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# Analysis of the Irradiation Data for A302B and A533B Correlation Monitor Materials


Prepared by
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**Prepared for**
**U.S. Nuclear Regulatory Commission**

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# Analysis of the Irradiation Data for A302B and A533B Correlation Monitor Materials

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# ABSTRACT

The results of Charpy V-notch impact tests for A302B and A533B-1 Correlation Monitor Materials (CMM) listed in the surveillance power reactor data base (PR-EDB) and material test reactor data base (TR-EDB) are analyzed. The shift of the transition temperature at 30 ft-lb ($T_{30}$) is considered as the primary measure of radiation embrittlement in this report. The hyperbolic tangent fitting model and uncertainty of the fitting parameters for Charpy impact tests are presented in this report. For the surveillance CMM data, the transition temperature shifts at 30 ft-lb ($\Delta T_{30}$) generally follow the predictions provided by Revision 2 of Regulatory Guide 1.99 (R.G. 1.99). Difference in capsule temperatures is a likely explanation for large deviations from R.G. 1.99 predictions. Deviations from the R.G. 1.99 predictions are correlated to similar deviations for the accompanying materials in the same capsules, but large random fluctuations prevent precise quantitative determination. Significant scatter is noted in the surveillance data, some of which may be attributed to variations from one specimen set to another, or inherent in Charpy V-notch testing. The major contributions to the uncertainty of the R.G. 1.99 prediction model, and the overall data scatter are from mechanical test results, chemical analysis, irradiation environments, fluence evaluation, and inhomogeneous material properties. Thus in order to improve the prediction model, control of the above-mentioned error sources needs to be improved. In general, the embrittlement behavior of both the A302B and A533B-1 plate materials is similar. There is evidence for a fluence-rate effect in the CMM data irradiated in test reactors; thus its implication on power reactor surveillance programs deserves special attention.

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# 1 INTRODUCTION

It is well known that the flux of energetic neutrons can displace significant numbers of atoms and thus alter physical and mechanical properties of reactor pressure vessel (RPV) steels. Property changes in materials due to neutron-induced displacement damage are a function of neutron energy, neutron flux, and temperature, as well as the material chemical composition and microstructure that determine how neutrons interact with atoms and how defects interact within the material.[1,2] The success of reactor design technology depends critically on the choice of material that has satisfactory material properties to resist the radiation damage. Presently, interest focuses on the radiation damage and its effect on RPV materials. It is generally accepted that radiation hardening and embrittlement in metals are caused by clusters of vacancies, interstitial and solute atoms that impede the motion of dislocations. The degree of embrittlement is conventionally correlated with fast neutron fluence or with total displacements per atom (dpa).

The aging and degradation of light-water-reactor (LWR) pressure vessels are of particular concern because of their importance to plant safety and the magnitude of the expected irradiation embrittlement. The radiation embrittlement of RPV materials depends on many different factors, primarily flux, fluence, neutron spectrum, irradiation temperature, pre-irradiation material history, and chemical composition.[3,4] These factors must be considered to reliably predict RPV embrittlement and to ensure the structural integrity of the reactor. Based on embrittlement predictions, decisions must be made concerning operating parameters, low-leakage-fuel management, possible life extension, and the need for annealing of the pressure vessel.[5]

Large amounts of data obtained from surveillance capsules and test reactor experiments and comprising many different materials and different irradiation conditions are needed to develop generally applicable damage prediction models that can be used for industry standards and regulatory guides. The U.S. Nuclear Regulatory Commission (NRC)/Oak Ridge National Laboratory (ORNL) embrittlement data base (EDB) is this comprehensive collection of data resulting from the merging of the Power Reactor Embrittlement Data Base (PR-EDB) and the Test Reactor Embrittlement Data Base (TR-EDB). Three major categories of data are included in the EDB, namely, pre-irradiation material history, irradiation environments, and mechanical test results. The following types of data are included:

1. fluence (E > 1.0 MeV, E > 0.1 MeV, and dpa), irradiation time, and irradiation temperature for each irradiated capsule;
2. Charpy test results before and after irradiation, both for individual specimen and evaluation of transition temperature and upper-shelf energies;
3. tensile test results before and after irradiation;
4. chemistry data for each material;
5. preirradiation heat treatment;
6. data concerning the fabrication of weld material; and
7. data related to the determination of the pressure-temperature limits.

The current version of the PR-EDB lists the test results of 98 heat-affected-zone (HAZ) materials, 105 weld materials, and 136 base materials that were irradiated in 252 capsules from 96 power reactors.[6] The current data collection of the TR-EDB contains 1230 different irradiated sets, 797 of which are from base materials, 378 from weld materials, and 55 from HAZ materials.[7] The EDB has been used in many radiation embrittlement studies of reactor vessels. This computerized data base for base material and weldments was compiled from surveillance reports of operating power reactors and available technical reports. All data are traceable to the reference sources, including page numbers. Most of the surveillance data have been verified by the reactor vendors responsible for the insertion of the material into surveillance capsules, and any changes and corrections have been documented in special files for future reference.

Generally, the surveillance programs of commercial power reactors include correlation monitor materials (CMM) in addition to base, weld, and HAZ of actual pressure vessel steels. These specimens are fabricated from standard reference steel plates that are similar in most cases in composition and heat treatment to the base material in the respective RPV and are supposed to serve as a reference for comparing the radiation embrittlement of the plant-specific material with the reference material and for detecting anomalies in the radiation environment of the surveillance capsules. In order to use these materials as a reference, the "normal" behavior in regard to fluence, flux, and irradiation temperature must be established first. This procedure requires the collection of data from a sufficient number of irradiations of the material at different irradiation environments, such as different fluxes and temperatures. Such data, obtained from irradiations in surveillance capsules and test reactors, are presently collected in the EDB, and the information is used for this study. The majority of surveillance programs use one or the other of two sources for the reference material, depending on the material in the pressure vessel. One source is the 6-in.-thick ASTM A302 grade B (A302B) reference plate by U.S. Steel, and the other source consists of three 12-in.-thick A533 grade B class 1 (A533B-1) plates fabricated by Lukens Steel and heat treated by Combustion Engineering (CE). These three plates were fabricated for the Heavy-Section Steel Technology (HSST) program in the late 1960s. Most surveillance data come from the second plate (HSST02); however, the first plate (HSST01) and third plate (HSTT03) are also used in surveillance capsules. The results obtained from the surveillance capsules and material test reactor experiments from these plates are included in this report. This report is restricted to A302B and A533B-1 materials. The detailed information of the heat treatments and chemistry compositions for the CMM are listed in Tables 1–5.

Table 1. Heat treatment of CMM

| Plate ID | Heat No. | Mat. ID | Thickness | Heat treatment |
|---|---|---|---|---|
| ASTM | A0421 | A302B | 14.24 cm | Austenized at 1650°F 6 h, water quenched to 300°F; tempered at 1200°F 6 h, air cooled (heated to 1200°F at 63°F per hour maximum). |
| HSST01 | A1008-1 | A533B-1 | 30.48 cm | Normalized at 1670-1700°F 4h, air cooled; austenized at 1550-1650°F 4 h, water quenched to 300°F; tempered at 1200-1250°F 4 h, furnace cooled to 600°F; stress relieved at 1125-1175°F 40 h, furnace cooled to 600°F. |
| HSST02 | A1195-1 | A533B-1 | 30.48 cm | Normalized at 1650-1700°F 4 h, air cooled; austenized at 1575-1625°F 4 h, water quenched to 300°F; tempered at 1200-1250°F 4 h, furnace cooled to 500°F; stress relieved at 1125-1175°F 40 h, furnace cooled to 600°F. |
| HSST03 | C2702 | A533B-1 | 30.48 cm | Normalized at 1650-1700°F 12 h, air cooled; austenized at 1550-1650°F 12 h, water quenched to 400°F; tempered at 1200-1250°F 18 h, furnace cooled to 600°F; stress relieved at 1100-1150°F 40 h, furnace cooled to 600°F, at 1020-1035°F 12 h, furnace cooled to 600°F. |

Table 2. A302B (ASTM) CMM chemical compositions

| Plant/Exp | | | | Chemistry Composition (wt %) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ID | HEAT_ID | CHEM_LAB | SPEC_ID | C | Mn | P | S | Si | Cr | Mo | Ni | Cu |
| | SASTM | U.S. Steel | HEAT | 0.240 | 1.340 | 0.011 | 0.023 | 0.230 | 0.110 | 0.510 | 0.180 | 0.200 |
| GAR | SASTM S2 | | HEAT | 0.220 | 1.390 | 0.016 | 0.017 | 0.260 | | 0.600 | | 0.230 |
| IP2 | SASTM | SWRI | R-60 | | | 0.010 | | | | | | 0.170 |
| IP2 | SASTM | SWRI | R-62 | | | 0.020 | | | | | | 0.190 |
| IP2 | SASTM | SWRI | R-33 | | | | | | | | 0.280 | 0.350 |
| IP2 | SASTM | SWRI | R-2 | | | | | | | | | 0.250 |
| IP2 | SASTM | SWRI | R-36 | | | | | | | | 0.270 | 0.310 |
| IP2 | SASTM | SWRI | R-40 | | | | | | | | 0.210 | 0.210 |
| IP2 | SASTM | SWRI | R-56 | | | | | | | | 0.180 | 0.200 |
| IP2 | SASTM | SWRI | R-52 | | | | | | | | 0.270 | 0.180 |
| NRL-1 | SASTM | NRL | | 0.230 | 1.350 | 0.015 | 0.021 | 0.220 | 0.120 | 0.520 | 0.220 | 0.220 |
| RRA | SASTM RRA | | @3-11 | 0.243 | 1.420 | 0.014 | 0.021 | 0.230 | 0.110 | 0.490 | 0.170 | 0.182 |
| SRM | SASTM | U.S. Steel | LADLE | 0.200 | 1.310 | 0.013 | 0.023 | 0.230 | | 0.480 | 0.180 | 0.180 |

Table 3. A533B (HSST01) CMM chemical compositions

| Plant/Exp | | | | Chemistry Composition (wt %) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ID | HEAT_ID | CHEM_LAB | SPEC_ID | C | Mn | P | S | Si | Cr | Mo | Ni | Cu |
| | SHSS01 | NRL | HEAT | 0.220 | 1.370 | 0.008 | 0.008 | 0.220 | 0.150 | 0.540 | 0.660 | 0.180 |
| | SHSS01 | Lukens | CHECK | 0.220 | 1.480 | 0.012 | 0.018 | 0.250 | | 0.520 | 0.680 | |
| | SHSS01 | Lukens | LADLE | 0.220 | 1.450 | 0.011 | 0.019 | 0.220 | | 0.530 | 0.620 | |
| MY | SHSS01 | Westinghouse | 61E | 0.221 | 1.524 | .0112 | .0174 | 0.198 | 0.080 | 0.577 | 0.665 | 0.173 |
| MY | SHSS01 | Westinghouse | 61D | 0.215 | 1.487 | .0104 | .0174 | 0.077 | 0.080 | 0.556 | 0.654 | 0.170 |
| HSST-0 | SHSS01K 0T[a] | ORNL | | 0.230 | 1.430 | 0.012 | 0.013 | 0.240 | | 0.550 | 0.810 | |
| HSST-0 | SHSS01K 12[a] | ORNL | | 0.260 | 1.240 | 0.021 | 0.012 | 0.240 | | 0.550 | 0.730 | |
| HSST-0 | SHSS01K 14[a] | ORNL | | 0.230 | 1.440 | 0.010 | 0.015 | 0.230 | | 0.540 | 0.840 | |
| HSST-0 | SHSS01K 18[a] | ORNL | | 0.220 | 1.410 | 0.010 | 0.014 | 0.230 | | 0.520 | 0.830 | |
| HSST-0 | SHSS01K 1T[a] | ORNL | | 0.240 | 1.370 | 0.015 | 0.013 | 0.230 | | 0.540 | 0.810 | |
| HSST-0 | SHSS01K 34[a] | ORNL | | 0.260 | 1.380 | 0.021 | 0.014 | 0.230 | | 0.530 | 0.840 | |
| HSST-0 | SHSS01K 38[a] | ORNL | | 0.230 | 1.450 | 0.015 | 0.012 | 0.240 | | 0.560 | 0.770 | |
| HSST-0 | SHSS01K 58[a] | ORNL | | 0.260 | 1.180 | 0.017 | 0.013 | 0.230 | | 0.560 | 0.740 | |
| HSST-0 | SHSS01K 78[a] | ORNL | | 0.240 | 1.300 | 0.016 | 0.014 | 0.230 | | 0.530 | 0.800 | |
| HSST-0 | SHSS01MU0T[a] | ORNL | | 0.230 | 1.440 | 0.014 | 0.014 | 0.260 | | 0.540 | 0.670 | |
| HSST-0 | SHSS01MU12[a] | ORNL | | 0.200 | 1.380 | 0.010 | 0.011 | 0.220 | | 0.520 | 0.670 | |
| HSST-0 | SHSS01MU14[a] | ORNL | | 0.230 | 1.390 | 0.010 | 0.012 | 0.260 | | 0.530 | 0.680 | |

[a]The last two digits of HEAT_ID are used to specify the specimen locatino in parent material,

OT - inner surface, 12 - 1/2 thickness, 14 - 1/4 thickness, 18 - 1/8 thickness, 1T - outer surface, 34 - 3/4 thickness, 38 - 3/8 thickness, 58 - 5/8 thickness, 78 - 7/8 thickness.

## Table 4. A533B (HSST02) CMM chemical compositions

| Plant/Exp ID | HEAT_ID | CHEM_LAB | SPEC_ID | Chemistry Composition (wt %) C | Mn | P | S | Si | Cr | Mo | Ni | Cu |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | SHSS02 | | HEAT | 0.230 | 1.390 | 0.013 | 0.013 | 0.210 | | 0.500 | 0.640 | 0.170 |
| | SHSS02 | Lukens | LADLE | 0.220 | 1.450 | 0.011 | 0.019 | 0.220 | | 0.530 | 0.620 | |
| DC1 | SHSS02 | | R47 | 0.200 | 1.560 | 0.008 | 0.011 | 0.190 | 0.110 | 0.470 | 0.650 | 0.150 |
| SA1 | SHSS02 | Westinghouse | HEAT | 0.220 | 1.480 | 0.012 | 0.018 | 0.250 | 0.080 | 0.520 | 0.680 | 0.140 |
| HSST-0 | SHSS02 | ORNL | CHECK | 0.240 | 1.420 | 0.010 | 0.017 | 0.220 | 0.120 | 0.500 | 0.700 | 0.140 |
| HSST-0 | SHSS02FB0T[a] | ORNL | | 0.270 | 1.500 | 0.013 | 0.014 | 0.210 | | 0.500 | 0.720 | |
| HSST-0 | SHSS02FB12[a] | ORNL | | 0.260 | 1.480 | 0.012 | 0.012 | 0.230 | | 0.490 | 0.640 | |
| HSST-0 | SHSS02FB14[a] | ORNL | | 0.270 | 1.490 | 0.013 | 0.013 | 0.210 | | 0.500 | 0.640 | |
| HSST-4 | SHSS02GA | | | 0.230 | 1.550 | 0.009 | 0.014 | 0.200 | 0.040 | 0.530 | 0.670 | 0.140 |
| NRL-2 | SHSS02 | NRL | HEAT | 0.230 | 1.480 | 0.008 | 0.016 | 0.190 | 0.120 | 0.510 | 0.680 | 0.140 |
| VDE | SHSS02A | | | 0.220 | 1.440 | 0.012 | 0.008 | 0.300 | 0.120 | 0.510 | 0.630 | 0.120 |

[a]The last two digits of HEAT_ID are used to specify the specimen locatino in parent material,
OT - inner surface, 12 - 1/2 thickness, 14 - 1/4 thickness.

## Table 5. A533B (HSST03) CMM chemical compositions

| Plant/Exp ID | HEAT_ID | CHEM_LAB | SPEC_ID | Chemistry Composition (wt %) C | Mn | P | S | Si | Cr | Mo | Ni | Cu |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| HSST-0 | SHSS03 | Lukens | CHECK | 0.200 | 1.260 | 0.011 | 0.018 | 0.250 | 0.100 | 0.450 | 0.560 | 0.120 |
| HSST-0 | SHSS03 | Lukens | LADLE | 0.210 | 1.310 | 0.012 | 0.018 | 0.240 | 0.150 | 0.500 | 0.600 | 0.130 |
| HSST-0 | SHSS03E 0T[a] | ORNL | | 0.260 | 1.330 | 0.011 | 0.016 | 0.240 | | 0.510 | 0.650 | |
| HSST-0 | SHSS03E 12[a] | ORNL | | 0.250 | 1.270 | 0.010 | 0.020 | 0.280 | | 0.490 | 0.700 | |
| HSST-0 | SHSS03E 14[a] | ORNL | | 0.260 | 1.360 | 0.011 | 0.015 | 0.260 | | 0.520 | 0.620 | |
| HSST-0 | SHSS03E 1T[a] | ORNL | | 0.250 | 1.410 | 0.010 | 0.016 | 0.280 | | 0.500 | 0.610 | |
| HSST-0 | SHSS03E 34[a] | ORNL | | 0.260 | 1.370 | 0.010 | 0.019 | 0.250 | | 0.430 | 0.620 | |

[a]The last two digits of HEAT_ID are used to specify the specimen locatino in parent material,
OT - inner surface, 12 - 1/2 thickness, 14 - 1/4 thickness, IT - outer surface, 34 - 3/4 thickness.

# 2 PROCEDURES USED IN EMBRITTLEMENT ANALYSIS

The CMMs are used in the surveillance program in the form of Charpy and tensile specimens. The majority of data are from the Charpy impact test, and only limited tensile test data are avail-able from General Electric's (GE) boiling-water-reactor (BWR) surveillance program. Thus only the Charpy test results are considered here, and the $\Delta T_{30}$ is considered as the primary measure for radiation embrittlement.

The computer curve fitting of Charpy V-notch transition temperature test data could promote more uniform analytical interpretation of Charpy data, particularly those obtained from reactor materials surveillance programs. The use of computerized methods is preferable to the hand fitting, which was widely practiced in the past. It eliminates some of the arbitrariness of the hand-fitted curve and allows calculation of the variance and covariance of the model parameters. Among the curve-fitting methods available are the four-parameter hyperbolic tangent method,[8] the four-parameter exponential curve method,[9] the five-parameter exponential term, the six-parameter Gauss-Integral method,[10] and the polynomial curve fit.[11] A mathematical expression of the hyperbolic tangent-shaped curves, typical of most Charpy impact energy, lateral expansion, and ductile fracture appearance vs test temperature data, requires at least four adjustable parameters to provide a useful characterization.

## 2.1 Description of the EDB Charpy Curve-Fitting Procedures

In order to have a uniform and consistent determination of the $\Delta T_{30}$ for the surveillance reference materials, the raw Charpy data are fitted to a hyperbolic tangent model. It relates impact energy E to the test temperature T according to the formula

$$E = (LSE + USE)/2 + [(USE - LSE)/2] * \tanh(SLOPE(T - TM))$$

with USE and LSE the upper- and lower-shelf energy, respectively, with TM as the midpoint of the transition temperature region, and SLOPE as the slope of the curve at TM. This model is purely phenomenological but well characterizes the general shape of a Charpy curve in four basic parameters: USE, LSE, TM, and SLOPE. Currently, this hyperbolic tangent function is the most widely used fitting procedure next to hand (eyeball) fitting.

The fitting parameters in this report were obtained from the EDB data-fitting procedures, which use the IMSL subroutine ZXSSQ. This subroutine is based on the Levenberg-Marquardt algorithm to solve the nonlinear least-squares problems. In the EDB Charpy curve-fitting utility, the initial values for the fitting parameters were determined by first separating the two shelves from the transition region using fracture appearance and the relative magnitude of the impact energy as criteria. From the test data in the transition region, crude estimates are obtained for TM and SLOPE, respectively. In the fitting procedure, an additional constraint is introduced for USE, and LSE is assigned to 3 joules, which restrains the variation in these parameters. It avoids runaway values for USE and negative LSE if data points in these regions are missing. With these precautions, any reasonable set of Charpy data can be fitted as well and more consistently than by a human evaluator. The procedure is completely automated with no operator intervention required or allowed. However, visual inspection is made to ensure that the fitting is properly performed. When the procedure fails, it is generally the result of outliers which must be removed or the data are such that no reasonable fit can be made. The simplicity and appeal of the least-squares method brings with it the danger that it may be used inappropriately, which was pointed out in Ref. 12. In any use, the underlying assumption and limitations should be clearly kept in mind, and the "best estimates" are good only within the bounds of their statistical uncertainties.

Uncertainties for the fitting parameters are needed to determine accuracy and credibility of the transition temperature and upper shelf data. A covariance matrix of the fitting parameters is part of any least-squares procedure, but these covariances are not used for uncertainty analysis in the EDB fitting program. The unavoidable linearization used for the determination of the covariances disregards second-order effects, and there is no possibility to account for uncertainties in test temperature. A more reliable procedure is the use of random variations of the input data (Monte Carlo procedure); such variations can be applied to both impact energy and test temperature, and the results reflect more accurately the influences of nonlinearities. The generated fitting parameters with corresponding plots of the Charpy curves and uncertainty analyses are demonstrated in Appendix A. Both the hyperbolic tangent fit and hyperbolic tangent fit plus Monte Carlo procedure (which assigns 10 J uncertainty for the impact energy and 4°C uncertainty for the testing temperature) show good agreement in the determination of $T_{30}$. The trend curves of raw Charpy data generated by the hyperbolic tangent fit plus Monte Carlo procedure seem to be more representative than that of the hyperbolic tangent fit alone, especially for those data sets with large data scatter.

## 2.2 Determination of Trend Curves for Radiation Embrittlement

The dependency of the $\Delta T_{30}$ on the damage fluence (i.e., the trend curve) for the two materials needs to be determined. The transition temperature shift values predicted by Regulatory Guide 1.99 (R.G. 1.99) are used for the determination of the trend curve, which is given by the formula

$$\Delta RT_{NDT} = [CF] \cdot f^{(0.28-0.10\log f)}$$

where [CF] is a "chemistry factor" which is given in tabular form, depending on the copper and nickel content, and separately for base material and welds. The symbol f stands for fluence, E > 1.0 MeV in $10^{19}$ n/cm$^2$. $\Delta RT_{NDT}$ is in degrees Fahrenheit at 30 ft-lb.

### 2.2.1 Background of Regulatory Guide 1.99, Rev. 2

According to Randall's paper, "Basis for Rev. 2 of the U. S. Nuclear Regulatory Commission's Regulatory Guide 1.99,"[13] there were two embrittlement models, Guthrie's[14] and Odette's,[15] involved in the development of R.G. 1.99, Rev. 2. Both models are based on the least-squares fitting scheme and adopted similar approaches in several areas: (1) separate welds and base metals; (2) the correlation is expressed as the product of a chemistry factor and a fluence factor; (3) the elements in the chemistry factor are copper and nickel; and (4) the fluence factor provides a trend curve slope of about 0.25 ~ 0.30 at $10^{19}$ n/cm$^2$.

Three major data bases were involved in the modeling of R.G. 1.99, Rev. 2. The data base and their influence on R.G. 1.99, Rev. 2, are described below:

## 177 Data Points Data Base

Fifty-one weld and 126 base metal data points were taken from surveillance reports by Randall and rechecked by Guthrie, where 41 of 126 base data are CMMs. The fluence contents are from Simon's[16] data when available. This data base is used in Guthrie's embrittlement model, which used an unconventional least-squares scheme and a Monte Carlo procedure in the model development.

The fluence factor (FF) of R.G. 1.99, Rev. 2, is determined primarily by Guthrie's fluence factor, with slight modifications.

For chemistry factor (CF) of the weld materials, Odette's model is chosen as the main guide for R.G. 1.99, Rev. 2; however, both models have good agreement on CF. For CF of the base metals, Guthrie's model is used, with two exceptions: first, when Guthrie's CF for base metals exceeds those for welds by Odette, the latter was used. Second, at very low copper levels, the CF is assigned as 20°F.

The 2$\sigma$ margins for R.G. 1.99, Rev. 2, are based on the residual study of the 177 Data Points.

## EPRI Data Base[17]

The Electric Power Research Institute's (EPRI) data base used in Odette's modeling contains 65 weld and 151 base metal data and was collected directly from surveillance reports where 37 of 151 base metal data are CMMs. The shift value was determined by a hyperbolic tangent fitting procedure. EPRI's data base overlapped the 177 Data Points almost completely.

For weld materials, Odette's CF is used, except for very low copper, and is assigned the value of 20 °F.

## Test Reactor Data

For very low copper contents, there are not sufficient data from the above two data bases. Therefore, an additional judgment was made from test reactor data[18,19] for the determination of CF, which is assigned as 20°F.

## 2.3 Basis of CMM and Its Implication on Radiation Embrittlement

The use of CMMs is based on the idea that anomalous conditions with regard to fluence, fluence rate, and irradiation temperature can be detected by correspondingly anomalous behavior of the CMM. The difficulty is that it is not easy to determine whether anomalous embrittlement is caused by the radiation environment, such as neutron energy spectrum, flux, fluence, irradiation temperature, and reactor operation history; or by problems inherent in the reference material, such as inhomogeneous material properties of the CMM; or uncertainties in the determination of the trend curve for the reference material, and uncertainties in the determination of the $\Delta T_{30}$. Significant errors in the trend curve determination will show up as systematic biases. These biases may be either independent of the fluence (e.g., due to an incorrect chemistry factor) or fluence dependent, indicating errors in the fluence factor. Such systematic biases can never be completely separated from random errors, but relatively large numbers of data will guard against neglecting large inconsistencies with the trend curve model.

The variation of material properties, such as mechanical test results and chemical compositions, within the reference material is a serious problem. Tests made from different sets of specimens for the unirradiated material reveal considerable differences in the baseline $T_{30}$ for the ASTM A302B plate as well as the three HSST plates (HSST01, HSST02, and HSST03). The test specimens used for the baseline of the A302B reference material (LT orientation) have the range of $T_{30}$ from 4 to 32 °F, and the range of chemistry composition for copper and nickel is 0.17–0.31wt % and 0.17–0.27 wt %, respectively. For the HSST01 plate, the LT baseline specimens have the range of $T_{30}$ from -20 to 36 °F at one-quarter thickness; and the range of copper and nickel contents are 0.17–0.18 wt % and 0.62–0.84 wt %, respectively. For the HSST02 plate, the LT baseline specimens have the range of $T_{30}$ from -3 to 47 °F; and the range of copper and nickel contents are 0.12–0.17 wt % and 0.62–0.72 wt %, respectively. For the HSST03 plate, the TL baseline specimens have the range of $T_{30}$ from 31 to 42 °F at one-quarter thickness and from 17 to 29°F or LT orientation; and the range of copper and nickel contents are 0.12–0.13 wt % and 0.56–0.70 wt %, respectively. The possible fluctuations in the material properties from one specimen set to another can be detected only as random deviations, and these deviations cannot be clearly separated from other random errors.

The standard method used to determine the uncertainty for the $T_{30}$ is based on the uncertainties in determining the fitting parameters in the least-squares fit and the mean-square difference between model and experimental data. However, this procedure does not consider possible deviations between the idealized model and the actual physical mechanism, and this may lead to serious underestimation of the uncertainties, the more so the more restrictive the model is. It can be assumed that the information for determining $T_{30}$ is based on mean values and the slope of the relevant data regardless of what model is actually used, and that this information or the lack of it determines the uncertainties. However, the estimated values of $T_{30}$ and USE as well as the experimental uncertainties are still based on a specific model. From past studies of several fitting models,[20] it appears that differences among selected fit models are mostly within uncertainty bounds.

Hyperbolic tangent fit results for CMM data are listed in Tables 6–8 for surveillance data, and Tables 9–12 for TR-EDB's CMM data, together with the values reported by the original investigation. The index transition temperature at the 30 ft-lb energy level is used in the study, which is the index temperature required by ASTM E-185 for the determination of the transition temperature shift. The 30 ft-lb energy level was used in preference to the old standard of 50 ft-lb

Table 6. Summary of A302B surveillance CMM

| Tag | Reactor name | Capsule | Orient. | Fluence E > 1 MeV $10^{19}$ n/cm² | Flux E > 1 MeV $10^{11}$ n/cm²s | $C_v$ transition temp. °F at 30-ft-lb, unirradiated R | T | MT | U | $C_v$ transition temp. °F at 30-ft lb, irradiated R | T | MT | U | $C_v$ transition temp. °F shift at 30-ft lb R | P | T | MT | U |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| W | Beznau Unit 1 | R | LT | 0.572 | 0.682 | 36 | 32 | 33 | 6.1 | 144 | 135 | 135 | 11.5 | 108 | 84 | 103 | 102 | 13.0 |
| W | Beznau Unit 1 | V | LT | 0.277 | 0.776 | 36 | 32 | 33 | 6.1 | 81 | 81 | 82 | 19.5 | 45 | 65 | 35 | 49 | 20.4 |
| W | Jose Cabrera-Zorita | K | LT | 1.400 | | 40 | 32 | 33 | 6.1 | 160 | 131 | 128 | 20.2 | 120 | 109 | 99 | 95 | 21.1 |
| W | Jose Cabrera-Zorita | N | LT | 3.680 | 1.579 | 40 | 32 | 33 | 6.1 | 195 | 168 | 168 | 15.6 | 155 | 134 | 136 | 135 | 16.8 |
| W | Jose Cabrera-Zorita | P | LT | 1.430 | | 40 | 32 | 33 | 6.1 | 178 | 164 | 163 | 12.0 | 138 | 110 | 132 | 130 | 13.5 |
| W | Haddam Neck | A | LT | 0.259 | 0.486 | 40 | 32 | 33 | 6.1 | 125 | 133 | 134 | 13.4 | 85 | 63 | 101 | 101 | 14.7 |
| W | Haddam Neck | D | LT | 2.280 | 0.665 | 40 | 32 | 33 | 6.1 | 180 | 170 | 165 | 17.3 | 140 | 122 | 138 | 132 | 18.3 |
| W | Haddam Neck | F | LT | 0.463 | 0.604 | 40 | 32 | 33 | 6.1 | 120 | 124 | 123 | 13.1 | 80 | 79 | 92 | 90 | 14.5 |
| W | Haddam Neck | H | LT | 1.550 | 0.646 | 40 | 32 | 33 | 6.1 | 167 | 169 | 166 | 12.0 | 127 | 112 | 137 | 133 | 13.5 |
| G | Garigliano | 113B | LT | 1.100 | 0.414 | 27 | 32 | 33 | 6.1 | 153 | 140 | 140 | 12.5 | 126 | 103 | 108 | 107 | 13.9 |
| G | Garigliano | 113D | LT | 0.737 | 0.547 | 27 | 32 | 33 | 6.1 | 133 | | | | 106 | 91 | | | |
| G | Garigliano | 114A | LT | 4.650 | 4.947 | 27 | 32 | 33 | 6.1 | 194 | | | | 167 | 139 | | | |
| G | Garigliano | 114B | LT | 2.210 | 5.725 | 27 | 32 | 33 | 6.1 | 142 | | | | 115 | 121 | | | |
| G | Garigliano | 114C | LT | 5.470 | 8.238 | 27 | 32 | 33 | 6.1 | 178 | | | | 151 | 142 | | | |
| W | R. E. Ginna Unit 1 | R | LT | 1.100 | 1.368 | 40 | 32 | 33 | 6.1 | 136 | 134 | 132 | 13.4 | 96 | 103 | 102 | 99 | 14.7 |
| W | R. E. Ginna Unit 1 | T | LT | 1.910 | 0.880 | 40 | 32 | 33 | 6.1 | 180 | 167 | 165 | 16.7 | 140 | 118 | 135 | 132 | 17.8 |
| W | R. E. Ginna Unit 1 | V | LT | 0.585 | 1.315 | 40 | 32 | 33 | 6.1 | 130 | 128 | 128 | 10.9 | 90 | 85 | 96 | 95 | 12.5 |
| W | H. B. Robinson Unit 2 | S | TL | 0.506 | 1.253 | 64 | 64 | 64 | 13.0 | 141 | 138 | 142 | 20.0 | 77 | 81 | 74 | 78 | 23.9 |
| W | H. B. Robinson Unit 2 | T | TL | 4.420 | 1.930 | 65 | 64 | 64 | 13.0 | 215 | 228 | 232 | 28.4 | 150 | 138 | 164 | 168 | 31.2 |
| W | H. B. Robinson Unit 2 | V | TL | 0.601 | 0.595 | 64 | 64 | 64 | 13.0 | 169 | 135 | 135 | 20.0 | 105 | 86 | 71 | 71 | 23.9 |
| W | Indian Point Unit 2 | T | LT | 0.243 | 0.542 | 38 | 32 | 33 | 6.1 | 110 | 106 | 107 | 11.7 | 72 | 62 | 74 | 74 | 13.2 |
| W | Indian Point Unit 2 | V | LT | 0.506 | 0.186 | 38 | 32 | 33 | 6.1 | 128 | 132 | 132 | 13.5 | 90 | 81 | 100 | 99 | 14.8 |
| W | Indian Point Unit 2 | Y | LT | 0.453 | 0.615 | 38 | 32 | 33 | 6.1 | 108 | 106 | 106 | 10.7 | 70 | 78 | 74 | 73 | 12.3 |
| W | Indian Point Unit 2 | Z | LT | 1.080 | 0.663 | 38 | 32 | 33 | 6.1 | 138 | 120 | 117 | 16.6 | 100 | 102 | 88 | 84 | 17.7 |
| W | Point Beach Unit 1 | R | LT | 2.360 | 1.466 | 40 | 32 | 33 | 6.1 | 150 | 156 | 154 | 10.3 | 110 | 123 | 124 | 121 | 12.0 |
| W | Point Beach Unit 1 | S | LT | 0.798 | 0.700 | 40 | 32 | 33 | 6.1 | 135 | 126 | 126 | 13.8 | 95 | 94 | 94 | 93 | 15.1 |
| W | Point Beach Unit 1 | T | LT | 2.370 | 0.809 | 40 | 32 | 33 | 6.1 | 160 | 162 | 162 | 13.1 | 120 | 123 | 130 | 129 | 14.5 |
| W | Point Beach Unit 1 | V | LT | 0.524 | 1.117 | 40 | 32 | 33 | 6.1 | 135 | 132 | 131 | 11.3 | 95 | 82 | 100 | 98 | 12.8 |
| W | San Onofre Unit 1 | A | LT | 1.750 | 2.986 | 40 | 32 | 33 | 6.1 | 155 | 148 | 146 | 11.8 | 115 | 115 | 116 | 113 | 13.3 |
| W | San Onofre Unit 1 | D | LT | 3.480 | 3.910 | 40 | 32 | 33 | 6.1 | 190 | 186 | 187 | 13.7 | 150 | 133 | 154 | 154 | 15.0 |
| W | San Onofre Unit 1 | F | LT | 3.850 | 1.584 | 40 | 32 | 33 | 6.1 | 170 | 162 | 160 | 14.3 | 130 | 135 | 130 | 127 | 15.5 |
| W | Turkey Point Unit 3 | S | LT | 1.720 | 1.578 | 35 | 32 | 33 | 6.1 | 160 | 156 | 150 | 14.3 | 125 | 115 | 124 | 117 | 15.5 |
| W | Turkey Point Unit 3 | T | LT | 0.739 | 2.041 | 35 | 32 | 33 | 6.1 | 117 | 118 | 115 | 15.4 | 82 | 92 | 86 | 82 | 16.6 |
| W | Turkey Point Unit 3 | V | LT | 1.530 | 0.602 | 35 | 32 | 33 | 6.1 | 160 | 132 | 131 | 14.9 | 125 | 112 | 100 | 98 | 16.1 |
| W | Yankee-Rowe | 01 | | 9.000 | 32.847 | 15 | 32 | 33 | 6.1 | 325 | | | | 310 | 150 | | | |
| W | Yankee-Rowe | 02 | | 9.000 | 30.928 | 15 | 32 | 33 | 6.1 | 325 | | | | 310 | 150 | | | |
| W | Yankee-Rowe | 06 | | 7.000 | 25.830 | 15 | 32 | 33 | 6.1 | 275 | | | | 260 | 146 | | | |
| W | Yankee-Rowe | 08 | | 5.000 | 17.007 | 15 | 32 | 33 | 6.1 | 240 | | | | 225 | 140 | | | |

R - as reported; T - hyperbolic tangent model; MT - hyperbolic tangent model plus Monte Carlo method; U - uncertainty (1 standard deviation); P - R.G. 1.99, Rev.2, prediction.

Tag field, W - Westinghouse; G - General Electric.

Westinghouse fluences obtained from "Westinghouse Surveillance Capsule Neutron Fluence Reevaluation," WCAP-14044.

Table 7. Summary of A533B, HSST01, surveillance CMM

| Tag | Reactor Name | Capsule | Orient. | Fluence E > 1 MeV $10^{19}$ n/cm² | Flux E > 1 MeV $10^{11}$ n/cm²s | $C_v$ transition temp. °F at 30 ft-lb, unirradiated | | | | $C_v$ transition temp. °F at 30 ft-lb, irradiated | | | | $C_v$ transition temp. °F shift at 30 ft-lb | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | R | T | Mt | U | R | T | Mt | U | R | P | T | Mt | U |
| C | Calvert Cliffs Unit 1 | W263 | LT | 0.590 | 0.636 | 39 | 32 | 31 | 5.4 | 127 | 132 | 132 | 7.9 | 88 | 116 | 100 | 101 | 9.6 |
| C | Calvert Cliffs Unit 2 | W263 | LT | 0.814 | 0.564 | 25 | 24 | 23 | 6.7 | 153 | 151 | 153 | 8.5 | 128 | 128 | 127 | 130 | 10.8 |
| C | Fort Calhoun Unit 1 | W225 | LT | 0.583 | 0.711 | 27 | 14 | 13 | 7.4 | 151 | 147 | 146 | 8.6 | 124 | 115 | 133 | 133 | 11.3 |
| C | Fort Calhoun Unit 1 | W275 | LT | 1.280 | 0.298 | 27 | 14 | 13 | 7.4 | 168 | 186 | 186 | 19.5 | 141 | 145 | 172 | 173 | 20.9 |
| C | Millstone Unit 2 | W104 | LT | 0.884 | 0.282 | 24 | 30 | 30 | 7.7 | 165 | 165 | 163 | 8.8 | 141 | 131 | 135 | 133 | 11.7 |
| C | Maine Yankee | A25 | LT | 1.300 | 4.348 | 15 | 14 | 13 | 7.4 | 165 | 169 | 168 | 11.3 | 150 | 146 | 155 | 155 | 13.5 |
| C | Maine Yankee | W253 | LT | 1.250 | 0.339 | 15 | 14 | 13 | 7.4 | 175 | 180 | 179 | 8.6 | 160 | 144 | 166 | 166 | 11.3 |
| C | Palo Verde Unit 2 | W137 | LT | 0.407 | 0.284 | 3 | 14 | 13 | 7.4 | 120 | 110 | 110 | 14.5 | 117 | 102 | 96 | 97 | 16.3 |
| C | Palisades | W110 | LT | 1.779 | 0.567 | 15 | 14 | 13 | 7.4 | 163 | 169 | 169 | 9.2 | 148 | 158 | 155 | 156 | 11.8 |
| C | St. Lucie Unit 1 | W104 | LT | 0.716 | 0.239 | 39 | 36 | 36 | 5.6 | 149 | 160 | 160 | 9.5 | 110 | 123 | 124 | 124 | 11.0 |

R - as reported; T - hyperbolic tangent model; MT - hyperbolic tangent model plus Monte Carlo method; U - uncertainty (1 standard deviation).
P - predicted shift per Reg. Guide 199, Revison 2.
Tag field, C - Combustion Engineering.

## Table 8. Summary of A 533B, HSST02, surveillance CMM

| Tag | Reactor name | Capsule | Orient. | Fluence E > 1 MeV $10^{19}$ n/cm² | Flux E > 1 MeV $10^{11}$ n/cm² s | $C_v$ transition temp. °F at 30 ft-lb,unirradiated | | | | $C_v$ transition temp. °F at 30 ft-lb,irradiated | | | | $C_v$ transition temp. °F at 30 ft-lb,unirradiated | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | R | T | MT | U | R | T | MT | U | R | P | T | MT | U |
| B | Arkansas Unit 1 | A | LT | 1.030 | | 48 | 47 | 46 | 5.1 | 94 | 121 | 116 | 16.1 | 46 | 129 | 74 | 70 | 16.9 |
| B | Arkansas Unit 1 | B | LT | 0.428 | | 48 | 47 | 46 | 5.1 | 98 | 97 | 98 | 10.4 | 50 | 98 | 50 | 52 | 11.6 |
| B | Arkansas Unit 1 | C | LT | 1.460 | | 48 | 47 | 46 | 5.1 | 116 | 122 | 121 | 12.7 | 68 | 141 | 75 | 75 | 13.7 |
| B | Arkansas Unit 1 | E | LT | 0.073 | 0.244 | 56 | 47 | 46 | 5.1 | | 75 | 73 | 12.4 | 40* | 46 | 28 | 27 | 13.4 |
| W | Donald C. Cook Unit 1 | T | LT | 0.269 | 0.673 | 45 | 47 | 46 | 5.1 | 105 | 106 | 105 | 13.1 | 60 | 82 | 59 | 59 | 14.1 |
| W | Donald C. Cook Unit 1 | U | LT | 1.770 | 0.610 | 45 | 47 | 46 | 5.1 | 165 | 186 | 186 | 10.0 | 120 | 148 | 139 | 140 | 11.2 |
| W | Donald C. Cook Unit 1 | X | LT | 0.813 | 0.760 | 45 | 47 | 46 | 5.1 | 145 | 148 | 149 | 9.6 | 100 | 121 | 101 | 103 | 10.9 |
| W | Donald C. Cook Unit 1 | Y | LT | 1.230 | 0.788 | 45 | 47 | 46 | 5.1 | 155 | 156 | 156 | 10.7 | 110 | 135 | 109 | 110 | 11.9 |
| B | Crystal River Unit 3 | C | LT | 0.656 | 0.513 | 48 | 47 | 46 | 5.1 | 121 | 130 | 129 | 13.8 | 73 | 113 | 83 | 83 | 14.7 |
| B | Davis-Besse Unit 1 | A | LT | 1.290 | 1.230 | 48 | 47 | 46 | 5.1 | 154 | 160 | 160 | 13.9 | 106 | 137 | 113 | 114 | 14.8 |
| W | Diablo Canyon Unit 1 | S | LT | 0.284 | 0.714 | 46 | 47 | 46 | 5.1 | 112 | 112 | 113 | 9.2 | 66 | 84 | 65 | 67 | 10.5 |
| W | Diablo Canyon Unit 1 | Y | LT | 0.941 | 0.509 | 46 | 47 | 46 | 5.1 | 158 | 160 | 160 | 10.8 | 112 | 126 | 113 | 114 | 11.9 |
| W | Indian Point Unit 3 | Y | LT | 0.724 | 0.690 | 50 | 47 | 46 | 5.1 | 190 | 194 | 191 | 11.4 | 140 | 116 | 147 | 145 | 12.5 |
| W | Kewaunee | P | LT | 2.840 | 0.809 | 45 | 47 | 46 | 5.1 | 200 | 201 | 201 | 10.8 | 155 | 164 | 154 | 155 | 11.9 |
| W | Kewaunee | R | LT | 1.900 | 1.301 | 45 | 47 | 46 | 5.1 | 185 | 202 | 194 | 10.3 | 140 | 150 | 155 | 148 | 11.5 |
| W | Kewaunee | V | LT | 0.608 | 1.498 | 45 | 47 | 46 | 5.1 | 140 | 143 | 141 | 11.8 | 95 | 110 | 96 | 95 | 12.9 |
| B | Oconee Unit 1 | A | LT | 0.895 | | 56 | 47 | 46 | 5.1 | 144 | 130 | 131 | 11.4 | 88 | 124 | 83 | 85 | 12.5 |
| B | Oconee Unit 1 | C | LT | 0.986 | | 48 | 47 | 46 | 5.1 | 116 | 122 | 121 | 12.6 | 68 | 194 | 75 | 75 | 13.6 |
| B | Oconee Unit 1 | E | LT | 0.150 | 0.289 | 56 | 47 | 46 | 5.1 | | 78 | 77 | 14.2 | 64* | 64 | 31 | 31 | 15.1 |
| B | Oconee Unit 1 | F | LT | 0.057 | 0.213 | 56 | 47 | 46 | 5.1 | | 56 | 56 | 12.4 | 28* | 40 | 9 | 10 | 13.4 |
| B | Oconee Unit 2 | A | LT | 0.337 | | 48 | 47 | 46 | 5.1 | 119 | 116 | 115 | 7.6 | 71 | 90 | 69 | 69 | 9.2 |
| B | Oconee Unit 2 | C | LT | 0.094 | 0.248 | 56 | 47 | 46 | 5.1 | | 74 | 73 | 11.4 | 42* | 52 | 27 | 27 | 12.5 |
| B | Oconee Unit 2 | E | LT | 1.210 | | 48 | 47 | 46 | 5.1 | 143 | 170 | 168 | 16.9 | 95 | 135 | 123 | 122 | 17.7 |
| B | Oconee Unit 3 | B | LT | 0.312 | | 56 | 47 | 46 | 5.1 | 95 | 99 | 99 | 8.6 | 39 | 87 | 52 | 53 | 10.0 |
| B | Oconee Unit 3 | D | LT | 1.450 | | 32 | 47 | 46 | 5.1 | 151 | 153 | 150 | 16.5 | 119 | 141 | 106 | 104 | 17.3 |
| W | Point Beach Unit 2 | R | LT | 2.520 | 1.537 | 49 | 47 | 46 | 5.1 | 200 | 201 | 200 | 12.0 | 151 | 160 | 154 | 154 | 13.0 |
| W | Point Beach Unit 2 | S | LT | 3.760 | 0.807 | 49 | 47 | 46 | 5.1 | 194 | 198 | 197 | 12.5 | 145 | 172 | 151 | 151 | 13.5 |
| W | Point Beach Unit 2 | T | LT | 1.010 | 0.927 | 49 | 47 | 46 | 5.1 | 154 | 168 | 168 | 13.3 | 105 | 128 | 121 | 122 | 14.2 |
| W | Point Beach Unit 2 | V | LT | 0.585 | 1.216 | 45 | 47 | 46 | 5.1 | 135 | 141 | 141 | 10.7 | 90 | 109 | 94 | 95 | 11.9 |
| W | Prairie Island Unit 1 | P | LT | 1.460 | 0.807 | 49 | 47 | 46 | 5.1 | 205 | 208 | 207 | 8.1 | 156 | 141 | 161 | 161 | 9.6 |
| W | Prairie Island Unit 1 | R | LT | 3.950 | 1.463 | 49 | 47 | 46 | 5.1 | 235 | 241 | 240 | 9.9 | 186 | 173 | 194 | 194 | 11.1 |
| W | Prairie Island Unit 1 | V | LT | 0.540 | 1.280 | 49 | 47 | 46 | 5.1 | 159 | 151 | 150 | 11.0 | 110 | 106 | 104 | 104 | 12.1 |
| W | Prairie Island Unit 2 | R | LT | 4.050 | 1.457 | 45 | 47 | 46 | 5.1 | 225 | 230 | 229 | 10.3 | 180 | 174 | 183 | 183 | 11.5 |
| W | Prairie Island Unit 2 | T | LT | 1.090 | 0.838 | 45 | 47 | 46 | 5.1 | 205 | 205 | 204 | 8.7 | 160 | 131 | 158 | 158 | 10.1 |
| W | Prairie Island Unit 2 | V | LT | 0.578 | 1.314 | 45 | 47 | 46 | 5.1 | 170 | 170 | 169 | 11.1 | 125 | 108 | 123 | 123 | 12.2 |
| W | Salem Unit 1 | T | LT | 0.256 | 0.738 | 50 | 47 | 46 | 5.1 | 110 | 113 | 114 | 11.9 | 60 | 81 | 66 | 68 | 12.9 |

## Table 8 (continued)

| Tag | Reactor name | Capsule | Orient. | Fluence E > 1 MeV $10^{19}$ n/cm² | Flux E > 1 MeV $10^{11}$ n/cm² s | $C_v$ transition temp. °F at 30 ft-lb, unirradiated | | | | $C_v$ transition temp. °F at 30 ft-lb, irradiated | | | | $C_v$ transition temp. °F at 30 ft-lb, unirradiated | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | R | T | MT | U | R | T | MT | U | R | P | T | MT | U |
| W | Salem Unit 1 | Y | LT | 0.930 | 0.823 | 50 | 47 | 46 | 5.1 | 175 | 180 | 180 | 8.9 | 125 | 125 | 133 | 134 | 10.3 |
| W | Salem Unit 1 | Z | LT | 1.230 | 0.644 | 50 | 47 | 46 | 5.1 | 185 | 182 | 182 | 8.4 | 135 | 135 | 135 | 136 | 9.8 |
| W | Surry Unit 1 | T | LT | 0.282 | 0.834 | 45 | 47 | 46 | 5.1 | 115 | 119 | 117 | 10.9 | 70 | 84 | 72 | 71 | 12.0 |
| W | Surry Unit 1 | V | LT | 1.970 | 0.779 | 45 | 47 | 46 | 5.1 | 190 | 189 | 189 | 10.2 | 145 | 152 | 142 | 143 | 11.4 |
| W | Surry Unit 2 | V | LT | 1.750 | 0.663 | 45 | 47 | 46 | 5.1 | 165 | 152 | 150 | 12.2 | 120 | 148 | 105 | 104 | 13.2 |
| W | Surry Unit 2 | X | LT | 0.294 | 0.797 | 40 | 47 | 46 | 5.1 | 100 | 109 | 108 | 9.8 | 60 | 85 | 62 | 62 | 11.0 |
| B | Three Mile Island Unit 1 | C | LT | 0.866 | | 48 | 47 | 46 | 5.1 | 125 | 126 | 125 | 9.9 | 77 | 123 | 79 | 79 | 11.1 |
| B | Three Mile Island Unit 1 | E | LT | 0.107 | 0.263 | 56 | 47 | 46 | 5.1 | | 90 | 89 | 9.2 | 44* | 55 | 43 | 43 | 10.5 |
| W | Turkey Point Unit 4 | S | LT | 1.430 | 1.324 | 45 | 47 | 46 | 5.1 | | 152 | 151 | 9.2 | 115* | 141 | 105 | 105 | 10.5 |
| W | Turkey Point Unit 4 | T | LT | 0.708 | 1.914 | 45 | 47 | 46 | 5.1 | 135 | 136 | 136 | 12.1 | 90 | 116 | 89 | 90 | 13.1 |
| W | Zion Unit 1 | T | LT | 0.325 | 0.846 | 42 | 47 | 46 | 5.1 | 108 | 113 | 113 | 8.8 | 66 | 88 | 66 | 67 | 10.2 |
| W | Zion Unit 1 | U | LT | 0.964 | 0.853 | 42 | 47 | 46 | 5.1 | 172 | 175 | 170 | 12.6 | 130 | 127 | 128 | 124 | 13.6 |
| W | Zion Unit 1 | X | LT | 1.330 | 0.816 | 42 | 47 | 46 | 5.1 | 162 | 166 | 165 | 10.1 | 120 | 138 | 119 | 119 | 11.3 |
| W | Zion Unit 1 | Y | LT | 1.780 | 0.657 | 42 | 47 | 46 | 5.1 | 171 | 169 | 169 | 11.9 | 129 | 148 | 122 | 123 | 12.9 |
| W | Zion Unit 2 | T | LT | 0.840 | 0.743 | 50 | 47 | 46 | 5.1 | 150 | 147 | 146 | 10.6 | 100 | 122 | 100 | 100 | 11.8 |
| W | Zion Unit 2 | U | LT | 0.282 | 0.676 | 50 | 47 | 46 | 5.1 | 100 | 95 | 96 | 9.4 | 50 | 84 | 48 | 50 | 10.7 |
| W | Zion Unit 2 | Y | LT | 1.670 | 0.576 | 50 | 47 | 46 | 5.1 | 185 | 183 | 183 | 8.6 | 135 | 146 | 136 | 137 | 10.0 |

R - as reported; T - hyperbolic tangent model; MT - hyperbolic tangent model plus Monte Carlo method; U - uncertainty (1 standard deviation).

P - predicted shift per R.G. 1.99, Rev. 2.

* 50 ft-lb transition temperature shift

Tag Field, B - Babcock & Wilcox; W - Westinghouse

Westinghouse Fluences obtained from "Westinghouse Surveillance Capsule Neutron Fluence Reevaluation," WCAP-14044.

Table 9. Summary of A302B, ASTM, CMM per TR-EDB

| Experiment Tag | Reactor ID | Capsule | Heat ID | Orient. | Fluence E > 1 MeV $10^{19}$ n/cm² | Flux E > 1 MeV $10^{13}$ n/cm² s | Irrad. temp. °F | $C_v$ transition temp. °F at 30 ft-lb, unirradiated | | | $C_v$ transition temp. °F at 30 ft-lb, irradiated | | | $C_v$ transition temp. °F shift at 30 ft-lb | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | R | MT | U | R | MT | U | R | P | MT | U |
| HAW-AN | LITR | 57 88A | SASTM F23 | LT | 1.080 | | 500 | 30 | 13 | 6.6 | 210 | | | 180 | 102 | | |
| HAW-AN | LITR | 57 88B | SASTM F23 | LT | 0.910 | | 470 | 30 | 13 | 6.6 | 210 | | | 180 | 97 | | |
| MEA-RT | UBR | B4-65 | SASTM F23 | LT | 0.560 | 1.008 | 550 | 7 | 4 | 9.1 | 88 | 84 | 6.8 | 81 | 84 | 80 | 11.4 |
| MEA-RT | UBR | B4-76 | SASTM F23 | LT | 2.230 | 1.006 | 550 | 7 | 4 | 9.1 | 132 | 130 | 7.4 | 125 | 122 | 126 | 11.7 |
| MEA-RT | UBR | C2-75 | SASTM F23 | LT | 1.040 | 0.937 | 550 | 7 | 4 | 9.1 | 113 | 110 | 9.1 | 106 | 101 | 106 | 12.9 |
| MEA-RT | UBR | CE-44 | SASTM F23 | LT | 0.790 | 0.079 | 550 | 7 | 4 | 9.1 | 110 | 110 | 8.8 | 103 | 93 | 106 | 12.7 |
| MEA-RT | UBR | CE-45 | SASTM F23 | LT | 3.850 | 0.096 | 550 | 7 | 4 | 9.1 | 139 | 131 | 8.1 | 132 | 135 | 127 | 12.2 |
| MEA-RT | UBR | CE-46A | SASTM F23 | LT | 1.500 | 0.074 | 550 | 7 | 4 | 9.1 | 120 | 119 | 8.6 | 113 | 111 | 115 | 12.5 |
| MEA-RT | UBR | RE-38 | SASTM F23 | LT | 0.540 | 0.009 | 550 | 7 | 4 | 9.1 | 100 | 98 | 6.6 | 93 | 83 | 94 | 11.2 |
| NRL-4 | UBR | UB-01 | SASTM F26 | LT | 0.120 | 0.700 | 550 | 0 | | | 40 | | | 40 | 45 | | |
| NRL-EP | BSR | 7 | SASTM N | TL | 2.700 | 0.340 | 550 | 60 | 57 | 16.9 | 205 | 200 | 19.7 | 145 | 127 | 143 | 26.0 |
| NRL-EP | UBR | UB-31 | SASTM N | LT | 3.600 | 0.899 | 550 | 20 | 16 | 4.4 | 195 | 182 | 9.1 | 175 | 133 | 166 | 10.1 |
| ORRPSF | ORR | 0-TF | SASTM F23 | LT | 5.400 | 0.105 | 550 | 25 | 25 | 8.3 | 171 | 161 | 8.5 | 146 | 142 | 136 | 11.9 |
| ORRPSF | ORR | 1/2 TF | SASTM F23 | LT | 1.400 | 0.027 | 550 | 25 | 25 | 8.3 | 115 | 114 | 8.4 | 90 | 109 | 89 | 11.8 |
| ORRPSF | ORR | 1/4 TF | SASTM F23 | LT | 2.800 | 0.055 | 550 | 25 | 25 | 8.3 | 145 | 127 | 8.8 | 121 | 127 | 102 | 12.1 |
| ORRPSF | ORR | SSC1F | SASTM F23 | LT | 2.790 | 0.726 | 550 | 25 | 25 | 8.3 | 172 | 157 | 11.5 | 148 | 127 | 132 | 14.2 |
| ORRPSF | ORR | SSC2F | SASTM F23 | LT | 5.400 | 0.695 | 550 | 25 | 25 | 8.3 | 194 | 185 | 8.1 | 169 | 142 | 160 | 11.6 |
| PR-EDB | YR | 8 | SASTM D36 | LT | 5.000 | 0.170 | 490 | 15 | | | 240 | | | 225 | 140 | | |
| PR-EDB | YR | W1 | SASTM D36 | LT | 0.220 | 0.003 | 490 | 35 | | | 120 | | | 85 | 59 | | |
| RRA | DIDO | 2V4(9) | SASTM RRA | TL | 0.475 | 0.228 | 482 | 21 | | | 174 | | | 153 | 79 | | |
| RRA | DIDO | 2V4(9) | SASTM RRA | TL | 1.020 | 0.251 | 482 | 21 | | | 228 | | | 185 | 101 | | |
| SM-2 | LITR | X02 | SASTM X | | 3.000 | ~0.500 | 550 | 15 | | | 170 | | | 155 | 129 | | |
| SRM | BGR | 9 | SASTM X | | 0.740 | | 300 | | | | | | | 240 | 92 | | |
| SRM | BGR | 10 | SASTM X | | 0.550 | | 300 | | | | | | | 205 | 83 | | |
| SRM | BR | 122-3 | SASTM F23 | LT | 7.100 | | 585 | 30 | 13 | 6.6 | 195 | | | 165 | 147 | | |
| SRM | CVTR | 10L | SASTM X | | 0.780 | | 300 | | | | | | | 240 | 93 | | |
| SRM | ETR | XX | SASTM X | | 0.270 | | 450 | | | | | | | 67 | 64 | | |
| SRM | ETR | XX | SASTM X | | 0.450 | | 450 | | | | | | | 95 | 78 | | |
| SRM | ETR | XX | SASTM X | | 7.600 | | 450 | | | | | | | 201 | 148 | | |
| SRM | IRL | 1 | SASTM X | | 0.035 | | 300 | | | | | | | 35 | 24 | | |
| SRM | IRL | 1 | SASTM X | | 0.059 | | 300 | | | | | | | 50 | 32 | | |
| SRM | IRL | 1 | SASTM X | | 0.099 | | 300 | | | | | | | 50 | 41 | | |
| SRM | IRL | 1 | SASTM X | | 0.160 | | 300 | | | | | | | 80 | 52 | | |
| SRM | IRL | 1 | SASTM X | | 0.260 | | 300 | | | | | | | 105 | 63 | | |
| SRM | IRL | 2 | SASTM X | | 0.065 | | 300 | | | | | | | 55 | 34 | | |
| SRM | IRL | 2 | SASTM X | | 0.114 | | 300 | | | | | | | 70 | 44 | | |
| SRM | IRL | 2 | SASTM X | | 0.186 | | 300 | | | | | | | 120 | 55 | | |

## Table 9 (continued)

| Experiment Tag | Reactor ID | Capsule | Heat ID | Orient. | Fluence E > 1 MeV $10^{19}$ n/cm² | Flux E > 1 MeV $10^{13}$ n/cm² s | Irrad. temp. °F | $C_v$ transition temp. °F at 30 ft-lb, unirradiated R | MT | U | $C_v$ transition temp. °F at 30 ft-lb, irradiated R | MT | U | $C_v$ transition temp. °F shift at 30 ft-lb R | P | MT | U |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SRM | IRL | 2 | SASTM X | | 0.310 | | 300 | | | | | | | 150 | 68 | | |
| SRM | IRL | 2 | SASTM X | | 0.500 | | 300 | | | | | | | 180 | 81 | | |
| SRM | IRL | 3 | SASTM X | | 0.008 | | 300 | | | | | | | 0 | 9 | | |
| SRM | IRL | 3 | SASTM X | | 0.014 | | 300 | | | | | | | 0 | 14 | | |
| SRM | IRL | 3 | SASTM X | | 0.036 | | 300 | | | | | | | 20 | 24 | | |
| SRM | IRL | 3 | SASTM X | | 0.091 | | 300 | | | | | | | 50 | 40 | | |
| SRM | IRL | 3 | SASTM X | | 0.140 | | 300 | | | | | | | 80 | 49 | | |
| SRM | IRL | 3 | SASTM X | | 0.250 | | 300 | | | | | | | 125 | 62 | | |
| SRM | IRL | 3 | SASTM X | | 0.630 | | 300 | | | | | | | 165 | 87 | | |
| SRM | KE | 1 | SASTM X | | 0.470 | | 300 | | | | | | | 205 | 79 | | |
| SRM | KE | 1 | SASTM X | | 0.480 | | 300 | | | | | | | 205 | 80 | | |
| SRM | KE | 1 | SASTM X | | 0.570 | | 300 | | | | | | | 230 | 84 | | |
| SRM | KE | 2 | SASTM X | | 0.890 | | 300 | | | | | | | 265 | 97 | | |
| SRM | KE | 2 | SASTM X | | 0.910 | | 300 | | | | | | | 265 | 97 | | |
| SRM | KE | 2 | SASTM X | | 1.100 | | 300 | | | | | | | 275 | 103 | | |
| SRM | KE | 3 | SASTM X | | 2.300 | | 300 | | | | | | | 360 | 123 | | |
| SRM | KE | 3 | SASTM X | | 2.500 | | 300 | | | | | | | 310 | 125 | | |
| SRM | KE | 3 | SASTM X | | 2.800 | | 300 | | | | | | | 360 | 127 | | |
| SRM | LITR | 18 3 | SASTM X | | 0.800 | ~0.500 | 300 | | | | | | | 200 | 94 | | |
| SRM | LITR | 18 3 | SASTM X | | 1.000 | ~0.500 | 300 | | | | | | | 250 | 100 | | |
| SRM | LITR | 18 8 | SASTM D36 | LT | 0.545 | ~0.500 | 550 | 15 | | | 80 | | | 65 | 83 | | |
| SRM | LITR | 18 8 | SASTM X | | 0.545 | ~0.500 | 300 | | | | | | | 170 | 83 | | |
| SRM | LITR | 18 8 | SASTM X | | 0.545 | ~0.500 | 400 | | | | | | | 130 | 83 | | |
| SRM | LITR | 18 8 | SASTM X | | 0.545 | ~0.500 | 450 | | | | | | | 140 | 83 | | |
| SRM | LITR | 18 8 | SASTM X | | 0.730 | ~0.500 | 465 | | | | | | | 191 | 91 | | |
| SRM | LITR | 18 13 | SASTM D36 | LT | 3.270 | ~0.500 | 550 | 15 | | | 180 | | | 165 | 131 | | |
| SRM | LITR | 18 13 | SASTM D36 | LT | 3.270 | ~0.500 | 650 | 15 | | | 125 | | | 110 | 131 | | |
| SRM | LITR | 18 13 | SASTM D36 | LT | 3.270 | ~0.500 | 750 | 15 | | | 80 | | | 65 | 131 | | |
| SRM | LITR | 18 20H | SASTM D36 | LT | 4.250 | ~0.500 | 550 | 15 | | | 210 | | | 195 | 137 | | |
| SRM | LITR | 18 42 | SASTM F26 | LT | 1.700 | ~0.500 | 700 | 15 | | | 45 | | | 30 | 115 | | |
| SRM | LITR | 18 45 | SASTM F26 | LT | 3.597 | ~0.500 | 550 | 30 | | | 185 | | | 155 | 133 | | |
| SRM | LITR | 18 62 | SASTM X | LT | 1.800 | ~0.500 | 300 | | | | | | | 255 | 116 | | |
| SRM | LITR | 18105H | SASTM X | LT | 2.289 | ~0.500 | 550 | 15 | | | 155 | | | 140 | 122 | | |
| SRM | LITR | 28 49 | SASTM X | LT | 1.250 | | 300 | | | | | | | 220 | 106 | | |
| SRM | LITR | 43 72 | SASTM X | LT | 3.100 | ~0.690 | 300 | | | | | | | 310 | 130 | | |
| SRM | LITR | 43 72 | SASTM X | LT | 3.100 | ~0.690 | 300 | | | | | | | 315 | 130 | | |
| SRM | LITR | 43 86 | SASTM S3SR | LT | 3.373 | ~0.690 | 550 | 40 | | | 200 | | | 160 | 132 | | |

## Table 9 (continued)

| Experiment Tag | Reactor ID | Capsule | Heat ID | Orient. | Fluence E > 1 MeV $10^{19}$ n/cm$^2$ | Flux E > 1 MeV $10^{13}$ n/cm$^2$ s | Irrad. temp. °F | $C_v$ transition temp. °F at 30 ft-lb, unirradiated | | | $C_v$ transition temp. °F at 30 ft-lb, irradiated | | | $C_v$ transition temp. °F shift at 30 ft-lb | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | R | MT | U | R | MT | U | R | P | MT | U |
| SRM | LITR | 43 95 | SASTM X | LT | 4.100 | ~0.690 | 650 | 15 | | | 105 | | | 90 | 136 | | |
| SRM | LITR | 43 98 | SASTM X | LT | 5.600 | ~0.690 | 750 | 15 | | | 80 | | | 65 | 142 | | |
| SRM | LITR | 43108 | SASTM X | LT | 3.270 | ~0.690 | 550 | 15 | | | 170 | | | 155 | 131 | | |
| SRM | LITR | 49 47 | SASTM X | LT | 0.750 | | 300 | | | | | | | 205 | 92 | | |
| SRM | LITR | 53 25 | SASTM X | LT | 2.000 | ~0.278 | 300 | | | | | | | 315 | 119 | | |
| SRM | LITR | 53 25 | SASTM X | LT | 2.000 | ~0.278 | 300 | | | | | | | 295 | 119 | | |
| SRM | LITR | 53 50 | SASTM X | LT | 1.200 | ~0.278 | 300 | | | | | | | 215 | 105 | | |
| SRM | LITR | 53 68H | SASTM F23 | LT | 1.695 | ~0.278 | 550 | 30 | 13 | 7 | 185 | | | 155 | 115 | | |
| SRM | LITR | 53 87 | SASTM X | | 1.700 | ~0.278 | 300 | | | | | | | 300 | 115 | | |
| SRM | LITR | 55 6 | SASTM X | | 0.850 | ~0.358 | 300 | | | | | | | 230 | 95 | | |
| SRM | LITR | 55 31 | SASTM D36 | LT | 1.582 | ~0.358 | 490 | 15 | | | 215 | | | 200 | 113 | | |
| SRM | LITR | 55 54H | SASTM F26 | LT | 3.503 | ~0.358 | 550 | 30 | | | 185 | | | 155 | 133 | | |
| SRM | LITR | 55 61H | SASTM F26 | LT | 3.503 | ~0.358 | 550 | 30 | | | 200 | | | 170 | 133 | | |
| SRM | LITR | 55 80 | SASTM X | LT | 2.938 | ~0.358 | 600 | 15 | | | 150 | | | 135 | 129 | | |
| SRM | LITR | 55 84 | SASTM X | | 2.100 | ~0.358 | 300 | | | | | | | 290 | 120 | | |
| SRM | LITR | 55 85 | SASTM X | LT | 5.424 | ~0.358 | 550 | 15 | | | 210 | | | 195 | 142 | | |
| SRM | LITR | 55 99H | SASTM F23 | LT | 2.599 | ~0.358 | 550 | 30 | 13 | 7 | 190 | | | 160 | 126 | | |
| SRM | LITR | 55111 | SASTM X | LT | 1.921 | ~0.358 | 550 | 30 | | | 170 | | | 140 | 118 | | |
| SRM | LITR | 57 88H | SASTM F23 | LT | 1.243 | | 550 | 30 | 13 | 7 | 170 | | | 140 | 106 | | |
| SRM | MTR | S17 | SASTM X | LT | 1.800 | | 300 | | | | | | | 300 | 116 | | |
| SRM | MTR | S17 | SASTM X | ST | 1.800 | | 300 | | | | | | | 290 | 116 | | |
| SRM | MTR | S19 | SASTM X | LT | 1.300 | | 300 | | | | | | | 265 | 107 | | |
| SRM | MTR | S20 | SASTM X | LT | 2.200 | | 300 | | | | | | | 300 | 121 | | |
| SRM | MTR | S26 | SASTM X | LT | 7.000 | | 300 | | | | | | | 405 | 146 | | |
| SRM | MTR | S30 | SASTM X | LT | 11.000 | | 300 | | | | | | | 385 | 152 | | |
| SRM | MTR | S33 | SASTM X | LT | 10.000 | | 300 | | | | | | | 385 | 151 | | |
| SRM | TRINO1 | XX | SASTM X | LT | 0.250 | | 500 | 15 | | | 102 | | | 87 | 62 | | |
| SRM | UCRR | C3 1C | SASTM X | LT | 0.750 | | 300 | | | | | | | 170 | 92 | | |
| SRM | UCRR | D3 14H | SASTM X | LT | 0.174 | | 550 | 20 | | | 70 | | | 50 | 54 | | |
| SRM | WR1 | XX | SASTM X | LT | 0.300 | | 550 | 15 | | | 95 | | | 80 | 67 | | |
| SRM | WR2 | XX | SASTM X | LT | 0.200 | | 550 | 15 | | | 100 | | | 85 | 57 | | |
| SRM | XXX | EXP A | SASTM X | | 0.350 | | 495 | | | | | | | 65 | 71 | | |
| SRM | XXX | EXP A | SASTM X | | 18.000 | | 495 | | | | | | | 375 | 156 | | |
| SRM | YR | 1 | SASTM D36 | LT | 9.000 | 0.328 | 490 | 15 | | | 325 | | | 310 | 150 | | |
| SRM | YR | 6 | SASTM D36 | LT | 7.000 | 0.258 | 490 | 15 | | | 275 | | | 260 | 146 | | |

R - as reported; MT - hyperbolic tangent model plus Monte Carlo method; U - uncertainty (1 standard deviation).

P - predicted shift per R.G. 1.99, Rev. 2.

Table 10. Summary of A533B, HSST01, CMM per TR-EDB

| Experiment ID | Reactor ID | Capsule | Heat ID[a] | Orient. | Fluence E > 1MeV $10^{19}$ n/cm$^2$ | Irrad. temp. °F | $C_v$ transition temp. °F at 30 ft-lb, unirradiated | | | $C_v$ transition temp. °F at 30 ft-lb, irradiated | | | $C_v$ transition temp. °F shift at 30 ft lb | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | R | MT | U | R | MT | U | R | P | MT | U |
| HSST-1 | ORR | XX | SHSS01K 0T | LT | 0.410 | 142 | -145 | -139 | 4.8 | -15 | -26 | 12.1 | 130 | 102 | 113 | 13.0 |
| HSST-1 | ORR | XX | SHSS01K 0T | LT | 0.500 | 552 | -145 | -139 | 4.8 | -75 | -77 | 8.0 | 70 | 110 | 62 | 9.3 |
| HSST-1 | ORR | XX | SHSS01K 0T | LT | 0.550 | 450 | -145 | -139 | 4.8 | 10 | -11 | 10.0 | 155 | 113 | 128 | 11.1 |
| HSST-1 | ORR | XX | SHSS01K 0T | LT | 1.000 | 143 | -145 | -139 | 4.8 | 5 | -4 | 8.6 | 150 | 136 | 135 | 9.8 |
| HSST-1 | ORR | XX | SHSS01K 0T | LT | 1.110 | 642 | -145 | -139 | 4.8 | -90 | -91 | 9.0 | 55 | 140 | 48 | 10.2 |
| HSST-1 | ORR | XX | SHSS01K 0T | LT | 1.280 | 554 | -145 | -139 | 4.8 | -50 | -63 | 11.4 | 95 | 145 | 76 | 12.4 |
| HSST-1 | ORR | XX | SHSS01K 12 | LT | 0.470 | 130 | 15 | -3 | 2.6 | 165 | 160 | 10.1 | 150 | 107 | 163 | 10.4 |
| HSST-1 | ORR | XX | SHSS01K 12 | LT | 0.580 | 139 | 15 | -3 | 2.6 | 180 | 175 | 13.3 | 165 | 115 | 178 | 13.6 |
| HSST-1 | ORR | XX | SHSS01K 12 | LT | 0.680 | 147 | 15 | -3 | 2.6 | 210 | 195 | 7.3 | 195 | 121 | 198 | 7.7 |
| HSST-1 | ORR | XX | SHSS01K 12 | LT | 0.740 | 455 | 15 | -3 | 2.6 | 195 | 179 | 9.3 | 180 | 125 | 182 | 9.7 |
| HSST-1 | ORR | XX | SHSS01K 12 | LT | 0.920 | 458 | 15 | -3 | 2.6 | 195 | 180 | 8.5 | 180 | 133 | 183 | 8.9 |
| HSST-1 | ORR | XX | SHSS01K 12 | LT | 0.980 | 661 | 15 | -3 | 2.6 | 65 | 63 | 9.3 | 50 | 135 | 66 | 9.7 |
| HSST-1 | ORR | XX | SHSS01K 12 | LT | 1.060 | 561 | 15 | -3 | 2.6 | 150 | 138 | 16.1 | 135 | 138 | 141 | 16.3 |
| HSST-1 | ORR | XX | SHSS01K 14 | LT | 0.460 | 146 | 0 | -20 | 2.8 | 150 | 144 | 7.1 | 150 | 107 | 164 | 7.6 |
| HSST-1 | ORR | XX | SHSS01K 14 | LT | 0.600 | 155 | 0 | -20 | 2.8 | 175 | 175 | 8.2 | 175 | 117 | 195 | 8.7 |
| HSST-1 | ORR | XX | SHSS01K 14 | LT | 0.660 | 454 | 0 | -20 | 2.8 | 165 | 154 | 7.3 | 165 | 120 | 174 | 7.8 |
| HSST-1 | ORR | XX | SHSS01K 14 | LT | 0.880 | 556 | 0 | -20 | 2.8 | 100 | 89 | 7.5 | 100 | 131 | 109 | 8.0 |
| HSST-1 | ORR | XX | SHSS01K 14 | LT | 0.970 | 143 | 0 | -20 | 2.8 | 190 | 183 | 5.6 | 190 | 135 | 203 | 6.3 |
| HSST-1 | ORR | XX | SHSS01K 14 | LT | 1.240 | 550 | 0 | -20 | 2.8 | 115 | 114 | 10.2 | 115 | 144 | 134 | 10.6 |
| HSST-1 | ORR | XX | SHSS01K 14 | LT | 1.340 | 655 | 0 | -20 | 2.8 | 45 | 37 | 6.2 | 45 | 147 | 57 | 6.8 |
| HSST-1 | ORR | XX | SHSS01K 14 | TL | 0.660 | 130 | 25 | 20 | 8.0 | 180 | 170 | 7.7 | 155 | 120 | 150 | 11.1 |
| HSST-1 | ORR | XX | SHSS01K 14 | TL | 0.780 | 460 | 25 | 20 | 8.0 | 155 | 154 | 10.5 | 130 | 127 | 134 | 13.2 |
| NRL-2 | MTR | X01 | SHSS01 | TL | 2.700 | 300 | 15 | | | 325 | | | 310 | 172 | | |
| NRL-2 | UCRR | B3 51 | SHSS01 | TL | 2.500 | 550 | 15 | | | 215 | | | 200 | 169 | | |

R - as reported; MT - hyperbolic tangent model plus Monte Carlo method; U - uncertainty (1 standard deviation).

P - predicted shift per R.G. 1.99, Rev. 2.

[a]The last two characters of Heat ID are used to specif the specimen position in the parent material.
OT - at surface, 12 - 1/2 thickness, 14 - 1/4 thickness.

## Table 11. Sumary of A533B, HSST02, CMM per TR-EDB

| Experiment Tag | Reactor ID | Capsule | Heat ID | Orient. | Fluence E > 1 MeV $10^{19}$ n/cm$^2$ | Flux E > 1 MeV $10^{13}$ n/cm$^2$ s | Irrad. temp. °F | $C_v$ trnsition temp. °F at 30 ft-lb, unirradiated | | | $C_v$ trnsition temp. °F at 30 ft-lb, irradiated | | | $C_v$ transition temp. °F shift at 30 ft-lb | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | R | MT | U | R | MT | U | R | P | MT | U |
| HSST-1 | ORR | XX | SHSS02FB13 | LT | 0.530 | | 548 | 45 | 29 | 5.5 | 95 | 94 | 7.5 | 50 | 105 | 65 | 9.3 |
| HSST-1 | ORR | XX | SHSS02FB13 | LT | 1.060 | | 150 | 45 | 29 | 5.5 | 235 | 214 | 8.5 | 190 | 130 | 185 | 10.1 |
| HSST-1 | ORR | XX | SHSS02FB13 | LT | 1.260 | | 451 | 45 | 29 | 5.5 | 235 | 232 | 7.7 | 190 | 136 | 203 | 9.5 |
| HSST-4 | BSR | A4 | SHSS02GA | TL | 2.000 | 0.120 | 550 | 45 | 41 | 4.0 | 154 | 163 | 4.8 | 109 | 152 | 122 | 6.2 |
| NRL-2 | MTR | X02 | SHSS02 | LT | 3.100 | | 300 | 30 | | | 325 | | | 295 | 166 | | |
| NRL-2 | MTR | X03 | SHSS02 | TL | 2.800 | | 300 | 45 | | | 360 | | | 315 | 163 | | |
| NRL-2 | MTR | X04 | SHSS02 0T | TL | 3.300 | | 300 | -105 | | | 165 | | | 270 | 168 | | |
| NRL-2 | UCRR | B3 45 | SHSS02 | LT | 2.400 | | 550 | 30 | | | 200 | | | 170 | 158 | | |
| NRL-2 | UCRR | B3 45 | SHSS02 | TL | 2.300 | | 475 | 45 | | | 210 | | | 165 | 157 | | |
| VDE | FRJ-2 | X01030 | SHSS02A | LT | 1.000 | 2.310 | 572 | 23 | 23 | 5.5 | 82 | 78 | 9.6 | 59 | 128 | 55 | 11.1 |
| VDE | FRJ-2 | X01030 | SHSS02A | TL | 1.000 | 2.310 | 572 | 34 | 38 | 7.0 | 73 | 73 | 7.7 | 40 | 128 | 35 | 10.4 |
| VDE | FRJ-2 | X01040 | SHSS02A | LT | 1.000 | 2.310 | 752 | 23 | 23 | 5.5 | 45 | 34 | 6.7 | 22 | 128 | 11 | 8.7 |
| VDE | FRJ-2 | X01040 | SHSS02A | TL | 1.000 | 2.310 | 752 | 34 | 38 | 7.0 | 46 | 42 | 6.6 | 13 | 128 | 4 | 9.6 |
| VDE | FRJ-2 | X05030 | SHSS02A | LT | 5.000 | 2.510 | 572 | 23 | 23 | 5.5 | 144 | 144 | 9.9 | 121 | 180 | 121 | 11.3 |
| VDE | FRJ-2 | X05030 | SHSS02A | TL | 5.000 | 2.510 | 572 | 34 | 38 | 7.0 | 138 | 135 | 10.3 | 104 | 180 | 97 | 12.5 |
| VDE | FRJ-2 | X05040 | SHSS02A | LT | 5.000 | 2.510 | 752 | 23 | 23 | 5.5 | 61 | 67 | 6.2 | 38 | 180 | 44 | 8.3 |
| VDE | FRJ-2 | X05040 | SHSS02A | TL | 5.000 | 2.510 | 752 | 34 | 38 | 7.0 | 75 | 74 | 8.6 | 41 | 180 | 36 | 11.1 |
| VDE | FRJ-2 | X10030 | SHSS02A | LT | 10.000 | 2.362 | 572 | 23 | 23 | 5.5 | 216 | 195 | 10.0 | 193 | 194 | 172 | 11.4 |
| VDE | FRJ-2 | X10030 | SHSS02A | TL | 10.000 | 2.362 | 572 | 34 | 38 | 7.0 | 225 | 211 | 8.8 | 191 | 194 | 173 | 11.2 |
| VDE | FRJ-2 | X10040 | SHSS02A | LT | 10.000 | 2.362 | 752 | 23 | 23 | 5.5 | 93 | 91 | 6.7 | 70 | 194 | 68 | 8.7 |
| VDE | FRJ-2 | X10040 | SHSS02A | TL | 10.000 | 2.362 | 752 | 34 | 38 | 7.0 | 104 | 96 | 9.8 | 70 | 194 | 58 | 12.0 |

R - as reported; MT - hyperbolic tangent model plus Monte Carlo method; U - uncertainty (1 standard deviation).

P - predicted shift per R.G. 1.99, Rev. 2.

Table 12. Summary of A533B, HSST03, CMM per TR-EDB

| Experiment Tag | Reactor ID | Capsule | Heat ID | Orient. | Fluence E > 1 MeV $10^{19}$ n/cm² | Flux E > 1 MeV $10^{13}$ n/cm² s | Irrad. temp. °F | $C_v$ trnsition temp. °F at 30 ft-lb, unirradiated R | MT | U | $C_v$ trnsition temp. °F at 30 ft-lb, irradiated R | MT | U | $C_v$ trnsition temp. °F shift at 30 ft-lb R | P | MT | U |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| IAEAG | FRG-2 | XX | SHSS03NR | LT | 2.060 | 1.700 | 550 | 32 | 17 | 7.4 | 108 | | | 76 | 98 | | |
| IAEAG | FRG-2 | XX | SHSS03NR | LT | 9.450 | 1.700 | 545 | 32 | 17 | 7.4 | 216 | | | 184 | 124 | | |
| IAEAG | FRG-2 | XX | SHSS03NR | TL | 0.550 | 1.700 | 549 | 32 | 33 | 9.0 | 70 | | | 38 | 68 | | |
| IAEAG | FRG-2 | XX | SHSS03NR | TL | 1.730 | 1.700 | 554 | 32 | 33 | 9.0 | 100 | | | 68 | 95 | | |
| IAEAG | FRG-2 | XX | SHSS03NR | TL | 2.060 | 1.700 | 547 | 32 | 33 | 9.0 | 109 | | | 77 | 98 | | |
| IAEAG | FRG-2 | XX | SHSS03NR | TL | 2.680 | 1.700 | 549 | 32 | 33 | 9.0 | 124 | | | 90 | 104 | | |
| IAEAG | FRG-2 | XX | SHSS03NR | TL | 6.540 | 1.700 | 554 | 32 | 33 | 9.0 | 183 | | | 151 | 119 | | |
| IAEAG | FRG-2 | XX | SHSS03NR | TL | 6.970 | 1.700 | 549 | 32 | 33 | 9.0 | 243 | | | 211 | 120 | | |
| IAEAG | FRG-2 | XX | SHSS03NR | TL | 7.990 | 1.700 | 552 | 32 | 33 | 9.0 | 216 | | | 184 | 122 | | |
| IAEAG | FRG-2 | XX | SHSS03NR | TL | 9.450 | 1.700 | 543 | 32 | 33 | 9.0 | 244 | | | 212 | 124 | | |
| IAEAG | KKS | XX | SHSS03NR | TL | 2.300 | 0.080 | 540 | 32 | 33 | 9.0 | 108 | | | 76 | 101 | | |
| IAEAG | VAK | XX | SHSS03NR | TL | 2.400 | 0.300 | 545 | 32 | 33 | 9.0 | 145 | | | 113 | 102 | | |
| IAEAU | UBR | UB-23 | SHSS03MUNE | TL | 2.100 | 0.700 | 550 | 30 | 33 | 9.0 | 109 | | | 79 | 99 | | |
| KFA | FRJ-1 | X00115 | SHSS03LF | TL | 0.150 | 0.200 | 302 | 32 | 33 | 9.0 | 129 | 127 | 6.6 | 97 | 41 | 94 | 11.2 |
| KFA | FRJ-1 | X00315 | SHSS03LF | TL | 0.350 | 0.200 | 302 | 32 | 33 | 9.0 | 189 | 179 | 6.8 | 157 | 58 | 146 | 11.3 |
| KFA | FRJ-1 | X00715 | SHSS03LF | TL | 0.700 | 0.200 | 302 | 32 | 33 | 9.0 | 230 | 221 | 5.7 | 198 | 74 | 188 | 10.7 |
| KFA | FRJ-1 | X01015 | SHSS03LF-4 | TL | 1.000 | 0.200 | 302 | 32 | 33 | 9.0 | 304 | 316 | 16.1 | 272 | 82 | 283 | 18.4 |
| KFA | FRJ-1 | X01515 | SHSS03LF | TL | 1.500 | 0.200 | 302 | 32 | 33 | 9.0 | 282 | 273 | 6.0 | 250 | 91 | 240 | 10.8 |
| KFA | FRJ-1 | X01829 | SHSS03GU | TL | 1.800 | 0.200 | 550 | 32 | 33 | 9.0 | 118 | 100 | 10.0 | 86 | 95 | 67 | 13.5 |
| KFA | FRJ-1 | X03015 | SHSS03LF | TL | 3.000 | 0.200 | 302 | 32 | 33 | 9.0 | 297 | 297 | 4.6 | 265 | 106 | 264 | 10.1 |
| KFA | FRJ-1 | X07015 | SHSS03LF | TL | 7.000 | 0.200 | 302 | 32 | 33 | 9.0 | 358 | 345 | 13.0 | 326 | 120 | 312 | 15.8 |
| KFA | FRJ-1 | X08029 | SHSS03GU | TL | 8.000 | 0.200 | 550 | 32 | 33 | 9.0 | 268 | 252 | 8.0 | 236 | 122 | 219 | 12.0 |
| KFA | FRJ-2 | X06025 | SHSS03LS | TL | 6.000 | 3.000 | 491 | 32 | 33 | 9.0 | 313 | 299 | 12.9 | 281 | 118 | 266 | 15.7 |
| KFA | FRJ-2 | X06027 | SHSS03LS | TL | 6.000 | 3.000 | 518 | 32 | 33 | 9.0 | 261 | 252 | 11.6 | 229 | 118 | 219 | 14.7 |
| KFA | FRJ-2 | X06029 | SHSS03LS | TL | 6.000 | 3.000 | 554 | 32 | 33 | 9.0 | 207 | 193 | 16.1 | 175 | 118 | 160 | 18.4 |
| KFA | FRJ-2 | X06033 | SHSS03LS | TL | 6.000 | 3.000 | 626 | 32 | 33 | 9.0 | 126 | 124 | 10.2 | 94 | 118 | 91 | 13.6 |
| KFA | FRJ-2 | X06036 | SHSS03LS | TL | 6.000 | 3.000 | 689 | 32 | 33 | 9.0 | 95 | 93 | 14.5 | 63 | 118 | 60 | 17.1 |
| KFA | HFR | X00220 | SHSS03PL | TL | 0.220 | 23.500 | 392 | 32 | 33 | 9.0 | 140 | 129 | 9.0 | 108 | 49 | 96 | 12.7 |
| KFA | HFR | X00520 | SHSS03PL | TL | 0.470 | 21.050 | 392 | 32 | 33 | 9.0 | 183 | 188 | 8.1 | 151 | 65 | 155 | 12.1 |
| KFA | HFR | X01120 | SHSS03PL | TL | 1.100 | 23.150 | 392 | 32 | 33 | 9.0 | 234 | 217 | 9.0 | 202 | 84 | 184 | 12.7 |
| KFA | HFR | X02120 | SHSS03PL | TL | 2.100 | 22.970 | 392 | 32 | 33 | 9.0 | 262 | 259 | 7.5 | 230 | 99 | 226 | 11.7 |
| KFA | HFR | X02120 | SHSS03PL | TL | 2.100 | 22.970 | 392 | 32 | 33 | 9.0 | 262 | 259 | 7.5 | 230 | 99 | 226 | 11.7 |
| KFA | HFR | X09819 | SHSS03PL | TL | 9.800 | 26.350 | 374 | 32 | 33 | 9.0 | 397 | 399 | 7.0 | 365 | 124 | 366 | 11.4 |
| NRL-4 | UBR | UB-09 | SHSS03MU | LT | 1.700 | 0.700 | 550 | 30 | 33 | 9.0 | 110 | | | 80 | 94 | | |
| ORRPSF | ORR | 0-TF | SHSS03PSF | TL | 5.000 | 0.097 | 550 | 30 | 33 | 9.0 | 165 | 157 | 11.6 | 135 | 115 | 124 | 14.7 |
| ORRPSF | ORR | 1/2 TF | SHSS03PSF | TL | 1.300 | 0.025 | 550 | 30 | 33 | 9.0 | 126 | 123 | 11.6 | 95 | 88 | 90 | 14.7 |
| ORRPSF | ORR | 1/4 TF | SHSS03PSF | TL | 2.500 | 0.049 | 550 | 30 | 33 | 9.0 | 154 | 146 | 10.5 | 124 | 102 | 113 | 13.8 |
| ORRPSF | ORR | SSC1F | SHSS03PSF | TL | 2.550 | 0.664 | 550 | 30 | 33 | 9.0 | 140 | 156 | 10.6 | 110 | 103 | 123 | 13.9 |
| ORRPSF | ORR | SSC2F | SHSS03PSF | TL | 5.000 | 0.644 | 550 | 30 | 33 | 9.0 | 176 | 178 | 10.7 | 146 | 115 | 145 | 14.0 |

R - as reported; MT - hyperbolic tangent model plus Monte Carlo method; U - uncertainty (1 standard deviation).
P - predicted shift per R.G. 1.99, Rev. 2.

because the higher energy is too close to or above the upper shelf for some of the materials used. From the reported surveillance data, there are over 40 data points whose irradiated upper shelf are less than 50 ft-lb. In a few cases, suspect Charpy tests have been eliminated from the fitting and determination of uncertainties. This procedure is rather subjective, but the results are more reasonable (see the figures and tables in Appendix A, where the specimen identification of a rejected Charpy test is pre-affixed with a "*," and the rejected data are plotted with a solid symbol in the figure).

If the deviations from the expected radiation damage exceed the uncertainties described above and the anomalies in the capsule environment (i.e., fluence), flux, irradiation temperature, or plant operation history must be suspected. Errors in fluence determination, which are large enough to significantly influence the damage prediction, are small in most cases, perhaps with the exception of very low fluences or very high fluences. For example, a $1.0 \times 10^{19}$ n/cm² fluence with a large uncertainty (e.g., 35% uncertainty in the fluence evaluation) will result in only an 8% uncertainty in the fluence factor of R.G. 1.99, Rev. 2. From the present investigation of power reactor data, the dependency of radiation damage on the fluence rate cannot be confirmed nor ruled out. Whenever the radiation damage is larger or smaller than expected, fluence rates have not differed significantly from other capsules that behave normally. This leaves irradiation temperature as the most likely cause for variations with comparable fluence, excluding the very low and very high fluence range. Temperature monitors within the surveillance capsules give only the upper bound and, in case of melting, do not indicate whether any high temperature was transient or sustained. The investigation of the material test reactor data, which cover wider ranges of fluence, flux, and irradiation temperature compared with that of power reactor data, seems to reveal the fluence-rate effect and the synergistic effect of irradiation temperature and fluence and flux. Both the power reactor and test reactor data show the strong influence of the irradiation temperature on the radiation embrittlement.

It is a good indication that capsule anomalies are the cause for deviation from the expected radiation damage of the reference material if the other materials in the capsules show similar deviations. For this reason, the radiation damage for all materials in a given capsule from the reported surveillance data is investigated in this report, and the summary is listed in Tables 13–15; excluded were the HAZ materials and the materials where the copper and nickel content were not determined. Based on PR-EDB, Version 2, reported data, the new 2σ uncertainties per R.G. 1.99, Rev. 2, for base and weld metals, are determined as 56 and 63°F, respectively, but absolute residuals greater than 100°F were not included in the uncertainty study. Three plots of residual (with the 2σ bounds) vs fluence were generated for plate, forging, and weld materials, respectively (see Figs. 1–3). "Residual" is defined as the measured $\Delta T_{30}$ minus the R.G. 1.99, Rev. 2, prediction. The manufacturer's chemistry data were used in the residual study.

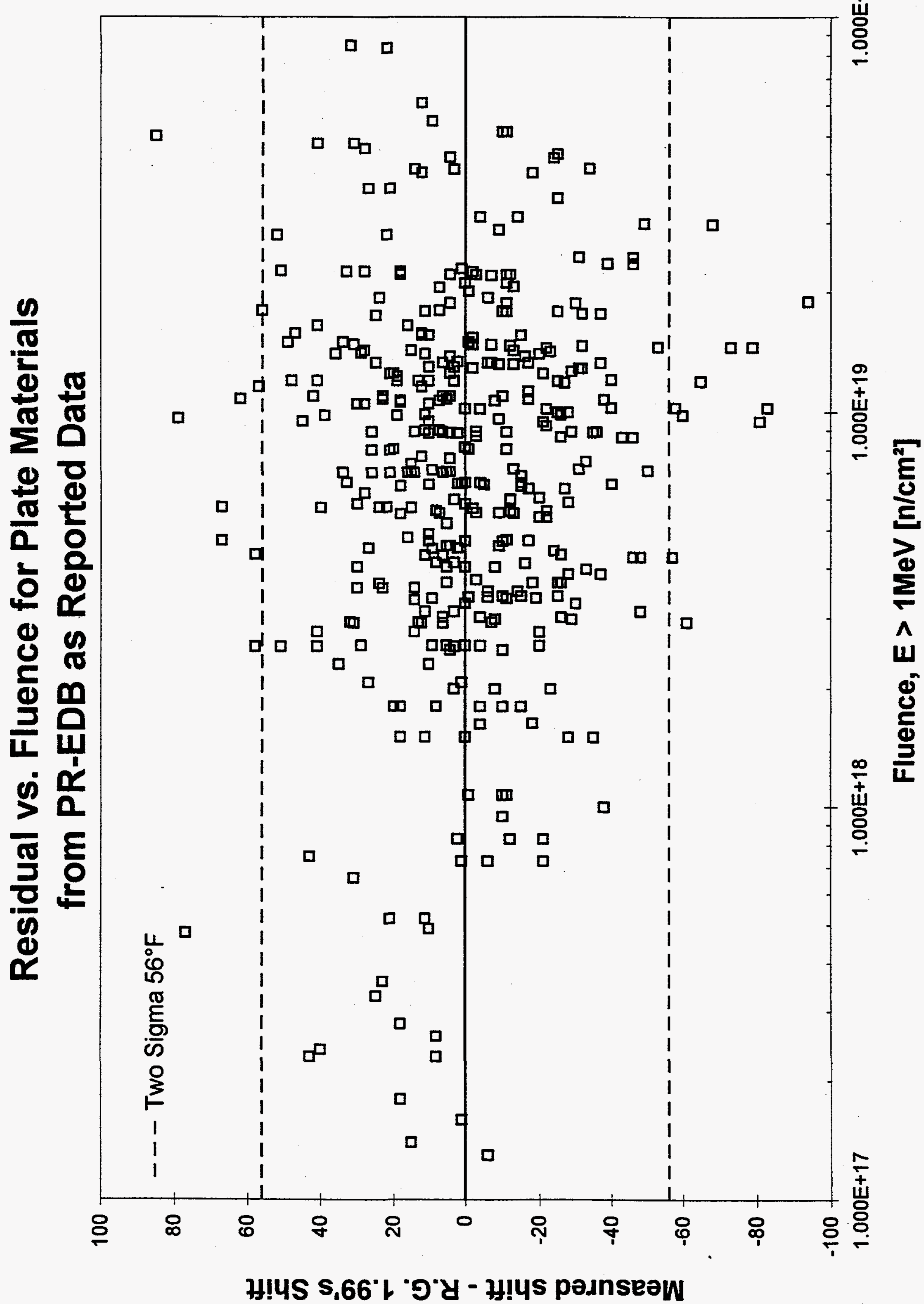


Figure 1 Embrittlement of surveillance plate materials relative to the R.G. 1.99, Rev. 2, prediction

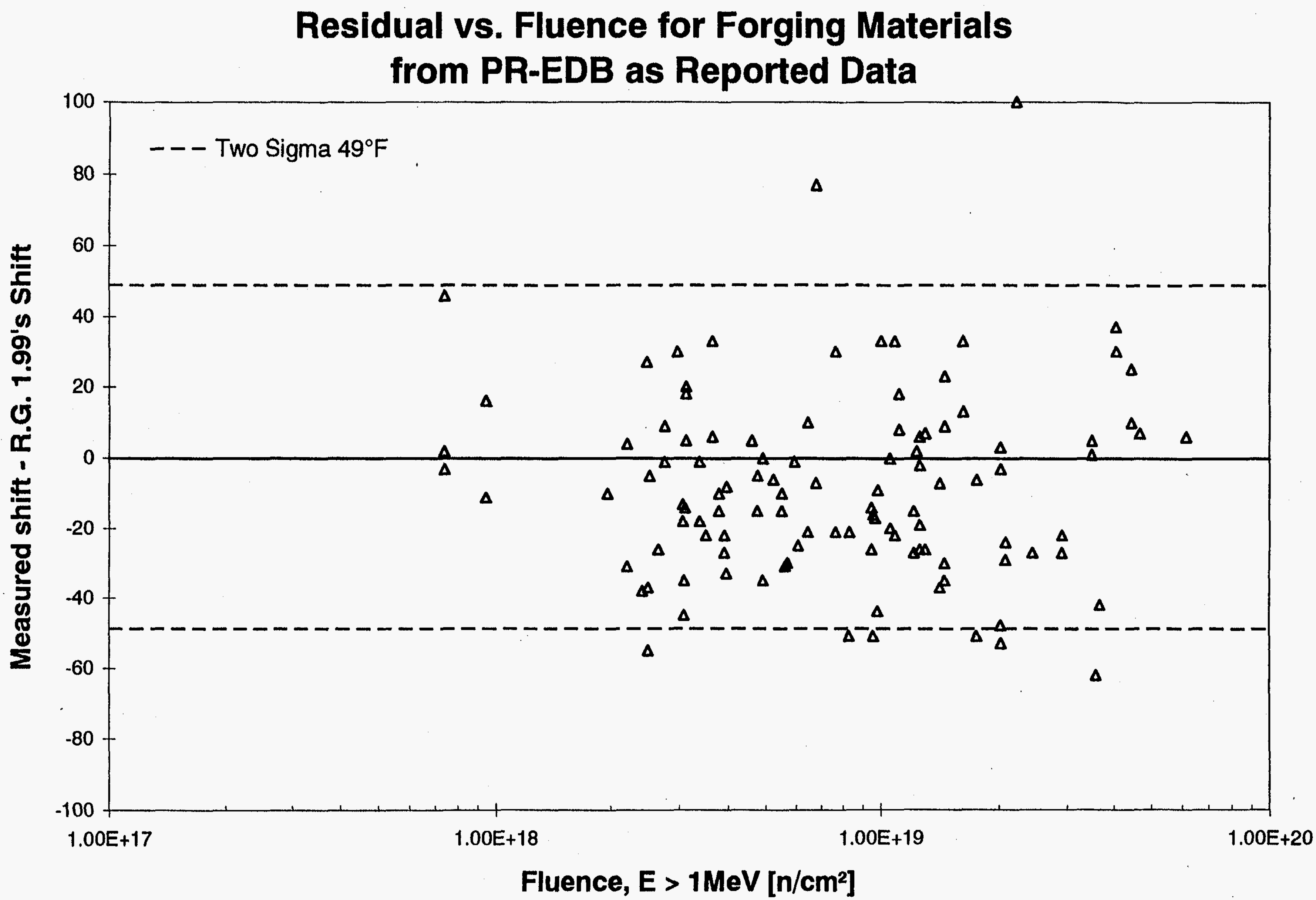


Figure 2 Embrittlement of surveillance forging materials relative to the R.G. 1.99, Rev. 2, prediction

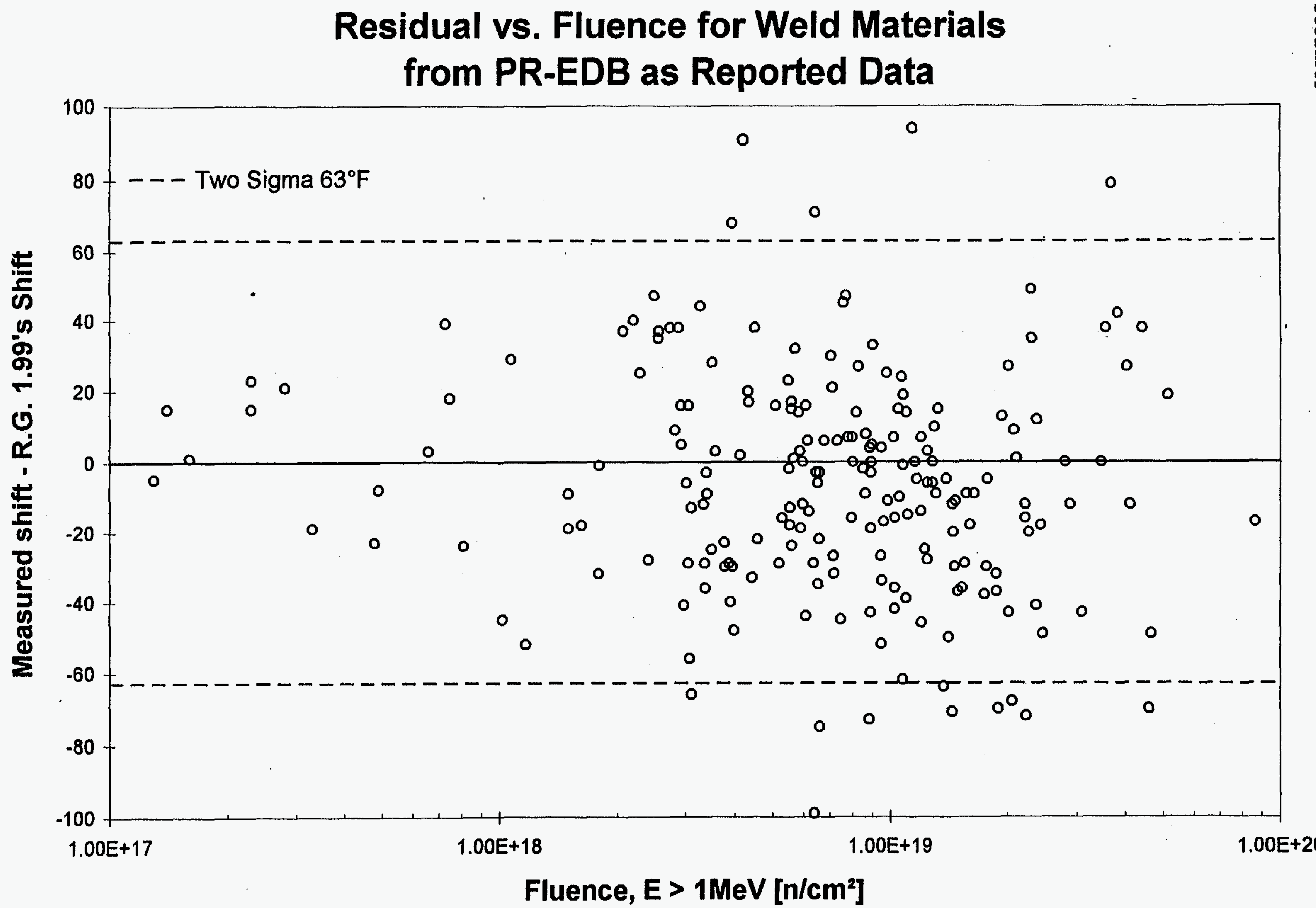


Figure 3 Embrittlement of surveillance weld relative to the R.G. 1.99, Rev. 2, prediction

# 3 RESULTS

The copper and nickel contents of CMM are listed in detail in Tables 1–3. The manufacturer's chemistry is used for the determination of the trend curves per R.G. 1.99, Rev. 2; the copper and nickel contents, and the chemistry factor according to R.G. 1.99, Rev. 2, are listed below.

| Material | Cu (%) | Ni (%) | Chemistry factor(°F) |
|---|---|---|---|
| ASTM | 0.200 | 0.180 | 100 |
| HSST01 | 0.180 | 0.660 | 136 |
| HSST02 | 0.170 | 0.640 | 128 |
| HSST03 | 0.120 | 0.560 | 82 |

## 3.1 Power Reactor Surveillance Data

### 3.1.1 A302B (ASTM) CMM

The results from 33 capsules in 10 Westinghouse plants, and 5 capsules in 1 GE plant, have been investigated. The capsules in the H.B. Robinson Reactor contain specimens fabricated in the TL orientation; all others are fabricated in the LT orientation. The Yankee Rowe surveillance data exhibit a much greater shift than predicted by R.G. 1.99, Rev. 2, mainly due to the relative low operation temperature (450~525°F) and high flux ($1.7 \times 10^{12} \sim 3.2 \times 10^{12}$ n/cm²·s) compared with that of the data used to develop the R.G. 1.99, Rev. 2, and are excluded from the uncertainty study.

Compared to the R.G. 1.99, Rev. 2, the 1σ uncertainty of the data scatter band around the Regulatory Guide's trend curve is 15°F for EDB hyperbolic tangent fit results; and a bias of 6.1% is detected for CMM [i.e., the measured $\Delta T_{30}$ are on the average 6.1% larger than the Regulatory Guide predicted values (see Fig. 4)]. These values indicate that R.G. 1.99, Rev. 2, gave fairly good predictions for the radiation embrittlement of the ASTM CMM under different irradiation environments. However, this result may not be surprising since 41 out of the 126 base metal data points included in the initial sample used for the development of the R.G. 1.99, Rev. 2, were from CMM. In order to demonstrate this point, the shift data for ASTM CMM included in the R.G. 1.99, Rev. 2, data base (177 Data Points) are distinguished and identified by a solid symbol. As shown in Fig. 5, over 65% of Westinghouse's ASTM CMM were used in the development of R.G. 1.99, Rev. 2. Thus the characteristics of these CMM data are well incorporated into the R.G. 1.99, Rev. 2.

From Table 6, the comparison of reported shift and EDB hyperbolic tangent fit results, the average absolute difference between these two types of data is 12%. The bias and the 1σ uncertainty per R.G. 1.99's predictions determined by the reported shift data are 7.5% and 12°F, respectively. A similar bias, namely 6.9%, is found from all capsules that contain the A302B CMM per PR-EDB reported data, but with a relatively large data scatter band, a 1σ uncertainty of 25°F. For the A302B RPV steels, the majority of ASTM CMM shifts are greater than that of the base materials loaded in the same capsule due to the higher copper content of the CMM plate. This may serve as an upper bound for the irradiated A302B plate materials. One special case, Yankee Rowe, has a base metal that appears to be much more sensitive to the radiation embrittlement than ASTM CMM material and has less reported copper content, 0.18 wt %, compared with that of ASTM CMM, 0.20 wt %. However, the phosphorous content in Yankee Rowe's plate is higher than that of the ASTM CMM material.

Although the general underprediction of radiation damage for the CMM parallels the underprediction for companion materials in the same capsules, there are many exceptions to this rule. Only 12 out of 23 underpredicted surveillance capsules have good correlations between the behavior of the reference and plant- specific materials. This situation may be due to (1) deviation of the trend curve for plant-specific material from R.G. 1.99, Rev. 2, (2) uncertainties in the chemistry of the plant-specific material, (3) differences in temperature and fluence within the capsule, and (4) sample-to-sample variations in both plant-specific and CMM. Overall, 23 out of 37 surveillance capsules containing both CMM and A302B base metals show the same correlation towards the R.G. 1.99 predicted values; 14 out of 25 surveillance capsules contained both the CMM and weld metals show the same correlation towards the R.G. 1.99 predicted values. Where only 14 out of 37 surveillance capsules, the CMM and the accompanying materials in the same capsule show the same correlation towards the R.G.1.99 predicted values. Findings of large deviations from the R.G. 1.99, Rev. 2, trend curve are useful as warning flags that invite further investigation.

### 3.1.2 A533B (HSST) CMM

Results for the HSST01 plate in 10 capsules of 8 CE plates, and HSST02 plate in 53 capsules of 7 B&W plants and 13 Westinghouse plants were investigated.

The results of a comparison of HSST01 data with R.G. 1.99, Rev. 2, trend curves are demonstrated in Figs. 6 and 7 for EDB hyperbolic tangent fit results and reported shift data, respectively. On the average, R.G. 1.99, Rev. 2, underpredicted the experimental values for all surveillance capsules by 3.6% according to the EDB hyperbolic tangent fit results; and the 1$\sigma$ uncertainty of the data scatter bands per the R.G. 1.99, Rev. 2, trend curve is 12.6°F.

A comparison of the HSST02 data with the R.G. 1.99, Rev. 2, trend curves is illustrated in Figs. 8 and 9 for EDB hyperbolic tangent fit results and reported data, respectively. It was found that R.G. 1.99 overpredicted the experimental values for all surveillance capsules by an average of 18% according to EDB hyperbolic tangent fit results; and the 1$\sigma$ uncertainty of the data scatter bands per R.G. 1.99, Rev. 2, trend curve is 24°F. In order to determine whether this is capsule-specific (or vendor-specific), the biases are determined separately for the B&W and Westinghouse plants with the result that the average bias for B&W plants is −38% and −7.4% for Westinghouse (see Fig. 8). These values indicate a tendency for overprediction in the B&W capsules. The most likely reason is the capsule temperature. In the B&W capsules, significant melting of the thermal monitors is reported consistently and, even though this may well be due to transients, as stated in the reports, the average nominal capsule irradiation temperature is about 608°F, which is higher than that of the other vendors; also, the B&W plants follow a unique heatup curve for plant operation. Thus caution must be exercised in plant-specific, trend curve determinations from surveillance capsule results if the measured damage is substantially less than predicted. If similar overpredictions are found for the companion CMM, corrections must be made to the plant-specific trend curve to avoid nonconservative predictions for the pressure vessel material.

From Table 8, the mean absolute difference between EDB hyperbolic tangent fit results and reported shift data for B&W is 22% and 4% for Westinghouse. The large discrepancy of EDB hyper-bolic tangent fit results and reported shift data per B&W is demonstrated in Figs. 8 and 9. In Fig. 9, the data involved in the development of R.G. 1.99, Rev. 2, were identified by solid symbols. The majority of the B&W data are outside the 34°F 2$\sigma$ uncertainty, whereas the B&W data near the trend curve of the R.G. 1.99, Rev. 2, are those samples used in the development of R.G. 1.99, Rev. 2.

Similar to the findings for the A302B CMM, large deviations between measured $\Delta T_{30}$ and their Regulatory Guide predictions for the CMM are correlated with similar deviations for the companion materials in the same capsules, for example, B&W's surveillance capsules. Overall, 13 out of 35 surveillance capsules contained both the CMM and A533B base metals and show the same correlation towards the R.G. 1.99 predicted values; 22 out of 31 surveillance capsules, containing both the CMM and weld metals, show the same correlation towards the R.G. 1.99 predicted values. Where there are only 10 out of 35 surveillance capsules, the CMM and the accompanying materials in the same capsule show the same correlation towards the R.G. 1.99 predicted values. The random fluctuations for the A533B-1 materials (including plate and weld materials) appear to be the same as those of the A302B material (including plate and weld materials); both have about 50°F 2$\sigma$ uncertainty per the R.G. 1.99 prediction; and the biases are −9°F and 6°F for A533B-1 and A302B materials, respectively (see Figs. 10 and 11). These values indicate that, overall, R.G. 1.99, Rev. 2, underpredicted the A302B materials and overpredicted the A533B-1 materials.

### 3.1.3 Reactor Pressure Vessels Made of A302B Materials

The detailed summary of all the RPVs made of A302B materials with the corresponding CMM are listed in Table 13. The trend curves of $\Delta T_{30}$ vs fluence are illustrated in Figs. 12 and 13 for plate and weld materials, respectively, where the companion CMM were identified by solid dot symbols for comparison purposes. From Fig. 12, all the CMM shifts are greater than that of A302B plate materials, except those of Indian Point Unit 2. The majority of the CMM shift data are greater than that of the R.G. 1.99, Rev. 2, prediction, with the exceptions of B&W and GE's CMM data.

The mean chemistry contents with 1 standard deviation from all the A302B plate data, not including A302B CMM data, are 0.135 ± 0.043 and 0.315 ± 0.193 wt % for copper and nickel, respectively. The trend curve of R.G. 1.99, Rev. 2, for mean chemistry of the A302B plate materials and for ASTM A302B were both illustrated in Fig. 12 for comparison purposes. The mean chemistry contents with 1 standard deviation from the A302B weld materials are 0.245 ± 0.064 and 0.515 ± 0.322 wt % for copper and nickel, respectively. From Fig. 13, all the weld $\Delta T_{30}$ are greater than that of the companion CMM shifts except that of Haddam Neck capsule D.

### 3.1.4 Reactor Pressure Vessels Made of A533B-1 Materials

A detailed summary of all the RPVs made of A533B-1 materials with the corresponding CMM are listed in Table 14. The trend curves of $\Delta T_{30}$ vs fluence are illustrated in Figs. 14 and 15 for plate and weld materials, respectively, where the companion CMM were identified by solid dot symbols for comparison purposes. The mean chemistry contents with 1 standard deviation from the A533B-1 plate materials, not including A533B-1 CMM, are 0.141 ± 0.038 and 0.521 ± 0.038 wt % for copper and nickel, respectively. The trend curve of R.G. 1.99, Rev. 2, for mean chemistry of the A533B-1 plate materials and for HSST02 are both illustrated in Fig. 14 for comparison purposes. The mean chemistry contents with 1 standard deviation of the A533B-1 weld materials are 0.279 ± 0.062 and 0.559 ± 0.289 wt % for copper and nickel, respectively. From Fig. 15, all the weld $\Delta T_{30}$ values are greater than those of the companion CMM shifts except those of CE's and one of Westinghouse's data.

### 3.1.5 Reactor Pressure Vessels Made of Forging Materials

The detailed summary of all the RPVs made of A508 class 2 (A508-2), A508 class 3 (A508-3), and A336 as modified by the ASME code case 1236 forging materials with the corresponding CMM were listed in Table 15. The trend curves of $\Delta T_{30}$ vs fluence are illustrated in Fig. 16 for forging materials, where the companion CMM were identified by solid dot symbols for comparison purposes. The mean chemistry contents with 1 standard deviation from the A508-2 forging materials are 0.053 ± 0.020 and 0.72 ± 0.03 wt % for copper and nickel, respectively. The trend curve of R.G. 1.99, Rev. 2, for mean chemistry of the A508-2 forging materials and for HSST02 were both illustrated in Fig. 16 for comparison purposes. From Fig. 16, the forging materials are considerably less sensitive to radiation embrittlement compared with that of companion CMM, except the Garigliano A336 forging.

### 3.1.6 Comparison of the A302B and A533B-1 Plate Materials

Plate materials in all the RPVs of the U.S. commercial power plants are either A302B or A533B-1, where the older plants were made of A302B materials, and the newer plants were made of A533B-1 materials. The data trend of surveillance plates for the A302B and A533B-1 CMM, per Westinghouse and CE, are shown in Fig. 17, and the scatter bands of $\Delta T_{30}$ data for A302B and A533B CMM are completely overlapped. Therefore, the sensitivity of A302B materials to radiation embrittlement appears to be equivalent to that of A533B material). Further investigation was done on all A302B and A533B-1 materials from

Westinghouse surveillance capsules (see Fig. 18). Here, the $\Delta T_{30}$ data were further divided into three subgroups according to the three ranges of the copper contents, namely, Cu < = 0.1, 0.1 < Cu < 0.2, Cu > 0.2 wt %. A large data scatter appears on the figure for both the A302B and A533B-1 materials, and no distinct bias can be detected between A302B and A533B-1 materials for different ranges of chemistry. For example, at a range of 0.1 < Cu < 0.2, the scatter band of $\Delta T_{30}$ for A302B material is slightly larger than that of the A533B material, and the scatter band of A302B overlapped the scatter band of A533B almost completely. In Fig. 19, 3-D plots of $\Delta T_{30}$ vs fluence vs copper content for Westinghouse data also indicate that the radiation-induced $\Delta T_{30}$ of both the A302B and A533B-1 are similar.

## 3.2 Material Test Reactor Data

### 3.2.1 A302B (ASTM) CMM

The results of 113 irradiated data sets from the Charpy impact test have been investigated, and the summary is listed in Table 9. The trend curve and $\Delta T_{30}$ data are illustrated in Fig. 20; here, the trend curve of A302B ASTM CMM per R.G. 1.99, Rev. 2, was used as an index curve for $\Delta T_{30}$ at 550°F irradiation temperature. The $\Delta T_{30}$ data were divided into eight subgroups based on the different irradiation temperature ranges. Figure 20 clearly shows the effect of irradiation temperature. At the same fluence, the irradiated specimen with a lower irradiation temperature exhibits more radiation embrittlement. At a 550°F irradiation temperature and fluence greater than $1.5 \times 10^{19}$ n/cm², a clear bias can be detected compared with the trend curve of A302B ASTM CMM per R.G. 1.99, Rev. 2. R.G. 1.99, Rev. 2, underpredicted the $\Delta T_{30}$ by about 19.3%. This effect may be a fluence-rate effect; higher fluence rates are expected to lead to higher values for the $\Delta T_{30}$ at high fluences[4,21,22]. The specimens irradiated in a material test reactor normally experience a 1- to 2-orders of magnitude higher fluence rate compared with that of commercial power reactors. However, fluence rate and spectral effects are difficult to separate experimentally. Variations in flux are usually obtained by varying the irradiation position in a reactor or by employing different reactors. These flux changes are invariably accompanied by changes in the neutron spectrum. A clearer picture for ASTM CMM data irradiated at 550°F with fluence greater than $1.5 \times 10^{19}$ n/cm² is demonstrated in Fig. 21. The power reactor surveillance data are also included in the figure; the average fluence rate for these data is $1.55 \times 10^{11}$ n/cm²·s, which shows that the R.G. 1.99, Rev. 2, underpredicted the $\Delta T_{30}$ for ASTM CMM data with higher fluence from power reactor surveillance capsules In Fig. 21, test reactor data were further subdivided into two subgroups for fluence rates less than $1.1 \times 10^{11}$ n/cm²·s and fluence rates greater than $2.5 \times 10^{11}$ n/cm²·s, respectively. From Fig. 21, it appears that the $\Delta T_{30}$ for lower fluence rates formed the lower bound for the test reactor data. This may indicate that the fluence-rate effect or the combined effect of fluence rate and spectral effect do exist in the test reactor data. In order to further investigate this issue, the test reactor data listed in Fig. 21 were subdivided into three subgroups, namely, test reactor data irradiated in-core position, test reactor data irradiated at core-edge position, and test reactor data from the simulated surveillance and through-wall specimen capsules irradiated at Oak Ridge Research Reactor Pool Side Facility (ORRPSF).[23] The data were plotted in Fig. 22. The ORRPSF data on Fig. 22 were not from the in-core positions, two $\Delta T_{30}$ data were from simulated surveillance capsule (SSC) positions, one $\Delta T_{30}$ data from wall surface (0T) capsule position, and one from a quarter thickness wall (1/4T) capsule position. The two SCC data (which have higher fluence rates) show larger $\Delta T_{30}$ compared with that of 0T and 1/4T data. The effect of the spectral difference between the SSC and 1/4T positions is negligible for the ORRPSF experiment. Thus the fluence-rate effect may be supported from the ORRPSF data.

From Fig. 22, three $\Delta T_{30}$ data have fluence at about $5.4 \times 10^{19}$ n/cm²: two were from ORRPSF data, and one was a test reactor data irradiated in-core position with the fluence rate at about $4 \times 10^{12}$ n/cm²·s. The test reactor data at in-core position gave the largest $\Delta T_{30}$; however, its fluence rate was less than that of ORRPSF data at the SCC position, which has $6.95 \times 10^{12}$ n/cm²·s fluence rate. The main cause of the above-mentioned situation may be due to the different physical locations of the irradiated specimens in the test reactors; in our case, one was at the in-core position and one was at the out-of-core position. There is a difference in neutron energy spectrum between the in-core and out-of-core positions. This specific example may imply that induced shift by the combined effect of the fluence rate and spectral effect of the test reactor data at in-core position are greater than the induced shift by the fluence-rate effect of ORRPSF data at out-of-core position.

Figure 23 is a duplicate of Fig. 20 with the fluence limited to a maximum of $4 \times 10^{19}$ n/cm² to give a better picture of radiation embrittlement for the relatively low fluence data. From Fig. 23, at irradiation temperatures less than 300°F, embrittlement develops quite rapidly up to a fluence of about $1 \times 10^{19}$ n/cm²; above $1 \times 10^{19}$ n/cm², embrittlement buildup is less rapid, and some indication of embrittlement saturation appears.

### 3.2.2 A533B-1 (HSST01) CMM

The results of 24 irradiated Charpy sets, where 22 sets were irradiated in the Oak Ridge Research Reactor, have been investigated. The summary of HSST01 material is listed in Table 10. This shows a strong dependence for the unirradiated $T_{30}$ on specimen location in the original parent plate; for example, the lowest $T_{30}$ is from the specimen position near the surface (0T) of the parent plate. The $\Delta T_{30}$ data also show a similar dependence on the specimen position. Irradiated specimens originally located near the surface of the parent plate appear to be the least sensitive to radiation embrittlement. This specimen position effect on transition temperature shift is demonstrated in Fig. 24, where the $\Delta T_{30}$ of the 0T specimens were identified by solid symbols. The R. G. 1.99 prediction for the HSST01 plate is used as the trend curve of the 550°F irradiation temperature. The trend curve and measured shift data per PR-EDB reported data were plotted in Fig. 25. The mean absolute difference between reported $\Delta T_{30}$ data and EDB hyperbolic tangent fit results is 10.6%.

### 3.2.3 A533B-1 (HSST02) CMM

The results of 21 irradiated Charpy sets have been investigated. The summary of HSST02 materials is listed in Table 11. The R.G. 1.99, Rev. 2, prediction for the HSST02 plate is used as the trend curve for the 550°F irradiation temperature. The trend curve and reported $\Delta T_{30}$ data are illustrated in Fig. 26, where the reported $\Delta T_{30}$ data were divided into four subgroups for four ranges of irradiation temperatures. The data trend shows the strong influence of irradiation temperature on the $\Delta T_{30}$. The $\Delta T_{30}$ data irradiated at 572°F and 752°F are from the German VDE experiments,[7] and the test specimens were experienced with high fluence rates at about $2.3 \times 10^{13}$ n/cm²·s. The VDE $\Delta T_{30}$ data irradiated at 572°F appear to be less sensitive to radiation embrittlement at high fluence compared to the trend curve of R.G. 1.99, Rev. 2, for the HSST02 CMM with copper content of 0.17 wt %. The reason behind this situation is due to the difference in copper contents between the VDE HSST02 CMM, which has reported copper content as 0.12 wt %, and the copper content , 0.17 wt %, used in the evaluation of R.G. 1.99, Rev. 2. Thus in order to correct this bias caused by the difference in copper content, the normalized value of the VDE $\Delta T_{30}$ to copper content of 17 wt % is used in Fig. 27. The data trend of the normalized VDE data irradiated at 572°F seems to be more consistent with the conclusion drawn on the fluence-rate effect from ASTM CMM data irradiated at 550°F, and a higher irradiation temperature of the VDE experiment at 572°F seems to delay the incubation time of fluence-rate effect at higher fluence. From this section it may imply that the fluence-rate effect strongly depends on exposure neutron fluence, irradiation temperature, and material chemical compositions, such as copper content. There are indications that a higher fluence rate may lead to higher shifts at relatively high fluence, depending on copper content.[24]

### 3.2.4 A533B-1 (HSST03) CMM

The results of 39 irradiated Charpy sets have been investigated. The summary of HSST03 materials is listed in Table 12. The trend curve and $\Delta T_{30}$ data are illustrated in Fig. 28. The trend curve of HSST03 per R.G. 1.99, Rev. 2, was used as an index curve for $\Delta T_{30}$ at the 550°F irradiation temperature. The $\Delta T_{30}$ data were divided into five subgroups, based on four ranges of irradiation temperatures and two ranges of fluence rates. Figure 25 clearly shows the irradiation temperature effect, that is a specimen irradiated at a lower temperature will exhibit more radiation embrittlement. At 550°F irradiation temperature, a clear bias can be detected, compared with the trend curve of HSST03 CMM per R.G. 1.99, Rev. 2; that is, R.G. 1.99, Rev. 2, underpredicted the $\Delta T_{30}$ for fluences greater than $2.4 \times 10^{19}$ n/cm$^2$ and overpredicted the $\Delta T_{30}$ for fluences less than $2.4 \times 10^{19}$ n/cm$^2$, especially for fluence rates greater than $2.0 \times 10^{12}$ n/cm$^2$·s. This may be a fluence-rate effect; higher fluence rates are expected to lead to higher values for the $\Delta T_{30}$ at relatively high fluences and lower values for the $\Delta T_{30}$ at relatively low fluences. In order to have a better picture for fluence-rate effect on the CMM data irradiated at 550°F, an additional plot was generated for the trend curve of HSST03 CMM with shift data irradiated at 550°F (see Fig. 29), where the ORRPSF and other test reactor data were identified with different symbols.

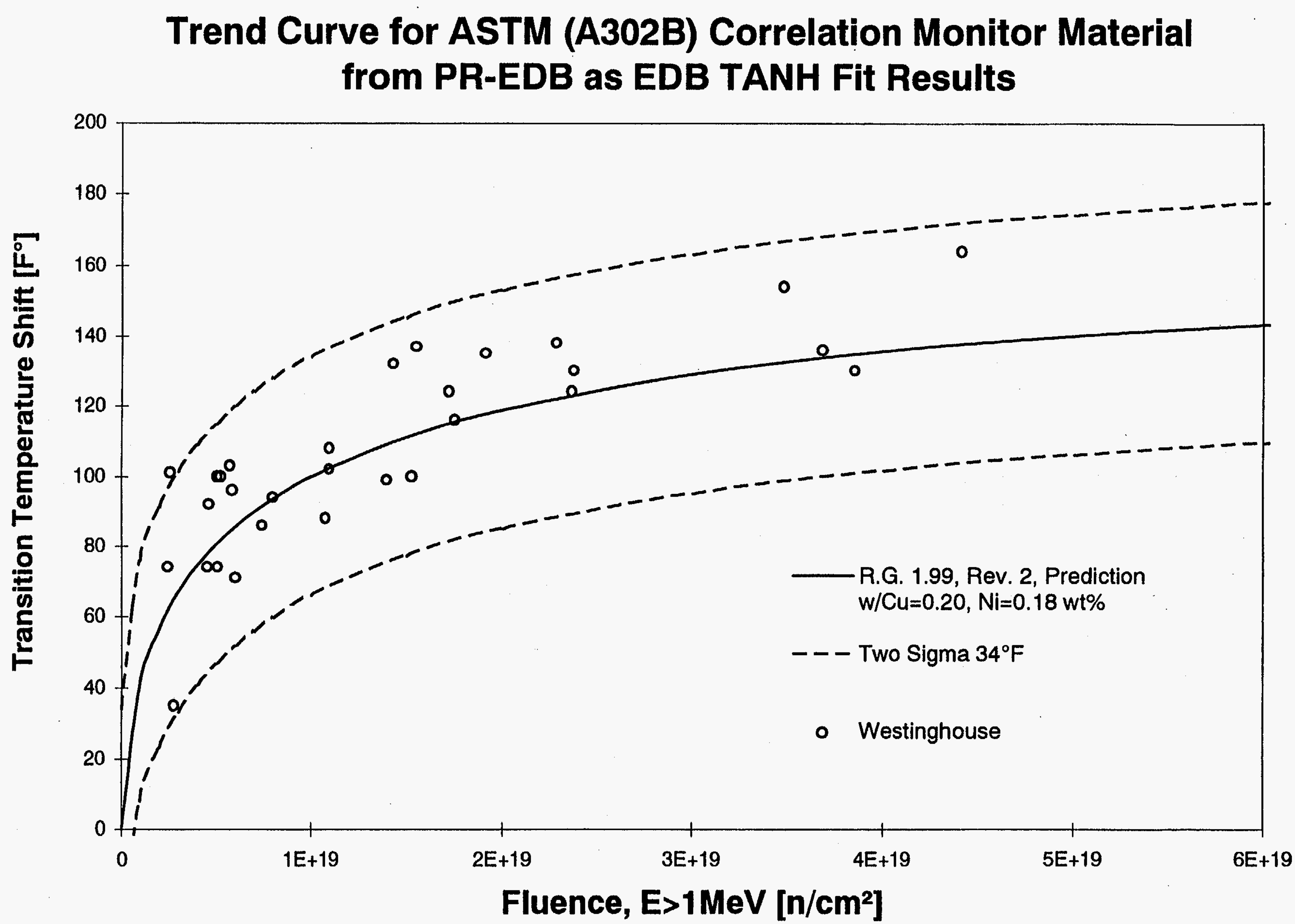


Figure 4 Embrittlement of the A302B ASTM CMM relative to the R.G. 1.99, Rev. 2, prediction

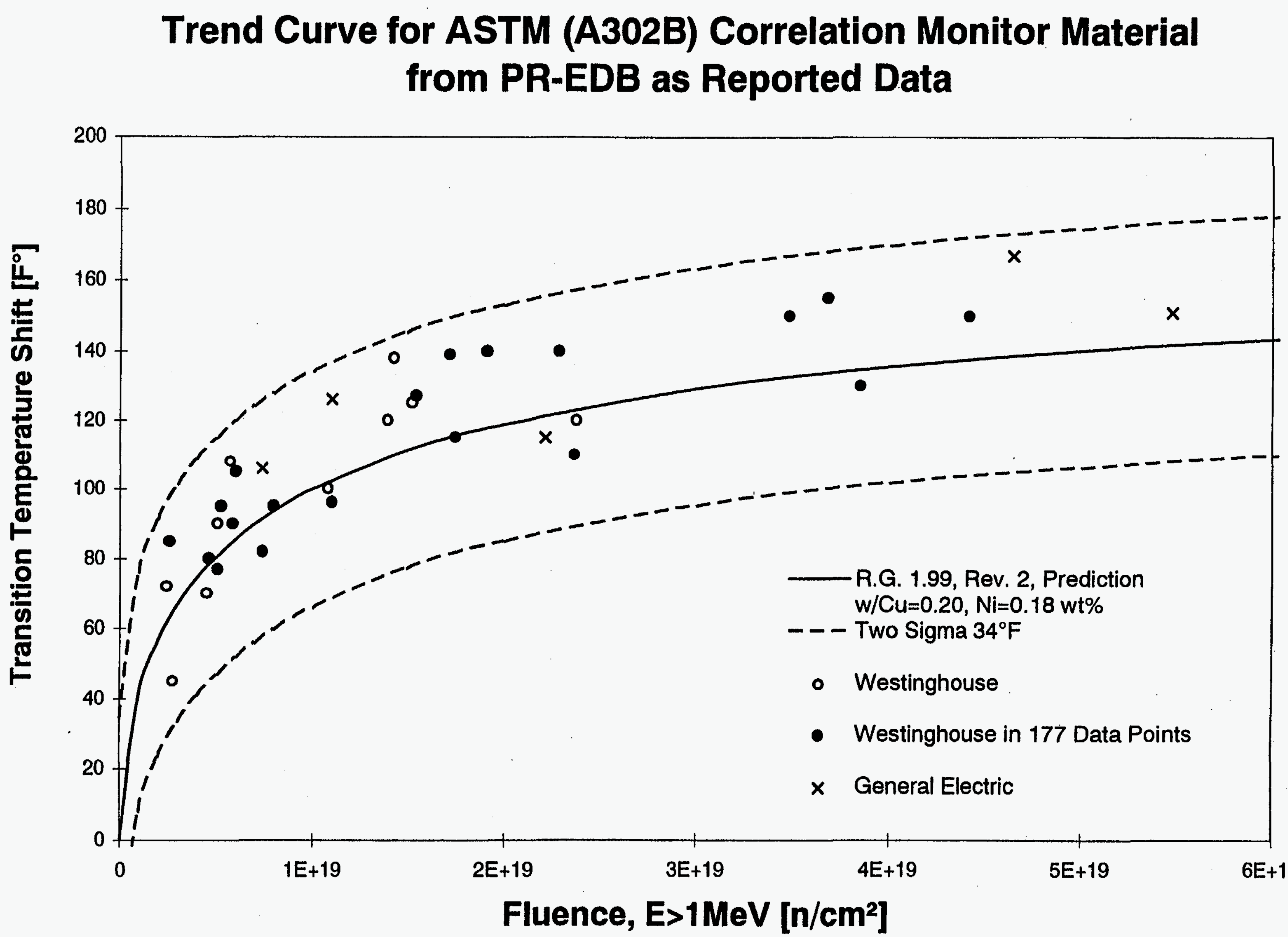


Figure 5 Embrittlement of the A302B ASTM CMM relative to the R.G. 1.99, Rev. 2, prediction

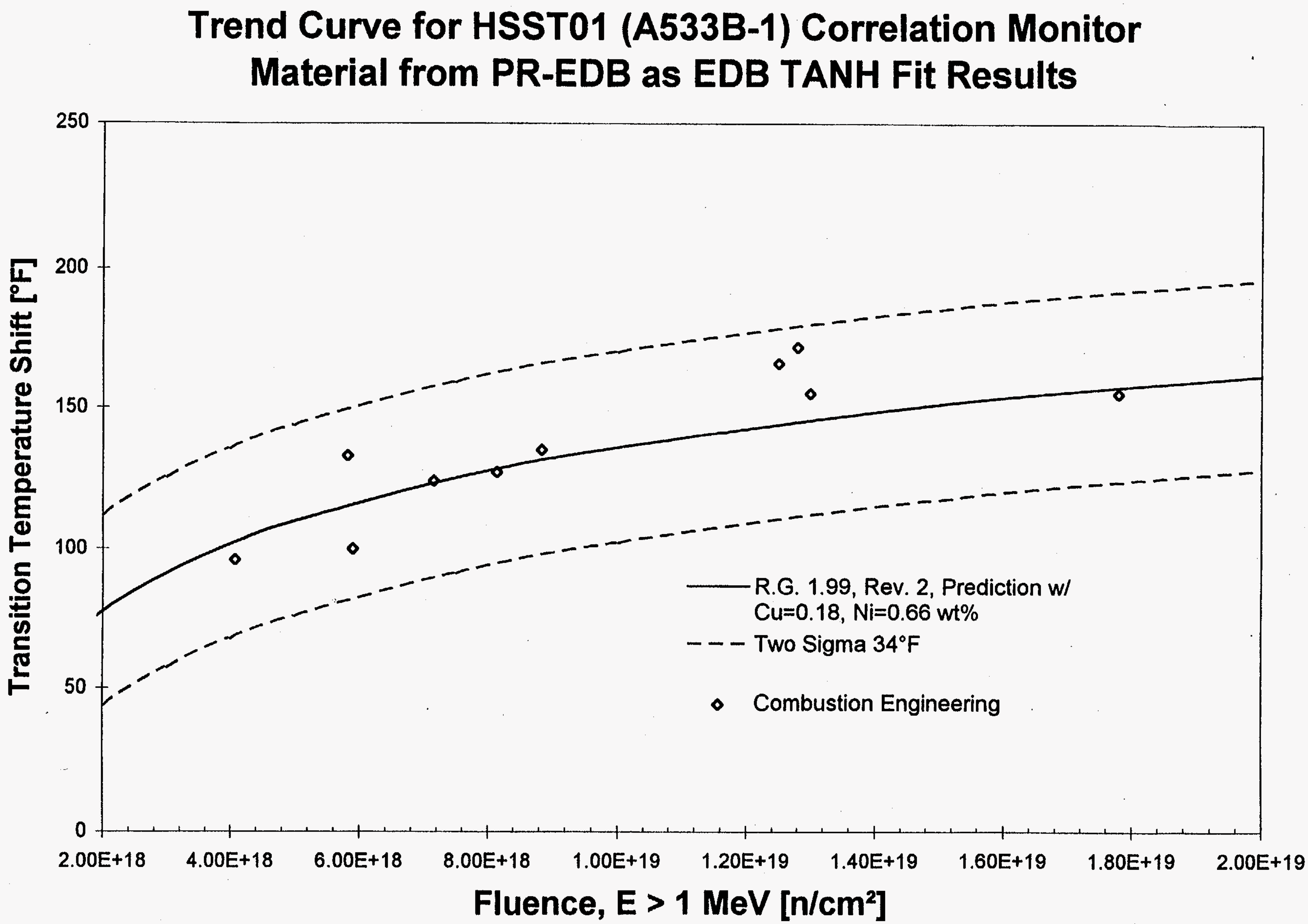


Figure 6 Embrittlement of the HSST01 CMM relative to the R.G. 1.99, Rev. 2, prediction

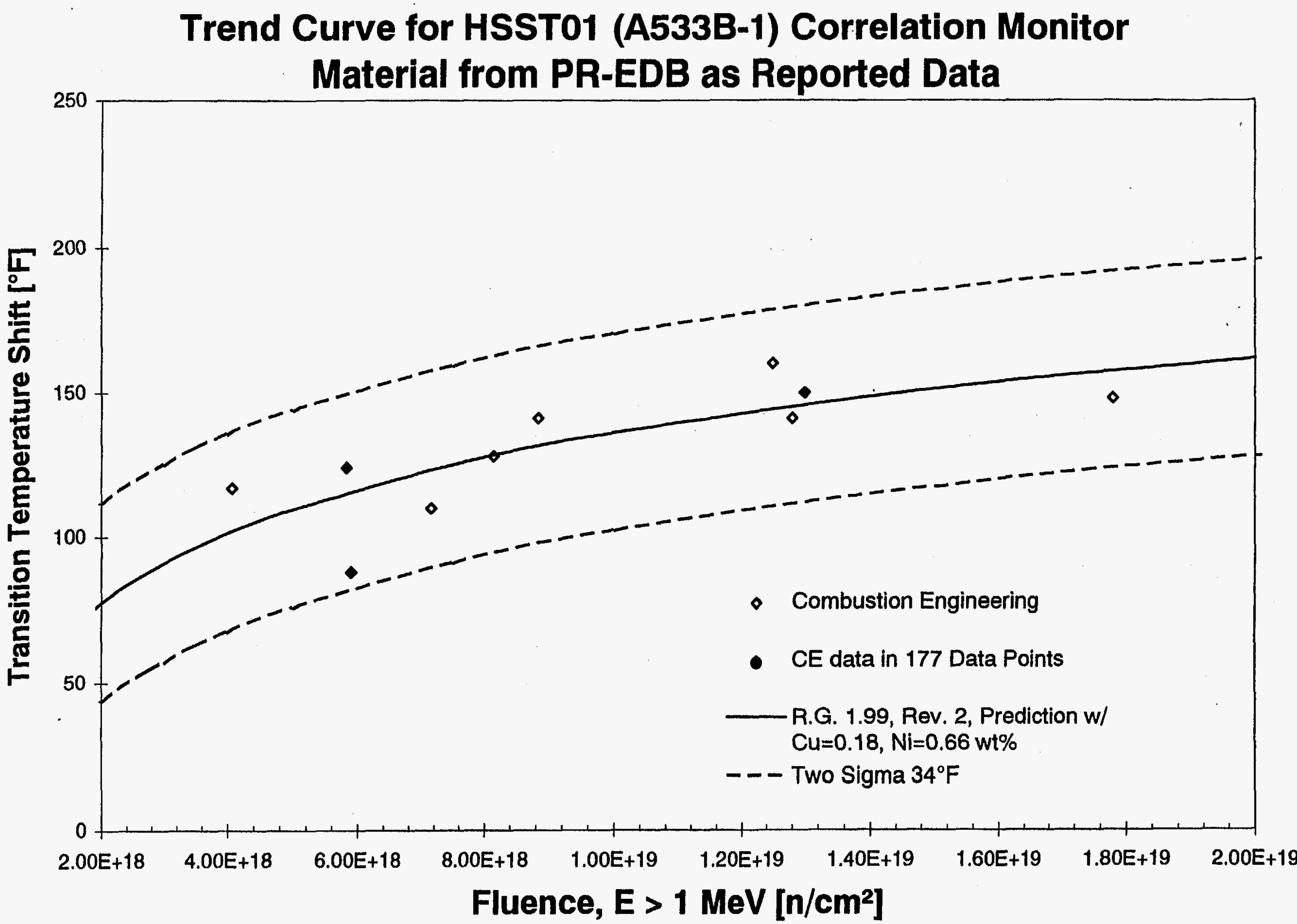


Figure 7 Embrittlement of the HSST01 CMM relative to the R.G. 1.99, Rev. 2, prediction

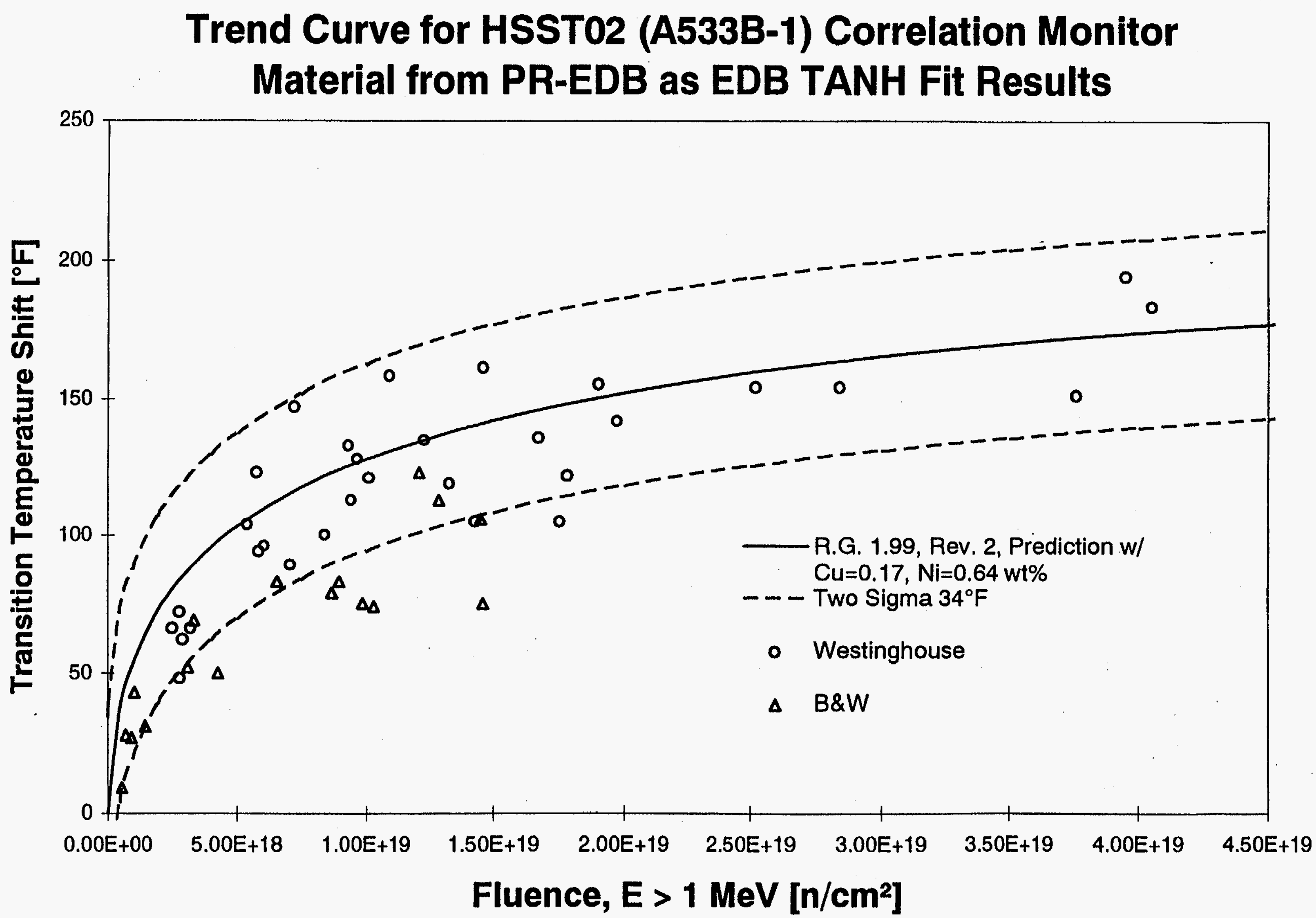


Figure 8 Embrittlement of the HSST02 CMM relative to R.G. 1.99, Rev. 2, prediction. Significant bias exists toward overprediction of the B&W surveillance data

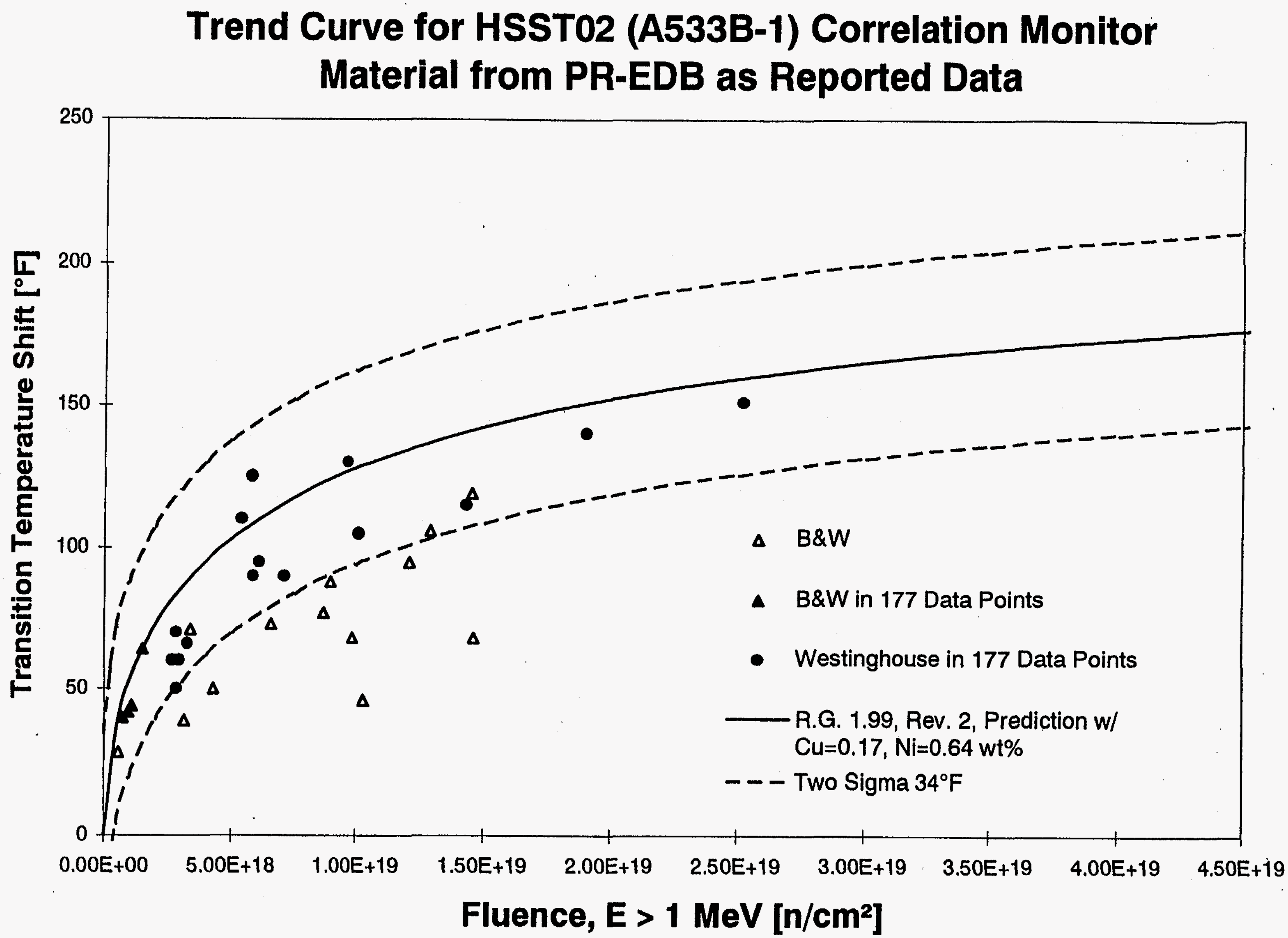


Figure 9. Embrittlement of the HSST02 CMM relative to the R.G. 1.99, Rev. 2, prediction. Significant bias exists toward overprediction of the B&W surveillance data

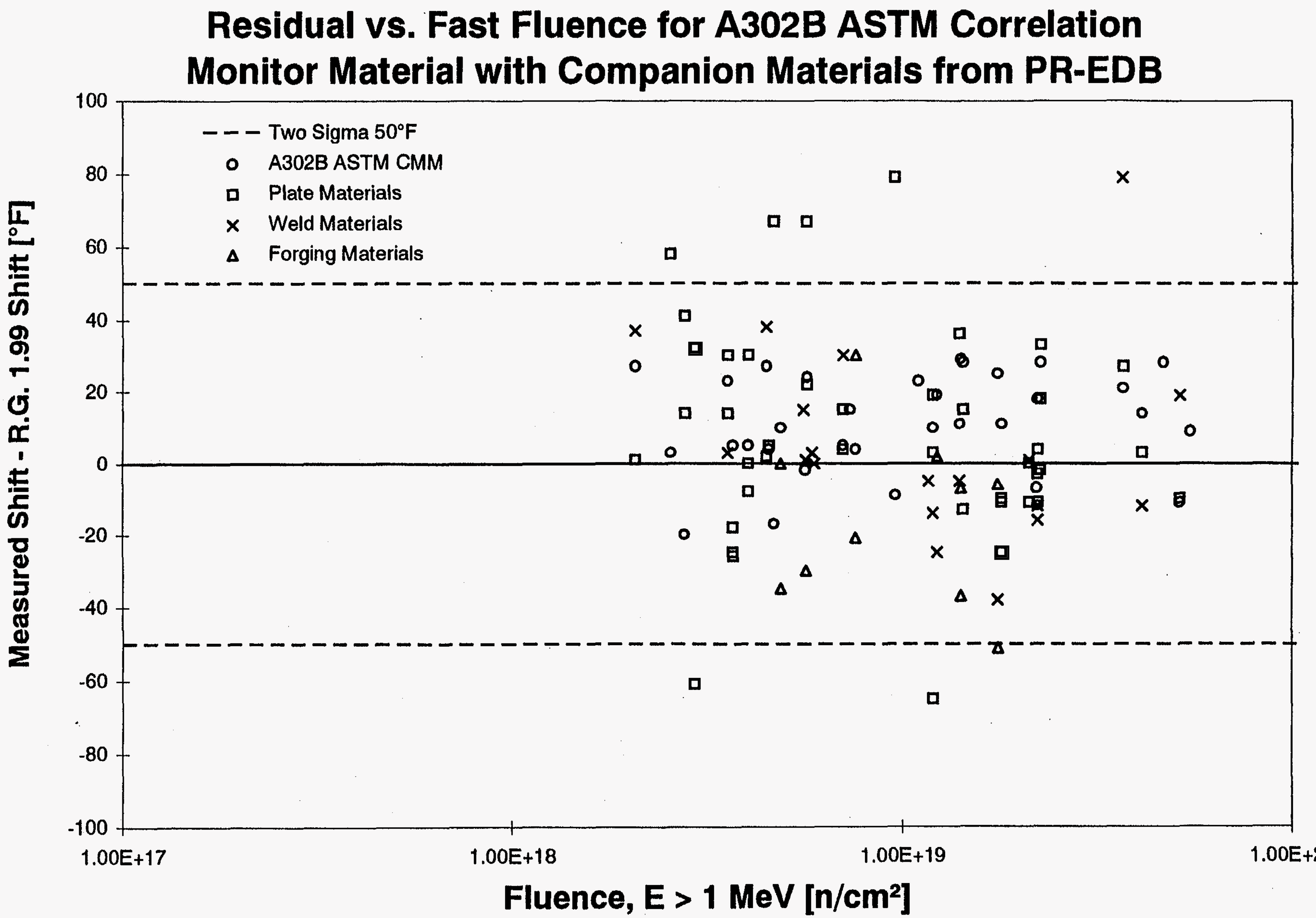


Figure 10 Plot of residual vs fast fluence for A302B ASTM CMM with companion materials, the overall two-sigma uncertainty is about 50°F. Garigliano A336 forgings and weld data, and Yankee Rowes' data were not included.

