#414879

SUPPLEMENTAL SUMMARY OF EPA-MANDATED PERFORMANCE ASSESSMENT VERIFICATION TEST (ALL REPLICATES) AND COMPARISON WITH THE COMPLIANCE CERTIFICATION APPLICATION CALCULATIONS

WPO # 46702

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1.0 INTRODUCTION

A prior report (WPO #46674) described in detail the results obtained from replicate 1 of the U.S. Environmental Protection Agency (EPA) Mandated Performance Assessment Verification Test (PAVT) of the U.S. Department of Energy's Performance Assessment Analyses supporting the Waste Isolation Pilot Plant (WIPP) Compliance Certification Application (CCA). Two additional PAVT replicates were run to confirm that the variation between replicate results is not significant.

Analysis of all three PAVT replicates showed complimentary cumulative distribution functions (CCDFs) for total normalized radionuclide releases to the accessible environment to exhibit only small variations across the three replicates. Releases due to cuttings, spallings, direct brine release, and Culebra transport showed similar small variations across replicates. This report provides an overall summary of the PAVT results from replicates 1,2, and 3 and gives summary comparisons with CCA replicates. More detailed discussions are presented in the prior report (WPO #46674).

This report is divided into the following sections to maintain consistency with the prior report: Introduction and Summary of Differences Between the PAVT and CCA (Section 1); Salado Flow Calculations (Section 2); Salado Transport Calculations (Section 3); Culebra Flow and Transport Calculations (Section 4); Cuttings, Cavings, and Spallings Calculations (Section 5); Direct Brine Release Calculations (Section 6); and CCDF Calculations (Section 7). In the first section, a summary of differences between the PAVT and CCA is provided. The conclusions of this summary are unchanged from those presented in the prior report and are only updated to include the confirmatory results of replicates 2 and 3. A summary of differences between the PAVT replicates is also provided in the first section. In each of the subsequent sections, the following information is provided:

- Results of the three PAVT replicates and their comparison with the CCA results.
- A comparison of PAVT replicate 1,2, and 3 results.

1.1 Summary of Differences Between the PAVT and CCA

In both the PAVT and the CCA, radionuclide releases (in EPA units) were dominated by cuttings and spallings releases, with a smaller contribution from direct brine release. Culebra, Salado interbed, and Dewey Lake releases across the land withdrawal boundary (LWB) were negligible. The PAVT overall mean CCDF for total normalized releases to the accessible environment does not exceed or come within an order of magnitude of the EPA Limit. The following discussion summarizes the major differences in the PAVT results relative to the CCA. Factors affecting indirect releases through the Salado and Culebra are discussed first, followed by a discussion of direct releases (cuttings, spallings, and direct brine) and CCDFs. As noted in the introduction, PAVT results for each replicate were found to be in good agreement with each other.

Salado Flow

Undisturbed Scenario
In terms of repository pressures, brine saturations, and gas generation, undisturbed repository performance was not significantly impacted by changes in parameters. However, one PAVT vector (R1V38, vector #38 of replicate 1) produced increased brine flow (3326 m^3) across the land withdrawal boundary (LWB). This flow was caused by a combination of factors: the highest interbed permeability, the 8th highest DRZ permeability, low far-field pressure, and a high repository pressure at 1000 years. Maximum flow across the LWB in replicates 2 (185 m^3) and 3 (130 m^3) were much less. The maximum flow across the LWB in the CCA was 216 m^3.

Disturbed Scenarios S2 and S3 (E1 intrusion at 350 and 1000 years)
Parameter changes that had the most impact on repository performance in the E1 intrusion scenarios were the brine reservoir volume (approximately two orders of magnitude larger), borehole permeability (lower minimum permeabilities), and corrosion rates (higher). These changes resulted in higher repository pressures and larger upward borehole brine flows, on average, to the Culebra. For S3, the maximum flow in PAVT replicates 1 and 3 (102,340 m^3 in replicate 1; 114,000 m^3 in replicate 3) was about two times larger than the maximum flow predicted in the CCA (67,000 m^3) and the maximum flow in PAVT replicate 2 (71,000 m^3) about the same as the maximum in the CCA. As in the undisturbed scenario, one PAVT vector (R1V38) produced increased flow (2630 m^3) across the LWB. In the CCA, flows across the LWB in all disturbed scenarios were negligible.

