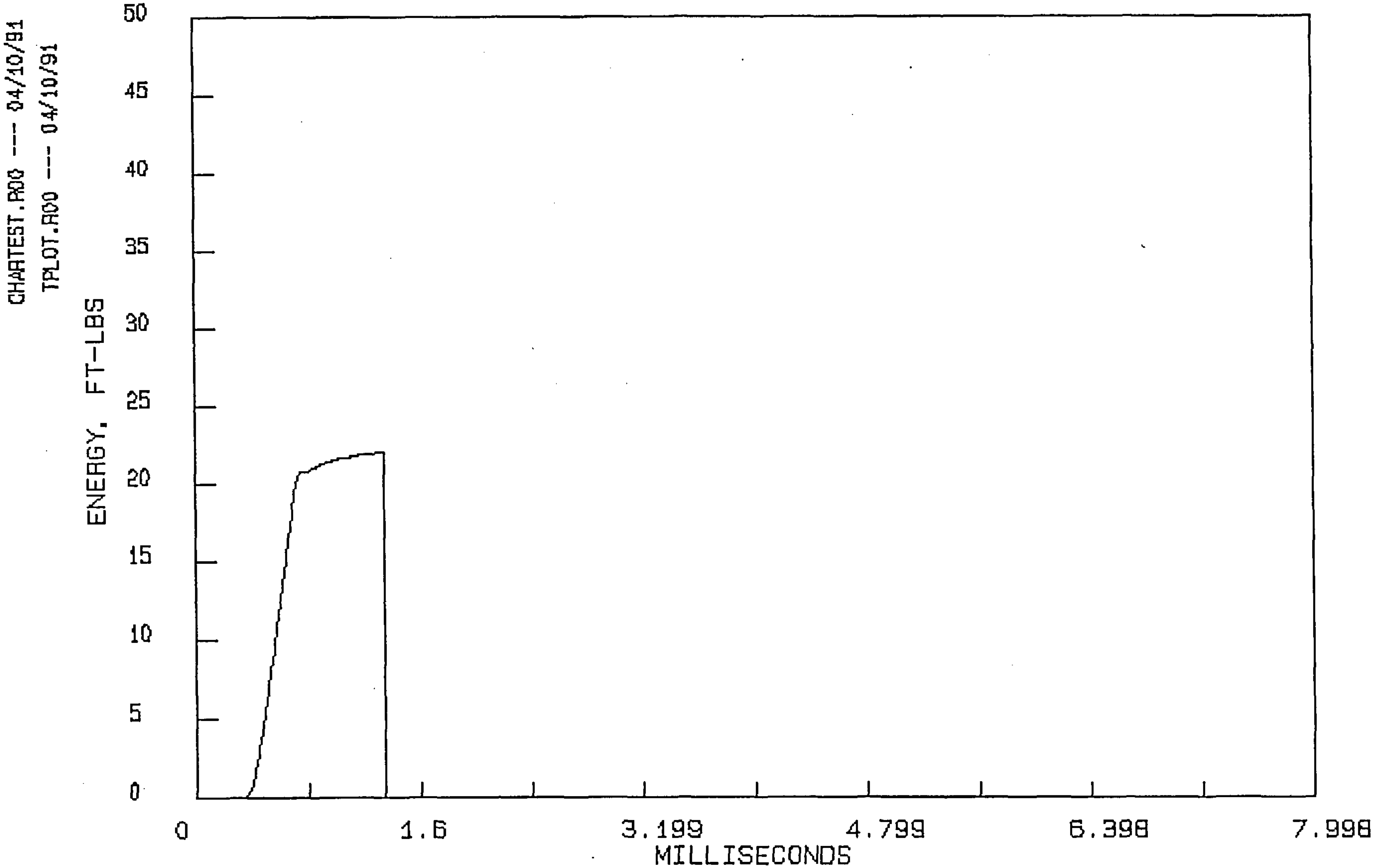
********* NO VIOLATIONS *********

PROJ. NO. 1295-001-03-08 QA NO. 99001



PROJ. NO. 1295-001-03-08   QA NO. 99001

ENERGY - TIME TRACE FOR SPECIMEN P355



CHARTEST.R00 --- 04/10/91
ANALYZE.R00 --- 04/10/91

INSTRUMENTED IMPACT TEST RESULTS

ANALYSIS DATE: 12/08/2003
MATERIAL: WELD
INITIAL HAMMER ENERGY, FT-LBS: 240
INITIAL HAMMER VELOCITY, FT/SEC: 17
LOAD CALIBRATION, LBS/VOLT: 1150
SPECIMEN WIDTH, INCH: .394
NOTCH DEPTH, INCH: 7.900001E-02
RESPONSE TIME, MSEC: .0519
TECHNICAL PROCEDURE(S): TP-80 TP-412

ANALYSIS BY: BJV
TEST DATE: 11/06/2003
SPEC. ID: P356
PROJ. NO.: 1295-001-03-08
QA NO.: 99001
TEST TEMP (F): 225
OPERATOR: BJV

PROPERTY	ENERGY, FT-LBS		LOAD POUNDS	TIME MSEC
	UNCORRECTED	CORRECTED		
GENERAL YIELD	5.425048	5.394391	3477.6	.162
FLOW LOAD	9.195618	9.107535	3761.65	.2239999
MAXIMUM LOAD	16.90684	16.60909	4045.7	.34
FAST FRACTURE LOAD	19.23845	18.85291	4025	.374
ARREST LOAD	24.10835	23.50292	1679	.4959999
PROPAGATION LOAD	13.43109	12.7701	2346	0
TOTAL ENERGY	30.33793	29.37919	0	0
SHEAR LIP ENERGY	11.09948	10.52628	0	0
TOTAL EVENT TIME	0	0	0	1.57

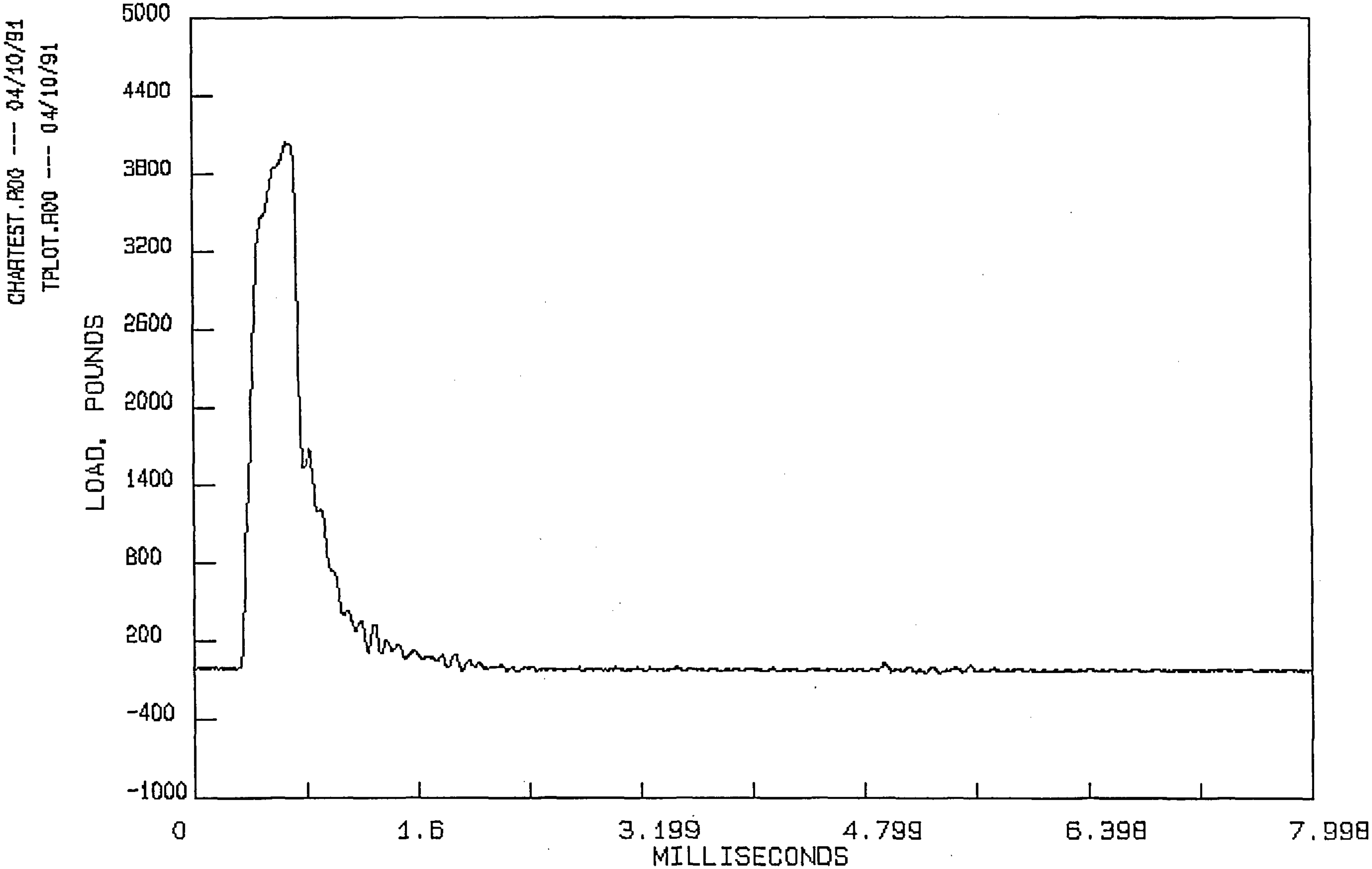
DYNAMIC YIELD STRENGTH (KSI) = 100
DYNAMIC FLOW STRENGTH (KSI) = 108
DIAL ENERGY READING (FT-LBS) = 31

TEST VIOLATIONS

********* NO VIOLATIONS *********

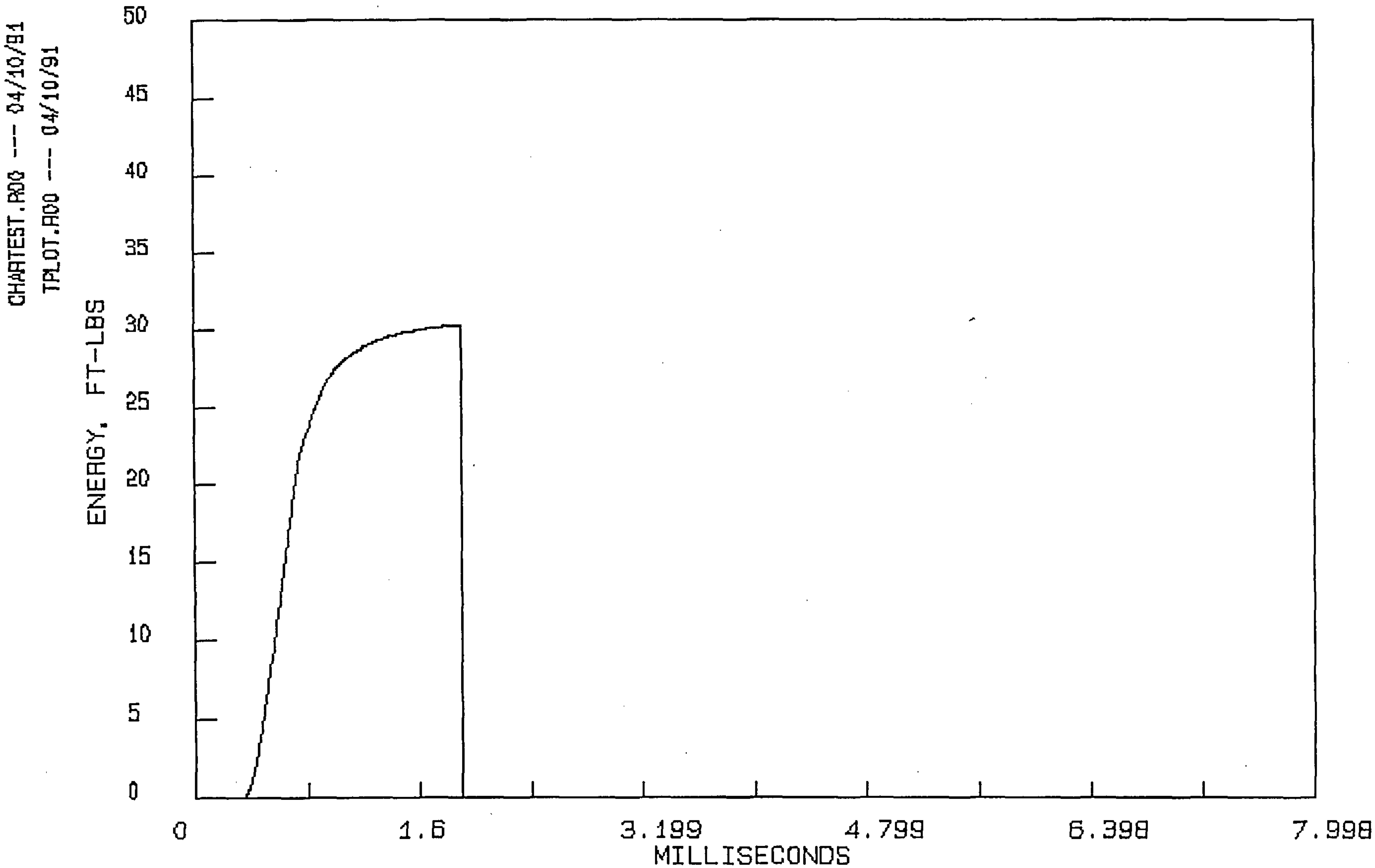
PROJ. NO. 1295-001-03-08 QA NO. 99001

LOAD - TIME TRACE FOR SPECIMEN P356



PROJ. NO. 1295-001-03-08 QA NO. 99001

ENERGY - TIME TRACE FOR SPECIMEN P356



CHARTEST.R00 --- 04/10/91
ANALYZE.R00 --- 04/10/91

INSTRUMENTED IMPACT TEST RESULTS

ANALYSIS DATE: 12/08/2003
MATERIAL: WELD
INITIAL HAMMER ENERGY, FT-LBS: 240
INITIAL HAMMER VELOCITY, FT/SEC: 17
LOAD CALIBRATION, LBS/VOLT: 1150
SPECIMEN WIDTH, INCH: .394
NOTCH DEPTH, INCH: 7.900001E-02
RESPONSE TIME, MSEC: .0519
TECHNICAL PROCEDURE(S): TP-80 TP-412

ANALYSIS BY: BJV
TEST DATE: 11/05/2003
SPEC. ID: P35A
PROJ. NO.: 1295-001-03-08
QA NO.: 99001
TEST TEMP (F): 250
OPERATOR: BJV

PROPERTY	ENERGY, FT-LBS		LOAD POUNDS	TIME MSEC
	UNCORRECTED	CORRECTED		
GENERAL YIELD	5.025836	4.999525	3387.9	.1580001
FLOW LOAD	8.808607	8.727782	3663.9	.2220001
MAXIMUM LOAD	16.19296	15.91982	3939.9	.3360001
FAST FRACTURE LOAD	19.1332	18.75187	3900.8	.3800001
ARREST LOAD	23.49402	22.91905	1922.8	.486
PROPAGATION LOAD	16.35623	15.52578	1978	0
TOTAL ENERGY	32.54919	31.4456	0	0
SHEAR LIP ENERGY	13.41599	12.69373	0	0
TOTAL EVENT TIME	0	0	0	1.474

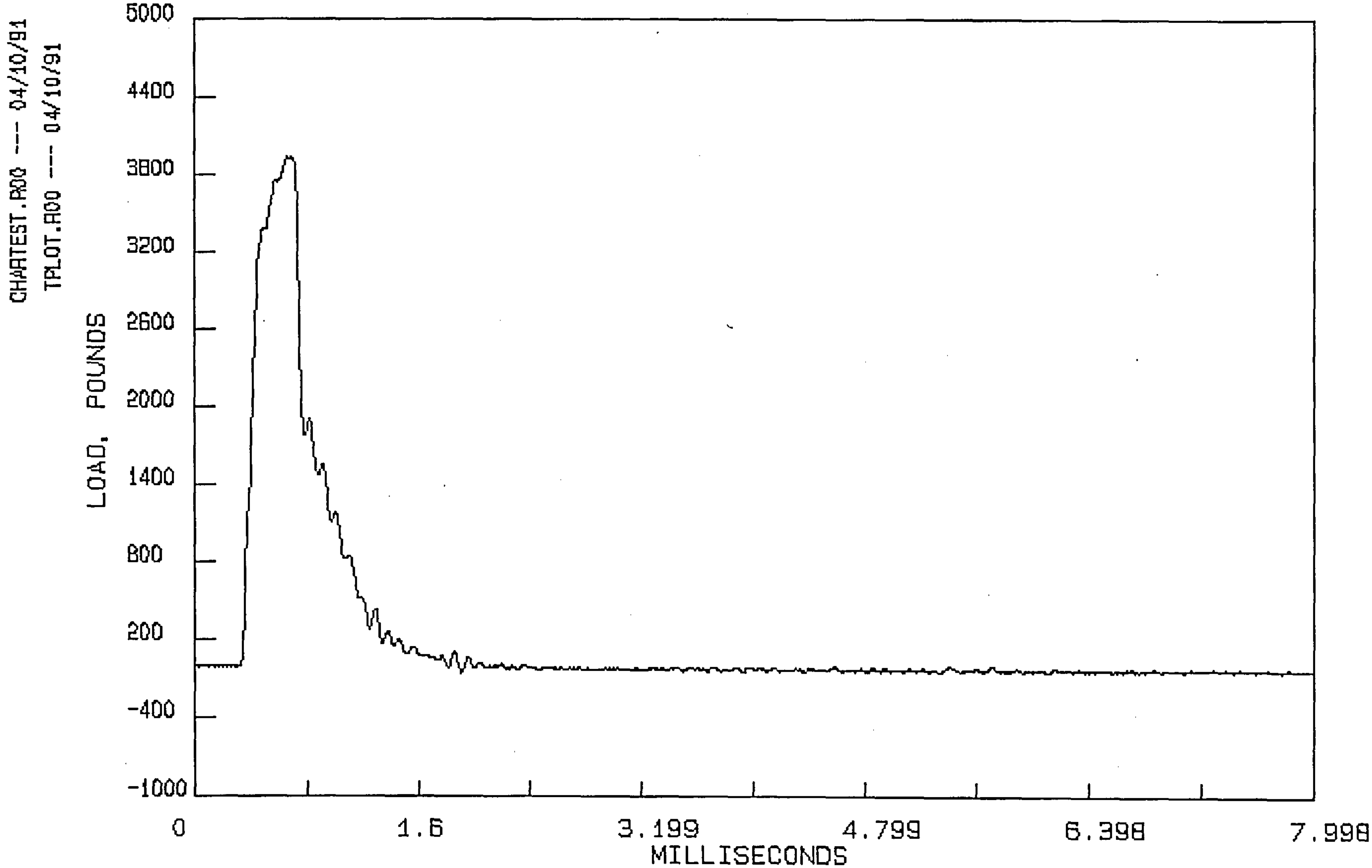
DYNAMIC YIELD STRENGTH (KSI) = 97
DYNAMIC FLOW STRENGTH (KSI) = 105
DIAL ENERGY READING (FT-LBS) = 32.5

TEST VIOLATIONS

********* NO VIOLATIONS *********

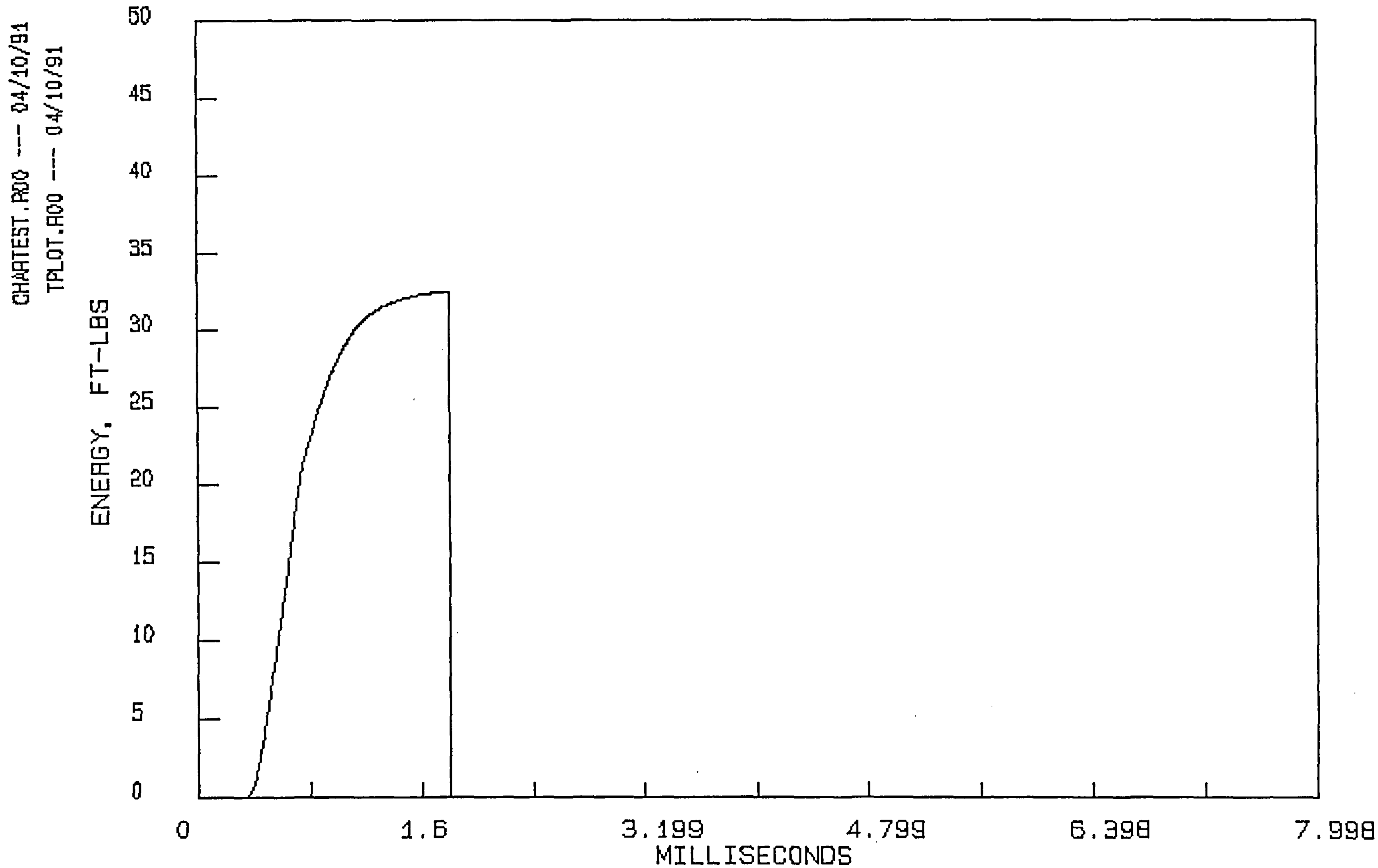
PROJ. NO. 1295-001-03-08 QA NO. 99001

LOAD - TIME TRACE FOR SPECIMEN P35A



PROJ. NO. 1295-001-03-08 QA NO. 99001

ENERGY - TIME TRACE FOR SPECIMEN P35A



CHARTEST.R00 --- 04/10/91
ANALYZE.R00 --- 04/10/91

INSTRUMENTED IMPACT TEST RESULTS

ANALYSIS DATE: 12/08/2003
MATERIAL: WELD
INITIAL HAMMER ENERGY, FT-LBS: 240
INITIAL HAMMER VELOCITY, FT/SEC: 17
LOAD CALIBRATION, LBS/VOLT: 1150
SPECIMEN WIDTH, INCH: .394
NOTCH DEPTH, INCH: 7.900001E-02
RESPONSE TIME, MSEC: .0519
TECHNICAL PROCEDURE(S): TP-80 TP-412

ANALYSIS BY: BJV
TEST DATE: 11/06/2003
SPEC. ID: P35C
PROJ. NO.: 1295-001-03-08
QA NO.: 99001
TEST TEMP (F): 275
OPERATOR: BJV

PROPERTY	ENERGY, FT-LBS		LOAD POUNDS	TIME MSEC
	UNCORRECTED	CORRECTED		
GENERAL YIELD	4.686213	4.663337	3417.8	.154
FLOW LOAD	9.078552	8.992698	3729.45	.228
MAXIMUM LOAD	22.35801	21.8373	4041.1	.428
FAST FRACTURE LOAD	26.93318	26.17756	3896.2	.496
ARREST LOAD	31.40097	30.37387	1888.3	.608
PROPAGATION LOAD	15.30272	14.346	2007.9	0
TOTAL ENERGY	37.66073	36.1833	0	0
SHEAR LIP ENERGY	10.72755	10.00574	0	0
TOTAL EVENT TIME	0	0	0	1.576

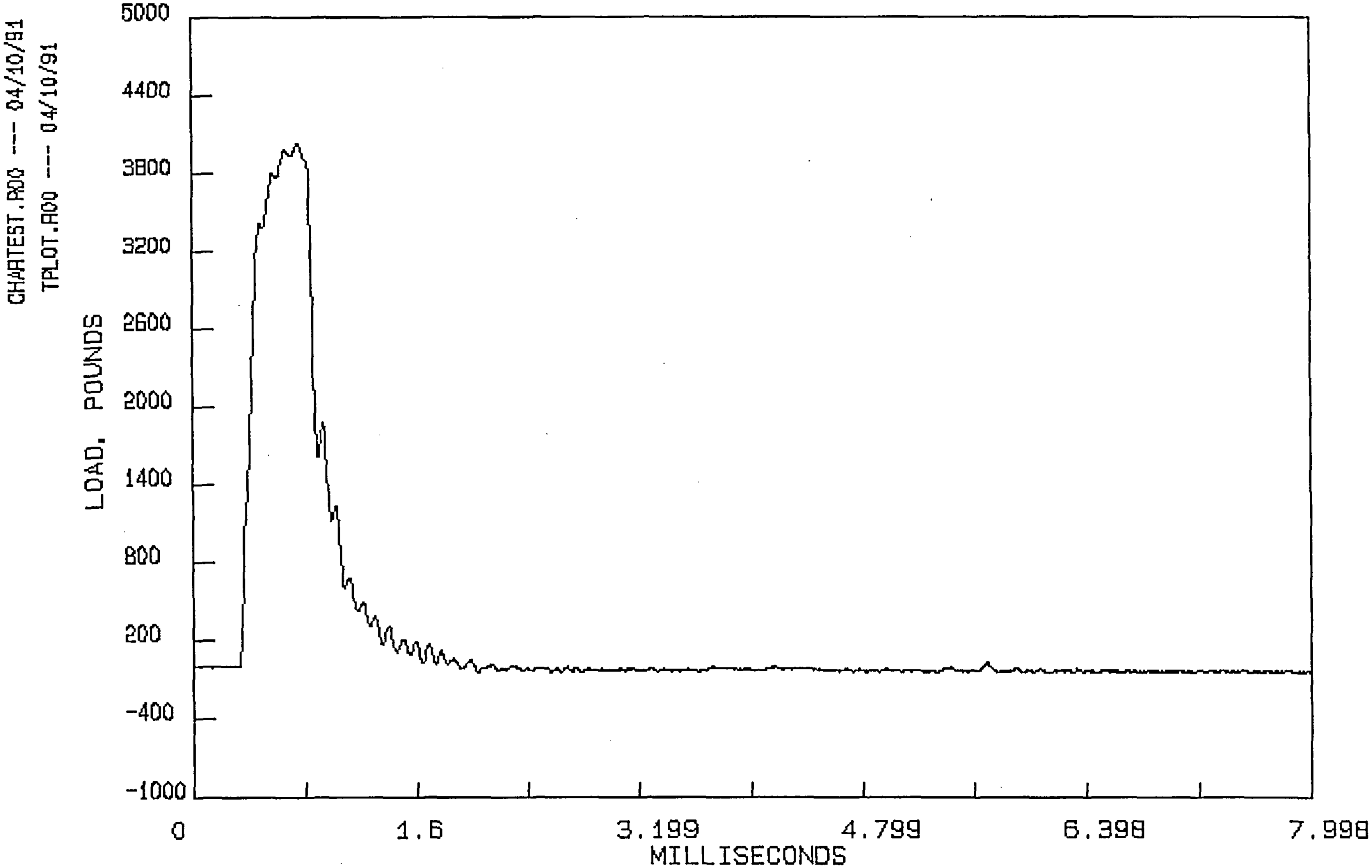
DYNAMIC YIELD STRENGTH (KSI) = 98
DYNAMIC FLOW STRENGTH (KSI) = 107
DIAL ENERGY READING (FT-LBS) = 37.5

TEST VIOLATIONS

********* NO VIOLATIONS *********

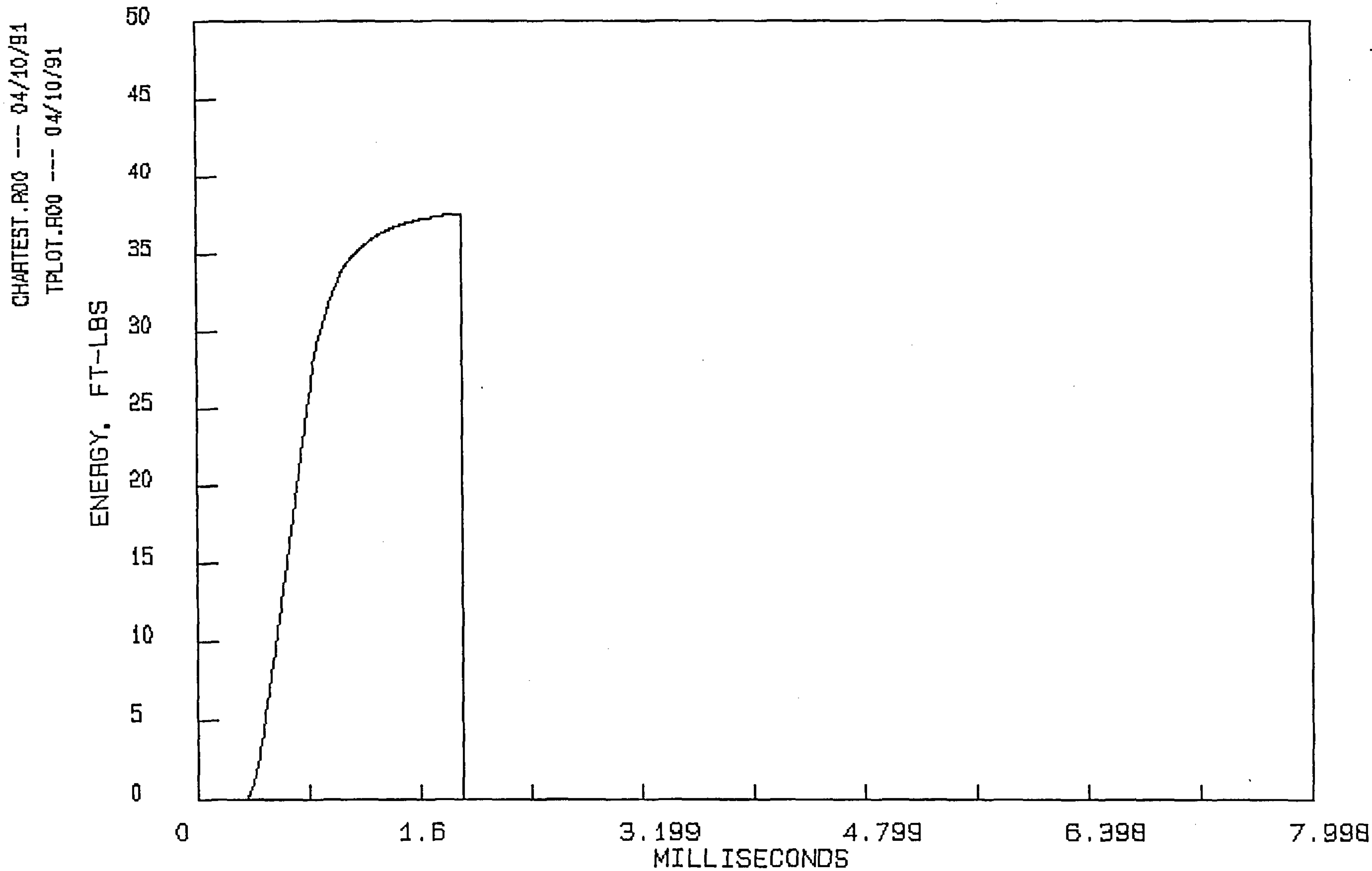
PROJ. NO. 1295-001-03-08 QA NO. 99001

LOAD - TIME TRACE FOR SPECIMEN P35C



PROJ. NO. 1295-001-03-08   QA NO. 99001

ENERGY - TIME TRACE FOR SPECIMEN P35C



CHARTEST.R00 --- 04/10/91
ANALYZE.R00 --- 04/10/91

INSTRUMENTED IMPACT TEST RESULTS

ANALYSIS DATE: 12/08/2003
MATERIAL: WELD
INITIAL HAMMER ENERGY, FT-LBS: 240
INITIAL HAMMER VELOCITY, FT/SEC: 17
LOAD CALIBRATION, LBS/VOLT: 1150
SPECIMEN WIDTH, INCH: .394
NOTCH DEPTH, INCH: 7.900001E-02
RESPONSE TIME, MSEC: .0519
TECHNICAL PROCEDURE(S): TP-80 TP-412

ANALYSIS BY: BJV
TEST DATE: 11/10/2003
SPEC. ID: P353
PROJ. NO.: 1295-001-03-08
QA NO.: 99001
TEST TEMP (F): 275
OPERATOR: BJV

PROPERTY	ENERGY, FT-LBS UNCORRECTED	ENERGY, FT-LBS CORRECTED	LOAD POUNDS	TIME MSEC
GENERAL YIELD	5.212891	5.184585	3293.6	.162
FLOW LOAD	9.75592	9.656776	3630.55	.24
MAXIMUM LOAD	22.0481	21.54173	3967.5	.43
FAST FRACTURE LOAD	33.74854	32.56212	3668.5	.6079999
ARREST LOAD	38.32285	36.79302	2313.8	.706
PROPAGATION LOAD	29.58868	27.3176	1354.7	0
TOTAL ENERGY	51.63678	48.85933	0	0
SHEAR LIP ENERGY	17.88824	16.29721	0	0
TOTAL EVENT TIME	0	0	0	1.98

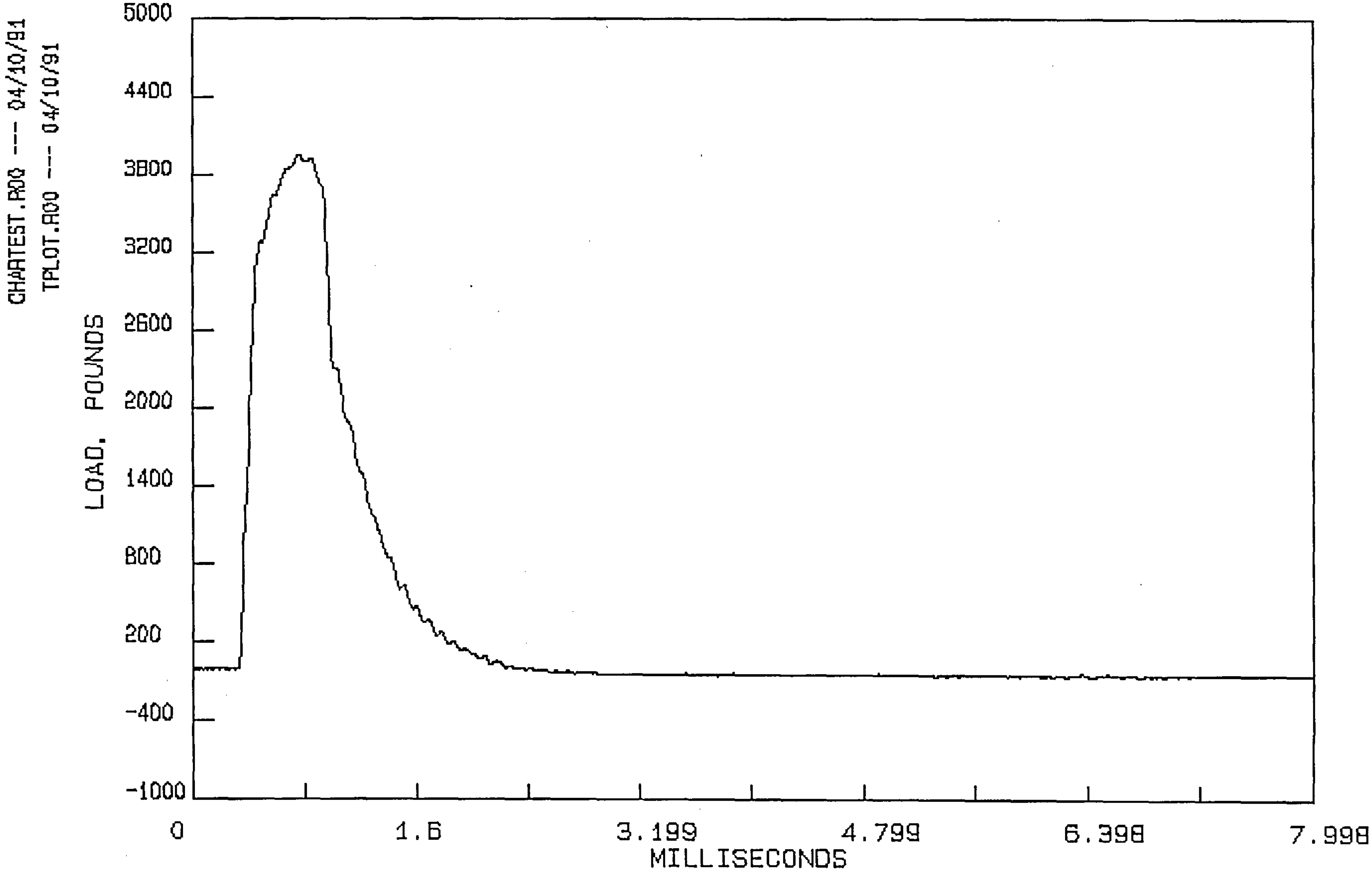
DYNAMIC YIELD STRENGTH (KSI) = 95
DYNAMIC FLOW STRENGTH (KSI) = 104
DIAL ENERGY READING (FT-LBS) = 50

TEST VIOLATIONS

********* NO VIOLATIONS *********

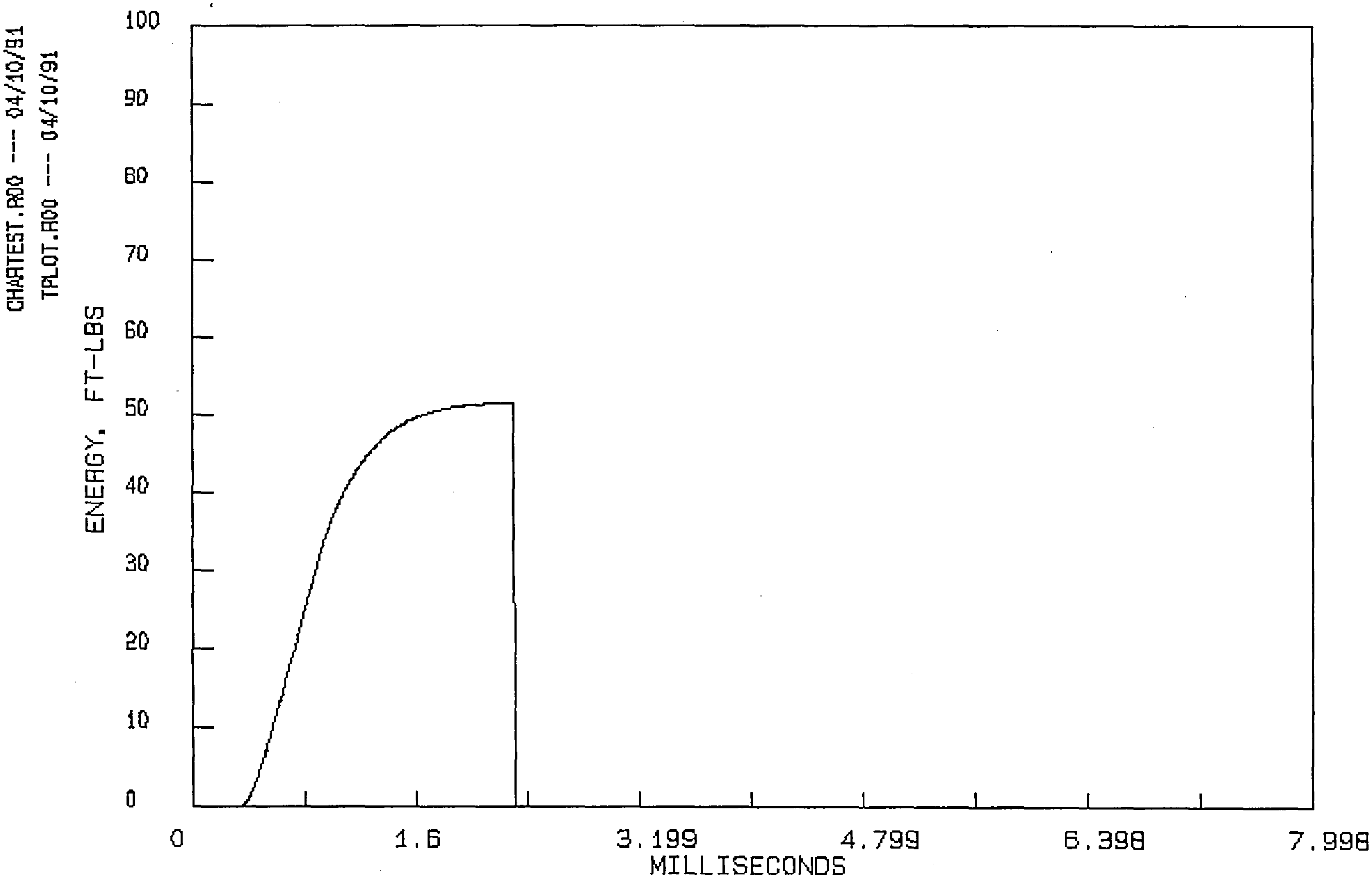
PROJ. NO. 1295-001-03-08   QA NO. 99001

LOAD - TIME TRACE FOR SPECIMEN P353



PROJ. NO. 1295-001-03-08 QA NO. 99001

ENERGY - TIME TRACE FOR SPECIMEN P353



CHARTEST.R00 --- 04/10/91
ANALYZE.R00 --- 04/10/91

INSTRUMENTED IMPACT TEST RESULTS

ANALYSIS DATE: 12/08/2003
MATERIAL: WELD
INITIAL HAMMER ENERGY, FT-LBS: 240
INITIAL HAMMER VELOCITY, FT/SEC: 17
LOAD CALIBRATION, LBS/VOLT: 1150
SPECIMEN WIDTH, INCH: .394
NOTCH DEPTH, INCH: 7.900001E-02
RESPONSE TIME, MSEC: .0519
TECHNICAL PROCEDURE(S): TP-80 TP-412

ANALYSIS BY: BJV
TEST DATE: 11/10/2003
SPEC. ID: P352
PROJ. NO.: 1295-001-03-08
QA NO.: 99001
TEST TEMP (F): 285
OPERATOR: BJV

PROPERTY	ENERGY, FT-LBS		LOAD POUNDS	TIME MSEC
	UNCORRECTED	CORRECTED		
GENERAL YIELD	4.323834	4.304359	3185.5	.2059999
FLOW LOAD	9.476588	9.38304	3522.45	.296
MAXIMUM LOAD	22.97196	22.42226	3859.4	.508
FAST FRACTURE LOAD	39.1466	37.55029	2990	.776
ARREST LOAD	42.62742	40.73461	2359.8	.854
PROPAGATION LOAD	33.39594	30.63591	630.2	0
TOTAL ENERGY	56.3679	53.05817	0	0
SHEAR LIP ENERGY	17.2213	15.50788	0	0
TOTAL EVENT TIME	0	0	0	2.258

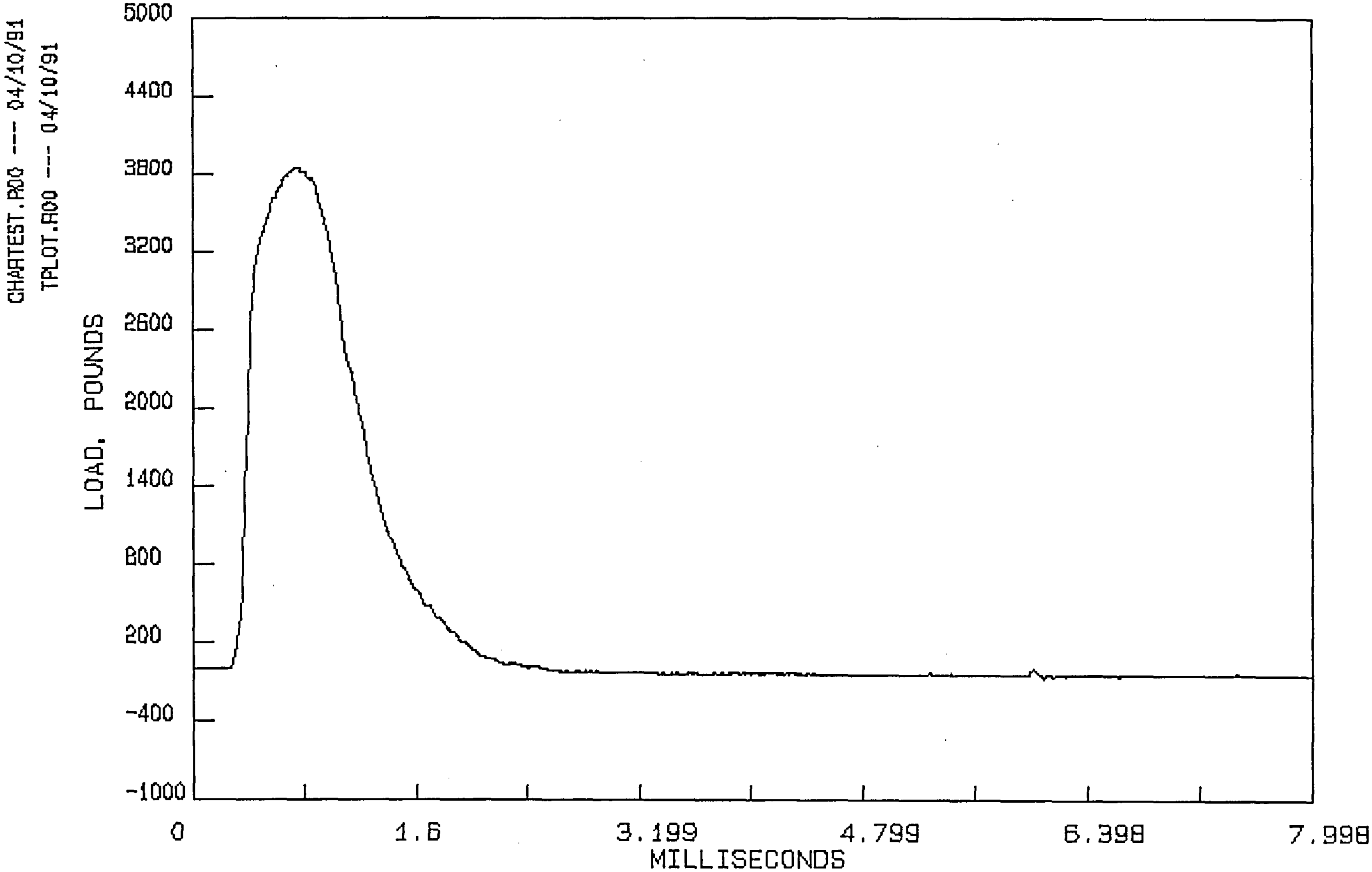
DYNAMIC YIELD STRENGTH (KSI) = 91
DYNAMIC FLOW STRENGTH (KSI) = 101
DIAL ENERGY READING (FT-LBS) = 55