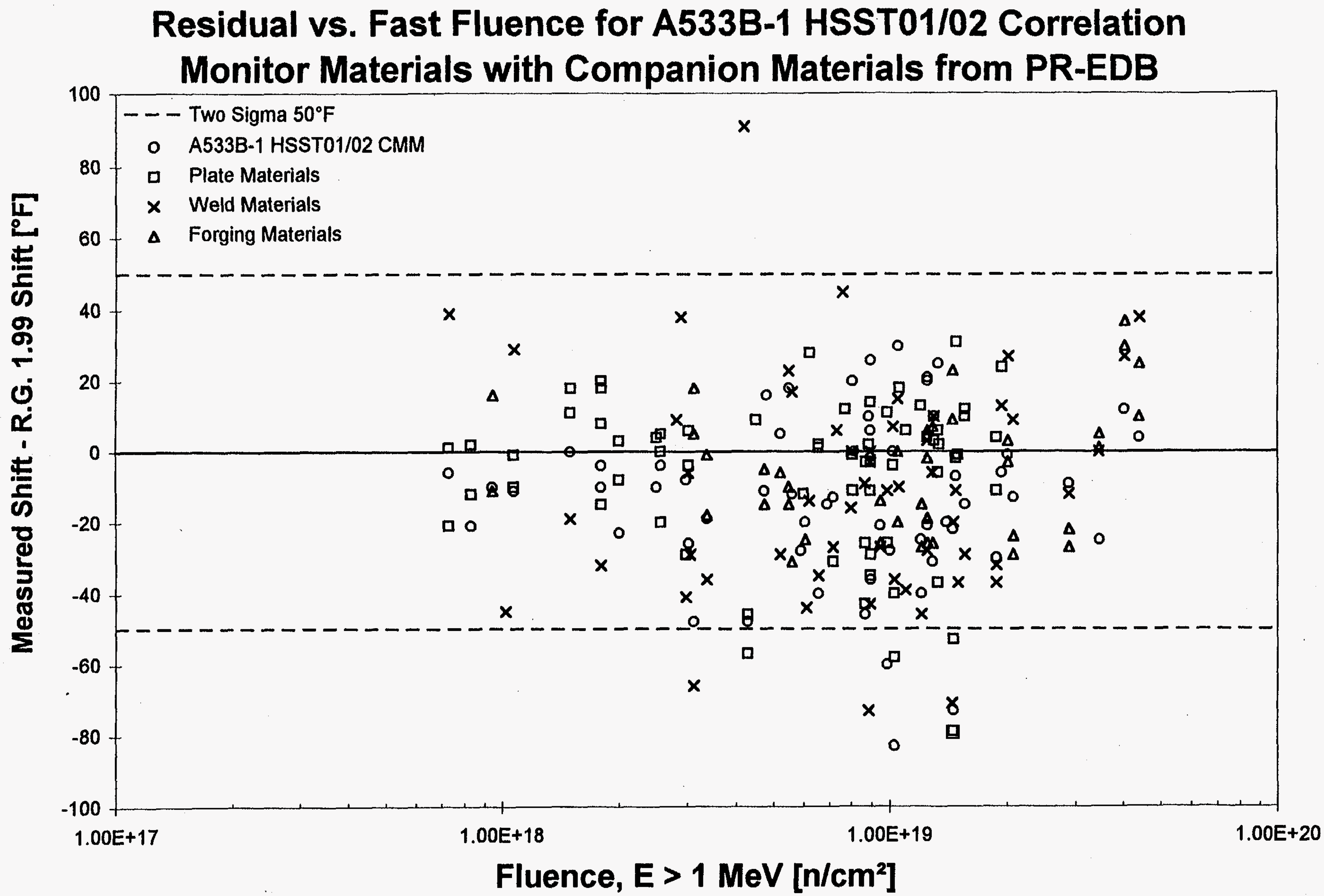


Figure 11 Plot of residual vs fast fluence for A533B-1 HSST01/HSST02 CMM with companion materials, the overall two sigma is 50°F

Table 13. Summary of A302B reactor pressure vessel steels per PR-EDB reported data

| Tag | Heat No. | Material ID | Heat ID | Prod. ID | Orient. | Fluence E > 1 MeV n/cm² | $C_v$ transition temp. at 30 ft-lb, °F Unirradiated | $C_v$ transition temp. at 30 ft-lb, °F Irradiated | $C_v$ transition temp. Shift at 30 ft-lb, °F Measured | $C_v$ transition temp. Shift at 30 ft-lb, °F R.G. 1.99 | $C_v$ transition temp. Shift at 30 ft-lb, °F Residual | Chemistry, wt % P | Chemistry, wt % NI | Chemistry, wt % CU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Big Rock Point Reactor, Capsule 119** | | | | | | | | | | | | | | |
| G | 20192-2 | A302B | SHM3 | SRM | LT | 1.500e+18 | 0 | 15 | 15 | 50 | -35 | 0.016 | 0.180 | 0.200 |
| G | 192462/3 | A302B | PBR_01 | Plate | TL | 1.500e+18 | -5 | -5 | 0 | 28 | -28 | 0.016 | 0.180 | 0.100 |
| G | 192462/3 | A302B | WBR_01 | Weld | TS | 1.500e+18 | -70 | -15 | 55 | 64 | -9 | 0.014 | 0.100 | 0.270 |
| **Big Rock Point Reactor, Capsule 127** | | | | | | | | | | | | | | |
| G | 20192-2 | A302B | SHM3 | SRM | LT | 7.100e+18 | 0 | 40 | 40 | 90 | -50 | 0.016 | 0.180 | 0.200 |
| G | 192462/3 | A302B | PBR_01 | Plate | TL | 7.100e+18 | -5 | 55 | 60 | 51 | 9 | 0.016 | 0.180 | 0.100 |
| G | 192462/3 | A302B | WBR_01 | Weld | TS | 7.100e+18 | -70 | 65 | 135 | 114 | 21 | 0.014 | 0.100 | 0.270 |
| **Haddam Neck, Capsule A** | | | | | | | | | | | | | | |
| W | A0421 | A302B | SASTM | SRM | LT | 2.070e+18 | 40 | 125 | 85 | 58 | 27 | 0.011 | 0.180 | 0.200 |
| W | A5892 | A302B | PCTY02 | Plate | LT | 2.070e+18 | -30 | 5 | 35 | 34 | 1 | 0.010 | 0.200 | 0.100 |
| W | 86054B | A302B | WCTY01 | Weld | TL | 2.070e+18 | -50 | 45 | 95 | 58 | 37 | 0.020 | 0.046 | 0.220 |
| **Haddam Neck, Capsule D** | | | | | | | | | | | | | | |
| W | A0421 | A302B | SASTM | SRM | LT | 2.220e+19 | 40 | 180 | 140 | 122 | 18 | 0.011 | 0.180 | 0.200 |
| W | A5877 | A302B | PCTY04 | Plate | LT | 2.220e+19 | -24 | 54 | 78 | 81 | -3 | 0.010 | 0.200 | 0.120 |
| W | 86054B | A302B | WCTY01 | Weld | TL | 2.220e+19 | -50 | 60 | 110 | 122 | -12 | 0.020 | 0.046 | 0.220 |
| **Haddam Neck, Capsule F** | | | | | | | | | | | | | | |
| W | A0421 | A302B | SASTM | SRM | LT | 4.04e+18 | 40 | 120 | 80 | 75 | 5 | 0.011 | 0.180 | 0.200 |
| W | A5892 | A302B | PCTY02 | Plate | LT | 4.04e+18 | -30 | 5 | 35 | 43 | -8 | 0.010 | 0.200 | 0.100 |
| W | A5877 | A302B | PCTY04 | Plate | LT | 4.04e+18 | -20 | 60 | 80 | 50 | 30 | 0.010 | 0.200 | 0.120 |
| W | A5911 | A302B | PCTY07 | Plate | LT | 4.04e+18 | -25 | 25 | 50 | 50 | 0 | 0.013 | 0.200 | 0.120 |
| **Haddam Neck, Capsule H** | | | | | | | | | | | | | | |
| W | A0421 | A302B | SASTM | SRM | LT | 1.790e+19 | 40 | 167 | 127 | 116 | 11 | 0.011 | 0.180 | 0.200 |
| W | A5892 | A302B | PCTY02 | Plate | LT | 1.790e+19 | -50 | 7 | 57 | 67 | -10 | 0.010 | 0.200 | 0.100 |
| W | A5877 | A302B | PCTY04 | Plate | LT | 1.790e+19 | -24 | 43 | 67 | 78 | -11 | 0.010 | 0.200 | 0.120 |
| W | A5911 | A302B | PCTY07 | Plate | LT | 1.790e+19 | -30 | 23 | 53 | 78 | -25 | 0.013 | 0.200 | 0.120 |

Table 13 (continued)

| Tag | Heat No. | Material ID | Heat ID | Prod. ID | Orient. | Fluence E > 1 MeV n/cm² | $C_v$ transition temp. at 30 ft-lb, °F Unirradiated | Irradiated | $C_v$ transition temp. Shift at 30 ft-lb, °F Measured | R.G. 1.99 | Residual | Chemistry, wt % P | NI | CU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Dresden Nuclear Plant Station Unit 1, Capsule CORE-5** | | | | | | | | | | | | | | |
| G | 20192-2 | A302B | SHM3 O | SRM | TS | 1.300e+20 | 10 | 165 | 155 | 154 | 1 | 0.016 | 0.180 | 0.200 |
| G | 19716 | A302B | PDR101O | Plate | LS | 1.300e+20 | 60 | 190 | 130 | 126 | 4 | 0.018 | 0.540 | 0.120 |
| **H. B. Robinson Unit 2, Capsule S** | | | | | | | | | | | | | | |
| W | A0421 | A302B | SASTM | SRM | TL | 3.690e+18 | 64 | 141 | 77 | 72 | 5 | 0.011 | 0.180 | 0.200 |
| W | A6604-1 | A302B | PHB201 | Plate | LT | 3.690e+18 | -18 | 13 | 31 | 49 | -18 | 0.007 | 0.200 | 0.120 |
| W | B1256-1 | A302B | PHB202 | Plate | LT | 3.690e+18 | 11 | 27 | 16 | 42 | -26 | 0.010 | 0.200 | 0.100 |
| W | B1250-1 | A302B | PHB203 | Plate | LT | 3.690e+18 | 28 | 41 | 13 | 38 | -25 | 0.010 | 0.200 | 0.090 |
| **H. B. Robinson Unit 2, Capsule T** | | | | | | | | | | | | | | |
| W | A0421 | A302B | SASTM | SRM | TL | 4.110e+19 | 65 | 215 | 150 | 136 | 14 | 0.011 | 0.180 | 0.200 |
| W | B1250-1 | A302B | PHB203 | Plate | LT | 4.110e+19 | 30 | 105 | 75 | 72 | 3 | 0.010 | 0.200 | 0.090 |
| W | W5214 | A302B | WHB201 | Weld | TL | 4.110e+19 | -60 | 225 | 285 | 297 | -12 | 0.021 | 0.660 | 0.340 |
| **H. B. Robinson Unit 2, Capsule V** | | | | | | | | | | | | | | |
| W | A0421 | A302B | SASTM | SRM | TL | 4.510e+18 | | | 105 | 78 | 27 | 0.011 | 0.180 | 0.200 |
| W | B1256-1 | A302B | PHB202 | Plate | LT | 4.510e+18 | 11 | 58 | 47 | 45 | 2 | 0.010 | 0.200 | 0.100 |
| W | W5214 | A302B | WHB201 | Weld | TL | 4.510e+18 | -87 | 120 | 207 | 169 | 38 | 0.021 | 0.660 | 0.340 |
| **Humboldt Bay Power Plant Unit 3, Capsule 4** | | | | | | | | | | | | | | |
| G | 20192-2 | A302B | SHM3 | SRM | LT | 3.000e+19 | 0 | 80 | 80 | 129 | -49 | 0.016 | 0.180 | 0.200 |
| **Indian Point Unit 2, Capsule T** | | | | | | | | | | | | | | |
| W | A0421 | A302B | SASTM | SRM | LT | 2.550e+18 | | | 72 | 69 | 3 | 0.010 | 0.270 | 0.200 |
| W | B4688-2 | A302B | PIP201 | Plate | LT | 2.930e+18 | | | 54 | 115 | -61 | 0.010 | 0.580 | 0.250 |
| W | B4701-2 | A302B | PIP202 | Plate | LT | 2.930e+18 | | | 94 | 62 | 32 | 0.014 | 0.460 | 0.140 |
| W | B4922-1 | A302B | PIP203 | Plate | LT | 2.550e+18 | | | 120 | 62 | 58 | 0.011 | 0.570 | 0.140 |
| **Indian Point Unit 2, Capsule V** | | | | | | | | | | | | | | |
| W | A0421 | A302B | SASTM | SRM | LT | 4.570e+18 | | | 90 | 86 | 4 | 0.010 | 0.270 | 0.200 |
| W | B4701-2 | A302B | PIP202 | Plate | LT | 4.570e+18 | | | 78 | 73 | 5 | 0.014 | 0.460 | 0.140 |
| W | W5214 | A302B | WIP201 | Weld | TL | 5.590e+18 | | | 204 | 189 | 15 | 0.010 | 1.020 | 0.200 |

Table 13 (continued)

| Tag | Heat No. | Material ID | Heat ID | Prod. ID | Orient. | Fluence E > 1 MeV n/cm² | $C_v$ transition temp. at 30 ft-lb, °F Unirradiated | Irradiated | $C_v$ transition temp. Shift at 30 ft-lb, °F Measured | R.G. 1.99 | Residual | Chemistry, wt % P | NI | CU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Indian Point Unit 2, Capsule Y** | | | | | | | | | | | | | | |
| W | A0421 | A302B | SASTM | SRM | LT | 4.720e+18 | | | 70 | 87 | -17 | 0.010 | 0.270 | 0.200 |
| W | B4922-1 | A302B | PIP203 | Plate | LT | 4.720e+18 | | | 145 | 78 | 67 | 0.011 | 0.570 | 0.140 |
| W | W5214 | A302B | WIP201 | Weld | TL | 5.890e+18 | | | 195 | 192 | 3 | 0.010 | 1.020 | 0.200 |
| **Indian Point Unit 2, Capsule Z** | | | | | | | | | | | | | | |
| W | A0421 | A302B | SASTM | SRM | LT | 9.620e+18 | | | 100 | 109 | -9 | 0.010 | 0.270 | 0.200 |
| W | B4688-2 | A302B | PIP201 | Plate | LT | 1.200e+19 | | | 117 | 182 | -65 | 0.010 | 0.580 | 0.250 |
| W | B4701-2 | A302B | PIP202 | Plate | LT | 1.200e+19 | | | 117 | 98 | 19 | 0.014 | 0.460 | 0.140 |
| W | B4922-1 | A302B | PIP203 | Plate | LT | 9.620e+18 | | | 177 | 98 | 79 | 0.011 | 0.570 | 0.140 |
| **Indian Point Unit 3, Capsule Y** | | | | | | | | | | | | | | |
| W | A1195-1 | A533B-1 | SHSS02 | SRM | LT | 8.050e+18 | 50 | 190 | 140 | 120 | 20 | 0.010 | 0.640 | 0.170 |
| W | A0512-2 | A302B | PIP304 | Plate | TL | 8.050e+18 | 60 | 210 | 150 | 151 | -1 | 0.012 | 0.520 | 0.240 |
| W | W5214 | A302B | WIP301 | Weld | TL | 8.050e+18 | -55 | 125 | 180 | 180 | 0 | 0.019 | 1.020 | 0.150 |
| **Lacrosse Boiling Water Reactor (Genoa-2), Capsule 1A/1B** | | | | | | | | | | | | | | |
| A | N31438 | A302B | SLAC01 | SRM | LT | 4.350e+18 | -60 | 30 | 90 | 32 | 58 | 0.017 | 0.180 | 0.070 |
| A | A5848 | A302B | PLAC02 | Plate | LT | 4.350e+18 | -75 | -45 | 30 | 56 | -26 | 0.009 | 0.180 | 0.140 |
| A | 3C2B | A302B | WLAC01 | Weld | TL | 4.350e+18 | -30 | 55 | 85 | 68 | 17 | 0.016 | 0.120 | 0.180 |
| **Lacrosse Boiling Water Reactor (Genoa-2), Capsule 2A/7B** | | | | | | | | | | | | | | |
| A | N31438 | A302B | SLAC01 | SRM | LT | 1.100e+19 | -60 | 25 | 85 | 43 | 42 | 0.017 | 0.180 | 0.070 |
| A | A5848 | A302B | PLAC02 | Plate | LT | 1.100e+19 | -75 | -10 | 65 | 75 | -10 | 0.009 | 0.180 | 0.140 |
| A | 3C2B | A302B | WLAC01 | Weld | TL | 1.100e+19 | -20 | 85 | 105 | 91 | 14 | 0.016 | 0.120 | 0.180 |
| **Lacrosse Boiling Water Reactor (Genoa-2), Capsule 38AB** | | | | | | | | | | | | | | |
| A | N31438 | A302B | SLAC01 | SRM | LT | 1.080e+19 | -60 | 45 | 105 | 43 | 62 | 0.017 | 0.180 | 0.070 |
| A | A5848 | A302B | PLAC02 | Plate | LT | 1.080e+19 | -75 | 5 | 80 | 75 | 5 | 0.009 | 0.180 | 0.140 |
| A | 3C2B | A302B | WLAC01 | Weld | TL | 1.080e+19 | -20 | 90 | 110 | 91 | 19 | 0.016 | 0.120 | 0.180 |

Table 13 (continued)

| Tag | Heat No. | Material ID | Heat ID | Prod. ID | Orient. | Fluence E > 1 MeV n/cm² | $C_v$ transition temp. at 30 ft-lb, °F Unirradiated | Irradiated | $C_v$ transition temp. Shift at 30 ft-lb, °F Measured | R.G. 1.99 | Residual | Chemistry, wt % P | NI | CU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Lacrosse Boiling Water Reactor (Genoa-2), Capsule 9A/9B** | | | | | | | | | | | | | | |
| A | N31438 | A302B | SLAC01 | SRM | LT | 6.600e+18 | -60 | 10 | 70 | 37 | 33 | 0.017 | 0.180 | 0.070 |
| A | A5848 | A302B | PLAC02 | Plate | LT | 6.600e+18 | -75 | -10 | 65 | 65 | 0 | 0.009 | 0.180 | 0.140 |
| A | 3C2B | A302B | WLAC01 | Weld | TL | 6.600e+18 | -20 | 55 | 75 | 78 | -3 | 0.016 | 0.120 | 0.180 |
| **Oconee Nuclear Station Unit 1, Capsule A** | | | | | | | | | | | | | | |
| B | A1195-1 | A533B-1 | SHSS02 | SRM | LT | 8.950e+18 | 56 | 144 | 88 | 124 | -36 | 0.010 | 0.640 | 0.170 |
| B | C3265-1 | A302B | POC102 | Plate | LT | 8.950e+18 | -5 | 55 | 60 | 63 | -3 | 0.015 | 0.500 | 0.100 |
| B | C3265-1 | A302B | POC102 | Plate | TL | 8.950e+18 | 5 | 39 | 34 | 63 | -29 | 0.015 | 0.500 | 0.100 |
| B | 406L44 | A302B | WOC101 | Weld | TL | 8.950e+18 | -5 | 186 | 191 | 191 | 0 | 0.024 | 0.590 | 0.310 |
| **Oconee Nuclear Station Unit 1, Capsule C** | | | | | | | | | | | | | | |
| B | A1195-1 | A533B-1 | SHSS02 | SRM | LT | 9.860e+18 | 48 | 116 | 68 | 128 | -60 | 0.010 | 0.640 | 0.170 |
| B | C3265-1 | A302B | POC102 | Plate | LT | 9.860e+18 | -5 | 34 | 76 | 65 | 11 | 0.015 | 0.500 | 0.100 |
| B | C3265-1 | A302B | POC102 | Plate | TL | 9.860e+18 | 18 | 94 | 39 | 65 | -26 | 0.015 | 0.500 | 0.100 |
| B | 406L44 | A302B | WOC101 | Weld | TL | 9.860e+18 | -5 | 180 | 185 | 196 | -11 | 0.024 | 0.590 | 0.310 |
| **Oconee Nuclear Station Unit 1, Capsule E** | | | | | | | | | | | | | | |
| B | A1195-1 | A533B-1 | SHSS02 | SRM | LT | 1.500e+18 | 56 | | 64* | 64 | 0 | 0.010 | 0.640 | 0.170 |
| B | C3265-1 | A302B | POC102 | Plate | LT | 1.500e+18 | -11 | 40 | 51 | 33 | 18 | 0.015 | 0.500 | 0.100 |
| B | C3265-1 | A302B | POC102 | Plate | TL | 1.500e+18 | 7 | 51 | 44 | 33 | 11 | 0.015 | 0.500 | 0.100 |
| B | 406L44 | A302B | WOC101 | Weld | TL | 1.500e+18 | -5 | 75 | 80 | 99 | -19 | 0.024 | 0.590 | 0.310 |
| **Oconee Nuclear Station Unit 1, Capsule F** | | | | | | | | | | | | | | |
| B | C2800-2 | A302B | POC101 | Plate | LT | 8.300e+17 | 0 | 16 | 16 | 28 | -12 | 0.012 | 0.630 | 0.110 |
| B | A1195-1 | A533B-1 | SHSS02 | SRM | LT | 8.300e+17 | 56 | | 28* | 49 | -21 | 0.010 | 0.640 | 0.170 |
| B | C2800-2 | A302B | POC101 | Plate | TL | 8.300e+17 | -2 | 28 | 30 | 28 | 2 | 0.012 | 0.630 | 0.110 |
| **Palisades, Capsule W110** | | | | | | | | | | | | | | |
| C | A1008-1 | A533B-1 | SHSS01 | SRM | LT | 1.779e+19 | 15 | 163 | 148 | 158 | -10 | 0.0112 | 0.665 | 0.173 |
| C | C1279-3 | A302BM | PPAL01 | Plate | LT | 1.779e+19 | 0 | 180 | 180 | 192 | -12 | 0.011 | 0.53 | 0.25 |
| C | 3277 | A302BM | WPAL01 | Weld | TL | 1.779e+19 | -85 | 229 | 314 | 267 | 47 | 0.011 | 0.95 | 0.24 |
| **Point Beach Nuclear Plant Unit 1, Capsule R** | | | | | | | | | | | | | | |
| W | A0421 | A302B | SASTM | SRM | LT | 2.220e+19 | 40 | 150 | 110 | 122 | -12 | 0.011 | 0.180 | 0.200 |
| W | A9811 | A302B | PPB101 | Plate | LT | 2.220e+19 | -45 | 60 | 105 | 101 | 4 | 0.010 | 0.056 | 0.190 |
| W | C1423 | A302B | PPB102 | Plate | LT | 2.220e+19 | -30 | 20 | 50 | 61 | -11 | 0.014 | 0.065 | 0.110 |
| W | 72445 | A302B | WPB101 | Weld | TL | 2.220e+19 | -45 | 120 | 165 | 181 | -16 | 0.019 | 0.570 | 0.180 |

Table 13 (continued)

| Tag | Heat No. | Material ID | Heat ID | Prod. ID | Orient. | Fluence E > 1 MeV n/cm² | $C_v$ transition temp. at 30 ft-lb, °F Unirradiated | Irradiated | $C_v$ transition temp. Shift at 30 ft-lb, °F Measured | R.G. 1.99 | Residual | Chemistry, wt % P | NI | CU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Point Beach Nuclear Plant Unit 1, Capsule S** | | | | | | | | | | | | | | |
| W | A0421 | A302B | SASTM | SRM | LT | 7.050e+18 | 40 | 135 | 95 | 90 | 5 | 0.011 | 0.180 | 0.200 |
| W | A9811 | A302B | PPB101 | Plate | LT | 7.050e+18 | -45 | 45 | 90 | 75 | 15 | 0.010 | 0.056 | 0.190 |
| W | C1423 | A302B | PPB102 | Plate | LT | 7.050e+18 | -30 | 20 | 50 | 46 | 4 | 0.014 | 0.065 | 0.110 |
| W | 72445 | A302B | WPB101 | Weld | TL | 7.050e+18 | -45 | 120 | 165 | 135 | 30 | 0.019 | 0.570 | 0.180 |
| **Point Beach Nuclear Plant Unit 1, Capsule T** | | | | | | | | | | | | | | |
| W | A0421 | A302B | SASTM | SRM | LT | 2.110e+19 | 40 | 160 | 120 | 120 | 0 | 0.011 | 0.180 | 0.200 |
| W | A9811 | A302B | PPB101 | Plate | LT | 2.110e+19 | -45 | 55 | 100 | 100 | 0 | 0.010 | 0.056 | 0.190 |
| W | C1423 | A302B | PPB102 | Plate | LT | 2.110e+19 | -30 | 20 | 50 | 61 | -11 | 0.014 | 0.065 | 0.110 |
| W | 72445 | A302B | WPB101 | Weld | TL | 2.110e+19 | -45 | 135 | 180 | 179 | 1 | 0.019 | 0.570 | 0.180 |
| **Point Beach Nuclear Plant Unit 1, Capsule V** | | | | | | | | | | | | | | |
| W | A0421 | A302B | SASTM | SRM | LT | 3.580e+18 | 40 | 135 | 95 | 72 | 23 | 0.011 | 0.180 | 0.200 |
| W | A9811 | A302B | PPB101 | Plate | LT | 3.580e+18 | -45 | 45 | 90 | 60 | 30 | 0.010 | 0.056 | 0.190 |
| W | C1423 | A302B | PPB102 | Plate | LT | 3.580e+18 | -30 | 20 | 50 | 36 | 14 | 0.014 | 0.065 | 0.110 |
| W | 72445 | A302B | WPB101 | Weld | TL | 3.580e+18 | -45 | 65 | 110 | 107 | 3 | 0.019 | 0.570 | 0.180 |
| **San Onofre Unit 1, Capsule A** | | | | | | | | | | | | | | |
| W | A0421 | A302B | SASTM | SRM | LT | 1.200e+19 | 40 | 155 | 115 | 105 | 10 | 0.011 | 0.180 | 0.200 |
| W | A3119 | A302B | PSO103 | Plate | LT | 1.200e+19 | | | 100 | 97 | 3 | 0.014 | 0.200 | 0.180 |
| W | | A302B | WSO101 | Weld | TL | 1.200e+19 | -20 | 100 | 80 | 94 | -14 | 0.017 | 0.080 | 0.190 |
| **San Onofre Unit 1, Capsule D** | | | | | | | | | | | | | | |
| W | A0421 | A302B | SASTM | SRM | LT | 2.260e+19 | 40 | 190 | 150 | 122 | 28 | 0.011 | 0.180 | 0.200 |
| W | 19585 | A302B | PSO101 | Plate | LT | 2.260e+19 | | | 140 | 107 | 33 | 0.013 | 0.200 | 0.170 |
| W | A3099 | A302B | PSO102 | Plate | LT | 2.260e+19 | | | 110 | 112 | -2 | 0.012 | 0.200 | 0.180 |
| W | A3119 | A302B | PSO103 | Plate | LT | 2.260e+19 | | | 130 | 112 | 18 | 0.014 | 0.200 | 0.180 |
| **San Onofre Unit 1, Capsule F** | | | | | | | | | | | | | | |
| W | A0421 | A302B | SASTM | SRM | LT | 5.140e+19 | 40 | 170 | 130 | 141 | -11 | 0.011 | 0.180 | 0.200 |
| W | A3099 | A302B | PSO102 | Plate | LT | 5.140e+19 | 10 | 130 | 120 | 130 | -10 | 0.012 | 0.200 | 0.180 |
| W | | A302B | WSO101 | Weld | TL | 5.140e+19 | -20 | 125 | 145 | 126 | 19 | 0.017 | 0.080 | 0.190 |
| **Three Mile Island Nuclear Station Unit 1, Capsule C** | | | | | | | | | | | | | | |
| B | A1195-1 | A533B-1 | SHSS02 | SRM | LT | 8.660e+18 | 48 | 125 | 77 | 123 | -46 | 0.010 | 0.640 | 0.170 |
| B | C2789-2 | A302B | PTM101 | Plate | LT | 8.660e+18 | -27 | 3 | 30 | 56 | -26 | 0.010 | 0.570 | 0.090 |
| B | C2789-2 | A302B | PTM101 | Plate | TL | 8.660e+18 | 28 | 41 | 13 | 56 | -43 | 0.010 | 0.570 | 0.090 |
| B | 299L44 | A302B | WTM101 | Weld | TL | 8.660e+18 | -56 | 147 | 203 | 212 | -9 | 0.019 | 0.710 | 0.330 |

## Table 13 (continued)

| | | | | | | | $C_v$ transition temp. at 30 ft-lb, °F | | $C_v$ transition temp. Shift at 30 ft-lb, °F | | | Chemistry, wt % | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Tag | Heat No. | Material ID | Heat ID | Prod. ID | Orient. | Fluence E > 1 MeV n/cm² | Unirradiated | Irradiated | Measured | R.G. 1.99 | Residual | P | NI | CU |
| **Three Mile Island Nuclear Station Unit 1, Capsule E** | | | | | | | | | | | | | | |
| B | A1195-1 | A533B-1 | SHSS02 | SRM | LT | 1.070e+18 | 56 | | 44* | 55 | -11 | 0.010 | 0.640 | 0.170 |
| B | C2789-2 | A302B | PTM101 | Plate | LT | 1.070e+18 | -11 | 13 | 24 | 25 | -1 | 0.010 | 0.570 | 0.090 |
| B | C2789-2 | A302B | PTM101 | Plate | TL | 1.070e+18 | 24 | -29 | -53 | 25 | -10 | 0.010 | 0.570 | 0.090 |
| B | 299L44 | A302B | WTM101 | Weld | TL | 1.070e+18 | -56 | 68 | 124 | 95 | 29 | 0.019 | 0.710 | 0.330 |
| **Yankee-Rowe, Capsule 01** | | | | | | | | | | | | | | |
| W | A0421 | A302B | SASTM S1 | SRM | | 9.000e+19 | 15 | 325 | 310 | 150 | 160 | 0.011 | 0.180 | 0.200 |
| W | 19281-2 | A302B | PYR_01 | Plate | LT | 9.000e+19 | 10 | 410 | 400 | 135 | 265 | 0.020 | 0.180 | 0.180 |
| **Yankee-Rowe, Capsule 02** | | | | | | | | | | | | | | |
| W | A0421 | A302B | SASTM S1 | SRM | | 9.000e+19 | 15 | 325 | 310 | 150 | 160 | 0.011 | 0.180 | 0.200 |
| W | 19281-2 | A302B | PYR_01 | Plate | LT | 9.000e+19 | 10 | 410 | 400 | 135 | 265 | 0.020 | 0.180 | 0.180 |
| **Yankee-Rowe, Capsule 06** | | | | | | | | | | | | | | |
| W | A0421 | A302B | SASTM S1 | SRM | | 7.000e+19 | 15 | 275 | 260 | 146 | 114 | 0.011 | 0.180 | 0.200 |
| W | 19281-2 | A302B | PYR_01 | Plate | LT | 7.000e+19 | 10 | 370 | 360 | 132 | 228 | 0.020 | 0.180 | 0.180 |
| **Yankee-Rowe, Capsule 08** | | | | | | | | | | | | | | |
| W | A0421 | A302B | SASTM S1 | SRM | | 5.000e+19 | 15 | 240 | 225 | 140 | 85 | 0.011 | 0.180 | 0.200 |
| W | 19281-2 | A302B | PYR_01 | Plate | LT | 5.000e+19 | 10 | 330 | 320 | 126 | 194 | 0.020 | 0.180 | 0.180 |

* 50 ft-lb transition temperature shift

Residual is defined as measured shift - R.G. 1.99, Rev. 2, shift.

Tag Field, A - Allis Chalmers; B - Babcock & Wilcox; C - Combustion Engineering; G - General Electric; W- Westinghouse.

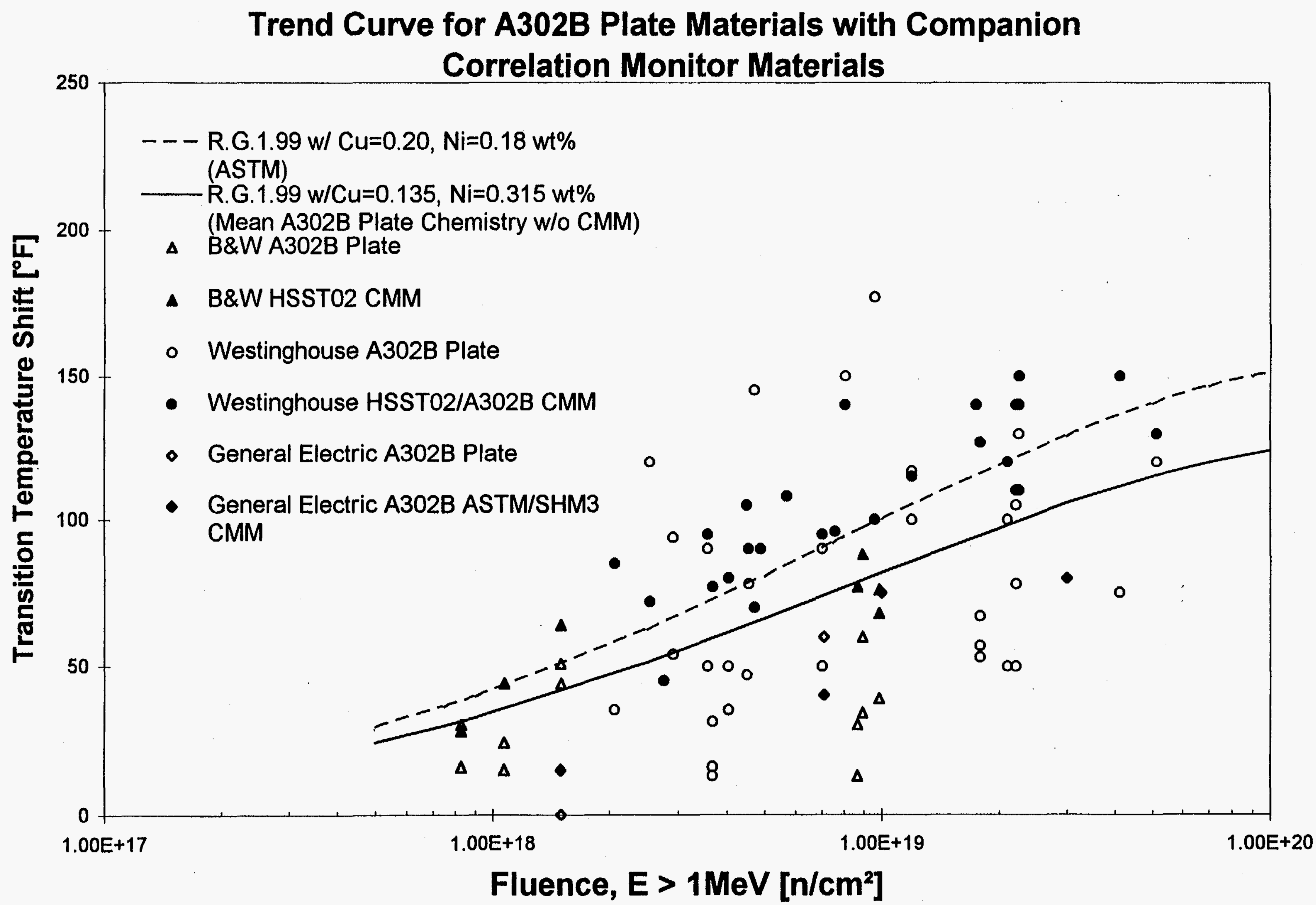


Figure 12 Trend curve for A302B plate materials and the corresponding CMMs (The SRM data are identified with a solid symbol, the corresponding A302B plate is identified with a hollow symbol)

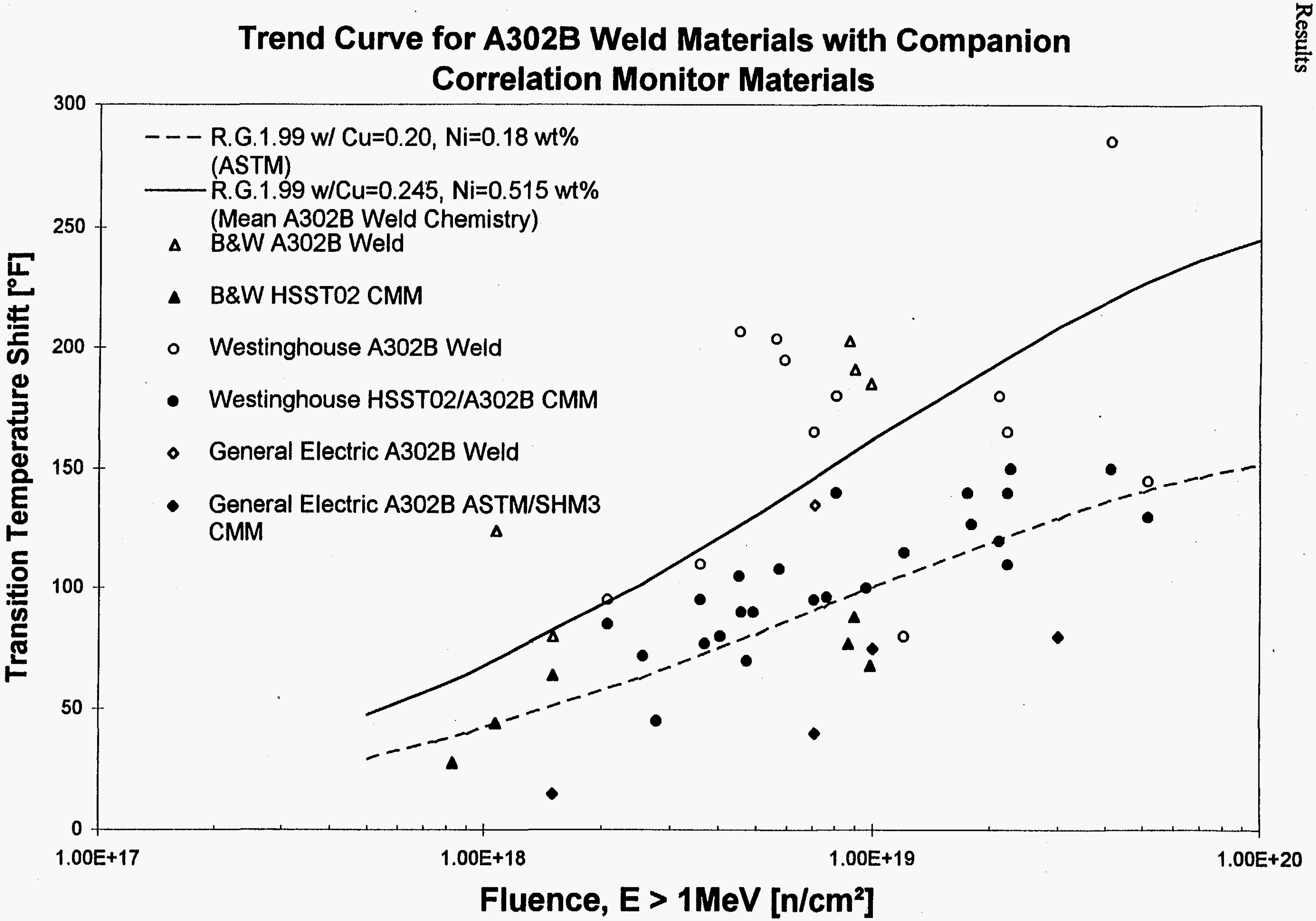


Figure 13 Trend curve for A302B weld materials and the corresponding CMM(The CMM data are identified with a solid symbol, the corresponding A302B weld data are identified with a hollow symbol)

Table 14. Summary of A533B reactor pressure vessel steels per PR-EDB reported data

| Tag | Heat No. | Material ID | HEAT ID | Prod. ID | Orient. | Fluence E > 1 MeV n/cm² | $C_v$ transition temp. at 30 ft-lb | | $C_v$ transition temp. Shift at 30 ft-lb | | | Chemistry | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Unirradiated | Irradiated | Measured | R.G. 1.99 | Residual | P | NI | CU |
| **Arkansas Nuclear One, Unit 1, Capsule A** | | | | | | | | | | | | | | |
| B | A1195-1 | A533B-1 | SHSS02 | SRM | LT | 1.030e+19 | 48 | 94 | 46 | 129 | -83 | 0.010 | 0.640 | 0.170 |
| B | C5114-1 | A533B-1 | PAN101 | Plate | LT | 1.030e+19 | -31 | 17 | 48 | 106 | -58 | 0.010 | 0.520 | 0.150 |
| B | C5114-1 | A533B-1 | PAN101 | Plate | TL | 1.030e+19 | 17 | 83 | 66 | 106 | -40 | 0.010 | 0.520 | 0.150 |
| B | 406L44 | A533B-1 | WAN101 | Weld | TL | 1.030e+19 | 5 | 156 | 151 | 187 | -36 | 0.016 | 0.590 | 0.280 |
| **Arkansas Nuclear One, Unit 1, Capsule B** | | | | | | | | | | | | | | |
| B | A1195-1 | A533B-1 | SHSS02 | SRM | LT | 4.280e+18 | 48 | 98 | 50 | 98 | -48 | 0.010 | 0.640 | 0.170 |
| B | C5114-2 | A533B-1 | PAN102 | Plate | LT | 4.280e+18 | -13 | 22 | 35 | 81 | -46 | 0.010 | 0.520 | 0.150 |
| B | C5114-2 | A533B-1 | PAN102 | Plate | TL | 4.280e+18 | 19 | 15 | 24* | 81 | -57 | 0.010 | 0.520 | 0.150 |
| **Arkansas Nuclear One, Unit 1, Capsule C** | | | | | | | | | | | | | | |
| B | A1195-1 | A533B-1 | SHSS02 | SRM | LT | 1.460e+19 | 48 | 116 | 68 | 141 | -73 | 0.010 | 0.640 | 0.170 |
| B | C5114-1 | A533B-1 | PAN101 | Plate | LT | 1.460e+19 | -31 | 33 | 64 | 117 | -53 | 0.010 | 0.520 | 0.150 |
| B | C5114-1 | A533B-1 | PAN101 | Plate | TL | 1.460e+19 | 17 | 55 | 38 | 117 | -79 | 0.010 | 0.520 | 0.150 |
| B | 406L44 | A533B-1 | WAN101 | Weld | TL | 1.460e+19 | 5 | 190 | 185 | 205 | -20 | 0.016 | 0.590 | 0.280 |
| **Arkansas Nuclear One, Unit 1, Capsule E** | | | | | | | | | | | | | | |
| B | A1195-1 | A533B-1 | SHSS02 | SRM | LT | 7.270e+17 | 56 | | 40* | 46 | -6 | 0.010 | 0.640 | 0.170 |
| B | C5114-1 | A533B-1 | PAN101 | Plate | LT | 7.270e+17 | -21 | -4 | 17 | 38 | -21 | 0.010 | 0.520 | 0.150 |
| B | C5114-1 | A533B-1 | PAN101 | Plate | TL | 7.270e+17 | 7 | 46 | 39 | 38 | 1 | 0.010 | 0.520 | 0.150 |
| B | 406L44 | A533B-1 | WAN101 | Weld | TL | 7.270e+17 | 5 | 110 | 105 | 66 | 39 | 0.016 | 0.590 | 0.280 |
| **Jose Cabrera-Zorita Reactor, Capsule K** | | | | | | | | | | | | | | |
| W | A0421 | A302B | SASTM | SRM | LT | 1.400e+19 | 40 | 160 | 120 | 109 | 11 | 0.011 | 0.180 | 0.200 |
| W | A8312-1 | A533B-1 | PCAB01 | Plate | LT | 1.400e+19 | -50 | 90 | 140 | 104 | 36 | 0.013 | 0.500 | 0.140 |
| W | 1248 | A533B-1 | WCAB01 | Weld | TL | 1.400e+19 | -20 | 90 | 110 | 115 | -5 | 0.015 | 0.110 | 0.220 |
| **Jose Cabrera-Zorita Reactor, Capsule N** | | | | | | | | | | | | | | |
| W | A0421 | A302B | SASTM | SRM | LT | 3.680e+19 | 40 | 195 | 155 | 134 | 21 | 0.011 | 0.180 | 0.200 |
| W | A8312-1 | A533B-1 | PCAB01 | Plate | LT | 3.680e+19 | -50 | 105 | 155 | 128 | 27 | 0.013 | 0.500 | 0.140 |
| W | 1248 | A533B-1 | WCAB01 | Weld | TL | 3.680e+19 | -20 | 200 | 220 | 141 | 79 | 0.015 | 0.110 | 0.220 |

Table 14 (continued)

| Tag | Heat No. | Material ID | HEAT ID | Prod. ID | Orient. | Fluence E > 1 MeV n/cm² | $C_v$ transition temp. at 30 ft-lb | | $C_v$ transition temp. Shift at 30 ft-lb | | | Chemistry | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Unirradiated | Irradiated | Measured | R.G. 1.99 | Residual | P | NI | CU |
| **Jose Cabrera-Zorita Reactor, Capsule P** | | | | | | | | | | | | | | |
| W | A0421 | A302B | SASTM | SRM | LT | 1.430e+19 | 40 | 178 | 138 | 110 | 28 | 0.011 | 0.180 | 0.200 |
| W | A8312-1 | A533B-1 | PCAB01 | Plate | LT | 1.430e+19 | -50 | 70 | 120 | 105 | 15 | 0.013 | 0.500 | 0.140 |
| W | B3170-1 | A533B-1 | PCAB02 | Plate | LT | 1.430e+19 | -24 | 44 | 68 | 81 | -13 | 0.011 | 0.530 | 0.110 |
| **Calvert Cliffs Unit 1, Capsule W263** | | | | | | | | | | | | | | |
| C | A1008-1 | A533B-1 | SHSS01 | SRM | LT | 5.900e+18 | 39 | 127 | 88 | 116 | -28 | 0.008 | 0.660 | 0.180 |
| C | C4441-1 | A533B-1 | PCC103 | Plate | LT | 6.000e+18 | 8 | 68 | 60 | 72 | -12 | 0.011 | 0.640 | 0.120 |
| C | 33A277 | A533B-1 | WCC101 | Weld | TL | 6.100e+18 | -50 | 9 | 59 | 103 | -44 | 0.040 | 0.180 | 0.240 |
| **Calvert Cliffs Unit 2, Capsule W263** | | | | | | | | | | | | | | |
| C | A1008-1 | A533B-1 | SHSS01 | SRM | LT | 8.140e+18 | 25 | 153 | 128 | 128 | 0 | 0.008 | 0.660 | 0.180 |
| C | C5286-1 | A533B-1 | PCC202 | Plate | LT | 8.060e+18 | 9 | 93 | 84 | 95 | -11 | 0.005 | 0.660 | 0.140 |
| C | 10137 | A533B-1 | WCC201 | Weld | TL | 7.970e+18 | -50 | 19 | 69 | 85 | -16 | 0.016 | 0.040 | 0.200 |
| **Donald C. Cook Unit 1, Capsule T** | | | | | | | | | | | | | | |
| W | A1195-1 | A533B-1 | SHSS02 | SRM | LT | 1.800e+18 | 45 | 105 | 60 | 70 | -10 | 0.010 | 0.640 | 0.170 |
| W | C3506-1 | A533B-1 | PCK101 | Plate | LT | 1.800e+18 | 5 | 65 | 60 | 52 | 8 | 0.009 | 0.490 | 0.140 |
| W | C3506-1 | A533B-1 | PCK101 | Plate | TL | 1.800e+18 | 20 | 90 | 70 | 52 | 18 | 0.009 | 0.490 | 0.140 |
| W | 13253 | A533B-1 | WCK101 | Weld | | 1.800e+18 | -90 | -10 | 80 | 112 | -32 | 0.023 | 0.740 | 0.270 |
| **Donald C. Cook Unit 1, Capsule U** | | | | | | | | | | | | | | |
| W | A1195-1 | A533B-1 | SHSS02 | SRM | LT | 1.880e+19 | 45 | 165 | 120 | 150 | -30 | 0.010 | 0.640 | 0.170 |
| W | C3506-1 | A533B-1 | PCK101 | Plate | LT | 1.880e+19 | 5 | 120 | 115 | 111 | 4 | 0.009 | 0.490 | 0.140 |
| W | C3506-1 | A533B-1 | PCK101 | Plate | TL | 1.880e+19 | 15 | 130 | 115 | 111 | 4 | 0.009 | 0.490 | 0.140 |
| W | 13253 | A533B-1 | WCK101 | Weld | | 1.880e+19 | -90 | 115 | 205 | 242 | -37 | 0.023 | 0.740 | 0.270 |
| **Donald C. Cook Unit 1, Capsule X** | | | | | | | | | | | | | | |
| W | A1195-1 | A533B-1 | SHSS02 | SRM | LT | 6.900e+18 | 45 | 145 | 100 | 115 | -15 | 0.010 | 0.640 | 0.170 |
| W | C3506-1 | A533B-1 | PCK101 | Plate | LT | 7.700e+18 | 5 | 105 | 100 | 88 | 12 | 0.009 | 0.490 | 0.140 |
| W | C3506-1 | A533B-1 | PCK101 | Plate | TL | 6.200e+18 | 15 | 125 | 110 | 82 | 28 | 0.009 | 0.490 | 0.140 |
| W | 13253 | A533B-1 | WCK101 | Weld | TL | 6.200e+18 | -90 | 255 | 165 | 179 | -14 | 0.023 | 0.740 | 0.270 |

Table 14 (continued)

| Tag | Heat No. | Material ID | HEAT ID | Prod. ID | Orient. | Fluence E > 1 MeV n/cm² | $C_v$ transition temp. at 30 ft-lb: Unirradiated | $C_v$ transition temp. at 30 ft-lb: Irradiated | $C_v$ transition temp. Shift at 30 ft-lb: Measured | $C_v$ transition temp. Shift at 30 ft-lb: R.G. 1.99 | $C_v$ transition temp. Shift at 30 ft-lb: Residual | Chemistry: P | Chemistry: NI | Chemistry: CU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Donald C. Cook Unit 1, Capsule Y** | | | | | | | | | | | | | | |
| W | A1195-1 | A533B-1 | SHSS02 | SRM | LT | 1.200e+19 | 45 | 155 | 110 | 135 | -25 | 0.010 | 0.640 | 0.170 |
| W | C3506-1 | A533B-1 | PCK101 | Plate | LT | 1.340e+19 | 5 | 110 | 105 | 103 | 2 | 0.009 | 0.490 | 0.140 |
| W | C3506-1 | A533B-1 | PCK101 | Plate | TL | 1.060e+19 | 15 | 130 | 115 | 97 | 18 | 0.009 | 0.490 | 0.140 |
| W | 13253 | A533B-1 | WCK101 | Weld | | 1.060e+19 | -90 | 290 | 200 | 210 | -10 | 0.023 | 0.740 | 0.270 |
| **Crystal River Unit 3, Capsule C** | | | | | | | | | | | | | | |
| B | A1195-1 | A533B-1 | SHSS02 | SRM | LT | 6.560e+18 | 48 | 121 | 73 | 113 | -40 | 0.010 | 0.640 | 0.170 |
| B | C4344-1 | A533B-1 | PCR301 | Plate | TL | 6.560e+18 | 16 | 142 | 126 | 125 | 1 | 0.008 | 0.540 | 0.200 |
| B | C4344-2 | A533B-1 | PCR302 | Plate | TL | 6.560e+18 | 16 | 143 | 127 | 125 | 2 | 0.008 | 0.540 | 0.200 |
| B | | A533B-1 | WCR301 | Weld | TL | 6.560e+18 | 36 | 158 | 122 | 157 | -35 | 0.021 | 0.100 | 0.390 |
| **Diablo Canyon Unit 1, Capsule S** | | | | | | | | | | | | | | |
| W | A1195-1 | A533B-1 | SHSS02 | SRM | LT | 2.980e+18 | 46 | 112 | 66 | 74 | -8 | 0.008 | 0.650 | 0.150 |
| W | C2793-1 | A533B-1 | PDC103 | Plate | LT | 2.980e+18 | 5 | 3 | 4* | 33 | -29 | 0.011 | 0.460 | 0.077 |
| W | 27204 | A533B-1 | WDC101 | Weld | TL | 2.980e+18 | -67 | 43 | 110 | 151 | -41 | 0.016 | 0.980 | 0.210 |
| **Diablo Canyon Unit 1, Capsule Y** | | | | | | | | | | | | | | |
| W | A1195-1 | A533B-1 | SHSS02 | SRM | LT | 1.020e+19 | 46 | 158 | 112 | 112 | 0 | 0.008 | 0.650 | 0.150 |
| W | C2793-1 | A533B-1 | PDC103 | Plate | LT | 1.020e+19 | 5 | 52 | 47 | 51 | -4 | 0.010 | 0.466 | 0.079 |
| W | 27204 | A533B-1 | WDC101 | Weld | TL | 1.020e+19 | -67 | 167 | 234 | 227 | 7 | 0.016 | 0.980 | 0.210 |
| **Fort Calhoun Station Unit 1, Capsule W225** | | | | | | | | | | | | | | |
| C | A1008-1 | A533B-1 | SHSS01 | SRM | LT | 4.800e+18 | 27 | 151 | 124 | 108 | 16 | 0.008 | 0.660 | 0.180 |
| C | A1768-1 | A533B-1 | PFC101 | Plate | LT | 4.500e+18 | 22 | 82 | 60 | 51 | 9 | 0.013 | 0.480 | 0.100 |
| C | 305414 | A533B-1 | WFC101 | Weld | TL | 4.200e+18 | -28 | 210 | 238 | 147 | 91 | 0.012 | 0.600 | 0.300 |
| **Millstone Nuclear Power Station Unit 2, Capsule W104** | | | | | | | | | | | | | | |
| C | A1008-1 | A533B-1 | SHSS01 | SRM | LT | 8.840e+18 | 24 | 165 | 141 | 131 | 10 | 0.008 | 0.660 | 0.180 |
| C | C5667-1 | A533B-1 | PML201 | Plate | LT | 8.840e+18 | 38 | 137 | 99 | 97 | 2 | 0.006 | 0.610 | 0.140 |
| C | 90136 | A533B-1 | WML201 | Weld | TL | 8.840e+18 | -30 | 28 | 58 | 131 | -73 | 0.014 | 0.060 | 0.300 |
| **Maine Yankee Nuclear Plant, Capsule A25** | | | | | | | | | | | | | | |
| C | A1008-1 | A533B-1 | SHSS01 | SRM | LT | 1.300e+19 | 15 | 165 | 150 | 140 | 10 | 0.011 | 0.665 | 0.173 |
| C | B7955-1 | A533B-1 | PMY_01 | Plate | LT | 1.300e+19 | 0 | 120 | 120 | 117 | 3 | 0.013 | 0.590 | 0.150 |
| C | IP3571 | A533B-1 | WMY_01 | Weld | TL | 1.300e+19 | -30 | 240 | 270 | 260 | 10 | 0.015 | 0.780 | 0.360 |

Table 14 (continued)

| Tag | Heat No. | Material ID | HEAT ID | Prod. ID | Orient. | Fluence E > 1 MeV n/cm² | $C_v$ transition temp. at 30 ft-lb Unirradiated | $C_v$ transition temp. at 30 ft-lb Irradiated | $C_v$ transition temp. Shift at 30 ft-lb Measured | $C_v$ transition temp. Shift at 30 ft-lb R.G. 1.99 | $C_v$ transition temp. Shift at 30 ft-lb Residual | Chemistry P | Chemistry NI | Chemistry CU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Maine Yankee Nuclear Plant, W253** | | | | | | | | | | | | | | |
| C | A1008-1 | A533B-1 | SHSS01 | SRM | LT | 1.250e+19 | 15 | 175 | 160 | 139 | 21 | 0.011 | 0.665 | 0.173 |
| C | B7955-1 | A533B-1 | PMY_01 | Plate | LT | 1.250e+19 | 0 | 120 | 120 | 116 | 4 | 0.013 | 0.590 | 0.150 |
| C | IP3571 | A533B-1 | WMY_01 | Weld | TL | 1.250e+19 | -30 | 230 | 260 | 257 | 3 | 0.015 | 0.780 | 0.360 |
| **Salem Unit 1, Capsule T** | | | | | | | | | | | | | | |
| W | A1195-1 | A533B-1 | SHSS02 | SRM | LT | 2.560e+18 | 50 | 110 | 60 | 64 | -4 | 0.012 | 0.680 | 0.140 |
| W | C1354-1 | A533B-1 | PSA101 | Plate | LT | 2.560e+18 | -20 | 80 | 100 | 95 | 5 | 0.010 | 0.530 | 0.220 |
| W | C1354-2 | A533B-1 | PSA102 | Plate | LT | 2.560e+18 | -25 | 75 | 100 | 100 | 0 | 0.010 | 0.540 | 0.230 |
| W | C1397-2 | A533B-1 | PSA103 | Plate | LT | 2.560e+18 | -50 | 25 | 75 | 95 | -20 | 0.011 | 0.520 | 0.220 |
| **Salem Unit 1, Capsule Y** | | | | | | | | | | | | | | |
| W | A1195-1 | A533B-1 | SHSS02 | SRM | LT | 8.910e+18 | 50 | 175 | 125 | 99 | 26 | 0.012 | 0.680 | 0.140 |
| W | C1397-2 | A533B-1 | PSA103 | Plate | LT | 8.910e+18 | -50 | 60 | 110 | 145 | -35 | 0.011 | 0.520 | 0.220 |
| W | 39B196 | A533B-1 | WSA101 | Weld | TL | 8.910e+18 | -135 | 30 | 165 | 208 | -43 | 0.019 | 1.260 | 0.160 |
| **Salem Unit 1, Capsule Z** | | | | | | | | | | | | | | |
| W | A1195-1 | A533B-1 | SHSS02 | SRM | LT | 1.330e+19 | 50 | 185 | 135 | 110 | 25 | 0.012 | 0.680 | 0.140 |
| W | C1354-1 | A533B-1 | PSA101 | Plate | LT | 1.330e+19 | -20 | 150 | 170 | 164 | 6 | 0.010 | 0.530 | 0.220 |
| W | C1354-2 | A533B-1 | PSA102 | Plate | LT | 1.330e+19 | -25 | 140 | 165 | 171 | -6 | 0.010 | 0.540 | 0.230 |
| W | C1397-2 | A533B-1 | PSA103 | Plate | LT | 1.330e+19 | -50 | 75 | 125 | 162 | -37 | 0.011 | 0.520 | 0.220 |
| **St. Lucie Unit 1, Capsule W104** | | | | | | | | | | | | | | |
| C | A1008-1 | A533B-1 | SHSS01 | SRM | LT | 7.160e+18 | 39 | 149 | 110 | 123 | -13 | 0.008 | 0.660 | 0.180 |
| C | C5935-2 | A533B-1 | PSL101 | Plate | LT | 7.160e+18 | 8 | 75 | 67 | 98 | -31 | 0.006 | 0.570 | 0.150 |
| C | 90136 | A533B-1 | WSL101 | Weld | TL | 7.160e+18 | -53 | 20 | 73 | 100 | -27 | 0.013 | 0.110 | 0.230 |
| **Surry Unit 1, Capsule T** | | | | | | | | | | | | | | |
| W | A1195-1 | A533B-1 | SHSS02 | SRM | LT | 2.500e+18 | 45 | 115 | 70 | 80 | -10 | 0.010 | 0.640 | 0.170 |
| W | C4415-1 | A533B-1 | PSU101 | Plate | LT | 2.500e+18 | -10 | 40 | 50 | 46 | 4 | 0.014 | 0.500 | 0.110 |
| W | 299L44 | A533B-1 | WSU101 | Weld | TL | 2.880e+18 | -15 | 150 | 165 | 127 | 38 | 0.011 | 0.700 | 0.250 |
| **Surry Unit 1, Capsule V** | | | | | | | | | | | | | | |
| W | A1195-1 | A533B-1 | SHSS02 | SRM | LT | 1.940e+19 | 45 | 190 | 145 | 151 | -6 | 0.010 | 0.640 | 0.170 |
| W | C4415-1 | A533B-1 | PSU101 | Plate | LT | 1.940e+19 | -10 | 100 | 110 | 86 | 24 | 0.014 | 0.500 | 0.110 |
| W | 299L44 | A533B-1 | WSU101 | Weld | TL | 1.940e+19 | -15 | 225 | 240 | 227 | 13 | 0.011 | 0.700 | 0.250 |

Table 14 (continued)

| Tag | Heat No. | Material ID | HEAT ID | Prod. ID | Orient. | Fluence E > 1 MeV n/cm² | $C_v$ transition temp. at 30 ft-lb Unirradiated | Irradiated | $C_v$ transition temp. Shift at 30 ft-lb Measured | R.G. 1.99 | Residual | Chemistry P | NI | CU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Surry Unit 2, Capsule V** | | | | | | | | | | | | | | |
| W | A1195-1 | A533B-1 | SHSS02 | SRM | LT | 1.880e+19 | 45 | 165 | 120 | 150 | -30 | 0.010 | 0.640 | 0.170 |
| W | C4339-1 | A533B-1 | PSU201 | Plate | LT | 1.880e+19 | -5 | 70 | 75 | 86 | -11 | 0.012 | 0.540 | 0.110 |
| W | C4339-1 | A533B-1 | PSU201 | Plate | TL | 1.880e+19 | 5 | 80 | 75 | 86 | -11 | 0.012 | 0.540 | 0.110 |
| W | 227 | A533B-1 | WSU201 | Weld | TL | 1.880e+19 | -20 | 125 | 145 | 177 | -32 | 0.017 | 0.560 | 0.190 |
| **Surry Unit 2, Capsule X** | | | | | | | | | | | | | | |
| W | A1195-1 | A533B-1 | SHSS02 | SRM | LT | 3.020e+18 | 40 | 100 | 60 | 86 | -26 | 0.010 | 0.640 | 0.170 |
| W | C4339-1 | A533B-1 | PSU201 | Plate | LT | 3.020e+18 | -5 | 50 | 55 | 49 | 6 | 0.012 | 0.540 | 0.110 |
| W | C4339-1 | A533B-1 | PSU201 | Plate | TL | 3.020e+18 | 5 | 50 | 45 | 49 | -4 | 0.012 | 0.540 | 0.110 |
| W | 227 | A533B-1 | WSU201 | Weld | TL | 3.020e+18 | -20 | 75 | 95 | 101 | -6 | 0.017 | 0.560 | 0.190 |
| **Zion Nuclear Plant Reactor Unit 1, Capsule T** | | | | | | | | | | | | | | |
| W | A1195-1 | A533B-1 | SHSS02 | SRM | LT | 1.800e+18 | 42 | 108 | 66 | 70 | -4 | 0.010 | 0.640 | 0.170 |
| W | B7835-1 | A533B-1 | PZN101 | Plate | LT | 1.800e+18 | -5 | 55 | 60 | 40 | 20 | 0.010 | 0.490 | 0.110 |
| W | B7835-1 | A533B-1 | PZN101 | Plate | TL | 1.800e+18 | 25 | 50 | 25 | 40 | -15 | 0.010 | 0.490 | 0.110 |
| W | 72105 | A533B-1 | WZN101 | Weld | TL | 3.060e+18 | 4 | 116 | 112 | 141 | -29 | 0.020 | 0.570 | 0.350 |
| **Zion Nuclear Plant Reactor Unit 1, Capsule U** | | | | | | | | | | | | | | |
| W | A1195-1 | A533B-1 | SHSS02 | SRM | LT | 8.920e+18 | 42 | 172 | 130 | 124 | 6 | 0.010 | 0.640 | 0.170 |
| W | B7835-1 | A533B-1 | PZN101 | Plate | LT | 8.920e+18 | -5 | 80 | 85 | 71 | 14 | 0.010 | 0.490 | 0.110 |
| W | B7835-1 | A533B-1 | PZN101 | Plate | TL | 8.920e+18 | 25 | 85 | 60 | 71 | -11 | 0.010 | 0.490 | 0.110 |
| W | 72105 | A533B-1 | WZN101 | Weld | TL | 8.920e+18 | 4 | 203 | 199 | 202 | -3 | 0.020 | 0.570 | 0.350 |
| **Zion Nuclear Plant Reactor Unit 1, Capsule X** | | | | | | | | | | | | | | |
| W | A1195-1 | A533B-1 | SHSS02 | SRM | LT | 1.400e+19 | 42 | 162 | 120 | 140 | -20 | 0.010 | 0.640 | 0.170 |
| W | B7835-1 | A533B-1 | PZN101 | Plate | LT | 1.200e+19 | -5 | 95 | 90 | 77 | 13 | 0.010 | 0.490 | 0.110 |
| W | B7835-1 | A533B-1 | PZN101 | Plate | TL | 1.500e+19 | 25 | 105 | 80 | 81 | -1 | 0.010 | 0.490 | 0.110 |
| W | 72105 | A533B-1 | WZN101 | Weld | TL | 1.500e+19 | 4 | 199 | 195 | 232 | -37 | 0.020 | 0.570 | 0.350 |
| **Zion Nuclear Plant Reactor Unit 1, Capsule Y** | | | | | | | | | | | | | | |
| W | A1195-1 | A533B-1 | SHSS02 | SRM | LT | 1.560e+19 | 42 | 171 | 129 | 144 | -15 | 0.010 | 0.640 | 0.170 |
| W | B7835-1 | A533B-1 | PZN101 | Plate | LT | 1.560e+19 | -5 | 87 | 92 | 82 | 10 | 0.010 | 0.490 | 0.110 |
| W | B7835-1 | A533B-1 | PZN101 | Plate | TL | 1.560e+19 | 25 | 119 | 94 | 82 | 12 | 0.010 | 0.490 | 0.110 |
| W | 72105 | A533B-1 | WZN101 | Weld | TL | 1.560e+19 | 4 | 209 | 205 | 234 | -29 | 0.020 | 0.570 | 0.350 |

Table 14 (continued)

| Tag | Heat No. | Material ID | HEAT ID | Prod. ID | Orient. | Fluence E > 1 MeV n/cm² | $C_v$ transition temp. at 30 ft-lb: Unirradiated | $C_v$ transition temp. at 30 ft-lb: Irradiated | $C_v$ transition temp. Shift at 30 ft-lb: Measured | $C_v$ transition temp. Shift at 30 ft-lb: R.G. 1.99 | $C_v$ transition temp. Shift at 30 ft-lb: Residual | Chemistry: P | Chemistry: NI | Chemistry: CU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Zion Nuclear Plant Reactor Unit 2, Capsule T** | | | | | | | | | | | | | | |
| W | A1195-1 | A533B-1 | SHSS02 | SRM | LT | 1.000e+19 | 50 | 150 | 100 | 128 | -28 | 0.010 | 0.640 | 0.170 |
| W | C4007-1 | A533B-1 | PZN201 | Plate | LT | 8.700e+18 | 37 | 112 | 75 | 78 | -3 | 0.010 | 0.530 | 0.120 |
| W | C4007-1 | A533B-1 | PZN201 | Plate | TL | 1.100e+19 | 49 | 139 | 90 | 84 | 6 | 0.010 | 0.530 | 0.120 |
| W | 72105 | A533B-1 | WZN201 | Weld | LT | 1.100e+19 | 4 | 179 | 175 | 214 | -39 | 0.020 | 0.570 | 0.350 |
| **Zion Nuclear Plant Reactor Unit 2, Capsule U** | | | | | | | | | | | | | | |
| W | A1195-1 | A533B-1 | SHSS02 | SRM | LT | 2.000e+18 | 50 | 100 | 50 | 73 | -23 | 0.010 | 0.640 | 0.170 |
| W | C4007-1 | A533B-1 | PZN201 | Plate | LT | 2.000e+18 | 37 | 75 | 38 | 46 | -8 | 0.010 | 0.530 | 0.120 |
| W | C4007-1 | A533B-1 | PZN201 | Plate | TL | 2.000e+18 | 49 | 98 | 49 | 46 | 3 | 0.010 | 0.530 | 0.120 |
| W | 72105 | A533B-1 | WZN201 | Weld | LT | 2.820e+18 | -23 | 122 | 145 | 136 | 9 | 0.020 | 0.570 | 0.350 |
| **Zion Nuclear Plant Reactor Unit 2, Capsule Y** | | | | | | | | | | | | | | |
| W | A1195-1 | A533B-1 | SHSS02 | SRM | LT | 1.480e+19 | 50 | 185 | 135 | 142 | -7 | 0.010 | 0.640 | 0.170 |
| W | C4007-1 | A533B-1 | PZN201 | Plate | LT | 1.480e+19 | 37 | 125 | 88 | 90 | -2 | 0.010 | 0.530 | 0.120 |
| W | C4007-1 | A533B-1 | PZN201 | Plate | TL | 1.480e+19 | 49 | 170 | 121 | 90 | 31 | 0.010 | 0.530 | 0.120 |
| W | 72105 | A533B-1 | WZN201 | Weld | LT | 1.480e+19 | -10 | 210 | 220 | 231 | -11 | 0.020 | 0.570 | 0.350 |

* 50 ft-lb transition temperature shift.

Residual is defined as measured shift - R.G. 1.99, Rev. 2, shift.

Tag Field, B - Babcock & Wilcox; C - Combustion Engineering; W- Westinghouse.

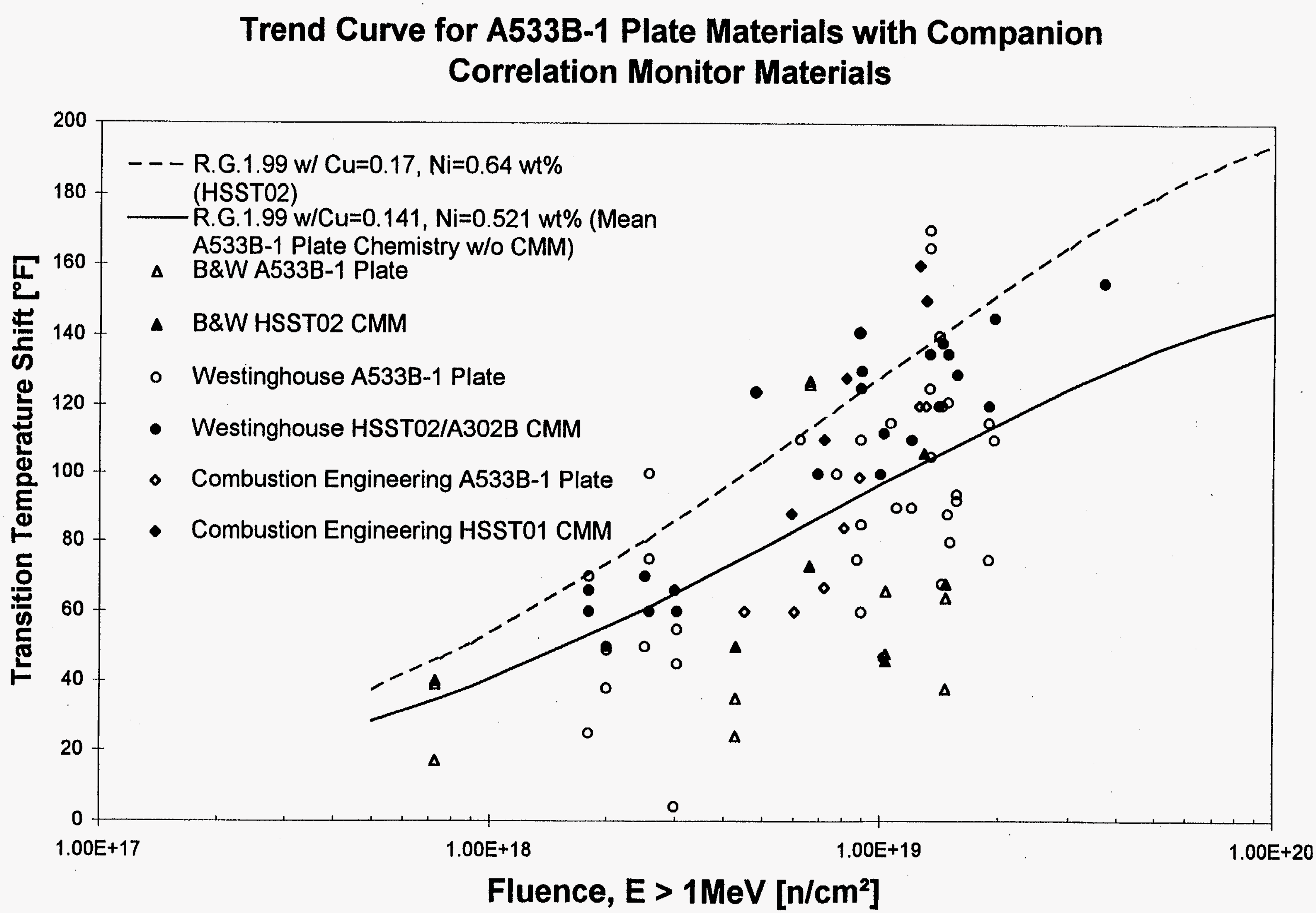


Figure 14 Trend curve for A533B-1 plate materials and the corresponding CMMs. The SRM data are identified with a solid symbol, and the corresponding A533B-1 plate is identified with a hollow symbol

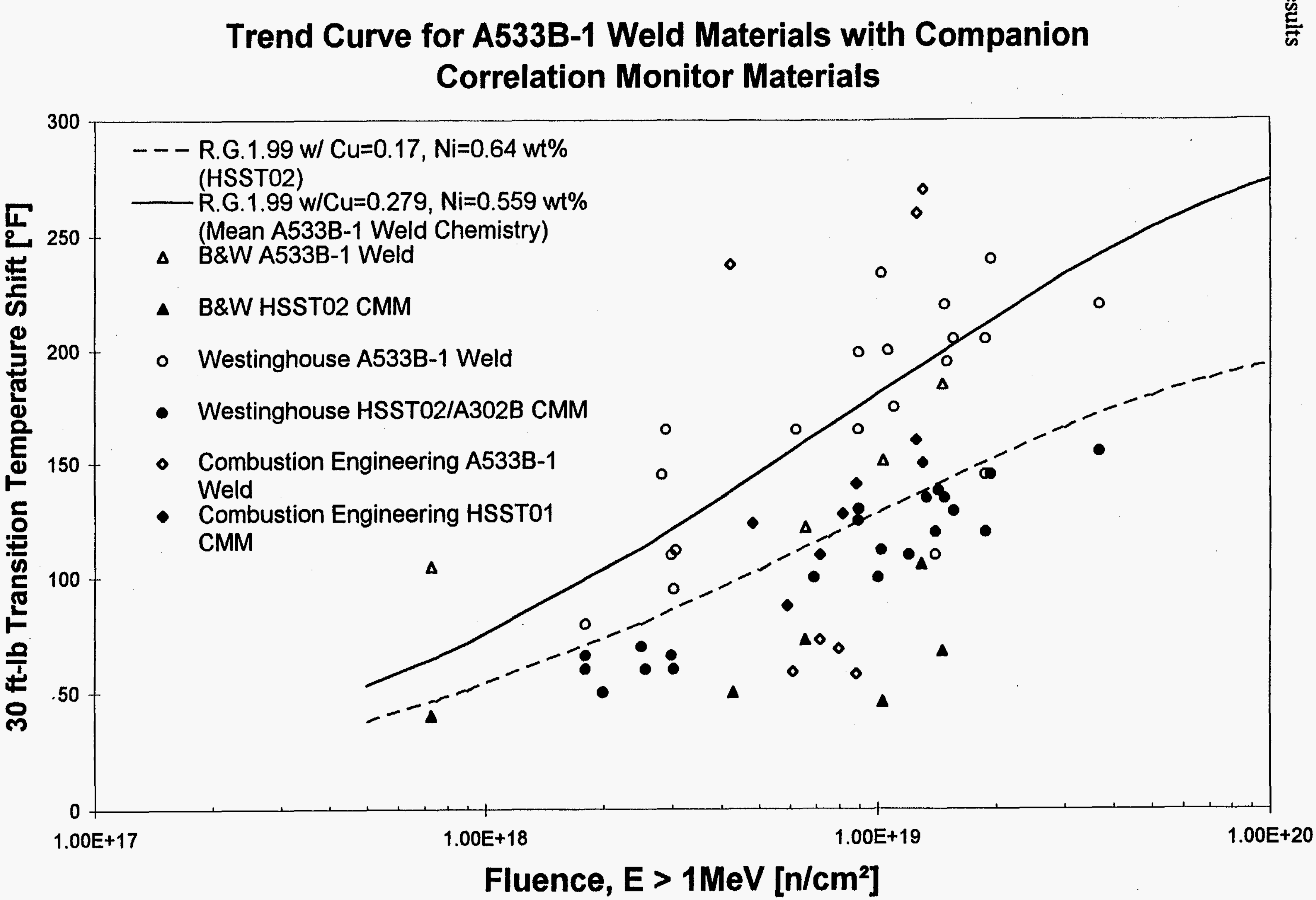


Figure 15 Trend curves for A533B-1 weld materials and the corresponding CMMs. The SRM data are identified with a solid symbol, and the corresponding weld is identified with a hollow symbol

Table 15. Summary of forging reactor pressure vessel steels per PR-EDB reported data

| | | | | | | | $C_v$ transition temp. at 30 ft-lb | | $C_v$ transition temp. at 30 ft-lb | | | Chemistry | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Tag | Number | ID | ID. | ID. | Orient. | Fluence E > 1 MeV n/cm² | Unirradiated | Irradiated | Measured | R.G. 1.99 | Residual | P | NI | CU |
| **Davis-Besse Nuclear Power Station Unit 1, Capsule A** | | | | | | | | | | | | | | |
| B | A1195-1 | A533B-1 | SHSS02 | SRM | LT | 1.29e+19 | 48 | 154 | 106 | 137 | -31 | 0.010 | 0.640 | 0.170 |
| B | 123X244 | A508-2 | FDB101 | Forging | TL | 1.29e+19 | -26 | -24 | 2 | 28 | -26 | 0.004 | 0.770 | 0.040 |
| B | 5P4086 | A508-2 | FDB102 | Forging | TL | 1.29e+19 | 16 | 44 | 28 | 21 | 7 | 0.011 | 0.810 | 0.020 |
| **Garigliano, Capsule 113B** | | | | | | | | | | | | | | |
| G | A0421 | A302B | SASTM S2 | SRM | LT | 1.10e+19 | 27 | 153 | 126 | 103 | 23 | 0.016 | 0.180 | 0.200 |
| G | 1675 | A336 | FGAR01OD | Forging | LT | 9.20e+18 | -69 | 109 | 178 | 50 | 128 | 0.025 | 0.800 | 0.080 |
| G | 2120 | A336 | FGAR02OD | Forging | TL | 1.00e+19 | -8 | 257 | 265 | 232 | 33 | 0.020 | 0.860 | 0.300 |
| **Garigliano, Capsule 113D** | | | | | | | | | | | | | | |
| G | A0421 | A302B | SASTM S2 | SRM | LT | 7.37e+18 | 27 | 133 | 106 | 91 | 15 | 0.016 | 0.180 | 0.200 |
| G | 1675 | A336 | FGAR01ID | Forging | LT | 6.76e+18 | -53 | 70 | 122 | 45 | 77 | 0.025 | 0.800 | 0.080 |
| G | 2120 | A336 | FGAR02ID | Forging | TL | 6.76e+18 | 23 | 223 | 200 | 207 | -7 | 0.020 | 0.860 | 0.300 |
| **Garigliano, Capsule 114A** | | | | | | | | | | | | | | |
| G | A0421 | A302B | SASTM S2 | SRM | LT | 4.65e+19 | 27 | 194 | 167 | 139 | 28 | 0.016 | 0.180 | 0.200 |
| G | 1675 | A336 | FGAR01ID | Forging | LT | 4.48e+19 | -53 | 225 | 277 | 70 | 207 | 0.025 | 0.800 | 0.080 |
| G | 2120 | A336 | FGAR02ID | Forging | TL | 4.65e+19 | 23 | 352 | 329 | 322 | 7 | 0.020 | 0.860 | 0.300 |
| **Garigliano, Capsule 114B** | | | | | | | | | | | | | | |
| G | A0421 | A302B | SASTM S2 | SRM | LT | 2.21e+19 | 27 | 142 | 115 | 122 | -7 | 0.016 | 0.180 | 0.200 |
| G | 1675 | A336 | FGAR01ID | Forging | LT | 2.21e+19 | -53 | 109 | 162 | 62 | 100 | 0.025 | 0.800 | 0.080 |
| G | 2120 | A336 | FGAR02ID | Forging | TL | 2.43e+19 | 23 | 284 | 261 | 288 | -27 | 0.020 | 0.860 | 0.300 |
| **Garigliano, Capsule 114C** | | | | | | | | | | | | | | |
| G | A0421 | A302B | SASTM S2 | SRM | LT | 5.47e+19 | 27 | 178 | 151 | 142 | 9 | 0.016 | 0.180 | 0.200 |
| G | 1675 | A336 | FGAR01ID | Forging | LT | 6.64e+19 | -53 | 217 | 270 | 74 | 196 | 0.025 | 0.800 | 0.080 |
| G | 2120 | A336 | FGAR02ID | Forging | TL | 6.12e+19 | 23 | 363 | 340 | 334 | 6 | 0.020 | 0.860 | 0.300 |

Table 15 (continued)

| Tag | Heat No. | Material ID | Heat ID | Prod. ID | Orient. | Fluence E > 1 MeV n/cm² | $C_v$ transition temp. at 30 ft-lb Unirradiated | $C_v$ transition temp. at 30 ft-lb Irradiated | $C_v$ transition temp. at 30 ft-lb Measured | $C_v$ transition temp. at 30 ft-lb R.G. 1.99 | $C_v$ transition temp. at 30 ft-lb Residual | Chemistry P | Chemistry NI | Chemistry CU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Robert E. Ginna Nuclear Plant Unit 1, Capsule R** | | | | | | | | | | | | | | |
| W | A0421 | A302B | SASTM | SRM | LT | 7.60e+18 | 40 | 136 | 96 | 92 | 4 | 0.011 | 0.180 | 0.200 |
| W | 125P666 | A508-2 | FGIN01 | Forging | LT | 7.60e+18 | -48 | 11 | 59 | 29 | 30 | 0.010 | 0.690 | 0.050 |
| W | 125S255 | A508-2 | FGIN02 | Forging | LT | 7.60e+18 | -29 | -9 | 20 | 41 | -21 | 0.010 | 0.690 | 0.070 |
| **Robert E. Ginna Nuclear Plant Unit 1, Capsule T** | | | | | | | | | | | | | | |
| W | A0421 | A302B | SASTM | SRM | LT | 1.75e+19 | 40 | 180 | 140 | 115 | 25 | 0.011 | 0.180 | 0.200 |
| W | 125P666 | A508-2 | FGIN01 | Forging | LT | 1.75e+19 | -40 | -10 | 30 | 36 | -6 | 0.010 | 0.690 | 0.050 |
| W | 125S255 | A508-2 | FGIN02 | Forging | LT | 1.75e+19 | -25 | -25 | 0 | 51 | -51 | 0.010 | 0.690 | 0.070 |
| **Robert E. Ginna Nuclear Plant Unit 1, Capsule V** | | | | | | | | | | | | | | |
| W | A0421 | A302B | SASTM | SRM | LT | 4.90e+18 | 40 | 130 | 90 | 80 | 10 | 0.011 | 0.180 | 0.200 |
| W | 125P666 | A508-2 | FGIN01 | Forging | LT | 4.90e+18 | -40 | -15 | 25 | 25 | 0 | 0.010 | 0.690 | 0.050 |
| W | 125S255 | A508-2 | FGIN02 | Forging | LT | 4.90e+18 | -25 | -25 | 0 | 35 | -35 | 0.010 | 0.690 | 0.070 |
| **Kewaunee Nuclear Power Plant, Capsule P** | | | | | | | | | | | | | | |
| W | A1195-1 | A533B-1 | SHSS02 | SRM | LT | 2.89e+19 | 45 | 200 | 155 | 164 | -9 | 0.010 | 0.640 | 0.170 |
| W | 122X208VA1 | A508-2 | FKWE01 | Forging | LT | 2.89e+19 | -25 | 0 | 25 | 47 | -22 | 0.010 | 0.710 | 0.060 |
| W | 123X167VA1 | A508-2 | FKWE02 | Forging | LT | 2.89e+19 | -50 | -30 | 20 | 47 | -27 | 0.010 | 0.750 | 0.060 |
| **Kewaunee Nuclear Power Plant, Capsule R** | | | | | | | | | | | | | | |
| W | A1195-1 | A533B-1 | SHSS02 | SRM | LT | 2.07e+19 | 45 | 185 | 140 | 153 | -13 | 0.010 | 0.640 | 0.170 |
| W | 122X208VA1 | A508-2 | FKWE01 | Forging | LT | 2.07e+19 | -25 | -10 | 15 | 44 | -29 | 0.010 | 0.710 | 0.060 |
| W | 123X167VA1 | A508-2 | FKWE02 | Forging | LT | 2.07e+19 | -50 | -30 | 20 | 44 | -24 | 0.010 | 0.750 | 0.060 |
| **Kewaunee Nuclear Power Plant, Capsule V** | | | | | | | | | | | | | | |
| W | A1195-1 | A533B-1 | SHSS02 | SRM | LT | 5.59e+18 | 45 | 140 | 95 | 107 | -12 | 0.010 | 0.640 | 0.170 |
| W | 122X208VA1 | A508-2 | FKWE01 | Forging | LT | 5.59e+18 | -25 | -25 | 0 | 31 | -31 | 0.010 | 0.710 | 0.060 |
| W | 123X167VA1 | A508-2 | FKWE02 | Forging | LT | 5.59e+18 | -50 | -50 | 0 | 31 | -31 | 0.010 | 0.750 | 0.060 |
| **Oconee Nuclear Station Unit 2, Capsule A** | | | | | | | | | | | | | | |
| B | A1195-1 | A533B-1 | SHSS02 | SRM | LT | 3.37e+18 | 48 | 119 | 71 | 90 | -19 | 0.010 | 0.640 | 0.170 |
| B | 3P2359 | A508-2 | FOC201 | Forging | LT | 3.37e+18 | -24 | -30 | 0 | 18 | -18 | 0.006 | 0.750 | 0.040 |
| B | 3P2359 | A508-2 | FOC201 | Forging | TL | 3.37e+18 | -28 | -11 | 17 | 18 | -1 | 0.006 | 0.750 | 0.040 |

Table 15 (continued)

| Tag | Heat No. | Material ID | Heat ID | Prod. ID | Orient. | Fluence E > 1 MeV n/cm² | $C_v$ transition temp. at 30 ft-lb Unirradiated | $C_v$ transition temp. at 30 ft-lb Irradiated | $C_v$ transition temp. at 30 ft-lb Measured | $C_v$ transition temp. at 30 ft-lb R.G. 1.99 | $C_v$ transition temp. at 30 ft-lb Residual | Chemistry P | Chemistry NI | Chemistry CU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Oconee Nuclear Station Unit 2, Capsule C** | | | | | | | | | | | | | | |
| B | A1195-1 | A533B-1 | SHSS02 | SRM | LT | 9.43e+17 | 56 | | 42* | 52 | -10 | 0.010 | 0.640 | 0.170 |
| B | 3P2359 | A508-2 | FOC201 | Forging | LT | 9.43e+17 | -31 | -4 | 27 | 11 | 16 | 0.006 | 0.750 | 0.040 |
| B | 3P2359 | A508-2 | FOC201 | Forging | TL | 9.43e+17 | -31 | -74 | 0 | 11 | -11 | 0.006 | 0.750 | 0.040 |
| **Oconee Nuclear Station Unit 2, Capsule E** | | | | | | | | | | | | | | |
| B | A1195-1 | A533B-1 | SHSS02 | SRM | LT | 1.21e+19 | 48 | 143 | 95 | 135 | -40 | 0.010 | 0.640 | 0.170 |
| B | 3P2359 | A508-2 | FOC201 | Forging | LT | 1.21e+19 | -24 | -12 | 12 | 27 | -15 | 0.006 | 0.750 | 0.040 |
| B | 3P2359 | A508-2 | FOC201 | Forging | TL | 1.21e+19 | -28 | -30 | 0 | 27 | -27 | 0.006 | 0.750 | 0.040 |
| **Oconee Nuclear Station Unit 3, Capsule B** | | | | | | | | | | | | | | |
| B | A1195-1 | A533B-1 | SHSS02 | SRM | LT | 3.12e+18 | 56 | 95 | 39 | 87 | -48 | 0.010 | 0.640 | 0.170 |
| B | 522194 | A508-2 | FOC301 | Forging | TL | 3.12e+18 | -9 | 12 | 32 | 14 | 18 | 0.014 | 0.760 | 0.020 |
| B | 522314 | A508-2 | FOC302 | Forging | TL | 3.12e+18 | -9 | 10 | 19 | 14 | 5 | 0.011 | 0.730 | 0.010 |
| **Oconee Nuclear Station Unit 3, Capsule D** | | | | | | | | | | | | | | |
| B | A1195-1 | A533B-1 | SHSS02 | SRM | LT | 1.45e+19 | 32 | 151 | 119 | 141 | -22 | 0.010 | 0.640 | 0.170 |
| B | 522194 | A508-2 | FOC301 | Forging | TL | 1.45e+19 | -9 | 22 | 31 | 22 | 9 | 0.014 | 0.760 | 0.020 |
| B | 522314 | A508-2 | FOC302 | Forging | TL | 1.45e+19 | -9 | 36 | 45 | 22 | 23 | 0.011 | 0.730 | 0.010 |
| **Point Beach Nuclear Plant Unit 2, Capsule R** | | | | | | | | | | | | | | |
| W | A1195-1 | A533B-1 | SHSS02 | SRM | LT | 2.01e+19 | 49 | 200 | 151 | 152 | -1 | 0.010 | 0.640 | 0.170 |
| W | 122W195VA1 | A508-2 | FPB201 | Forging | LT | 2.01e+19 | -45 | -10 | 35 | 38 | -3 | 0.010 | 0.700 | 0.051 |
| W | 123V500VA1 | A508-2 | FPB202 | Forging | LT | 2.01e+19 | -80 | -10 | 70 | 67 | 3 | 0.009 | 0.710 | 0.088 |
| **Point Beach Nuclear Plant Unit 2, Capsule S** | | | | | | | | | | | | | | |
| W | A1195-1 | A533B-1 | SHSS02 | SRM | LT | 3.47e+19 | 49 | 194 | 145 | 170 | -25 | 0.010 | 0.640 | 0.170 |
| W | 122W195VA1 | A508-2 | FPB201 | Forging | LT | 3.47e+19 | -45 | 2 | 47 | 42 | 5 | 0.010 | 0.700 | 0.051 |
| W | 123V500VA1 | A508-2 | FPB202 | Forging | LT | 3.47e+19 | -80 | -4 | 76 | 75 | 1 | 0.009 | 0.710 | 0.088 |
| **Point Beach Nuclear Plant Unit 2, Capsule T** | | | | | | | | | | | | | | |
| W | A1195-1 | A533B-1 | SHSS02 | SRM | LT | 9.45e+18 | 49 | 154 | 105 | 126 | -21 | 0.010 | 0.640 | 0.170 |
| W | 122W195VA1 | A508-2 | FPB201 | Forging | LT | 9.45e+18 | -45 | -28 | 17 | 31 | -14 | 0.010 | 0.700 | 0.051 |
| W | 123V500VA1 | A508-2 | FPB202 | Forging | LT | 9.45e+18 | -80 | -50 | 30 | 56 | -26 | 0.009 | 0.710 | 0.088 |

## Table 15 (continued)

| Tag | Heat No. | Material ID | Heat ID | Prod. ID | Orient. | Fluence E > 1 MeV n/cm$^2$ | $C_v$ transition temp. at 30 ft-lb | | $C_v$ transition temp. at 30 ft-lb | | | Chemistry | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Unirradiated | Irradiated | Measured | R.G. 1.99 | Residual | P | NI | CU |
| **Point Beach Nuclear Plant Unit 2, Capsule V** | | | | | | | | | | | | | | |
| W | A1195-1 | A533B-1 | SHSS02 | SRM | LT | 4.74e+18 | 45 | 135 | 90 | 101 | -11 | 0.010 | 0.640 | 0.170 |
| W | 122W195VA1 | A508-2 | FPB201 | Forging | LT | 4.74e+18 | -55 | -35 | 20 | 25 | -5 | 0.010 | 0.700 | 0.051 |
| W | 123V500VA1 | A508-2 | FPB202 | Forging | LT | 4.74e+18 | -80 | -50 | 30 | 45 | -15 | 0.009 | 0.710 | 0.088 |
| **Prairie Island Unit 1, Capsule P** | | | | | | | | | | | | | | |
| W | A1195-1 | A533B-1 | SHSS02 | SRM | LT | 1.25e+19 | 49 | 205 | 156 | 136 | 20 | 0.010 | 0.640 | 0.170 |
| W | 21918 | A508-3 | FPI101 | Forging | LT | 1.25e+19 | -25 | -5 | 20 | 39 | -19 | 0.013 | 0.720 | 0.060 |
| W | 21918 | A508-3 | FPI101 | Forging | TL | 1.25e+19 | -27 | 10 | 37 | 39 | -2 | 0.013 | 0.720 | 0.060 |
| **Prairie Island Unit 1, Capsule R** | | | | | | | | | | | | | | |
| W | A1195-1 | A533B-1 | SHSS02 | SRM | LT | 4.03e+19 | 49 | 235 | 186 | 174 | 12 | 0.010 | 0.640 | 0.170 |
| W | 21918 | A508-3 | FPI101 | Forging | LT | 4.03e+19 | -25 | 55 | 80 | 50 | 30 | 0.013 | 0.720 | 0.060 |
| W | 21918 | A508-3 | FPI101 | Forging | TL | 4.03e+19 | -27 | 60 | 87 | 50 | 37 | 0.013 | 0.720 | 0.060 |
| **Prairie Island Unit 1, Capsule V** | | | | | | | | | | | | | | |
| W | A1195-1 | A533B-1 | SHSS02 | SRM | LT | 5.21e+18 | 49 | 159 | 110 | 105 | 5 | 0.010 | 0.640 | 0.170 |
| W | 21918 | A508-3 | FPI101 | Forging | TL | 5.21e+18 | -27 | -3 | 24 | 30 | -6 | 0.013 | 0.720 | 0.060 |
| **Prairie Island Unit 2, Capsule R** | | | | | | | | | | | | | | |
| W | A1195-1 | A533B-1 | SHSS02 | SRM | LT | 4.42e+19 | 45 | 225 | 180 | 176 | 4 | 0.010 | 0.640 | 0.170 |
| W | 22642 | A508-3 | FPI201 | Forging | LT | 4.42e+19 | -25 | 75 | 100 | 75 | 25 | 0.011 | 0.700 | 0.085 |
| W | 22642 | A508-3 | FPI201 | Forging | TL | 4.42e+19 | 0 | 85 | 85 | 75 | 10 | 0.011 | 0.700 | 0.085 |
| **Prairie Island Unit 2, Capsule T** | | | | | | | | | | | | | | |
| W | A1195-1 | A533B-1 | SHSS02 | SRM | LT | 1.05e+19 | 45 | 205 | 160 | 130 | 30 | 0.010 | 0.640 | 0.170 |
| W | 22642 | A508-3 | FPI201 | Forging | LT | 1.05e+19 | -25 | 30 | 55 | 55 | 0 | 0.011 | 0.700 | 0.085 |
| W | 22642 | A508-3 | FPI201 | Forging | TL | 1.05e+19 | 0 | 35 | 35 | 55 | -20 | 0.011 | 0.700 | 0.085 |
| **Prairie Island Unit 2, Capsule V** | | | | | | | | | | | | | | |
| W | A1195-1 | A533B-1 | SHSS02 | SRM | LT | 5.49e+18 | 45 | 170 | 125 | 107 | 18 | 0.010 | 0.640 | 0.170 |
| W | 22642 | A508-3 | FPI201 | Forging | LT | 5.49e+18 | -25 | 10 | 35 | 45 | -10 | 0.011 | 0.700 | 0.085 |
| W | 22642 | A508-3 | FPI201 | Forging | TL | 5.49e+18 | 0 | 30 | 30 | 45 | -15 | 0.011 | 0.700 | 0.085 |

## Table 15 (continued)

| Tag | Heat No. | Material ID | Heat ID | Prod. ID | Orient. | Fluence E > 1 MeV n/cm² | $C_v$ transition temp. at 30 ft-lb Unirradiated | $C_v$ transition temp. at 30 ft-lb Irradiated | $C_v$ transition temp. at 30 ft-lb Measured | R.G. 1.99 | Residual | Chemistry P | NI | CU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Turkey Point Nuclear Power Station Unit 3, Capsule S** | | | | | | | | | | | | | | |
| W | A0421 | A302B | SASTM | SRM | LT | 1.41e+19 | 35 | | 139* | 110 | 29 | 0.011 | 0.180 | 0.200 |
| W | 123P461VA1 | A508-2 | FTP301 | Forging | LT | 1.41e+19 | -47 | -45 | 2 | 39 | -37 | 0.010 | 0.700 | 0.058 |
| W | 123S266VA1 | A508-2 | FTP302 | Forging | LT | 1.41e+19 | -63 | -15 | 48 | 55 | -7 | 0.010 | 0.680 | 0.079 |
| **Turkey Point Nuclear Power Station Unit 3, Capsule T** | | | | | | | | | | | | | | |
| W | A0421 | A302B | SASTM | SRM | LT | 5.68e+18 | 35 | 117 | 82 | 84 | -2 | 0.011 | 0.180 | 0.200 |
| W | 123P461VA1 | A508-2 | FTP301 | Forging | LT | 5.68e+18 | -47 | -47 | 0 | 30 | -30 | 0.010 | 0.700 | 0.058 |
| **Turkey Point Nuclear Power Station Unit 3, Capsule V** | | | | | | | | | | | | | | |
| W | A0421 | A302B | SASTM | SRM | LT | 1.23e+19 | 35 | 160 | 125 | 106 | 19 | 0.011 | 0.180 | 0.200 |
| W | 123S266VA1 | A508-2 | FTP302 | Forging | LT | 1.23e+19 | -50 | 5 | 55 | 53 | 2 | 0.010 | 0.680 | 0.079 |
| **Turkey Point Nuclear Power Station Unit 4, Capsule S** | | | | | | | | | | | | | | |
| W | A1195-1 | A533B-1 | SHSS02 | SRM | LT | 1.25e+19 | 45 | | 115* | 136 | -21 | 0.010 | 0.640 | 0.170 |
| W | 122S180VA1 | A508-2 | FTP401 | Forging | LT | 1.25e+19 | -29 | -53 | -24 | 37 | -26 | 0.011 | 0.700 | 0.056 |
| W | 123P481VA1 | A508-2 | FTP402 | Forging | LT | 1.25e+19 | -12 | 29 | 41 | 35 | 6 | 0.010 | 0.710 | 0.054 |
| **Turkey Point Nuclear Power Station Unit 4, Capsule T** | | | | | | | | | | | | | | |
| W | A1195-1 | A533B-1 | SHSS02 | SRM | LT | 6.05e+18 | 45 | 135 | 90 | 110 | -20 | 0.010 | 0.640 | 0.170 |
| W | 122S180VA1 | A508-2 | FTP401 | Forging | LT | 6.05e+18 | -29 | -24 | 5 | 30 | -25 | 0.011 | 0.700 | 0.056 |

* 50 ft-lb transition temperature shift.

Residual is defined as measured shift - Reg. Guide 199 Rev. 2's shift.

Tag Field, B - Babcock & Wilcox; G - General Electric; W- Westinghouse.

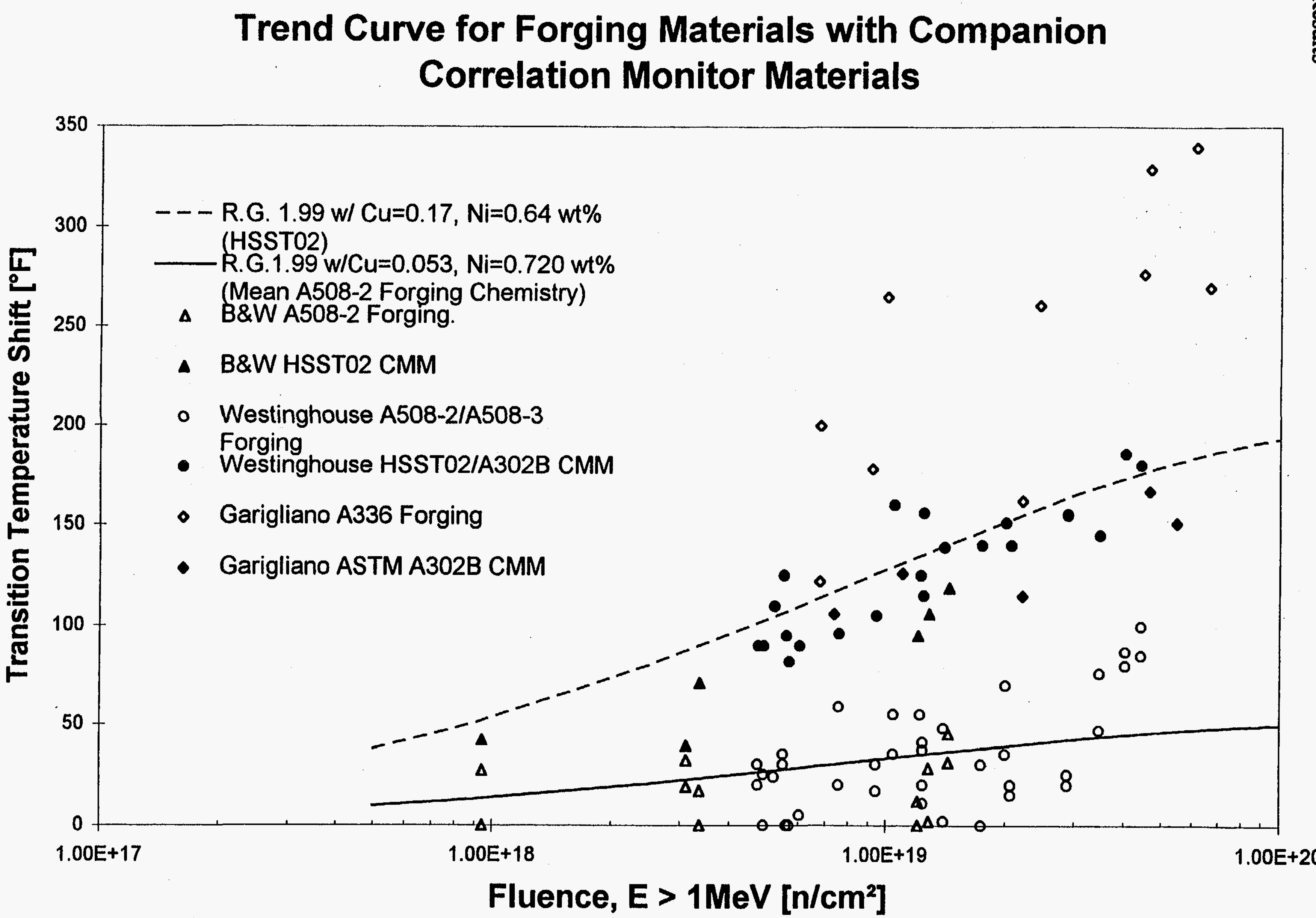


Figure 16 Trend curve for forging materials and the corresponding CMMs. The SRM data are identified with a solid symbol, and the corresponding forging is identified with a hollow symbol

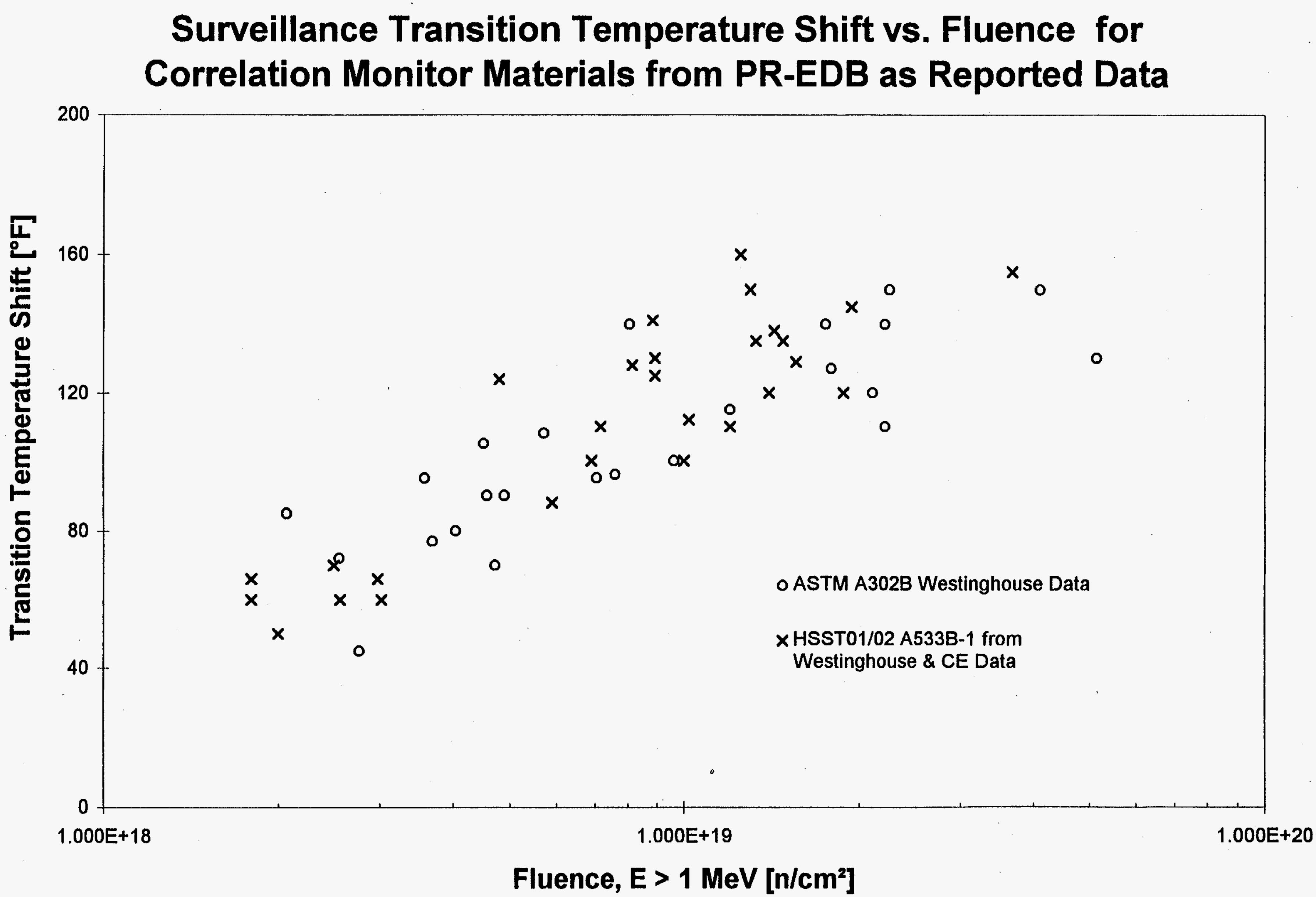


Figure 17 Plot of surveillance NDT shift vs fluence for ASTM A302B and HSST01/02 A533B-1 CMMs per PR-EDB reported data

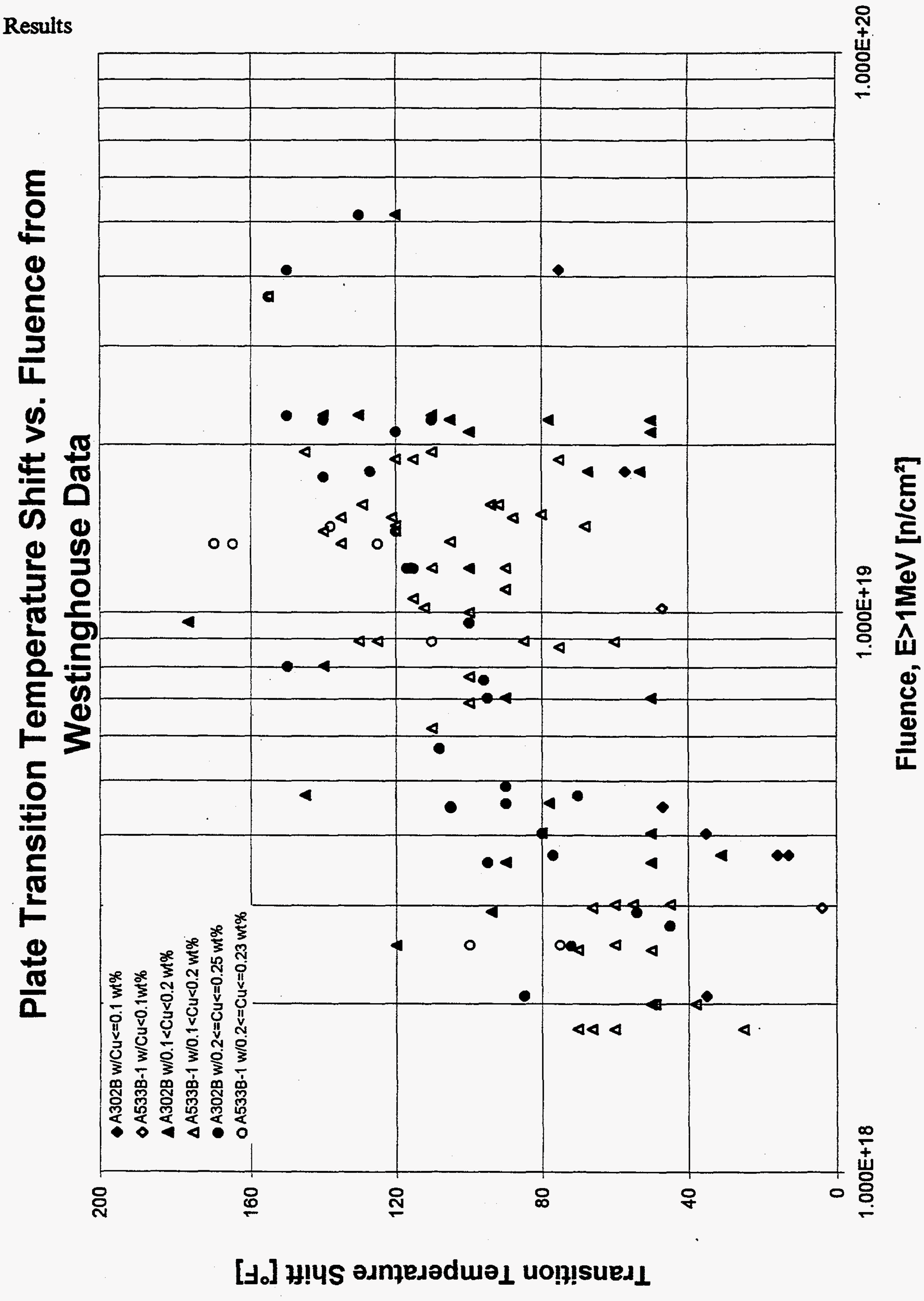


Figure 18 Plot of transition temperature shift vs fast fluence for A302B and A533B-1 plate materials from Westinghouse.

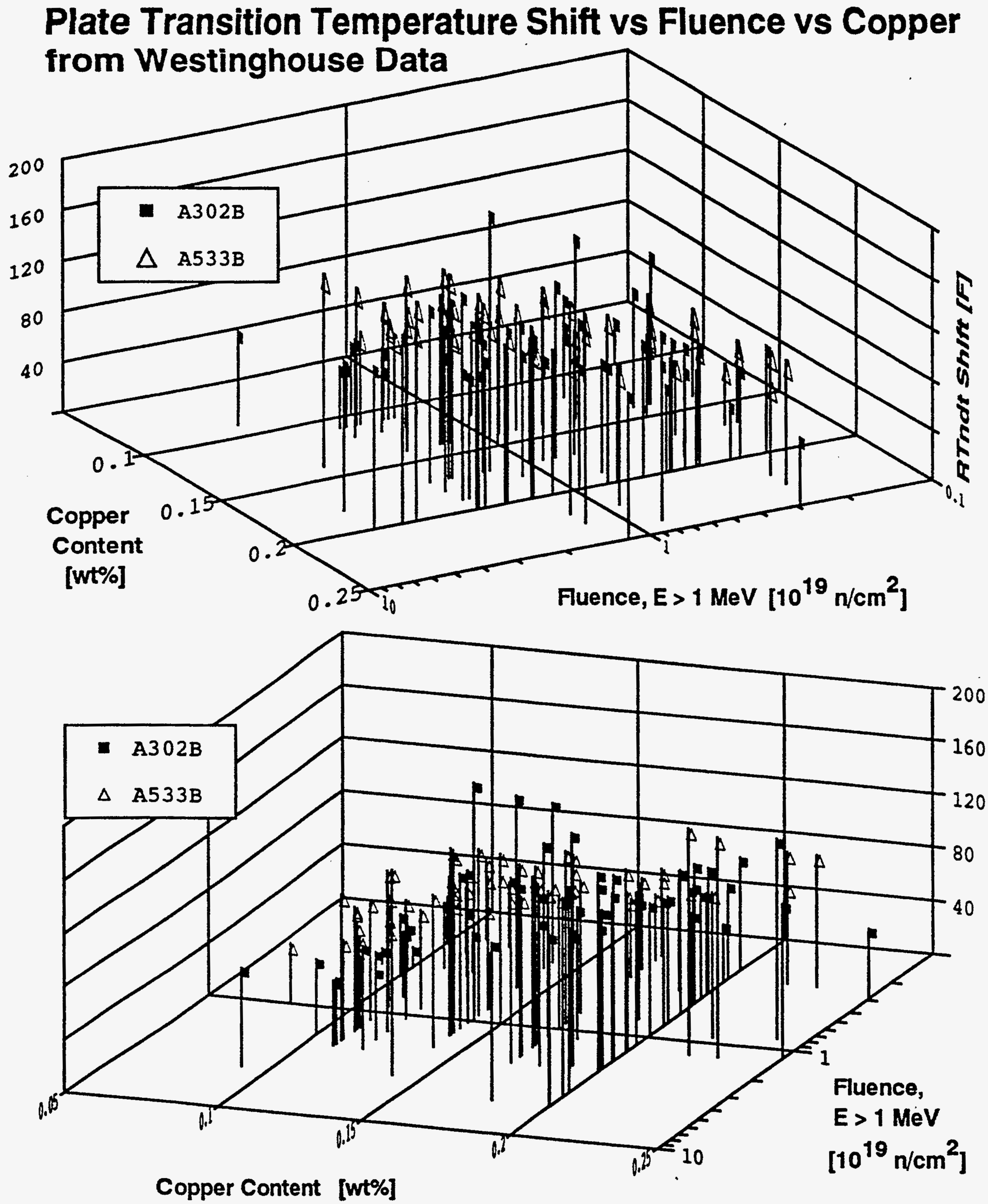


Figure 19 3-D plots of $RT_{NDT}$ shift vs fluence vs copper content for A302B and A533B-1 materials per Westinghouse data

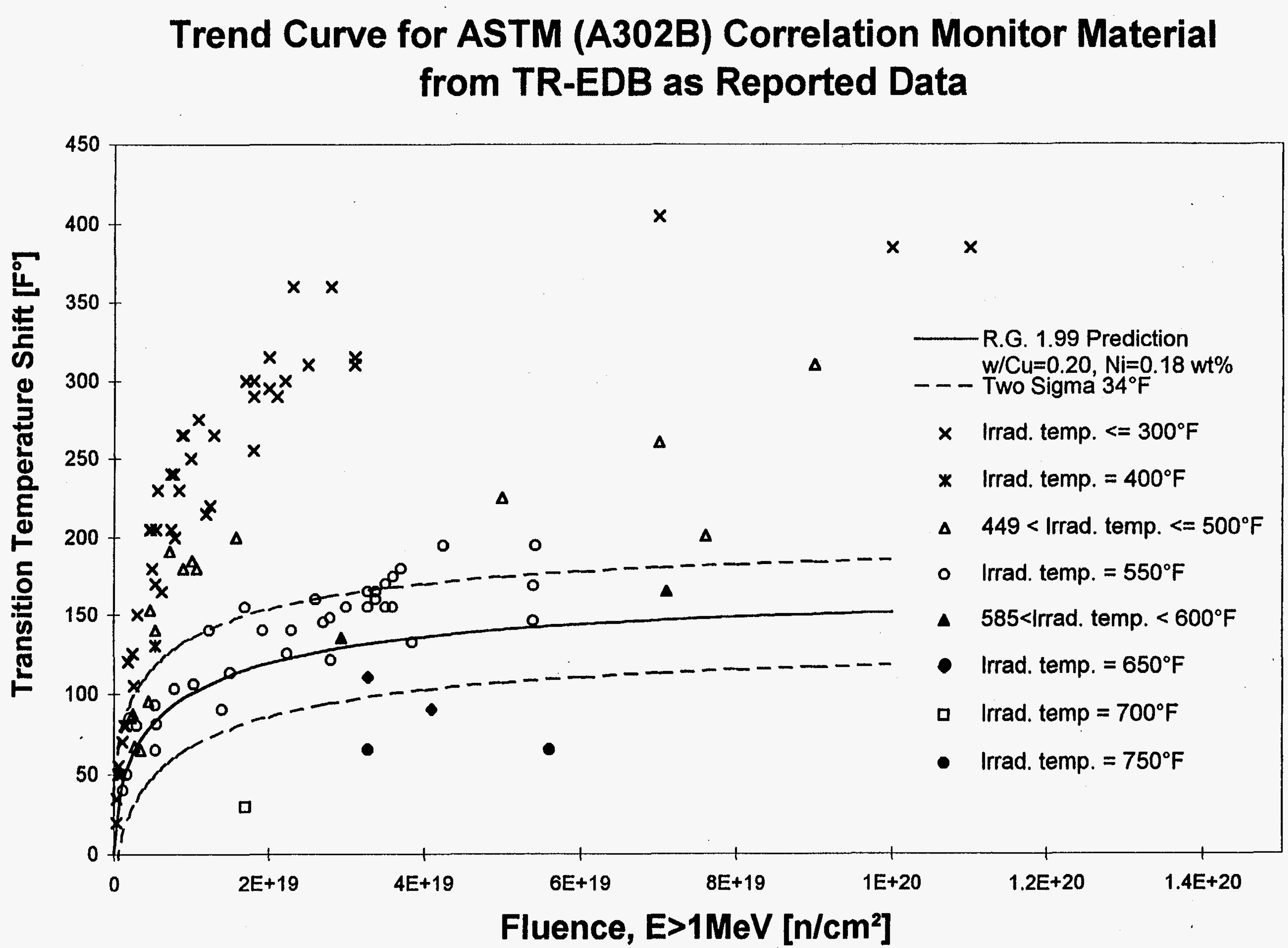


Figure 20 Embrittlement of the A302B ASTM CMM relative to the R.G. 1.99, Rev. 2, prediction

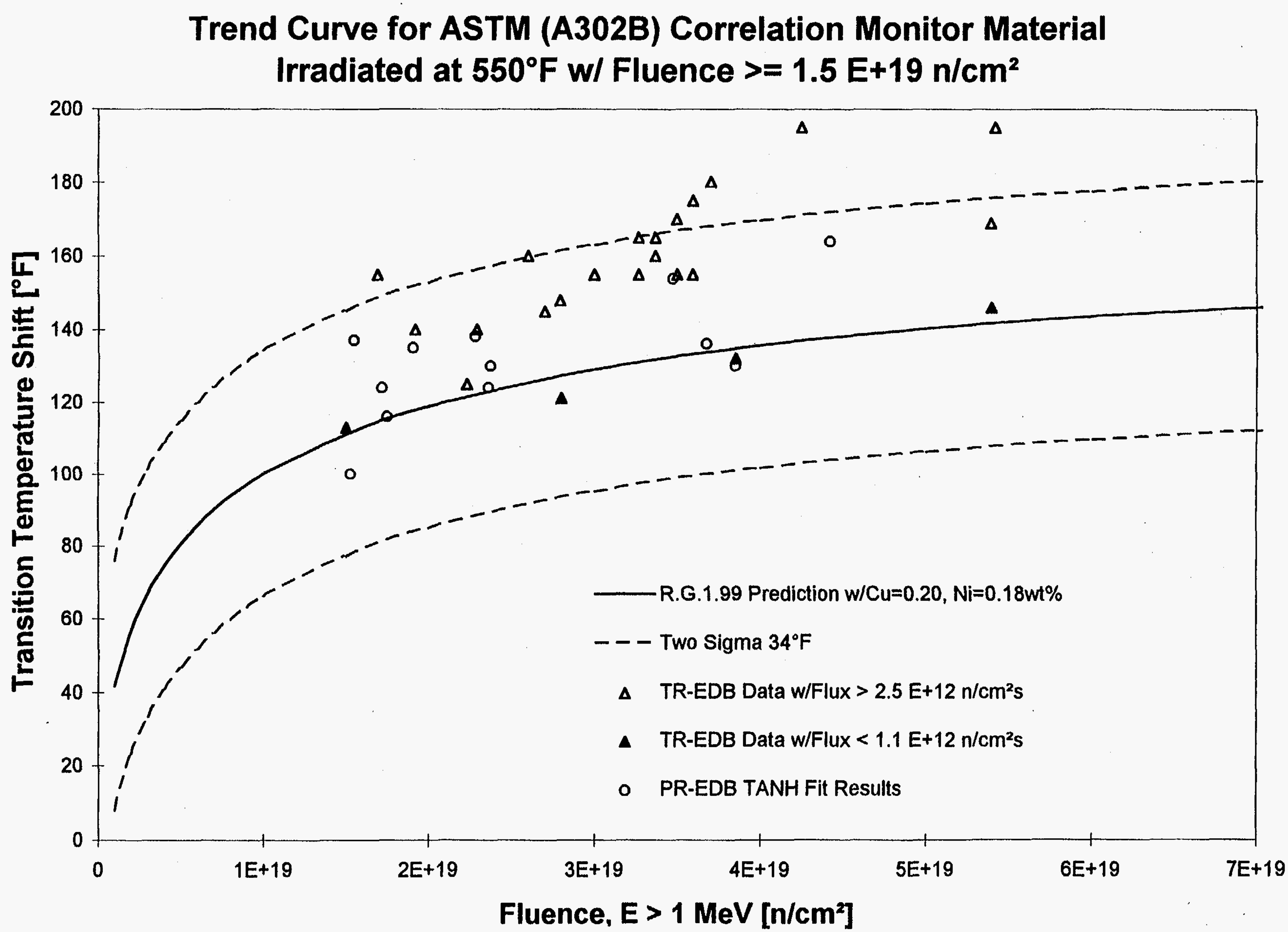


Figure 21 Embrittlement of the A302B ASTM CMM relative to the R.G. 1.99, Rev. 2, prediction for fluence > 1.5E+19 n/cm²

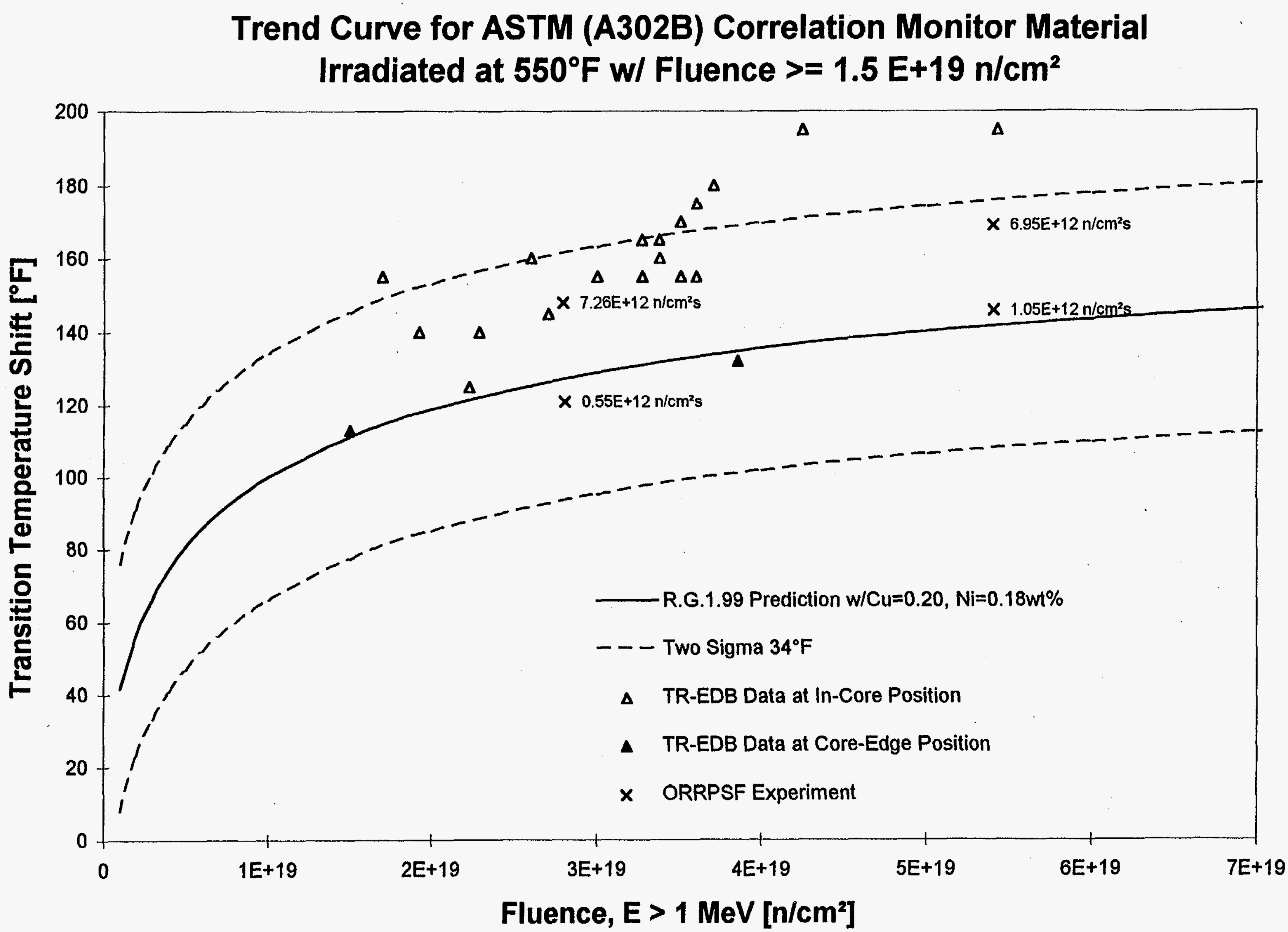


Figure 22 Embrittlement of the HSST01 CMM relative to the R.G. 1.99, Rev. 2, prediction

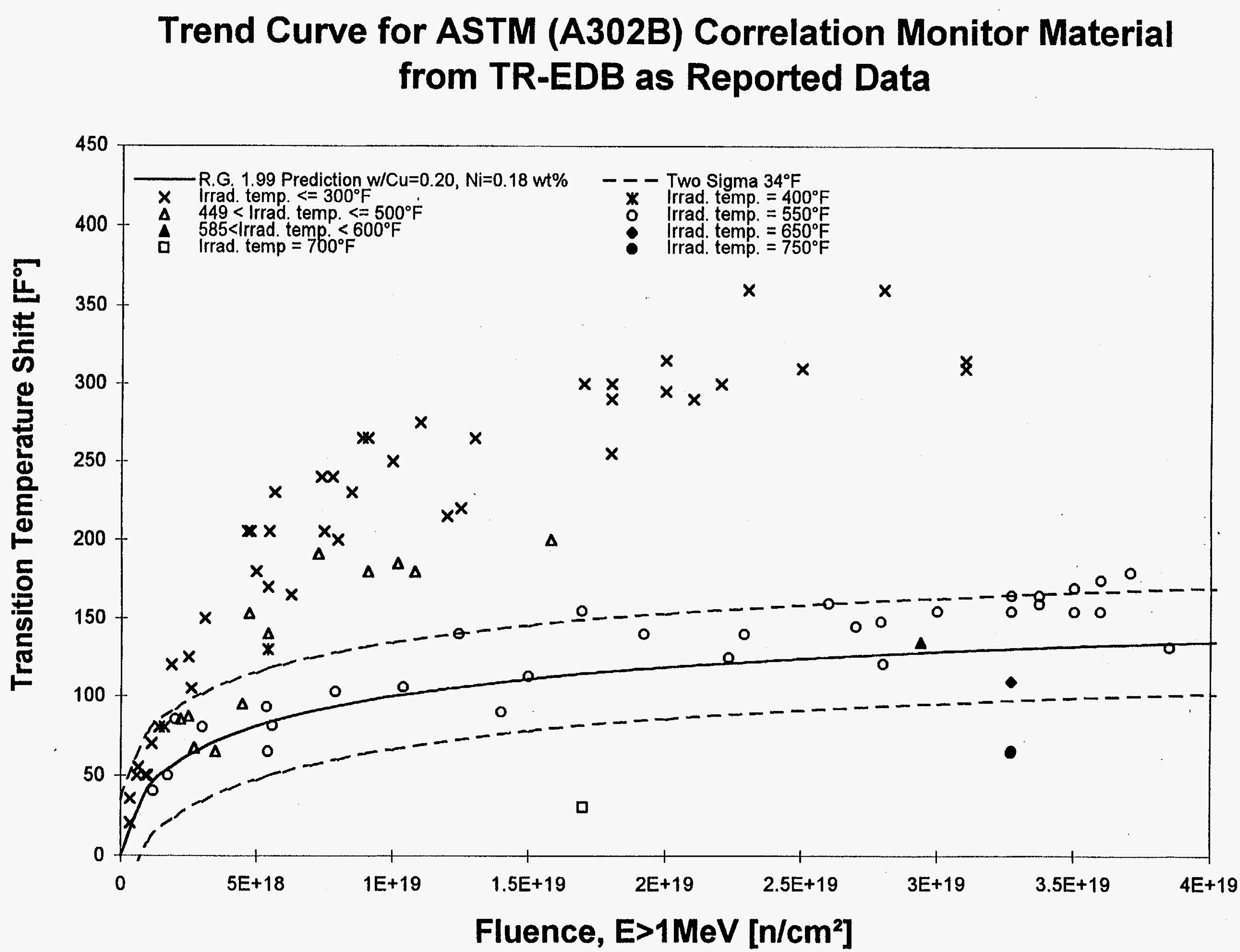


Figure 23. Embrittlement of the HSST01 CMM relative to the R.G. 1.99, Rev. 2, prediction

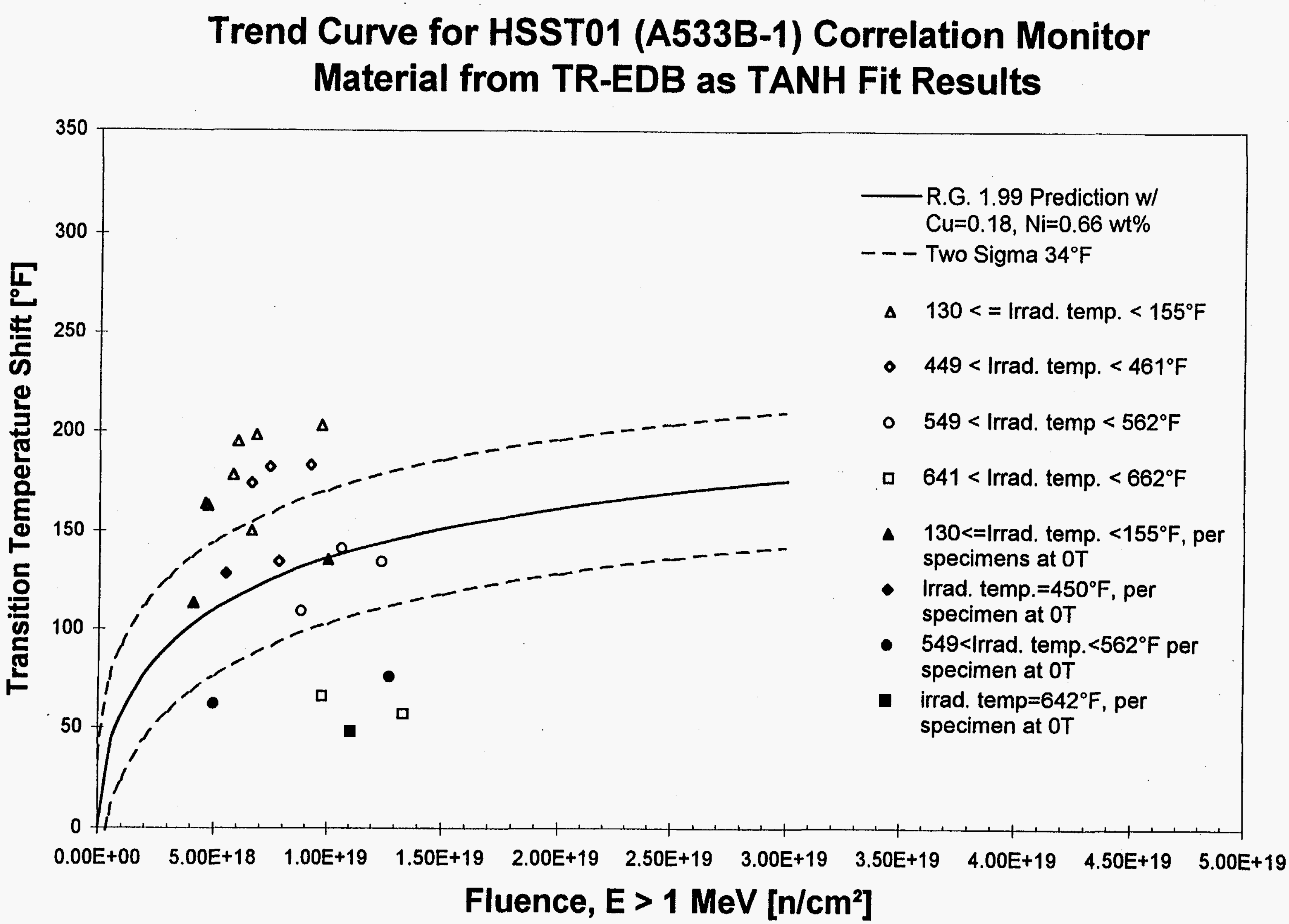


Figure 24 Embrittlement of the HSST02 CMM relative to R.G. 1.99, Rev. 2, prediction

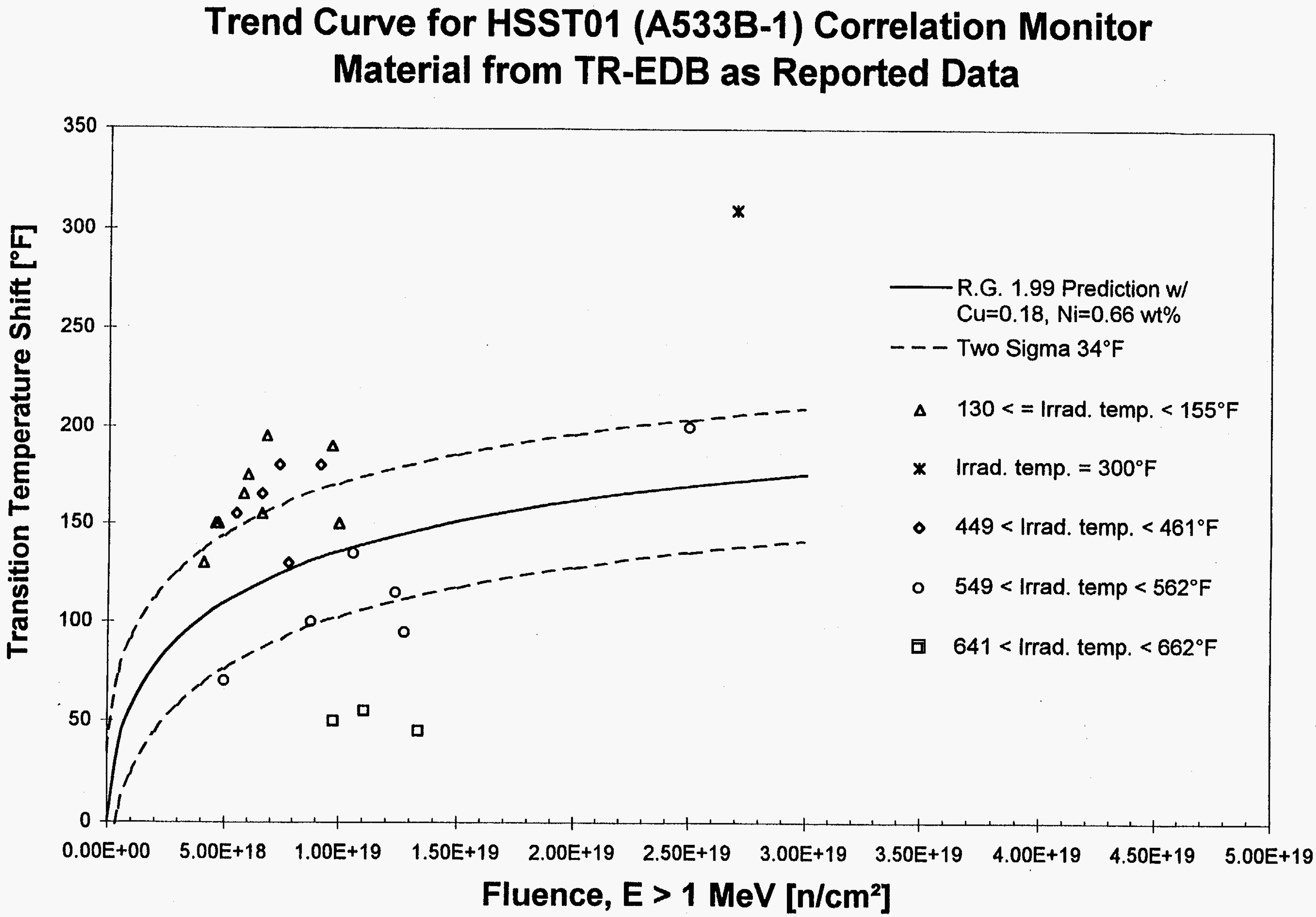


Figure 25 Embrittlement of the HSST03 CMM relative to R.G. 1.99, Rev. 2, prediction

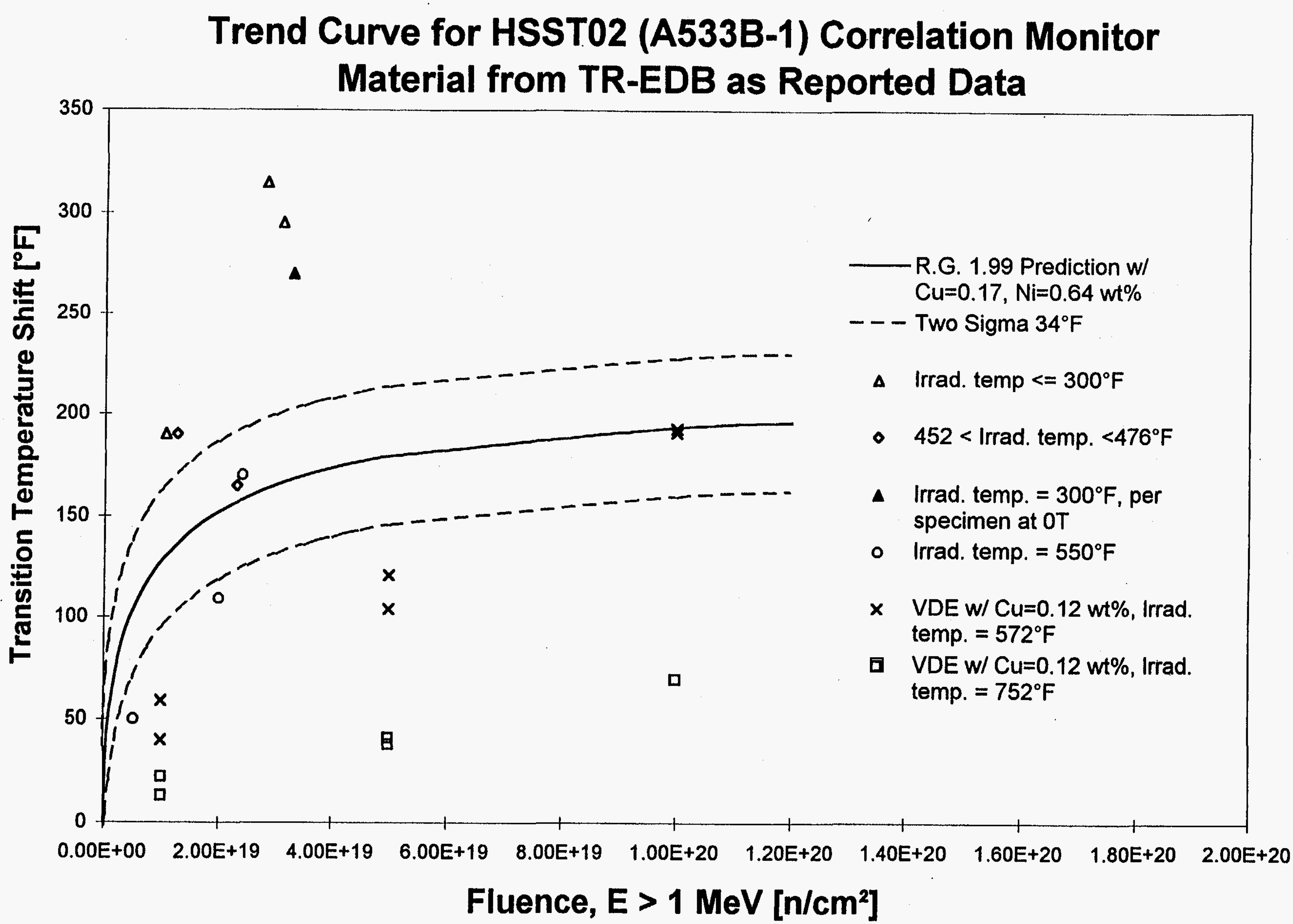


Figure 26 Embrittlement of the HSST02 CMM relative to R.G. 1.99, Rev. 2, prediction

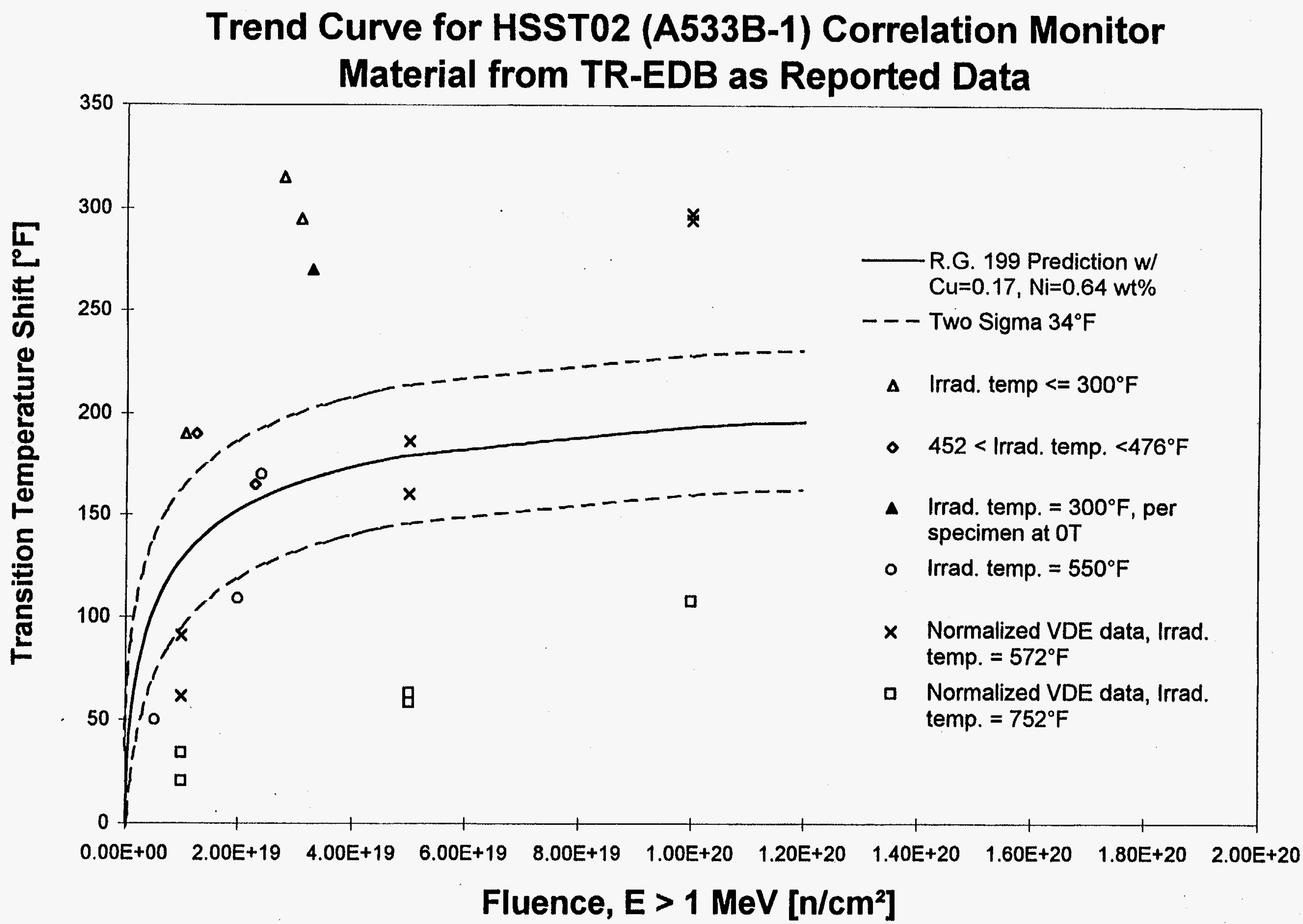


Figure 27 Embrittlement of the HSST02 CMM relative to R.G. 1.99, Rev. 2. VDE data were normalized to 17 wt % copper content

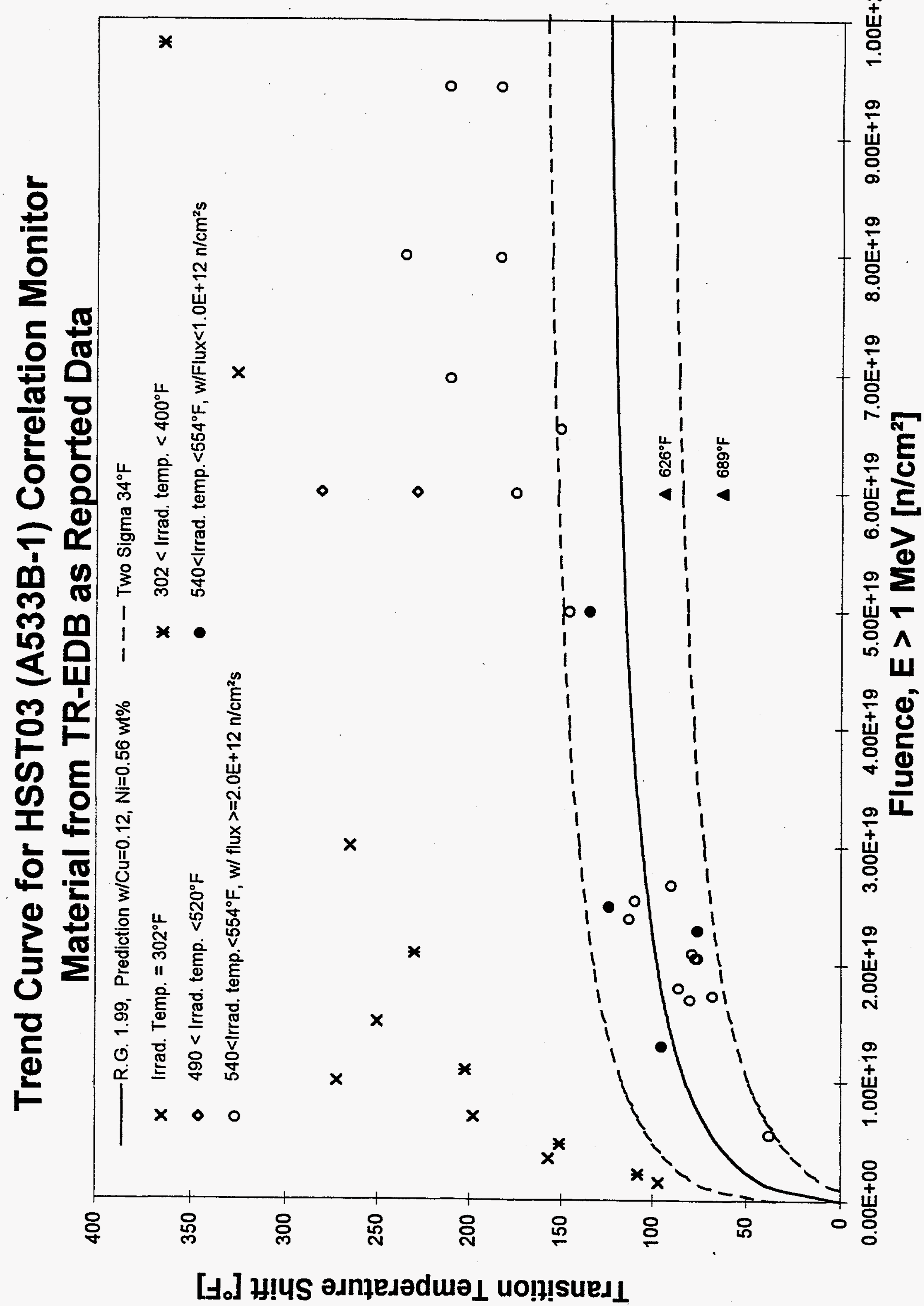


Figure 28 Embrittlement of the HSST03 CMM relative to R.G. 1.99, Rev. 2, prediction

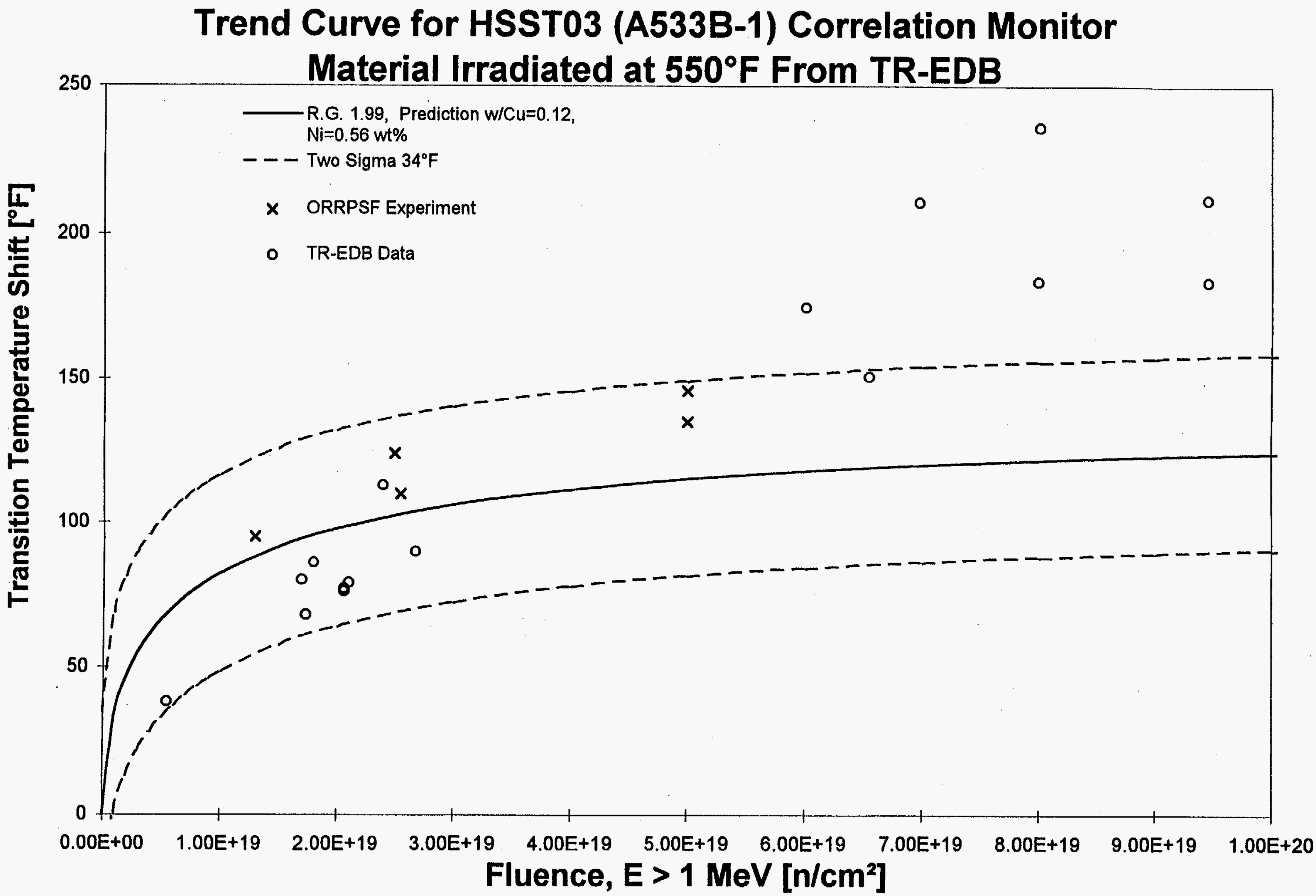


Figure 29 Embrittlement of the HSST03 CMM irradiated at 550°F relative to R.G. 1.99, Rev. 2, prediction

# 4 CONCLUSIONS

The results from the surveillance capsules show that the trend curves for the A302B (ASTM) and A533B (HSST) CMM closely follow the model of the R.G. 1.99, Rev. 2. Significant scatter is noted in the data, some of which may be attributed to variations from one specimen set to another. The major contributions to the uncertainty of the R.G. 1.99 prediction model and the overall data scatter are from mechanical test results, chemical analysis, irradiation environments, fluence evaluation, and inhomogeneous material properties. Thus in order to improve the prediction model, control of the above-mentioned error sources needs to be improved. Thus properly documented information on mechanical testing procedures, material properties and material history, irradiation environments, reactor power-time history, and neutronic analysis are vital for the development of an embrittlement model. For example, information as to the exact location of the test specimens within the parent material should be provided.

In this report, the data fitting procedure was also demonstrated to be another independent source contributing to the uncertainty. For example, the mean absolute difference between EDB hyperbolic tangent fit results and reported $\Delta T_{30}$ for B&W data can be up to 22%. Thus a unified data-fitting procedure is essential to generate consistent results among different laboratories, such as EDB data fitting procedures demonstrated in this report.. When the greater inhomogeneity of specific test sets are known (for example, additional chemical compositions are available for the individual test specimen), further constraints need to be added into the Charpy curve-fitting model, such as copper and nickel contents in addition to the impact energy and test temperature, to account for the material inhomogeneity.

For surveillance data, significant deviations of the measured shift from the trend curve (i.e., more or less than 34 °F for plate materials) should be considered as a warning flag pointing to a possible anomalous capsule environment. The most likely reason for deviations from the trend curve is the capsule temperature; fluence and fluence rate can be determined fairly accurately, and possible effects from these sources are relatively small in a power reactor environment. A quantitative relation between irradiation temperature and $\Delta T_{30}$ has been established in the past,[20] based on the nominal capsule temperature determined by the melt wires loaded in the irradiated capsule. This shows that the weld materials are the most sensitive and the forging materials are the least sensitive to the irradiation temperature. However, a more detailed investigation needs to be done on the issue related to the irradiation temperature of surveillance capsules. These effects must be considered if material- and reactor-specific trend curves are established.

The investigation shows that results from CMMs can indeed be used to detect anomalies in the surveillance capsule irradiation. Nominal values for the $\Delta T_{30}$ in the CMM for a given fluence can be determined from R.G. 1.99, Rev. 2. Any significant deviation from the trend curve should be investigated as to the possible causes. The exact location of the test samples within the plate should be ascertained, if possible, and variations in the baseline values between samples should be considered. If the material inhomogeneity is a suspect for a particular test set, the detailed chemical compositions from the broken specimens are needed to generate a more accurate embrittlement index from a more realistic curve-fitting model, which incorporates the chemistry constraints into the regression analysis. Influence of irradiation temperature may be inferred from the results of the CMM and should be considered whenever material- and reactor-specific trend curves are to be established.

There is some evidence for a fluence-rate effect in the CMM data irradiated in test reactors. The existence of a fluence-rate effect has important implications for the U.S. commercial power industries, since accelerated locations have almost invariably been used in RPV surveillance programs. For example, the GE surveillance data have a large range of fluxes, ranging from $2.0 \times 10^8$ to $4.6 \times 10^{12}$ n/cm²·s, whereas for B&W data it ranges from $2.4 \times 10^{10}$ to $9.66 \times 10^{11}$ n/cm²·s, for CE data, $2.3 \times 10^{10}$ to $6.31 \times 10^{11}$ n/cm²·s, and for Westinghouse data (not including Yankee Rowe data)

$7.5 \times 10^9$ to $2.47 \times 10^{11}$ n/cm$^2$·s. Thus, the implication of a fluence-rate effect in a nuclear commercial power reactor environment deserves special attention, especially for GE BWR surveillance data. The current embrittlement models are based on surveillance data without accounting for fluence-rate effects. If the fuence-rate effect is significant over the range of interest, use of surveillance data with a high lead factor may result in a conservative or nonconservative prediction of vessel embrittlement, depending on the particular fluence range. Thus, depending on the lead factor involved, it may be prudent to apply some correction to the surveillance data in application to the prediction of vessel embrittlement. Based on the available data, however, definition of a "high" lead factor and the development of such correction factors are not yet practicable. Additional data from the CMMs irradiated over a range of fluence rates are needed to establish the fluence-rate effects with confidence.

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# APPENDIX A

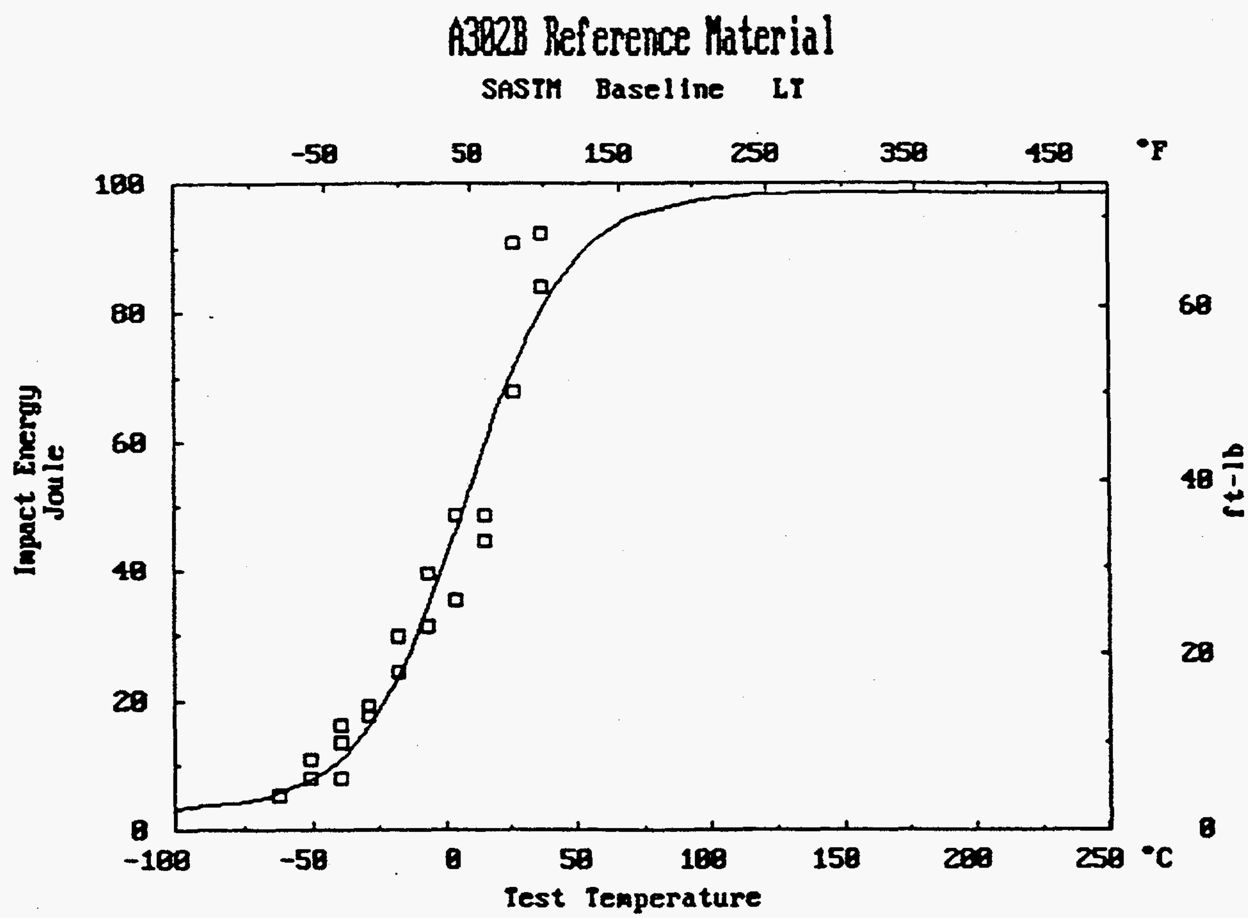
# HYPERBOLIC TANGENT FITS AND UNCERTAINTY STUDY FOR A302B AND A533B SURVEILLANCE REFERENCE MATERIALS

In this appendix, CMM is referred to as reference material.