Disturbed Scenarios S4 and S5 (E2 intrusion at 350 and 1000 years)
Parameter changes that had the most impact on repository performance in the E2 intrusion scenarios were corrosion rates (higher), borehole permeabilities (lower minimum permeabilities), and DRZ permeability (sampled over a range of higher and lower permeabilities). These changes resulted in higher repository pressures and smaller upward borehole brine flows, on average, to the Culebra, with the maximum flows in the PAVT replicates ranging from about 2 to 10 times smaller than the maximum amounts predicted in the CCA. As in the E1 intrusion scenarios, cumulative brine flow across the LWB was significant (2735 m^3) in only one PAVT vector (R1V38).

Disturbed Scenario S6 (E2 intrusion at 1000 years and an E1 intrusion at 2000 years)
Parameter changes that had the most impact on repository performance in the E2E1 intrusion scenarios were the brine reservoir volume (approximately two orders of magnitude larger), borehole permeability (lower minimum permeabilities), and corrosion rates (higher). As in scenarios S2 and S3, these changes resulted in higher repository pressures and larger upward borehole brine flows to the Culebra, on average, with the maximum flow in PAVT replicates 1 and 3 (108,960 m^3 in replicate 1; 115,700 m^3 in replicate 3) about two times larger than the maximum flow predicted in the CCA (62,000 m^3) and the maximum flow in PAVT replicate 2 (68,641 m^3) about the same as the maximum in the CCA. Again, cumulative brine flow across the LWB was significant in PAVT vector R1V38 only (3203 m^3).

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Salado Transport

Parameter changes that had the most impact on radionuclide releases to the Culebra via the borehole were the changes in actinide solubilities. In particular, these changes substantially reduced the solubilities of ^{241}Am in the Salado and Castile brines and reduced the solubility of ^{239}Pu in the Salado brine. The solubility of ^{239}Pu in the Castile brine was similar to the CCA. ^{241}Am was the dominant radionuclide for transport at early time (<2000 years after closure) while ^{239}Pu was the dominant radionuclide at later times. Castile solubilities were used for E1 intrusion scenarios (S2, S3, S6) and Salado solubilities were used for the other scenarios. For the E1 scenarios with early time intrusions, larger upward borehole flows (relative to the CCA), were offset by the reduced ^{241}Am solubility. As a consequence, radionuclide releases to the Culebra from early time E1 intrusions were only slightly larger, on average, than those in the CCA. For later E1 intrusion times, PAVT releases tended to be moderately larger than those in the CCA. The larger flows were not offset as much at later times because the ^{239}Pu solubilities were similar to the CCA. For E2 intrusions at all times, radionuclide releases to the Culebra tended to be less than in the CCA due to both lower upward borehole flows and reduced solubilities. There were no radionuclide releases upward in the borehole beyond the top of the Rustler in any scenario. Integrated releases across the LWB via the interbeds were very small (< 5.0E-10 EPA units) even for vector #38 of replicate 1. These releases were likely artificial and due to numerical dispersion.

Culebra Transport

The most significant factors impacting Culebra transport were the matrix distribution coefficients (k_d). The k_d s were represented by loguniform probability distributions rather than the uniform probability distributions used in the CCA. As a result, sampled k_d values tended to be lower in the PAVT and several more realizations discharged ^{234}U across the LWB in the PAVT than in the CCA. However, as in the CCA, these discharges were very small and were not significant contributors to total mean CCDF.

Cuttings, Cavings, and Spallings

The most significant factors that impacted total cuttings, cavings, and spallings volume releases were the waste shear strength and the parameters influencing repository pressure (corrosion rate, brine reservoir volume, and borehole permeability). The change in the waste shear strength distribution produced more cuttings and cavings volume releases in the PAVT. Repository pressures in the PAVT disturbed scenarios tended to be higher than in the CCA (more vectors had pressures above 8 MPa). As a result, more vectors produced spallings volume releases.