TEST VIOLATIONS

********* NO VIOLATIONS *********

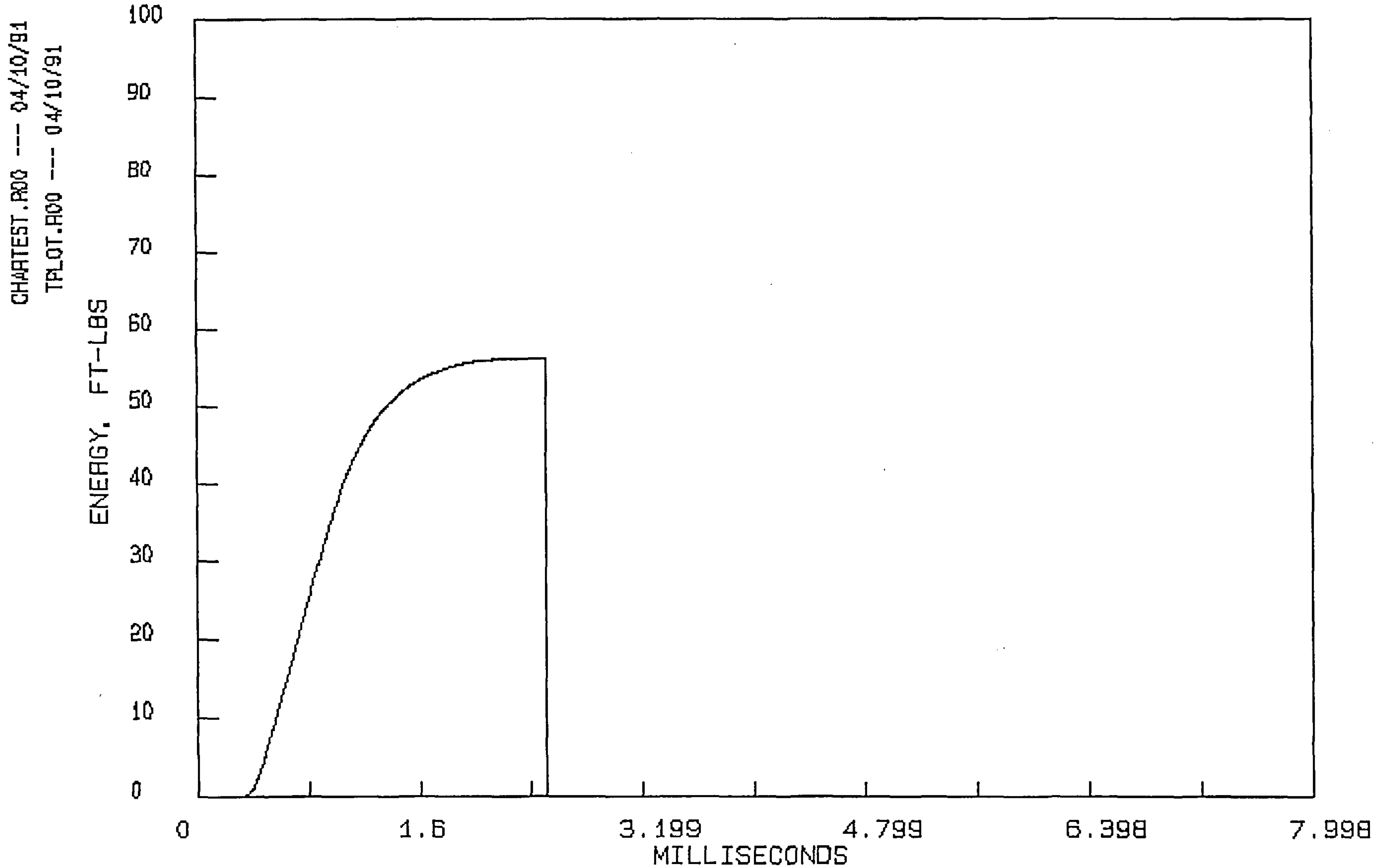
PROJ. NO. 1295-001-03-08 QA NO. 99001

LOAD - TIME TRACE FOR SPECIMEN P352



PROJ. NO. 1295-001-03-08 QA NO. 99001

ENERGY - TIME TRACE FOR SPECIMEN P352



CHARTEST.R00 --- 04/10/91
ANALYZE.R00 --- 04/10/91

INSTRUMENTED IMPACT TEST RESULTS

ANALYSIS DATE: 12/08/2003
MATERIAL: WELD
INITIAL HAMMER ENERGY, FT-LBS: 240
INITIAL HAMMER VELOCITY, FT/SEC: 17
LOAD CALIBRATION, LBS/VOLT: 1150
SPECIMEN WIDTH, INCH: .394
NOTCH DEPTH, INCH: 7.900001E-02
RESPONSE TIME, MSEC: .0519
TECHNICAL PROCEDURE(S): TP-80 TP-412

ANALYSIS BY: BJV
TEST DATE: 11/05/2003
SPEC. ID: P35J
PROJ. NO.: 1295-001-03-08
QA NO.: 99001
TEST TEMP (F): 300
OPERATOR: BJV

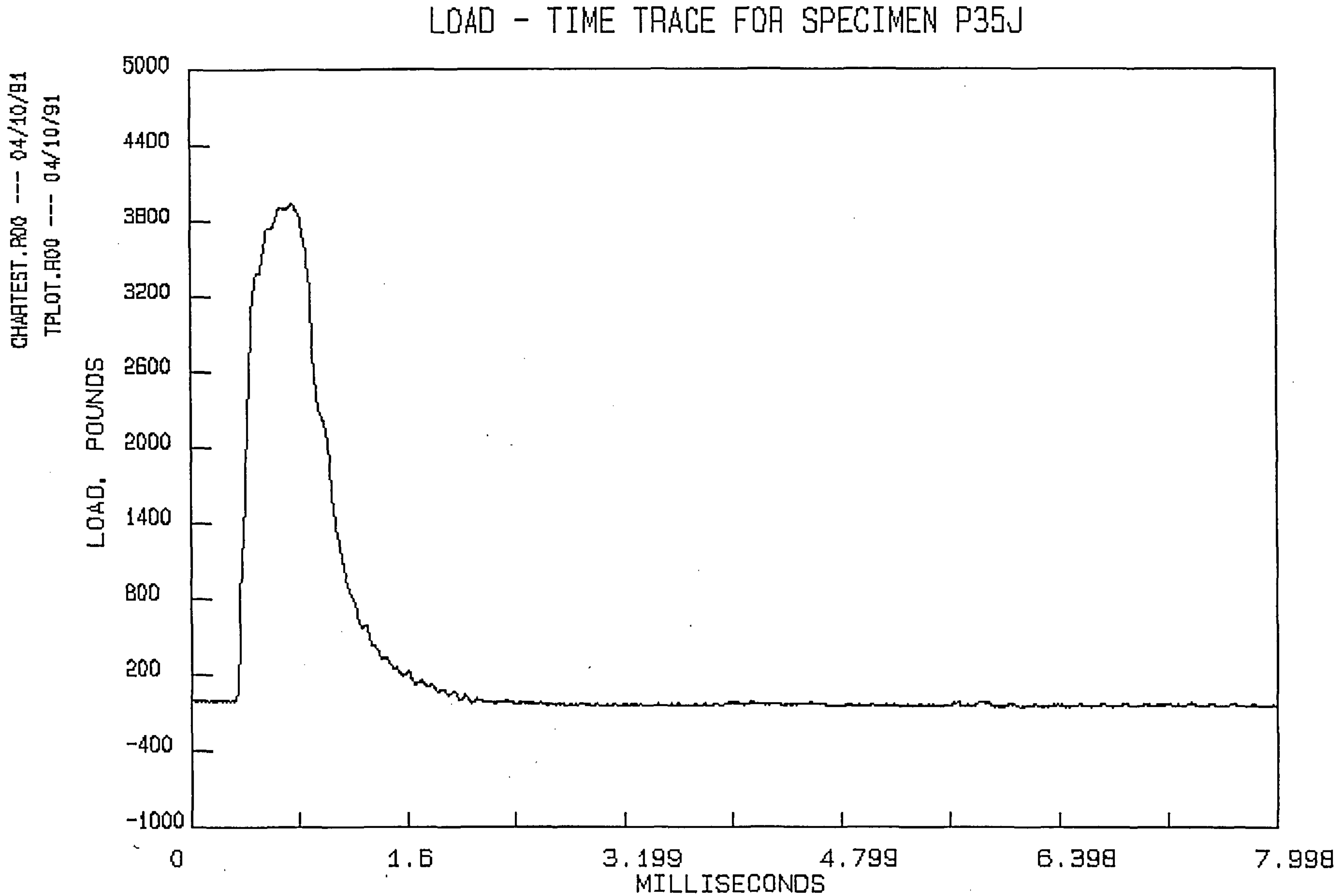
PROPERTY	ENERGY, FT-LBS		LOAD POUNDS	TIME MSEC
	UNCORRECTED	CORRECTED		
GENERAL YIELD	5.324326	5.294797	3387.9	.162
FLOW LOAD	8.993393	8.909142	3669.65	.2240001
MAXIMUM LOAD	21.81186	21.31628	3951.4	.42
FAST FRACTURE LOAD	29.85942	28.93069	3355.7	.5460001
ARREST LOAD	34.02717	32.82108	2242.5	.64
PROPAGATION LOAD	21.1904	19.75974	1113.2	0
TOTAL ENERGY	43.00226	41.07602	0	0
SHEAR LIP ENERGY	13.14284	12.14533	0	0
TOTAL EVENT TIME	0	0	0	1.648

DYNAMIC YIELD STRENGTH (KSI) = 97
DYNAMIC FLOW STRENGTH (KSI) = 105
DIAL ENERGY READING (FT-LBS) = 43

TEST VIOLATIONS

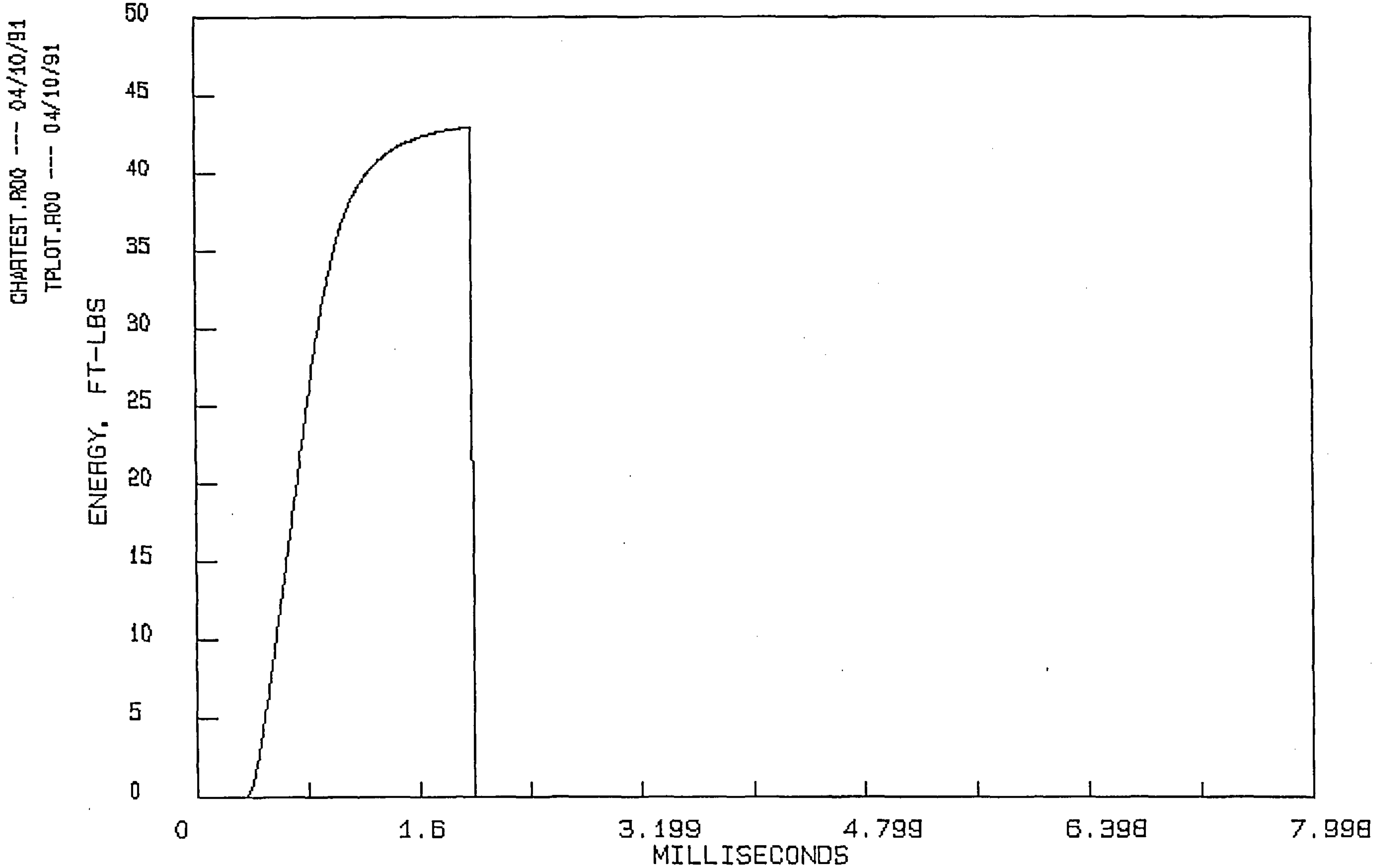
********* NO VIOLATIONS *********

PROJ. NO. 1295-001-03-08 QA NO. 99001



PROJ. NO. 1295-001-03-08   QA NO. 99001

ENERGY - TIME TRACE FOR SPECIMEN P35J



CHARTEST.R00 --- 04/10/91
ANALYZE.R00 --- 04/10/91

INSTRUMENTED IMPACT TEST RESULTS

ANALYSIS DATE: 12/08/2003
MATERIAL: WELD
INITIAL HAMMER ENERGY, FT-LBS: 240
INITIAL HAMMER VELOCITY, FT/SEC: 17
LOAD CALIBRATION, LBS/VOLT: 1150
SPECIMEN WIDTH, INCH: .394
NOTCH DEPTH, INCH: 7.900001E-02
RESPONSE TIME, MSEC: .0519
TECHNICAL PROCEDURE(S): TP-80 TP-412

ANALYSIS BY: BJV
TEST DATE: 11/06/2003
SPEC. ID: P35D
PROJ. NO.: 1295-001-03-08
QA NO.: 99001
TEST TEMP (F): 325
OPERATOR: BJV

PROPERTY	ENERGY, FT-LBS		LOAD POUNDS	TIME MSEC
	UNCORRECTED	CORRECTED		
GENERAL YIELD	4.987675	4.961762	3351.1	.1580001
FLOW LOAD	9.219547	9.131005	3655.85	.23
MAXIMUM LOAD	22.30257	21.78444	3960.6	.43
FAST FRACTURE LOAD	27.81841	27.0123	3742.1	.5140001
ARREST LOAD	32.22208	31.14056	2941.7	.594
PROPAGATION LOAD	25.56733	23.69845	800.4002	0
TOTAL ENERGY	47.8699	45.48289	0	0
SHEAR LIP ENERGY	20.05149	18.47059	0	0
TOTAL EVENT TIME	0	0	0	1.832

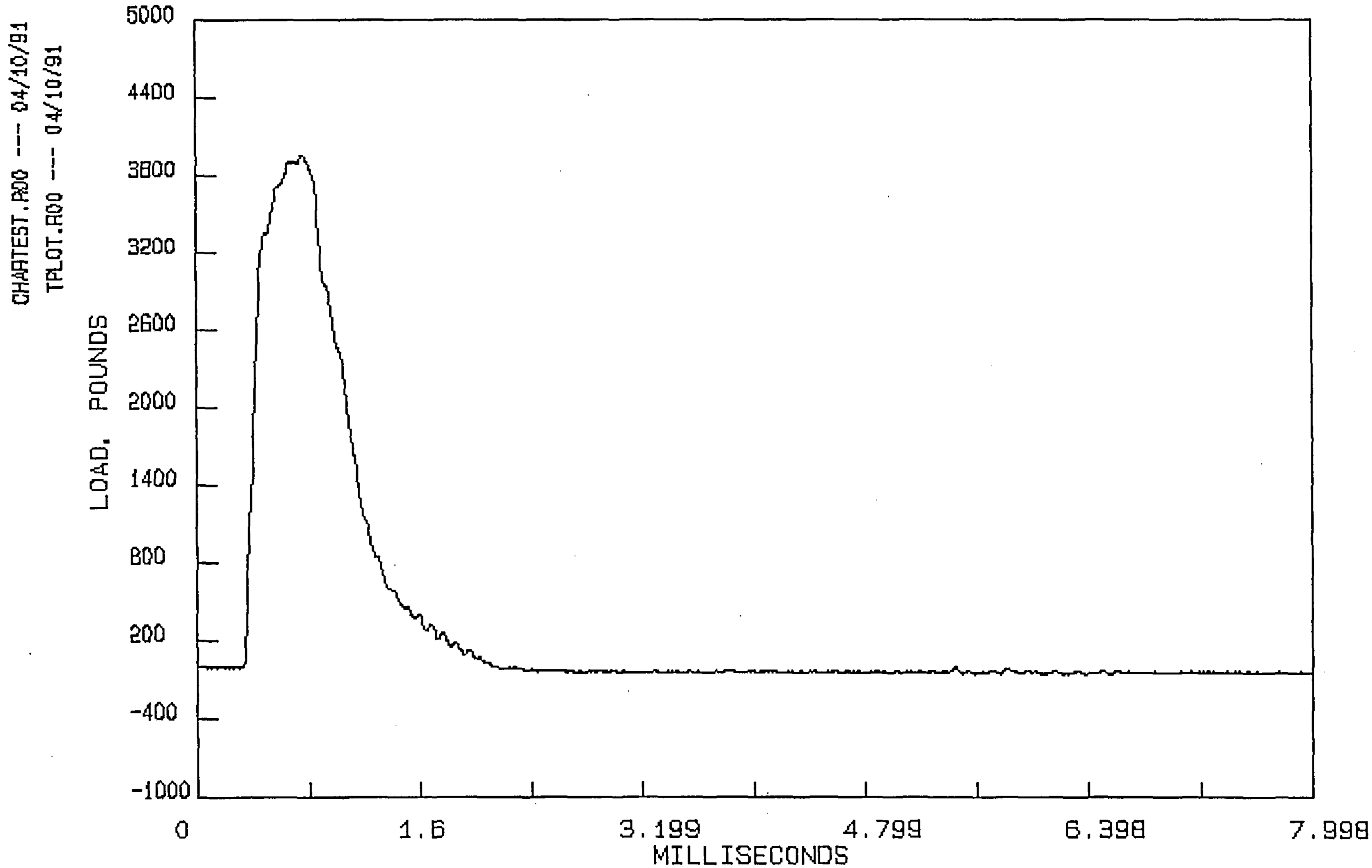
DYNAMIC YIELD STRENGTH (KSI) = 96
DYNAMIC FLOW STRENGTH (KSI) = 105
DIAL ENERGY READING (FT-LBS) = 47

TEST VIOLATIONS

********* NO VIOLATIONS *********

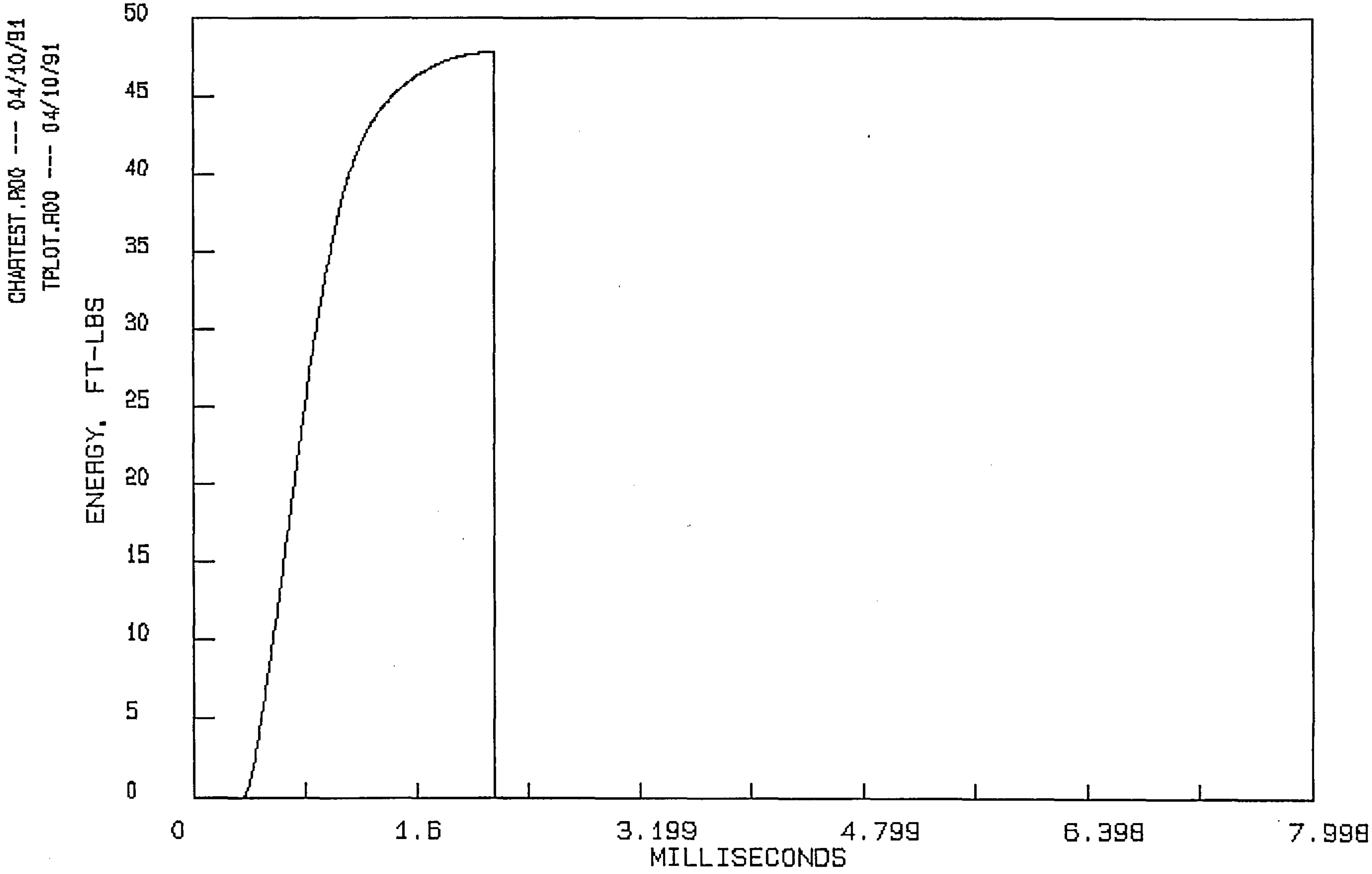
PROJ. NO. 1295-001-03-08 QA NO. 99001

LOAD - TIME TRACE FOR SPECIMEN P35D



PROJ. NO. 1295-001-03-08 QA NO. 99001

ENERGY - TIME TRACE FOR SPECIMEN P35D



CHARTEST.R00 --- 04/10/91
ANALYZE.R00 --- 04/10/91

INSTRUMENTED IMPACT TEST RESULTS

ANALYSIS DATE: 12/08/2003
MATERIAL: WELD
INITIAL HAMMER ENERGY, FT-LBS: 240
INITIAL HAMMER VELOCITY, FT/SEC: 17
LOAD CALIBRATION, LBS/VOLT: 1150
SPECIMEN WIDTH, INCH: .394
NOTCH DEPTH, INCH: 7.900001E-02
RESPONSE TIME, MSEC: .0519
TECHNICAL PROCEDURE(S): TP-80 TP-412

ANALYSIS BY: BJV
TEST DATE: 11/05/2003
SPEC. ID: P357
PROJ. NO.: 1295-001-03-08
QA NO.: 99001
TEST TEMP (F): 350
OPERATOR: BJV

PROPERTY	ENERGY, FT-LBS		LOAD POUNDS	TIME MSEC
	UNCORRECTED	CORRECTED		
GENERAL YIELD	4.982434	4.956575	3233.8	.1540001
FLOW LOAD	8.968679	8.884891	3527.05	.224
MAXIMUM LOAD	21.83586	21.33919	3820.3	.428
FAST FRACTURE LOAD	50.79827	48.11029	0	1.832
ARREST LOAD	50.79827	48.11029	0	1.832
PROPAGATION LOAD	28.96241	26.7711	0	0
TOTAL ENERGY	50.79827	48.11029	0	0
SHEAR LIP ENERGY	0	0	0	0
TOTAL EVENT TIME	0	0	0	1.832

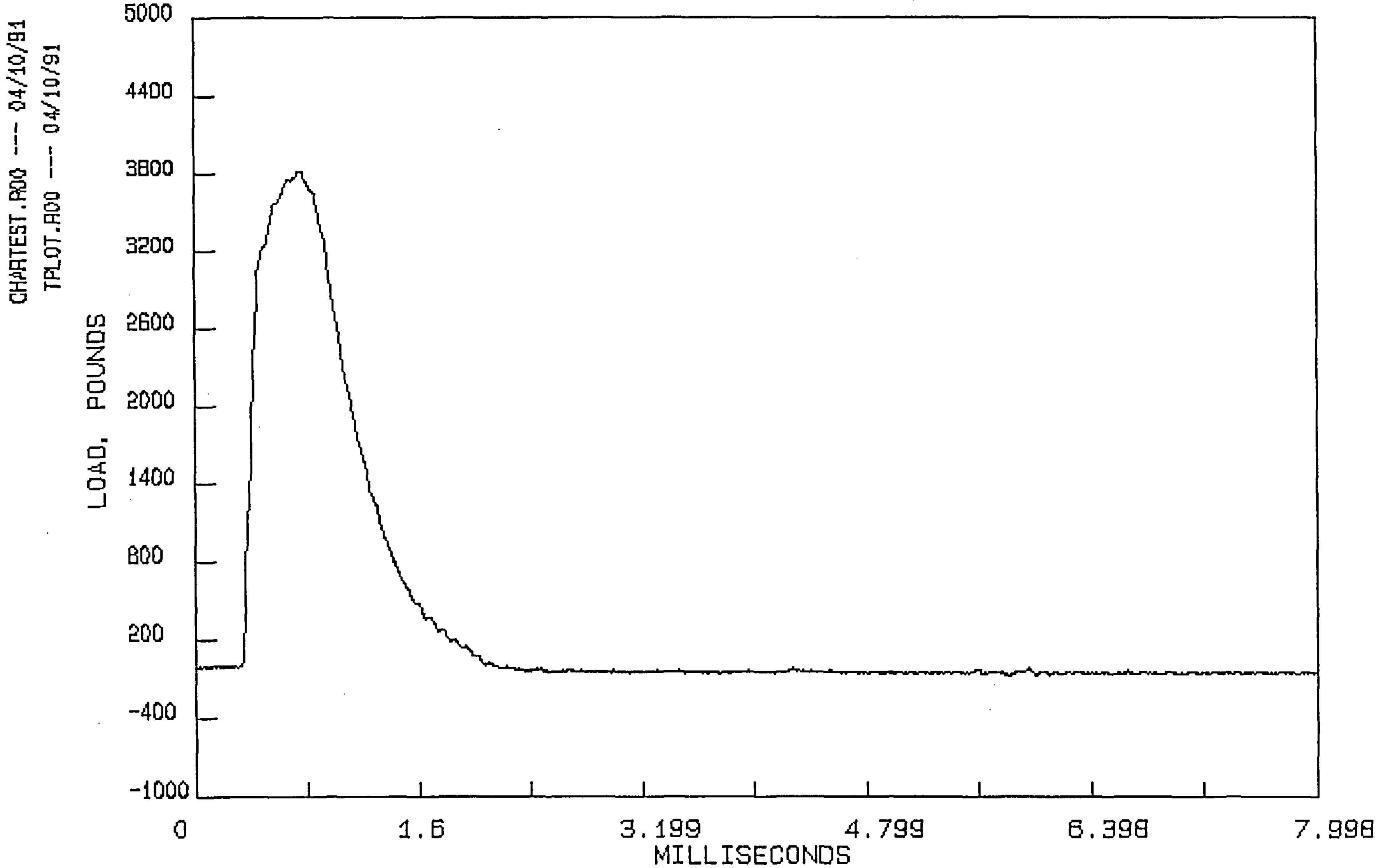
DYNAMIC YIELD STRENGTH (KSI) = 93
DYNAMIC FLOW STRENGTH (KSI) = 101
DIAL ENERGY READING (FT-LBS) = 50

TEST VIOLATIONS

********* NO VIOLATIONS *********

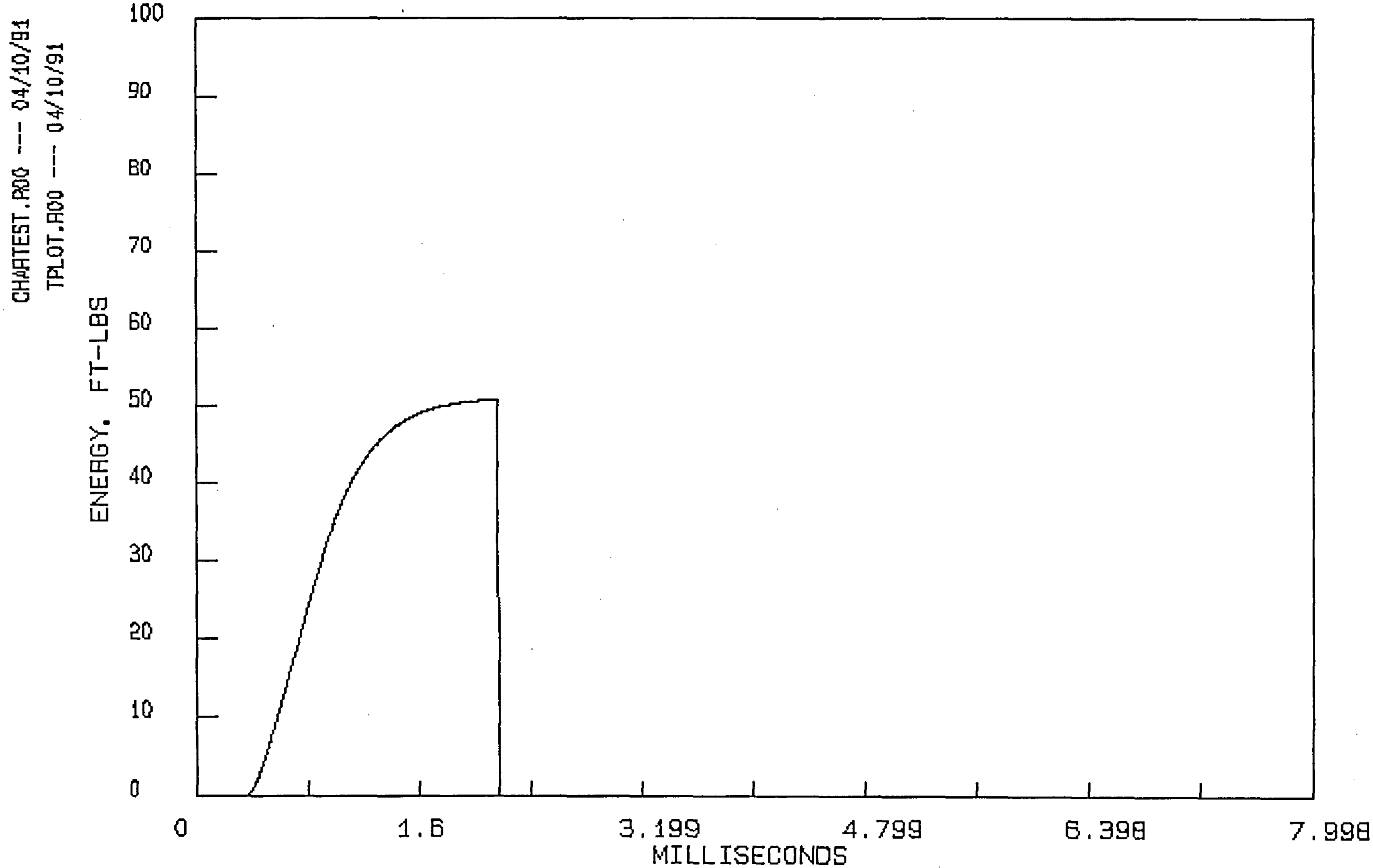
PROJ. NO. 1295-001-03-08 QA NO. 99001

LOAD - TIME TRACE FOR SPECIMEN P357



PROJ. NO. 1295-001-03-08 QA NO. 99001

ENERGY - TIME TRACE FOR SPECIMEN P357



CHARTEST.R00 --- 04/10/91
ANALYZE.R00 --- 04/10/91

INSTRUMENTED IMPACT TEST RESULTS

ANALYSIS DATE: 12/08/2003
MATERIAL: WELD
INITIAL HAMMER ENERGY, FT-LBS: 240
INITIAL HAMMER VELOCITY, FT/SEC: 17
LOAD CALIBRATION, LBS/VOLT: 1150
SPECIMEN WIDTH, INCH: .394
NOTCH DEPTH, INCH: 7.900001E-02
RESPONSE TIME, MSEC: .0519
TECHNICAL PROCEDURE(S): TP-80 TP-412

ANALYSIS BY: BJV
TEST DATE: 11/06/2003
SPEC. ID: P354
PROJ. NO.: 1295-001-03-08
QA NO.: 99001
TEST TEMP (F): 400
OPERATOR: BJV

PROPERTY	ENERGY, FT-LBS		LOAD POUNDS	TIME MSEC
	UNCORRECTED	CORRECTED		
GENERAL YIELD	4.981653	4.955802	3123.4	.156
FLOW LOAD	10.96161	10.83645	3470.7	.262
MAXIMUM LOAD	21.35032	20.87549	3818	.4279999
FAST FRACTURE LOAD	55.04927	51.89258	-2.441406E-04968	
ARREST LOAD	55.04927	51.89258	-2.441406E-04968	
PROPAGATION LOAD	33.69895	31.01709	0	0
TOTAL ENERGY	55.04927	51.89258	0	0
SHEAR LIP ENERGY	0	0	0	0
TOTAL EVENT TIME	0	0	0	1.968

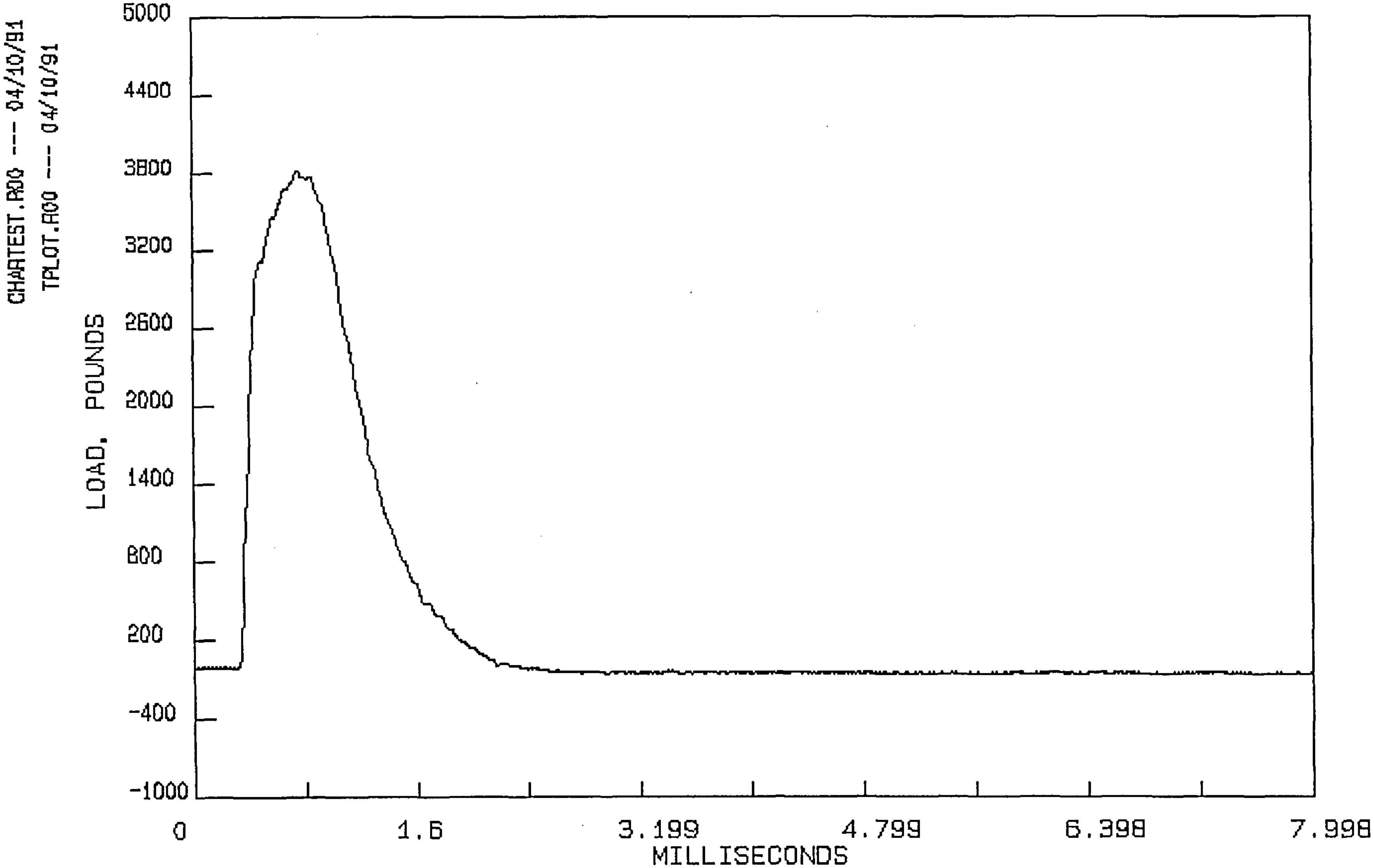
DYNAMIC YIELD STRENGTH (KSI) = 90
DYNAMIC FLOW STRENGTH (KSI) = 100
DIAL ENERGY READING (FT-LBS) = 55

TEST VIOLATIONS

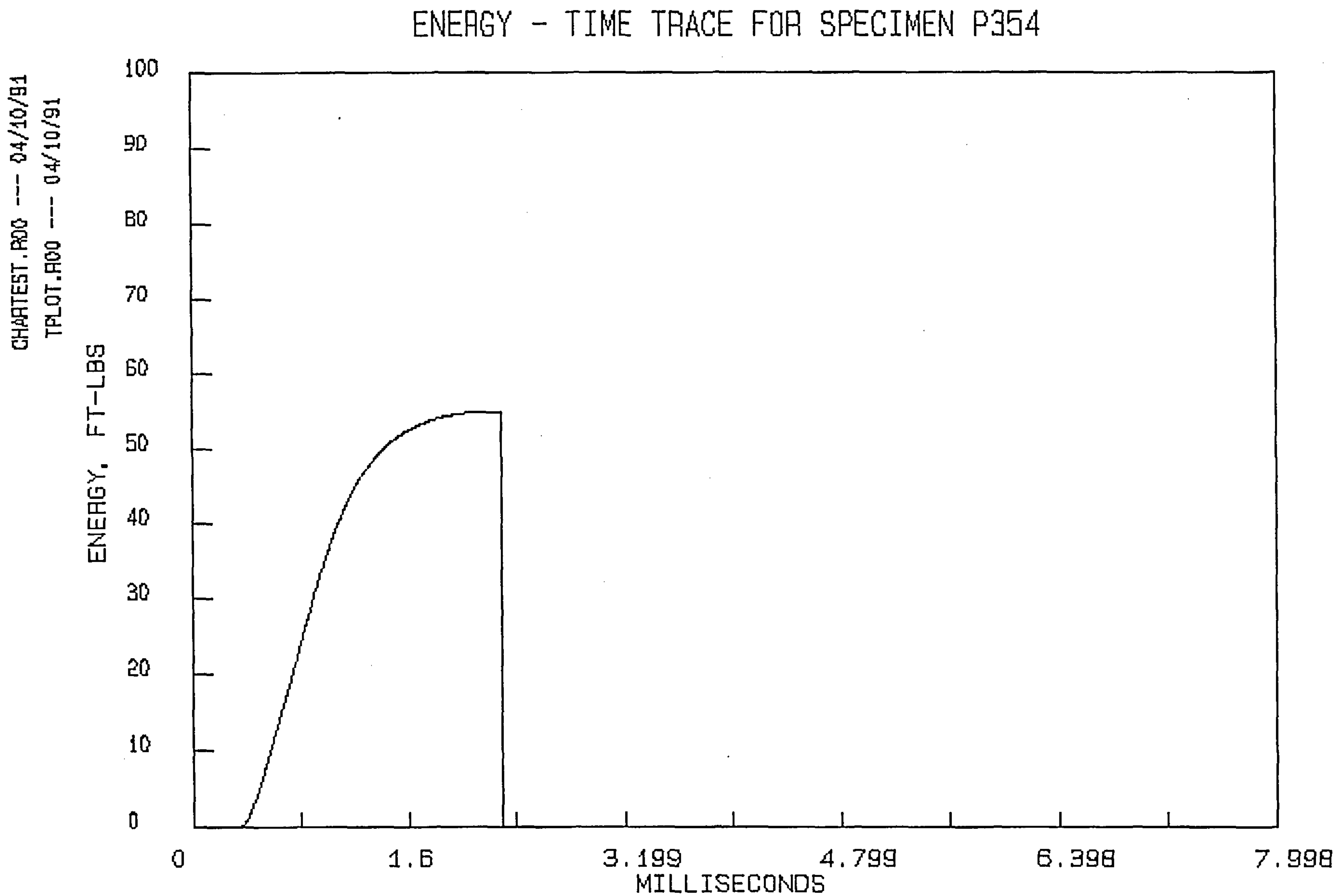
********* NO VIOLATIONS *********

PROJ. NO. 1295-001-03-08   QA NO. 99001

LOAD - TIME TRACE FOR SPECIMEN P354



PROJ. NO. 1295-001-03-08   QA NO. 99001



CHARTEST.R00 --- 04/10/91
ANALYZE.R00 --- 04/10/91

INSTRUMENTED IMPACT TEST RESULTS

ANALYSIS DATE: 12/08/2003
MATERIAL: HAZ
INITIAL HAMMER ENERGY, FT-LBS: 240
INITIAL HAMMER VELOCITY, FT/SEC: 17
LOAD CALIBRATION, LBS/VOLT: 1150
SPECIMEN WIDTH, INCH: .394
NOTCH DEPTH, INCH: 7.900001E-02
RESPONSE TIME, MSEC: .0519
TECHNICAL PROCEDURE(S): TP-80 TP-412

ANALYSIS BY: BJV
TEST DATE: 11/06/2003
SPEC. ID: P414
PROJ. NO.: 1295-001-03-08
QA NO.: 99001
TEST TEMP (F): -50
OPERATOR: BJV

PROPERTY	ENERGY, FT-LBS		LOAD POUNDS	TIME MSEC
	UNCORRECTED	CORRECTED		
GENERAL YIELD	3.747657	3.733027	3868.6	.124
FLOW LOAD	3.747657	3.733027	3868.6	.124
MAXIMUM LOAD	3.747657	3.733027	3868.6	.124
FAST FRACTURE LOAD	3.747657	3.733027	3868.6	.124
ARREST LOAD	5.471654	5.440467	-39.10034	.172
PROPAGATION LOAD	1.724662	1.708098	3907.7	0
TOTAL ENERGY	5.472319	5.441125	0	0
SHEAR LIP ENERGY	1.724662	1.708098	0	0
TOTAL EVENT TIME	0	0	0	.172