A302B REFERENCE MATERIAL, Baseline (Longitudinal Direction)

USE= 98.8 J, LSE= 3.1 J, CVT(1/2)= 8.C , Slope = 0.0250
Unirradiated Charpy Specimen, CVT(41J) = 0. C , CVT(68J) = 23. C

| Spec. ID | Test Temp. C | Test Temp. F | Impact Energy J | Impact Energy ft-lb | Lat. Exp. mm | Lat. Exp. mil | % Shear |
|---|---|---|---|---|---|---|---|
| | -62. | -80. | 5. | 4. | 0.15 | 6. | 2. |
| | -62. | -80. | 5. | 4. | 0.15 | 6. | 2. |
| | -51. | -60. | 11. | 8. | 0.15 | 6. | 3. |
| | -51. | -60. | 8. | 6. | 0.15 | 6. | 3. |
| | -40. | -40. | 16. | 12. | 0.36 | 14. | 10. |
| | -40. | -40. | 14. | 10. | 0.25 | 10. | 5. |
| | -40. | -40. | 8. | 6. | 0.18 | 7. | 5. |
| | -29. | -20. | 19. | 14. | 0.36 | 14. | 15. |
| | -29. | -20. | 18. | 13. | 0.36 | 14. | 15. |
| | -18. | 0. | 30. | 22. | 0.56 | 22. | 30. |
| | -18. | 0. | 24. | 18. | 0.46 | 18. | 25. |
| | -7. | 20. | 39. | 29. | 0.71 | 28. | 35. |
| | -7. | 20. | 31. | 23. | 0.58 | 23. | 35. |
| | 4. | 40. | 49. | 36. | 0.84 | 33. | 45. |
| | 4. | 40. | 35. | 26. | 0.66 | 26. | 45. |
| | 16. | 60. | 49. | 36. | 1.02 | 40. | 50. |
| | 16. | 60. | 45. | 33. | 0.89 | 35. | 45. |
| | 27. | 80. | 91. | 67. | 1.52 | 60. | 100. |
| | 27. | 80. | 68. | 50. | 1.22 | 48. | 70. |
| | 38. | 100. | 92. | 68. | 1.52 | 60. | 98. |
| | 38. | 100. | 84. | 62. | 1.47 | 58. | 85. |



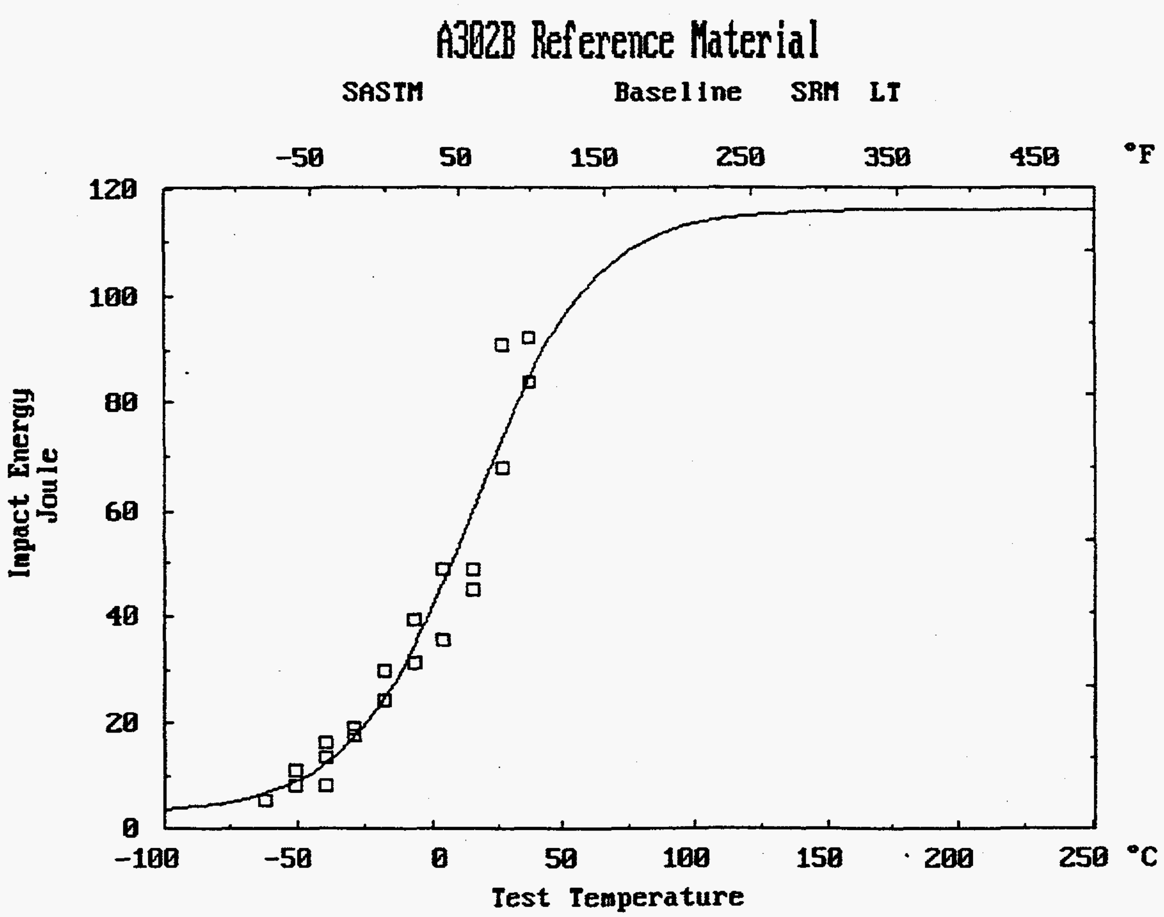
A302B REFERENCE MATERIAL

Baseline (Longitudinal Direction)

```
Impact Energy Uncertainty =  10.0 J
Test Temperature Uncertainty =   4.0 Degree C
Number of Successful Iterations =  200, Maximum = 1000
```

SASTM Baseline SRM LT

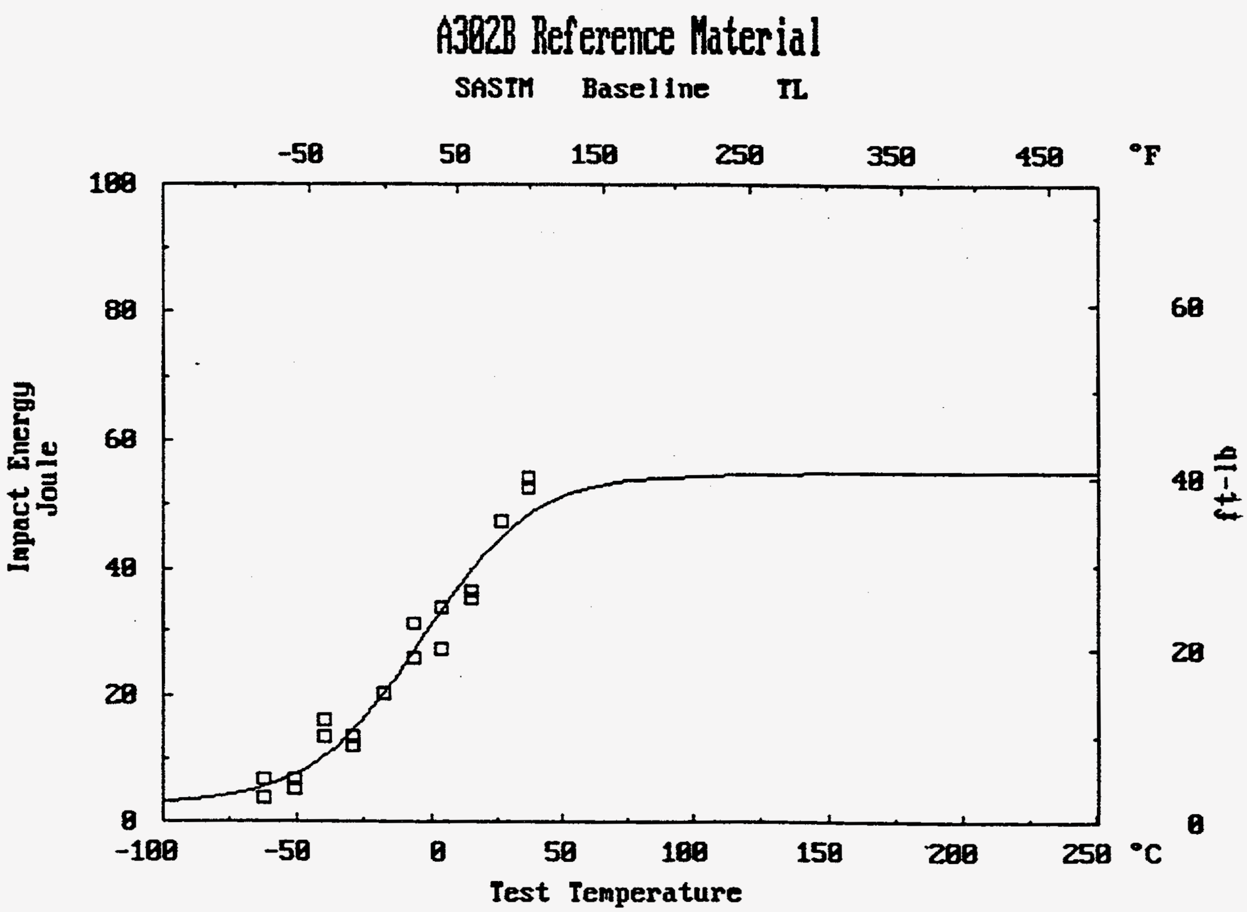
| Parameter | Mean | Std.Dev. | Correlation Coefficients | | | | |
|---|---|---|---|---|---|---|---|
| Lower Shelf Energy (J) | 3.1 | 0.1 | | | | | |
| Upper Shelf Energy (J) | 116.1 | 21.5 | 0.105 | | | | |
| CVT at Midpoint (C) | 15.5 | 9.6 | 0.118 | 0.951 | | | |
| 1/slope (C) | 45.5 | 7.0 | -0.239 | 0.615 | 0.650 | | |
| CVT at 41 Joule (C) | 0.3 | 3.3 | 0.289 | 0.381 | 0.582 | -0.026 | |
| CVT at 68 Joule (C) | 23.6 | 3.6 | -0.097 | -0.094 | 0.164 | 0.317 | 0.508 |



A302B REFERENCE MATERIAL, Baseline (Transverse Direction)

USE= 55.1 J, LSE= 3.0 J, CVT(1/2)= -3.C , Slope = 0.0244
Unirradiated Charpy Specimen, CVT(41J) = 18. C , CVT(68J) =****** C

| Spec. ID | Test Temp. C | Test Temp. F | Impact Energy J | Impact Energy ft-lb | Lat. Exp. mm | Lat. Exp. mil | % Shear |
|---|---|---|---|---|---|---|---|
| | -62. | -80. | 4. | 3. | 0.15 | 6. | 2. |
| | -62. | -80. | 7. | 5. | 0.18 | 7. | 2. |
| | -51. | -60. | 5. | 4. | 0.15 | 6. | 3. |
| | -51. | -60. | 7. | 5. | 0.18 | 7. | 3. |
| | -40. | -40. | 14. | 10. | 0.25 | 10. | 5. |
| | -40. | -40. | 16. | 12. | 0.30 | 12. | 10. |
| | -29. | -20. | 12. | 9. | 0.30 | 12. | 20. |
| | -29. | -20. | 14. | 10. | 0.30 | 12. | 20. |
| | -18. | 0. | 20. | 15. | 0.41 | 16. | 25. |
| | -18. | 0. | 20. | 15. | 0.43 | 17. | 25. |
| | -7. | 20. | 26. | 19. | 0.51 | 20. | 40. |
| | -7. | 20. | 31. | 23. | 0.66 | 26. | 40. |
| | 4. | 40. | 27. | 20. | 0.76 | 30. | 45. |
| | 4. | 40. | 34. | 25. | 0.79 | 31. | 45. |
| | 16. | 60. | 35. | 26. | 0.74 | 29. | 60. |
| | 16. | 60. | 37. | 27. | 0.74 | 29. | 70. |
| | 27. | 80. | 47. | 35. | 0.94 | 37. | 70. |
| | 27. | 80. | 47. | 35. | 1.02 | 40. | 85. |
| | 38. | 100. | 53. | 39. | 1.07 | 42. | 98. |
| | 38. | 100. | 54. | 40. | 1.17 | 46. | 100. |



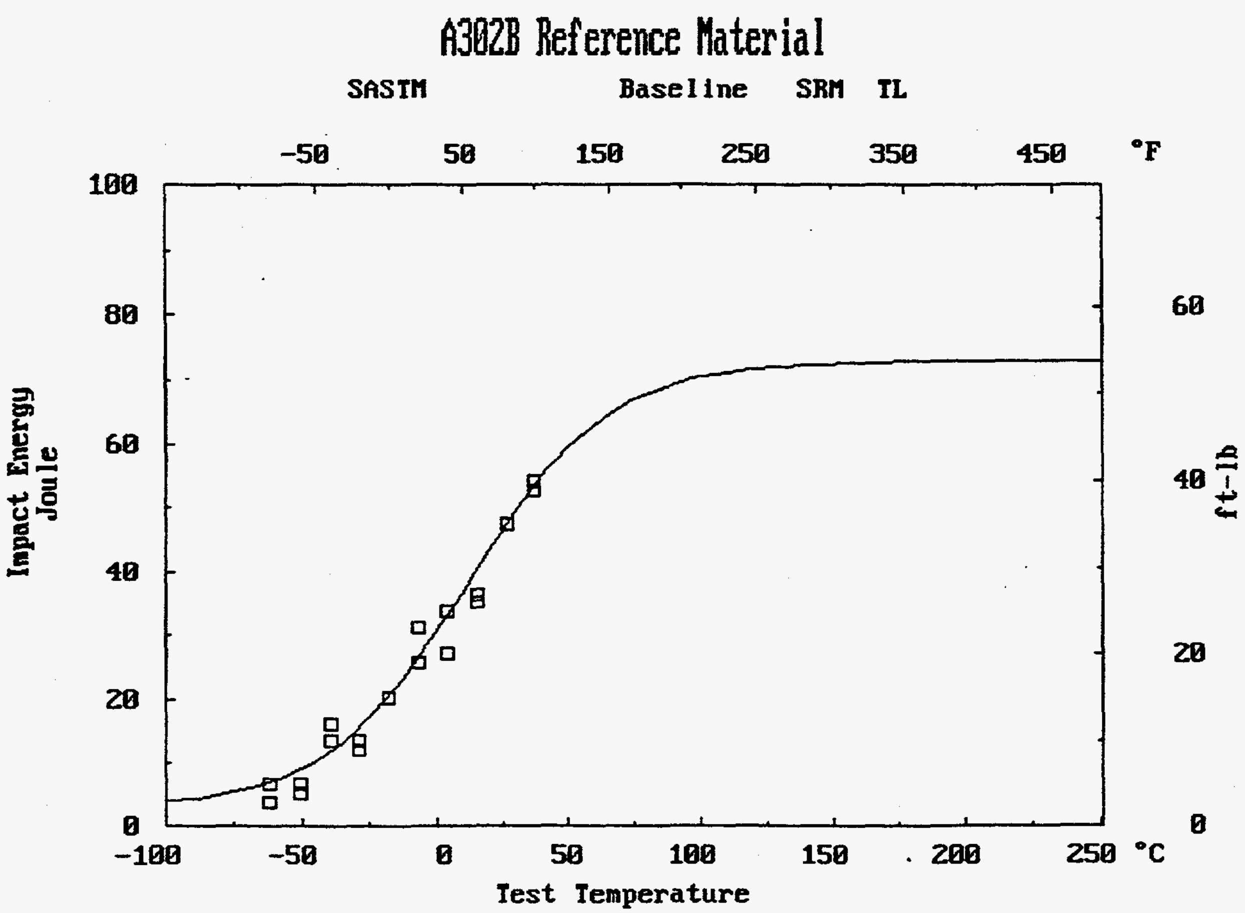
A302B REFERENCE MATERIAL

Baseline (Transverse Direction)

Impact Energy Uncertainty = 10.0 J
Test Temperature Uncertainty = 4.0 Degree C
Number of Successful Iterations = 200, Maximum = 1000

SASTM Baseline SRM TL

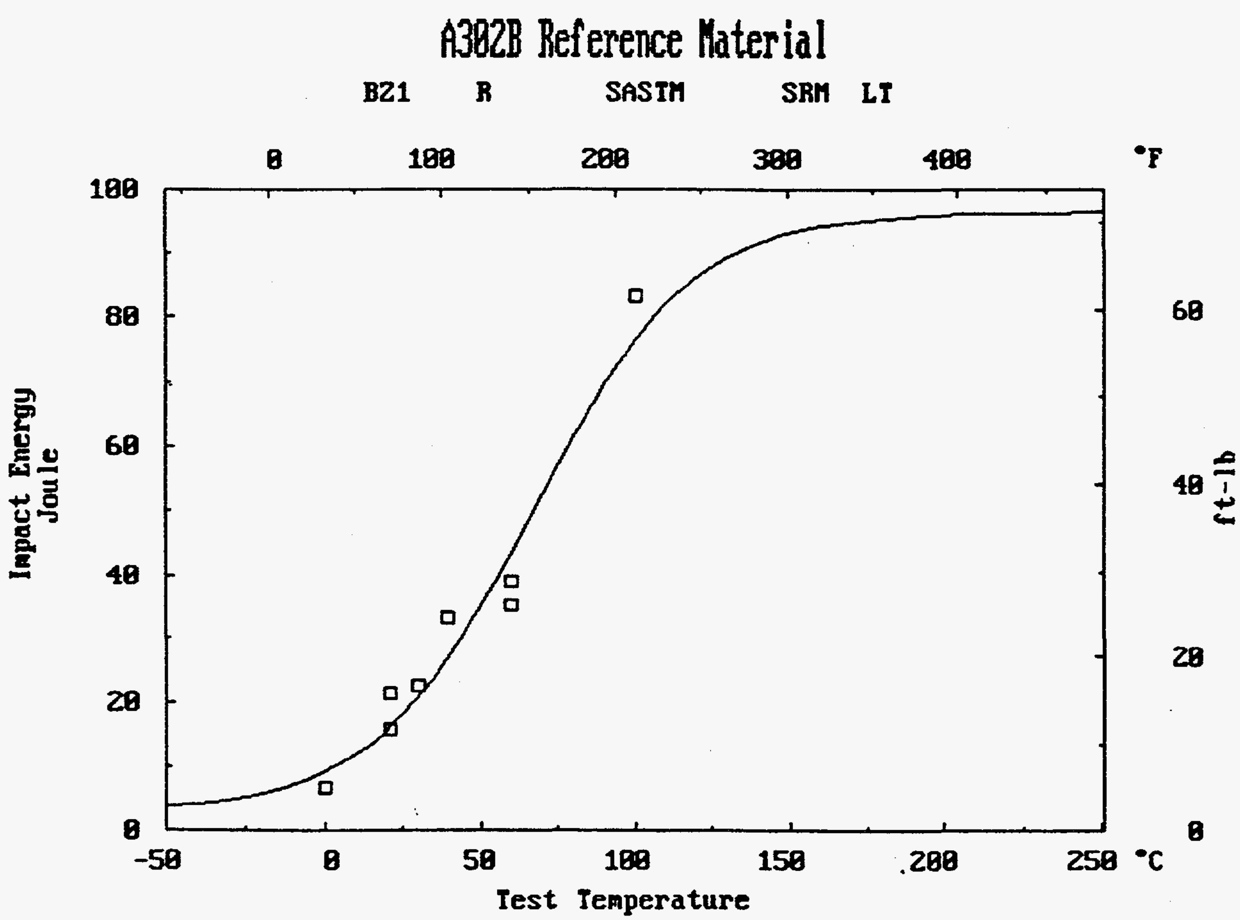
| Parameter | Mean | Std.Dev. | Correlation Coefficients | | | |
|---|---|---|---|---|---|---|
| Lower Shelf Energy (J) | 3.0 | 0.0 | | | | |
| Upper Shelf Energy (J) | 72.9 | 14.7 | 0.206 | | | |
| CVT at Midpoint (C) | 11.8 | 12.8 | 0.222 | 0.919 | | |
| 1/slope (C) | 53.5 | 12.6 | -0.160 | 0.498 | 0.548 | |
| CVT at 41 Joule (C) | 17.8 | 5.5 | -0.038 | 0.023 | 0.340 | 0.425 |



## A302B REFERENCE MATERIAL
Beznau Unit 1, Capsule R

USE= 96.6 J, LSE= 3.0 J, CVT(1/2)= 67.C , Slope = 0.0197
CVT(41J) = 57. C , CVT(68J) = 88. C ,
Fluence = 5.720E+18 , Irr. Temp. = 288 C

| Spec. ID | Test Temp. C | Test Temp. F | Impact Energy J | Impact Energy ft-lb | Lat. Exp. mm | Lat. Exp. mil | % Shear |
|---|---|---|---|---|---|---|---|
| R14 | 0. | 32. | 7. | 5. | 0.20 | 8. | 3. |
| R13 | 21. | 70. | 21. | 16. | 0.43 | 17. | 17. |
| R9 | 21. | 70. | 16. | 12. | 0.28 | 11. | 15. |
| R15 | 30. | 86. | 23. | 17. | 0.48 | 19. | 19. |
| R16 | 40. | 104. | 33. | 25. | 0.69 | 27. | 32. |
| R10 | 60. | 140. | 39. | 29. | 0.63 | 25. | 37. |
| R12 | 60. | 140. | 35. | 26. | 0.63 | 25. | 31. |
| R11 | 100. | 212. | 83. | 62. | 1.32 | 52. | 100. |



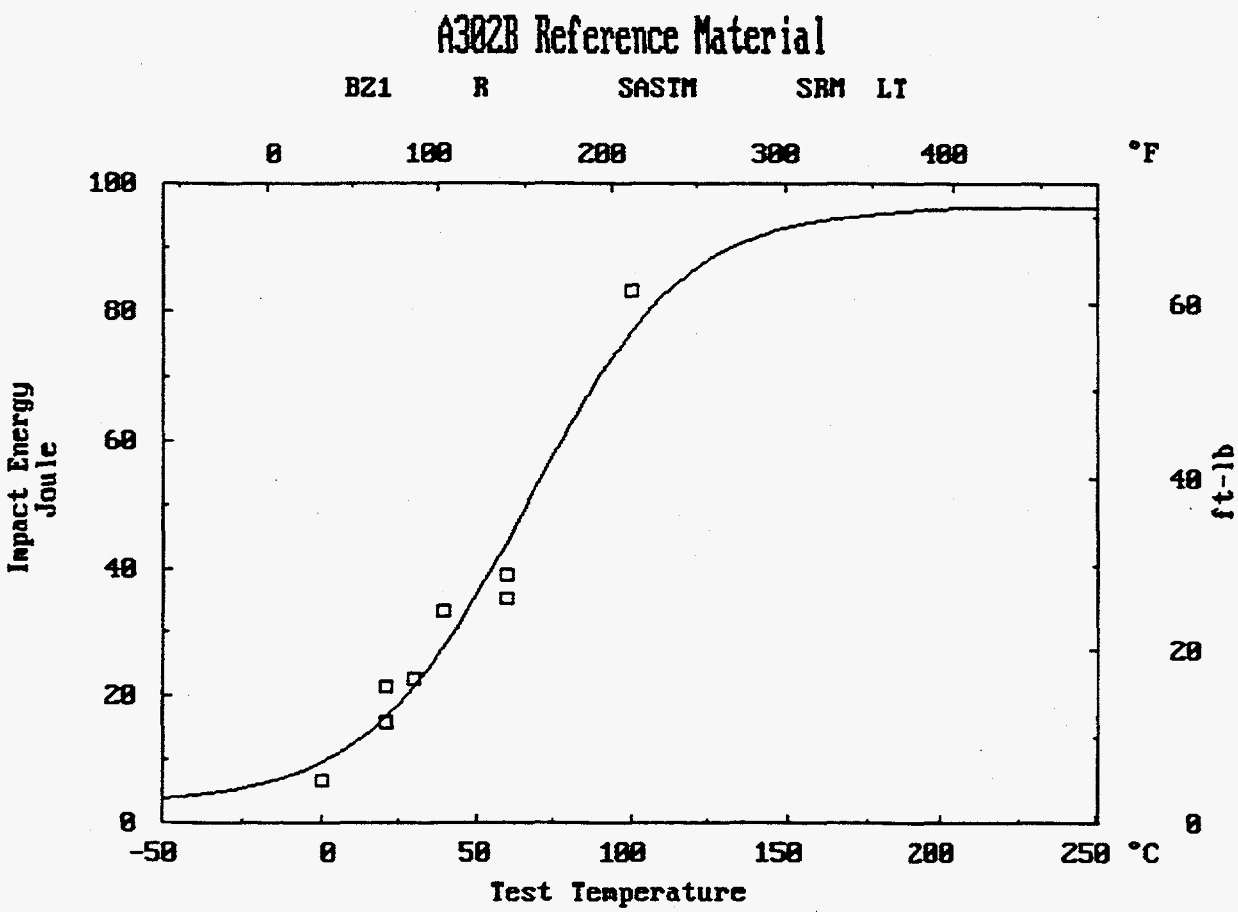
A302B REFERENCE MATERIAL

Beznau Unit 1, Capsule R

Impact Energy Uncertainty = 10.0 J
Test Temperature Uncertainty = 4.0 Degree C
Number of Successful Iterations = 200, Maximum = 1000

BZ1 R SASTM SRM LT : Fluence = 5.720E+18 , Irr. Temp. = 288

| Parameter | Mean | Std.Dev. | Correlation Coefficients | | | | |
|---|---|---|---|---|---|---|---|
| Lower Shelf Energy (J) | 3.0 | 0.0 | | | | | |
| Upper Shelf Energy (J) | 96.6 | 13.8 | 0.480 | | | | |
| CVT at Midpoint (C) | 66.1 | 8.1 | 0.599 | 0.661 | | | |
| 1/slope (C) | 51.0 | 10.9 | -0.085 | -0.034 | 0.089 | | |
| CVT at 41 Joule (C) | 57.3 | 6.4 | 0.343 | -0.163 | 0.579 | -0.091 | |
| CVT at 68 Joule (C) | 91.5 | 16.5 | -0.130 | -0.643 | -0.129 | 0.458 | 0.504 |

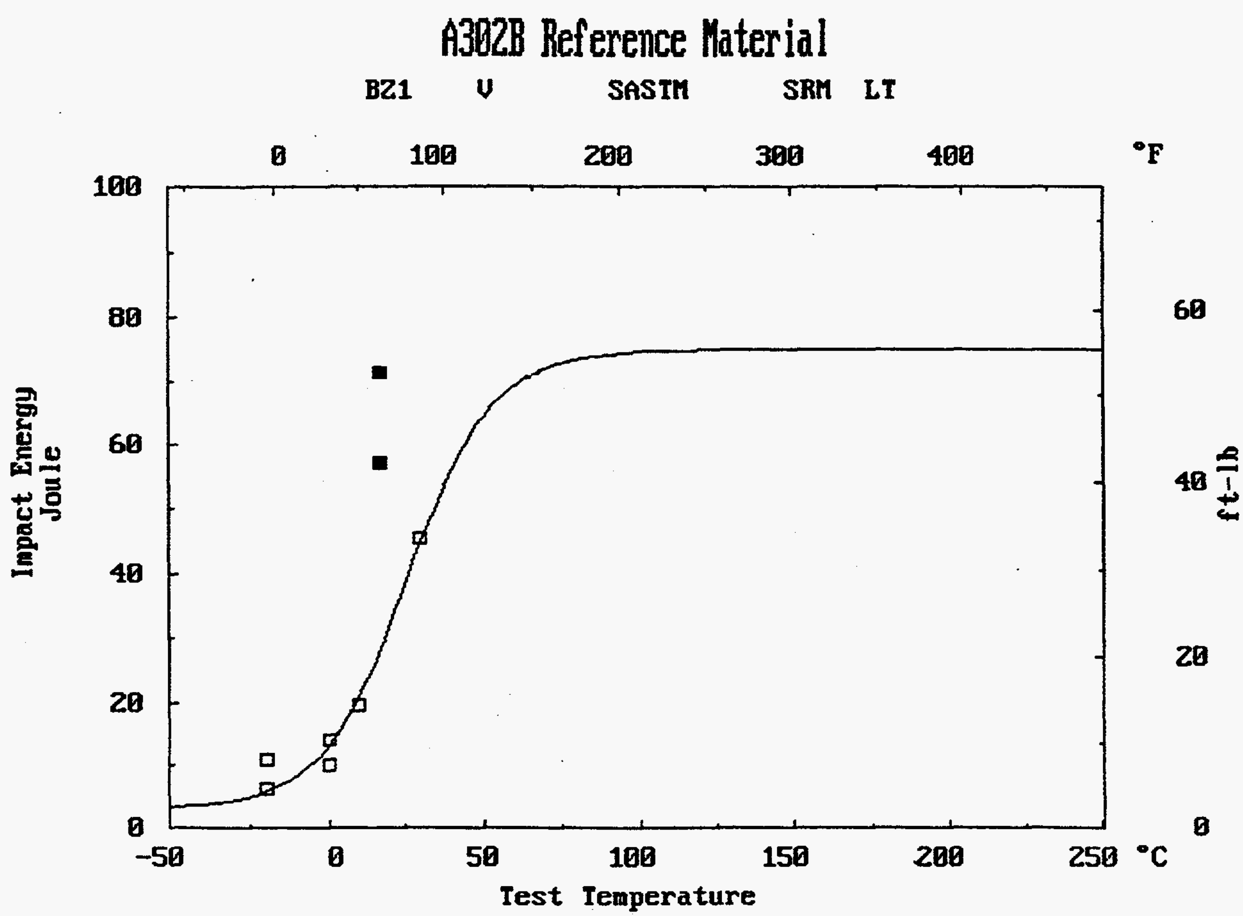


A302B REFERENCE MATERIAL
Beznau Unit 1, Capsule V

USE= 75.1 J, LSE= 3.0 J, CVT(1/2)= 26.C , Slope = 0.0357
CVT(41J) = 27. C , CVT(68J) = 57. C ,
Fluence = 2.770E+18 , Irr. Temp. = 288 C

| Spec. ID | Test Temp. C | F | Impact Energy J | ft-lb | Lat. Exp. mm | mil | % Shear |
|---|---|---|---|---|---|---|---|
| R5 | 0. | 32. | 14. | 10. | 0.28 | 11. | |
| R6 | 0. | 32. | 10. | 8. | 0.30 | 12. | |
| R8 | 10. | 50. | 20. | 14. | 0.38 | 15. | |
| *R1 | 17. | 62. | 57. | 42. | 0.51 | 20. | |
| *R2 | 17. | 62. | 71. | 53. | 0.41 | 16. | |
| R7 | 30. | 86. | 45. | 33. | 0.74 | 29. | |
| R3 | -20. | -4. | 11. | 8. | 0.18 | 7. | |
| R4 | -20. | -4. | 6. | 5. | 0.13 | 5. | |

** The initial USE is assigned as 53 ft-lb.



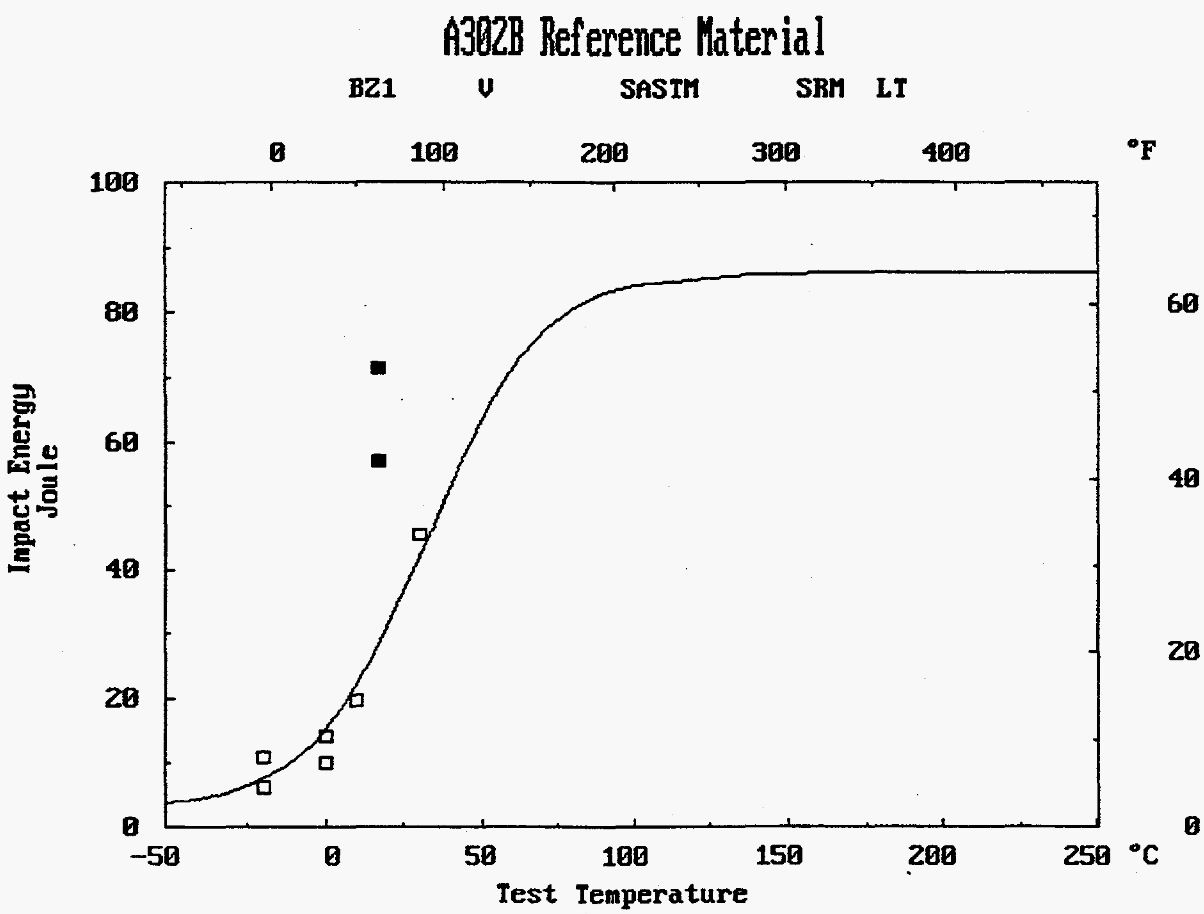
A302B REFERENCE MATERIAL

Beznau Unit 1, Capsule V

Impact Energy Uncertainty = 10.0 J
Test Temperature Uncertainty = 4.0 Degree C
Number of Successful Iterations = 200, Maximum = 1000

BZ1 V SASTM SRM LT : Fluence = 2.770E+18 , Irr. Temp. = 288

| Parameter | Mean | Std.Dev. | Correlation Coefficients | | | | |
|---|---|---|---|---|---|---|---|
| Lower Shelf Energy (J) | 3.0 | 0.0 | | | | | |
| Upper Shelf Energy (J) | 86.2 | 12.6 | 0.110 | | | | |
| CVT at Midpoint (C) | 32.2 | 9.2 | 0.075 | 0.672 | | | |
| 1/slope (C) | 36.2 | 11.0 | -0.182 | 0.352 | 0.587 | | |
| CVT at 41 Joule (C) | 29.2 | 6.8 | 0.037 | 0.134 | 0.806 | 0.435 | |
| CVT at 68 Joule (C) | 58.8 | 15.5 | -0.143 | -0.298 | 0.335 | 0.601 | 0.685 |

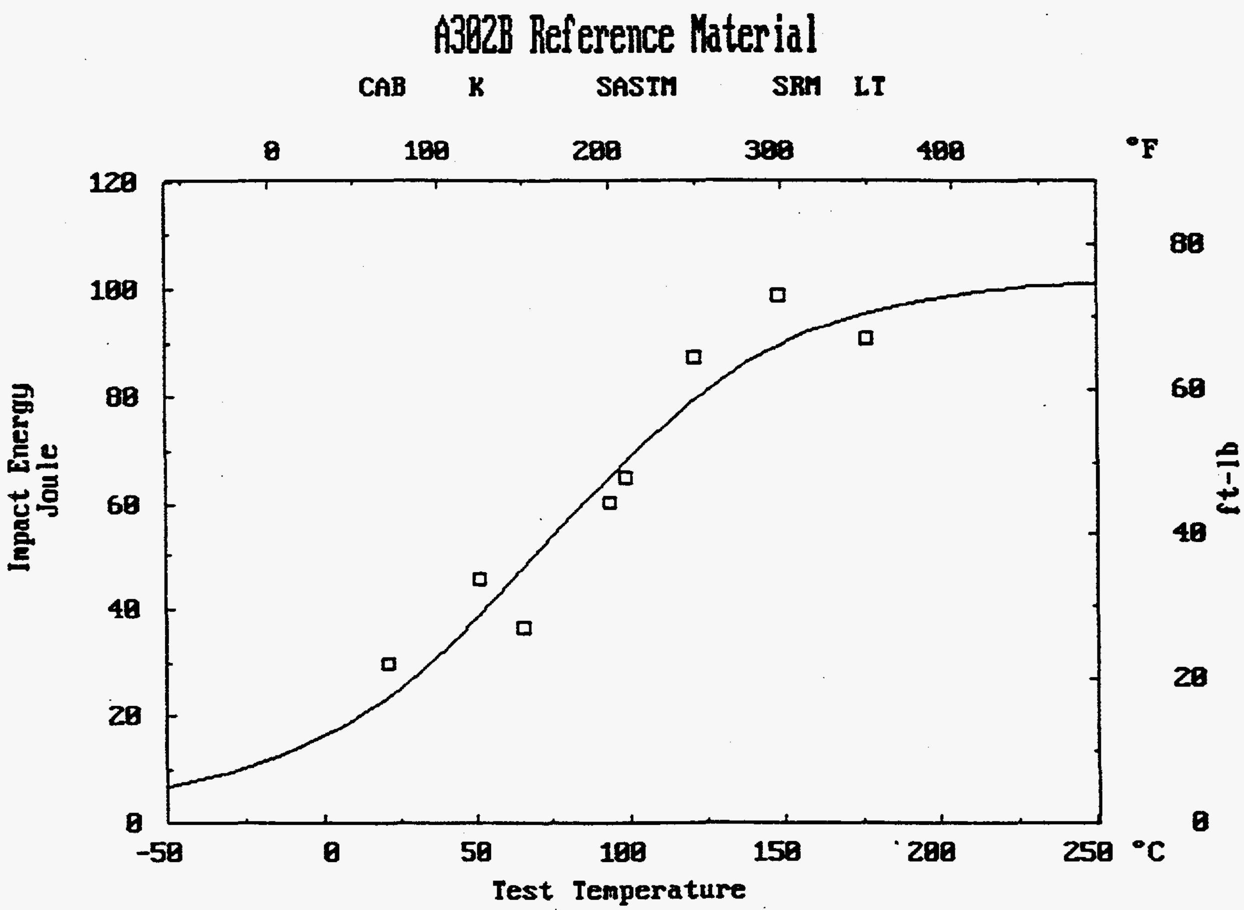


## A302B REFERENCE MATERIAL

Jose Cabrera-Zorita, Capsule K

USE= 102.1 J, LSE= 3.0 J, CVT(1/2)= 73.C , Slope = 0.0130
CVT(41J) = 55. C , CVT(68J) = 98. C ,
Fluence = 1.400E+19 , Irr. Temp. = 304 C

| Spec. ID | Test Temp. C | Test Temp. F | Impact Energy J | Impact Energy ft-lb | Lat. Exp. mm | Lat. Exp. mil | % Shear |
|---|---|---|---|---|---|---|---|
| R57 | 21. | 70. | 30. | 22. | 0.46 | 18. | 20. |
| R60 | 52. | 125. | 45. | 33. | 0.63 | 25. | 35. |
| R62 | 66. | 150. | 37. | 27. | 0.66 | 26. | 30. |
| R58 | 93. | 200. | 60. | 44. | 0.99 | 39. | 60. |
| R59 | 99. | 210. | 65. | 48. | 1.12 | 44. | 85. |
| R63 | 121. | 250. | 87. | 64. | 1.19 | 47. | 100. |
| R64 | 149. | 300. | 99. | 73. | 1.37 | 54. | 100. |
| R61 | 177. | 350. | 91. | 67. | 1.32 | 52. | 100. |



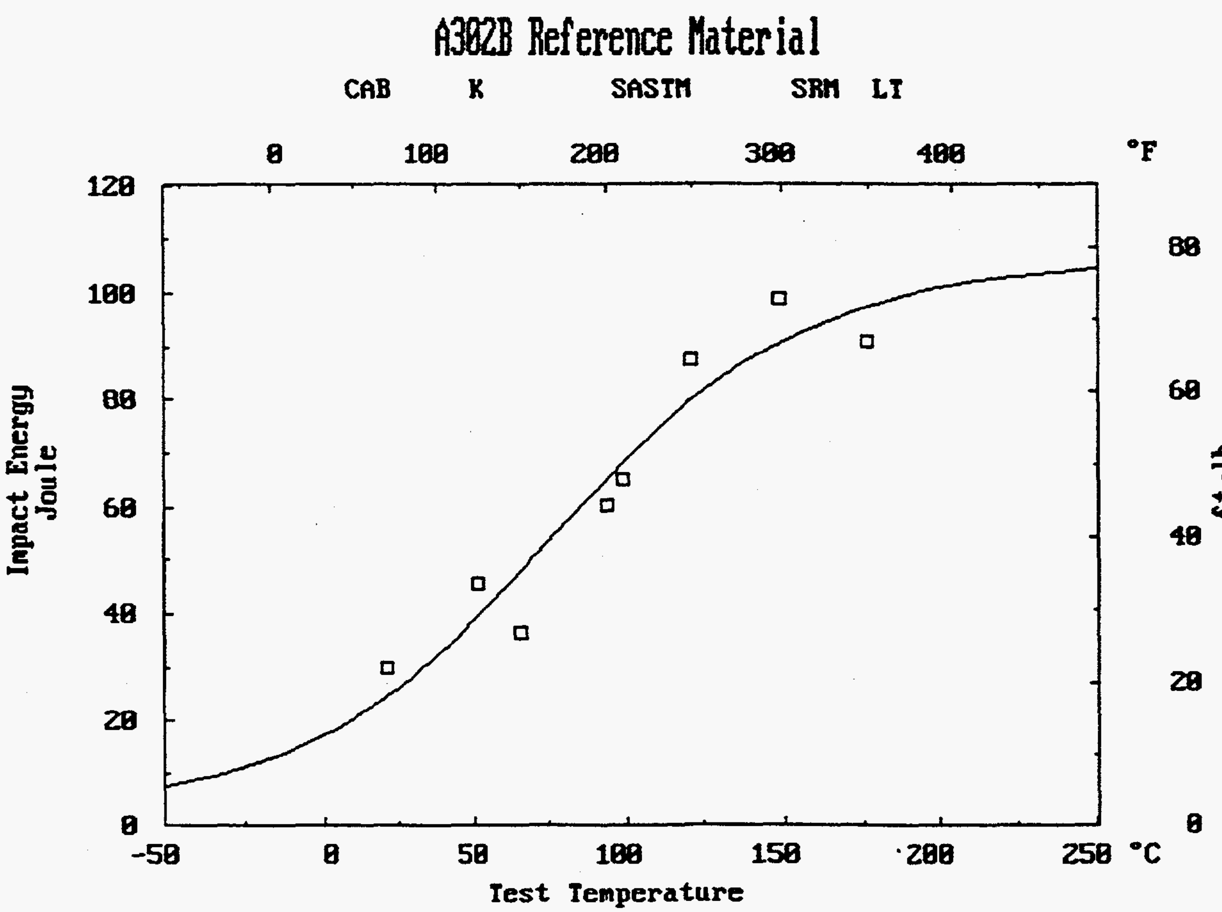
A302B REFERENCE MATERIAL

Jose Cabrera-Zorita, Capsule K

Impact Energy Uncertainty = 10.0 J
Test Temperature Uncertainty = 4.0 Degree C
Number of Successful Iterations = 200, Maximum = 1000

CAB K SASTM SRM LT : Fluence = 1.400E+19 , Irr. Temp. = 304

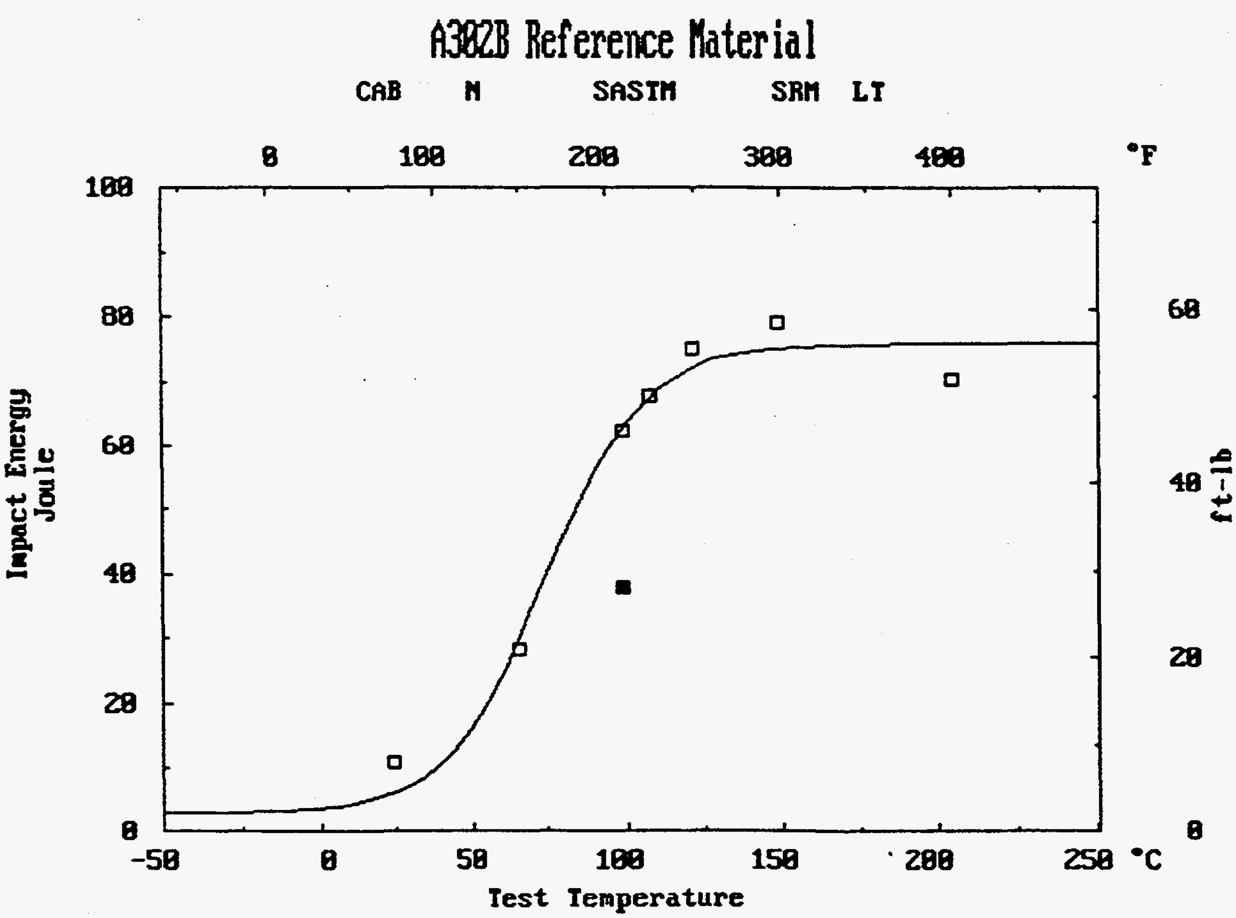
| Parameter | Mean | Std.Dev. | Correlation Coefficients | | | | |
|---|---|---|---|---|---|---|---|
| Lower Shelf Energy (J) | 3.0 | 0.0 | | | | | |
| Upper Shelf Energy (J) | 105.8 | 13.5 | 0.157 | | | | |
| CVT at Midpoint (C) | 76.1 | 15.4 | 0.330 | 0.818 | | | |
| 1/slope (C) | 82.3 | 22.4 | -0.250 | 0.615 | 0.374 | | |
| CVT at 41 Joule (C) | 53.6 | 11.1 | 0.481 | -0.014 | 0.499 | -0.541 | |
| CVT at 68 Joule (C) | 98.6 | 8.6 | 0.132 | 0.121 | 0.563 | 0.265 | 0.531 |



A302B REFERENCE MATERIAL
Jose Cabrera-Zorita, Capsule N

USE= 76.0 J, LSE= 3.0 J, CVT(1/2)= 74.C , Slope = 0.0313
CVT(41J) = 76. C , CVT(68J) = 108. C ,
Fluence = 3.680E+19 , Irr. Temp. = 304 C

| Spec. ID | Test Temp. C | Test Temp. F | Impact Energy J | Impact Energy ft-lb | Lat. Exp. mm | Lat. Exp. mil | % Shear |
|---|---|---|---|---|---|---|---|
| R47 | 24. | 76. | 11. | 8. | 0.28 | 11. | 5. |
| R46 | 66. | 150. | 28. | 21. | 0.56 | 22. | 21. |
| R41 | 99. | 210. | 62. | 46. | 1.02 | 40. | 78. |
| *R48 | 99. | 210. | 38. | 28. | 0.51 | 20. | 48. |
| R43 | 107. | 225. | 68. | 50. | 1.42 | 56. | 94. |
| R45 | 121. | 250. | 75. | 55. | 1.45 | 57. | 100. |
| R42 | 149. | 300. | 79. | 58. | 1.40 | 55. | 100. |
| R44 | 204. | 400. | 70. | 52. | 1.47 | 58. | 100. |



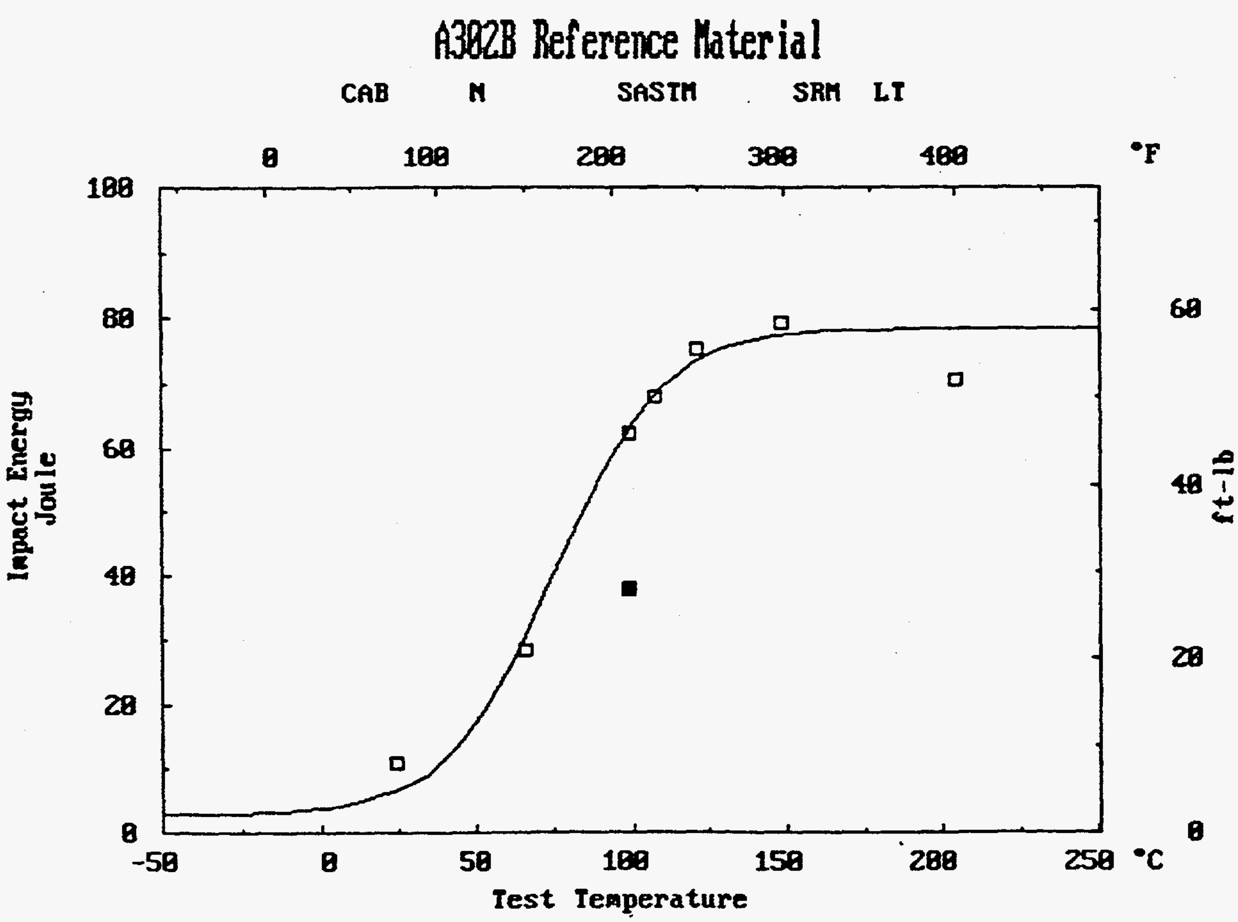
A302B REFERENCE MATERIAL

Jose Cabrera-Zorita, Capsule N

Impact Energy Uncertainty = 10.0 J
Test Temperature Uncertainty = 4.0 Degree C
Number of Successful Iterations = 200, Maximum = 1000

CAB N SASTM SRM LT : Fluence = 3.680E+19 , Irr. Temp. = 304

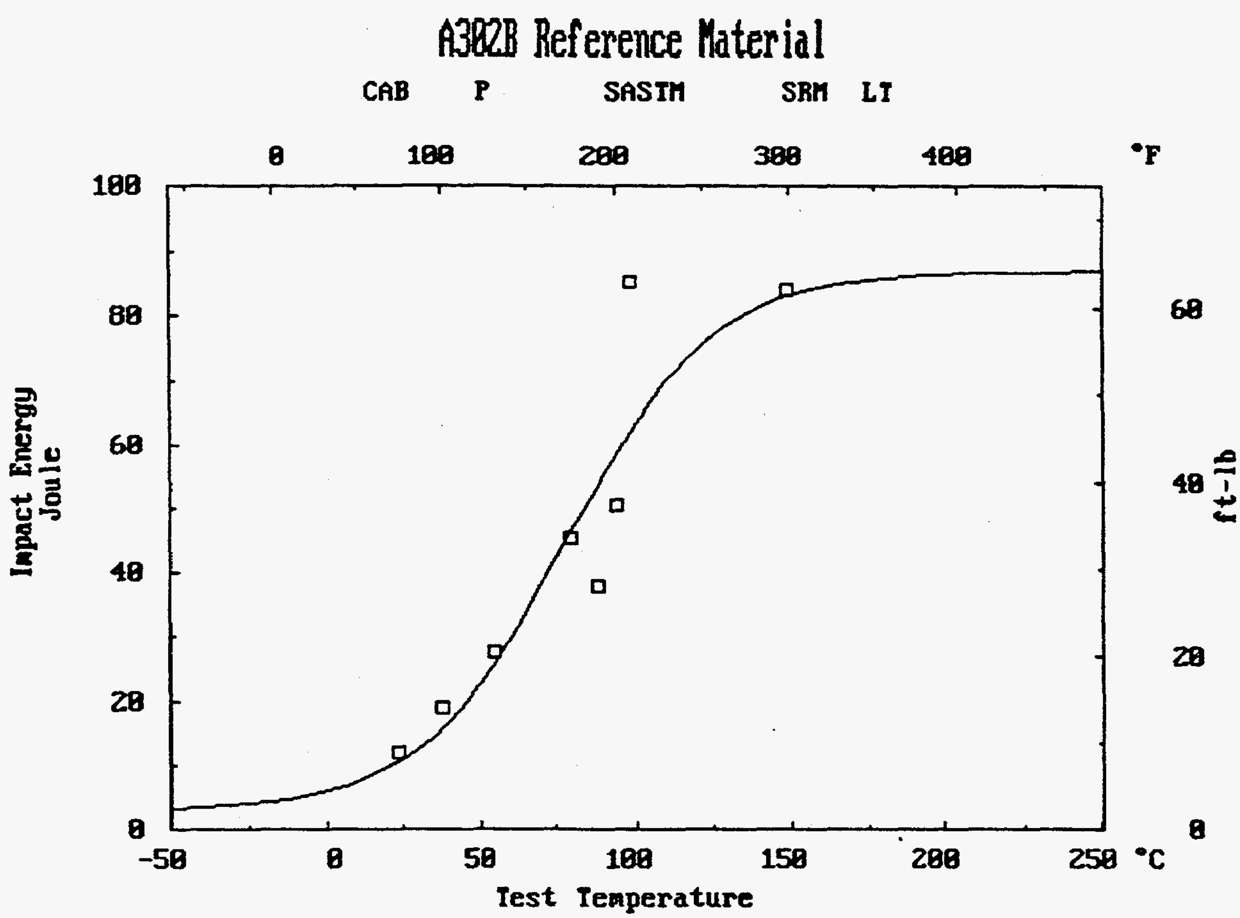
| Parameter | Mean | Std.Dev. | Correlation Coefficients | | | | |
|---|---|---|---|---|---|---|---|
| Lower Shelf Energy (J) | 3.0 | 0.0 | | | | | |
| Upper Shelf Energy (J) | 78.3 | 5.4 | -0.094 | | | | |
| CVT at Midpoint (C) | 75.3 | 9.3 | 0.283 | 0.371 | | | |
| 1/slope (C) | 34.0 | 10.6 | -0.182 | 0.385 | -0.136 | | |
| CVT at 41 Joule (C) | 75.4 | 8.6 | 0.316 | 0.095 | 0.956 | -0.260 | |
| CVT at 68 Joule (C) | 108.0 | 11.3 | 0.117 | -0.226 | 0.381 | 0.453 | 0.489 |



A302B REFERENCE MATERIAL
Jose Cabrera-Zorita, Capsule P

USE= 87.0 J, LSE= 3.0 J, CVT(1/2)= 78.C , Slope = 0.0215
CVT(41J) = 73. C , CVT(68J) = 106. C ,
Fluence = 1.430E+19 , Irr. Temp. = 304 C

| Spec. ID | Test Temp. C | Test Temp. F | Impact Energy J | Impact Energy ft-lb | Lat. Exp. mm | Lat. Exp. mil | % Shear |
|---|---|---|---|---|---|---|---|
| R13 | 23. | 74. | 12. | 9. | 0.10 | 4. | 5. |
| R16 | 38. | 100. | 19. | 14. | 0.30 | 12. | 20. |
| R12 | 54. | 130. | 28. | 20. | 0.36 | 14. | 25. |
| R14 | 79. | 175. | 45. | 33. | 0.76 | 30. | 40. |
| R9 | 88. | 190. | 38. | 28. | 0.66 | 26. | 40. |
| R10 | 93. | 200. | 51. | 37. | 0.81 | 32. | 60. |
| R11 | 98. | 209. | 85. | 63. | 1.12 | 44. | 100. |
| R15 | 149. | 300. | 84. | 62. | 1.32 | 52. | 100. |



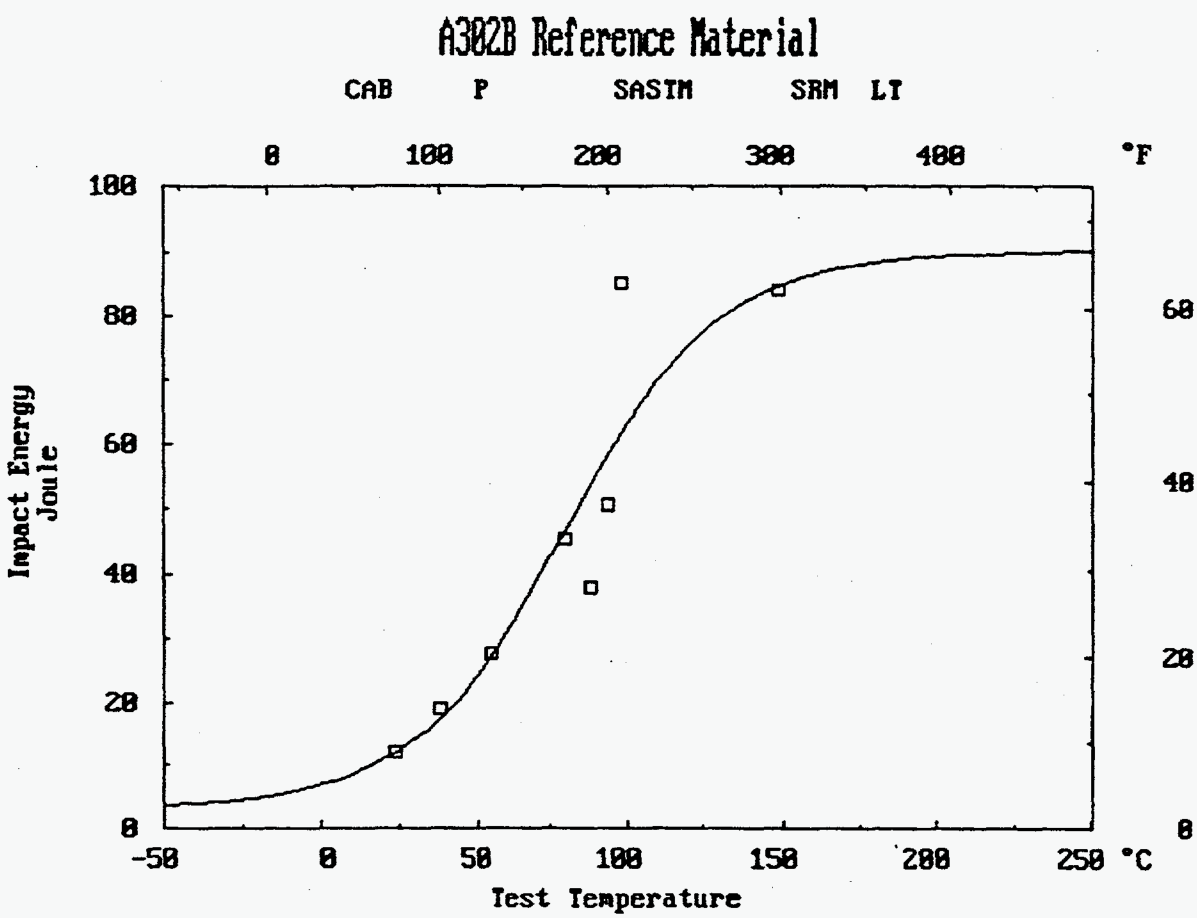
A302B REFERENCE MATERIAL

Jose Cabrera-Zorita, Capsule P

Impact Energy Uncertainty = 10.0 J
Test Temperature Uncertainty = 4.0 Degree C
Number of Successful Iterations = 200, Maximum = 1000

CAB P SASTM SRM LT : Fluence = 1.430E+19 , Irr. Temp. = 304

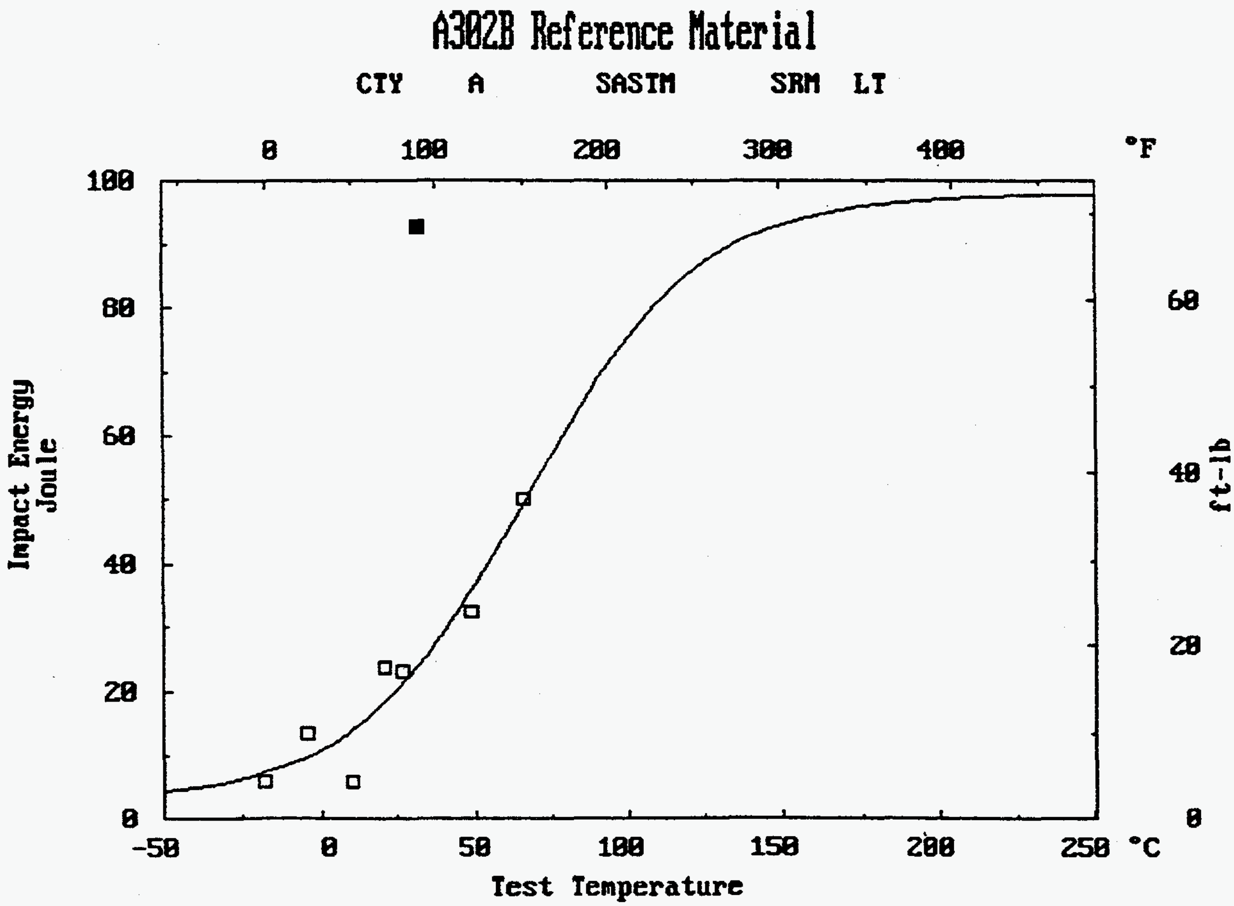
| Parameter | Mean | Std.Dev. | Correlation Coefficients | | | | |
|---|---|---|---|---|---|---|---|
| Lower Shelf Energy (J) | 3.0 | 0.0 | | | | | |
| Upper Shelf Energy (J) | 90.3 | 11.4 | 0.106 | | | | |
| CVT at Midpoint (C) | 79.6 | 9.5 | 0.173 | 0.746 | | | |
| 1/slope (C) | 51.1 | 14.8 | -0.211 | 0.384 | 0.202 | | |
| CVT at 41 Joule (C) | 73.0 | 6.7 | 0.220 | 0.024 | 0.646 | -0.332 | |
| CVT at 68 Joule (C) | 109.5 | 12.2 | -0.137 | -0.392 | -0.049 | 0.439 | 0.238 |



A302B REFERENCE MATERIAL
Haddam Neck, Capsule A

USE= 98.0 J, LSE= 3.0 J, CVT(1/2)= 67.C , Slope = 0.0178
CVT(41J) = 56. C , CVT(68J) = 89. C ,
Fluence = 2.070E+18 , Irr. Temp. = 304 C

| Spec. ID | Test Temp. C | F | Impact Energy J | ft-lb | Lat. Exp. mm | mil | % Shear |
|---|---|---|---|---|---|---|---|
| R44 | -18. | 0. | 6. | 4. | 0.10 | 4. | 0. |
| R42 | -4. | 25. | 14. | 10. | 0.25 | 10. | 5. |
| R46 | 10. | 50. | 6. | 4. | 0.15 | 6. | 0. |
| R47 | 21. | 70. | 24. | 17. | 0.48 | 19. | 5. |
| R41 | 27. | 80. | 23. | 17. | 0.46 | 18. | 5. |
| *R43 | 32. | 90. | 93. | 68. | 1.22 | 48. | 100. |
| R45 | 49. | 120. | 33. | 24. | 0.61 | 24. | 40. |
| R48 | 66. | 150. | 50. | 37. | 1.02 | 40. | 60. |



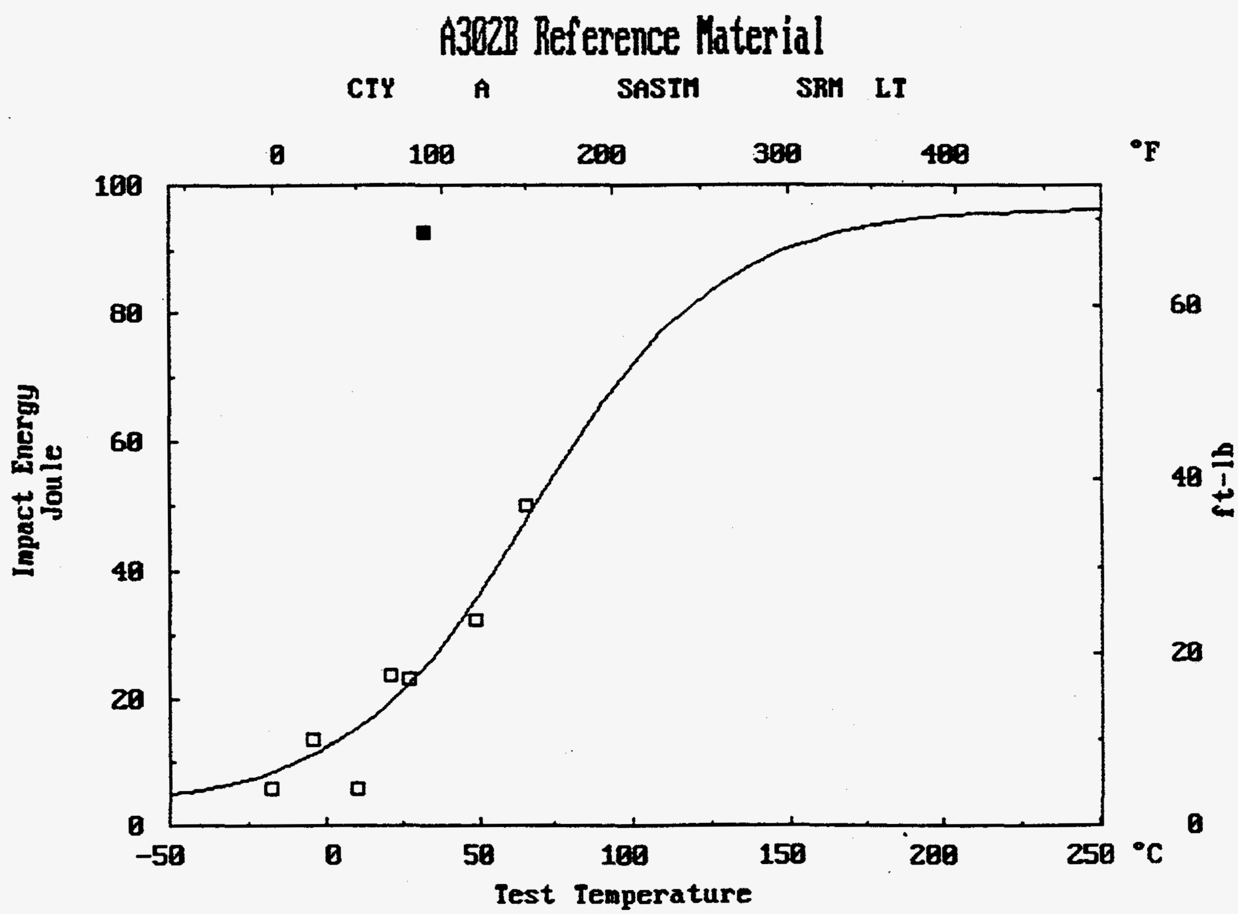
A302B REFERENCE MATERIAL

Haddam Neck, Capsule A

Impact Energy Uncertainty = 10.0 J
Test Temperature Uncertainty = 4.0 Degree C
Number of Successful Iterations = 200, Maximum = 1000

CTY A SASTM SRM LT : Fluence = 2.070E+18 , Irr. Temp. = 304

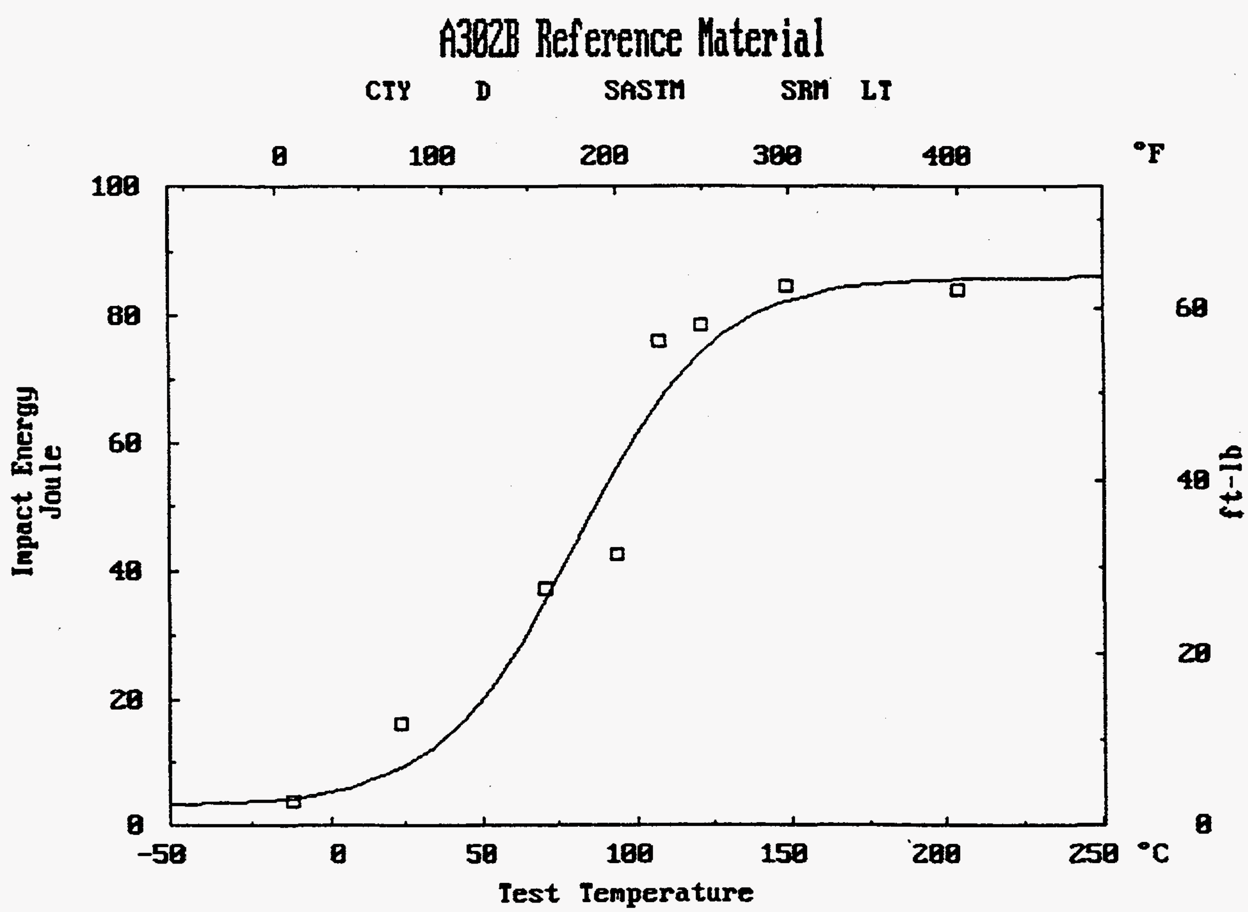
| Parameter | Mean | Std.Dev. | Correlation Coefficients | | | | |
|---|---|---|---|---|---|---|---|
| Lower Shelf Energy (J) | 3.0 | 0.0 | | | | | |
| Upper Shelf Energy (J) | 96.7 | 11.0 | 0.180 | | | | |
| CVT at Midpoint (C) | 68.4 | 14.2 | 0.199 | 0.664 | | | |
| 1/slope (C) | 61.8 | 19.5 | 0.059 | 0.359 | 0.718 | | |
| CVT at 41 Joule (C) | 56.5 | 8.8 | 0.157 | 0.202 | 0.816 | 0.457 | |
| CVT at 68 Joule (C) | 94.8 | 16.9 | 0.044 | -0.037 | 0.656 | 0.800 | 0.760 |



A302B REFERENCE MATERIAL
Haddam Neck, Capsule D

USE= 86.1 J, LSE= 3.0 J, CVT(1/2)= 81.C , Slope = 0.0224
CVT(41J) = 77. C , CVT(68J) = 109. C ,
Fluence = 2.220E+19 , Irr. Temp. = 304 C

| Spec. ID | Test Temp. | | Impact Energy | | Lat. Exp. | | % Shear |
|---|---|---|---|---|---|---|---|
| | C | F | J | ft-lb | mm | mil | |
| R49 | -12. | 10. | 4. | 3. | 0.30 | 12. | 1. |
| R50 | 24. | 75. | 16. | 12. | 0.38 | 15. | 14. |
| R53 | 71. | 160. | 37. | 27. | 0.61 | 24. | 27. |
| R51 | 93. | 200. | 43. | 32. | 1.07 | 42. | 51. |
| R54 | 107. | 225. | 76. | 56. | 1.04 | 41. | 93. |
| R55 | 121. | 250. | 79. | 58. | 1.09 | 43. | 100. |
| R52 | 149. | 300. | 85. | 62. | 1.14 | 45. | 100. |
| R56 | 204. | 400. | 84. | 62. | 1.27 | 50. | 100. |



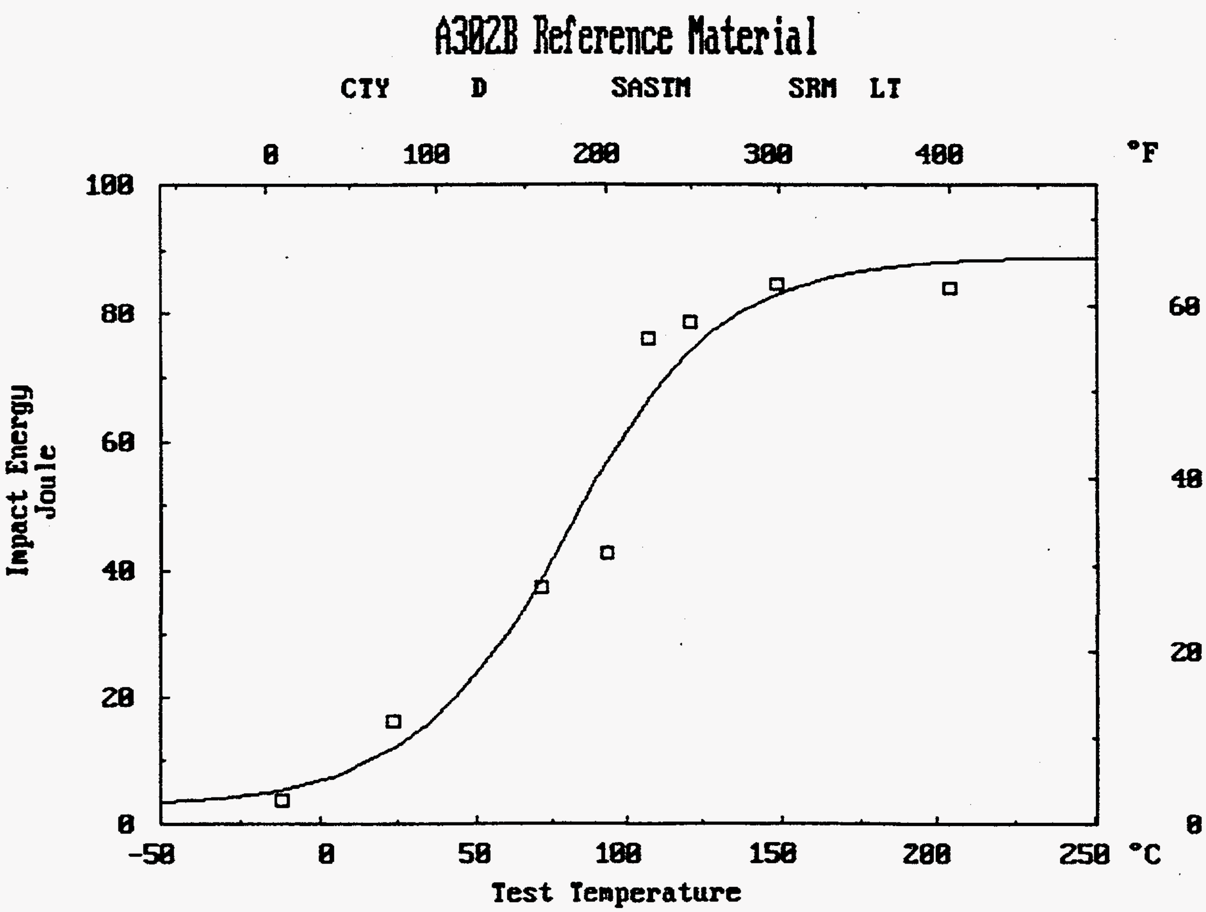
A302B REFERENCE MATERIAL

Haddam Neck, Capsule D

```
Impact Energy Uncertainty =  10.0 J
Test Temperature Uncertainty =   4.0 Degree C
Number of Successful Iterations =  200, Maximum = 1000
```

CTY D SASTM SRM LT : Fluence = 2.220E+19 , Irr. Temp. = 304

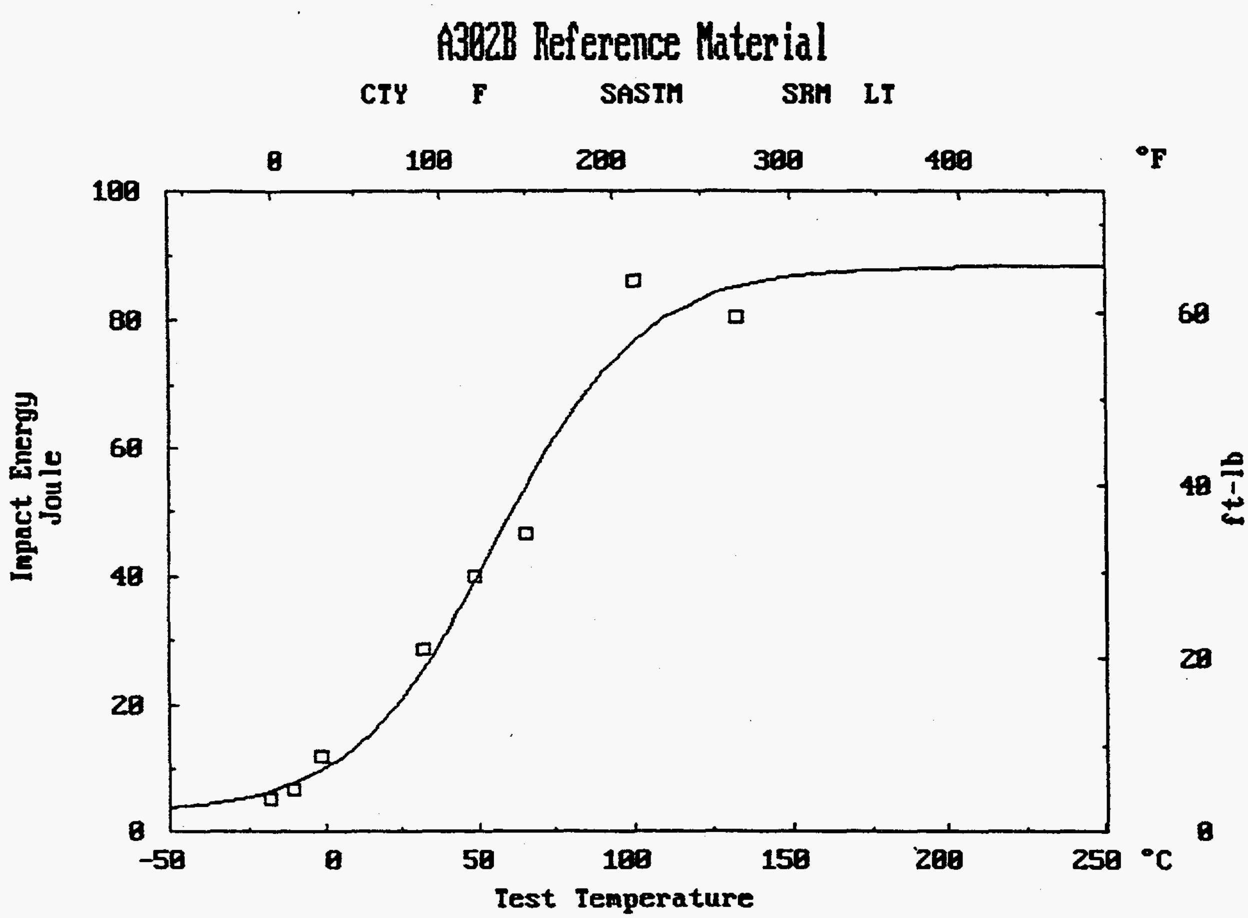
| Parameter | Mean | Std.Dev. | Correlation Coefficients | | | | |
|---|---|---|---|---|---|---|---|
| Lower Shelf Energy (J) | 3.0 | 0.0 | | | | | |
| Upper Shelf Energy (J) | 89.0 | 8.5 | -0.171 | | | | |
| CVT at Midpoint (C) | 80.2 | 10.9 | 0.274 | 0.563 | | | |
| 1/slope (C) | 52.1 | 16.2 | -0.432 | 0.485 | -0.043 | | |
| CVT at 41 Joule (C) | 73.8 | 9.6 | 0.462 | 0.031 | 0.825 | -0.491 | |
| CVT at 68 Joule (C) | 110.5 | 9.5 | 0.042 | -0.104 | 0.353 | 0.374 | 0.381 |



## A302B REFERENCE MATERIAL
Haddam Neck, Capsule F

USE= 88.5 J, LSE= 3.0 J, CVT(1/2)= 56.C , Slope = 0.0212
CVT(41J) = 51. C , CVT(68J) = 84. C ,
Fluence = 4.040E+18 , Irr. Temp. = 304 C

| Spec. ID | Test Temp. C | Test Temp. F | Impact Energy J | Impact Energy ft-lb | Lat. Exp. mm | Lat. Exp. mil | % Shear |
|---|---|---|---|---|---|---|---|
| R21 | -18. | 0. | 5. | 4. | 0.03 | 1. | 0. |
| R24 | -10. | 14. | 7. | 5. | 0.05 | 2. | 3. |
| R20 | -1. | 30. | 12. | 9. | 0.13 | 5. | 2. |
| R22 | 32. | 90. | 29. | 21. | 0.53 | 21. | 15. |
| R18 | 49. | 120. | 40. | 29. | 0.66 | 26. | 25. |
| R19 | 66. | 150. | 47. | 34. | 0.76 | 30. | 40. |
| R23 | 100. | 212. | 86. | 63. | 1.40 | 55. | 95. |
| R17 | 132. | 270. | 81. | 59. | 1.27 | 50. | 97. |



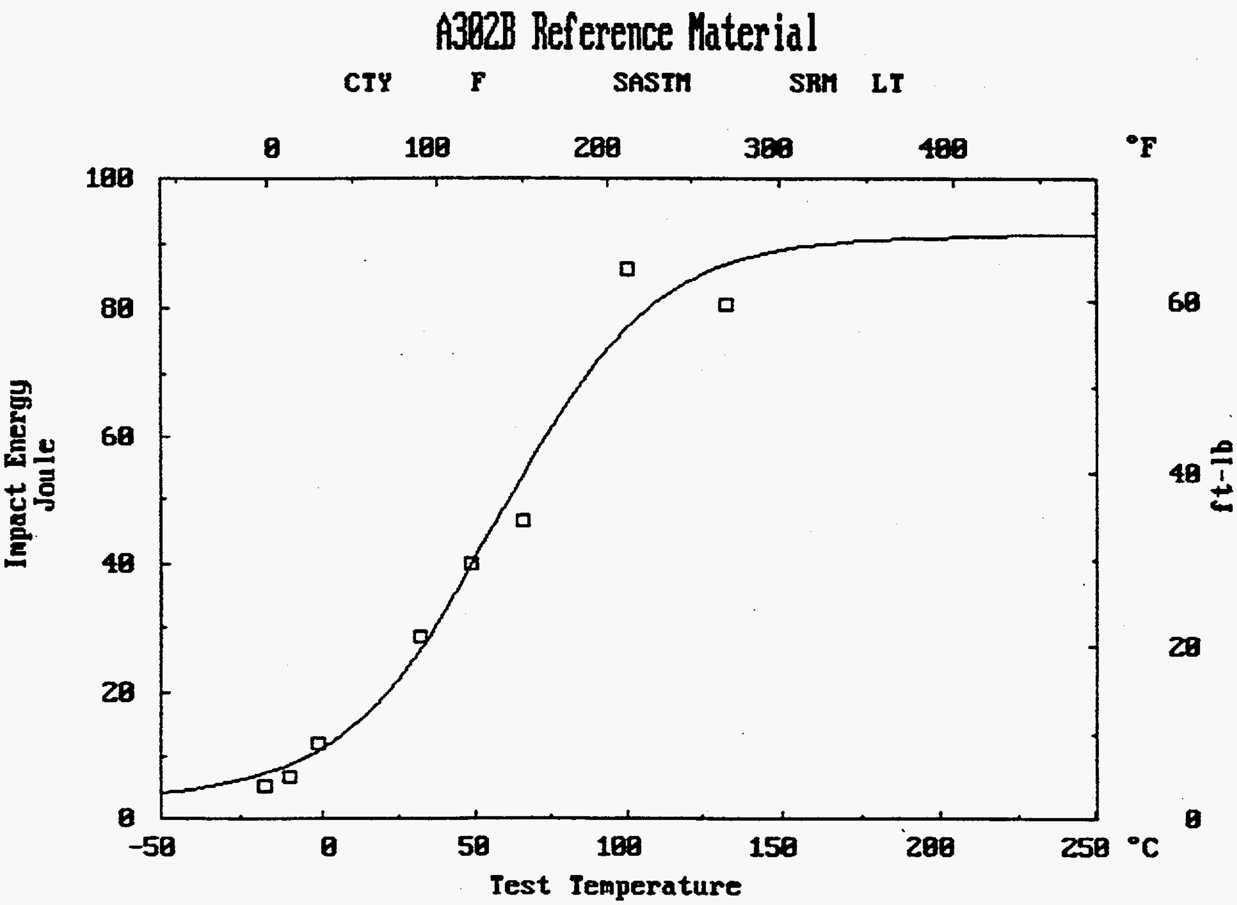
A302B REFERENCE MATERIAL

Haddam Neck, Capsule F

Impact Energy Uncertainty = 10.0 J
Test Temperature Uncertainty = 4.0 Degree C
Number of Successful Iterations = 200, Maximum = 1000

CTY F SASTM SRM LT : Fluence = 4.040E+18 , Irr. Temp. = 304

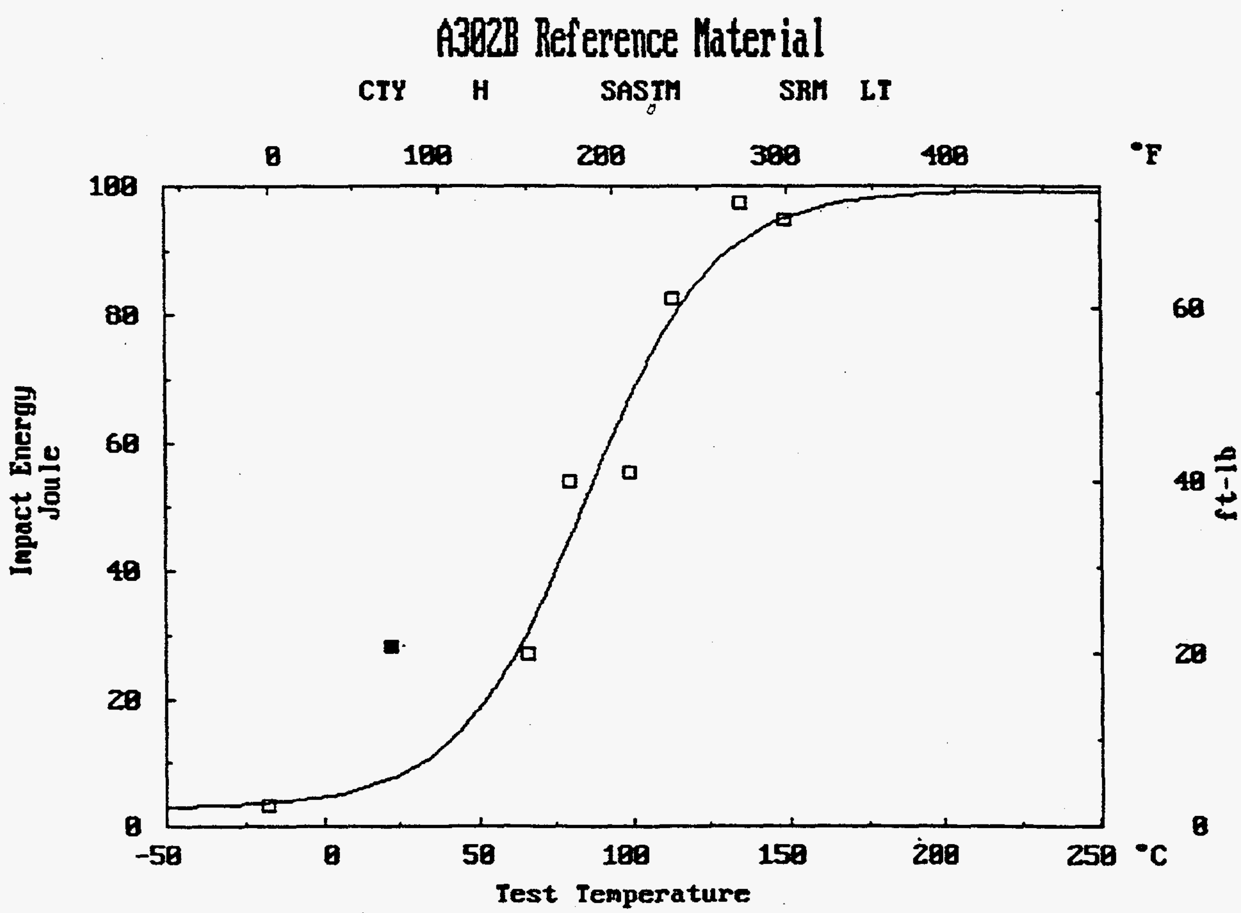
| Parameter | Mean | Std.Dev. | Correlation Coefficients | | | | |
|---|---|---|---|---|---|---|---|
| Lower Shelf Energy (J) | 3.0 | 0.0 | | | | | |
| Upper Shelf Energy (J) | 91.4 | 11.2 | 0.210 | | | | |
| CVT at Midpoint (C) | 57.9 | 11.2 | 0.274 | 0.778 | | | |
| 1/slope (C) | 51.0 | 12.7 | -0.155 | 0.458 | 0.432 | | |
| CVT at 41 Joule (C) | 50.7 | 7.3 | 0.326 | 0.264 | 0.784 | 0.027 | |
| CVT at 68 Joule (C) | 86.2 | 11.4 | -0.007 | -0.207 | 0.256 | 0.471 | 0.475 |



A302B REFERENCE MATERIAL
Haddam Neck, Capsule H

USE= 99.3 J, LSE= 3.0 J, CVT(1/2)= 85.C , Slope = 0.0242
CVT(41J) = 76. C , CVT(68J) = 100. C ,
Fluence = 1.790E+19 , Irr. Temp. = 288 C

| Spec. ID | Test Temp. C | Test Temp. F | Impact Energy J | Impact Energy ft-lb | Lat. Exp. mm | Lat. Exp. mil | % Shear |
|---|---|---|---|---|---|---|---|
| R38 | -18. | 0. | 3. | 2. | 0.05 | 2. | 1. |
| *R40 | 22. | 72. | 28. | 21. | 0.36 | 14. | 15. |
| R33 | 66. | 150. | 27. | 20. | 0.41 | 16. | 35. |
| R39 | 79. | 175. | 54. | 40. | 0.69 | 27. | 55. |
| R37 | 99. | 210. | 56. | 41. | 0.66 | 26. | 60. |
| R36 | 113. | 235. | 83. | 61. | 0.94 | 37. | 95. |
| R34 | 135. | 275. | 98. | 72. | 1.35 | 53. | 100. |
| R35 | 149. | 300. | 95. | 70. | 1.32 | 52. | 100. |



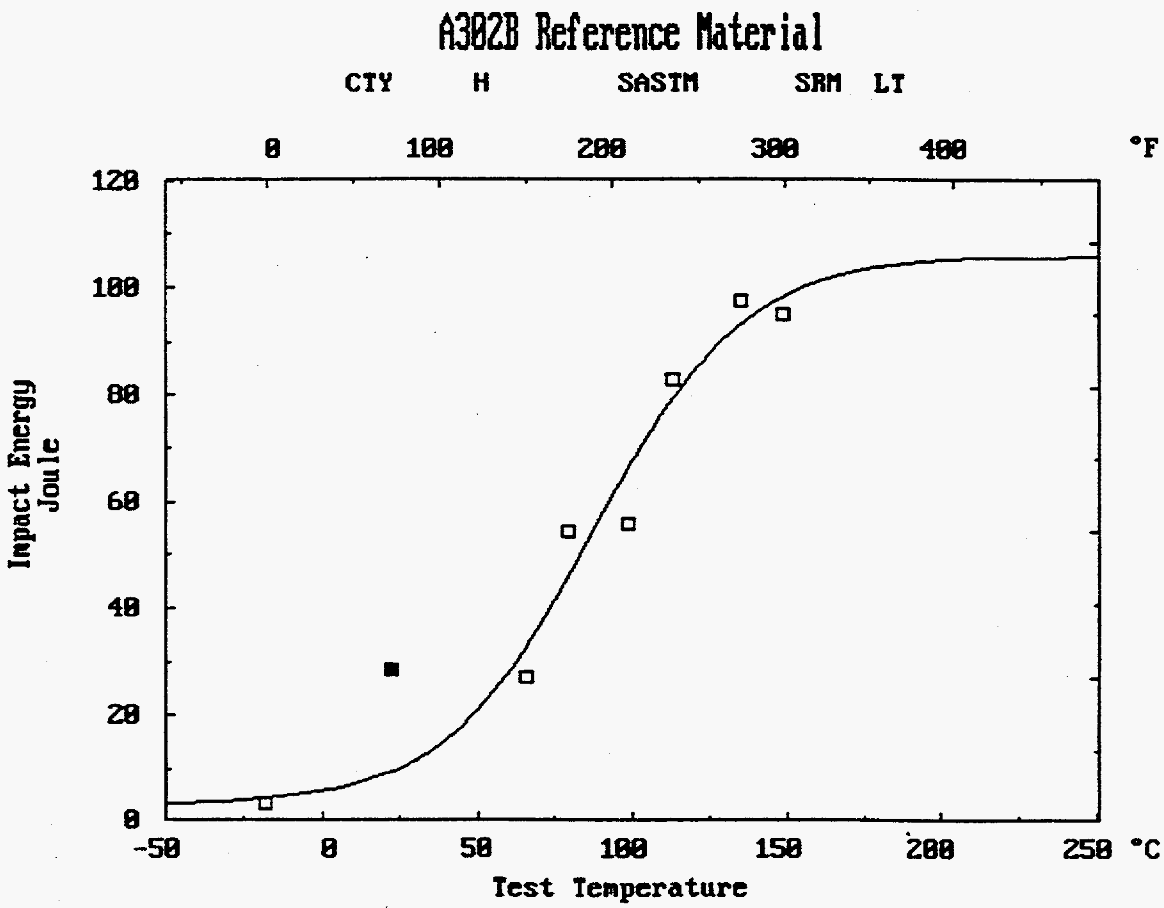
A302B REFERENCE MATERIAL

Haddam Neck, Capsule H

Impact Energy Uncertainty = 10.0 J
Test Temperature Uncertainty = 4.0 Degree C
Number of Successful Iterations = 200, Maximum = 1000

CTY H SASTM SRM LT : Fluence = 1.790E+19 , Irr. Temp. = 288

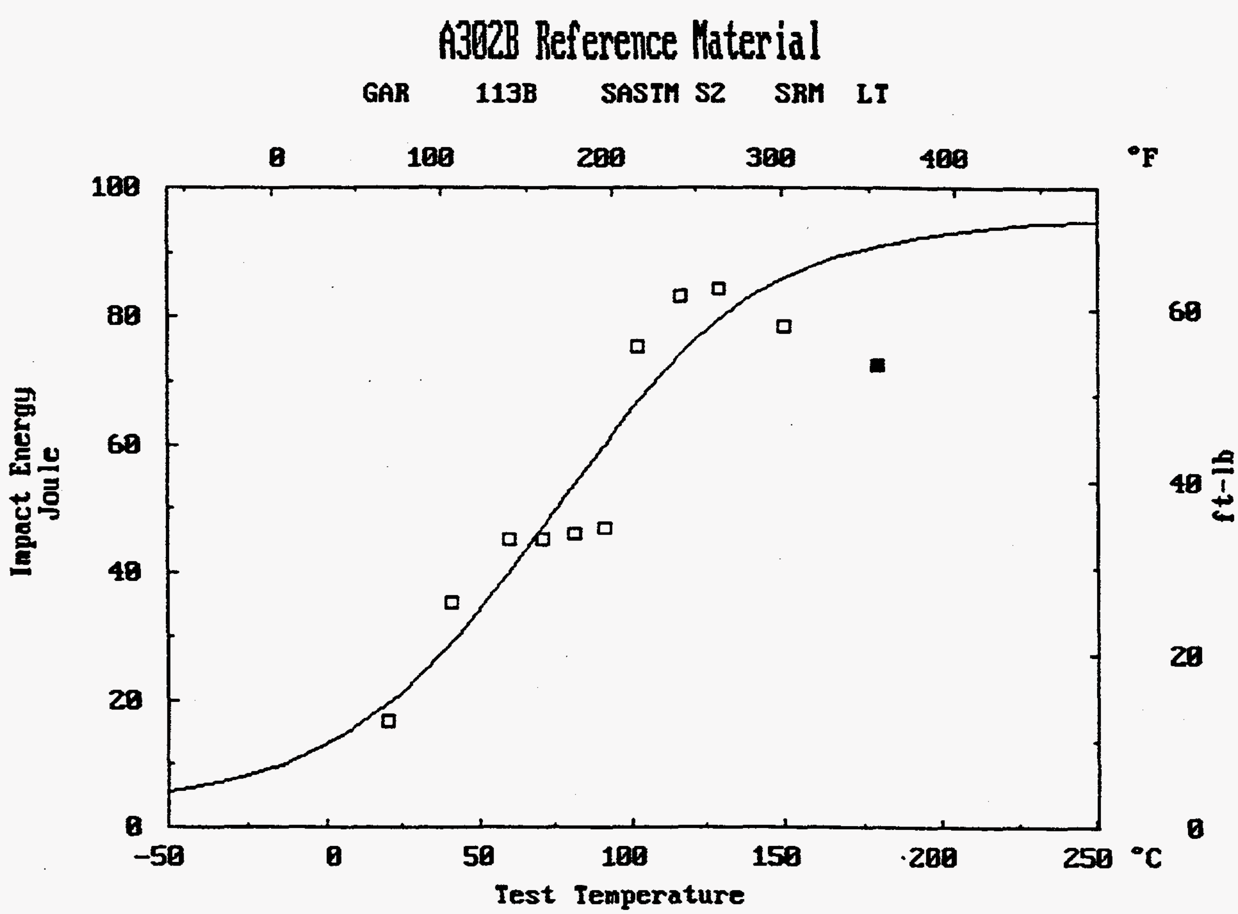
| Parameter | Mean | Std.Dev. | Correlation Coefficients | | | | |
|---|---|---|---|---|---|---|---|
| Lower Shelf Energy (J) | 3.0 | 0.0 | | | | | |
| Upper Shelf Energy (J) | 105.9 | 13.5 | 0.015 | | | | |
| CVT at Midpoint (C) | 87.6 | 9.8 | 0.147 | 0.810 | | | |
| 1/slope (C) | 48.0 | 14.6 | 0.006 | 0.714 | 0.514 | | |
| CVT at 41 Joule (C) | 74.2 | 6.7 | 0.183 | -0.041 | 0.486 | -0.424 | |
| CVT at 68 Joule (C) | 100.2 | 6.1 | 0.197 | 0.279 | 0.707 | 0.403 | 0.572 |



## A302B REFERENCE MATERIAL
Garigliano, Capsule 113B

USE= 95.5 J, LSE= 3.0 J, CVT(1/2)= 74.C , Slope = 0.0144
CVT(41J) = 61. C , CVT(68J) = 104. C ,
Fluence = 1.100E+19 , Irr. Temp. = -17 C

| Spec. ID | Test Temp. C | Test Temp. F | Impact Energy J | Impact Energy ft-lb | Lat. Exp. mm | Lat. Exp. mil | % Shear |
|---|---|---|---|---|---|---|---|
| Y7E | 21. | 69. | 17. | 12. | 0.30 | 12. | 10. |
| Y7B | 41. | 106. | 35. | 26. | 0.51 | 20. | 20. |
| Y7M | 60. | 140. | 45. | 33. | 0.86 | 34. | 30. |
| Y7T | 71. | 160. | 45. | 33. | | | 30. |
| Y7Y | 81. | 178. | 46. | 34. | 0.66 | 26. | 40. |
| Y7L | 91. | 196. | 47. | 35. | 0.91 | 36. | 40. |
| Y7K | 102. | 216. | 76. | 56. | 1.17 | 46. | 70. |
| Y7P | 116. | 241. | 83. | 62. | 1.22 | 48. | 80. |
| Y7J | 129. | 264. | 84. | 62. | | | 60. |
| Y7U | 150. | 302. | 78. | 58. | 1.30 | 51. | 50. |
| *Y7C | 180. | 356. | 73. | 53. | 1.24 | 49. | 50. |



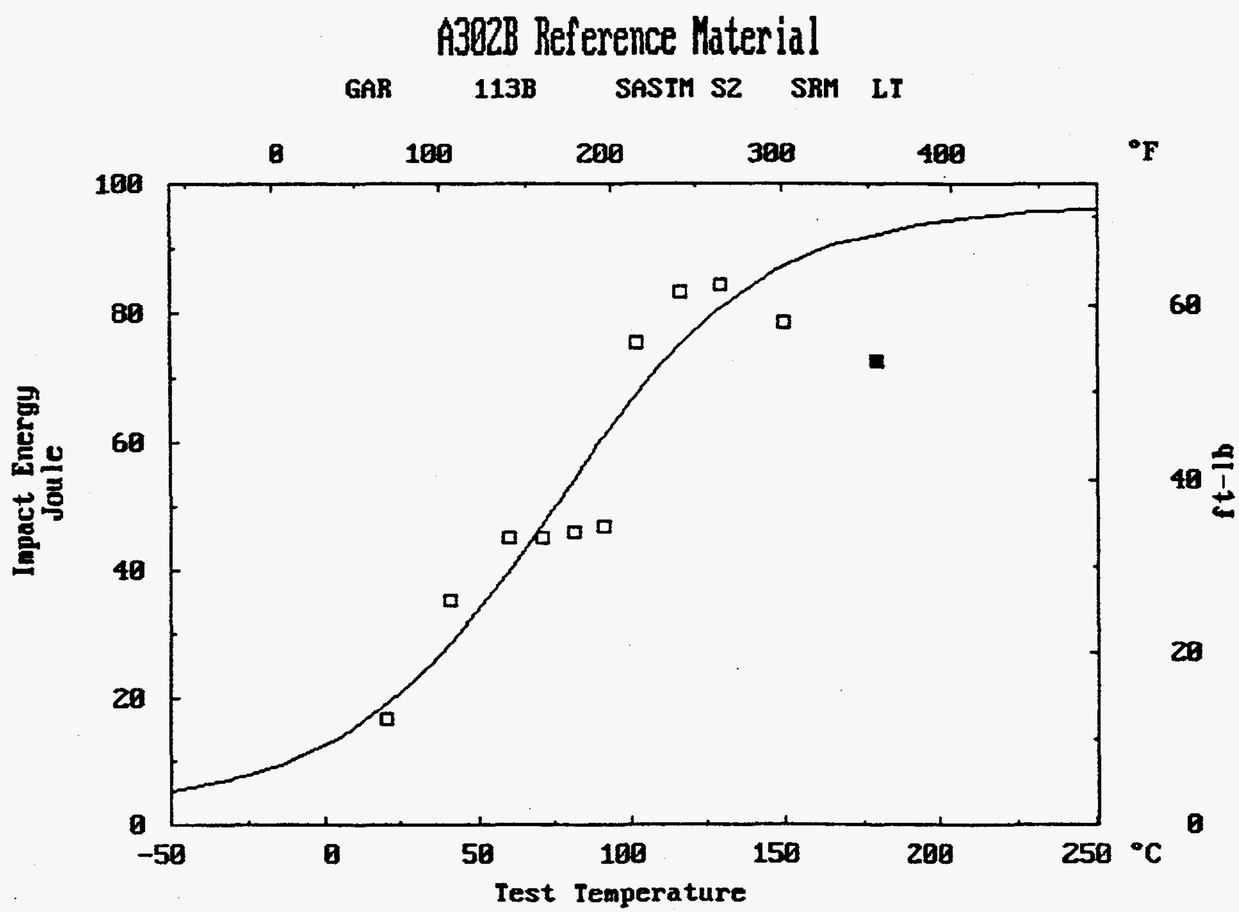
A302B REFERENCE MATERIAL

Garigliano, Capsule 113B

Impact Energy Uncertainty = 10.0 J
Test Temperature Uncertainty = 4.0 Degree C
Number of Successful Iterations = 200, Maximum = 1000

GAR 113B SASTM S2 SRM LT : Fluence = 1.100E+19 , Irr. Temp. = -17

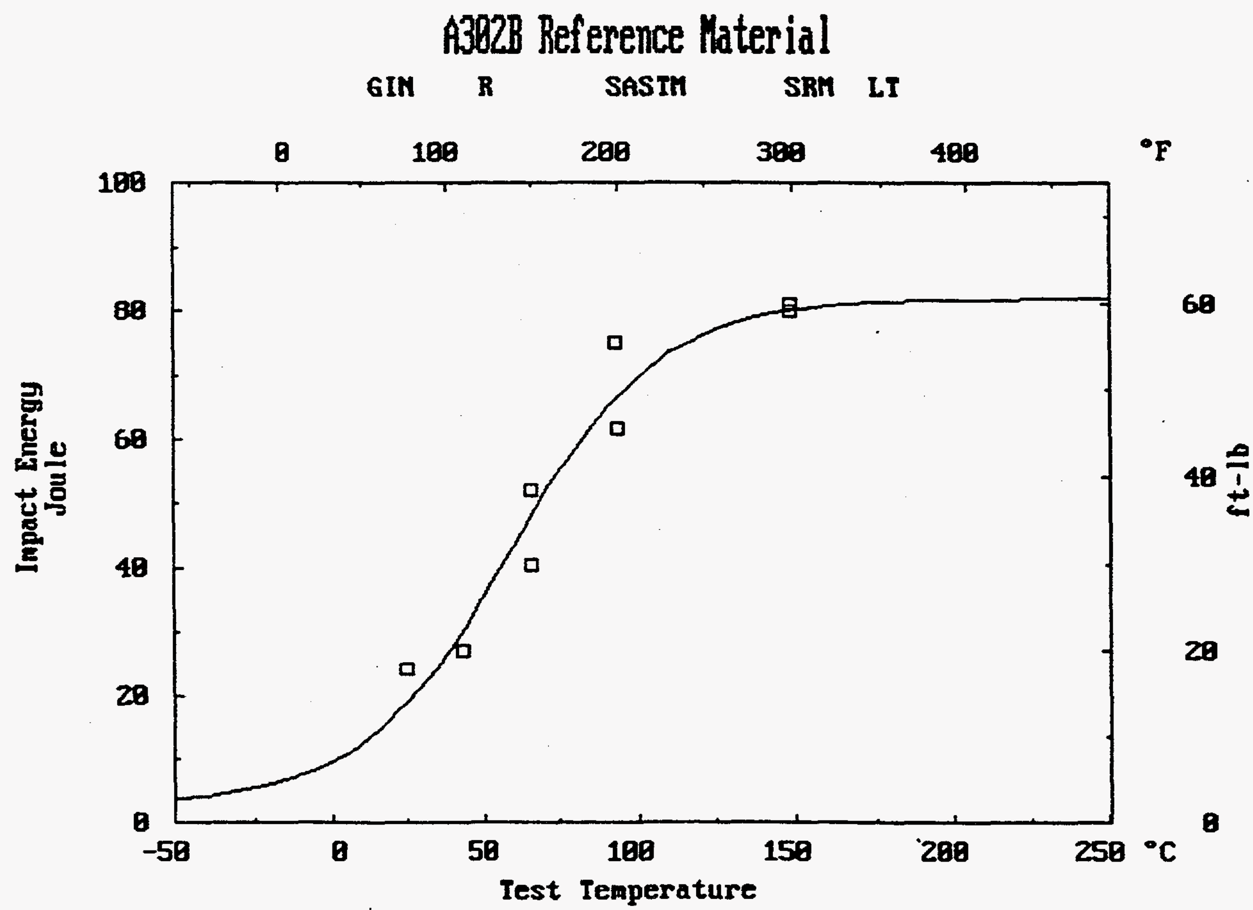
| Parameter | Mean | Std.Dev. | Correlation Coefficients | | | | |
|---|---|---|---|---|---|---|---|
| Lower Shelf Energy (J) | 3.0 | 0.0 | | | | | |
| Upper Shelf Energy (J) | 96.6 | 14.9 | 0.113 | | | | |
| CVT at Midpoint (C) | 74.7 | 15.2 | 0.230 | 0.891 | | | |
| 1/slope (C) | 68.5 | 20.1 | -0.068 | 0.677 | 0.539 | | |
| CVT at 41 Joule (C) | 61.1 | 7.9 | 0.357 | 0.175 | 0.557 | -0.280 | |
| CVT at 68 Joule (C) | 104.5 | 8.9 | 0.004 | -0.031 | 0.214 | 0.372 | 0.266 |



## A302B REFERENCE MATERIAL
R. E. Ginna Unit 1, Capsule R

```
USE=  82.1 J, LSE=   3.0 J, CVT(1/2)=    59.C , Slope = 0.0204
CVT(41J) =    57. C , CVT(68J) =   96. C ,
Fluence = 7.600E+18 , Irr. Temp. = 288 C
```

| Spec. ID | Test Temp. C | Test Temp. F | Impact Energy J | Impact Energy ft-lb | Lat. Exp. mm | Lat. Exp. mil | % Shear |
|---|---|---|---|---|---|---|---|
| R12 | 25. | 77. | 24. | 18. | 0.43 | 17. | 15. |
| R10 | 43. | 110. | 27. | 20. | 0.53 | 21. | 20. |
| R11 | 66. | 150. | 52. | 38. | 0.91 | 36. | 40. |
| R16 | 66. | 150. | 41. | 30. | 0.69 | 27. | 40. |
| R9 | 93. | 199. | 75. | 55. | 1.27 | 50. | 75. |
| R14 | 93. | 200. | 62. | 45. | 1.07 | 42. | 70. |
| R13 | 149. | 300. | 80. | 59. | 1.55 | 61. | 99. |
| R15 | 149. | 300. | 81. | 60. | 1.47 | 58. | 100. |



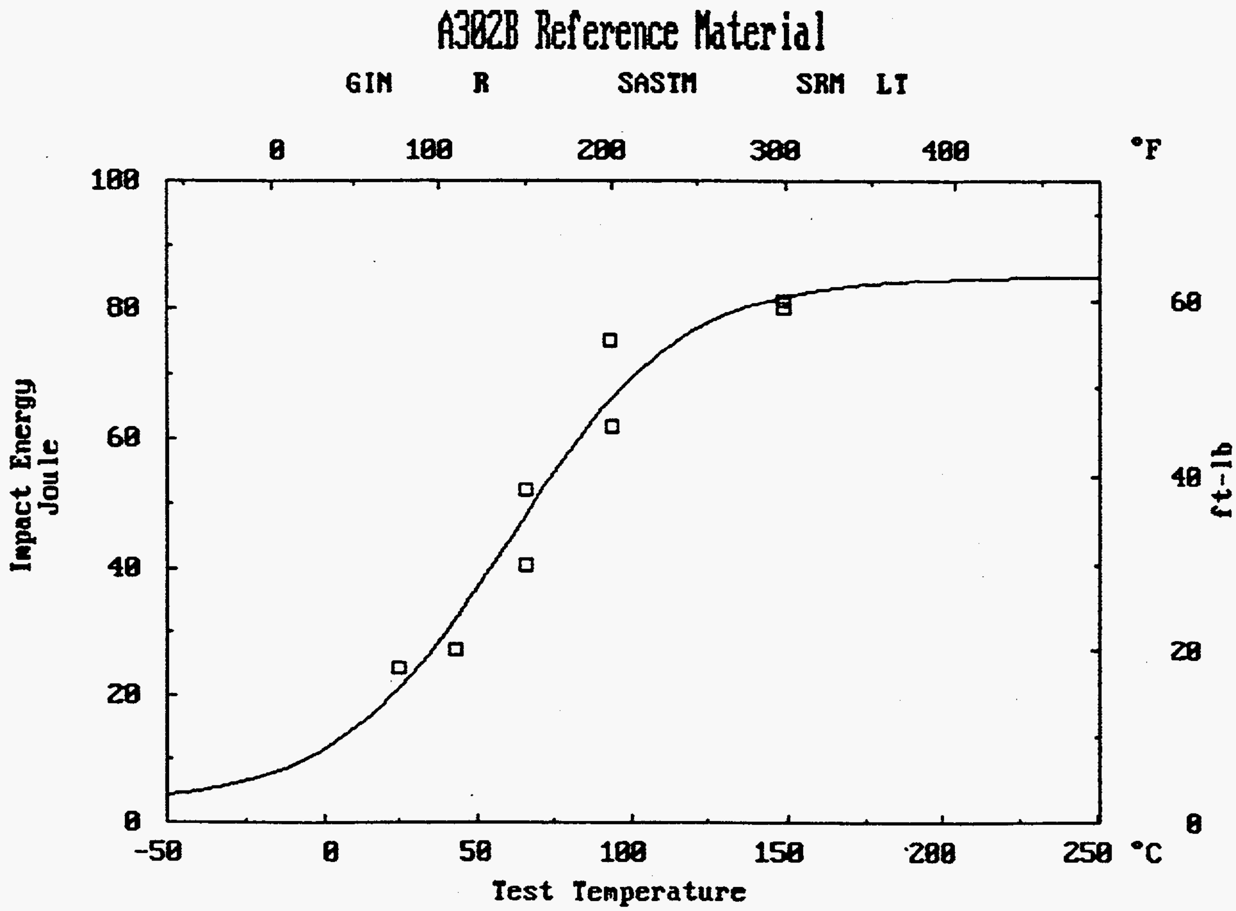
A302B REFERENCE MATERIAL

R. E. Ginna Unit 1, Capsule R

Impact Energy Uncertainty = 10.0 J
Test Temperature Uncertainty = 4.0 Degree C
Number of Successful Iterations = 200, Maximum = 1000

GIN R SASTM SRM LT : Fluence = 7.600E+18 , Irr. Temp. = 288

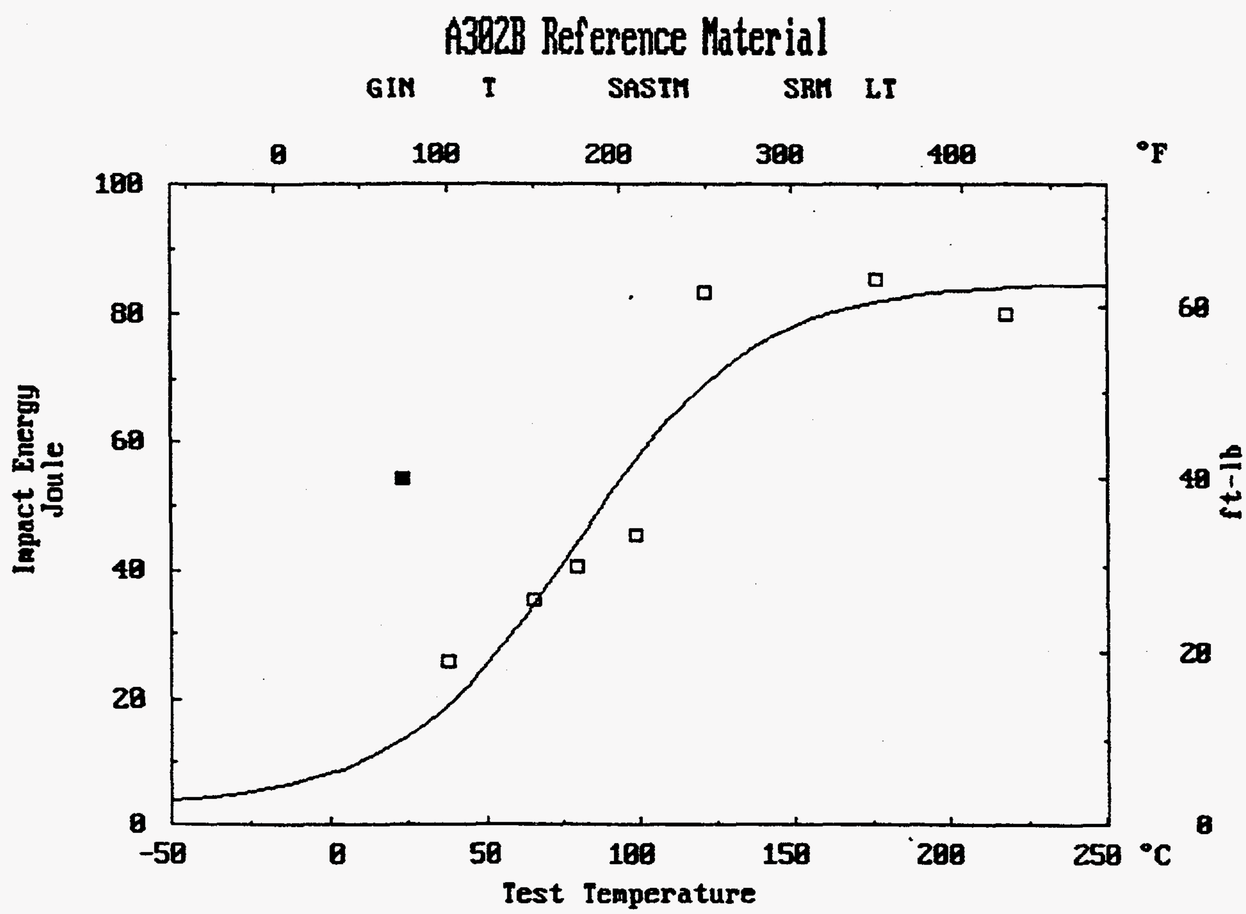
| Parameter | Mean | Std.Dev. | Correlation Coefficients | | | | |
|---|---|---|---|---|---|---|---|
| Lower Shelf Energy (J) | 3.0 | 0.0 | | | | | |
| Upper Shelf Energy (J) | 85.2 | 8.4 | 0.011 | | | | |
| CVT at Midpoint (C) | 60.1 | 9.5 | 0.217 | 0.678 | | | |
| 1/slope (C) | 55.7 | 17.9 | -0.178 | 0.562 | 0.175 | | |
| CVT at 41 Joule (C) | 55.4 | 7.4 | 0.299 | 0.024 | 0.731 | -0.372 | |
| CVT at 68 Joule (C) | 98.5 | 11.5 | -0.032 | -0.149 | 0.120 | 0.503 | 0.200 |



## A302B REFERENCE MATERIAL
R. E. Ginna Unit 1, Capsule T

USE= 84.8 J, LSE= 3.0 J, CVT(1/2)= 79.C , Slope = 0.0171
CVT(41J) = 75. C , CVT(68J) = 119. C ,
Fluence = 1.750E+19 , Irr. Temp. = 304 C

| Spec. ID | Test Temp. C | Test Temp. F | Impact Energy J | Impact Energy ft-lb | Lat. Exp. mm | Lat. Exp. mil | % Shear |
|---|---|---|---|---|---|---|---|
| *R20 | 24. | 75. | 54. | 40. | 0.63 | 25. | 53. |
| R24 | 38. | 100. | 26. | 19. | 0.33 | 13. | 15. |
| R22 | 66. | 150. | 35. | 26. | 0.74 | 29. | 41. |
| R23 | 79. | 175. | 41. | 30. | 0.71 | 28. | 44. |
| R19 | 99. | 210. | 45. | 33. | 0.63 | 25. | 48. |
| R18 | 121. | 250. | 83. | 62. | 1.22 | 48. | 100. |
| R17 | 177. | 350. | 85. | 63. | 1.24 | 49. | 100. |
| R21 | 218. | 425. | 80. | 59. | 1.09 | 43. | 100. |



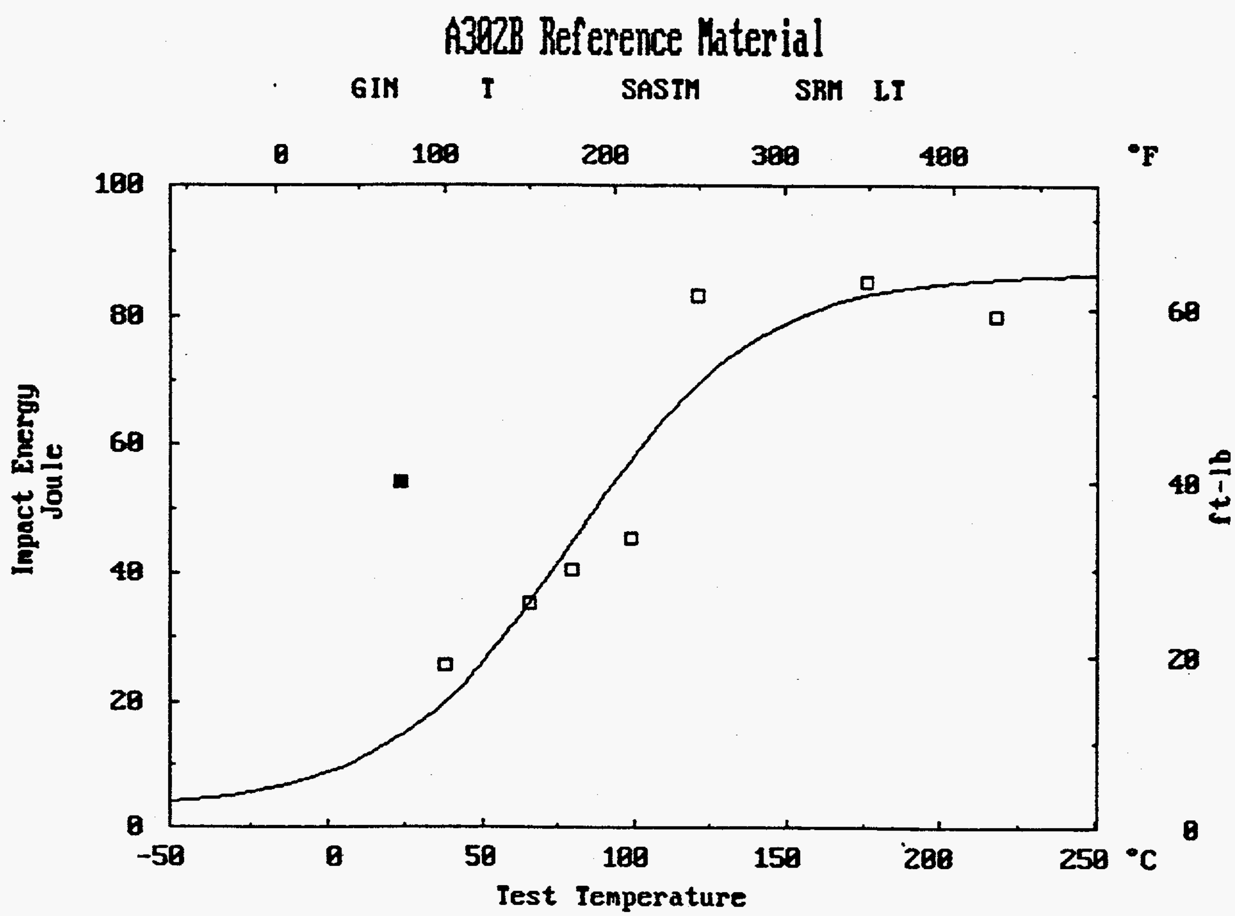
A302B REFERENCE MATERIAL

R. E. Ginna Unit 1, Capsule T

```
Impact Energy Uncertainty =  10.0 J
Test Temperature Uncertainty =   4.0 Degree C
Number of Successful Iterations =  200, Maximum = 1000
```

GIN T SASTM SRM LT : Fluence = 1.750E+19 , Irr. Temp. = 304

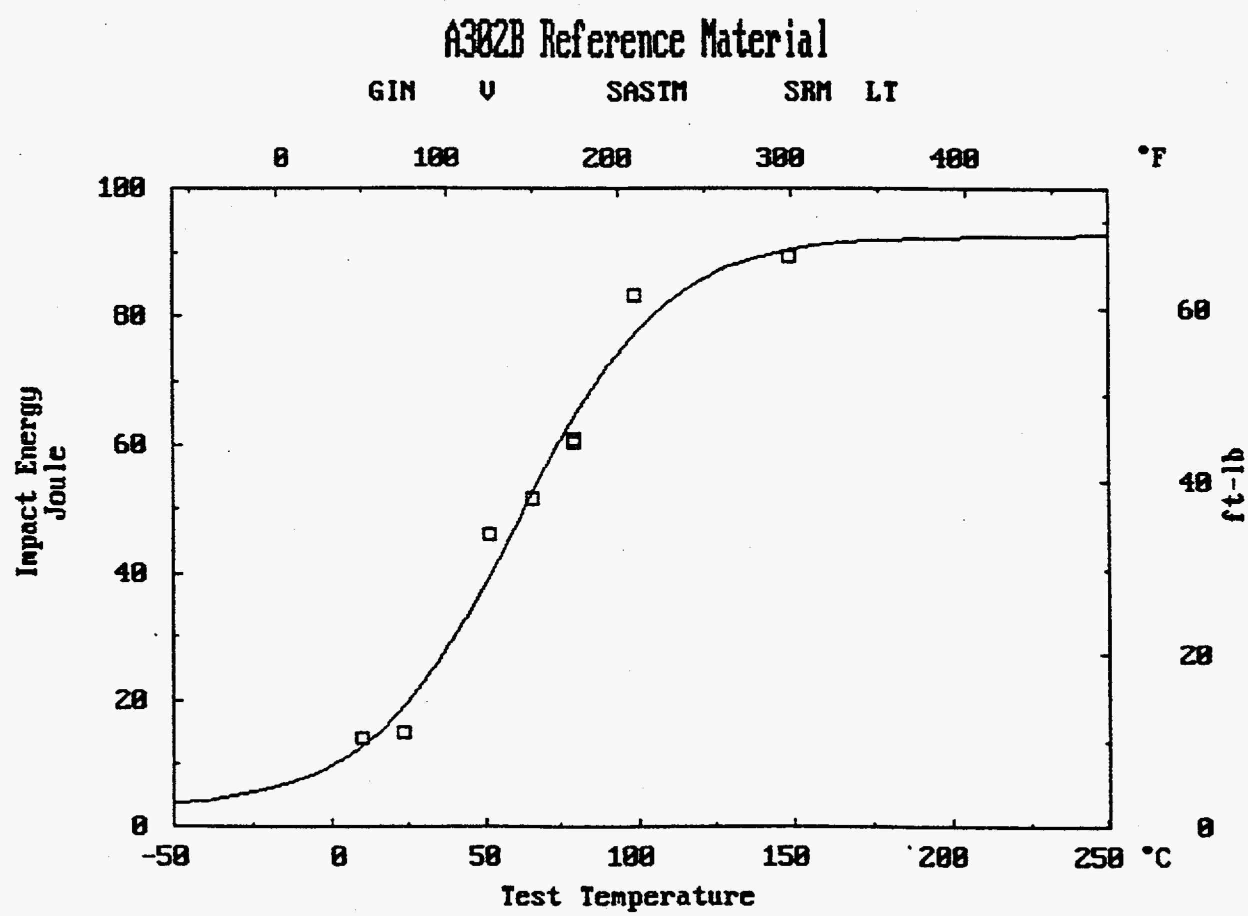
| Parameter | Mean | Std.Dev. | Correlation Coefficients | | | | |
|---|---|---|---|---|---|---|---|
| Lower Shelf Energy (J) | 3.0 | 0.0 | | | | | |
| Upper Shelf Energy (J) | 86.7 | 7.4 | 0.242 | | | | |
| CVT at Midpoint (C) | 79.7 | 11.3 | 0.310 | 0.625 | | | |
| 1/slope (C) | 60.7 | 19.5 | -0.246 | 0.228 | -0.137 | | |
| CVT at 41 Joule (C) | 74.1 | 9.3 | 0.317 | 0.132 | 0.832 | -0.477 | |
| CVT at 68 Joule (C) | 119.7 | 14.5 | -0.204 | -0.350 | -0.109 | 0.620 | -0.004 |



## A302B REFERENCE MATERIAL
R. E. Ginna Unit 1, Capsule V

USE= 92.8 J, LSE= 3.0 J, CVT(1/2)= 61.C , Slope = 0.0207
CVT(41J) = 53. C , CVT(68J) = 84. C ,
Fluence = 4.900E+18 , Irr. Temp. = 288 C

| Spec. ID | Test Temp. C | Test Temp. F | Impact Energy J | Impact Energy ft-lb | Lat. Exp. mm | Lat. Exp. mil | % Shear |
|---|---|---|---|---|---|---|---|
| R3 | 10. | 50. | 14. | 10. | 0.25 | 10. | |
| R1 | 24. | 75. | 15. | 11. | 0.28 | 11. | |
| R5 | 52. | 125. | 46. | 34. | 0.76 | 30. | |
| R4 | 66. | 150. | 52. | 38. | 0.84 | 33. | |
| R7 | 79. | 175. | 61. | 45. | 1.07 | 42. | |
| R8 | 79. | 175. | 60. | 44. | 1.04 | 41. | |
| R2 | 99. | 210. | 83. | 62. | 1.30 | 51. | |
| R6 | 149. | 300. | 89. | 66. | 1.30 | 51. | |



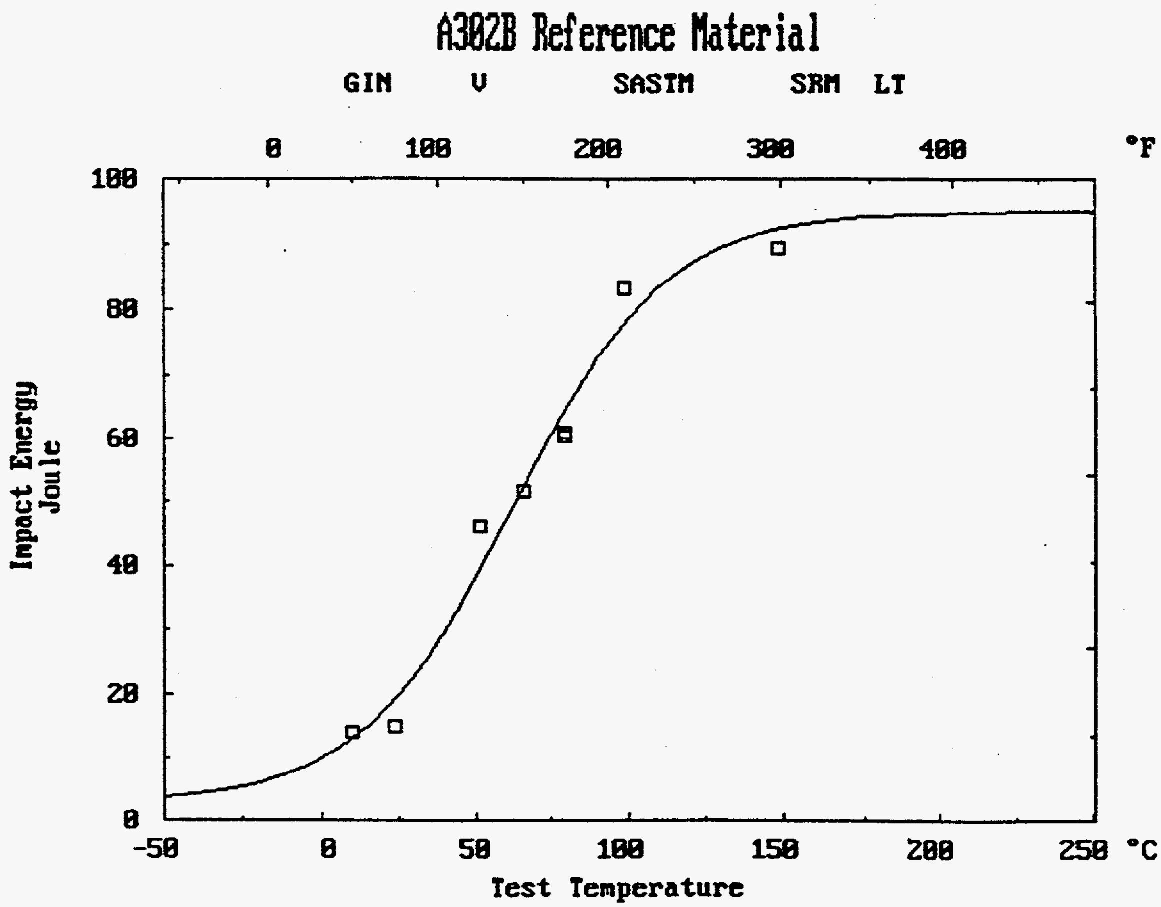
A302B REFERENCE MATERIAL

R. E. Ginna Unit 1, Capsule V

```
Impact Energy Uncertainty =  10.0 J
Test Temperature Uncertainty =   4.0 Degree C
Number of Successful Iterations =  200, Maximum = 1000


GIN   V     SASTM     SRM  LT : Fluence = 4.900E+18 , Irr. Temp. =  288
```

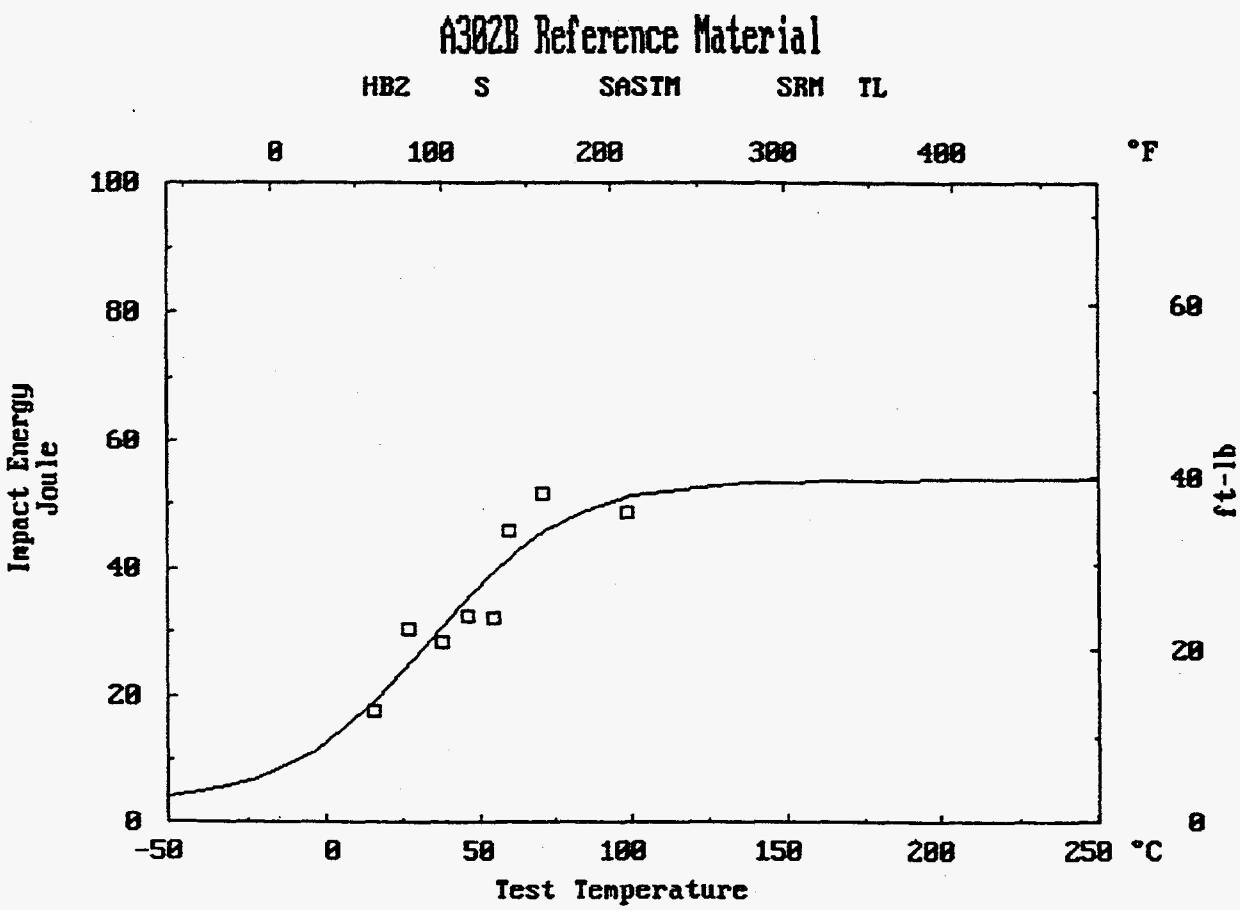
| Parameter | Mean | Std.Dev. | Correlation Coefficients | | | | |
|---|---|---|---|---|---|---|---|
| Lower Shelf Energy (J) | 3.0 | 0.0 | | | | | |
| Upper Shelf Energy (J) | 95.2 | 11.1 | 0.095 | | | | |
| CVT at Midpoint (C) | 62.2 | 9.1 | 0.174 | 0.770 | | | |
| 1/slope (C) | 49.6 | 13.5 | 0.046 | 0.464 | 0.361 | | |
| CVT at 41 Joule (C) | 53.3 | 6.1 | 0.181 | 0.096 | 0.651 | -0.279 | |
| CVT at 68 Joule (C) | 85.1 | 9.1 | 0.115 | -0.202 | 0.184 | 0.466 | 0.305 |



A302B REFERENCE MATERIAL
H. B. Robinson Unit 2, Capsule S

```
USE=  53.9 J, LSE=   3.0 J, CVT(1/2)=   34.C , Slope = 0.0217
CVT(41J) =    59. C , CVT(68J) =****** C ,
Fluence = 3.690E+18 , Irr. Temp. = 304 C
```

| Spec. ID | Test Temp. C | Test Temp. F | Impact Energy J | Impact Energy ft-lb | Lat. Exp. mm | Lat. Exp. mil | % Shear |
|---|---|---|---|---|---|---|---|
| R1 | 16. | 60. | 18. | 13. | 0.28 | 11. | |
| R3 | 27. | 80. | 30. | 22. | 0.51 | 20. | |
| R6 | 38. | 100. | 28. | 21. | 0.51 | 20. | |
| R4 | 46. | 115. | 33. | 24. | 0.58 | 23. | |
| R7 | 54. | 130. | 32. | 24. | 0.61 | 24. | |
| R5 | 60. | 140. | 46. | 34. | 0.74 | 29. | |
| R2 | 71. | 160. | 52. | 38. | 1.02 | 40. | |
| R8 | 99. | 210. | 49. | 36. | 0.97 | 38. | |



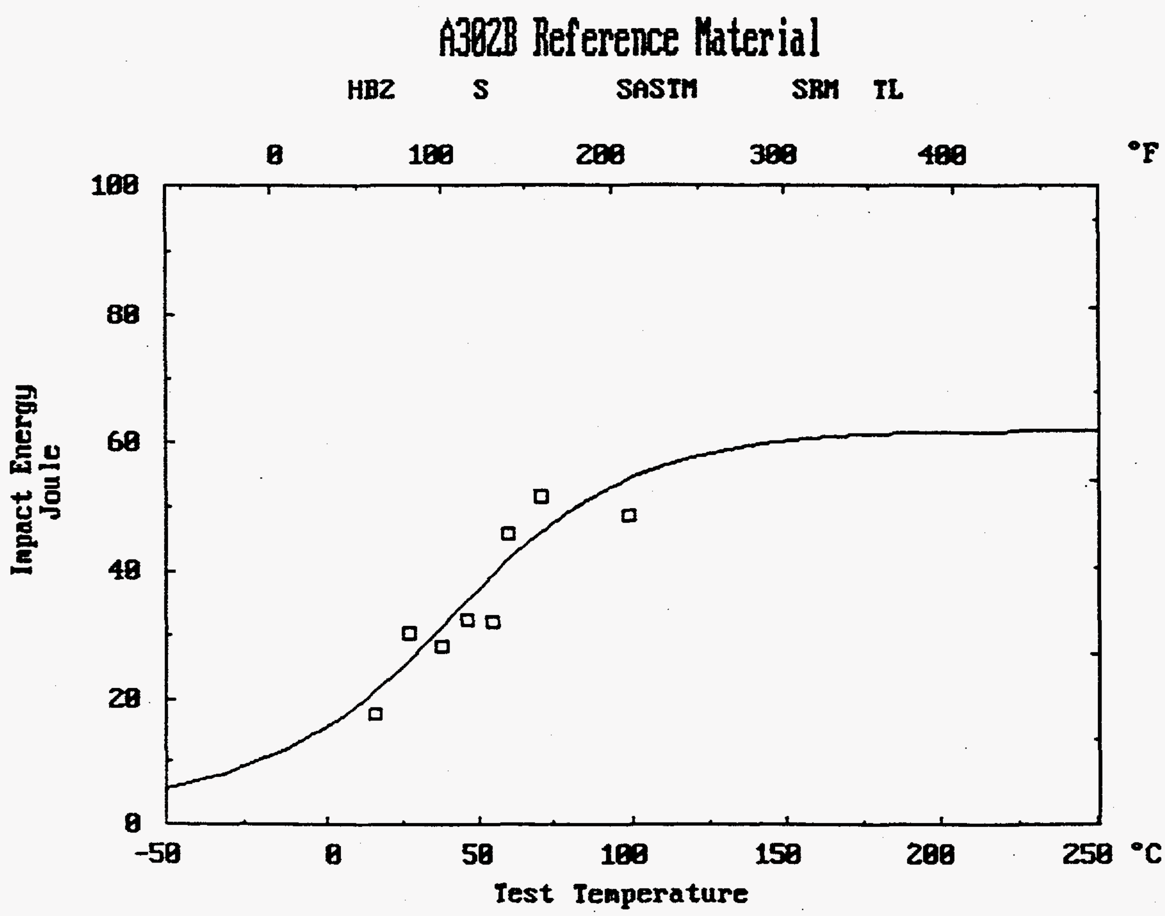
A302B REFERENCE MATERIAL

H. B. Robinson Unit 2, Capsule S

```
Impact Energy Uncertainty =  10.0 J
Test Temperature Uncertainty =   4.0 Degree C
Number of Successful Iterations =  200, Maximum = 1000
```

HB2 S SASTM SRM TL : Fluence = 3.690E+18 , Irr. Temp. = 304

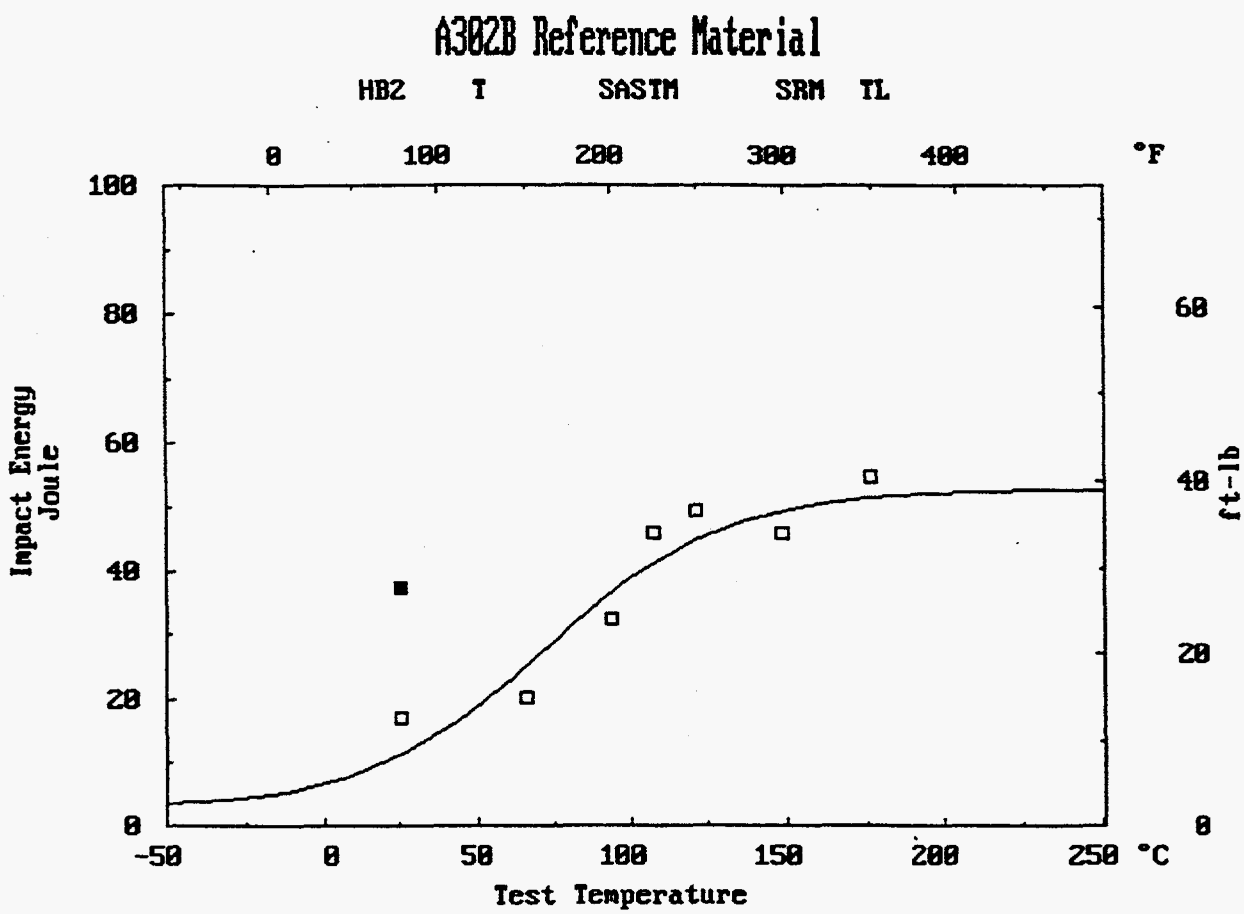
| Parameter | Mean | Std.Dev. | Correlation Coefficients | | | |
|---|---|---|---|---|---|---|
| Lower Shelf Energy (J) | 3.0 | 0.0 | | | | |
| Upper Shelf Energy (J) | 61.7 | 10.1 | 0.284 | | | |
| CVT at Midpoint (C) | 40.2 | 13.7 | 0.344 | 0.789 | | |
| 1/slope (C) | 60.0 | 21.1 | -0.006 | 0.273 | 0.098 | |
| CVT at 41 Joule (C) | 61.0 | 11.1 | 0.010 | -0.249 | 0.119 | 0.416 |



A302B REFERENCE MATERIAL
H. B. Robinson Unit 2, Capsule T

USE= 53.0 J, LSE= 3.0 J, CVT(1/2)= 73.C , Slope = 0.0174
CVT(41J) = 106. C , CVT(68J) =****** C ,
Fluence = 4.110E+19 , Irr. Temp. = 304 C

| Spec. ID | Test Temp. C | Test Temp. F | Impact Energy J | Impact Energy ft-lb | Lat. Exp. mm | Lat. Exp. mil | % Shear |
|---|---|---|---|---|---|---|---|
| R59 | 26. | 78. | 17. | 12. | 0.25 | 10. | 10. |
| *R63 | 26. | 78. | 37. | 27. | 0.56 | 22. | 15. |
| R62 | 66. | 150. | 20. | 15. | 0.28 | 11. | 35. |
| R64 | 93. | 200. | 33. | 24. | 0.53 | 21. | 45. |
| R58 | 107. | 225. | 46. | 34. | 0.81 | 32. | 96. |
| R60 | 121. | 250. | 49. | 36. | 0.89 | 35. | 99. |
| R61 | 149. | 300. | 46. | 34. | 0.81 | 32. | 100. |
| R57 | 177. | 350. | 55. | 40. | 0.94 | 37. | 100. |



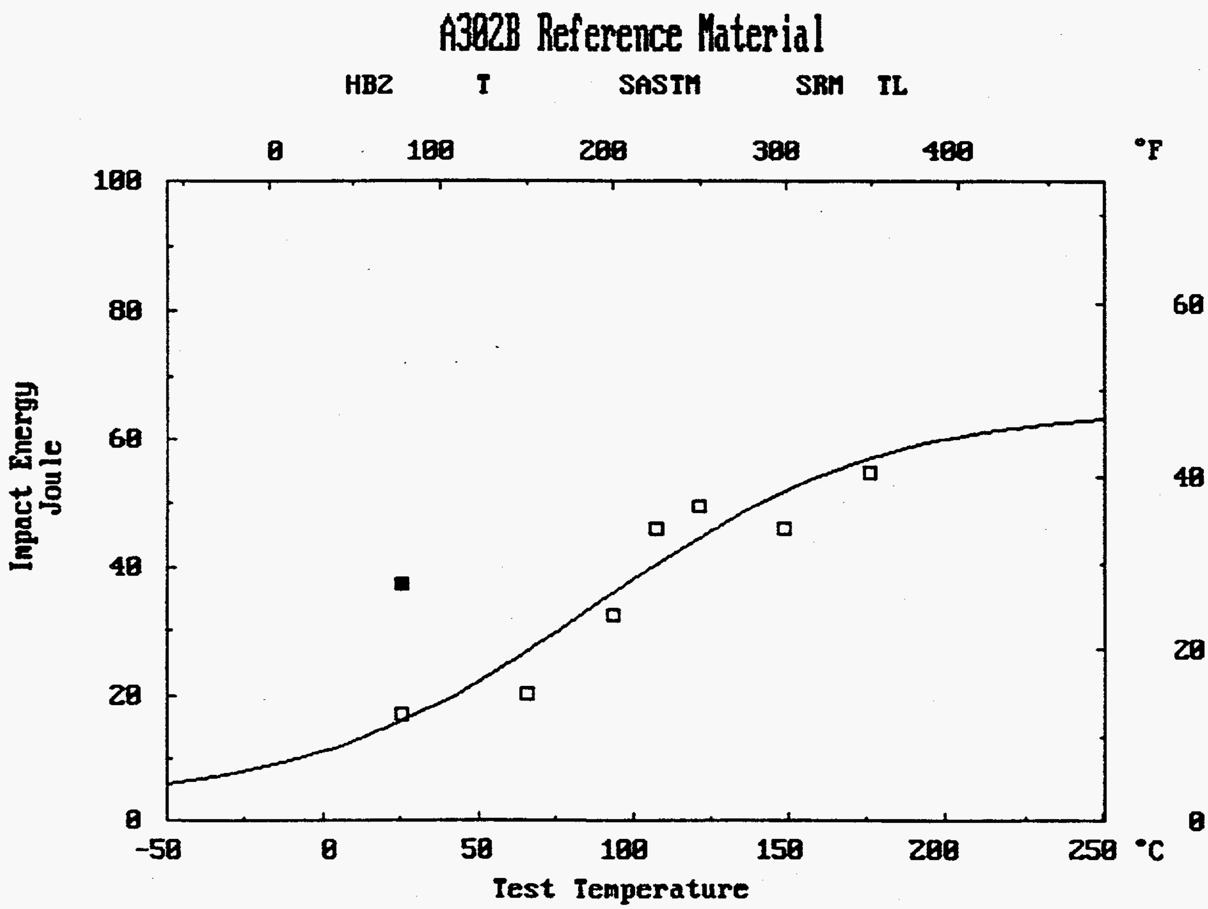
A302B REFERENCE MATERIAL

H. B. Robinson Unit 2, Capsule T

```
Impact Energy Uncertainty =  10.0 J
Test Temperature Uncertainty =   4.0 Degree C
Number of Successful Iterations =  200, Maximum = 1000
```

HB2 T SASTM SRM TL : Fluence = 4.110E+19 , Irr. Temp. = 304

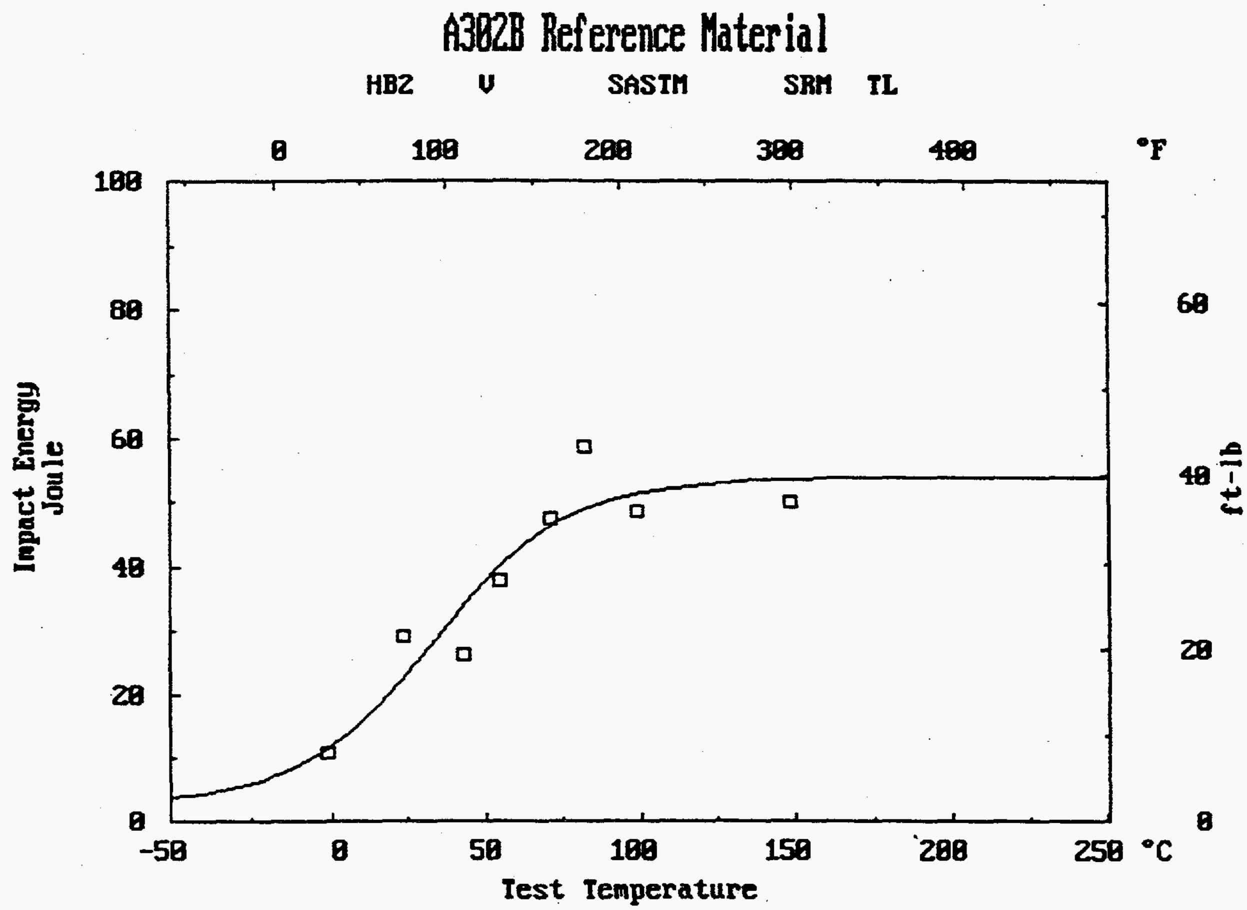
| Parameter | Mean | Std.Dev. | Correlation Coefficients | | | |
|---|---|---|---|---|---|---|
| Lower Shelf Energy (J) | 3.0 | 0.0 | | | | |
| Upper Shelf Energy (J) | 65.0 | 11.8 | 0.256 | | | |
| CVT at Midpoint (C) | 87.5 | 22.9 | 0.324 | 0.787 | | |
| 1/slope (C) | 92.2 | 29.5 | -0.070 | 0.424 | 0.292 | |
| CVT at 41 Joule (C) | 111.3 | 15.8 | 0.074 | -0.133 | 0.384 | 0.271 |



A302B REFERENCE MATERIAL
H. B. Robinson Unit 2, Capsule V

USE= 53.9 J, LSE= 3.0 J, CVT(1/2)= 33.C , Slope = 0.0232
CVT(41J) = 57. C , CVT(68J) =****** C ,
Fluence = 4.510E+18 , Irr. Temp. = 304 C

| Spec. ID | Test Temp. C | Test Temp. F | Impact Energy J | Impact Energy ft-lb | Lat. Exp. mm | Lat. Exp. mil | % Shear |
|---|---|---|---|---|---|---|---|
| R51 | -1. | 30. | 11. | 8. | 0.15 | 6. | 0. |
| R55 | 24. | 75. | 29. | 21. | 0.48 | 19. | 5. |
| R54 | 43. | 110. | 26. | 19. | 0.48 | 19. | 5. |
| R52 | 54. | 130. | 38. | 28. | 0.66 | 26. | 10. |
| R56 | 71. | 160. | 47. | 35. | 0.84 | 33. | 15. |
| R49 | 82. | 180. | 59. | 43. | 1.09 | 43. | 100. |
| R53 | 99. | 210. | 49. | 36. | 0.86 | 34. | 20. |
| R50 | 149. | 300. | 50. | 37. | 1.04 | 41. | 100. |



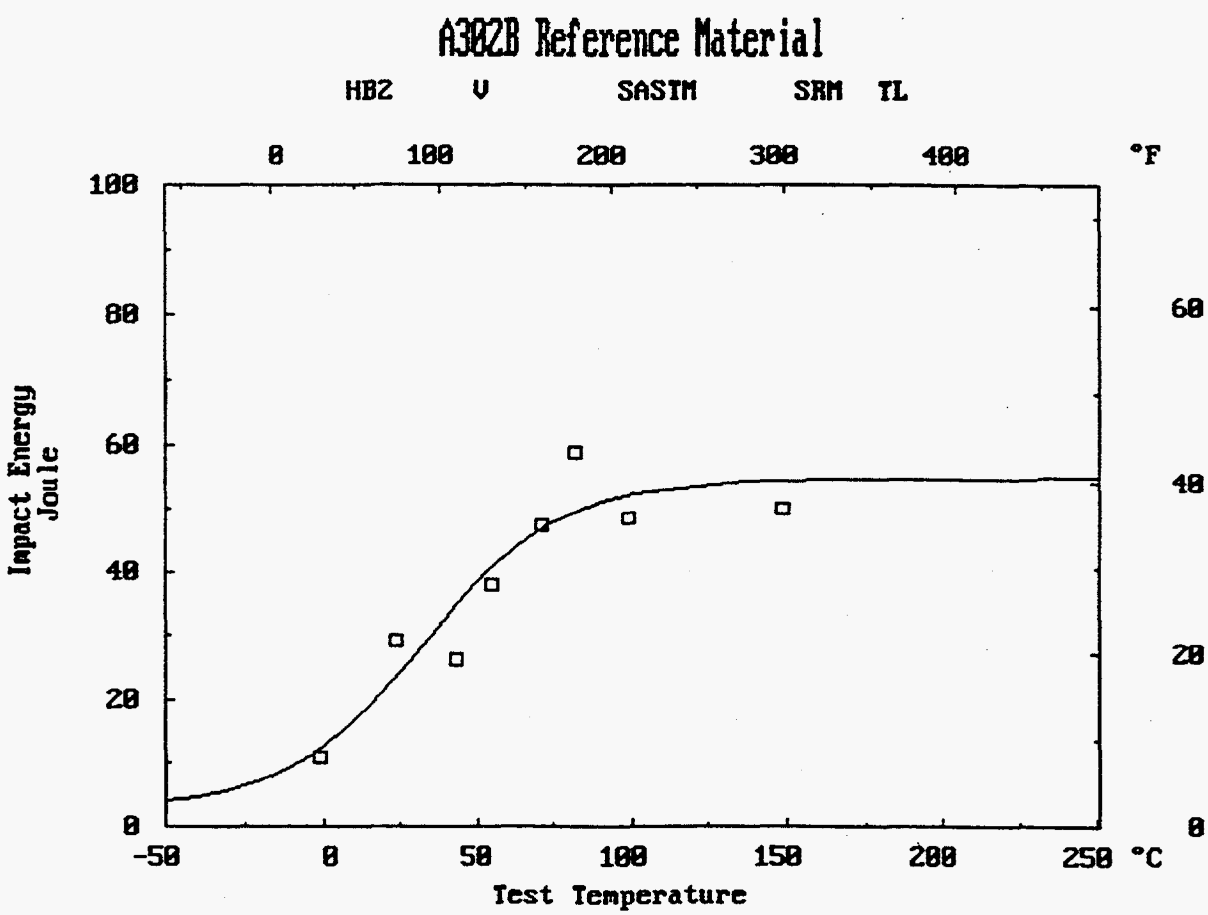
A302B REFERENCE MATERIAL

H. B. Robinson Unit 2, Capsule V

Impact Energy Uncertainty = 10.0 J
Test Temperature Uncertainty = 4.0 Degree C
Number of Successful Iterations = 200, Maximum = 1000

HB2 V SASTM SRM TL : Fluence = 4.510E+18 , Irr. Temp. = 304

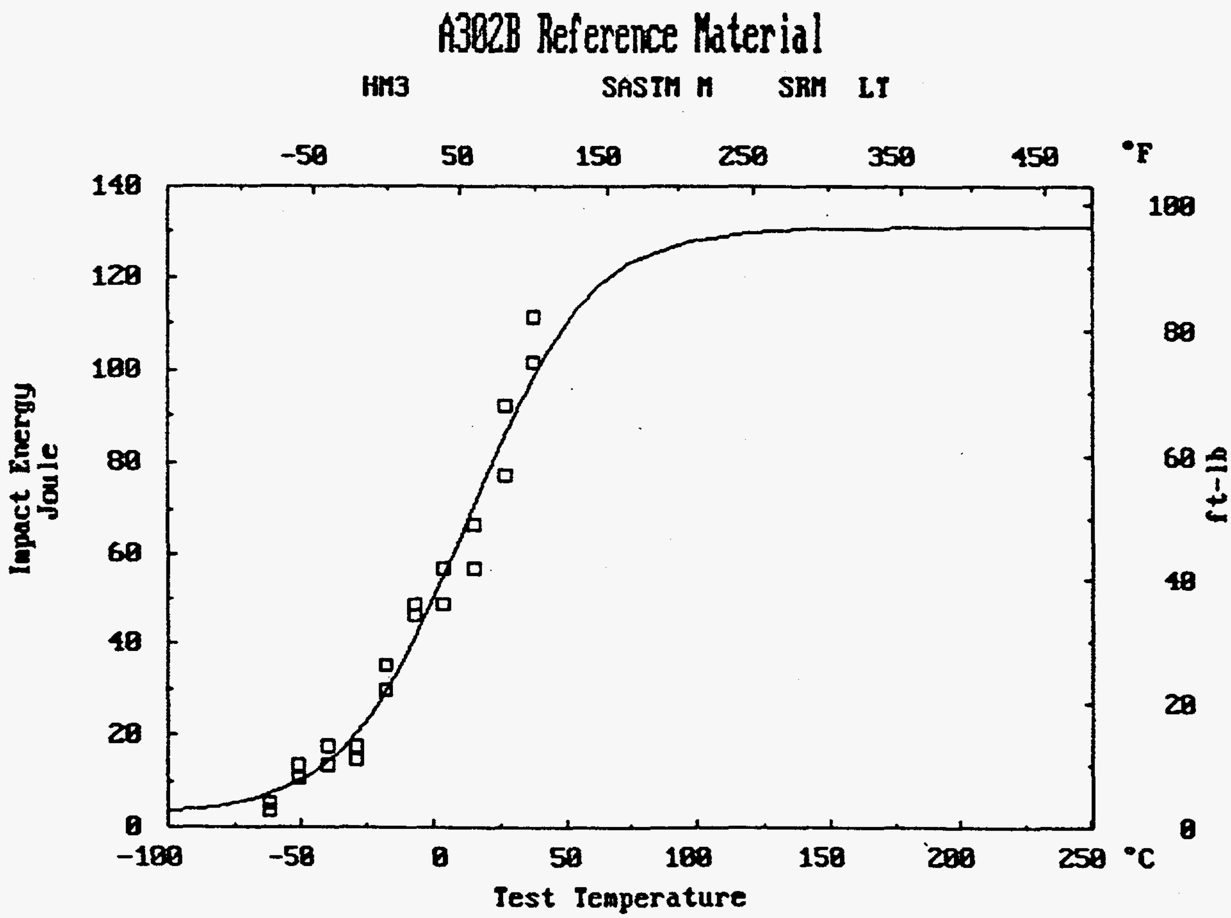
| Parameter | Mean | Std.Dev. | Correlation Coefficients | | | |
|---|---|---|---|---|---|---|
| Lower Shelf Energy (J) | 3.0 | 0.0 | | | | |
| Upper Shelf Energy (J) | 55.0 | 6.8 | 0.177 | | | |
| CVT at Midpoint (C) | 33.0 | 14.0 | 0.285 | 0.659 | | |
| 1/slope (C) | 44.4 | 14.5 | -0.072 | 0.363 | -0.003 | |
| CVT at 41 Joule (C) | 57.2 | 11.1 | 0.152 | -0.070 | 0.443 | 0.316 |



A302B REFERENCE MATERIAL, Humbolt Unit 3, Baseline (Longitudinal Direction)

USE= 130.8 J, LSE= 3.0 J, CVT(1/2)= 13.C , Slope = 0.0221
Unirradiated Charpy SpecimenCVT(41J) = -7. C , CVT(68J) = 14. C

| Spec. ID | Test Temp. C | Test Temp. F | Impact Energy J | Impact Energy ft-lb | Lat. Exp. mm | Lat. Exp. mil | % Shear |
|---|---|---|---|---|---|---|---|
| | -62. | -80. | 4. | 3. | 0.15 | 6. | 2. |
| | -62. | -80. | 5. | 4. | 0.20 | 8. | 2. |
| | -51. | -60. | 11. | 8. | 0.18 | 7. | 3. |
| | -51. | -60. | 14. | 10. | 0.20 | 8. | 3. |
| | -40. | -40. | 14. | 10. | 0.28 | 11. | 10. |
| | -40. | -40. | 18. | 13. | 0.28 | 11. | 10. |
| | -29. | -20. | 15. | 11. | 0.38 | 15. | 20. |
| | -29. | -20. | 18. | 13. | 0.46 | 18. | 20. |
| | -18. | 0. | 30. | 22. | 0.56 | 22. | 35. |
| | -18. | 0. | 35. | 26. | 0.66 | 26. | 35. |
| | -7. | 20. | 46. | 34. | 0.81 | 32. | 40. |
| | -7. | 20. | 49. | 36. | 0.86 | 34. | 40. |
| | 4. | 40. | 49. | 36. | 0.86 | 34. | 45. |
| | 4. | 40. | 57. | 42. | 0.97 | 38. | 45. |
| | 16. | 60. | 57. | 42. | 0.94 | 37. | 50. |
| | 16. | 60. | 66. | 49. | 1.09 | 43. | 50. |
| | 27. | 80. | 77. | 57. | 1.30 | 51. | 65. |
| | 27. | 80. | 92. | 68. | 1.45 | 57. | 80. |
| | 38. | 100. | 102. | 75. | 1.63 | 64. | 98. |
| | 38. | 100. | 111. | 82. | 1.83 | 72. | 100. |



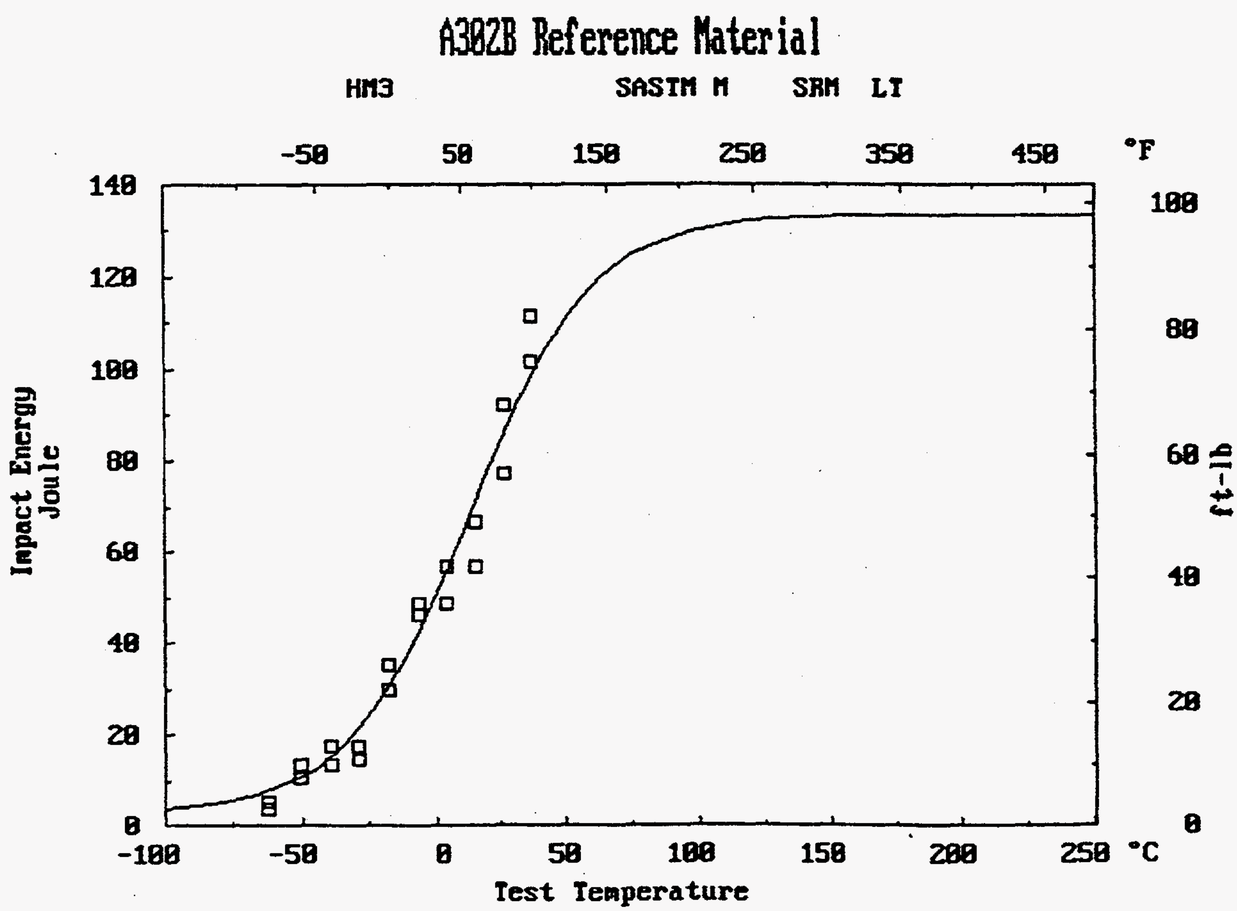
A302B REFERENCE MATERIAL

Humbolt Unit 3, Baseline (Longitudinal Direction)

```
Impact Energy Uncertainty =  10.0 J
Test Temperature Uncertainty =   4.0 Degree C
Number of Successful Iterations =  200, Maximum = 1000
```