Direct Brine Release

The most significant factors impacting direct brine release volumes were the parameters influencing repository pressure (corrosion rate, brine reservoir volume, waste permeability, and borehole permeability). In the disturbed scenarios, repository pressures and direct brine volume releases tended to be higher in the PAVT as compared to the CCA, with about three times as many PAVT calculations releasing brine. However, due to reduced actinide solubilities, direct brine radionuclide releases in the PAVT were only slightly larger than in the CCA.

CCDFs

The PAVT mean CCDF for total normalized releases shifted to the right of the CCA mean CCDF by a factor of 2 or 3 for all probabilities of exceedance. This increase is primarily due to the increase in cuttings releases. Total releases were dominated by cuttings and spallings releases, with a smaller contribution from direct brine release. Culebra, Salado interbed, and Dewey Lake releases across the LWB were negligible. Analysis of all three PAVT replicates showed CCDFs for total normalized releases to the accessible environment to exhibit only small variations across the three replicates. Releases due to cuttings, spallings, direct brine release, and Culebra transport showed similar small variations across replicates. The PAVT mean CCDF for total normalized releases to the accessible environment does not exceed or come within an order of magnitude of the EPA Limit. This provides a high degree of confidence that the WIPP meets the regulatory standard.

2.0 SALADO FLOW CALCULATIONS

This section provides a summary comparison of PAVT and CCA Salado two-phase flow results. A discussion of differences between PAVT replicate results is also provided. Six different repository scenarios were considered:

- S1. Undisturbed
- S2. E1 Intrusion at 350 Years
- S3. E1 Intrusion at 1000 Years
- S4. E2 Intrusion at 350 Years
- S5. E2 Intrusion at 1000 Years
- S6. E2E1 Intrusion

This summary focuses on values of key two-phase flow performance measures for each scenario. Key performance measures for the S1 scenario include pressure and brine saturation in the panel at times of 350 and 1000 years and cumulative brine flow across the land withdrawal boundary via the interbeds. Brine flow up the shaft was insignificant and is therefore not presented. For the disturbed scenarios, S2, S3, S4, S5, and S6, a key performance measure, in addition to the S1 performance measures, is the cumulative brine flow up the borehole to the Culebra. Tables with key performance measure values at specified times are provided for each scenario. In addition, statistical summary plots corresponding to the tabulated performance measures are included in Appendix A. In these plots, four curves are shown for each replicate: the mean, the median, the 10th percentile, and the 90th percentile. The mean curve represents the mean value of the dependent variable at each point in time among all 100 realizations. The 10th percentile curve is the value of the dependent variable at each point in time which is larger than 10 percent and smaller than 90 percent of the 100 realizations. The 90th percentile curve is the value of the dependent variable at each point in time which is larger than 90 percent and smaller than 10 percent of the 100 realizations. The median (50th percentile) curve is similarly constructed. Generally, all of these statistical measures were similar between replicates. The 90th percentile showed the most variation across replicates because it was influenced the most by outlier values. Mean values were also sometimes influenced by extreme outlier values. 10th percentile values were often zero and were therefore not as strongly influenced by outliers.

2.1 Comparison Between PAVT and CCA Replicates

2.1.1 Undisturbed Scenario S1

Parameter changes that had the most impact on repository performance in the undisturbed scenario were corrosion rates (higher) and DRZ permeability (sampled over a range with both higher and lower permeabilities and a lower median). Values for important performance measures are provided in Table 2.1. The higher corrosion rates produced marginally higher pressures through 1000 years in all PAVT replicates relative to the CCA. The range in DRZ permeability resulted in a wider range in brine inflow volumes. However, in each PAVT replicate more than half of the realizations had sampled initial DRZ permeabilities less than the constant CCA value of $1x10^{-15}$ m^2 which resulted in lower mean and median cumulative brine flows into the repository than in the CCA. Higher brine consumption rates (associated with the higher corrosion rates), slightly higher pressures, and lower inflow rates resulted in lower brine saturations in the repository in all three PAVT replicates. At times greater than 1000 years, these conditions resulted in slightly lower gas generation rates and less overall total gas generation.