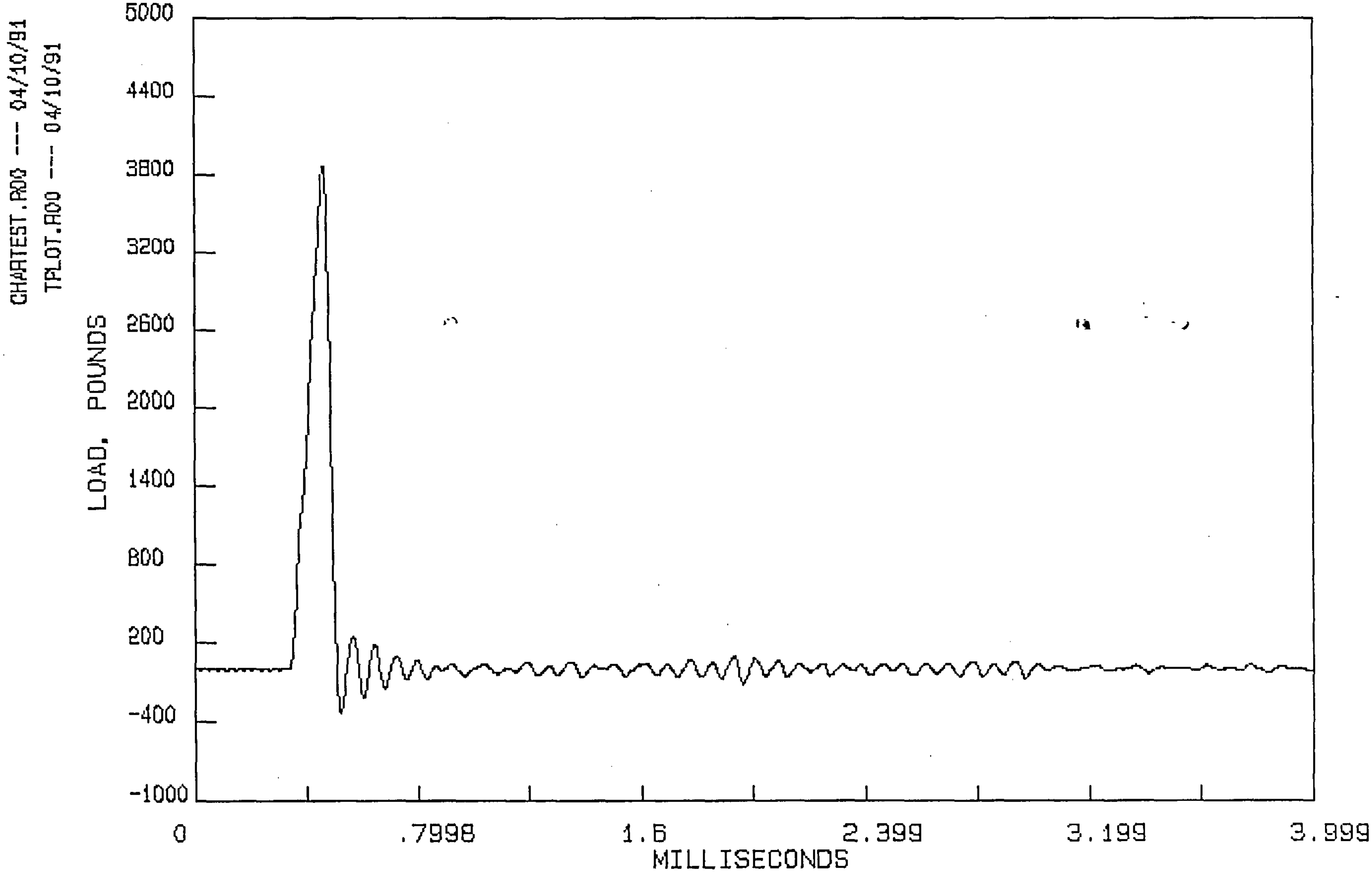
DYNAMIC YIELD STRENGTH (KSI) = 111
DYNAMIC FLOW STRENGTH (KSI) = 111
DIAL ENERGY READING (FT-LBS) = 4.5

TEST VIOLATIONS

********* NO VIOLATIONS *********

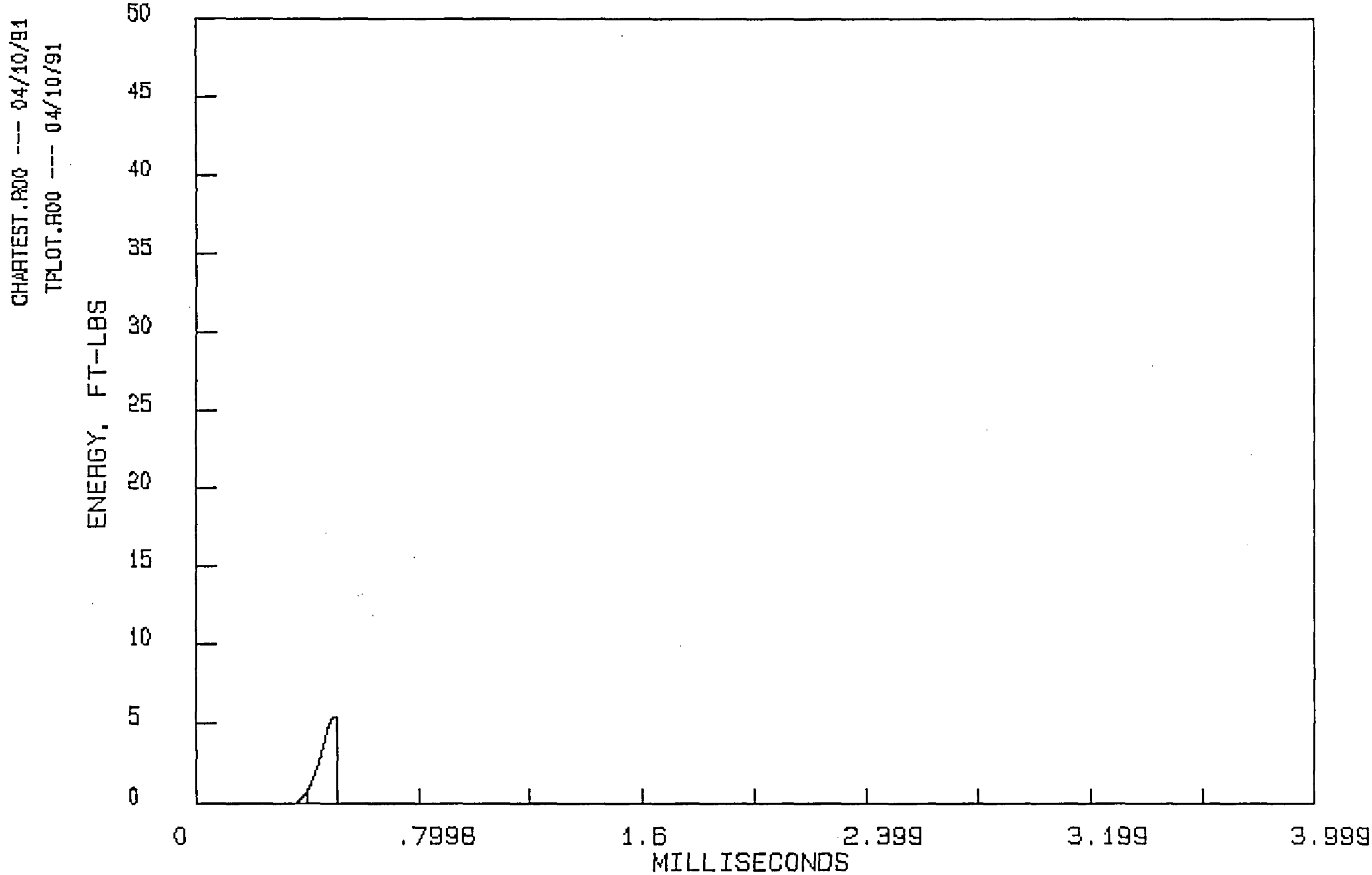
PROJ. NO. 1295-001-03-08 QA NO. 99001

LOAD - TIME TRACE FOR SPECIMEN P414



PROJ. NO. 1295-001-03-08   QA NO. 99001

ENERGY - TIME TRACE FOR SPECIMEN P414



CHARTEST.R00 --- 04/10/91
ANALYZE.R00 --- 04/10/91

INSTRUMENTED IMPACT TEST RESULTS

ANALYSIS DATE: 12/08/2003
MATERIAL: HAZ
INITIAL HAMMER ENERGY, FT-LBS: 240
INITIAL HAMMER VELOCITY, FT/SEC: 17
LOAD CALIBRATION, LBS/VOLT: 1150
SPECIMEN WIDTH, INCH: .394
NOTCH DEPTH, INCH: 7.900001E-02
RESPONSE TIME, MSEC: .0519
TECHNICAL PROCEDURE(S): TP-80 TP-412

ANALYSIS BY: BJV
TEST DATE: 11/06/2003
SPEC. ID: P47L
PROJ. NO.: 1295-001-03-08
QA NO.: 99001
TEST TEMP (F): 0
OPERATOR: BJV

PROPERTY	ENERGY, FT-LBS		LOAD POUNDS	TIME MSEC
	UNCORRECTED	CORRECTED		
GENERAL YIELD	5.529953	5.498098	3882.4	.15
FLOW LOAD	5.529953	5.498098	3882.4	.15
MAXIMUM LOAD	5.529953	5.498098	3882.4	.15
FAST FRACTURE LOAD	7.433537	7.375977	3875.5	.179
ARREST LOAD	9.354909	9.263748	-34.50024	.232
PROPAGATION LOAD	3.825543	3.766226	3910	0
TOTAL ENERGY	9.355496	9.264324	0	0
SHEAR LIP ENERGY	1.921959	1.888347	0	0
TOTAL EVENT TIME	0	0	0	.232

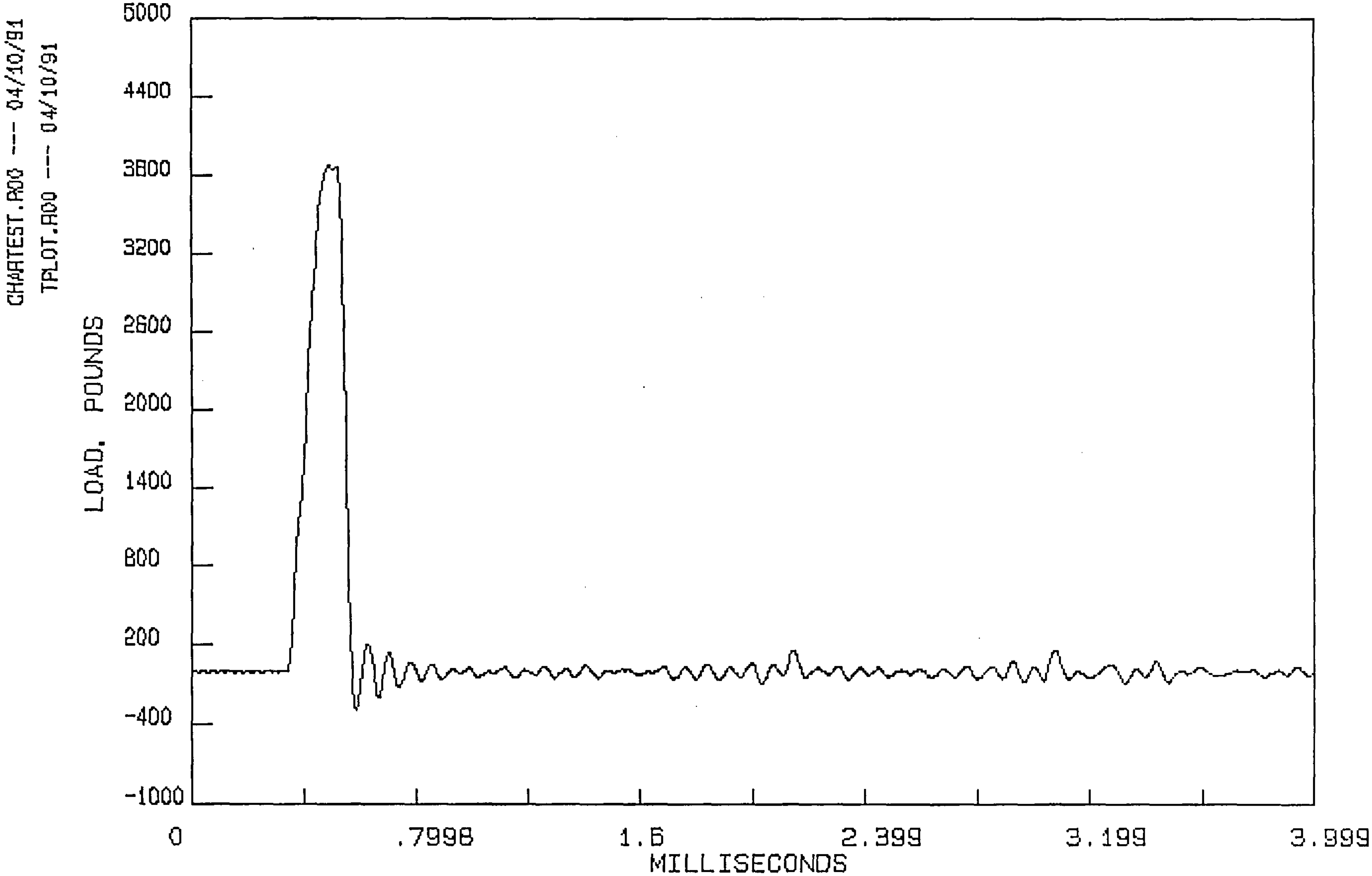
DYNAMIC YIELD STRENGTH (KSI) = 112
DYNAMIC FLOW STRENGTH (KSI) = 112
DIAL ENERGY READING (FT-LBS) = 10

TEST VIOLATIONS

********* NO VIOLATIONS *********

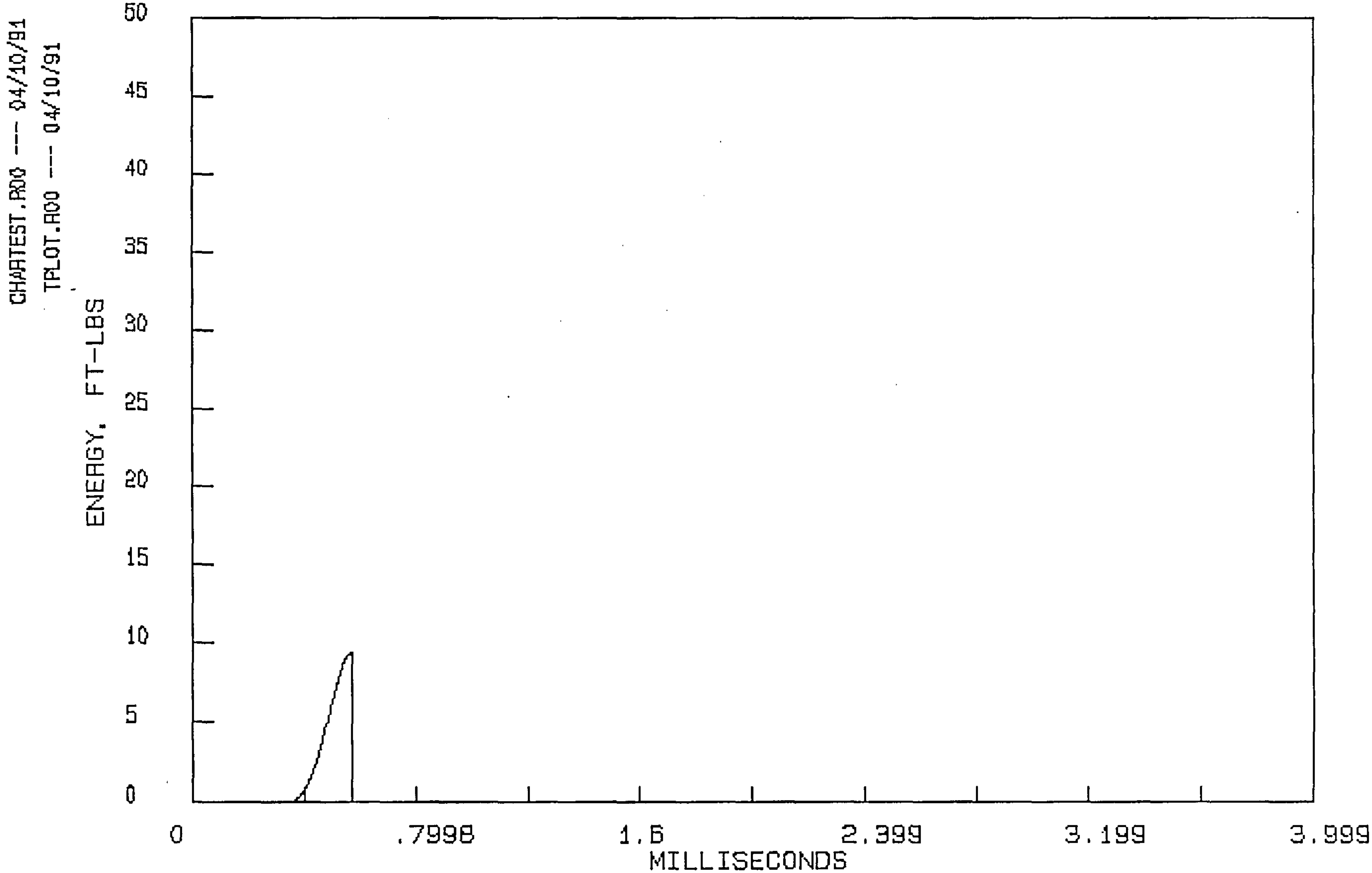
PROJ. NO. 1295-001-03-08 QA NO. 99001

LOAD - TIME TRACE FOR SPECIMEN P47L



PROJ. NO. 1295-001-03-08 QA NO. 99001

ENERGY - TIME TRACE FOR SPECIMEN P47L



CHARTEST.R00 --- 04/10/91
ANALYZE.R00 --- 04/10/91

INSTRUMENTED IMPACT TEST RESULTS

ANALYSIS DATE: 12/08/2003
MATERIAL: HAZ
INITIAL HAMMER ENERGY, FT-LBS: 240
INITIAL HAMMER VELOCITY, FT/SEC: 17
LOAD CALIBRATION, LBS/VOLT: 1150
SPECIMEN WIDTH, INCH: .394
NOTCH DEPTH, INCH: 7.900001E-02
RESPONSE TIME, MSEC: .0519
TECHNICAL PROCEDURE(S): TP-80 TP-412

ANALYSIS BY: BJV
TEST DATE: 11/05/2003
SPEC. ID: P431
PROJ. NO.: 1295-001-03-08
QA NO.: 99001
TEST TEMP (F): 0
OPERATOR: BJV

PROPERTY	ENERGY, FT-LBS UNCORRECTED	ENERGY, FT-LBS CORRECTED	LOAD POUNDS	TIME MSEC
GENERAL YIELD	4.970549	4.944813	3728.3	.147
FLOW LOAD	15.08549	14.84844	4076.75	.3009999
MAXIMUM LOAD	44.1907	42.15652	4425.2	.6989999
FAST FRACTURE LOAD	47.23894	44.91444	4317.1	.74
ARREST LOAD	49.86239	47.27254	-6.900391	.804
PROPAGATION LOAD	5.67181	5.116131	4324.001	0
TOTAL ENERGY	49.86251	47.27265	0	0
SHEAR LIP ENERGY	2.62357	2.358212	0	0
TOTAL EVENT TIME	0	0	0	.804

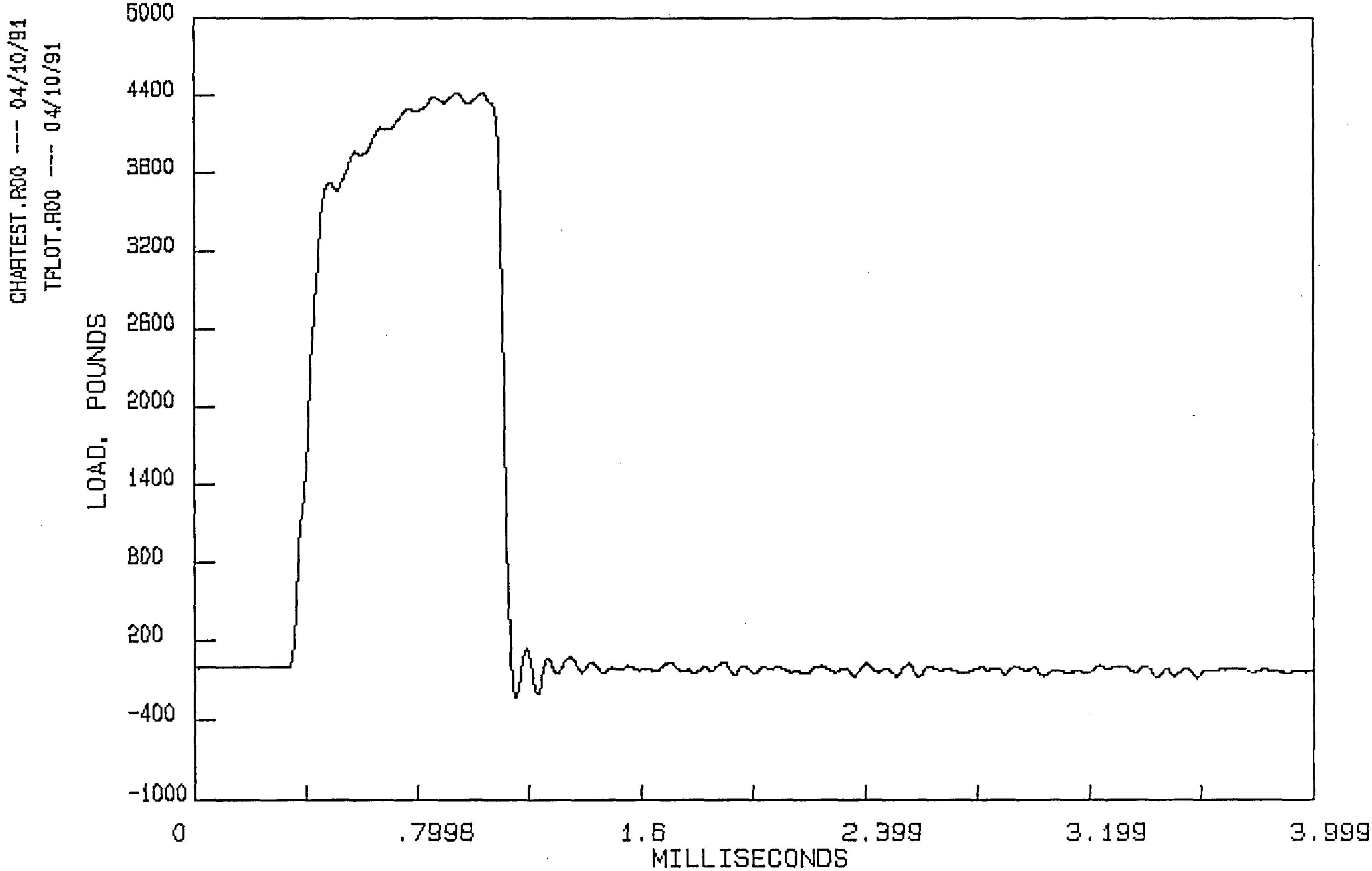
DYNAMIC YIELD STRENGTH (KSI) = 107
DYNAMIC FLOW STRENGTH (KSI) = 117
DIAL ENERGY READING (FT-LBS) = 49.5

TEST VIOLATIONS

********* NO VIOLATIONS *********

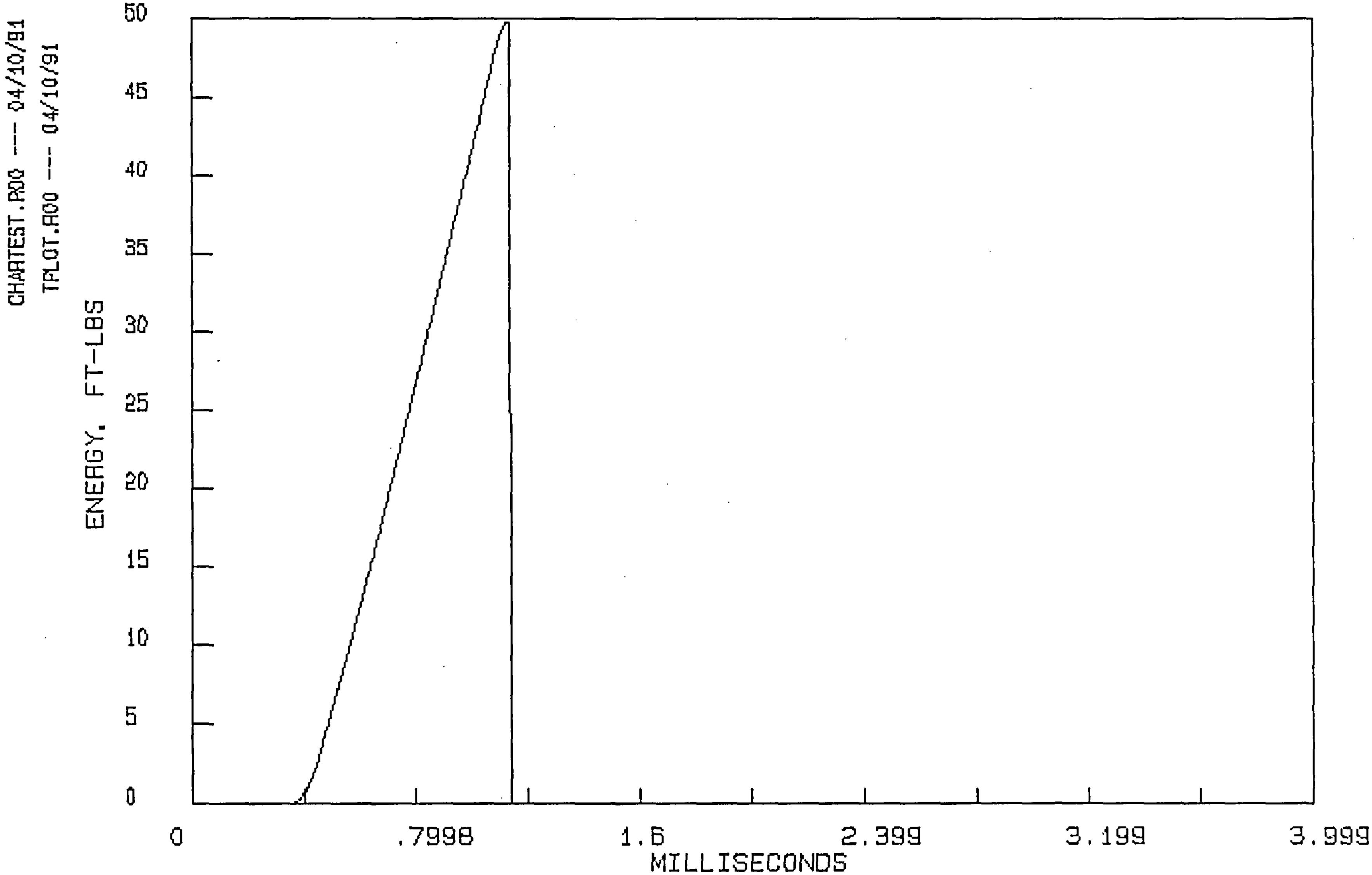
PROJ. NO. 1295-001-03-08   QA NO. 99001

LOAD - TIME TRACE FOR SPECIMEN P431



PROJ. NO. 1295-001-03-08 QA NO. 99001

ENERGY - TIME TRACE FOR SPECIMEN P431



CHARTEST.R00 --- 04/10/91
ANALYZE.R00 --- 04/10/91

INSTRUMENTED IMPACT TEST RESULTS

ANALYSIS DATE: 12/08/2003
MATERIAL: HAZ
INITIAL HAMMER ENERGY, FT-LBS: 240
INITIAL HAMMER VELOCITY, FT/SEC: 17
LOAD CALIBRATION, LBS/VOLT: 1150
SPECIMEN WIDTH, INCH: .394
NOTCH DEPTH, INCH: 7.900001E-02
RESPONSE TIME, MSEC: .0519
TECHNICAL PROCEDURE(S): TP-80 TP-412

ANALYSIS BY: BJV
TEST DATE: 11/10/2003
SPEC. ID: P411
PROJ. NO.: 1295-001-03-08
QA NO.: 99001
TEST TEMP (F): 40
OPERATOR: BJV

PROPERTY	ENERGY, FT-LBS UNCORRECTED	ENERGY, FT-LBS CORRECTED	LOAD POUNDS	TIME MSEC
GENERAL YIELD	5.370657	5.340611	3838.7	.153
FLOW LOAD	6.540568	6.496007	3844.45	.171
MAXIMUM LOAD	7.582505	7.522615	3850.2	.1869999
FAST FRACTURE LOAD	7.582505	7.522615	3850.2	.1869999
ARREST LOAD	9.614332	9.518045	-4.600342	.2469999
PROPAGATION LOAD	2.031905	1.995507	3854.8	0
TOTAL ENERGY	9.61441	9.518122	0	0
SHEAR LIP ENERGY	2.031905	1.995507	0	0
TOTAL EVENT TIME	0	0	0	.2469999

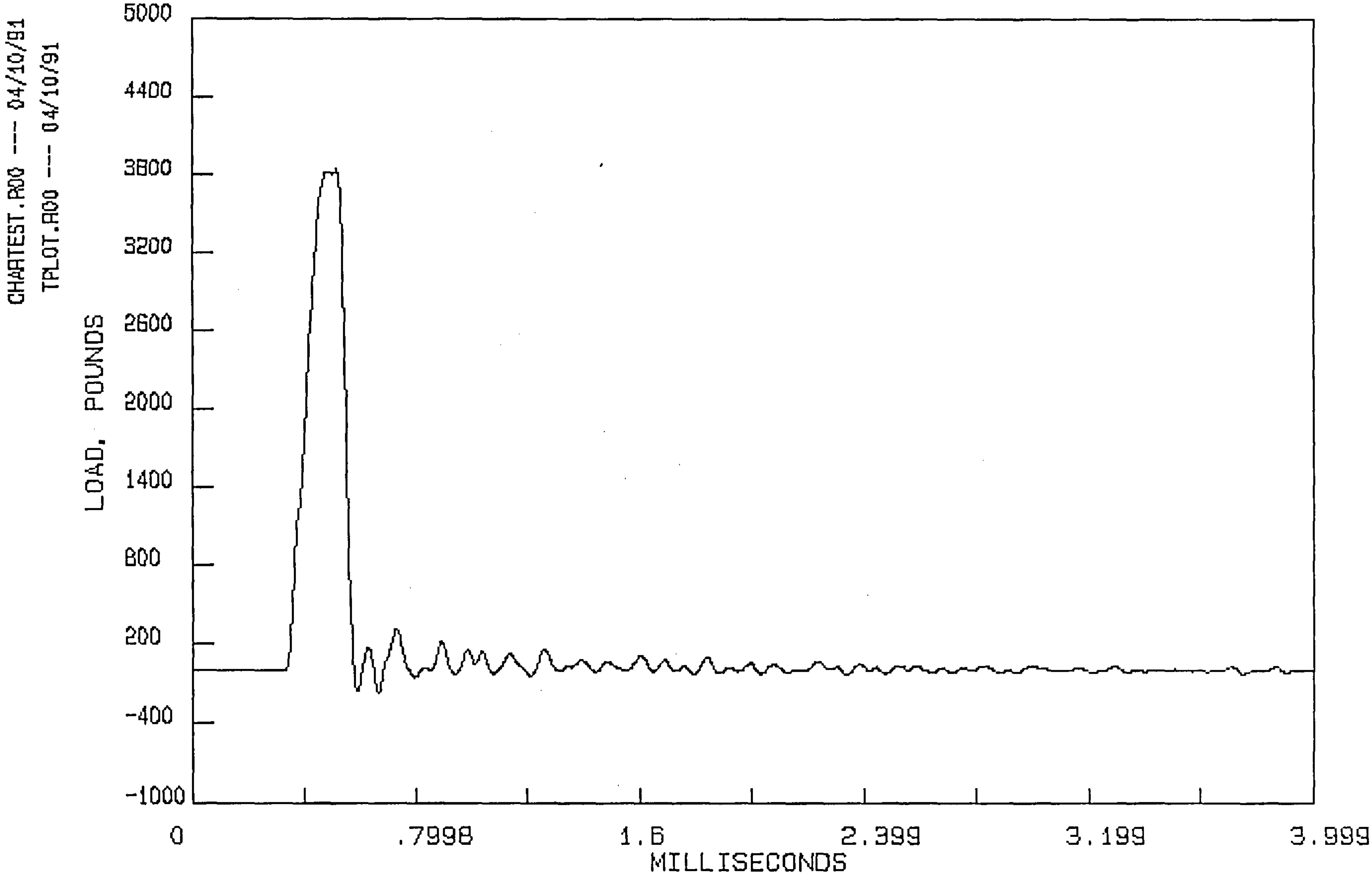
DYNAMIC YIELD STRENGTH (KSI) = 110
DYNAMIC FLOW STRENGTH (KSI) = 110
DIAL ENERGY READING (FT-LBS) = 12

TEST VIOLATIONS

********* NO VIOLATIONS *********

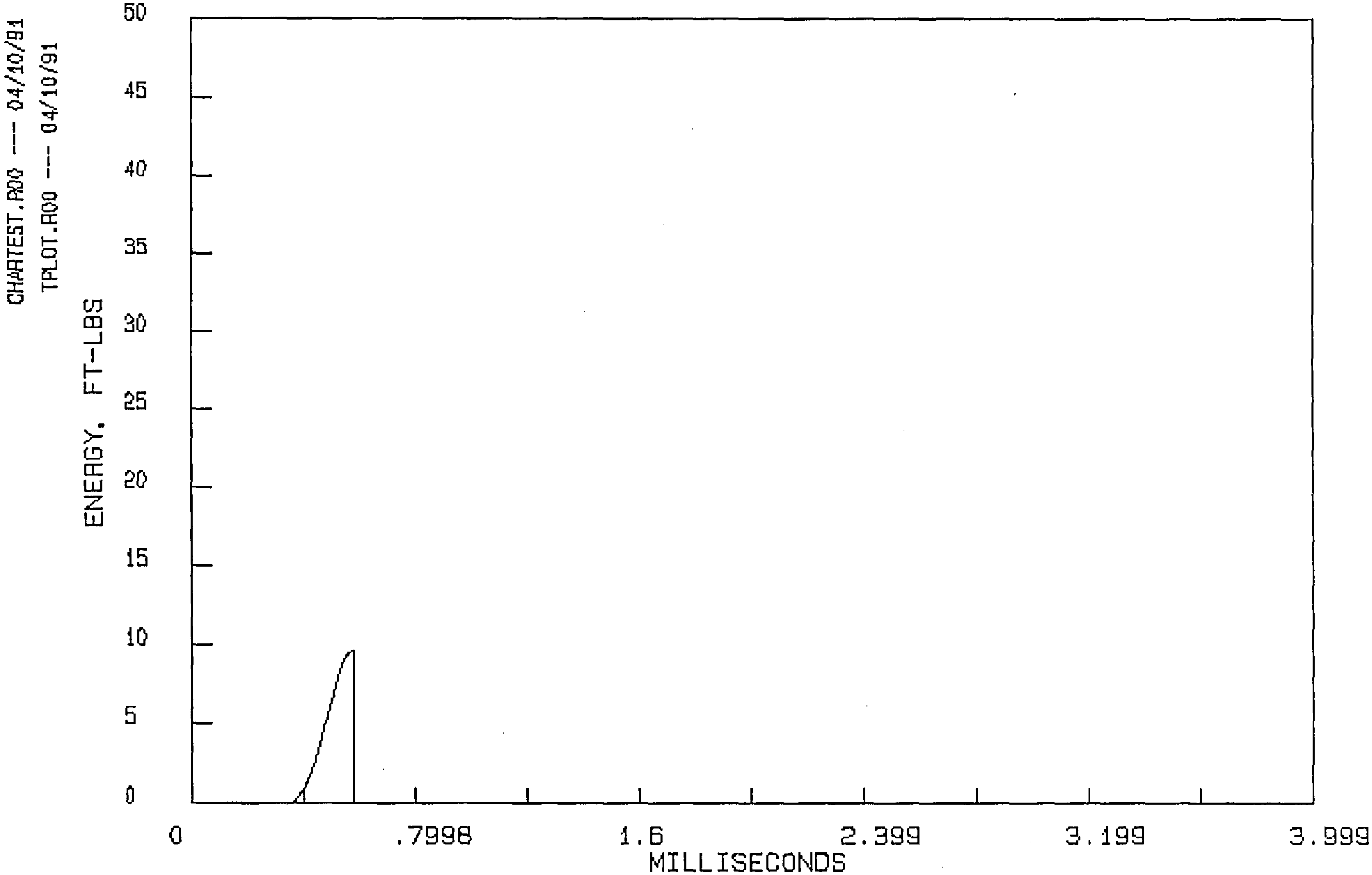
PROJ. NO. 1295-001-03-08   QA NO. 99001

LOAD - TIME TRACE FOR SPECIMEN P411



PROJ. NO. 1295-001-03-08 QA NO. 99001

ENERGY - TIME TRACE FOR SPECIMEN P411



INSTRUMENTED IMPACT TEST RESULTS

ANALYSIS DATE: 12/08/2003
MATERIAL: HAZ
INITIAL HAMMER ENERGY, FT-LBS: 240
INITIAL HAMMER VELOCITY, FT/SEC: 17
LOAD CALIBRATION, LBS/VOLT: 1150
SPECIMEN WIDTH, INCH: .394
NOTCH DEPTH, INCH: 7.900001E-02
RESPONSE TIME, MSEC: .0519
TECHNICAL PROCEDURE(S): TP-80 TP-412

ANALYSIS BY: BJV
TEST DATE: 11/05/2003
SPEC. ID: P416
PROJ. NO.: 1295-001-03-08
QA NO.: 99001
TEST TEMP (F): 70
OPERATOR: BJV

PROPERTY	ENERGY, FT-LBS		LOAD POUNDS	TIME MSEC
	UNCORRECTED	CORRECTED		
GENERAL YIELD	5.348061	5.318268	3783.5	.153
FLOW LOAD	9.106588	9.020203	3951.4	.211
MAXIMUM LOAD	11.03926	10.91232	4119.3	.239
FAST FRACTURE LOAD	11.3191	11.18564	4110.1	.2429999
ARREST LOAD	15.26285	15.02019	1462.8	.3559999
PROPAGATION LOAD	8.47803	8.208169	2647.3	0
TOTAL ENERGY	19.51729	19.12049	0	0
SHEAR LIP ENERGY	8.19819	7.934849	0	0
TOTAL EVENT TIME	0	0	0	.88

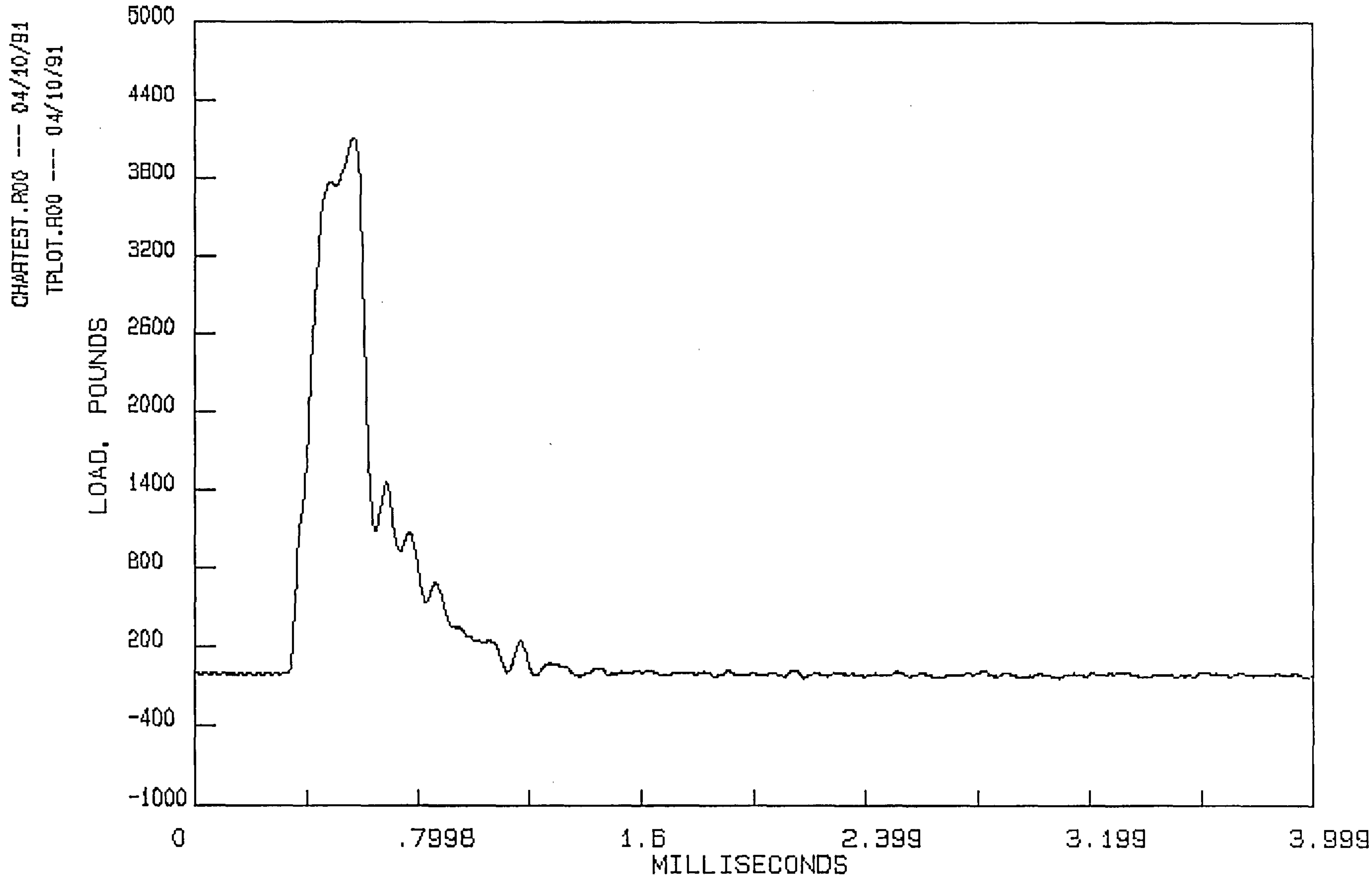
DYNAMIC YIELD STRENGTH (KSI) = 109
DYNAMIC FLOW STRENGTH (KSI) = 113
DIAL ENERGY READING (FT-LBS) = 21

TEST VIOLATIONS

********* NO VIOLATIONS *********

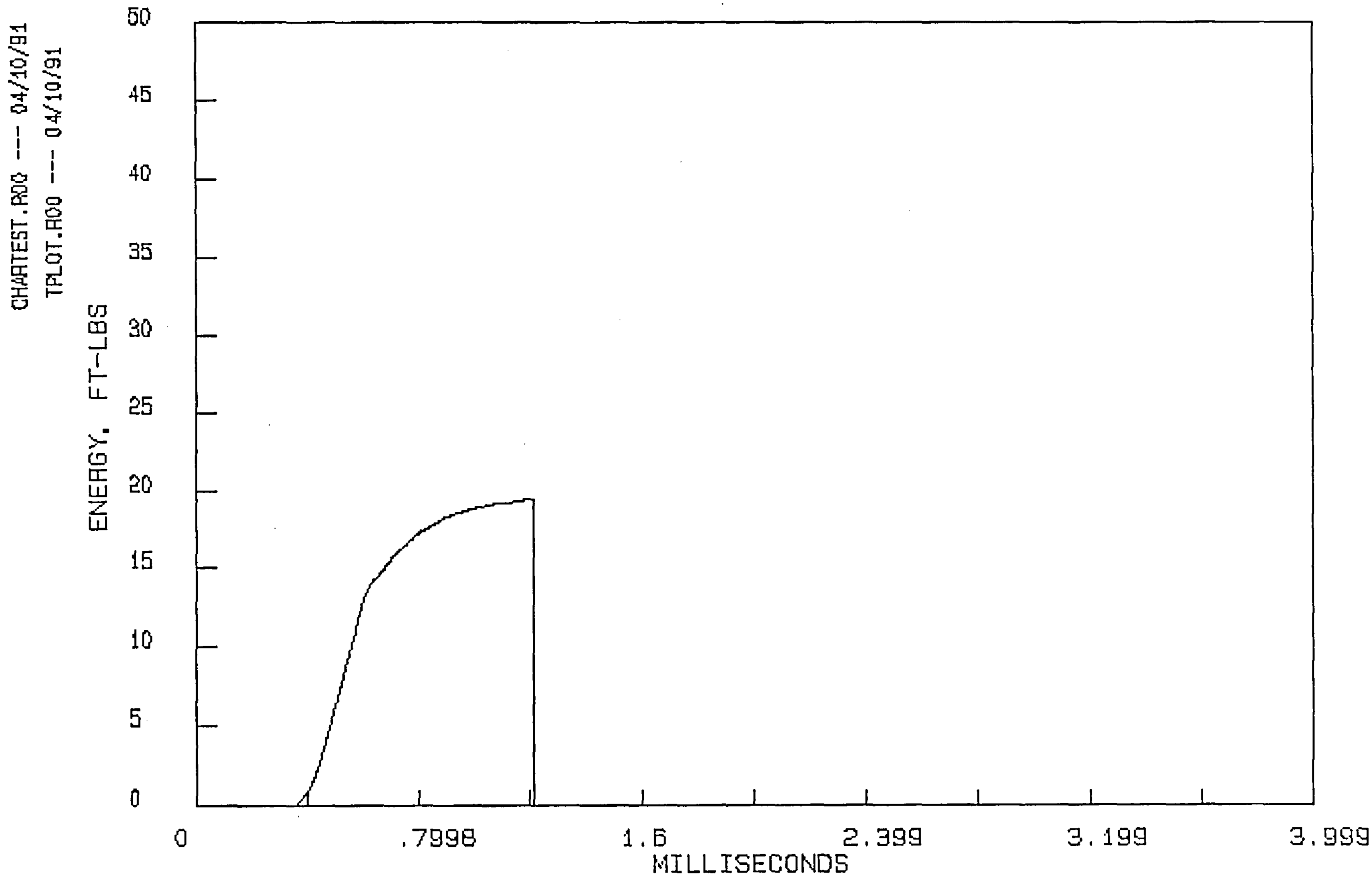
PROJ. NO. 1295-001-03-08 QA NO. 99001

LOAD - TIME TRACE FOR SPECIMEN P416



PROJ. NO. 1295-001-03-08 QA NO. 99001

ENERGY - TIME TRACE FOR SPECIMEN P416



CHARTEST.R00 --- 04/10/91
ANALYZE.R00 --- 04/10/91

INSTRUMENTED IMPACT TEST RESULTS

ANALYSIS DATE: 12/08/2003
MATERIAL: HAZ
INITIAL HAMMER ENERGY, FT-LBS: 240
INITIAL HAMMER VELOCITY, FT/SEC: 17
LOAD CALIBRATION, LBS/VOLT: 1150
SPECIMEN WIDTH, INCH: .394
NOTCH DEPTH, INCH: 7.900001E-02
RESPONSE TIME, MSEC: .0519
TECHNICAL PROCEDURE(S): TP-80 TP-412