HM3 SASTM M SRM LT

| Parameter | Mean | Std.Dev. | Correlation Coefficients | | | | |
|---|---|---|---|---|---|---|---|
| Lower Shelf Energy (J) | 3.0 | 0.1 | | | | | |
| Upper Shelf Energy (J) | 133.4 | 23.2 | 0.136 | | | | |
| CVT at Midpoint (C) | 13.5 | 9.6 | 0.179 | 0.948 | | | |
| 1/slope (C) | 47.0 | 7.2 | -0.013 | 0.694 | 0.741 | | |
| CVT at 41 Joule (C) | -7.3 | 3.2 | 0.312 | 0.316 | 0.520 | -0.016 | |
| CVT at 68 Joule (C) | 13.9 | 3.2 | 0.185 | 0.256 | 0.531 | 0.479 | 0.702 |

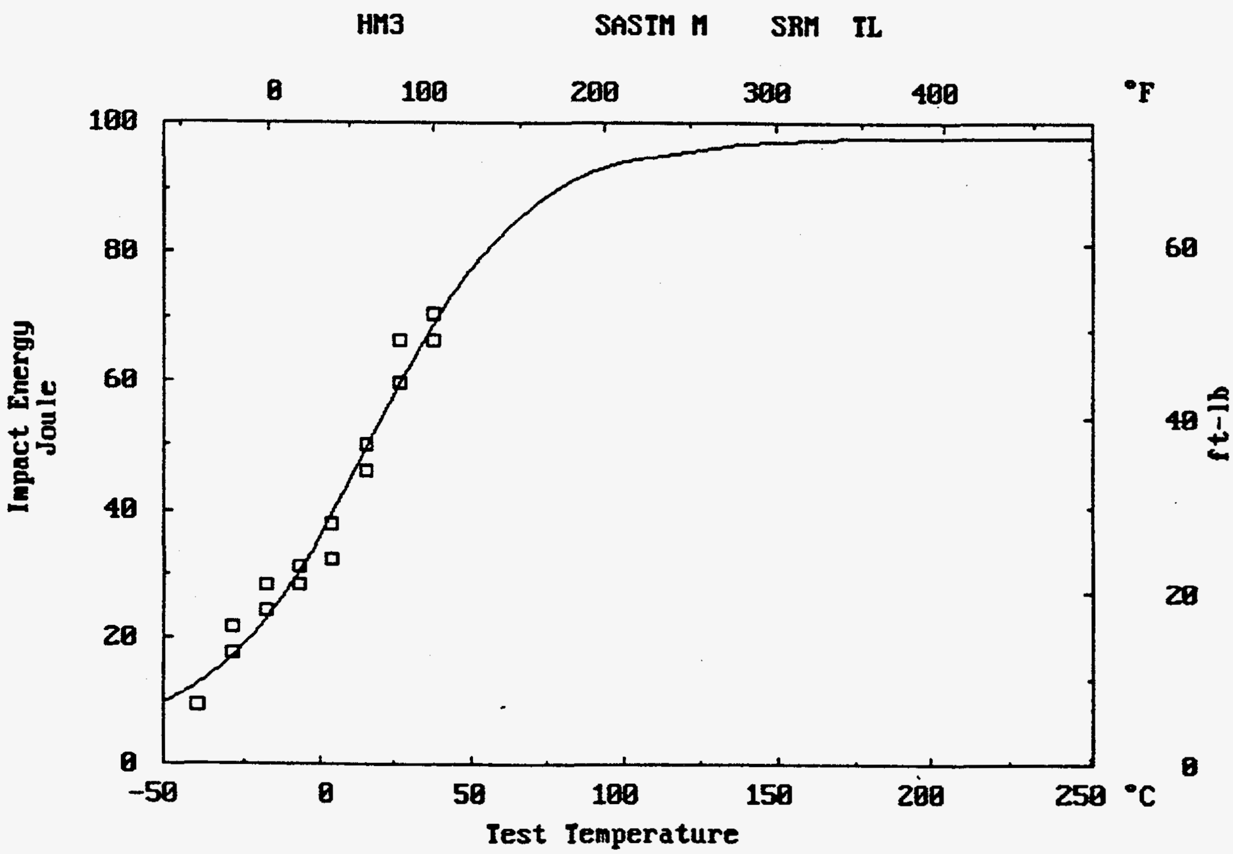


A302B REFERENCE MATERIAL
Humbolt Unit 3, Baseline (Transverse Direction)

USE= 97.9 J, LSE= 3.0 J, CVT(1/2)= 17.C , Slope = 0.0193
Unirradiated Charpy SpecimenCVT(41J) = 6. C , CVT(68J) = 37. C

| Spec. ID | Test Temp. C | Test Temp. F | Impact Energy J | Impact Energy ft-lb | Lat. Exp. mm | Lat. Exp. mil | % Shear |
|---|---|---|---|---|---|---|---|
| | -40. | -40. | 9. | 7. | 0.23 | 9. | 10. |
| | -40. | -40. | 9. | 7. | 0.28 | 11. | 10. |
| | -29. | -20. | 18. | 13. | 0.36 | 14. | 15. |
| | -29. | -20. | 18. | 13. | 0.41 | 16. | 15. |
| | -29. | -20. | 22. | 16. | 0.43 | 17. | 25. |
| | -18. | 0. | 24. | 18. | 0.51 | 20. | 30. |
| | -18. | 0. | 28. | 21. | 0.56 | 22. | 35. |
| | -7. | 20. | 28. | 21. | 0.66 | 26. | 40. |
| | -7. | 20. | 31. | 23. | 0.76 | 30. | 40. |
| | 4. | 40. | 33. | 24. | 0.76 | 30. | 50. |
| | 4. | 40. | 38. | 28. | 0.76 | 30. | 50. |
| | 16. | 60. | 46. | 34. | 0.89 | 35. | 60. |
| | 16. | 60. | 50. | 37. | 0.99 | 39. | 75. |
| | 27. | 80. | 60. | 44. | 1.24 | 49. | 75. |
| | 27. | 80. | 66. | 49. | 1.32 | 52. | 90. |
| | 38. | 100. | 66. | 49. | 1.27 | 50. | 95. |
| | 38. | 100. | 70. | 52. | 1.30 | 51. | 95. |

A302B Reference Material



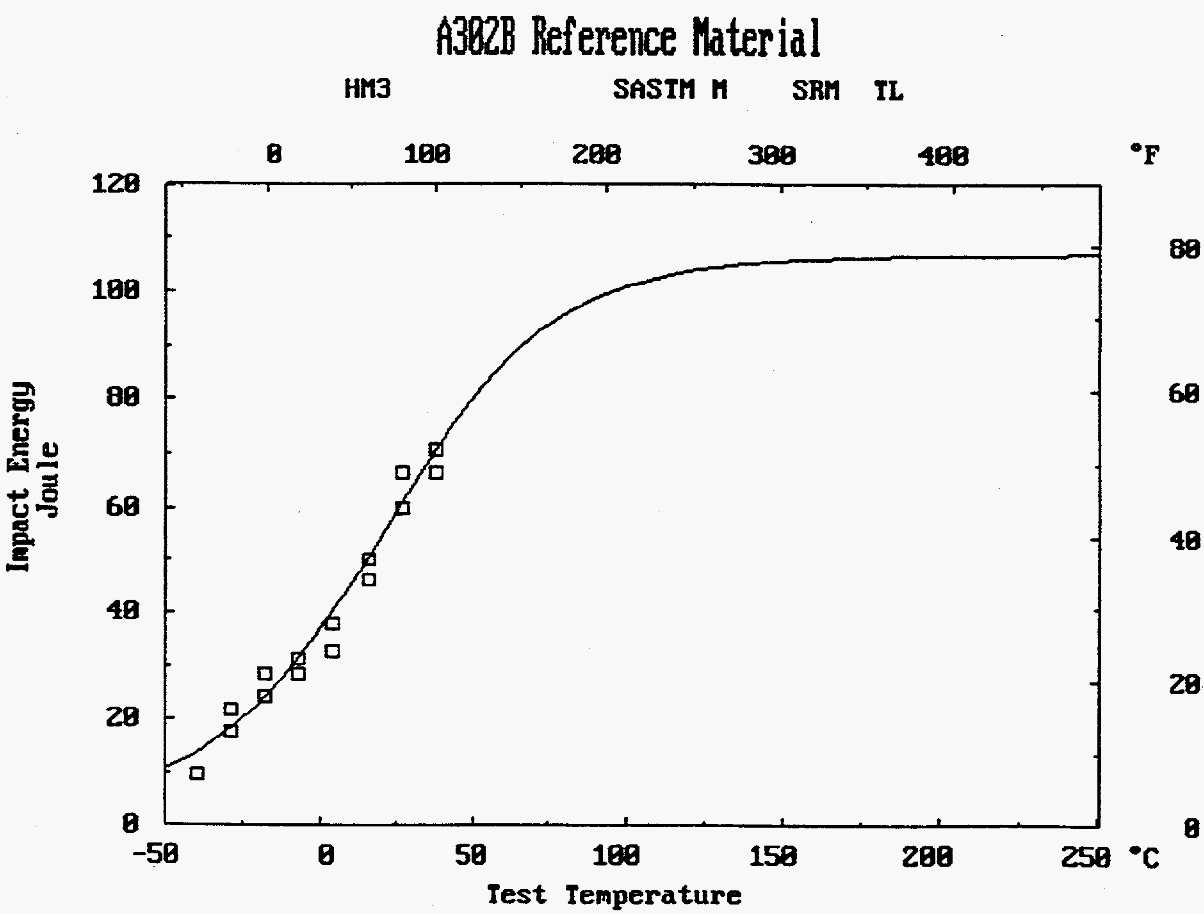
A302B REFERENCE MATERIAL

Humbolt Unit 3, Baseline (Transverse Direction)

```
Impact Energy Uncertainty =  10.0 J
Test Temperature Uncertainty =   4.0 Degree C
Number of Successful Iterations =  200, Maximum = 1000
```

HM3 SASTM M SRM TL

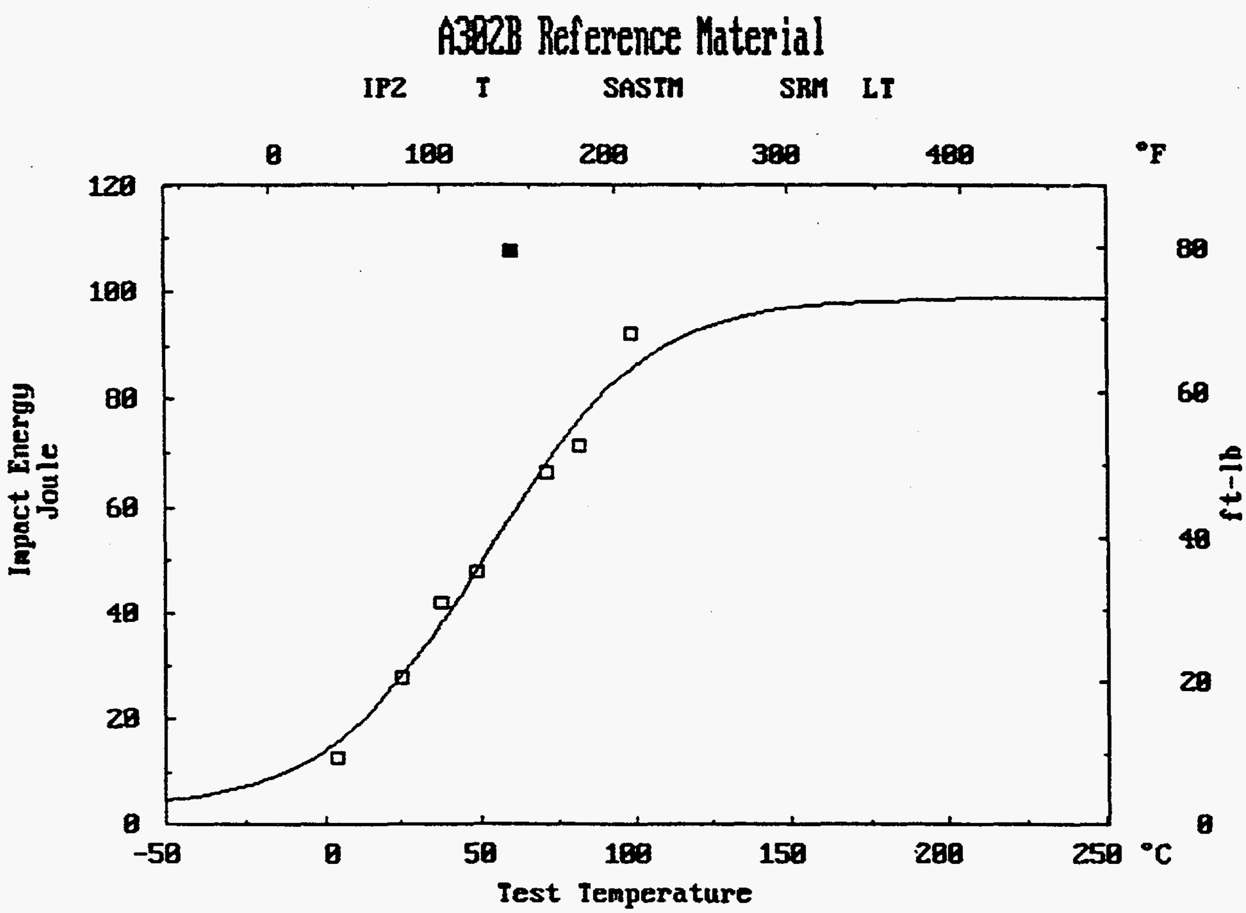
| Parameter | Mean | Std.Dev. | Correlation Coefficients | | | | |
|---|---|---|---|---|---|---|---|
| Lower Shelf Energy (J) | 3.0 | 0.0 | | | | | |
| Upper Shelf Energy (J) | 106.8 | 23.0 | 0.413 | | | | |
| CVT at Midpoint (C) | 20.3 | 13.6 | 0.405 | 0.936 | | | |
| 1/slope (C) | 55.8 | 12.2 | 0.147 | 0.570 | 0.700 | | |
| CVT at 41 Joule (C) | 5.5 | 3.8 | 0.256 | 0.313 | 0.537 | 0.185 | |
| CVT at 68 Joule (C) | 38.6 | 8.7 | -0.160 | -0.458 | -0.258 | 0.238 | 0.202 |



A302B REFERENCE MATERIAL
Indian Point Unit 2, Capsule T

USE= 98.9 J, LSE= 3.0 J, CVT(1/2)= 52.C , Slope = 0.0197
CVT(41J) = 41. C , CVT(68J) = 71. C ,
Fluence = 2.020E+18 , Irr. Temp. = 304 C

| Spec. ID | Test Temp. C | Test Temp. F | Impact Energy J | Impact Energy ft-lb | Lat. Exp. mm | Lat. Exp. mil | % Shear |
|---|---|---|---|---|---|---|---|
| R5 | 4. | 40. | 13. | 9. | 0.23 | 9. | 0. |
| R1 | 26. | 78. | 28. | 20. | 0.46 | 18. | 5. |
| R6 | 38. | 100. | 42. | 31. | 0.69 | 27. | 10. |
| R4 | 49. | 120. | 48. | 35. | 0.81 | 32. | 15. |
| *R7 | 60. | 140. | 108. | 79. | 1.68 | 66. | 100. |
| R3 | 71. | 160. | 66. | 49. | 1.04 | 41. | 70. |
| R8 | 82. | 180. | 71. | 52. | 1.02 | 40. | 60. |
| R2 | 99. | 210. | 92. | 68. | 1.52 | 60. | 100. |



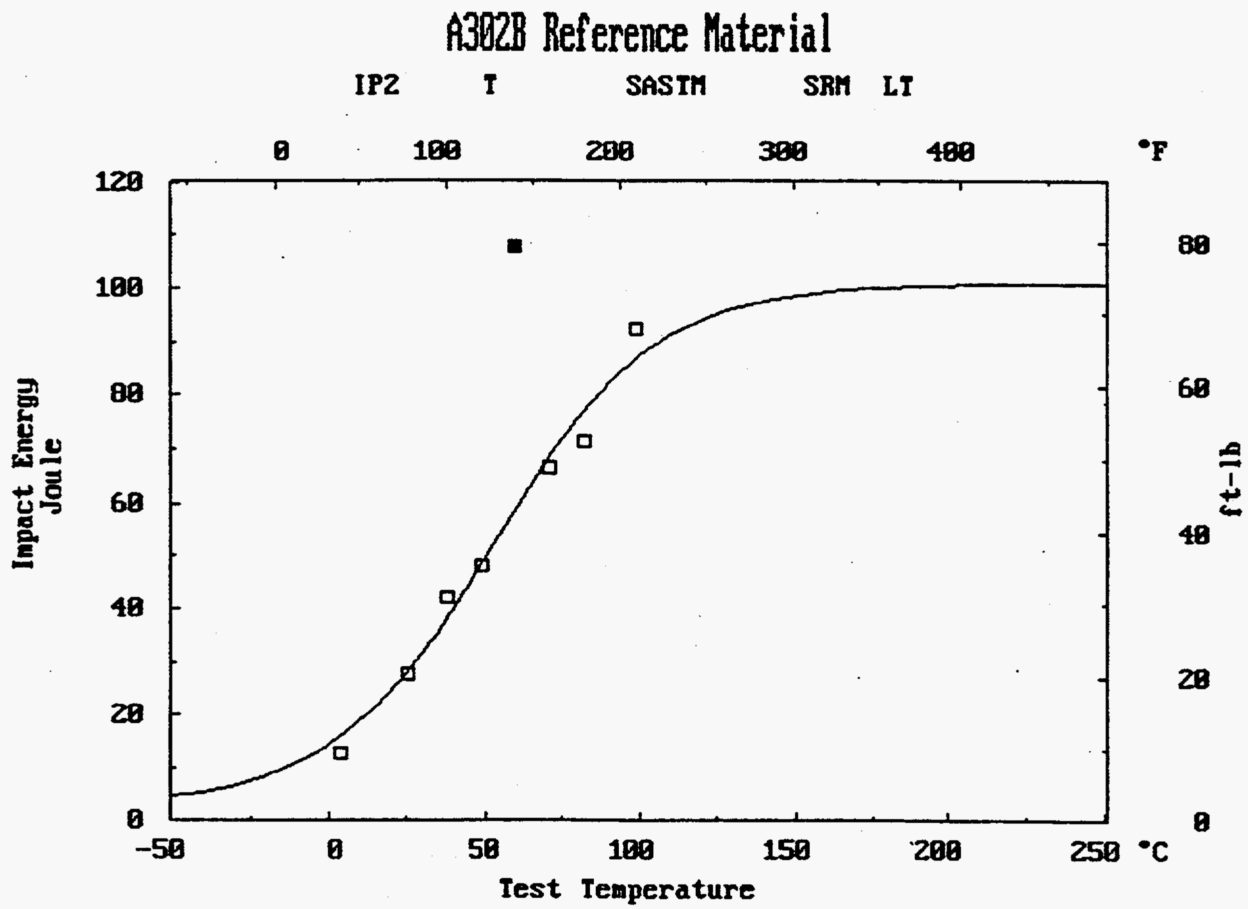
A302B REFERENCE MATERIAL

Indian Point Unit 2, Capsule T

```
Impact Energy Uncertainty =  10.0 J
Test Temperature Uncertainty =   4.0 Degree C
Number of Successful Iterations =  200, Maximum = 1000
```

```
IP2   T     SASTM     SRM  LT : Fluence = 2.020E+18 , Irr. Temp. =  304
```

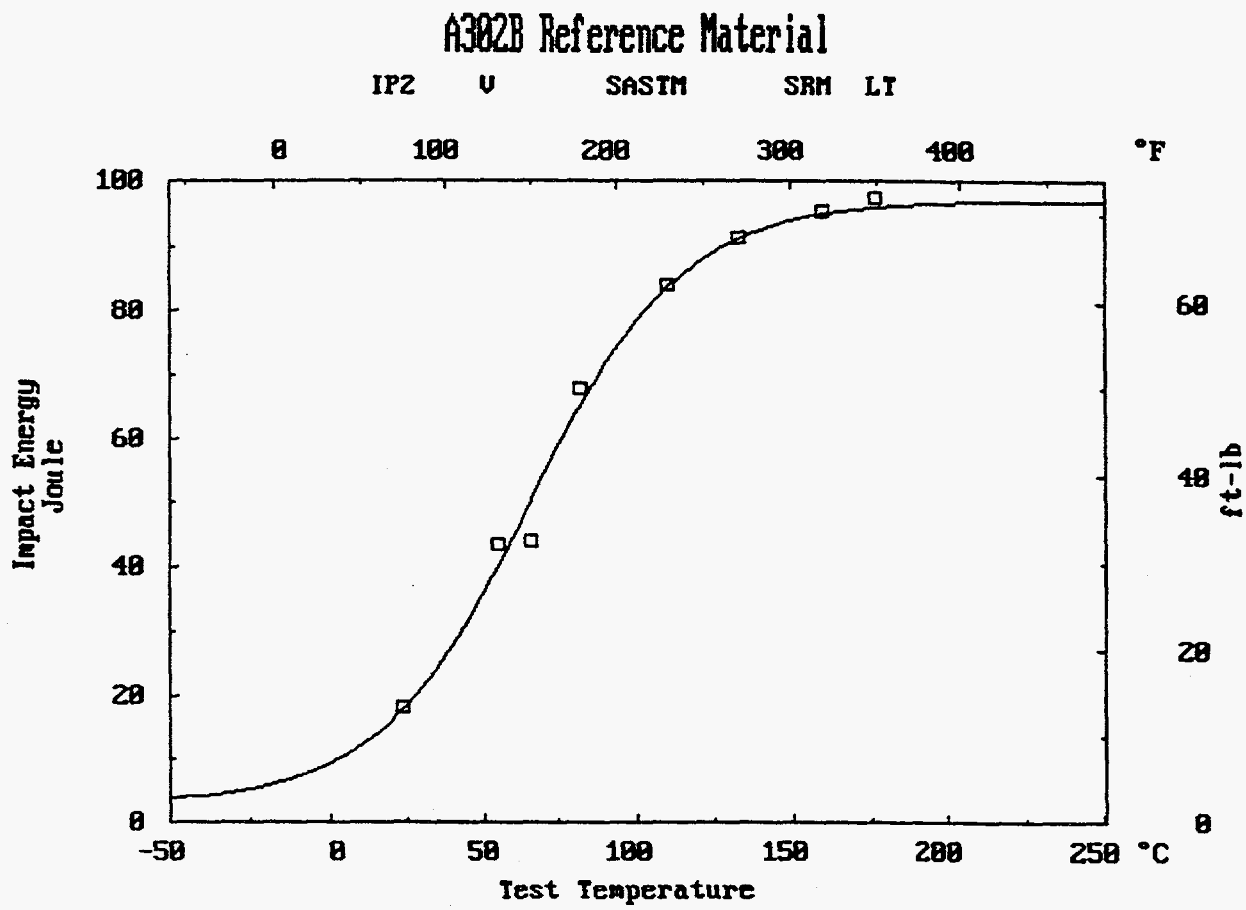
| Parameter | Mean | Std.Dev. | Correlation Coefficients | | | | |
|---|---|---|---|---|---|---|---|
| Lower Shelf Energy (J) | 3.0 | 0.0 | | | | | |
| Upper Shelf Energy (J) | 100.7 | 14.7 | 0.355 | | | | |
| CVT at Midpoint (C) | 52.8 | 10.6 | 0.340 | 0.818 | | | |
| 1/slope (C) | 51.5 | 12.2 | 0.155 | 0.432 | 0.392 | | |
| CVT at 41 Joule (C) | 41.2 | 6.5 | 0.131 | 0.211 | 0.687 | -0.154 | |
| CVT at 68 Joule (C) | 72.3 | 8.7 | -0.014 | -0.222 | 0.218 | 0.383 | 0.477 |



A302B REFERENCE MATERIAL
Indian Point Unit 2, Capsule V

USE= 97.1 J, LSE= 3.0 J, CVT(1/2)= 65.C , Slope = 0.0202
CVT(41J) = 56. C , CVT(68J) = 85. C ,
Fluence = 4.570E+18 , Irr. Temp. = 304 C

| Spec. ID | Test Temp. C | Test Temp. F | Impact Energy J | Impact Energy ft-lb | Lat. Exp. mm | Lat. Exp. mil | % Shear |
|---|---|---|---|---|---|---|---|
| R49 | 23. | 74. | 18. | 13. | 0.36 | 14. | 5. |
| R50 | 54. | 130. | 43. | 32. | 1.04 | 41. | 20. |
| R56 | 66. | 150. | 44. | 32. | 0.84 | 33. | 30. |
| R51 | 82. | 180. | 68. | 50. | 1.12 | 44. | 75. |
| R52 | 110. | 230. | 84. | 62. | 1.47 | 58. | 95. |
| R53 | 132. | 270. | 92. | 67. | 1.50 | 59. | 100. |
| R54 | 160. | 320. | 96. | 70. | 1.63 | 64. | 100. |
| R55 | 177. | 350. | 98. | 72. | 1.57 | 62. | 100. |



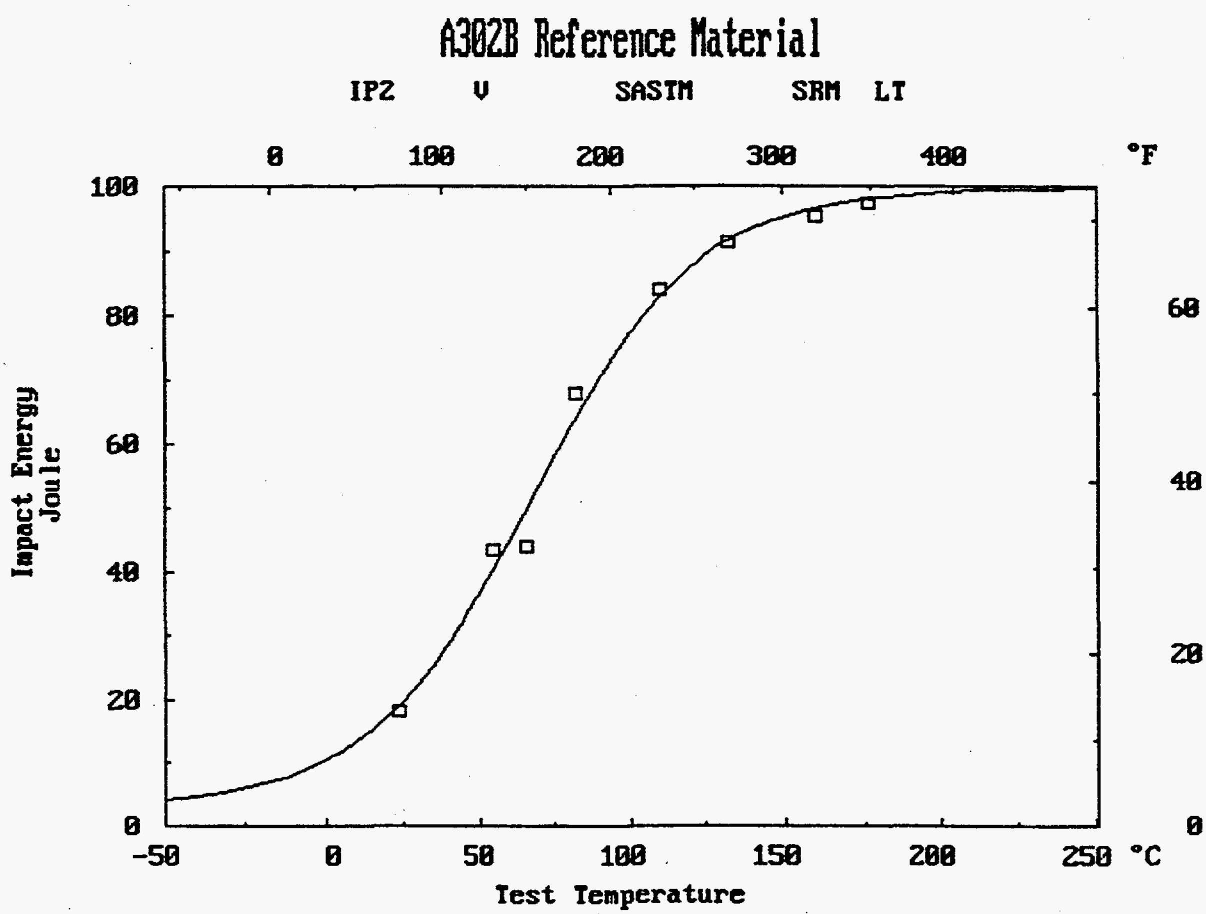
A302B REFERENCE MATERIAL

Indian Point Unit 2, Capsule V

Impact Energy Uncertainty = 10.0 J
Test Temperature Uncertainty = 4.0 Degree C
Number of Successful Iterations = 200, Maximum = 1000

IP2 V SASTM SRM LT : Fluence = 4.570E+18 , Irr. Temp. = 304

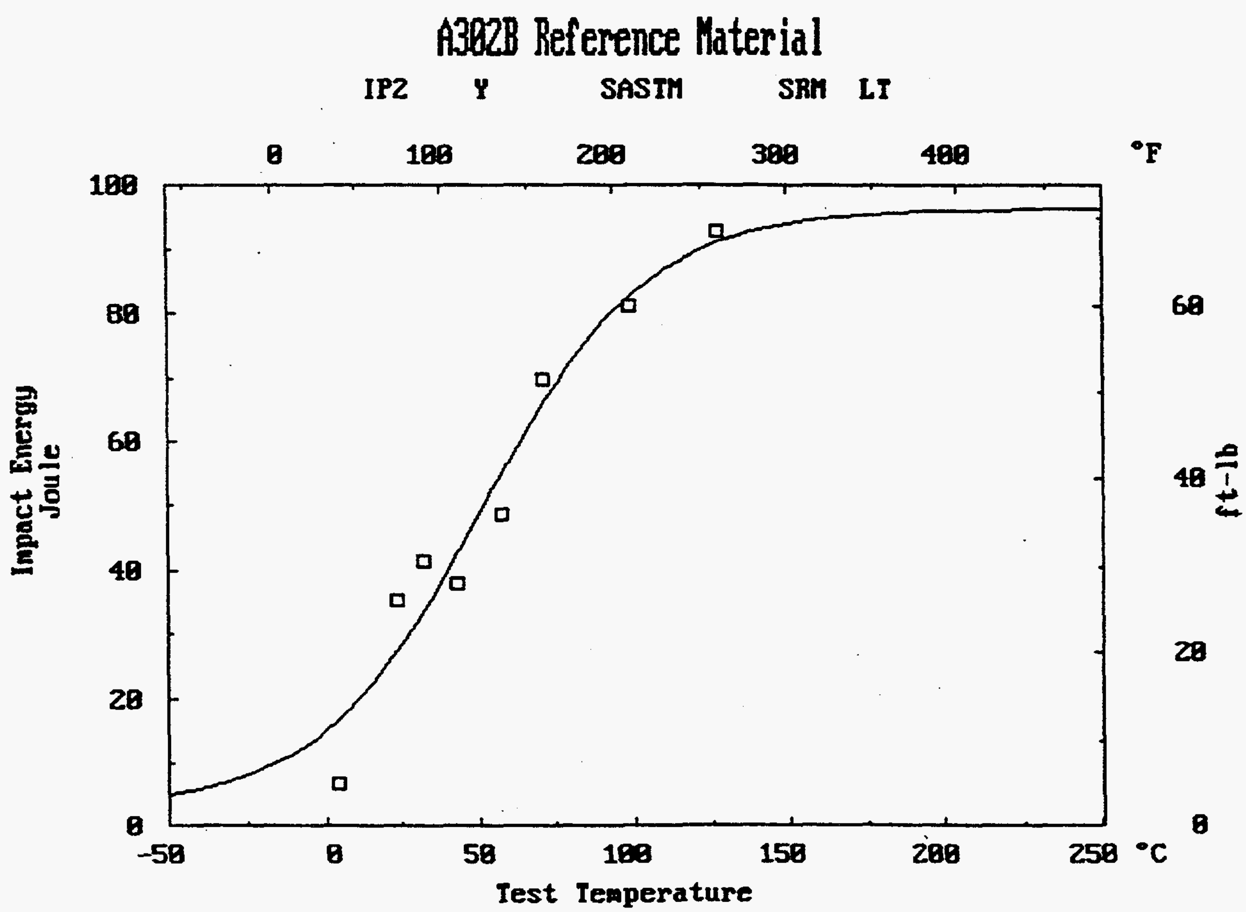
| Parameter | Mean | Std.Dev. | Correlation Coefficients | | | | |
|---|---|---|---|---|---|---|---|
| Lower Shelf Energy (J) | 3.0 | 0.0 | | | | | |
| Upper Shelf Energy (J) | 99.9 | 8.8 | 0.073 | | | | |
| CVT at Midpoint (C) | 67.5 | 9.2 | 0.086 | 0.667 | | | |
| 1/slope (C) | 54.3 | 16.4 | -0.026 | 0.626 | 0.403 | | |
| CVT at 41 Joule (C) | 55.2 | 7.5 | 0.072 | -0.065 | 0.634 | -0.361 | |
| CVT at 68 Joule (C) | 86.5 | 8.4 | -0.005 | 0.212 | 0.723 | 0.542 | 0.511 |



A302B REFERENCE MATERIAL
Indian Point Unit 2, Capsule Y

USE= 96.4 J, LSE= 3.0 J, CVT(1/2)= 51.C , Slope = 0.0186
CVT(41J) = 41. C , CVT(68J) = 74. C ,
Fluence = 4.720E+18 , Irr. Temp. = 304 C

| Spec. ID | Test Temp. C | Test Temp. F | Impact Energy J | Impact Energy ft-lb | Lat. Exp. mm | Lat. Exp. mil | % Shear |
|---|---|---|---|---|---|---|---|
| R60 | 4. | 40. | 7. | 5. | 0.10 | 4. | 0. |
| R57 | 23. | 74. | 35. | 26. | 0.56 | 22. | 5. |
| R62 | 32. | 90. | 41. | 30. | 0.66 | 26. | 10. |
| R58 | 43. | 110. | 38. | 28. | 0.66 | 26. | 15. |
| R59 | 57. | 135. | 49. | 36. | 0.81 | 32. | 20. |
| R63 | 71. | 160. | 70. | 51. | 1.09 | 43. | 40. |
| R64 | 99. | 210. | 81. | 60. | 1.35 | 53. | 90. |
| R61 | 127. | 260. | 93. | 68. | 1.47 | 58. | 100. |



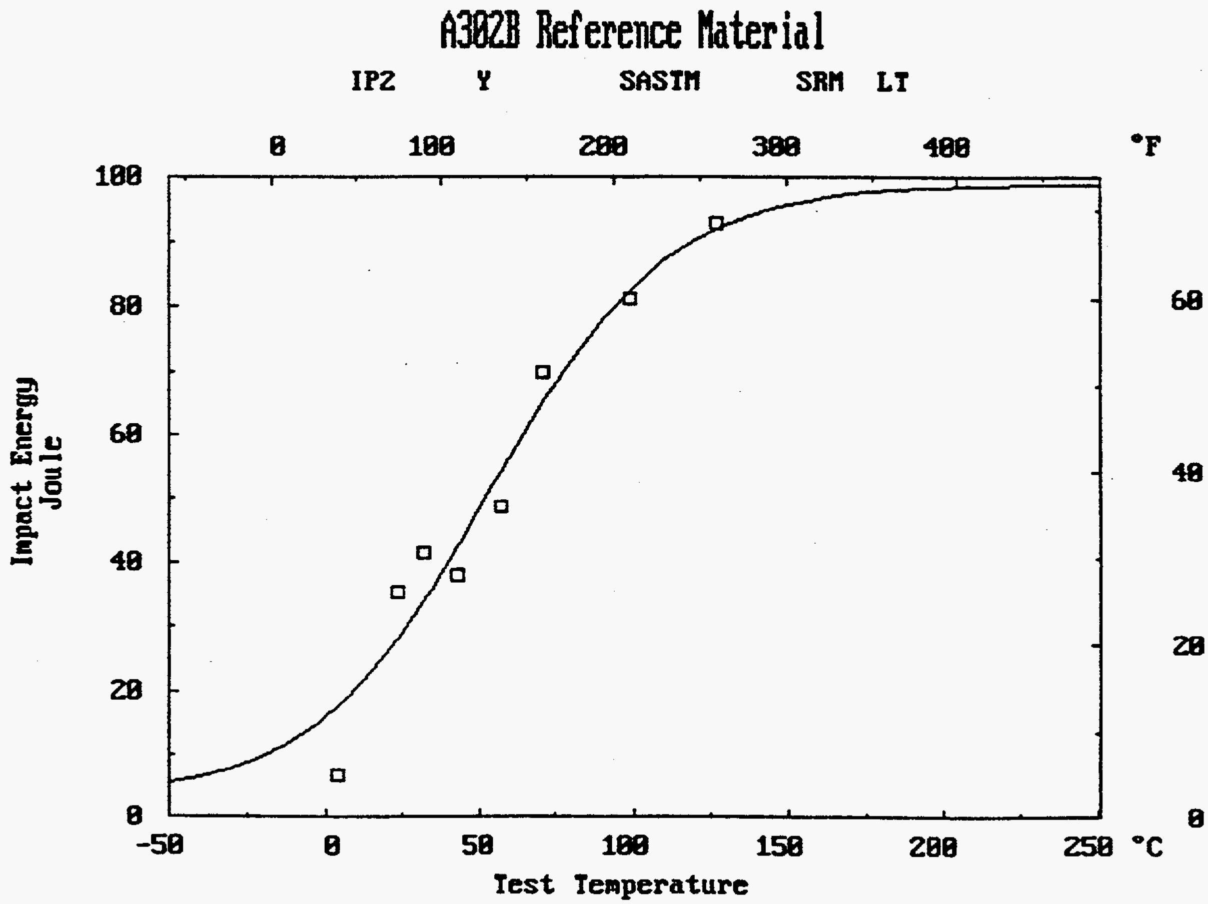
A302B REFERENCE MATERIAL

Indian Point Unit 2, Capsule Y

Impact Energy Uncertainty = 10.0 J
Test Temperature Uncertainty = 4.0 Degree C
Number of Successful Iterations = 200, Maximum = 1000

IP2 Y SASTM SRM LT : Fluence = 4.720E+18 , Irr. Temp. = 304

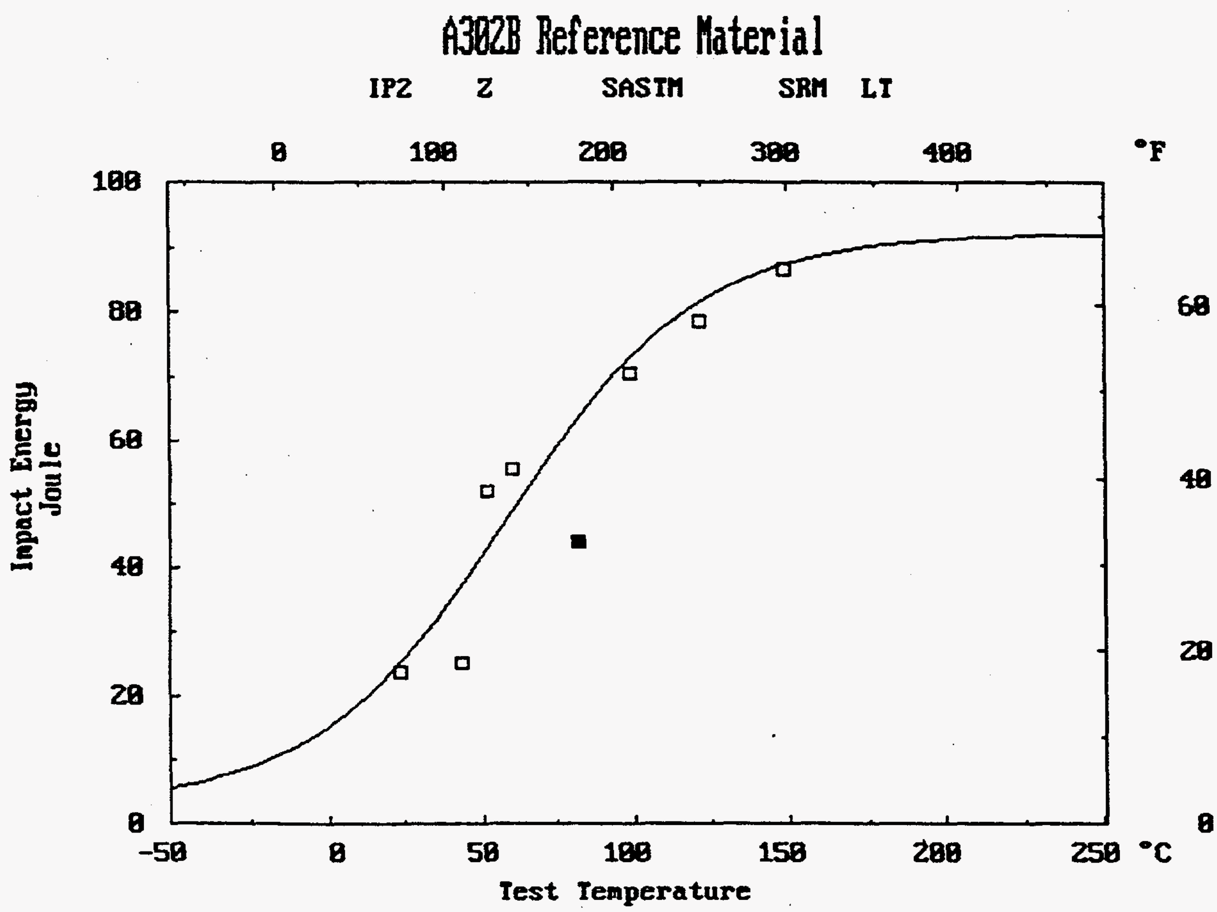
| Parameter | Mean | Std.Dev. | Correlation Coefficients | | | | |
|---|---|---|---|---|---|---|---|
| Lower Shelf Energy (J) | 3.0 | 0.0 | | | | | |
| Upper Shelf Energy (J) | 99.2 | 12.6 | 0.277 | | | | |
| CVT at Midpoint (C) | 53.7 | 11.5 | 0.367 | 0.861 | | | |
| 1/slope (C) | 57.7 | 15.1 | 0.316 | 0.605 | 0.640 | | |
| CVT at 41 Joule (C) | 41.1 | 5.9 | 0.257 | 0.288 | 0.682 | 0.077 | |
| CVT at 68 Joule (C) | 75.5 | 9.0 | 0.319 | 0.143 | 0.536 | 0.652 | 0.578 |



## A302B REFERENCE MATERIAL
Indian Point Unit 2, Capsule Z

USE= 92.3 J, LSE= 3.0 J, CVT(1/2)= 58.C , Slope = 0.0160
CVT(41J) = 49. C , CVT(68J) = 89. C ,
Fluence = 9.620E+18 , Irr. Temp. = 304 C

| Spec. ID | Test Temp. C | Test Temp. F | Impact Energy J | Impact Energy ft-lb | Lat. Exp. mm | Lat. Exp. mil | % Shear |
|---|---|---|---|---|---|---|---|
| R-33 | 24. | 75. | 24. | 17. | 0.25 | 10. | 16. |
| R-36 | 43. | 110. | 25. | 18. | 0.13 | 5. | 16. |
| R-40 | 52. | 125. | 52. | 38. | 0.63 | 25. | 35. |
| R-37 | 60. | 140. | 56. | 41. | 1.27 | 50. | 39. |
| *R-38 | 82. | 180. | 44. | 32. | 0.51 | 20. | 34. |
| R-34 | 99. | 210. | 70. | 52. | 2.54 | 100. | 49. |
| R-39 | 121. | 250. | 79. | 58. | 2.54 | 100. | 57. |
| R-35 | 149. | 300. | 87. | 64. | 2.54 | 100. | 55. |



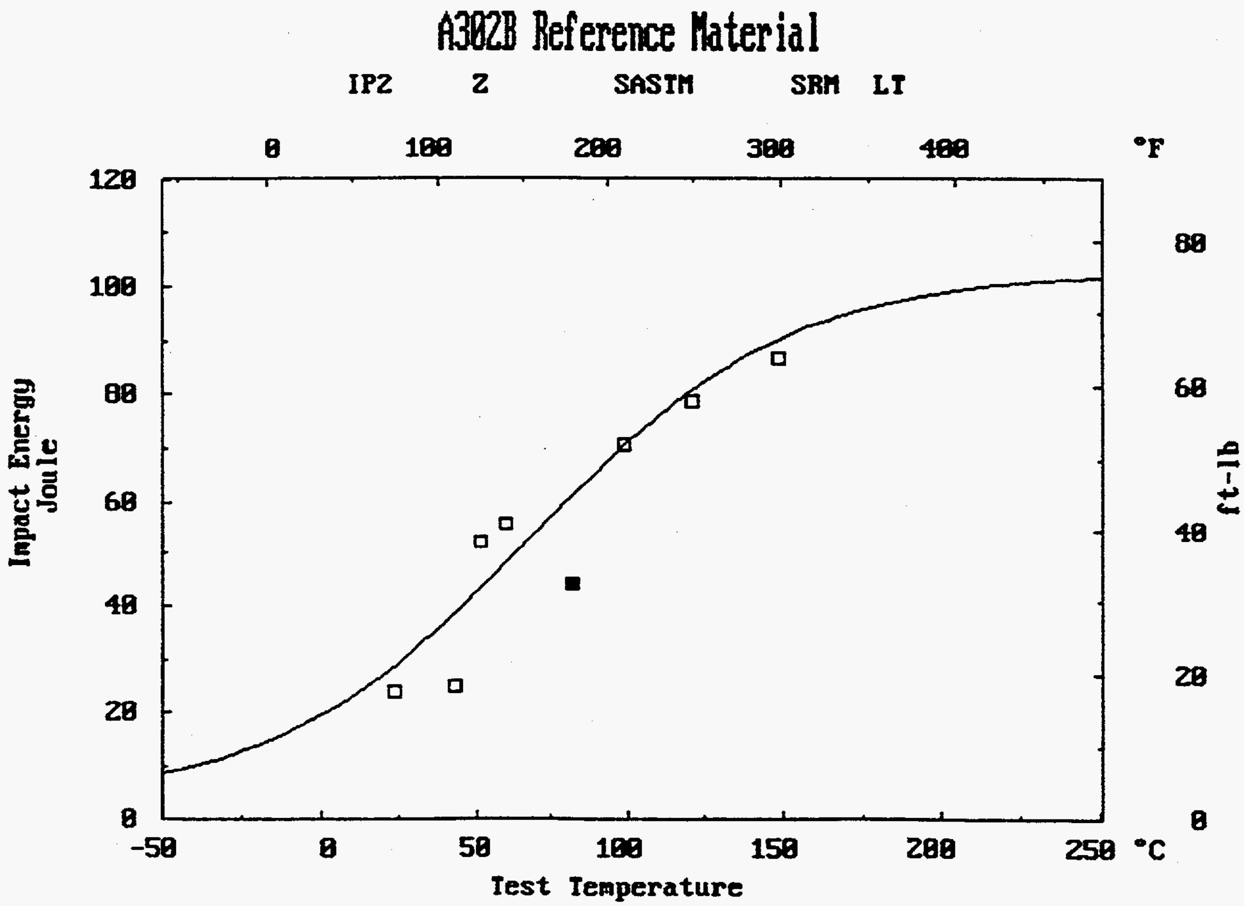
A302B REFERENCE MATERIAL

Indian Point Unit 2, Capsule Z

Impact Energy Uncertainty = 10.0 J
Test Temperature Uncertainty = 4.0 Degree C
Number of Successful Iterations = 200, Maximum = 1000

IP2 Z SASTM SRM LT : Fluence = 9.620E+18 , Irr. Temp. = 304

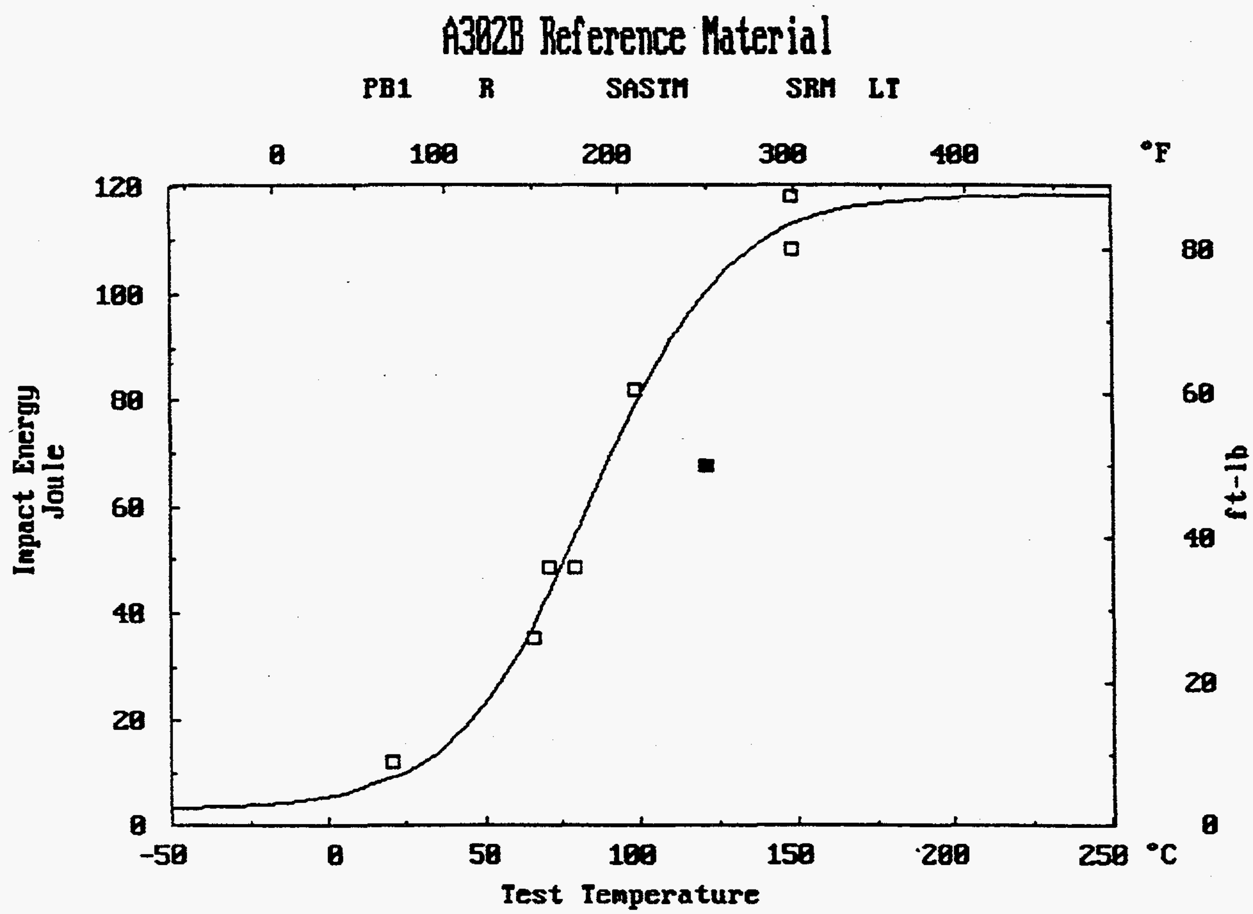
| Parameter | Mean | Std.Dev. | Correlation Coefficients | | | | |
|---|---|---|---|---|---|---|---|
| Lower Shelf Energy (J) | 3.0 | 0.0 | | | | | |
| Upper Shelf Energy (J) | 102.9 | 14.6 | -0.100 | | | | |
| CVT at Midpoint (C) | 67.9 | 15.9 | -0.103 | 0.856 | | | |
| 1/slope (C) | 83.1 | 21.7 | 0.072 | 0.543 | 0.460 | | |
| CVT at 41 Joule (C) | 47.5 | 9.2 | -0.172 | 0.036 | 0.459 | -0.422 | |
| CVT at 68 Joule (C) | 95.0 | 10.0 | -0.019 | -0.076 | 0.310 | 0.429 | 0.375 |



## A302B REFERENCE MATERIAL
Point Beach Unit 1, Capsule R

USE= 118.5 J, LSE= 3.0 J, CVT(1/2)= 84.C , Slope = 0.0230
CVT(41J) = 69. C , CVT(68J) = 90. C ,
Fluence = 2.220E+19 , Irr. Temp. = 304 C

| Spec. ID | Test Temp. C | Test Temp. F | Impact Energy J | Impact Energy ft-lb | Lat. Exp. mm | Lat. Exp. mil | % Shear |
|---|---|---|---|---|---|---|---|
| R10 | 21. | 70. | 12. | 9. | 0.10 | 4. | 10. |
| R13 | 66. | 150. | 35. | 26. | 0.53 | 21. | 30. |
| R15 | 71. | 160. | 49. | 36. | 0.69 | 27. | 40. |
| R9 | 79. | 175. | 49. | 36. | 0.71 | 28. | 40. |
| R11 | 99. | 210. | 82. | 60. | 1.07 | 42. | 85. |
| *R12 | 121. | 250. | 68. | 50. | 1.07 | 42. | 80. |
| R14 | 149. | 300. | 118. | 87. | 1.47 | 58. | 100. |
| R16 | 149. | 300. | 108. | 80. | 1.27 | 50. | 100. |



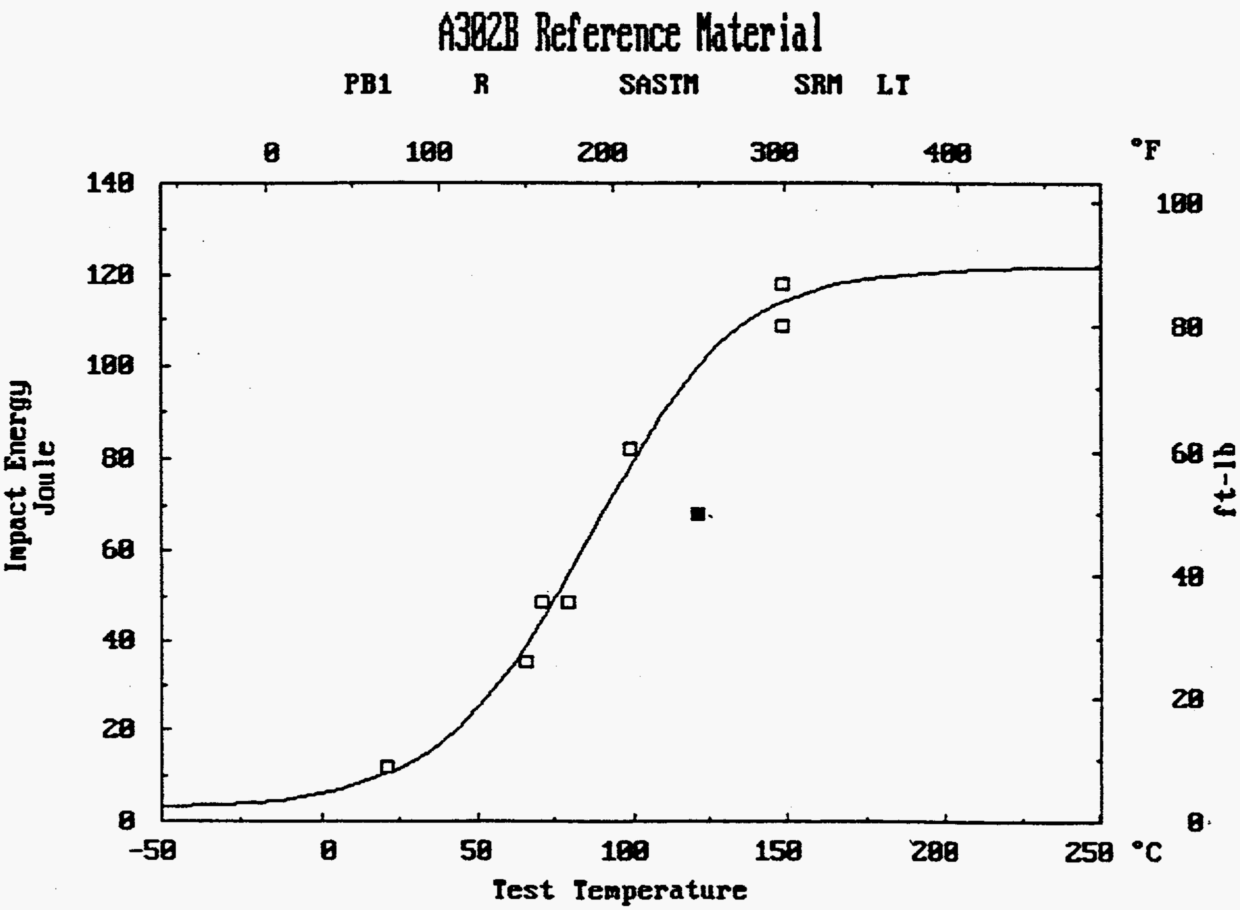
A302B REFERENCE MATERIAL

Point Beach Unit 1, Capsule R

Impact Energy Uncertainty = 10.0 J
Test Temperature Uncertainty = 4.0 Degree C
Number of Successful Iterations = 200, Maximum = 1000

PB1 R SASTM SRM LT : Fluence = 2.220E+19 , Irr. Temp. = 304

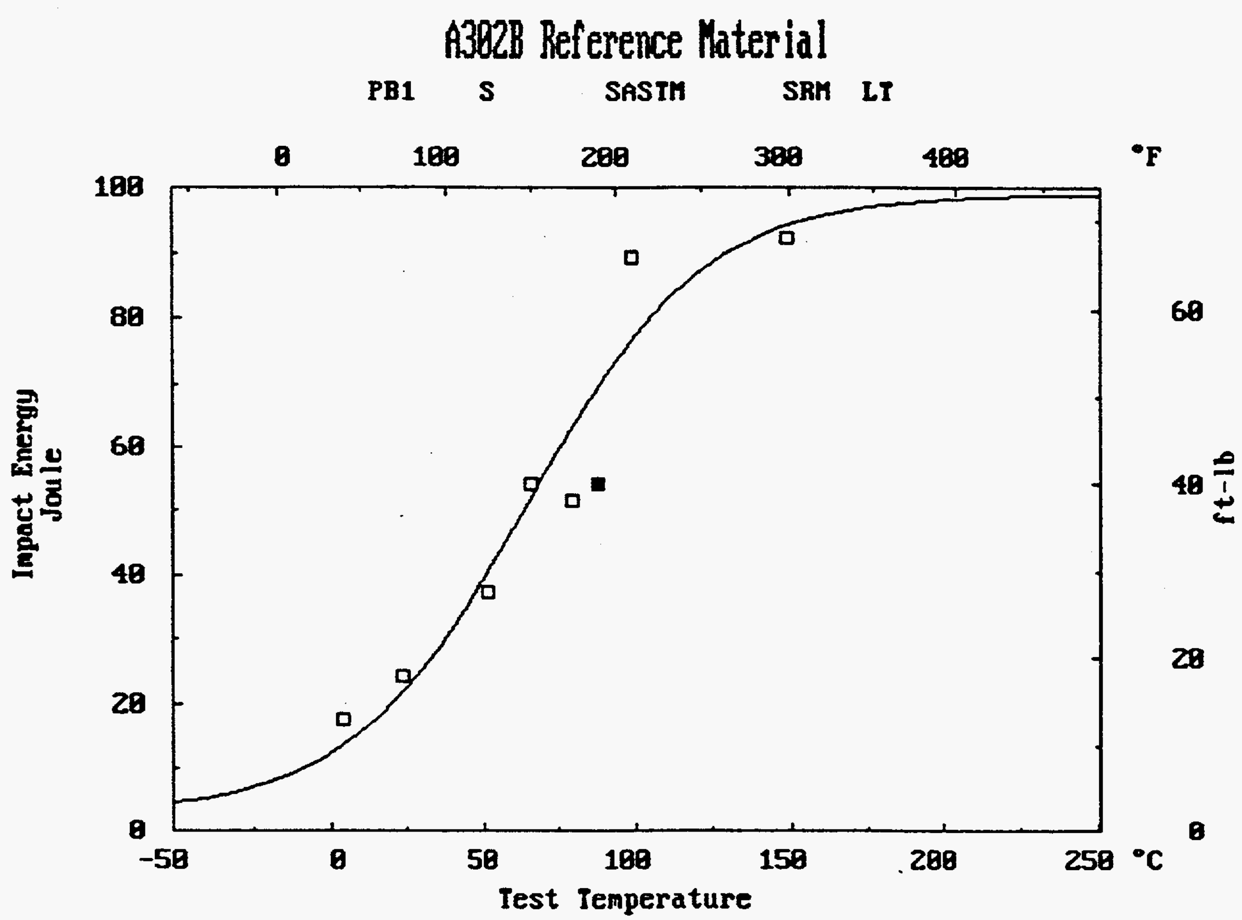
| Parameter | Mean | Std.Dev. | Correlation Coefficients | | | | |
|---|---|---|---|---|---|---|---|
| Lower Shelf Energy (J) | 3.0 | 0.0 | | | | | |
| Upper Shelf Energy (J) | 121.7 | 11.5 | 0.068 | | | | |
| CVT at Midpoint (C) | 85.8 | 7.9 | 0.002 | 0.771 | | | |
| 1/slope (C) | 47.3 | 12.7 | -0.066 | 0.541 | 0.536 | | |
| CVT at 41 Joule (C) | 67.7 | 5.7 | -0.005 | -0.065 | 0.399 | -0.472 | |
| CVT at 68 Joule (C) | 90.1 | 5.5 | -0.111 | 0.200 | 0.754 | 0.437 | 0.548 |



## A302B REFERENCE MATERIAL
Point Beach Unit 1, Capsule S

USE= 99.3 J, LSE= 3.0 J, CVT(1/2)= 65.C , Slope = 0.0173
CVT(41J) = 52. C , CVT(68J) = 86. C ,
Fluence = 7.050E+18 , Irr. Temp. = 304 C

| Spec. ID | Test Temp. C | Test Temp. F | Impact Energy J | Impact Energy ft-lb | Lat. Exp. mm | Lat. Exp. mil | % Shear |
|---|---|---|---|---|---|---|---|
| R28 | 4. | 40. | 18. | 13. | 0.15 | 6. | 5. |
| R26 | 24. | 75. | 24. | 18. | 0.30 | 12. | 20. |
| R25 | 52. | 125. | 37. | 27. | 0.51 | 20. | 30. |
| R27 | 66. | 150. | 54. | 40. | 0.76 | 30. | 40. |
| R29 | 79. | 175. | 52. | 38. | 0.81 | 32. | 45. |
| *R31 | 88. | 190. | 54. | 40. | 0.97 | 38. | 99. |
| R32 | 99. | 210. | 89. | 66. | 1.24 | 49. | 95. |
| R30 | 149. | 300. | 92. | 68. | 1.42 | 56. | 100. |



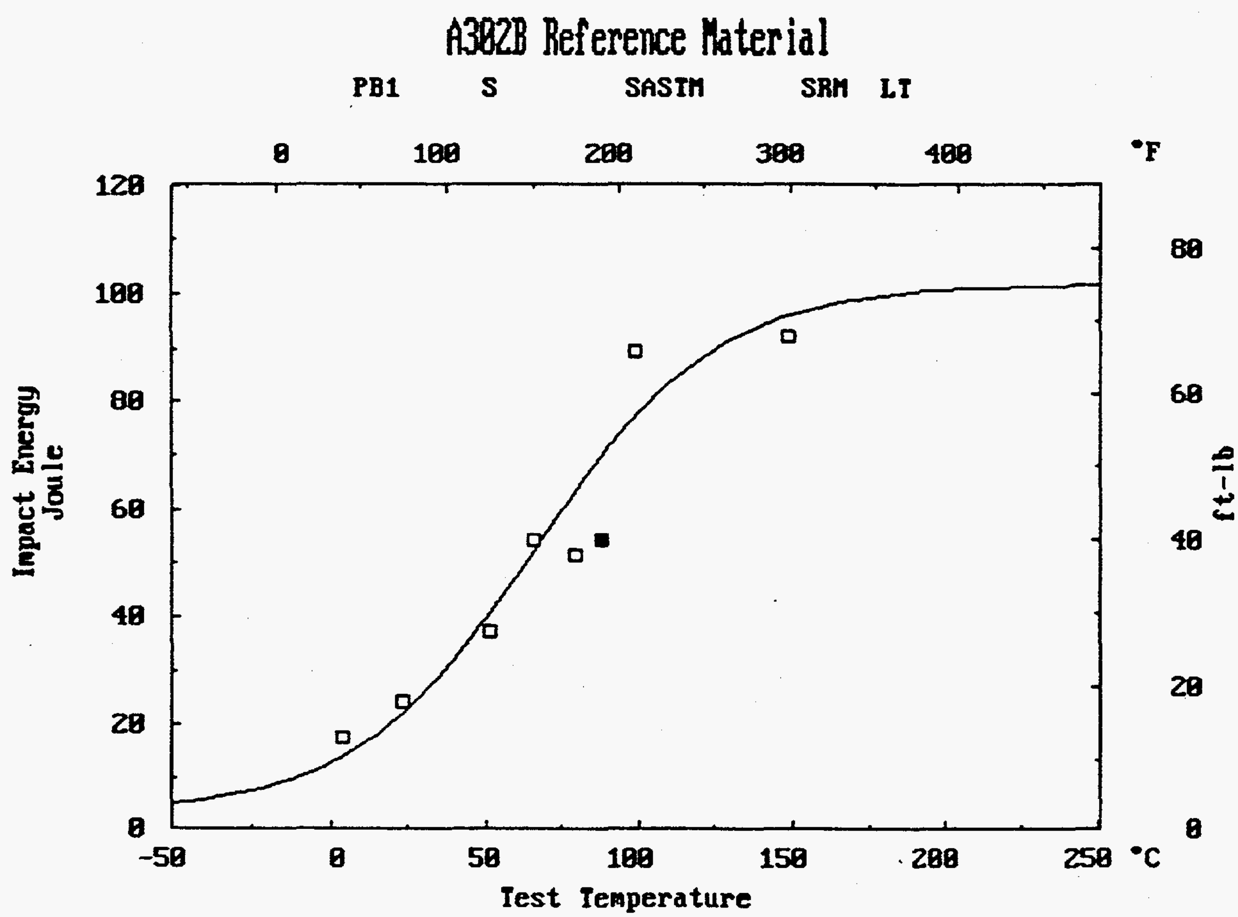
A302B REFERENCE MATERIAL

Point Beach Unit 1, Capsule S

```
Impact Energy Uncertainty =  10.0 J
Test Temperature Uncertainty =   4.0 Degree C
Number of Successful Iterations =  200, Maximum = 1000
```

PB1 S SASTM SRM LT : Fluence = 7.050E+18 , Irr. Temp. = 304

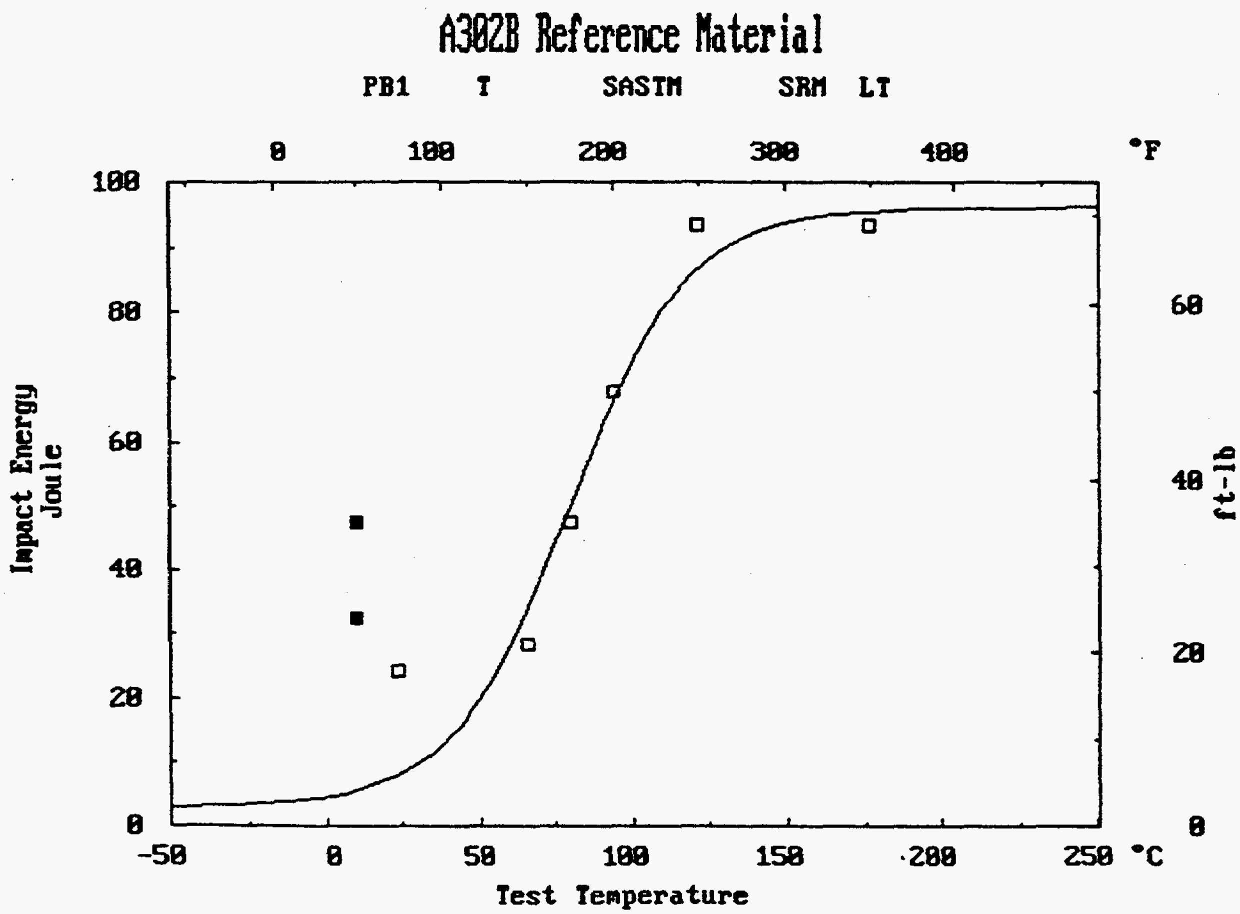
| Parameter | Mean | Std.Dev. | Correlation Coefficients | | | | |
|---|---|---|---|---|---|---|---|
| Lower Shelf Energy (J) | 3.0 | 0.0 | | | | | |
| Upper Shelf Energy (J) | 101.8 | 13.1 | 0.184 | | | | |
| CVT at Midpoint (C) | 66.1 | 10.7 | 0.318 | 0.792 | | | |
| 1/slope (C) | 59.7 | 17.1 | -0.212 | 0.434 | 0.297 | | |
| CVT at 41 Joule (C) | 52.0 | 7.6 | 0.420 | 0.037 | 0.562 | -0.452 | |
| CVT at 68 Joule (C) | 86.5 | 8.5 | 0.026 | -0.104 | 0.331 | 0.479 | 0.358 |



## A302B REFERENCE MATERIAL
Point Beach Unit 1, Capsule T

USE= 96.2 J, LSE= 3.1 J, CVT(1/2)= 79.C , Slope = 0.0261
CVT(41J) = 72. C , CVT(68J) = 95. C ,
Fluence = 2.110E+19 , Irr. Temp. = 304 C

| Spec. ID | Test Temp. C | Test Temp. F | Impact Energy J | Impact Energy ft-lb | Lat. Exp. mm | Lat. Exp. mil | % Shear |
|---|---|---|---|---|---|---|---|
| *R17 | 10. | 50. | 33. | 24. | 0.51 | 20. | 44. |
| *R24 | 10. | 50. | 47. | 35. | 0.63 | 25. | 33. |
| R19 | 23. | 74. | 24. | 18. | 0.36 | 14. | 21. |
| R20 | 66. | 150. | 28. | 21. | 0.51 | 20. | 32. |
| R18 | 79. | 175. | 47. | 35. | 0.71 | 28. | 40. |
| R23 | 93. | 200. | 68. | 50. | 0.81 | 32. | 57. |
| R22 | 121. | 250. | 94. | 69. | 1.30 | 51. | 98. |
| R21 | 177. | 350. | 94. | 69. | 1.30 | 51. | 100. |



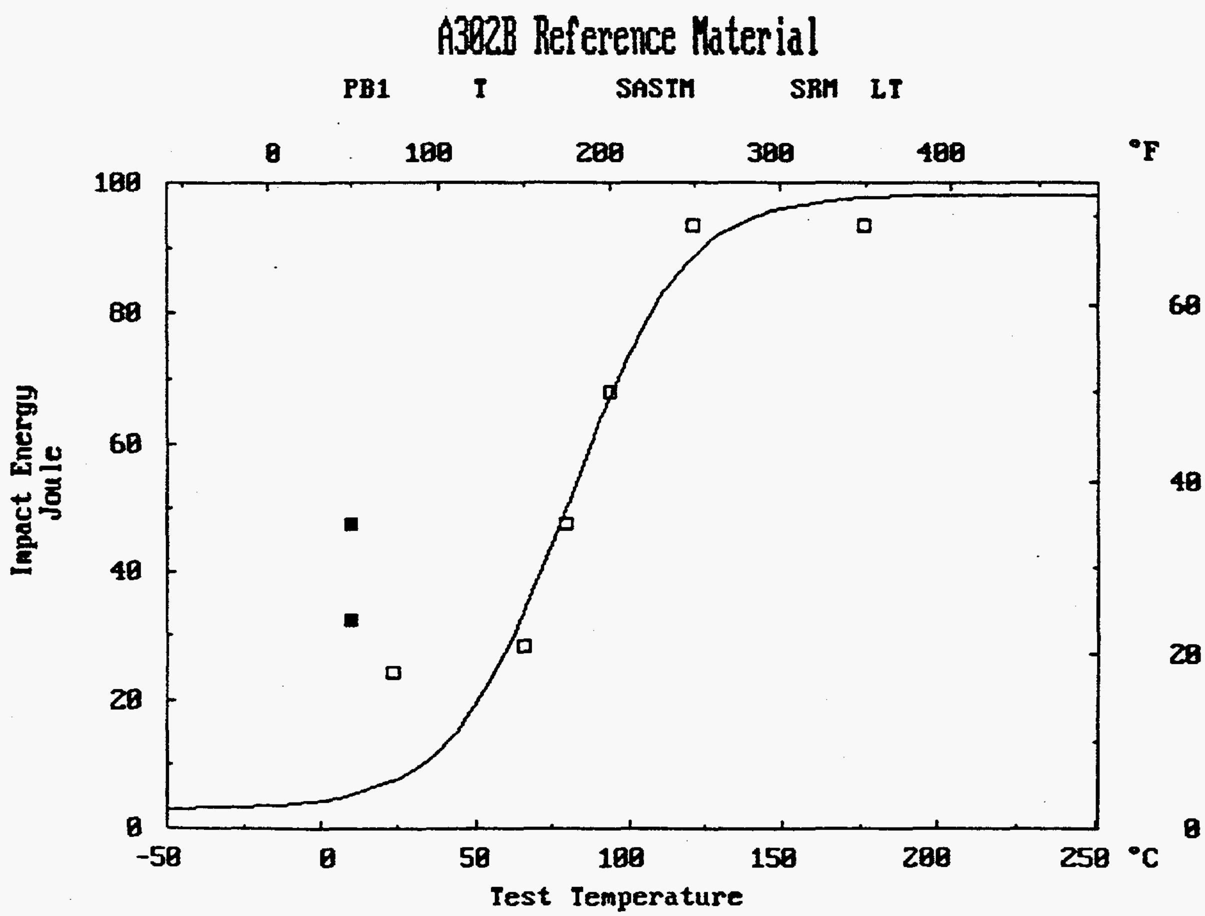
A302B REFERENCE MATERIAL

Point Beach Unit 1, Capsule T

```
Impact Energy Uncertainty =  10.0 J
Test Temperature Uncertainty =   4.0 Degree C
Number of Successful Iterations =  200, Maximum = 1000
```

PB1 T SASTM SRM LT : Fluence = 2.110E+19 , Irr. Temp. = 304

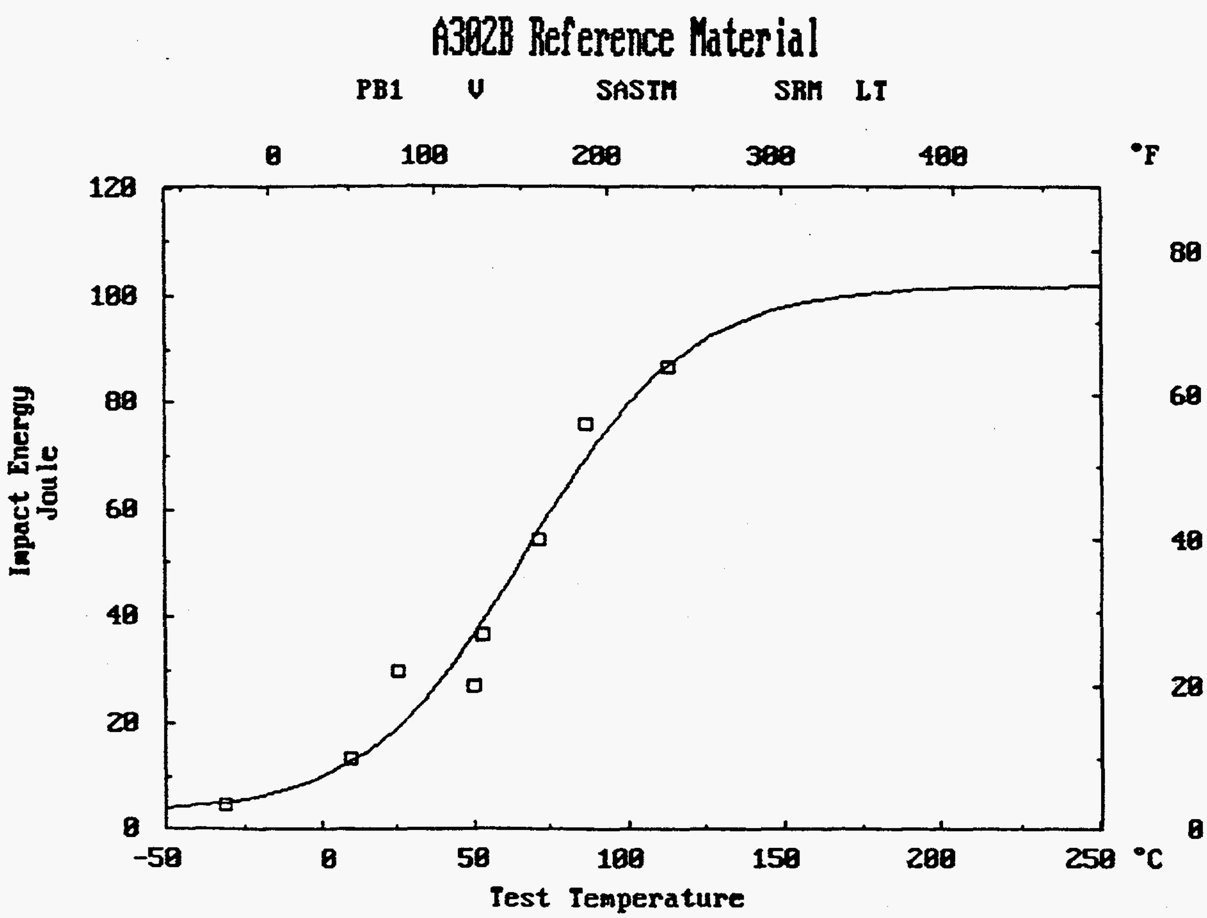
| Parameter | Mean | Std.Dev. | Correlation Coefficients | | | | |
|---|---|---|---|---|---|---|---|
| Lower Shelf Energy (J) | 3.1 | 0.0 | | | | | |
| Upper Shelf Energy (J) | 98.2 | 8.0 | 0.086 | | | | |
| CVT at Midpoint (C) | 80.0 | 7.2 | 0.317 | 0.523 | | | |
| 1/slope (C) | 37.2 | 13.4 | -0.520 | 0.233 | -0.126 | | |
| CVT at 41 Joule (C) | 72.3 | 7.3 | 0.482 | 0.036 | 0.810 | -0.586 | |
| CVT at 68 Joule (C) | 94.5 | 6.8 | -0.133 | -0.074 | 0.492 | 0.478 | 0.352 |



A302B REFERENCE MATERIAL
Point Beach Unit 1, Capsule V

USE= 102.0 J, LSE= 3.0 J, CVT(1/2)= 68.C , Slope = 0.0192
CVT(41J) = 56. C , CVT(68J) = 85. C ,
Fluence = 3.580E+18 , Irr. Temp. = 304 C

| Spec. ID | Test Temp. C | Test Temp. F | Impact Energy J | Impact Energy ft-lb | Lat. Exp. mm | Lat. Exp. mil | % Shear |
|---|---|---|---|---|---|---|---|
| R6 | -32. | -25. | 5. | 3. | 0.05 | 2. | 2. |
| R1 | 10. | 50. | 14. | 10. | 0.20 | 8. | 10. |
| R7 | 26. | 78. | 30. | 22. | 0.48 | 19. | 15. |
| R5 | 50. | 122. | 27. | 20. | 0.53 | 21. | 30. |
| R4 | 53. | 127. | 37. | 27. | 0.66 | 26. | 40. |
| R2 | 72. | 161. | 54. | 40. | 0.91 | 36. | 55. |
| R3 | 87. | 188. | 76. | 56. | 1.30 | 51. | 75. |
| R8 | 113. | 236. | 87. | 64. | 1.37 | 54. | 98. |



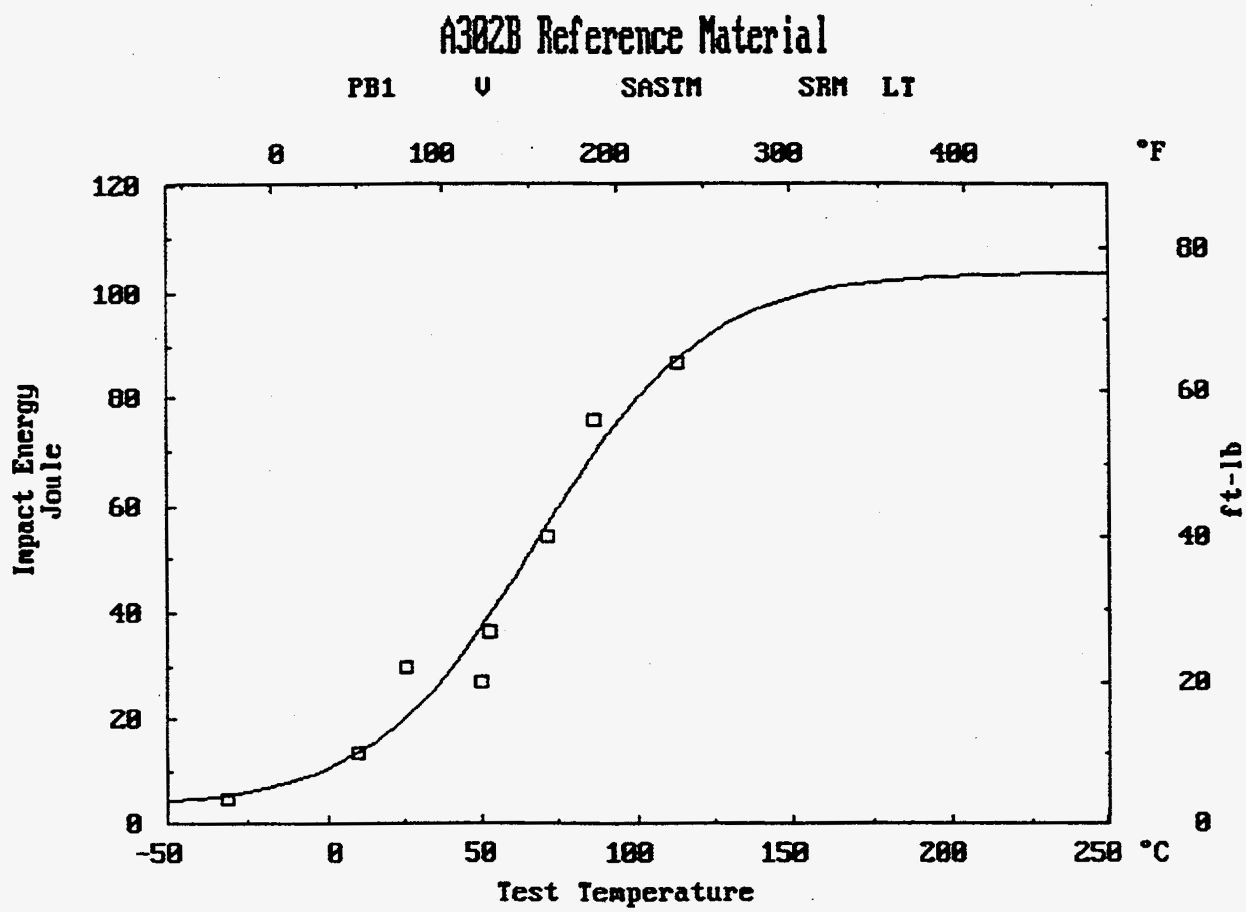
A302B REFERENCE MATERIAL

Point Beach Unit 1, Capsule V

Impact Energy Uncertainty = 10.0 J
Test Temperature Uncertainty = 4.0 Degree C
Number of Successful Iterations = 200, Maximum = 1000

PB1 V SASTM SRM LT : Fluence = 3.580E+18 , Irr. Temp. = 304

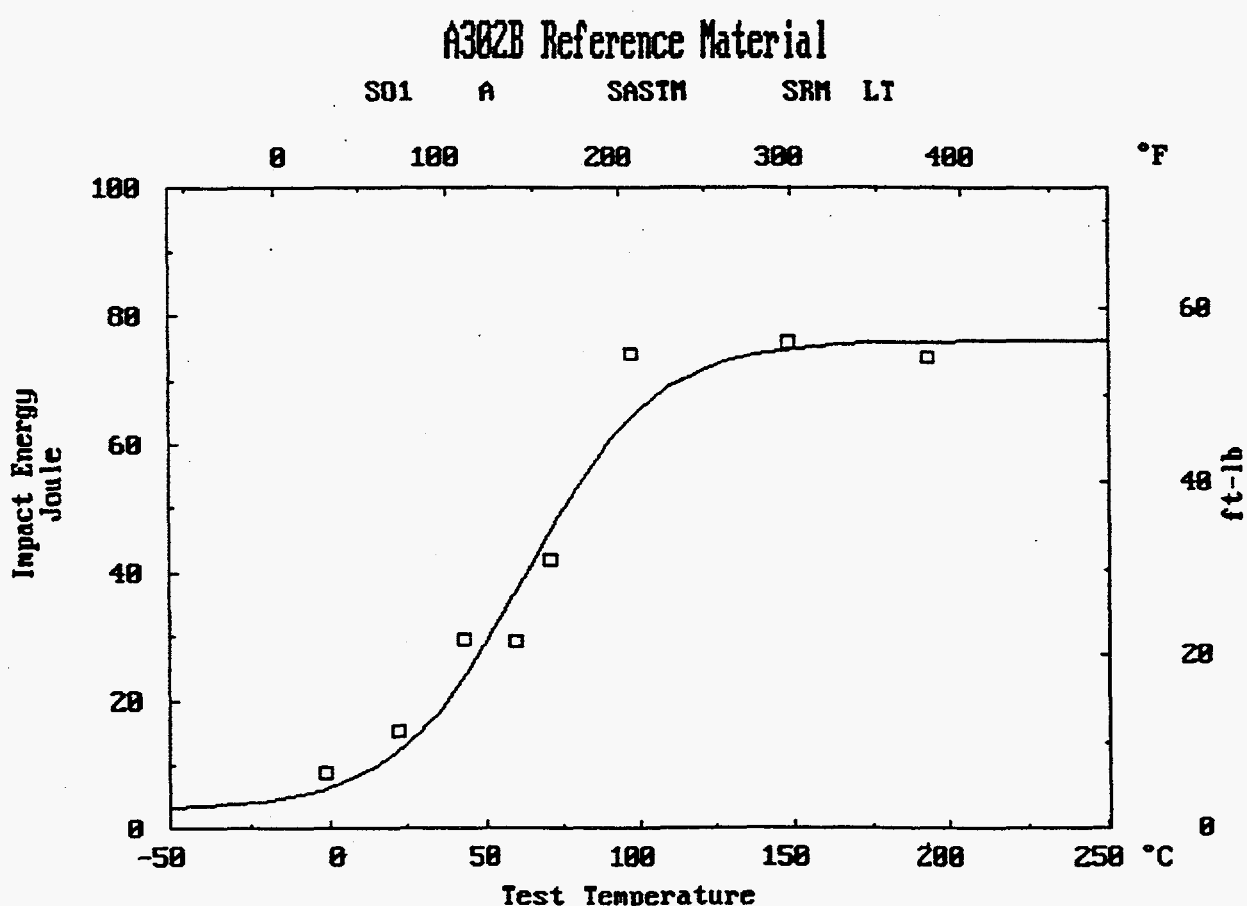
| Parameter | Mean | Std.Dev. | Correlation Coefficients | | | | |
|---|---|---|---|---|---|---|---|
| Lower Shelf Energy (J) | 3.0 | 0.0 | | | | | |
| Upper Shelf Energy (J) | 103.9 | 15.5 | 0.176 | | | | |
| CVT at Midpoint (C) | 68.5 | 10.9 | 0.310 | 0.854 | | | |
| 1/slope (C) | 54.1 | 14.0 | -0.197 | 0.438 | 0.386 | | |
| CVT at 41 Joule (C) | 54.9 | 6.3 | 0.434 | 0.171 | 0.571 | -0.348 | |
| CVT at 68 Joule (C) | 86.1 | 7.8 | 0.031 | -0.210 | 0.114 | 0.395 | 0.265 |



A302B REFERENCE MATERIAL
San Onofre Unit 1, Capsule A

USE= 76.3 J, LSE= 3.0 J, CVT(1/2)= 63.C , Slope = 0.0239
CVT(41J) = 65. C , CVT(68J) = 106. C ,
Fluence = 1.200E+19 , Irr. Temp. = 304 C

| Spec. ID | Test Temp. C | Test Temp. F | Impact Energy J | Impact Energy ft-lb | Lat. Exp. mm | Lat. Exp. mil | % Shear |
|---|---|---|---|---|---|---|---|
| R48 | -1. | 30. | 9. | 6. | 0.15 | 6. | 2. |
| R43 | 22. | 72. | 15. | 11. | 0.30 | 12. | 5. |
| R45 | 43. | 110. | 30. | 22. | 0.46 | 18. | 5. |
| R44 | 60. | 140. | 29. | 21. | 0.56 | 22. | 10. |
| R41 | 71. | 160. | 42. | 31. | 0.74 | 29. | 20. |
| R47 | 97. | 207. | 74. | 55. | 1.24 | 49. | 95. |
| R42 | 149. | 300. | 76. | 56. | 1.19 | 47. | 100. |
| R46 | 193. | 380. | 74. | 54. | 1.40 | 55. | 100. |



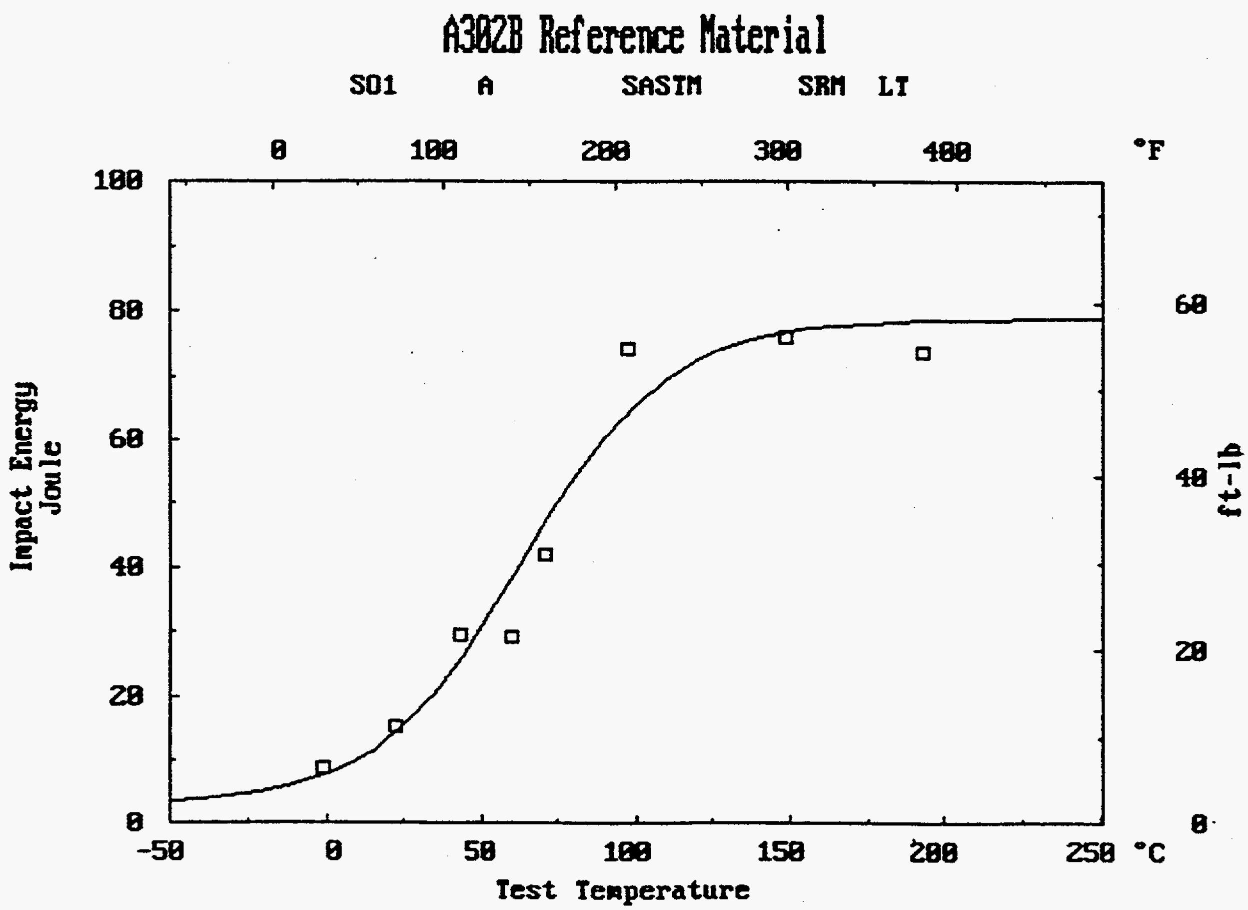
A302B REFERENCE MATERIAL

San Onofre Unit 1, Capsule A

Impact Energy Uncertainty = 10.0 J
Test Temperature Uncertainty = 4.0 Degree C
Number of Successful Iterations = 200, Maximum = 1000

SO1 A SASTM SRM LT : Fluence = 1.200E+19 , Irr. Temp. = 304

| Parameter | Mean | Std.Dev. | Correlation Coefficients | | | | |
|---|---|---|---|---|---|---|---|
| Lower Shelf Energy (J) | 3.0 | 0.0 | | | | | |
| Upper Shelf Energy (J) | 78.9 | 5.5 | 0.074 | | | | |
| CVT at Midpoint (C) | 63.3 | 7.5 | 0.302 | 0.468 | | | |
| 1/slope (C) | 47.2 | 13.6 | -0.364 | 0.182 | -0.060 | | |
| CVT at 41 Joule (C) | 63.5 | 6.6 | 0.302 | -0.043 | 0.853 | -0.151 | |
| CVT at 68 Joule (C) | 108.9 | 18.4 | -0.212 | -0.491 | -0.061 | 0.627 | 0.262 |

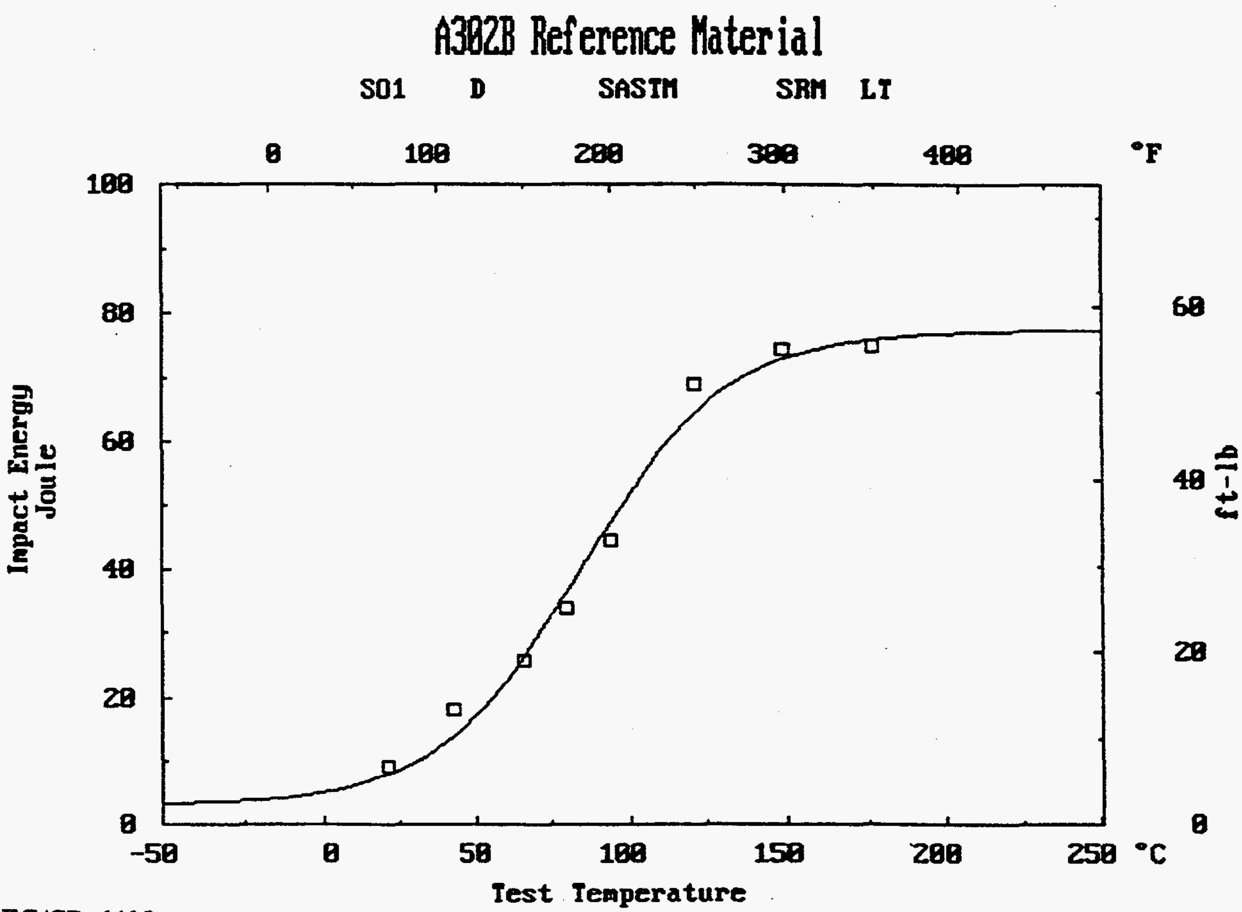


A302B REFERENCE MATERIAL
San Onofre Unit 1, Capsule D

USE= 77.6 J, LSE= 3.0 J, CVT(1/2)= 84.C , Slope = 0.0213
CVT(41J) = 85. C , CVT(68J) = 129. C ,
Fluence = 2.360E+19 , Irr. Temp. = 304 C

| Spec. ID | Test Temp. C | Test Temp. F | Impact Energy J | Impact Energy ft-lb | Lat. Exp. mm | Lat. Exp. mil | % Shear |
|---|---|---|---|---|---|---|---|
| R13 | 21. | 70. | 9. | 7. | 0.13 | 5. | 2. |
| R10 | 43. | 110. | 18. | 13. | 0.30 | 12. | 5. |
| R11 | 66. | 150. | 26. | 19. | 0.41 | 16. | 20. |
| R9 | 79. | 175. | 34. | 25. | 0.58 | 23. | 20. |
| R16 | 93. | 200. | 45. | 33. | 0.76 | 30. | 40. |
| R12 | 121. | 250. | 69. | 51. | 1.27 | 50. | 100. |
| R15 | 149. | 300. | 75. | 55. | 1.42 | 56. | 90. |
| R14 | 177. | 350. | 75. | 55. | 0.91 | 36. | 100. |



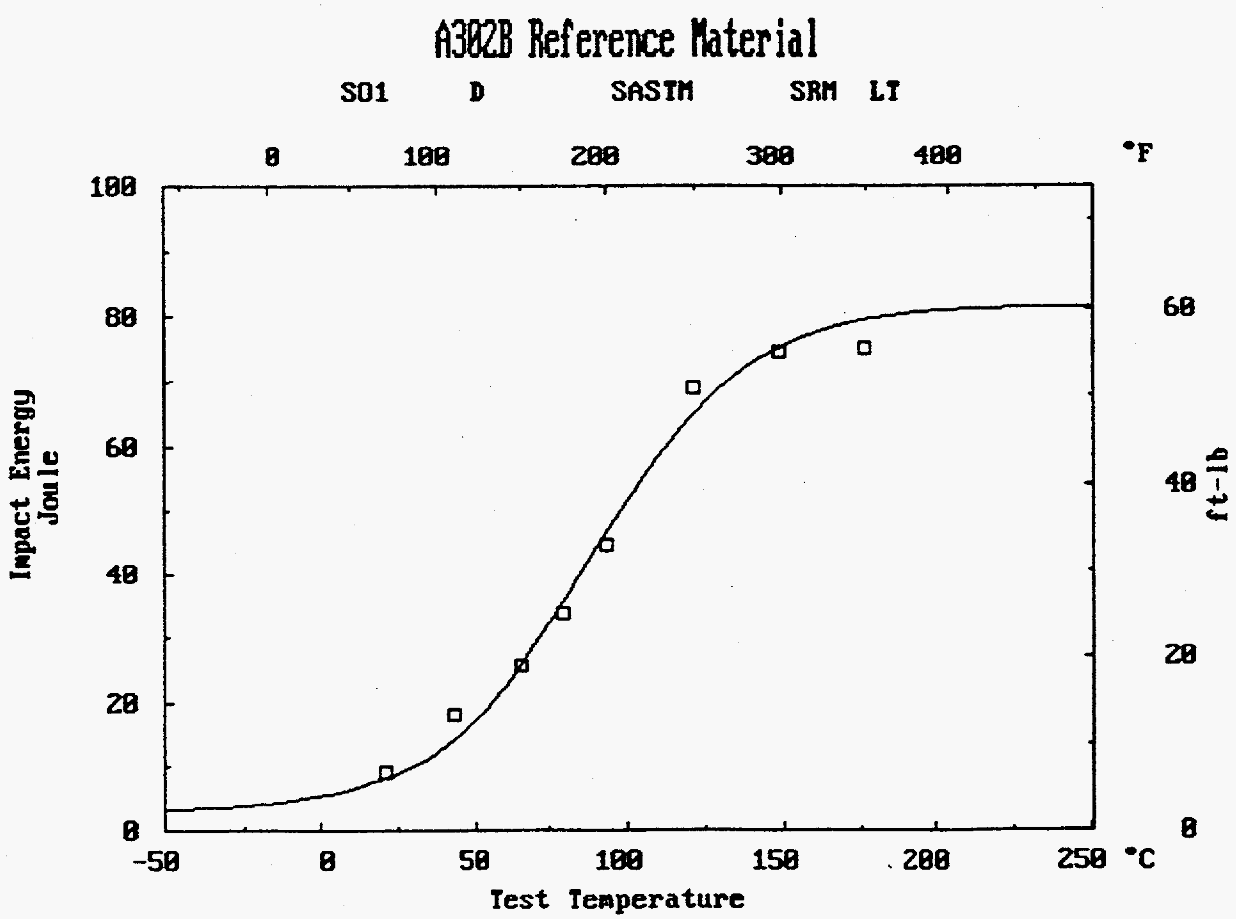
A302B REFERENCE MATERIAL

San Onofre Unit 1, Capsule D

```
Impact Energy Uncertainty =  10.0 J
Test Temperature Uncertainty =   4.0 Degree C
Number of Successful Iterations =  200, Maximum = 1000
```

```
SO1    D     SASTM     SRM  LT : Fluence = 2.360E+19 , Irr. Temp. =  304
```

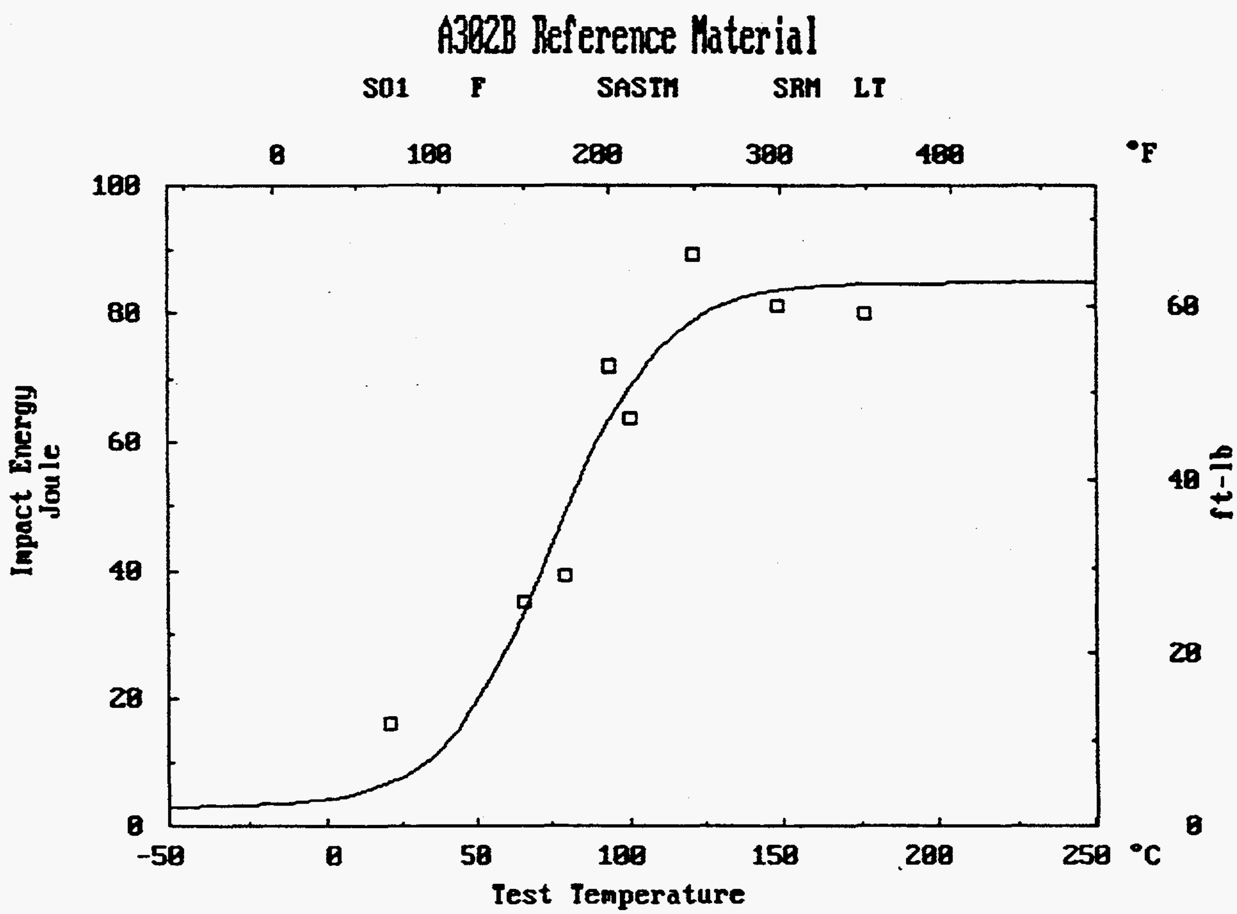
| Parameter | Mean | Std.Dev. | Correlation Coefficients | | | | |
|---|---|---|---|---|---|---|---|
| Lower Shelf Energy (J) | 3.0 | 0.0 | | | | | |
| Upper Shelf Energy (J) | 81.7 | 8.5 | -0.113 | | | | |
| CVT at Midpoint (C) | 88.0 | 10.8 | 0.081 | 0.717 | | | |
| 1/slope (C) | 49.9 | 15.7 | -0.341 | 0.589 | 0.394 | | |
| CVT at 41 Joule (C) | 85.9 | 7.6 | 0.210 | 0.249 | 0.843 | 0.058 | |
| CVT at 68 Joule (C) | 129.6 | 14.9 | -0.155 | -0.175 | 0.212 | 0.485 | 0.407 |



## A302B REFERENCE MATERIAL
San Onofre Unit 1, Capsule F

```
USE=  85.0 J, LSE=   3.0 J, CVT(1/2)=    75.C , Slope = 0.0281
CVT(41J) =    72. C , CVT(68J) =    99. C ,
Fluence = 5.140E+19 , Irr. Temp. = 304 C
```

| Spec. ID | Test Temp. C | Test Temp. F | Impact Energy J | Impact Energy ft-lb | Lat. Exp. mm | Lat. Exp. mil | % Shear |
|---|---|---|---|---|---|---|---|
| R57 | 21. | 70. | 16. | 12. | 0.41 | 16. | 10. |
| R63 | 66. | 150. | 35. | 26. | 0.61 | 24. | 20. |
| R58 | 79. | 175. | 39. | 29. | 0.71 | 28. | 25. |
| R61 | 93. | 200. | 72. | 53. | 1.12 | 44. | 80. |
| R60 | 100. | 212. | 64. | 47. | 1.02 | 40. | 85. |
| R62 | 121. | 250. | 89. | 66. | 1.32 | 52. | 100. |
| R64 | 149. | 300. | 81. | 60. | 1.19 | 47. | 100. |
| R59 | 177. | 350. | 80. | 59. | 1.30 | 51. | 100. |



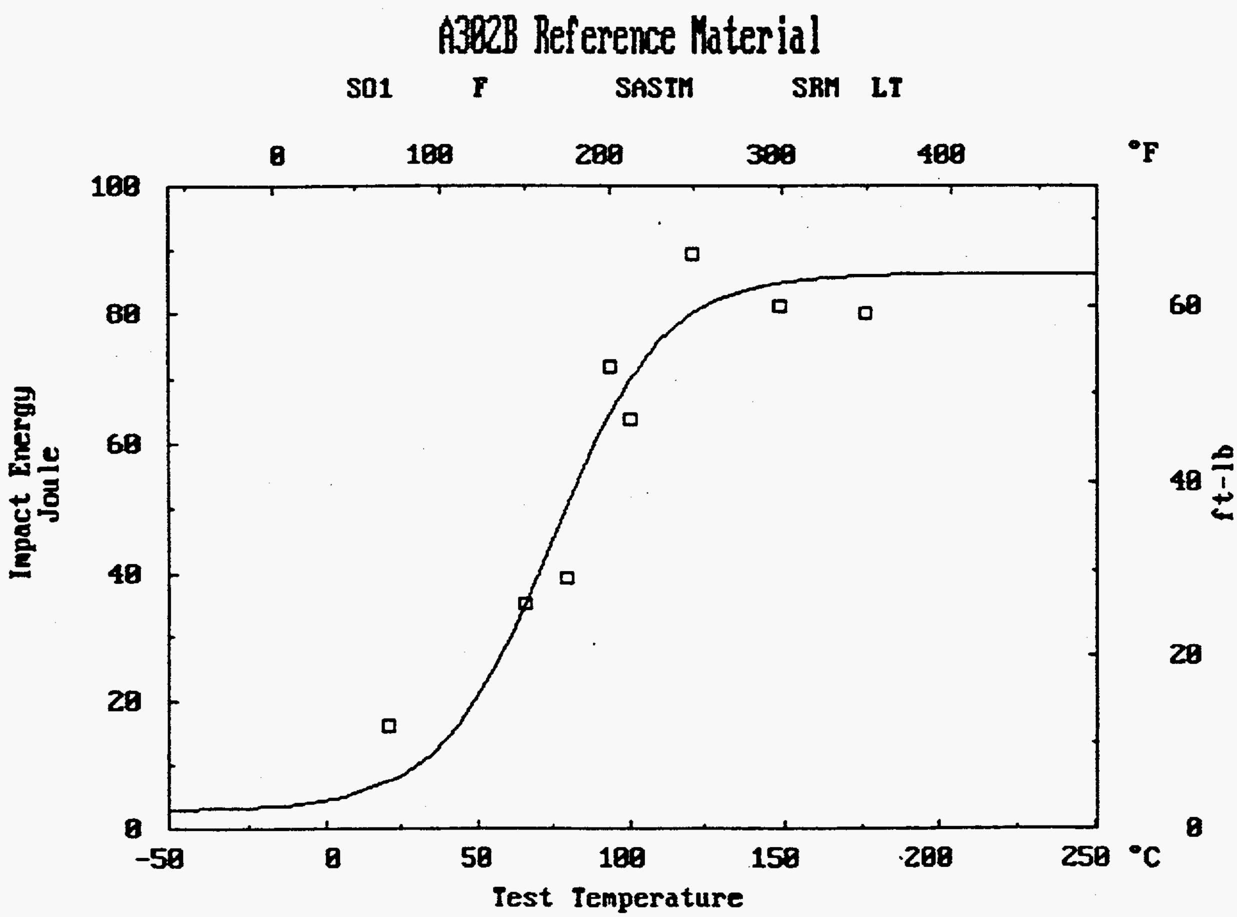
A302B REFERENCE MATERIAL

San Onofre Unit 1, Capsule F

```
Impact Energy Uncertainty =  10.0 J
Test Temperature Uncertainty =   4.0 Degree C
Number of Successful Iterations =  200, Maximum = 1000
```

SO1 F SASTM SRM LT : Fluence = 5.140E+19 , Irr. Temp. = 304

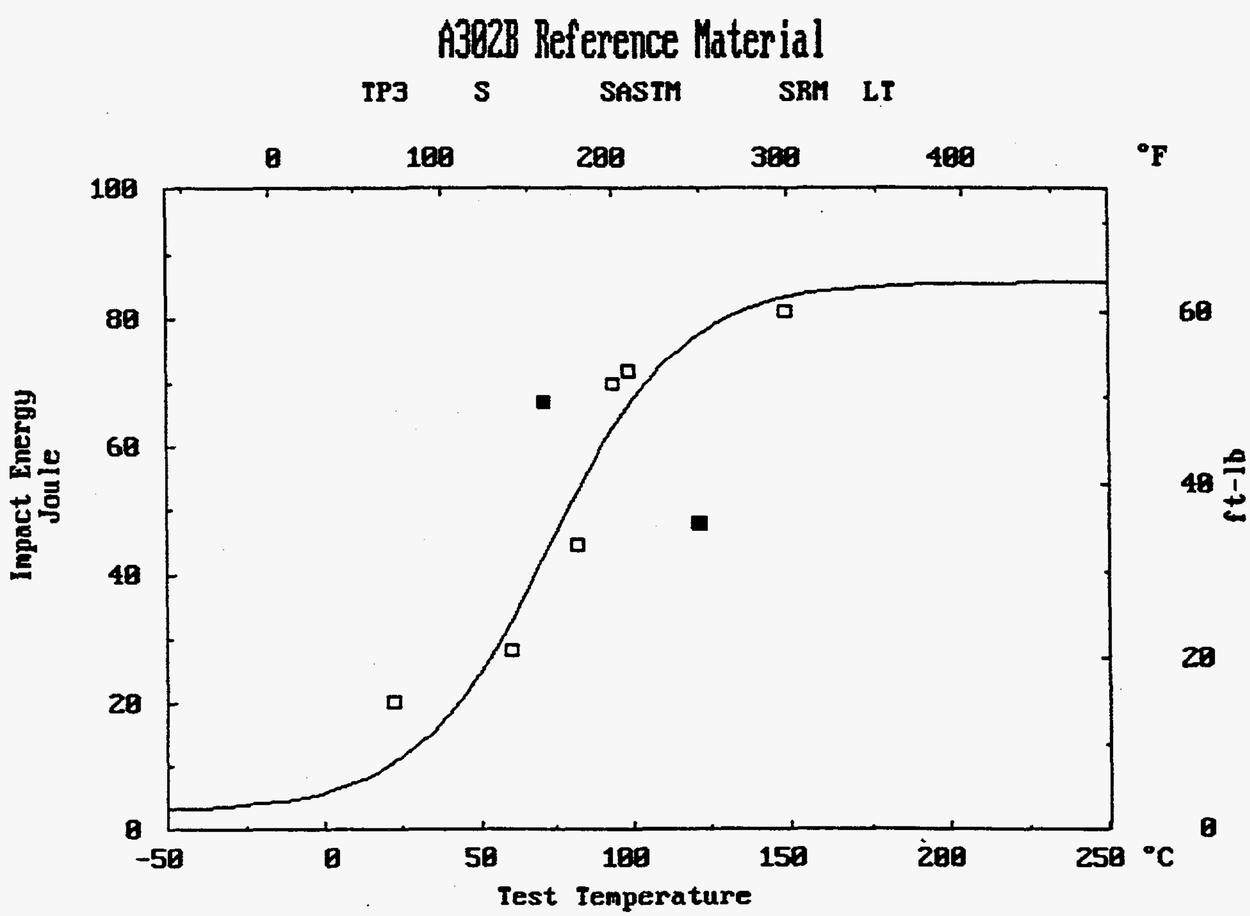
| Parameter | Mean | Std.Dev. | Correlation Coefficients | | | | |
|---|---|---|---|---|---|---|---|
| Lower Shelf Energy (J) | 3.0 | 0.0 | | | | | |
| Upper Shelf Energy (J) | 86.2 | 6.5 | 0.117 | | | | |
| CVT at Midpoint (C) | 74.3 | 8.3 | 0.411 | 0.498 | | | |
| 1/slope (C) | 36.4 | 12.2 | -0.394 | 0.273 | -0.377 | | |
| CVT at 41 Joule (C) | 71.1 | 7.9 | 0.451 | 0.150 | 0.921 | -0.631 | |
| CVT at 68 Joule (C) | 98.1 | 6.4 | -0.064 | -0.075 | 0.274 | 0.427 | 0.258 |



A302B REFERENCE MATERIAL
Turkey Point Unit 3, Capsule S

USE= 85.8 J, LSE= 3.0 J, CVT(1/2)= 73.C , Slope = 0.0230
CVT(41J) = 69. C , CVT(68J) = 101. C ,
Fluence = 1.410E+19 , Irr. Temp. = 304 C

| Spec. ID | Test Temp. C | Test Temp. F | Impact Energy J | Impact Energy ft-lb | Lat. Exp. mm | Lat. Exp. mil | % Shear |
|---|---|---|---|---|---|---|---|
| R1 | 22. | 72. | 20. | 15. | 0.33 | 13. | 5. |
| R2 | 60. | 140. | 28. | 21. | 0.48 | 19. | 15. |
| *R5 | 71. | 160. | 67. | 49. | 1.02 | 40. | 40. |
| R6 | 82. | 180. | 45. | 33. | 0.79 | 31. | 50. |
| R8 | 93. | 200. | 70. | 51. | 1.27 | 50. | 95. |
| R3 | 99. | 210. | 72. | 53. | 1.19 | 47. | 90. |
| *R7 | 121. | 250. | 48. | 35. | 0.86 | 34. | 60. |
| R4 | 149. | 300. | 81. | 60. | 1.30 | 51. | 100. |



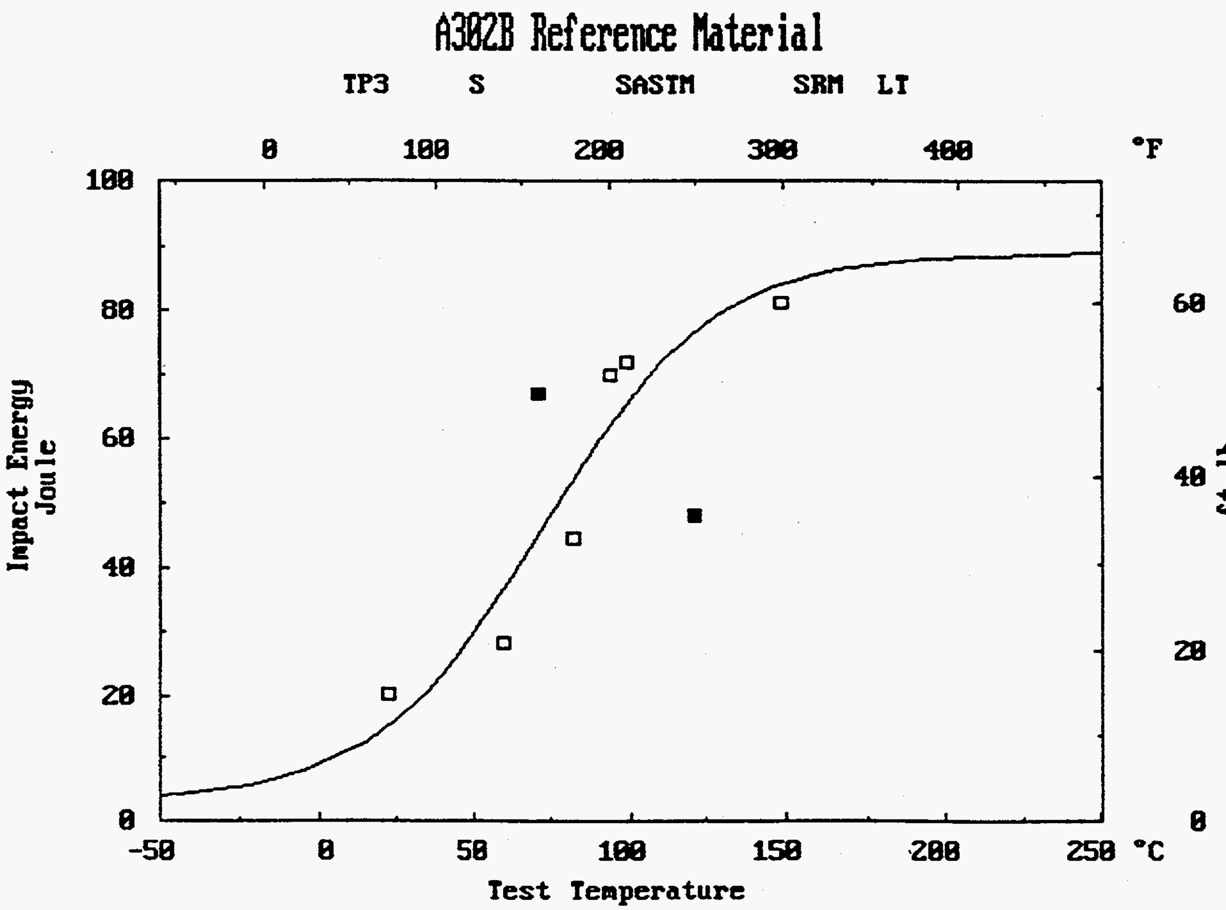
A302B REFERENCE MATERIAL

Turkey Point Unit 3, Capsule S

Impact Energy Uncertainty = 10.0 J
Test Temperature Uncertainty = 4.0 Degree C
Number of Successful Iterations = 200, Maximum = 1000

TP3 S SASTM SRM LT : Fluence = 1.410E+19 , Irr. Temp. = 304

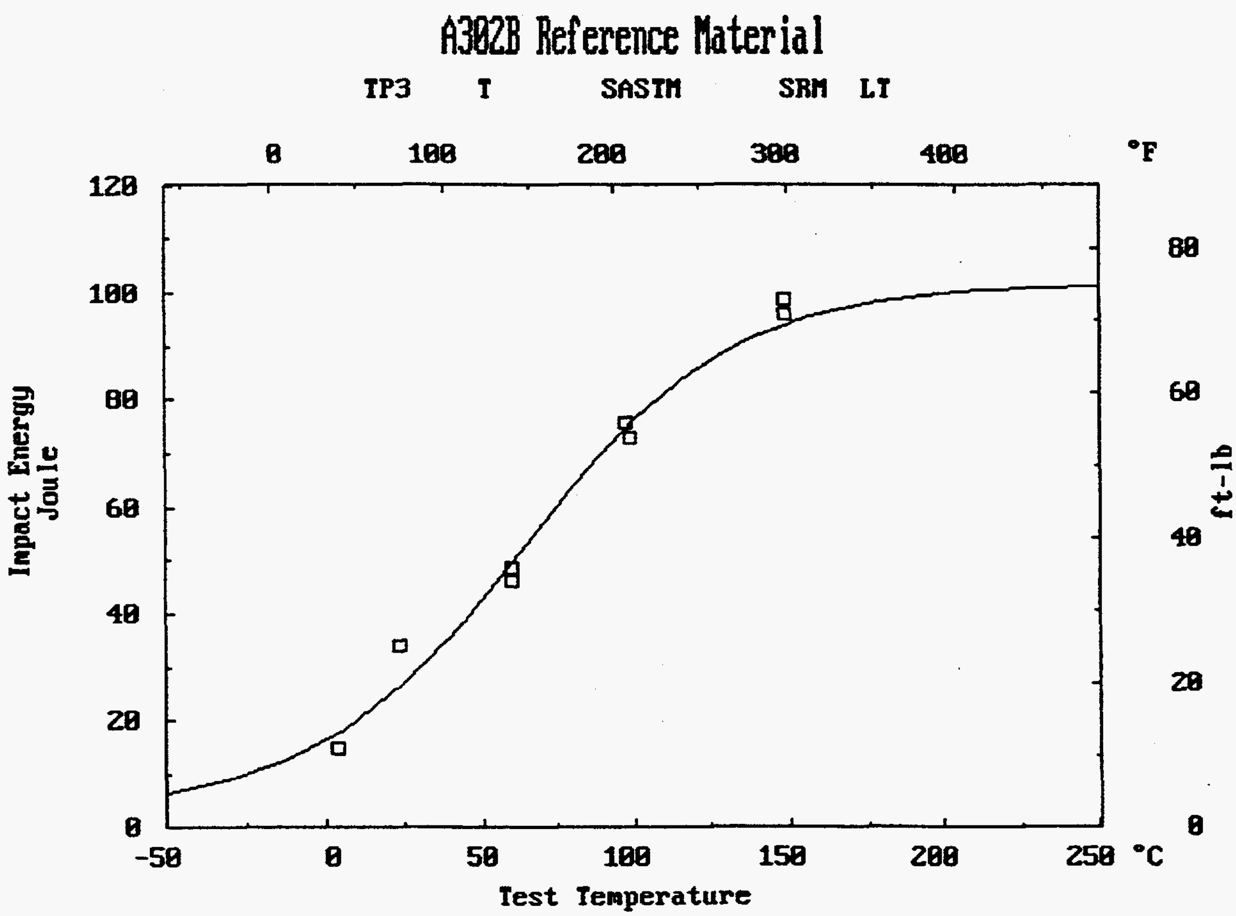
| Parameter | Mean | Std.Dev. | Correlation Coefficients | | | | |
|---|---|---|---|---|---|---|---|
| Lower Shelf Energy (J) | 3.0 | 0.0 | | | | | |
| Upper Shelf Energy (J) | 89.2 | 11.9 | 0.135 | | | | |
| CVT at Midpoint (C) | 72.1 | 11.5 | 0.266 | 0.778 | | | |
| 1/slope (C) | 54.9 | 18.3 | -0.313 | 0.342 | 0.048 | | |
| CVT at 41 Joule (C) | 65.7 | 7.9 | 0.346 | 0.143 | 0.694 | -0.489 | |
| CVT at 68 Joule (C) | 106.7 | 14.2 | -0.243 | -0.402 | -0.291 | 0.459 | -0.091 |



## A302B REFERENCE MATERIAL
Turkey Point Unit 3, Capsule T

USE= 101.8 J, LSE= 3.0 J, CVT(1/2)= 64.C , Slope = 0.0147
CVT(41J) = 48. C , CVT(68J) = 86. C ,
Fluence = 5.680E+18 , Irr. Temp. = 304 C

| Spec. ID | Test Temp. C | Test Temp. F | Impact Energy J | Impact Energy ft-lb | Lat. Exp. mm | Lat. Exp. mil | % Shear |
|---|---|---|---|---|---|---|---|
| R59 | 4. | 40. | 15. | 11. | 0.15 | 6. | 3. |
| R63 | 24. | 75. | 34. | 25. | 0.43 | 17. | 5. |
| R60 | 60. | 140. | 49. | 36. | 0.69 | 27. | 30. |
| R61 | 60. | 140. | 46. | 34. | 0.61 | 24. | 15. |
| R57 | 98. | 208. | 76. | 56. | 1.19 | 47. | 75. |
| R64 | 99. | 210. | 73. | 54. | 0.89 | 35. | 70. |
| R58 | 149. | 300. | 99. | 73. | 1.42 | 56. | 100. |
| R62 | 149. | 300. | 96. | 71. | 1.24 | 49. | 100. |



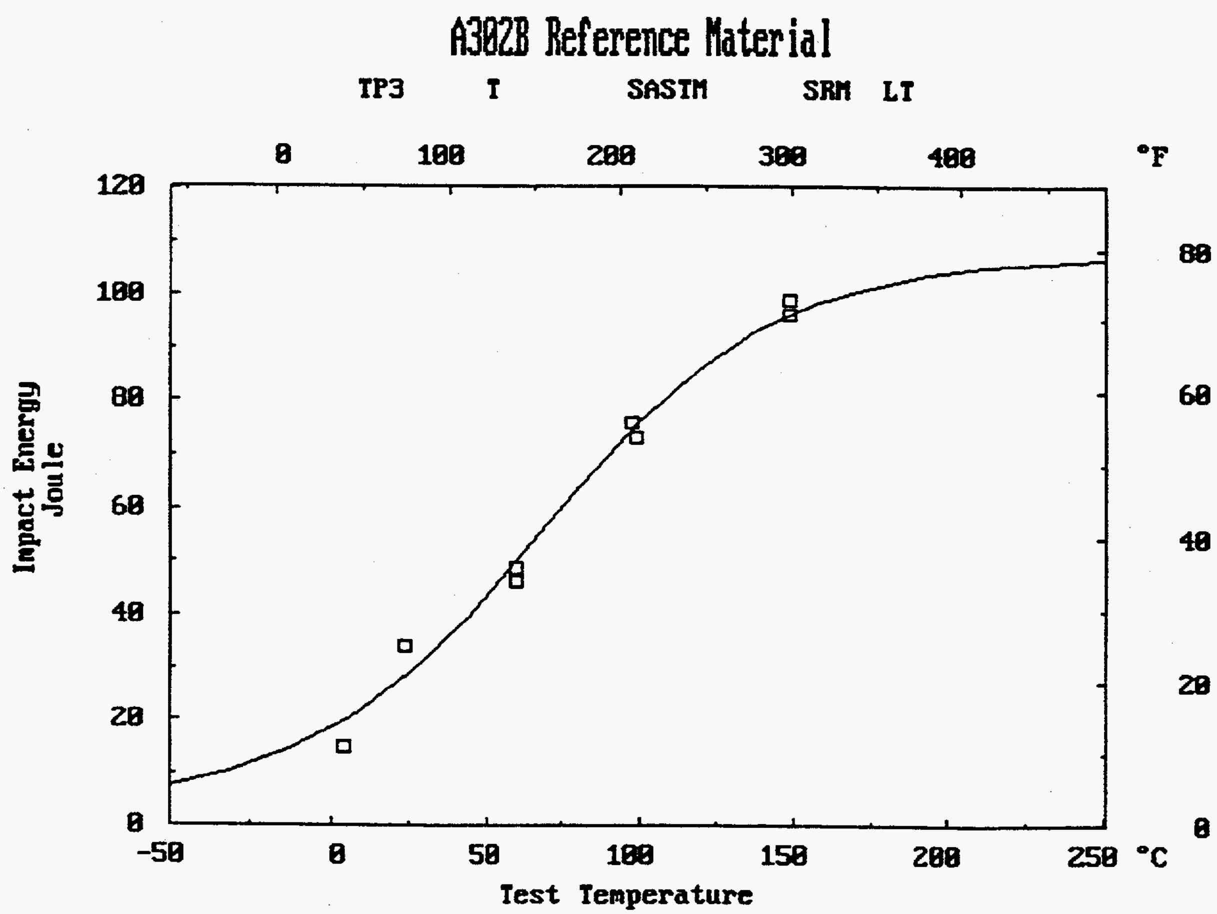
A302B REFERENCE MATERIAL

Turkey Point Unit 3, Capsule T

Impact Energy Uncertainty = 10.0 J
Test Temperature Uncertainty = 4.0 Degree C
Number of Successful Iterations = 200, Maximum = 1000

TP3 T SASTM SRM LT : Fluence = 5.680E+18 , Irr. Temp. = 304

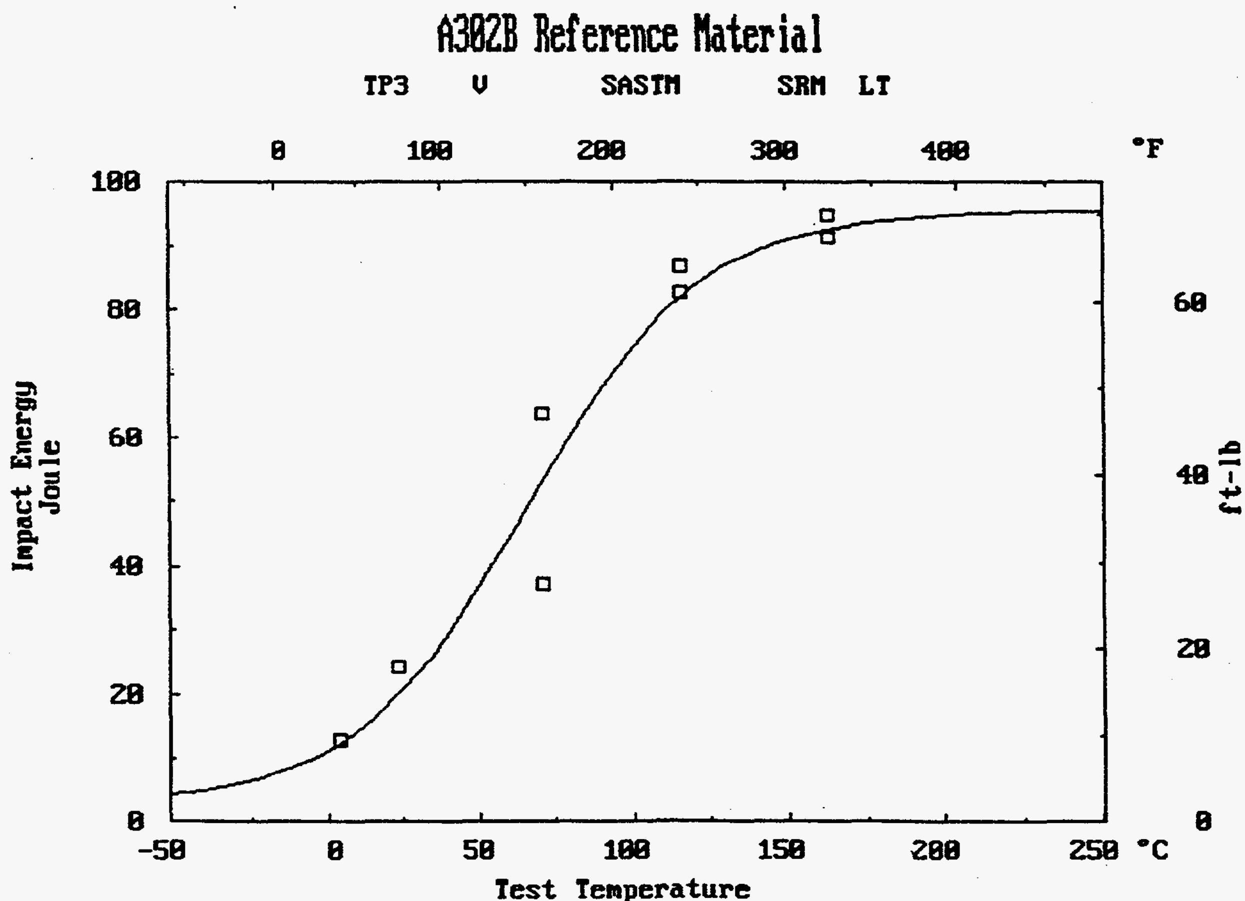
| Parameter | Mean | Std.Dev. | Correlation Coefficients | | | | |
|---|---|---|---|---|---|---|---|
| Lower Shelf Energy (J) | 3.0 | 0.0 | | | | | |
| Upper Shelf Energy (J) | 107.4 | 13.1 | 0.256 | | | | |
| CVT at Midpoint (C) | 67.6 | 13.9 | 0.365 | 0.871 | | | |
| 1/slope (C) | 76.1 | 17.9 | 0.089 | 0.616 | 0.455 | | |
| CVT at 41 Joule (C) | 46.0 | 8.6 | 0.322 | 0.146 | 0.550 | -0.407 | |
| CVT at 68 Joule (C) | 87.0 | 7.2 | 0.322 | 0.250 | 0.595 | 0.401 | 0.524 |



## A302B REFERENCE MATERIAL
Turkey Point Unit 3, Capsule V

USE= 95.7 J, LSE= 3.0 J, CVT(1/2)= 66.C , Slope = 0.0176
CVT(41J) = 56. C , CVT(68J) = 90. C ,
Fluence = 1.229E+19 , Irr. Temp. = 304 C

| Spec. ID | Test Temp. C | Test Temp. F | Impact Energy J | Impact Energy ft-lb | Lat. Exp. mm | Lat. Exp. mil | % Shear |
|---|---|---|---|---|---|---|---|
| R47 | 4. | 40. | 13. | 9. | 0.20 | 8. | 0. |
| R42 | 23. | 74. | 24. | 18. | 0.36 | 14. | 5. |
| R45 | 71. | 160. | 64. | 47. | 1.07 | 42. | 60. |
| R48 | 71. | 160. | 37. | 27. | 0.66 | 26. | 30. |
| R44 | 116. | 240. | 83. | 61. | 1.37 | 54. | 100. |
| R46 | 116. | 240. | 87. | 64. | 1.30 | 51. | 100. |
| R41 | 163. | 325. | 92. | 67. | 1.50 | 59. | 100. |
| R43 | 163. | 325. | 95. | 70. | 1.57 | 62. | 100. |



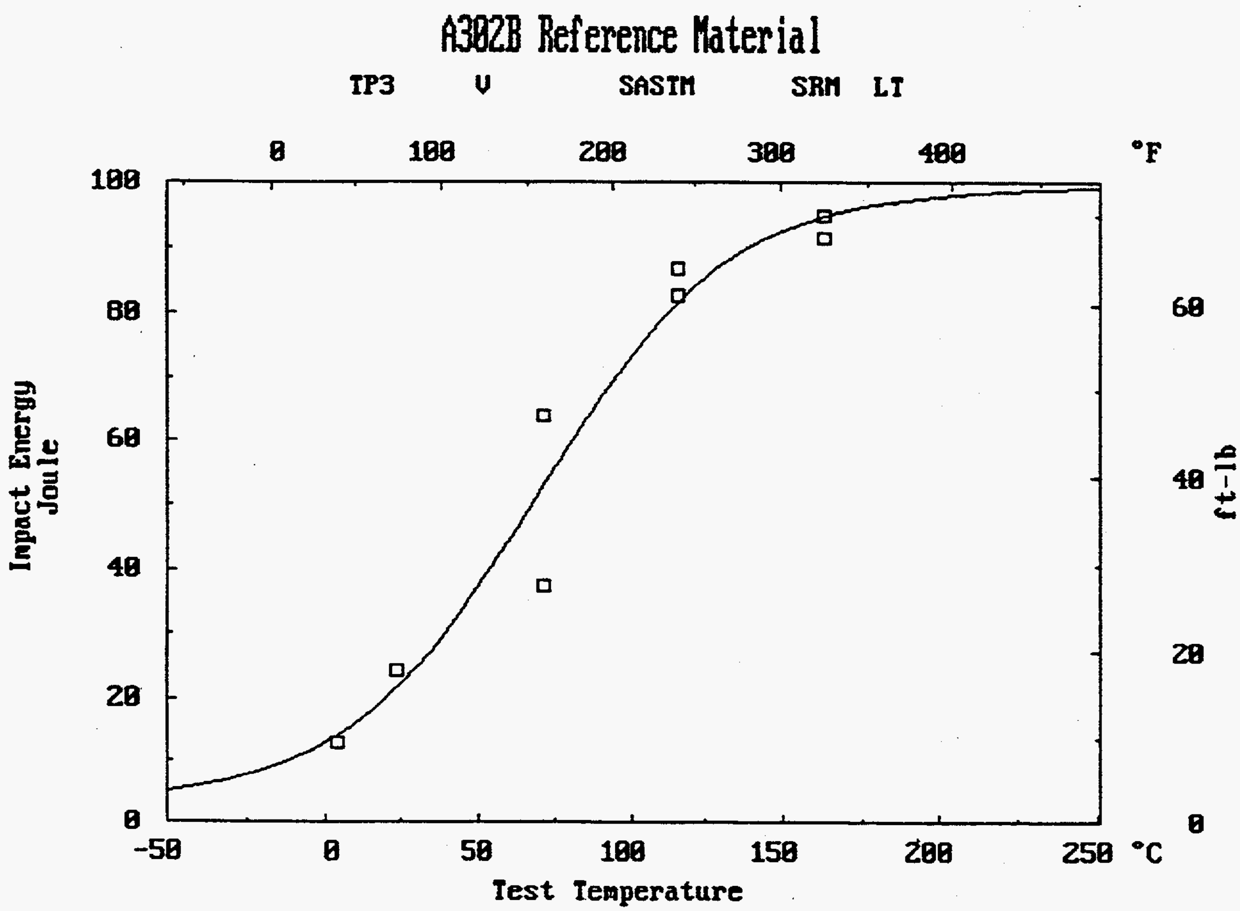
A302B REFERENCE MATERIAL

Turkey Point Unit 3, Capsule V

Impact Energy Uncertainty = 10.0 J
Test Temperature Uncertainty = 4.0 Degree C
Number of Successful Iterations = 200, Maximum = 1000

TP3 V SASTM SRM LT : Fluence = 1.229E+19 , Irr. Temp. = 304

| Parameter | Mean | Std.Dev. | Correlation Coefficients | | | | |
|---|---|---|---|---|---|---|---|
| Lower Shelf Energy (J) | 3.0 | 0.0 | | | | | |
| Upper Shelf Energy (J) | 99.5 | 8.9 | 0.032 | | | | |
| CVT at Midpoint (C) | 68.9 | 11.1 | 0.171 | 0.776 | | | |
| 1/slope (C) | 63.0 | 17.3 | -0.140 | 0.553 | 0.339 | | |
| CVT at 41 Joule (C) | 55.0 | 8.3 | 0.283 | 0.161 | 0.689 | -0.364 | |
| CVT at 68 Joule (C) | 91.7 | 8.4 | 0.091 | 0.303 | 0.682 | 0.553 | 0.475 |



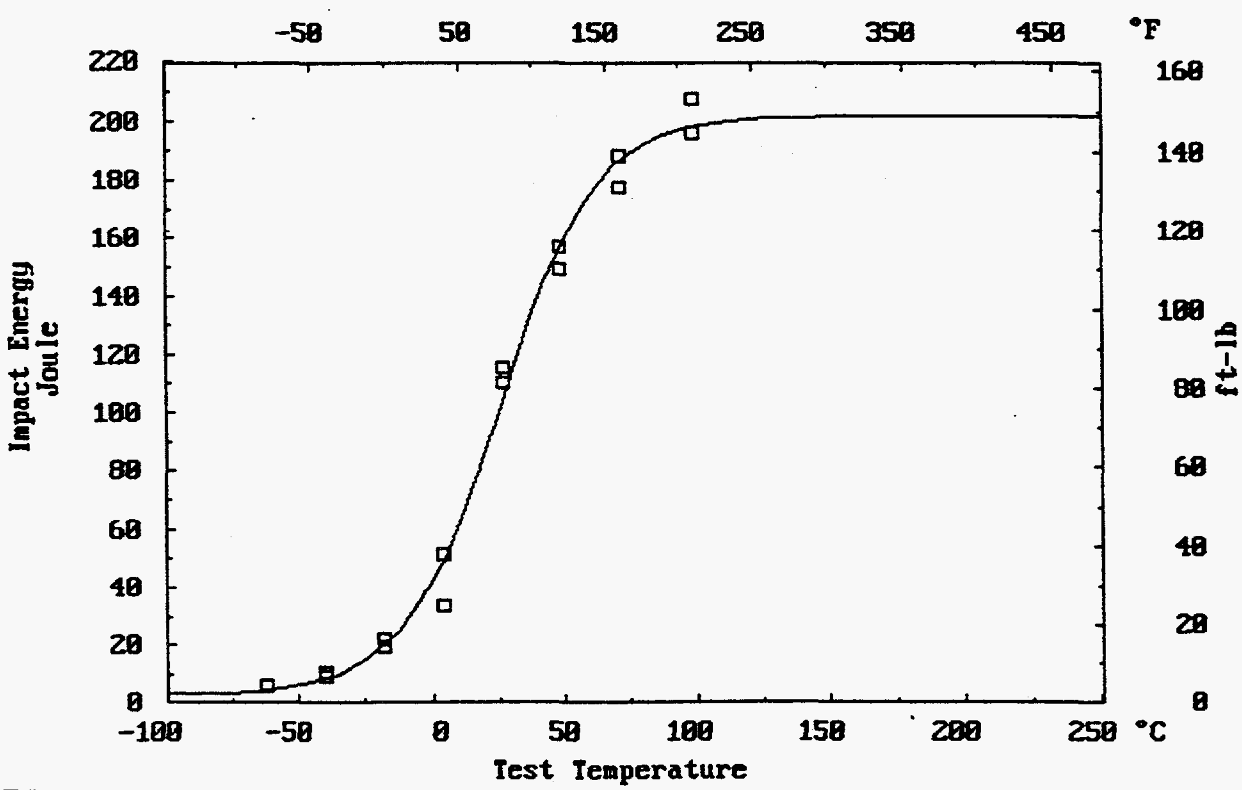
A533B HSST01 REFERENCE MATERIAL
Arkansas Unit 2, Baseline

USE= 201.7 J, LSE= 3.0 J, CVT(1/2)= 26.C , Slope = 0.0272
Unirradiated Charpy Specimen, CVT(41J) = -1. C , CVT(68J) = 13. C

| Spec. ID | Test Temp. C | Test Temp. F | Impact Energy J | Impact Energy ft-lb | Lat. Exp. mm | Lat. Exp. mil | % Shear |
|---|---|---|---|---|---|---|---|
| 7A3 | -62. | -80. | 6. | 4. | 0.05 | 2. | 0. |
| 7AA | -40. | -40. | 11. | 8. | 0.18 | 7. | 5. |
| 7AL | -40. | -40. | 9. | 7. | 0.15 | 6. | 5. |
| 7A1 | -18. | 0. | 22. | 16. | 0.43 | 17. | 15. |
| 7AK | -18. | 0. | 20. | 14. | 0.36 | 14. | 15. |
| 7A2 | 4. | 40. | 34. | 25. | 0.66 | 26. | 25. |
| 7A7 | 4. | 40. | 52. | 38. | 0.84 | 33. | 25. |
| 7A5 | 27. | 80. | 110. | 81. | 1.60 | 63. | 40. |
| 7AC | 27. | 80. | 115. | 85. | 1.73 | 68. | 50. |
| 7A4 | 49. | 120. | 149. | 110. | 1.98 | 78. | 70. |
| 7AJ | 49. | 120. | 157. | 116. | 2.13 | 84. | 70. |
| 7A6 | 71. | 160. | 188. | 139. | 2.31 | 91. | 95. |
| 7AD | 71. | 160. | 178. | 131. | 2.16 | 85. | 90. |
| 7AB | 99. | 210. | 196. | 144. | 2.31 | 91. | 100. |
| 7AE | 99. | 210. | 207. | 153. | 2.13 | 84. | 100. |

## A533B Reference Material (HSST Plate #1)

ANZ SHSS01 SRM LT



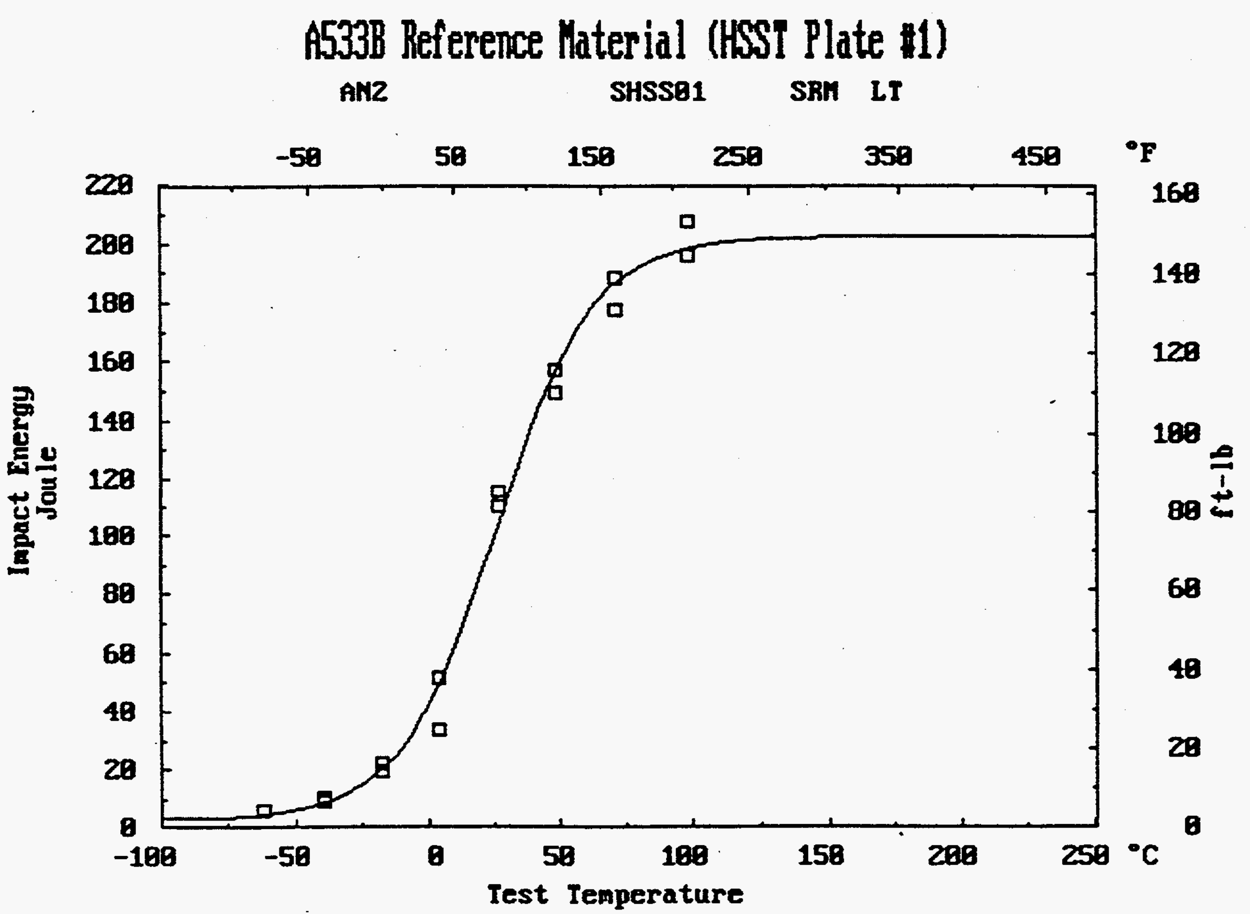
A533B HSST01 REFERENCE MATERIAL

Arkansas Unit 2, Baseline

```
Impact Energy Uncertainty =  10.0 J
Test Temperature Uncertainty =   4.0 Degree C
Number of Successful Iterations =  200, Maximum = 1000
```

AN2 SHSS01 SRM LT

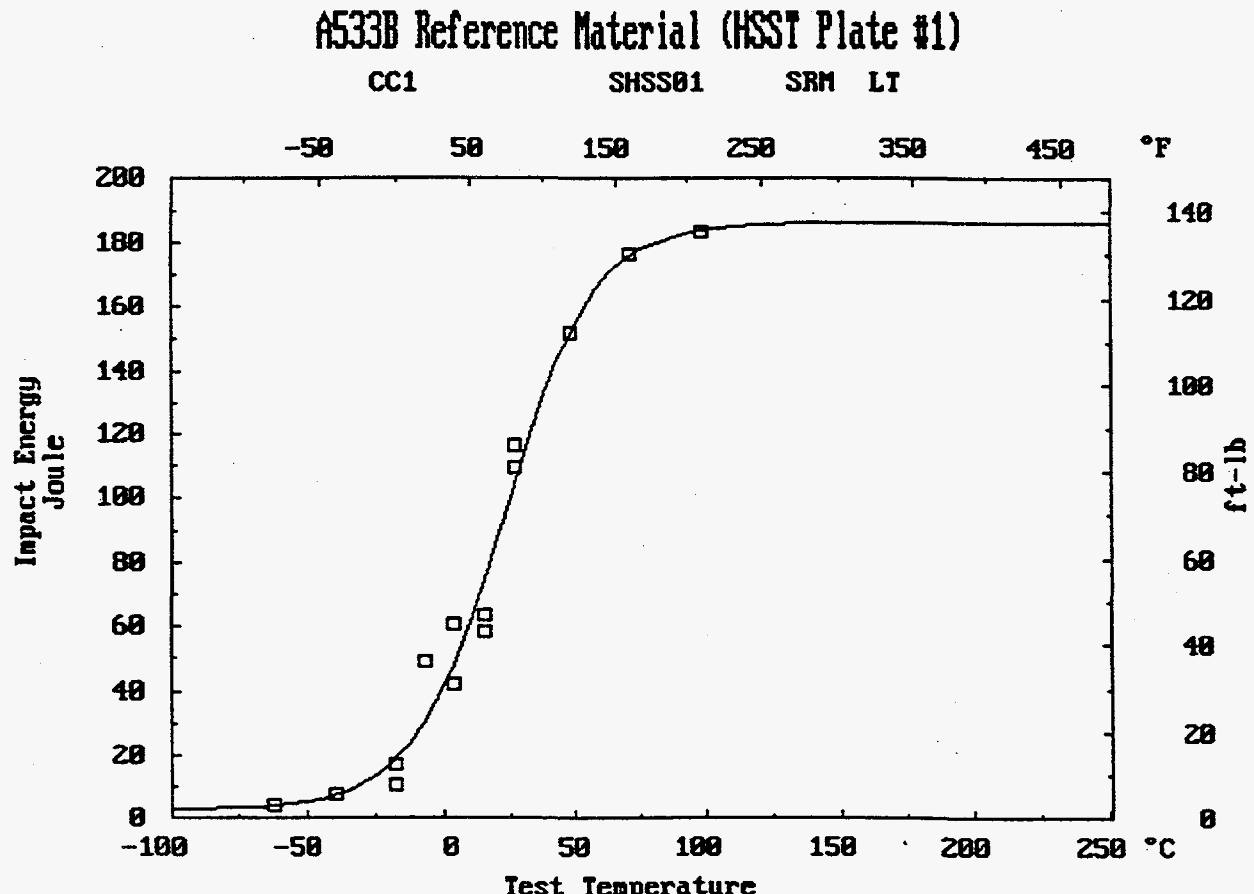
| Parameter | Mean | Std.Dev. | Correlation Coefficients | | | | |
|---|---|---|---|---|---|---|---|
| Lower Shelf Energy (J) | 3.0 | 0.1 | | | | | |
| Upper Shelf Energy (J) | 202.5 | 8.9 | -0.093 | | | | |
| CVT at Midpoint (C) | 26.2 | 3.5 | 0.034 | 0.768 | | | |
| 1/slope (C) | 36.9 | 5.9 | -0.250 | 0.721 | 0.591 | | |
| CVT at 41 Joule (C) | -0.6 | 3.8 | 0.324 | -0.363 | 0.059 | -0.760 | |
| CVT at 68 Joule (C) | 12.7 | 2.6 | 0.284 | -0.024 | 0.510 | -0.356 | 0.877 |



## A533B HSST01 REFERENCE MATERIAL
Calvert Cliffs Unit 1, Baseline

USE= 186.5 J, LSE= 3.0 J, CVT(1/2)= 23.C , Slope = 0.0291
Unirradiated Charpy Specimen, CVT(41J) = 0. C , CVT(68J) = 13. C

| Spec. ID | Test Temp. C | F | Impact Energy J | ft-lb | Lat. Exp. mm | mil | % Shear |
|---|---|---|---|---|---|---|---|
| 64U | -62. | -80. | 5. | 3. | 0.15 | 6. | 0. |
| 657 | -40. | -40. | 8. | 6. | 0.15 | 6. | 10. |
| 64L | -18. | 0. | 11. | 8. | 0.30 | 12. | 15. |
| 655 | -18. | 0. | 17. | 12. | 0.51 | 20. | 15. |
| 653 | -7. | 20. | 49. | 36. | 0.81 | 32. | 20. |
| 64K | 4. | 40. | 42. | 31. | 0.79 | 31. | 20. |
| 64T | 4. | 40. | 61. | 45. | 1.02 | 40. | 25. |
| 651 | 16. | 60. | 58. | 43. | 1.02 | 40. | 30. |
| 654 | 16. | 60. | 64. | 47. | 1.09 | 43. | 30. |
| 64M | 27. | 80. | 117. | 86. | 1.68 | 66. | 40. |
| 652 | 27. | 80. | 110. | 81. | 1.63 | 64. | 45. |
| 64Y | 49. | 120. | 152. | 112. | 2.18 | 86. | 75. |
| 656 | 49. | 120. | 152. | 112. | 2.03 | 80. | 75. |
| 64P | 71. | 160. | 176. | 130. | 2.39 | 94. | 90. |
| 65A | 99. | 210. | 184. | 135. | 2.34 | 92. | 100. |



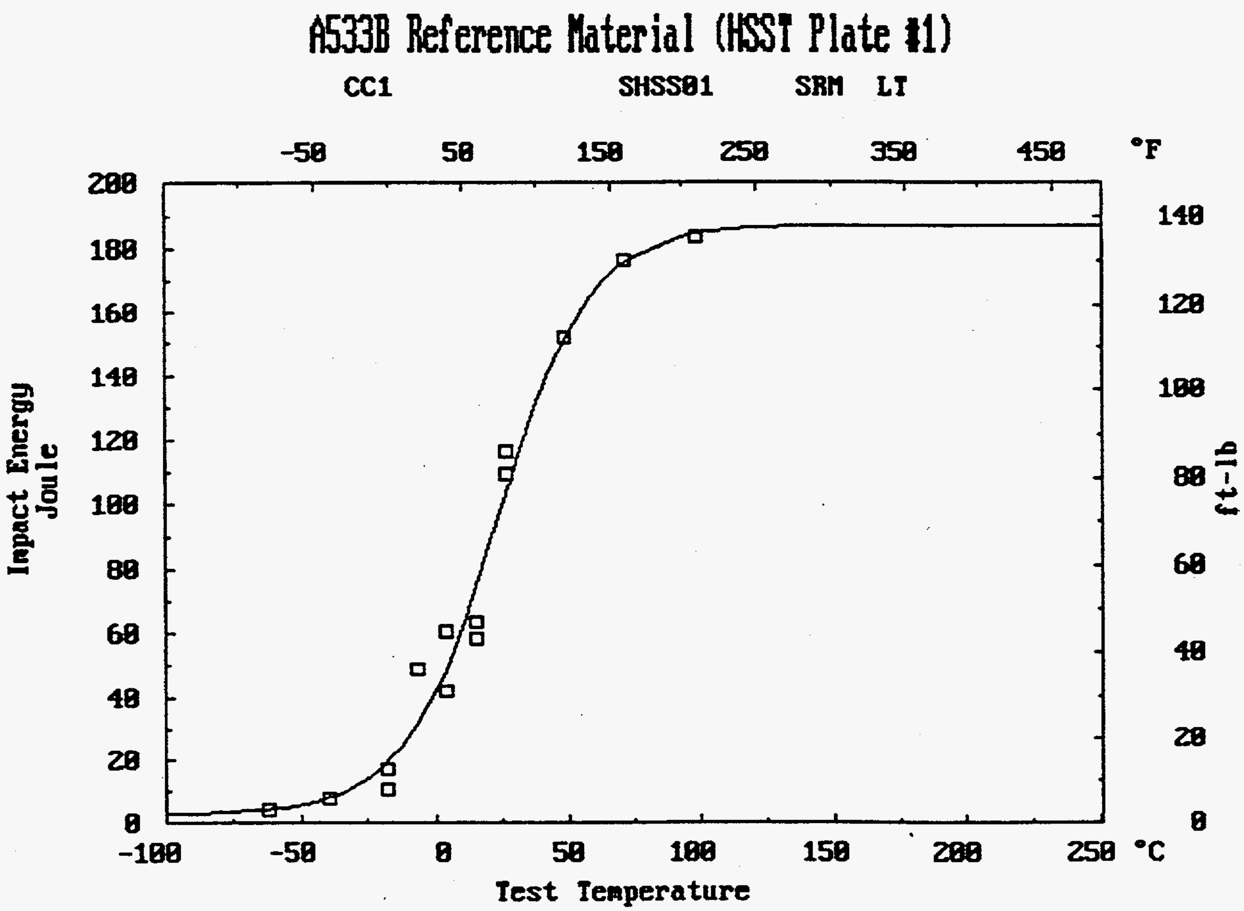
A533B HSST01 REFERENCE MATERIAL

Calvert Cliffs Unit 1, Baseline

```
Impact Energy Uncertainty =  10.0 J
Test Temperature Uncertainty =   4.0 Degree C
Number of Successful Iterations =  200, Maximum = 1000
```

CC1 SHSS01 SRM LT

| Parameter | Mean | Std.Dev. | Correlation Coefficients | | | | |
|---|---|---|---|---|---|---|---|
| Lower Shelf Energy (J) | 3.0 | 0.1 | | | | | |
| Upper Shelf Energy (J) | 187.1 | 9.2 | -0.071 | | | | |
| CVT at Midpoint (C) | 23.4 | 3.1 | 0.075 | 0.758 | | | |
| 1/slope (C) | 35.2 | 4.7 | -0.156 | 0.611 | 0.555 | | |
| CVT at 41 Joule (C) | -0.4 | 3.0 | 0.255 | -0.246 | 0.151 | -0.715 | |
| CVT at 68 Joule (C) | 12.6 | 2.1 | 0.246 | 0.039 | 0.585 | -0.257 | 0.857 |