Cumulative brine flows across the LWB were slightly less than in the CCA (see Table 2.1), except for one vector in PAVT replicate 1 (R1V38) which produced significant flow (3326 m^3) across the LWB (the majority of this flow occurs in Marker Bed 139). The maximum flow across the LWB in the CCA was 275 m^3. This significant flow in vector R1V38 was caused by a combination of factors: the highest interbed permeability, the 8th highest DRZ permeability, low far-field pressure, and a high repository pressure at 1000 years.

2.1.2 Disturbed Scenarios S2 and S3 (E1 intrusion at 350 and 1000 years)

Parameter changes that had the most impact on repository performance in the E1 intrusion scenarios were the brine reservoir volume (approximately two orders of magnitude larger), borehole permeability (lower minimum permeabilities), and corrosion rates (higher). Values for important performance measures are provided in Tables 2.2 and 2.3. Panel pressures and brine saturations prior to intrusion were the same as shown in Table 2.1 (prior to intrusion, the E1 intrusion scenarios were identical to the undisturbed scenario). The higher corrosion rates produced marginally higher repository pressures prior to intrusion in the PAVT relative to the CCA. Following intrusion, lower borehole permeabilities and higher corrosion rates in combination with increased flow from the brine reservoir (brine reservoir pressures remain high after intrusion) resulted in substantially higher pressures in the repository in all three PAVT replicates. Brine flows upward in the borehole to the Culebra were substantially higher in all PAVT replicates, with the maximum flow about two times larger than that predicted in the CCA. As in the CCA, there were very small amounts of brine flow upward in the borehole beyond the top of the Rustler (< 1.2 m^3) in all three PAVT replicates. Salado transport results (see Section 3.1.2) show that these small volumes of brine were uncontaminated. As in the undisturbed scenario, only one PAVT vector (R1V38) produced significant flow across the LWB. In the CCA, flows across the LWB in all disturbed scenarios were negligible.

2.1.3 Disturbed Scenarios S4 and S5 (E2 intrusion at 350 and 1000 years)

Parameter changes that had the most impact on repository performance in the E2 intrusion scenarios were corrosion rates (higher), borehole permeabilities (lower minimum permeabilities), and DRZ permeability (sampled over a range of higher and lower permeabilities). Values for important performance measures are provided in Tables 2.4 and 2.5. Panel pressures and brine saturations prior to intrusion were the same as shown in Table 2.1 (prior to intrusion, the E2 intrusion scenarios were identical to the undisturbed scenario). Higher corrosion rates produced marginally higher pressures prior to intrusion in the PAVT relative to the CCA. The range in DRZ permeability resulted in a wider range in brine inflow volumes. However, in all three PAVT replicates more than half of the realizations had initial DRZ permeabilities less than the CCA value of $1x10^{-15}$ m^2 which resulted in lower mean and median cumulative brine flows into the repository than in the CCA. The net result of the higher brine consumption, higher pressures, and decreased brine inflow was lower brine saturations in the repository in all three PAVT replicates. Following the borehole intrusion, panel pressures in each replicate stayed higher in the PAVT than in the CCA due primarily to the lower borehole permeabilities.

Although the upper end of the borehole permeability range was not changed, brine flows up the borehole in each PAVT replicate were substantially less than those predicted in the CCA. This behavior was due to a combination of factors: lower brine saturations in the repository; lower borehole permeabilities at the lower end of the range; and the range of DRZ permeabilities. In the CCA, the DRZ added brine directly to the borehole in the highest flow cases. In the PAVT, the highest flow cases have a high borehole permeability and a low DRZ permeability. As a result there was no additional contribution from the low permeability DRZ to flow up the borehole (which is already lower than in the CCA because of the lower brine saturations). As in the E1 intrusion scenarios, cumulative brine flow across the LWB was significant only in PAVT vector R1V38 (2640 m^3 in S4 and 2735 m^3 in S5).