ANALYSIS BY: BJV
TEST DATE: 11/05/2003
SPEC. ID: P47M
PROJ. NO.: 1295-001-03-08
QA NO.: 99001
TEST TEMP (F): 150
OPERATOR: BJV

PROPERTY	ENERGY, FT-LBS UNCORRECTED	ENERGY, FT-LBS CORRECTED	LOAD POUNDS	TIME MSEC
GENERAL YIELD	5.202177	5.173987	3397.1	.156
FLOW LOAD	11.72906	11.58576	3815.7	.262
MAXIMUM LOAD	29.78624	28.86205	4234.3	.522
FAST FRACTURE LOAD	32.4814	31.3824	4114.7	.56
ARREST LOAD	37.34967	35.89655	1826.2	.678
PROPAGATION LOAD	12.08301	11.18113	2288.5	0
TOTAL ENERGY	41.86925	40.04318	0	0
SHEAR LIP ENERGY	9.387852	8.660778	0	0
TOTAL EVENT TIME	0	0	0	1.482

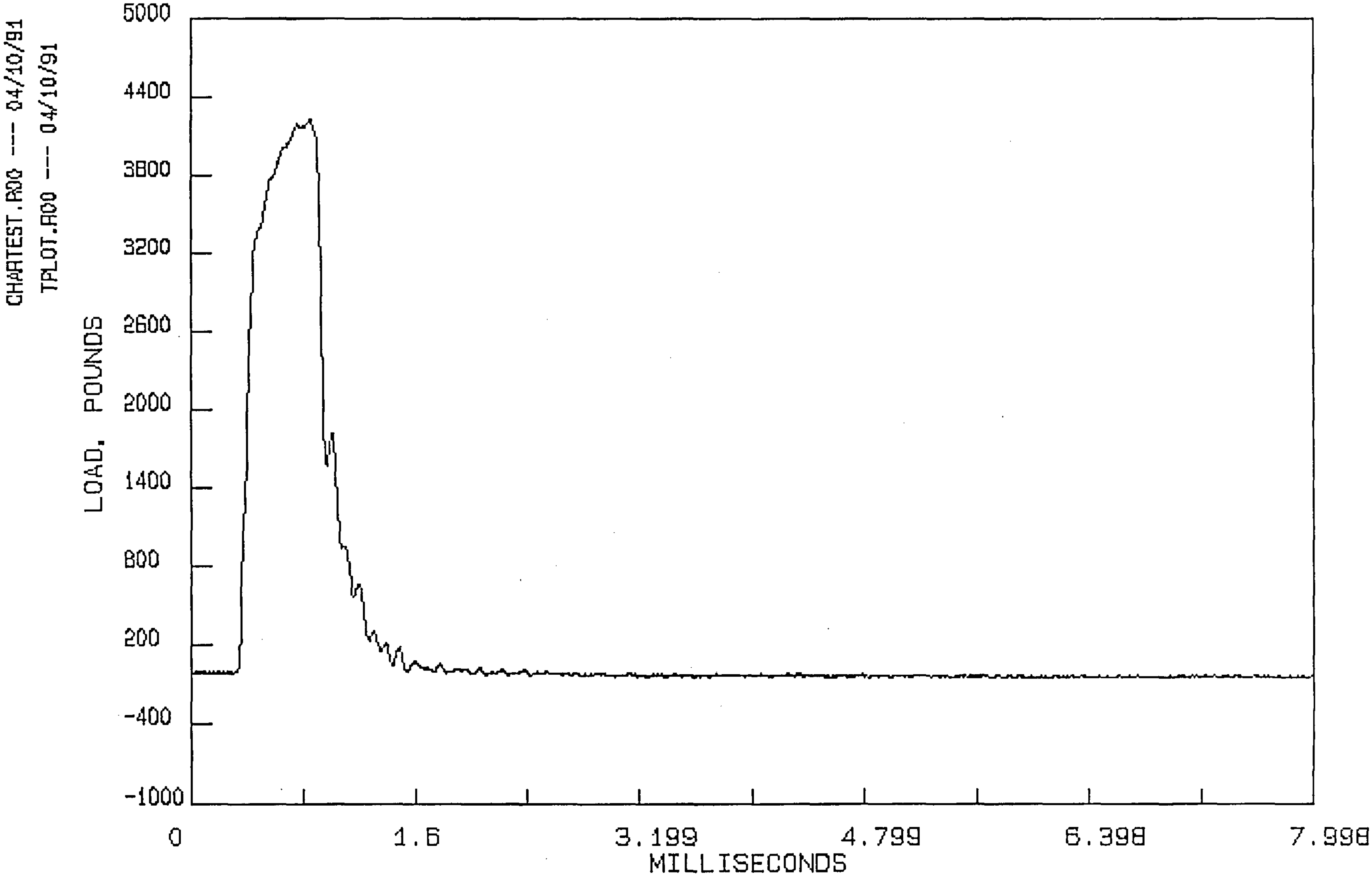
DYNAMIC YIELD STRENGTH (KSI) = 98
DYNAMIC FLOW STRENGTH (KSI) = 110
DIAL ENERGY READING (FT-LBS) = 42.5

TEST VIOLATIONS

********* NO VIOLATIONS *********

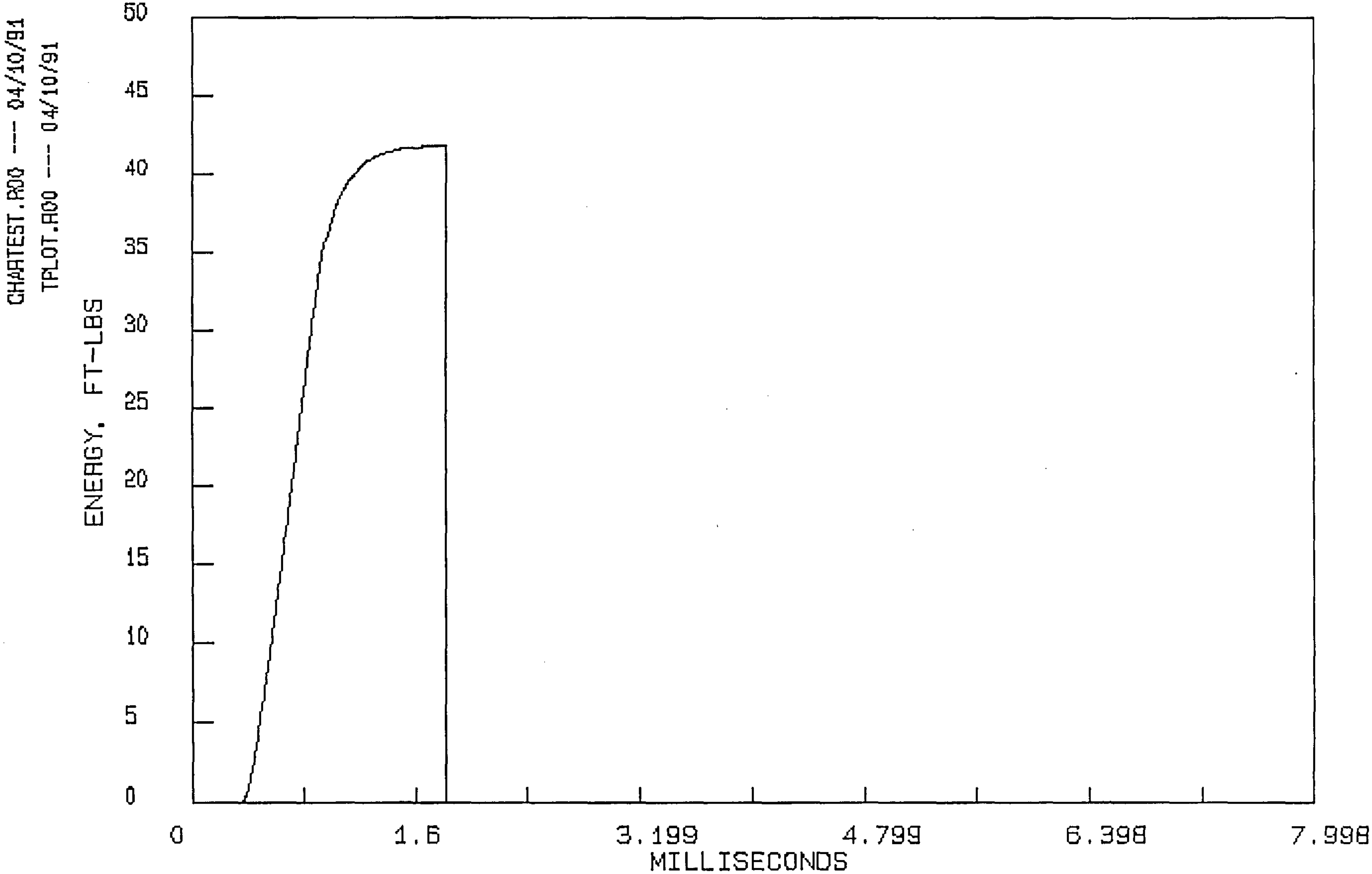
PROJ. NO. 1295-001-03-08 QA NO. 99001

LOAD - TIME TRACE FOR SPECIMEN P47M



PROJ. NO. 1295-001-03-08 QA NO. 99001

ENERGY - TIME TRACE FOR SPECIMEN P47M



CHARTEST.R00 --- 04/10/91
ANALYZE.R00 --- 04/10/91

INSTRUMENTED IMPACT TEST RESULTS

ANALYSIS DATE: 12/08/2003
MATERIAL: HAZ
INITIAL HAMMER ENERGY, FT-LBS: 240
INITIAL HAMMER VELOCITY, FT/SEC: 17
LOAD CALIBRATION, LBS/VOLT: 1150
SPECIMEN WIDTH, INCH: .394
NOTCH DEPTH, INCH: 7.900001E-02
RESPONSE TIME, MSEC: .0519
TECHNICAL PROCEDURE(S): TP-80 TP-412

ANALYSIS BY: BJV
TEST DATE: 11/05/2003
SPEC. ID: P47P
PROJ. NO.: 1295-001-03-08
QA NO.: 99001
TEST TEMP (F): 200
OPERATOR: BJV

PROPERTY	ENERGY, FT-LBS		LOAD POUNDS	TIME MSEC
	UNCORRECTED	CORRECTED		
GENERAL YIELD	5.158932	5.131209	3293.6	.1560001
FLOW LOAD	12.65284	12.48607	3770.85	.28
MAXIMUM LOAD	29.45473	28.551	4248.1	.5240001
FAST FRACTURE LOAD	47.34354	45.00874	3912.3	.7780001
ARREST LOAD	51.7448	48.95571	1957.3	.872
PROPAGATION LOAD	36.09039	32.51895	1955	0
TOTAL ENERGY	65.54511	61.06995	0	0
SHEAR LIP ENERGY	18.20157	16.06121	0	0
TOTAL EVENT TIME	0	0	0	2.914

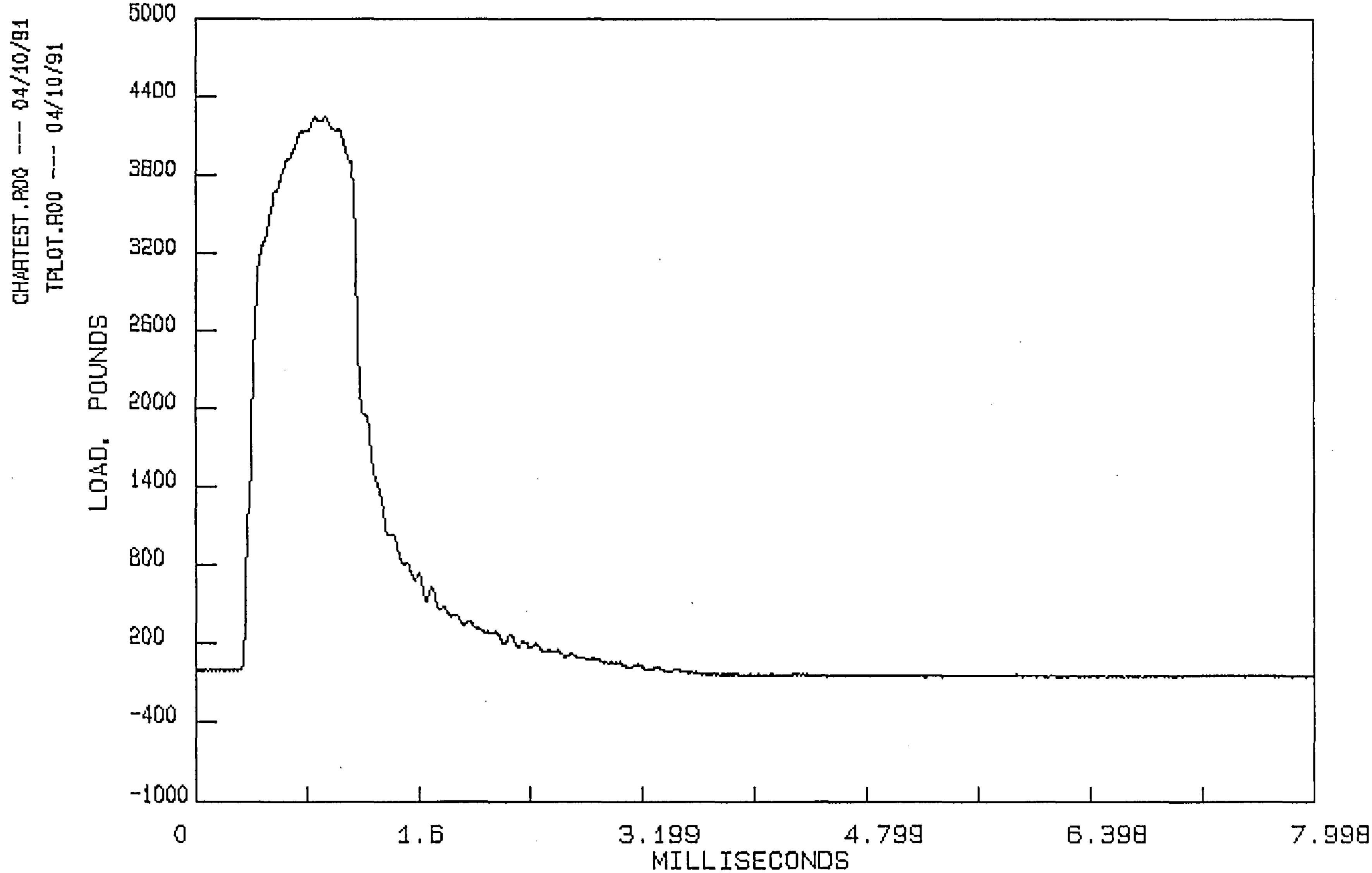
DYNAMIC YIELD STRENGTH (KSI) = 95
DYNAMIC FLOW STRENGTH (KSI) = 108
DIAL ENERGY READING (FT-LBS) = 65

TEST VIOLATIONS

********* NO VIOLATIONS *********

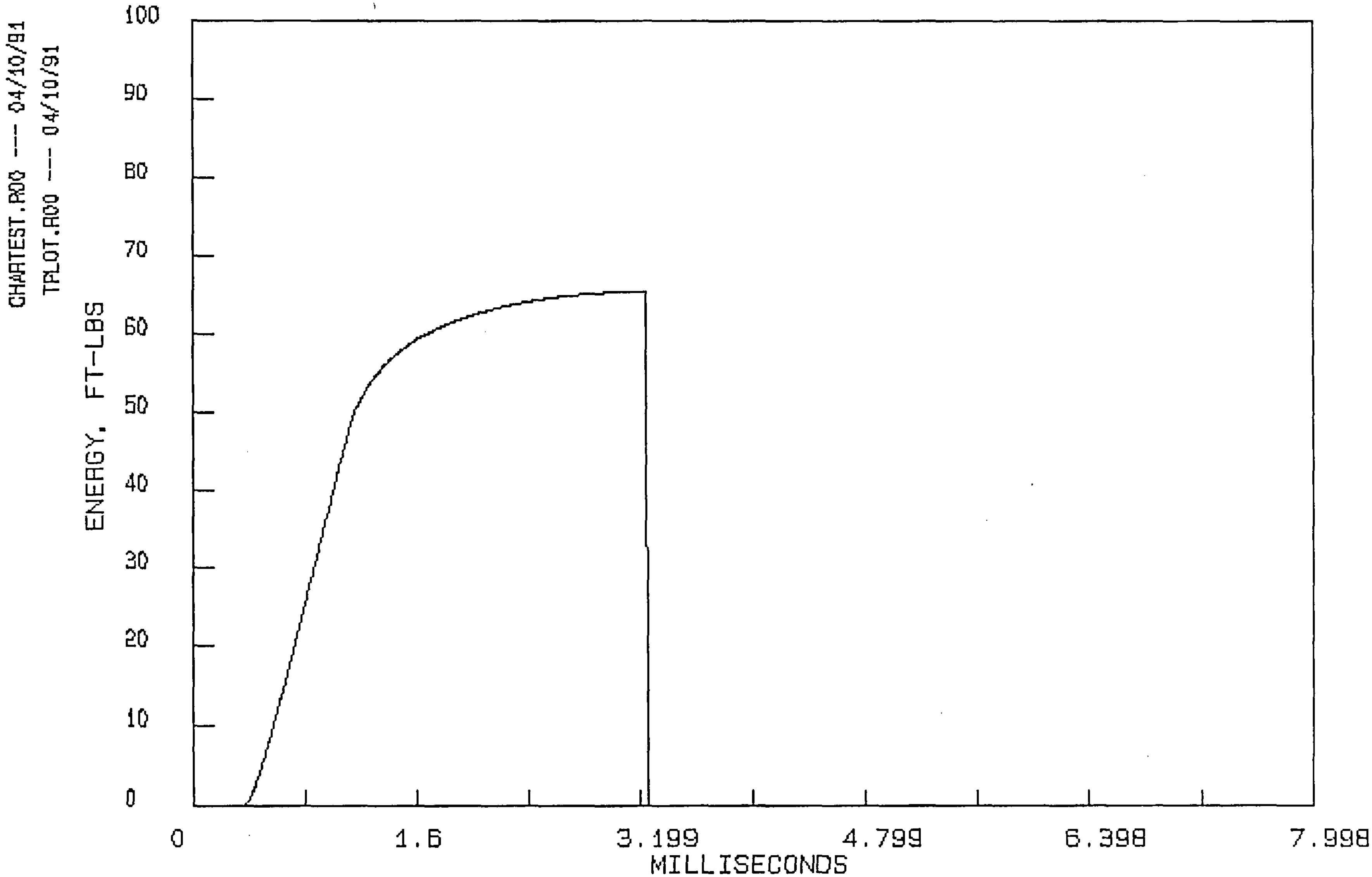
PROJ. NO. 1295-001-03-08 QA NO. 99001

LOAD - TIME TRACE FOR SPECIMEN P47P



PROJ. NO. 1295-001-03-08 QA NO. 99001

ENERGY - TIME TRACE FOR SPECIMEN P47P



CHARTEST.R00 --- 04/10/91
ANALYZE.R00 --- 04/10/91

INSTRUMENTED IMPACT TEST RESULTS

ANALYSIS DATE: 12/08/2003
MATERIAL: HAZ
INITIAL HAMMER ENERGY, FT-LBS: 240
INITIAL HAMMER VELOCITY, FT/SEC: 17
LOAD CALIBRATION, LBS/VOLT: 1150
SPECIMEN WIDTH, INCH: .394
NOTCH DEPTH, INCH: 7.900001E-02
RESPONSE TIME, MSEC: .0519
TECHNICAL PROCEDURE(S): TP-80 TP-412

ANALYSIS BY: BJV
TEST DATE: 11/06/2003
SPEC. ID: P415
PROJ. NO.: 1295-001-03-08
QA NO.: 99001
TEST TEMP (F): 225
OPERATOR: BJV

PROPERTY	ENERGY, FT-LBS		LOAD POUNDS	TIME MSEC
	UNCORRECTED	CORRECTED		
GENERAL YIELD	5.262	5.233158	3353.4	.158
FLOW LOAD	9.280071	9.190363	3627.1	.2259999
MAXIMUM LOAD	21.03384	20.57298	3900.8	.4079999
FAST FRACTURE LOAD	21.43125	20.95281	3893.9	.414
ARREST LOAD	27.02012	26.25961	2697.9	.524
PROPAGATION LOAD	20.81152	19.44839	1196	0
TOTAL ENERGY	41.84536	40.02137	0	0
SHEAR LIP ENERGY	20.41411	19.06856	0	0
TOTAL EVENT TIME	0	0	0	2.22

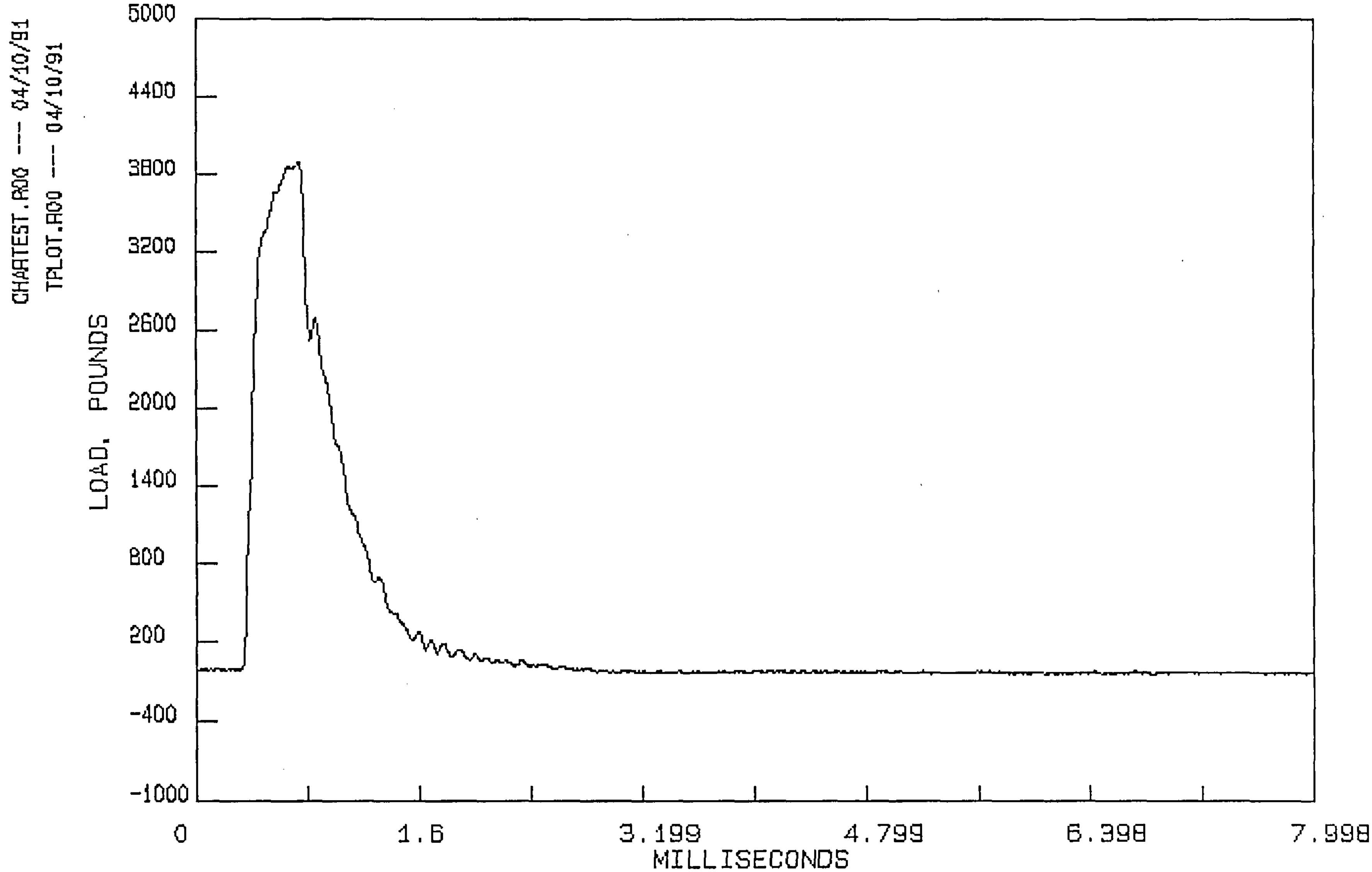
DYNAMIC YIELD STRENGTH (KSI) = 96
DYNAMIC FLOW STRENGTH (KSI) = 104
DIAL ENERGY READING (FT-LBS) = 42.5

TEST VIOLATIONS

********* NO VIOLATIONS *********

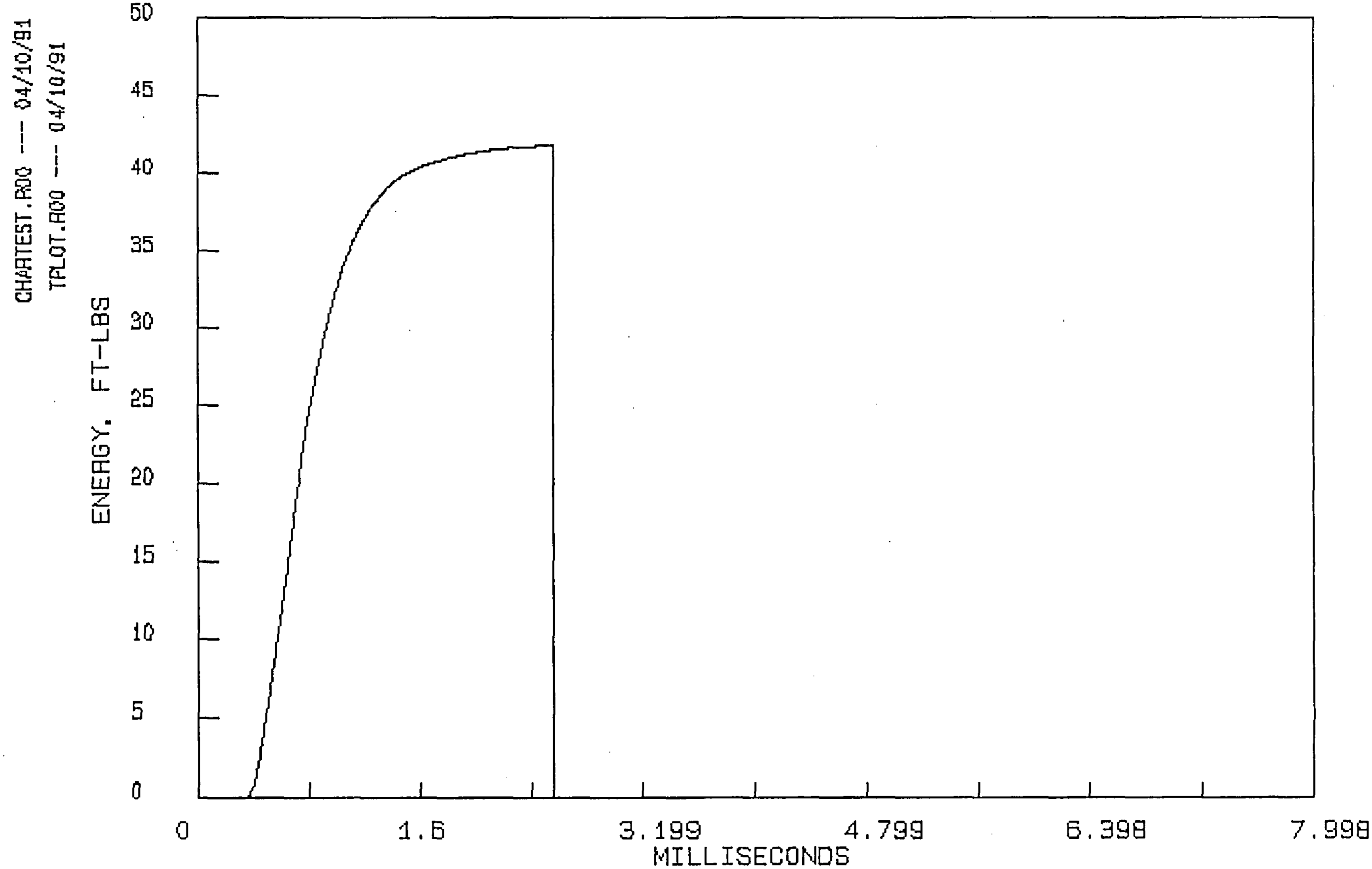
PROJ. NO. 1295-001-03-08 QA NO. 99001

LOAD - TIME TRACE FOR SPECIMEN P415



PROJ. NO. 1295-001-03-08 QA NO. 99001

ENERGY - TIME TRACE FOR SPECIMEN P415



CHARTEST.R00 --- 04/10/91
ANALYZE.R00 --- 04/10/91

INSTRUMENTED IMPACT TEST RESULTS

ANALYSIS DATE: 12/08/2003
MATERIAL: HAZ
INITIAL HAMMER ENERGY, FT-LBS: 240
INITIAL HAMMER VELOCITY, FT/SEC: 17
LOAD CALIBRATION, LBS/VOLT: 1150
SPECIMEN WIDTH, INCH: .394
NOTCH DEPTH, INCH: 7.900001E-02
RESPONSE TIME, MSEC: .0519
TECHNICAL PROCEDURE(S): TP-80 TP-412

ANALYSIS BY: BJV
TEST DATE: 11/10/2003
SPEC. ID: P412
PROJ. NO.: 1295-001-03-08
QA NO.: 99001
TEST TEMP (F): 225
OPERATOR: BJV

PROPERTY	ENERGY, FT-LBS		LOAD POUNDS	TIME MSEC
	UNCORRECTED	CORRECTED		
GENERAL YIELD	5.534526	5.502619	3353.4	.1679999
FLOW LOAD	9.705401	9.607282	3701.85	.238
MAXIMUM LOAD	22.87545	22.33036	4050.3	.4359999
FAST FRACTURE LOAD	30.19771	29.24781	3910	.544
ARREST LOAD	36.4269	35.04469	2550.7	.658
PROPAGATION LOAD	30.6254	28.18889	1359.3	0
TOTAL ENERGY	53.50085	50.51925	0	0
SHEAR LIP ENERGY	23.30314	21.27144	0	0
TOTAL EVENT TIME	0	0	0	2.632

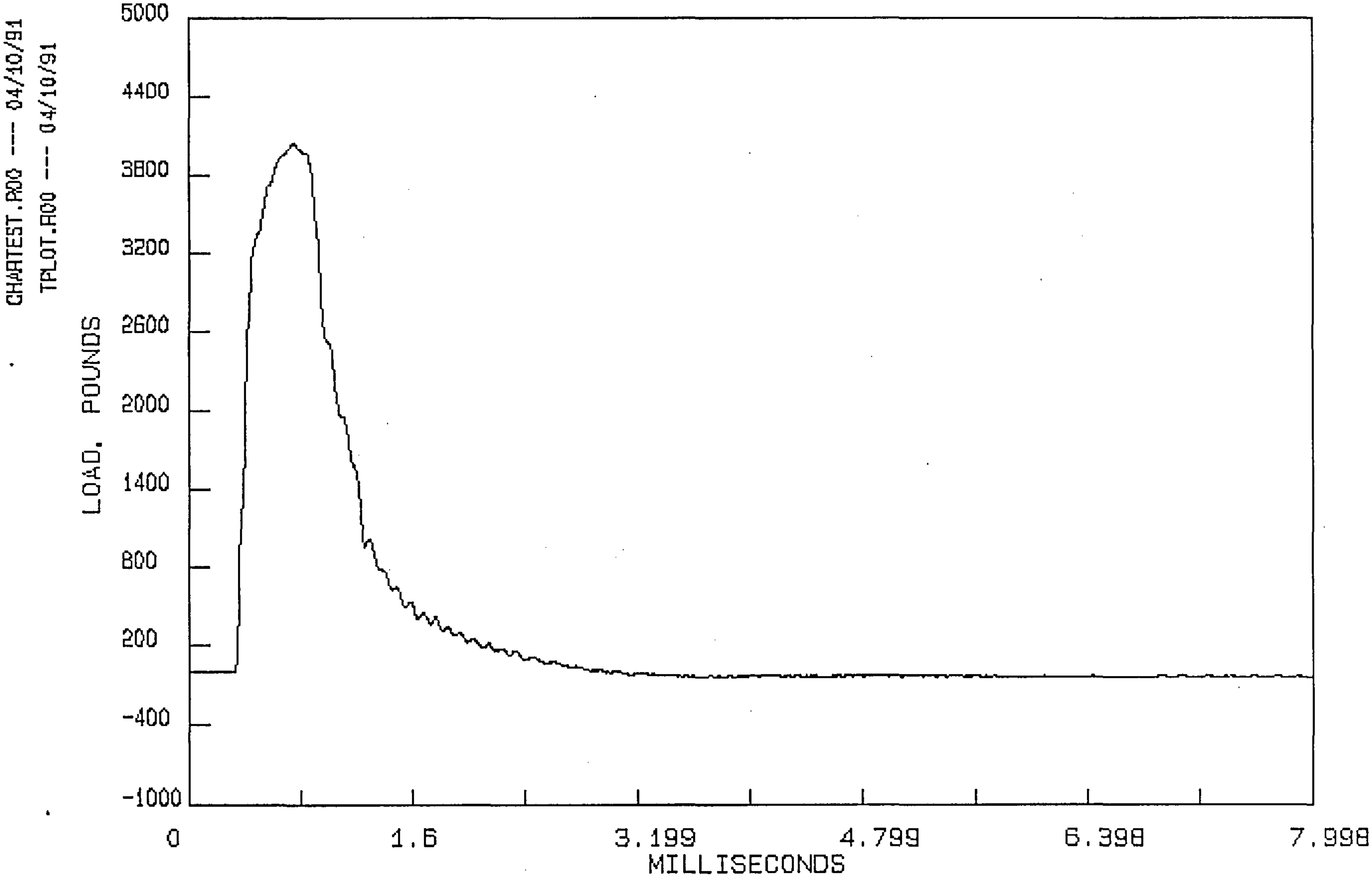
DYNAMIC YIELD STRENGTH (KSI) = 96
DYNAMIC FLOW STRENGTH (KSI) = 106
DIAL ENERGY READING (FT-LBS) = 52.5

TEST VIOLATIONS

********* NO VIOLATIONS *********

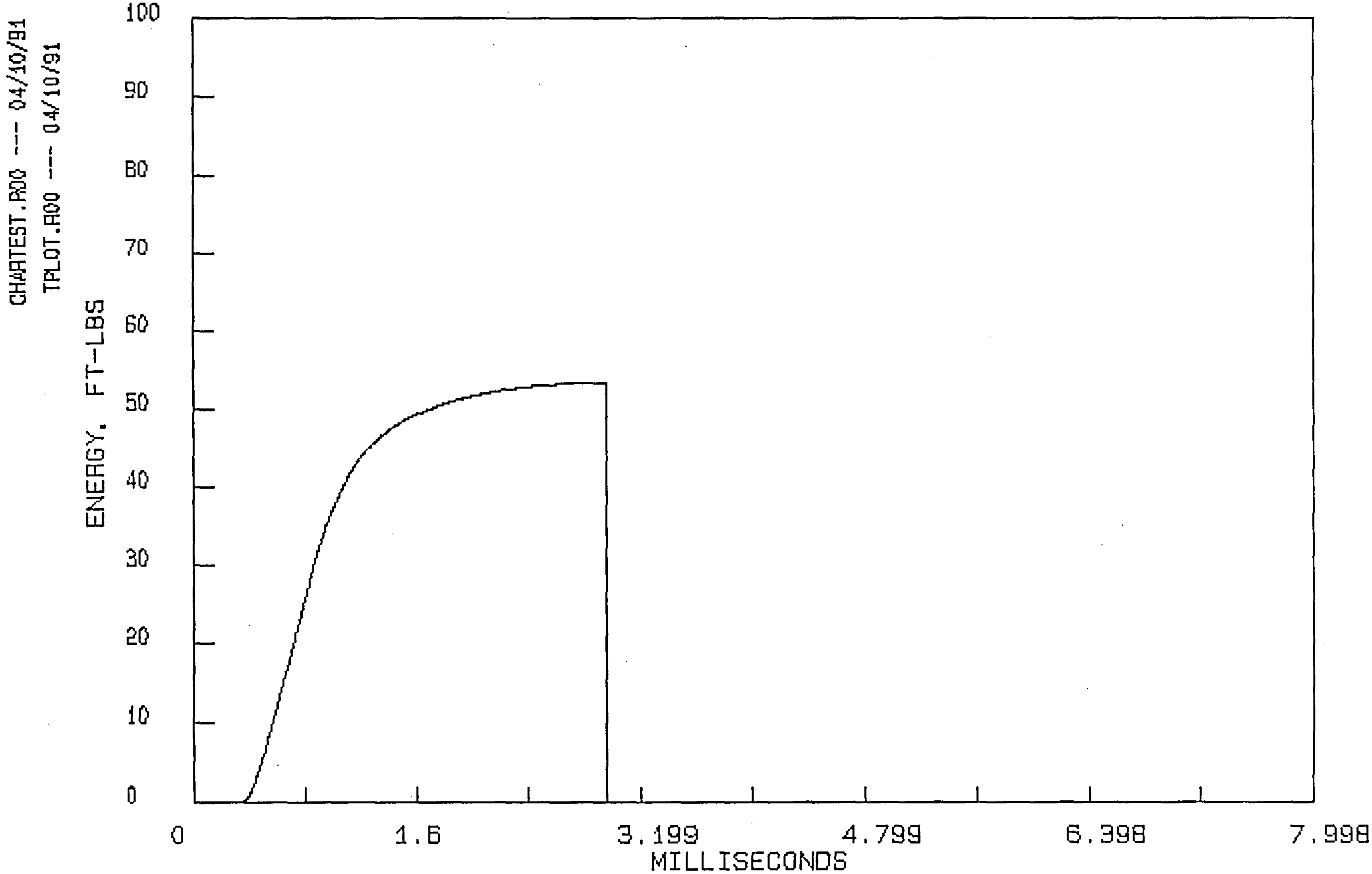
PROJ. NO. 1295-001-03-08 QA NO. 99001

LOAD - TIME TRACE FOR SPECIMEN P412



PROJ. NO. 1295-001-03-08 QA NO. 99001

ENERGY - TIME TRACE FOR SPECIMEN P412



CHARTEST.R00 --- 04/10/91
ANALYZE.R00 --- 04/10/91

INSTRUMENTED IMPACT TEST RESULTS

ANALYSIS DATE: 12/09/2003
MATERIAL: HAZ
INITIAL HAMMER ENERGY, FT-LBS: 240
INITIAL HAMMER VELOCITY, FT/SEC: 17
LOAD CALIBRATION, LBS/VOLT: 1150
SPECIMEN WIDTH, INCH: .394
NOTCH DEPTH, INCH: 7.900001E-02
RESPONSE TIME, MSEC: .0519
TECHNICAL PROCEDURE(S): TP-80 TP-412

ANALYSIS BY: BJV
TEST DATE: 11/10/2003
SPEC. ID: P413
PROJ. NO.: 1295-001-03-08
QA NO.: 99001
TEST TEMP (F): 235
OPERATOR: BJV

PROPERTY	ENERGY, FT-LBS		LOAD POUNDS	TIME MSEC
	UNCORRECTED	CORRECTED		
GENERAL YIELD	5.326124	5.296575	3330.4	.1619999
FLOW LOAD	11.2626	11.13047	3767.4	.2599999
MAXIMUM LOAD	29.30218	28.40779	4204.4	.522
FAST FRACTURE LOAD	54.18881	51.13003	-2.441406E-04634	
ARREST LOAD	54.18881	51.13003	-2.441406E-04634	
PROPAGATION LOAD	24.88663	22.72224	0	0
TOTAL ENERGY	54.18881	51.13003	0	0
SHEAR LIP ENERGY	0	0	0	0
TOTAL EVENT TIME	0	0	0	2.634

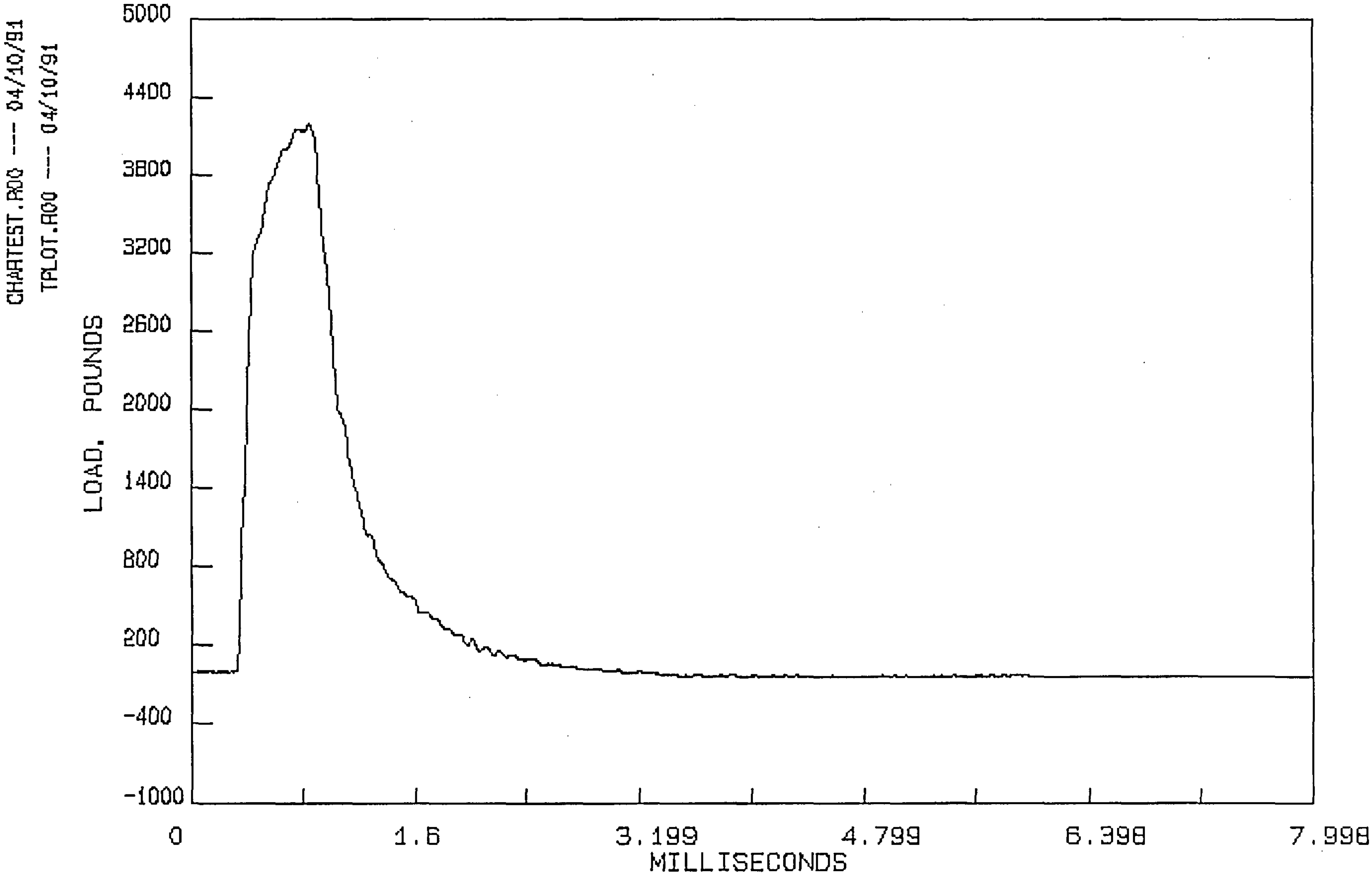
DYNAMIC YIELD STRENGTH (KSI) = 96
DYNAMIC FLOW STRENGTH (KSI) = 108
DIAL ENERGY READING (FT-LBS) = 53.5