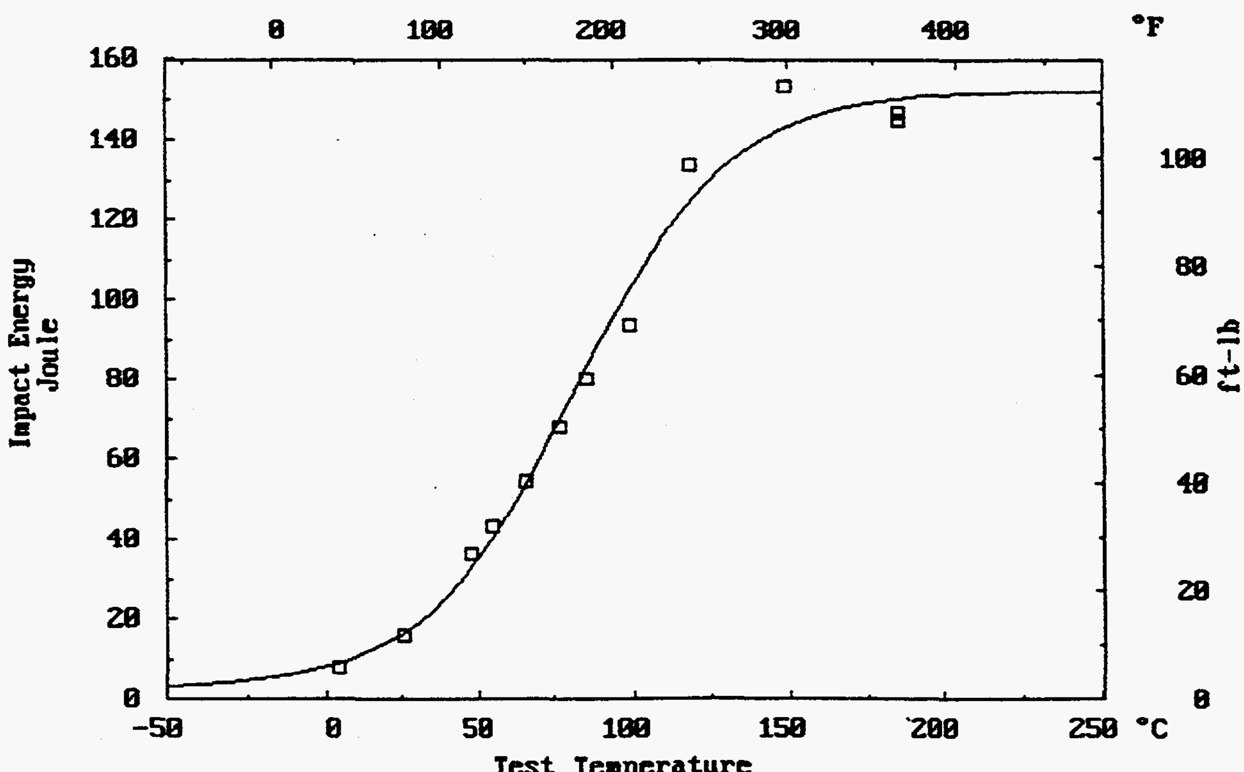
A533B HSST01 REFERENCE MATERIAL
Calvert Cliffs Unit 1, Capsule W263

USE= 152.2 J, LSE= 3.0 J, CVT(1/2)= 82.C , Slope = 0.0205
CVT(41J) = 56. C , CVT(68J) = 75. C ,
Fluence = 5.900E+18 , Irr. Temp. = 288 C

| Spec. ID | Test Temp. C | F | Impact Energy J | ft-lb | Lat. Exp. mm | mil | % Shear |
|---|---|---|---|---|---|---|---|
| 64B | 4. | 40. | 8. | 6. | 0.15 | 6. | 5. |
| 644 | 26. | 78. | 16. | 12. | 0.33 | 13. | 5. |
| 64J | 48. | 118. | 37. | 27. | 0.66 | 26. | 25. |
| 647 | 54. | 130. | 43. | 32. | 0.84 | 33. | 20. |
| 643 | 66. | 150. | 55. | 40. | 0.97 | 38. | 35. |
| 64C | 77. | 170. | 68. | 50. | 1.17 | 46. | 35. |
| 645 | 85. | 185. | 80. | 59. | 1.30 | 51. | 35. |
| 64D | 99. | 210. | 94. | 69. | 1.57 | 62. | 50. |
| 64E | 118. | 245. | 134. | 99. | 1.93 | 76. | 85. |
| 642 | 149. | 300. | 153. | 113. | 2.31 | 91. | 100. |
| 646 | 186. | 366. | 147. | 108. | 2.18 | 86. | 100. |
| 64A | 186. | 366. | 145. | 107. | 2.18 | 86. | 100. |

A533B Reference Material (HSST Plate #1)

CC1 W263 SHSS01 SRM LT



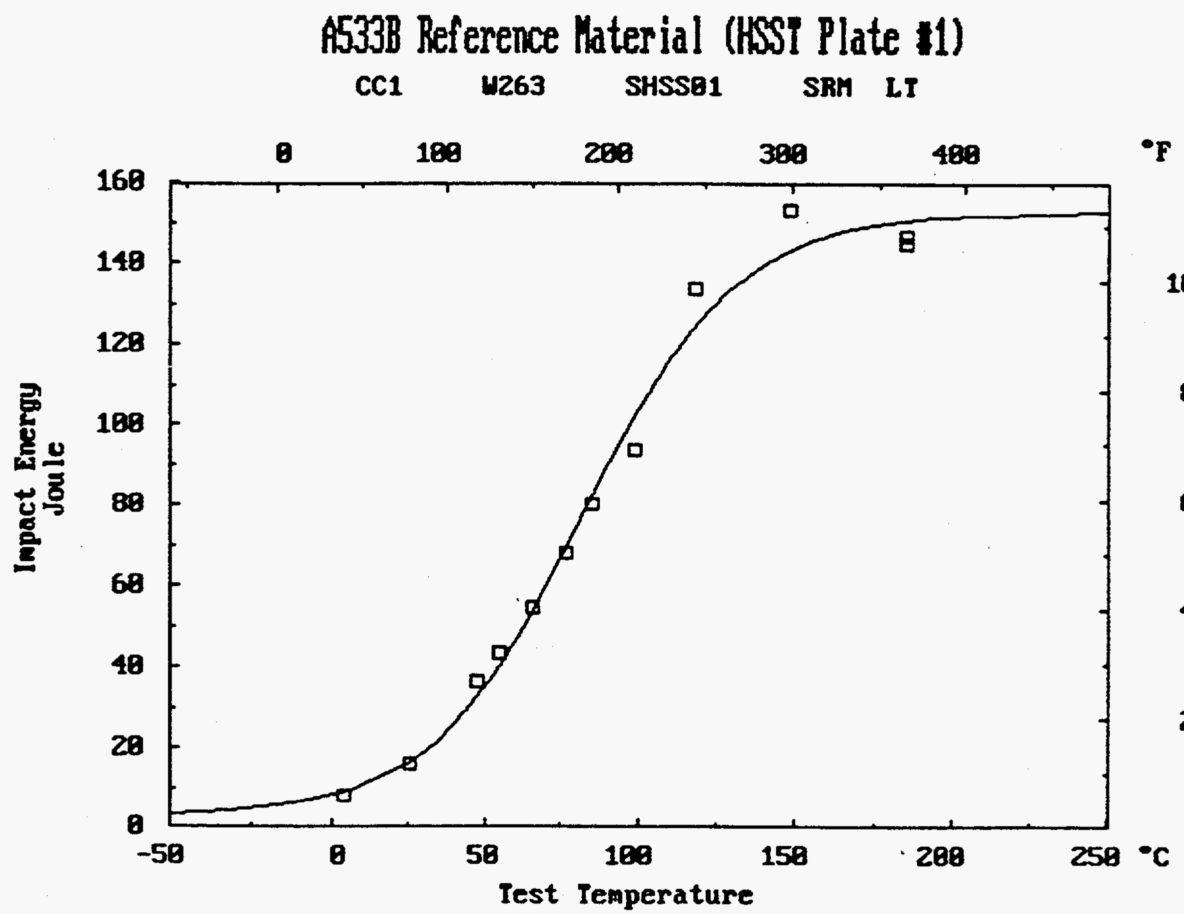
A533B HSST01 REFERENCE MATERIAL

Calvert Cliffs Unit 1, Capsule W263

```
Impact Energy Uncertainty =  10.0 J
Test Temperature Uncertainty =   4.0 Degree C
Number of Successful Iterations =  200, Maximum = 1000
```

CC1 W263 SHSS01 SRM LT : Fluence = 5.900E+18 , Irr. Temp. = 288

| Parameter | Mean | Std.Dev. | Correlation Coefficients | | | | |
|---|---|---|---|---|---|---|---|
| Lower Shelf Energy (J) | 3.0 | 0.0 | | | | | |
| Upper Shelf Energy (J) | 152.8 | 6.3 | -0.050 | | | | |
| CVT at Midpoint (C) | 82.2 | 4.2 | 0.040 | 0.626 | | | |
| 1/slope (C) | 49.1 | 6.5 | -0.172 | 0.345 | 0.282 | | |
| CVT at 41 Joule (C) | 55.7 | 4.4 | 0.184 | 0.005 | 0.529 | -0.630 | |
| CVT at 68 Joule (C) | 75.7 | 3.3 | 0.116 | 0.144 | 0.839 | -0.084 | 0.820 |

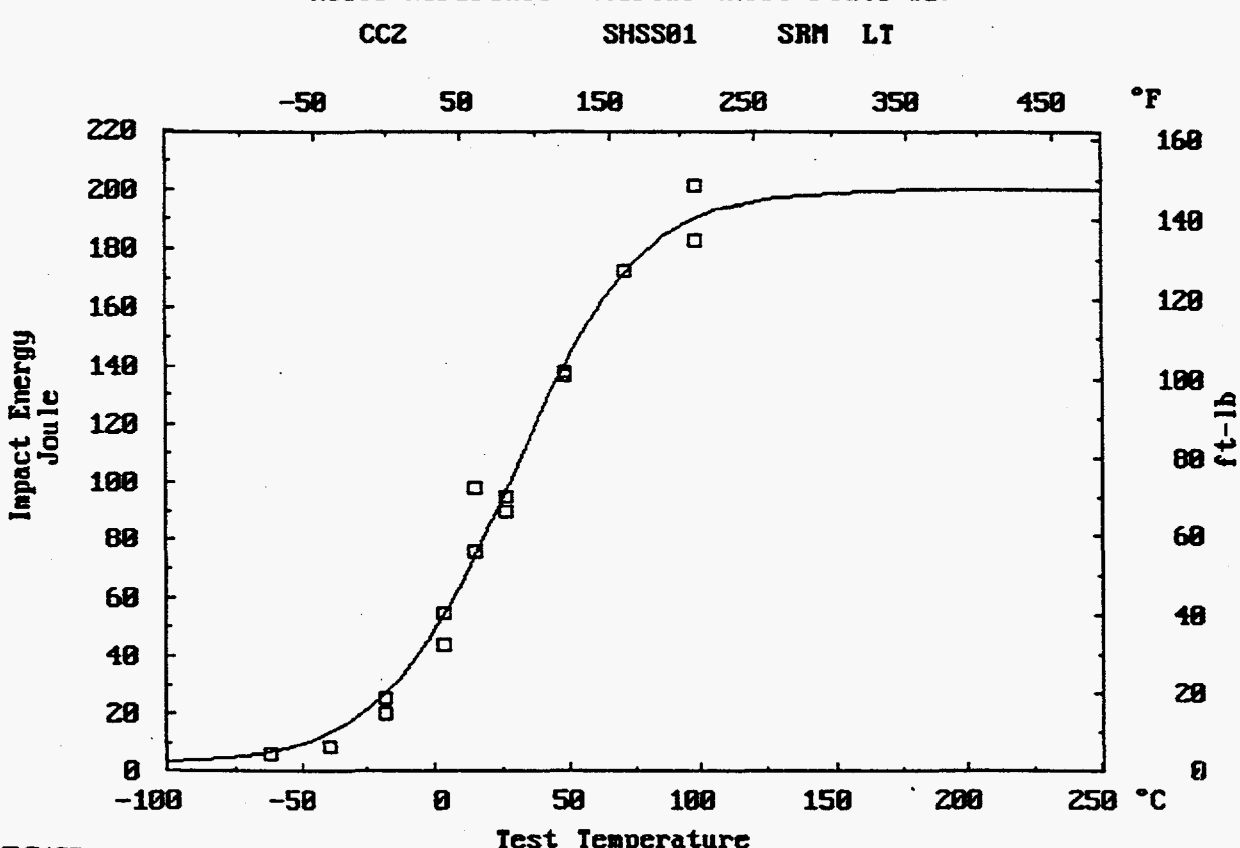


A533B HSST01 REFERENCE MATERIAL
Calvert Cliffs Unit 2, Baseline

USE= 200.0 J, LSE= 3.0 J, CVT(1/2)= 29.C , Slope = 0.0212
Unirradiated Charpy Specimen, CVT(41J) = -5. C , CVT(68J) = ´12. C

| Spec. ID | Test Temp. C | Test Temp. F | Impact Energy J | Impact Energy ft-lb | Lat. Exp. mm | Lat. Exp. mil | % Shear |
|---|---|---|---|---|---|---|---|
| 6A7 | -62. | -80. | 6. | 4. | 0.05 | 2. | 0. |
| 6A5 | -40. | -40. | 8. | 6. | 0.13 | 5. | 10. |
| 675 | -18. | 0. | 25. | 18. | 0.43 | 17. | 15. |
| 6A6 | -18. | 0. | 20. | 15. | 0.36 | 14. | 15. |
| 674 | 4. | 40. | 55. | 40. | 0.86 | 34. | 20. |
| 67U | 4. | 40. | 44. | 32. | 0.76 | 30. | 20. |
| 671 | 16. | 60. | 76. | 56. | 1.22 | 48. | 30. |
| 6A4 | 16. | 60. | 98. | 72. | 1.40 | 55. | 35. |
| 66Y | 27. | 80. | 90. | 66. | 1.35 | 53. | 40. |
| 6A2 | 27. | 80. | 95. | 70. | 1.42 | 56. | 40. |
| 67T | 49. | 120. | 138. | 101. | 1.83 | 72. | 65. |
| 67Y | 49. | 120. | 136. | 100. | 1.75 | 69. | 60. |
| 6A1 | 71. | 160. | 172. | 127. | 2.29 | 90. | 90. |
| 66U | 99. | 210. | 201. | 148. | 2.34 | 92. | 100. |
| 6A3 | 99. | 210. | 182. | 134. | 2.18 | 86. | 100. |

A533B Reference Material (HSST Plate #1)



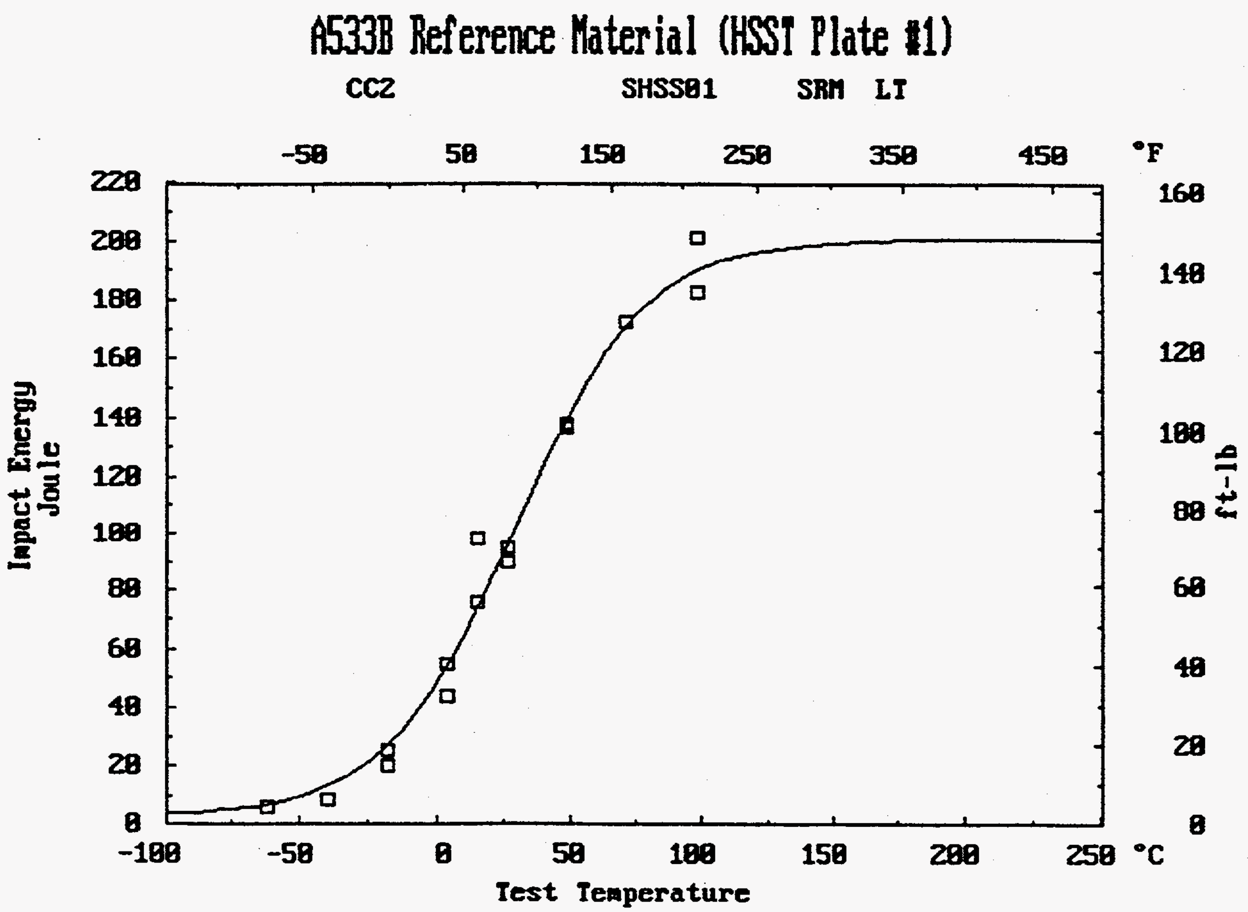
A533B HSST01 REFERENCE MATERIAL

Calvert Cliffs Unit 2, Baseline

Impact Energy Uncertainty = 10.0 J
Test Temperature Uncertainty = 4.0 Degree C
Number of Successful Iterations = 200, Maximum = 1000

CC2 SHSS01 SRM LT

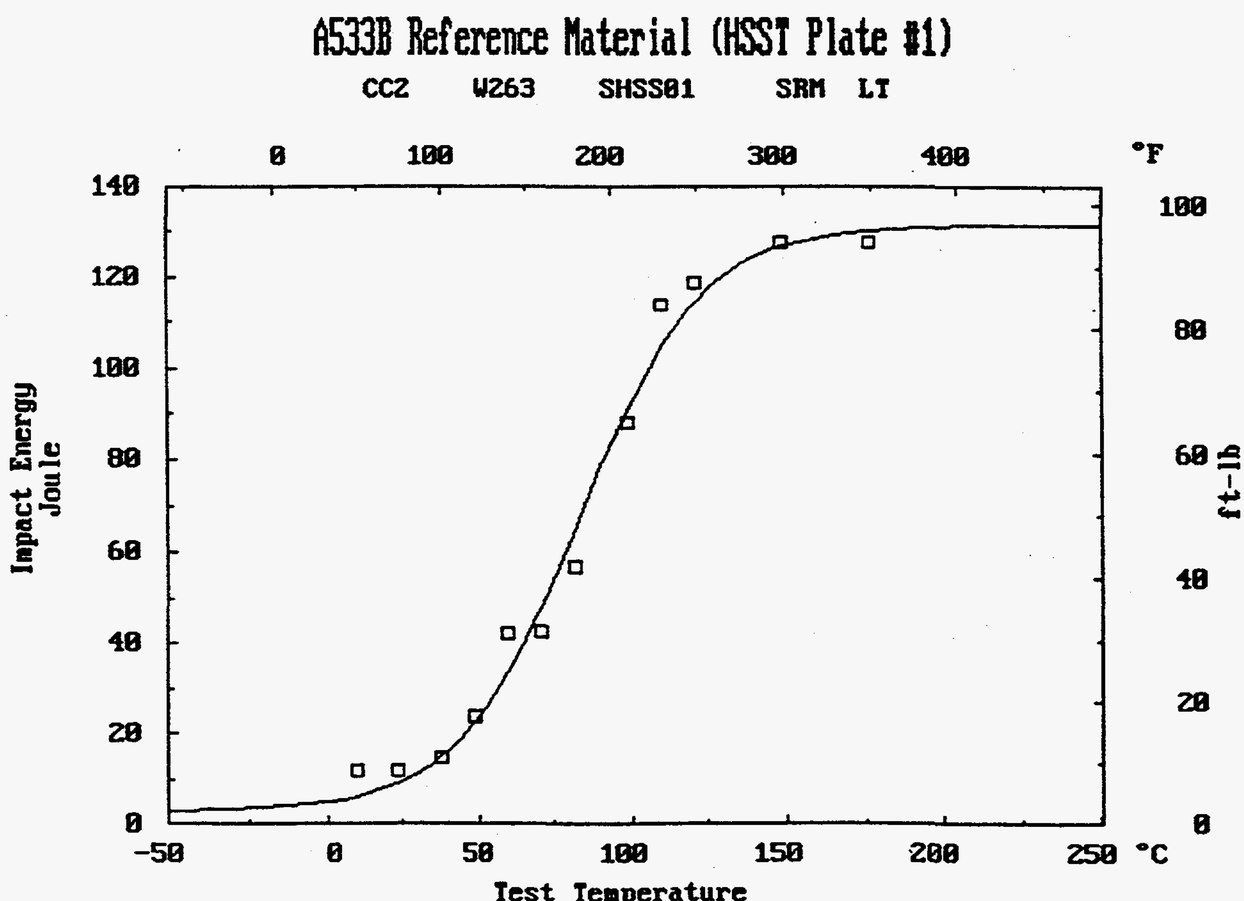
| Parameter | Mean | Std.Dev. | Correlation Coefficients | | | | |
|---|---|---|---|---|---|---|---|
| Lower Shelf Energy (J) | 3.0 | 0.0 | | | | | |
| Upper Shelf Energy (J) | 200.5 | 11.3 | 0.028 | | | | |
| CVT at Midpoint (C) | 29.6 | 4.5 | 0.025 | 0.854 | | | |
| 1/slope (C) | 47.8 | 6.0 | -0.056 | 0.622 | 0.626 | | |
| CVT at 41 Joule (C) | -4.8 | 3.7 | 0.074 | -0.171 | 0.068 | -0.712 | |
| CVT at 68 Joule (C) | 12.5 | 2.6 | 0.060 | 0.142 | 0.509 | -0.268 | 0.864 |



A533B HSST01 REFERENCE MATERIAL
Calvert Cliffs Unit 2, Capsule W263

USE= 131.3 J, LSE= 3.1 J, CVT(1/2)= 83.C , Slope = 0.0252
CVT(41J) = 66. C , CVT(68J) = 84. C ,
Fluence = 8.140E+18 , Irr. Temp. = 288 C

| Spec. ID | Test Temp. C | Test Temp. F | Impact Energy J | Impact Energy ft-lb | Lat. Exp. mm | Lat. Exp. mil | % Shear |
|---|---|---|---|---|---|---|---|
| 67A | 10. | 50. | 12. | 9. | 0.28 | 11. | 0. |
| 66D | 24. | 75. | 12. | 9. | 0.28 | 11. | 5. |
| 676 | 38. | 100. | 15. | 11. | 0.33 | 13. | 5. |
| 677 | 49. | 120. | 24. | 17. | 0.51 | 20. | 10. |
| 67P | 60. | 140. | 42. | 31. | 0.76 | 30. | 10. |
| 66T | 71. | 160. | 43. | 32. | 0.76 | 30. | 20. |
| 66A | 82. | 180. | 57. | 42. | 1.70 | 67. | 25. |
| 66C | 99. | 210. | 88. | 65. | 1.45 | 57. | 25. |
| 67K | 110. | 230. | 114. | 84. | 1.88 | 74. | 100. |
| 667 | 121. | 250. | 119. | 87. | 1.90 | 75. | 100. |
| 66M | 149. | 300. | 127. | 94. | 2.06 | 81. | 100. |
| 67L | 177. | 350. | 127. | 94. | 1.93 | 76. | 100. |



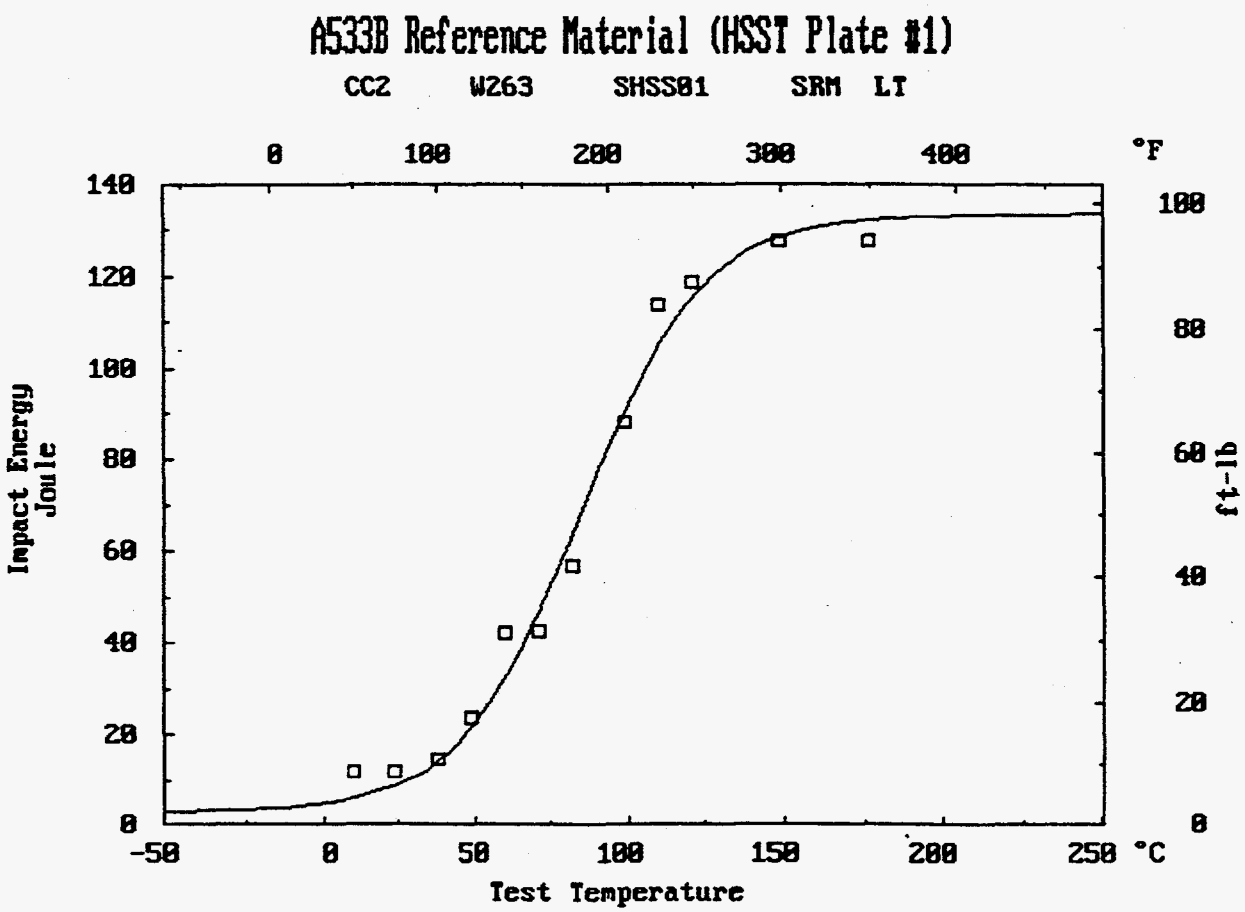
A533B HSST01 REFERENCE MATERIAL

Calvert Cliffs Unit 2, Capsule W263

Impact Energy Uncertainty = 10.0 J
Test Temperature Uncertainty = 4.0 Degree C
Number of Successful Iterations = 200, Maximum = 1000

CC2 W263 SHSS01 SRM LT : Fluence = 8.140E+18 , Irr. Temp. = 288

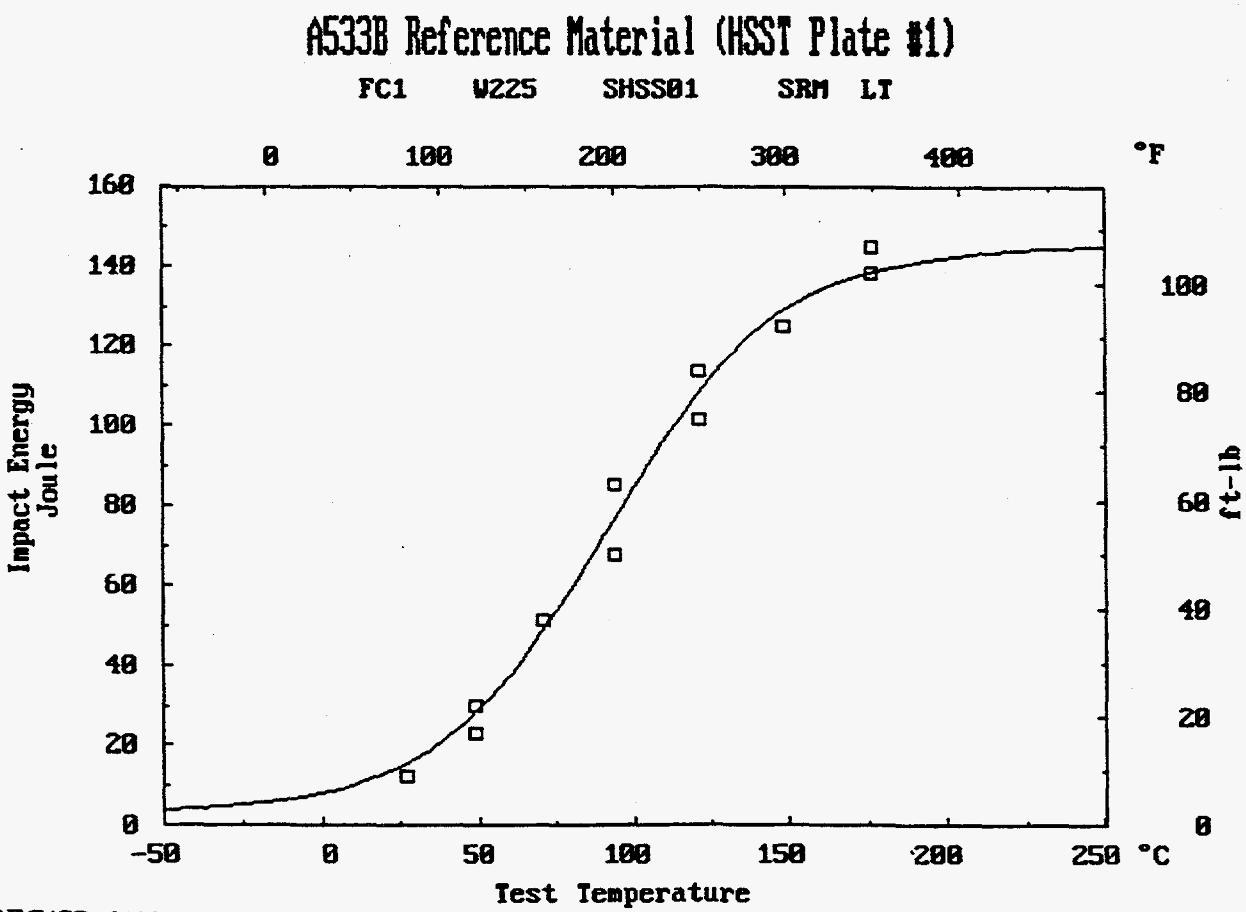
| Parameter | Mean | Std.Dev. | Correlation Coefficients | | | | |
|---|---|---|---|---|---|---|---|
| Lower Shelf Energy (J) | 3.1 | 0.1 | | | | | |
| Upper Shelf Energy (J) | 133.6 | 7.8 | 0.046 | | | | |
| CVT at Midpoint (C) | 84.8 | 4.9 | 0.243 | 0.702 | | | |
| 1/slope (C) | 39.7 | 7.8 | -0.387 | 0.425 | 0.286 | | |
| CVT at 41 Joule (C) | 67.0 | 4.7 | 0.518 | 0.043 | 0.556 | -0.601 | |
| CVT at 68 Joule (C) | 84.6 | 3.6 | 0.309 | 0.264 | 0.867 | 0.076 | 0.740 |



A533B HSST01 REFERENCE MATERIAL
Fort Calhoun Unit 1, Capsule W225

USE= 145.3 J, LSE= 3.0 J, CVT(1/2)= 92.C , Slope = 0.0180
CVT(41J) = 64. C , CVT(68J) = 87. C ,
Fluence = 4.800E+18 , Irr. Temp. = 288 C

| Spec. ID | Test Temp. C | Test Temp. F | Impact Energy J | Impact Energy ft-lb | Lat. Exp. mm | Lat. Exp. mil | % Shear |
|---|---|---|---|---|---|---|---|
| 55T | 27. | 80. | 12. | 9. | 0.18 | 7. | 0. |
| 566 | 49. | 120. | 30. | 22. | 0.53 | 21. | 0. |
| 573 | 49. | 120. | 23. | 17. | 0.48 | 19. | 0. |
| 55M | 71. | 160. | 52. | 38. | 0.61 | 24. | 20. |
| 55Y | 71. | 160. | 52. | 38. | 0.84 | 33. | 20. |
| 563 | 93. | 200. | 85. | 63. | 1.19 | 47. | 30. |
| 56J | 93. | 200. | 68. | 50. | 0.97 | 38. | 30. |
| 565 | 121. | 250. | 114. | 84. | 1.78 | 70. | 80. |
| 56A | 121. | 250. | 102. | 75. | 1.27 | 50. | 70. |
| 56D | 149. | 300. | 125. | 92. | 1.90 | 75. | 90. |
| 55P | 177. | 350. | 145. | 107. | 2.11 | 83. | 100. |
| 575 | 177. | 350. | 138. | 102. | 2.03 | 80. | 100. |



A533B HSST01 REFERENCE MATERIAL

Fort Calhoun Unit 1, Capsule W225

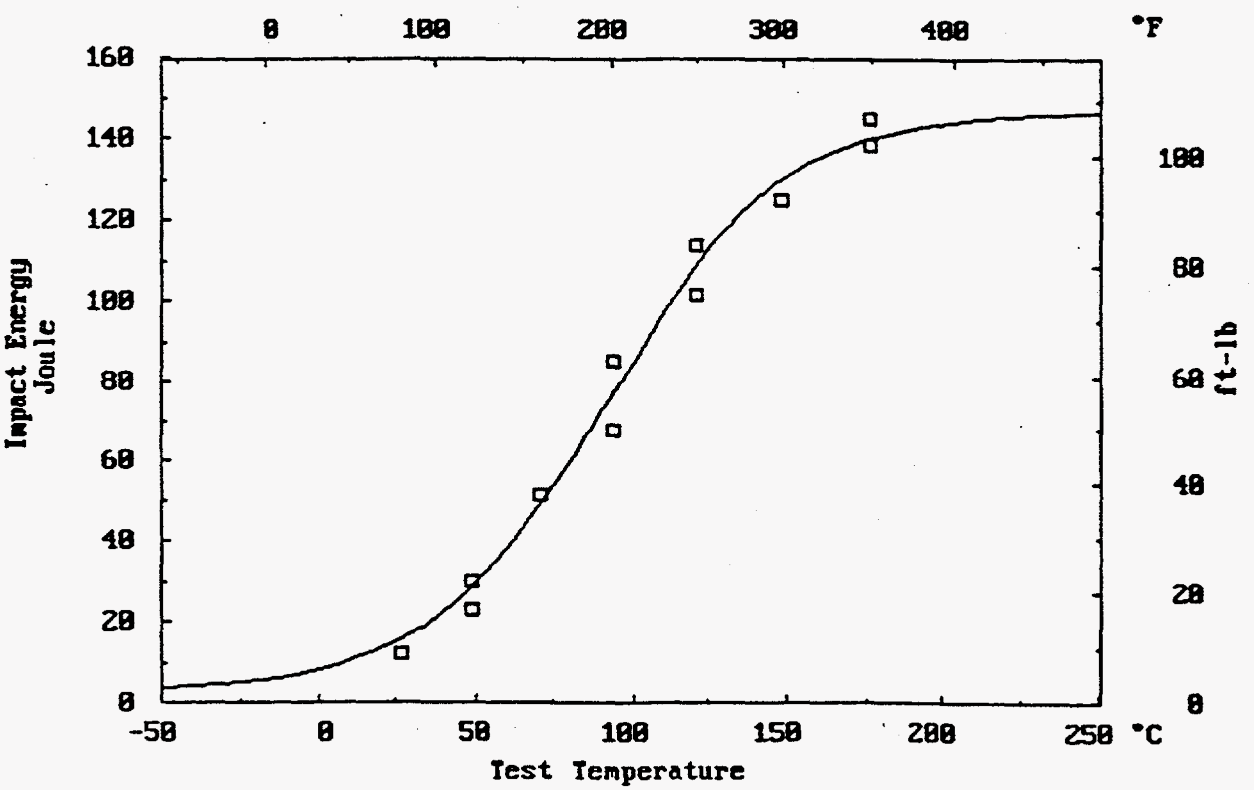
Impact Energy Uncertainty = 10.0 J
Test Temperature Uncertainty = 4.0 Degree C
Number of Successful Iterations = 200, Maximum = 1000

FC1 W225 SHSS01 SRM LT : Fluence = 4.800E+18 , Irr. Temp. = 288

| Parameter | Mean | Std.Dev. | Correlation Coefficients | | | | |
|---|---|---|---|---|---|---|---|
| Lower Shelf Energy (J) | 3.0 | 0.0 | | | | | |
| Upper Shelf Energy (J) | 147.0 | 9.9 | 0.109 | | | | |
| CVT at Midpoint (C) | 92.1 | 6.6 | 0.105 | 0.839 | | | |
| 1/slope (C) | 56.3 | 9.6 | 0.132 | 0.723 | 0.644 | | |
| CVT at 41 Joule (C) | 63.1 | 4.8 | -0.050 | -0.167 | 0.233 | -0.556 | |
| CVT at 68 Joule (C) | 86.5 | 3.8 | 0.056 | 0.315 | 0.769 | 0.189 | 0.700 |

A533B Reference Material (HSST Plate #1)

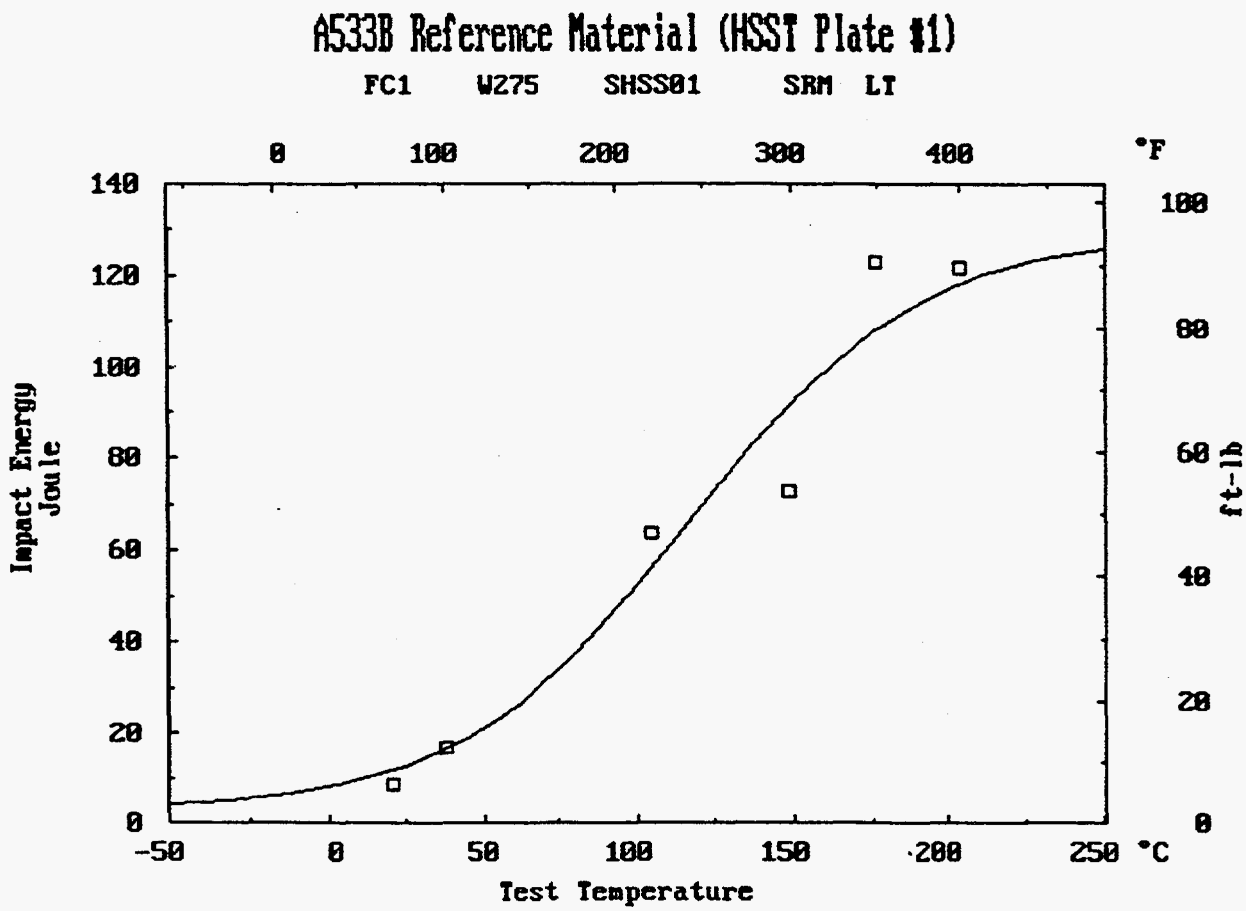
FC1 W225 SHSS01 SRM LT



A533B HSST01 REFERENCE MATERIAL
Fort Calhoun Unit 1, Capsule W275

USE= 129.1 J, LSE= 3.0 J, CVT(1/2)= 117.C , Slope = 0.0135
CVT(41J) = 86. C , CVT(68J) = 119. C ,
Fluence = 1.280E+19 , Irr. Temp. = 280 C

| Spec. ID | Test Temp. C | Test Temp. F | Impact Energy J | Impact Energy ft-lb | Lat. Exp. mm | Lat. Exp. mil | % Shear |
|---|---|---|---|---|---|---|---|
| 56T | 21. | 70. | 9. | 6. | 0.15 | 6. | 0. |
| 56E | 38. | 100. | 17. | 12. | 0.33 | 13. | 5. |
| 564 | 104. | 220. | 64. | 47. | 1.17 | 46. | 50. |
| 572 | 149. | 300. | 73. | 53. | 1.32 | 52. | 95. |
| 56K | 177. | 350. | 123. | 90. | 1.98 | 78. | 100. |
| 56B | 204. | 400. | 121. | 89. | 2.11 | 83. | 100. |



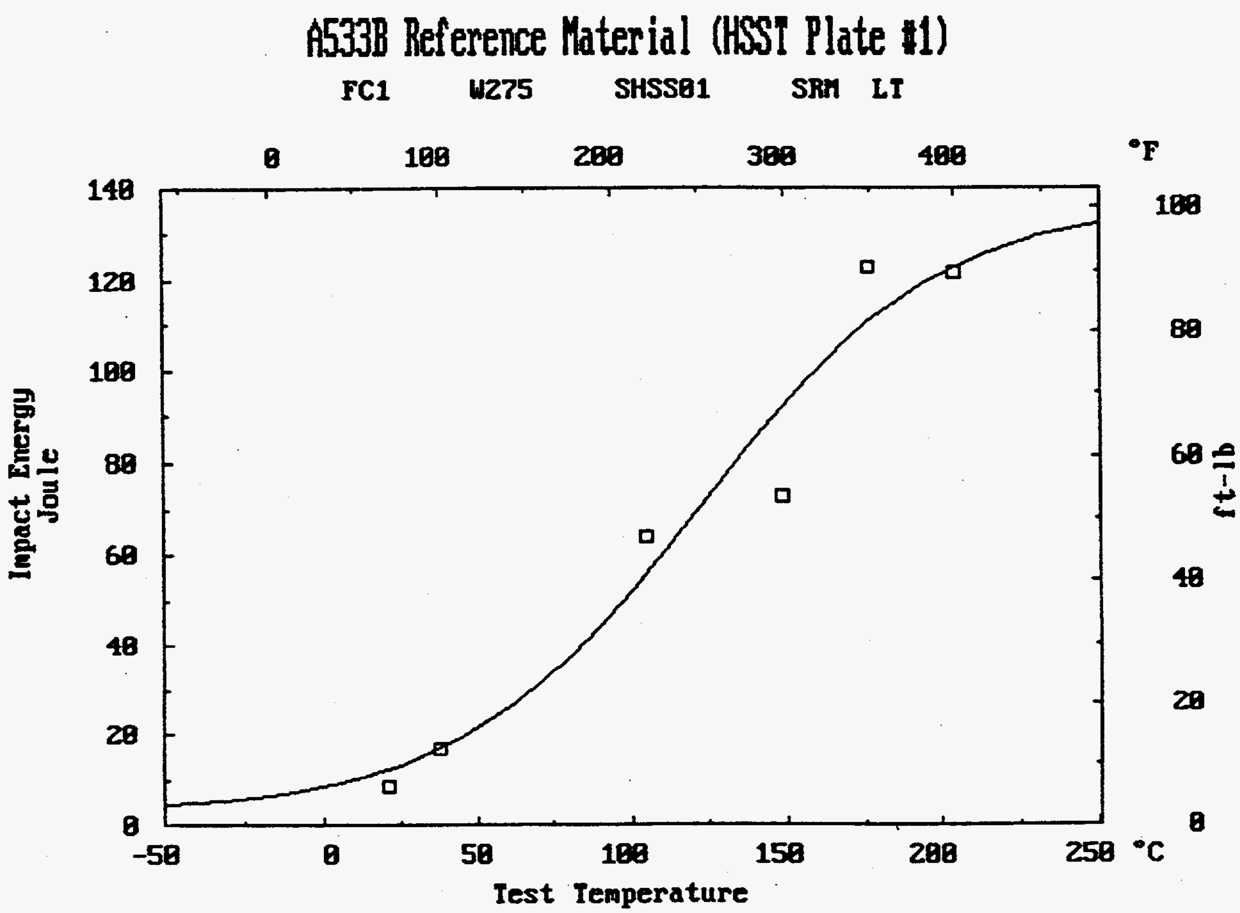
A533B HSST01 REFERENCE MATERIAL

Fort Calhoun Unit 1, Capsule W275

Impact Energy Uncertainty = 10.0 J
Test Temperature Uncertainty = 4.0 Degree C
Number of Successful Iterations = 200, Maximum = 1000

FC1 W275 SHSS01 SRM LT : Fluence = 1.280E+19 , Irr. Temp. = 280

| Parameter | Mean | Std.Dev. | Correlation Coefficients | | | | |
|---|---|---|---|---|---|---|---|
| Lower Shelf Energy (J) | 3.0 | 0.0 | | | | | |
| Upper Shelf Energy (J) | 137.0 | 17.8 | 0.218 | | | | |
| CVT at Midpoint (C) | 121.7 | 15.6 | 0.236 | 0.870 | | | |
| 1/slope (C) | 77.7 | 14.8 | 0.176 | 0.596 | 0.420 | | |
| CVT at 41 Joule (C) | 85.6 | 10.8 | 0.085 | 0.196 | 0.586 | -0.435 | |
| CVT at 68 Joule (C) | 119.5 | 8.6 | 0.171 | 0.390 | 0.786 | 0.023 | 0.872 |



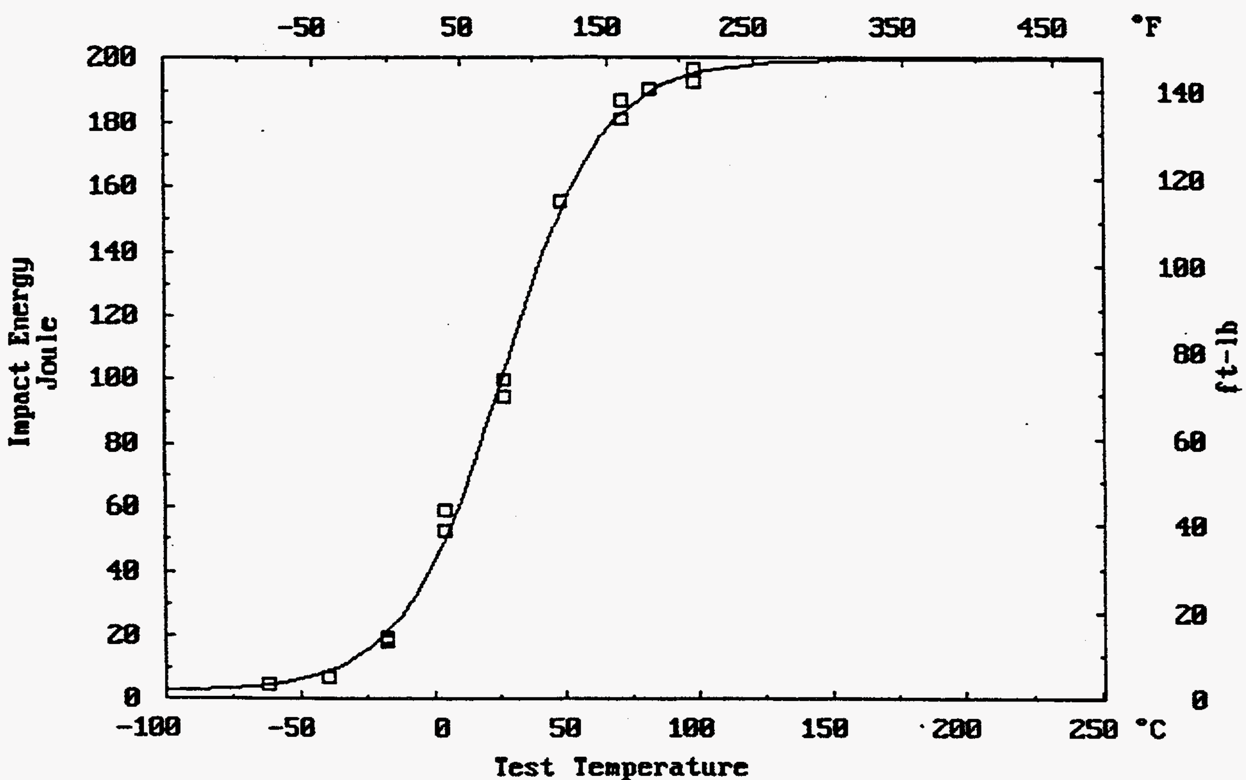
A533B HSST01 REFERENCE MATERIAL
Millstone Unit 2, Baseline

USE= 199.8 J, LSE= 3.0 J, CVT(1/2)= 26.C , Slope = 0.0261
Unirradiated Charpy Specimen, CVT(41J) = -1. C , CVT(68J) = 13. C

| Spec. ID | Test Temp. C | Test Temp. F | Impact Energy J | Impact Energy ft-lb | Lat. Exp. mm | Lat. Exp. mil | % Shear |
|---|---|---|---|---|---|---|---|
| 755 | -62. | -80. | 5. | 3. | 0.08 | 3. | 0. |
| 75U | -40. | -40. | 7. | 5. | 0.18 | 7. | 0. |
| 757 | -18. | 0. | 18. | 13. | 0.38 | 15. | 15. |
| 75J | -18. | 0. | 20. | 14. | 0.41 | 16. | 15. |
| 75B | 4. | 40. | 59. | 43. | 0.91 | 36. | 25. |
| 75M | 4. | 40. | 53. | 39. | 0.89 | 35. | 20. |
| 75C | 27. | 80. | 100. | 73. | 1.52 | 60. | 45. |
| 75D | 27. | 80. | 94. | 69. | 1.35 | 53. | 45. |
| 75A | 49. | 120. | 155. | 114. | 2.01 | 79. | 80. |
| 75P | 49. | 120. | 155. | 114. | 2.16 | 85. | 80. |
| 75K | 71. | 160. | 187. | 138. | 2.26 | 89. | 100. |
| 75T | 71. | 160. | 181. | 133. | 2.34 | 92. | 90. |
| 75L | 82. | 180. | 190. | 140. | 2.26 | 89. | 100. |
| 756 | 99. | 210. | 193. | 142. | 2.26 | 89. | 100. |
| 75E | 99. | 210. | 197. | 145. | 2.34 | 92. | 100. |

A533B Reference Material (HSST Plate #1)

ML2 SHSS01 SRM LT



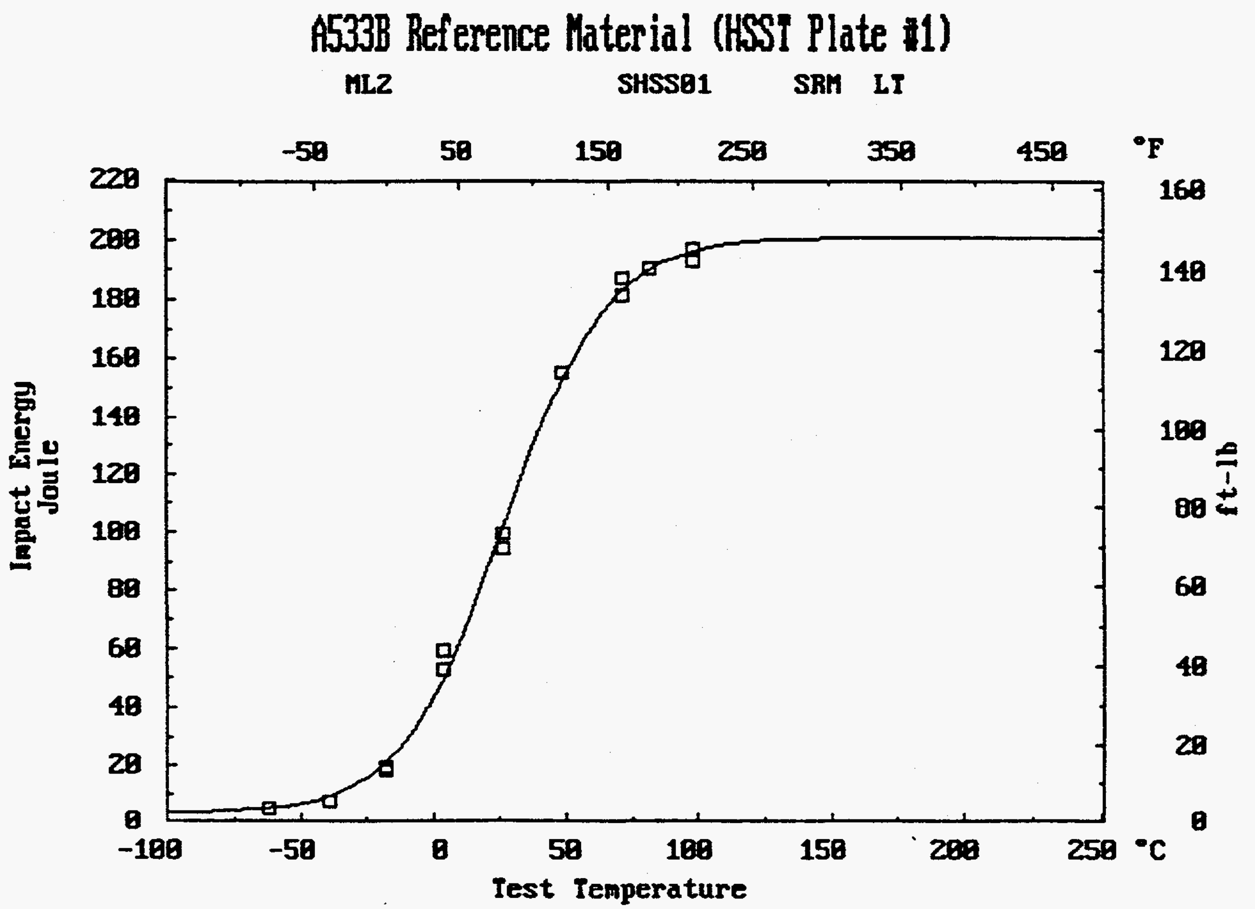
A533B HSST01 REFERENCE MATERIAL

Millstone Unit 2, Baseline

Impact Energy Uncertainty = 10.0 J
Test Temperature Uncertainty = 4.0 Degree C
Number of Successful Iterations = 200, Maximum = 1000

ML2 SHSS01 SRM LT

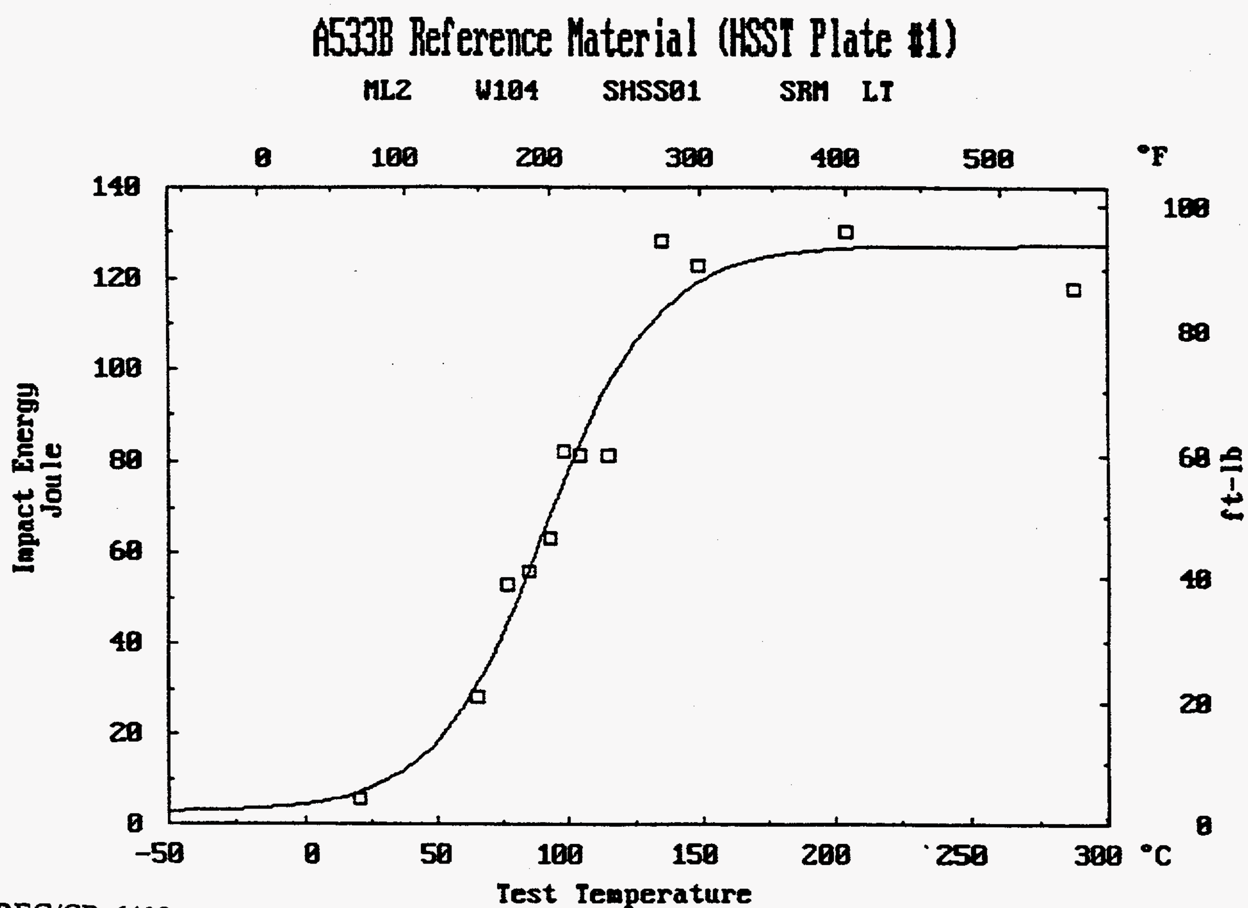
| Parameter | Mean | Std.Dev. | Correlation Coefficients | | | | |
|---|---|---|---|---|---|---|---|
| Lower Shelf Energy (J) | 3.0 | 0.1 | | | | | |
| Upper Shelf Energy (J) | 200.7 | 7.6 | -0.190 | | | | |
| CVT at Midpoint (C) | 26.8 | 3.4 | 0.068 | 0.669 | | | |
| 1/slope (C) | 38.5 | 5.4 | -0.381 | 0.676 | 0.356 | | |
| CVT at 41 Joule (C) | -0.9 | 4.3 | 0.429 | -0.295 | 0.324 | -0.760 | |
| CVT at 68 Joule (C) | 13.0 | 3.1 | 0.372 | -0.047 | 0.632 | -0.470 | 0.930 |



A533B HSST01 REFERENCE MATERIAL
Millstone Unit 2, Capsule W104

USE= 127.0 J, LSE= 3.0 J, CVT(1/2)= 91.C , Slope = 0.0236
CVT(41J) = 74. C , CVT(68J) = 93. C ,
Fluence = 8.840E+18 , Irr. Temp. = 288 C

| Spec. ID | Test Temp. C | Test Temp. F | Impact Energy J | Impact Energy ft-lb | Lat. Exp. mm | Lat. Exp. mil | % Shear |
|---|---|---|---|---|---|---|---|
| 74L | 21. | 70. | 6. | 4. | 0.20 | 8. | 0. |
| 74J | 66. | 150. | 28. | 21. | 0.56 | 22. | 20. |
| 747 | 77. | 170. | 53. | 39. | 0.91 | 36. | 40. |
| 74D | 85. | 185. | 56. | 41. | 0.97 | 38. | 40. |
| 751 | 93. | 200. | 63. | 46. | 1.19 | 47. | 50. |
| 741 | 99. | 210. | 82. | 60. | 1.30 | 51. | 60. |
| 754 | 104. | 220. | 81. | 60. | 1.37 | 54. | 60. |
| 74P | 116. | 240. | 81. | 60. | 1.45 | 57. | 60. |
| 74A | 135. | 275. | 128. | 94. | 2.01 | 79. | 100. |
| 74K | 149. | 300. | 123. | 90. | 1.96 | 77. | 100. |
| 74E | 204. | 400. | 130. | 96. | 2.16 | 85. | 100. |
| 742 | 288. | 550. | 118. | 87. | 1.98 | 78. | 100. |



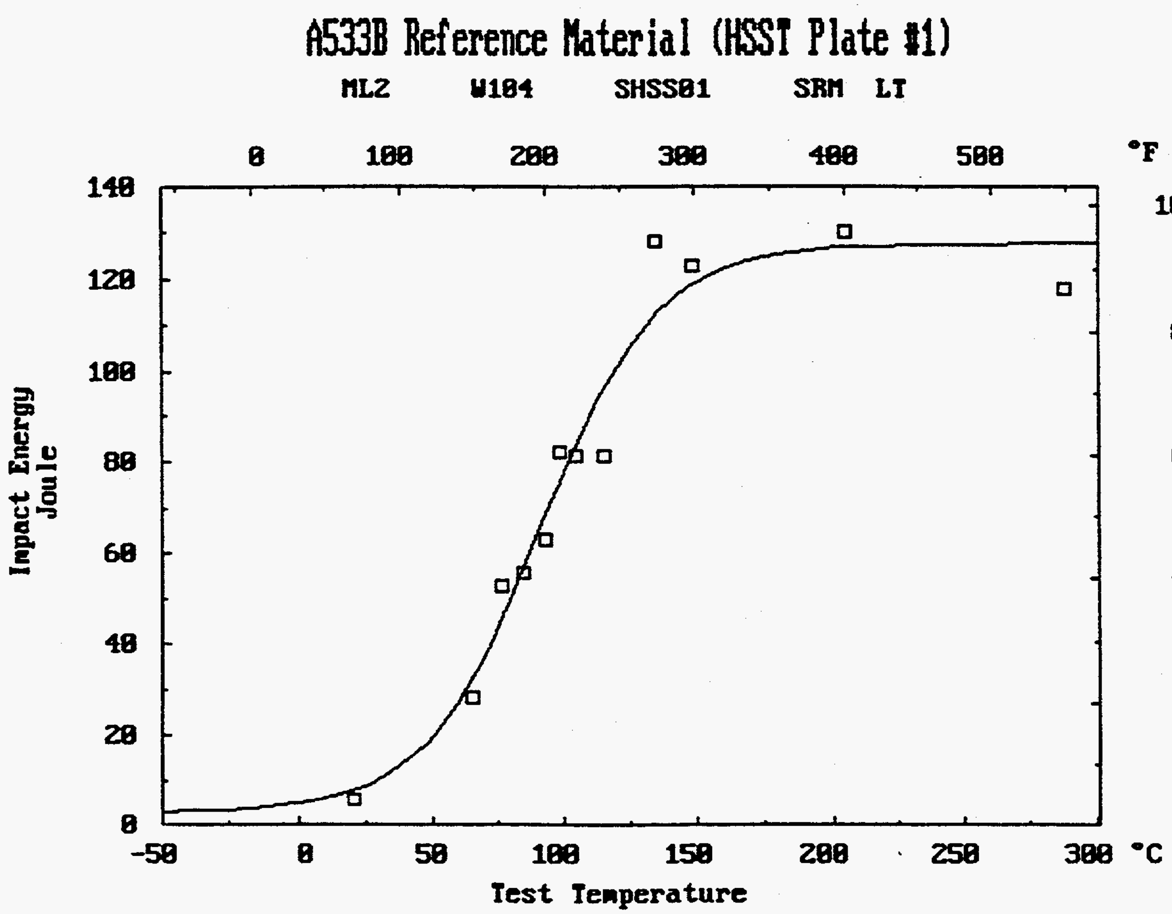
A533B HSST01 REFERENCE MATERIAL

Millstone Unit 2, Capsule W104

Impact Energy Uncertainty = 10.0 J
Test Temperature Uncertainty = 4.0 Degree C
Number of Successful Iterations = 200, Maximum = 1000

ML2 W104 SHSS01 SRM LT : Fluence = 8.840E+18 , Irr. Temp. = 288

| Parameter | Mean | Std.Dev. | Correlation Coefficients | | | | |
|---|---|---|---|---|---|---|---|
| Lower Shelf Energy (J) | 3.0 | 0.0 | | | | | |
| Upper Shelf Energy (J) | 127.4 | 5.2 | 0.108 | | | | |
| CVT at Midpoint (C) | 91.2 | 4.1 | 0.257 | 0.591 | | | |
| 1/slope (C) | 44.1 | 7.4 | -0.134 | 0.364 | 0.019 | | |
| CVT at 41 Joule (C) | 73.0 | 4.9 | 0.262 | -0.004 | 0.664 | -0.708 | |
| CVT at 68 Joule (C) | 93.2 | 3.3 | 0.231 | 0.181 | 0.894 | -0.101 | 0.765 |



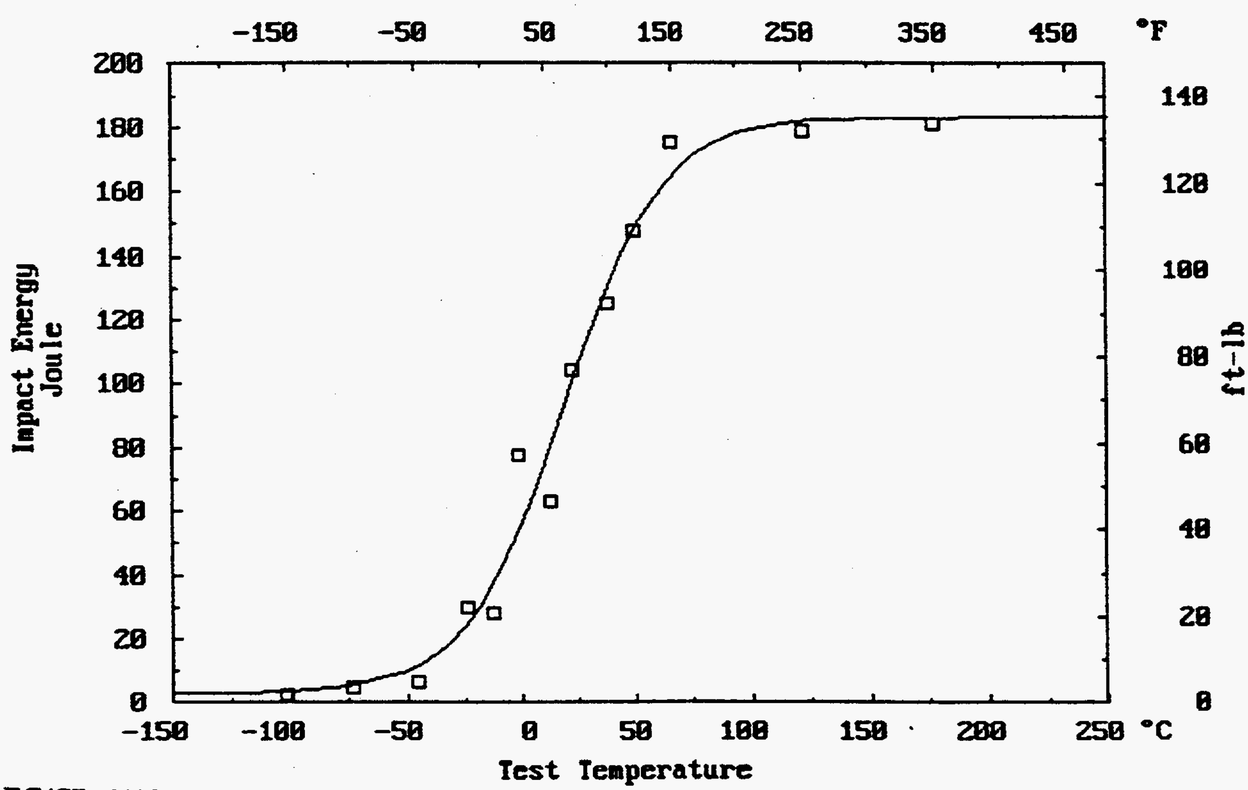
## A533B HSST01 REFERENCE MATERIAL
Maine Yankee, Baseline

USE= 183.2 J, LSE= 3.0 J, CVT(1/2)= 19.C , Slope = 0.0233
Unirradiated Charpy Specimen, CVT(41J) = -10. C , CVT(68J) = 6. C

| Spec. ID | Test Temp. C | Test Temp. F | Impact Energy J | Impact Energy ft-lb | Lat. Exp. mm | Lat. Exp. mil | % Shear |
|---|---|---|---|---|---|---|---|
| 5AY | -101. | -150. | 2. | 2. | 0.03 | 1. | 0. |
| 5AP | -73. | -100. | 5. | 3. | 0.10 | 4. | 0. |
| 62U | -46. | -50. | 7. | 5. | 0.20 | 8. | 1. |
| 5AJ | -23. | -10. | 30. | 22. | 0.63 | 25. | 20. |
| 62Y | -12. | 10. | 28. | 21. | 0.56 | 22. | 20. |
| 631 | -1. | 30. | 78. | 57. | 1.24 | 49. | 30. |
| 62T | 13. | 55. | 63. | 47. | 0.99 | 39. | 40. |
| 632 | 22. | 71. | 104. | 77. | 1.63 | 64. | 50. |
| 633 | 38. | 100. | 125. | 92. | 2.01 | 79. | 70. |
| 5AK | 49. | 120. | 148. | 109. | 2.21 | 87. | 80. |
| 5AU | 66. | 150. | 175. | 129. | 2.29 | 90. | 90. |
| 5AM | 121. | 250. | 179. | 132. | 2.46 | 97. | 99. |
| 5AL | 177. | 350. | 181. | 134. | 2.08 | 82. | 99. |

A533B Reference Material (HSST Plate #1)

MY SHSS01 SRM LT



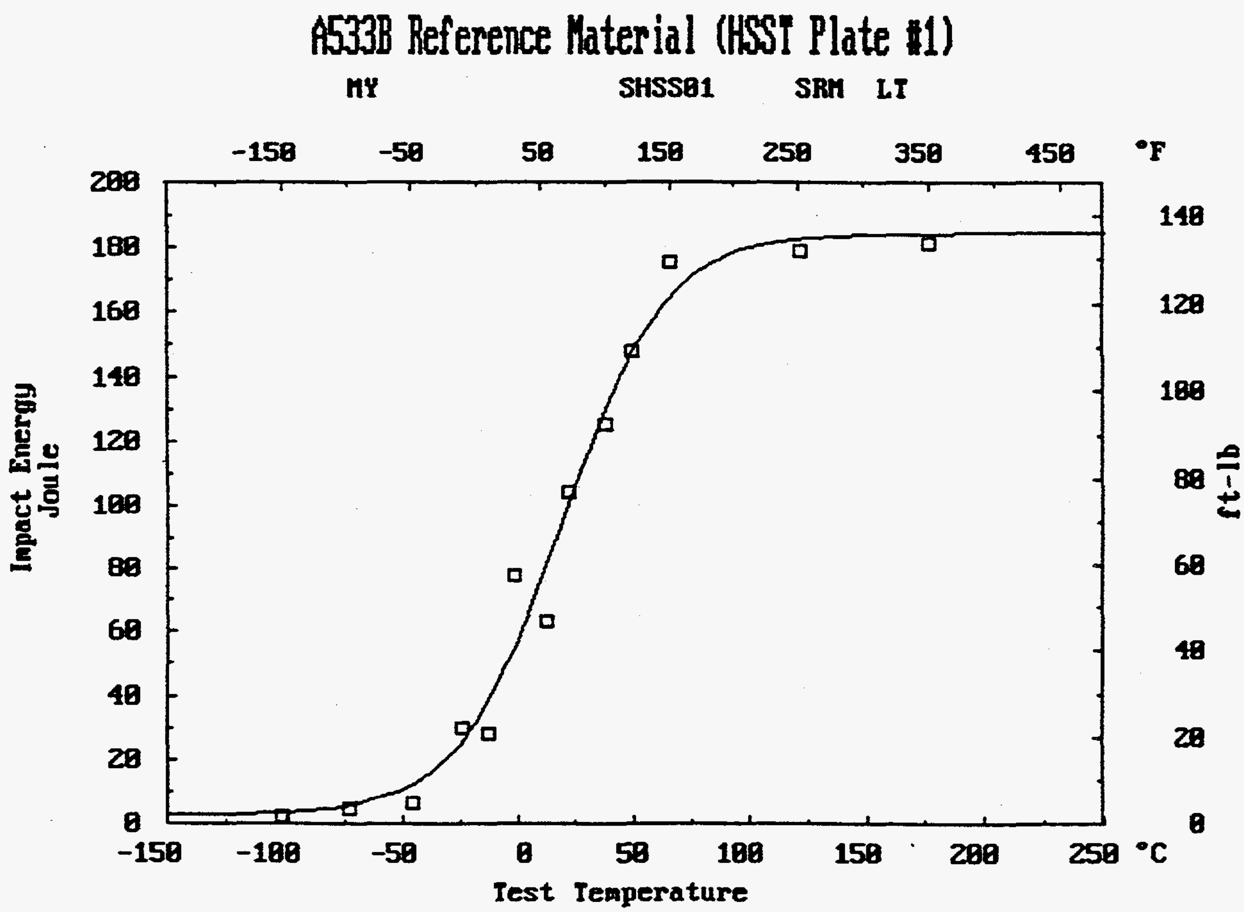
A533B HSST01 REFERENCE MATERIAL

Maine Yankee, Baseline

Impact Energy Uncertainty = 10.0 J
Test Temperature Uncertainty = 4.0 Degree C
Number of Successful Iterations = 200, Maximum = 1000

MY SHSS01 SRM LT

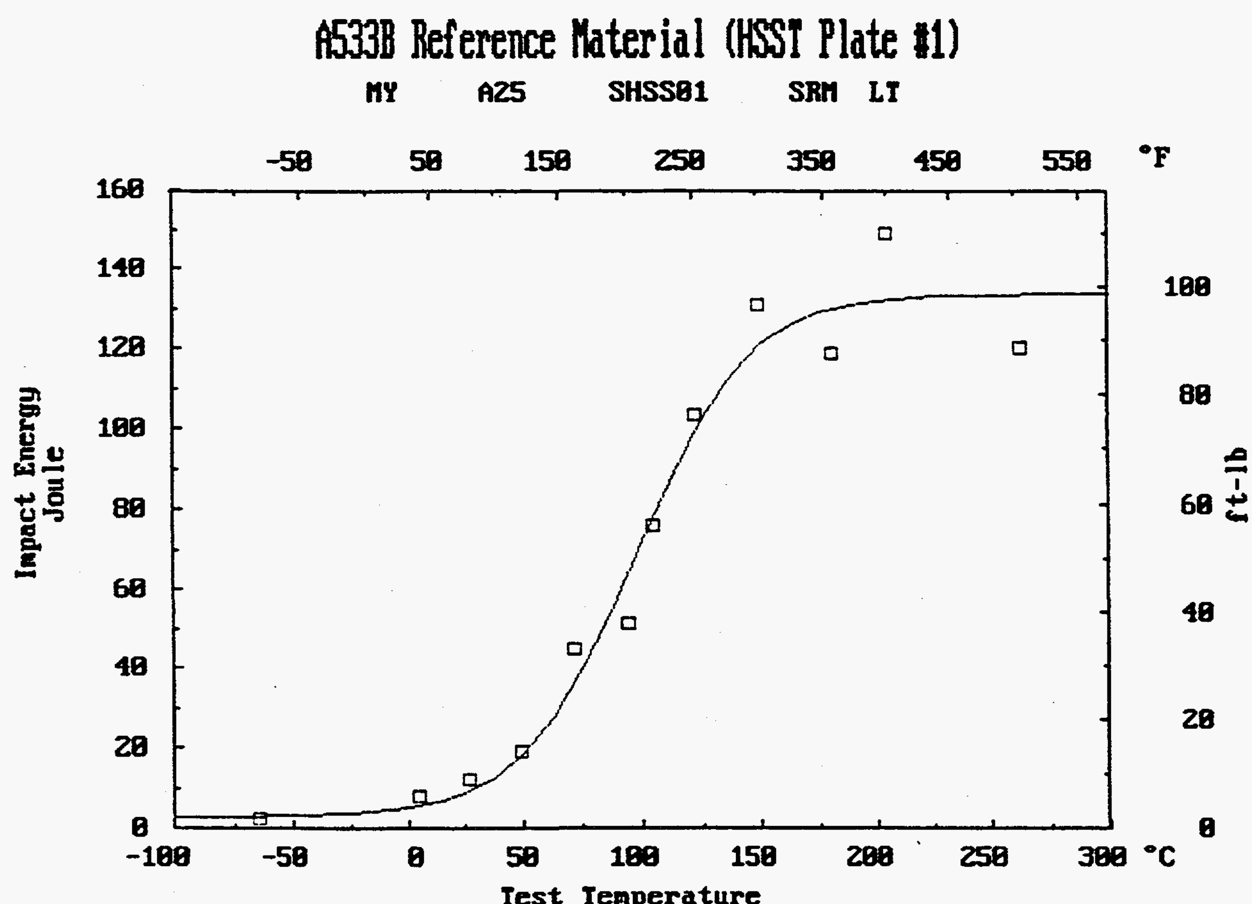
| Parameter | Mean | Std.Dev. | Correlation Coefficients | | | | |
|---|---|---|---|---|---|---|---|
| Lower Shelf Energy (J) | 3.0 | 0.1 | | | | | |
| Upper Shelf Energy (J) | 184.4 | 6.4 | -0.119 | | | | |
| CVT at Midpoint (C) | 18.8 | 3.4 | 0.022 | 0.610 | | | |
| 1/slope (C) | 44.2 | 5.3 | -0.323 | 0.403 | 0.277 | | |
| CVT at 41 Joule (C) | -10.6 | 4.1 | 0.315 | -0.084 | 0.436 | -0.726 | |
| CVT at 68 Joule (C) | 5.9 | 3.0 | 0.234 | 0.075 | 0.739 | -0.372 | 0.906 |



A533B HSST01 REFERENCE MATERIAL
Maine Yankee, Capsule A25

USE= 133.7 J, LSE= 3.0 J, CVT(1/2)= 97.C , Slope = 0.0212
CVT(41J) = 76. C , CVT(68J) = 97. C ,
Fluence = 1.300E+19 , Irr. Temp. = 288 C

| Spec. ID | Test Temp. C | Test Temp. F | Impact Energy J | Impact Energy ft-lb | Lat. Exp. mm | Lat. Exp. mil | % Shear |
|---|---|---|---|---|---|---|---|
| 62E | -64. | -84. | 3. | 2. | 0.10 | 4. | 0. |
| 61Y | 4. | 40. | 8. | 6. | 0.10 | 4. | 5. |
| 61B | 26. | 79. | 12. | 9. | 0.15 | 6. | 10. |
| 62B | 49. | 120. | 19. | 14. | 0.30 | 12. | 20. |
| 62M | 71. | 160. | 45. | 33. | 0.74 | 29. | 30. |
| 62C | 93. | 200. | 52. | 38. | 0.84 | 33. | 35. |
| 611 | 104. | 220. | 76. | 56. | 1.07 | 42. | 50. |
| 62D | 121. | 250. | 103. | 76. | 1.32 | 52. | 70. |
| 617 | 149. | 300. | 131. | 96. | 1.47 | 58. | 100. |
| 62L | 180. | 356. | 119. | 87. | 1.47 | 58. | 100. |
| 62K | 204. | 400. | 149. | 110. | 1.52 | 60. | 100. |
| 62J | 262. | 504. | 120. | 89. | 1.45 | 57. | 100. |



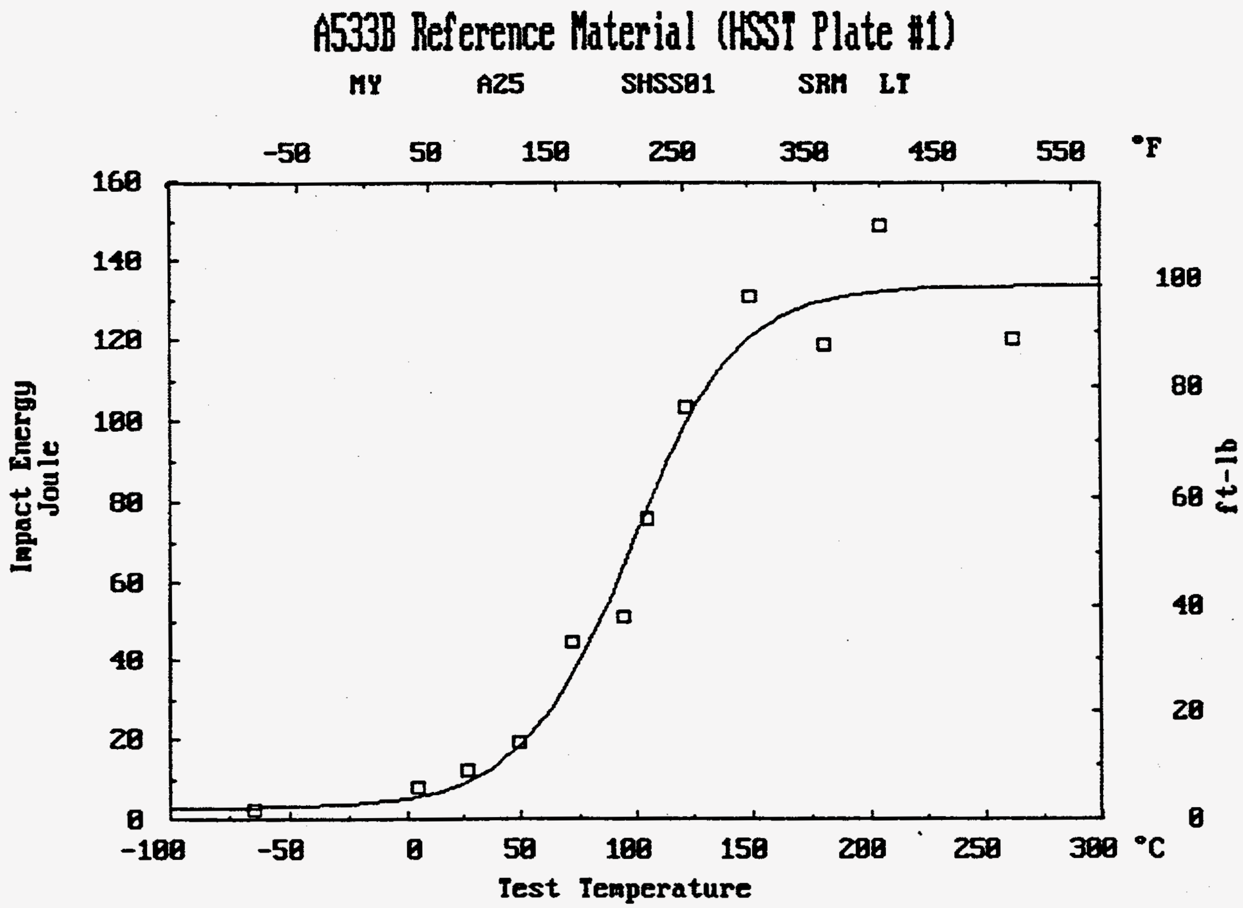
A533B HSST01 REFERENCE MATERIAL

Maine Yankee, Capsule A25

Impact Energy Uncertainty = 10.0 J
Test Temperature Uncertainty = 4.0 Degree C
Number of Successful Iterations = 200, Maximum = 1000

MY A25 SHSS01 SRM LT : Fluence = 1.300E+19 , Irr. Temp. = 288

| Parameter | Mean | Std.Dev. | Correlation Coefficients | | | | |
|---|---|---|---|---|---|---|---|
| Lower Shelf Energy (J) | 3.1 | 0.1 | | | | | |
| Upper Shelf Energy (J) | 133.6 | 5.8 | 0.015 | | | | |
| CVT at Midpoint (C) | 96.7 | 5.2 | 0.208 | 0.566 | | | |
| 1/slope (C) | 47.1 | 9.0 | -0.177 | 0.284 | 0.009 | | |
| CVT at 41 Joule (C) | 75.7 | 6.3 | 0.273 | 0.048 | 0.683 | -0.700 | |
| CVT at 68 Joule (C) | 96.5 | 4.3 | 0.234 | 0.188 | 0.914 | -0.133 | 0.795 |



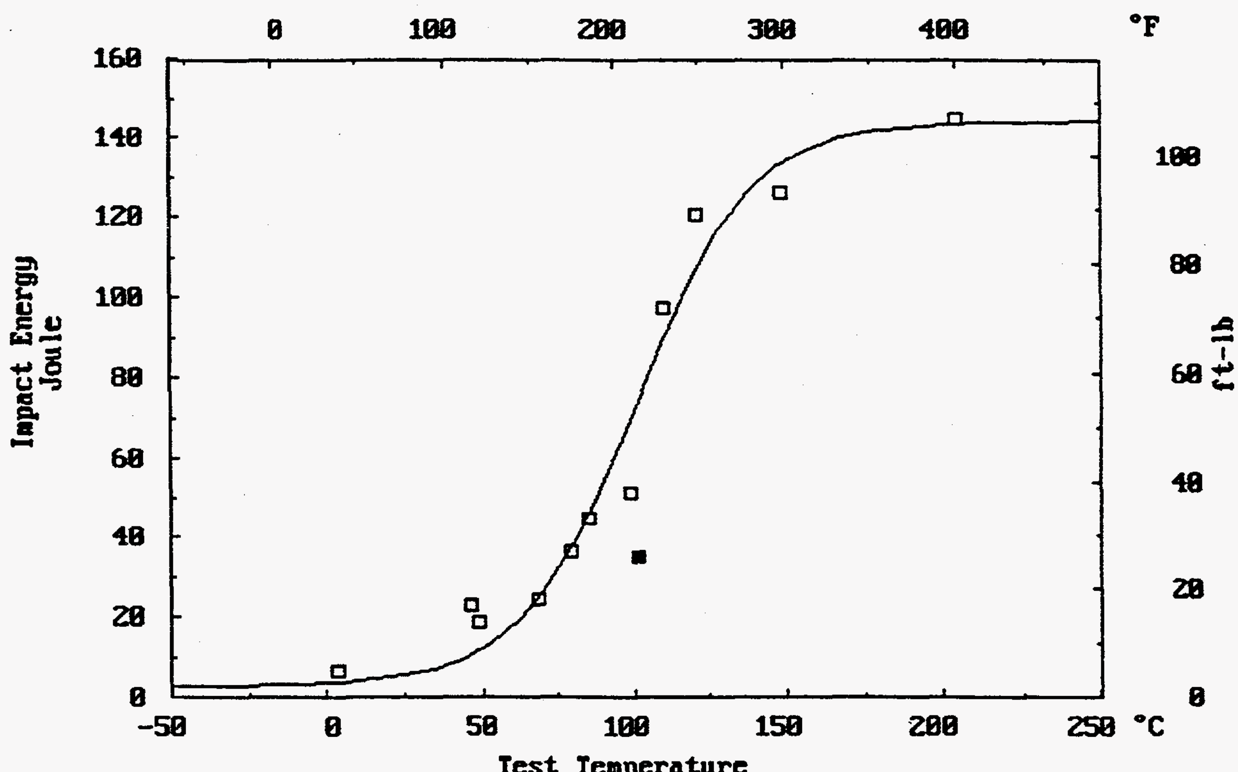
A533B HSST01 REFERENCE MATERIAL
Maine Yankee, Capsule W253

USE= 144.3 J, LSE= 3.1 J, CVT(1/2)= 101.C , Slope = 0.0263
CVT(41J) = 82. C , CVT(68J) = 98. C ,
Fluence = 1.250E+19 , Irr. Temp. = 288 C

| Spec. ID | Test Temp. C | Test Temp. F | Impact Energy J | Impact Energy ft-lb | Lat. Exp. mm | Lat. Exp. mil | % Shear |
|---|---|---|---|---|---|---|---|
| 61E | 4. | 40. | 7. | 5. | 0.25 | 10. | 5. |
| 614 | 46. | 115. | 23. | 17. | 0.41 | 16. | 15. |
| 61P | 49. | 120. | 19. | 14. | 0.30 | 12. | 15. |
| 61C | 68. | 155. | 24. | 18. | 0.41 | 16. | 20. |
| 61M | 79. | 175. | 37. | 27. | 0.66 | 26. | 35. |
| 627 | 85. | 185. | 45. | 33. | 0.74 | 29. | 35. |
| 62A | 99. | 210. | 52. | 38. | 0.89 | 35. | 45. |
| *61A | 102. | 215. | 35. | 26. | 0.69 | 27. | 40. |
| 61D | 110. | 230. | 98. | 72. | 1.45 | 57. | 95. |
| 61T | 121. | 250. | 121. | 89. | 1.75 | 69. | 100. |
| 61U | 149. | 300. | 126. | 93. | 1.93 | 76. | 100. |
| 61J | 204. | 400. | 145. | 107. | 2.29 | 90. | 100. |

A533B Reference Material (HSST Plate #1)

MY W253 SHSS01 SRM LT



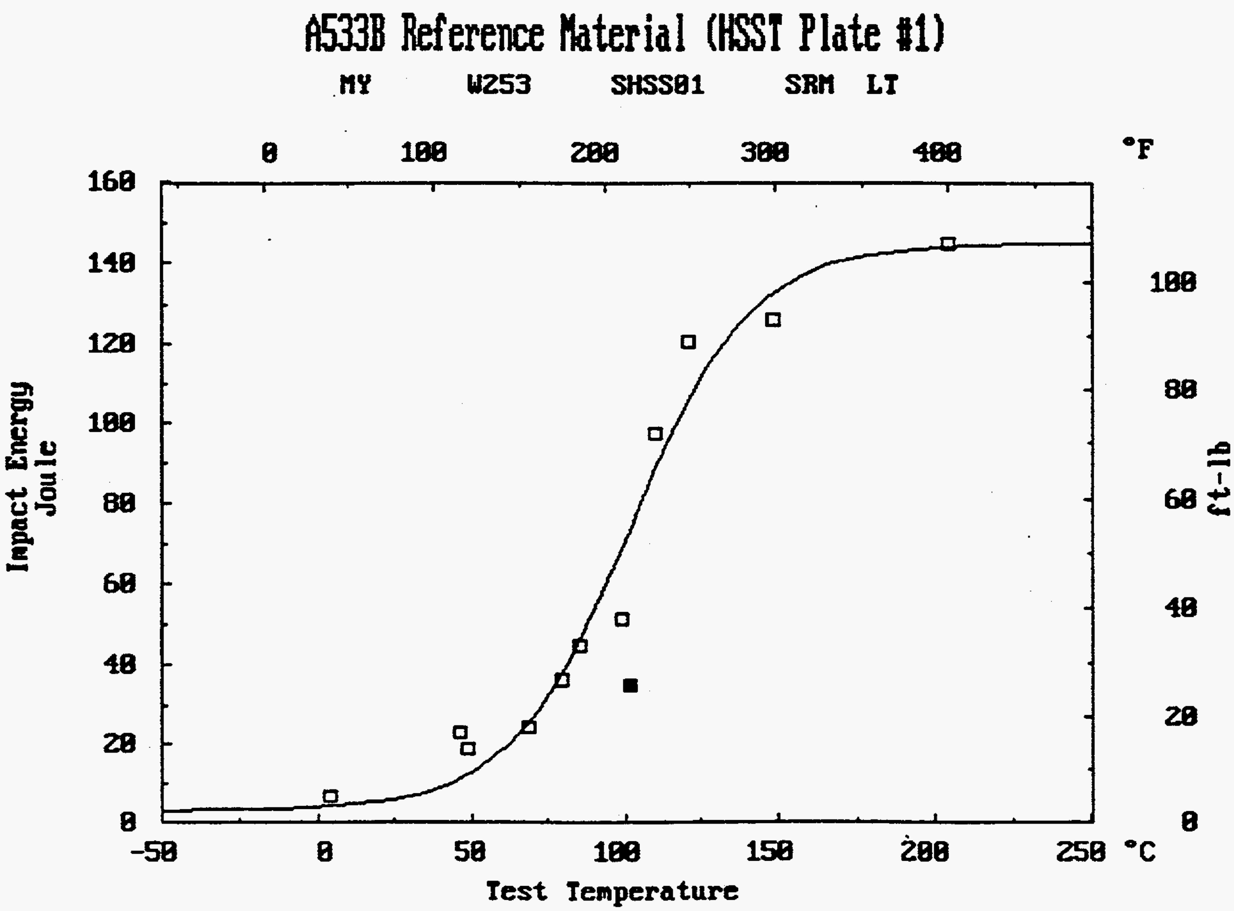
A533B HSST01 REFERENCE MATERIAL

Maine Yankee, Capsule W253

```
Impact Energy Uncertainty =  10.0 J
Test Temperature Uncertainty =   4.0 Degree C
Number of Successful Iterations =  200, Maximum = 1000
```

```
MY    W253  SHSS01    SRM  LT : Fluence = 1.250E+19 , Irr. Temp. =  288
```

| Parameter | Mean | Std.Dev. | Correlation Coefficients | | | | |
|---|---|---|---|---|---|---|---|
| Lower Shelf Energy (J) | 3.1 | 0.1 | | | | | |
| Upper Shelf Energy (J) | 144.9 | 9.7 | -0.178 | | | | |
| CVT at Midpoint (C) | 101.7 | 4.9 | -0.007 | 0.739 | | | |
| 1/slope (C) | 39.3 | 9.4 | -0.486 | 0.551 | 0.501 | | |
| CVT at 41 Joule (C) | 81.7 | 4.8 | 0.536 | -0.187 | 0.219 | -0.706 | |
| CVT at 68 Joule (C) | 98.2 | 3.2 | 0.237 | 0.189 | 0.778 | 0.060 | 0.655 |



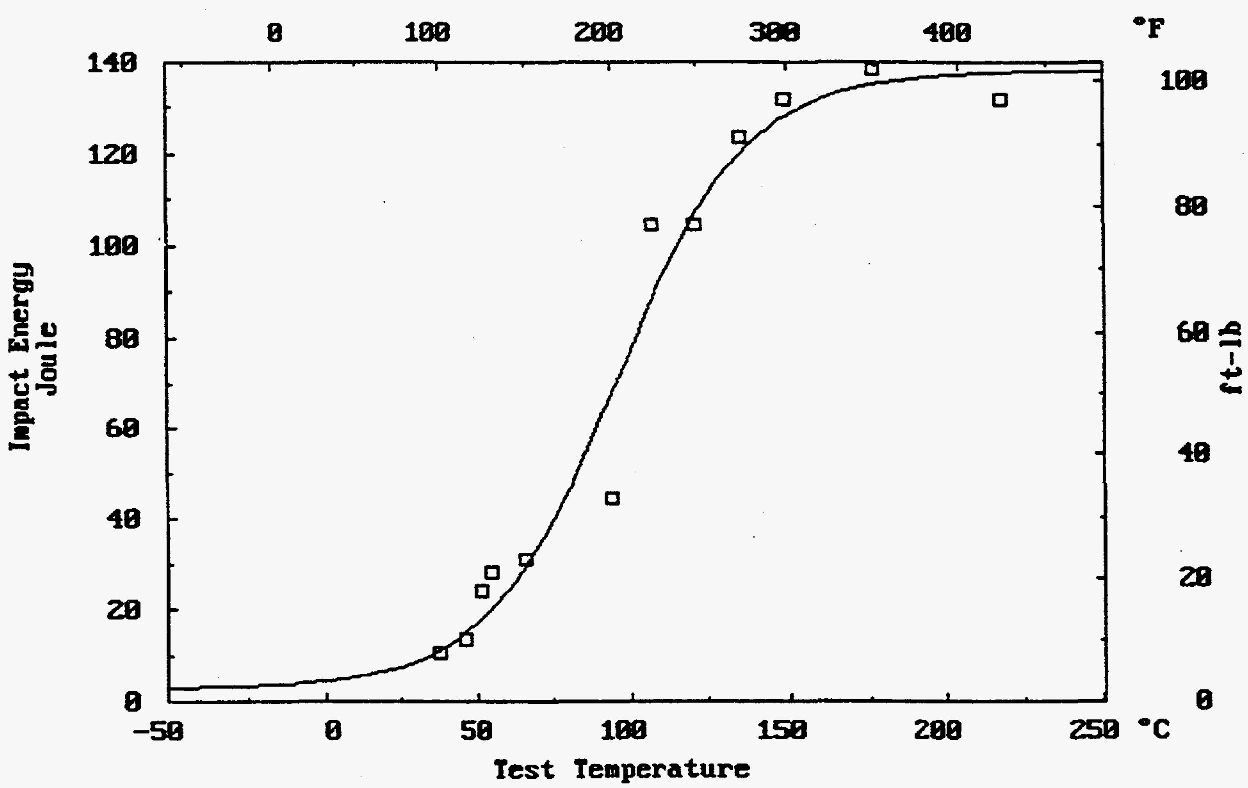
A533B HSST01 REFERENCE MATERIAL
Palisades, Capsule W110

USE= 137.9 J, LSE= 3.0 J, CVT(1/2)= 96.C , Slope = 0.0238
CVT(41J) = 76. C , CVT(68J) = 94. C ,
Fluence = 1.779E+19 , Irr. Temp. = 280 C

| Spec. ID | Test Temp. C | F | Impact Energy J | ft-lb | Lat. Exp. mm | mil | % Shear |
|---|---|---|---|---|---|---|---|
| 52Y | 38. | 100. | 11. | 8. | 0.18 | 7. | 5. |
| 52M | 46. | 115. | 14. | 10. | 0.28 | 11. | 10. |
| 52T | 52. | 125. | 24. | 18. | 0.58 | 23. | 10. |
| 52K | 54. | 130. | 28. | 21. | 0.46 | 18. | 15. |
| 52D | 66. | 150. | 31. | 23. | 0.56 | 22. | 15. |
| 52J | 93. | 200. | 45. | 33. | 0.69 | 27. | 25. |
| 52U | 107. | 225. | 104. | 77. | 1.45 | 57. | 60. |
| 514 | 121. | 250. | 104. | 77. | 1.42 | 56. | 80. |
| 52P | 135. | 275. | 123. | 91. | 1.37 | 54. | 80. |
| 512 | 149. | 300. | 132. | 97. | 1.90 | 75. | 100. |
| 513 | 177. | 350. | 138. | 102. | 1.98 | 78. | 100. |
| 52E | 218. | 425. | 132. | 97. | 1.93 | 76. | 100. |

A533B Reference Material (HSST Plate #1)

PAL W110 SHSS01 SRM LT



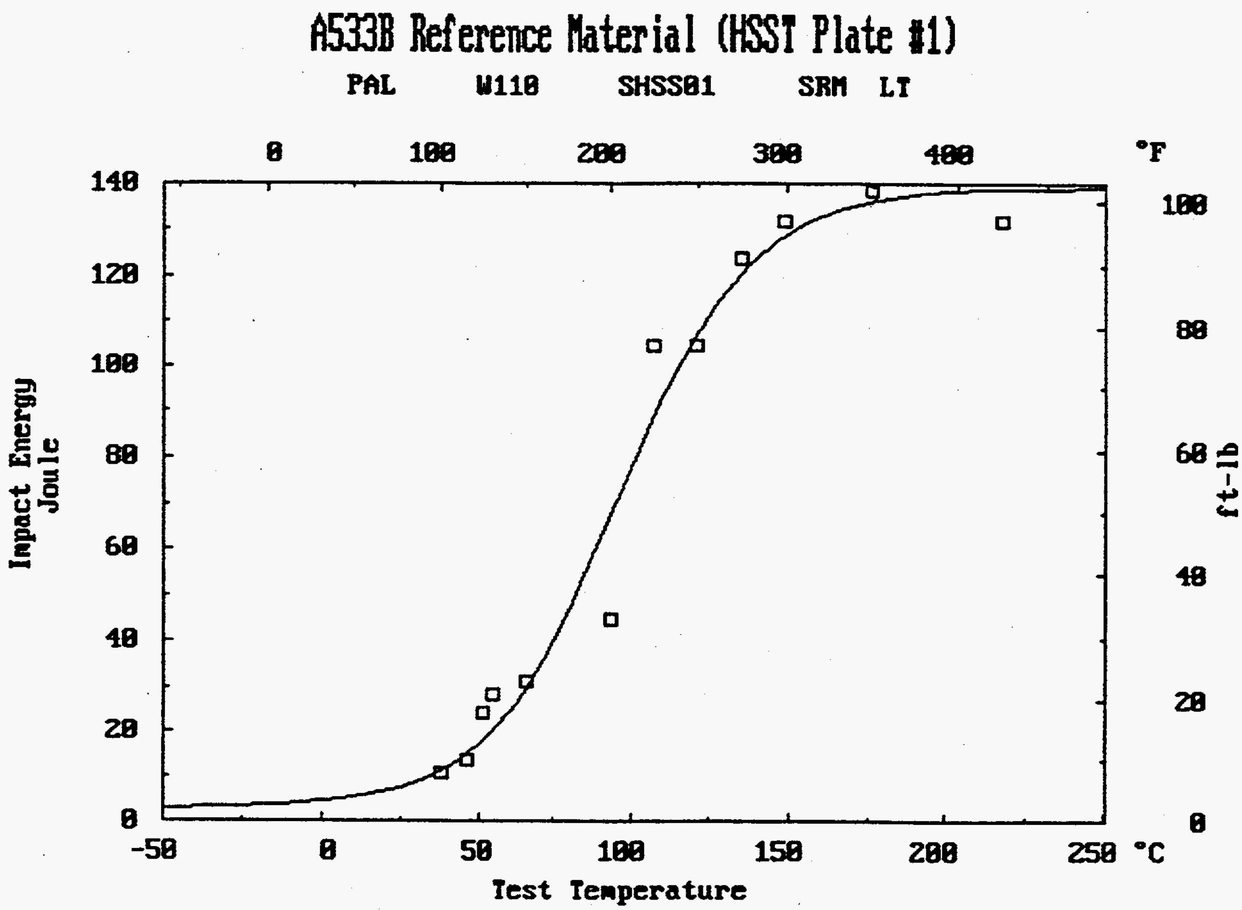
A533B HSST01 REFERENCE MATERIAL

Palisades, Capsule W110

```
Impact Energy Uncertainty =  10.0 J
Test Temperature Uncertainty =   4.0 Degree C
Number of Successful Iterations =  200, Maximum = 1000
```

PAL W110 SHSS01 SRM LT : Fluence = 1.779E+19 , Irr. Temp. = 280

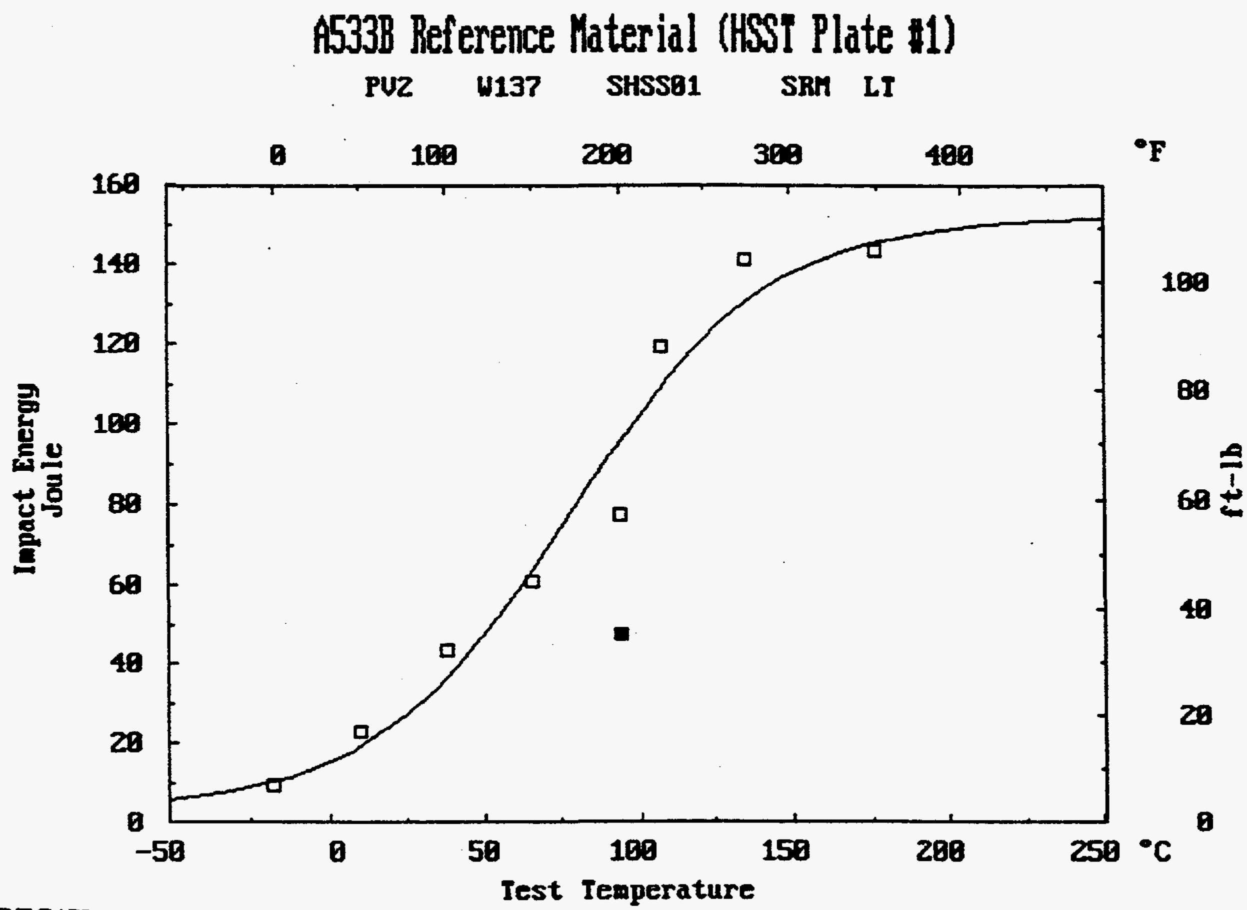
| Parameter | Mean | Std.Dev. | Correlation Coefficients | | | | |
|---|---|---|---|---|---|---|---|
| Lower Shelf Energy (J) | 3.1 | 0.1 | | | | | |
| Upper Shelf Energy (J) | 138.9 | 6.4 | -0.040 | | | | |
| CVT at Midpoint (C) | 96.0 | 4.5 | 0.298 | 0.573 | | | |
| 1/slope (C) | 42.2 | 6.7 | -0.497 | 0.334 | 0.056 | | |
| CVT at 41 Joule (C) | 76.0 | 5.1 | 0.574 | 0.025 | 0.682 | -0.662 | |
| CVT at 68 Joule (C) | 94.1 | 3.7 | 0.404 | 0.152 | 0.893 | -0.175 | 0.848 |



## A533B HSST01 REFERENCE MATERIAL
Palo Verde Unit 2, Capsule W137

USE= 152.1 J, LSE= 3.0 J, CVT(1/2)= 78.C , Slope = 0.0155
CVT(41J) = 43. C , CVT(68J) = 70. C ,
Fluence = 4.071E+18 , Irr. Temp. = 288 C

| Spec. ID | Test Temp. C | Test Temp. F | Impact Energy J | Impact Energy ft-lb | Lat. Exp. mm | Lat. Exp. mil | % Shear |
|---|---|---|---|---|---|---|---|
| 1BD3Y | -18. | 0. | 9. | 7. | 0.20 | 8. | 5. |
| 1BD43 | 10. | 50. | 23. | 17. | 0.51 | 20. | 15. |
| 1BD4P | 38. | 100. | 43. | 32. | 0.76 | 30. | 20. |
| 1BD35 | 66. | 150. | 61. | 45. | 1.17 | 46. | 40. |
| *1BD2D | 93. | 200. | 47. | 35. | 0.81 | 32. | 35. |
| 1BD52 | 93. | 200. | 77. | 57. | 1.35 | 53. | 60. |
| 1BD3E | 107. | 225. | 119. | 88. | 1.90 | 75. | 85. |
| 1BD2M | 135. | 275. | 141. | 104. | 2.13 | 84. | 100. |
| 1BD2B | 177. | 350. | 144. | 106. | 2.21 | 87. | 100. |



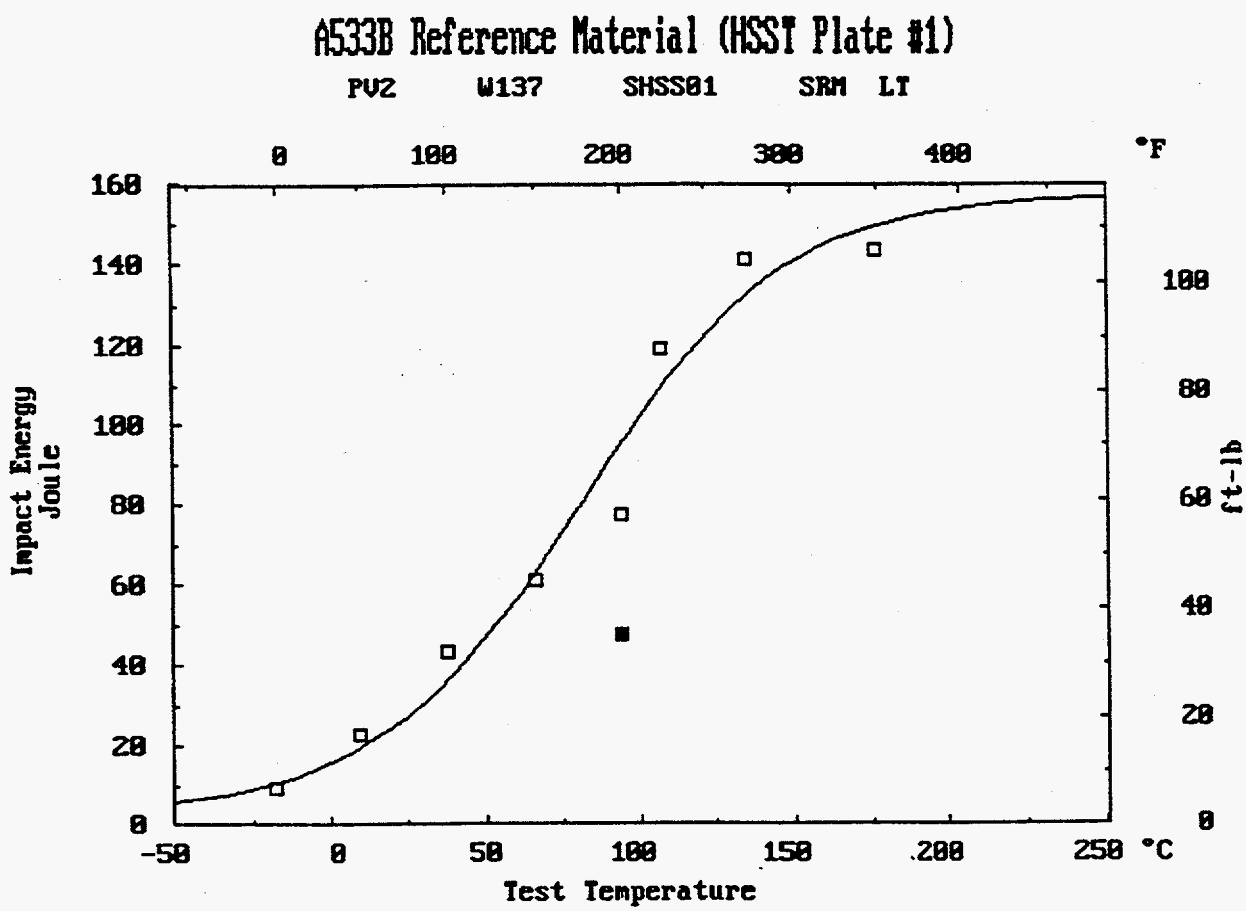
A533B HSST01 REFERENCE MATERIAL

Palo Verde Unit 2, Capsule W137

Impact Energy Uncertainty = 10.0 J
Test Temperature Uncertainty = 4.0 Degree C
Number of Successful Iterations = 200, Maximum = 1000

PV2 W137 SHSS01 SRM LT : Fluence = 4.071E+18 , Irr. Temp. = 288

| Parameter | Mean | Std.Dev. | Correlation Coefficients | | | | |
|---|---|---|---|---|---|---|---|
| Lower Shelf Energy (J) | 3.0 | 0.0 | | | | | |
| Upper Shelf Energy (J) | 157.7 | 12.7 | -0.163 | | | | |
| CVT at Midpoint (C) | 80.8 | 8.7 | 0.061 | 0.820 | | | |
| 1/slope (C) | 66.2 | 12.3 | -0.395 | 0.615 | 0.419 | | |
| CVT at 41 Joule (C) | 43.5 | 8.0 | 0.473 | -0.120 | 0.317 | -0.703 | |
| CVT at 68 Joule (C) | 70.0 | 5.4 | 0.372 | 0.174 | 0.676 | -0.259 | 0.863 |



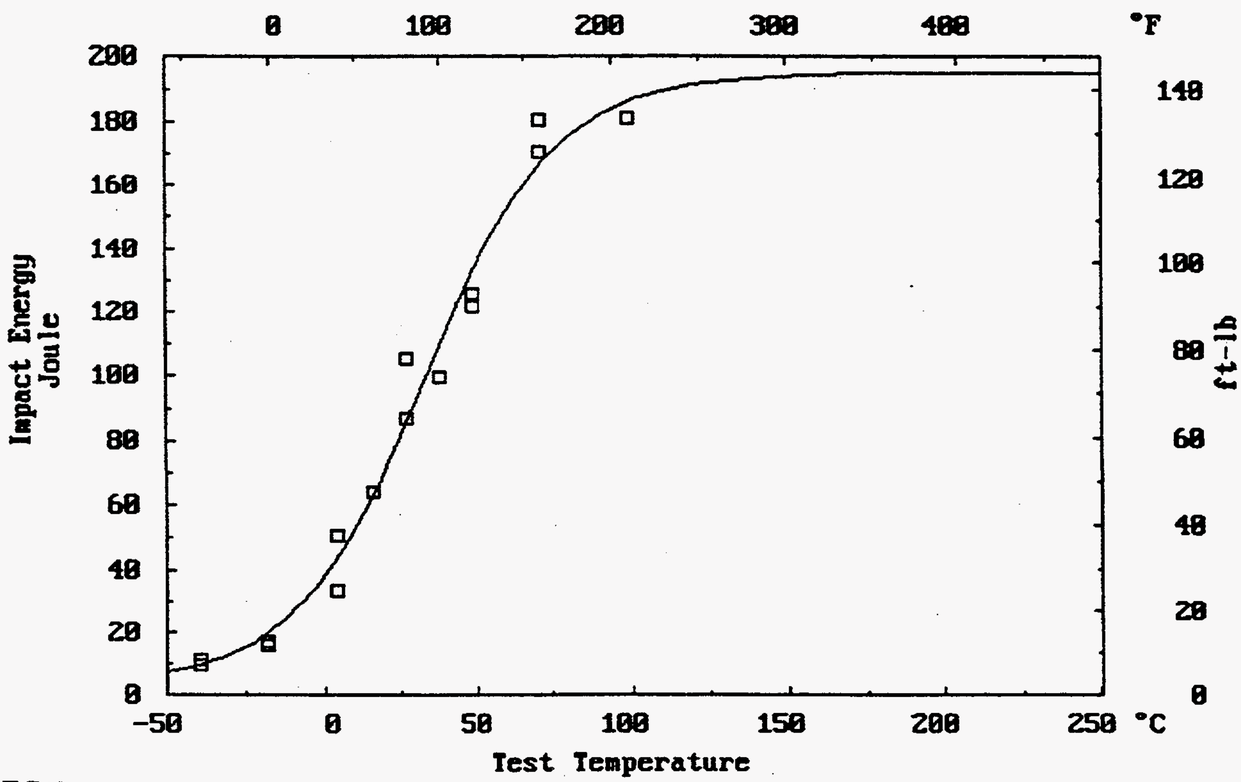
A533B HSST01 REFERENCE MATERIAL
St. Lucie Unit 1, Baseline

USE= 195.1 J, LSE= 3.0 J, CVT(1/2)= 33.C , Slope = 0.0229
Unirradiated Charpy Specimen, CVT(41J) = 2. C , CVT(68J) = 18. C

| Spec. ID | Test Temp. C | Test Temp. F | Impact Energy J | Impact Energy ft-lb | Lat. Exp. mm | Lat. Exp. mil | % Shear |
|---|---|---|---|---|---|---|---|
| 72J | -40. | -40. | 9. | 7. | 0.03 | 1. | 0. |
| 72L | -40. | -40. | 12. | 8. | 0.03 | 1. | 0. |
| 72U | -18. | 0. | 17. | 12. | 0.15 | 6. | 10. |
| 732 | -18. | 0. | 16. | 12. | 0.15 | 6. | 10. |
| 72K | 4. | 40. | 33. | 25. | 0.46 | 18. | 10. |
| 731 | 4. | 40. | 51. | 37. | 0.71 | 28. | 20. |
| 72P | 16. | 60. | 64. | 48. | 0.89 | 35. | 30. |
| 72E | 27. | 80. | 87. | 64. | 1.19 | 47. | 40. |
| 72T | 27. | 80. | 106. | 78. | 1.50 | 59. | 40. |
| 72C | 38. | 100. | 100. | 73. | 1.32 | 52. | 40. |
| 72B | 49. | 120. | 126. | 93. | 1.68 | 66. | 60. |
| 72Y | 49. | 120. | 122. | 90. | 1.68 | 66. | 60. |
| 72D | 71. | 160. | 180. | 133. | 2.11 | 83. | 95. |
| 72M | 71. | 160. | 171. | 126. | 2.11 | 83. | 95. |
| 72A | 99. | 210. | 181. | 133. | 2.21 | 87. | 100. |

## A533B Reference Material (HSST Plate #1)

SL1 SHSS01 SRM LT



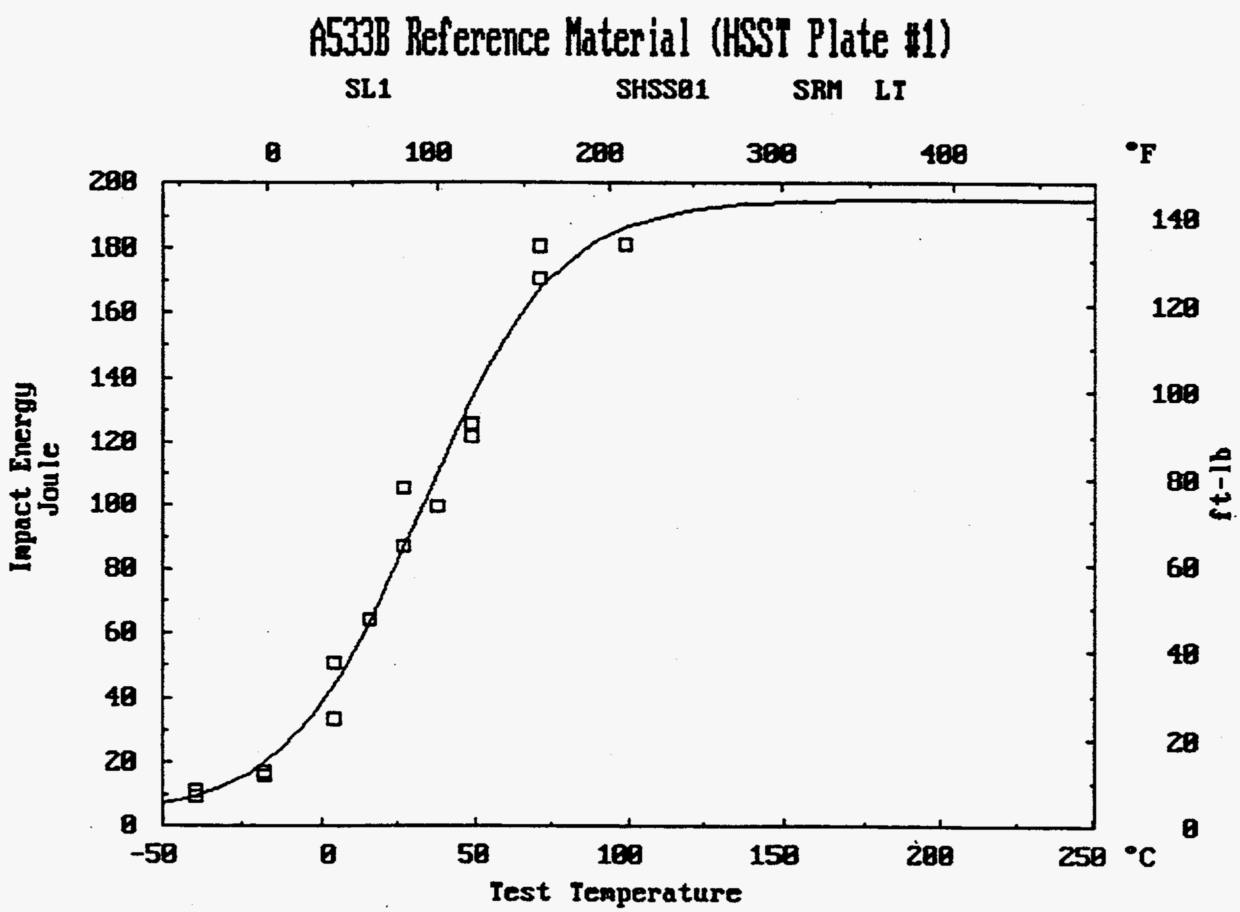
A533B HSST01 REFERENCE MATERIAL

St. Lucie Unit 1, Baseline

Impact Energy Uncertainty = 10.0 J
Test Temperature Uncertainty = 4.0 Degree C
Number of Successful Iterations = 200, Maximum = 1000

SL1 SHSS01 SRM LT

| Parameter | Mean | Std.Dev. | Correlation Coefficients | | | | |
|---|---|---|---|---|---|---|---|
| Lower Shelf Energy (J) | 3.0 | 0.1 | | | | | |
| Upper Shelf Energy (J) | 195.2 | 12.3 | -0.011 | | | | |
| CVT at Midpoint (C) | 32.7 | 4.5 | 0.024 | 0.877 | | | |
| 1/slope (C) | 43.4 | 5.7 | -0.095 | 0.743 | 0.728 | | |
| CVT at 41 Joule (C) | 2.2 | 3.1 | 0.151 | -0.258 | 0.007 | -0.657 | |
| CVT at 68 Joule (C) | 18.0 | 2.2 | 0.128 | 0.165 | 0.536 | -0.105 | 0.815 |



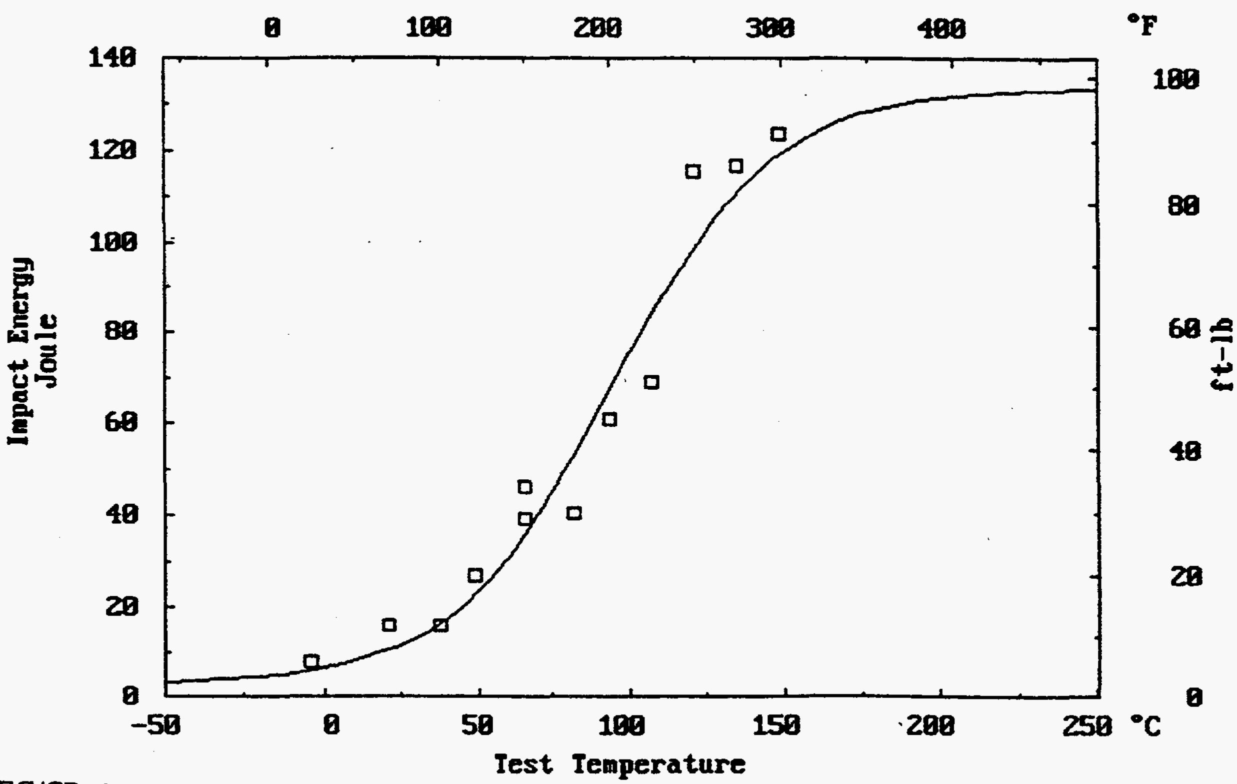
A533B HSST01 REFERENCE MATERIAL
St. Lucie Unit 1, Capsule W104

USE= 133.4 J, LSE= 3.1 J, CVT(1/2)= 94.C , Slope = 0.0192
CVT(41J) = 71. C , CVT(68J) = 94. C ,
Fluence = 7.160E+18 , Irr. Temp. = 288 C

| Spec. ID | Test Temp. C | Test Temp. F | Impact Energy J | Impact Energy ft-lb | Lat. Exp. mm | Lat. Exp. mil | % Shear |
|---|---|---|---|---|---|---|---|
| 721 | -4. | 25. | 8. | 6. | 0.23 | 9. | 5. |
| 71L | 21. | 70. | 16. | 12. | 0.18 | 7. | 10. |
| 71P | 38. | 100. | 16. | 12. | 0.36 | 14. | 10. |
| 724 | 49. | 120. | 27. | 20. | 0.46 | 18. | 15. |
| 723 | 66. | 150. | 46. | 34. | 0.71 | 28. | 30. |
| 726 | 66. | 150. | 39. | 29. | 0.58 | 23. | 20. |
| 725 | 82. | 180. | 41. | 30. | 0.74 | 29. | 40. |
| 71U | 93. | 200. | 61. | 45. | 0.91 | 36. | 40. |
| 71T | 107. | 225. | 69. | 51. | 1.22 | 48. | 90. |
| 71Y | 121. | 250. | 115. | 85. | 1.90 | 75. | 100. |
| 71M | 135. | 275. | 117. | 86. | 1.80 | 71. | 100. |
| 71A | 149. | 300. | 123. | 91. | 1.93 | 76. | 100. |

A533B Reference Material (HSST Plate #1)

SL1 W104 SHSS01 SRM LT



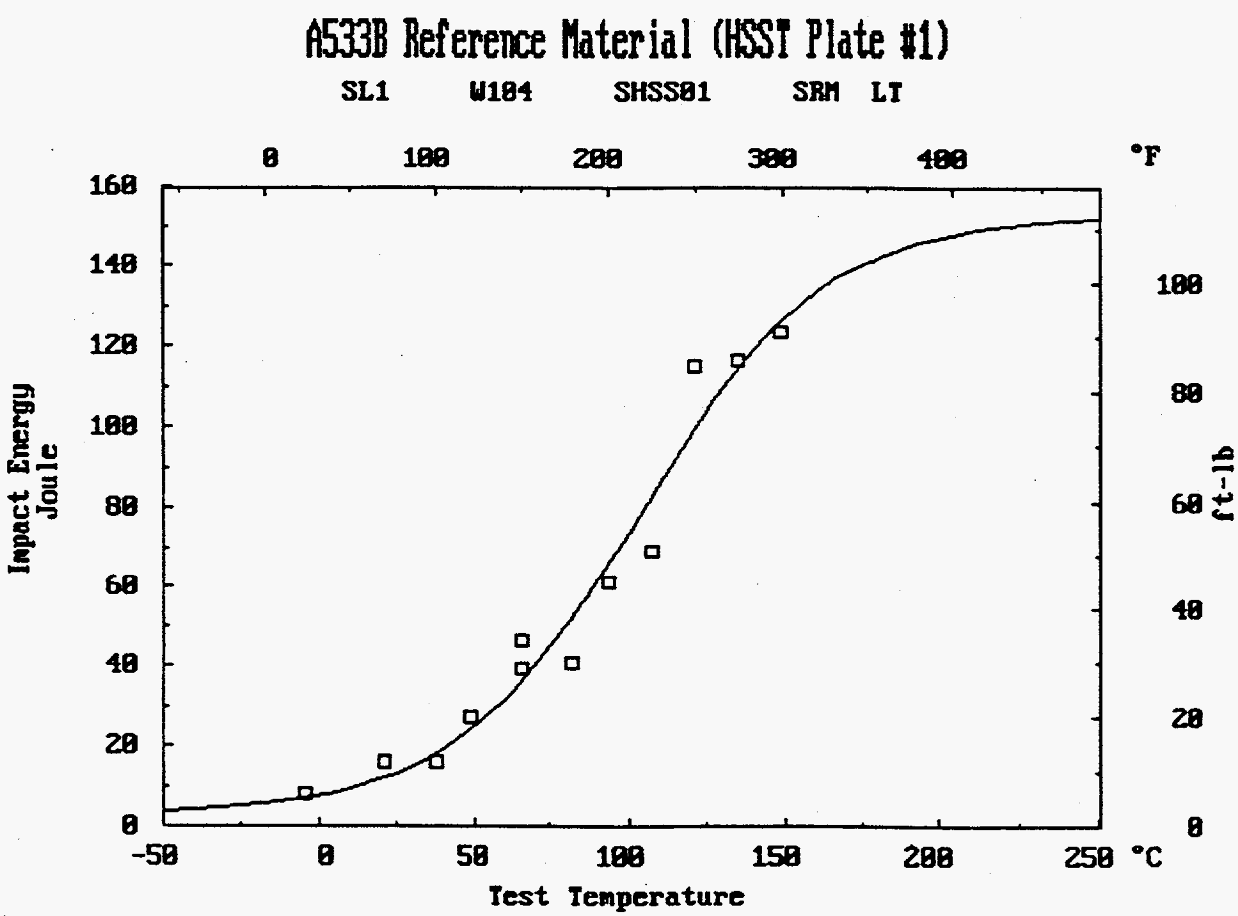
A533B HSST01 REFERENCE MATERIAL

St. Lucie Unit 1, Capsule W104

```
Impact Energy Uncertainty =  10.0 J
Test Temperature Uncertainty =   4.0 Degree C
Number of Successful Iterations =  200, Maximum = 1000
```

SL1 W104 SHSS01 SRM LT : Fluence = 7.160E+18 , Irr. Temp. = 288

| Parameter | Mean | Std.Dev. | Correlation Coefficients | | | | |
|---|---|---|---|---|---|---|---|
| Lower Shelf Energy (J) | 3.1 | 0.1 | | | | | |
| Upper Shelf Energy (J) | 152.8 | 23.5 | -0.183 | | | | |
| CVT at Midpoint (C) | 103.3 | 11.1 | -0.112 | 0.939 | | | |
| 1/slope (C) | 59.6 | 10.6 | -0.378 | 0.645 | 0.637 | | |
| CVT at 41 Joule (C) | 71.0 | 5.3 | 0.367 | 0.094 | 0.293 | -0.480 | |
| CVT at 68 Joule (C) | 95.5 | 3.9 | 0.159 | 0.340 | 0.622 | 0.145 | 0.753 |



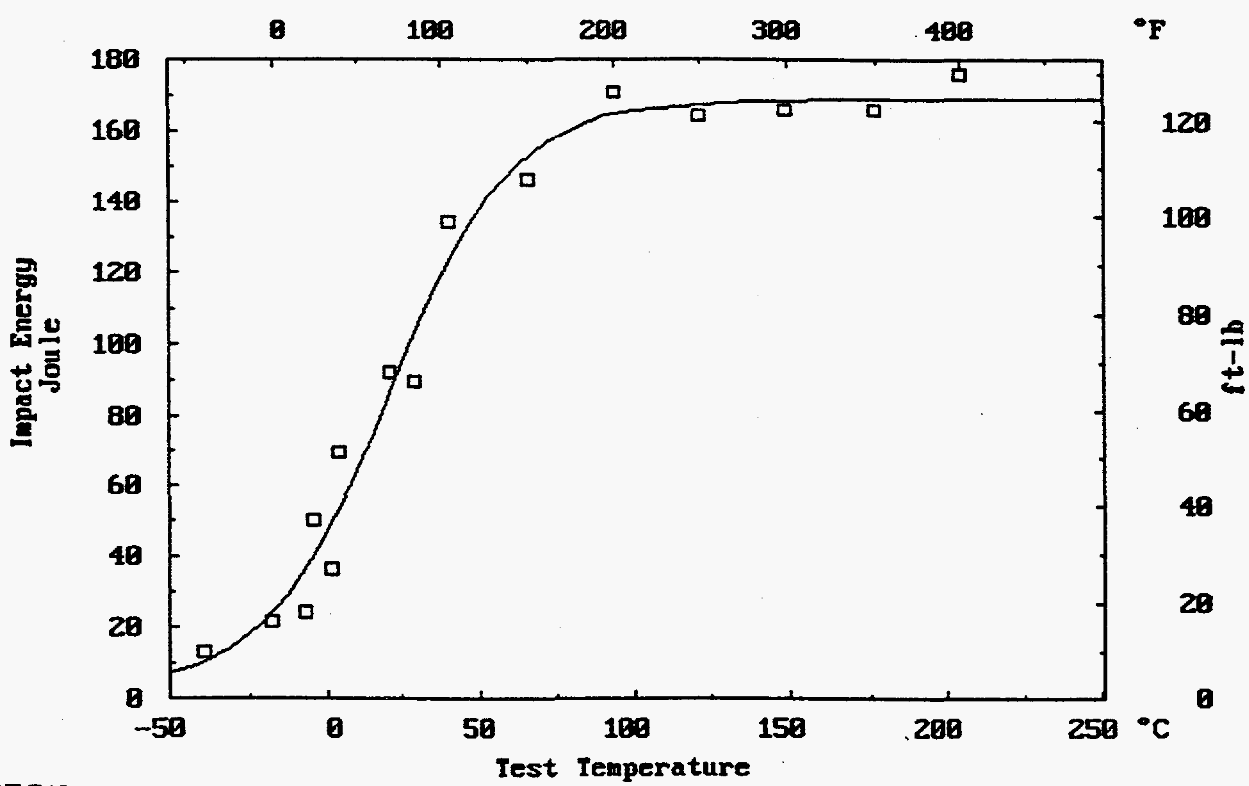
A533B HSST01 REFERENCE MATERIAL
St. Lucie Unit 2, Baseline

USE= 168.6 J, LSE= 3.0 J, CVT(1/2)= 21.C , Slope = 0.0252
Unirradiated Charpy Specimen, CVT(41J) = -3. C , CVT(68J) = 12. C

| Spec. ID | Test Temp. C | Test Temp. F | Impact Energy J | Impact Energy ft-lb | Lat. Exp. mm | Lat. Exp. mil | % Shear |
|---|---|---|---|---|---|---|---|
| B17 | -40. | -40. | 14. | 10. | 0.28 | 11. | 0. |
| AAL | -18. | 0. | 22. | 16. | 0.46 | 18. | 10. |
| AAT | -7. | 20. | 24. | 18. | 0.43 | 17. | 10. |
| B13 | -4. | 25. | 50. | 37. | 0.79 | 31. | 10. |
| B11 | 2. | 35. | 37. | 27. | 0.66 | 26. | 10. |
| AAK | 4. | 40. | 69. | 51. | 1.14 | 45. | 20. |
| AAJ | 21. | 70. | 92. | 68. | 1.40 | 55. | 50. |
| AAM | 29. | 85. | 89. | 66. | 1.35 | 53. | 50. |
| B12 | 41. | 105. | 134. | 99. | 1.85 | 73. | 70. |
| B14 | 66. | 150. | 146. | 108. | 2.08 | 82. | 100. |
| B16 | 93. | 200. | 171. | 126. | 2.01 | 79. | 100. |
| AAP | 121. | 250. | 164. | 121. | 1.80 | 71. | 100. |
| AAU | 149. | 300. | 165. | 122. | 1.88 | 74. | 100. |
| B15 | 177. | 350. | 165. | 122. | 1.98 | 78. | 100. |
| AAY | 204. | 400. | 176. | 130. | 1.93 | 76. | 100. |

A533B Reference Material (HSST Plate #1)

SL2 SHSS01 SRM LT



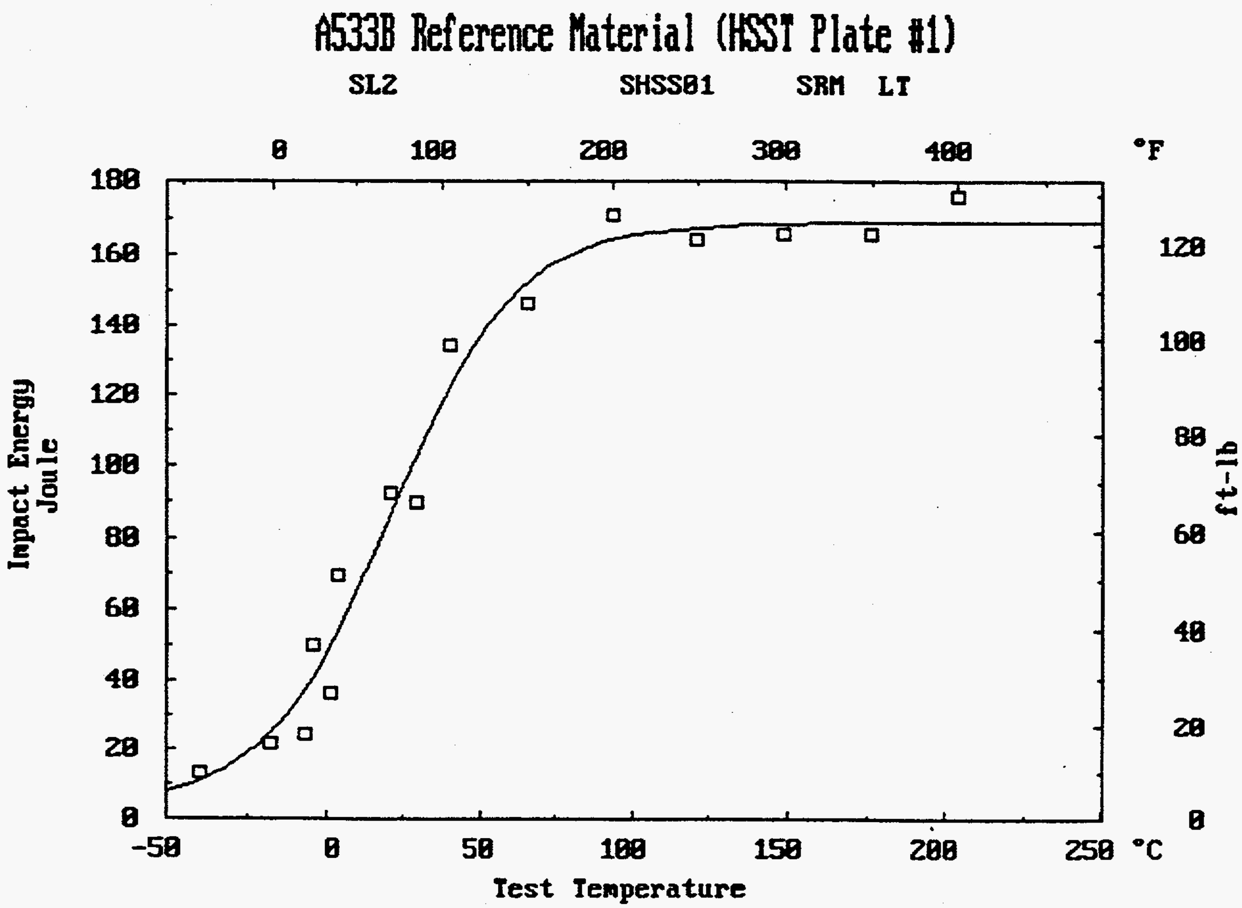
A533B HSST01 REFERENCE MATERIAL

St. Lucie Unit 2, Baseline

Impact Energy Uncertainty = 10.0 J
Test Temperature Uncertainty = 4.0 Degree C
Number of Successful Iterations = 200, Maximum = 1000

SL2 SHSS01 SRM LT

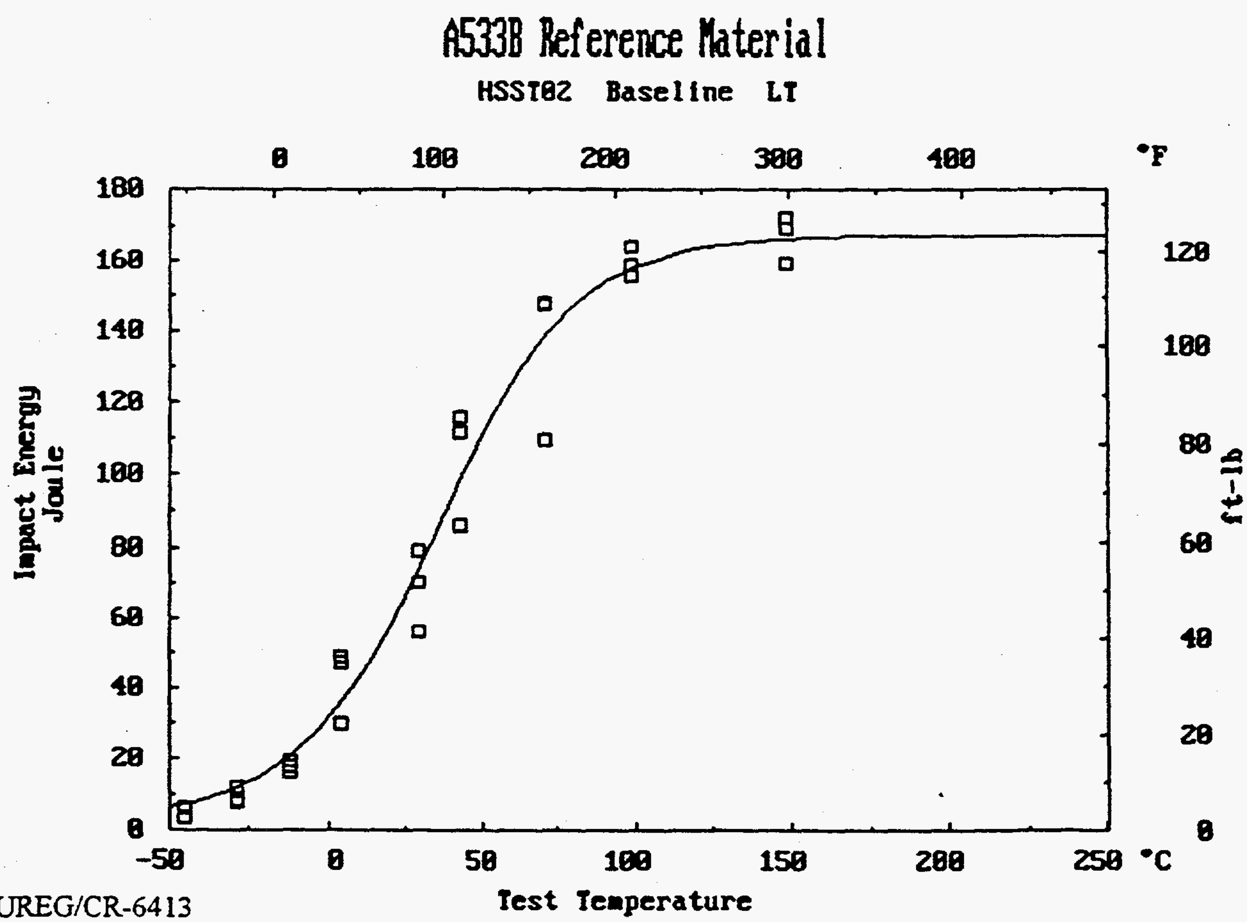
| Parameter | Mean | Std.Dev. | Correlation Coefficients | | | | |
|---|---|---|---|---|---|---|---|
| Lower Shelf Energy (J) | 3.0 | 0.0 | | | | | |
| Upper Shelf Energy (J) | 168.7 | 4.6 | -0.011 | | | | |
| CVT at Midpoint (C) | 20.8 | 3.2 | -0.051 | 0.430 | | | |
| 1/slope (C) | 40.9 | 4.8 | -0.094 | 0.337 | 0.368 | | |
| CVT at 41 Joule (C) | -4.0 | 3.5 | 0.030 | -0.102 | 0.525 | -0.577 | |
| CVT at 68 Joule (C) | 11.9 | 2.8 | -0.020 | 0.026 | 0.858 | -0.072 | 0.854 |



## A533B HSST02 REFERENCE MATERIAL, Baseline

USE= 167.4 J, LSE= 2.9 J, CVT(1/2)= 36.C , Slope = 0.0220
Unirradiated Charpy SpecimenCVT(41J) = 8. C , CVT(68J) = 26. C

| Spec. ID | Test Temp. C | Test Temp. F | Impact Energy J | Impact Energy ft-lb | Lat. Exp. mm | Lat. Exp. mil | % Shear |
|---|---|---|---|---|---|---|---|
| | -46. | -50. | 7. | 5. | 0.08 | 3. | 9. |
| | -46. | -50. | 7. | 5. | 0.13 | 5. | 9. |
| | -46. | -50. | 4. | 3. | 0.10 | 4. | 9. |
| | -29. | -20. | 9. | 6. | 0.15 | 6. | 9. |
| | -29. | -20. | 12. | 9. | 0.25 | 10. | 13. |
| | -29. | -20. | 8. | 6. | 0.23 | 9. | 13. |
| | -12. | 10. | 16. | 12. | 0.38 | 15. | 23. |
| | -12. | 10. | 20. | 14. | 0.36 | 14. | 23. |
| | -12. | 10. | 18. | 13. | 0.36 | 14. | 23. |
| | 4. | 40. | 30. | 22. | 0.58 | 23. | 33. |
| | 4. | 40. | 49. | 36. | 0.81 | 32. | 29. |
| | 4. | 40. | 47. | 35. | 0.81 | 32. | 29. |
| | 29. | 85. | 79. | 58. | 1.30 | 51. | 43. |
| | 29. | 85. | 56. | 41. | 1.07 | 42. | 41. |
| | 29. | 85. | 70. | 52. | 1.14 | 45. | 42. |
| | 43. | 110. | 112. | 82. | 1.52 | 60. | 58. |
| | 43. | 110. | 116. | 85. | 1.80 | 71. | 67. |
| | 43. | 110. | 86. | 63. | 1.37 | 54. | 55. |
| | 71. | 160. | 147. | 108. | 1.83 | 72. | 84. |
| | 71. | 160. | 110. | 81. | 1.75 | 69. | 85. |
| | 71. | 160. | 148. | 109. | 2.01 | 79. | 87. |
| | 99. | 210. | 159. | 117. | 2.13 | 84. | 98. |
| | 99. | 210. | 156. | 115. | 2.24 | 88. | 98. |
| | 99. | 210. | 164. | 121. | 2.21 | 87. | 100. |
| | 149. | 300. | 169. | 125. | 2.21 | 87. | 100. |
| | 149. | 300. | 159. | 117. | 2.11 | 83. | 100. |
| | 149. | 300. | 172. | 127. | 2.13 | 84. | 100. |



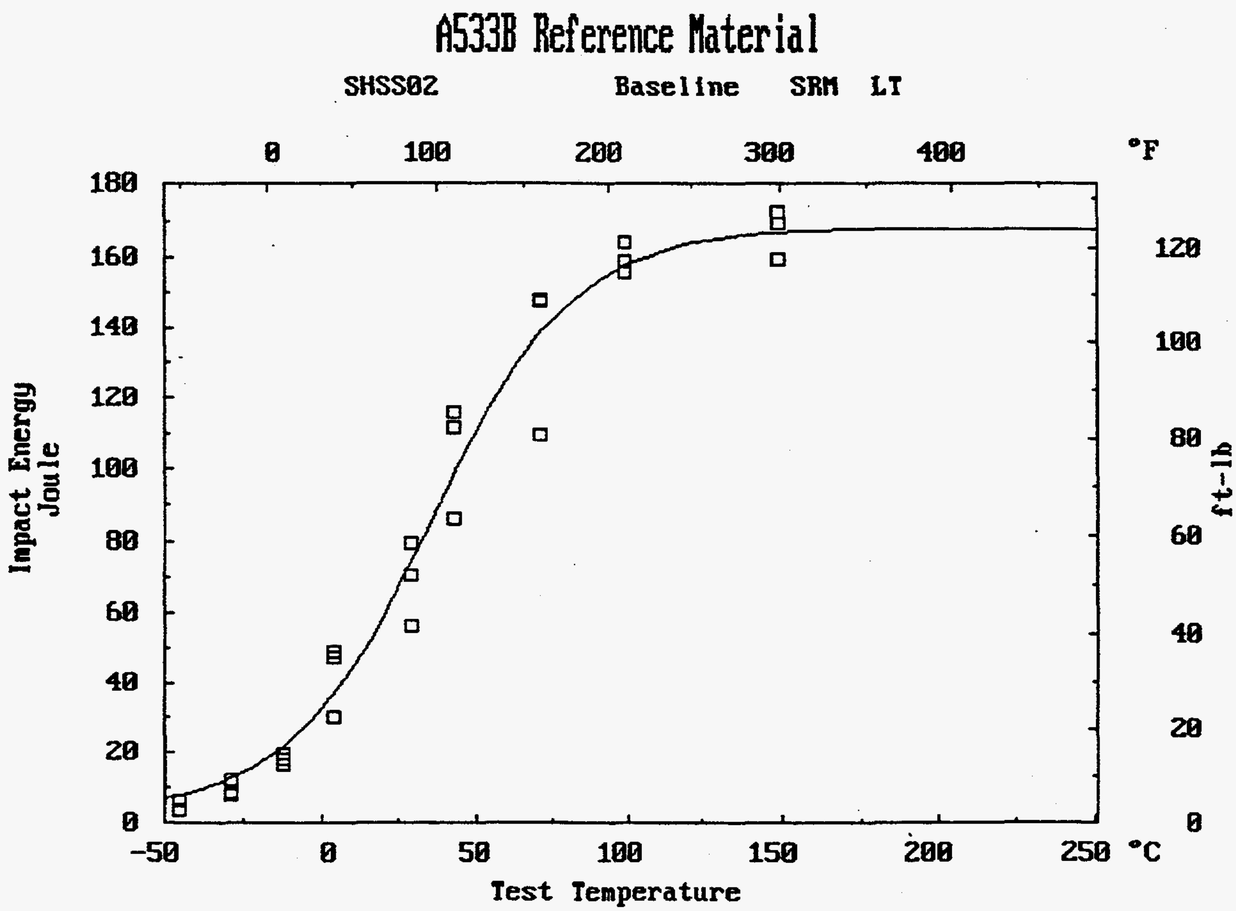
A533B HSST02 REFERENCE MATERIAL

Baseline

Impact Energy Uncertainty = 10.0 J
Test Temperature Uncertainty = 4.0 Degree C
Number of Successful Iterations = 200, Maximum = 1000

SHSS02 Baseline SRM LT

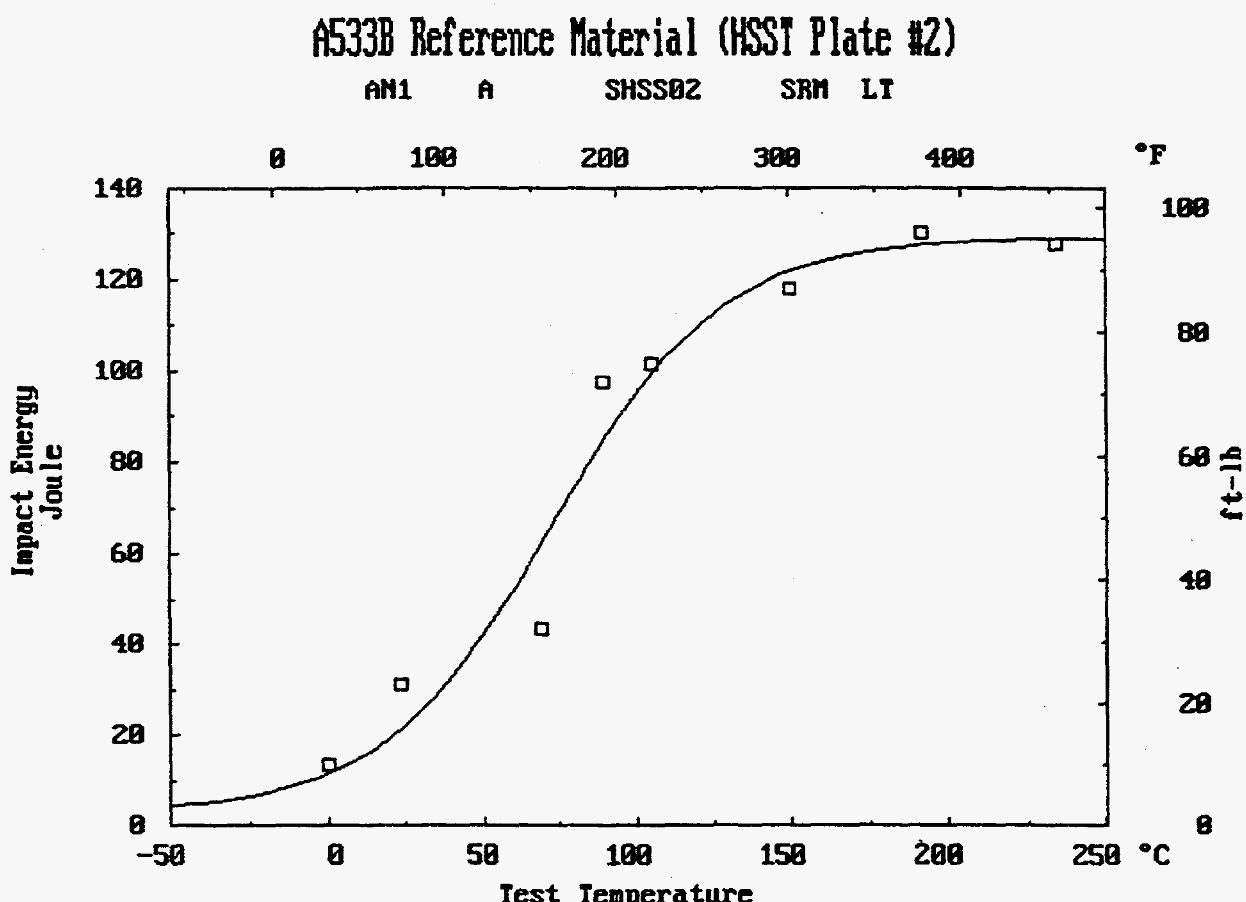
| Parameter | Mean | Std.Dev. | Correlation Coefficients | | | | |
|---|---|---|---|---|---|---|---|
| Lower Shelf Energy (J) | 3.0 | 0.1 | | | | | |
| Upper Shelf Energy (J) | 167.9 | 5.9 | -0.042 | | | | |
| CVT at Midpoint (C) | 35.7 | 3.4 | 0.024 | 0.741 | | | |
| 1/slope (C) | 46.5 | 4.6 | -0.251 | 0.582 | 0.607 | | |
| CVT at 41 Joule (C) | 7.6 | 2.6 | 0.295 | -0.077 | 0.331 | -0.518 | |
| CVT at 68 Joule (C) | 25.7 | 2.2 | 0.162 | 0.250 | 0.792 | 0.118 | 0.784 |



A533B HSST02 REFERENCE MATERIAL,
Arkansas Unit 1, Capsule A

USE= 129.0 J, LSE= 3.0 J, CVT(1/2)= 73.C , Slope = 0.0180
CVT(41J) = 49. C , CVT(68J) = 74. C ,
Fluence = 1.030E+19 , Irr. Temp. = 303 C

| Spec. ID | Test Temp. C | Test Temp. F | Impact Energy J | Impact Energy ft-lb | Lat. Exp. mm | Lat. Exp. mil | % Shear |
|---|---|---|---|---|---|---|---|
| GG940 | 0. | 32. | 14. | 10. | 0.23 | 9. | 0. |
| GG939 | 24. | 75. | 31. | 23. | 0.51 | 20. | 5. |
| GG942 | 69. | 156. | 43. | 32. | 0.76 | 30. | 15. |
| GG918 | 89. | 192. | 98. | 72. | 1.42 | 56. | 80. |
| GG932 | 106. | 222. | 102. | 75. | 1.40 | 55. | 95. |
| GG904 | 150. | 302. | 118. | 87. | 1.98 | 78. | 100. |
| GG935 | 192. | 378. | 130. | 96. | 1.90 | 75. | 100. |
| GG949 | 234. | 454. | 127. | 94. | 1.85 | 73. | 100. |



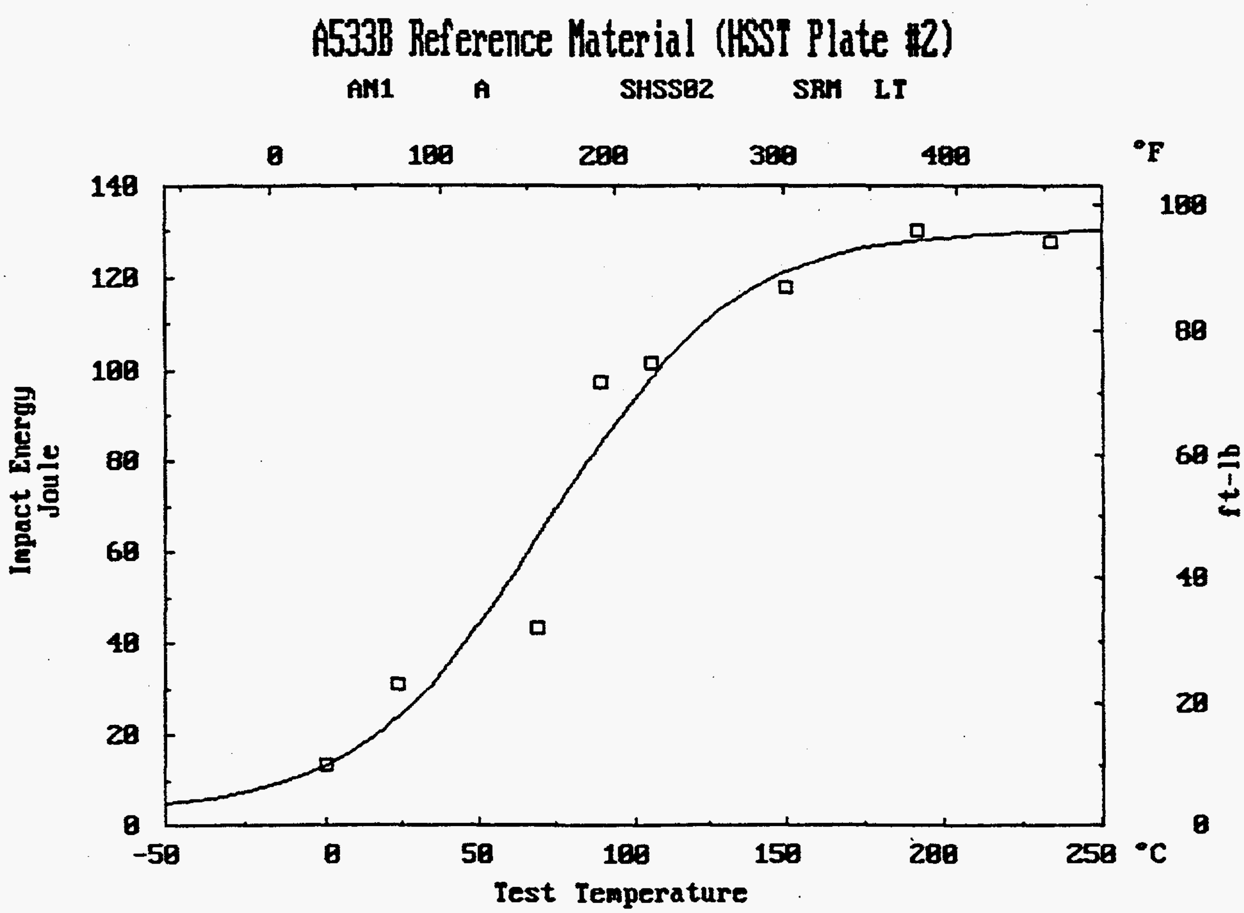
A533B HSST02 REFERENCE MATERIAL,

Arkansas Unit 1, Capsule A

```
Impact Energy Uncertainty =  10.0 J
Test Temperature Uncertainty =   4.0 Degree C
Number of Successful Iterations =  200, Maximum = 1000
```