2.1.4 Disturbed Scenario S6 (E2 intrusion at 1000 years and an E1 intrusion at 2000 years)

Parameter changes that had the most impact on repository performance in the E2E1 intrusion scenario was the brine reservoir volume (approximately two orders of magnitude larger), borehole permeability (lower minimum permeabilities), and corrosion rates (higher). Results for S6 are provided in Table 2.6. As in scenarios S2 and S3, S6 was dominated by the E1 intrusion because of the large brine reservoir. Panel pressures and brine saturations prior to the E2 intrusion were the same as shown in Table 2.1 (prior to first intrusion, the E2E1 intrusion scenarios is identical to the undisturbed scenario). The higher corrosion rates produced marginally higher repository pressures prior to the E2 intrusion in all PAVT replicates relative to the CCA. Following intrusion, lower borehole permeabilities and higher corrosion rates in combination with increased flow from the brine reservoir (brine reservoir pressures remain high after intrusion) resulted in substantially higher pressures in the repository in all three PAVT replicates. Brine flows upward in the borehole to the Culebra were substantially higher in all three replicates, with the maximum flow about two times larger than that predicted in the CCA. As in E1 and E2 intrusion scenarios, cumulative brine flow across the LWB was significant only in PAVT vector R1V38 (3203 m^3).

2.2 Summary of Differences Between PAVT Replicates

Differences between the PAVT replicates for important performance measures are summarized in Appendix A. In Appendix A, statistical summary plots corresponding to performance measures provided in Tables 2.1 through 2.6 are presented. In these plots, four curves are shown for each replicate: the mean, the median, the 10th percentile, and the 90th percentile. Generally, all of these statistical measures were similar between replicates. The 90th percentile showed the most variation across replicates because it was influenced the most by outlier values. Mean values were also sometimes influenced by extreme outlier values. 10th percentile values were often zero and were therefore not as strongly influenced by outliers.

Table 2.1. 10th Percentile, Median, Mean, 90th Percentile, and Maximum Output Variable Values from the PAVT and CCA Simulations for Scenario S1 (Undisturbed).

Output Variable Description	Time (yrs)	PAVT Simulation (R1,R2,R3)					CCA Simulation (R1, R2, R3)				
		10th	Median	Mean	90th	Max.	10th	Median	Mean	90th	Max
Average Pressure in Waste Panel (MPa)	350	1.6 1.6 1.2	4.0 3.9 3.9	4.4 4.4 4.4	9.0 9.0 9.0	10.5 11.4 11.1	1.0 1.0 1.2	3.2 3.2 3.2	4.0 4.0 4.0	9.2 9.2 9.2	10.4 10.2 10.0
	1000	3.7 3.8 2.7	7.1 7.0 6.9	7.7 7.6 7.6	12.9 13.3 12.9	14.0 15.0 14.4	2.1 2.0 2.7	6.1 6.1 6.0	6.7 6.7 6.7	12.2 12.4 12.4	13.5 14.0 14.5
	10000	6.9 6.7 6.9	10.2 9.7 10.0	10.5 10.4 10.4	13.7 14.1 14.1	16.8 16.2 15.8	7.0 7.1 6.8	10.8 11.0 10.7	10.8 10.8 10.7	14.2 14.1 14.0	15.5 16.3 16.2
Average Brine Saturation in Waste Panel	350	0.04 0.05 0.05	0.16 0.15 0.15	0.23 0.23 0.23	0.52 0.51 0.51	0.98 0.92 0.94	0.12 0.09 0.09	0.22 0.23 0.23	0.27 0.27 0.27	0.50 0.42 0.55	0.80 0.75 0.88
	1000	0.00 0.01 0.01	0.17 0.15 0.17	0.26 0.25 0.27	0.70 0.66 0.83	0.98 0.96 0.94	0.10 0.07 0.08	0.26 0.27 0.28	0.33 0.34 0.34	0.77 0.67 0.85	0.98 0.91 0.98
Cumulative Brine Flow out of MBs Across LWB (m^3)	10000	0.0 0.0 0.0	0.0 0.0 0.0	35 2.7 3.6	0.0 0.0 0.0	3326 185 130	0.0 0.0 0.0	0.1 0.1 0.1	5.0 4.2 4.5	0.3 0.4 0.3	216 275 168
Total Volume of Gas Generated (10^6 m^3)	10000	5.2 5.0 5.0	11.2 9.9 10.7	11.9 11.9 11.9	18.8 21.6 21.2	34.0 32.0 28.0	5.0 5.0 4.8	11.8 12.5 11.8	12.2 12.4 12.1	21.5 20.0 18.8	28.1 30.7 26.0
Cumulative Brine Flow into Repository (m^3)	10000	1000 1200 1200	7500 9300 9300	13000 13200 13900	35000 33900 34100	72000 67000 72000	3200 3200 3000	11200 12400 12200	16000 16000 16000	33000 32000 33500	85000 57000 55500