TEST VIOLATIONS

********* NO VIOLATIONS *********

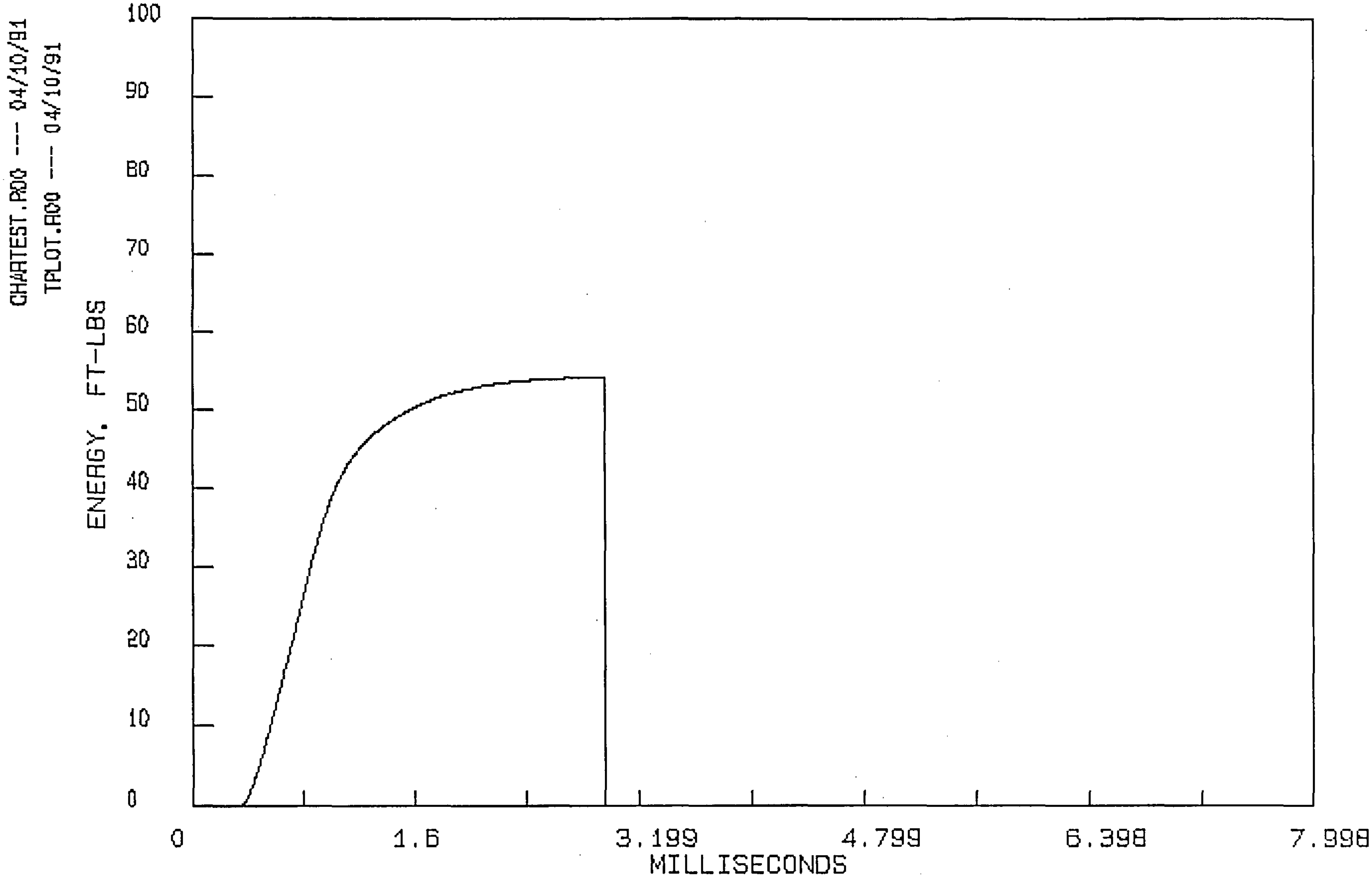
PROJ. NO. 1295-001-03-08 QA NO. 99001

LOAD - TIME TRACE FOR SPECIMEN P413



PROJ. NO. 1295-001-03-08 QA NO. 99001

ENERGY - TIME TRACE FOR SPECIMEN P413



CHARTEST.R00 --- 04/10/91
ANALYZE.R00 --- 04/10/91

INSTRUMENTED IMPACT TEST RESULTS

ANALYSIS DATE: 12/09/2003
MATERIAL: HAZ
INITIAL HAMMER ENERGY, FT-LBS: 240
INITIAL HAMMER VELOCITY, FT/SEC: 17
LOAD CALIBRATION, LBS/VOLT: 1150
SPECIMEN WIDTH, INCH: .394
NOTCH DEPTH, INCH: 7.900001E-02
RESPONSE TIME, MSEC: .0519
TECHNICAL PROCEDURE(S): TP-80 TP-412

ANALYSIS BY: BJV
TEST DATE: 11/05/2003
SPEC. ID: P47T
PROJ. NO.: 1295-001-03-08
QA NO.: 99001
TEST TEMP (F): 250
OPERATOR: BJV

PROPERTY	ENERGY, FT-LBS		LOAD POUNDS	TIME MSEC
	UNCORRECTED	CORRECTED		
GENERAL YIELD	5.083625	5.056705	3210.8	.166
FLOW LOAD	9.553459	9.458387	3569.6	.2439999
MAXIMUM LOAD	21.79951	21.30449	3928.4	.434
FAST FRACTURE LOAD	66.43821	61.84026	-2.441406E-04	2.938
ARREST LOAD	66.43821	61.84026	-2.441406E-04	2.938
PROPAGATION LOAD	44.6387	40.53577	0	0
TOTAL ENERGY	66.43821	61.84026	0	0
SHEAR LIP ENERGY	0	0	0	0
TOTAL EVENT TIME	0	0	0	2.938

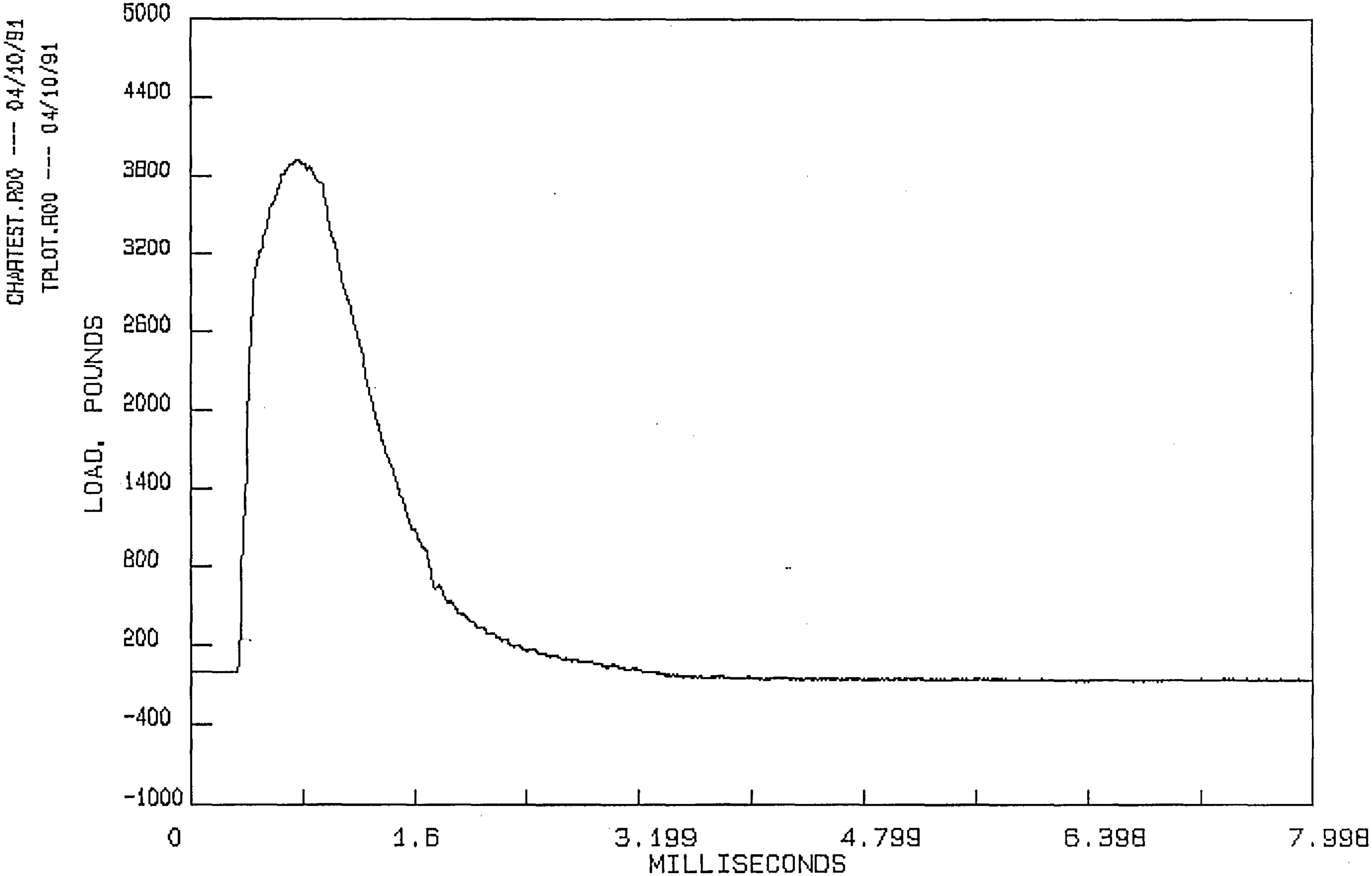
DYNAMIC YIELD STRENGTH (KSI) = 92
DYNAMIC FLOW STRENGTH (KSI) = 103
DIAL ENERGY READING (FT-LBS) = 65

TEST VIOLATIONS

********* NO VIOLATIONS *********

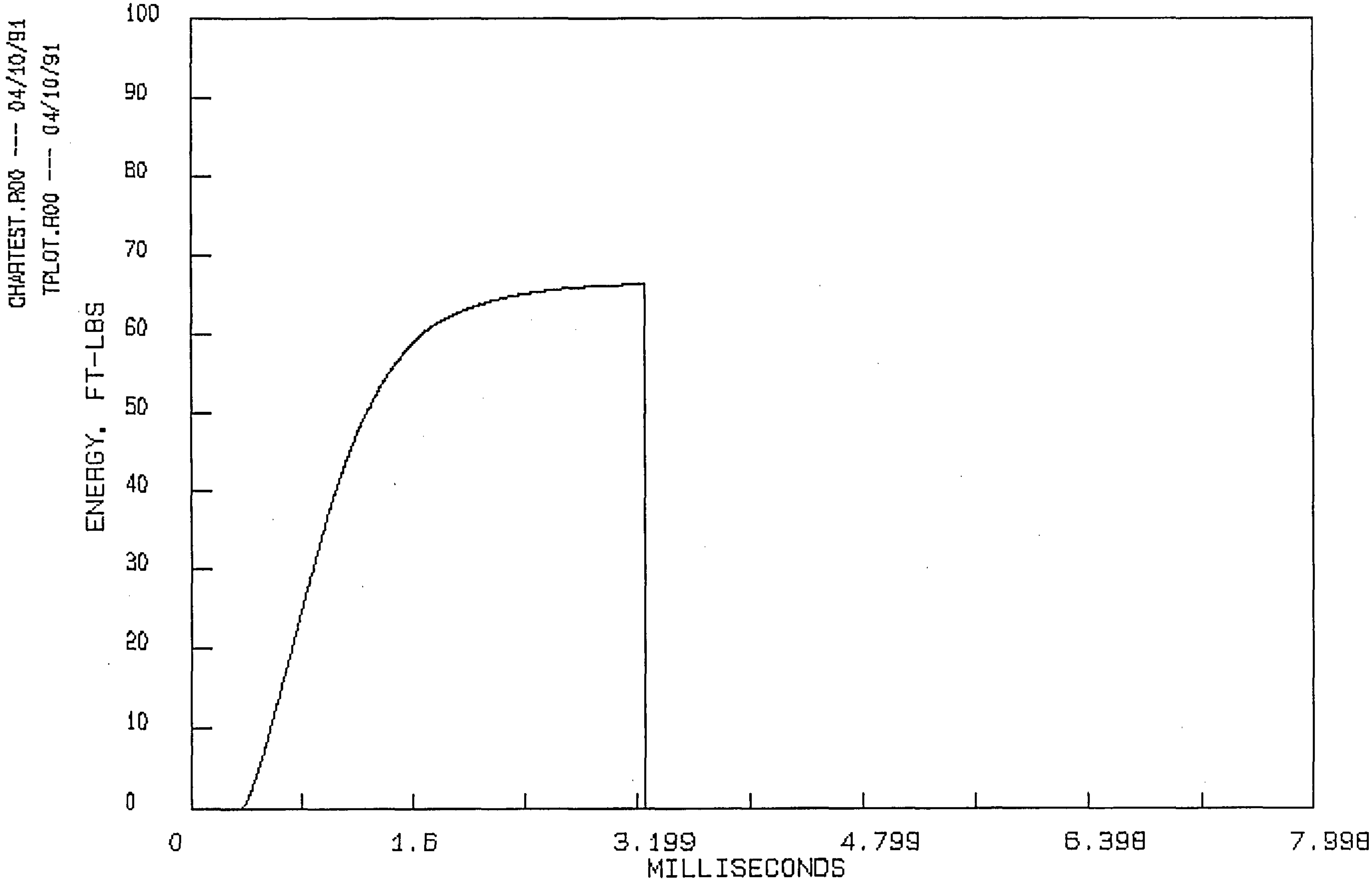
PROJ. NO. 1295-001-03-08 QA NO. 99001

LOAD - TIME TRACE FOR SPECIMEN P47T



PROJ. NO. 1295-001-03-08 QA NO. 99001

ENERGY - TIME TRACE FOR SPECIMEN P47T



CHARTEST.R00 --- 04/10/91
ANALYZE.R00 --- 04/10/91

INSTRUMENTED IMPACT TEST RESULTS

ANALYSIS DATE: 12/09/2003
MATERIAL: HAZ
INITIAL HAMMER ENERGY, FT-LBS: 240
INITIAL HAMMER VELOCITY, FT/SEC: 17
LOAD CALIBRATION, LBS/VOLT: 1150
SPECIMEN WIDTH, INCH: .394
NOTCH DEPTH, INCH: 7.900001E-02
RESPONSE TIME, MSEC: .0519
TECHNICAL PROCEDURE(S): TP-80 TP-412

ANALYSIS BY: BJV
TEST DATE: 11/05/2003
SPEC. ID: P417
PROJ. NO.: 1295-001-03-08
QA NO.: 99001
TEST TEMP (F): 300
OPERATOR: BJV

PROPERTY	ENERGY, FT-LBS UNCORRECTED	ENERGY, FT-LBS CORRECTED	LOAD POUNDS	TIME MSEC
GENERAL YIELD	4.979229	4.953403	3187.8	.1719999
FLOW LOAD	8.575647	8.499042	3499.45	.236
MAXIMUM LOAD	20.29822	19.86903	3811.1	.4219999
FAST FRACTURE LOAD	60.44297	56.63739	-2.441406E-04	2.648
ARREST LOAD	60.44297	56.63739	-2.441406E-04	2.648
PROPAGATION LOAD	40.14475	36.76836	0	0
TOTAL ENERGY	60.44297	56.63739	0	0
SHEAR LIP ENERGY	0	0	0	0
TOTAL EVENT TIME	0	0	0	2.648

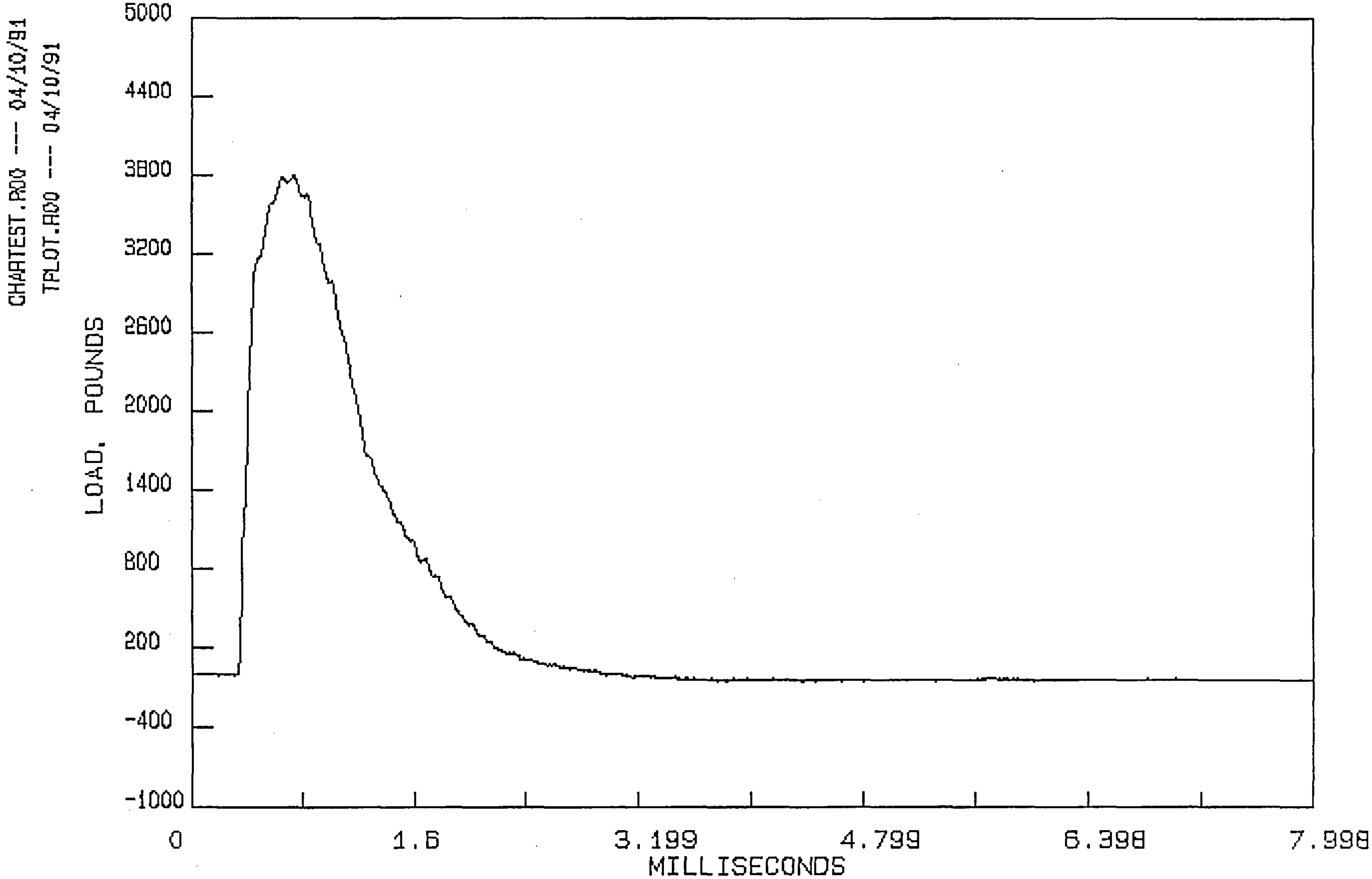
DYNAMIC YIELD STRENGTH (KSI) = 92
DYNAMIC FLOW STRENGTH (KSI) = 101
DIAL ENERGY READING (FT-LBS) = 60.5

TEST VIOLATIONS

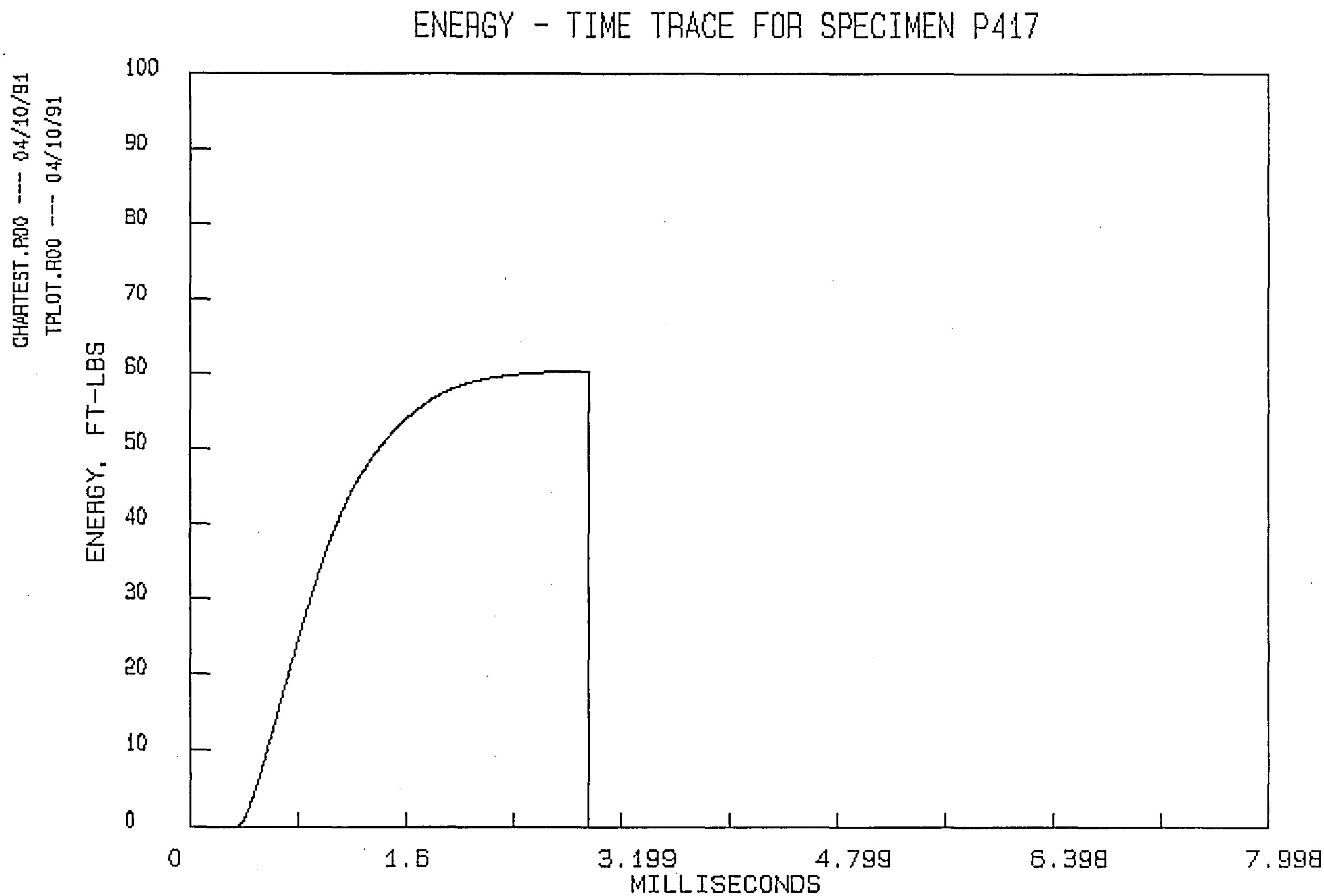
********* NO VIOLATIONS *********

PROJ. NO. 1295-001-03-08 QA NO. 99001

LOAD - TIME TRACE FOR SPECIMEN P417



PROJ. NO. 1295-001-03-08   QA NO. 99001



APPENDIX E

STRESS STRAIN CURVES
PALISADES CAPSULE W-100

TADS
<890928.1259>   TENSILE DATA ANALYSIS

1 Dec., 2003
File: 1J1

SPECIMEN ID PARAMETERS

Date of test	12/01/20	
Operator	BJV	
Project number	1295	
Specimen	1J1	
Test temperature	70 F	21. C
Material	BASE (LONG)	
Modulus	29126. ksi	200825. MPa
Cross Section type	CIRC	
Fluence	0.0000E+00	
Technical Specification . .	TP-78-15	

SET UP PARAMETERS

Initial disp rate	.0075 in/min	.190 mm/min
Second. disp rate	.0300 in/min	.76 mm/min
Gauge length (Ext)	1.000 in	25.40 mm

DIMENSIONAL

Diameter INITIAL	.2500 in	6.35 mm
FINAL	.1530 in	3.89 mm
Axial Fidical INITIAL . .	1.0000 in	25.40 mm
FINAL . .	.0000 in	.00 mm

TEST RESULTS

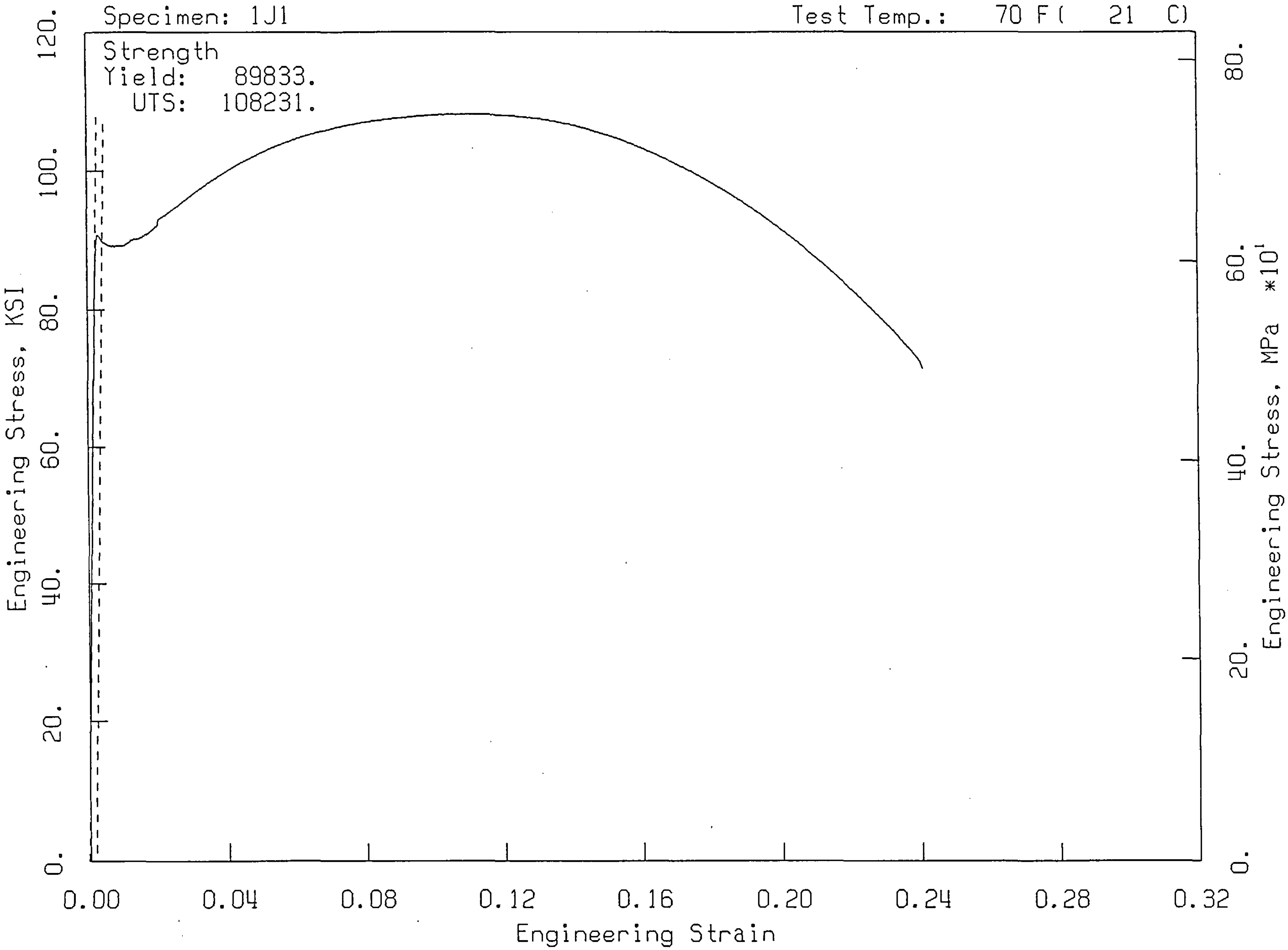
Yield Strength	89833. psi	619.4 MPa
Tensile Strength	108231. psi	746.3 MPa
Fracture Load	3505. lb	15590. N
Fracture Stress	190639. psi	1314.5 MPa
Fracture Strength	71403. psi	492.3 MPa
Young`s Modulus	3.36E+07 psi	2.32E+05 MPa
Elongation (fiducial). . .	-1.0000	
Uniform Elongation (Ext) .	.1084	
Total Elongation (Ext) . .	.2380	
Reduction in Diameter. . .	38.8 %	
Reduction in Area	62.5 %	

CURVE FIT

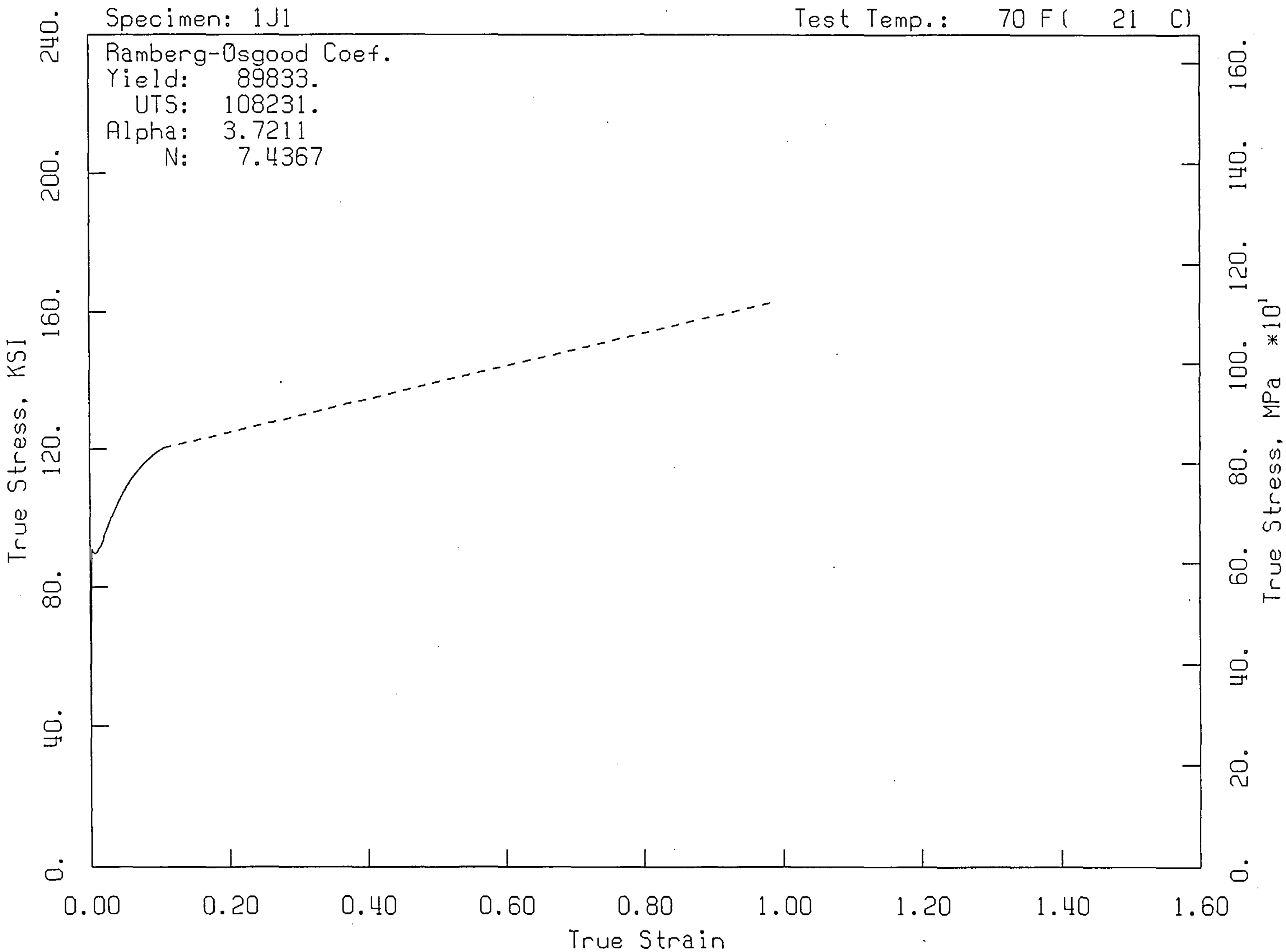
Ramberg-Osgood Equation

		Fit Std Dev
Alpha	3.721	.004
N	7.437	.024

1 Dec., 2003
File: 1J1



1 Dec., 2003
File: 1J1



TENSION TEST RECORD REPORT

PROGRAM IDENTIFICATION

Responsible Persons: | Date of Test 11/24/2003

Project Leader SM Henson | Specimen ID 1-1

Machine Operator BJ Vuwa | Project No. 1295-001 QA No. 99001

Data Reduction BJ Owen | Test Machine MTS 312 Serial No. 10000-5031

Tech. Procedure TP-78-15 Machine Location FSL LTC B

SPECIMEN PARAMETERS (INITIAL)

Type: Solid Round .... Subsize Round ✓ Tubular .... Flat .... Other ....

Gage Length: 1.0 in. Dimensions: Nominal ✓ Measured .....

Outside Diameter - OD_o = 0.25 in.

Inside Diameter - ID_o = NA in.

Width - W_o = NA in. Thickness - T_o = NA in.

Area - A_o = .0491 $in.^2$

TEST PARAMETERS

Computer Program (if used) TNSLTEST.000 Test Temp. 70 °F

Speed: Initial .00075 in/min through yield in. Secondary .03 in/min

Control Mode: Load .01 Strain .... Stroke ✓

Mode Ranges: Load 10 Kip Strain 0.5 in/in Stroke 1.0

TEST RESULTS

Location of Fracture within gage length

Description of Fracture ....

Other Comments ....

Dimensions After Fracture: Gage Length: NA in.

Outside Diameter - OD_{f1} = .1545 in. Width - W_f = NA in.

OD_{f2} = .1535 in. Thickness - T_f = NA in.

OD_{f3} = .1530 in. Area - A_f = .0184 $in.^2$

CALCULATED RESULTS

Software MTAD.000 Elastic Modulus - E = 3.36×10^7 psi

0.2% Offset Yield Strength - σ_{ys} = 89833 psi

Ultimate Tensile Strength - σ_{uts} = 108231 psi

Uniform Elongation - UE = 10.84 % Total Elongation - TE = 23.80 %

Reduction of Area - RA = 62.5 %

Ramberg-Osgood Parameters: α = 3.721 N = 7.437

Data reviewed and compared to computer results [signature] 1/8/04

TADS

<890928.1259> TENSILE DATA ANALYSIS

1 Dec., 2003

File: 1EY

SPECIMEN ID PARAMETERS

Date of test	12/01/20	
Operator	BJV	
Project number	1295	
Specimen	1EY	
Test temperature	250 F	121. C
Material	BASE (LONG)	
Modulus	28216. ksi	194551. MPa
Cross Section type	CIRC	
Fluence	0.0000E+00	
Technical Specification . .	TP-78-15	

SET UP PARAMETERS

Initial disp rate	.0075 in/min	.190 mm/min
Second. disp rate	.0300 in/min	.76 mm/min
Gauge length (Ext)	1.000 in	25.40 mm

DIMENSIONAL

Diameter INITIAL	.2500 in	6.35 mm
FINAL	.1585 in	4.03 mm
Axial Fidical INITIAL . .	1.0000 in	25.40 mm
FINAL . .	.0000 in	.00 mm

TEST RESULTS

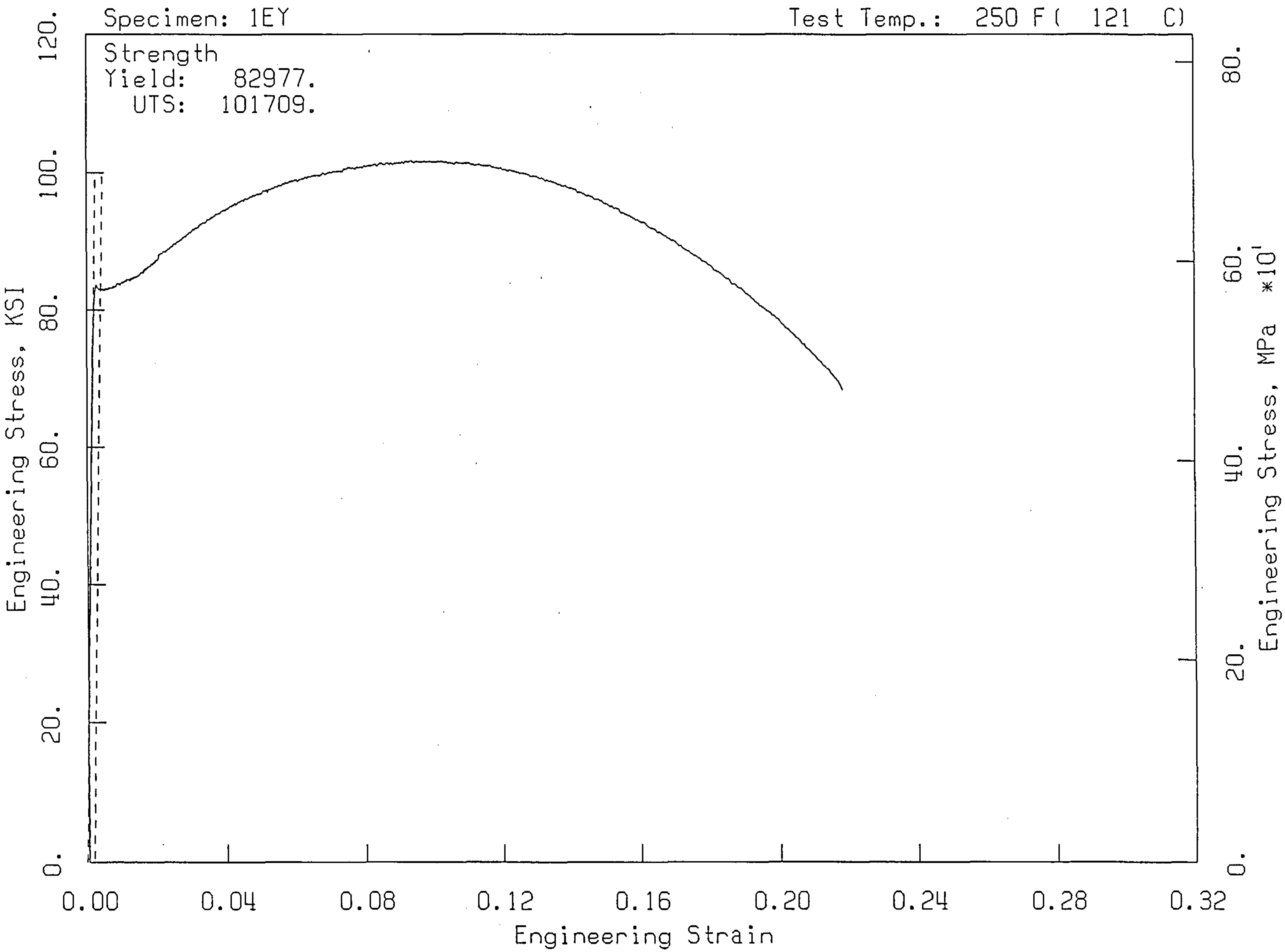
Yield Strength	82977. psi	572.1 MPa
Tensile Strength	101709. psi	701.3 MPa
Fracture Load	3353. lb	14913. N
Fracture Stress	169918. psi	1171.6 MPa
Fracture Strength	68300. psi	470.9 MPa
Young`s Modulus	3.33E+07 psi	2.29E+05 MPa
Elongation (fiducial). . . .	-1.0000	
Uniform Elongation (Ext) .	.0990	
Total Elongation (Ext) . .	.2162	
Reduction in Diameter. . .	36.6 %	
Reduction in Area	59.8 %	

CURVE FIT

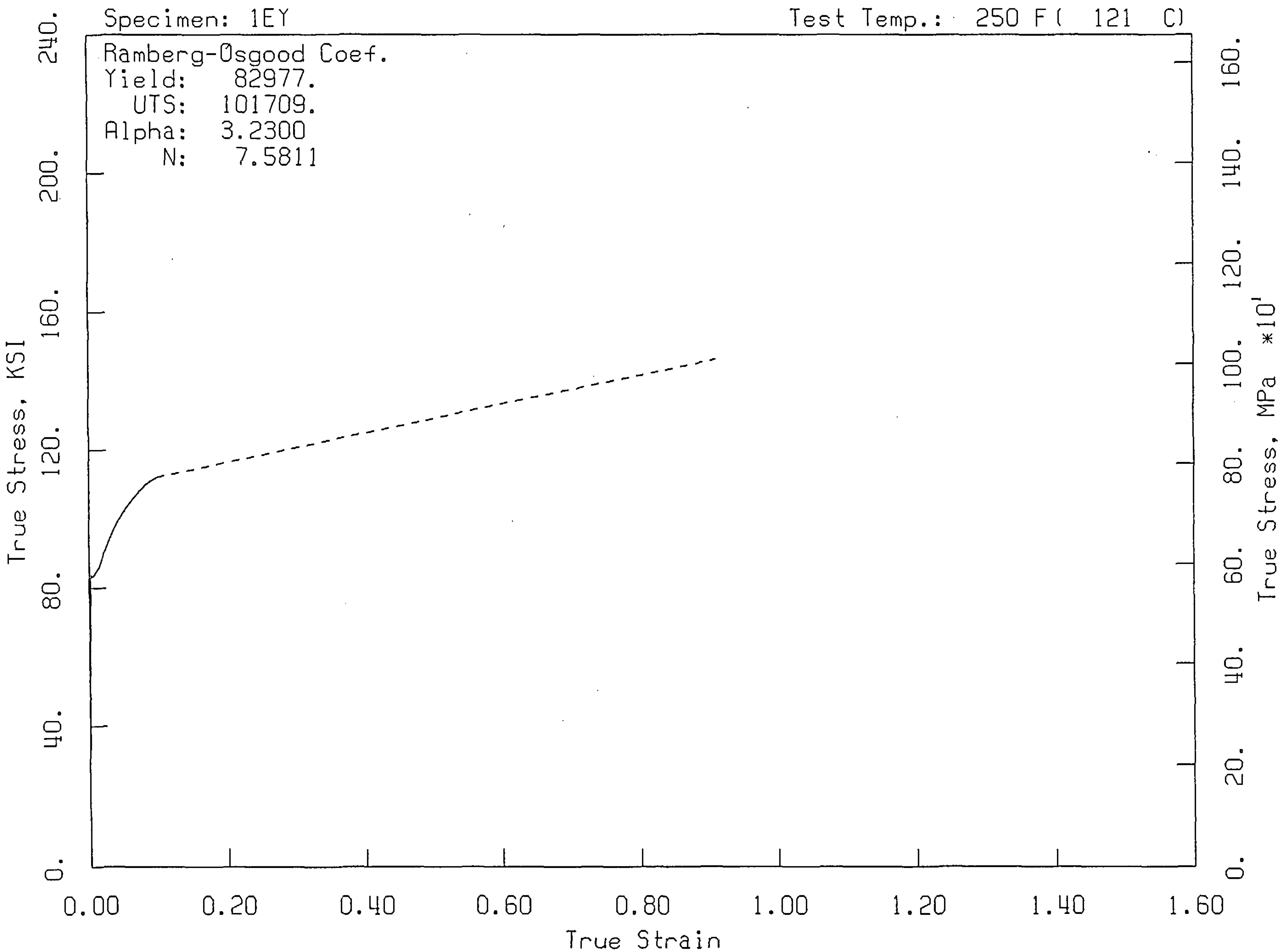
Ramberg-Osgood Equation

		Fit Std Dev
Alpha	3.230	.005
N	7.581	.025

1 Dec., 2003
File: 1EY



1 Dec., 2003
File: 1EY



TENSION TEST RECORD REPORT

PROGRAM IDENTIFICATION

Responsible Persons: | Date of Test 11/25/03

Project Leader SM Jensen | Specimen ID 1EY

Machine Operator BJ Vevere | Project No. 1295-001 QA No. 9900/

Data Reduction BJ Vevere | Test Machine MTS 312 Serial No. 1000-5831

Tech. Procedure TP-78-15 Machine Location FSL 456 'B'

SPECIMEN PARAMETERS (INITIAL)

Type: Solid Round .... Subsize Round ✓ Tubular .... Flat .... Other ....

Gage Length: 1.0 in. Dimensions: Nominal ✓ Measured .....

Outside Diameter - OD_o = 0.25 in.

Inside Diameter - ID_o = NA in.

Width - W_o = NA in. Thickness - T_o = NA in.

Area - A_o = 0.0491 in.^{2}

TEST PARAMETERS

Computer Program (if used) TNSLTEST.exe Test Temp. 250 °F

Speed: Initial .0075"/min through Yield in. Secondary .03"/min

Control Mode: Load .... Strain .... Stroke ✓

Mode Ranges: Load 10Kip Strain 0.5"/in Stroke 1.0in

TEST RESULTS

Location of Fracture Within gage length

Description of Fracture ....

Other Comments ....

Dimensions After Fracture: Gage Length: NA in.

Outside Diameter - OD_{f1} = .1580 in. Width - W_f = NA in.

OD_{f2} = .1590 in. Thickness - T_f = NA in.