AN1 A SHSS02 SRM LT : Fluence = 1.030E+19 , Irr. Temp. = 303

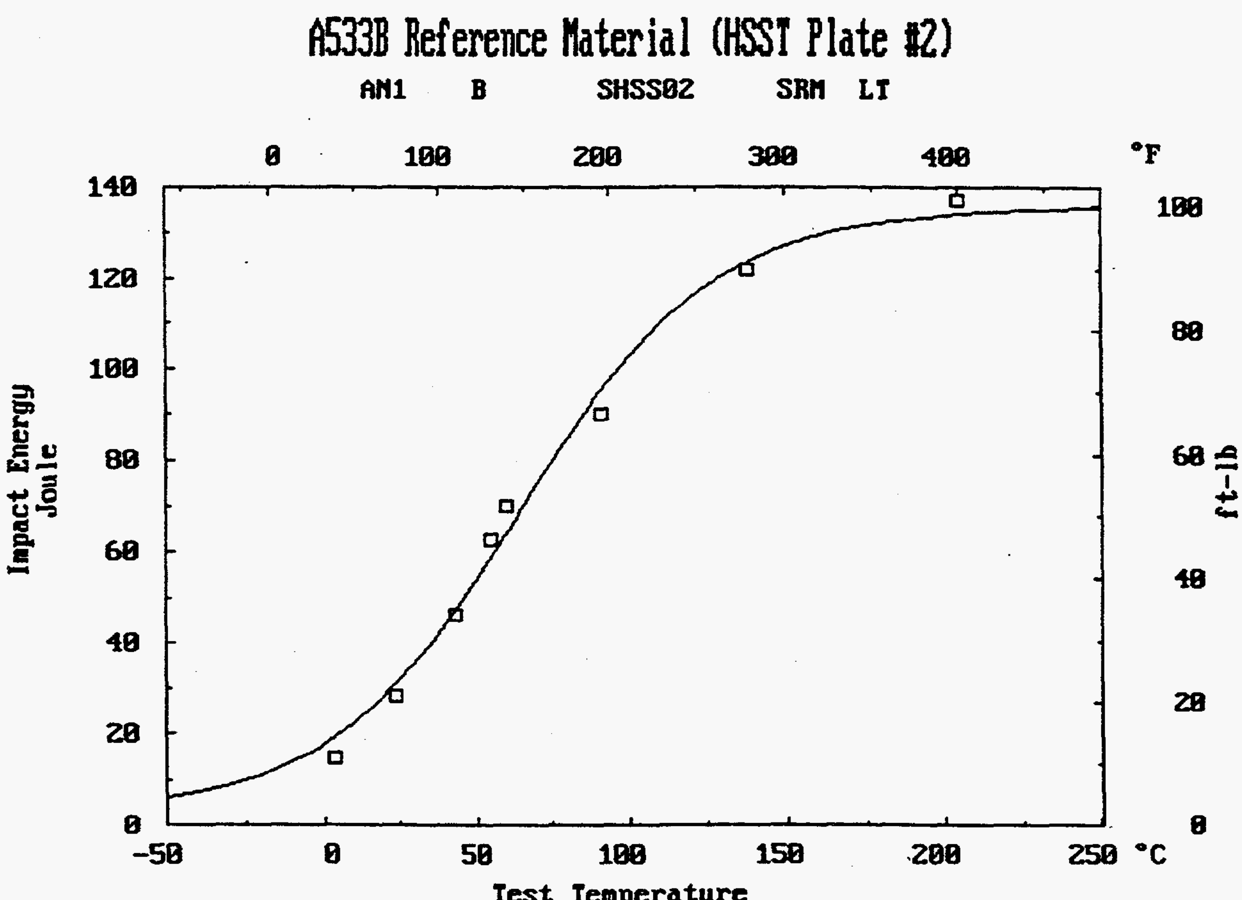
| Parameter | Mean | Std.Dev. | Correlation Coefficients | | | | |
|---|---|---|---|---|---|---|---|
| Lower Shelf Energy (J) | 3.0 | 0.0 | | | | | |
| Upper Shelf Energy (J) | 130.3 | 7.6 | 0.040 | | | | |
| CVT at Midpoint (C) | 72.5 | 7.7 | 0.251 | 0.565 | | | |
| 1/slope (C) | 60.0 | 13.6 | -0.412 | 0.386 | 0.101 | | |
| CVT at 41 Joule (C) | 46.7 | 9.0 | 0.472 | -0.060 | 0.625 | -0.679 | |
| CVT at 68 Joule (C) | 73.7 | 6.4 | 0.260 | 0.106 | 0.873 | -0.062 | 0.765 |



A533B HSST02 REFERENCE MATERIAL
Arkansas Unit 1, Capsule B

USE= 135.6 J, LSE= 3.0 J, CVT(1/2)= 65.C , Slope = 0.0160
CVT(41J) = 36. C , CVT(68J) = 64. C ,
Fluence = 4.280E+18 , Irr. Temp. = 309 C

| Spec. ID | Test Temp. C | Test Temp. F | Impact Energy J | Impact Energy ft-lb | Lat. Exp. mm | Lat. Exp. mil | % Shear |
|---|---|---|---|---|---|---|---|
| HH916 | 3. | 38. | 15. | 11. | 0.15 | 6. | 0. |
| HH909 | 24. | 75. | 28. | 21. | 0.48 | 19. | 10. |
| HH922 | 43. | 110. | 46. | 34. | 0.76 | 30. | 10. |
| HH936 | 54. | 130. | 62. | 46. | 0.84 | 33. | 30. |
| HH931 | 60. | 140. | 70. | 51. | 1.12 | 44. | 30. |
| HH929 | 91. | 196. | 90. | 66. | 1.57 | 62. | 100. |
| HH943 | 138. | 280. | 122. | 90. | 1.96 | 77. | 100. |
| HH905 | 204. | 400. | 137. | 101. | 1.98 | 78. | 100. |



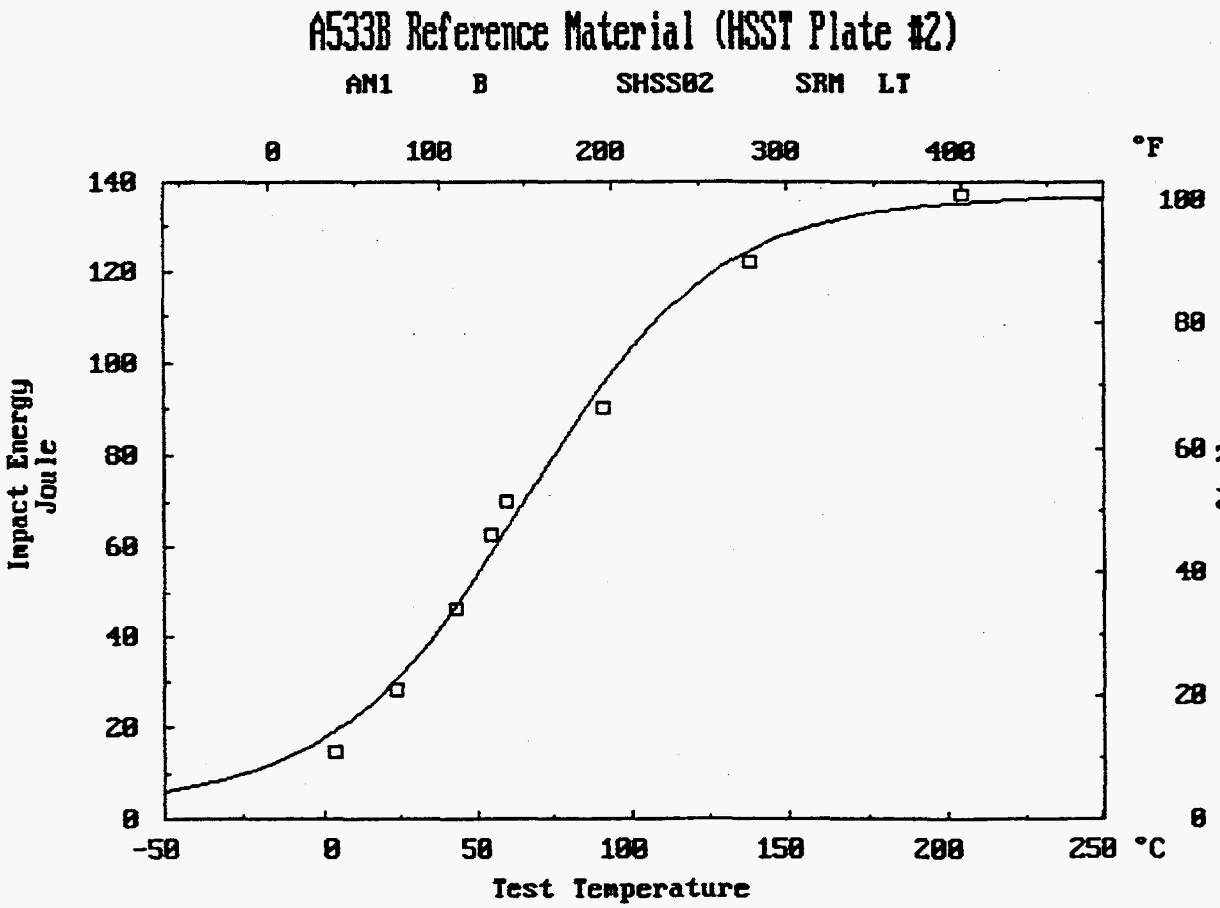
A533B HSST02 REFERENCE MATERIAL

Arkansas Unit 1, Capsule B

Impact Energy Uncertainty = 10.0 J
Test Temperature Uncertainty = 4.0 Degree C
Number of Successful Iterations = 200, Maximum = 1000

AN1 B SHSS02 SRM LT : Fluence = 4.280E+18 , Irr. Temp. = 309

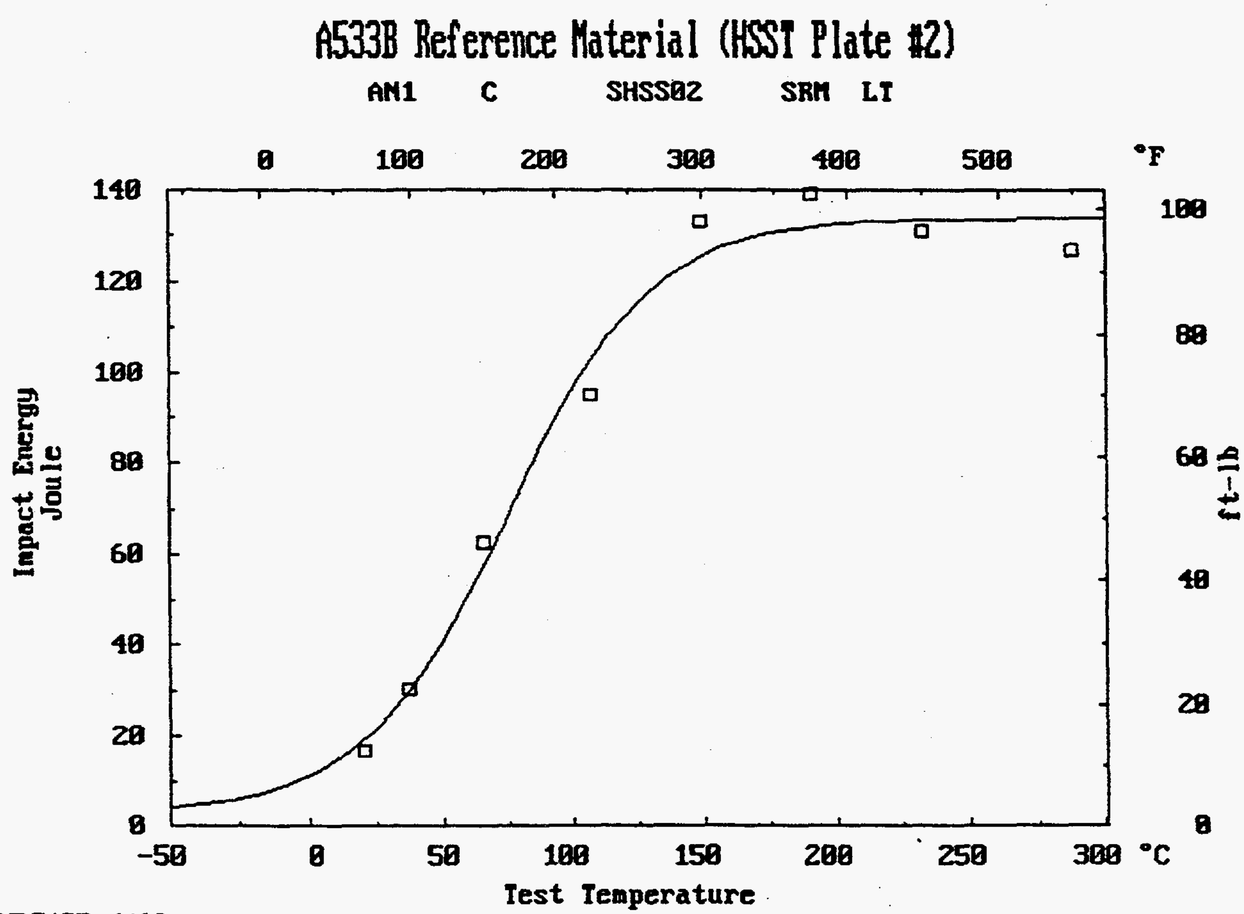
| Parameter | Mean | Std.Dev. | Correlation Coefficients | | | | |
|---|---|---|---|---|---|---|---|
| Lower Shelf Energy (J) | 3.0 | 0.0 | | | | | |
| Upper Shelf Energy (J) | 136.7 | 11.3 | 0.010 | | | | |
| CVT at Midpoint (C) | 65.6 | 9.9 | -0.044 | 0.839 | | | |
| 1/slope (C) | 62.6 | 13.9 | 0.094 | 0.681 | 0.704 | | |
| CVT at 41 Joule (C) | 36.4 | 5.8 | -0.179 | -0.008 | 0.333 | -0.384 | |
| CVT at 68 Joule (C) | 63.6 | 5.8 | -0.079 | 0.444 | 0.852 | 0.487 | 0.602 |



A533B HSST02 REFERENCE MATERIAL
Arkansas Unit 1, Capsule C

USE= 133.6 J, LSE= 3.0 J, CVT(1/2)= 75.C , Slope = 0.0181
CVT(41J) = 50. C , CVT(68J) = 74. C ,
Fluence = 1.460E+19 , Irr. Temp. = 303 C

| Spec. ID | Test Temp. C | Test Temp. F | Impact Energy J | Impact Energy ft-lb | Lat. Exp. mm | Lat. Exp. mil | % Shear |
|---|---|---|---|---|---|---|---|
| GG946 | 21. | 70. | 17. | 12. | 0.33 | 13. | 10. |
| GG920 | 38. | 100. | 31. | 22. | 0.46 | 18. | 20. |
| GG915 | 66. | 150. | 62. | 46. | 0.89 | 35. | 40. |
| GG937 | 107. | 225. | 95. | 70. | 1.55 | 61. | 90. |
| GG903 | 149. | 300. | 133. | 98. | 1.90 | 75. | 100. |
| GG941 | 191. | 375. | 139. | 102. | 2.06 | 81. | 100. |
| GG948 | 232. | 450. | 131. | 96. | 1.98 | 78. | 100. |
| GG927 | 288. | 550. | 127. | 93. | 2.08 | 82. | 100. |



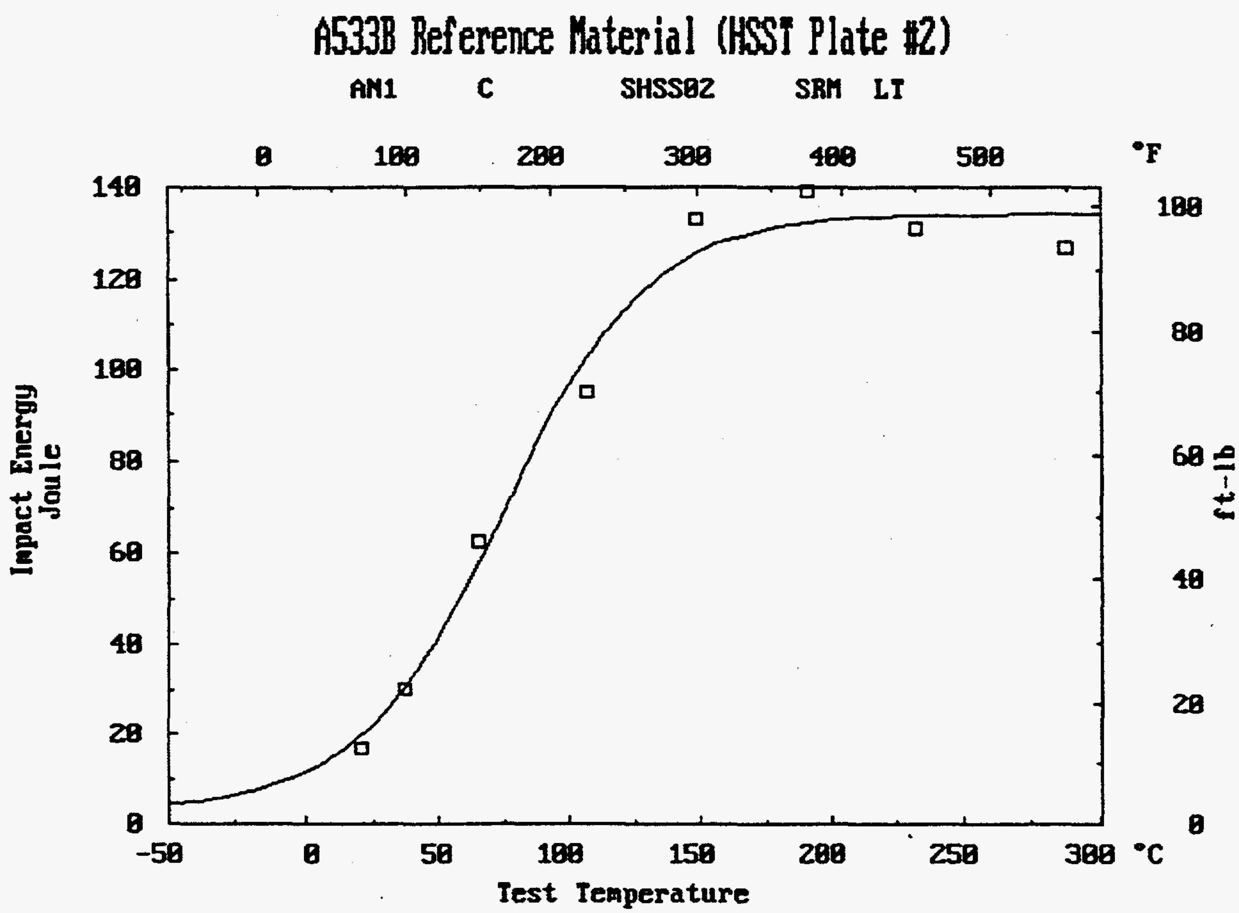
A533B HSST02 REFERENCE MATERIAL

Arkansas Unit 1, Capsule C

```
Impact Energy Uncertainty =  10.0 J
Test Temperature Uncertainty =   4.0 Degree C
Number of Successful Iterations =  200, Maximum = 1000
```

AN1 C SHSS02 SRM LT : Fluence = 1.460E+19 , Irr. Temp. = 303

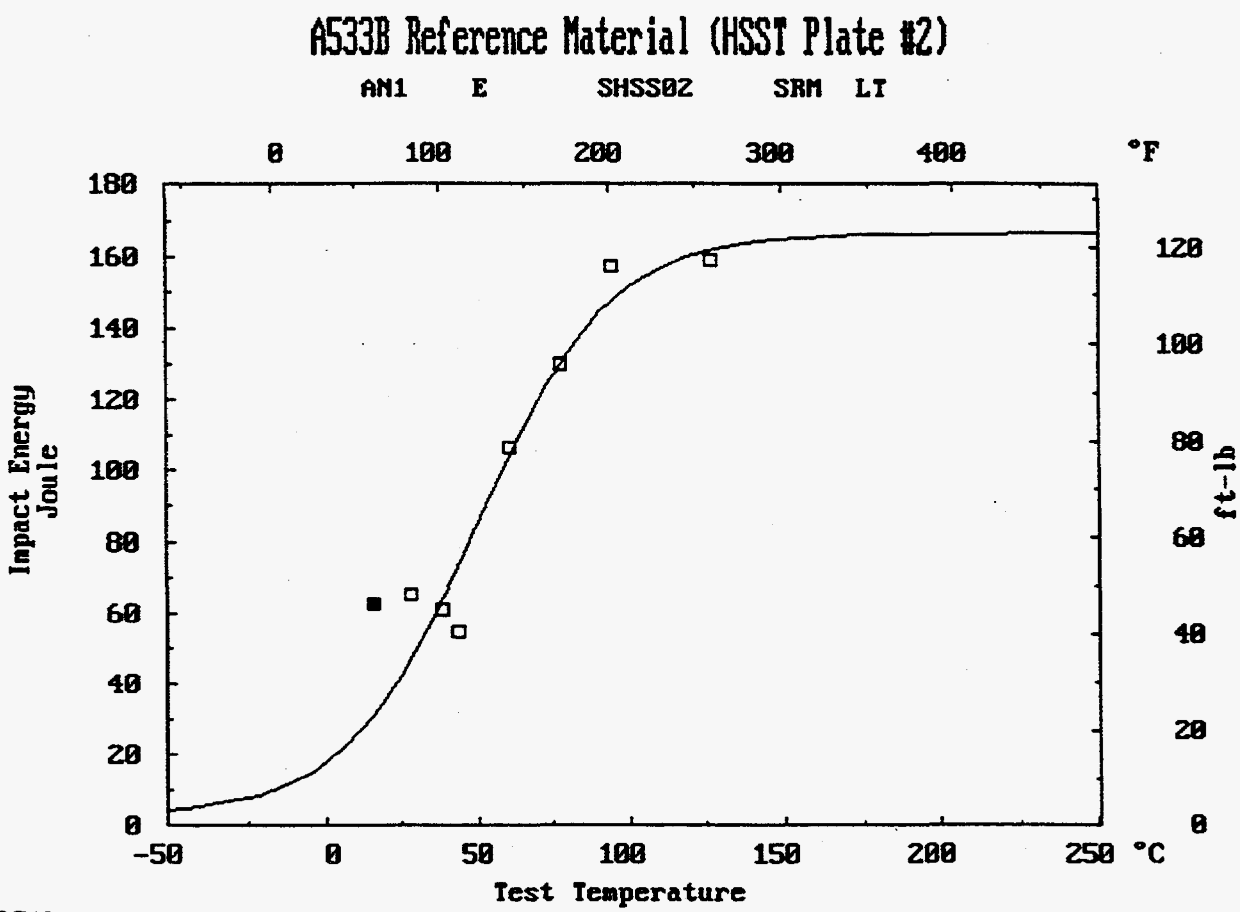
| Parameter | Mean | Std.Dev. | Correlation Coefficients | | | | |
|---|---|---|---|---|---|---|---|
| Lower Shelf Energy (J) | 3.0 | 0.0 | | | | | |
| Upper Shelf Energy (J) | 134.0 | 5.6 | 0.094 | | | | |
| CVT at Midpoint (C) | 74.3 | 7.7 | 0.255 | 0.543 | | | |
| 1/slope (C) | 55.8 | 9.8 | 0.197 | 0.332 | 0.333 | | |
| CVT at 41 Joule (C) | 49.3 | 7.0 | 0.132 | 0.144 | 0.757 | -0.333 | |
| CVT at 68 Joule (C) | 73.9 | 6.7 | 0.255 | 0.259 | 0.951 | 0.260 | 0.819 |



A533B HSST02 REFERENCE MATERIAL
Arkansas Unit 1, Capsule E

USE= 166.5 J, LSE= 3.0 J, CVT(1/2)= 50.C , Slope = 0.0230
CVT(41J) = 24. C , CVT(68J) = 41. C ,
Fluence = 7.270E+17 , Irr. Temp. = 304 C

| Spec. ID | Test Temp. C | Test Temp. F | Impact Energy J | Impact Energy ft-lb | Lat. Exp. mm | Lat. Exp. mil | % Shear |
|---|---|---|---|---|---|---|---|
| *GG928 | 16. | 60. | 62. | 46. | 0.74 | 29. | 6. |
| GG917 | 28. | 83. | 65. | 48. | 0.94 | 37. | 18. |
| GG924 | 38. | 101. | 61. | 45. | 0.81 | 32. | 20. |
| GG930 | 44. | 111. | 55. | 40. | 0.69 | 27. | 50. |
| GG912 | 61. | 141. | 106. | 78. | 1.30 | 51. | 50. |
| GG938 | 77. | 171. | 130. | 96. | 1.52 | 60. | 85. |
| GG913 | 94. | 202. | 157. | 116. | 1.70 | 67. | 100. |
| GG914 | 127. | 260. | 159. | 117. | 1.52 | 60. | 100. |



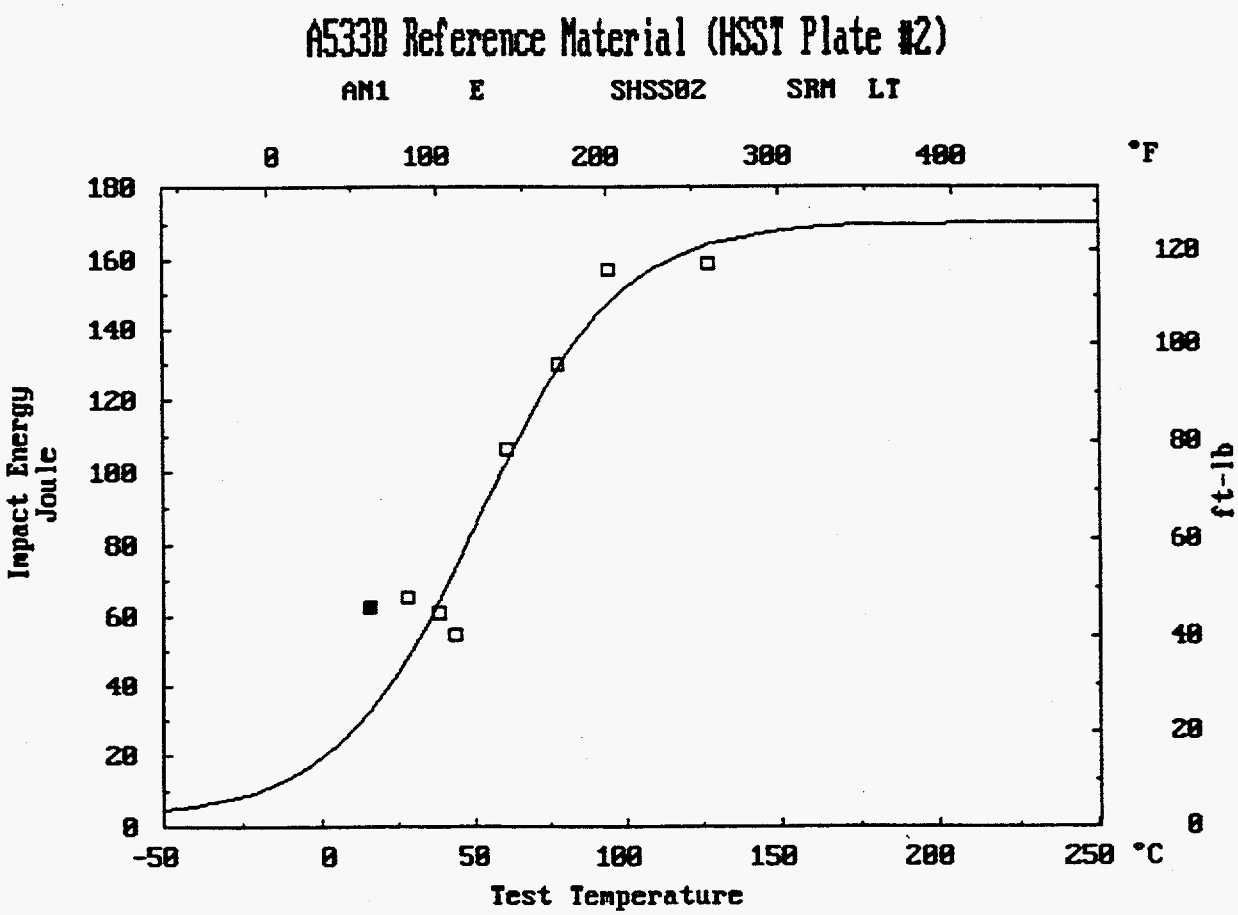
A533B HSST02 REFERENCE MATERIAL

Arkansas Unit 1, Capsule E

Impact Energy Uncertainty = 10.0 J
Test Temperature Uncertainty = 4.0 Degree C
Number of Successful Iterations = 200, Maximum = 1000

AN1 E SHSS02 SRM LT : Fluence = 7.270E+17 , Irr. Temp. = 304

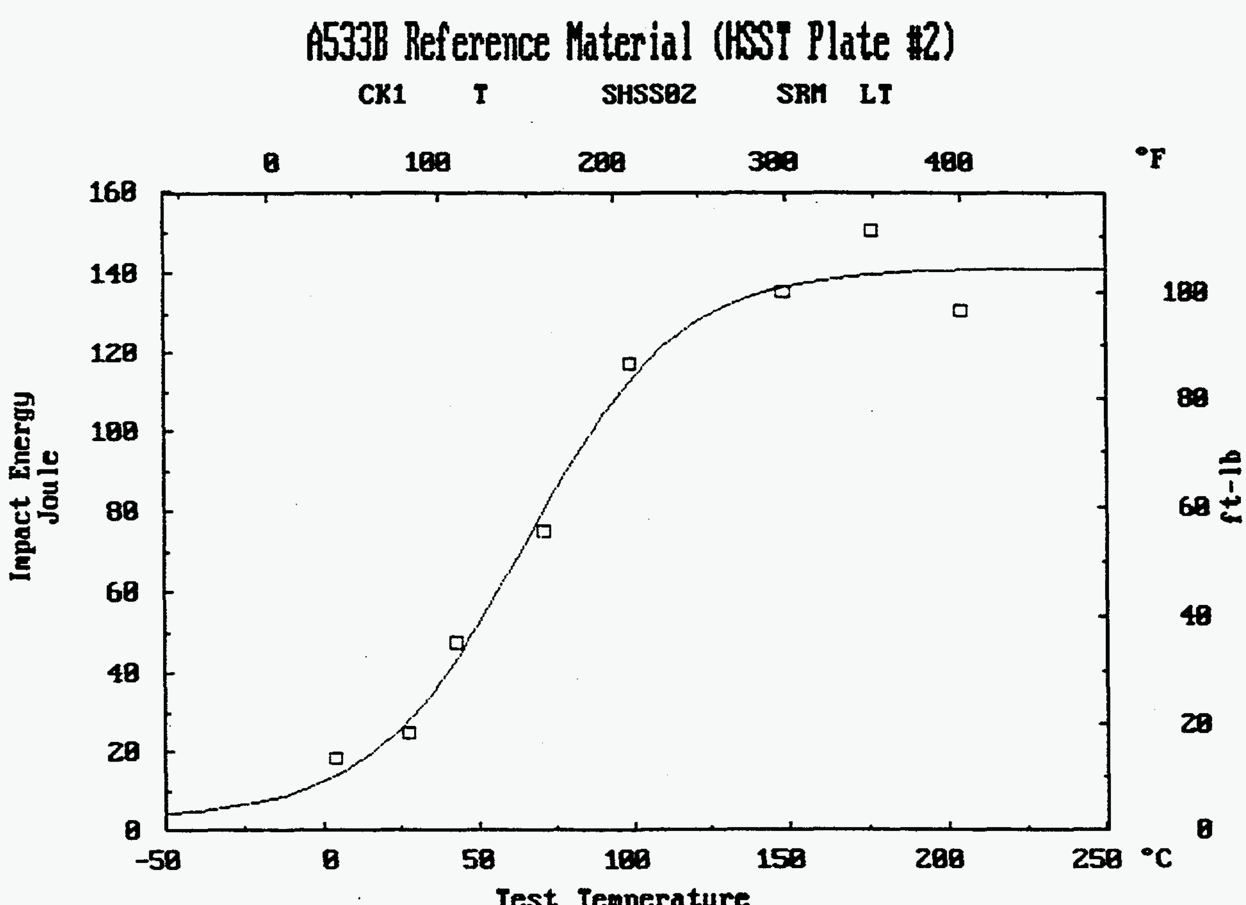
| Parameter | Mean | Std.Dev. | Correlation Coefficients | | | | |
|---|---|---|---|---|---|---|---|
| Lower Shelf Energy (J) | 3.0 | 0.0 | | | | | |
| Upper Shelf Energy (J) | 170.4 | 12.8 | -0.029 | | | | |
| CVT at Midpoint (C) | 51.4 | 6.0 | 0.126 | 0.803 | | | |
| 1/slope (C) | 46.5 | 10.6 | -0.206 | 0.665 | 0.443 | | |
| CVT at 41 Joule (C) | 22.7 | 6.9 | 0.331 | -0.300 | 0.146 | -0.807 | |
| CVT at 68 Joule (C) | 40.6 | 4.3 | 0.346 | 0.004 | 0.538 | -0.440 | 0.882 |



A533B HSST02 REFERENCE MATERIAL
Donald C. Cook Unit 1, Capsule T

USE= 141.4 J, LSE= 3.0 J, CVT(1/2)= 65.C , Slope = 0.0202
CVT(41J) = 41. C , CVT(68J) = 62. C ,
Fluence = 1.800E+18 , Irr. Temp. = 304 C

| Spec. ID | Test Temp. C | Test Temp. F | Impact Energy J | Impact Energy ft-lb | Lat. Exp. mm | Lat. Exp. mil | % Shear |
|---|---|---|---|---|---|---|---|
| R33 | 4. | 40. | 18. | 13. | 0.33 | 13. | 5. |
| R37 | 28. | 82. | 25. | 18. | 0.46 | 18. | 10. |
| R38 | 43. | 110. | 47. | 35. | 0.81 | 32. | 20. |
| R39 | 71. | 160. | 75. | 55. | 1.14 | 45. | 40. |
| R40 | 99. | 210. | 117. | 86. | 1.68 | 66. | 95. |
| R34 | 149. | 300. | 136. | 100. | 1.45 | 57. | 100. |
| R35 | 177. | 350. | 150. | 111. | 2.13 | 84. | 100. |
| R36 | 204. | 400. | 131. | 96. | 2.13 | 84. | 100. |



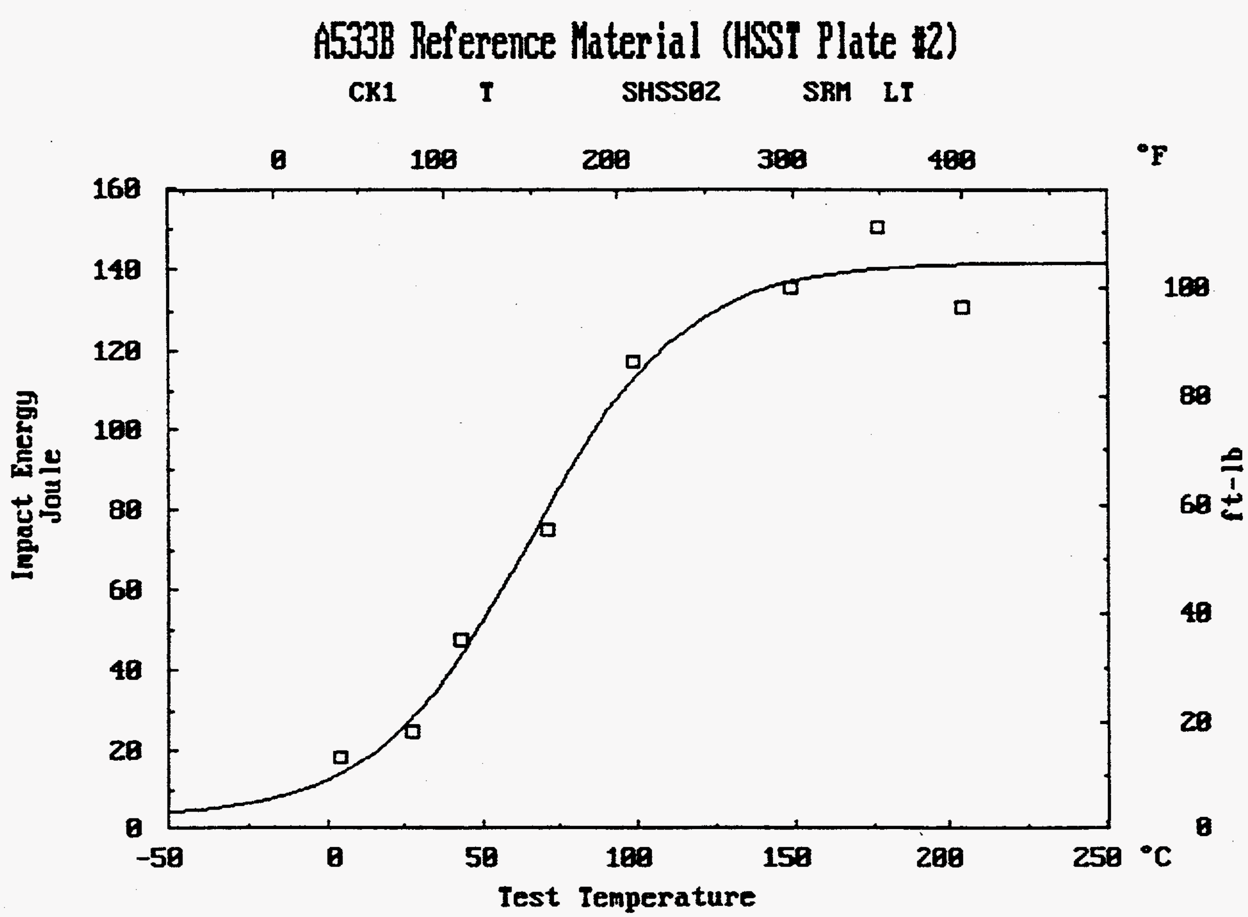
A533B HSST02 REFERENCE MATERIAL

Donald C. Cook Unit 1, Capsule T

```
Impact Energy Uncertainty =  10.0 J
Test Temperature Uncertainty =   4.0 Degree C
Number of Successful Iterations =  200, Maximum = 1000
```

CK1 T SHSS02 SRM LT : Fluence = 1.800E+18 , Irr. Temp. = 304

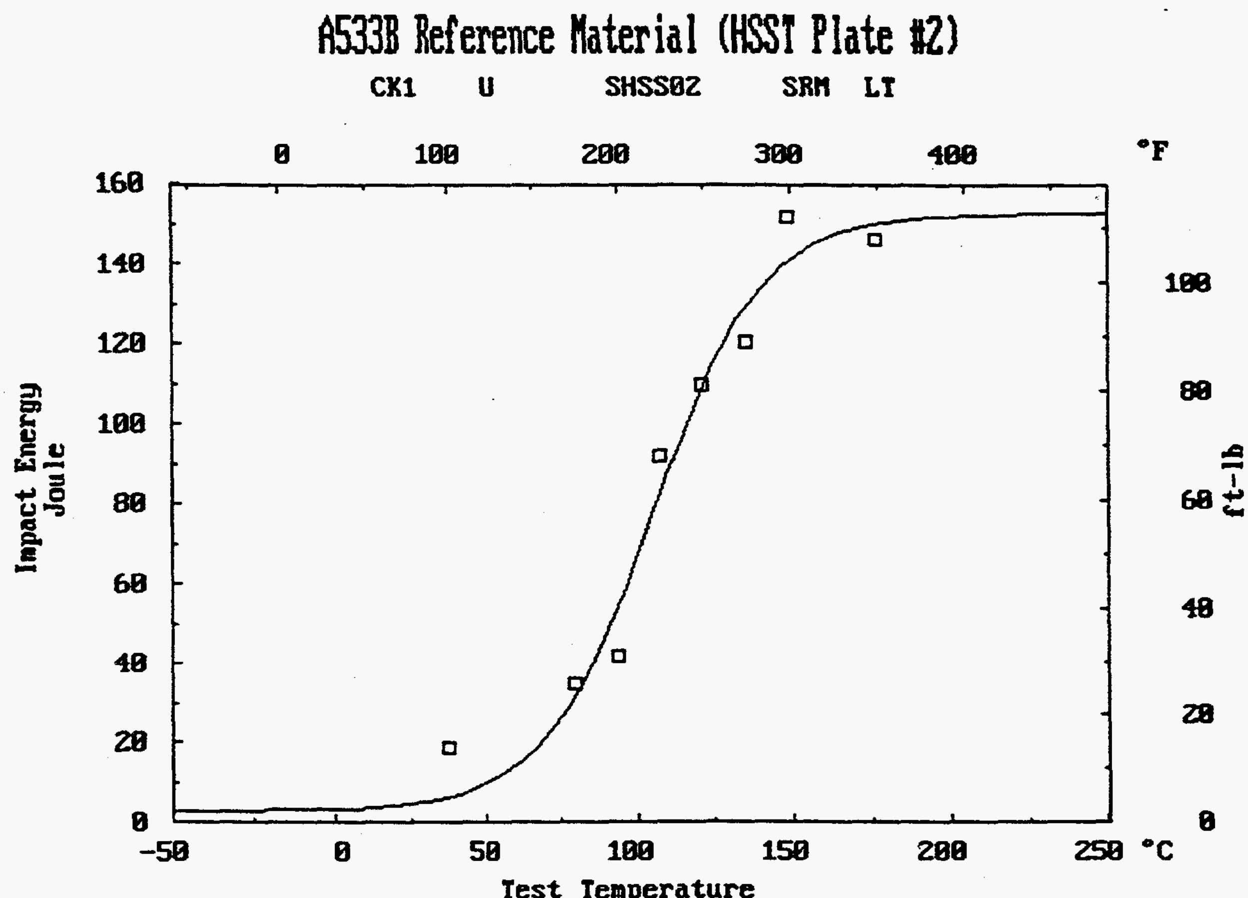
| Parameter | Mean | Std.Dev. | Correlation Coefficients | | | | |
|---|---|---|---|---|---|---|---|
| Lower Shelf Energy (J) | 3.0 | 0.0 | | | | | |
| Upper Shelf Energy (J) | 141.8 | 6.5 | 0.022 | | | | |
| CVT at Midpoint (C) | 65.1 | 5.6 | 0.160 | 0.510 | | | |
| 1/slope (C) | 49.8 | 10.8 | -0.140 | 0.475 | 0.135 | | |
| CVT at 41 Joule (C) | 40.7 | 7.3 | 0.214 | -0.183 | 0.546 | -0.739 | |
| CVT at 68 Joule (C) | 61.8 | 4.9 | 0.184 | 0.051 | 0.872 | -0.220 | 0.816 |



A533B HSST02 REFERENCE MATERIAL
Donald C. Cook Unit 1, Capsule U

USE= 152.8 J, LSE= 3.1 J, CVT(1/2)= 105.C , Slope = 0.0281
CVT(41J) = 86. C , CVT(68J) = 100. C ,
Fluence = 1.880E+19 , Irr. Temp. = 288 C

| Spec. ID | Test Temp. C | Test Temp. F | Impact Energy J | Impact Energy ft-lb | Lat. Exp. mm | Lat. Exp. mil | % Shear |
|---|---|---|---|---|---|---|---|
| R44 | 38. | 100. | 19. | 14. | 0.30 | 12. | 10. |
| R42 | 79. | 175. | 35. | 26. | 0.51 | 20. | 25. |
| R43 | 93. | 200. | 42. | 31. | 0.63 | 25. | 30. |
| R48 | 107. | 225. | 92. | 68. | 1.24 | 49. | 90. |
| R45 | 121. | 250. | 110. | 81. | 1.50 | 59. | 100. |
| R46 | 135. | 275. | 121. | 89. | 1.70 | 67. | 100. |
| R47 | 149. | 300. | 152. | 112. | 1.78 | 70. | 100. |
| R41 | 177. | 350. | 146. | 108. | 1.88 | 74. | 100. |



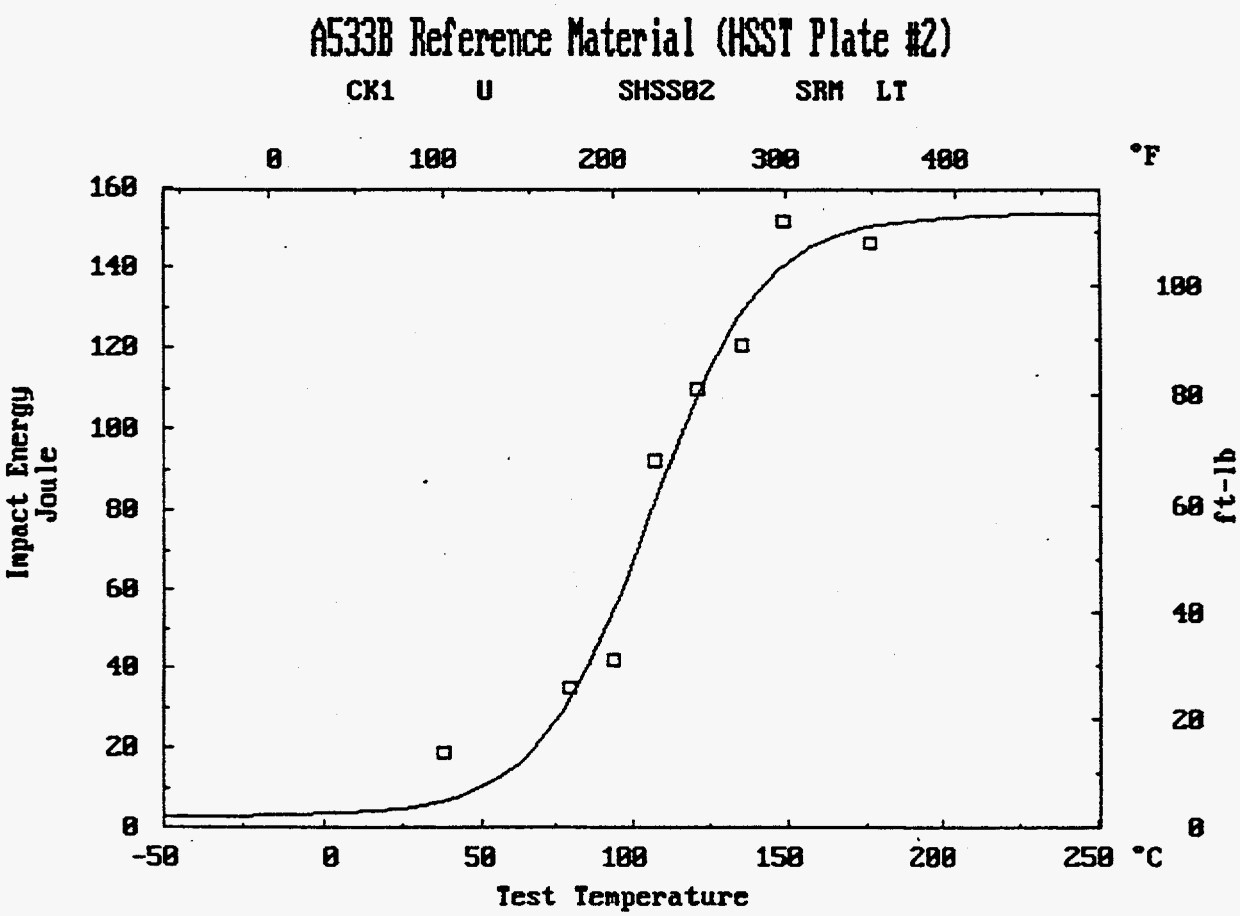
A533B HSST02 REFERENCE MATERIAL

Donald C. Cook Unit 1, Capsule U

Impact Energy Uncertainty = 10.0 J
Test Temperature Uncertainty = 4.0 Degree C
Number of Successful Iterations = 200, Maximum = 1000

CK1 U SHSS02 SRM LT : Fluence = 1.880E+19 , Irr. Temp. = 288

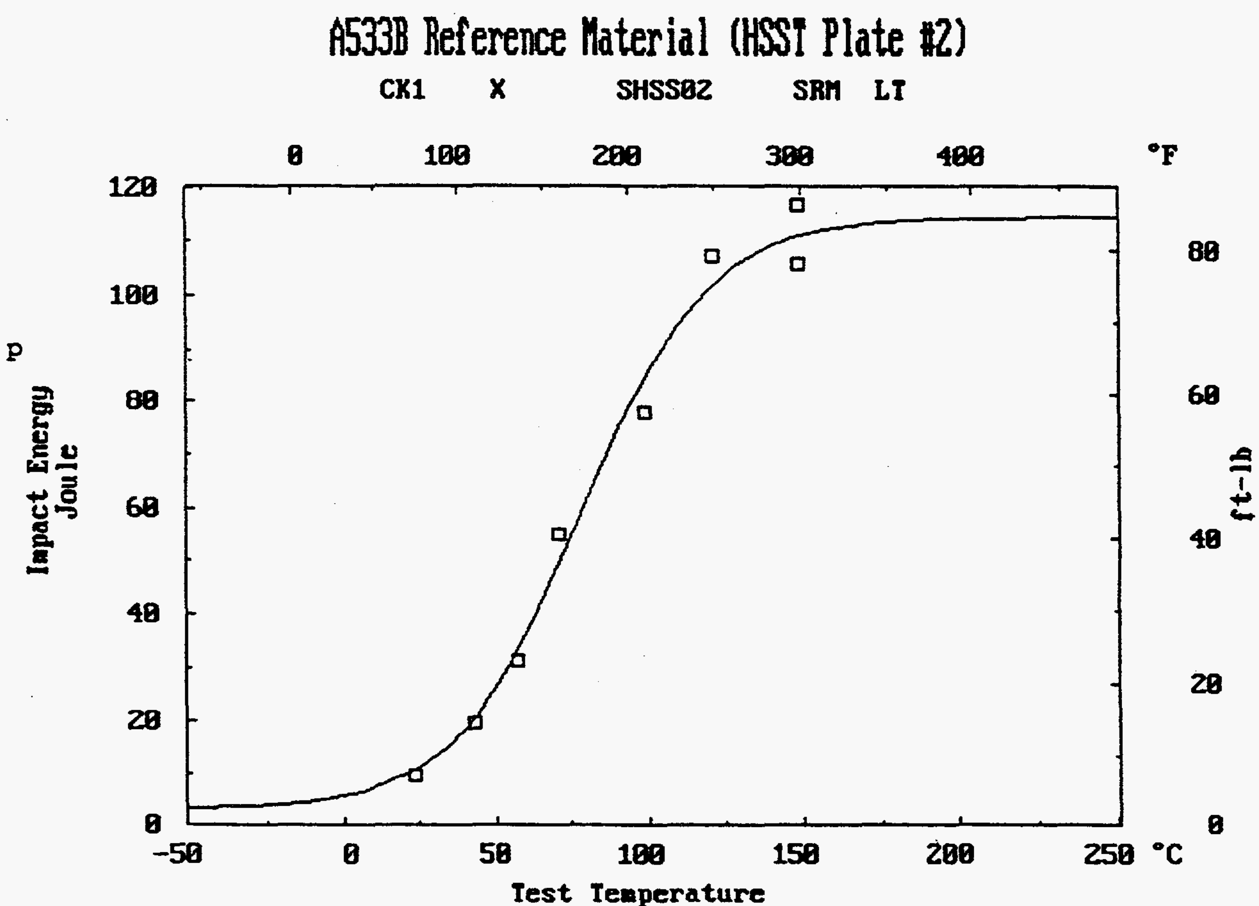
| Parameter | Mean | Std.Dev. | Correlation Coefficients | | | | |
|---|---|---|---|---|---|---|---|
| Lower Shelf Energy (J) | 3.1 | 0.1 | | | | | |
| Upper Shelf Energy (J) | 153.6 | 12.7 | -0.249 | | | | |
| CVT at Midpoint (C) | 105.5 | 5.1 | -0.109 | 0.771 | | | |
| 1/slope (C) | 36.5 | 9.5 | -0.418 | 0.721 | 0.493 | | |
| CVT at 41 Joule (C) | 85.3 | 5.5 | 0.381 | -0.381 | 0.125 | -0.780 | |
| CVT at 68 Joule (C) | 100.1 | 3.4 | 0.192 | -0.001 | 0.600 | -0.275 | 0.811 |



A533B HSST02 REFERENCE MATERIAL
Donald C. Cook Unit 1, Capsule X

USE= 114.5 J, LSE= 3.0 J, CVT(1/2)= 78.C , Slope = 0.0242
CVT(41J) = 64. C , CVT(68J) = 85. C ,
Fluence = 6.900E+18 , Irr. Temp. = 304 C

| Spec. ID | Test Temp. C | Test Temp. F | Impact Energy J | Impact Energy ft-lb | Lat. Exp. mm | Lat. Exp. mil | % Shear |
|---|---|---|---|---|---|---|---|
| R25 | 24. | 75. | 9. | 7. | 0.15 | 6. | |
| R26 | 43. | 110. | 20. | 14. | 0.38 | 15. | |
| R32 | 57. | 135. | 31. | 23. | 0.58 | 23. | |
| R27 | 71. | 160. | 55. | 40. | 0.89 | 35. | |
| R28 | 99. | 210. | 78. | 57. | 1.35 | 53. | |
| R29 | 121. | 250. | 107. | 79. | 1.78 | 70. | |
| R30 | 149. | 300. | 117. | 86. | 1.85 | 73. | |
| R31 | 149. | 300. | 106. | 78. | 1.78 | 70. | |



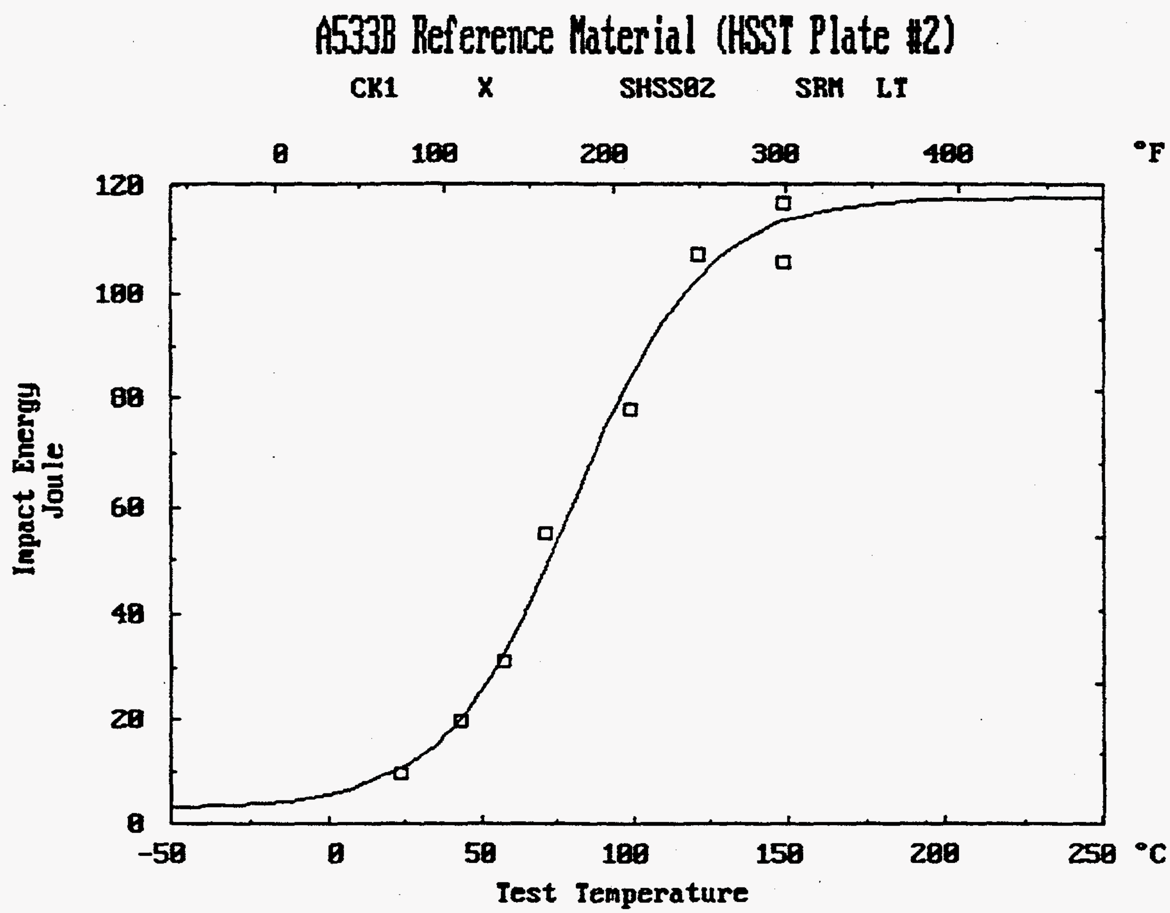
A533B HSST02 REFERENCE MATERIAL

Donald C. Cook Unit 1, Capsule X

Impact Energy Uncertainty = 10.0 J
Test Temperature Uncertainty = 4.0 Degree C
Number of Successful Iterations = 200, Maximum = 1000

CK1 X SHSS02 SRM LT : Fluence = 6.900E+18 , Irr. Temp. = 304

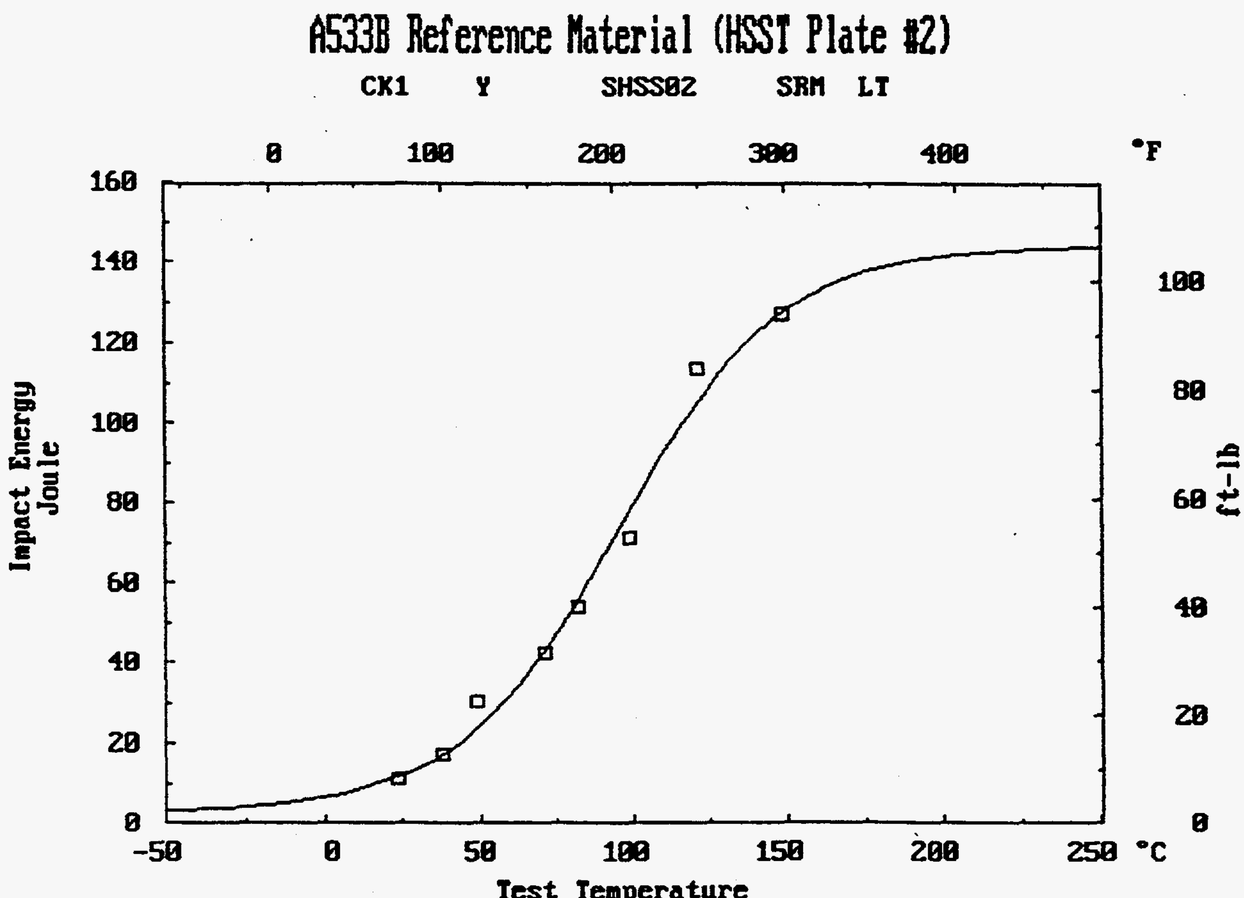
| Parameter | Mean | Std.Dev. | Correlation Coefficients | | | | |
|---|---|---|---|---|---|---|---|
| Lower Shelf Energy (J) | 3.0 | 0.0 | | | | | |
| Upper Shelf Energy (J) | 117.8 | 11.7 | -0.054 | | | | |
| CVT at Midpoint (C) | 80.2 | 9.2 | 0.001 | 0.851 | | | |
| 1/slope (C) | 42.4 | 10.9 | -0.028 | 0.727 | 0.669 | | |
| CVT at 41 Joule (C) | 64.9 | 5.3 | 0.045 | 0.262 | 0.659 | -0.055 | |
| CVT at 68 Joule (C) | 85.5 | 6.2 | 0.029 | 0.564 | 0.897 | 0.608 | 0.737 |



A533B HSST02 REFERENCE MATERIAL
Donald C. Cook Unit 1, Capsule Y

USE= 144.2 J, LSE= 3.0 J, CVT(1/2)= 95.C , Slope = 0.0190
CVT(41J) = 69. C , CVT(68J) = 91. C ,
Fluence = 1.060E+19 , Irr. Temp. = 304 C

| Spec. ID | Test Temp. C | Test Temp. F | Impact Energy J | Impact Energy ft-lb | Lat. Exp. mm | Lat. Exp. mil | % Shear |
|---|---|---|---|---|---|---|---|
| R50 | 24. | 75. | 12. | 8. | 0.18 | 7. | 2. |
| R55 | 38. | 100. | 18. | 13. | 0.33 | 13. | 5. |
| R52 | 49. | 120. | 31. | 22. | 0.53 | 21. | 10. |
| R49 | 71. | 160. | 43. | 32. | 0.76 | 30. | 15. |
| R51 | 82. | 180. | 54. | 40. | 0.97 | 38. | 25. |
| R54 | 99. | 210. | 71. | 52. | 1.19 | 47. | 60. |
| R53 | 121. | 250. | 114. | 84. | 1.80 | 71. | 100. |
| R56 | 149. | 300. | 127. | 94. | 2.06 | 81. | 100. |



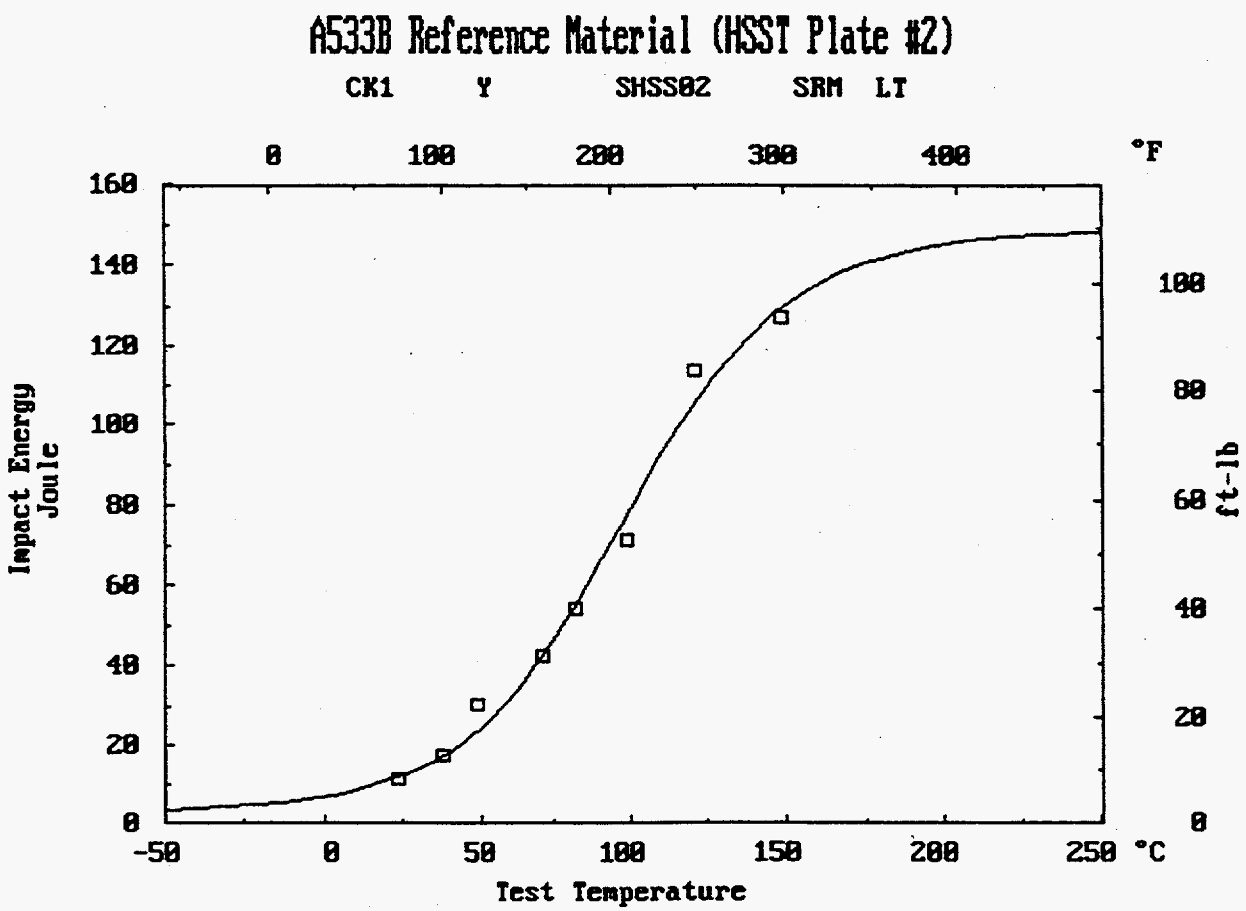
A533B HSST02 REFERENCE MATERIAL

Donald C. Cook Unit 1, Capsule Y

```
Impact Energy Uncertainty =  10.0 J
Test Temperature Uncertainty =   4.0 Degree C
Number of Successful Iterations =  200, Maximum = 1000
```

```
CK1    Y     SHSS02     SRM  LT : Fluence = 1.060E+19 , Irr. Temp. =  304
```

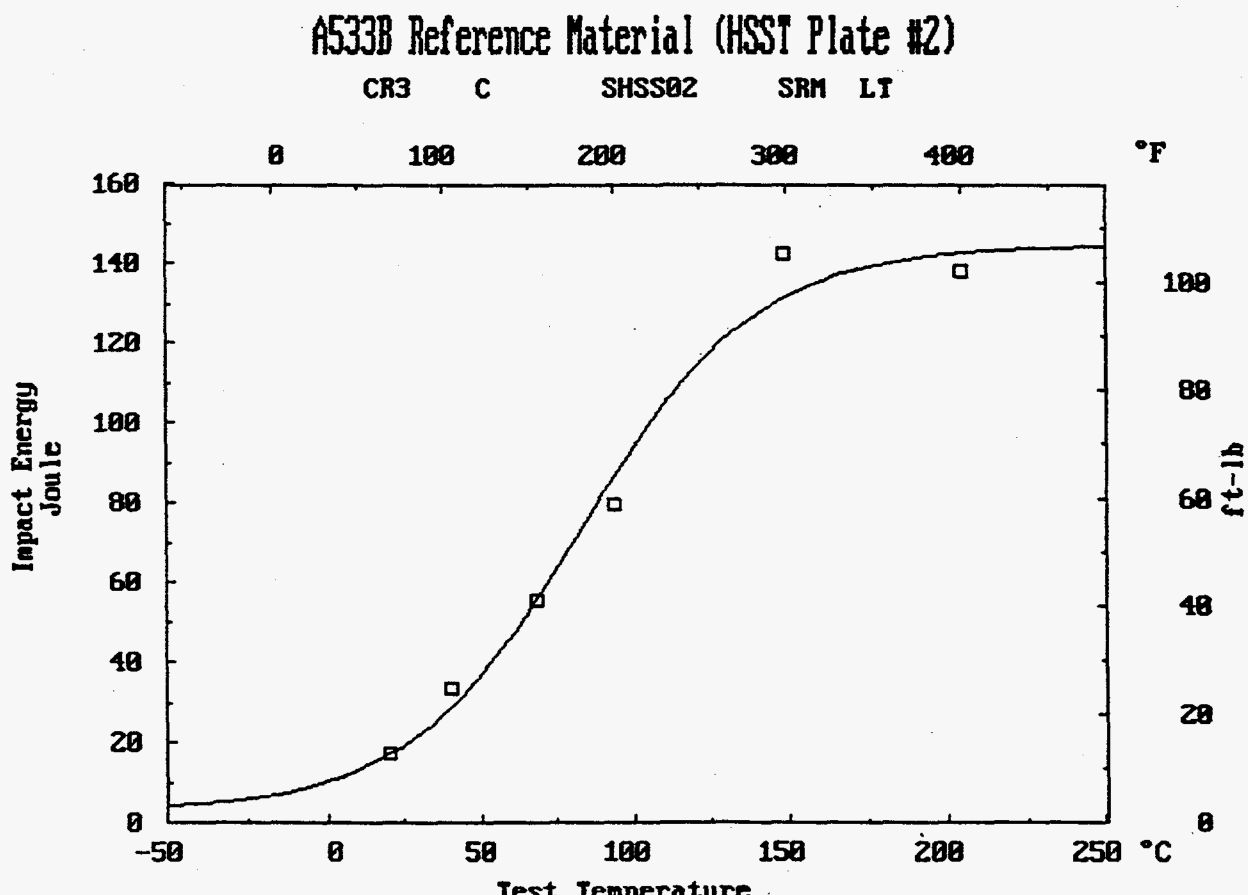
| Parameter | Mean | Std.Dev. | Correlation Coefficients | | | | |
|---|---|---|---|---|---|---|---|
| Lower Shelf Energy (J) | 3.0 | 0.0 | | | | | |
| Upper Shelf Energy (J) | 148.5 | 24.1 | -0.134 | | | | |
| CVT at Midpoint (C) | 97.5 | 11.8 | -0.095 | 0.918 | | | |
| 1/slope (C) | 53.6 | 13.3 | -0.273 | 0.778 | 0.754 | | |
| CVT at 41 Joule (C) | 69.1 | 5.9 | 0.261 | -0.148 | 0.123 | -0.501 | |
| CVT at 68 Joule (C) | 91.4 | 4.8 | 0.064 | 0.300 | 0.635 | 0.214 | 0.711 |



A533B HSST02 REFERENCE MATERIAL
Crystal River Unit 3, Capsule C

USE= 144.8 J, LSE= 3.0 J, CVT(1/2)= 83.C , Slope = 0.0175
CVT(41J) = 55. C , CVT(68J) = 78. C ,
Fluence = 6.560E+18 , Irr. Temp. = 303 C

| Spec. ID | Test Temp. C | Test Temp. F | Impact Energy J | Impact Energy ft-lb | Lat. Exp. mm | Lat. Exp. mil | % Shear |
|---|---|---|---|---|---|---|---|
| NN918 | 21. | 69. | 18. | 13. | 0.33 | 13. | 5. |
| NN903 | 41. | 105. | 34. | 25. | 0.51 | 20. | 20. |
| NN901 | 68. | 155. | 56. | 41. | 0.84 | 33. | 35. |
| NN911 | 93. | 200. | 80. | 59. | 1.22 | 48. | 60. |
| NN909 | 149. | 300. | 142. | 105. | 2.03 | 80. | 100. |
| NN912 | 204. | 400. | 138. | 102. | 1.90 | 75. | 100. |



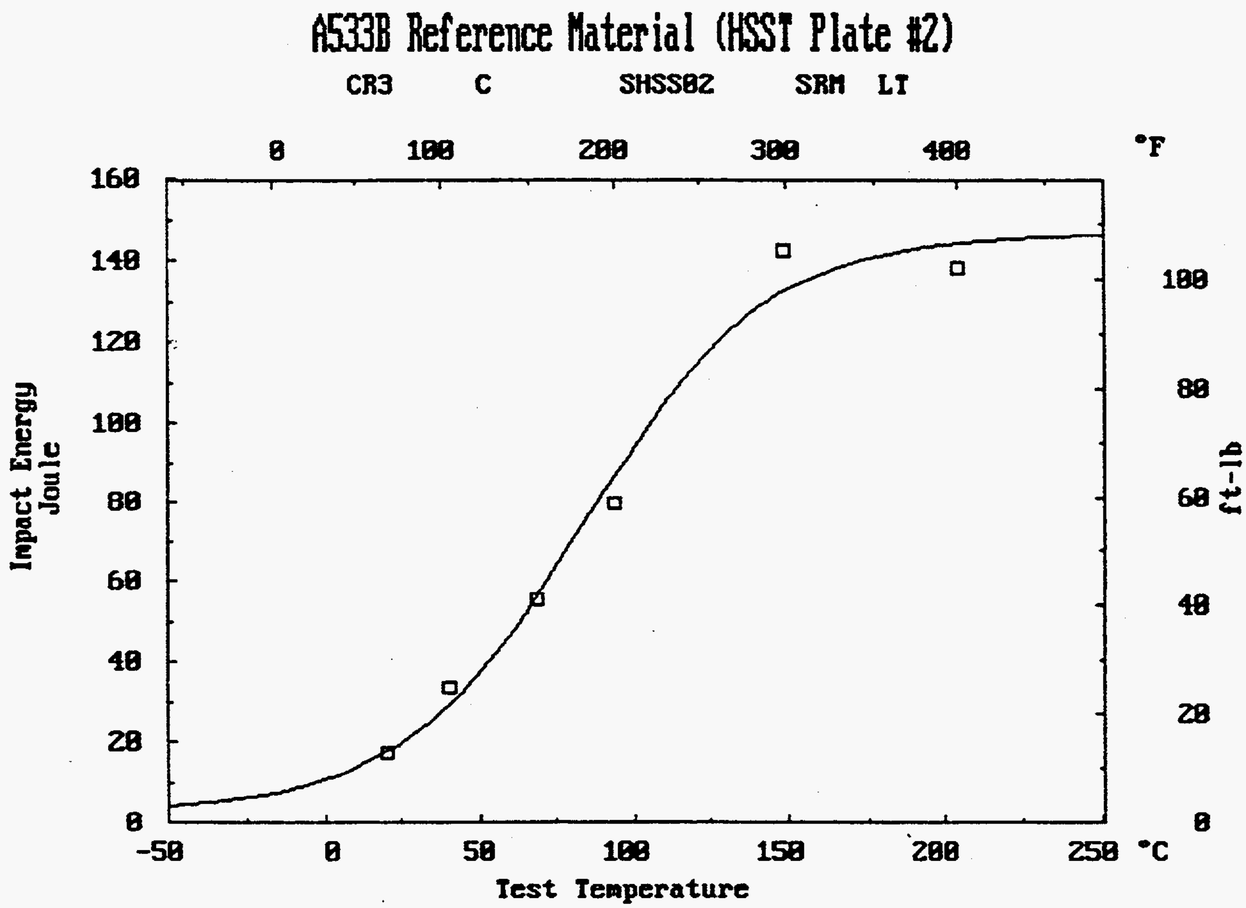
A533B HSST02 REFERENCE MATERIAL

Crystal River Unit 3, Capsule C

Impact Energy Uncertainty = 10.0 J
Test Temperature Uncertainty = 4.0 Degree C
Number of Successful Iterations = 200, Maximum = 1000

CR3 C SHSS02 SRM LT : Fluence = 6.560E+18 , Irr. Temp. = 303

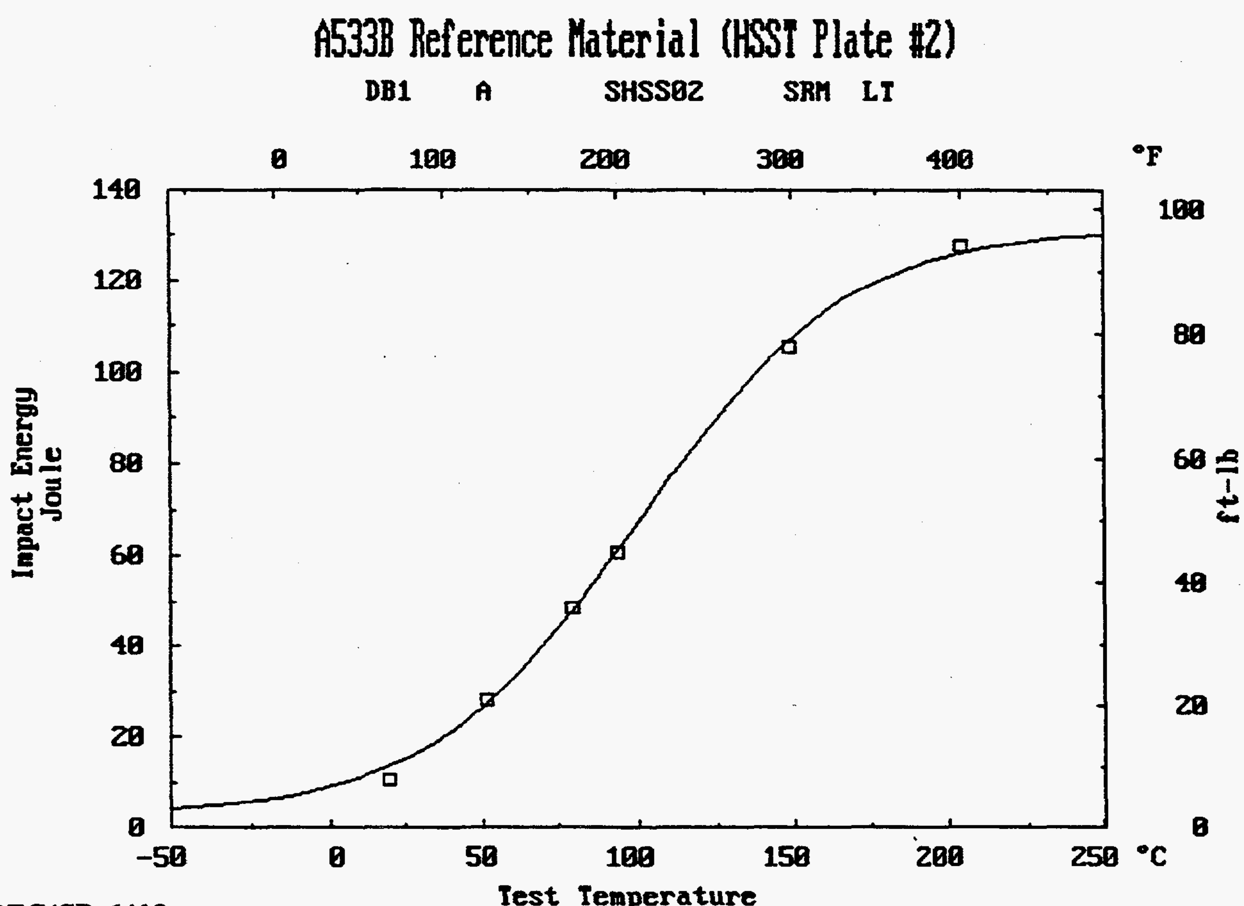
| Parameter | Mean | Std.Dev. | Correlation Coefficients | | | | |
|---|---|---|---|---|---|---|---|
| Lower Shelf Energy (J) | 3.0 | 0.0 | | | | | |
| Upper Shelf Energy (J) | 146.7 | 9.6 | 0.174 | | | | |
| CVT at Midpoint (C) | 83.8 | 8.3 | 0.235 | 0.713 | | | |
| 1/slope (C) | 58.3 | 11.5 | -0.129 | 0.409 | 0.340 | | |
| CVT at 41 Joule (C) | 53.9 | 7.6 | 0.299 | 0.073 | 0.536 | -0.574 | |
| CVT at 68 Joule (C) | 78.2 | 5.9 | 0.254 | 0.261 | 0.845 | 0.002 | 0.809 |



A533B HSST02 REFERENCE MATERIAL
Davis-Besse Unit 1, Capsule A

USE= 131.5 J, LSE= 3.0 J, CVT(1/2)= 100.C , Slope = 0.0150
CVT(41J) = 71. C , CVT(68J) = 101. C ,
Fluence = 1.290E+19 , Irr. Temp. = 303 C

| Spec. ID | Test Temp. C | Test Temp. F | Impact Energy J | Impact Energy ft-lb | Lat. Exp. mm | Lat. Exp. mil | % Shear |
|---|---|---|---|---|---|---|---|
| SS928 | 20. | 68. | 11. | 8. | 0.20 | 8. | 0. |
| SS905 | 52. | 125. | 28. | 21. | 0.46 | 18. | 20. |
| SS913 | 79. | 175. | 49. | 36. | 0.76 | 30. | 40. |
| SS930 | 93. | 200. | 61. | 45. | 1.02 | 40. | 50. |
| SS901 | 149. | 300. | 106. | 78. | 1.60 | 63. | 70. |
| SS921 | 204. | 400. | 127. | 94. | 1.85 | 73. | 100. |



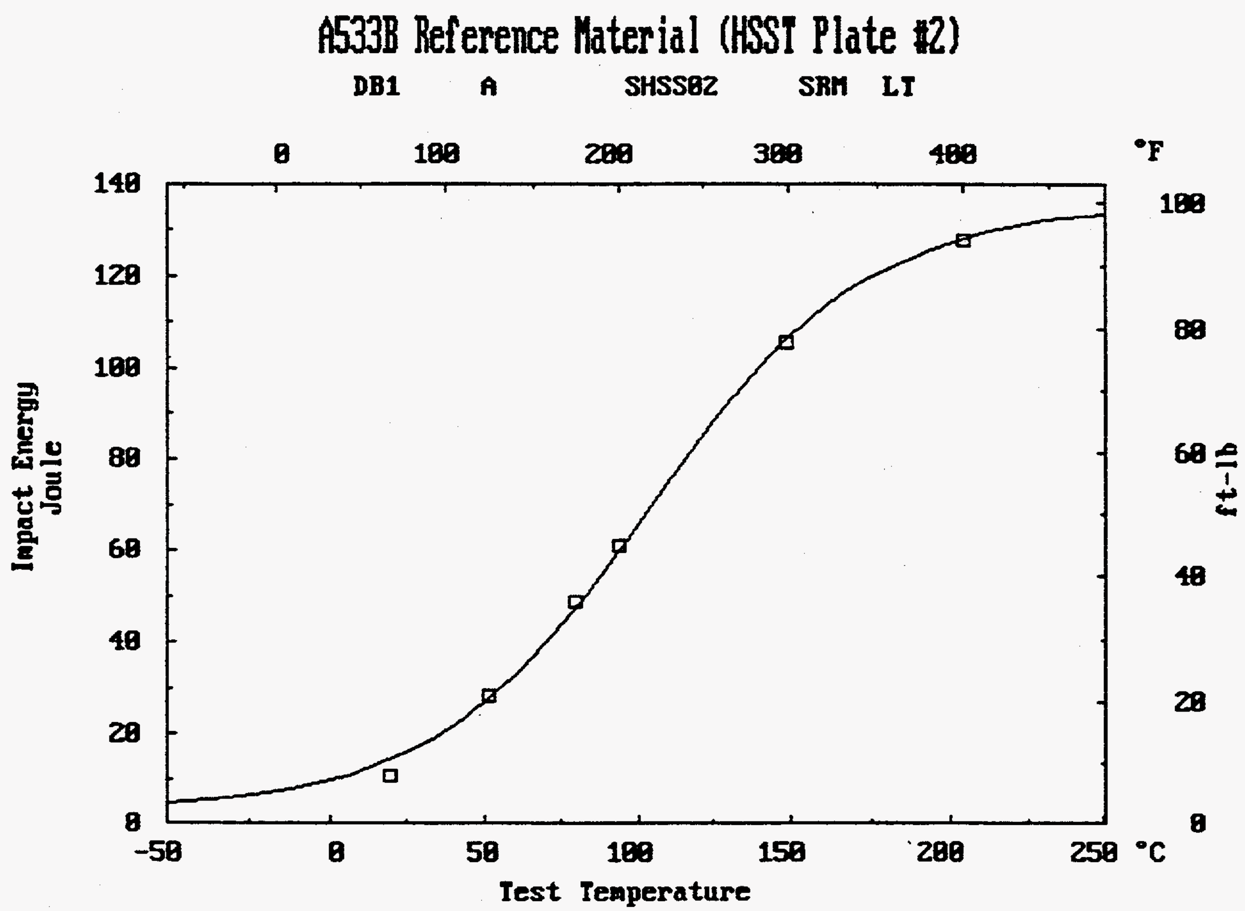
A533B HSST02 REFERENCE MATERIAL

Davis-Besse Unit 1, Capsule A

Impact Energy Uncertainty = 10.0 J
Test Temperature Uncertainty = 4.0 Degree C
Number of Successful Iterations = 200, Maximum = 1000

DB1 A SHSS02 SRM LT : Fluence = 1.290E+19 , Irr. Temp. = 303

| Parameter | Mean | Std.Dev. | Correlation Coefficients | | | | |
|---|---|---|---|---|---|---|---|
| Lower Shelf Energy (J) | 3.0 | 0.0 | | | | | |
| Upper Shelf Energy (J) | 135.4 | 14.3 | -0.036 | | | | |
| CVT at Midpoint (C) | 103.9 | 13.4 | -0.013 | 0.837 | | | |
| 1/slope (C) | 70.8 | 17.4 | -0.055 | 0.589 | 0.662 | | |
| CVT at 41 Joule (C) | 71.3 | 7.7 | 0.035 | 0.107 | 0.440 | -0.297 | |
| CVT at 68 Joule (C) | 102.3 | 8.1 | -0.014 | 0.386 | 0.817 | 0.508 | 0.644 |



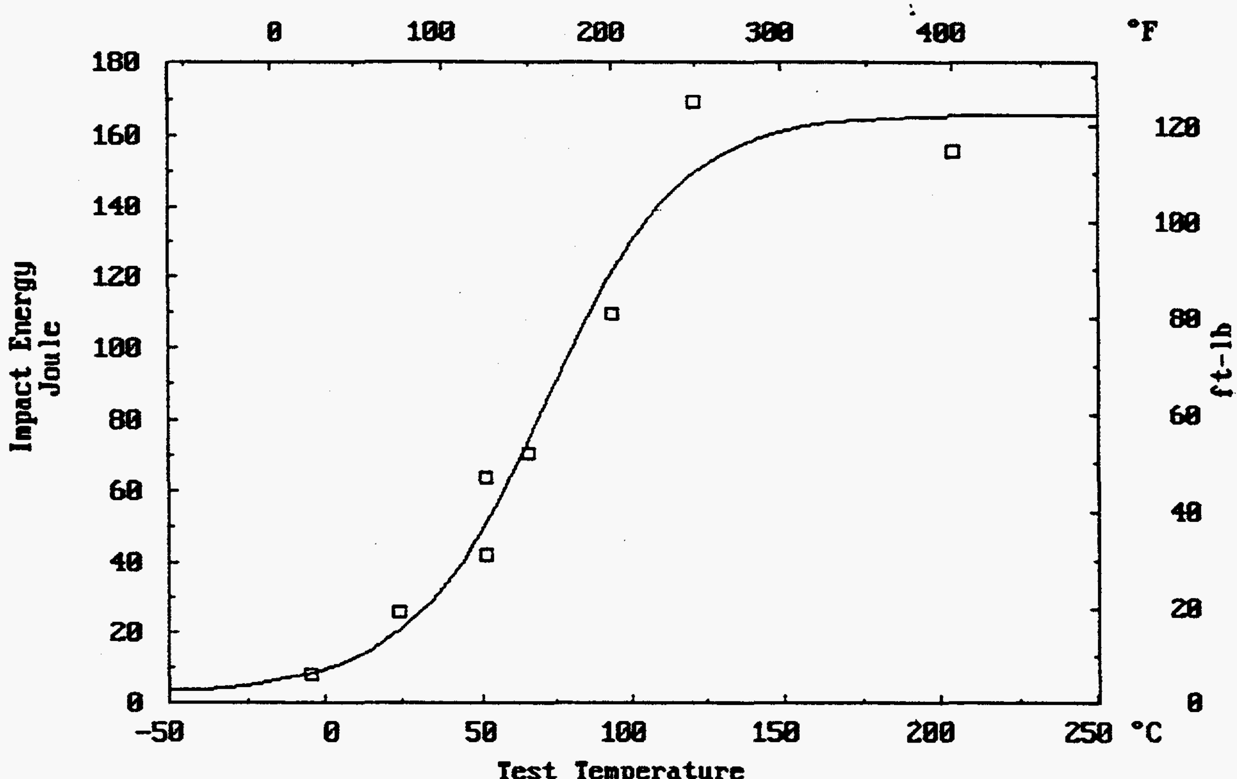
A533B HSST02 REFERENCE MATERIAL
Diablo Canyon Unit 1, Capsule S

USE= 165.9 J, LSE= 3.0 J, CVT(1/2)= 71.C , Slope = 0.0222
CVT(41J) = 45. C , CVT(68J) = 62. C ,
Fluence = 2.980E+18 , Irr. Temp. = 304 C

| Spec. ID | Test Temp. C | Test Temp. F | Impact Energy J | Impact Energy ft-lb | Lat. Exp. mm | Lat. Exp. mil | % Shear |
|---|---|---|---|---|---|---|---|
| R43 | -4. | 25. | 8. | 6. | 0.18 | 7. | 1. |
| R42 | 24. | 76. | 26. | 19. | 0.51 | 20. | 10. |
| R45 | 52. | 125. | 42. | 31. | 0.76 | 30. | 30. |
| R46 | 52. | 125. | 64. | 47. | 1.09 | 43. | 45. |
| R44 | 66. | 150. | 70. | 52. | 1.14 | 45. | 45. |
| R48 | 93. | 200. | 110. | 81. | 1.52 | 60. | 60. |
| R47 | 121. | 250. | 169. | 125. | 2.13 | 84. | 100. |
| R41 | 204. | 400. | 156. | 115. | 2.11 | 83. | 100. |

A533B Reference Material (HSST Plate #2)

DC1 S SHSS02 SRM LT



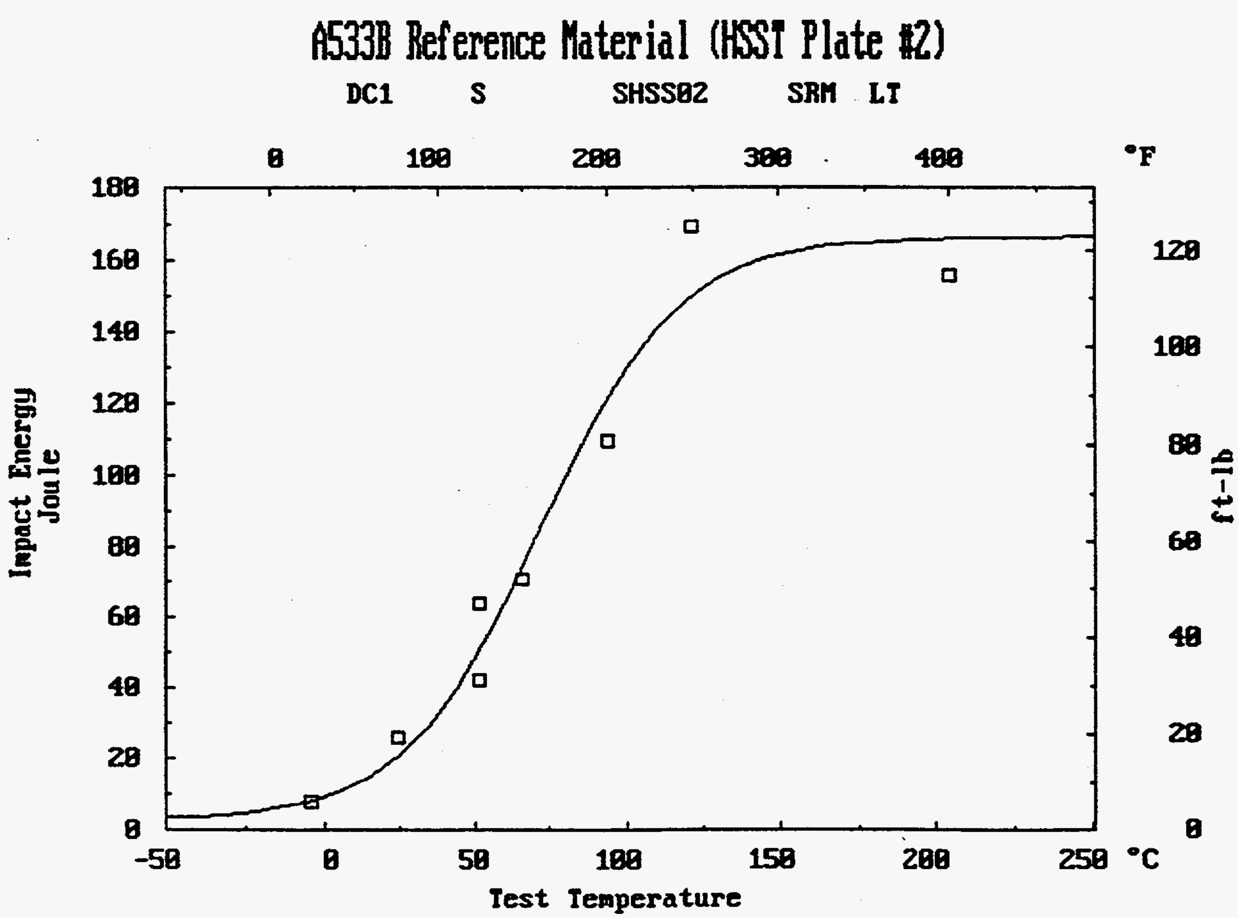
A533B HSST02 REFERENCE MATERIAL

Diablo Canyon Unit 1, Capsule S

```
Impact Energy Uncertainty =  10.0 J
Test Temperature Uncertainty =   4.0 Degree C
Number of Successful Iterations =  200, Maximum = 1000
```

DC1 S SHSS02 SRM LT : Fluence = 2.980E+18 , Irr. Temp. = 304

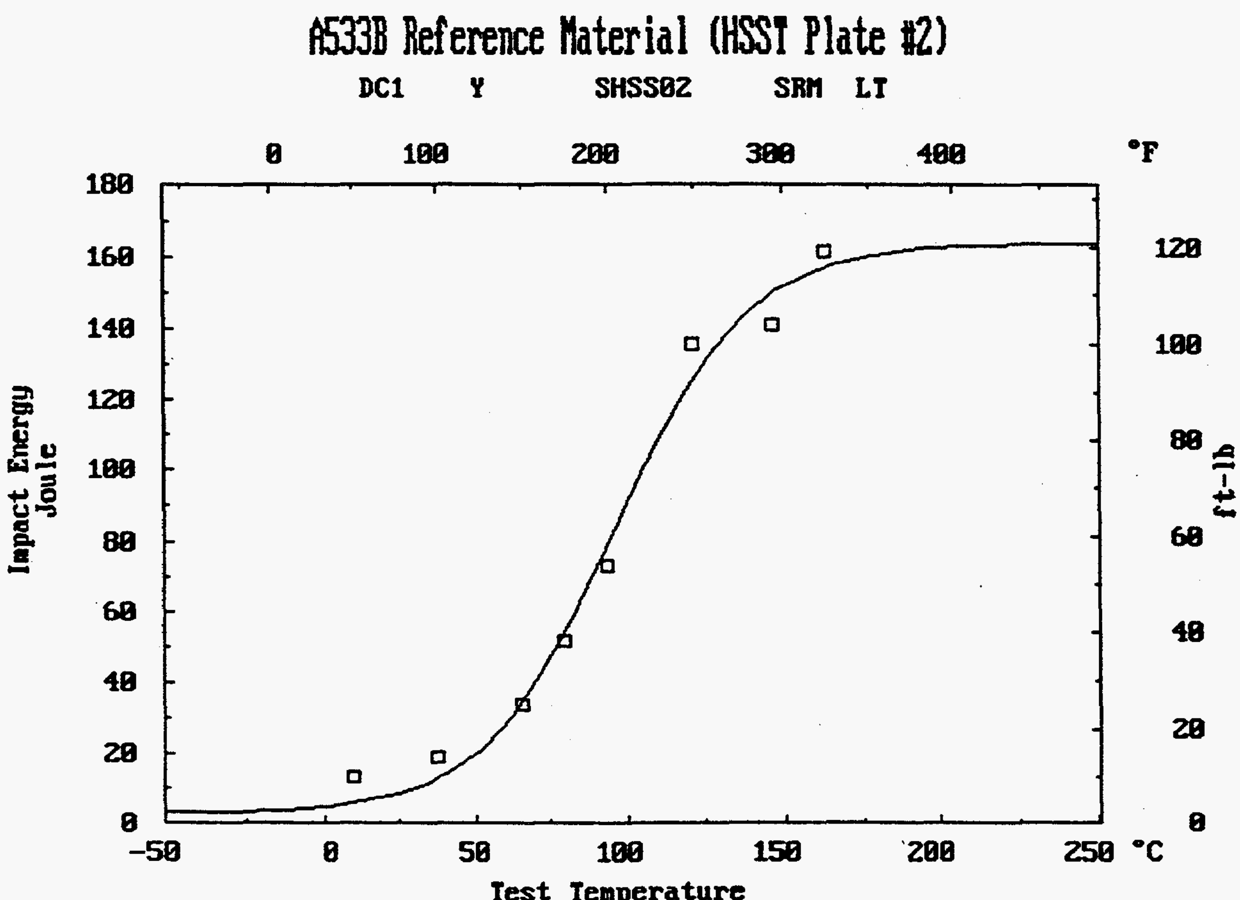
| Parameter | Mean | Std.Dev. | Correlation Coefficients | | | | |
|---|---|---|---|---|---|---|---|
| Lower Shelf Energy (J) | 3.0 | 0.1 | | | | | |
| Upper Shelf Energy (J) | 166.5 | 8.4 | 0.126 | | | | |
| CVT at Midpoint (C) | 71.8 | 4.6 | 0.308 | 0.666 | | | |
| 1/slope (C) | 45.0 | 6.8 | -0.198 | 0.252 | 0.212 | | |
| CVT at 41 Joule (C) | 44.9 | 5.1 | 0.396 | 0.102 | 0.536 | -0.682 | |
| CVT at 68 Joule (C) | 62.5 | 3.7 | 0.390 | 0.208 | 0.814 | -0.247 | 0.873 |



A533B HSST02 REFERENCE MATERIAL
Diablo Canyon Unit 1, Capsule Y

USE= 163.9 J, LSE= 3.1 J, CVT(1/2)= 96.C , Slope = 0.0234
CVT(41J) = 71. C , CVT(68J) = 88. C ,
Fluence = 1.020E+19 , Irr. Temp. = 288 C

| Spec. ID | Test Temp. C | Test Temp. F | Impact Energy J | Impact Energy ft-lb | Lat. Exp. mm | Lat. Exp. mil | % Shear |
|---|---|---|---|---|---|---|---|
| R60 | 10. | 50. | 14. | 10. | 0.25 | 10. | 10. |
| R62 | 38. | 100. | 19. | 14. | 0.36 | 14. | 15. |
| R61 | 66. | 150. | 34. | 25. | 0.58 | 23. | 25. |
| R57 | 79. | 175. | 52. | 38. | 0.81 | 32. | 40. |
| R59 | 93. | 200. | 73. | 54. | 1.07 | 42. | 50. |
| R64 | 121. | 250. | 136. | 100. | 1.85 | 73. | 96. |
| R58 | 146. | 295. | 141. | 104. | 2.11 | 83. | 100. |
| R63 | 163. | 325. | 161. | 119. | 2.29 | 90. | 100. |



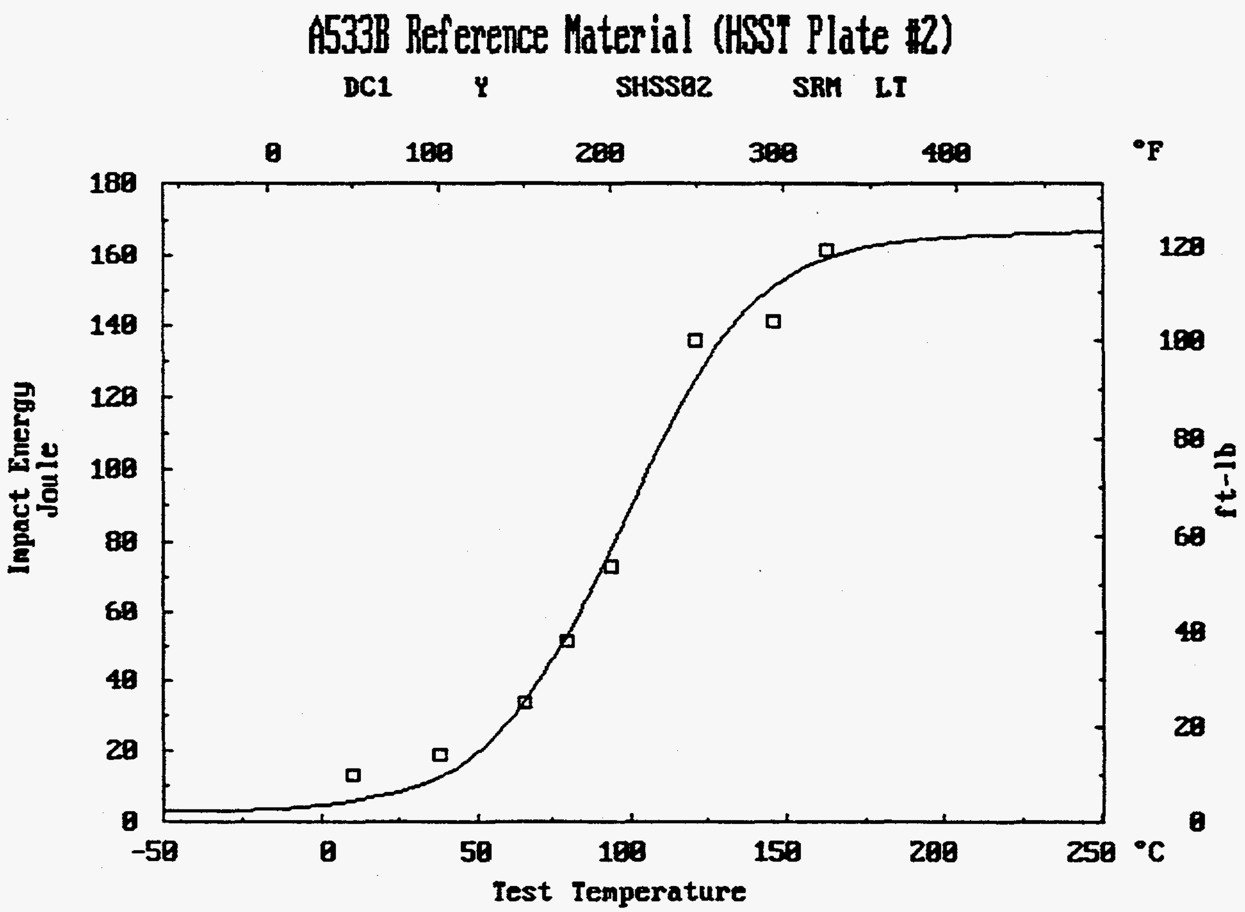
A533B HSST02 REFERENCE MATERIAL

Diablo Canyon Unit 1, Capsule Y

Impact Energy Uncertainty = 10.0 J
Test Temperature Uncertainty = 4.0 Degree C
Number of Successful Iterations = 200, Maximum = 1000

DC1 Y SHSS02 SRM LT : Fluence = 1.020E+19 , Irr. Temp. = 288

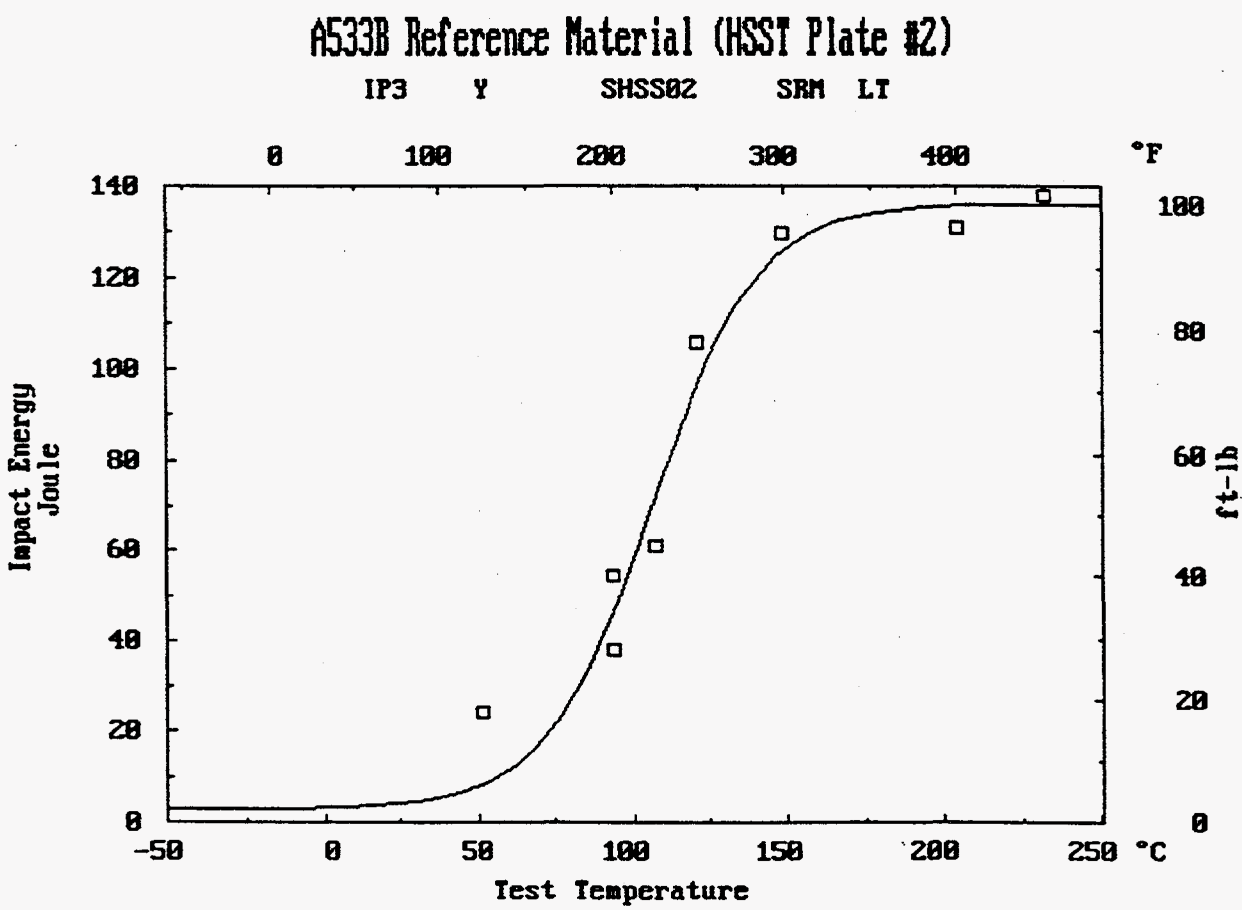
| Parameter | Mean | Std.Dev. | Correlation Coefficients | | | | |
|---|---|---|---|---|---|---|---|
| Lower Shelf Energy (J) | 3.1 | 0.1 | | | | | |
| Upper Shelf Energy (J) | 166.7 | 14.6 | -0.285 | | | | |
| CVT at Midpoint (C) | 97.4 | 6.6 | -0.136 | 0.836 | | | |
| 1/slope (C) | 43.2 | 11.1 | -0.439 | 0.736 | 0.630 | | |
| CVT at 41 Joule (C) | 71.2 | 6.0 | 0.452 | -0.353 | 0.012 | -0.748 | |
| CVT at 68 Joule (C) | 88.0 | 3.9 | 0.264 | 0.090 | 0.568 | -0.181 | 0.783 |



A533B HSST02 REFERENCE MATERIAL
Indian Point Unit 3, Capsule Y

USE= 135.9 J, LSE= 3.1 J, CVT(1/2)= 106.C , Slope = 0.0291
CVT(41J) = 90. C , CVT(68J) = 105. C ,
Fluence = 8.050E+18 , Irr. Temp. = 304 C

| Spec. ID | Test Temp. C | Test Temp. F | Impact Energy J | Impact Energy ft-lb | Lat. Exp. mm | Lat. Exp. mil | % Shear |
|---|---|---|---|---|---|---|---|
| R15 | 52. | 125. | 24. | 18. | 0.25 | 10. | 26. |
| R11 | 93. | 200. | 38. | 28. | 0.58 | 23. | 36. |
| R14 | 93. | 200. | 54. | 40. | 0.76 | 30. | 44. |
| R16 | 107. | 225. | 61. | 45. | 0.94 | 37. | 52. |
| R9 | 121. | 250. | 106. | 78. | 1.50 | 59. | 67. |
| R10 | 149. | 300. | 129. | 95. | 1.96 | 77. | 100. |
| R12 | 204. | 400. | 131. | 96. | 1.85 | 73. | 100. |
| R13 | 232. | 450. | 138. | 101. | 1.90 | 75. | 100. |



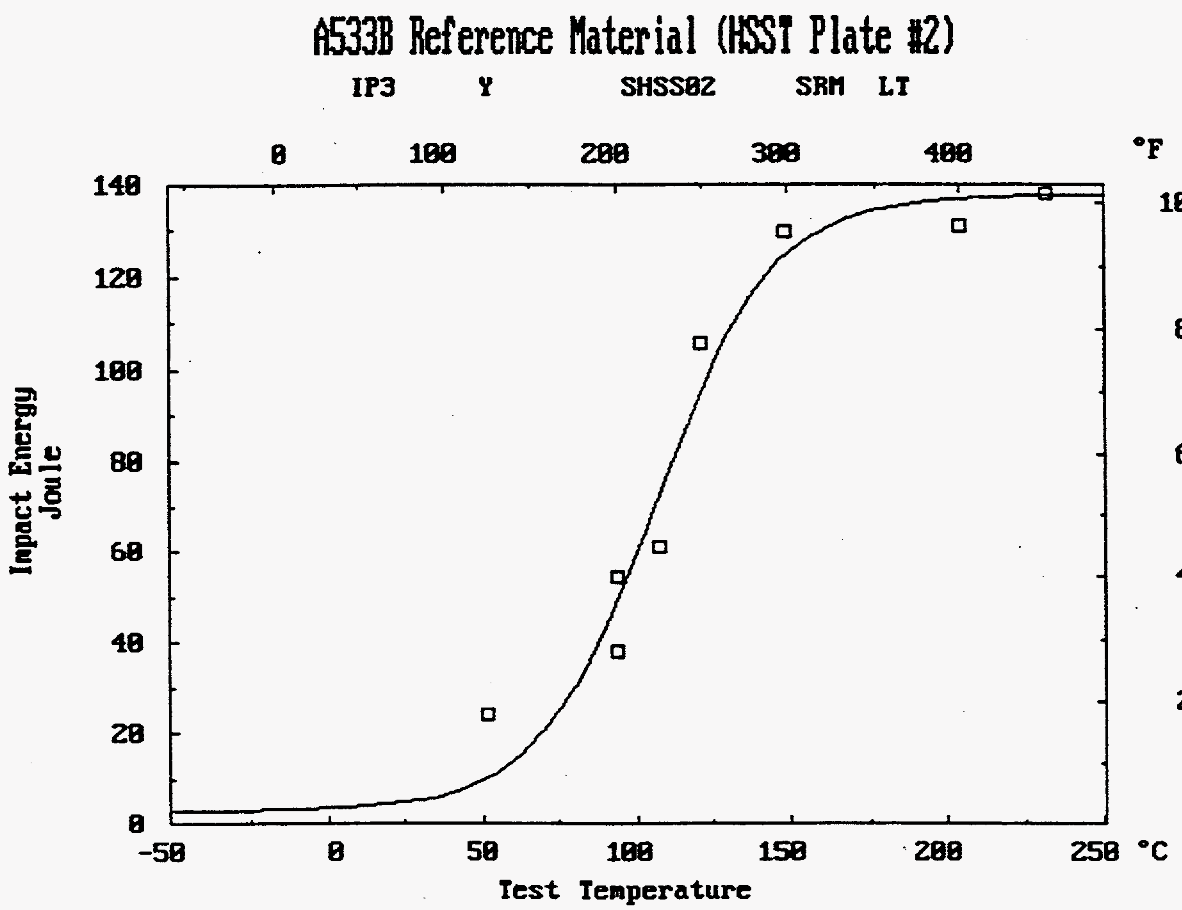
A533B HSST02 REFERENCE MATERIAL

Indian Point Unit 3, Capsule Y

Impact Energy Uncertainty = 10.0 J
Test Temperature Uncertainty = 4.0 Degree C
Number of Successful Iterations = 200, Maximum = 1000

IP3 Y SHSS02 SRM LT : Fluence = 8.050E+18 , Irr. Temp. = 304

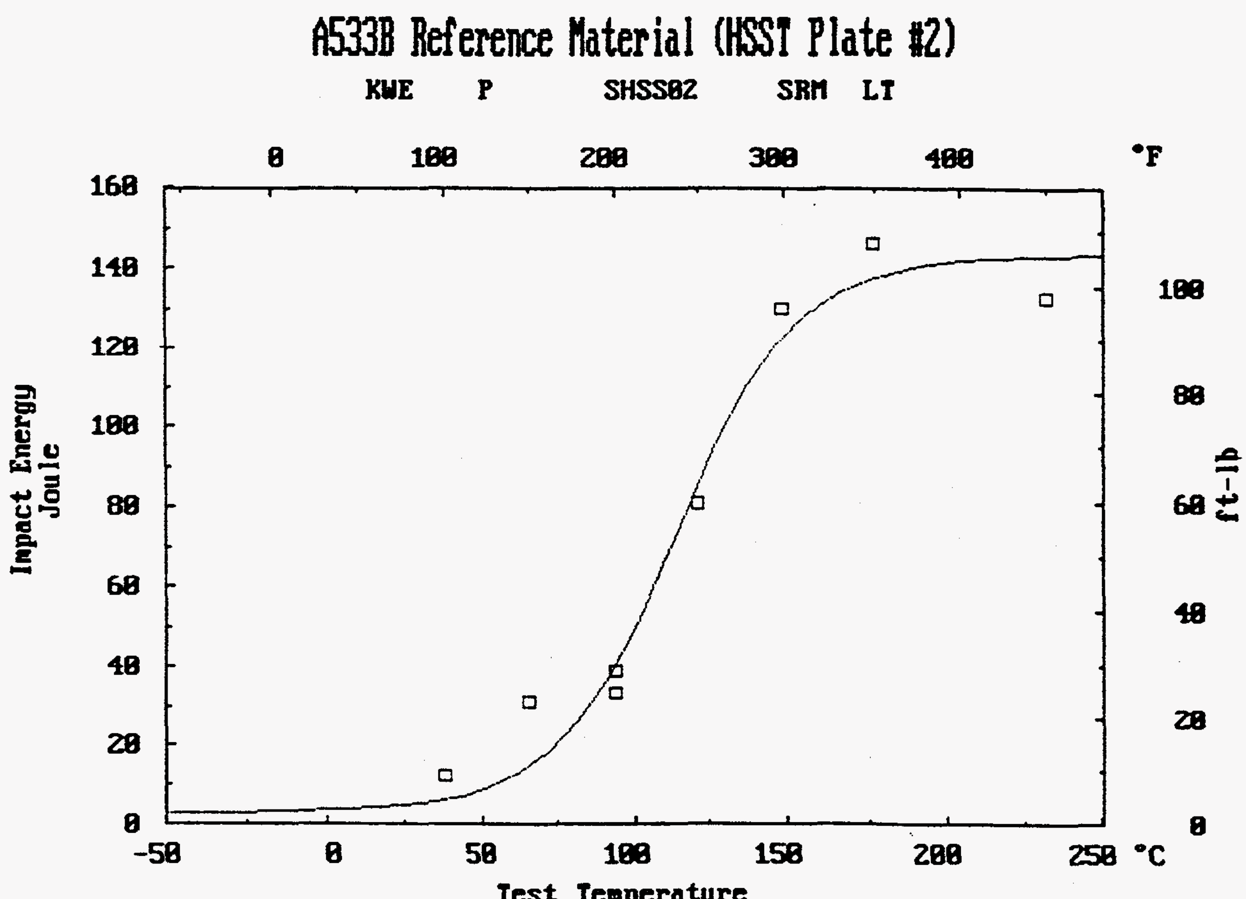
| Parameter | Mean | Std.Dev. | Correlation Coefficients | | | | |
|---|---|---|---|---|---|---|---|
| Lower Shelf Energy (J) | 3.1 | 0.0 | | | | | |
| Upper Shelf Energy (J) | 137.4 | 6.2 | -0.141 | | | | |
| CVT at Midpoint (C) | 106.1 | 3.9 | 0.074 | 0.424 | | | |
| 1/slope (C) | 37.8 | 11.2 | -0.495 | 0.463 | 0.174 | | |
| CVT at 41 Joule (C) | 88.3 | 6.3 | 0.485 | -0.332 | 0.373 | -0.833 | |
| CVT at 68 Joule (C) | 104.7 | 3.5 | 0.207 | -0.101 | 0.841 | -0.187 | 0.694 |



A533B HSST02 REFERENCE MATERIAL
Kewaunee, Capsule P

USE= 143.4 J, LSE= 3.1 J, CVT(1/2)= 114.C , Slope = 0.0251
CVT(41J) = 94. C , CVT(68J) = 111. C ,
Fluence = 2.890E+19 , Irr. Temp. = 304 C

| Spec. ID | Test Temp. C | Test Temp. F | Impact Energy J | Impact Energy ft-lb | Lat. Exp. mm | Lat. Exp. mil | % Shear |
|---|---|---|---|---|---|---|---|
| R41 | 38. | 100. | 12. | 9. | 0.23 | 9. | 10. |
| R45 | 66. | 150. | 31. | 23. | 0.53 | 21. | 20. |
| R42 | 93. | 200. | 34. | 25. | 0.61 | 24. | 25. |
| R46 | 93. | 200. | 39. | 29. | 0.61 | 24. | 30. |
| R47 | 121. | 250. | 81. | 60. | 1.22 | 48. | 65. |
| R44 | 149. | 300. | 130. | 96. | 2.01 | 79. | 100. |
| R48 | 177. | 350. | 146. | 108. | 2.08 | 82. | 100. |
| R43 | 232. | 450. | 133. | 98. | 2.26 | 89. | 100. |



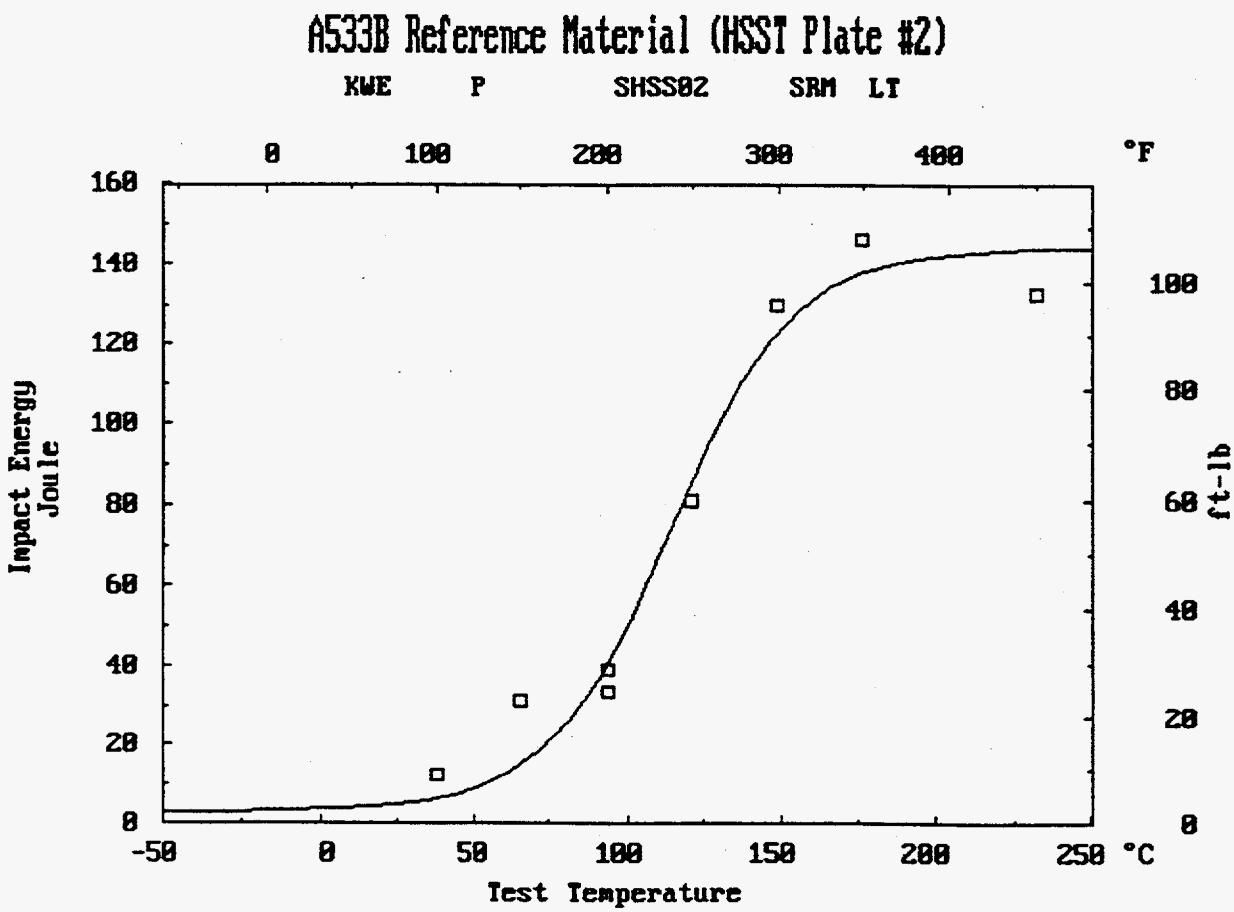
A533B HSST02 REFERENCE MATERIAL

Kewaunee, Capsule P

```
Impact Energy Uncertainty =  10.0 J
Test Temperature Uncertainty =   4.0 Degree C
Number of Successful Iterations =  200, Maximum = 1000
```

KWE P SHSS02 SRM LT : Fluence = 2.890E+19 , Irr. Temp. = 304

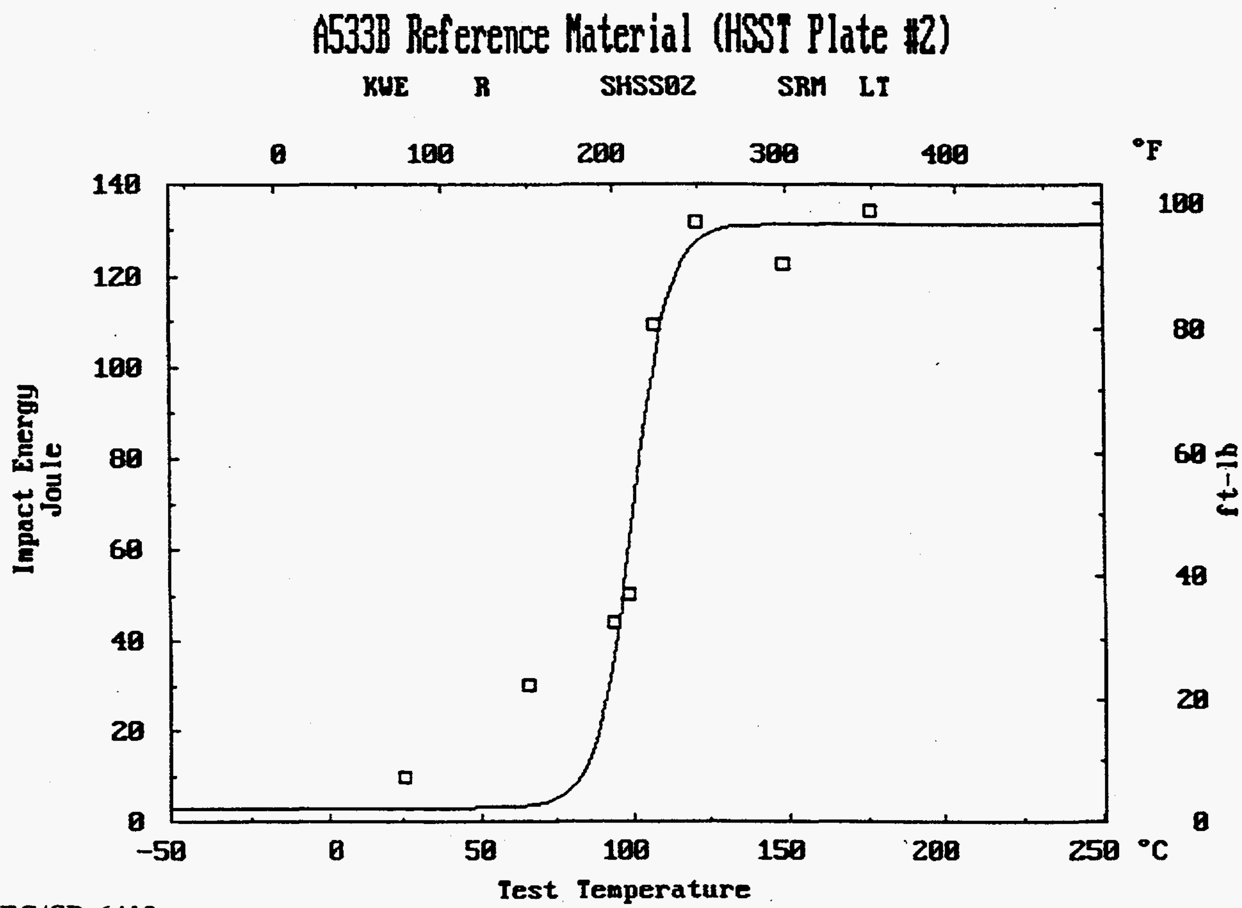
| Parameter | Mean | Std.Dev. | Correlation Coefficients | | | | |
|---|---|---|---|---|---|---|---|
| Lower Shelf Energy (J) | 3.1 | 0.1 | | | | | |
| Upper Shelf Energy (J) | 144.2 | 7.6 | -0.003 | | | | |
| CVT at Midpoint (C) | 113.9 | 5.3 | 0.142 | 0.501 | | | |
| 1/slope (C) | 40.1 | 8.8 | -0.475 | 0.372 | 0.220 | | |
| CVT at 41 Joule (C) | 93.8 | 6.0 | 0.470 | -0.075 | 0.593 | -0.630 | |
| CVT at 68 Joule (C) | 110.6 | 4.6 | 0.232 | 0.088 | 0.895 | -0.056 | 0.807 |



A533B HSST02 REFERENCE MATERIAL
Kewaunee, Capsule R

USE= 131.2 J, LSE= 3.2 J, CVT(1/2)= 100.C , Slope = 0.0837
CVT(41J) = 95. C , CVT(68J) = 100. C ,
Fluence = 2.070E+19 , Irr. Temp. = 304 C

| Spec. ID | Test Temp. C | Test Temp. F | Impact Energy J | Impact Energy ft-lb | Lat. Exp. mm | Lat. Exp. mil | % Shear |
|---|---|---|---|---|---|---|---|
| R13 | 26. | 78. | 10. | 8. | 0.13 | 5. | 14. |
| R12 | 66. | 150. | 31. | 22. | 0.48 | 19. | 25. |
| R9 | 93. | 200. | 44. | 32. | 0.76 | 30. | 27. |
| R10 | 99. | 210. | 50. | 37. | 0.76 | 30. | 35. |
| R16 | 107. | 225. | 109. | 80. | 1.40 | 55. | 70. |
| R15 | 121. | 250. | 132. | 97. | 1.75 | 69. | 69. |
| R11 | 149. | 300. | 123. | 90. | 1.90 | 75. | 100. |
| R14 | 177. | 350. | 134. | 99. | 2.36 | 93. | 100. |



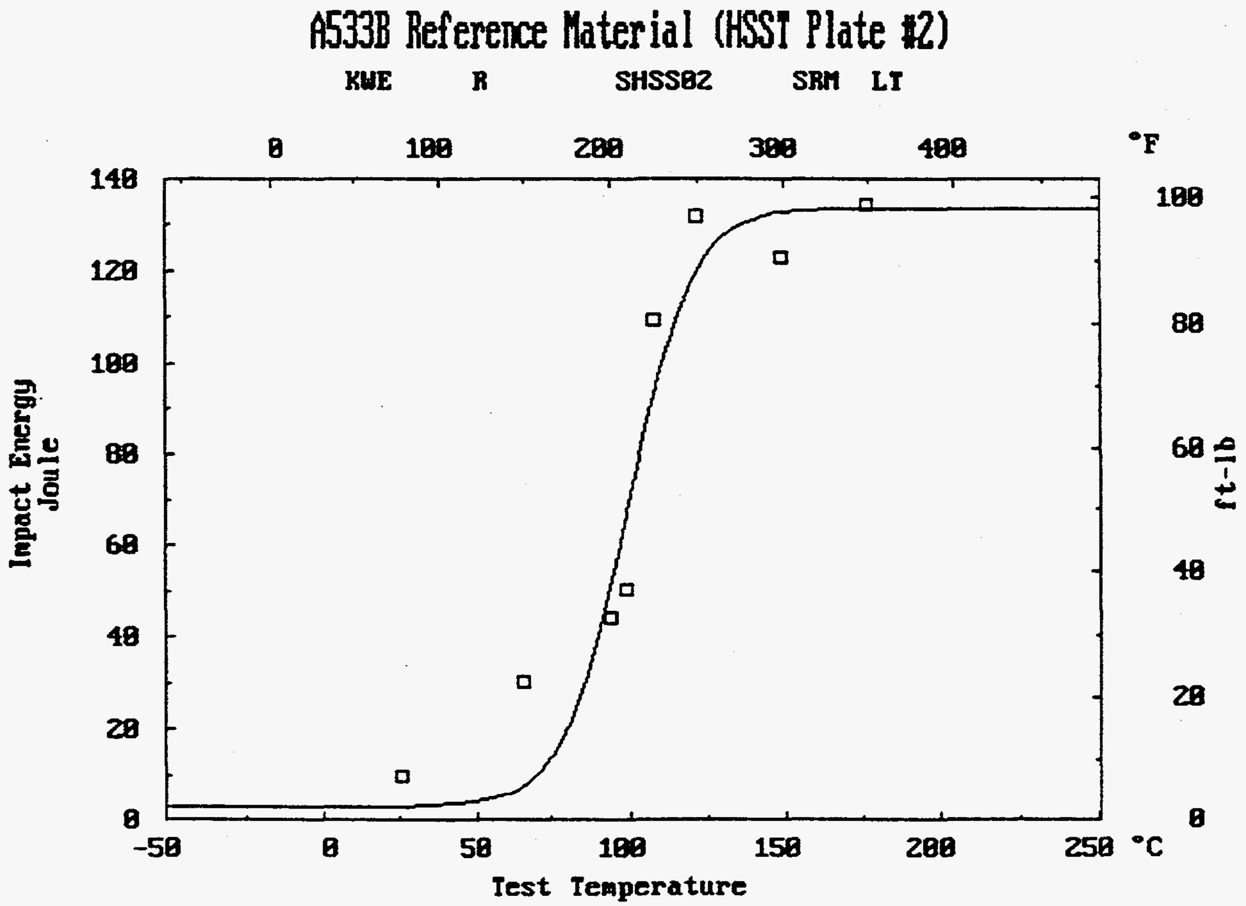
A533B HSST02 REFERENCE MATERIAL

Kewaunee, Capsule R

```
Impact Energy Uncertainty =  10.0 J
Test Temperature Uncertainty =   4.0 Degree C
Number of Successful Iterations =  200, Maximum = 1000
```

```
KWE    R     SHSS02     SRM  LT : Fluence = 2.070E+19 , Irr. Temp. =  304
```

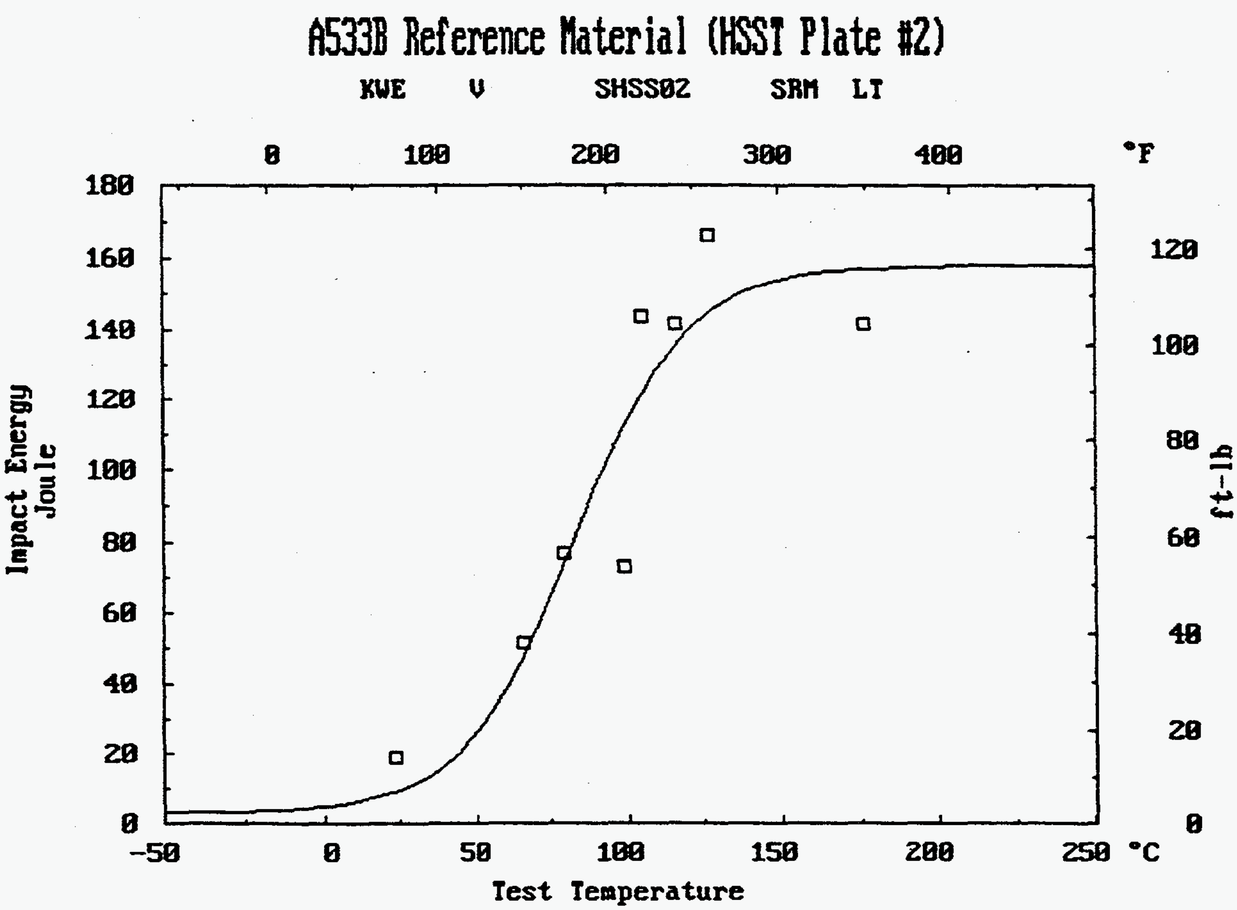
| Parameter | Mean | Std.Dev. | Correlation Coefficients | | | | |
|---|---|---|---|---|---|---|---|
| Lower Shelf Energy (J) | 3.2 | 0.1 | | | | | |
| Upper Shelf Energy (J) | 133.5 | 7.0 | -0.043 | | | | |
| CVT at Midpoint (C) | 99.2 | 3.5 | 0.245 | 0.321 | | | |
| 1/slope (C) | 20.1 | 7.8 | -0.534 | 0.326 | -0.319 | | |
| CVT at 41 Joule (C) | 90.1 | 5.7 | 0.480 | -0.142 | 0.752 | -0.854 | |
| CVT at 68 Joule (C) | 99.0 | 3.3 | 0.285 | -0.003 | 0.938 | -0.475 | 0.861 |



A533B HSST02 REFERENCE MATERIAL
Kewaunee, Capsule V

USE= 157.8 J, LSE= 3.1 J, CVT(1/2)= 83.C , Slope = 0.0272
CVT(41J) = 62. C , CVT(68J) = 77. C ,
Fluence = 5.590E+18 , Irr. Temp. = 304 C

| Spec. ID | Test Temp. C | Test Temp. F | Impact Energy J | Impact Energy ft-lb | Lat. Exp. mm | Lat. Exp. mil | % Shear |
|---|---|---|---|---|---|---|---|
| R2 | 24. | 75. | 19. | 14. | 0.30 | 12. | 10. |
| R7 | 66. | 150. | 52. | 38. | 0.66 | 26. | 30. |
| R8 | 79. | 175. | 77. | 56. | 1.12 | 44. | 40. |
| R1 | 99. | 210. | 73. | 54. | 1.07 | 42. | 50. |
| R3 | 104. | 220. | 144. | 106. | 1.80 | 71. | 100. |
| R6 | 116. | 240. | 142. | 105. | 1.83 | 72. | 100. |
| R4 | 127. | 260. | 166. | 122. | 1.98 | 78. | 100. |
| R5 | 177. | 350. | 142. | 105. | 1.96 | 77. | 100. |



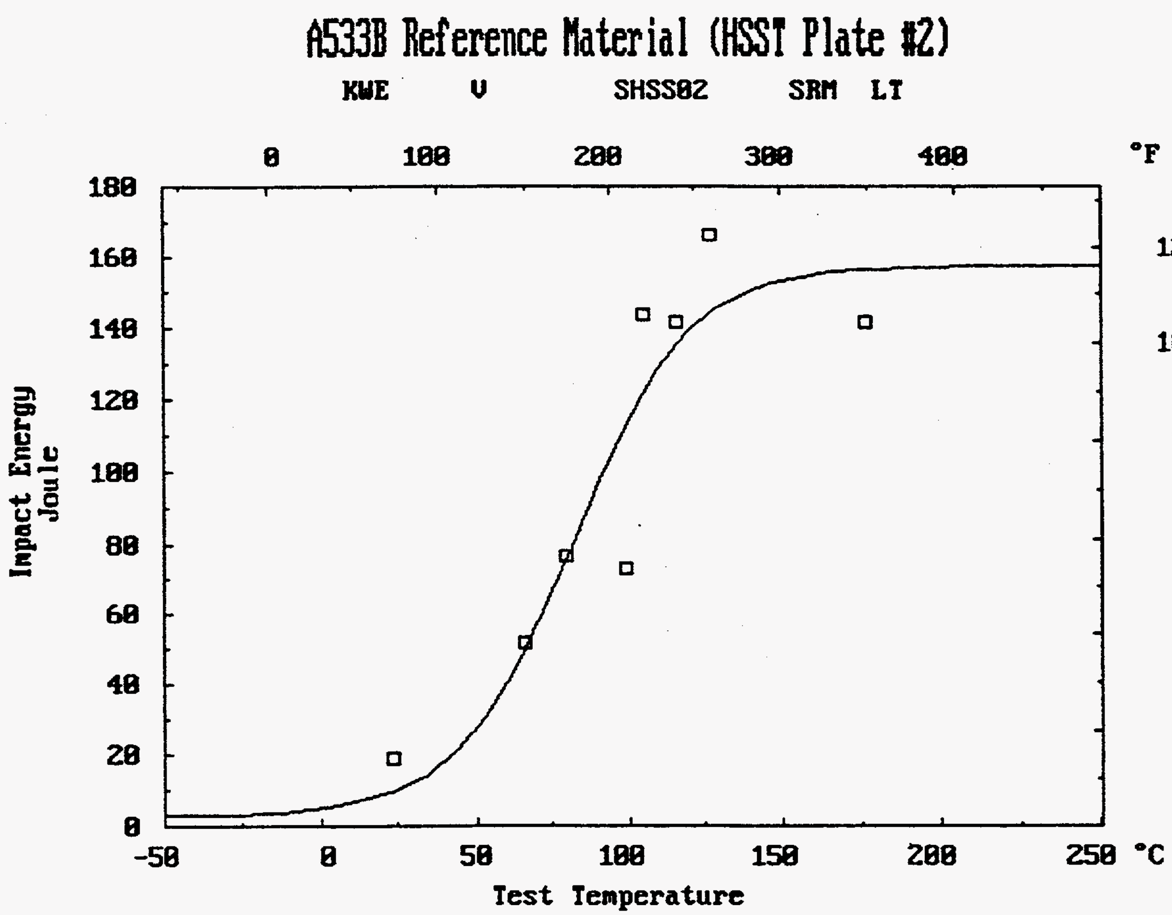
A533B HSST02 REFERENCE MATERIAL

Kewaunee, Capsule V

```
Impact Energy Uncertainty =  10.0 J
Test Temperature Uncertainty =   4.0 Degree C
Number of Successful Iterations =  200, Maximum = 1000
```

```
KWE   V     SHSS02    SRM  LT : Fluence = 5.590E+18 , Irr. Temp. =  304
```

| Parameter | Mean | Std.Dev. | Correlation Coefficients | | | | |
|---|---|---|---|---|---|---|---|
| Lower Shelf Energy (J) | 3.1 | 0.0 | | | | | |
| Upper Shelf Energy (J) | 157.2 | 7.6 | 0.027 | | | | |
| CVT at Midpoint (C) | 81.6 | 4.6 | 0.365 | 0.530 | | | |
| 1/slope (C) | 37.6 | 7.2 | -0.314 | 0.410 | -0.135 | | |
| CVT at 41 Joule (C) | 60.5 | 6.5 | 0.445 | -0.072 | 0.688 | -0.799 | |
| CVT at 68 Joule (C) | 75.6 | 4.5 | 0.440 | 0.073 | 0.862 | -0.551 | 0.940 |



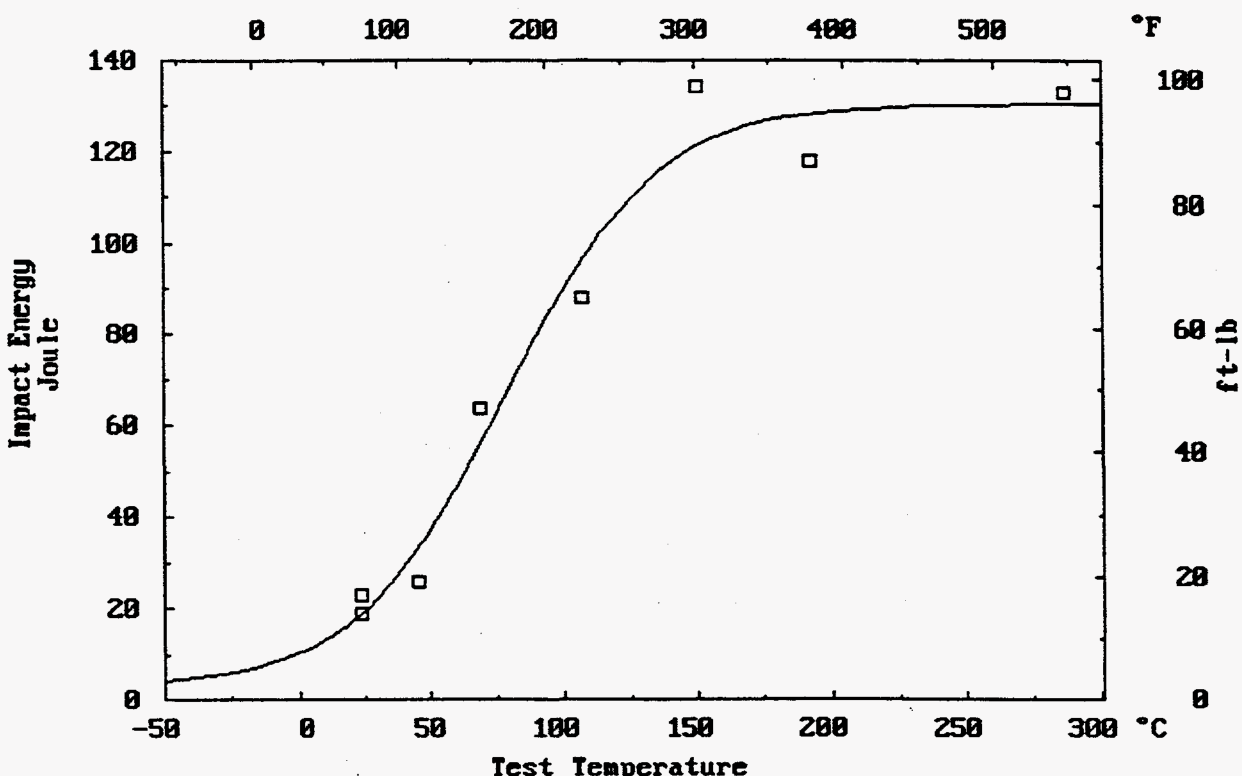
A533B HSST02 REFERENCE MATERIAL
Oconee Unit 1, Capsule A

USE= 130.4 J, LSE= 3.0 J, CVT(1/2)= 79.C , Slope = 0.0178
CVT(41J) = 54. C , CVT(68J) = 80. C ,
Fluence = 8.950E+18 , Irr. Temp. = 303 C

| Spec. ID | Test Temp. C | Test Temp. F | Impact Energy J | Impact Energy ft-lb | Lat. Exp. mm | Lat. Exp. mil | % Shear |
|---|---|---|---|---|---|---|---|
| AA922 | 24. | 75. | 23. | 17. | 0.46 | 18. | 0. |
| AA974 | 24. | 75. | 19. | 14. | 0.36 | 14. | 0. |
| AA950 | 46. | 115. | 26. | 19. | 0.46 | 18. | 5. |
| AA903 | 69. | 156. | 64. | 47. | 0.89 | 35. | 15. |
| AA920 | 107. | 225. | 88. | 65. | 1.24 | 49. | 100. |
| AA946 | 150. | 302. | 134. | 99. | 1.90 | 75. | 100. |
| AA961 | 192. | 378. | 118. | 87. | 1.75 | 69. | 100. |
| AA948 | 287. | 548. | 133. | 98. | 1.96 | 77. | 100. |

A533B Reference Material (HSST Plate #2)

OC1 A SHSS02 SRM LT



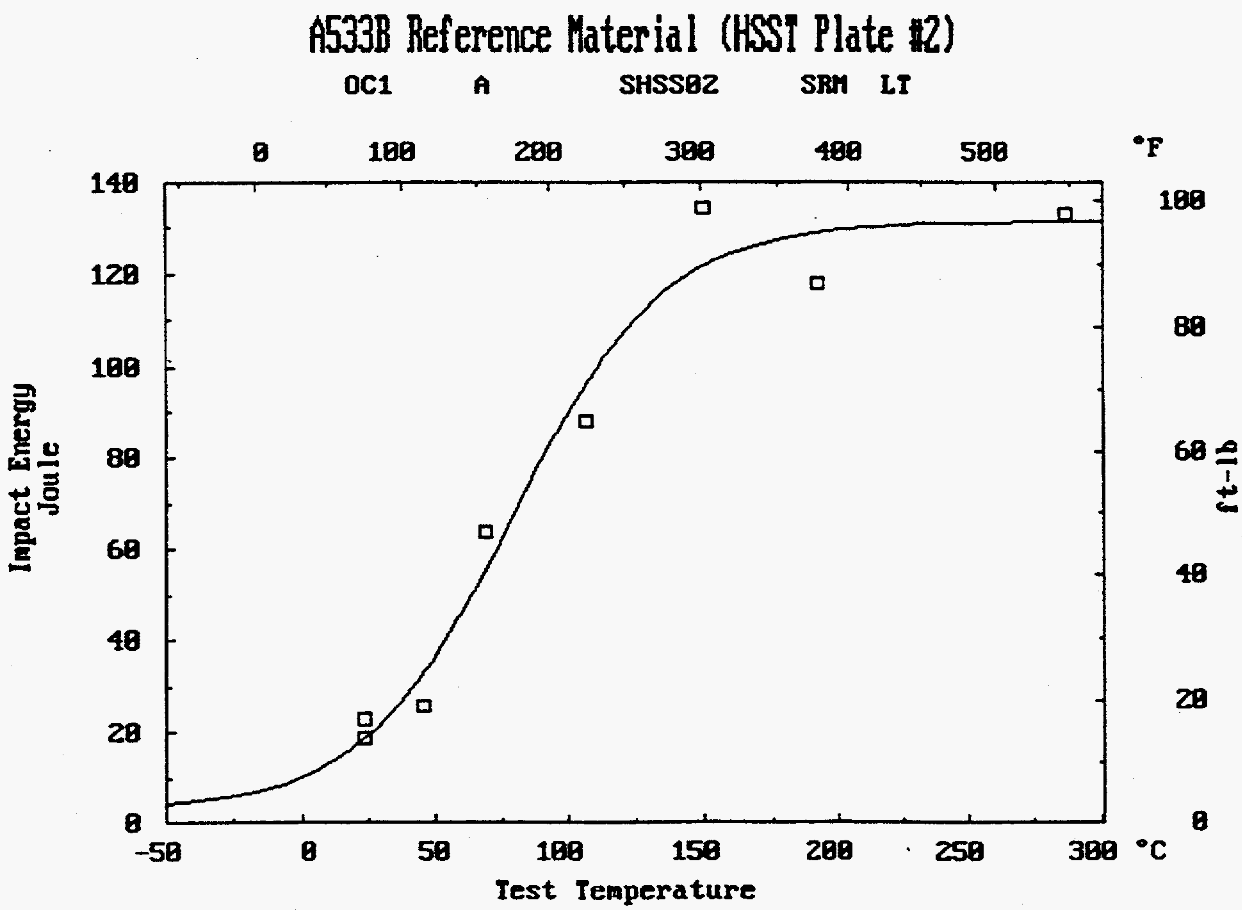
A533B HSST02 REFERENCE MATERIAL

Oconee Unit 1, Capsule A

```
Impact Energy Uncertainty =  10.0 J
Test Temperature Uncertainty =   4.0 Degree C
Number of Successful Iterations =  200, Maximum = 1000

OC1    A     SHSS02    SRM  LT : Fluence = 8.950E+18 , Irr. Temp. =  303
```

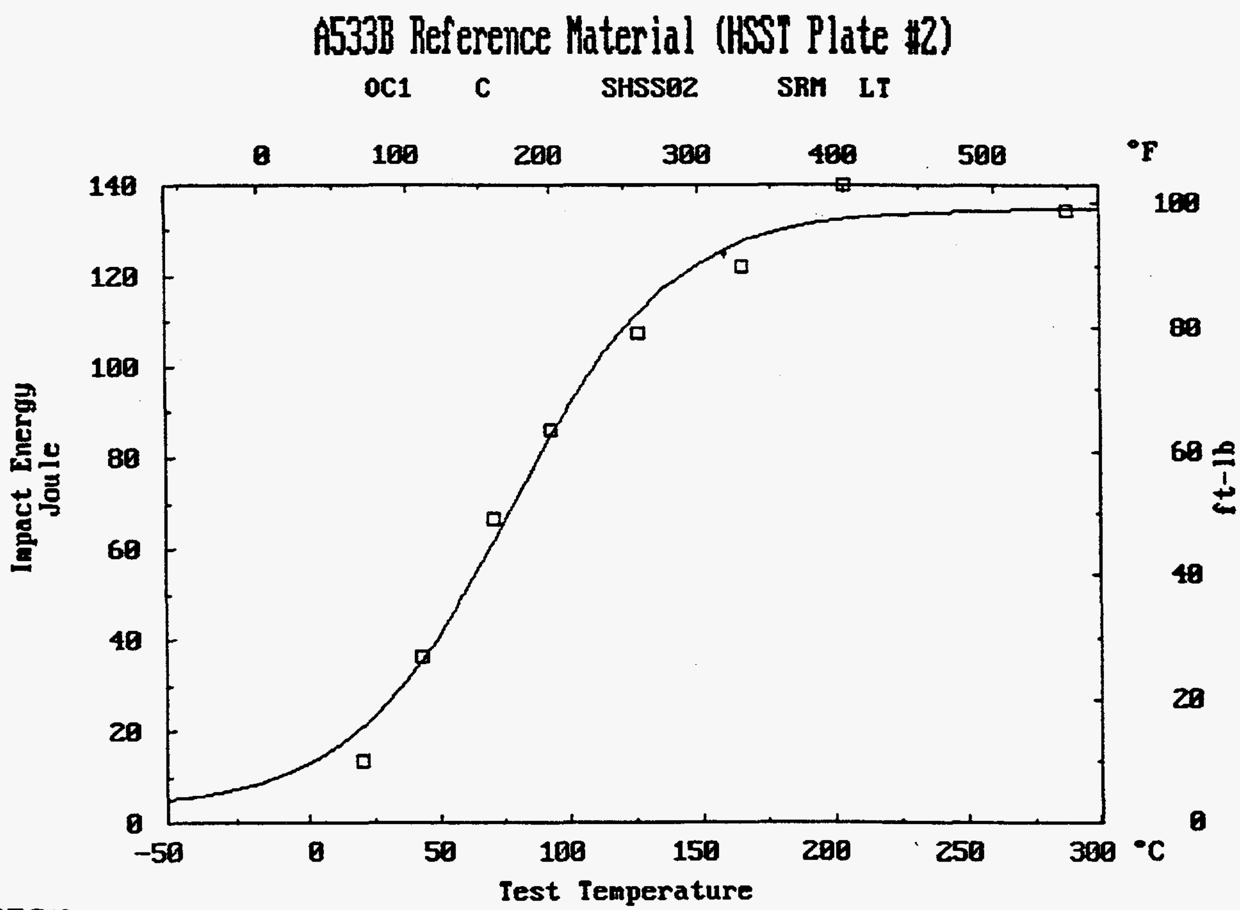
| Parameter | Mean | Std.Dev. | Correlation Coefficients | | | | |
|---|---|---|---|---|---|---|---|
| Lower Shelf Energy (J) | 3.0 | 0.0 | | | | | |
| Upper Shelf Energy (J) | 131.2 | 6.9 | 0.018 | | | | |
| CVT at Midpoint (C) | 79.3 | 7.7 | 0.063 | 0.590 | | | |
| 1/slope (C) | 56.3 | 10.8 | -0.087 | 0.399 | 0.472 | | |
| CVT at 41 Joule (C) | 54.9 | 6.4 | 0.136 | 0.070 | 0.649 | -0.319 | |
| CVT at 68 Joule (C) | 80.0 | 6.4 | 0.070 | 0.227 | 0.918 | 0.380 | 0.747 |



A533B HSST02 REFERENCE MATERIAL
Oconee Unit 1, Capsule C

USE= 134.6 J, LSE= 3.0 J, CVT(1/2)= 78.C , Slope = 0.0161
CVT(41J) = 50. C , CVT(68J) = 77. C ,
Fluence = 9.860E+18 , Irr. Temp. = 303 C

| Spec. ID | Test Temp. C | Test Temp. F | Impact Energy J | Impact Energy ft-lb | Lat. Exp. mm | Lat. Exp. mil | % Shear |
|---|---|---|---|---|---|---|---|
| AAC949 | 21. | 70. | 14. | 10. | 0.18 | 7. | 10. |
| AAC931 | 43. | 110. | 37. | 27. | 0.61 | 24. | 30. |
| AAC942 | 71. | 160. | 66. | 49. | 0.91 | 36. | 50. |
| AAC939 | 93. | 200. | 86. | 63. | 1.42 | 56. | 60. |
| AAC959 | 127. | 260. | 107. | 79. | 1.57 | 62. | 95. |
| AAC956 | 166. | 330. | 122. | 90. | 1.93 | 76. | 100. |
| AAC905 | 204. | 400. | 140. | 103. | 1.96 | 77. | 100. |
| AAC954 | 288. | 550. | 134. | 99. | 1.90 | 75. | 100. |



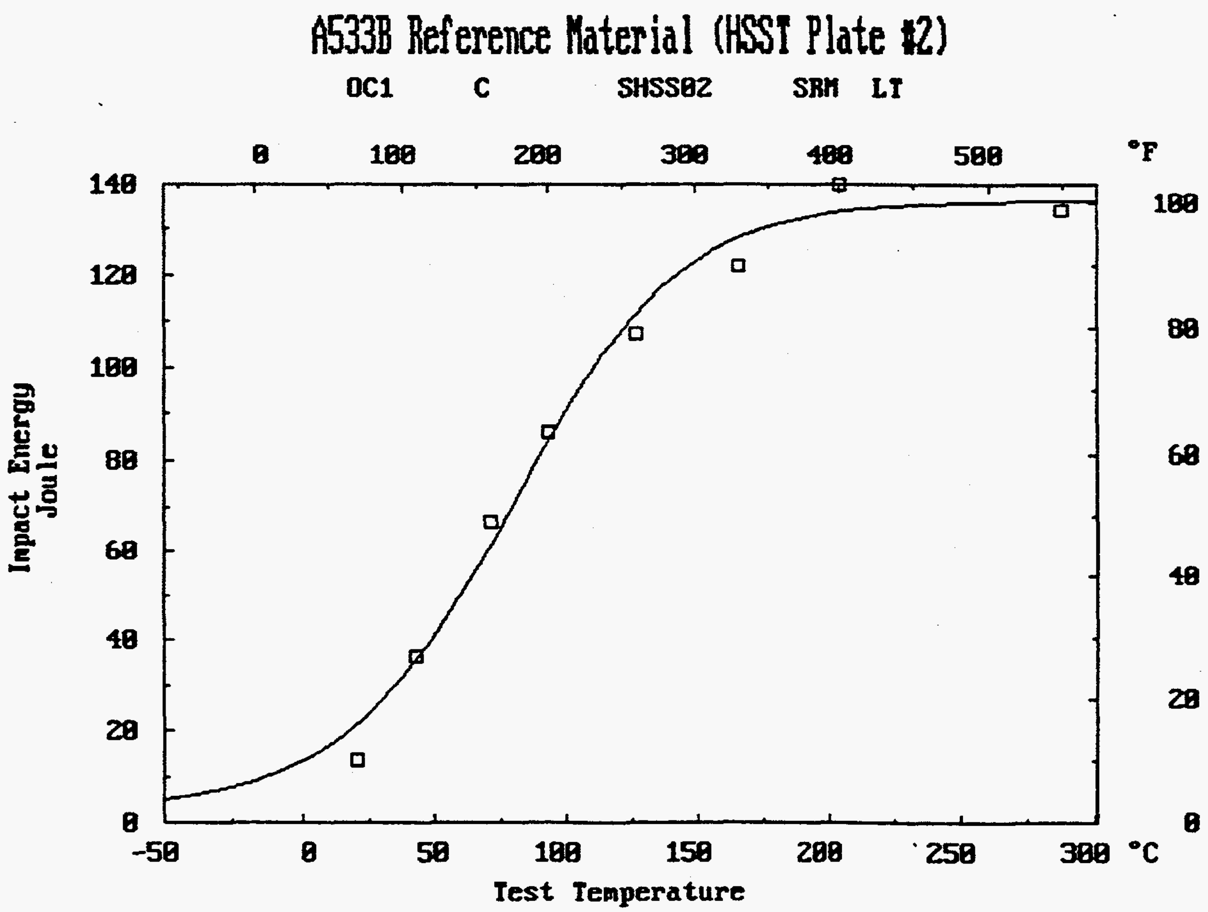
A533B HSST02 REFERENCE MATERIAL

Oconee Unit 1, Capsule C

```
Impact Energy Uncertainty =  10.0 J
Test Temperature Uncertainty =   4.0 Degree C
Number of Successful Iterations =  200, Maximum = 1000
```

OC1 C SHSS02 SRM LT : Fluence = 9.860E+18 , Irr. Temp. = 303

| Parameter | Mean | Std.Dev. | Correlation Coefficients | | | | |
|---|---|---|---|---|---|---|---|
| Lower Shelf Energy (J) | 3.0 | 0.0 | | | | | |
| Upper Shelf Energy (J) | 136.4 | 8.1 | 0.112 | | | | |
| CVT at Midpoint (C) | 79.3 | 8.4 | 0.068 | 0.754 | | | |
| 1/slope (C) | 63.9 | 14.7 | 0.149 | 0.600 | 0.567 | | |
| CVT at 41 Joule (C) | 49.7 | 7.0 | -0.114 | -0.094 | 0.336 | -0.552 | |
| CVT at 68 Joule (C) | 77.4 | 5.9 | 0.006 | 0.351 | 0.870 | 0.314 | 0.609 |



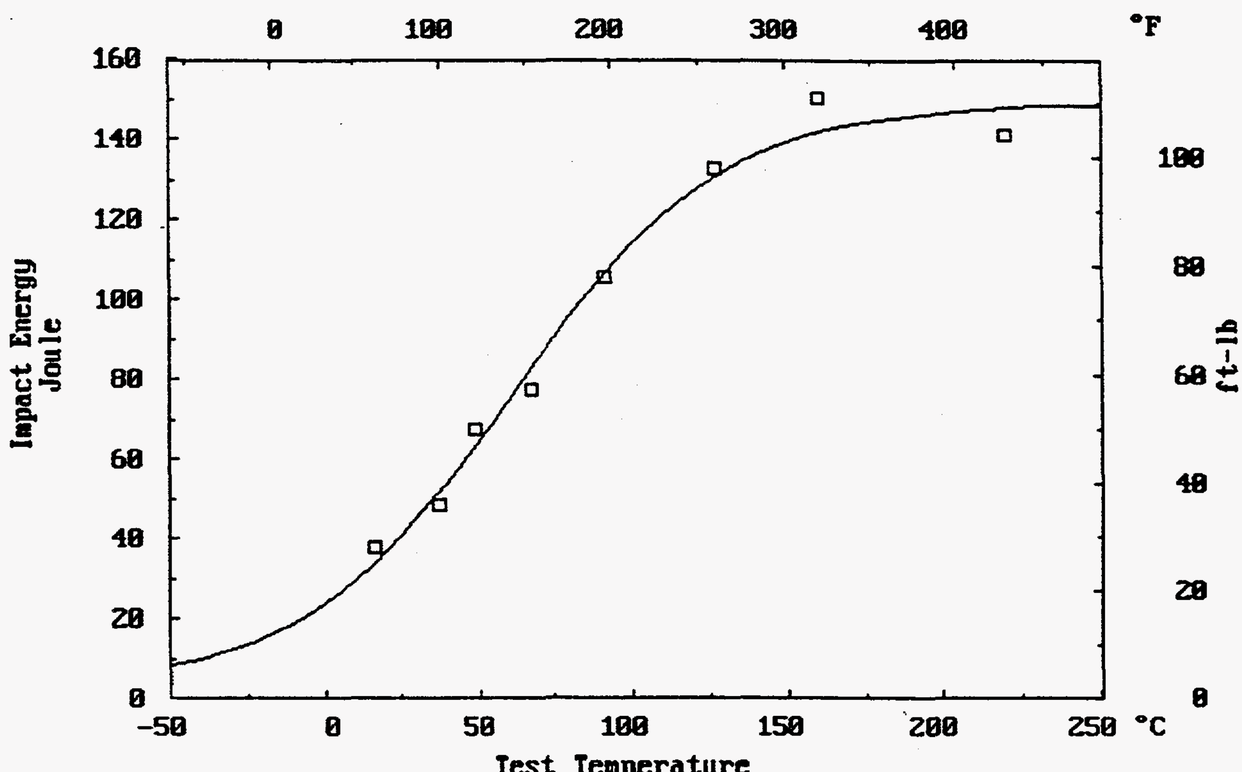
A533B HSST02 REFERENCE MATERIAL
Oconee Unit 1, Capsule E