OD_{fv} = .1585 in. Area - A_f = .01973 in.^{2}

CALCULATED RESULTS

Software MTPRO.LOO Elastic Modulus - E = 3.33x10^7 psi

0.2% Offset Yield Strength - σ_{ys} = 82977 psi

Ultimate Tensile Strength - σ_{uts} = 101709 psi

Uniform Elongation - UE = 9.90 % Total Elongation - TE = 21.62 %

Reduction of Area - RA = 59.8 %

Ramberg-Osgood Parameters: α = 3.230 N = 7.581

Data reviewed and compared to computer results 1/8/04

TADS
<890928.1259> TENSILE DATA ANALYSIS

1 Dec., 2003
File: 1E7

SPECIMEN ID PARAMETERS

Date of test	12/01/20	
Operator	BJV	
Project number	1295	
Specimen	1E7	
Test temperature	550 F	288. C
Material	BASE (LONG)	
Modulus	26700. ksi	184095. MPa
Cross Section type	CIRC	
Fluence	0.0000E+00	
Technical Specification . .	TP-78-15	

SET UP PARAMETERS

Initial disp rate	.0075 in/min	.190 mm/min
Second. disp rate	.0300 in/min	.76 mm/min
Gauge length (Ext)	1.000 in	25.40 mm

DIMENSIONAL

Diameter INITIAL	.2500 in	6.35 mm
FINAL	.1730 in	4.39 mm
Axial Fidical INITIAL . .	1.0000 in	25.40 mm
FINAL . .	.0000 in	.00 mm

TEST RESULTS

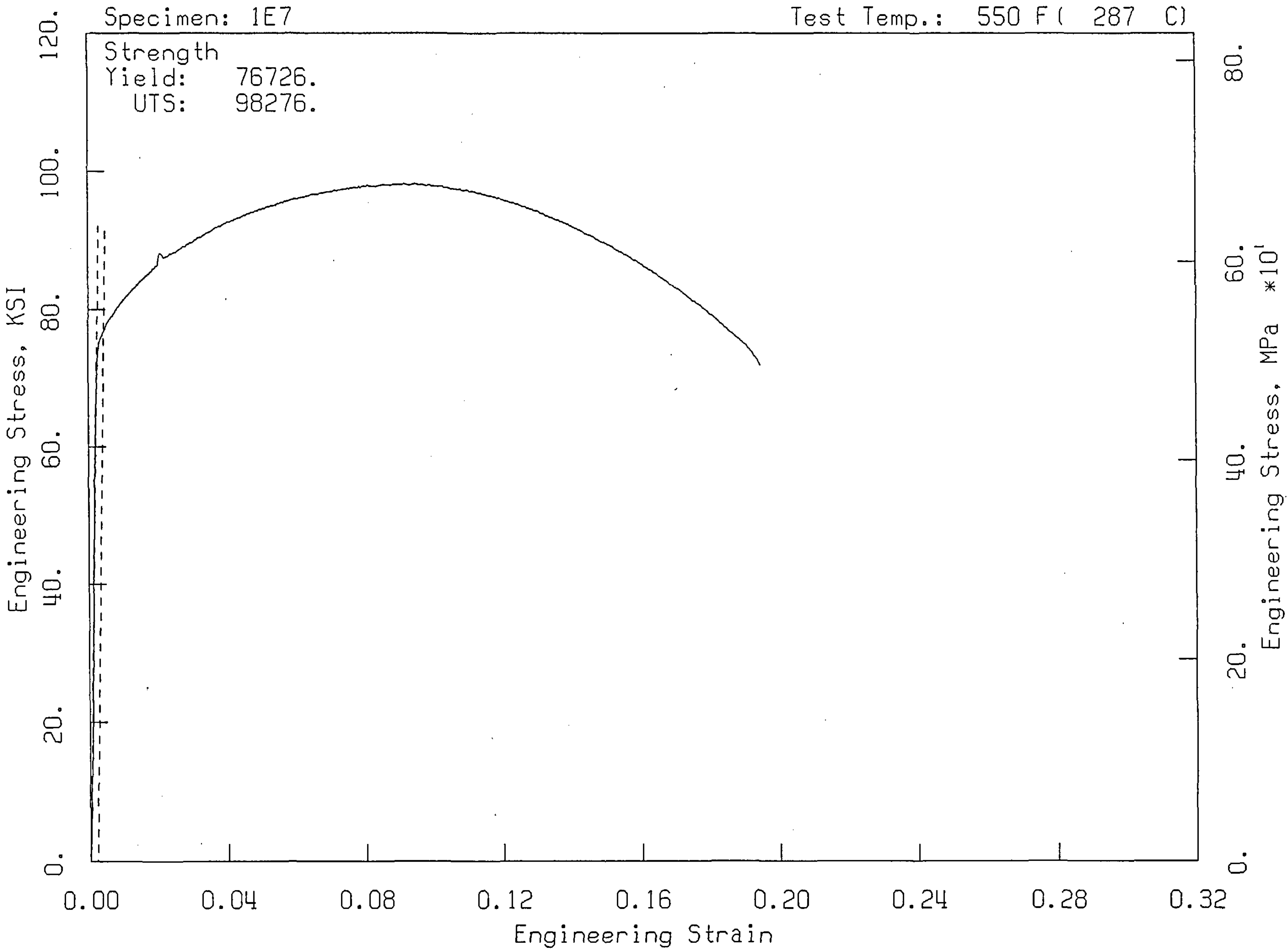
Yield Strength	76726. psi	529.0 MPa
Tensile Strength	98276. psi	677.6 MPa
Fracture Load	3528. lb	15691. N
Fracture Stress	150076. psi	1034.8 MPa
Fracture Strength	71866. psi	495.5 MPa
Young`s Modulus	3.11E+07 psi	2.15E+05 MPa
Elongation (fiducial). . .	-1.0000	
Uniform Elongation (Ext) .	.0878	
Total Elongation (Ext) . .	.1921	
Reduction in Diameter. . .	30.8 %	
Reduction in Area	52.1 %	

CURVE FIT

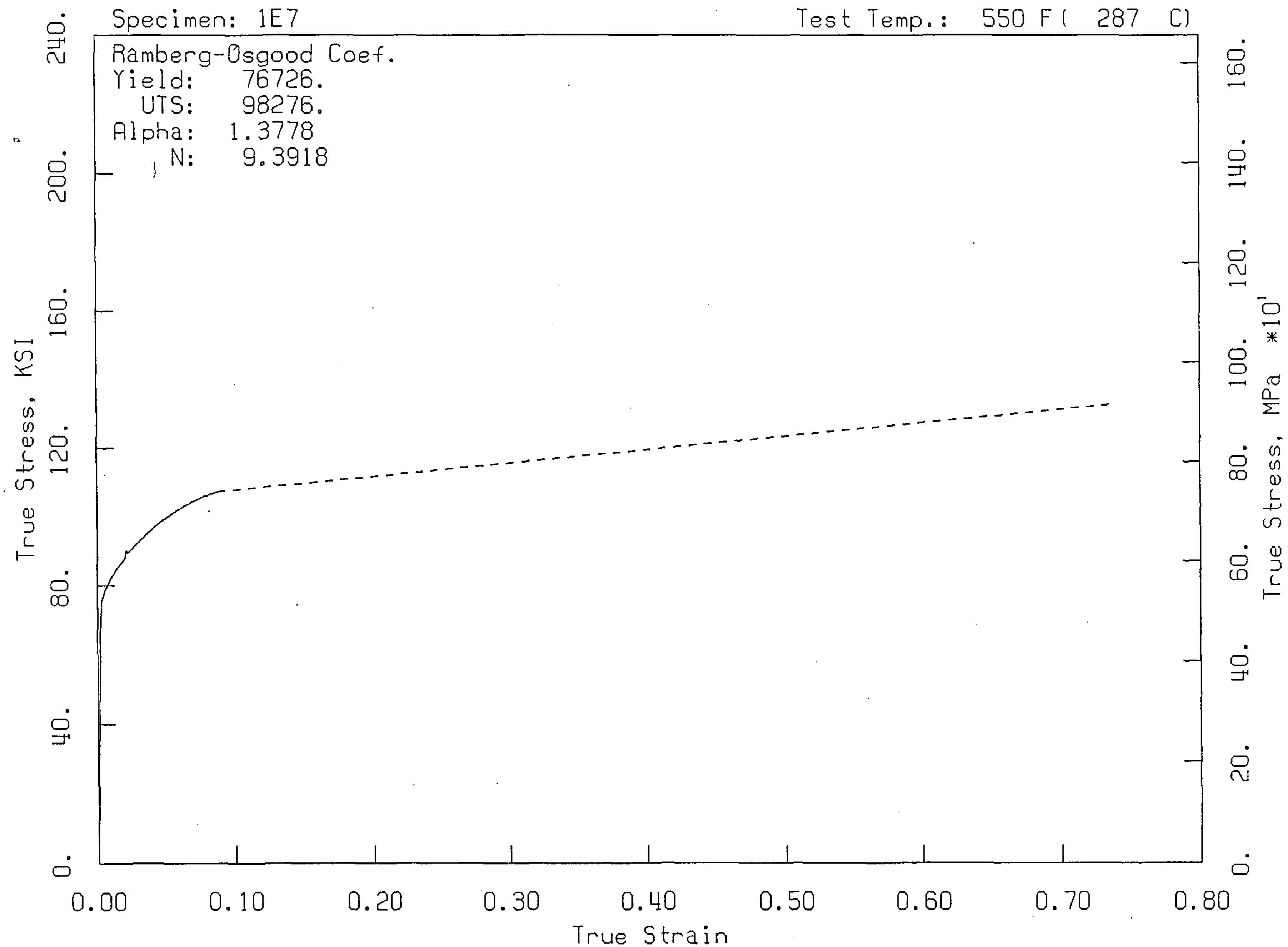
Ramberg-Osgood Equation

		Fit Std Dev
Alpha	1.378	.013
N	9.392	.065

1 Dec., 2003
File: 1E7



1 Dec., 2003
File: 1E7



TENSION TEST RECORD REPORT

PROGRAM IDENTIFICATION

Responsible Persons: | Date of Test ..11/25/03......

Project Leader ..SM Jensen.......... | Specimen ID ..1E7..........

Machine Operator ..BJ Vaver......... | Project No. .1295.001... QA No. .95061.....

Data Reduction ..BJ Vaver......... | Test Machine .MTS 312.. Serial No. .10000-5831.

Tech. Procedure .TP-78-15.... Machine Location .RL CTL D.....

SPECIMEN PARAMETERS (INITIAL)

Type: Solid Round .... Subsize Round .✓.. Tubular .... Flat .... Other ....

Gage Length: .1.0..in. Dimensions: Nominal .✓... Measured .....

Outside Diameter - OD_o = .0.25....in.

Inside Diameter - ID_o = ..NA...in.

Width - W_o = ..NA...in. Thickness - T_o = ..NA....in.

Area - A_o = .0.0491.$in.^2$

TEST PARAMETERS

Computer Program (if used) ..TNSLTEST.000................ Test Temp. .550..°F

Speed: Initial ..0.0075 in/min..... through ..yield.....in. Secondary ..0.03 in/min......

Control Mode: Load .... Strain .... Stroke .✓.......

Mode Ranges: Load .10 kip... Strain .0.5 in/in. Stroke .1.0 in.....

TEST RESULTS

Location of Fracture ..Within gage length.............................

Description of Fracture ....

Other Comments ....

Dimensions After Fracture: Gage Length: .NA....in.

Outside Diameter - OD_{f1} = .1720..in. Width - W_f = .NA...in.

OD_{f2} = .1710..in. Thickness - T_f = .NA...in.

OD_{f3} = .1730..in. Area - A_f = .0.235.$in.^2$

CALCULATED RESULTS

Software ..MTIADL00.................. Elastic Modulus - E = .3.11×10^7..psi

0.2% Offset Yield Strength - σ_{ys} = ..76726..psi

Ultimate Tensile Strength - σ_{uts} = ..98276..psi

Uniform Elongation - UE = ..8.78..% Total Elongation - TE = .19.21..%

Reduction of Area - RA = ..52.1..%

Ramberg-Osgood Parameters: α = 1.378... N = ..9.392...

Data reviewed and compared to computer results ....SM J....1/8/04......

TADS <890928.1259> TENSILE DATA ANALYSIS

1 Dec., 2003
File: 3DT

SPECIMEN ID PARAMETERS

Date of test	12/01/20	
Operator	BJV	
Project number	1295	
Specimen	3DT	
Test temperature	70 F	21. C
Material	WELD	
Modulus	29126. ksi	200825. MPa
Cross Section type	CIRC	
Fluence	0.0000E+00	
Technical Specification . .	TP-78-15	

SET UP PARAMETERS

Initial disp rate	.0075 in/min	.190 mm/min
Second. disp rate	.0300 in/min	.76 mm/min
Gauge length (Ext)	1.000 in	25.40 mm

DIMENSIONAL

Diameter INITIAL	.2500 in	6.35 mm
FINAL	.1730 in	4.39 mm
Axial Fidical INITIAL . .	1.0000 in	25.40 mm
FINAL . .	.0000 in	.00 mm

TEST RESULTS

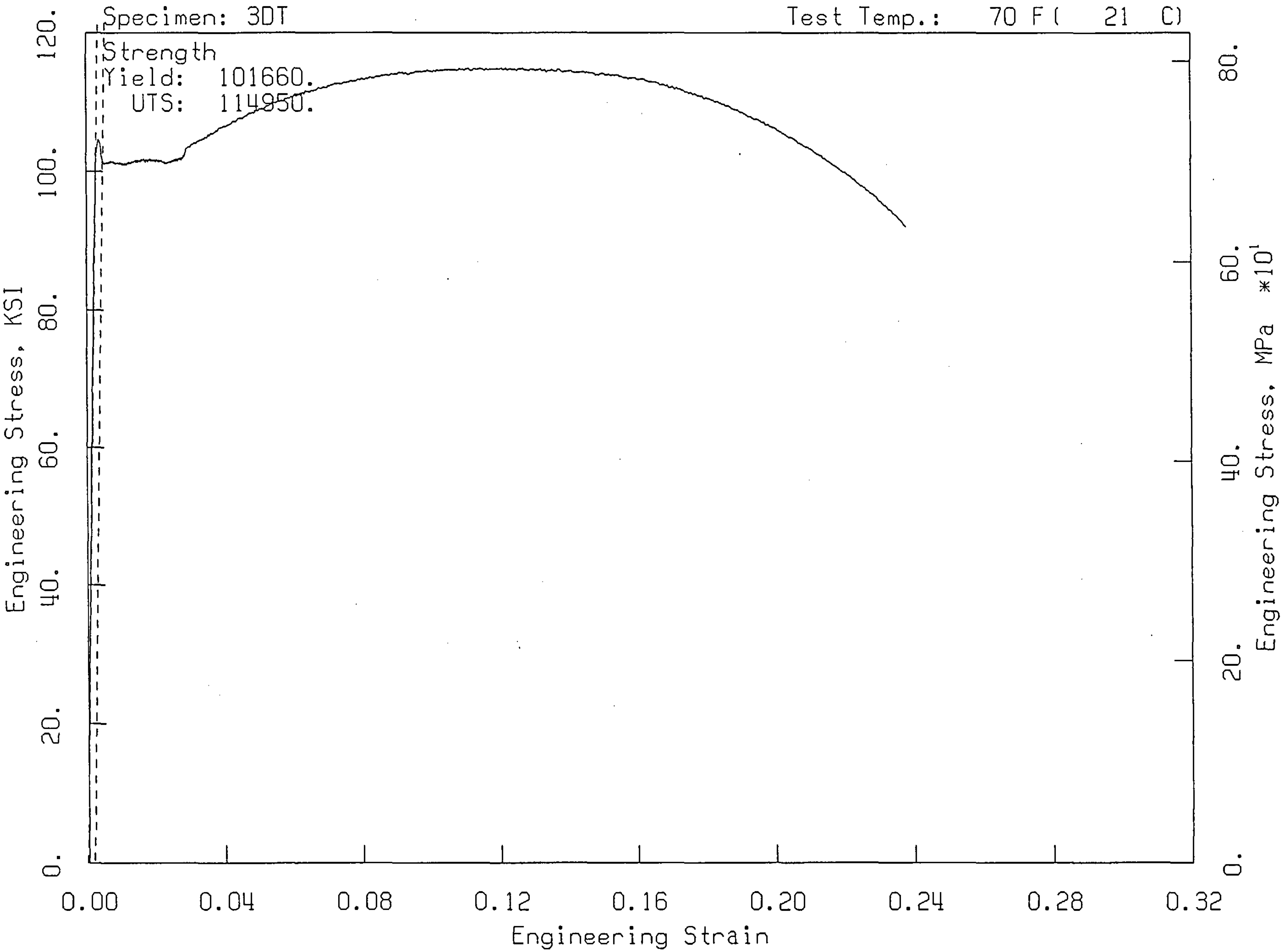
Yield Strength	101660. psi	700.9 MPa
Tensile Strength	114950. psi	792.6 MPa
Fracture Load	4515. lb	20084. N
Fracture Stress	192093. psi	1324.5 MPa
Fracture Strength	91986. psi	634.2 MPa
Young`s Modulus	3.19E+07 psi	2.20E+05 MPa
Elongation (fiducial). . . .	-1.0000	
Uniform Elongation (Ext) .	.1168	
Total Elongation (Ext) . .	.2346	
Reduction in Diameter. . .	30.8 %	
Reduction in Area	52.1 %	

CURVE FIT

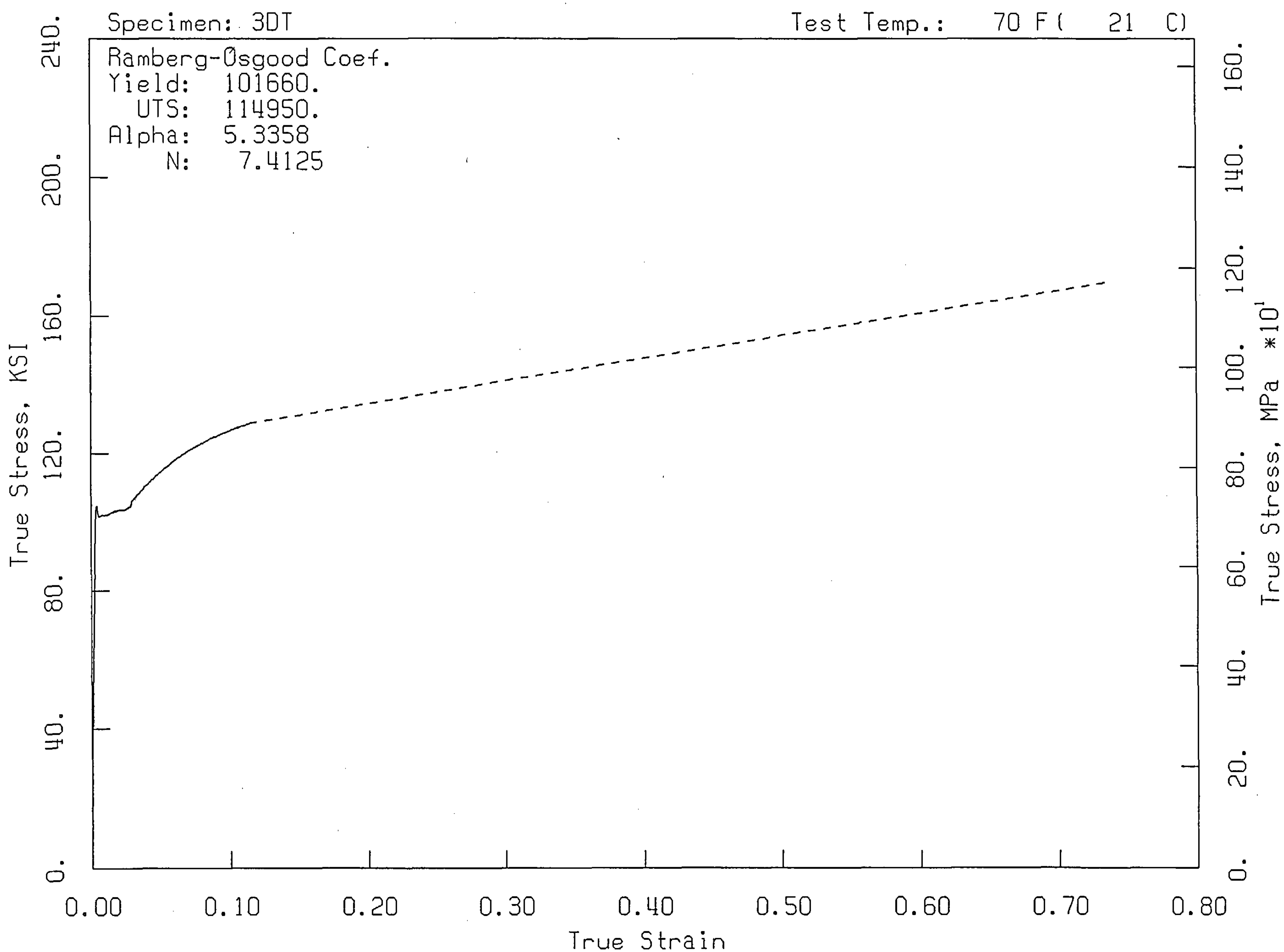
Ramberg-Osgood Equation

		Fit Std Dev
Alpha	5.336	.002
N	7.412	.015

1 Dec., 2003
File: 3DT



1 Dec., 2003
File: 3DT



TENSION TEST RECORD REPORT

PROGRAM IDENTIFICATION

Responsible Persons: | Date of Test 11/24/2003

Project Leader SM Jensen | Specimen ID 3DT

Machine Operator BJ Veeder | Project No. 1295-001 QA No. 9001

Data Reduction BJ Veeder | Test Machine MTS 312 Serial No. 1-000-5051

Tech. Procedure TP-78-15 Machine Location SCL UTL B

SPECIMEN PARAMETERS (INITIAL)

Type: Solid Round .... Subsize Round ✓ Tubular .... Flat .... Other ....

Gage Length: 1.0 in. Dimensions: Nominal ✓ Measured .....

Outside Diameter - OD_o = .25 in.

Inside Diameter - ID_o = NA in.

Width - W_o = NA in. Thickness - T_o = NA in.

Area - A_o = .0491 in.^{2}

TEST PARAMETERS

Computer Program (if used) TNSLTEST.000 Test Temp. 70 °F

Speed: Initial .0095 in/min through .020 in. Secondary .03 in/min

Control Mode: Load .... Strain .... Stroke ✓

Mode Ranges: Load 10 kip Strain .5 in/in Stroke 1.0 in.

TEST RESULTS

Location of Fracture Within gage length

Description of Fracture ....

Other Comments ....

Dimensions After Fracture: Gage Length: NA in.

Outside Diameter - OD_{f1} = .1720 in. Width - W_f = NA in.

OD_{f2} = .1740 in. Thickness - T_f = NA in.

OD_{fv} = .1730 in. Area - A_f = .0235 in.^{2}

CALCULATED RESULTS

Software MTAO.LOO Elastic Modulus - E = 3.19×10^7 psi

0.2% Offset Yield Strength - σ_{ys} = 101660 psi

Ultimate Tensile Strength - σ_{uts} = 114950 psi

Uniform Elongation - UE = 11.68 % Total Elongation - TE = 23.46 %

Reduction of Area - RA = 52.1 %

Ramberg-Osgood Parameters: α = 5.336 N = 7.412

Data reviewed and compared to computer results .... [signature] 1/8/04

TADS   1 Dec., 2003
<890928.1259>   TENSILE DATA ANALYSIS   File: 3DP

SPECIMEN ID PARAMETERS

Date of test	12/01/20	
Operator	BJV	
Project number	1295	
Specimen	3DP	
Test temperature	300 F	149. C
Material	WELD	
Modulus	27964. ksi	192808. MPa
Cross Section type	CIRC	
Fluence	0.0000E+00	
Technical Specification . .	TP-78-15	

SET UP PARAMETERS

Initial disp rate	.0075 in/min	.190 mm/min
Second. disp rate	.0300 in/min	.76 mm/min
Gauge length (Ext)	1.000 in	25.40 mm

DIMENSIONAL

Diameter INITIAL	.2500 in	6.35 mm
FINAL	.1870 in	4.75 mm
Axial Fidical INITIAL . .	1.0000 in	25.40 mm
FINAL . .	.0000 in	.00 mm

TEST RESULTS

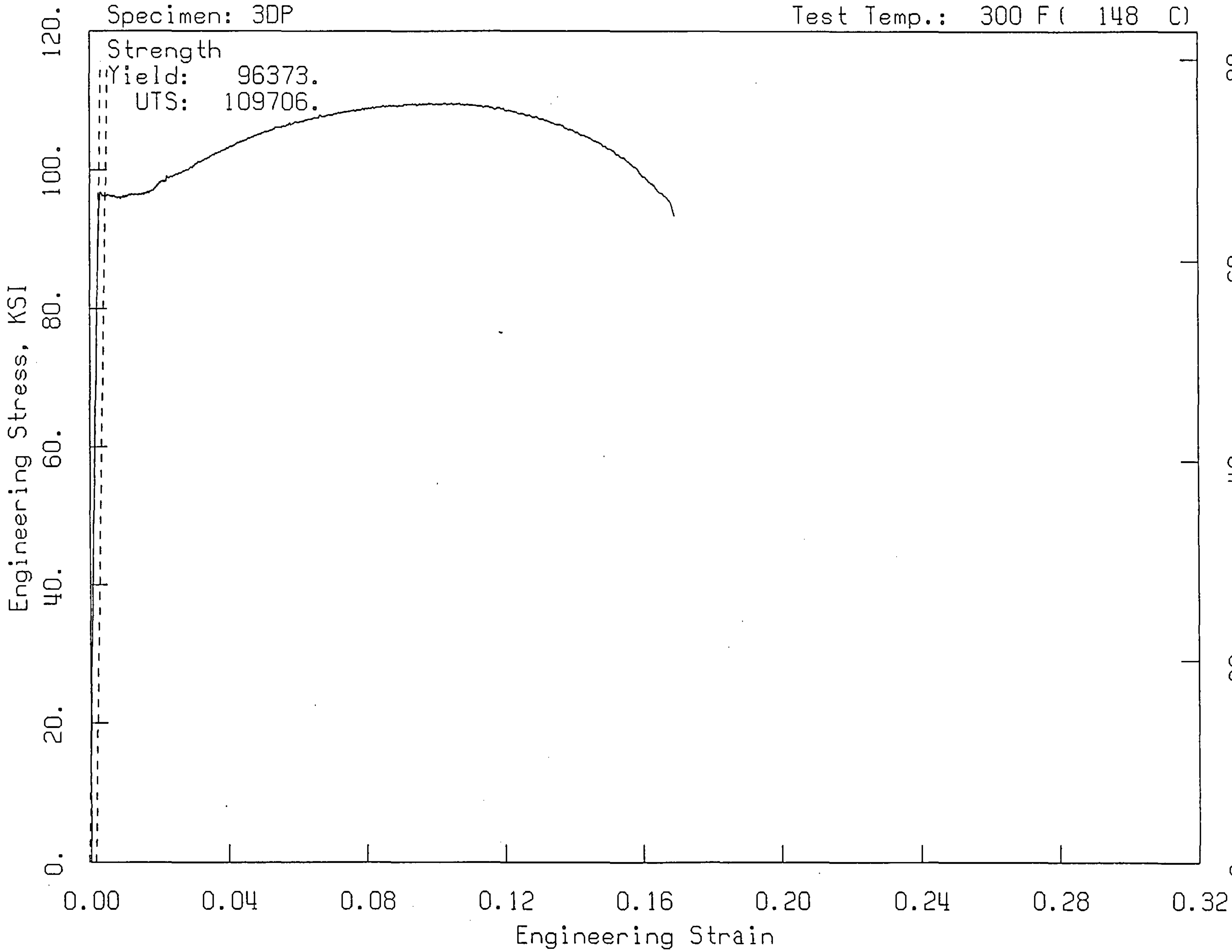
Yield Strength	96373. psi	664.5 MPa
Tensile Strength	109706. psi	756.4 MPa
Fracture Load	4589. lb	20414. N
Fracture Stress	167104. psi	1152.2 MPa
Fracture Strength	93496. psi	644.7 MPa
Young`s Modulus	3.13E+07 psi	2.16E+05 MPa
Elongation (fiducial) . . .	-1.0000	
Uniform Elongation (Ext) .	.0944	
Total Elongation (Ext) . .	.1659	
Reduction in Diameter. . .	25.2 %	
Reduction in Area	44.0 %	

CURVE FIT

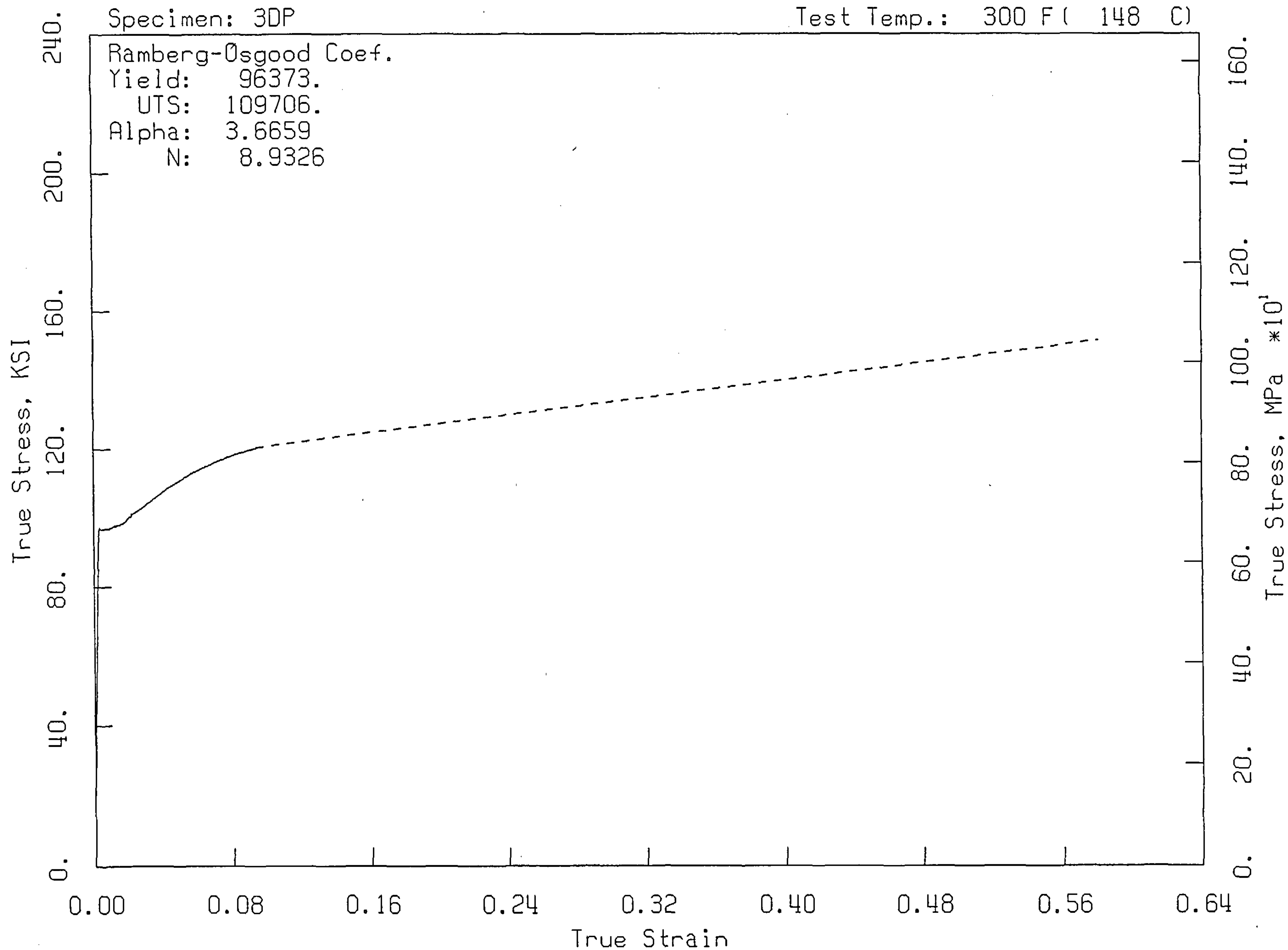
Ramberg-Osgood Equation

		Fit Std Dev
Alpha	3.666	.006
N	8.933	.044

1 Dec., 2003
File: 3DP



1 Dec., 2003
File: 3DP



TENSION TEST RECORD REPORT

PROGRAM IDENTIFICATION

Responsible Persons: | Date of Test 11/25/03

Project Leader J M Jensen | Specimen ID 308

Machine Operator B J Vevone | Project No. 1295-001 QA No. 99001

Data Reduction B J Vevone | Test Machine MTS 312 Serial No. 1-0000-5031

Tech. Procedure TP-78-15 Machine Location FFL LTG B

SPECIMEN PARAMETERS (INITIAL)

Type: Solid Round .... Subsize Round ✓ Tubular .... Flat .... Other ....

Gage Length: 1.0 in. Dimensions: Nominal ✓ Measured .....

Outside Diameter - OD_o = 0.25 in.

Inside Diameter - ID_o = NA in.

Width - W_o = NA in. Thickness - T_o = NA in.

Area - A_o = 0.0491 in^2

TEST PARAMETERS

Computer Program (if used) TNSLT651.003 Test Temp. 300 °F

Speed: Initial .0075 in/min through 4.00 in. Secondary .03 in/min

Control Mode: Load .... Strain .... Stroke ✓

Mode Ranges: Load 10 kip Strain 0.5 in/in Stroke 1.0 in

TEST RESULTS

Location of Fracture Within gage length

Description of Fracture ....

Other Comments ....

Dimensions After Fracture: Gage Length: NA in.

Outside Diameter - OD_{f1} = .1880 in. Width - W_f = NA in.

OD_{f2} = .1860 in. Thickness - T_f = NA in.

OD_{f3} = .1870 in. Area - A_f = .0275 in^2

CALCULATED RESULTS

Software MTAO.400 Elastic Modulus - E = 3.13×10^7 psi

0.2% Offset Yield Strength - σ_{ys} = 96373 psi

Ultimate Tensile Strength - σ_{uts} = 109706 psi

Uniform Elongation - UE = 9.44 % Total Elongation - TE = 16.59 %

Reduction of Area - RA = 44.0 %

Ramberg-Osgood Parameters: α = 3.666 N = 8.533

Data reviewed and compared to computer results [signature] 1/8/04

TADS
<890928.1259> TENSILE DATA ANALYSIS

1 Dec., 2003
File: 3DM

SPECIMEN ID PARAMETERS

Date of test	12/01/20	
Operator	BJV	
Project number	1295	
Specimen	3DM	
Test temperature	550 F	288. C
Material	WELD	
Modulus	26700. ksi	184095. MPa
Cross Section type	CIRC	
Fluence	0.0000E+00	
Technical Specification . .	TP-78-15	

SET UP PARAMETERS

Initial disp rate	.0075 in/min	.190 mm/min
Second. disp rate	.0300 in/min	.76 mm/min
Gauge length (Ext)	1.000 in	25.40 mm

DIMENSIONAL

Diameter INITIAL	.2500 in	6.35 mm
FINAL	.1845 in	4.69 mm
Axial Fidical INITIAL . .	1.0000 in	25.40 mm
FINAL . .	.0000 in	.00 mm

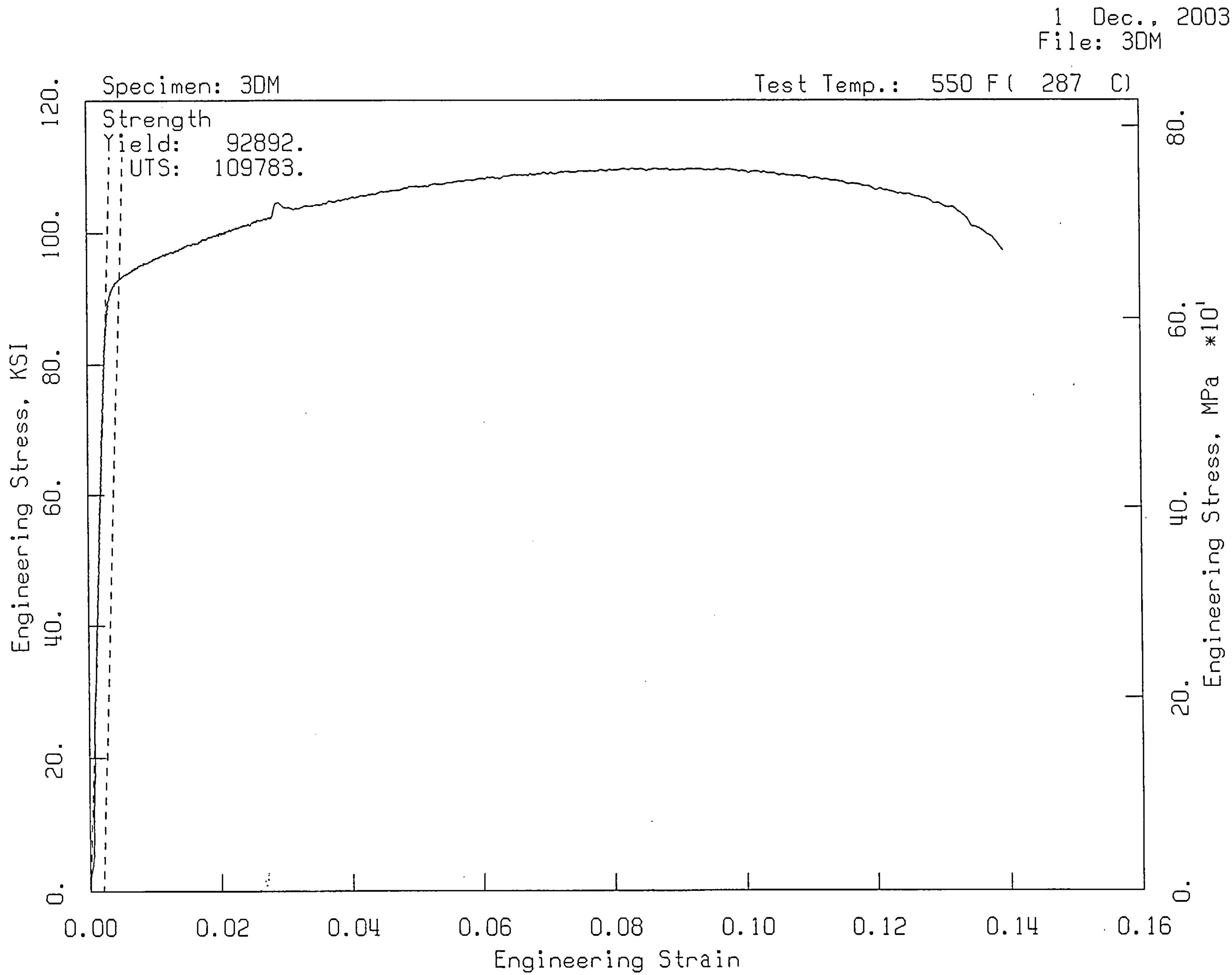
TEST RESULTS

Yield Strength	92892. psi	640.5 MPa
Tensile Strength	109783. psi	757.0 MPa
Fracture Load	4775. lb	21237. N
Fracture Stress	178585. psi	1231.3 MPa
Fracture Strength	97266. psi	670.6 MPa
Young`s Modulus	3.21E+07 psi	2.21E+05 MPa
Elongation (fiducial). . .	-1.0000	
Uniform Elongation (Ext) .	.0792	
Total Elongation (Ext) . .	.1357	
Reduction in Diameter. . .	26.2 %	
Reduction in Area	45.5 %	

CURVE FIT

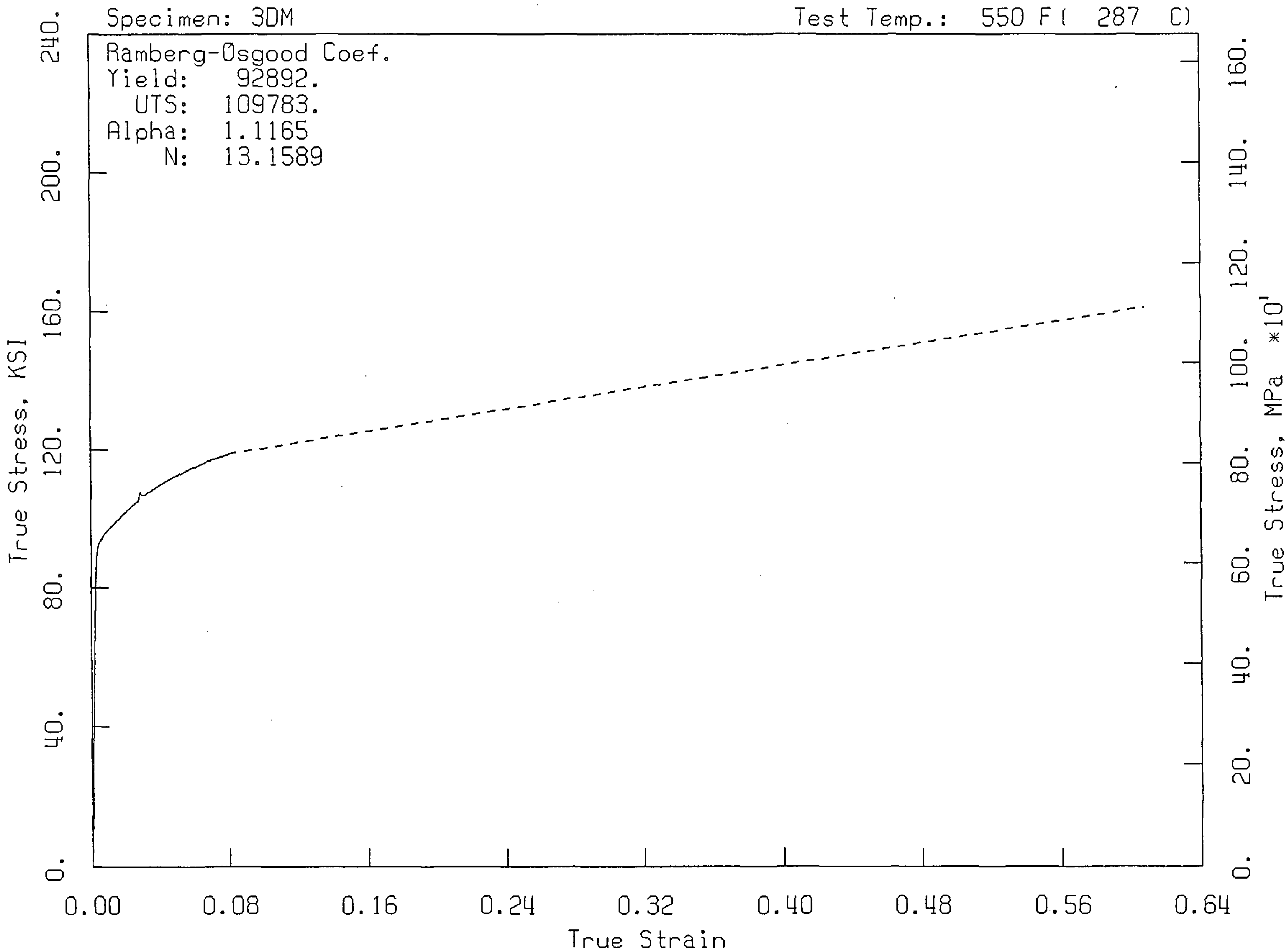
Ramberg-Osgood Equation

		Fit Std Dev
Alpha	1.117	.023
N	13.159	.170



1 Dec., 2003
File: 3DM
Specimen: 3DM
Test Temp.: 550 F(287 C)
Strength
Yield: 92892.
UTS: 109783.
Engineering Stress, KSI
0.
20.
40.
60.
80.
100.
120.
Engineering Stress, MPa *10'
0.
20.
40.
60.
80.
0.00
0.02
0.04
0.06
0.08
0.10
0.12
0.14
0.16
Engineering Strain

1 Dec., 2003
File: 3DM



TENSION TEST RECORD REPORT

PROGRAM IDENTIFICATION

Responsible Persons: | Date of Test 11/26/03

Project Leader SM Hanson | Specimen ID 3DM

Machine Operator BJ Vaver | Project No. 1295-001 QA No. 99001

Data Reduction BJ Vaver | Test Machine MTS 314 Serial No. 1-000-503

Tech. Procedure TP-7845 Machine Location FRL CTC "B"

SPECIMEN PARAMETERS (INITIAL)

Type: Solid Round .... Subsize Round ✓ Tubular .... Flat .... Other ....

Gage Length: 1.0 in. Dimensions: Nominal ✓ Measured .....

Outside Diameter - OD_o = 0.25 in.

Inside Diameter - ID_o = NA in.

Width - W_o = NA in. Thickness - T_o = NA in.

Area - A_o = 0.0491 in.^{2}

TEST PARAMETERS

Computer Program (if used) TWSLTest.000 Test Temp. 550 °F

Speed: Initial .0075 in/min through yield in. Secondary .03

Control Mode: Load .... Strain .... Stroke ✓

Mode Ranges: Load 10 kip Strain 0.5 in/in Stroke 1.0 in

TEST RESULTS

Location of Fracture Within gage length

Description of Fracture ....

Other Comments ....

Dimensions After Fracture: Gage Length: NA in.

Outside Diameter - OD_{f1} = .1840 in. Width - W_f = NA in.

OD_{f2} = .1850 in. Thickness - T_f = NA in.