USE= 149.4 J, LSE= 3.0 J, CVT(1/2)= 61.C , Slope = 0.0147
CVT(41J) = 25. C , CVT(68J) = 53. C ,
Fluence = 1.500E+18 , Irr. Temp. = 309 C

| Spec. ID | Test Temp. C | Test Temp. F | Impact Energy J | Impact Energy ft-lb | Lat. Exp. mm | Lat. Exp. mil | % Shear |
|---|---|---|---|---|---|---|---|
| AAE967 | 17. | 62. | 38. | 28. | 0.58 | 23. | 2. |
| AAE971 | 37. | 99. | 49. | 36. | 0.76 | 30. | 6. |
| AAE927 | 49. | 120. | 68. | 50. | 0.99 | 39. | 30. |
| AAE908 | 68. | 154. | 77. | 57. | 1.09 | 43. | 30. |
| AAE964 | 92. | 197. | 106. | 78. | 1.32 | 52. | 65. |
| AAE966 | 127. | 260. | 133. | 98. | 1.75 | 69. | 95. |
| AAE935 | 161. | 321. | 150. | 111. | 1.80 | 71. | 100. |
| AAE929 | 220. | 428. | 141. | 104. | 1.88 | 74. | 100. |

A533B Reference Material (HSST Plate #2)

OC1 E SHSS02 SRM LT



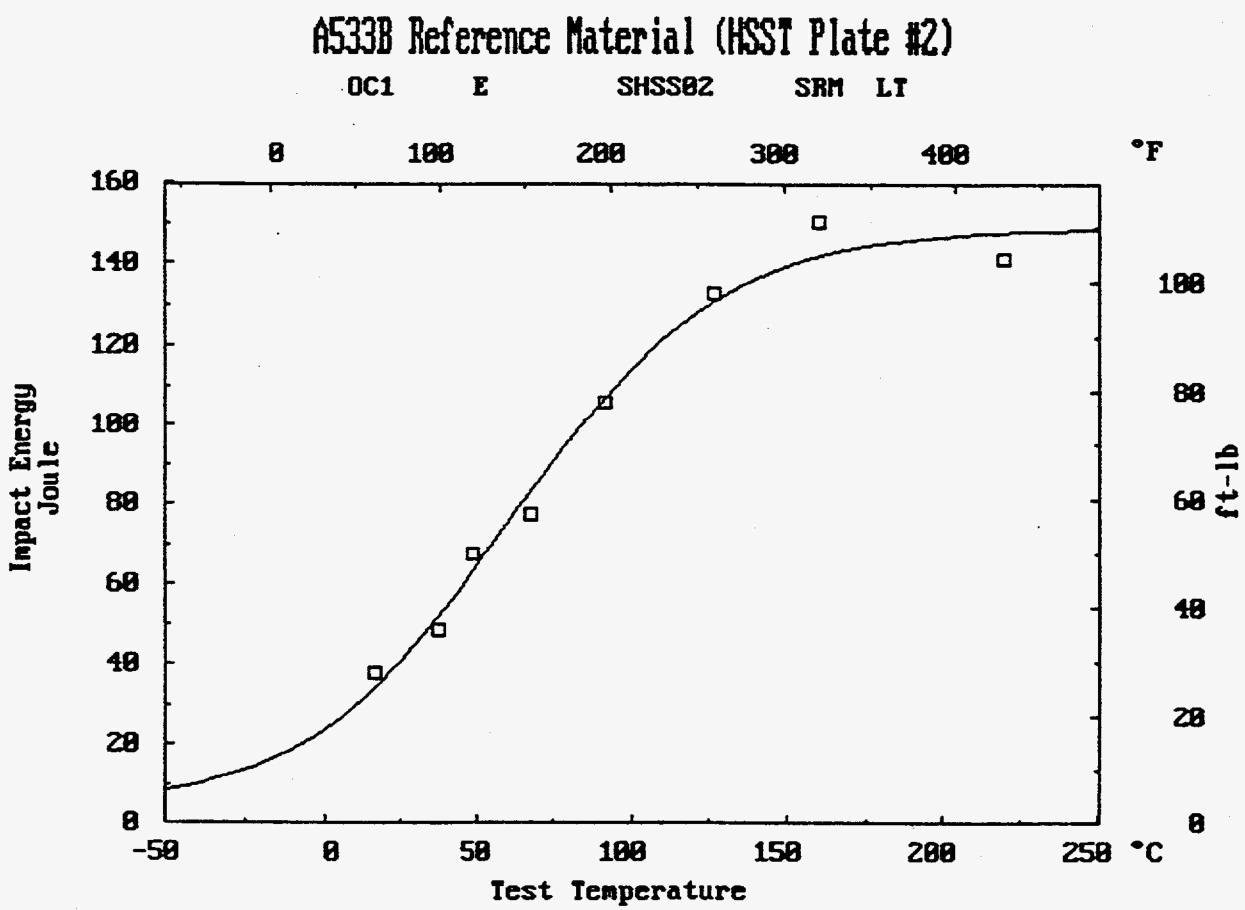
A533B HSST02 REFERENCE MATERIAL

Oconee Unit 1, Capsule E

Impact Energy Uncertainty = 10.0 J
Test Temperature Uncertainty = 4.0 Degree C
Number of Successful Iterations = 200, Maximum = 1000

OC1 E SHSS02 SRM LT : Fluence = 1.500E+18 , Irr. Temp. = 309

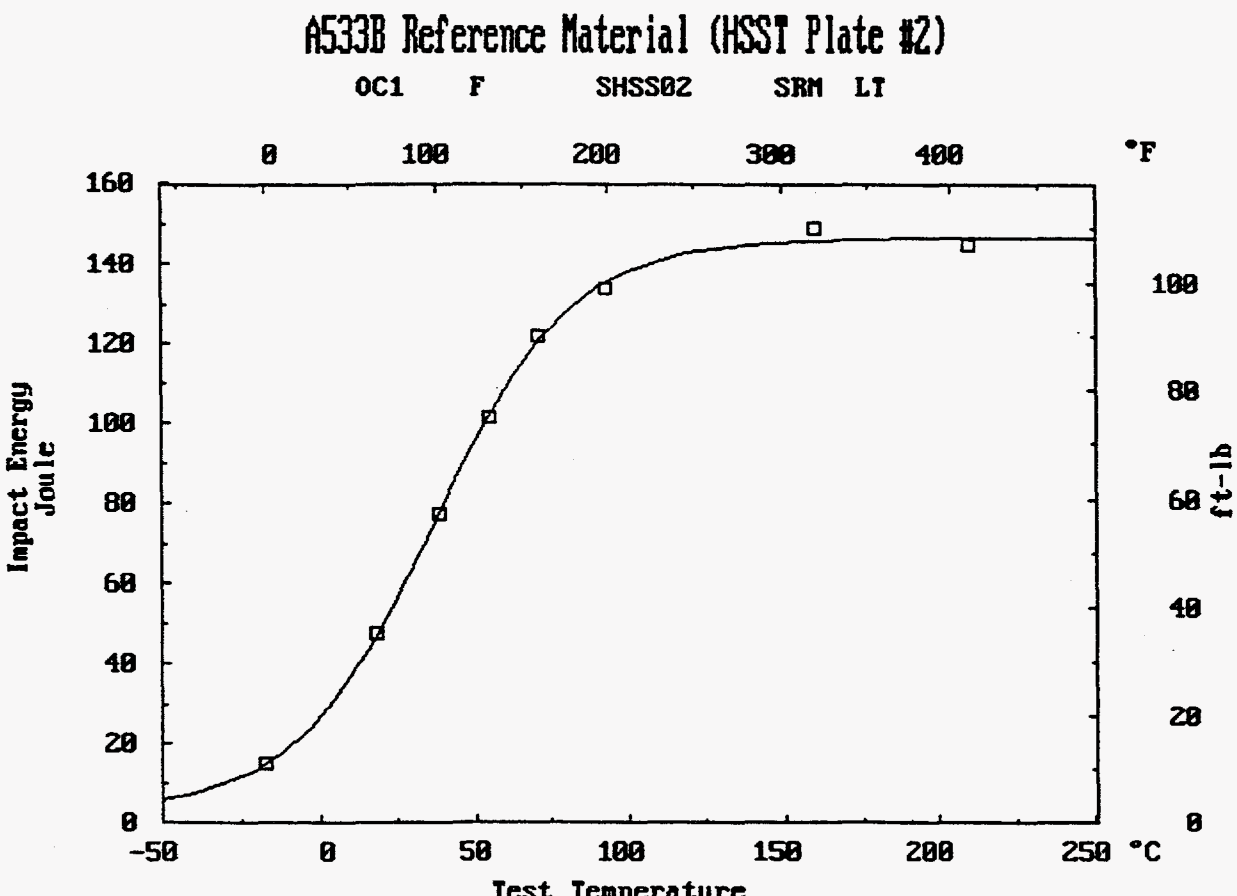
| Parameter | Mean | Std.Dev. | Correlation Coefficients | | | | |
|---|---|---|---|---|---|---|---|
| Lower Shelf Energy (J) | 3.0 | 0.0 | | | | | |
| Upper Shelf Energy (J) | 149.3 | 8.5 | 0.147 | | | | |
| CVT at Midpoint (C) | 60.9 | 6.9 | 0.178 | 0.710 | | | |
| 1/slope (C) | 67.9 | 13.1 | -0.040 | 0.593 | 0.397 | | |
| CVT at 41 Joule (C) | 25.1 | 7.9 | 0.156 | -0.238 | 0.289 | -0.739 | |
| CVT at 68 Joule (C) | 53.1 | 5.2 | 0.177 | 0.079 | 0.725 | -0.190 | 0.796 |



A533B HSST02 REFERENCE MATERIAL
Oconee Unit 1, Capsule F

USE= 146.7 J, LSE= 3.0 J, CVT(1/2)= 37.C , Slope = 0.0221
CVT(41J) = 14. C , CVT(68J) = 32. C ,
Fluence = 8.300E+17 , Irr. Temp. = 309 C

| Spec. ID | Test Temp. C | Test Temp. F | Impact Energy J | Impact Energy ft-lb | Lat. Exp. mm | Lat. Exp. mil | % Shear |
|---|---|---|---|---|---|---|---|
| BBF936 | -17. | 1. | 15. | 11. | 0.25 | 10. | 2. |
| BBF921 | 18. | 65. | 47. | 35. | 0.74 | 29. | 12. |
| BBF969 | 38. | 101. | 77. | 57. | 1.07 | 42. | 30. |
| BBF968 | 54. | 130. | 102. | 75. | 1.32 | 52. | 35. |
| BBF958 | 71. | 160. | 122. | 90. | 1.42 | 56. | 55. |
| BBF901 | 93. | 199. | 134. | 99. | 1.60 | 63. | 100. |
| BBF940 | 160. | 320. | 149. | 110. | 1.57 | 62. | 100. |
| BBF910 | 211. | 411. | 145. | 107. | 1.57 | 62. | 100. |



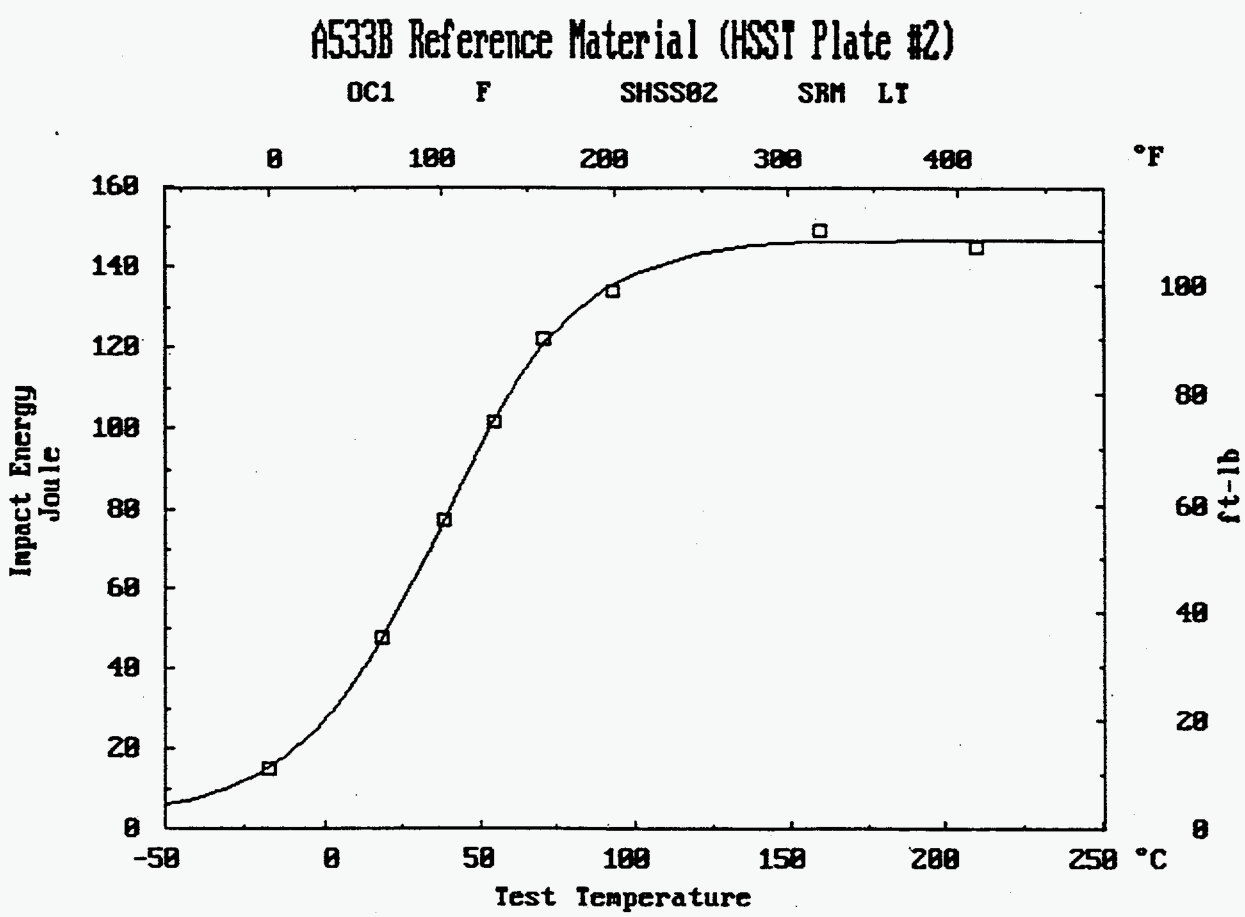
A533B HSST02 REFERENCE MATERIAL

Oconee Unit 1, Capsule F

Impact Energy Uncertainty = 10.0 J
Test Temperature Uncertainty = 4.0 Degree C
Number of Successful Iterations = 200, Maximum = 1000

OC1 F SHSS02 SRM LT : Fluence = 8.300E+17 , Irr. Temp. = 309

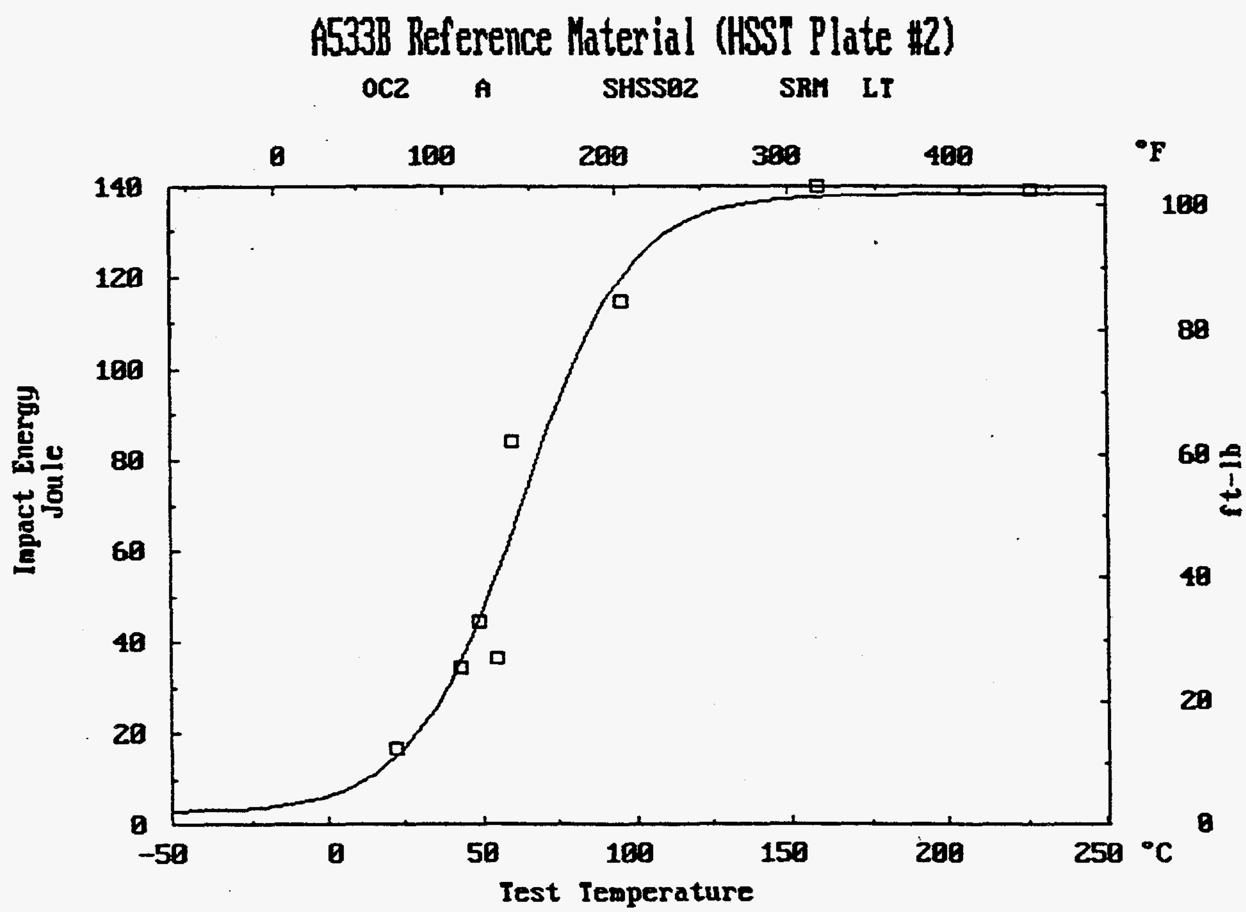
| Parameter | Mean | Std.Dev. | Correlation Coefficients | | | | |
|---|---|---|---|---|---|---|---|
| Lower Shelf Energy (J) | 3.0 | 0.0 | | | | | |
| Upper Shelf Energy (J) | 146.8 | 6.5 | -0.047 | | | | |
| CVT at Midpoint (C) | 36.8 | 5.3 | 0.016 | 0.575 | | | |
| 1/slope (C) | 45.7 | 9.7 | -0.181 | 0.493 | 0.121 | | |
| CVT at 41 Joule (C) | 13.3 | 6.9 | 0.152 | -0.120 | 0.568 | -0.734 | |
| CVT at 68 Joule (C) | 32.2 | 4.7 | 0.075 | 0.141 | 0.876 | -0.271 | 0.850 |



A533B HSST02 REFERENCE MATERIAL
Oconee Unit 2, Capsule A

USE= 138.2 J, LSE= 3.0 J, CVT(1/2)= 63.C , Slope = 0.0285
CVT(41J) = 47. C , CVT(68J) = 62. C ,
Fluence = 3.370E+18 , Irr. Temp. = 321 C

| Spec. ID | Test Temp. C | Test Temp. F | Impact Energy J | Impact Energy ft-lb | Lat. Exp. mm | Lat. Exp. mil | % Shear |
|---|---|---|---|---|---|---|---|
| EE950 | 22. | 72. | 17. | 12. | 0.25 | 10. | 2. |
| EE942 | 43. | 110. | 35. | 25. | 0.53 | 21. | 30. |
| EE903 | 49. | 120. | 45. | 33. | 0.76 | 30. | 15. |
| EE904 | 54. | 130. | 37. | 27. | 0.81 | 32. | 30. |
| EE934 | 60. | 140. | 84. | 62. | 1.35 | 53. | 35. |
| EE919 | 96. | 204. | 115. | 84. | 1.63 | 64. | 100. |
| EE914 | 159. | 318. | 140. | 103. | 2.13 | 84. | 100. |
| EE935 | 227. | 440. | 139. | 102. | 1.98 | 78. | 100. |



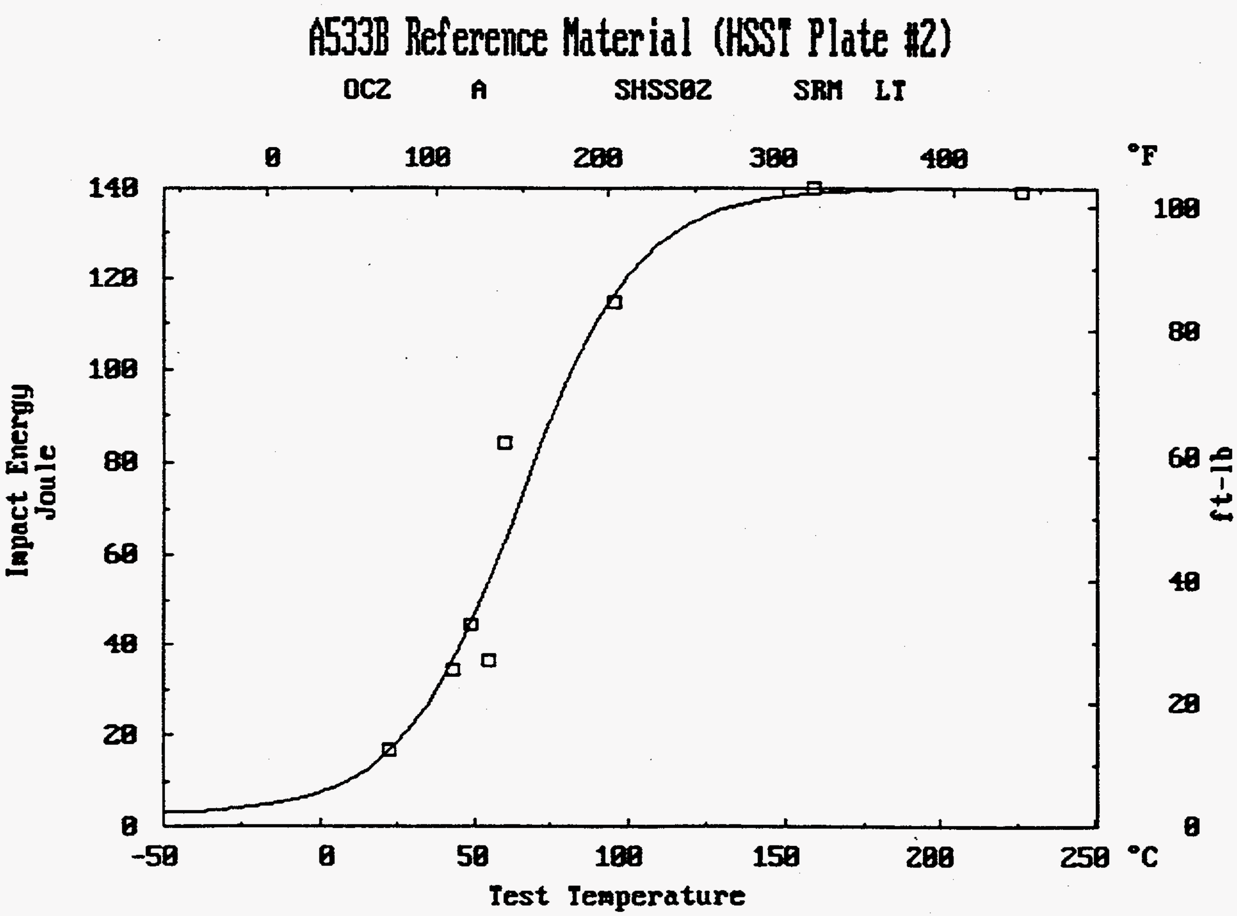
A533B HSST02 REFERENCE MATERIAL

Oconee Unit 2, Capsule A

```
Impact Energy Uncertainty =  10.0 J
Test Temperature Uncertainty =   4.0 Degree C
Number of Successful Iterations =  200, Maximum = 1000
```

```
OC2    A     SHSS02    SRM  LT : Fluence = 3.370E+18 , Irr. Temp. =  321
```

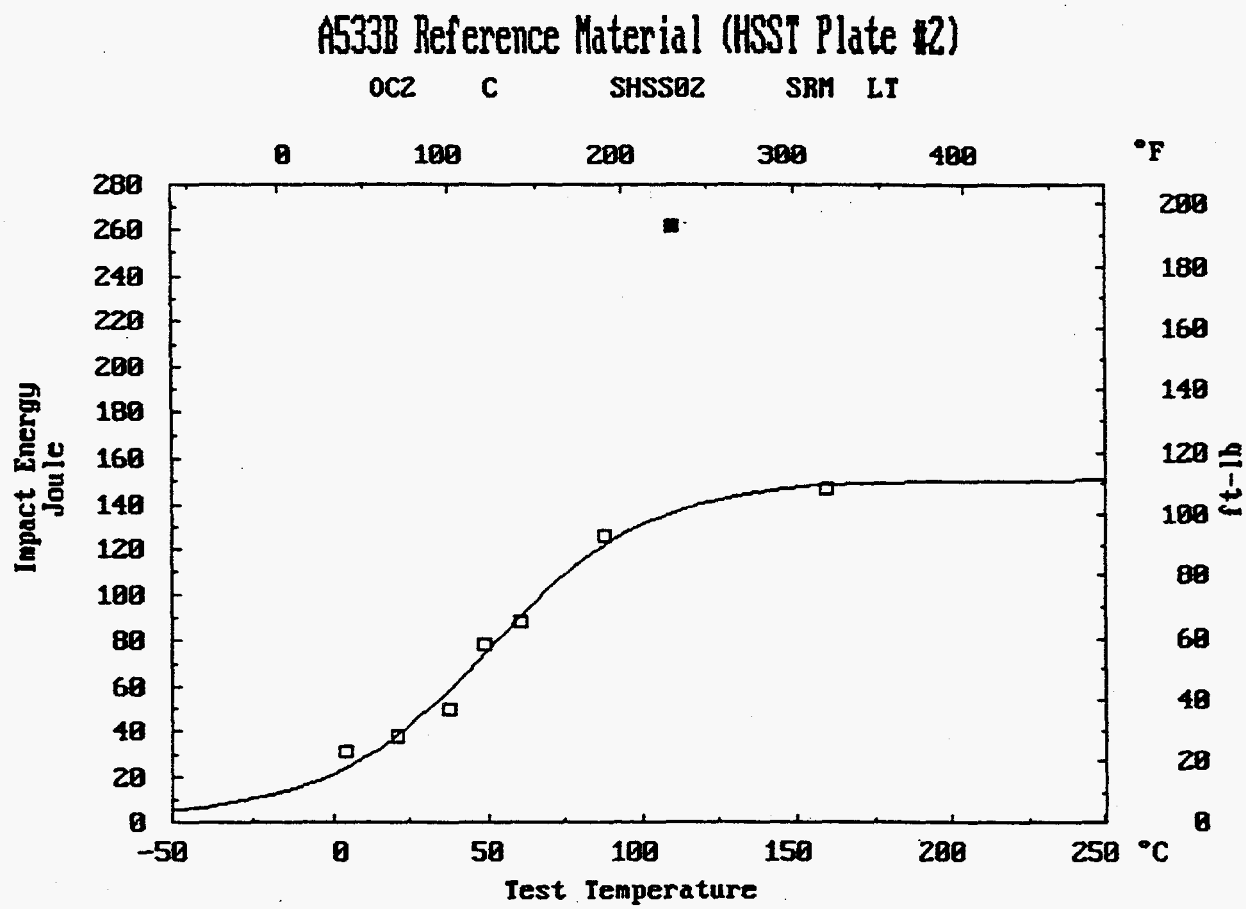
| Parameter | Mean | Std.Dev. | Correlation Coefficients | | | | |
|---|---|---|---|---|---|---|---|
| Lower Shelf Energy (J) | 3.0 | 0.0 | | | | | |
| Upper Shelf Energy (J) | 139.9 | 8.0 | -0.023 | | | | |
| CVT at Midpoint (C) | 65.0 | 5.6 | -0.071 | 0.650 | | | |
| 1/slope (C) | 38.7 | 9.4 | -0.228 | 0.484 | 0.625 | | |
| CVT at 41 Joule (C) | 46.4 | 4.2 | 0.150 | -0.045 | 0.395 | -0.431 | |
| CVT at 68 Joule (C) | 62.9 | 4.2 | -0.065 | 0.274 | 0.900 | 0.456 | 0.598 |



A533B HSST02 REFERENCE MATERIAL
Oconee Unit 2, Capsule C

USE= 150.7 J, LSE= 3.0 J, CVT(1/2)= 51.C , Slope = 0.0193
CVT(41J) = 23. C , CVT(68J) = 45. C ,
Fluence = 9.430E+17 , Irr. Temp. = 309 C

| Spec. ID | Test Temp. | | Impact Energy | | Lat. Exp. | | % Shear |
|---|---|---|---|---|---|---|---|
| | C | F | J | ft-lb | mm | mil | |
| EE911 | 4. | 40. | 31. | 23. | 0.51 | 20. | 4. |
| EE928 | 21. | 70. | 38. | 28. | 0.58 | 23. | 12. |
| EE930 | 38. | 100. | 50. | 37. | 0.66 | 26. | 18. |
| EE939 | 49. | 120. | 79. | 58. | 0.99 | 39. | 28. |
| EE912 | 60. | 140. | 88. | 65. | 1.22 | 48. | 40. |
| EE941 | 88. | 190. | 125. | 92. | 1.37 | 54. | 88. |
| *EE958 | 110. | 230. | 262. | 193. | 1.50 | 59. | 95. |
| EE921 | 159. | 319. | 147. | 108. | 1.47 | 58. | 100. |



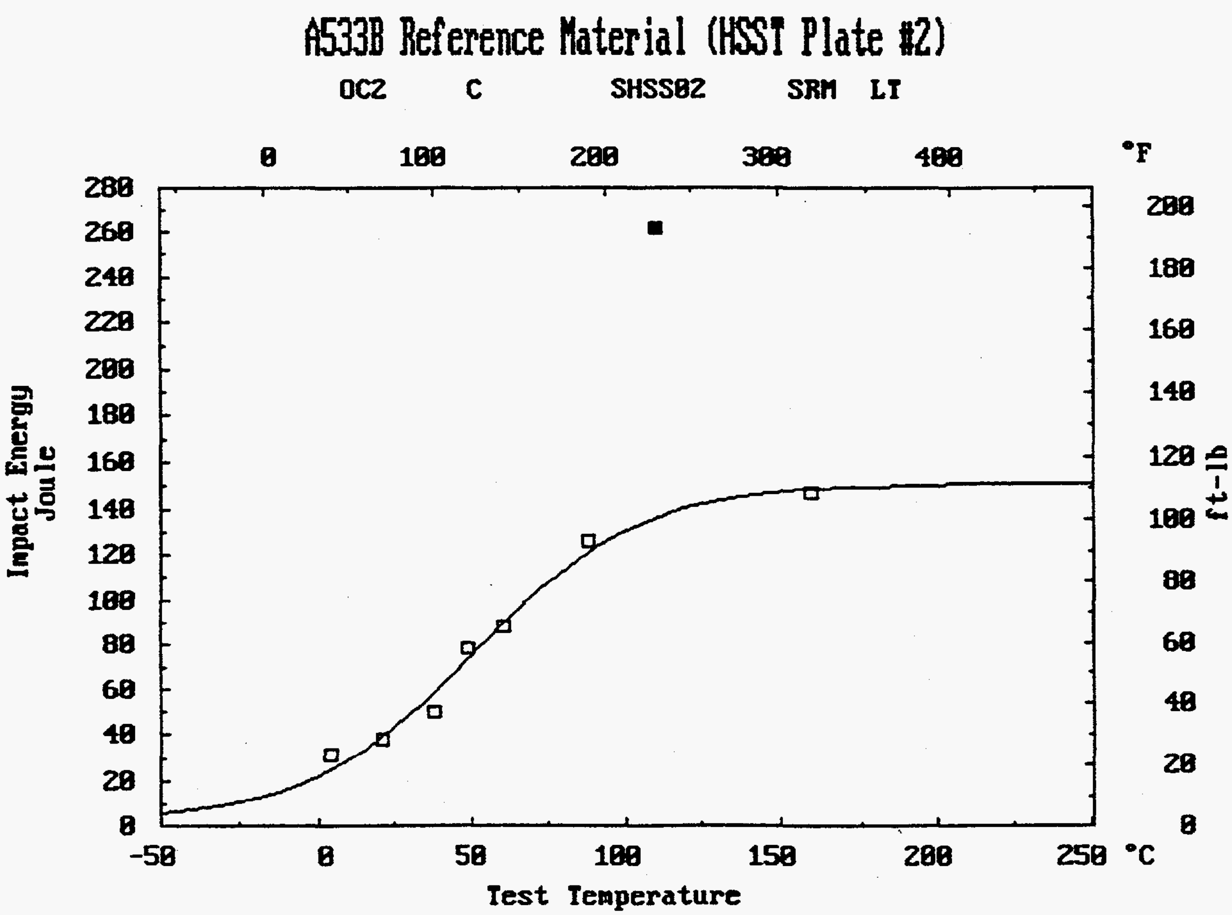
A533B HSST02 REFERENCE MATERIAL

Oconee Unit 2, Capsule C

```
Impact Energy Uncertainty =  10.0 J
Test Temperature Uncertainty =   4.0 Degree C
Number of Successful Iterations =  200, Maximum = 1000
```

```
OC2   C     SHSS02     SRM  LT : Fluence = 9.430E+17 , Irr. Temp. =  309
```

| Parameter | Mean | Std.Dev. | Correlation Coefficients | | | | |
|---|---|---|---|---|---|---|---|
| Lower Shelf Energy (J) | 3.0 | 0.0 | | | | | |
| Upper Shelf Energy (J) | 151.2 | 10.1 | -0.059 | | | | |
| CVT at Midpoint (C) | 51.3 | 6.1 | 0.041 | 0.748 | | | |
| 1/slope (C) | 53.4 | 12.5 | -0.297 | 0.464 | 0.495 | | |
| CVT at 41 Joule (C) | 22.8 | 6.3 | 0.365 | -0.177 | 0.117 | -0.776 | |
| CVT at 68 Joule (C) | 44.6 | 3.8 | 0.216 | 0.109 | 0.687 | -0.050 | 0.658 |



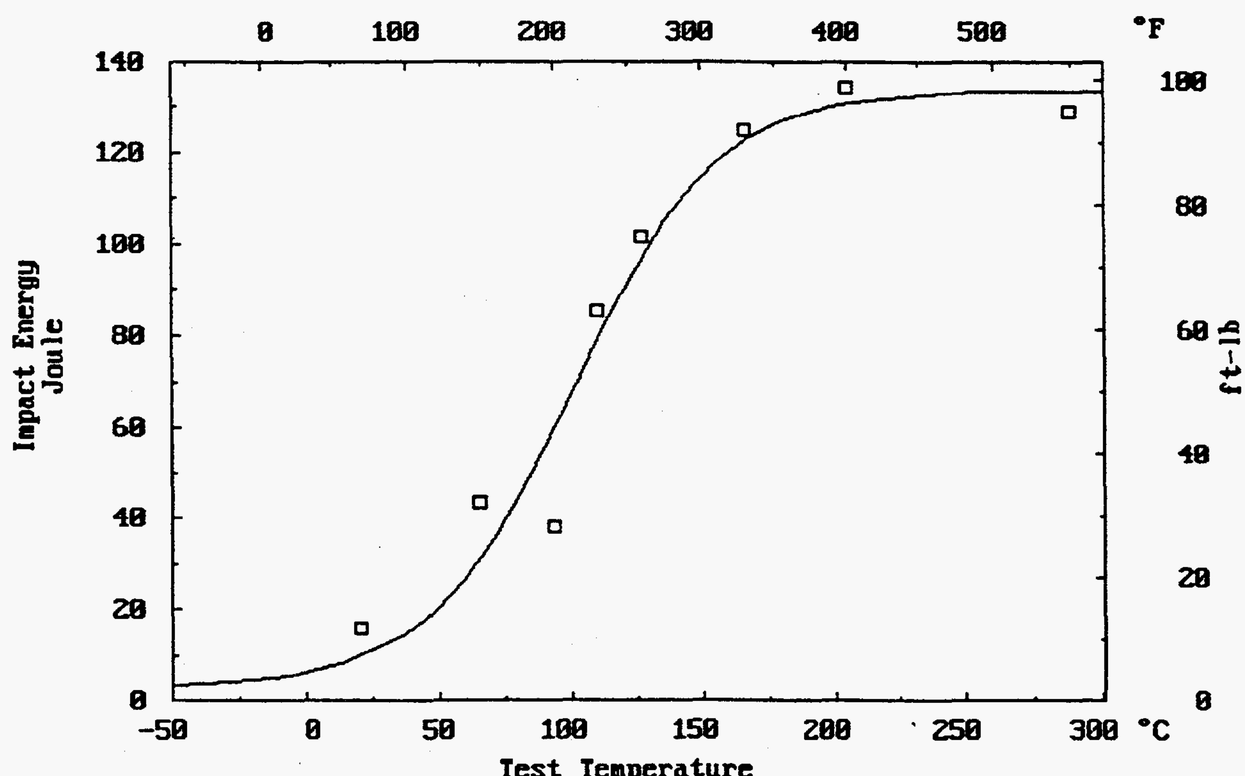
A533B HSST02 REFERENCE MATERIAL
Oconee Unit 2, Capsule E

USE= 133.6 J, LSE= 3.0 J, CVT(1/2)= 101.C , Slope = 0.0183
CVT(41J) = 77. C , CVT(68J) = 101. C ,
Fluence = 1.210E+19 , Irr. Temp. = 303 C

| Spec. ID | Test Temp. C | Test Temp. F | Impact Energy J | Impact Energy ft-lb | Lat. Exp. mm | Lat. Exp. mil | % Shear |
|---|---|---|---|---|---|---|---|
| EE944 | 21. | 70. | 16. | 12. | 0.30 | 12. | 20. |
| EE937 | 66. | 150. | 43. | 32. | 0.66 | 26. | 40. |
| EE947 | 93. | 200. | 38. | 28. | 0.61 | 24. | 70. |
| EE916 | 110. | 230. | 85. | 63. | 1.24 | 49. | 80. |
| EE959 | 127. | 260. | 102. | 75. | 1.57 | 62. | 95. |
| EE955 | 166. | 330. | 125. | 92. | 1.85 | 73. | 100. |
| EE929 | 204. | 400. | 134. | 99. | 2.03 | 80. | 100. |
| EE925 | 288. | 550. | 129. | 95. | 2.41 | 95. | 100. |

A533B Reference Material (HSST Plate #2)

OCZ E SHSS0Z SRM LT



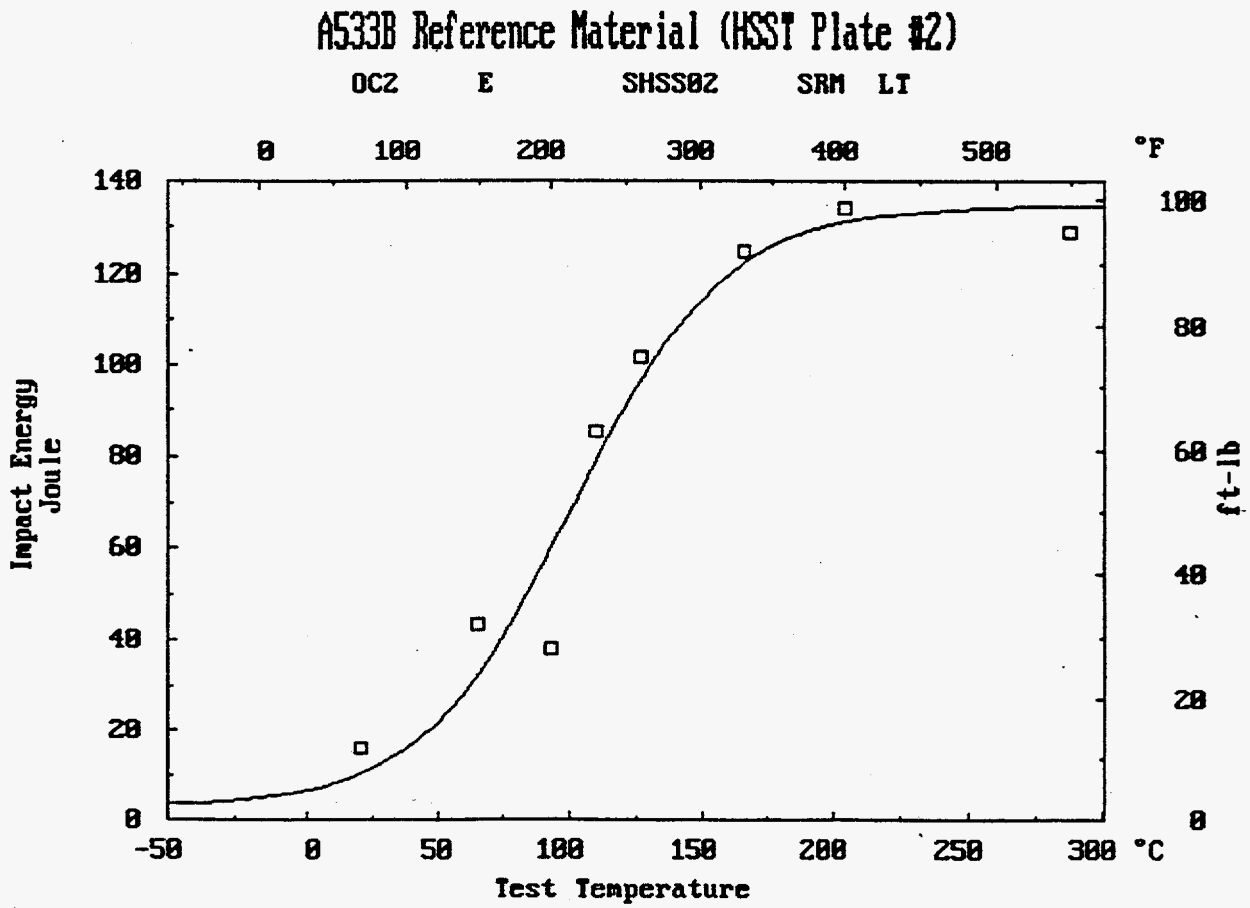
A533B HSST02 REFERENCE MATERIAL

Oconee Unit 2, Capsule E

```
Impact Energy Uncertainty =  10.0 J
Test Temperature Uncertainty =   4.0 Degree C
Number of Successful Iterations =  200, Maximum = 1000
```

```
OC2   E     SHSS02    SRM  LT : Fluence = 1.210E+19 , Irr. Temp. =  303
```

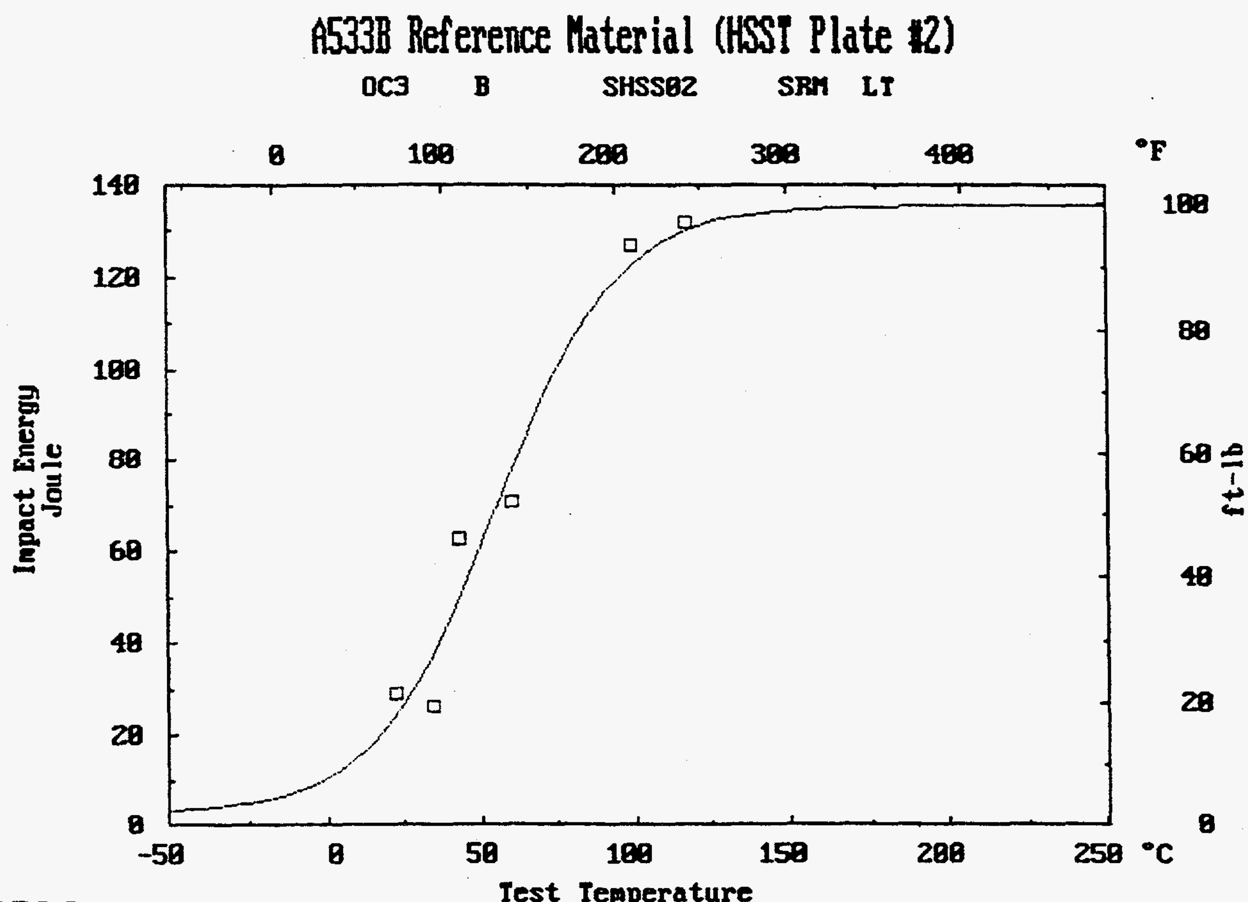
| Parameter | Mean | Std.Dev. | Correlation Coefficients | | | | |
|---|---|---|---|---|---|---|---|
| Lower Shelf Energy (J) | 3.0 | 0.0 | | | | | |
| Upper Shelf Energy (J) | 134.6 | 7.0 | -0.061 | | | | |
| CVT at Midpoint (C) | 101.1 | 6.4 | 0.242 | 0.467 | | | |
| 1/slope (C) | 56.8 | 13.2 | -0.409 | 0.491 | -0.092 | | |
| CVT at 41 Joule (C) | 75.3 | 9.4 | 0.433 | -0.234 | 0.620 | -0.820 | |
| CVT at 68 Joule (C) | 100.2 | 5.7 | 0.306 | -0.043 | 0.855 | -0.412 | 0.854 |



A533B HSST02 REFERENCE MATERIAL
Oconee Unit 3, Capsule B

USE= 135.4 J, LSE= 3.0 J, CVT(1/2)= 55.C , Slope = 0.0254
CVT(41J) = 37. C , CVT(68J) = 54. C ,
Fluence = 3.120E+18 , Irr. Temp. = 309 C

| Spec. ID | Test Temp. C | Test Temp. F | Impact Energy J | Impact Energy ft-lb | Lat. Exp. mm | Lat. Exp. mil | % Shear |
|---|---|---|---|---|---|---|---|
| JJ918 | 22. | 72. | 29. | 21. | 0.43 | 17. | 5. |
| JJ916 | 34. | 94. | 26. | 19. | 0.41 | 16. | 10. |
| JJ908 | 43. | 110. | 62. | 46. | 0.89 | 35. | 20. |
| JJ902 | 60. | 140. | 70. | 52. | 1.07 | 42. | 40. |
| JJ914 | 99. | 210. | 127. | 93. | 1.85 | 73. | 100. |
| JJ911 | 117. | 242. | 132. | 97. | 1.90 | 75. | 100. |



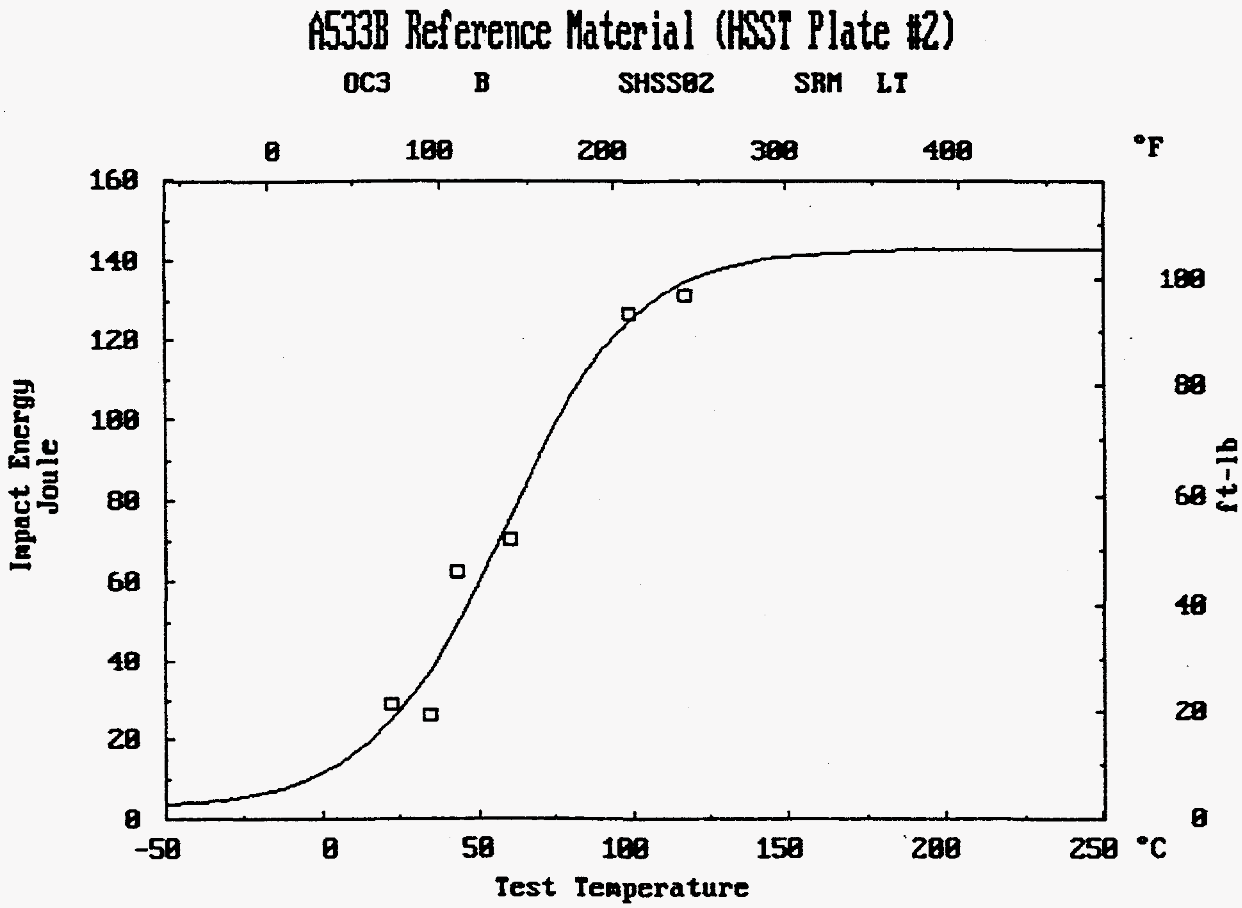
A533B HSST02 REFERENCE MATERIAL

Oconee Unit 3, Capsule B

```
Impact Energy Uncertainty =  10.0 J
Test Temperature Uncertainty =   4.0 Degree C
Number of Successful Iterations =  200, Maximum = 1000
```

OC3 B SHSS02 SRM LT : Fluence = 3.120E+18 , Irr. Temp. = 309

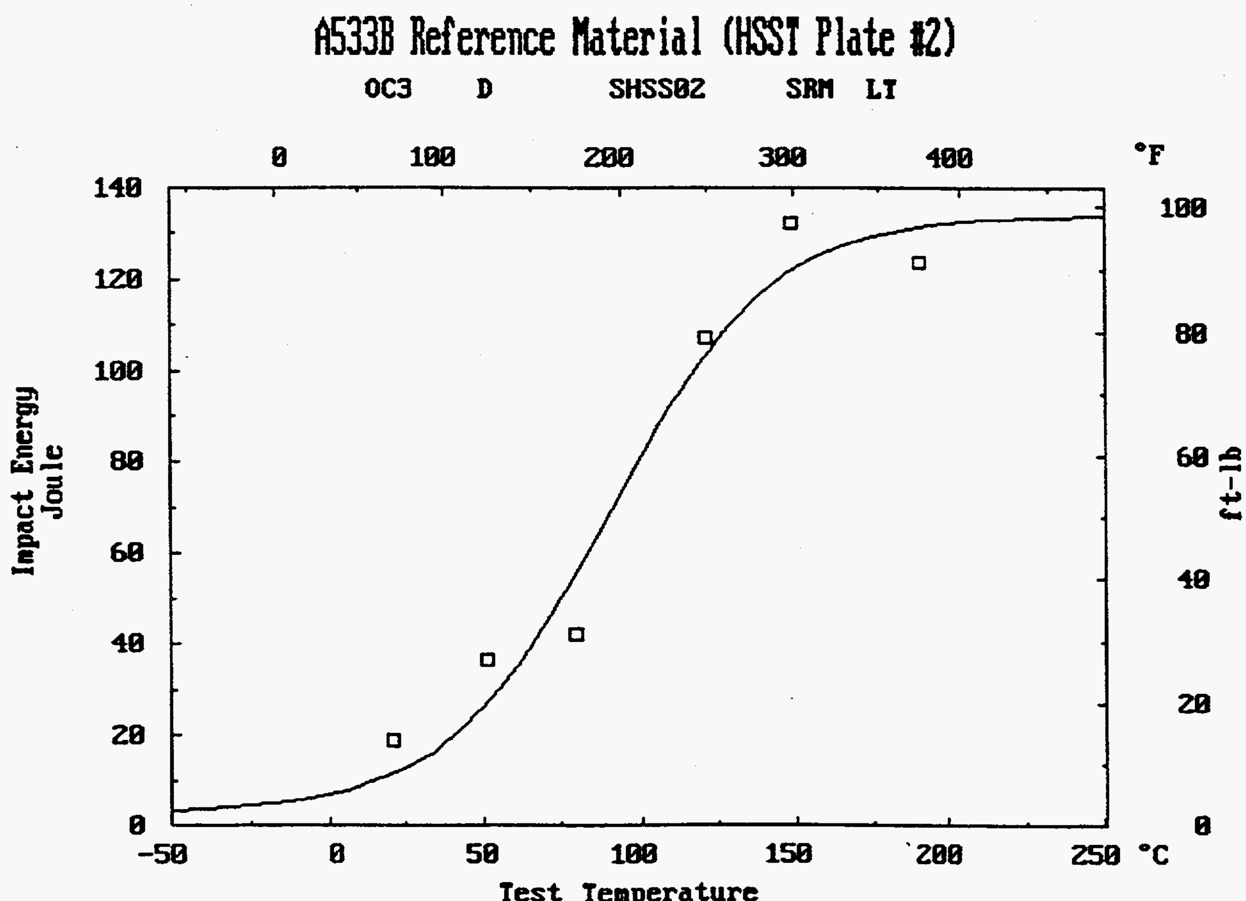
| Parameter | Mean | Std.Dev. | Correlation Coefficients | | | | |
|---|---|---|---|---|---|---|---|
| Lower Shelf Energy (J) | 3.0 | 0.0 | | | | | |
| Upper Shelf Energy (J) | 143.2 | 16.5 | -0.013 | | | | |
| CVT at Midpoint (C) | 58.4 | 9.0 | 0.079 | 0.870 | | | |
| 1/slope (C) | 42.5 | 11.2 | -0.003 | 0.753 | 0.749 | | |
| CVT at 41 Joule (C) | 37.0 | 4.8 | 0.172 | -0.042 | 0.294 | -0.360 | |
| CVT at 68 Joule (C) | 54.9 | 4.7 | 0.178 | 0.450 | 0.820 | 0.441 | 0.664 |



A533B HSST02 REFERENCE MATERIAL
Oconee Unit 3, Capsule D

USE= 133.9 J, LSE= 3.0 J, CVT(1/2)= 90.C , Slope = 0.0195
CVT(41J) = 67. C , CVT(68J) = 90. C ,
Fluence = 1.450E+19 , Irr. Temp. = 292 C

| Spec. ID | Test Temp. C | Test Temp. F | Impact Energy J | Impact Energy ft-lb | Lat. Exp. mm | Lat. Exp. mil | % Shear |
|---|---|---|---|---|---|---|---|
| JJ907 | 21. | 70. | 19. | 14. | 0.28 | 11. | 10. |
| JJ904 | 52. | 125. | 37. | 27. | 0.56 | 22. | 20. |
| JJ906 | 79. | 175. | 42. | 31. | 0.74 | 29. | 30. |
| JJ912 | 121. | 250. | 107. | 79. | 1.68 | 66. | 70. |
| JJ913 | 149. | 300. | 132. | 97. | 1.96 | 77. | 90. |
| JJ909 | 191. | 375. | 123. | 91. | 2.08 | 82. | 100. |



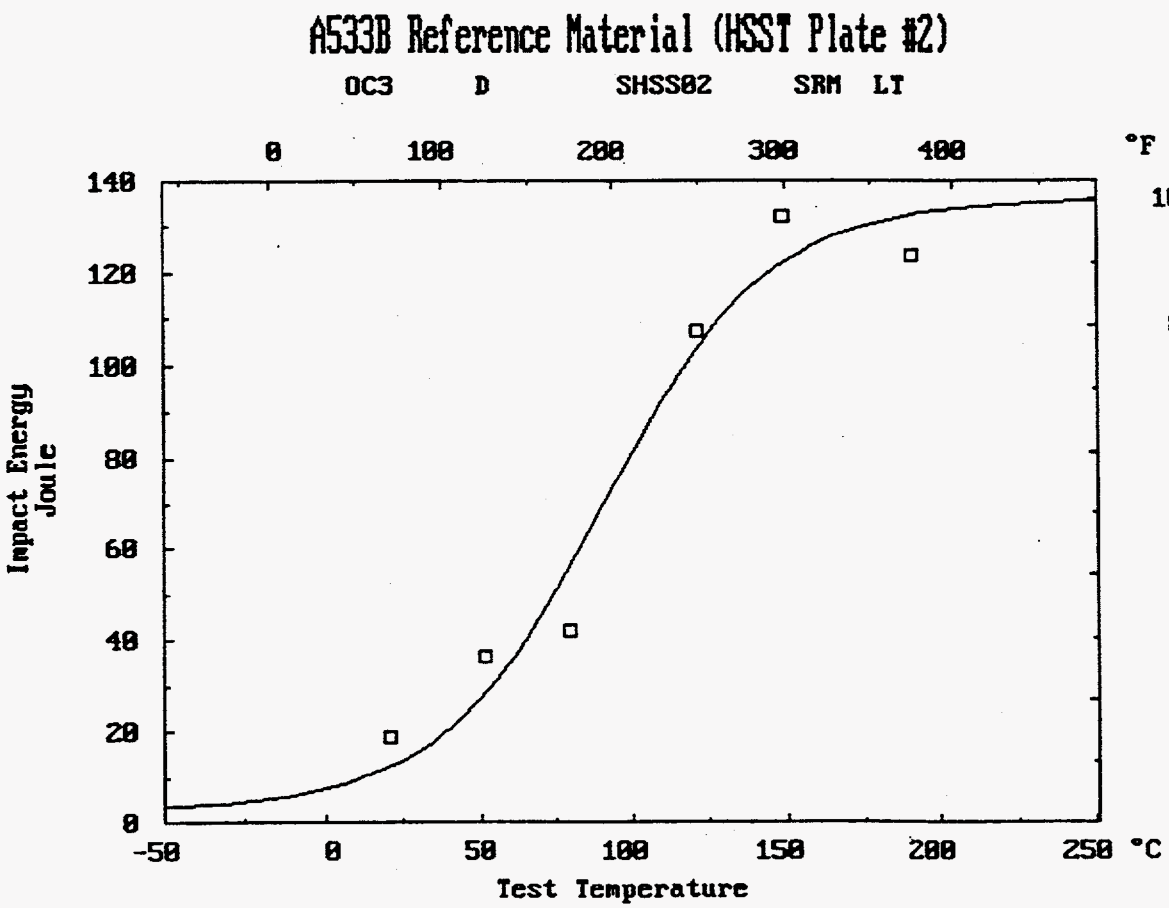
A533B HSST02 REFERENCE MATERIAL

Oconee Unit 3, Capsule D

Impact Energy Uncertainty = 10.0 J
Test Temperature Uncertainty = 4.0 Degree C
Number of Successful Iterations = 200, Maximum = 1000

OC3 D SHSS02 SRM LT : Fluence = 1.450E+19 , Irr. Temp. = 292

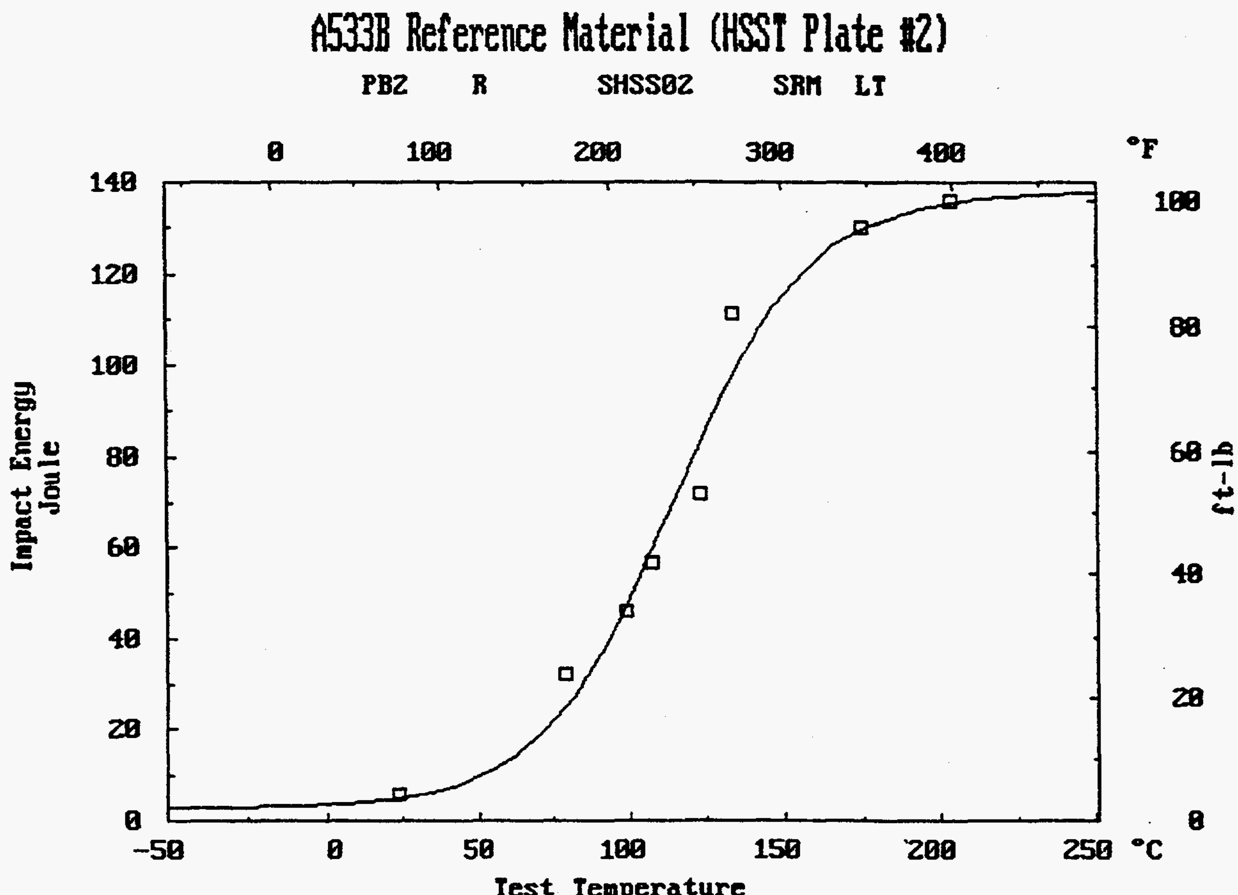
| Parameter | Mean | Std.Dev. | Correlation Coefficients | | | | |
|---|---|---|---|---|---|---|---|
| Lower Shelf Energy (J) | 3.0 | 0.0 | | | | | |
| Upper Shelf Energy (J) | 135.5 | 10.0 | 0.060 | | | | |
| CVT at Midpoint (C) | 90.2 | 8.2 | 0.289 | 0.645 | | | |
| 1/slope (C) | 53.5 | 13.0 | -0.419 | 0.511 | 0.149 | | |
| CVT at 41 Joule (C) | 65.6 | 9.2 | 0.517 | -0.071 | 0.589 | -0.686 | |
| CVT at 68 Joule (C) | 89.0 | 6.4 | 0.361 | 0.171 | 0.856 | -0.190 | 0.837 |



A533B HSST02 REFERENCE MATERIAL
Point Beach Unit 2, Capsule R

USE= 137.6 J, LSE= 3.0 J, CVT(1/2)= 114.C , Slope = 0.0230
CVT(41J) = 94. C , CVT(68J) = 113. C ,
Fluence = 2.010E+19 , Irr. Temp. = 304 C

| Spec. ID | Test Temp. C | Test Temp. F | Impact Energy J | Impact Energy ft-lb | Lat. Exp. mm | Lat. Exp. mil | % Shear |
|---|---|---|---|---|---|---|---|
| R14 | 24. | 75. | 6. | 4. | 0.05 | 2. | 5. |
| R12 | 79. | 174. | 33. | 24. | 0.66 | 26. | 23. |
| R13 | 99. | 210. | 46. | 34. | 0.71 | 28. | 34. |
| R11 | 107. | 225. | 57. | 42. | 0.99 | 39. | 38. |
| R10 | 123. | 253. | 72. | 53. | 0.76 | 30. | 62. |
| R9 | 134. | 273. | 111. | 82. | 1.52 | 60. | 52. |
| R15 | 175. | 347. | 130. | 96. | 1.68 | 66. | 100. |
| R16 | 204. | 399. | 136. | 100. | 2.01 | 79. | 100. |



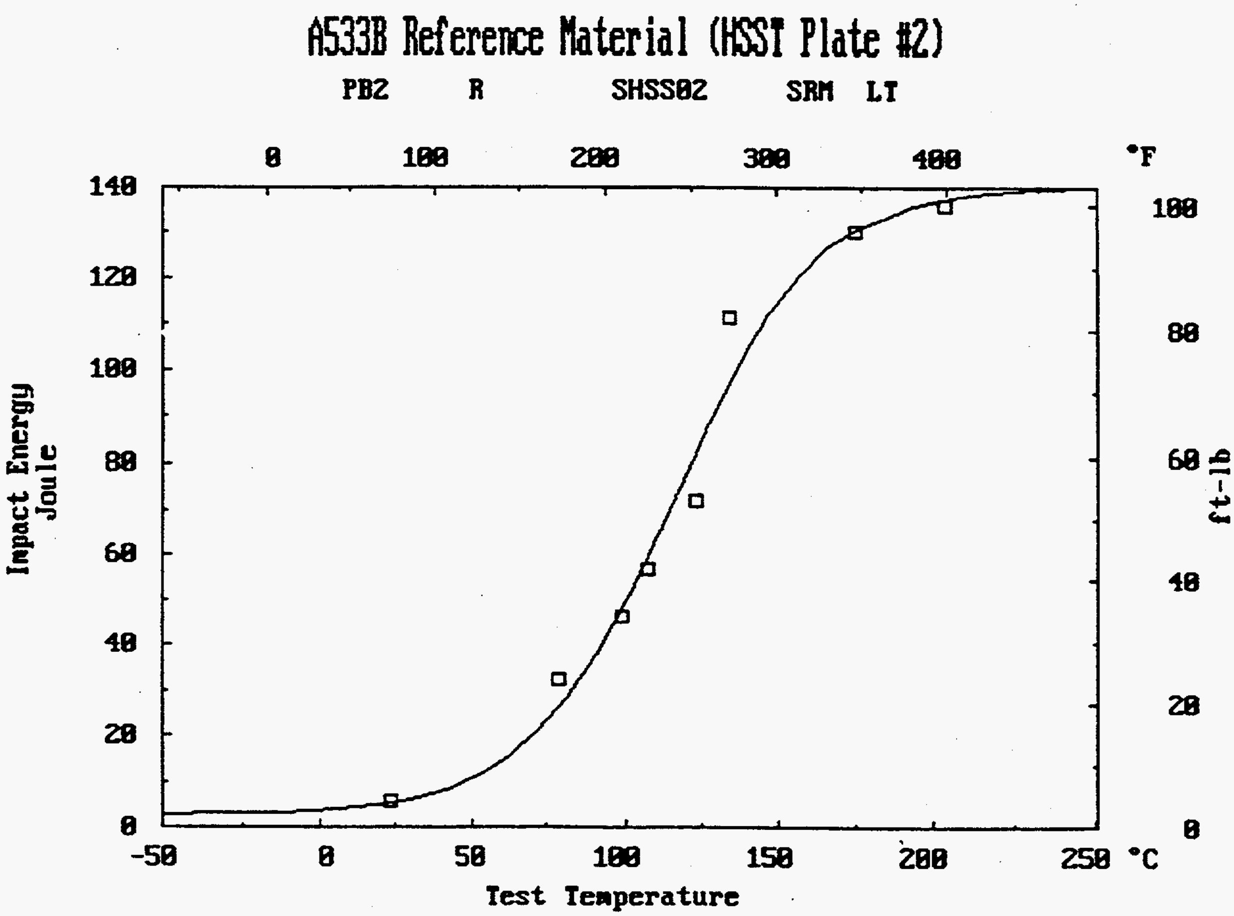
A533B HSST02 REFERENCE MATERIAL

Point Beach Unit 2, Capsule R

Impact Energy Uncertainty = 10.0 J
Test Temperature Uncertainty = 4.0 Degree C
Number of Successful Iterations = 200, Maximum = 1000

PB2 R SHSS02 SRM LT : Fluence = 2.010E+19 , Irr. Temp. = 304

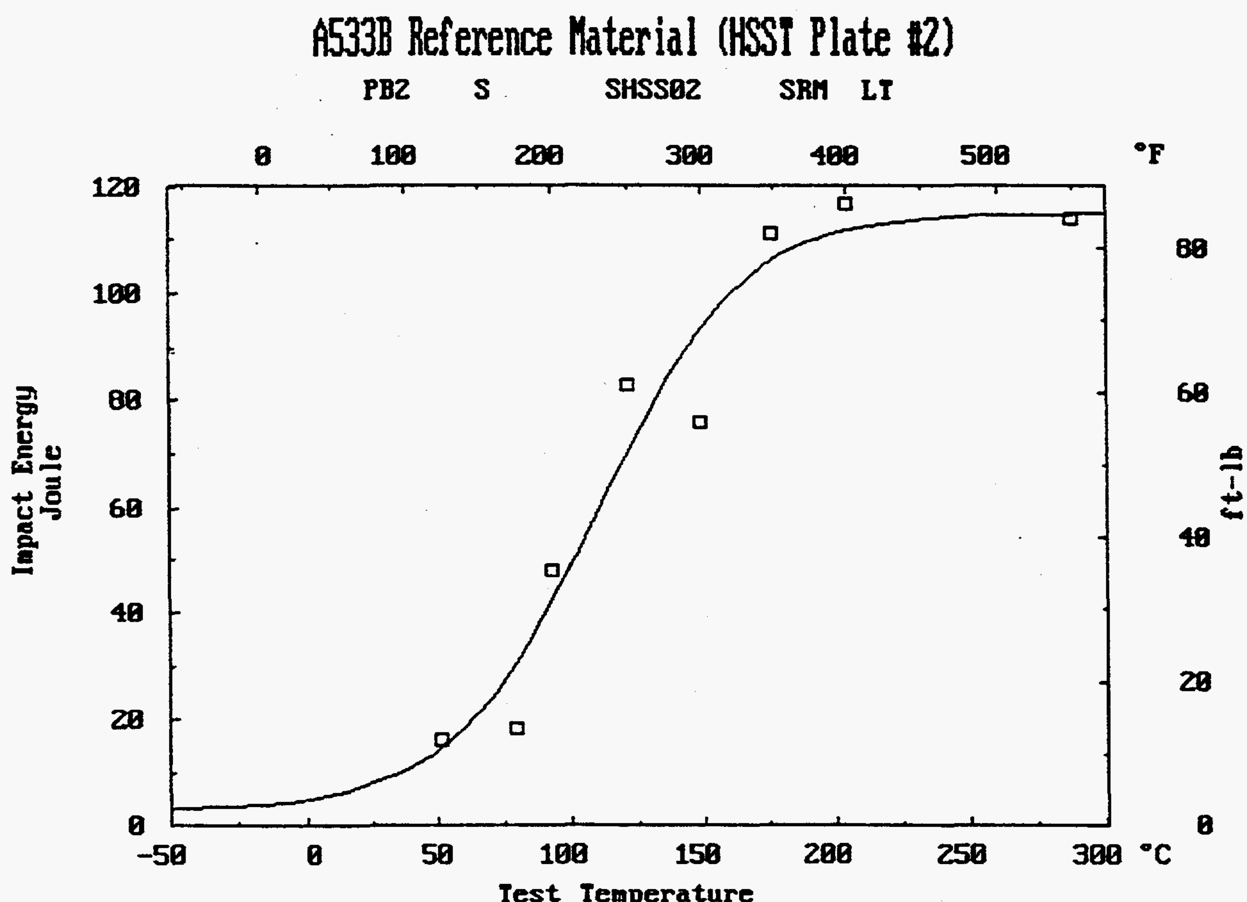
| Parameter | Mean | Std.Dev. | Correlation Coefficients | | | | |
|---|---|---|---|---|---|---|---|
| Lower Shelf Energy (J) | 3.0 | 0.0 | | | | | |
| Upper Shelf Energy (J) | 140.3 | 8.9 | -0.085 | | | | |
| CVT at Midpoint (C) | 115.6 | 5.8 | 0.115 | 0.708 | | | |
| 1/slope (C) | 46.1 | 12.0 | -0.356 | 0.400 | 0.306 | | |
| CVT at 41 Joule (C) | 93.3 | 6.7 | 0.438 | -0.057 | 0.364 | -0.750 | |
| CVT at 68 Joule (C) | 113.0 | 4.2 | 0.279 | 0.214 | 0.819 | -0.048 | 0.688 |



A533B HSST02 REFERENCE MATERIAL
Point Beach Unit 2, Capsule S

USE= 115.0 J, LSE= 3.0 J, CVT(1/2)= 110.C , Slope = 0.0185
CVT(41J) = 92. C , CVT(68J) = 119. C ,
Fluence = 3.470E+19 , Irr. Temp. = 304 C

| Spec. ID | Test Temp. C | Test Temp. F | Impact Energy J | Impact Energy ft-lb | Lat. Exp. mm | Lat. Exp. mil | % Shear |
|---|---|---|---|---|---|---|---|
| R18 | 52. | 125. | 16. | 12. | 0.25 | 10. | 10. |
| R22 | 79. | 175. | 18. | 13. | 0.28 | 11. | 45. |
| R20 | 93. | 200. | 48. | 35. | 0.76 | 30. | 40. |
| R17 | 121. | 250. | 83. | 61. | 1.19 | 47. | 60. |
| R21 | 149. | 300. | 76. | 56. | 1.24 | 49. | 90. |
| R24 | 177. | 350. | 111. | 82. | 1.75 | 69. | 100. |
| R23 | 204. | 400. | 117. | 86. | 1.80 | 71. | 100. |
| R19 | 288. | 550. | 114. | 84. | 1.78 | 70. | 100. |



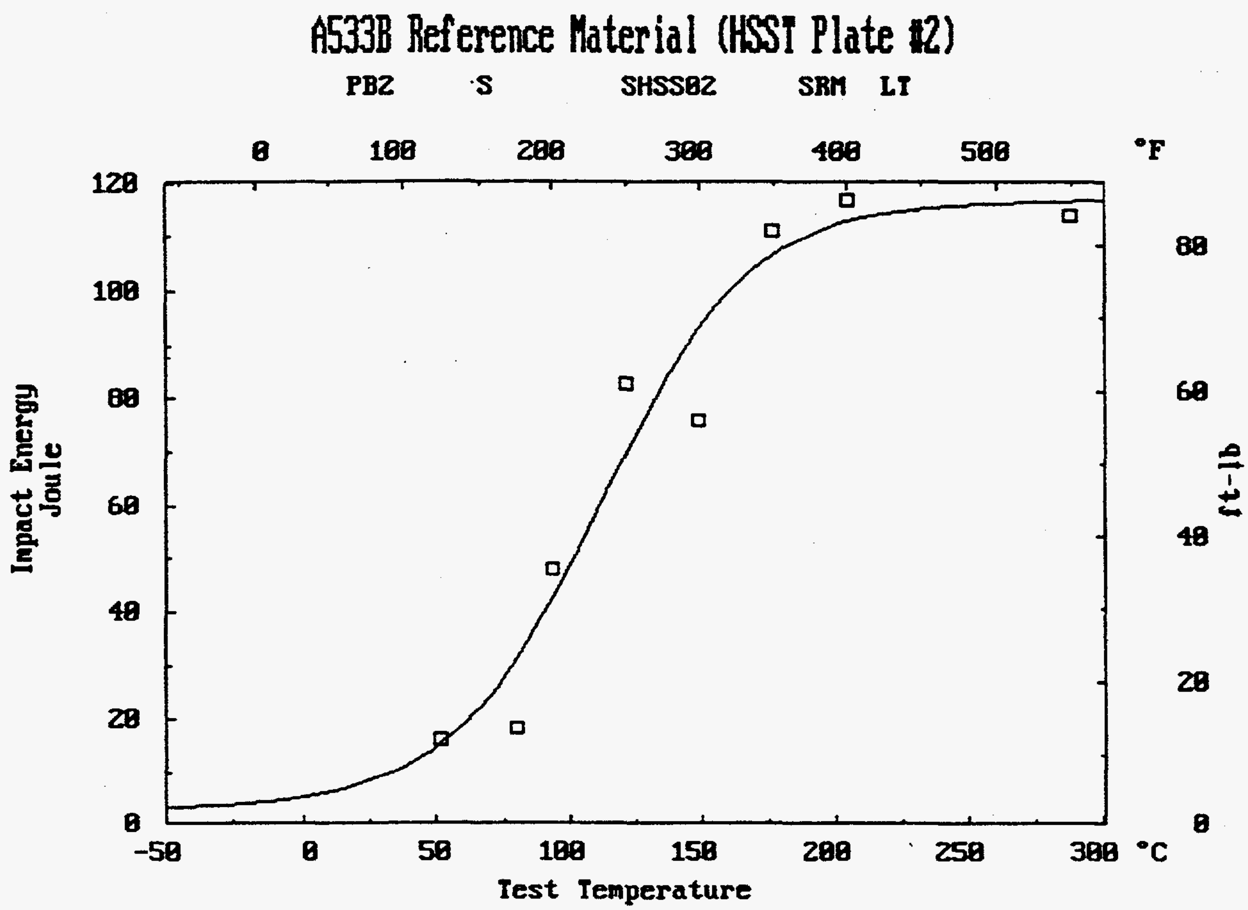
A533B HSST02 REFERENCE MATERIAL

Point Beach Unit 2, Capsule S

Impact Energy Uncertainty = 10.0 J
Test Temperature Uncertainty = 4.0 Degree C
Number of Successful Iterations = 200, Maximum = 1000

PB2 S SHSS02 SRM LT : Fluence = 3.470E+19 , Irr. Temp. = 304

| Parameter | Mean | Std.Dev. | Correlation Coefficients | | | | |
|---|---|---|---|---|---|---|---|
| Lower Shelf Energy (J) | 3.0 | 0.0 | | | | | |
| Upper Shelf Energy (J) | 116.8 | 8.0 | -0.073 | | | | |
| CVT at Midpoint (C) | 111.2 | 8.6 | -0.001 | 0.683 | | | |
| 1/slope (C) | 56.3 | 12.2 | -0.012 | 0.603 | 0.456 | | |
| CVT at 41 Joule (C) | 91.6 | 6.9 | 0.034 | 0.020 | 0.643 | -0.333 | |
| CVT at 68 Joule (C) | 119.1 | 6.8 | 0.041 | 0.299 | 0.881 | 0.387 | 0.721 |

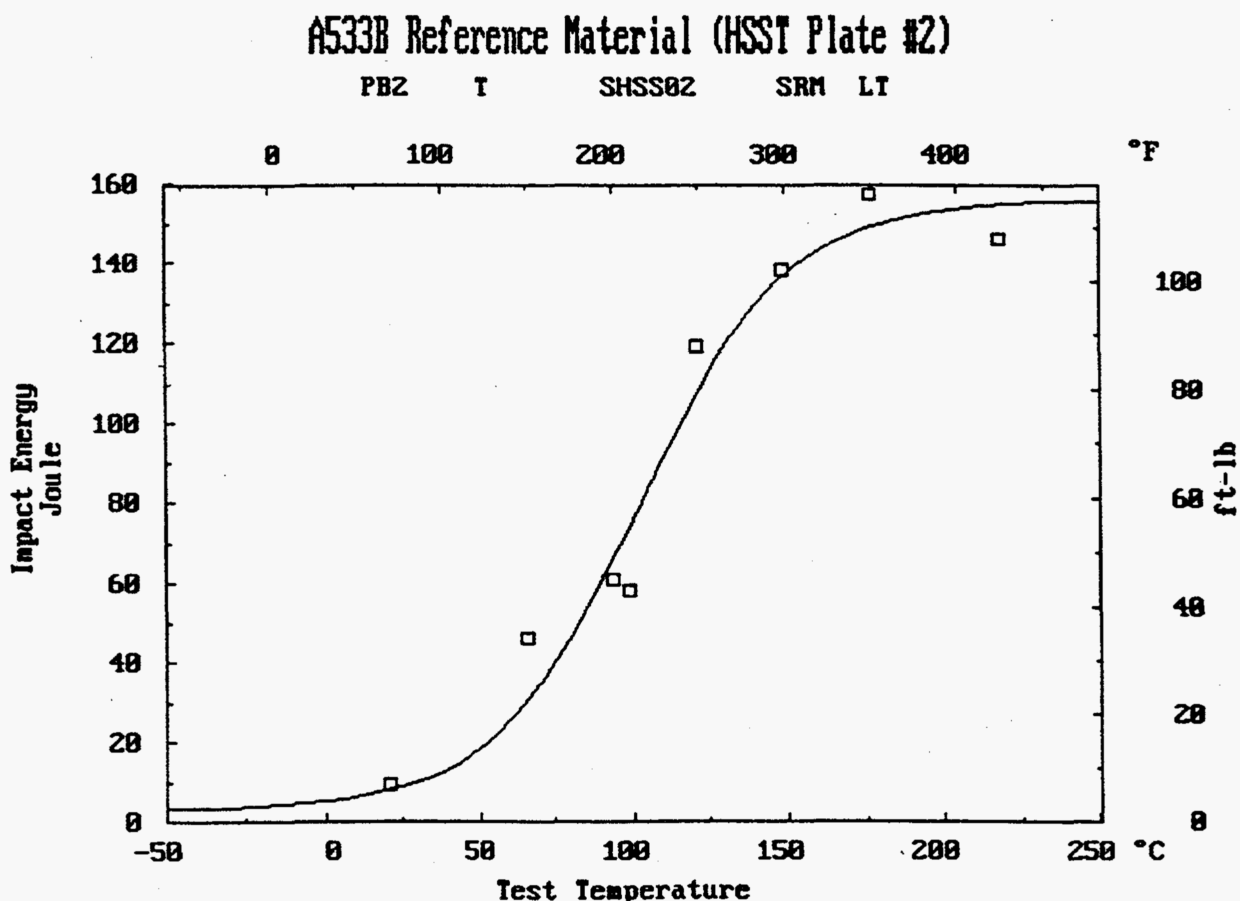


## A533B HSST02 REFERENCE MATERIAL

Point Beach Unit 2, Capsule T

USE= 156.1 J, LSE= 3.0 J, CVT(1/2)= 102.C , Slope = 0.0209
CVT(41J) = 76. C , CVT(68J) = 95. C ,
Fluence = 9.450E+18 , Irr. Temp. = 304 C

| Spec. ID | Test Temp. C | Test Temp. F | Impact Energy J | Impact Energy ft-lb | Lat. Exp. mm | Lat. Exp. mil | % Shear |
|---|---|---|---|---|---|---|---|
| R30 | 21. | 70. | 9. | 7. | 0.08 | 3. | 5. |
| R32 | 66. | 150. | 46. | 34. | 0.66 | 26. | 20. |
| R26 | 93. | 200. | 61. | 45. | 0.86 | 34. | 30. |
| R27 | 99. | 210. | 58. | 43. | 0.86 | 34. | 40. |
| R31 | 121. | 250. | 119. | 88. | 1.57 | 62. | 70. |
| R28 | 149. | 300. | 138. | 102. | 1.98 | 78. | 100. |
| R25 | 177. | 350. | 157. | 116. | 2.13 | 84. | 100. |
| R29 | 218. | 425. | 146. | 108. | 1.73 | 68. | 100. |



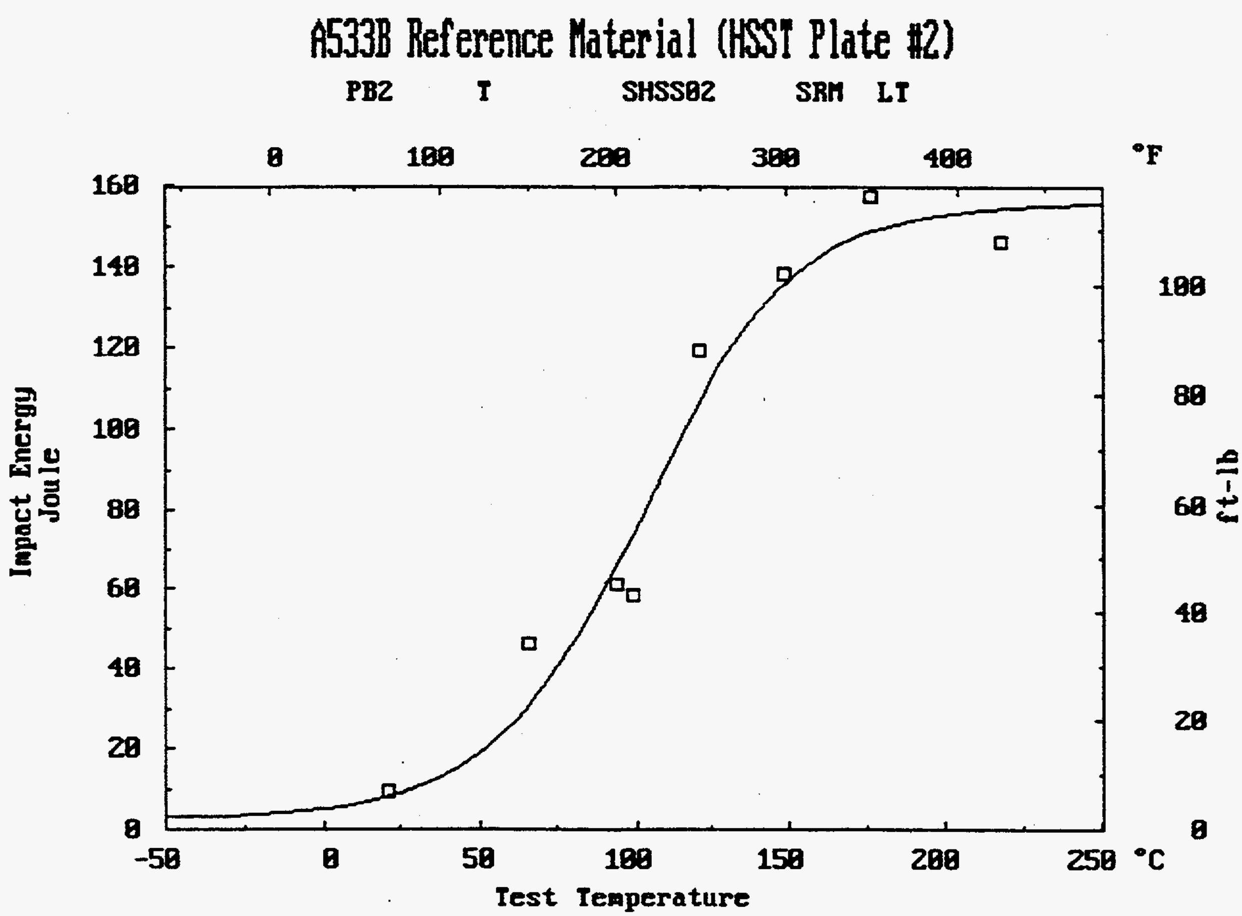
A533B HSST02 REFERENCE MATERIAL

Point Beach Unit 2, Capsule T

Impact Energy Uncertainty = 10.0 J
Test Temperature Uncertainty = 4.0 Degree C
Number of Successful Iterations = 200, Maximum = 1000

PB2 T SHSS02 SRM LT : Fluence = 9.450E+18 , Irr. Temp. = 304

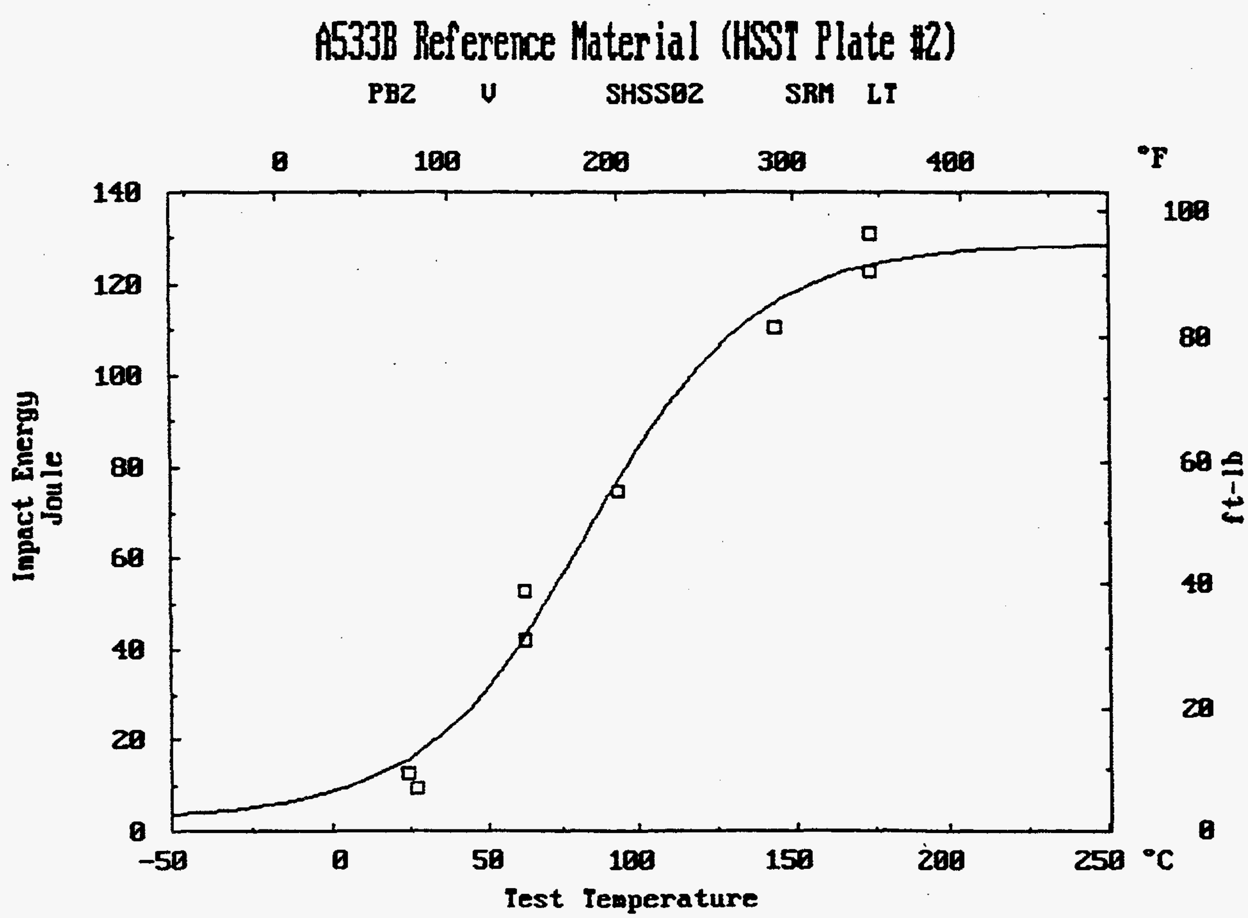
| Parameter | Mean | Std.Dev. | Correlation Coefficients | | | | |
|---|---|---|---|---|---|---|---|
| Lower Shelf Energy (J) | 3.0 | 0.0 | | | | | |
| Upper Shelf Energy (J) | 156.1 | 7.5 | -0.060 | | | | |
| CVT at Midpoint (C) | 102.5 | 5.1 | 0.265 | 0.503 | | | |
| 1/slope (C) | 48.7 | 10.1 | -0.357 | 0.553 | 0.121 | | |
| CVT at 41 Joule (C) | 75.4 | 7.4 | 0.460 | -0.292 | 0.486 | -0.793 | |
| CVT at 68 Joule (C) | 95.0 | 4.9 | 0.407 | -0.089 | 0.786 | -0.430 | 0.888 |



A533B HSST02 REFERENCE MATERIAL
Point Beach Unit 2, Capsule V

USE= 128.6 J, LSE= 3.0 J, CVT(1/2)= 83.C , Slope = 0.0182
CVT(41J) = 61. C , CVT(68J) = 85. C ,
Fluence = 4.740E+18 , Irr. Temp. = 310 C

| Spec. ID | Test Temp. C | Test Temp. F | Impact Energy J | Impact Energy ft-lb | Lat. Exp. mm | Lat. Exp. mil | % Shear |
|---|---|---|---|---|---|---|---|
| R7 | 24. | 76. | 13. | 9. | 0.36 | 14. | 10. |
| R2 | 27. | 80. | 9. | 7. | 0.28 | 11. | 10. |
| R4 | 63. | 145. | 53. | 39. | 1.12 | 44. | 25. |
| R5 | 63. | 145. | 42. | 31. | 0.91 | 36. | 30. |
| R6 | 93. | 200. | 75. | 55. | 1.40 | 55. | 50. |
| R8 | 143. | 290. | 110. | 81. | 1.93 | 76. | 90. |
| R1 | 174. | 345. | 131. | 96. | 2.13 | 84. | 100. |
| R3 | 174. | 345. | 123. | 90. | 2.24 | 88. | 100. |



A533B HSST02 REFERENCE MATERIAL

Point Beach Unit 2, Capsule V

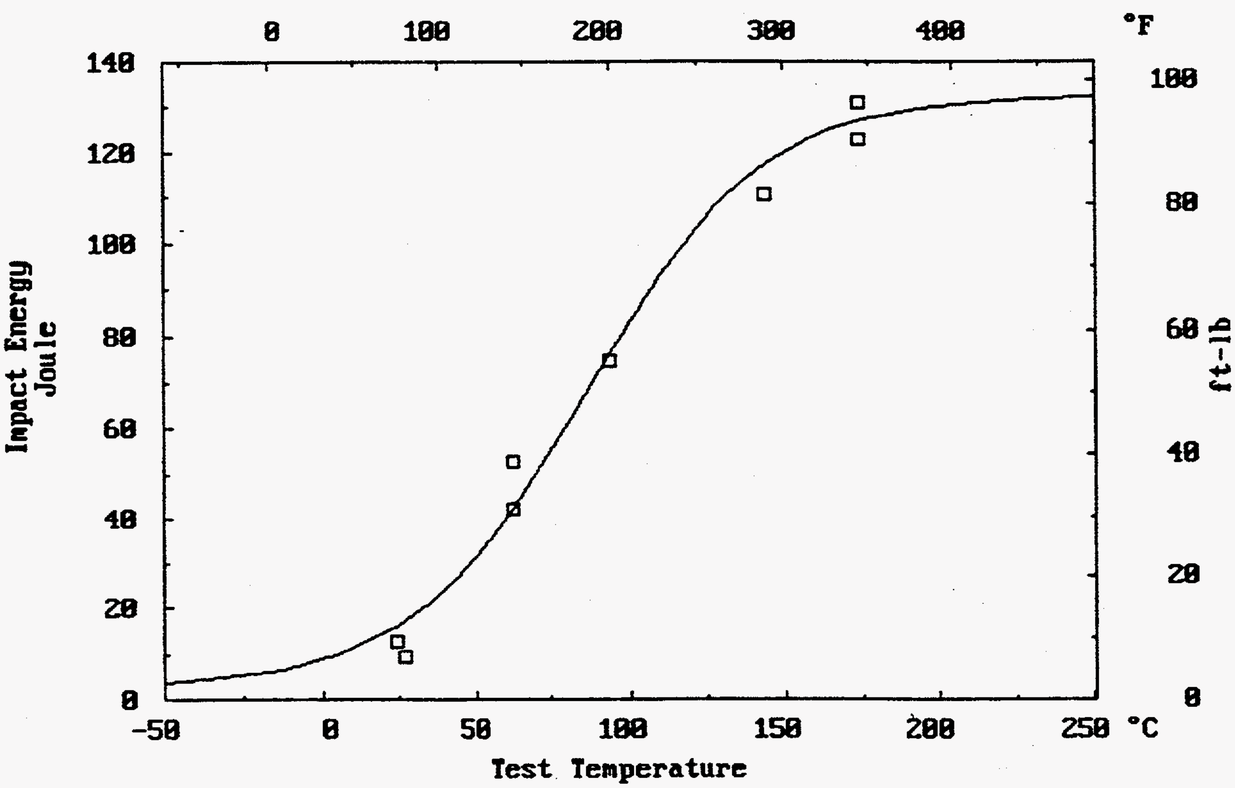
```
Impact Energy Uncertainty =  10.0 J
Test Temperature Uncertainty =   4.0 Degree C
Number of Successful Iterations =  200, Maximum = 1000
```

```
PB2   V     SHSS02    SRM  LT : Fluence = 4.740E+18 , Irr. Temp. =  310
```

| Parameter | Mean | Std.Dev. | Correlation Coefficients | | | | |
|---|---|---|---|---|---|---|---|
| Lower Shelf Energy (J) | 3.0 | 0.0 | | | | | |
| Upper Shelf Energy (J) | 132.4 | 12.6 | 0.105 | | | | |
| CVT at Midpoint (C) | 86.2 | 11.4 | 0.196 | 0.855 | | | |
| 1/slope (C) | 56.7 | 14.9 | 0.222 | 0.769 | 0.774 | | |
| CVT at 41 Joule (C) | 60.8 | 5.9 | 0.038 | 0.074 | 0.446 | -0.171 | |
| CVT at 68 Joule (C) | 85.9 | 7.1 | 0.212 | 0.544 | 0.895 | 0.609 | 0.664 |

## A533B Reference Material (HSST Plate #2)

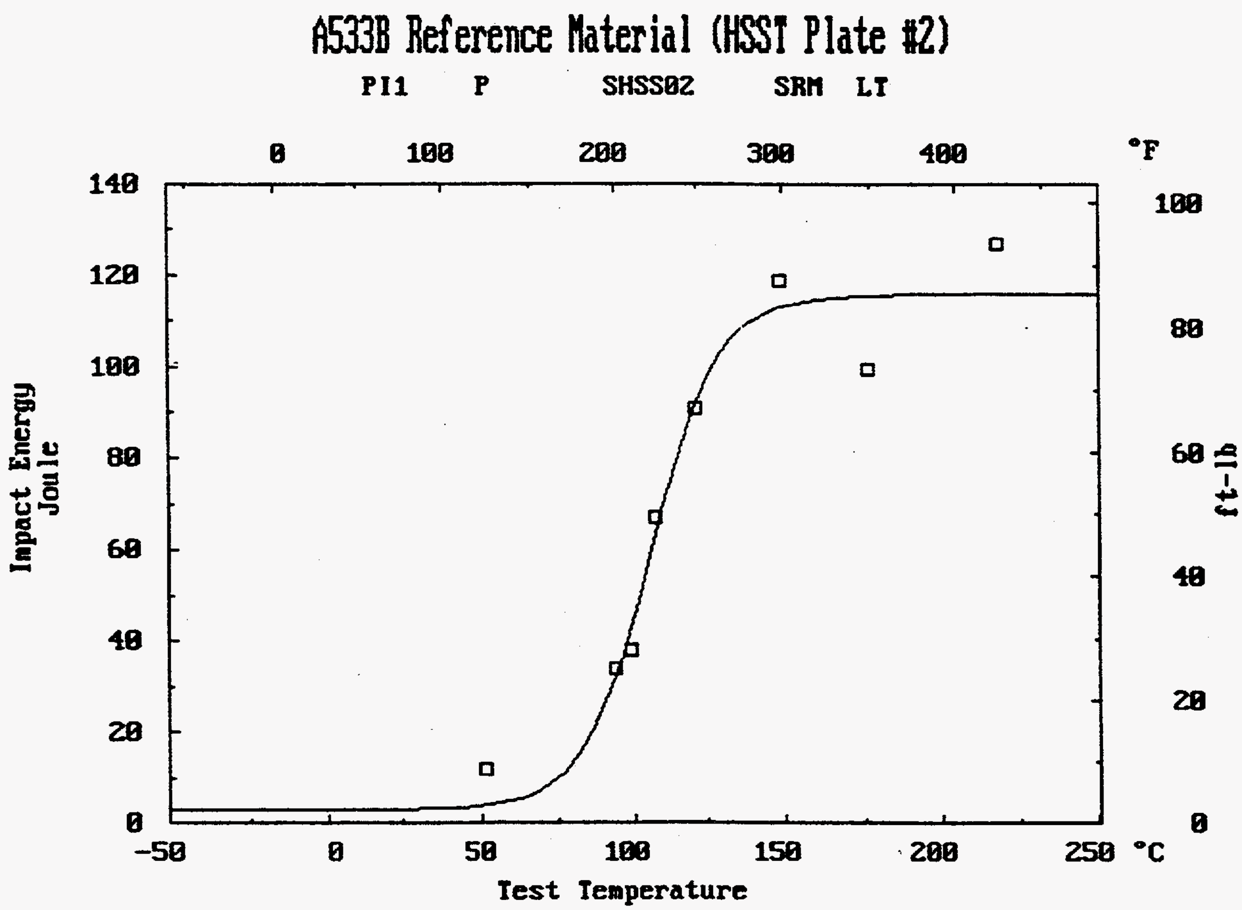
PB2 V SHSS02 SRM LT



A533B HSST02 REFERENCE MATERIAL
Prairie Island Unit 1, Capsule P

USE= 115.7 J, LSE= 3.0 J, CVT(1/2)= 106.C , Slope = 0.0435
CVT(41J) = 98. C , CVT(68J) = 109. C ,
Fluence = 1.250E+19 , Irr. Temp. = 304 C

| Spec. ID | Test Temp. C | Test Temp. F | Impact Energy J | Impact Energy ft-lb | Lat. Exp. mm | Lat. Exp. mil | % Shear |
|---|---|---|---|---|---|---|---|
| R47 | 52. | 125. | 12. | 9. | 0.13 | 5. | 9. |
| R44 | 93. | 200. | 34. | 25. | 0.53 | 21. | 38. |
| R48 | 99. | 210. | 38. | 28. | 0.84 | 33. | 34. |
| R43 | 107. | 225. | 67. | 49. | 0.91 | 36. | 58. |
| R45 | 121. | 250. | 91. | 67. | 1.47 | 58. | 65. |
| R41 | 149. | 300. | 119. | 87. | 1.19 | 47. | 100. |
| R42 | 177. | 350. | 100. | 73. | 1.75 | 69. | 100. |
| R46 | 218. | 425. | 127. | 93. | 1.55 | 61. | 100. |



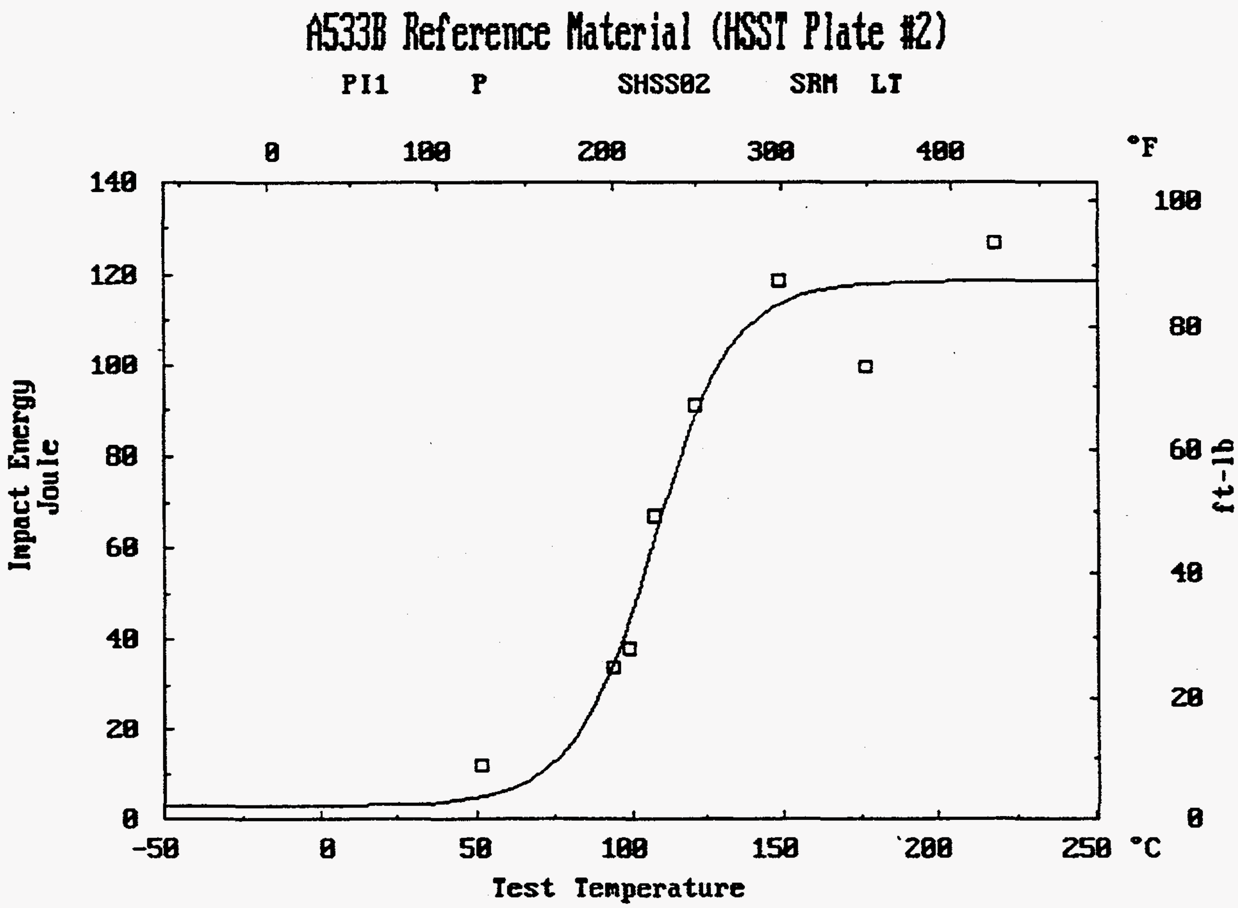
A533B HSST02 REFERENCE MATERIAL

Prairie Island Unit 1, Capsule P

Impact Energy Uncertainty = 10.0 J
Test Temperature Uncertainty = 4.0 Degree C
Number of Successful Iterations = 200, Maximum = 1000

PI1 P SHSS02 SRM LT : Fluence = 1.250E+19 , Irr. Temp. = 304

| Parameter | Mean | Std.Dev. | Correlation Coefficients | | | | |
|---|---|---|---|---|---|---|---|
| Lower Shelf Energy (J) | 3.0 | 0.0 | | | | | |
| Upper Shelf Energy (J) | 118.6 | 6.5 | -0.058 | | | | |
| CVT at Midpoint (C) | 106.8 | 4.1 | 0.084 | 0.540 | | | |
| 1/slope (C) | 27.0 | 9.4 | -0.244 | 0.492 | 0.303 | | |
| CVT at 41 Joule (C) | 97.0 | 4.5 | 0.271 | -0.159 | 0.513 | -0.637 | |
| CVT at 68 Joule (C) | 110.0 | 3.6 | 0.045 | 0.237 | 0.914 | 0.354 | 0.486 |



A533B HSST02 REFERENCE MATERIAL

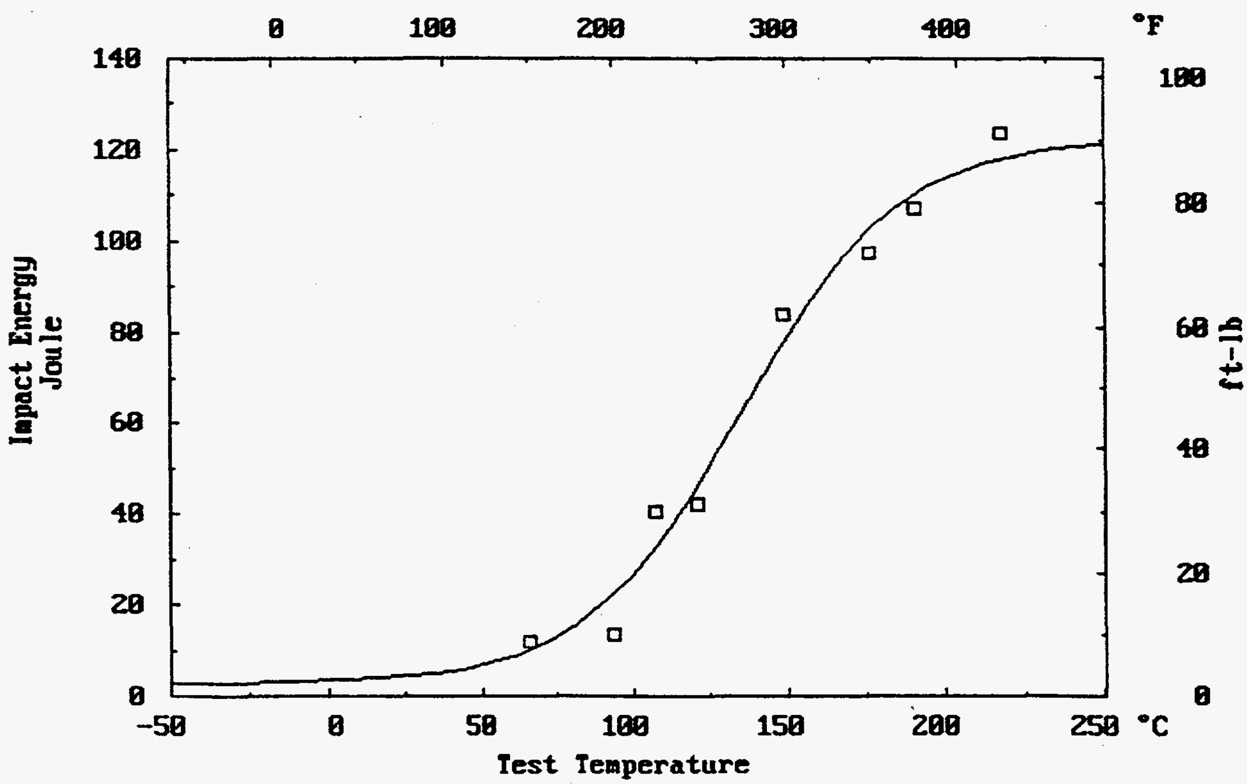
Prairie Island Unit 1, Capsule R

USE= 122.3 J, LSE= 3.0 J, CVT(1/2)= 135.C , Slope = 0.0198
CVT(41J) = 116. C , CVT(68J) = 140. C ,
Fluence = 4.030E+19 , Irr. Temp. = 304 C

| Spec. ID | Test Temp. C | Test Temp. F | Impact Energy J | Impact Energy ft-lb | Lat. Exp. mm | Lat. Exp. mil | % Shear |
|---|---|---|---|---|---|---|---|
| R9 | 66. | 150. | 12. | 9. | 0.15 | 6. | 13. |
| R14 | 93. | 200. | 14. | 10. | 0.25 | 10. | 23. |
| R15 | 107. | 225. | 41. | 30. | 0.58 | 23. | 32. |
| R12 | 121. | 250. | 42. | 31. | 0.46 | 18. | 32. |
| R16 | 149. | 300. | 84. | 62. | 1.04 | 41. | 59. |
| R13 | 177. | 350. | 98. | 72. | 1.42 | 56. | 100. |
| R11 | 191. | 375. | 107. | 79. | 0.99 | 39. | 100. |
| R10 | 218. | 425. | 123. | 91. | 1.78 | 70. | 100. |

A533B Reference Material (HSST Plate #2)

PI1 R SHSS02 SRM LT



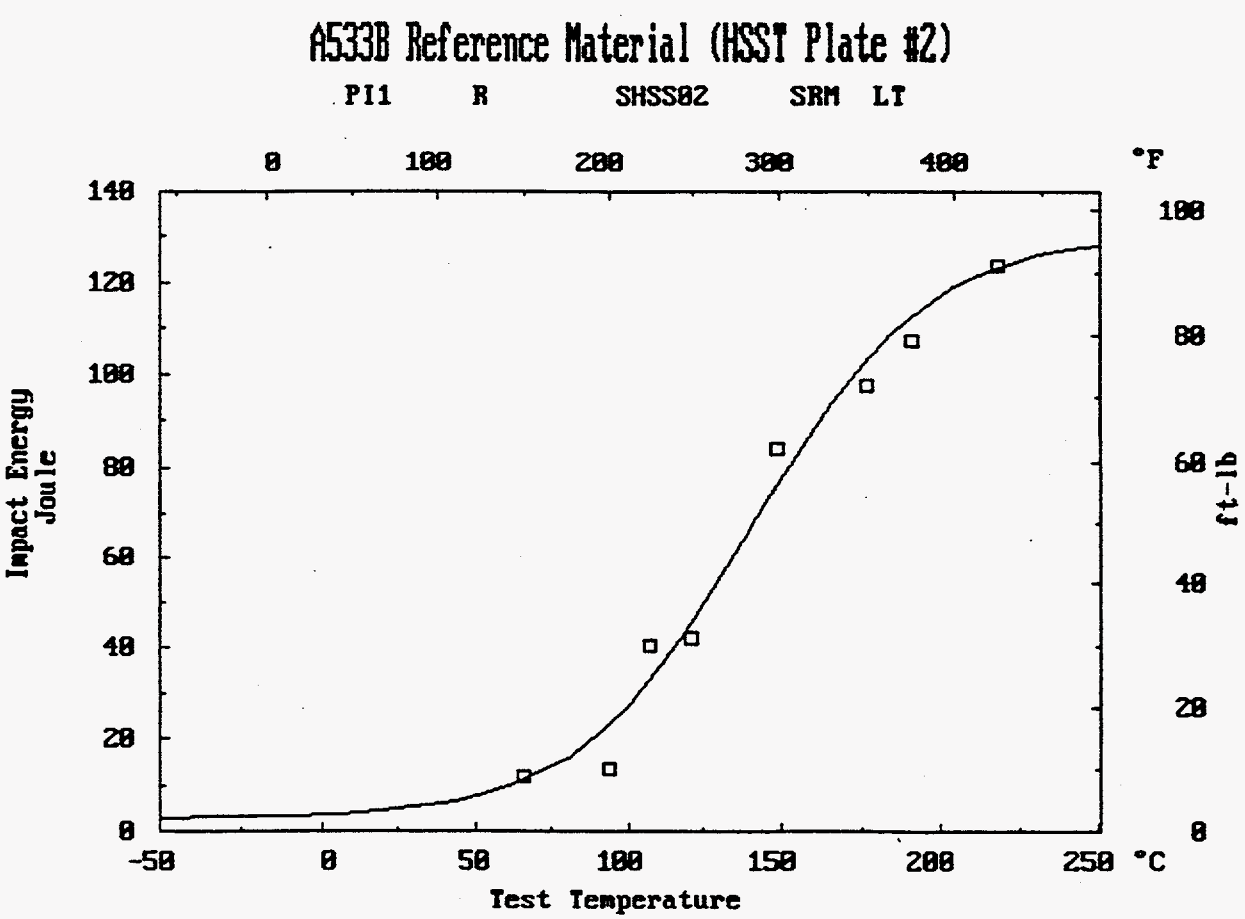
A533B HSST02 REFERENCE MATERIAL

Prairie Island Unit 1, Capsule R

Impact Energy Uncertainty = 10.0 J
Test Temperature Uncertainty = 4.0 Degree C
Number of Successful Iterations = 200, Maximum = 1000

PI1 R SHSS02 SRM LT : Fluence = 4.030E+19 , Irr. Temp. = 304

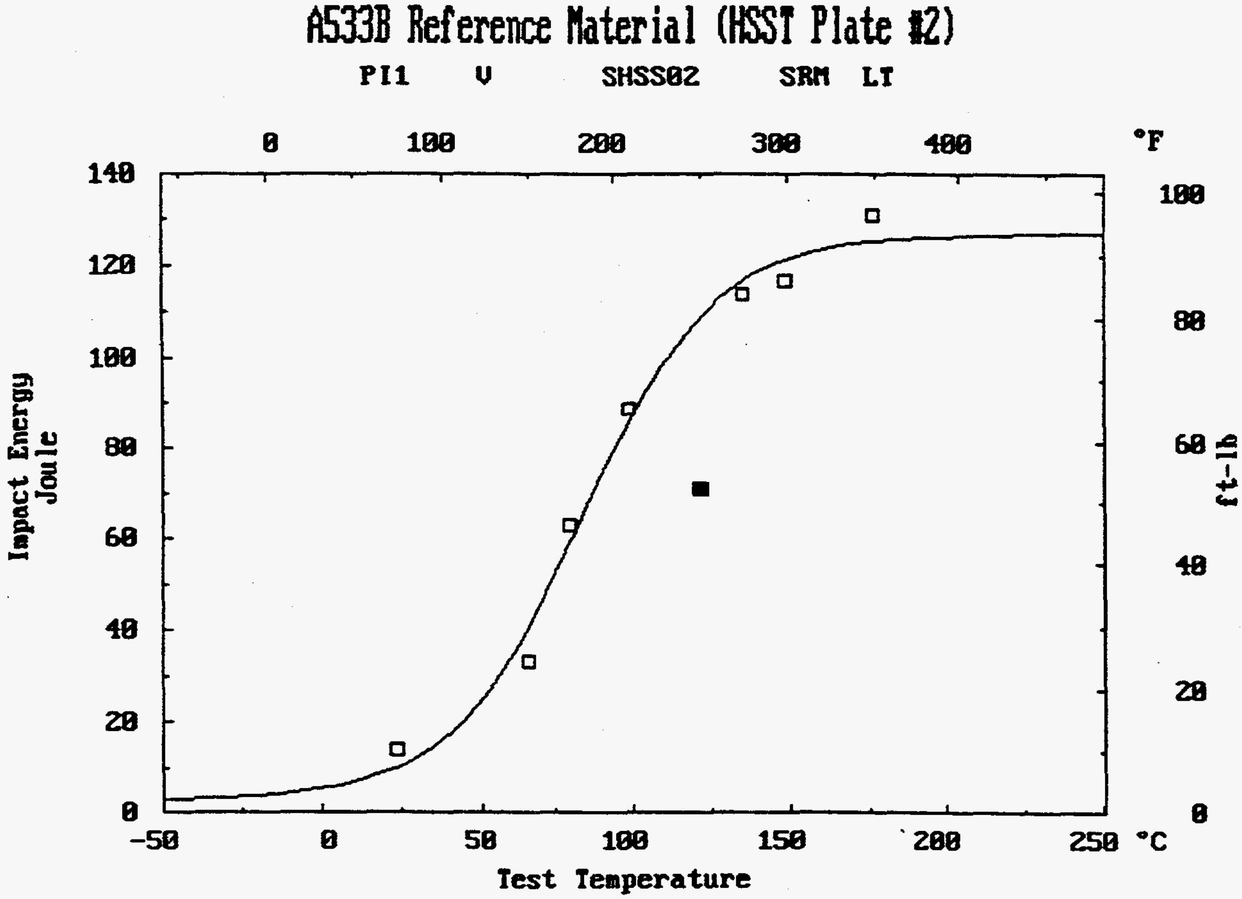
| Parameter | Mean | Std.Dev. | Correlation Coefficients | | | | |
|---|---|---|---|---|---|---|---|
| Lower Shelf Energy (J) | 3.0 | 0.0 | | | | | |
| Upper Shelf Energy (J) | 130.6 | 18.2 | -0.175 | | | | |
| CVT at Midpoint (C) | 140.4 | 12.6 | -0.136 | 0.916 | | | |
| 1/slope (C) | 55.8 | 15.3 | -0.129 | 0.833 | 0.822 | | |
| CVT at 41 Joule (C) | 115.8 | 5.5 | -0.008 | -0.013 | 0.292 | -0.232 | |
| CVT at 68 Joule (C) | 140.8 | 6.3 | -0.086 | 0.522 | 0.810 | 0.578 | 0.633 |



A533B HSST02 REFERENCE MATERIAL
Prairie Island Unit 1, Capsule V

USE= 126.8 J, LSE= 3.0 J, CVT(1/2)= 84.C , Slope = 0.0234
CVT(41J) = 66. C , CVT(68J) = 86. C ,
Fluence = 5.210E+18 , Irr. Temp. = 304 C

| Spec. ID | Test Temp. C | Test Temp. F | Impact Energy J | Impact Energy ft-lb | Lat. Exp. mm | Lat. Exp. mil | % Shear |
|---|---|---|---|---|---|---|---|
| R3 | 24. | 75. | 14. | 10. | 0.05 | 2. | 10. |
| R7 | 66. | 150. | 33. | 25. | 0.46 | 18. | 20. |
| R1 | 79. | 175. | 63. | 46. | 0.91 | 36. | 35. |
| R2 | 99. | 210. | 89. | 65. | 1.19 | 47. | 50. |
| *R8 | 121. | 250. | 71. | 52. | 1.17 | 46. | 50. |
| R5 | 135. | 275. | 114. | 84. | 1.50 | 59. | 70. |
| R6 | 149. | 300. | 117. | 86. | 1.73 | 68. | 100. |
| R4 | 177. | 350. | 131. | 96. | 1.93 | 76. | 100. |



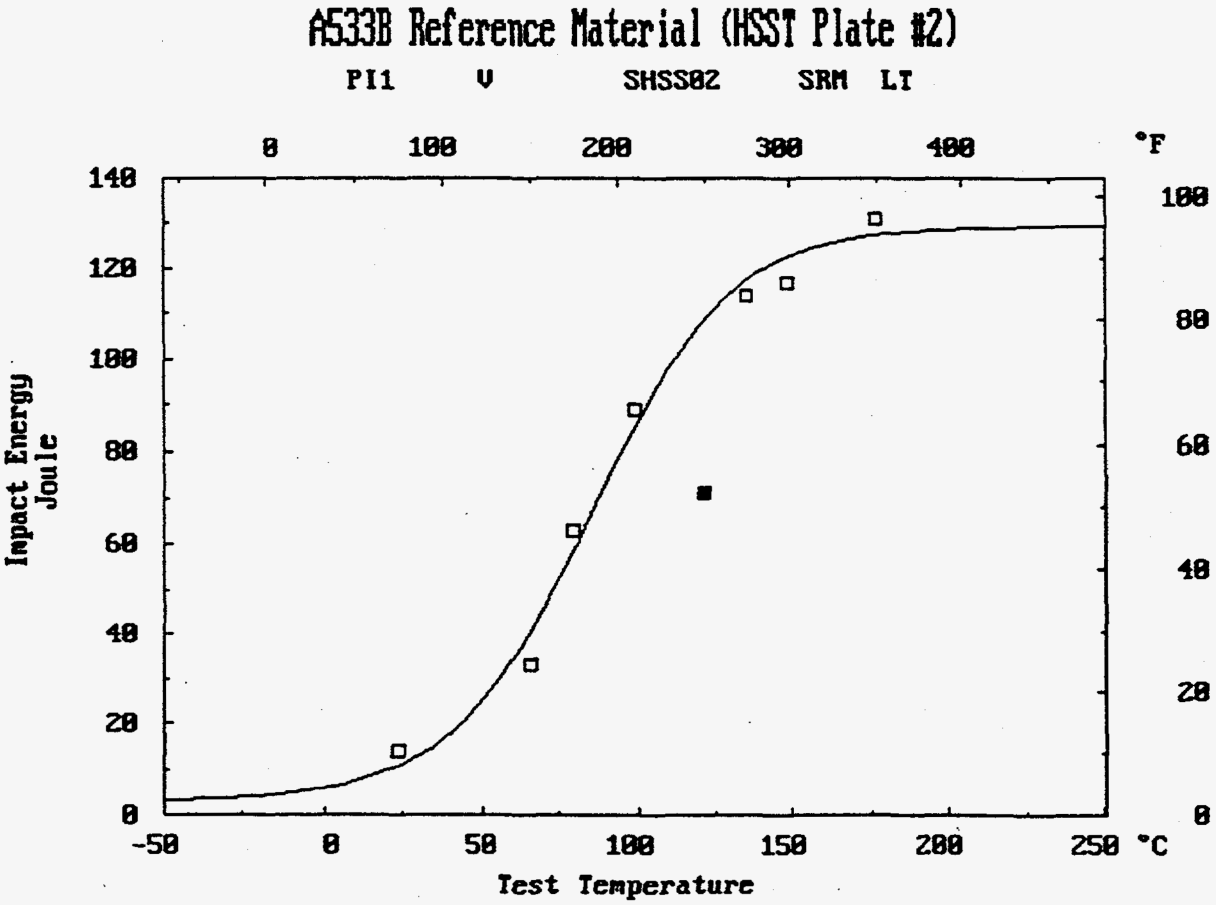
A533B HSST02 REFERENCE MATERIAL

Prairie Island Unit 1, Capsule V

```
Impact Energy Uncertainty =  10.0 J
Test Temperature Uncertainty =   4.0 Degree C
Number of Successful Iterations =  200, Maximum = 1000
```

```
PI1    V     SHSS02    SRM  LT : Fluence = 5.210E+18 , Irr. Temp. =  304
```

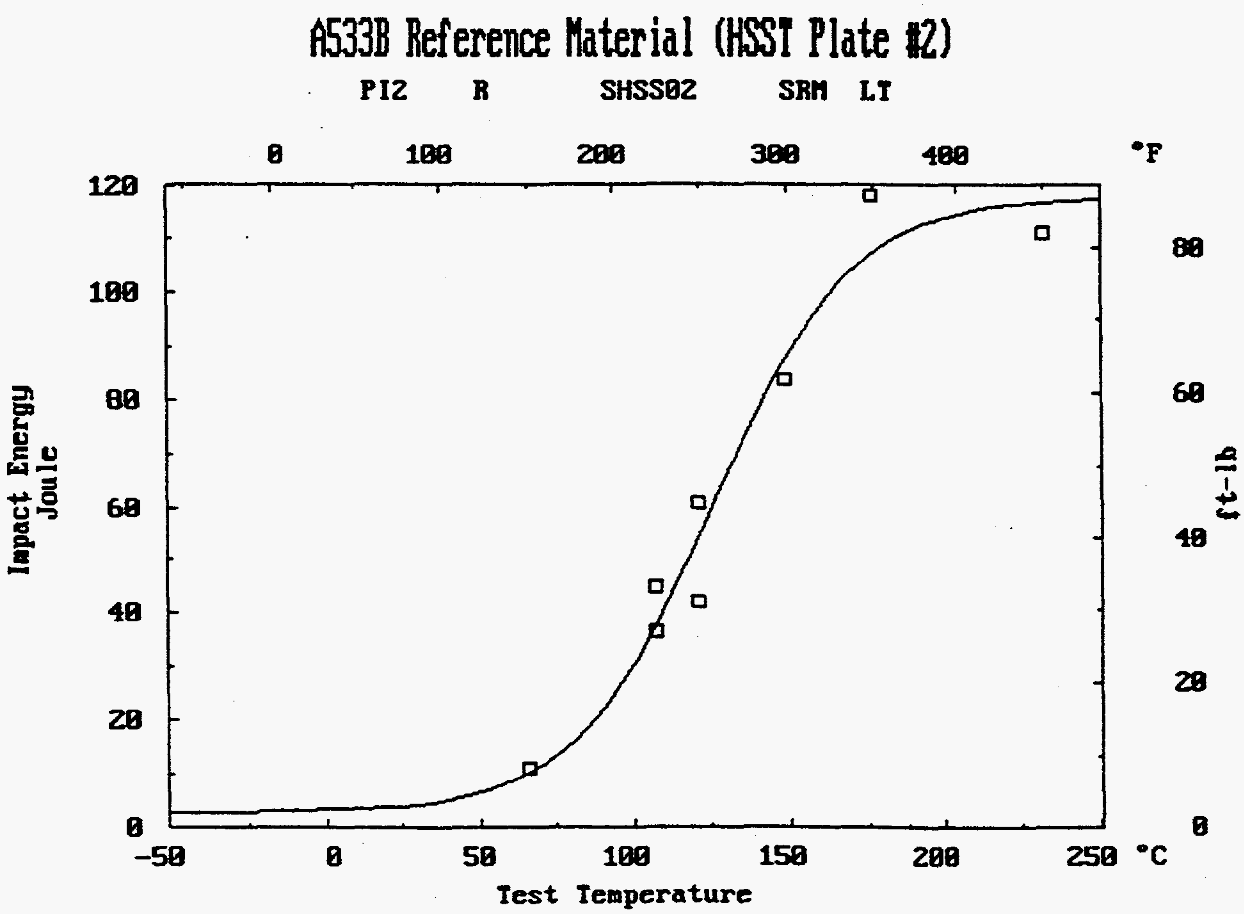
| Parameter | Mean | Std.Dev. | Correlation Coefficients | | | | |
|---|---|---|---|---|---|---|---|
| Lower Shelf Energy (J) | 3.0 | 0.0 | | | | | |
| Upper Shelf Energy (J) | 129.3 | 12.0 | -0.127 | | | | |
| CVT at Midpoint (C) | 84.9 | 8.0 | -0.074 | 0.809 | | | |
| 1/slope (C) | 44.5 | 14.1 | -0.179 | 0.768 | 0.627 | | |
| CVT at 41 Joule (C) | 65.6 | 6.1 | 0.150 | -0.252 | 0.220 | -0.591 | |
| CVT at 68 Joule (C) | 85.6 | 4.9 | -0.007 | 0.395 | 0.846 | 0.338 | 0.547 |



## A533B HSST02 REFERENCE MATERIAL
Prairie Island Unit 2, Capsule R

USE= 117.7 J, LSE= 3.0 J, CVT(1/2)= 126.C , Slope = 0.0228
CVT(41J) = 110. C , CVT(68J) = 132. C ,
Fluence = 4.420E+19 , Irr. Temp. = 304 C

| Spec. ID | Test Temp. C | Test Temp. F | Impact Energy J | Impact Energy ft-lb | Lat. Exp. mm | Lat. Exp. mil | % Shear |
|---|---|---|---|---|---|---|---|
| R15 | 66. | 150. | 11. | 8. | 0.25 | 10. | 13. |
| R10 | 107. | 225. | 37. | 27. | 0.74 | 29. | 33. |
| R16 | 107. | 225. | 45. | 33. | 0.66 | 26. | 41. |
| R11 | 121. | 250. | 61. | 45. | 0.86 | 34. | 56. |
| R9 | 121. | 250. | 42. | 31. | 0.63 | 25. | 46. |
| R14 | 149. | 300. | 84. | 62. | 1.42 | 56. | 100. |
| R12 | 177. | 350. | 118. | 87. | 1.78 | 70. | 100. |
| R13 | 232. | 450. | 111. | 82. | 1.37 | 54. | 100. |



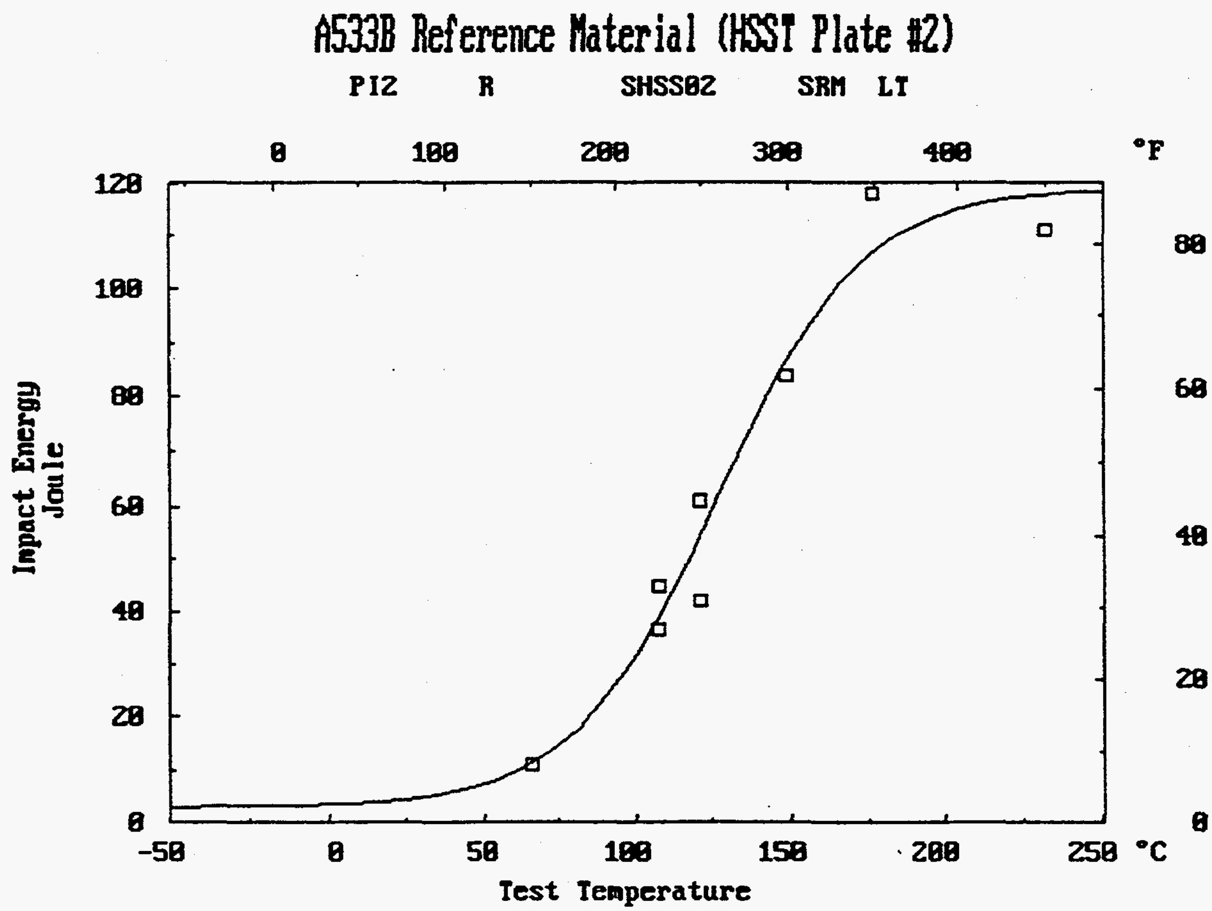
A533B HSST02 REFERENCE MATERIAL

Prairie Island Unit 2, Capsule R

Impact Energy Uncertainty = 10.0 J
Test Temperature Uncertainty = 4.0 Degree C
Number of Successful Iterations = 200, Maximum = 1000

PI2 R SHSS02 SRM LT : Fluence = 4.420E+19 , Irr. Temp. = 304

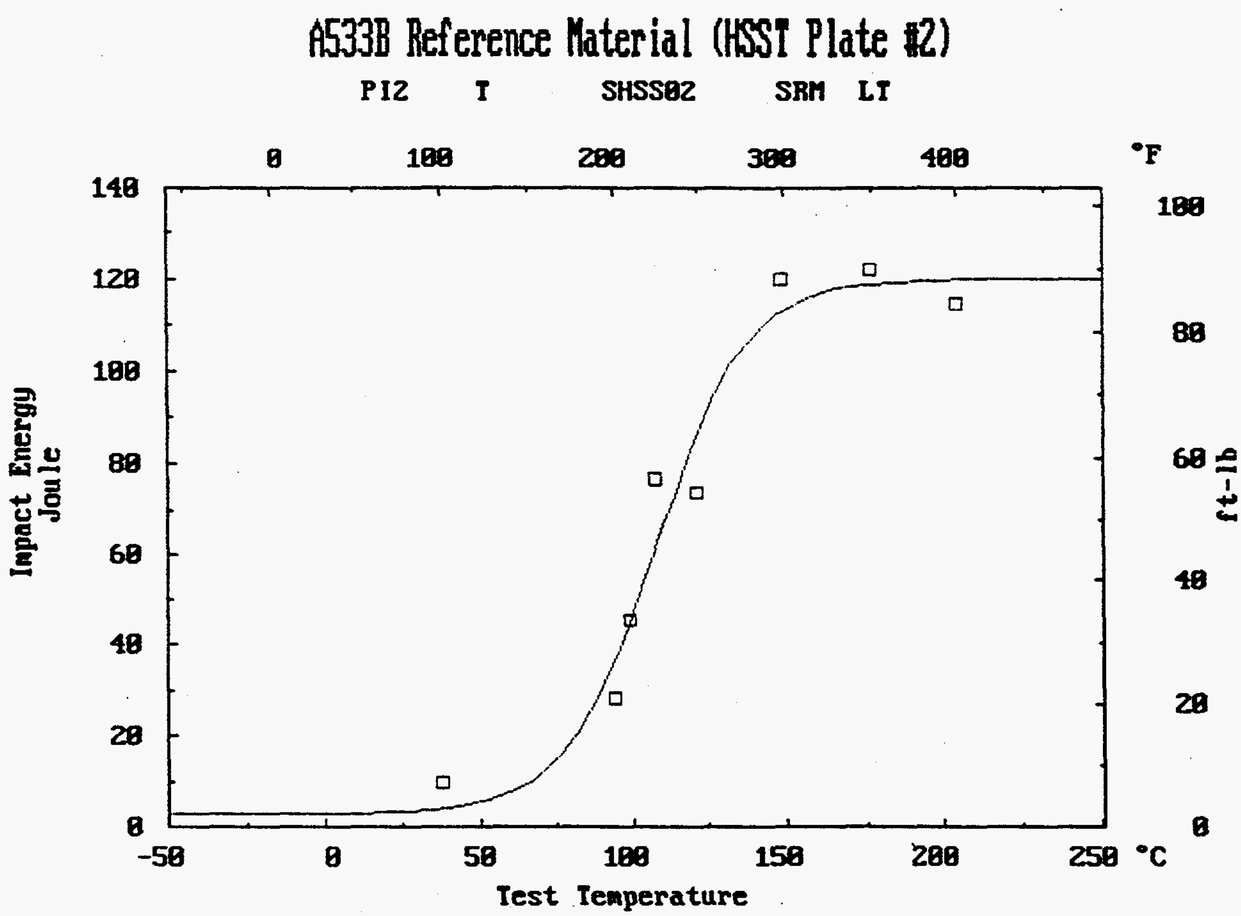
| Parameter | Mean | Std.Dev. | Correlation Coefficients | | | | |
|---|---|---|---|---|---|---|---|
| Lower Shelf Energy (J) | 3.0 | 0.0 | | | | | |
| Upper Shelf Energy (J) | 119.2 | 10.4 | -0.029 | | | | |
| CVT at Midpoint (C) | 126.4 | 6.8 | 0.066 | 0.760 | | | |
| 1/slope (C) | 46.8 | 11.8 | -0.158 | 0.497 | 0.395 | | |
| CVT at 41 Joule (C) | 109.3 | 5.7 | 0.233 | -0.046 | 0.439 | -0.585 | |
| CVT at 68 Joule (C) | 131.9 | 4.6 | 0.116 | 0.190 | 0.748 | 0.321 | 0.540 |



A533B HSST02 REFERENCE MATERIAL
Prairie Island Unit 2, Capsule T

USE= 120.0 J, LSE= 3.0 J, CVT(1/2)= 107.C , Slope = 0.0333
CVT(41J) = 96. C , CVT(68J) = 111. C ,
Fluence = 1.050E+19 , Irr. Temp. = 304 C

| Spec. ID | Test Temp. C | Test Temp. F | Impact Energy J | Impact Energy ft-lb | Lat. Exp. mm | Lat. Exp. mil | % Shear |
|---|---|---|---|---|---|---|---|
| R31 | 38. | 100. | 10. | 8. | 0.15 | 6. | 14. |
| R32 | 93. | 200. | 28. | 21. | 0.46 | 18. | 25. |
| R25 | 99. | 210. | 45. | 33. | 0.71 | 28. | 30. |
| R27 | 107. | 225. | 77. | 56. | 1.19 | 47. | 53. |
| R28 | 121. | 250. | 74. | 54. | 1.04 | 41. | 62. |
| R30 | 149. | 300. | 120. | 88. | 2.01 | 79. | 100. |
| R29 | 177. | 350. | 122. | 90. | 1.75 | 69. | 100. |
| R26 | 204. | 400. | 115. | 84. | 2.01 | 79. | 100. |



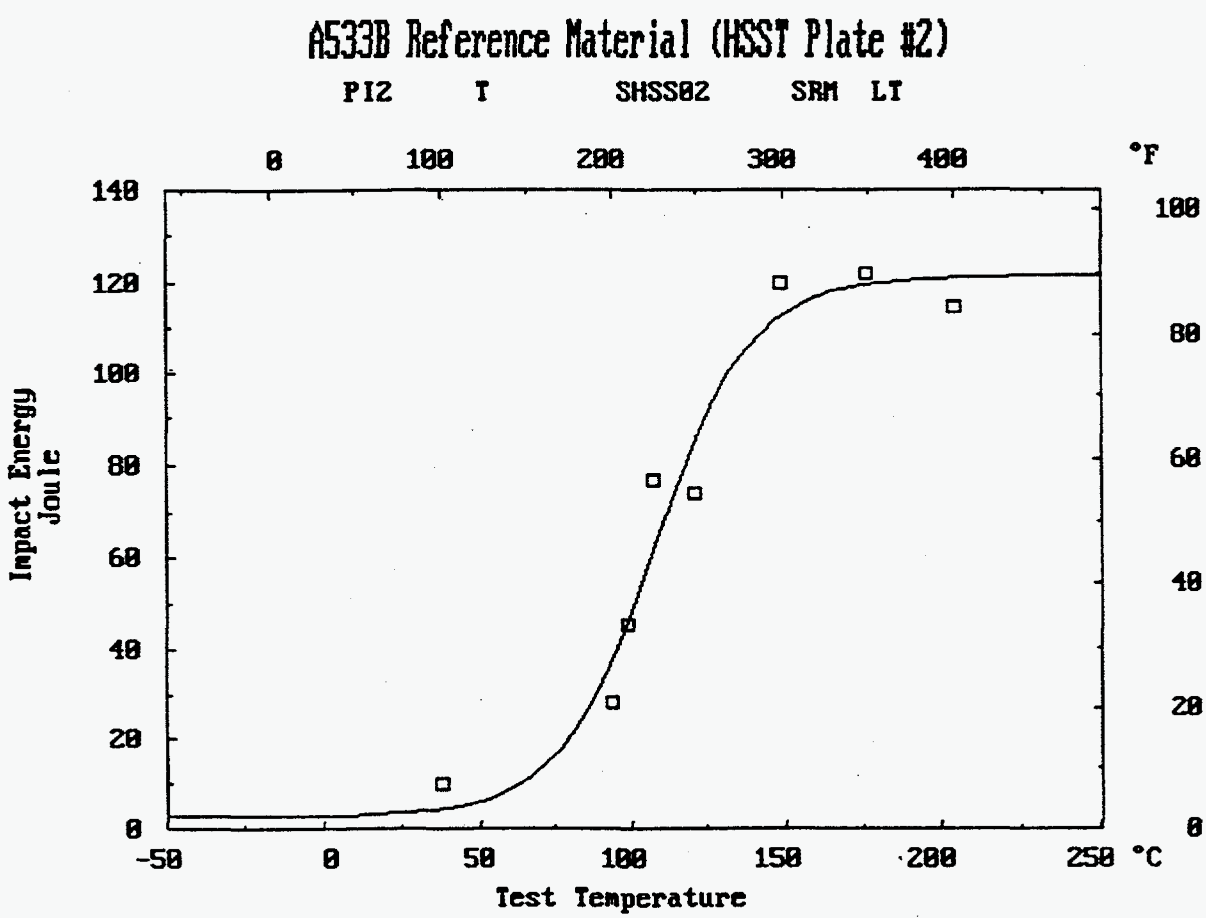
A533B HSST02 REFERENCE MATERIAL

Prairie Island Unit 2, Capsule T

Impact Energy Uncertainty = 10.0 J
Test Temperature Uncertainty = 4.0 Degree C
Number of Successful Iterations = 200, Maximum = 1000

PI2 T SHSS02 SRM LT : Fluence = 1.050E+19 , Irr. Temp. = 304

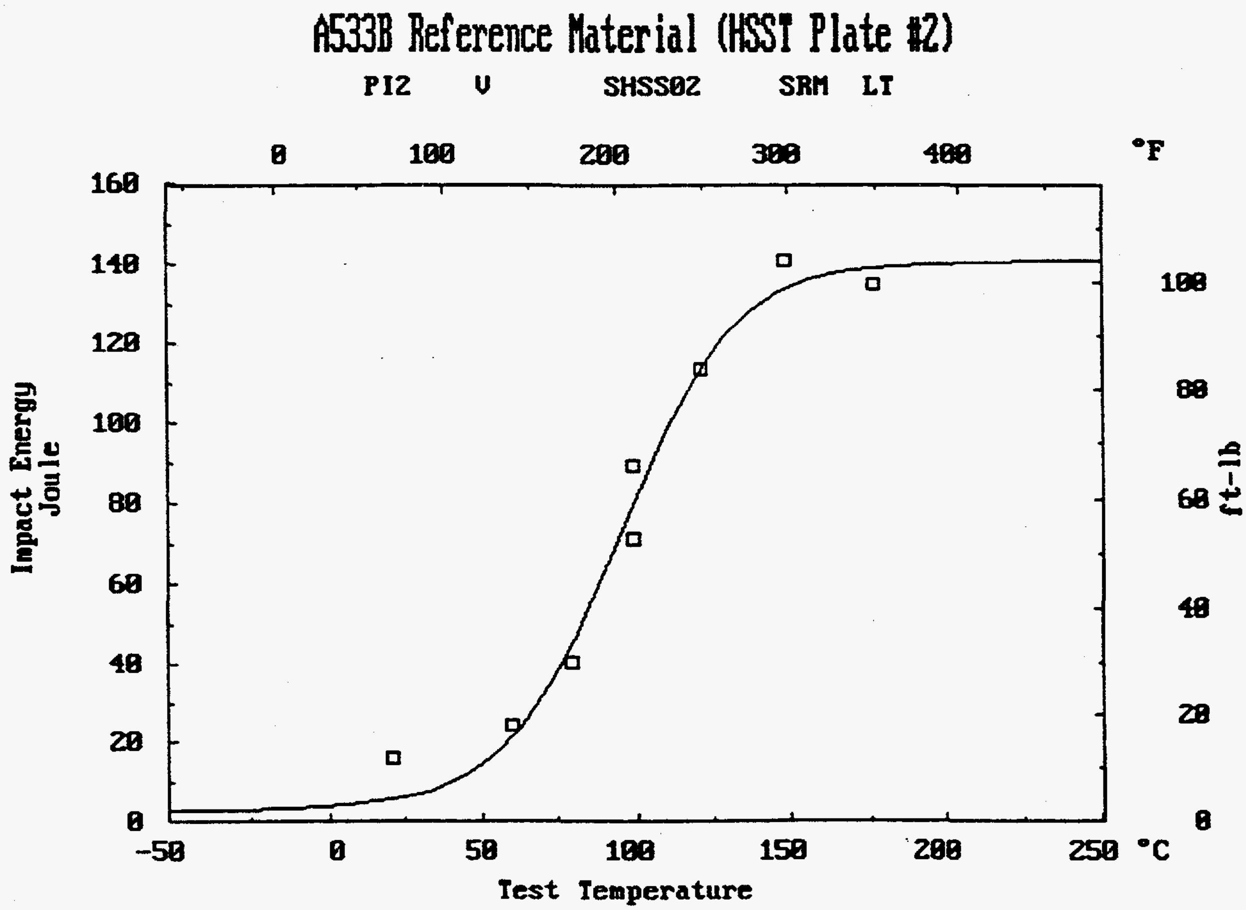
| Parameter | Mean | Std.Dev. | Correlation Coefficients | | | | |
|---|---|---|---|---|---|---|---|
| Lower Shelf Energy (J) | 3.0 | 0.0 | | | | | |
| Upper Shelf Energy (J) | 121.4 | 6.1 | -0.060 | | | | |
| CVT at Midpoint (C) | 107.7 | 4.2 | 0.025 | 0.455 | | | |
| 1/slope (C) | 32.0 | 8.0 | -0.184 | 0.402 | 0.131 | | |
| CVT at 41 Joule (C) | 95.6 | 4.9 | 0.148 | -0.122 | 0.667 | -0.617 | |
| CVT at 68 Joule (C) | 110.8 | 3.8 | 0.015 | 0.073 | 0.900 | 0.144 | 0.680 |



A533B HSST02 REFERENCE MATERIAL
Prairie Island Unit 2, Capsule V

USE= 141.1 J, LSE= 3.1 J, CVT(1/2)= 95.C , Slope = 0.0271
CVT(41J) = 77. C , CVT(68J) = 93. C ,
Fluence = 5.490E+18 , Irr. Temp. = 304 C

| Spec. ID | Test Temp. C | Test Temp. F | Impact Energy J | Impact Energy ft-lb | Lat. Exp. mm | Lat. Exp. mil | % Shear |
|---|---|---|---|---|---|---|---|
| R5 | 21. | 70. | 16. | 12. | 0.18 | 7. | 5. |
| R8 | 60. | 140. | 24. | 18. | 0.41 | 16. | 30. |
| R3 | 79. | 175. | 41. | 30. | 0.66 | 26. | 40. |
| R2 | 99. | 210. | 89. | 66. | 1.02 | 40. | 50. |
| R7 | 99. | 210. | 71. | 52. | 0.81 | 32. | 50. |
| R6 | 121. | 250. | 114. | 84. | 1.19 | 47. | 80. |
| R1 | 149. | 300. | 141. | 104. | 1.55 | 61. | 100. |
| R4 | 177. | 350. | 135. | 99. | 1.65 | 65. | 100. |



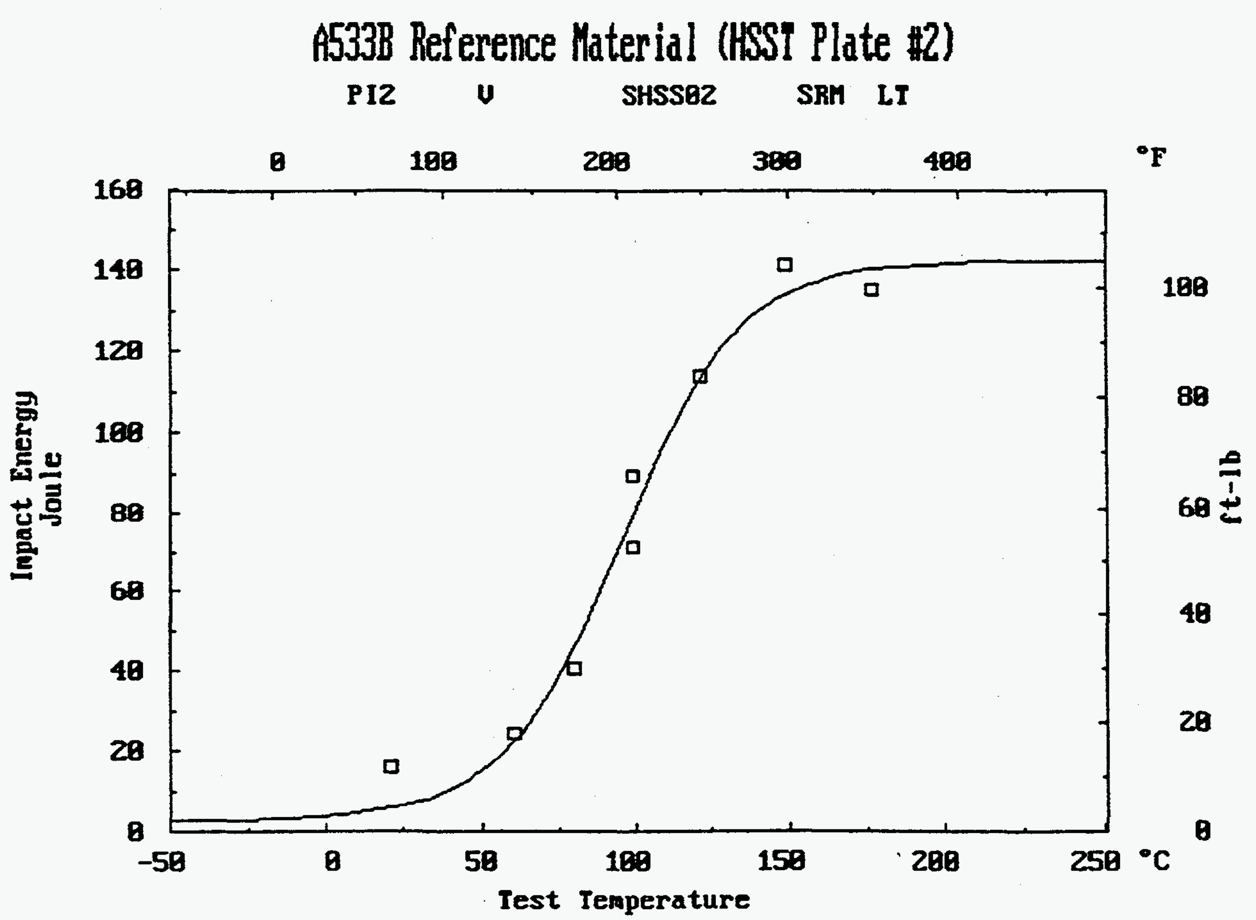
A533B HSST02 REFERENCE MATERIAL

Prairie Island Unit 2, Capsule V

```
Impact Energy Uncertainty =  10.0 J
Test Temperature Uncertainty =   4.0 Degree C
Number of Successful Iterations =  200, Maximum = 1000
```

PI2 V SHSS02 SRM LT : Fluence = 5.490E+18 , Irr. Temp. = 304

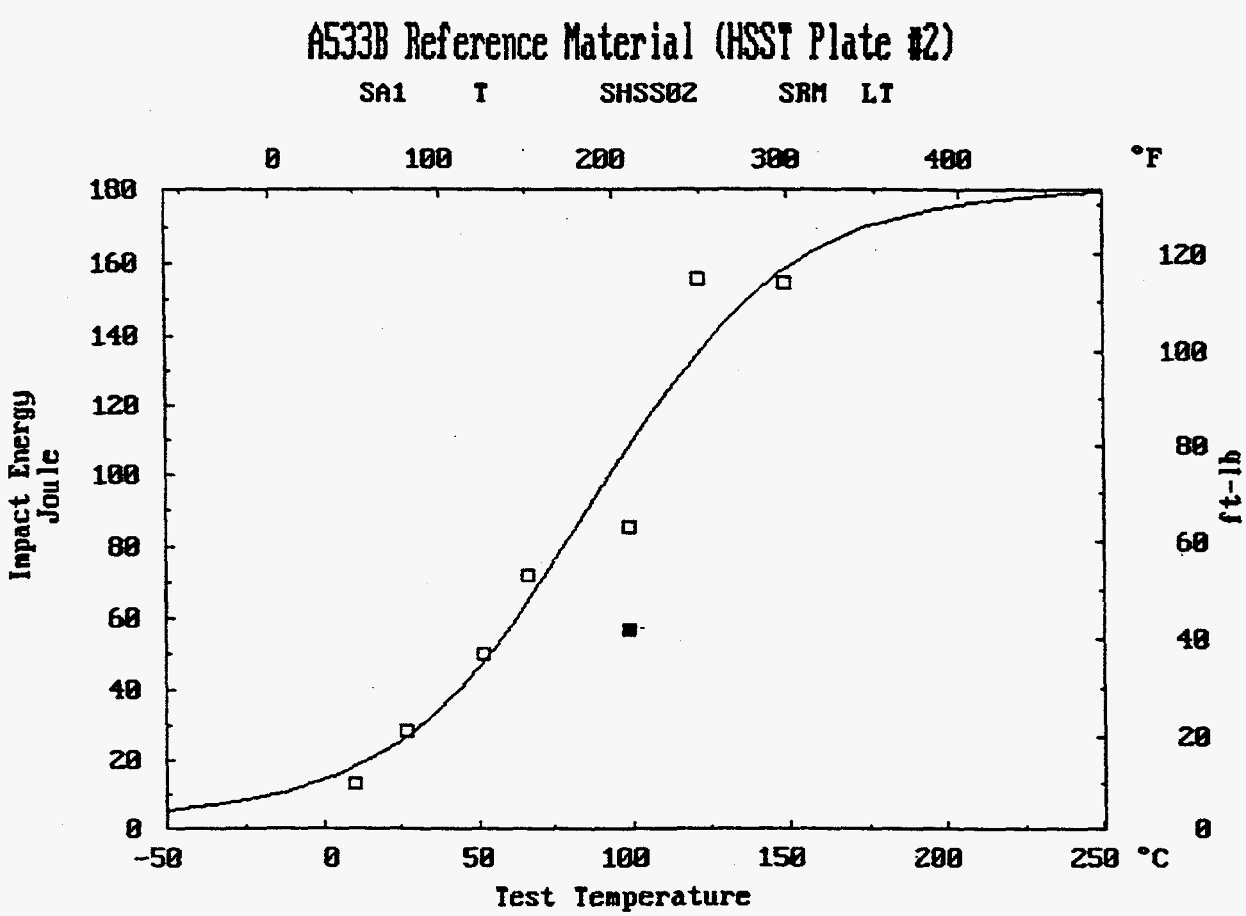
| Parameter | Mean | Std.Dev. | Correlation Coefficients | | | | |
|---|---|---|---|---|---|---|---|
| Lower Shelf Energy (J) | 3.1 | 0.1 | | | | | |
| Upper Shelf Energy (J) | 142.2 | 8.5 | 0.000 | | | | |
| CVT at Midpoint (C) | 95.0 | 4.6 | 0.142 | 0.598 | | | |
| 1/slope (C) | 38.3 | 9.7 | -0.284 | 0.494 | 0.173 | | |
| CVT at 41 Joule (C) | 76.1 | 6.2 | 0.313 | -0.211 | 0.444 | -0.784 | |
| CVT at 68 Joule (C) | 92.3 | 3.8 | 0.194 | 0.036 | 0.805 | -0.260 | 0.798 |



A533B HSST02 REFERENCE MATERIAL
Salem Unit 1, Capsule T

USE= 180.8 J, LSE= 3.0 J, CVT(1/2)= 87.C , Slope = 0.0156
CVT(41J) = 45. C , CVT(68J) = 69. C ,
Fluence = 2.560E+18 , Irr. Temp. = 304 C

| Spec. ID | Test Temp. C | Test Temp. F | Impact Energy J | Impact Energy ft-lb | Lat. Exp. mm | Lat. Exp. mil | % Shear |
|---|---|---|---|---|---|---|---|
| R2 | 10. | 50. | 14. | 10. | 0.23 | 9. | 1. |
| R1 | 27. | 80. | 28. | 21. | 0.36 | 14. | 10. |
| R8 | 52. | 125. | 50. | 37. | 0.81 | 32. | 25. |
| R6 | 66. | 151. | 72. | 53. | 1.04 | 41. | 35. |
| R3 | 99. | 210. | 85. | 63. | 1.37 | 54. | 65. |
| *R7 | 99. | 210. | 57. | 42. | 1.09 | 43. | 45. |
| R5 | 121. | 250. | 156. | 115. | 2.18 | 86. | 95. |
| R4 | 149. | 300. | 155. | 114. | 2.06 | 81. | 100. |



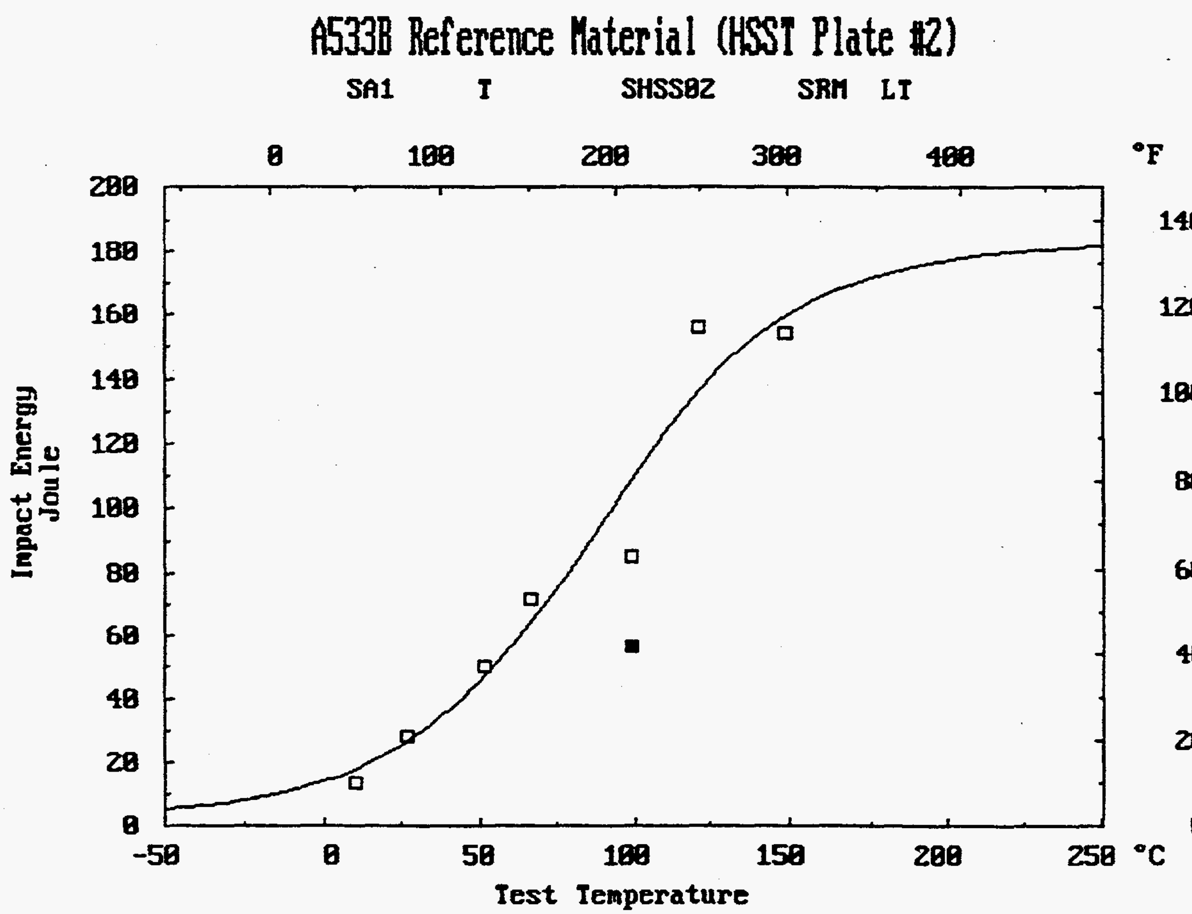
A533B HSST02 REFERENCE MATERIAL

Salem Unit 1, Capsule T

Impact Energy Uncertainty = 10.0 J
Test Temperature Uncertainty = 4.0 Degree C
Number of Successful Iterations = 200, Maximum = 1000

SA1 T SHSS02 SRM LT : Fluence = 2.560E+18 , Irr. Temp. = 304

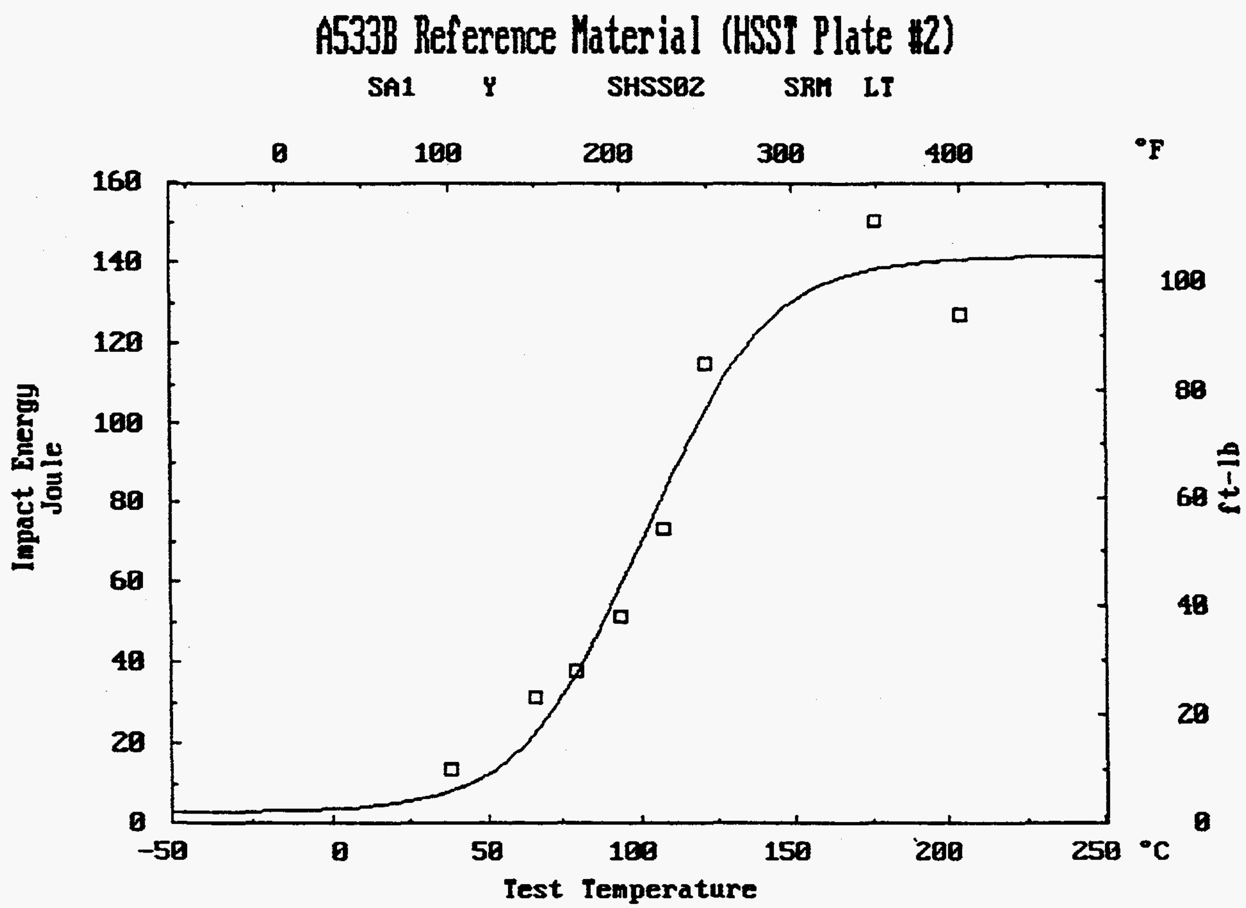
| Parameter | Mean | Std.Dev. | Correlation Coefficients | | | | |
|---|---|---|---|---|---|---|---|
| Lower Shelf Energy (J) | 3.0 | 0.0 | | | | | |
| Upper Shelf Energy (J) | 182.6 | 18.9 | 0.237 | | | | |
| CVT at Midpoint (C) | 87.3 | 9.6 | 0.340 | 0.867 | | | |
| 1/slope (C) | 63.6 | 9.7 | 0.138 | 0.609 | 0.567 | | |
| CVT at 41 Joule (C) | 45.4 | 6.6 | 0.198 | 0.026 | 0.343 | -0.537 | |
| CVT at 68 Joule (C) | 69.2 | 5.2 | 0.303 | 0.273 | 0.666 | -0.094 | 0.884 |



A533B HSST02 REFERENCE MATERIAL
Salem Unit 1, Capsule Y

USE= 141.7 J, LSE= 3.1 J, CVT(1/2)= 102.C ; Slope = 0.0254
CVT(41J) = 82. C , CVT(68J) = 99. C ,
Fluence = 8.910E+18 , Irr. Temp. = 304 C

| Spec. ID | Test Temp. C | Test Temp. F | Impact Energy J | Impact Energy ft-lb | Lat. Exp. mm | Lat. Exp. mil | % Shear |
|---|---|---|---|---|---|---|---|
| R62 | 38. | 100. | 14. | 10. | 0.23 | 9. | 16. |
| R59 | 66. | 150. | 31. | 23. | 0.56 | 22. | 24. |
| R57 | 79. | 175. | 38. | 28. | 0.79 | 31. | 27. |
| R64 | 93. | 200. | 52. | 38. | 0.76 | 30. | 33. |
| R58 | 107. | 225. | 73. | 54. | 0.94 | 37. | 48. |
| R60 | 121. | 250. | 115. | 85. | 1.55 | 61. | 64. |
| R63 | 177. | 350. | 150. | 111. | 2.08 | 82. | 100. |
| R61 | 204. | 400. | 127. | 94. | 1.83 | 72. | 100. |



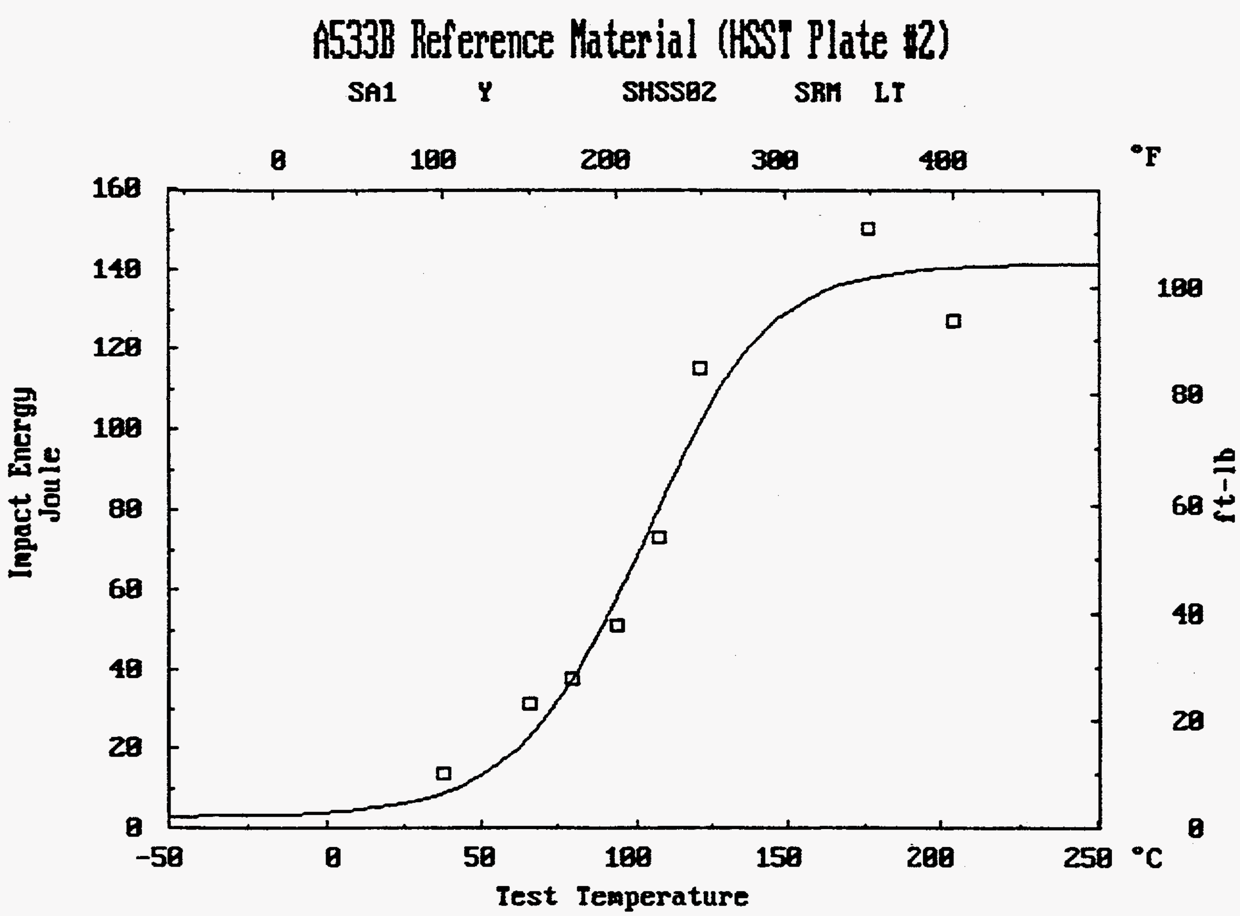
A533B HSST02 REFERENCE MATERIAL

Salem Unit 1, Capsule Y

```
Impact Energy Uncertainty =  10.0 J
Test Temperature Uncertainty =   4.0 Degree C
Number of Successful Iterations =  200, Maximum = 1000
```

SA1 Y SHSS02 SRM LT : Fluence = 8.910E+18 , Irr. Temp. = 304

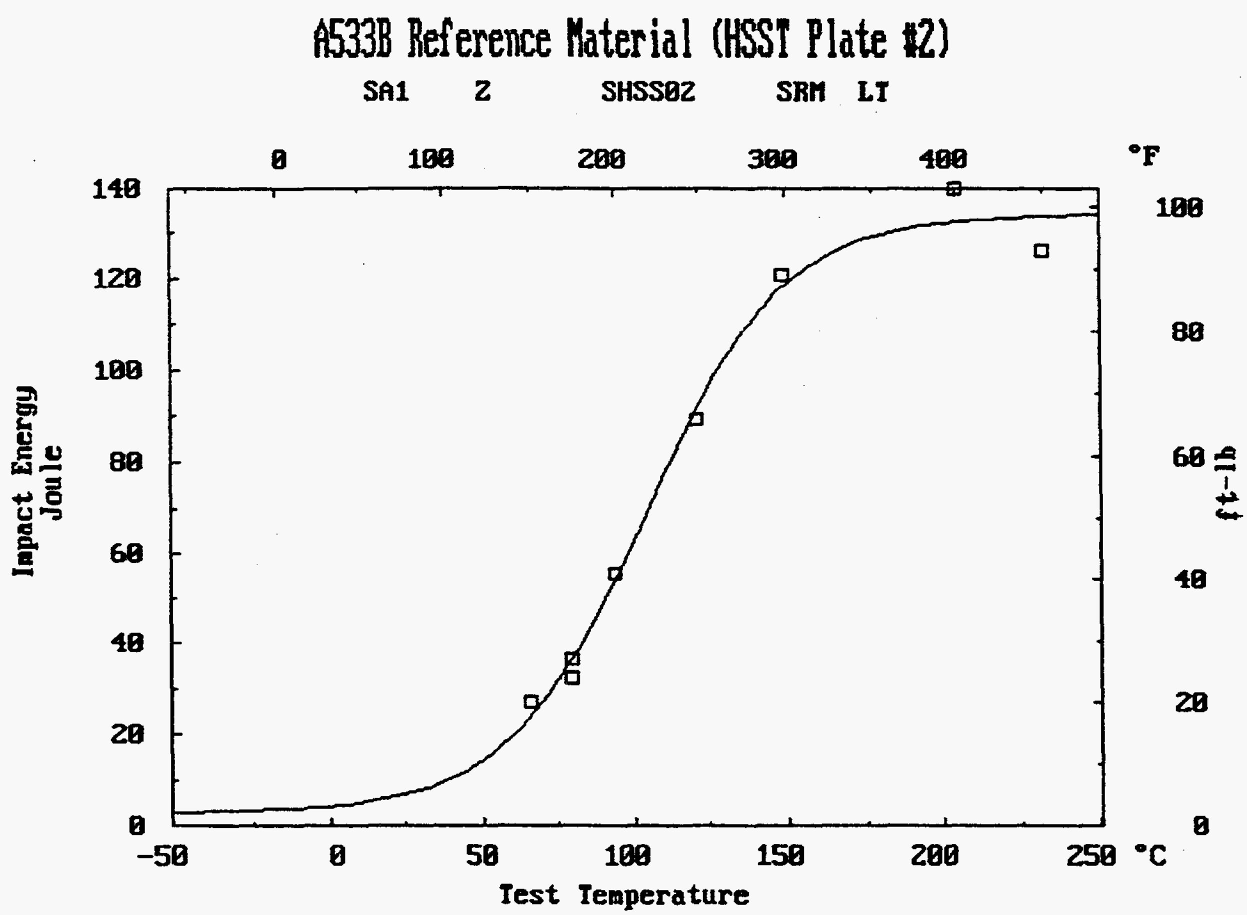
| Parameter | Mean | Std.Dev. | Correlation Coefficients | | | | |
|---|---|---|---|---|---|---|---|
| Lower Shelf Energy (J) | 3.1 | 0.0 | | | | | |
| Upper Shelf Energy (J) | 142.0 | 7.8 | -0.049 | | | | |
| CVT at Midpoint (C) | 102.4 | 4.2 | 0.085 | 0.563 | | | |
| 1/slope (C) | 41.1 | 8.5 | -0.294 | 0.283 | 0.271 | | |
| CVT at 41 Joule (C) | 82.3 | 4.9 | 0.337 | -0.080 | 0.437 | -0.709 | |
| CVT at 68 Joule (C) | 99.7 | 3.4 | 0.189 | 0.009 | 0.815 | -0.022 | 0.712 |



A533B HSST02 REFERENCE MATERIAL
Salem Unit 1, Capsule Z

USE= 134.2 J, LSE= 3.0 J, CVT(1/2)= 104.C , Slope = 0.0220
CVT(41J) = 84. C , CVT(68J) = 104. C ,
Fluence = 1.330E+19 , Irr. Temp. = 304 C

| Spec. ID | Test Temp. C | Test Temp. F | Impact Energy J | Impact Energy ft-lb | Lat. Exp. mm | Lat. Exp. mil | % Shear |
|---|---|---|---|---|---|---|---|
| R35 | 66. | 150. | 27. | 20. | 0.56 | 22. | 15. |
| R33 | 79. | 175. | 37. | 27. | 0.76 | 30. | 25. |
| R40 | 79. | 175. | 33. | 24. | 0.63 | 25. | 20. |
| R38 | 93. | 200. | 56. | 41. | 0.99 | 39. | 35. |
| R39 | 121. | 250. | 89. | 66. | 1.78 | 70. | 65. |
| R36 | 149. | 300. | 121. | 89. | 1.98 | 78. | 95. |
| R37 | 204. | 400. | 140. | 103. | 2.26 | 89. | 100. |
| R34 | 232. | 450. | 126. | 93. | 2.03 | 80. | 100. |



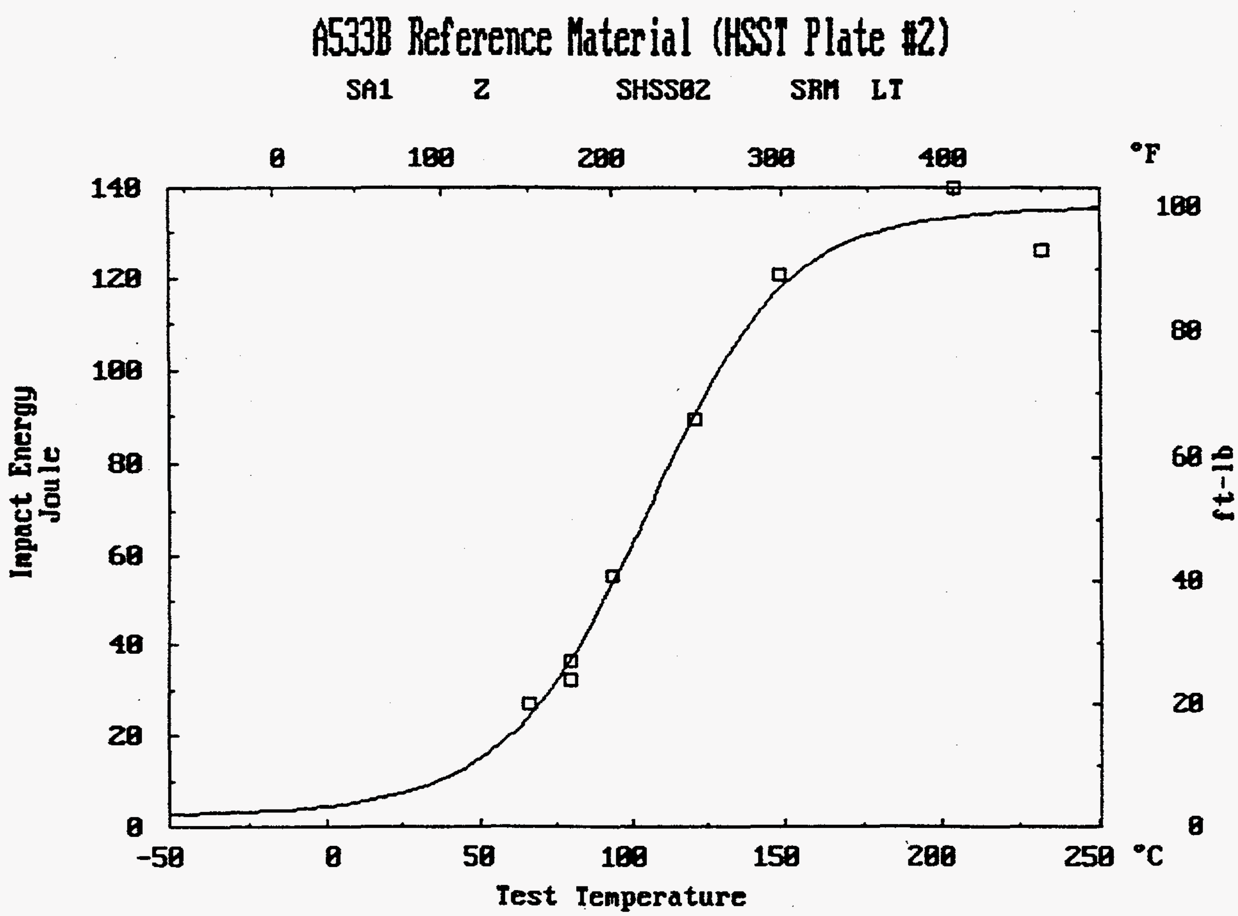
A533B HSST02 REFERENCE MATERIAL

Salem Unit 1, Capsule Z

Impact Energy Uncertainty = 10.0 J
Test Temperature Uncertainty = 4.0 Degree C
Number of Successful Iterations = 200, Maximum = 1000

SA1 Z SHSS02 SRM LT : Fluence = 1.330E+19 , Irr. Temp. = 304

| Parameter | Mean | Std.Dev. | Correlation Coefficients | | | | |
|---|---|---|---|---|---|---|---|
| Lower Shelf Energy (J) | 3.0 | 0.0 | | | | | |
| Upper Shelf Energy (J) | 135.7 | 8.0 | -0.003 | | | | |
| CVT at Midpoint (C) | 104.9 | 5.6 | 0.122 | 0.682 | | | |
| 1/slope (C) | 47.2 | 10.4 | -0.077 | 0.549 | 0.598 | | |
| CVT at 41 Joule (C) | 83.2 | 4.7 | 0.227 | -0.178 | 0.295 | -0.543 | |
| CVT at 68 Joule (C) | 103.8 | 4.2 | 0.173 | 0.197 | 0.843 | 0.368 | 0.568 |



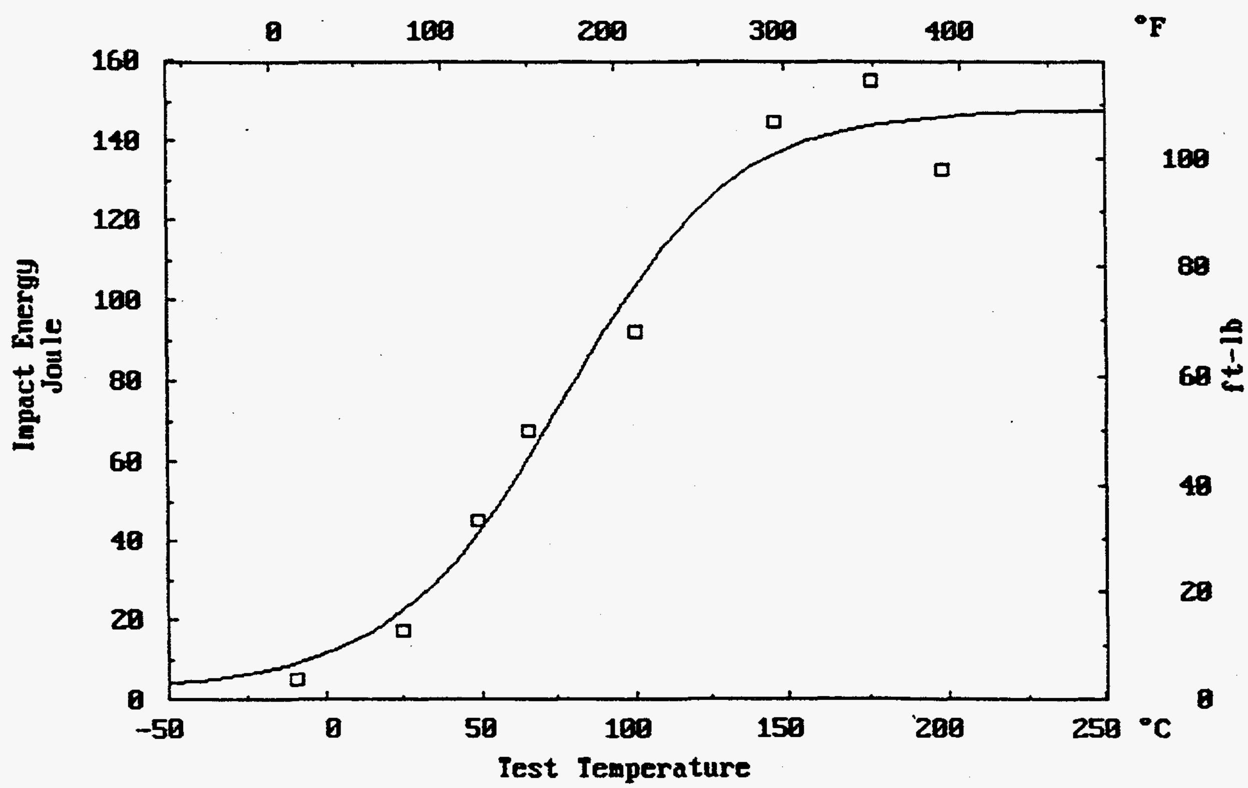
A533B HSST02 REFERENCE MATERIAL
Surry Unit 1, Capsule T

USE= 148.2 J, LSE= 3.0 J, CVT(1/2)= 77.C , Slope = 0.0179
CVT(41J) = 48. C , CVT(68J) = 71. C ,
Fluence = 2.500E+18 , Irr. Temp. = 310 C

| Spec. ID | Test Temp. C | F | Impact Energy J | ft-lb | Lat. Exp. mm | mil | % Shear |
|---|---|---|---|---|---|---|---|
| R33 | -9. | 15. | 5. | 4. | 0.18 | 7. | 0. |
| R40 | 25. | 77. | 18. | 13. | 0.43 | 17. | 20. |
| R38 | 49. | 120. | 45. | 33. | 0.94 | 37. | 25. |
| R36 | 66. | 150. | 68. | 50. | 1.24 | 49. | 45. |
| R39 | 100. | 212. | 92. | 68. | 1.57 | 62. | 70. |
| R37 | 146. | 295. | 145. | 107. | 2.26 | 89. | 100. |
| R34 | 177. | 350. | 155. | 114. | 1.80 | 71. | 100. |
| R35 | 199. | 390. | 133. | 98. | 1.88 | 74. | 100. |

A533B Reference Material (HSST Plate #2)

SU1 T SHSS02 SRM LT



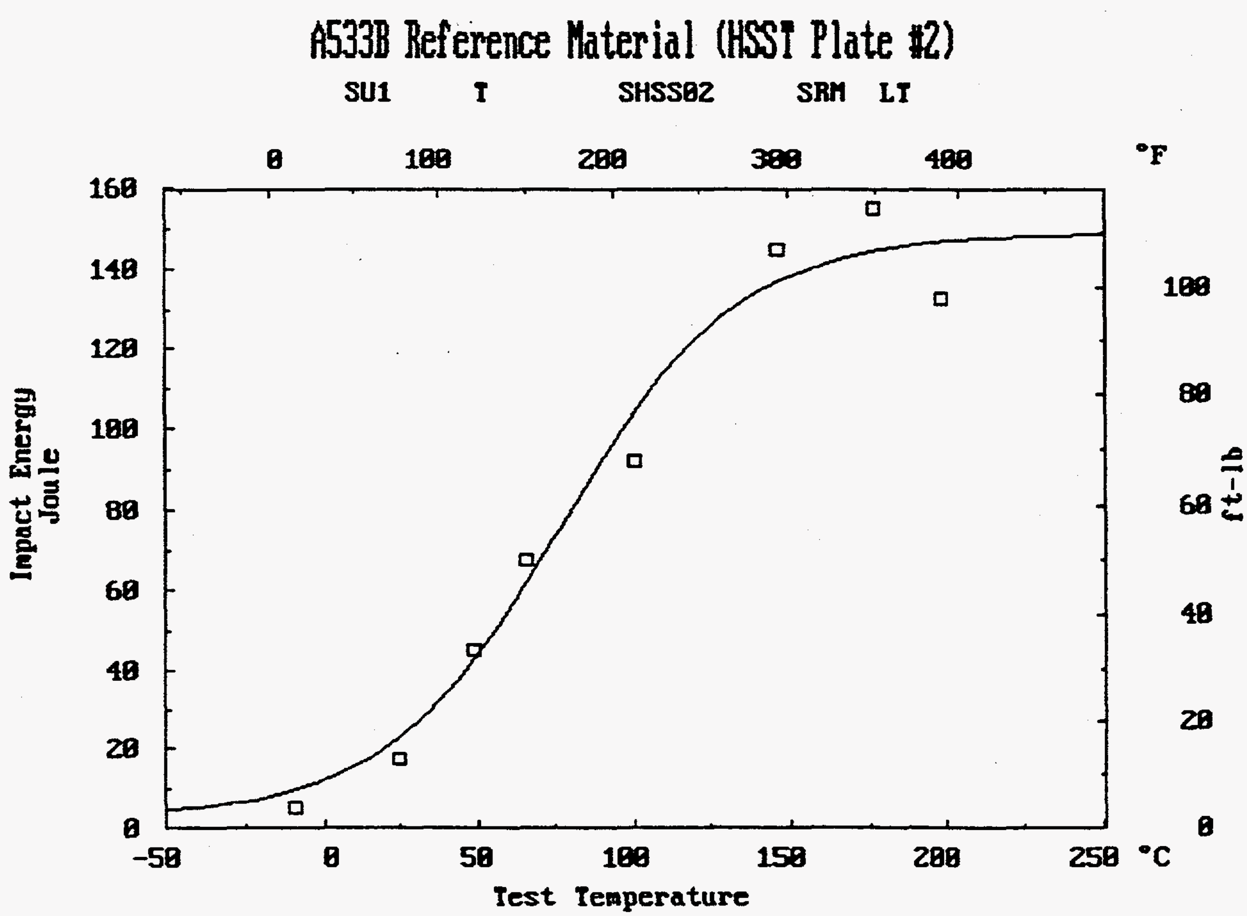
A533B HSST02 REFERENCE MATERIAL

Surry Unit 1, Capsule T

```
Impact Energy Uncertainty =  10.0 J
Test Temperature Uncertainty =   4.0 Degree C
Number of Successful Iterations =  200, Maximum = 1000
```

```
SU1    T     SHSS02    SRM  LT : Fluence = 2.500E+18 , Irr. Temp. =  310
```

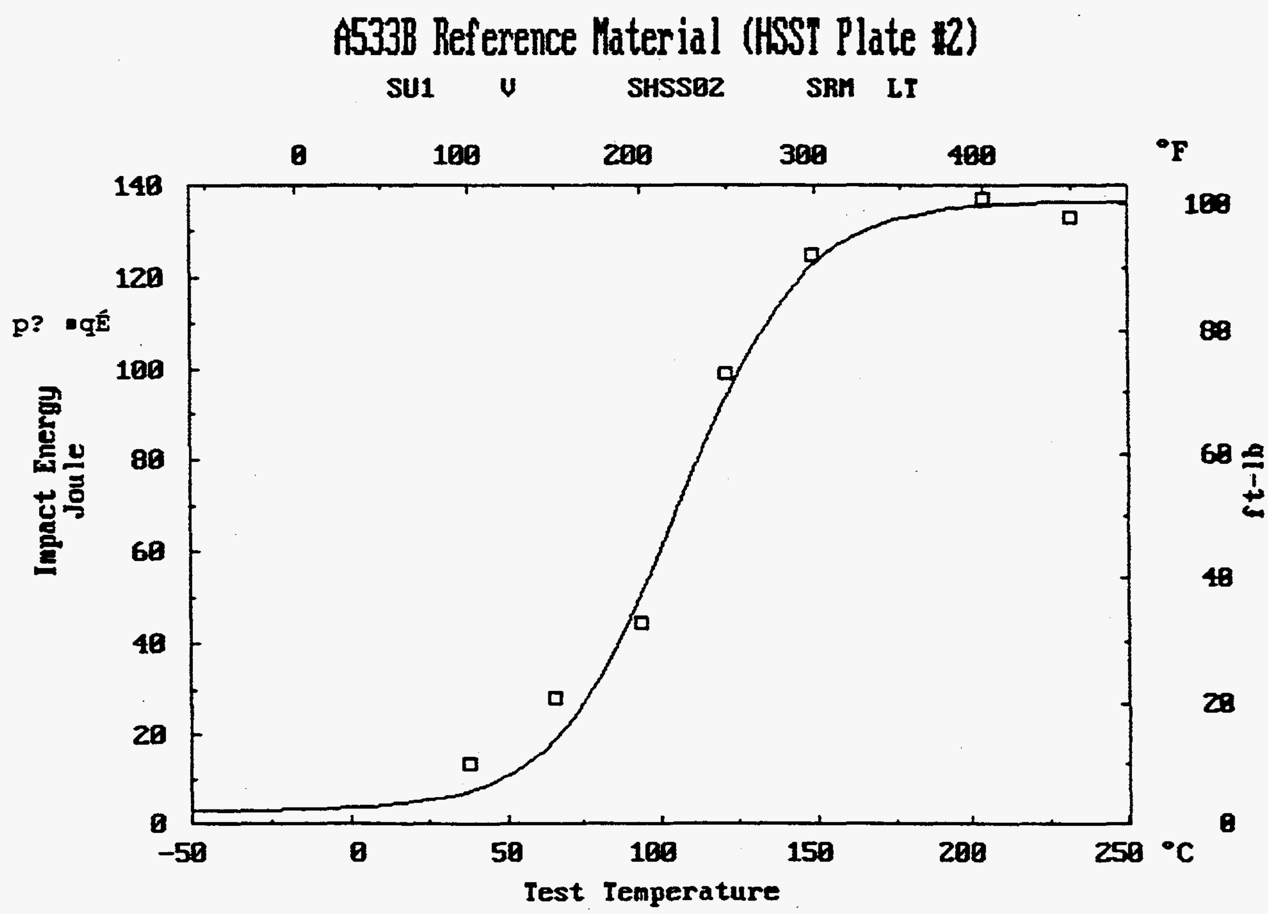
| Parameter | Mean | Std.Dev. | Correlation Coefficients | | | | |
|---|---|---|---|---|---|---|---|
| Lower Shelf Energy (J) | 3.0 | 0.0 | | | | | |
| Upper Shelf Energy (J) | 148.9 | 6.9 | 0.067 | | | | |
| CVT at Midpoint (C) | 77.0 | 6.4 | 0.143 | 0.571 | | | |
| 1/slope (C) | 56.9 | 8.9 | 0.007 | 0.510 | 0.408 | | |
| CVT at 41 Joule (C) | 47.2 | 6.1 | 0.119 | -0.093 | 0.564 | -0.494 | |
| CVT at 68 Joule (C) | 70.7 | 5.2 | 0.137 | 0.137 | 0.879 | 0.072 | 0.827 |



A533B HSST02 REFERENCE MATERIAL
Surry Unit 1, Capsule V

USE= 136.4 J, LSE= 3.1 J, CVT(1/2)= 106.C , Slope = 0.0250
CVT(41J) = 87. C , CVT(68J) = 105. C ,
Fluence = 1.940E+19 , Irr. Temp. = 304 C

| Spec. ID | Test Temp. C | Test Temp. F | Impact Energy J | Impact Energy ft-lb | Lat. Exp. mm | Lat. Exp. mil | % Shear |
|---|---|---|---|---|---|---|---|
| R41 | 38. | 100. | 14. | 10. | 0.25 | 10. | 4. |
| R43 | 66. | 150. | 28. | 21. | 0.48 | 19. | 10. |
| R47 | 93. | 200. | 45. | 33. | 0.71 | 28. | 33. |
| R48 | 93. | 200. | 45. | 33. | 0.58 | 23. | 26. |
| R46 | 121. | 250. | 99. | 73. | 1.14 | 45. | 43. |
| R44 | 149. | 300. | 125. | 92. | 1.75 | 69. | 92. |
| R45 | 204. | 400. | 137. | 101. | 1.78 | 70. | 100. |
| R42 | 232. | 450. | 133. | 98. | 1.85 | 73. | 100. |



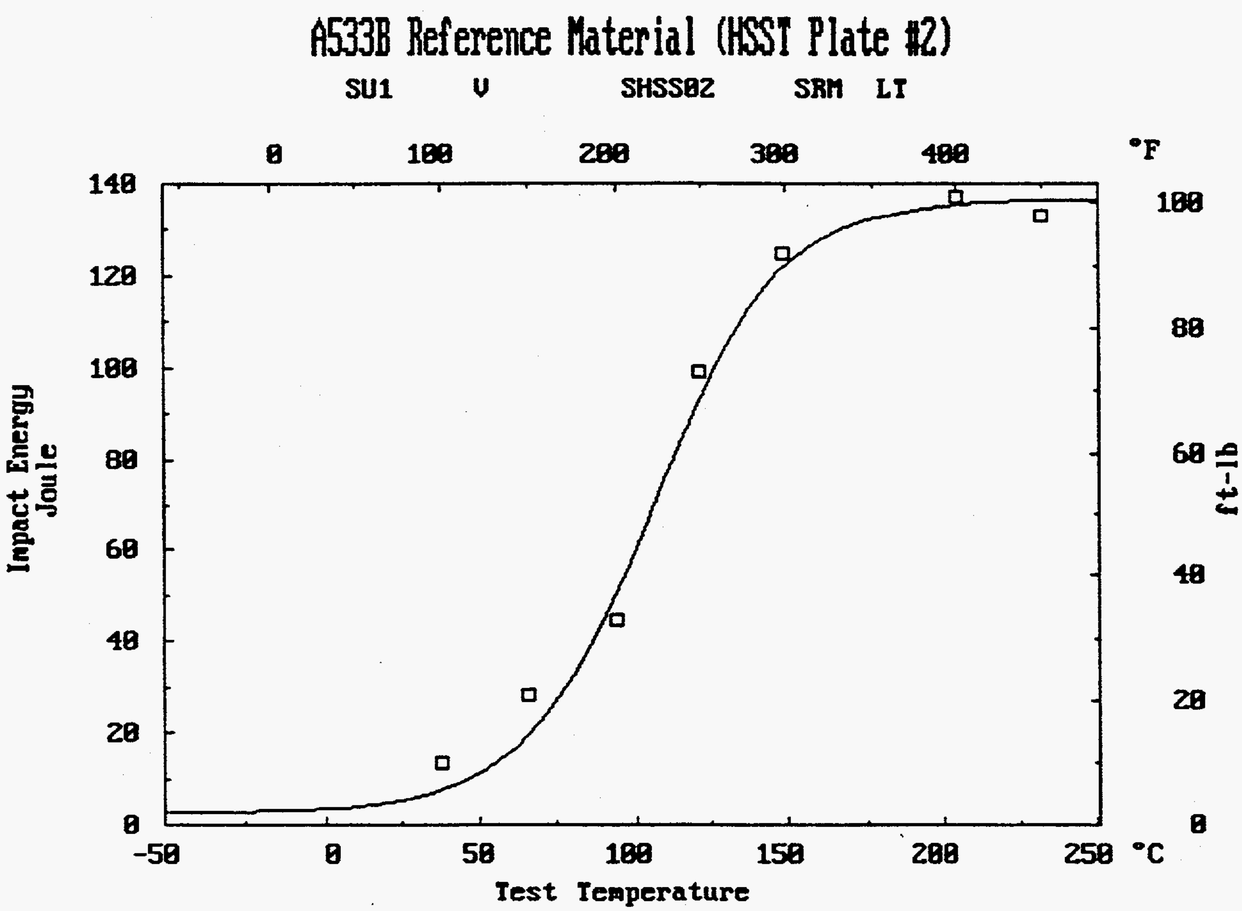
A533B HSST02 REFERENCE MATERIAL

Surry Unit 1, Capsule V

```
Impact Energy Uncertainty =  10.0 J
Test Temperature Uncertainty =   4.0 Degree C
Number of Successful Iterations =  200, Maximum = 1000
```

SU1 V SHSS02 SRM LT : Fluence = 1.940E+19 , Irr. Temp. = 304

| Parameter | Mean | Std.Dev. | Correlation Coefficients | | | | |
|---|---|---|---|---|---|---|---|
| Lower Shelf Energy (J) | 3.1 | 0.1 | | | | | |
| Upper Shelf Energy (J) | 136.3 | 6.8 | -0.109 | | | | |
| CVT at Midpoint (C) | 105.8 | 5.4 | 0.105 | 0.626 | | | |
| 1/slope (C) | 40.7 | 9.9 | -0.459 | 0.392 | 0.283 | | |
| CVT at 41 Joule (C) | 87.0 | 5.7 | 0.488 | 0.018 | 0.541 | -0.632 | |
| CVT at 68 Joule (C) | 104.7 | 4.2 | 0.206 | 0.282 | 0.919 | 0.112 | 0.693 |



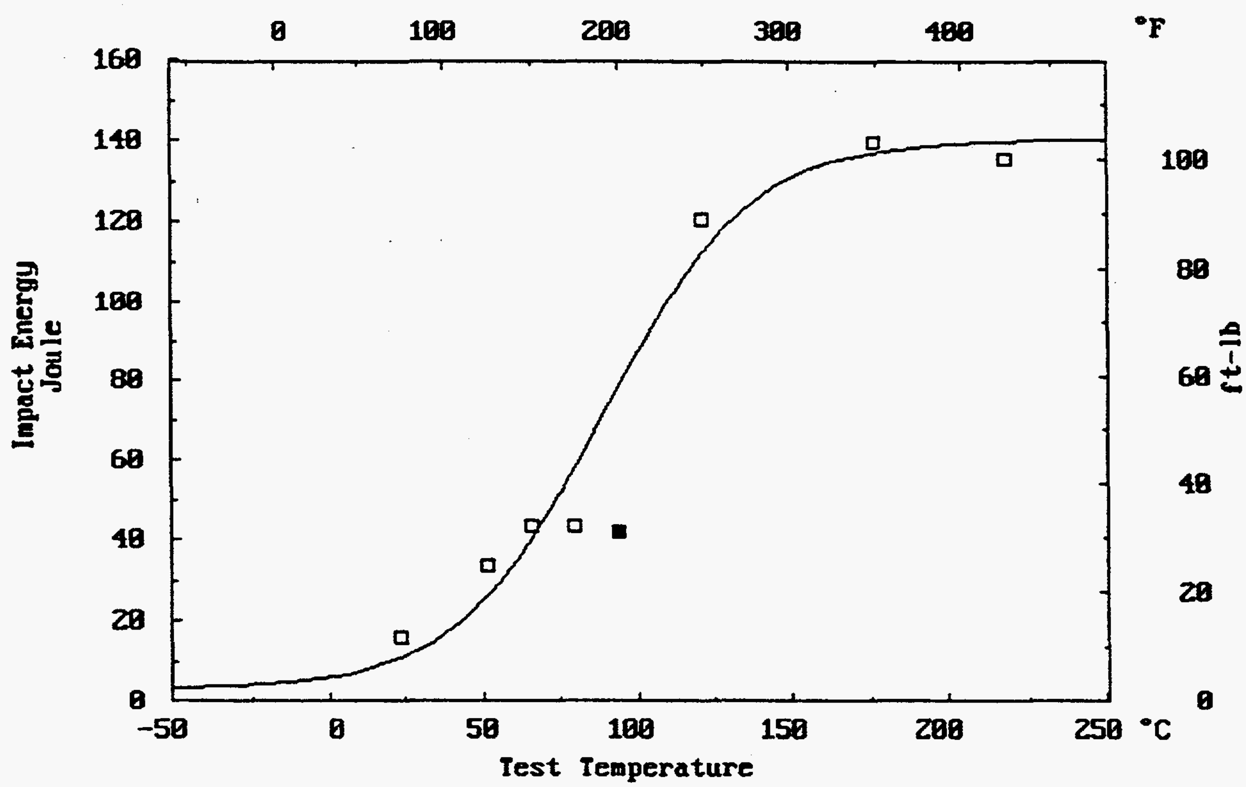
A533B HSST02 REFERENCE MATERIAL
Surry Unit 2, Capsule V

USE= 140.3 J, LSE= 3.0 J, CVT(1/2)= 89.C , Slope = 0.0215
CVT(41J) = 67. C , CVT(68J) = 87. C ,
Fluence = 1.880E+19 , Irr. Temp. = 304 C

| Spec. ID | Test Temp. C | Test Temp. F | Impact Energy J | Impact Energy ft-lb | Lat. Exp. mm | Lat. Exp. mil | % Shear |
|---|---|---|---|---|---|---|---|
| R15 | 24. | 75. | 16. | 12. | 0.43 | 17. | 15. |
| R12 | 52. | 125. | 34. | 25. | 0.51 | 20. | 25. |
| R16 | 66. | 150. | 43. | 32. | 0.56 | 22. | 25. |
| R11 | 79. | 175. | 43. | 32. | 0.71 | 28. | 35. |
| *R13 | 93. | 200. | 42. | 31. | 0.84 | 33. | 45. |
| R10 | 121. | 250. | 121. | 89. | 1.57 | 62. | 50. |
| R14 | 177. | 350. | 140. | 103. | 2.06 | 81. | 100. |
| R9 | 218. | 425. | 136. | 100. | 2.06 | 81. | 100. |

A533B Reference Material (HSST Plate #2)

SU2 V SHSS02 SRM LT



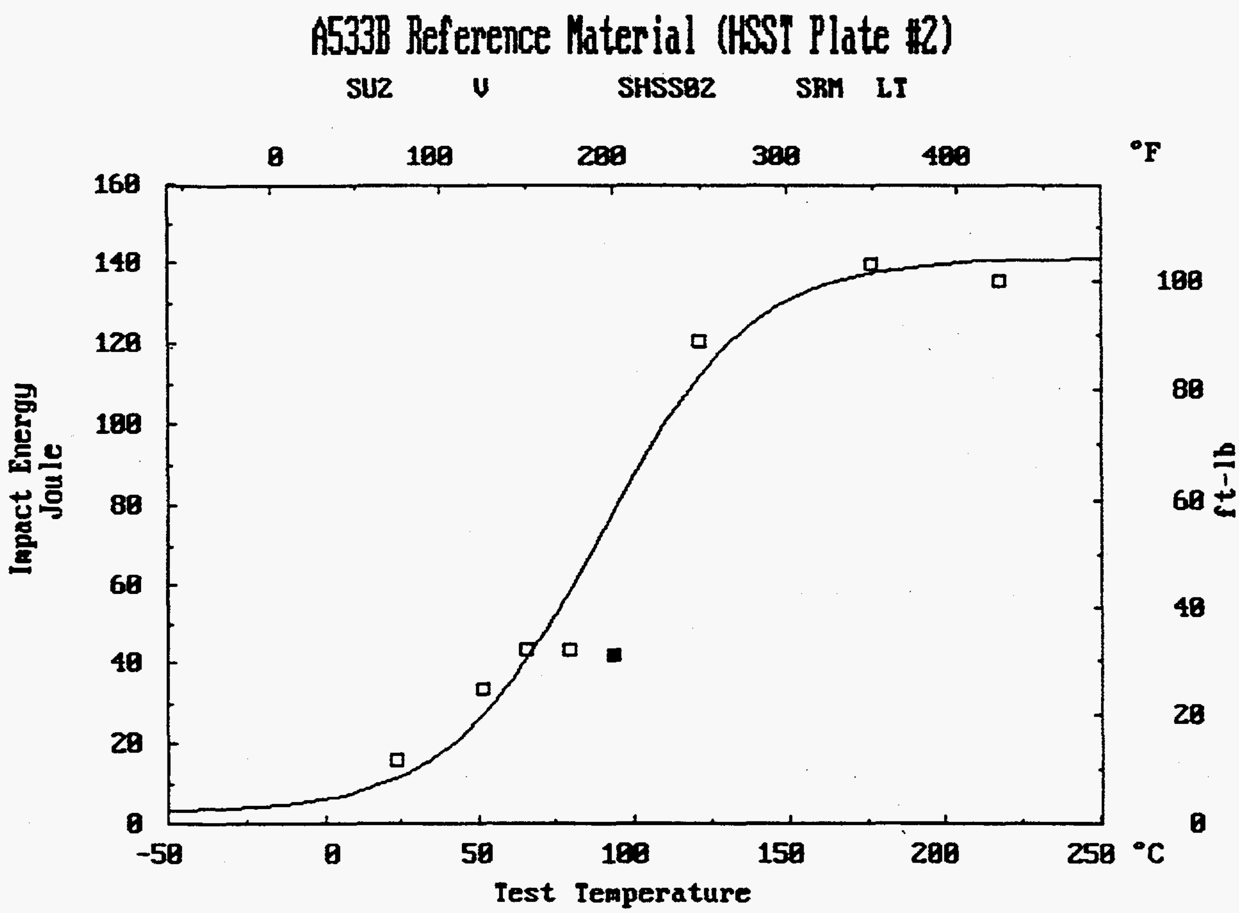
A533B HSST02 REFERENCE MATERIAL

Surry Unit 2, Capsule V

```
Impact Energy Uncertainty =  10.0 J
Test Temperature Uncertainty =   4.0 Degree C
Number of Successful Iterations =  200, Maximum = 1000
```

SU2 V SHSS02 SRM LT : Fluence = 1.880E+19 , Irr. Temp. = 304

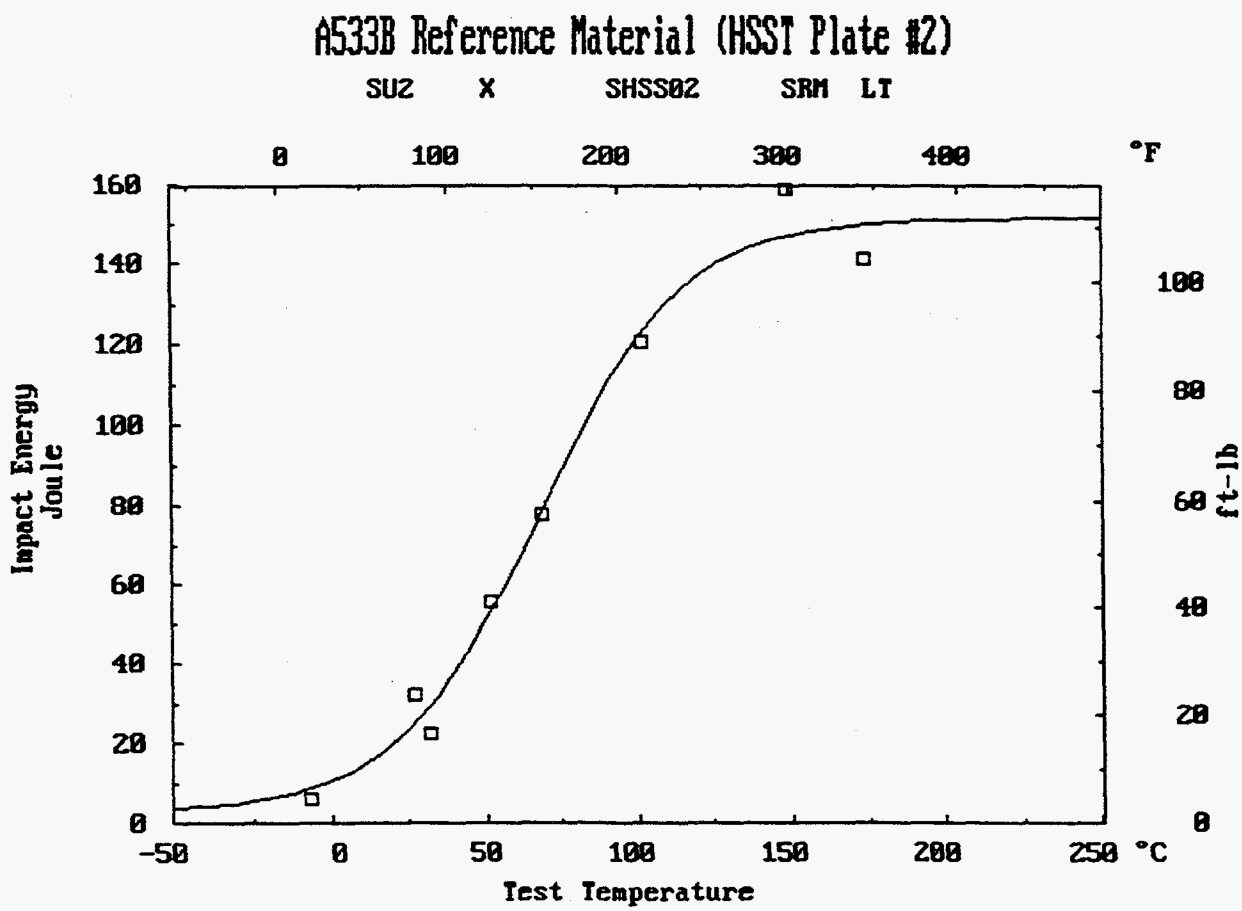
| Parameter | Mean | Std.Dev. | Correlation Coefficients | | | | |
|---|---|---|---|---|---|---|---|
| Lower Shelf Energy (J) | 3.0 | 0.0 | | | | | |
| Upper Shelf Energy (J) | 141.3 | 7.7 | 0.026 | | | | |
| CVT at Midpoint (C) | 89.2 | 6.6 | 0.197 | 0.540 | | | |
| 1/slope (C) | 48.2 | 10.3 | -0.258 | 0.351 | 0.292 | | |
| CVT at 41 Joule (C) | 65.7 | 6.8 | 0.368 | -0.018 | 0.601 | -0.554 | |
| CVT at 68 Joule (C) | 86.2 | 5.5 | 0.241 | 0.125 | 0.895 | 0.069 | 0.786 |



A533B HSST02 REFERENCE MATERIAL
Surry Unit 2, Capsule X

USE= 151.4 J, LSE= 3.0 J, CVT(1/2)= 67.C , Slope = 0.0214
CVT(41J) = 43. C , CVT(68J) = 62. C ,
Fluence = 3.020E+18 , Irr. Temp. = 310 C

| Spec. ID | Test Temp. C | Test Temp. F | Impact Energy J | Impact Energy ft-lb | Lat. Exp. mm | Lat. Exp. mil | % Shear |
|---|---|---|---|---|---|---|---|
| R32 | -7. | 20. | 6. | 4. | 0.13 | 5. | 3. |
| R28 | 27. | 80. | 33. | 24. | 0.63 | 25. | 15. |
| R29 | 32. | 90. | 22. | 16. | 0.58 | 23. | 15. |
| R30 | 52. | 125. | 56. | 41. | 0.97 | 38. | 25. |
| R27 | 68. | 155. | 78. | 57. | 1.45 | 57. | 35. |
| R31 | 102. | 215. | 121. | 89. | 2.01 | 79. | 100. |
| R25 | 149. | 300. | 159. | 117. | 2.26 | 89. | 100. |
| R26 | 174. | 345. | 141. | 104. | 2.11 | 83. | 100. |



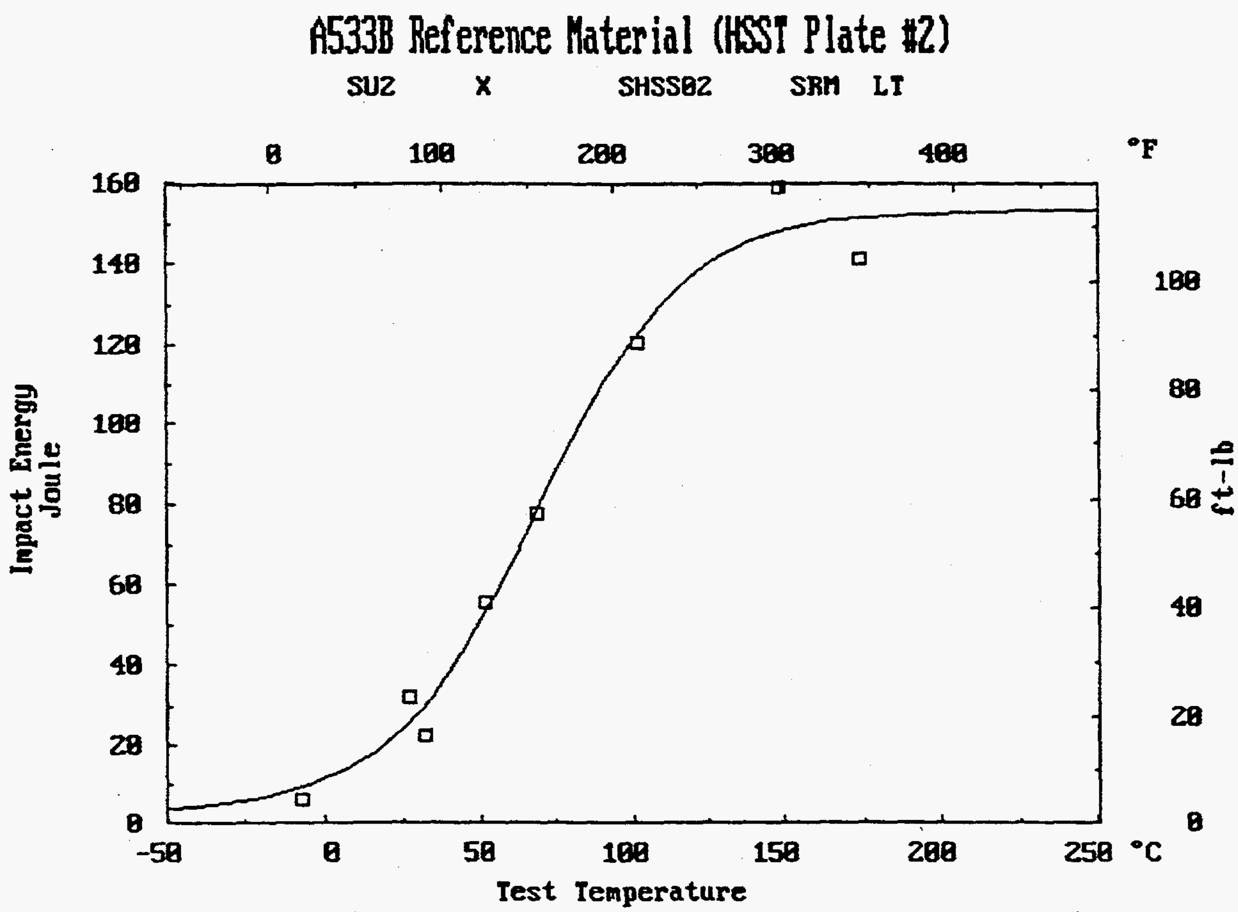
A533B HSST02 REFERENCE MATERIAL

Surry Unit 2, Capsule X

Impact Energy Uncertainty = 10.0 J
Test Temperature Uncertainty = 4.0 Degree C
Number of Successful Iterations = 200, Maximum = 1000

SU2 X SHSS02 SRM LT : Fluence = 3.020E+18 , Irr. Temp. = 310

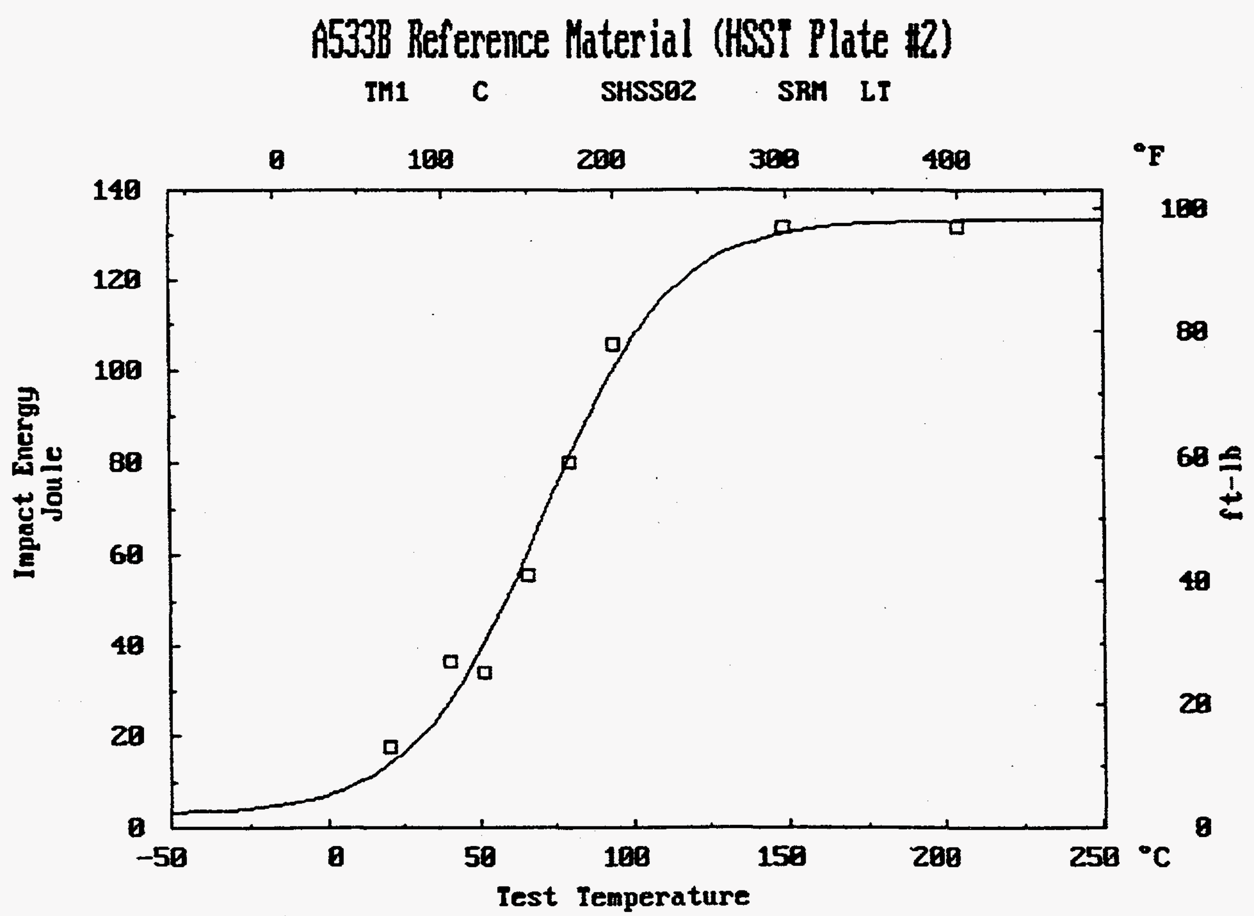
| Parameter | Mean | Std.Dev. | Correlation Coefficients | | | | |
|---|---|---|---|---|---|---|---|
| Lower Shelf Energy (J) | 3.0 | 0.0 | | | | | |
| Upper Shelf Energy (J) | 153.3 | 9.5 | 0.000 | | | | |
| CVT at Midpoint (C) | 68.3 | 7.1 | 0.077 | 0.744 | | | |
| 1/slope (C) | 48.1 | 9.7 | -0.133 | 0.619 | 0.606 | | |
| CVT at 41 Joule (C) | 42.0 | 5.4 | 0.231 | -0.029 | 0.417 | -0.441 | |
| CVT at 68 Joule (C) | 61.6 | 4.9 | 0.154 | 0.333 | 0.855 | 0.234 | 0.764 |



A533B HSST02 REFERENCE MATERIAL
Three Mile Island Unit 1, Capsule C

USE= 133.4 J, LSE= 3.0 J, CVT(1/2)= 71.C , Slope = 0.0237
CVT(41J) = 52. C , CVT(68J) = 71. C ,
Fluence = 8.660E+18 , Irr. Temp. = 303 C

| Spec. ID | Test Temp. C | Test Temp. F | Impact Energy J | Impact Energy ft-lb | Lat. Exp. mm | Lat. Exp. mil | % Shear |
|---|---|---|---|---|---|---|---|
| CC945 | 21. | 69. | 18. | 13. | 0.36 | 14. | 5. |
| CC921 | 41. | 105. | 37. | 27. | 0.58 | 23. | 20. |
| CC915 | 52. | 125. | 34. | 25. | 0.58 | 23. | 25. |
| CC961 | 66. | 150. | 56. | 41. | 0.86 | 34. | 30. |
| CC928 | 79. | 175. | 80. | 59. | 1.22 | 48. | 50. |
| CC937 | 93. | 200. | 106. | 78. | 1.52 | 60. | 60. |
| CC916 | 149. | 300. | 132. | 97. | 1.88 | 74. | 100. |
| CC955 | 204. | 400. | 132. | 97. | 2.06 | 81. | 100. |



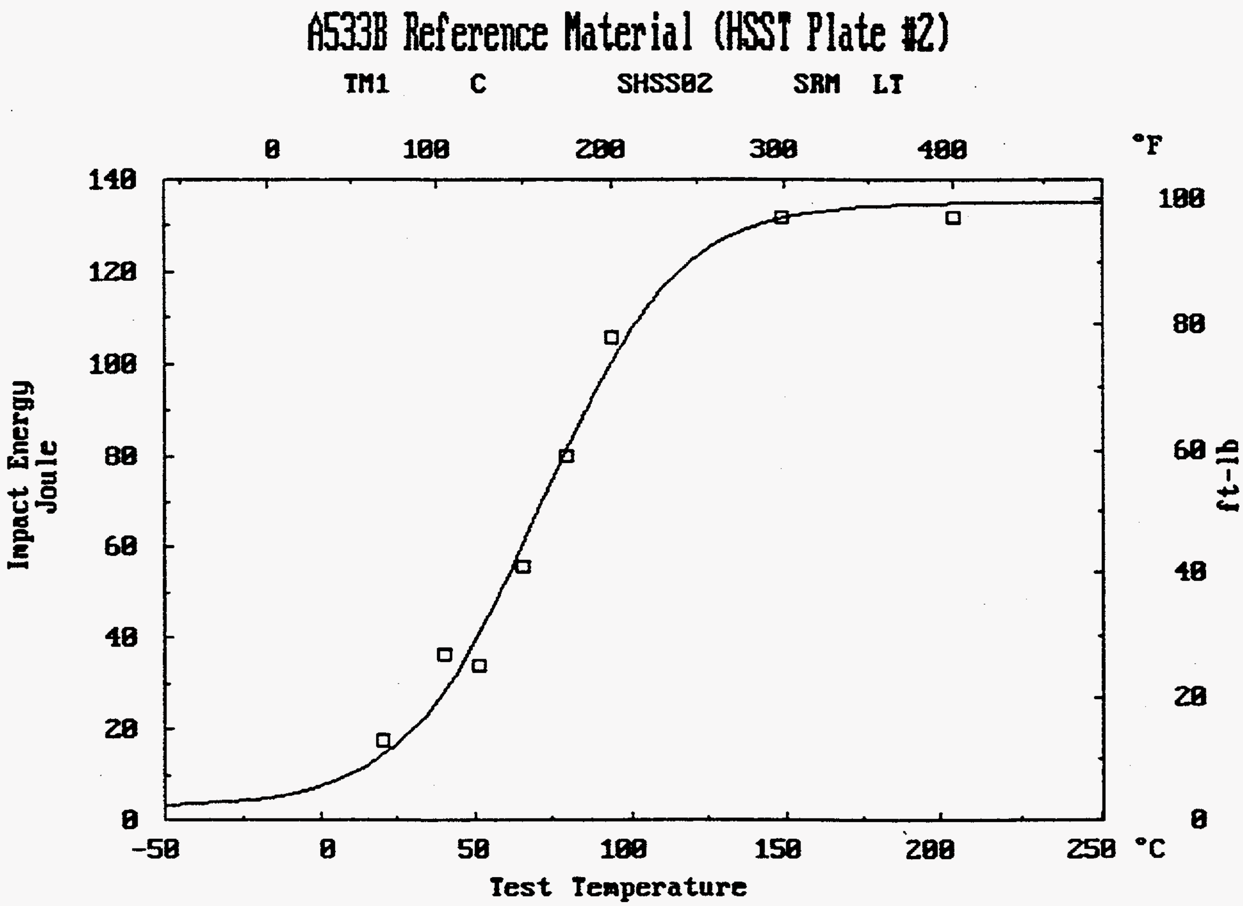
A533B HSST02 REFERENCE MATERIAL

Three Mile Island Unit 1, Capsule C

Impact Energy Uncertainty = 10.0 J
Test Temperature Uncertainty = 4.0 Degree C
Number of Successful Iterations = 200, Maximum = 1000

TM1 C SHSS02 SRM LT : Fluence = 8.660E+18 , Irr. Temp. = 303

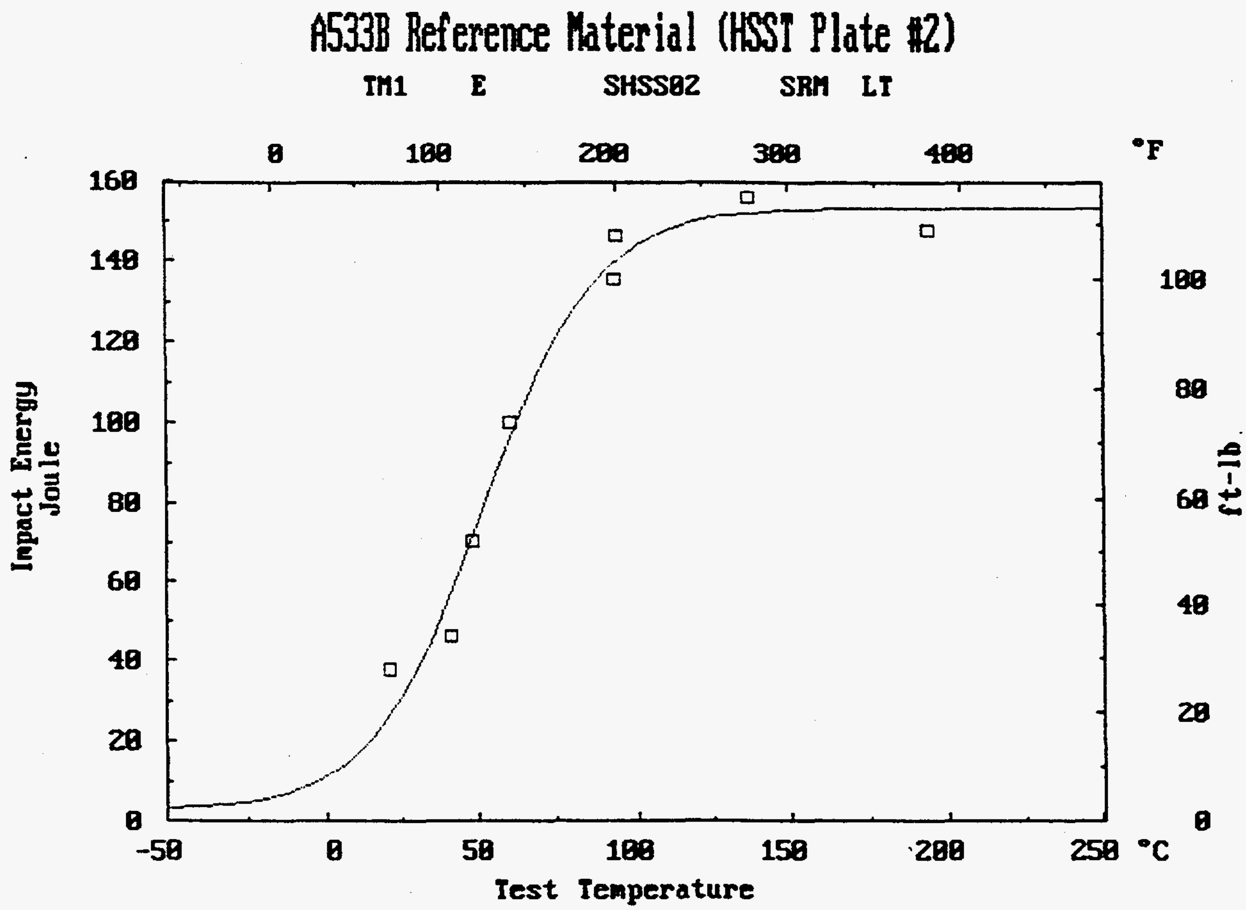
| Parameter | Mean | Std.Dev. | Correlation Coefficients | | | | |
|---|---|---|---|---|---|---|---|
| Lower Shelf Energy (J) | 3.0 | 0.0 | | | | | |
| Upper Shelf Energy (J) | 135.0 | 8.0 | -0.050 | | | | |
| CVT at Midpoint (C) | 71.4 | 5.0 | 0.085 | 0.593 | | | |
| 1/slope (C) | 43.0 | 9.4 | -0.365 | 0.382 | 0.257 | | |
| CVT at 41 Joule (C) | 51.8 | 5.5 | 0.369 | -0.094 | 0.500 | -0.669 | |
| CVT at 68 Joule (C) | 70.6 | 4.0 | 0.142 | 0.076 | 0.840 | 0.034 | 0.709 |



A533B HSST02 REFERENCE MATERIAL
Three Mile Island Unit 1, Capsule E

USE= 153.3 J, LSE= 3.0 J, CVT(1/2)= 52.C , Slope = 0.0278
CVT(41J) = 32. C , CVT(68J) = 47. C ,
Fluence = 1.070E+18 , Irr. Temp. = 309 C

| Spec. ID | Test Temp. C | Test Temp. F | Impact Energy J | Impact Energy ft-lb | Lat. Exp. mm | Lat. Exp. mil | % Shear |
|---|---|---|---|---|---|---|---|
| CCE922 | 21. | 70. | 38. | 28. | 0.53 | 21. | 12. |
| CCE948 | 41. | 106. | 46. | 34. | 0.61 | 24. | 20. |
| CCE964 | 49. | 119. | 70. | 52. | 0.94 | 37. | 20. |
| CCE919 | 60. | 140. | 100. | 74. | 1.37 | 54. | 35. |
| CCE925 | 93. | 199. | 136. | 100. | 1.35 | 53. | 100. |
| CCE962 | 94. | 201. | 146. | 108. | 1.40 | 55. | 92. |
| CCE913 | 136. | 277. | 156. | 115. | 1.65 | 65. | 100. |
| CCE969 | 194. | 381. | 148. | 109. | 1.75 | 69. | 100. |



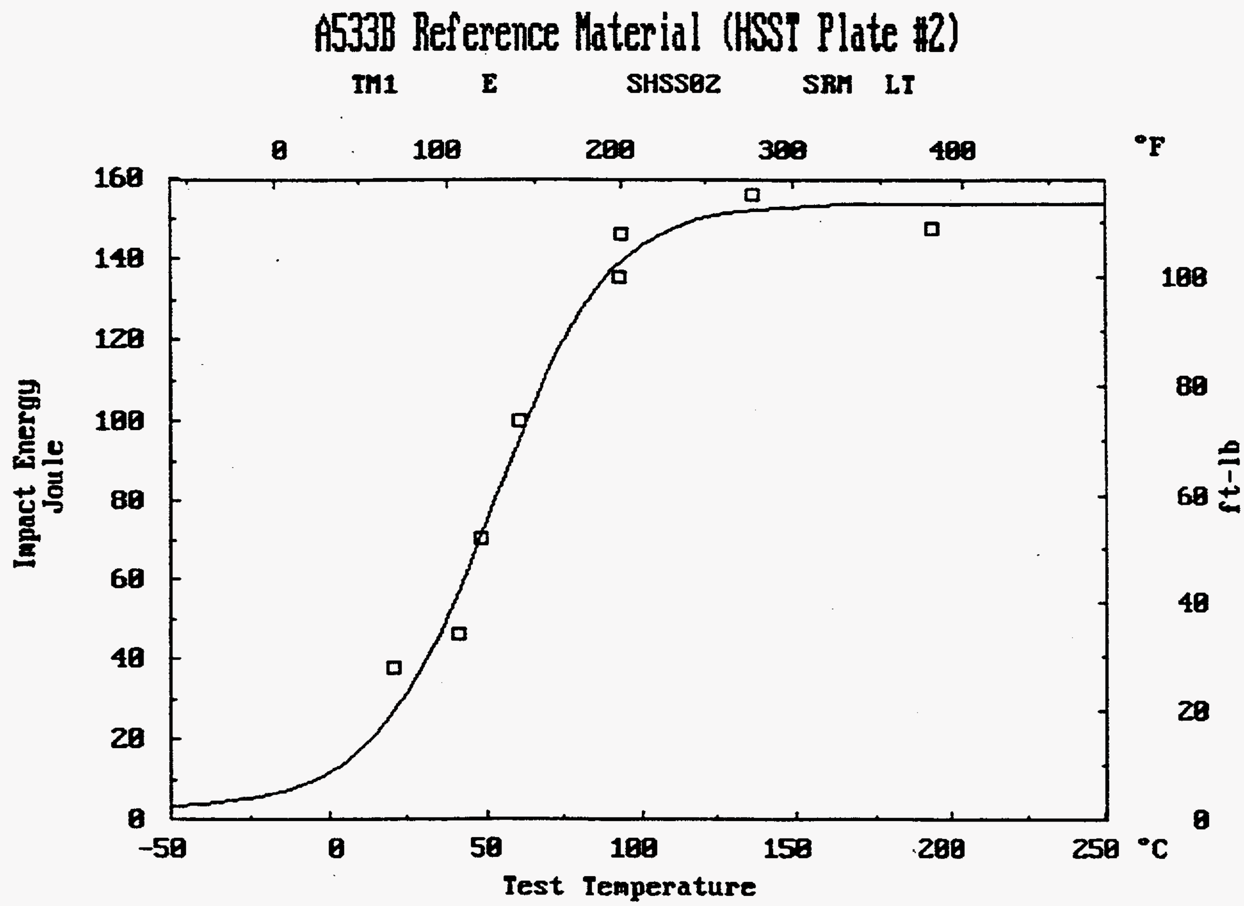
A533B HSST02 REFERENCE MATERIAL

Three Mile Island Unit 1, Capsule E

Impact Energy Uncertainty = 10.0 J
Test Temperature Uncertainty = 4.0 Degree C
Number of Successful Iterations = 200, Maximum = 1000

TM1 E SHSS02 SRM LT : Fluence = 1.070E+18 , Irr. Temp. = 309

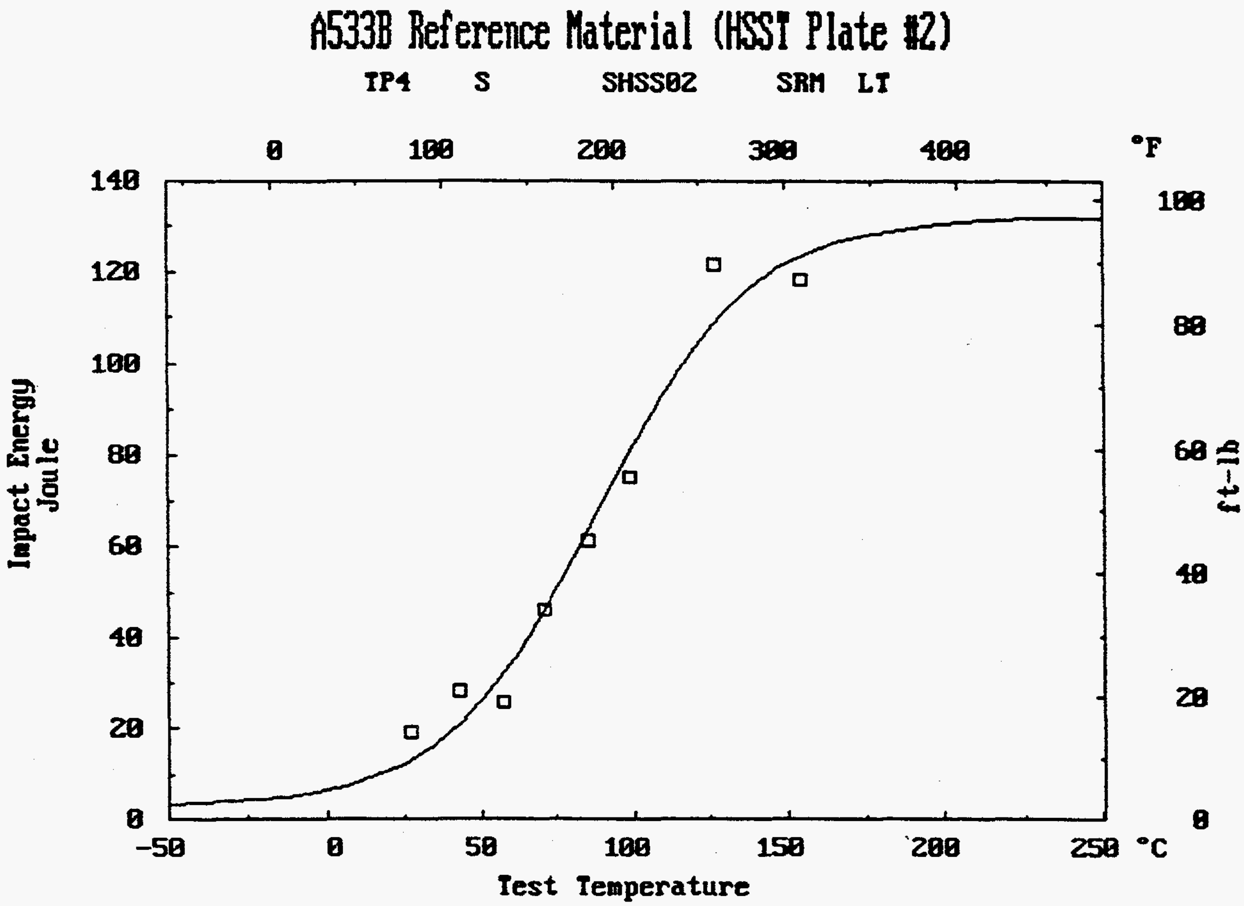
| Parameter | Mean | Std.Dev. | Correlation Coefficients | | | | |
|---|---|---|---|---|---|---|---|
| Lower Shelf Energy (J) | 3.0 | 0.0 | | | | | |
| Upper Shelf Energy (J) | 153.8 | 6.8 | 0.112 | | | | |
| CVT at Midpoint (C) | 52.0 | 4.2 | 0.248 | 0.538 | | | |
| 1/slope (C) | 36.9 | 7.5 | -0.116 | 0.548 | 0.274 | | |
| CVT at 41 Joule (C) | 31.9 | 5.1 | 0.272 | -0.231 | 0.467 | -0.707 | |
| CVT at 68 Joule (C) | 46.8 | 3.6 | 0.278 | 0.037 | 0.834 | -0.208 | 0.837 |



A533B HSST02 REFERENCE MATERIAL
Turkey Point Unit 4, Capsule S

USE= 132.0 J, LSE= 3.0 J, CVT(1/2)= 88.C , Slope = 0.0200
CVT(41J) = 67. C , CVT(68J) = 89. C ,
Fluence = 1.250E+19 , Irr. Temp. = 304 C

| Spec. ID | Test Temp. C | Test Temp. F | Impact Energy J | Impact Energy ft-lb | Lat. Exp. mm | Lat. Exp. mil | % Shear |
|---|---|---|---|---|---|---|---|
| R1 | 27. | 80. | 20. | 14. | 0.33 | 13. | 0. |
| R2 | 43. | 110. | 28. | 21. | 0.43 | 17. | 10. |
| R8 | 57. | 135. | 26. | 19. | 0.41 | 16. | 15. |
| R3 | 71. | 160. | 46. | 34. | 0.74 | 29. | 20. |
| R7 | 85. | 185. | 61. | 45. | 1.02 | 40. | 25. |
| R4 | 99. | 210. | 75. | 55. | 1.22 | 48. | 60. |
| R5 | 127. | 260. | 122. | 90. | 1.90 | 75. | 95. |
| R6 | 154. | 310. | 118. | 87. | 1.73 | 68. | 100. |



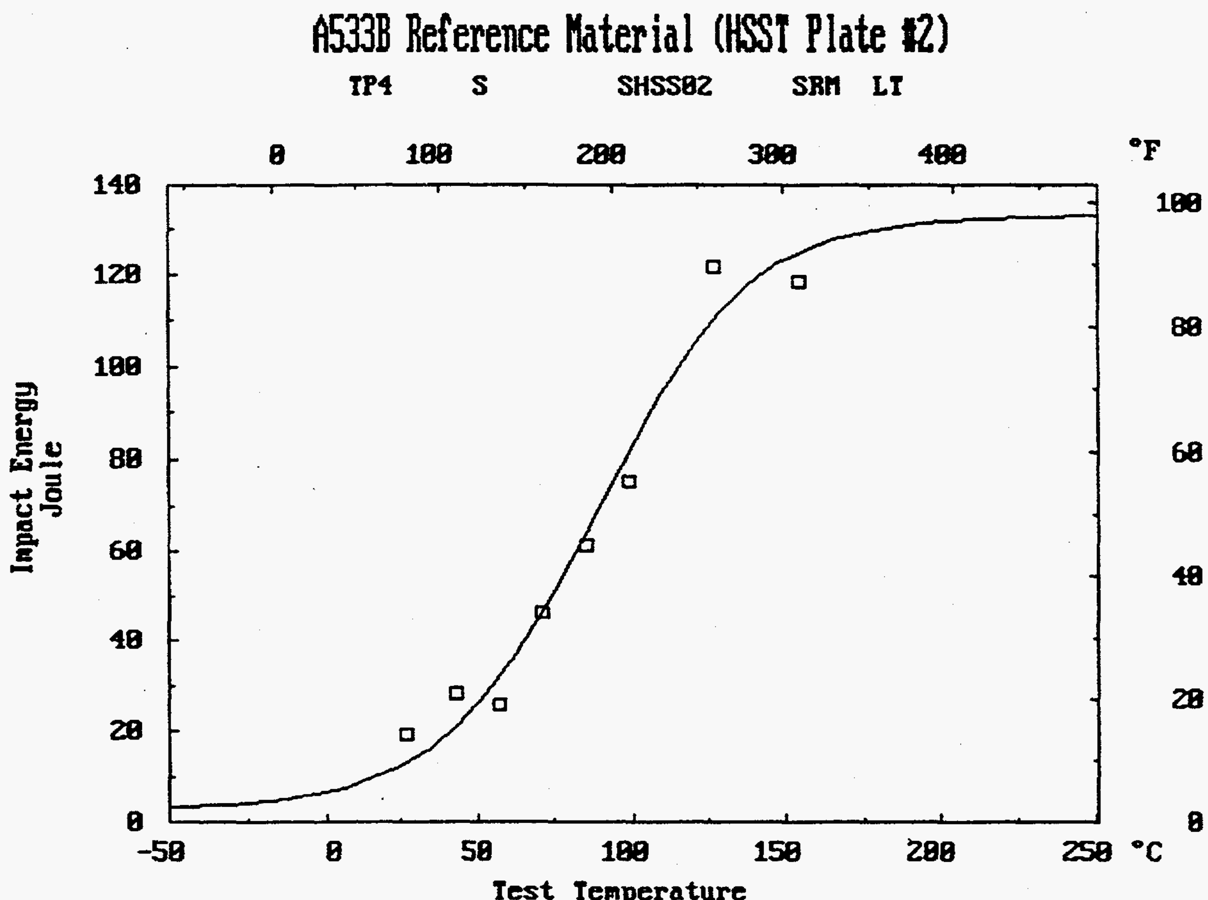
A533B HSST02 REFERENCE MATERIAL

Turkey Point Unit 4, Capsule S

```
Impact Energy Uncertainty =  10.0 J
Test Temperature Uncertainty =   4.0 Degree C
Number of Successful Iterations =  200, Maximum = 1000
```

TP4 S SHSS02 SRM LT : Fluence = 1.250E+19 , Irr. Temp. = 304

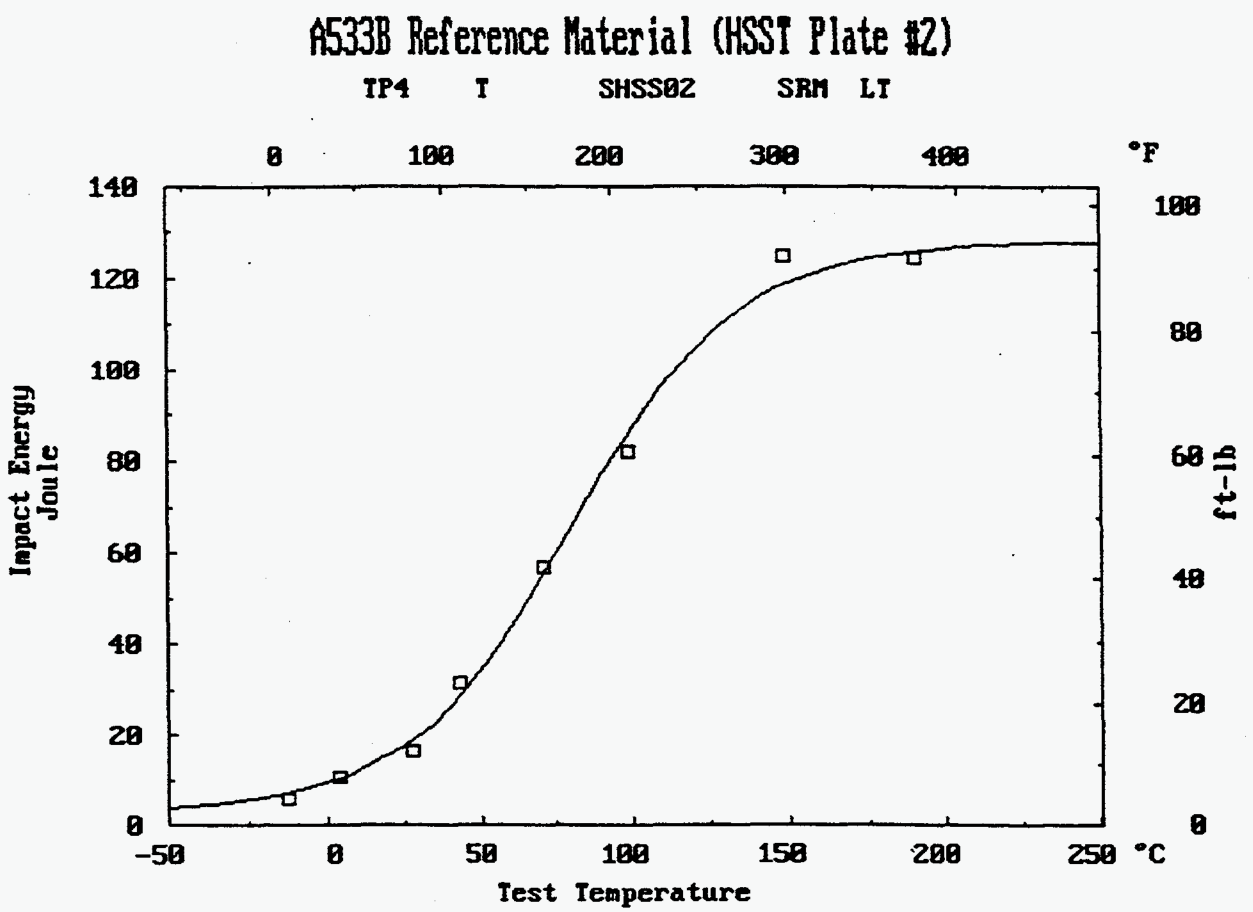
| Parameter | Mean | Std.Dev. | Correlation Coefficients | | | | |
|---|---|---|---|---|---|---|---|
| Lower Shelf Energy (J) | 3.0 | 0.0 | | | | | |
| Upper Shelf Energy (J) | 132.9 | 13.1 | 0.068 | | | | |
| CVT at Midpoint (C) | 88.3 | 7.8 | 0.138 | 0.875 | | | |
| 1/slope (C) | 49.3 | 12.2 | -0.177 | 0.634 | 0.619 | | |
| CVT at 41 Joule (C) | 66.2 | 5.1 | 0.333 | -0.060 | 0.220 | -0.582 | |
| CVT at 68 Joule (C) | 88.1 | 4.0 | 0.155 | 0.403 | 0.781 | 0.370 | 0. |



A533B HSST02 REFERENCE MATERIAL
Turkey Point Unit 4, Capsule T

USE= 128.0 J, LSE= 3.0 J, CVT(1/2)= 80.C , Slope = 0.0184
CVT(41J) = 58. C , CVT(68J) = 82. C ,
Fluence = 6.050E+18 , Irr. Temp. = 304 C

| Spec. ID | Test Temp. C | Test Temp. F | Impact Energy J | Impact Energy ft-lb | Lat. Exp. mm | Lat. Exp. mil | % Shear |
|---|---|---|---|---|---|---|---|
| R62 | -12. | 10. | 6. | 4. | 0.05 | 2. | 0. |
| R63 | 4. | 40. | 11. | 8. | 0.13 | 5. | 5. |
| R64 | 27. | 81. | 17. | 12. | 0.25 | 10. | 10. |
| R61 | 43. | 110. | 32. | 23. | 0.43 | 17. | 15. |
| R60 | 71. | 160. | 57. | 42. | 0.84 | 33. | 20. |
| R59 | 99. | 210. | 82. | 60. | 1.24 | 49. | 50. |
| R58 | 149. | 300. | 125. | 92. | 2.11 | 83. | 100. |
| R57 | 191. | 375. | 124. | 92. | 2.03 | 80. | 100. |



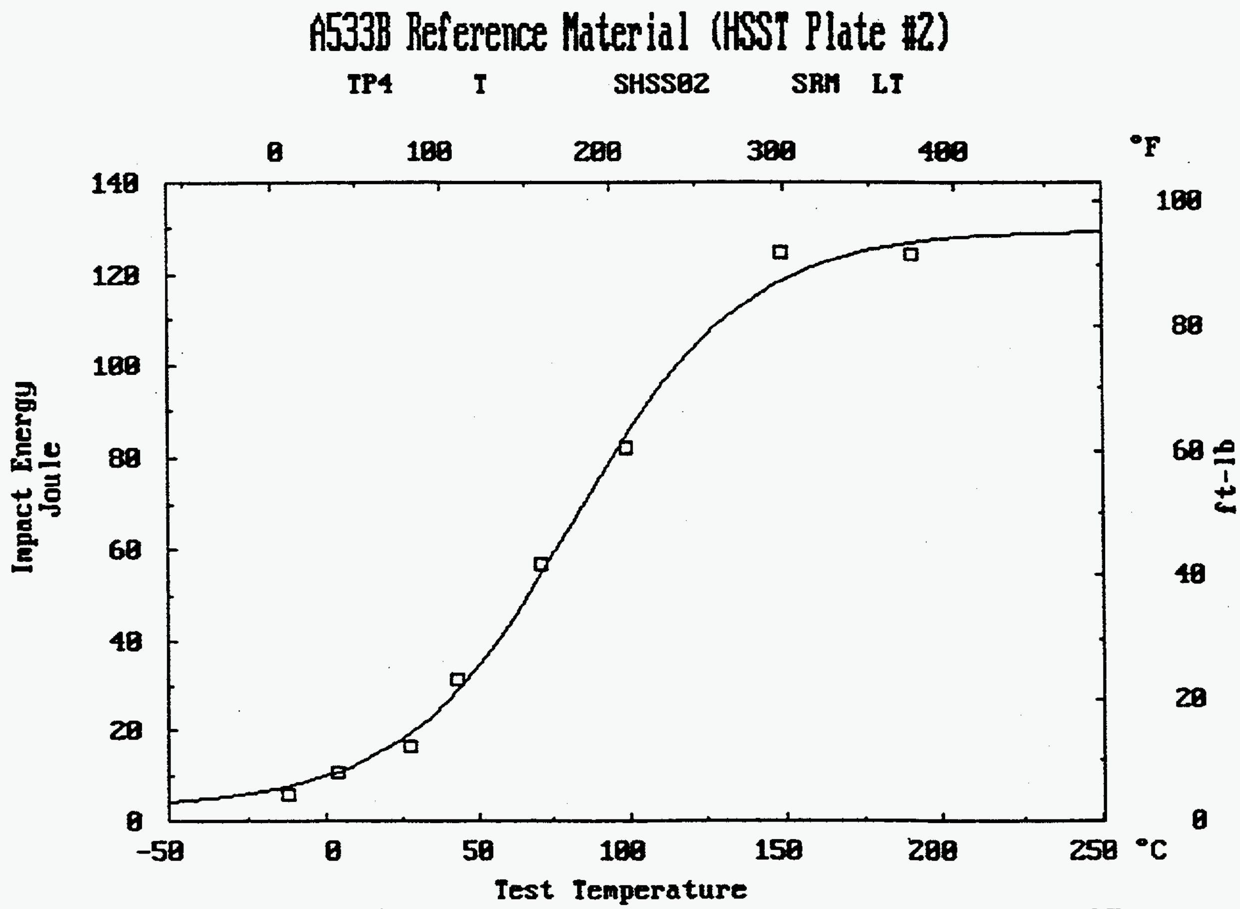
A533B HSST02 REFERENCE MATERIAL

Turkey Point Unit 4, Capsule T

```
Impact Energy Uncertainty =  10.0 J
Test Temperature Uncertainty =   4.0 Degree C
Number of Successful Iterations =  200, Maximum = 1000
```

TP4 T SHSS02 SRM LT : Fluence = 6.050E+18 , Irr. Temp. = 304

| Parameter | Mean | Std.Dev. | Correlation Coefficients | | | | |
|---|---|---|---|---|---|---|---|
| Lower Shelf Energy (J) | 3.0 | 0.0 | | | | | |
| Upper Shelf Energy (J) | 129.6 | 9.4 | -0.012 | | | | |
| CVT at Midpoint (C) | 81.8 | 8.7 | 0.077 | 0.720 | | | |
| 1/slope (C) | 57.0 | 11.9 | -0.090 | 0.501 | 0.486 | | |
| CVT at 41 Joule (C) | 57.5 | 6.7 | 0.170 | 0.088 | 0.591 | -0.359 | |
| CVT at 68 Joule (C) | 83.2 | 6.5 | 0.106 | 0.305 | 0.875 | 0.355 | 0.731 |



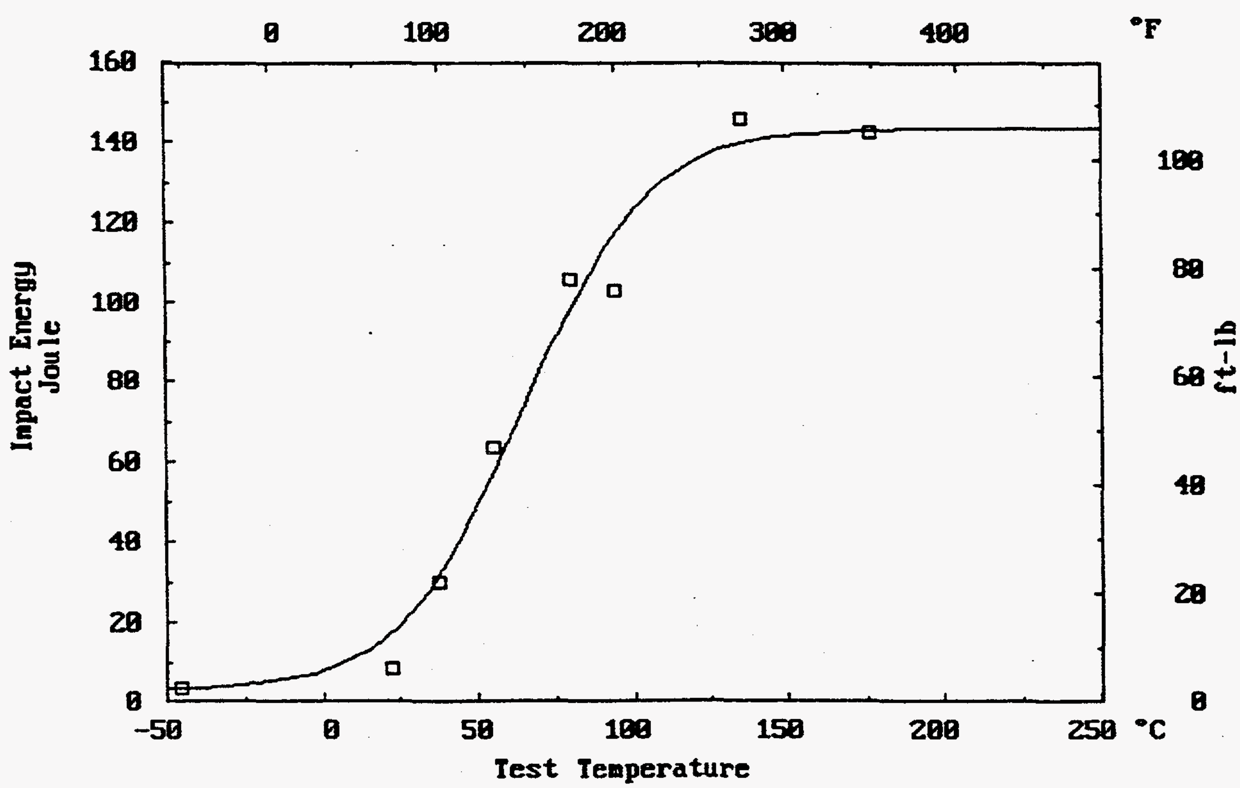
A533B HSST02 REFERENCE MATERIAL
Zion Unit 1, Capsule T

USE= 143.6 J, LSE= 3.0 J, CVT(1/2)= 65.C , Slope = 0.0255
CVT(41J) = 45. C , CVT(68J) = 62. C ,
Fluence = 1.800E+18 , Irr. Temp. = 288 C

| Spec. ID | Test Temp. C | F | Impact Energy J | ft-lb | Lat. Exp. mm | mil | % Shear |
|---|---|---|---|---|---|---|---|
| R34 | -46. | -50. | 3. | 2. | 0.03 | 1. | 0. |
| R38 | 22. | 72. | 9. | 6. | 0.20 | 8. | 10. |
| R37 | 38. | 100. | 30. | 22. | 0.61 | 24. | 25. |
| R39 | 56. | 132. | 64. | 47. | 1.02 | 40. | 35. |
| R40 | 79. | 175. | 106. | 78. | 1.57 | 62. | 50. |
| R36 | 93. | 200. | 103. | 76. | 1.47 | 58. | 55. |
| R33 | 135. | 275. | 146. | 108. | 1.78 | 70. | 100. |
| R35 | 177. | 350. | 142. | 105. | 2.08 | 82. | 100. |

A533B Reference Material (HSST Plate #2)

ZN1 T SHSS02 SRM LT



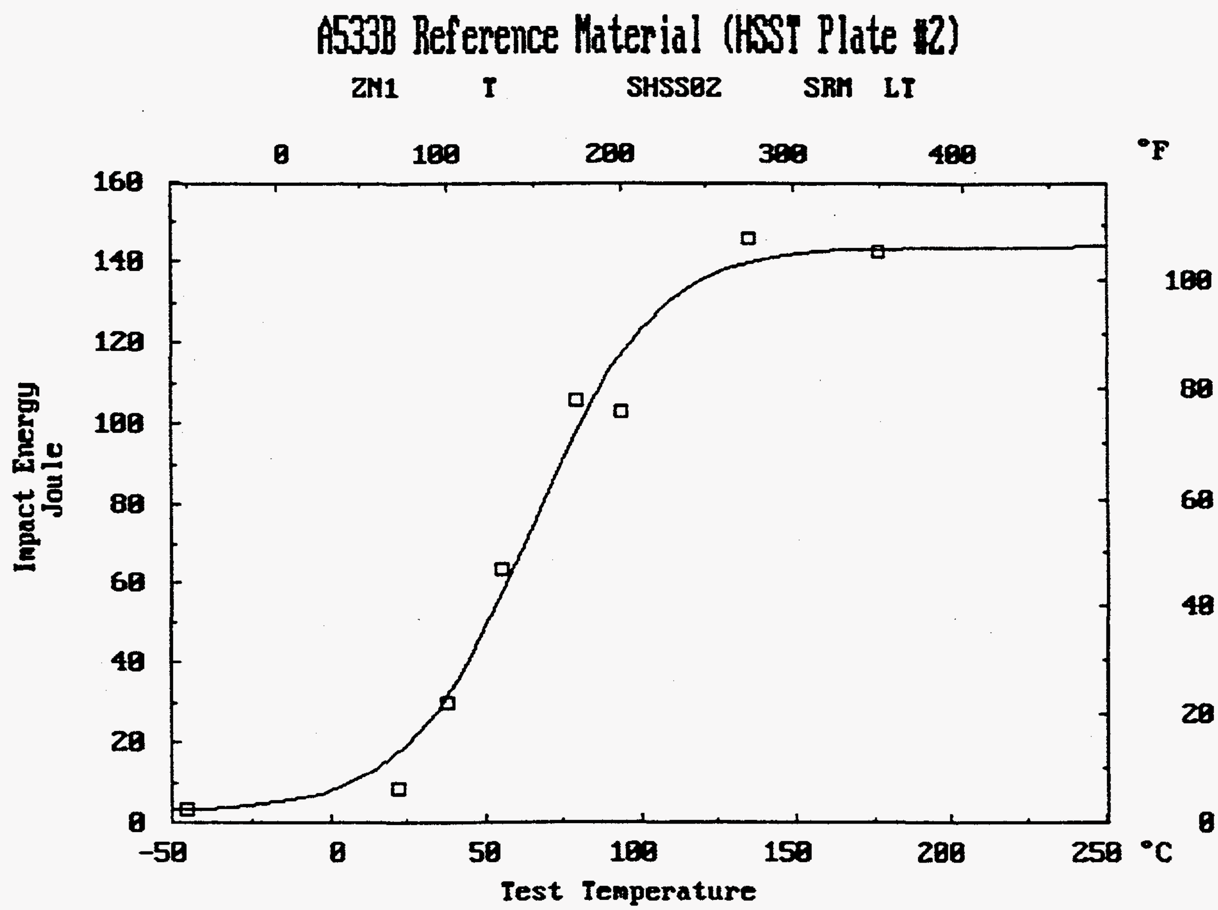
A533B HSST02 REFERENCE MATERIAL

Zion Unit 1, Capsule T

Impact Energy Uncertainty = 10.0 J
Test Temperature Uncertainty = 4.0 Degree C
Number of Successful Iterations = 200, Maximum = 1000

ZN1 T SHSS02 SRM LT : Fluence = 1.800E+18 , Irr. Temp. = 288

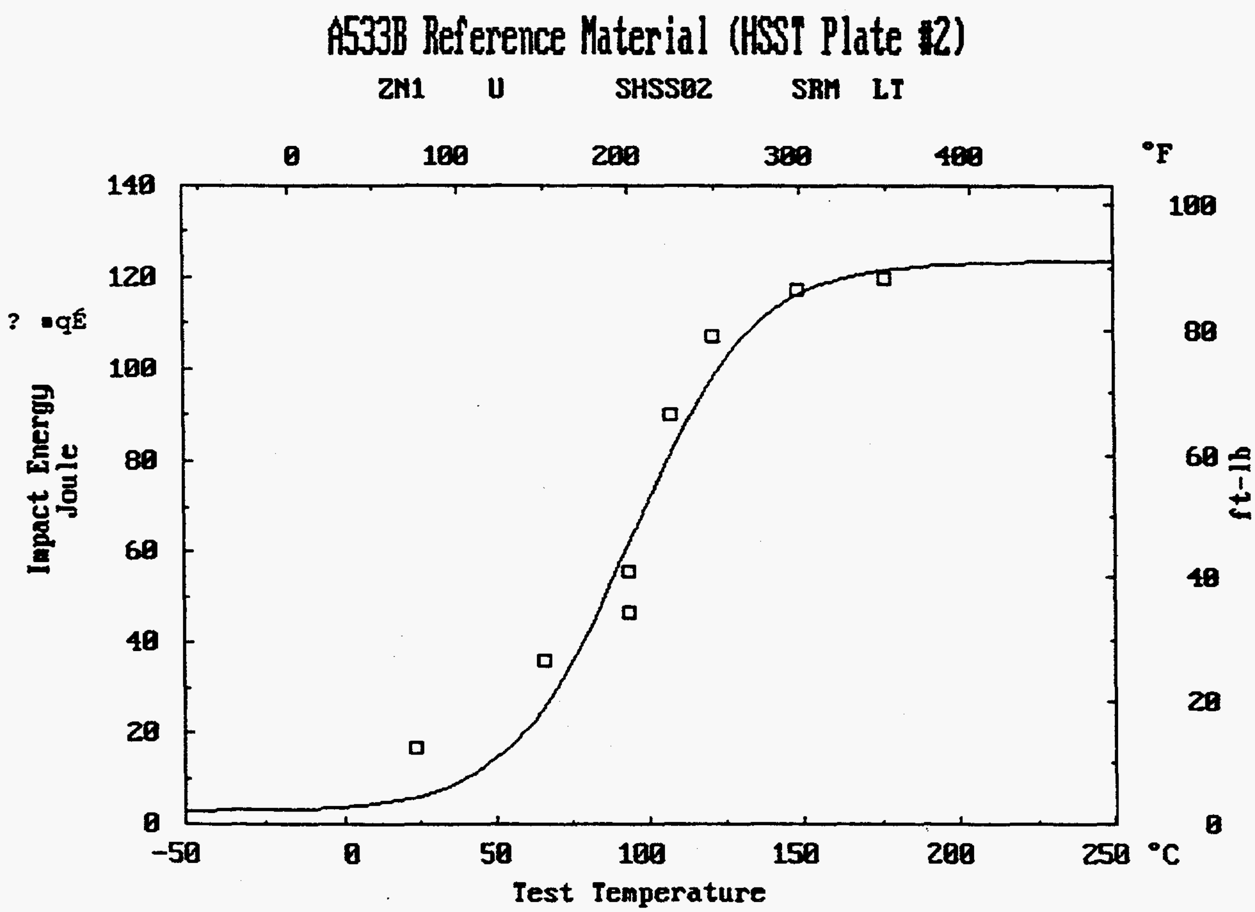
| Parameter | Mean | Std.Dev. | Correlation Coefficients | | | | |
|---|---|---|---|---|---|---|---|
| Lower Shelf Energy (J) | 3.0 | 0.0 | | | | | |
| Upper Shelf Energy (J) | 143.7 | 8.0 | 0.113 | | | | |
| CVT at Midpoint (C) | 64.7 | 5.6 | 0.097 | 0.651 | | | |
| 1/slope (C) | 39.3 | 7.9 | 0.101 | 0.555 | 0.480 | | |
| CVT at 41 Joule (C) | 45.1 | 4.9 | -0.022 | -0.011 | 0.561 | -0.429 | |
| CVT at 68 Joule (C) | 61.6 | 4.4 | 0.037 | 0.285 | 0.905 | 0.213 | 0.787 |



A533B HSST02 REFERENCE MATERIAL
Zion Unit 1, Capsule U

USE= 123.6 J, LSE= 3.1 J, CVT(1/2)= 95.C , Slope = 0.0255
CVT(41J) = 79. C , CVT(68J) = 98. C ,
Fluence = 8.920E+18 , Irr. Temp. = 304 C

| Spec. ID | Test Temp. C | Test Temp. F | Impact Energy J | Impact Energy ft-lb | Lat. Exp. mm | Lat. Exp. mil | % Shear |
|---|---|---|---|---|---|---|---|
| R47 | 24. | 75. | 17. | 12. | 0.20 | 8. | 17. |
| R43 | 66. | 150. | 36. | 26. | 0.56 | 22. | 32. |
| R41 | 93. | 200. | 47. | 34. | 0.63 | 25. | 39. |
| R42 | 93. | 200. | 56. | 41. | 0.97 | 38. | 52. |
| R48 | 107. | 225. | 90. | 66. | 1.40 | 55. | 58. |
| R46 | 121. | 250. | 107. | 79. | 1.78 | 70. | 81. |
| R44 | 149. | 300. | 117. | 86. | 1.96 | 77. | 99. |
| R45 | 177. | 350. | 120. | 88. | 1.96 | 77. | 100. |



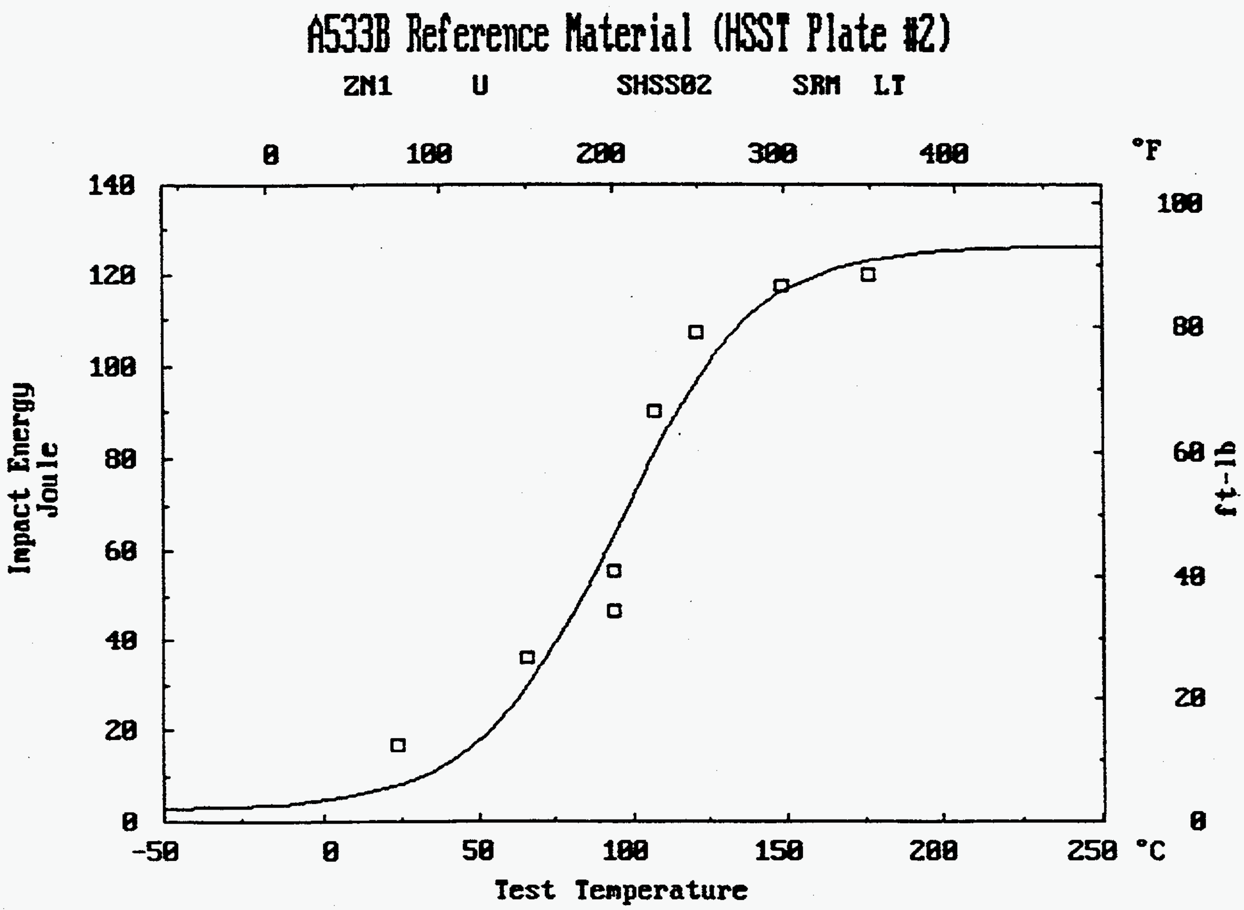
A533B HSST02 REFERENCE MATERIAL

Zion Unit 1, Capsule U

```
Impact Energy Uncertainty =  10.0 J
Test Temperature Uncertainty =   4.0 Degree C
Number of Successful Iterations =  200, Maximum = 1000
```

ZN1 U SHSS02 SRM LT : Fluence = 8.920E+18 , Irr. Temp. = 304

| Parameter | Mean | Std.Dev. | Correlation Coefficients | | | | |
|---|---|---|---|---|---|---|---|
| Lower Shelf Energy (J) | 3.1 | 0.0 | | | | | |
| Upper Shelf Energy (J) | 126.1 | 9.6 | -0.088 | | | | |
| CVT at Midpoint (C) | 94.8 | 6.1 | 0.156 | 0.674 | | | |
| 1/slope (C) | 44.6 | 12.2 | -0.387 | 0.476 | 0.148 | | |
| CVT at 41 Joule (C) | 76.6 | 7.0 | 0.425 | -0.138 | 0.483 | -0.760 | |
| CVT at 68 Joule (C) | 97.1 | 4.3 | 0.209 | 0.121 | 0.793 | -0.064 | 0.679 |



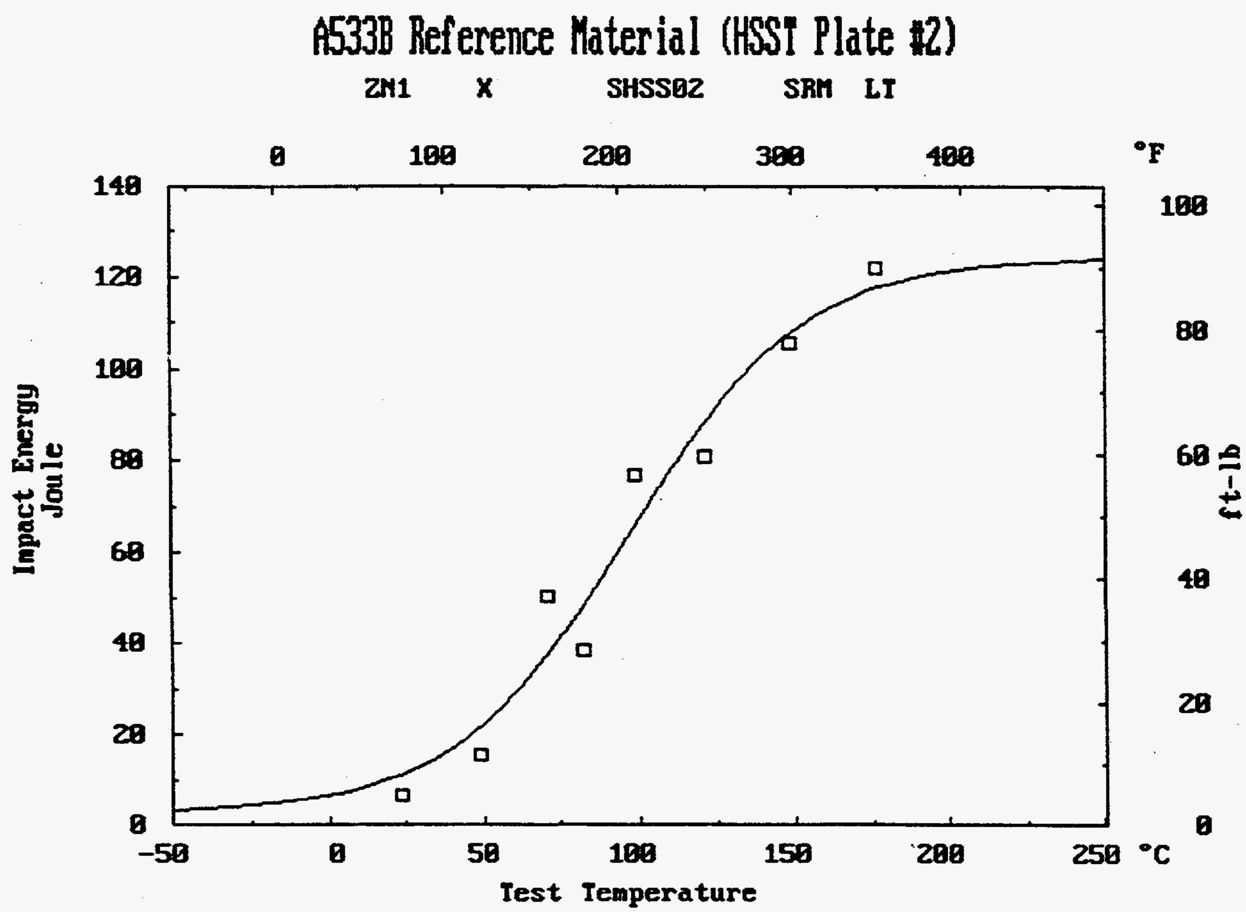
Appendix A

A533B HSST02 REFERENCE MATERIAL

Zion Unit 1, Capsule X

USE= 124.2 J, LSE= 3.0 J, CVT(1/2)= 97.C , Slope = 0.0178
CVT(41J) = 75. C , CVT(68J) = 101. C ,
Fluence = 1.400E+19 , Irr. Temp. = 304 C

| Spec. ID | Test Temp. C | Test Temp. F | Impact Energy J | Impact Energy ft-lb | Lat. Exp. mm | Lat. Exp. mil | % Shear |
|---|---|---|---|---|---|---|---|
| R25 | 24. | 75. | 7. | 5. | 0.10 | 4. | 5. |
| R28 | 49. | 120. | 16. | 11. | 0.25 | 10. | 10. |
| R26 | 71. | 160. | 50. | 37. | 0.81 | 32. | 15. |
| R32 | 82. | 180. | 39. | 28. | 0.69 | 27. | 30. |
| R27 | 99. | 210. | 77. | 56. | 1.19 | 47. | 25. |
| R31 | 121. | 250. | 81. | 59. | 1.37 | 54. | 50. |
| R29 | 149. | 300. | 106. | 78. | 1.47 | 58. | 100. |
| R30 | 177. | 350. | 122. | 90. | 1.63 | 64. | 100. |



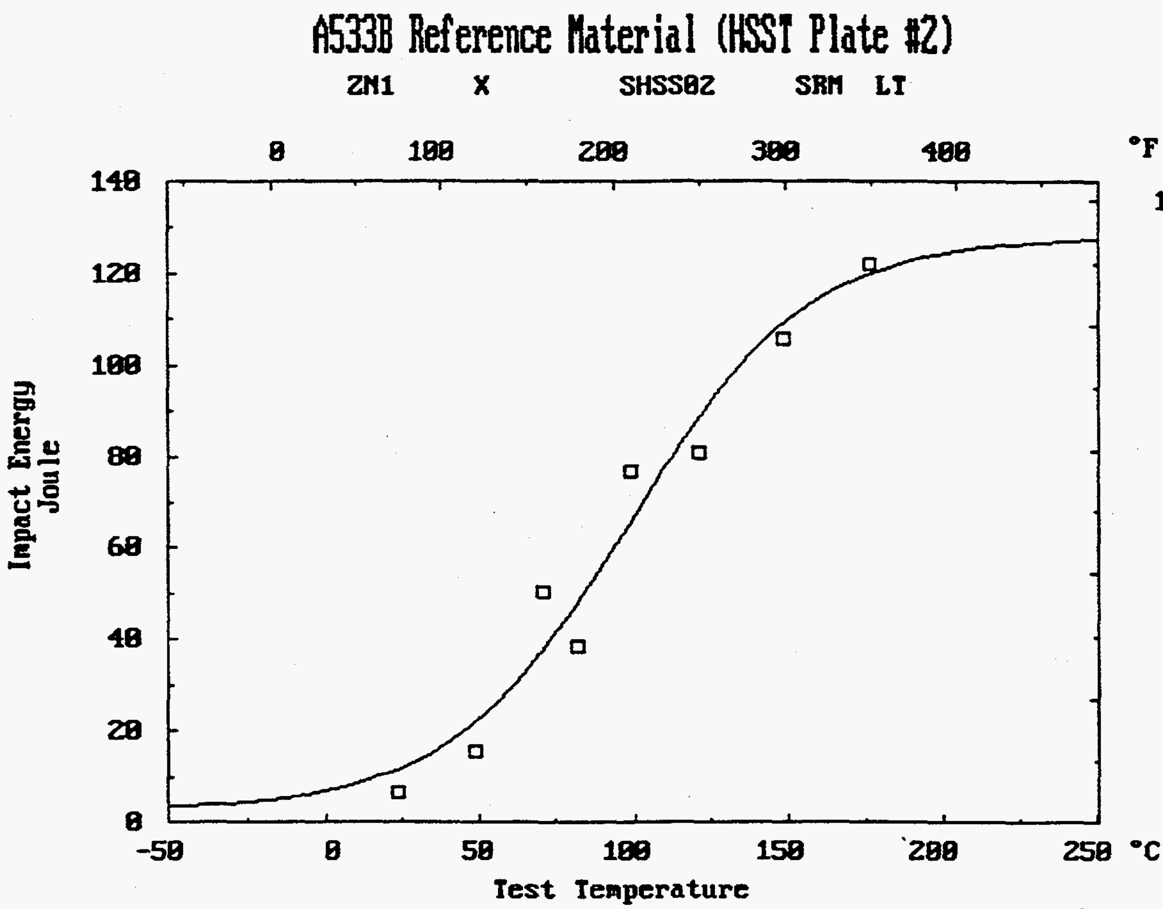
A533B HSST02 REFERENCE MATERIAL

Zion Unit 1, Capsule X

Impact Energy Uncertainty = 10.0 J
Test Temperature Uncertainty = 4.0 Degree C
Number of Successful Iterations = 200, Maximum = 1000

ZN1 X SHSS02 SRM LT : Fluence = 1.400E+19 , Irr. Temp. = 304

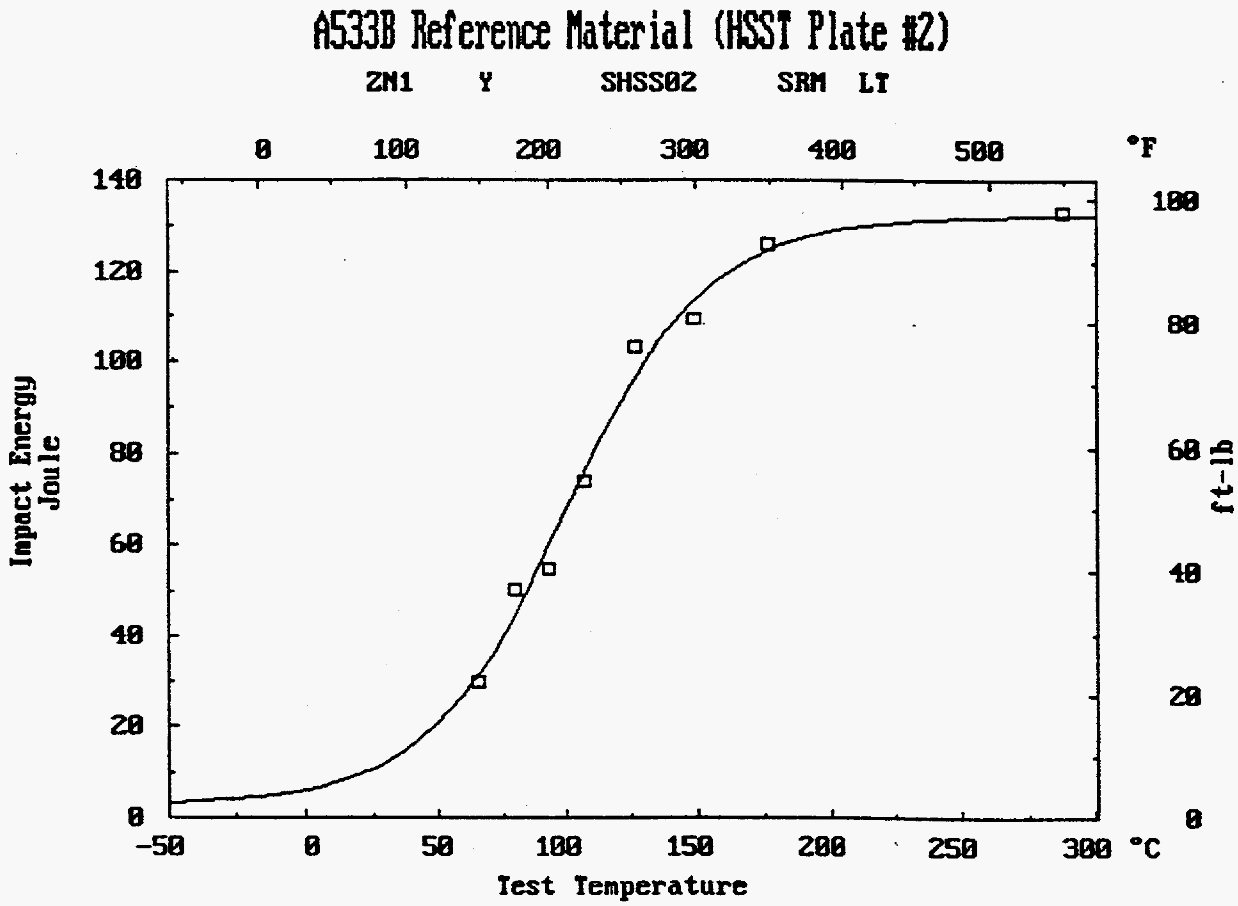
| Parameter | Mean | Std.Dev. | Correlation Coefficients | | | | |
|---|---|---|---|---|---|---|---|
| Lower Shelf Energy (J) | 3.0 | 0.0 | | | | | |
| Upper Shelf Energy (J) | 127.8 | 16.7 | 0.066 | | | | |
| CVT at Midpoint (C) | 98.4 | 13.0 | 0.083 | 0.926 | | | |
| 1/slope (C) | 57.6 | 15.1 | 0.053 | 0.816 | 0.791 | | |
| CVT at 41 Joule (C) | 74.0 | 5.6 | 0.055 | 0.165 | 0.439 | -0.142 | |
| CVT at 68 Joule (C) | 100.3 | 6.5 | 0.074 | 0.630 | 0.868 | 0.637 | 0.645 |



A533B HSST02 REFERENCE MATERIAL
Zion Unit 1, Capsule Y

```
USE= 132.1 J, LSE=   3.0 J, CVT(1/2)=  100.C , Slope = 0.0183
CVT(41J) =   76. C , CVT(68J) =  100. C ,
Fluence = 1.560E+19 , Irr. Temp. = 304 C
```

| Spec. ID | Test Temp. C | F | Impact Energy J | ft-lb | Lat. Exp. mm | mil | % Shear |
|---|---|---|---|---|---|---|---|
| R53 | 66. | 150. | 30. | 22. | 0.46 | 18. | 20. |
| R55 | 79. | 175. | 50. | 37. | 0.81 | 32. | 40. |
| R50 | 93. | 200. | 55. | 40. | 0.86 | 34. | 40. |
| R52 | 107. | 225. | 74. | 54. | 1.12 | 44. | 60. |
| R56 | 127. | 260. | 103. | 76. | 1.55 | 61. | 100. |
| R51 | 149. | 300. | 109. | 80. | 1.68 | 66. | 100. |
| R49 | 177. | 350. | 126. | 93. | 1.96 | 77. | 100. |
| R54 | 288. | 550. | 133. | 98. | 2.13 | 84. | 100. |



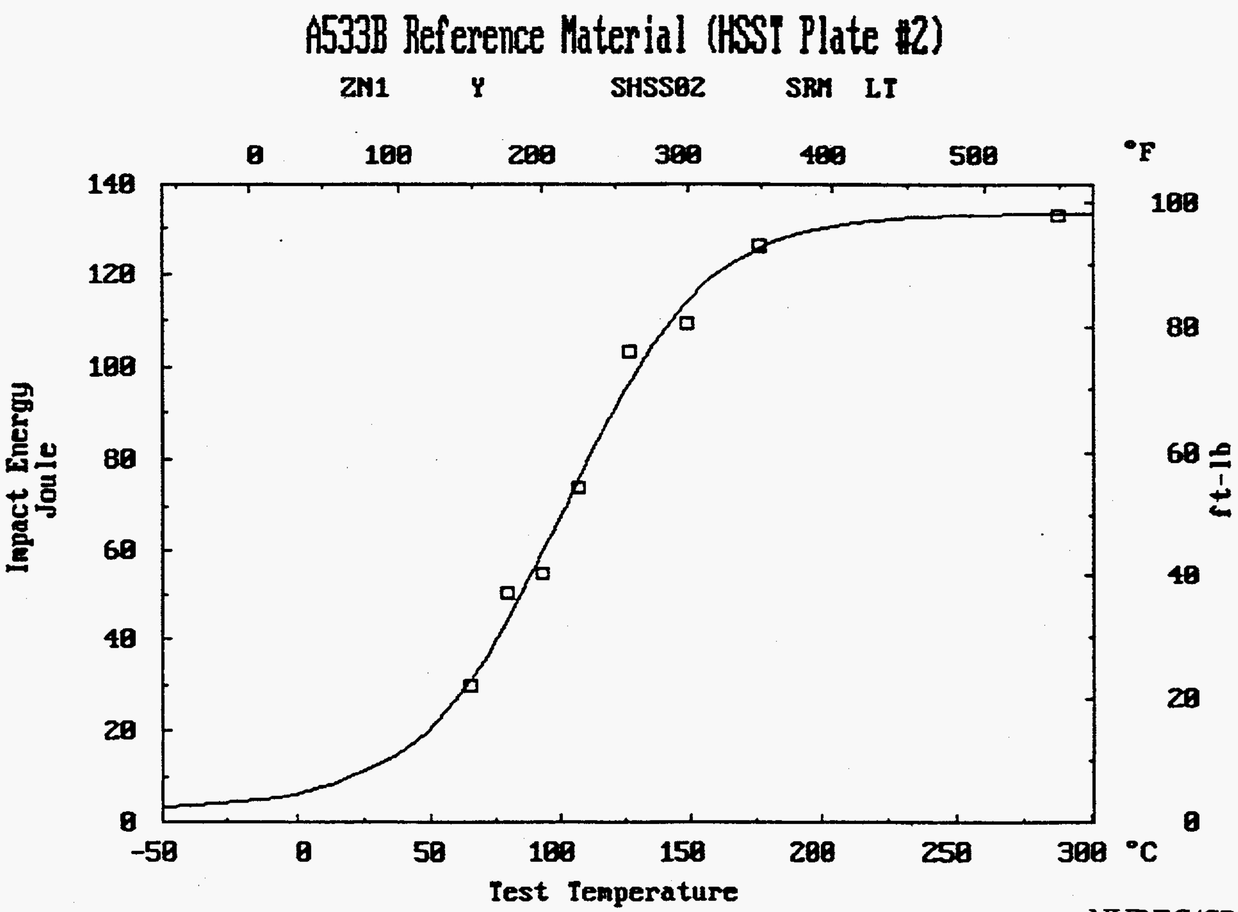
A533B HSST02 REFERENCE MATERIAL

Zion Unit 1, Capsule Y

```
Impact Energy Uncertainty =  10.0 J
Test Temperature Uncertainty =   4.0 Degree C
Number of Successful Iterations =  200, Maximum = 1000
```

```
ZN1    Y     SHSS02    SRM   LT : Fluence = 1.560E+19 , Irr. Temp. =  304
```

| Parameter | Mean | Std.Dev. | Correlation Coefficients | | | | |
|---|---|---|---|---|---|---|---|
| Lower Shelf Energy (J) | 3.0 | 0.0 | | | | | |
| Upper Shelf Energy (J) | 133.4 | 8.9 | -0.076 | | | | |
| CVT at Midpoint (C) | 100.8 | 6.9 | -0.073 | 0.721 | | | |
| 1/slope (C) | 55.0 | 13.1 | -0.035 | 0.610 | 0.475 | | |
| CVT at 41 Joule (C) | 76.1 | 6.6 | 0.001 | -0.220 | 0.293 | -0.671 | |
| CVT at 68 Joule (C) | 100.4 | 4.7 | -0.015 | 0.200 | 0.812 | 0.136 | 0.631 |



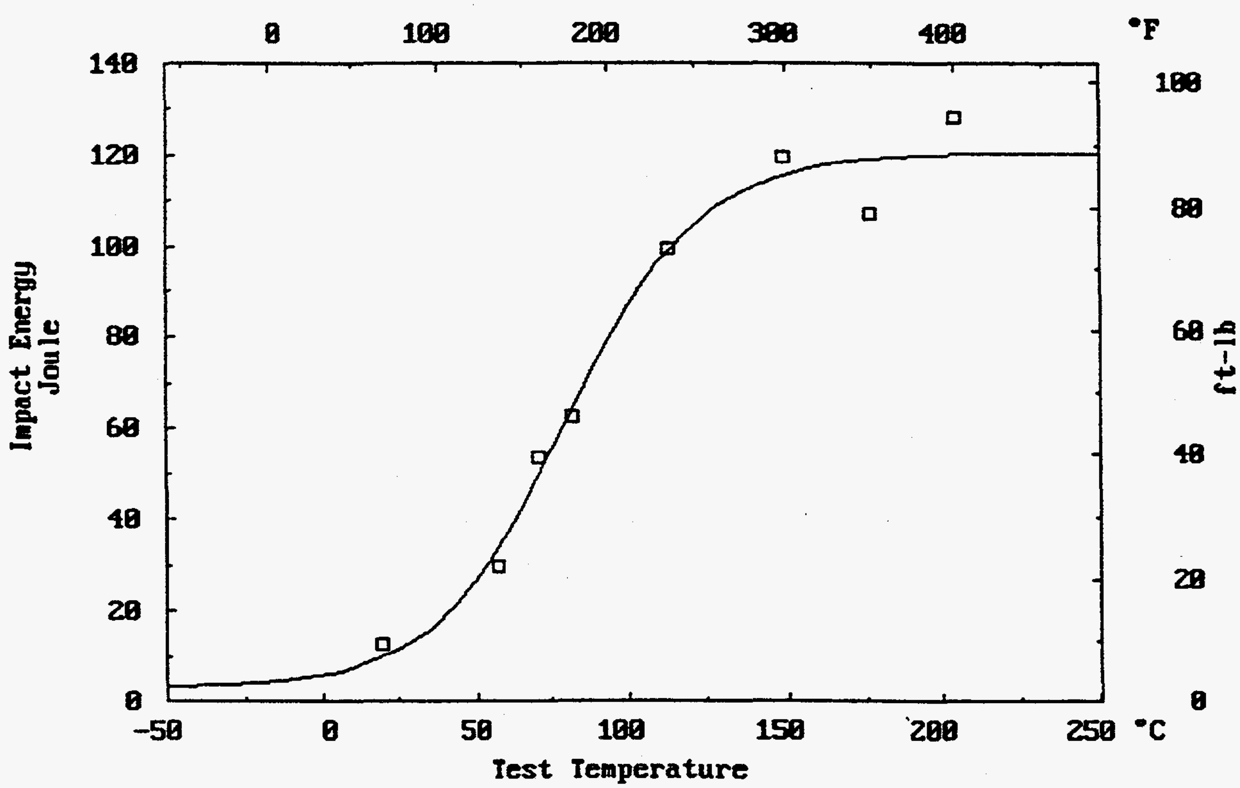
A533B HSST02 REFERENCE MATERIAL
Zion Unit 2, Capsule T

USE= 120.3 J, LSE= 3.0 J, CVT(1/2)= 80.C , Slope = 0.0230
CVT(41J) = 64. C , CVT(68J) = 85. C ,
Fluence = 1.000E+19 , Irr. Temp. = 304 C

| Spec. ID | Test Temp. C | Test Temp. F | Impact Energy J | Impact Energy ft-lb | Lat. Exp. mm | Lat. Exp. mil | % Shear |
|---|---|---|---|---|---|---|---|
| R40 | 20. | 68. | 13. | 9. | 0.20 | 8. | 10. |
| R39 | 57. | 135. | 30. | 22. | 0.53 | 21. | 20. |
| R33 | 71. | 160. | 54. | 39. | 0.86 | 34. | 30. |
| R38 | 82. | 180. | 62. | 46. | 1.14 | 45. | 30. |
| R37 | 113. | 235. | 100. | 73. | 1.63 | 64. | 80. |
| R36 | 149. | 300. | 119. | 88. | 1.93 | 76. | 100. |
| R35 | 177. | 350. | 107. | 79. | 1.80 | 71. | 100. |
| R34 | 204. | 400. | 128. | 94. | 2.08 | 82. | 100. |

A533B Reference Material (HSST Plate #2)

ZN2 T SHSS02 SRM LT



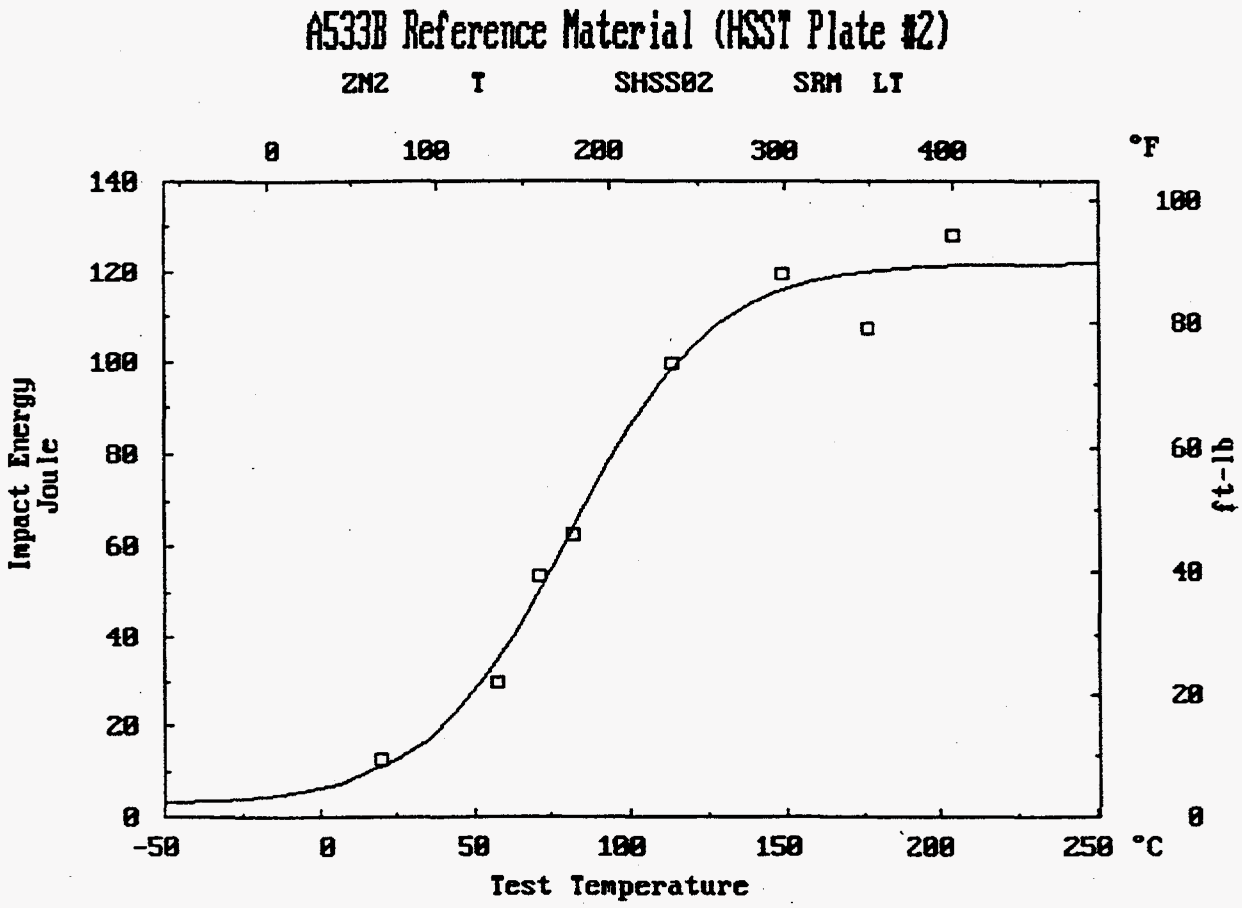
A533B HSST02 REFERENCE MATERIAL

Zion Unit 2, Capsule T

Impact Energy Uncertainty = 10.0 J
Test Temperature Uncertainty = 4.0 Degree C
Number of Successful Iterations = 200, Maximum = 1000

ZN2 T SHSS02 SRM LT : Fluence = 1.000E+19 , Irr. Temp. = 304

| Parameter | Mean | Std.Dev. | Correlation Coefficients | | | | |
|---|---|---|---|---|---|---|---|
| Lower Shelf Energy (J) | 3.0 | 0.0 | | | | | |
| Upper Shelf Energy (J) | 121.8 | 7.3 | -0.120 | | | | |
| CVT at Midpoint (C) | 80.7 | 6.7 | -0.007 | 0.620 | | | |
| 1/slope (C) | 46.1 | 12.7 | -0.314 | 0.614 | 0.502 | | |
| CVT at 41 Joule (C) | 63.1 | 5.9 | 0.290 | -0.165 | 0.481 | -0.483 | |
| CVT at 68 Joule (C) | 84.8 | 5.6 | -0.008 | 0.292 | 0.916 | 0.441 | 0.562 |

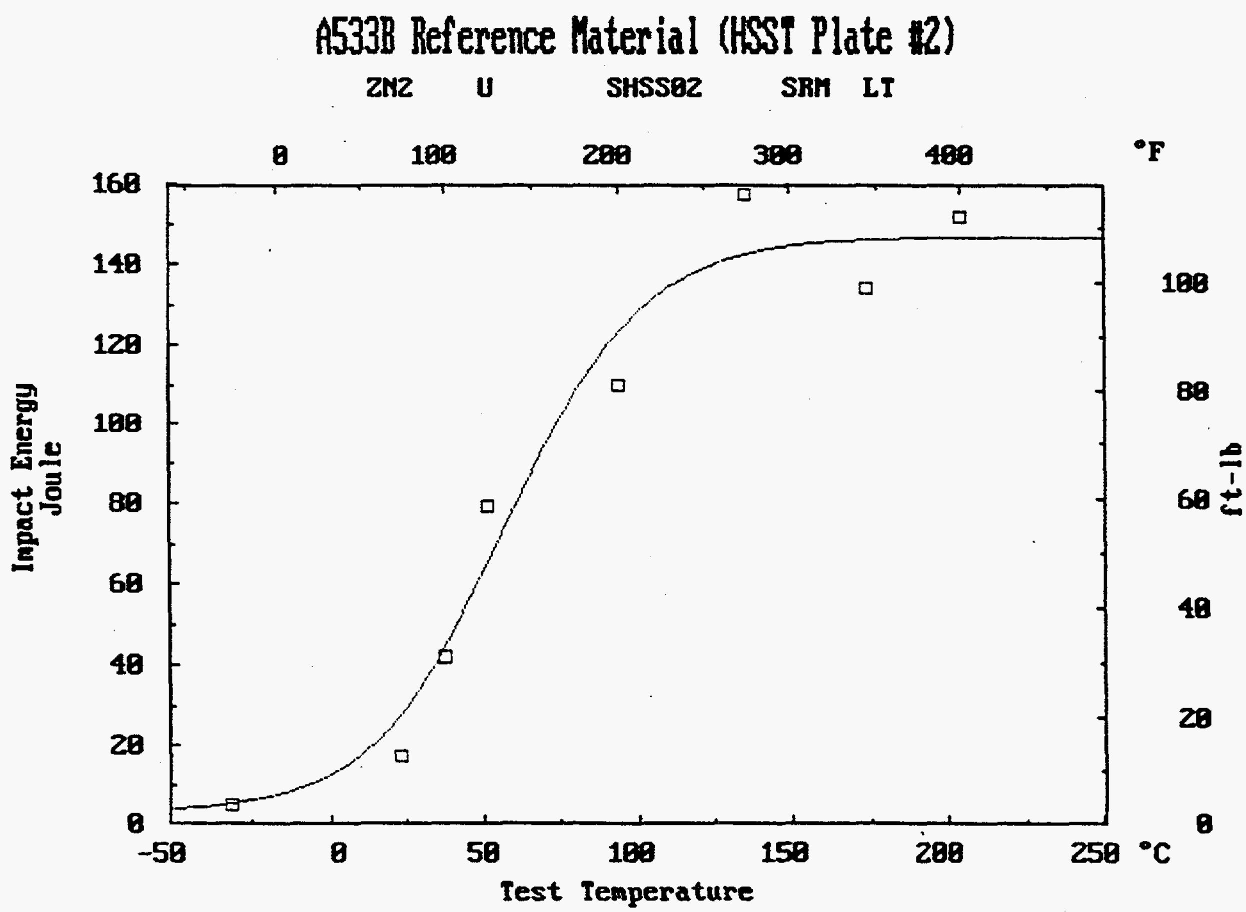


A533B HSST02 REFERENCE MATERIAL

Zion Unit 2, Capsule U

USE= 146.8 J, LSE= 3.0 J, CVT(1/2)= 58.C , Slope = 0.0227
CVT(41J) = 35. C , CVT(68J) = 53. C ,
Fluence = 2.000E+18 , Irr. Temp. = 288 C

| Spec. ID | Test Temp. C | Test Temp. F | Impact Energy J | Impact Energy ft-lb | Lat. Exp. mm | Lat. Exp. mil | % Shear |
|---|---|---|---|---|---|---|---|
| R46 | -32. | -25. | 5. | 3. | 0.18 | 7. | 0. |
| R42 | 23. | 73. | 18. | 13. | 0.43 | 17. | 15. |
| R48 | 38. | 100. | 42. | 31. | 0.66 | 26. | 25. |
| R41 | 52. | 125. | 79. | 58. | 1.22 | 48. | 45. |
| R47 | 93. | 200. | 110. | 81. | 1.65 | 65. | 70. |
| R43 | 135. | 275. | 157. | 116. | 2.24 | 88. | 100. |
| R44 | 174. | 345. | 134. | 99. | 2.03 | 80. | 100. |
| R45 | 204. | 400. | 152. | 112. | 2.03 | 80. | 100. |



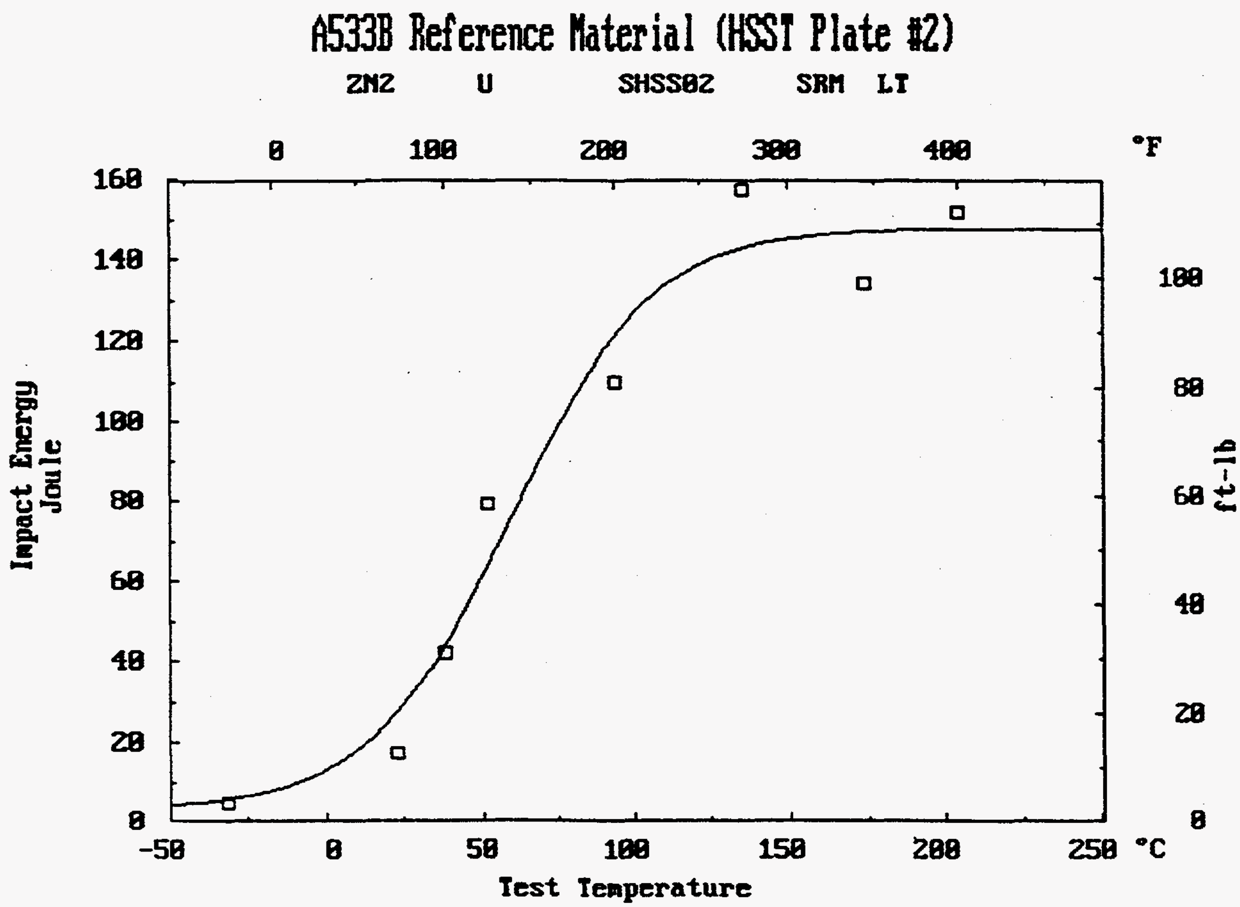
A533B HSST02 REFERENCE MATERIAL

Zion Unit 2, Capsule U

Impact Energy Uncertainty = 10.0 J
Test Temperature Uncertainty = 4.0 Degree C
Number of Successful Iterations = 200, Maximum = 1000

ZN2 U SHSS02 SRM LT : Fluence = 2.000E+18 , Irr. Temp. = 288

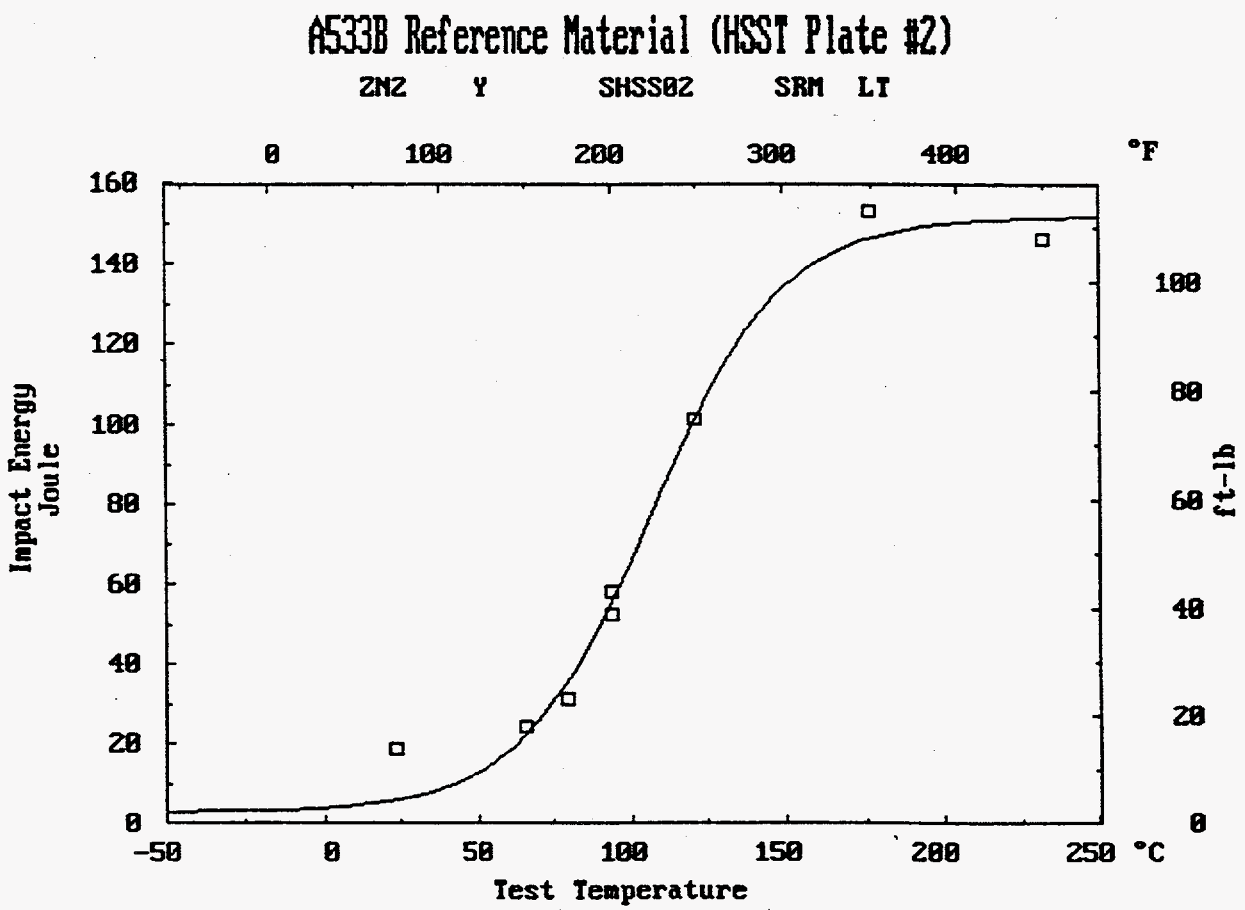
| Parameter | Mean | Std.Dev. | Correlation Coefficients | | | | |
|---|---|---|---|---|---|---|---|
| Lower Shelf Energy (J) | 3.0 | 0.0 | | | | | |
| Upper Shelf Energy (J) | 147.9 | 6.8 | 0.065 | | | | |
| CVT at Midpoint (C) | 59.3 | 6.7 | 0.010 | 0.635 | | | |
| 1/slope (C) | 45.7 | 10.0 | -0.050 | 0.525 | 0.612 | | |
| CVT at 41 Joule (C) | 35.5 | 5.2 | 0.047 | 0.001 | 0.488 | -0.369 | |
| CVT at 68 Joule (C) | 54.5 | 5.1 | 0.004 | 0.329 | 0.925 | 0.385 | 0.713 |



A533B HSST02 REFERENCE MATERIAL
Zion Unit 2, Capsule Y

USE= 151.9 J, LSE= 3.1 J, CVT(1/2)= 106.C , Slope = 0.0235
CVT(41J) = 84. C , CVT(68J) = 101. C ,
Fluence = 1.480E+19 , Irr. Temp. = 288 C

| Spec. ID | Test Temp. | | Impact Energy | | Lat. Exp. | | % Shear |
|---|---|---|---|---|---|---|---|
| | C | F | J | ft-lb | mm | mil | |
| R55 | 23. | 74. | 19. | 14. | 0.28 | 11. | 10. |
| R51 | 66. | 150. | 24. | 18. | 0.38 | 15. | 15. |
| R54 | 79. | 175. | 31. | 23. | 0.53 | 21. | 20. |
| R49 | 93. | 200. | 58. | 43. | 0.79 | 31. | 35. |
| R50 | 93. | 200. | 53. | 39. | 0.74 | 29. | 35. |
| R56 | 121. | 250. | 102. | 75. | 1.35 | 53. | 65. |
| R53 | 177. | 350. | 153. | 113. | 1.88 | 74. | 100. |
| R52 | 232. | 450. | 146. | 108. | 1.78 | 70. | 100. |



A533B HSST02 REFERENCE MATERIAL

Zion Unit 2, Capsule Y

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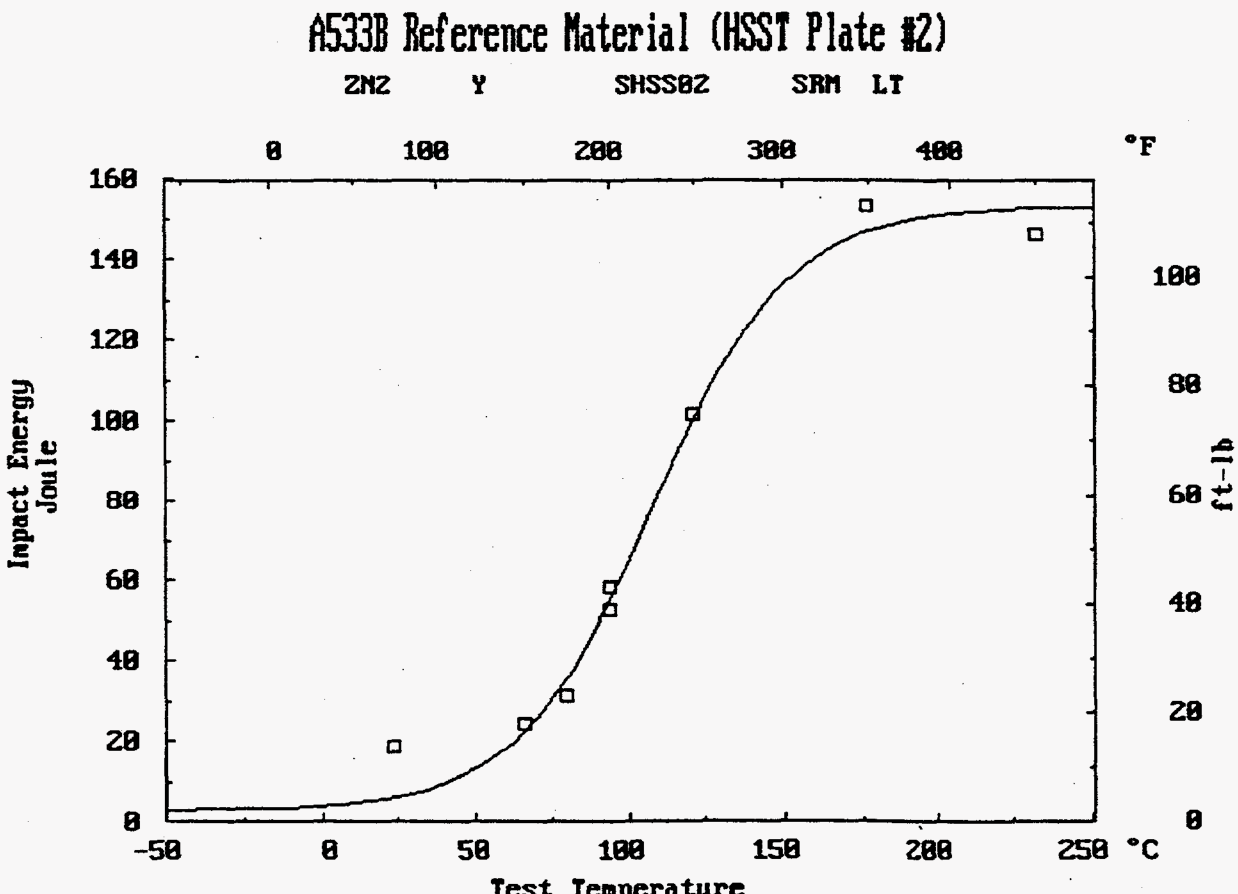
Impact Energy Uncertainty =  10.0 J
Test Temperature Uncertainty =   4.0 Degree C
Number of Successful Iterations =  200, Maximum = 1000
```

ZN2 Y SHSS02 SRM LT : Fluence = 1.480E+19 , Irr. Temp. = 288

| Parameter | Mean | Std.Dev. | Correlation Coefficients | | | | |
|---|---|---|---|---|---|---|---|
| Lower Shelf Energy (J) | 3.1 | 0.1 | | | | | |
| Upper Shelf Energy (J) | 153.2 | 7.4 | 0.025 | | | | |
| CVT at Midpoint (C) | 107.6 | 5.3 | 0.039 | 0.584 | | | |
| 1/slope (C) | 43.7 | 9.8 | -0.239 | 0.363 | 0.566 | | |
| CVT at 41 Joule (C) | 83.9 | 4.8 | 0.293 | -0.069 | 0.272 | -0.613 | |
| CVT at 68 Joule (C) | 101.6 | 3.8 | 0.118 | 0.171 | 0.857 | 0.226 | 0.627 |



# APPENDIX B

# BIBLIOGRAPHIC LISTING OF SURVEILLANCE REPORTS

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11. ABSTRACT *(200 words or less)*

The results of Charpy V-notch impact tests for A302B and A533B-1 Correlation Monitor Materials (CMM) listed in the surveillance power reactor data base (PR-EDB) and material test reactor data base (TR-EDB) are analyzed. The shift of the transition temperature at 30 ft-lb ($T_{30}$) is considered as the primary measure of radiation embrittlement in this report. The hyperbolic tangent fitting model and uncertainty of the fitting parameters for Charpy impact tests are presented in this report. For the surveillance CMM data, the transition temperature shifts at 30 ft-lb ($\Delta T_{30}$) generally follow the predictions provided by Revision 2 of Regulatory Guide 1.99 (R.G. 1.99). Difference in capsule temperatures is a likely explanation for large deviations from R.G. 1.99 predictions. Deviations from the R.G. 1.99 predictions are correlated to similar deviations for the accompanying materials in the same capsules, but large random fluctuations prevent precise quantitative determination. Significant scatter is noted in the surveillance data, some of which may be attributed to variations from one specimen set to another, or inherent in Charpy V-notch testing. In general, the embrittlement behavior of both the A302B and A533B-1 plate materials is similar. There is evidence for a fluence-rate effect in the CMM data irradiated in test reactors; thus its implication on power reactor surveillance programs deserves special attention.

12. KEY WORDS/DESCRIPTORS *(List words or phrases that will assist researchers in locating the report.)*

correlation monitor material; test reactor; radiation embrittlement; power reactor; Charpy curve fitting

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