OD_{fs} = .1845 in. Area - A_f = .0267 in.^{2}

CALCULATED RESULTS

Software MTAD.000 Elastic Modulus - E = 3.21x10^7 psi

0.2% Offset Yield Strength - σ_{ys} = 92892 psi

Ultimate Tensile Strength - σ_{uts} = 109783 psi

Uniform Elongation - UE = 7.92 % Total Elongation - TE = 13.57 %

Reduction of Area - RA = 45.5 %

Ramberg-Osgood Parameters: α = 1.117 N = 13.159

Data reviewed and compared to computer results ... HM ... 1/8/04

TADS
<890928.1259> TENSILE DATA ANALYSIS

1 Dec., 2003
File: 4JK

SPECIMEN ID PARAMETERS

Date of test	12/01/20	
Operator	BJV	
Project number	1295	
Specimen	4JK	
Test temperature	70 F	21. C
Material	HAZ	
Modulus	29126. ksi	200825. MPa
Cross Section type	CIRC	
Fluence	0.0000E+00	
Technical Specification . .	TP-78-15	

SET UP PARAMETERS

Initial disp rate	.0075 in/min	.190 mm/min
Second. disp rate	.0300 in/min	.76 mm/min
Gauge length (Ext)	1.000 in	25.40 mm

DIMENSIONAL

Diameter INITIAL	.2500 in	6.35 mm
FINAL	.1615 in	4.10 mm
Axial Fidical INITIAL . .	1.0000 in	25.40 mm
FINAL . .	.0000 in	.00 mm

TEST RESULTS

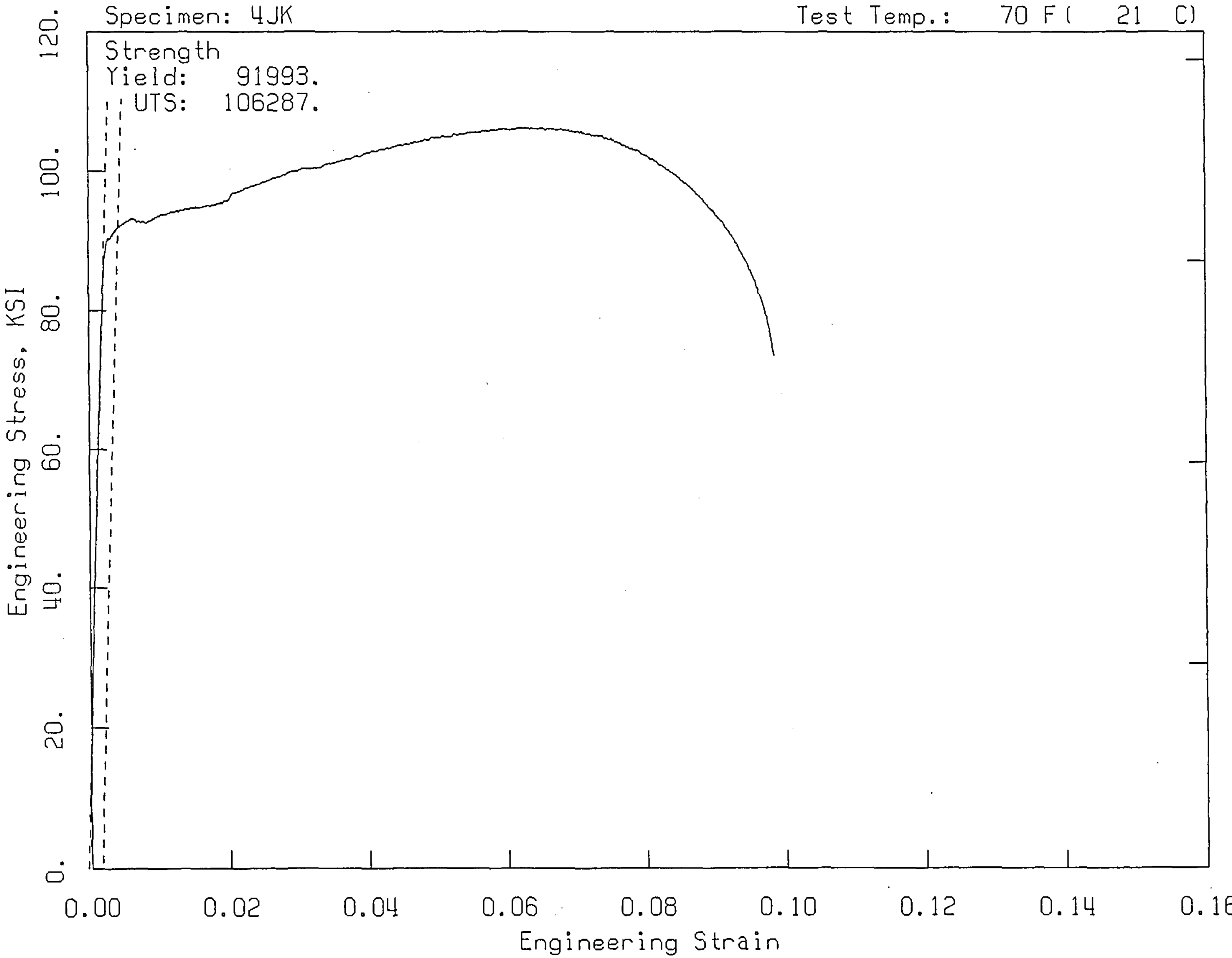
Yield Strength	91993. psi	634.3 MPa
Tensile Strength	106287. psi	732.8 MPa
Fracture Load	3602. lb	16024. N
Fracture Stress	175860. psi	1212.6 MPa
Fracture Strength	73389. psi	506.0 MPa
Young`s Modulus	3.31E+07 psi	2.28E+05 MPa
Elongation (fiducial). . .	-1.0000	
Uniform Elongation (Ext) .	.0601	
~~Total Elongation (Ext) . .~~	~~.0959~~ [illegible] 12/1/03	
Reduction in Diameter. . .	35.4 %	
Reduction in Area	58.3 %	

CURVE FIT

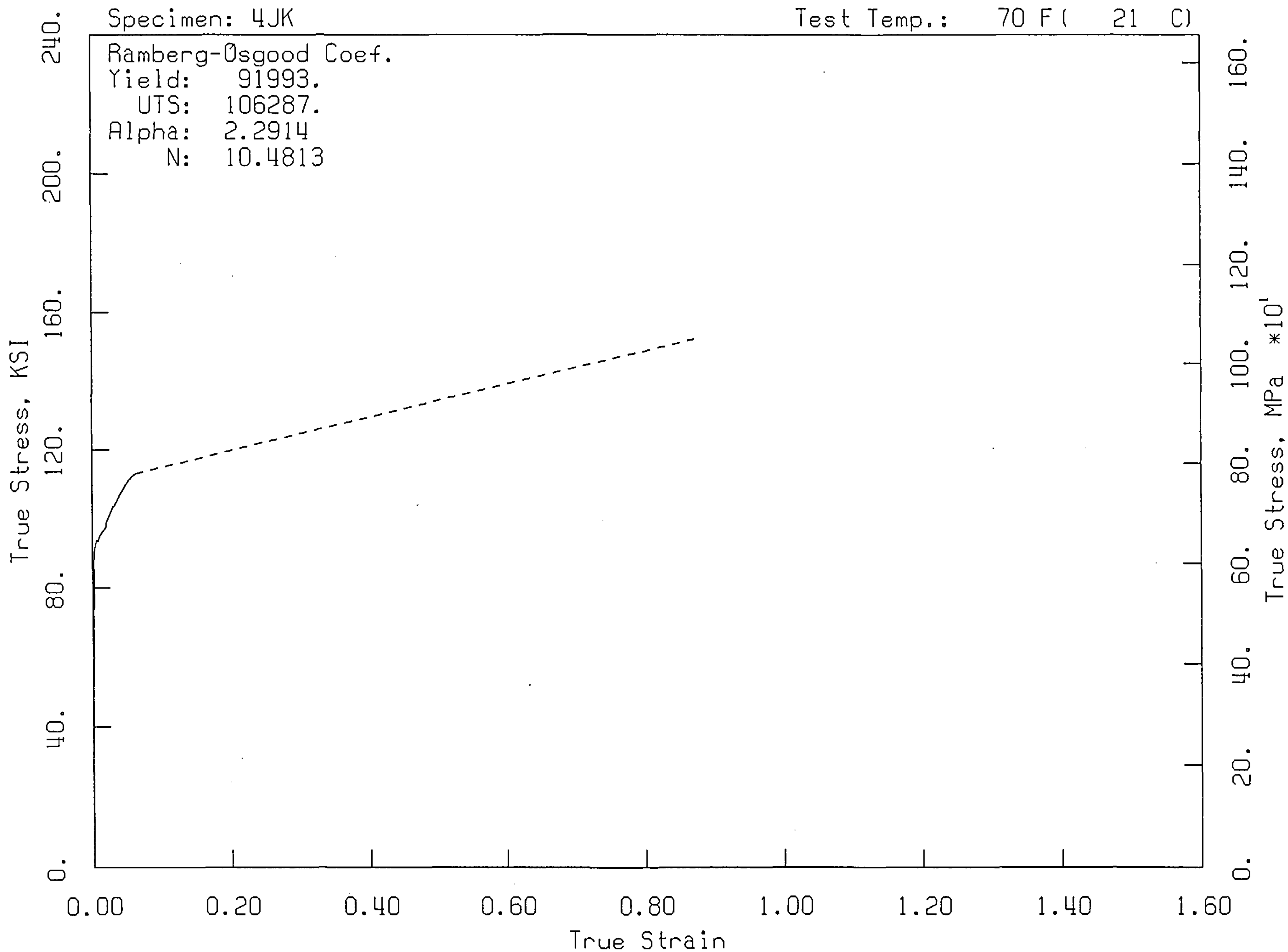
Ramberg-Osgood Equation

		Fit Std Dev
Alpha	2.291	.016
N	10.481	.134

1 Dec., 2003
File: 4JK



1 Dec., 2003
File: 4JK



TENSION TEST RECORD REPORT

PROGRAM IDENTIFICATION

Responsible Persons: | Date of Test 11/24/03

Project Leader SM Jensen | Specimen ID 41K

Machine Operator BJ Varner | Project No. 1295.001 QA No. 9900 l

Data Reduction BJ Varner | Test Machine MTS 312 Serial No. 1-0000-5631

Tech. Procedure TP-78-15 Machine Location FFL UTL "B"

SPECIMEN PARAMETERS (INITIAL)

Type: Solid Round .... Subsize Round ✓ .... Tubular .... Flat .... Other ....

Gage Length: 1.0 in. Dimensions: Nominal ✓ .... Measured .....

Outside Diameter - OD_o = 0.25 in.

Inside Diameter - ID_o = NA in.

Width - W_o = NA in. Thickness - T_o = NA in.

Area - A_o = .0491 in^2

TEST PARAMETERS

Computer Program (if used) TNSLTEST.000 Test Temp. 70 °F

Speed: Initial .0075 in/min through 4.000 in. Secondary .0312 in/min

Control Mode: Load .... Strain .... Stroke ✓ ....

Mode Ranges: Load 10 Kip Strain 5 in/in Stroke 1.0 in

TEST RESULTS

Location of Fracture Partially outside gage length

Description of Fracture ....

Other Comments ....

Dimensions After Fracture: Gage Length: NA in.

Outside Diameter - OD_{f1} = .1620 in. Width - W_f = NA in.

OD_{f2} = .1610 in. Thickness - T_f = NA in.

OD_{f3} = .1615 in. Area - A_f = .0205 in^2

CALCULATED RESULTS

Software MTAD.LOO Elastic Modulus - E = ~~2.28~~ 3.31 x 10^7 psi

0.2% Offset Yield Strength - σ_{ys} = 91993 psi

Ultimate Tensile Strength - σ_{uts} = 106287 psi

Uniform Elongation - UE = 6.01 % Total Elongation - TE = NA %

Reduction of Area - RA = 58.3 %

Ramberg-Osgood Parameters: α = 2.291 N = 10.481

Data reviewed and compared to computer results [signature] 1/8/04

TADS		1 Dec., 2003
<890928.1259>	TENSILE DATA ANALYSIS	File: 4JJ

SPECIMEN ID PARAMETERS

Date of test	12/01/20	
Operator	BJV	
Project number	1295	
Specimen	4JJ	
Test temperature	200 F	93. C
Material	HAZ	
Modulus	28469. ksi	196294. MPa
Cross Section type	CIRC	
Fluence	0.0000E+00	
Technical Specification . .	TP-78-15	

SET UP PARAMETERS

Initial disp rate	.0075 in/min	.190 mm/min
Second. disp rate	.0300 in/min	.76 mm/min
Gauge length (Ext)	1.000 in	25.40 mm

DIMENSIONAL

Diameter INITIAL	.2500 in	6.35 mm
FINAL	.1605 in	4.08 mm
Axial Fidical INITIAL . .	1.0000 in	25.40 mm
FINAL . .	.0000 in	.00 mm

TEST RESULTS

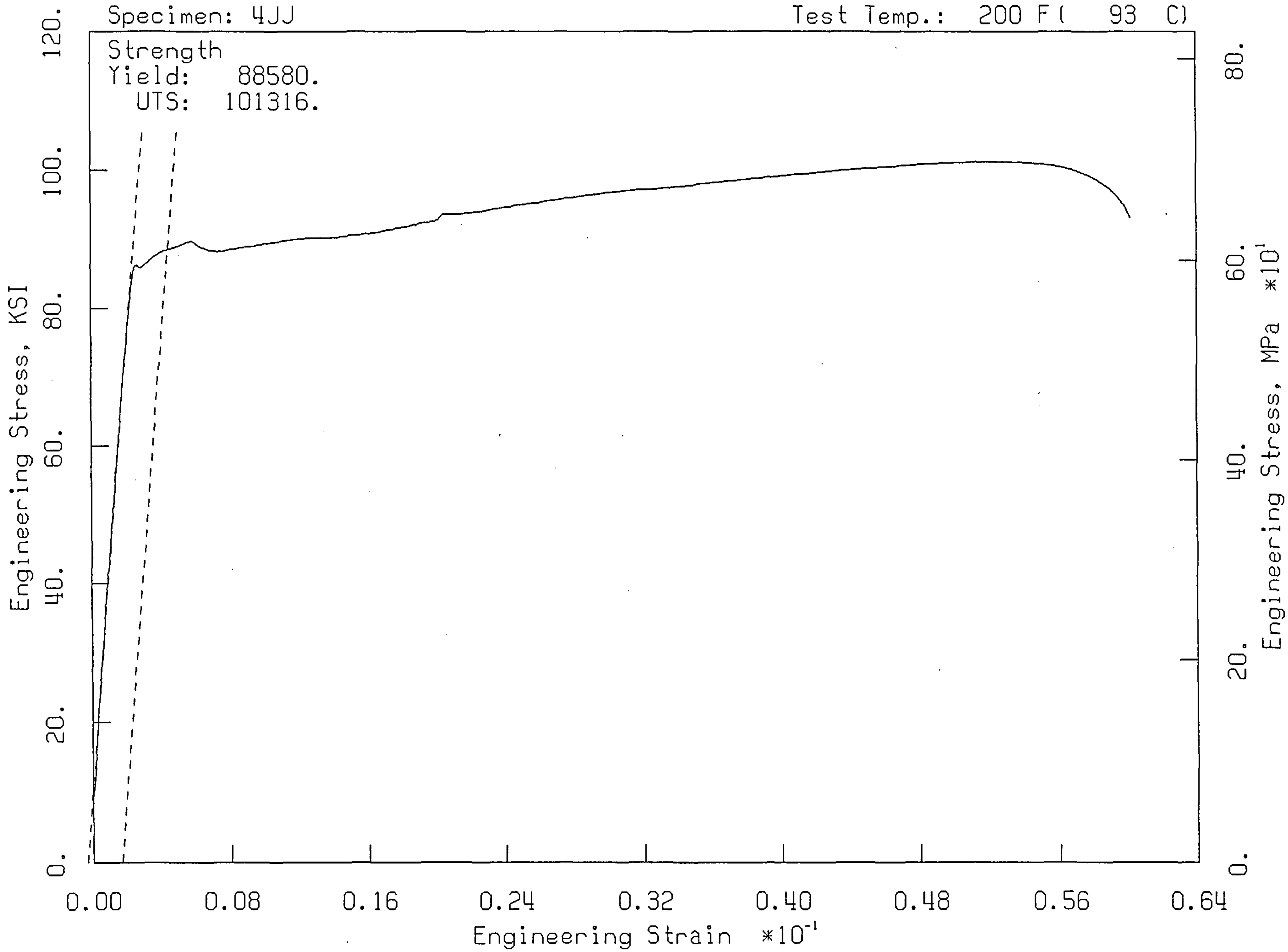
Yield Strength	88580. psi	610.8 MPa
Tensile Strength	101316. psi	698.6 MPa
Fracture Load	3468. lb	15428. N
Fracture Stress	171433. psi	1182.0 MPa
Fracture Strength	70658. psi	487.2 MPa
Young`s Modulus	3.21E+07 psi	2.22E+05 MPa
Elongation (fiducial). . .	-1.0000	
Uniform Elongation (Ext) .	.0491	
~~Total Elongation (Ext) . . .~~	~~.0577~~	
Reduction in Diameter. . .	35.8 %	
Reduction in Area	58.8 %	

CURVE FIT

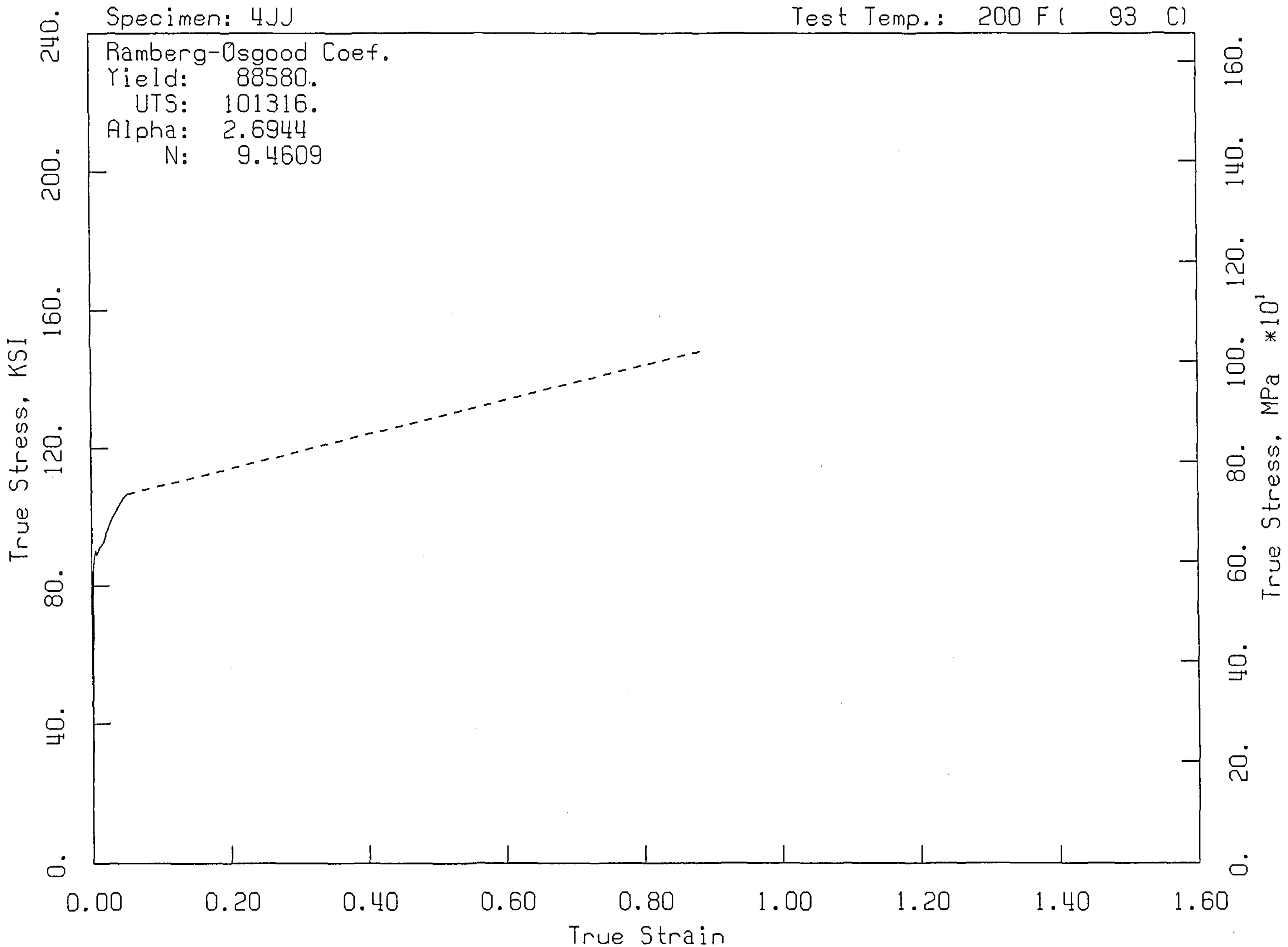
Ramberg-Osgood Equation

		Fit Std Dev
Alpha	2.694	.007
N	9.461	.064

1 Dec., 2003
File: 4JJ



1 Dec., 2003
File: 4JJ



TENSION TEST RECORD REPORT

PROGRAM IDENTIFICATION

Responsible Persons: | Date of Test ..11/25/03......

Project Leader SM Jensen .... | Specimen ID ...4JJ.........

Machine Operator BJ Vinson ...... | Project No. 1255-001.... QA No. 99001......

Data Reduction BJ Vinson .... | Test Machine MTS 312... Serial No. 1-0000-5031

Tech. Procedure .TP-78-15.. Machine Location ..PSL LTL "B"......

SPECIMEN PARAMETERS (INITIAL)

Type: Solid Round .... Subsize Round √.... Tubular .... Flat .... Other ....

Gage Length: ..1.0..in. Dimensions: Nominal √... Measured .....

Outside Diameter - OD_o = ..0.25..in.

Inside Diameter - ID_o = ..NA..in.

Width - W_o = ..NA..in. Thickness - T_o = ..NA...in.

Area - A_o = ..0491..in^2

TEST PARAMETERS

Computer Program (if used) ..TWSCPTST.000.......... Test Temp. ..200..°F

Speed: Initial ....0075 in/min.. through ..4000...in. Secondary ...03 in/min...

Control Mode: Load .... Strain .... Stroke √.........

Mode Ranges: Load 10,000 lb.. Strain ..5 in/in.. Stroke 1.0 in...

TEST RESULTS

Location of Fracture ...Outside gage length.............................

Description of Fracture ....

Other Comments ....

Dimensions After Fracture: Gage Length: ..N/A...in.

Outside Diameter - OD_{f1} = .1600.in. Width - W_f = ..NA..in.

OD_{f2} = .1610.in. Thickness - T_f = ..NA..in.

OD_{fa} = .1605.in. Area - A_f = .0202.in^2

CALCULATED RESULTS

Software ....MAOLOD.............. Elastic Modulus - E = $32.1 \times 10^{?}$ psi

0.2% Offset Yield Strength - σ_{ys} = ..88580..psi

Ultimate Tensile Strength - σ_{uts} = .101316.psi

Uniform Elongation - UE = ..4.91..% Total Elongation - TE = ..NA....%

Reduction of Area - RA = ..58.8...%

Ramberg-Osgood Parameters: α = ..2.694.. N = ..9.461.....

Data reviewed and compared to computer results ....[signature]..1/8/04........

TADS 1 Dec., 2003

<890928.1259> TENSILE DATA ANALYSIS File: 4JE

SPECIMEN ID PARAMETERS

Date of test	12/01/20	
Operator	BJV	
Project number	1295	
Specimen	4JE	
Test temperature	550 F	288. C
Material	HAZ	
Modulus	26700. ksi	184095. MPa
Cross Section type	CIRC	
Fluence	0.0000E+00	
Technical Specification . .	TP-78-15	

SET UP PARAMETERS

Initial disp rate	.0075 in/min	.190 mm/min
Second. disp rate	.0300 in/min	.76 mm/min
Gauge length (Ext)	1.000 in	25.40 mm

DIMENSIONAL

Diameter INITIAL	.2500 in	6.35 mm
FINAL	.1825 in	4.64 mm
Axial Fidical INITIAL . .	1.0000 in	25.40 mm
FINAL . .	.0000 in	.00 mm

TEST RESULTS

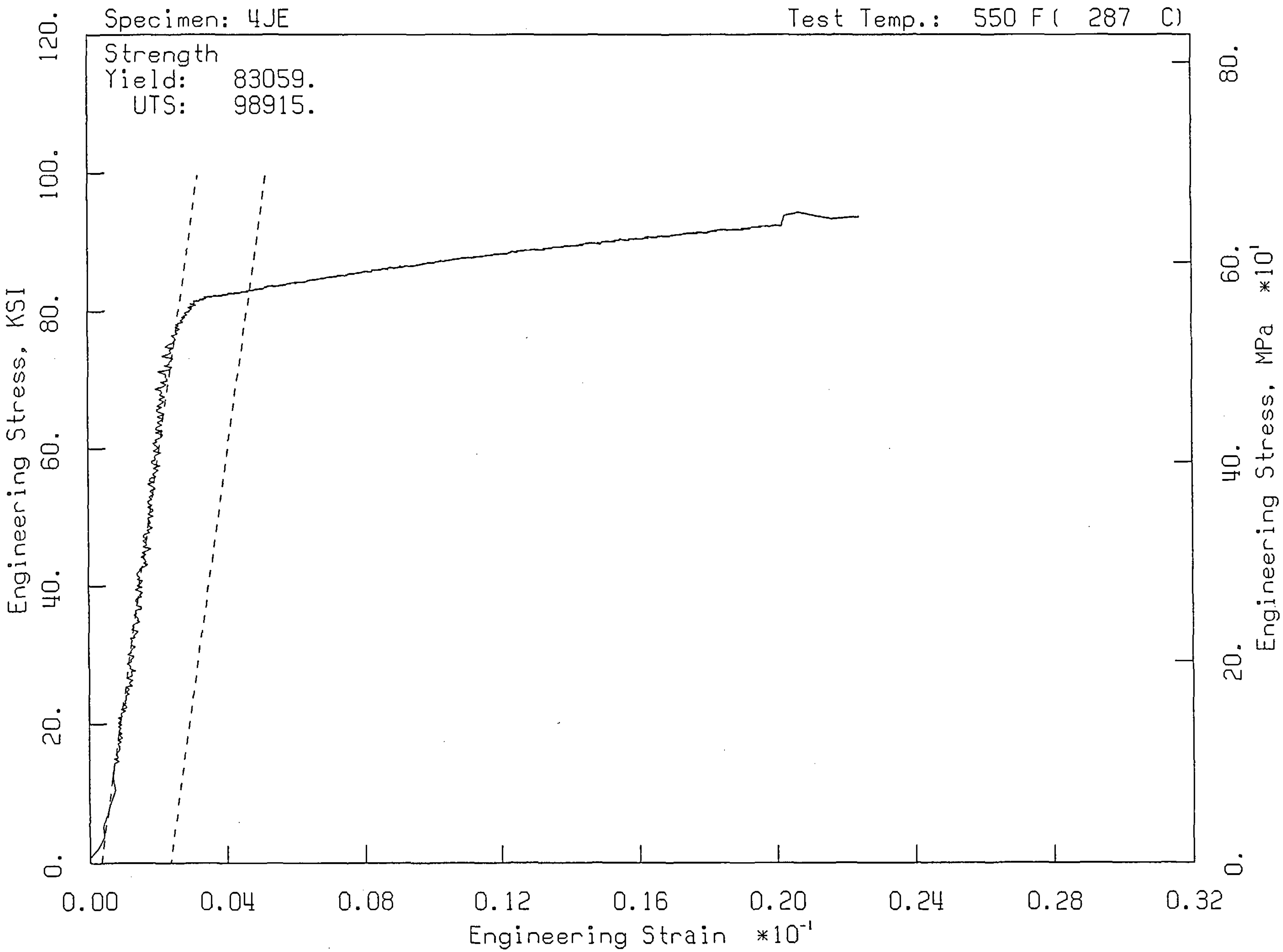
Yield Strength	83059. psi	572.7 MPa
Tensile Strength	98915. psi	682.0 MPa
Fracture Load	3841. lb	17083. N
Fracture Stress	146820. psi	1012.3 MPa
Fracture Strength	78240. psi	539.5 MPa
Young`s Modulus	3.51E+07 psi	2.42E+05 MPa
Elongation (fiducial). . . .	-1.0000	
Uniform Elongation (Ext) .	.0429	
~~Total Elongation (Ext) . .~~	~~.0194~~ BJV 12/1/07	
Reduction in Diameter. . .	27.0 %	
Reduction in Area	46.7 %	

CURVE FIT

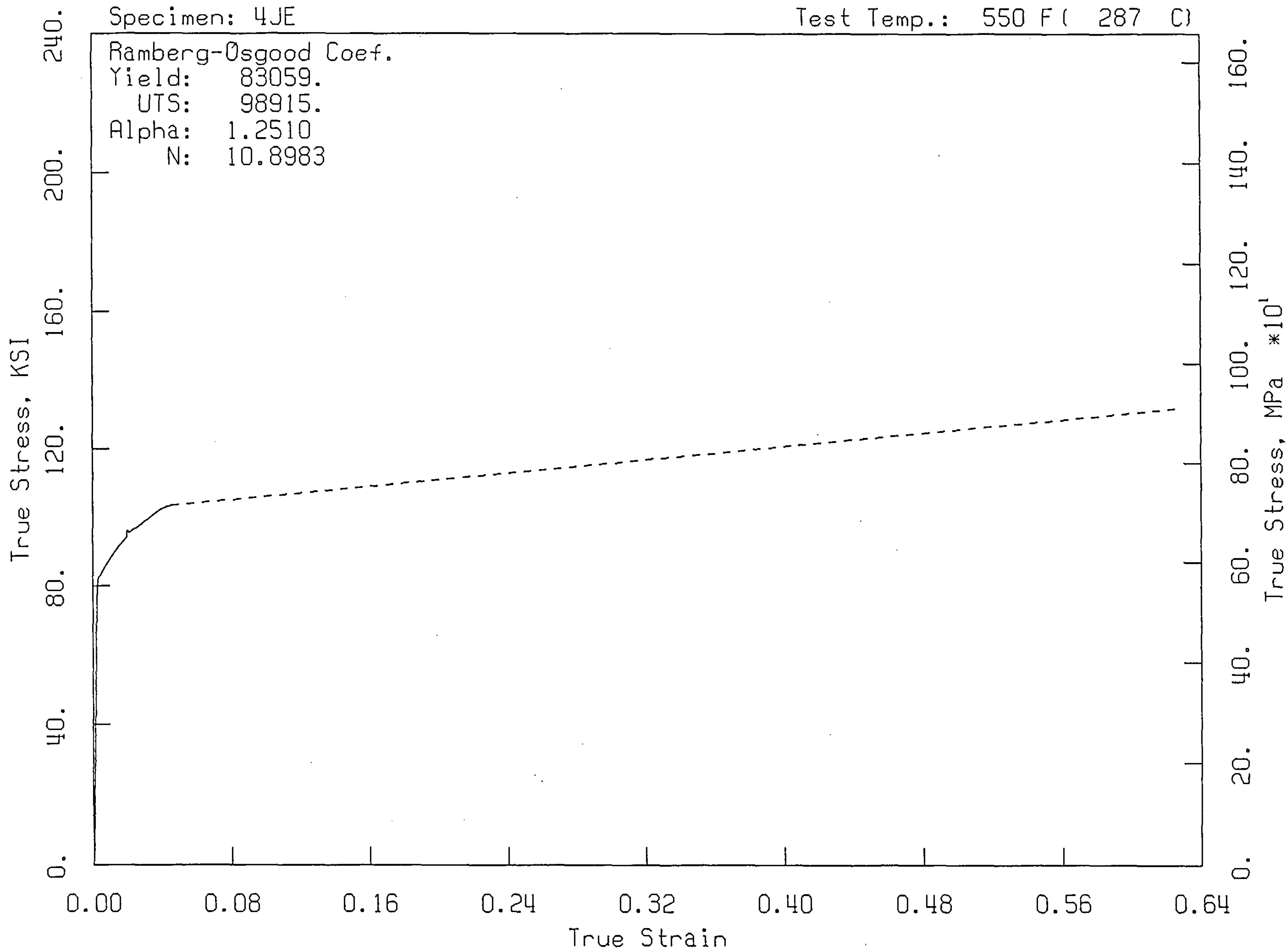
Ramberg-Osgood Equation

		Fit Std Dev
Alpha	1.251	.008
N	10.898	.059

1 Dec., 2003
File: 4JE



1 Dec., 2003
File: 4JE



TENSION TEST RECORD REPORT

PROGRAM IDENTIFICATION

Responsible Persons: | Date of Test 11/24/03

Project Leader SM... | Specimen ID 4TE

Machine Operator BJ Vawer | Project No. 1295-001 QA No. 99001

Data Reduction BJ Vawer | Test Machine MTS 312 Serial No. 1-0000-0001

Tech. Procedure R-78-15 Machine Location ...

SPECIMEN PARAMETERS (INITIAL)

Type: Solid Round .... Subsize Round √ .... Tubular .... Flat .... Other ....

Gage Length: 1.0 in. Dimensions: Nominal √ ... Measured .....

Outside Diameter - OD_o = 0.25 in.

Inside Diameter - ID_o = NA in.

Width - W_o = NA in. Thickness - T_o = NA in.

Area - A_o = 0.0491 in.^{2}

TEST PARAMETERS

Computer Program (if used) TWSUTEST.000 .... Test Temp. 550 °F

Speed: Initial .0075 in/min through yield in. Secondary .03 in/min

Control Mode: Load .... Strain .... Stroke √ ....

Mode Ranges: Load 10k ... Strain 0.5 in/in Stroke 1.0 ....

TEST RESULTS

Location of Fracture .... Outside gage section ....

Description of Fracture ....

Other Comments ....

Dimensions After Fracture: Gage Length: NA in.

Outside Diameter - OD_{f1} = .1840 in. Width - W_f = NA in.

OD_{f2} = .1810 in. Thickness - T_f = NA in.

OD_{f3} = .1825 in. Area - A_f = ~~.02...~~ .02616 in.^{2}

CALCULATED RESULTS

Software .... MTAD.LOD .... Elastic Modulus - E = 3.57×10^7 psi

0.2% Offset Yield Strength - σ_{ys} = 83059 psi

Ultimate Tensile Strength - σ_{uts} = 98915 psi

Uniform Elongation - UE = 4.29 % Total Elongation - TE = NA %

Reduction of Area - RA = 46.7 %

Ramberg-Osgood Parameters: α = 1.251 N = 10.898

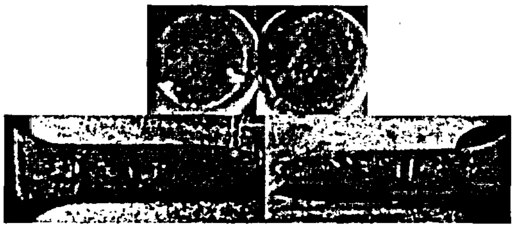
Data reviewed and compared to computer results .... [signature] 1/8/04 ....

APPENDIX F

PHOTOGRAPHS OF FRACTURED TENSILE SPECIMENS PALISADES CAPSULE W-100

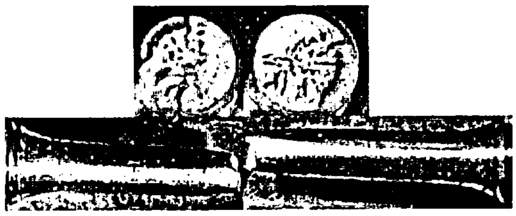
1J1 70°F

1EY 250°F

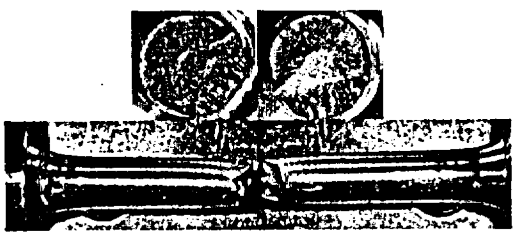


1E7 550°F

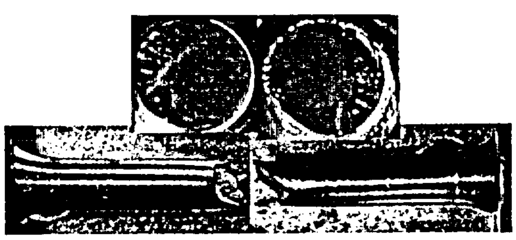
Longitudinal Base Metal Tensile Specimens



3DT 70°F

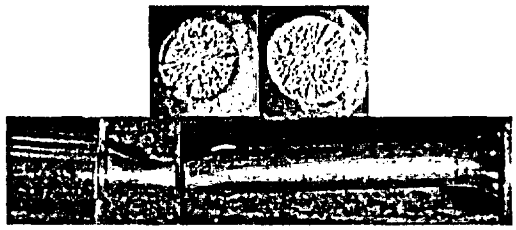


3DP 300°F

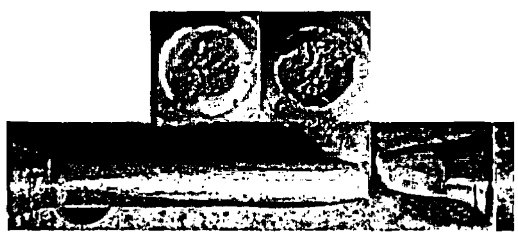


3DM 550°F

Weld Metal Tensile Specimens



4JK 70°F



4JJ 200°F

4JE 550°F

HAZ Tensile Specimens

APPENDIX G

DOSIMETER ANALYSIS DATA TABLES

SHUTDOWN DATE: MAR. 16, 2003 PALISADES W-100 CAPSULE DOSIMETRY

Cu DOSIMETERS	Type	Target Nuclide	Analyte Nuclide	Weight Fraction	Volume Fraction	Shielded (Yes/No)	Volume of Sample (ml)	+/-	Volume Error (ml)
PALISADES W-100 Seg 1 Top	WIRE	Cu-63	Co-60	0.6850	N/A	Yes	20.00000	+/-	0.08000
PALISADES W-100 Seg 4 Middle	WIRE	Cu-63	Co-60	0.6850	N/A	Yes	20.00000	+/-	0.08000
PALISADES W-100 Seg 7 Bottom	WIRE	Cu-63	Co-60	0.6850	N/A	Yes	20.00000	+/-	0.08000

Fe DOSIMETERS	Type	Target Nuclide	Analyte Nuclide	Weight Fraction	Volume Fraction	Shielded (Yes/No)	Post-Irrad Weight (grams)	+/-	Weight Error (grams)
PALISADES W-100 1 Top T83A	WIRE	Fe-54	Mn-54	0.0569	N/A	No	0.01060	+/-	0.00030
PALISADES W-100 1 Top T83B	WIRE	Fe-54	Mn-54	0.0569	N/A	No	0.00700	+/-	0.00030
PALISADES W-100 1 Top T161	WIRE	Fe-54	Mn-54	0.0569	N/A	No	0.01420	+/-	0.00030
PALISADES W-100 1 Top T162	WIRE	Fe-54	Mn-54	0.0569	N/A	No	0.01410	+/-	0.00030
PALISADES W-100 1 Top T163	WIRE	Fe-54	Mn-54	0.0569	N/A	No	0.01430	+/-	0.00030
PALISADES W-100 1 Top T164	WIRE	Fe-54	Mn-54	0.0569	N/A	No	0.01480	+/-	0.00030
PALISADES W-100 1 Top T165	WIRE	Fe-54	Mn-54	0.0569	N/A	No	0.01450	+/-	0.00030
PALISADES W-100 Middle M83A	WIRE	Fe-54	Mn-54	0.0569	N/A	No	0.01110	+/-	0.00030
PALISADES W-100 Middle M83B	WIRE	Fe-54	Mn-54	0.0569	N/A	No	0.00780	+/-	0.00030
PALISADES W-100 1 Middle M161	WIRE	Fe-54	Mn-54	0.0569	N/A	No	0.01410	+/-	0.00030
PALISADES W-100 1 Middle M162	WIRE	Fe-54	Mn-54	0.0569	N/A	No	0.01450	+/-	0.00030
PALISADES W-100 1 Middle M163	WIRE	Fe-54	Mn-54	0.0569	N/A	No	0.01420	+/-	0.00030
PALISADES W-100 1 Middle M164	WIRE	Fe-54	Mn-54	0.0569	N/A	No	0.01430	+/-	0.00030

Cu DOSIMETERS	Aliquot Drawn (ml)	+/-	Volume Error (ml)	Diluted to (ml)	+/-	Dilute Error (ml)	Conc. of Target in Dil Sol (ppm)	+/-	Concentration Error (ppm)	Element
PALISADES W-100 Seg 1 Top	1.0000	+/-	0.0800	1.0000	+/-	0.08	3470.0000	+/-	173.5000	Cu
PALISADES W-100 Seg 4 Middle	1.0000	+/-	0.0800	1.0000	+/-	0.08	2110.0000	+/-	105.5000	Cu
PALISADES W-100 Seg 7 Bottom	1.0000	+/-	0.0800	1.0000	+/-	0.08	2720.0000	+/-	136.0000	Cu

Fe DOSIMETERS	End (cm.)	Mid (cm.)	End (cm.)	Average Wire Diameter (cm.)	+/-	Diameter Error (cm.)	Wire Length (cm)	Element
PALISADES W-100 1 Top T83A	0.0178	0.0178	0.0178	0.0178	+/-	0.0005	4.689	Fe
PALISADES W-100 1 Top T83B	0.0178	0.0178	0.0178	0.0178	+/-	0.0005	3.124	Fe
PALISADES W-100 1 Top T161	0.0203	0.0203	0.0203	0.0203	+/-	0.0005	4.651	Fe
PALISADES W-100 1 Top T162	0.0203	0.0203	0.0203	0.0203	+/-	0.0005	4.679	Fe
PALISADES W-100 1 Top T163	0.0203	0.0203	0.0203	0.0203	+/-	0.0005	4.669	Fe
PALISADES W-100 1 Top T164	0.0203	0.0203	0.0203	0.0203	+/-	0.0005	4.686	Fe
PALISADES W-100 1 Top T165	0.0203	0.0203	0.0203	0.0203	+/-	0.0005	4.694	Fe
PALISADES W-100 Middle M83A	0.0254	0.0254	0.0254	0.0254	+/-	0.0005	4.470	Fe
PALISADES W-100 Middle M83B	0.0254	0.0254	0.0254	0.0254	+/-	0.0005	2.720	Fe
PALISADES W-100 1 Middle M161	0.0203	0.0203	0.0203	0.0203	+/-	0.0005	4.686	Fe
PALISADES W-100 1 Middle M162	0.0203	0.0203	0.0203	0.0203	+/-	0.0005	4.663	Fe
PALISADES W-100 1 Middle M163	0.0203	0.0203	0.0203	0.0203	+/-	0.0005	4.684	Fe
PALISADES W-100 1 Middle M164	0.0203	0.0203	0.0203	0.0203	+/-	0.0005	4.679	Fe

Cu DOSIMETERS	Attenuation Coefficient u	Shelf Letter	Detector Distance (cm.)	+/-	Distance Error (cm.)	Co-60 Activity (uCi)	+/-	Activity Error (%)	Grams of Target Cu	+/-
PALISADES W-100 Seg 1 Top	4.544E-01	NA	NA	+/-	NA	2.730E-01	+/-	0.85	6.940E-02	+/-
PALISADES W-100 Seg 4 Middle	4.544E-01	NA	NA	+/-	NA	1.790E-01	+/-	1.00	4.220E-02	+/-
PALISADES W-100 Seg 7 Bottom	4.544E-01	NA	NA	+/-	NA	2.630E-01	+/-	0.87	5.440E-02	+/-

Fe DOSIMETERS	Attenuation Coefficient u	Shelf Letter	Detector Distance (cm.)	+/-	Distance Error (cm.)	Mn-54 Activity (uCi)	+/-	Activity Error (%)	Geometry Offset Factor	+/-
PALISADES W-100 1 Top T83A	5.145E-01	E	7.718	+/-	0.068	3.310E-01	+/-	0.59	0.9977	+/-
PALISADES W-100 1 Top T83B	5.145E-01	E	7.718	+/-	0.068	2.340E-01	+/-	0.68	0.9977	+/-
PALISADES W-100 1 Top T161	5.145E-01	E	7.679	+/-	0.073	4.870E-01	+/-	0.45	0.9974	+/-
PALISADES W-100 1 Top T162	5.145E-01	E	7.718	+/-	0.068	4.690E-01	+/-	0.48	0.9974	+/-
PALISADES W-100 1 Top T163	5.145E-01	E	7.679	+/-	0.073	4.990E-01	+/-	0.45	0.9974	+/-
PALISADES W-100 1 Top T164	5.145E-01	E	7.718	+/-	0.068	5.050E-01	+/-	0.46	0.9974	+/-
PALISADES W-100 1 Top T165	5.145E-01	E	7.679	+/-	0.073	4.700E-01	+/-	0.49	0.9974	+/-
PALISADES W-100 Middle M83A	5.145E-01	E	7.718	+/-	0.068	3.020E-01	+/-	0.61	0.9967	+/-
PALISADES W-100 Middle M83B	5.145E-01	E	7.718	+/-	0.068	2.250E-01	+/-	0.69	0.9967	+/-
PALISADES W-100 1 Middle M161	5.145E-01	E	7.718	+/-	0.068	4.600E-01	+/-	0.49	0.9974	+/-
PALISADES W-100 1 Middle M162	5.145E-01	E	7.679	+/-	0.073	4.800E-01	+/-	0.47	0.9974	+/-
PALISADES W-100 1 Middle M163	5.145E-01	E	7.679	+/-	0.073	4.890E-01	+/-	0.46	0.9974	+/-
PALISADES W-100 1 Middle M164	5.145E-01	E	7.718	+/-	0.068	4.320E-01	+/-	0.51	0.9974	+/-

SHUTDOWN DATE: MAR. 16, 2003 PALISADES W-100 CAPSULE DOSIMETRY

Cu DOSIMETERS	Target Error	G2	+/-	G2 Error	U2	+/-	U2 Error	Self Abs. Wires V2	+/-
PALISADES W-100 Seg 1 Top	3.481E-03	N/A	+/-	N/A	N/A	+/-	N/A	N/A	+/-
PALISADES W-100 Seg 4 Middle	2.117E-03	N/A	+/-	N/A	N/A	+/-	N/A	N/A	+/-
PALISADES W-100 Seg 7 Bottom	2.729E-03	N/A	+/-	N/A	N/A	+/-	N/A	N/A	+/-

Fe DOSIMETERS	Offset Factor Error	G2	+/-	G2 Error	U2	+/-	U2 Error	Self Abs. Wires V2	+/-
PALISADES W-100 1 Top T83A	0.0298	1.0000	+/-	0.0298	0.9993	+/-	0.0298	0.9990	+/-
PALISADES W-100 1 Top T83B	0.0298	1.0000	+/-	0.0298	0.9993	+/-	0.0298	0.9990	+/-
PALISADES W-100 1 Top T161	0.0267	1.0000	+/-	0.0267	0.9992	+/-	0.0267	0.9988	+/-
PALISADES W-100 1 Top T162	0.0264	1.0000	+/-	0.0264	0.9992	+/-	0.0264	0.9988	+/-
PALISADES W-100 1 Top T163	0.0267	1.0000	+/-	0.0267	0.9992	+/-	0.0267	0.9988	+/-
PALISADES W-100 1 Top T164	0.0264	1.0000	+/-	0.0264	0.9992	+/-	0.0264	0.9988	+/-
PALISADES W-100 1 Top T165	0.0267	1.0000	+/-	0.0267	0.9992	+/-	0.0267	0.9988	+/-
PALISADES W-100 Middle M83A	0.0218	1.0000	+/-	0.0218	0.9990	+/-	0.0218	0.9985	+/-
PALISADES W-100 Middle M83B	0.0218	1.0000	+/-	0.0218	0.9990	+/-	0.0218	0.9985	+/-
PALISADES W-100 1 Middle M161	0.0264	1.0000	+/-	0.0264	0.9992	+/-	0.0264	0.9988	+/-
PALISADES W-100 1 Middle M162	0.0267	1.0000	+/-	0.0267	0.9992	+/-	0.0267	0.9988	+/-
PALISADES W-100 1 Middle M163	0.0267	1.0000	+/-	0.0267	0.9992	+/-	0.0267	0.9988	+/-
PALISADES W-100 1 Middle M164	0.0264	1.0000	+/-	0.0264	0.9992	+/-	0.0264	0.9988	+/-

Cu DOSIMETERS

	V2 Error	W2	+/-	W2 Error	Abs. Factor	+/-	Factor Error	Corrected Activity (uCi/gram)	+/-
PALISADES W-100 Seg 1 Top	N/A	N/A	+/-	N/A	N/A	+/-	N/A	N/A	+/-
PALISADES W-100 Seg 4 Middle	N/A	N/A	+/-	N/A	N/A	+/-	N/A	N/A	+/-
PALISADES W-100 Seg 7 Bottom	N/A	N/A	+/-	N/A	N/A	+/-	N/A	N/A	+/-

Fe DOSIMETERS

	V2 Error	W2	+/-	W2 Error	Abs. Factor	+/-	Factor Error	Corrected Activity (uCi/gram)	+/-
PALISADES W-100 1 Top T83A	0.0298	0.9987	+/-	0.0298	1.0039	+/-	0.0664	3.142E+01	+/-
PALISADES W-100 1 Top T83B	0.0298	0.9987	+/-	0.0298	1.0039	+/-	0.0664	3.364E+01	+/-
PALISADES W-100 1 Top T161	0.0267	0.9985	+/-	0.0267	1.0044	+/-	0.0592	3.454E+01	+/-
PALISADES W-100 1 Top T162	0.0264	0.9985	+/-	0.0264	1.0044	+/-	0.0588	3.350E+01	+/-
PALISADES W-100 1 Top T163	0.0267	0.9985	+/-	0.0267	1.0044	+/-	0.0592	3.514E+01	+/-
PALISADES W-100 1 Top T164	0.0264	0.9985	+/-	0.0264	1.0044	+/-	0.0588	3.436E+01	+/-
PALISADES W-100 1 Top T165	0.0267	0.9985	+/-	0.0267	1.0044	+/-	0.0592	3.264E+01	+/-
PALISADES W-100 Middle M83A	0.0218	0.9982	+/-	0.0218	1.0055	+/-	0.0482	2.745E+01	+/-
PALISADES W-100 Middle M83B	0.0218	0.9982	+/-	0.0218	1.0055	+/-	0.0482	2.910E+01	+/-
PALISADES W-100 1 Middle M161	0.0264	0.9985	+/-	0.0264	1.0044	+/-	0.0588	3.286E+01	+/-
PALISADES W-100 1 Middle M162	0.0267	0.9985	+/-	0.0267	1.0044	+/-	0.0592	3.334E+01	+/-
PALISADES W-100 1 Middle M163	0.0267	0.9985	+/-	0.0267	1.0044	+/-	0.0592	3.468E+01	+/-
PALISADES W-100 1 Middle M164	0.0264	0.9985	+/-	0.0264	1.0044	+/-	0.0588	3.042E+01	+/-

Cu DOSIMETERS	Activity Error (uCi/gram)	Systematic Error (%)	uCi/gram Target Cu-63	+/-	Error (uCi/gram)	% Error (%)
PALISADES W-100 Seg 1 Top	N/A	4.50	5.743E+00	+/-	2.922E-01	6.79
PALISADES W-100 Seg 4 Middle	N/A	4.50	6.192E+00	+/-	3.167E-01	6.81
PALISADES W-100 Seg 7 Bottom	N/A	4.50	7.058E+00	+/-	3.593E-01	6.79

Fe DOSIMETERS	Activity Error (uCi/gram)	Systematic Error (%)	uCi/gram Target Fe-54	+/-	Error (uCi/gram)	% Error (%)
PALISADES W-100 1 Top T83A	2.456E+00	4.50	5.520E+02	+/-	4.315E+01	9.02
PALISADES W-100 1 Top T83B	2.846E+00	4.50	5.909E+02	+/-	4.999E+01	9.58
PALISADES W-100 1 Top T161	2.357E+00	4.50	6.068E+02	+/-	4.141E+01	8.18
PALISADES W-100 1 Top T162	2.273E+00	4.50	5.885E+02	+/-	3.993E+01	8.14
PALISADES W-100 1 Top T163	2.397E+00	4.50	6.174E+02	+/-	4.211E+01	8.17
PALISADES W-100 1 Top T164	2.321E+00	4.50	6.037E+02	+/-	4.077E+01	8.11
PALISADES W-100 1 Top T165	2.225E+00	4.50	5.735E+02	+/-	3.908E+01	8.17
PALISADES W-100 Middle M83A	1.635E+00	4.50	4.822E+02	+/-	2.872E+01	7.46
PALISADES W-100 Middle M83B	1.910E+00	4.50	5.112E+02	+/-	3.355E+01	7.96
PALISADES W-100 1 Middle M161	2.230E+00	4.50	5.772E+02	+/-	3.917E+01	8.14
PALISADES W-100 1 Middle M162	2.271E+00	4.50	5.857E+02	+/-	3.990E+01	8.17
PALISADES W-100 1 Middle M163	2.367E+00	4.50	6.093E+02	+/-	4.159E+01	8.18
PALISADES W-100 1 Middle M164	2.062E+00	4.50	5.345E+02	+/-	3.623E+01	8.14

PALISADES W-100 1 Middle M165	WIRE	Fe-54	Mn-54	0.0569	N/A	No	0.01400	+/-	0.00030
PALISADES W-100 Bottom B83A	WIRE	Fe-54	Mn-54	0.0569	N/A	No	0.01420	+/-	0.00030
PALISADES W-100 Bottom B83B	WIRE	Fe-54	Mn-54	0.0569	N/A	No	0.00920	+/-	0.00030
PALISADES W-100 Bottom B161	WIRE	Fe-54	Mn-54	0.0569	N/A	No	0.01430	+/-	0.00030
PALISADES W-100 Bottom B162	WIRE	Fe-54	Mn-54	0.0569	N/A	No	0.01440	+/-	0.00030
PALISADES W-100 Bottom B163	WIRE	Fe-54	Mn-54	0.0569	N/A	No	0.01390	+/-	0.00030
PALISADES W-100 Bottom B164	WIRE	Fe-54	Mn-54	0.0569	N/A	No	0.00960	+/-	0.00030
PALISADES W-100 Bottom B165	WIRE	Fe-54	Mn-54	0.0569	N/A	No	0.01440	+/-	0.00030

Ti DOSIMETERS	Type	Target Nuclide	Analyte Nuclide	Weight Fraction	Volume Fraction	Shielded (Yes/No)	Post-Irrad Weight (grams)	+/-	Weight Error (grams)
PALISADES W-100 Top	WIRE	Ti-46	Sc-46	0.0791	N/A	No	0.02190	+/-	0.00030
PALISADES W-100 Middle	WIRE	Ti-46	Sc-46	0.0791	N/A	No	0.02790	+/-	0.00030
PALISADES W-100 Bottom	WIRE	Ti-46	Sc-46	0.0791	N/A	No	0.02560	+/-	0.00030

Ni DOSIMETERS	Type	Target Nuclide	Analyte Nuclide	Weight Fraction	Volume Fraction	Shielded (Yes/No)	Post-Irrad Weight (grams)	+/-	Weight Error (grams)
PALISADES W-100 Top	WIRE	Ni-58	Co-58	0.6736	N/A	Yes	0.02400	+/-	0.00030
PALISADES W-100 Middle	WIRE	Ni-58	Co-58	0.6736	N/A	Yes	0.02360	+/-	0.00030
PALISADES W-100 Bottom	WIRE	Ni-58	Co-58	0.6736	N/A	Yes	0.02600	+/-	0.00030

PALISADES W-100 1 Middle M165	0.0203	0.0203	0.0203	0.0203	+/-	0.0005	4.699	Fe
PALISADES W-100 Bottom B83A	0.0203	0.0203	0.0203	0.0203	+/-	0.0005	4.618	Fe
PALISADES W-100 Bottom B83B	0.0203	0.0203	0.0203	0.0203	+/-	0.0005	3.127	Fe
PALISADES W-100 Bottom B161	0.0203	0.0203	0.0203	0.0203	+/-	0.0005	4.669	Fe
PALISADES W-100 Bottom B162	0.0203	0.0203	0.0203	0.0203	+/-	0.0005	4.684	Fe
PALISADES W-100 Bottom B163	0.0203	0.0203	0.0203	0.0203	+/-	0.0005	4.707	Fe
PALISADES W-100 Bottom B164	0.0203	0.0203	0.0203	0.0203	+/-	0.0005	3.170	Fe
PALISADES W-100 Bottom B165	0.0203	0.0203	0.0203	0.0203	+/-	0.0005	4.722	Fe

Ti DOSIMETERS	End (cm.)	Mid (cm.)	End (cm.)	Average Wire Diameter (cm.)	+/-	Diameter Error (cm.)	Wire Length (cm)	Element
PALISADES W-100 Top	0.0533	0.0533	0.0533	0.0533	+/-	0.0005	2.809	Ti
PALISADES W-100 Middle	0.0533	0.0533	0.0533	0.0533	+/-	0.0005	3.343	Ti
PALISADES W-100 Bottom	0.0508	0.0508	0.0508	0.0508	+/-	0.0005	3.353	Ti

Ni DOSIMETERS	End (cm.)	Mid (cm.)	End (cm.)	Average Wire Diameter (cm.)	+/-	Diameter Error (cm.)	Wire Length (cm)	Element
PALISADES W-100 Top	0.0457	0.0457	0.0457	0.0457	+/-	0.0005	1.499	Ni
PALISADES W-100 Middle	0.0483	0.0483	0.0483	0.0483	+/-	0.0005	1.486	Ni
PALISADES W-100 Bottom	0.0457	0.0457	0.0457	0.0457	+/-	0.0005	1.562	Ni

PALISADES W-100 1 Middle M165	5.145E-01	E	7.679	+/-	0.073	5.120E-01	+/-	0.46	0.9974	+/-
PALISADES W-100 Bottom B83A	5.145E-01	E	7.718	+/-	0.068	4.670E-01	+/-	0.49	0.9974	+/-
PALISADES W-100 Bottom B83B	5.145E-01	E	7.679	+/-	0.073	3.340E-01	+/-	0.55	0.9974	+/-
PALISADES W-100 Bottom B161	5.145E-01	E	7.718	+/-	0.068	4.560E-01	+/-	0.48	0.9974	+/-
PALISADES W-100 Bottom B162	5.145E-01	E	7.679	+/-	0.073	4.940E-01	+/-	0.47	0.9974	+/-
PALISADES W-100 Bottom B163	5.145E-01	E	7.718	+/-	0.068	4.650E-01	+/-	0.49	0.9974	+/-
PALISADES W-100 Bottom B164	5.145E-01	E	7.718	+/-	0.068	3.360E-01	+/-	0.58	0.9974	+/-
PALISADES W-100 Bottom B165	5.145E-01	E	7.718	+/-	0.068	4.610E-01	+/-	0.49	0.9974	+/-

Ti DOSIMETERS	Attenuation Coefficient u	Shelf Letter	Detector Distance (cm.)	+/-	Distance Error (cm.)	Sc-46 Activity (uCi)	+/-	Activity Error (%)	Geometry Offset Factor	+/-
PALISADES W-100 Top	5.145E-01	D	2.690	+/-	0.026	3.020E-01	+/-	0.90	0.9805	+/-
PALISADES W-100 Middle	5.145E-01	D	2.683	+/-	0.026	3.390E-01	+/-	0.98	0.9805	+/-
PALISADES W-100 Bottom	5.145E-01	D	2.690	+/-	0.026	3.540E-01	+/-	0.97	0.9814	+/-

Ni DOSIMETERS	Attenuation Coefficient u	Shelf Letter	Detector Distance (cm.)	+/-	Distance Error (cm.)	Co-58 Activity (uCi)	+/-	Activity Error (%)	Geometry Offset Factor	+/-
PALISADES W-100 Top	6.092E-01	E	7.679	+/-	0.073	1.470E+01	+/-	0.19	0.9941	+/-
PALISADES W-100 Middle	6.092E-01	E	7.718	+/-	0.068	1.280E+01	+/-	0.21	0.9938	+/-
PALISADES W-100 Bottom	6.092E-01	E	7.679	+/-	0.073	1.400E+01	+/-	0.20	0.9941	+/-

PALISADES W-100 1 Middle M165	0.0267	1.0000	+/-	0.0267	0.9992	+/-	0.0267	0.9988	+/-
PALISADES W-100 Bottom B83A	0.0264	1.0000	+/-	0.0264	0.9992	+/-	0.0264	0.9988	+/-
PALISADES W-100 Bottom B83B	0.0267	1.0000	+/-	0.0267	0.9992	+/-	0.0267	0.9988	+/-
PALISADES W-100 Bottom B161	0.0264	1.0000	+/-	0.0264	0.9992	+/-	0.0264	0.9988	+/-
PALISADES W-100 Bottom B162	0.0267	1.0000	+/-	0.0267	0.9992	+/-	0.0267	0.9988	+/-
PALISADES W-100 Bottom B163	0.0264	1.0000	+/-	0.0264	0.9992	+/-	0.0264	0.9988	+/-
PALISADES W-100 Bottom B164	0.0264	1.0000	+/-	0.0264	0.9992	+/-	0.0264	0.9988	+/-
PALISADES W-100 Bottom B165	0.0264	1.0000	+/-	0.0264	0.9992	+/-	0.0264	0.9988	+/-

Ti DOSIMETERS	Offset Factor Error	G2	+/-	G2 Error	U2	+/-	U2 Error	Self Abs. Wires V2	+/-
PALISADES W-100 Top	0.0133	1.0000	+/-	0.0133	0.9943	+/-	0.0133	0.9912	+/-
PALISADES W-100 Middle	0.0133	1.0000	+/-	0.0133	0.9943	+/-	0.0133	0.9912	+/-
PALISADES W-100 Bottom	0.0136	1.0000	+/-	0.0136	0.9945	+/-	0.0136	0.9916	+/-

Ni DOSIMETERS	Offset Factor Error	G2	+/-	G2 Error	U2	+/-	U2 Error	Self Abs. Wires V2	+/-
PALISADES W-100 Top	0.0145	1.0000	+/-	0.0145	0.9983	+/-	0.0145	0.9973	+/-
PALISADES W-100 Middle	0.0136	1.0000	+/-	0.0136	0.9982	+/-	0.0136	0.9972	+/-
PALISADES W-100 Bottom	0.0145	1.0000	+/-	0.0145	0.9983	+/-	0.0145	0.9973	+/-

SHUTDOWN DATE: MAR. 16, 2003 PALISADES W-100 CAPSULE DOSIMETRY

PALISADES W-100 1 Middle M165	0.0267	0.9985	+/-	0.0267	1.0044	+/-	0.0592	3.683E+01	+/-
PALISADES W-100 Bottom B83A	0.0264	0.9985	+/-	0.0264	1.0044	+/-	0.0588	3.312E+01	+/-
PALISADES W-100 Bottom B83B	0.0267	0.9985	+/-	0.0267	1.0044	+/-	0.0592	3.656E+01	+/-
PALISADES W-100 Bottom B161	0.0264	0.9985	+/-	0.0264	1.0044	+/-	0.0588	3.211E+01	+/-
PALISADES W-100 Bottom B162	0.0267	0.9985	+/-	0.0267	1.0044	+/-	0.0592	3.455E+01	+/-
PALISADES W-100 Bottom B163	0.0264	0.9985	+/-	0.0264	1.0044	+/-	0.0588	3.369E+01	+/-
PALISADES W-100 Bottom B164	0.0264	0.9985	+/-	0.0264	1.0044	+/-	0.0588	3.525E+01	+/-
PALISADES W-100 Bottom B165	0.0264	0.9985	+/-	0.0264	1.0044	+/-	0.0588	3.224E+01	+/-

Ti DOSIMETERS	V2 Error	W2	+/-	W2 Error	Abs. Factor	+/-	Factor Error	Corrected Activity (uCi/gram)	+/-
PALISADES W-100 Top	0.0133	0.9892	+/-	0.0133	1.0116	+/-	0.0288	1.423E+01	+/-
PALISADES W-100 Middle	0.0133	0.9891	+/-	0.0133	1.0116	+/-	0.0288	1.254E+01	+/-
PALISADES W-100 Bottom	0.0136	0.9897	+/-	0.0136	1.0110	+/-	0.0296	1.424E+01	+/-

Ni DOSIMETERS	V2 Error	W2	+/-	W2 Error	Abs. Factor	+/-	Factor Error	Corrected Activity (uCi/gram)	+/-
PALISADES W-100 Top	0.0145	0.9967	+/-	0.0145	1.0118	+/-	0.0315	6.234E+02	+/-
PALISADES W-100 Middle	0.0136	0.9966	+/-	0.0136	1.0125	+/-	0.0297	5.526E+02	+/-
PALISADES W-100 Bottom	0.0145	0.9967	+/-	0.0145	1.0118	+/-	0.0315	5.481E+02	+/-

PALISADES W-100 1 Middle M165	2.517E+00	4.50	6.470E+02	+/-	4.423E+01	8.18
PALISADES W-100 Bottom B83A	2.246E+00	4.50	5.818E+02	+/-	3.946E+01	8.14
PALISADES W-100 Bottom B83B	2.658E+00	4.50	6.423E+02	+/-	4.670E+01	8.55
PALISADES W-100 Bottom B161	2.176E+00	4.50	5.642E+02	+/-	3.823E+01	8.13
PALISADES W-100 Bottom B162	2.355E+00	4.50	6.069E+02	+/-	4.138E+01	8.17
PALISADES W-100 Bottom B163	2.289E+00	4.50	5.919E+02	+/-	4.022E+01	8.15
PALISADES W-100 Bottom B164	2.527E+00	4.50	6.192E+02	+/-	4.439E+01	8.46
PALISADES W-100 Bottom B165	2.183E+00	4.50	5.664E+02	+/-	3.836E+01	8.13

Ti DOSIMETERS	Activity Error (uCi/gram)	Systematic Error (%)	uCi/gram Target Ti-46	+/-	Error (uCi/gram)	% Error (%)
PALISADES W-100 Top	5.051E-01	4.50	1.798E+02	+/-	6.383E+00	5.73
PALISADES W-100 Middle	4.353E-01	4.50	1.584E+02	+/-	5.501E+00	5.68
PALISADES W-100 Bottom	5.095E-01	4.50	1.800E+02	+/-	6.438E+00	5.75

Ni DOSIMETERS	Activity Error (uCi/gram)	Systematic Error (%)	uCi/gram Target Ni-58	+/-	Error (uCi/gram)	% Error (%)
PALISADES W-100 Top	2.287E+01	4.50	9.256E+02	+/-	3.395E+01	5.81
PALISADES W-100 Middle	1.924E+01	4.50	8.204E+02	+/-	2.857E+01	5.69
PALISADES W-100 Bottom	1.993E+01	4.50	8.137E+02	+/-	2.960E+01	5.79

SHUTDOWN DATE: MAR. 16, 2003 PALISADES W-100 CAPSULE DOSIMETRY

U-238 DOSIMETERS	Type	Target Nuclide	Analyte Nuclide	Weight Fraction	Volume Fraction	Shielded (Yes/No)	Volume of Sample (ml)	+/-	Volume Error (ml)
PALISADES W-100 Seg 1 Top	POWDER	U-238	Cs-137	1.00	N/A	No	20.0	+/-	0.08
PALISADES W-100 Seg 4 Middle	POWDER	U-238	Cs-137	1.00	N/A	No	20.0	+/-	0.08
PALISADES W-100 Seg 7 Bottom	POWDER	U-238	Cs-137	1.00	N/A	No	20.0	+/-	0.08
PALISADES W-100 Seg 1 Top Sh	POWDER	U-238	Cs-137	1.00	N/A	Yes	20.0	+/-	0.08
PALISADES W-100 Seg 4 Middle Sh	POWDER	U-238	Cs-137	1.00	N/A	Yes	20.0	+/-	0.08
PALISADES W-100 Seg 7 Bottom Sh	POWDER	U-238	Cs-137	1.00	N/A	Yes	20.0	+/-	0.08

U-238 DOSIMETERS	Aliquot Drawn (ml)	+/-	Volume Error (ml)	Diluted to (ml)	+/-	Dilute Error (ml)	Conc. of Target in Dil Sol (ppm)	+/-	Concentration Error (ppm)	Element
PALISADES W-100 Seg 1 Top	1.0	+/-	0.08	1.0	+/-	0.08	1410.00	+/-	70.50	U-238
PALISADES W-100 Seg 4 Middle	1.0	+/-	0.08	1.0	+/-	0.08	962.00	+/-	48.10	U-238
PALISADES W-100 Seg 7 Bottom	1.0	+/-	0.08	1.0	+/-	0.08	1530.00	+/-	76.50	U-238
PALISADES W-100 Seg 1 Top Sh	1.0	+/-	0.08	1.0	+/-	0.08	1240.00	+/-	62.00	U-238
PALISADES W-100 Seg 4 Middle Sh	1.0	+/-	0.08	1.0	+/-	0.08	1080.00	+/-	54.00	U-238
PALISADES W-100 Seg 7 Bottom Sh	1.0	+/-	0.08	1.0	+/-	0.08	1160.00	+/-	58.00	U-238

U-238 DOSIMETERS	Attenuation Coefficient u	Shelf Letter	Detector Distance (cm.)	+/-	Distance Error (cm.)	Cs-137 Activity (uCi)	+/-	Activity Error (%)	Grams of Target U-238	+/-
PALISADES W-100 Seg 1 Top	N/A	NA	N/A	+/-	N/A	1.190E+00	+/-	0.31	2.820E-02	+/-
PALISADES W-100 Seg 4 Middle	N/A	NA	N/A	+/-	N/A	5.870E-01	+/-	0.59	1.924E-02	+/-
PALISADES W-100 Seg 7 Bottom	N/A	NA	N/A	+/-	N/A	1.420E+00	+/-	0.40	3.060E-02	+/-
PALISADES W-100 Seg 1 Top Sh	N/A	NA	N/A	+/-	N/A	5.230E-01	+/-	0.57	2.480E-02	+/-
PALISADES W-100 Seg 4 Middle Sh	N/A	NA	N/A	+/-	N/A	2.390E-01	+/-	0.59	2.160E-02	+/-
PALISADES W-100 Seg 7 Bottom Sh	N/A	NA	N/A	+/-	N/A	4.840E-01	+/-	0.59	2.320E-02	+/-

U-238 DOSIMETERS	Target Error	G2	+/-	G2 Error	U2	+/-	U2 Error	Self Abs. Wires V2	+/-
PALISADES W-100 Seg 1 Top	1.415E-03	N/A	+/-	N/A	N/A	+/-	N/A	N/A	+/-
PALISADES W-100 Seg 4 Middle	9.651E-04	N/A	+/-	N/A	N/A	+/-	N/A	N/A	+/-
PALISADES W-100 Seg 7 Bottom	1.535E-03	N/A	+/-	N/A	N/A	+/-	N/A	N/A	+/-
PALISADES W-100 Seg 1 Top Sh	1.244E-03	N/A	+/-	N/A	N/A	+/-	N/A	N/A	+/-
PALISADES W-100 Seg 4 Middle Sh	1.083E-03	N/A	+/-	N/A	N/A	+/-	N/A	N/A	+/-
PALISADES W-100 Seg 7 Bottom Sh	1.164E-03	N/A	+/-	N/A	N/A	+/-	N/A	N/A	+/-

U-238 DOSIMETERS

	V2 Error	W2	+/-	W2 Error	Abs. Factor	+/-	Factor Error	Corrected Activity (uCi/gram)	+/-
PALISADES W-100 Seg 1 Top	N/A	N/A	+/-	N/A	N/A	+/-	N/A	N/A	+/-
PALISADES W-100 Seg 4 Middle	N/A	N/A	+/-	N/A	N/A	+/-	N/A	N/A	+/-
PALISADES W-100 Seg 7 Bottom	N/A	N/A	+/-	N/A	N/A	+/-	N/A	N/A	+/-
PALISADES W-100 Seg 1 Top Sh	N/A	N/A	+/-	N/A	N/A	+/-	N/A	N/A	+/-
PALISADES W-100 Seg 4 Middle Sh	N/A	N/A	+/-	N/A	N/A	+/-	N/A	N/A	+/-
PALISADES W-100 Seg 7 Bottom Sh	N/A	N/A	+/-	N/A	N/A	+/-	N/A	N/A	+/-

U-238 DOSIMETERS	Activity Error (uCi/gram)	Systematic Error (%)	uCi/gram Target U-238	+/-	Error (uCi/gram)	% Error (%)
PALISADES W-100 Seg 1 Top	N/A	4.50	4.220E+01	+/-	2.121E+00	6.75
PALISADES W-100 Seg 4 Middle	N/A	4.50	3.051E+01	+/-	1.541E+00	6.76
PALISADES W-100 Seg 7 Bottom	N/A	4.50	4.641E+01	+/-	2.335E+00	6.75
PALISADES W-100 Seg 1 Top Sh	N/A	4.50	2.109E+01	+/-	1.065E+00	6.76
PALISADES W-100 Seg 4 Middle Sh	N/A	4.50	1.106E+01	+/-	5.588E-01	6.76
PALISADES W-100 Seg 7 Bottom Sh	N/A	4.50	2.086E+01	+/-	1.054E+00	6.76

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Palisades	LTC	Constellation
John Kneeland (10)	Kevin Hour (1) Steve Jensen (3)	W. Pavinich (1)

Keywords: Reactor Vessel Surveillance Program (RVSP), Reactor Vessel, Weld Metal, Base Metal, HAZ, Tension Test, Charpy Test, Thermal Monitor, Dosimetry, Palisades, W-100

ATTACHMENT 2

REACTOR PRESSURE VESSEL SURVEILLANCE CAPSULE W-100 TEST REPORT

"FLUENCE ANALYSIS FOR REACTOR VESSEL SURVEILLANCE CAPSULE W100," DATED FEBRUARY 11, 2004

15 Pages Follow

Westinghouse

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P.O. Box 355
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USA

CPAL-04-8
February 11, 2004

Mr. John Kneeland
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NUCLEAR MANAGEMENT COMPANY
Palisades Nuclear Plant
Fluence Analysis for Reactor Vessel Surveillance Capsule W100

References:
1. Westinghouse Sales Order No. 25004
2. NMC Purchase Order No. P039762
3. LTR-REA-04-11

Dear Mr. Kneeland:

The attachment provides a report of the fluence analysis for Palisades reactor vessel surveillance capsule W100. Included are the neutron flux density, energy spectrum and fluence analysis for this capsule, consistent with requirements of ASTM E185-82 (Sections 8.2, 11.4.5.2 and 11.5).

This completes the Westinghouse scope related to the reference NMC Purchase Order.

If you have any questions regarding the attached please call Dave Chapman at 724-722-6014.

Very truly yours,

WESTINGHOUSE ELECTRIC COMPANY

Stephen P. Swigart

Stephen P. Swigart
Customer Project Manager

Neutron Fluence Analysis for Palisades Surveillance Capsule W100

February 2004

This report provides the fluence analysis for the Palisades Nuclear Plant (operated by Nuclear Management Company, LLC or NMC) reactor vessel surveillance capsule W100. The fluence analysis has been performed consistent with the requirements of ASTM E185-82 (Sections 8.2, 11.4.5.2 and 11.5); for fluence analysis, this is equivalent to the current version of the standard (ASTM E185-02). The location within the reactor on a first quadrant equivalent (FQE) basis, withdrawal time and irradiation time are as follows:

Capsule ID	FQE Azimuthal Location [1]	Withdrawal Time	Irradiation Time (EFPS)
W100	10°	EOC 16	5.344E+08

The energy spectrum at the center of the capsule is provided in Table 1. Table 2 provides the neutron flux density (exposure rate) and the fluence analysis, including "analyte" nuclide reaction rates, for this capsule. Also included in Table 2 are comparisons of the measured and calculated reaction rates. These include the "Least Squares Adjusted" (LSA) reaction rates. A comparison of the calculated and LSA exposure rates is provided in Table 3.

The methodology used in performing this analysis is described in WCAP-15353[2]. Additional transport ("DORT") calculations were required for the analysis of W100. These included updated calculations for Cycles 14 and 15 and new calculations for Cycle 16. The Cycle 16 geometry and material descriptions used were equivalent to those of Cycle 15 (see Figures 3.1-6 and 3.1-7 of WCAP-15353). Much of the background and supporting information provided in WCAP-15353 remains applicable for W100. Any additional data and information specific to W100 not provided in WCAP-15353 was provided by NMC. Capsule related data are provided in Appendix A.

[1] See Figures 2.2-1 and 3.1-1 through 3.1-7 of WCAP-15353.
[2] WCAP-15353, Revision 0, *Palisades Reactor Pressure Vessel Neutron Fluence Evaluation*, January 2000.

Table 1
CALCULATED NEUTRON ENERGY SPECTRA AT THE CENTER OF SURVEILLANCE CAPSULE W100

Lower Energy (MeV)	Neutron Flux (n/cm^2-sec)	Lower Energy (MeV)	Neutron Flux (n/cm^2-sec)
1.42E+01	1.551E+07	1.83E-01	5.415E+09
1.22E+01	4.854E+07	1.11E-01	4.644E+09
1.00E+01	2.002E+08	6.74E-02	3.642E+09
8.61E+00	3.877E+08	4.09E-02	3.138E+09
7.41E+00	6.716E+08	3.18E-02	1.281E+09
6.07E+00	1.762E+09	2.61E-02	6.991E+08
4.97E+00	2.570E+09	2.42E-02	9.390E+08
3.68E+00	4.517E+09	2.18E-02	5.683E+08
3.01E+00	3.070E+09	1.50E-02	1.894E+09
2.73E+00	2.164E+09	7.10E-03	3.614E+09
2.47E+00	2.409E+09	3.36E-03	3.778E+09
2.35E+00	1.473E+09	1.59E-03	3.544E+09
2.23E+00	1.454E+09	4.54E-04	5.927E+09
1.92E+00	3.584E+09	2.14E-04	3.392E+09
1.65E+00	3.577E+09	1.01E-04	3.625E+09
1.35E+00	4.758E+09	3.73E-05	4.765E+09
1.00E+00	6.409E+09	1.07E-05	5.918E+09
8.21E-01	3.912E+09	5.04E-06	3.482E+09
7.43E-01	2.066E+09	1.86E-06	4.684E+09
6.08E-01	4.548E+09	8.76E-07	3.488E+09
4.98E-01	3.686E+09	4.14E-07	3.146E+09
3.69E-01	4.051E+09	0.00E+00	5.506E+10
2.98E-01	3.385E+09		

NOTE: The upper energy of group 1 is 17.33 MeV.

Table 2

DERIVED EXPOSURE RATES FROM SURVEILLANCE CAPSULE W100
DOSIMETRY WITHDRAWN AT THE END OF FUEL CYCLE 16

	Trial Value	Adjusted Value	1σ % Uncertainty
$\phi(E > 1.0$ MeV)	3.904E+10	3.935E+10	6
$\phi(E > 0.1$ MeV)	7.154E+10	7.180E+10	9
$\phi(E < 0.414$ eV)	5.496E+10	5.500E+10	43
dpa/sec	5.620E-11	5.661E-11	6

COMPARISON OF MEASURED AND CALCULATED SENSOR REACTION RATES
SURVEILLANCE CAPSULE W100

	Reaction Rate (rps/nucleus)			Ratios		
	Measured	Trial Calc.	Least Squares Adjusted	M/C	LSA/M	LSA/C
^{46}Ti (n,p)	1.11E-15	9.59E-16	1.01E-15	1.16	0.91	1.06
^{54}Fe (n,p)	5.25E-15	5.37E-15	5.40E-15	0.98	1.03	1.00
^{238}U (n,f) Cd	1.85E-14	1.77E-14	1.79E-14	1.04	0.97	1.01
^{58}Ni (n,p) Cd	6.86E-15	6.99E-15	7.01E-15	0.98	1.02	1.00
^{63}Cu (n,α) Cd	5.70E-17	6.12E-17	6.01E-17	0.93	1.06	0.98

Table 3

COMPARISON OF LEAST SQUARES ADJUSTED AND CALCULATED EXPOSURE RATES FROM SURVEILLANCE CAPSULE W100, CORE MIDPLANE ONLY

	Calculated	LSA	LSA/C
$\phi(E > 1.0\ \text{MeV})$	3.904E+10	3.935E+10	1.01
$\phi(E > 0.1\ \text{MeV})$	7.154E+10	7.180E+10	1.00
Dpa/sec	5.620E-11	5.661E-11	1.01

Appendix A

SPECIFIC ACTIVITIES, IRRADIATION HISTORY, AND OTHER INPUTS

FOR SURVEILLANCE CAPSULE W100

The irradiation history of all capsules withdrawn to date at Palisades is as follows.

Cycle	Startup	Shutdown	Comment
1	12/31/71	12/20/75	
2	05/08/76	01/06/78	Capsule A240 Withdrawn
3	04/20/78	09/08/79	
4	05/24/80	08/29/81	
5	12/25/81	08/12/83	Capsule W290 Withdrawn
6	07/29/84	11/30/85	
7	03/02/86	08/08/88	
8	11/01/88	09/15/90	
9	03/10/91	02/06/92	Caps. W290-9 Installed/Withdrawn
10	04/18/92	06/05/93	Capsule W110 Withdrawn
11	11/06/93	05/22/95	
12	08/21/95	11/01/96	Capsule SA60-1, SA240-1 Installed
13	12/27/96	04/25/98	Capsule SA60-1 Withdrawn
14	06/07/98	10/15/99	Capsule SA240-1 Withdrawn
15	12/14/99	3/30/01	
16	5/10/01	3/16/03	Capsule W100 Withdrawn

Reference Core Power = 2530 MWt

The monthly thermal generation applicable to the Palisades reactor is provided in Table A-1. The in-vessel residency for W100 began in December 1971 and ended in March 2003, spanning Cycles 1 through 16 operation. The target nuclide isotopic and weight fractions for the measured sensors of W100 are provided in Table A-2. The measured specific activities of the sensors for W100 are provided in Table A-3.

Since the in-vessel surveillance capsule W100 was irradiated for multiple fuel cycles, flux adjustment factors, C_j, were employed in the reaction rate calculations for the individual sensor sets. The quantity C_j is defined as the calculated ratio of $\phi(E > 1.0\ MeV)$ during the irradiation period j to the time weighted average $\phi(E > 1.0\ MeV)$ over the entire irradiation period. The values of C_j used in the evaluation of the Palisades surveillance capsules W100 were as follows:

Cycle	Flux Adjustment Factor
1	1.3714
2	1.1945
3	1.6509
4	1.6952
5	1.6268
6	1.7028
7	1.6084
8	1.0791
9	.8075
10	.6010
11	.5418
12	.4446
13	.5999
14	.6051
15	.4602
16	.4727

TABLE A-1
IRRADIATION HISTORY OF PALISADES INTERNAL SURVEILLANCE CAPSULES

Month	Thermal Generation (MW-hr)	Month	Thermal Generation (MW-hr)	Month	Thermal Generation (MW-hr)
Dec-71	625	Apr-75	967872	Aug-78	1049064
Jan-72	155642	May-75	1334640	Sep-78	556008
Feb-72	16679	Jun-75	873360	Oct-78	1172520
Mar-72	247284	Jul-75	1116216	Nov-78	1683216
Apr-72	519993	Aug-75	749376	Dec-78	849192
May-72	0	Sep-75	977856	Jan-79	1801656
Jun-72	684662	Oct-75	1135152	Feb-79	1604952
Jul-72	669575	Nov-75	1212960	Mar-79	1785288
Aug-72	792640	Dec-75	537672	Apr-79	1371072
Sep-72	490476	Jan-76	0	May-79	590664
Oct-72	731045	Feb-76	0	Jun-79	1297416
Nov-72	552165	Mar-76	0	Jul-79	1702776
Dec-72	1071439	Apr-76	0	Aug-79	1570656
Jan-73	667608	May-76	569280	Sep-79	322368
Feb-73	0	Jun-76	1520760	Oct-79	0
Mar-73	1059289	Jul-76	1052469	Nov-79	0
Apr-73	1549797	Aug-76	1260240	Dec-79	0
May-73	983014	Sep-76	1449288	Jan-80	0
Jun-73	1578251	Oct-76	1207248	Feb-80	0
Jul-73	1534211	Nov-76	1080384	Mar-80	0
Aug-73	476077	Dec-76	1531608	Apr-80	0
Sep-73	0	Jan-77	1426488	May-80	161088
Oct-73	0	Feb-77	1428888	Jun-80	1600296
Nov-73	0	Mar-77	1507152	Jul-80	1182912
Dec-73	0	Apr-77	1454856	Aug-80	1335552
Jan-74	0	May-77	1024776	Sep-80	1328640
Feb-74	0	Jun-77	1596000	Oct-80	1663008
Mar-74	0	Jul-77	1554528	Nov-80	0
Apr-74	0	Aug-77	1122840	Dec-80	920760
May-74	0	Sep-77	1431480	Jan-81	1777944
Jun-74	0	Oct-77	1630296	Feb-81	1684176
Jul-74	0	Nov-77	1457736	Mar-81	1867008
Aug-74	0	Dec-77	1703640	Apr-81	1750200
Sep-74	0	Jan-78	270336	May-81	1641384
Oct-74	387048	Feb-78	0	Jun-81	1531584
Nov-74	8400	Mar-78	0	Jul-81	604440
Dec-74	0	Apr-78	381600	Aug-81	845688
Jan-75	0	May-78	947376	Sep-81	0
Feb-75	0	Jun-78	1245312	Oct-81	0
Mar-75	0	Jul-78	1288344	Nov-81	0

TABLE A-1 (continued)
IRRADIATION HISTORY OF PALISADES INTERNAL SURVEILLANCE CAPSULES

Month	Thermal Generation (MW-hr)	Month	Thermal Generation (MW-hr)	Month	Thermal Generation (MW-hr)
Dec-81	1104	Apr-85	1622592	Aug-88	444768
Jan-82	947952	May-85	1841352	Sep-88	0
Feb-82	168384	Jun-85	1708032	Oct-88	0
Mar-82	682224	Jul-85	1823376	Nov-88	29640
Apr-82	0	Aug-85	640848	Dec-88	454344
May-82	362304	Sep-85	1372872	Jan-89	1657920
Jun-82	1614336	Oct-85	1557216	Feb-89	0
Jul-82	581544	Nov-85	1744224	Mar-89	1248144
Aug-82	0	Dec-85	0	Apr-89	1392120
Sep-82	1558992	Jan-86	0	May-89	1499736
Oct-82	1669680	Feb-86	0	Jun-89	1457664
Nov-82	1802688	Mar-86	331392	Jul-89	1510872
Dec-82	1841424	Apr-86	1321872	Aug-89	1341864
Jan-83	1742448	May-86	1107336	Sep-89	1453344
Feb-83	1675200	Jun-86	0	Oct-89	504
Mar-83	1862568	Jul-86	0	Nov-89	0
Apr-83	1713816	Aug-86	0	Dec-89	502200
May-83	1688184	Sep-86	0	Jan-90	1372848
Jun-83	1761720	Oct-86	0	Feb-90	1352352
Jul-83	1735776	Nov-86	0	Mar-90	1378920
Aug-83	543720	Dec-86	0	Apr-90	741096
Sep-83	0	Jan-87	0	May-90	536208
Oct-83	0	Feb-87	0	Jun-90	1047984
Nov-83	0	Mar-87	0	Jul-90	1501584
Dec-83	0	Apr-87	951309	Aug-90	1501896
Jan-84	0	May-87	1454016	Sep-90	704184
Feb-84	0	Jun-87	1387536	Oct-90	0
Mar-84	0	Jul-87	875304	Nov-90	0
Apr-84	0	Aug-87	1410336	Dec-90	0
May-84	0	Sep-87	1566648	Jan-91	0
Jun-84	0	Oct-87	14832	Feb-91	0
Jul-84	9816	Nov-87	968160	Mar-91	480456
Aug-84	166704	Dec-87	197136	Apr-91	1809167
Sep-84	222792	Jan-88	204576	May-91	1885464
Oct-84	0	Feb-88	1484904	Jun-91	1818648
Nov-84	485160	Mar-88	1878312	Jul-91	1143408
Dec-84	1838256	Apr-88	1522344	Aug-91	1837560
Jan-85	1802520	May-88	1731336	Sep-91	1818984
Feb-85	1562424	Jun-88	1818696	Oct-91	1882521
Mar-85	1843632	Jul-88	1794168	Nov-91	1712592

TABLE A-1 (continued)[1]
IRRADIATION HISTORY OF PALISADES INTERNAL SURVEILLANCE CAPSULES

Month	Thermal Generation (MW-hr)	Month	Thermal Generation (MW-hr)	Month	Thermal Generation (MW-hr)
Dec-91	1513368	Apr-95	1811689	Aug-98	1875243
Jan-92	1867224	May-95	1170744	Sep-98	1762895
Feb-92	357888	Jun-95	0	Oct-98	1879383
Mar-92	0	Jul-95	0	Nov-98	1819726
Apr-92	620112	Aug-95	419871	Dec-98	782885
May-92	1878432	Sep-95	1588200	Jan-99	1406548
Jun-92	1819464	Oct-95	1863332	Feb-99	1697623
Jul-92	1392552	Nov-95	1814541	Mar-99	1867850
Aug-92	1459272	Dec-95	1757839	Apr-99	1812454
Sep-92	1260672	Jan-96	1010896	May-99	1186282
Oct-92	1779079	Feb-96	1755785	Jun-99	1819741
Nov-92	1326168	Mar-96	1802064	Jul-99	1880606
Dec-92	1880496	Apr-96	1811246	Aug-99	1880100
Jan-93	1879536	May-96	1874811	Sep-99	1816659
Feb-93	1698408	Jun-96	1750200	Oct-99	901277
Mar-93	1880544	Jul-96	1694185		
Apr-93	1688919	Aug-96	1874328		
May-93	862632	Sep-96	1813701		
Jun-93	237864	Oct-96	1877294		
Jul-93	0	Nov-96	53755		
Aug-93	0	Dec-96	169562		
Sep-93	0	Jan-97	772562		
Oct-93	0	Feb-97	860456		
Nov-93	1242336	Mar-97	1868293		
Dec-93	1876608	Apr-97	1809640		
Jan-94	1844112	May-97	1875000		
Feb-94	1004688	Jun-97	1814498		
Mar-94	0	Jul-97	1875400		
Apr-94	0	Aug-97	1875058		
May-94	0	Sep-97	1745398		
Jun-94	666768	Oct-97	891762		
Jul-94	1874208	Nov-97	1813953		
Aug-94	1874448	Dec-97	1874786		
Sep-94	1812408	Jan-98	1873929		
Oct-94	1869960	Feb-98	1434156		
Nov-94	1813872	Mar-98	1806566		
Dec-94	1867368	Apr-98	1393953		
Jan-95	1874304	May-98	0		
Feb-95	1655688	Jun-98	1210531		
Mar-95	1871832	Jul-98	1698733		

[1] This page and following pages are reformatted from WCAP-15353, page A-5. All preceding pages are the same.

TABLE A-1 (continued)
IRRADIATION HISTORY OF PALISADES INTERNAL SURVEILLANCE CAPSULES

Month	Thermal Generation (MW-hr)	Month	Thermal Generation (MW-hr)	Month	Thermal Generation (MW-hr)
Nov-99 [1]	0				
Dec-99	477245				
Jan-00	1569517				
Feb-00	248362				
Mar-00	1777032				
Apr-00	1575700				
May-00	1879446				
Jun-00	1700009				
Jul-00	1412630				
Aug-00	1858312				
Sep-00	1088882				
Oct-00	1817920				
Nov-00	1809025				
Dec-00	1874853				
Jan-01	1874201				
Feb-01	1633904				
Mar-01	1814984				
Apr-01	0				
May-01	1015833				
Jun-01	1208775				
Jul-01	0				
Aug-01	0				
Sep-01	0				
Oct-01	0				
Nov-01	0				
Dec-01	0				
Jan-02	575063				
Feb-02	1699451				
Mar-02	1877037				
Apr-02	1812744				
May-02	1834647				
Jun-02	1741560				
Jul-02	1881030				
Aug-02	1837173				
Sep-02	1776903				
Oct-02	1884001				
Nov-02	1787965				
Dec-02	1616317				
Jan-03	1858313				
Feb-03	1665040				
Mar-03	920721				

[1] Cycles 14 through 16 data are new relative to WCAP-15353.

TABLE A-2
ISOTOPIC FRACTIONS AND WEIGHT FRACTIONS OF TARGET NUCLIDES[1]
(MEASUREMENT BASIS)

Dosimeter	Target Nuclide	Isotopic Fraction of Target	Assumed Weight Fraction of Target Element
Iron	^{54}Fe	0.057	0.99865
Nickel	^{58}Ni	0.6739	0.99951
Copper	^{63}Cu	0.6850	ICP
Titanium	^{46}Ti	0.0793	0.99793
Uranium	^{238}U	1.0	ICP

[1] Table 7-2 of W100 results received by FAX January 27, 2004.

TABLE A-3
SPECIFIC ACTIVITIES FOR PALISADES CAPSULE W100[1]

Flux Monitor	Specimen ID	Shielded (Yes/No)	Target Nuclide	Analyte Nuclide	Specific Activity (μCi/gm)
U	T81	No	U-238	Cs-137	4.220E+01
Ti	T82	No	Ti-46	Sc-46	1.798E+02
FeA	T83A	No	Fe-54	Mn-54	5.520E+02
FeB	T83B	No	Fe-54	Mn-54	5.909E+02
U	T85	Yes	U-238	Cs-137	2.109E+01
Ni	T86	Yes	Ni-58	Co-58	9.256E+02
Cu	T87	Yes	Cu-63	Co-60	5.743E+00
FeC	T161	No	Fe-54	Mn-54	6.068E+02
FeD	T162	No	Fe-54	Mn-54	5.885E+02
FeE	T163	No	Fe-54	Mn-54	6.174E+02
FeF	T164	No	Fe-54	Mn-54	6.037E+02
FeG	T165	No	Fe-54	Mn-54	5.735E+02
U	M81	No	U-238	Cs-137	3.051E+01
Ti	M82	No	Ti-46	Sc-46	1.584E+02
FeA	M83A	No	Fe-54	Mn-54	4.822E+02
FeB	M83B	No	Fe-54	Mn-54	5.112E+02
U	M85	Yes	U-238	Cs-137	1.106E+01
Ni	M86	Yes	Ni-58	Co-58	8.204E+02
Cu	M87	Yes	Cu-63	Co-60	6.192E+00
FeC	M161	No	Fe-54	Mn-54	5.772E+02
FeD	M162	No	Fe-54	Mn-54	5.857E+02
FeE	M163	No	Fe-54	Mn-54	6.093E+02
FeF	M164	No	Fe-54	Mn-54	5.345E+02
FeG	M165	No	Fe-54	Mn-54	6.470E+02
U	B81	No	U-238	Cs-137	4.641E+01
Ti	B82	No	Ti-46	Sc-46	1.800E+02
FeA	B83A	No	Fe-54	Mn-54	5.818E+02
FeB	B83B	No	Fe-54	Mn-54	6.423E+02
U	B85	Yes	U-238	Cs-137	2.086E+01
Ni	B86	Yes	Ni-58	Co-58	8.137E+02
Cu	B87	Yes	Cu-63	Co-60	7.058E+00
FeC	B161	No	Fe-54	Mn-54	5.642E+02
FeD	B162	No	Fe-54	Mn-54	6.069E+02
FeE	B163	No	Fe-54	Mn-54	5.919E+02
FeF	B164	No	Fe-54	Mn-54	6.192E+02
FeG	B165	No	Fe-54	Mn-54	5.664E+02

[1] Tables 7-3, 7-4, and 7-5 of W100 results received by FAX January 27, 2004.