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Table 2.2. 10th Percentile, Median, Mean, 90th Percentile, and Maximum Output Variable Values from the PAVT and CCA Simulations for Scenario S2 (E1 Intrusion at 350 Years).

Output Variable Description	Time (yrs)	PAVT Simulation (R1,R2,R3)					CCA Simulation (R1, R2, R3)				
		10th	Median	Mean	90th	Max.	10th	Median	Mean	90th	Max
Average Pressure in Waste Panel (MPa)	10000	4.7 6.0 4.4	7.9 7.9 7.7	8.9 9.2 8.9	14.2 13.9 15.0	16.6 16.1 16.3	1.6 1.5 1.5	4.7 5.0 4.7	4.5 4.5 4.5	7.3 7.0 7.3	9.7 10.1 11.0
Average Brine Saturation in Waste Panel	350	0.04 0.05 0.05	0.16 0.15 0.15	0.23 0.23 0.23	0.52 0.51 0.51	0.98 0.92 0.94	0.12 0.09 0.09	0.22 0.23 0.23	0.27 0.27 0.27	0.50 0.42 0.55	0.80 0.75 0.88
Cum. Brine Flow up Borehole at Rustler/Cul. (m^3)	10000	0.0 0.0 0.0	27 40 25	6381 6000 7200	19100 24300 26500	105040 77000 118000	0.0 0.0 0.0	0.0 0.0 0.0	1030 1230 350	1330 700 670	39000 62000 12500
Cumulative Brine Flow out of MBs Across LWB (m^3)	10000	0.0 0.0 0.0	0.0 0.0 0.0	26 3.4 6.2	0.0 0.0 0.0	2487 320 475	0.02 0.02 0.02	0.08 0.08 0.08	0.11 0.11 0.10	0.25 0.26 0.22	0.79 0.43 0.43

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Table 2.3. 10th Percentile, Median, Mean, 90th Percentile, and Maximum Output Variable Values from the PAVT and CCA Simulations for Scenario S3 (E1 Intrusion at 1000 Years).

Output Variable Description	Time (yrs)	PAVT Simulation (R1,R2,R3)					CCA Simulation (R1, R2, R3)				
		10th	Median	Mean	90th	Max.	10th	Median	Mean	90th	Max
Average Pressure in Waste Panel (MPa)	10000	3.2 4.9 3.0	7.4 7.7 7.2	8.1 8.5 8.3	12.7 13.0 13.7	15.4 15.5 15.9	1.7 1.5 1.5	4.7 5.0 4.7	4.5 4.5 4.5	7.3 7.0 7.2	9.2 10.2 10.1
Average Brine Saturation in Waste Panel	1000	0.00 0.01 0.01	0.17 0.15 0.17	0.26 0.25 0.27	0.70 0.66 0.83	0.98 0.96 0.94	0.10 0.07 0.08	0.26 0.27 0.28	0.33 0.34 0.34	0.77 0.67 0.85	0.98 0.91 0.98
Cum. Brine Flow up Borehole at Rustler/Cul. (m^3)	10000	0.0 0.0 0.0	16 17 12	5935 5300 6900	18300 20000 22100	102340 71000 114000	0.0 0.0 0.0	0.0 0.0 0.0	1050 1150 450	1300 425 900	35200 67000 15600
Cumulative Brine Flow out of MBs Across LWB (m^3)	10000	0.0 0.0 0.0	0.0 0.0 0.0	26 1.1 4.9	0.0 0.0 0.0	2630 107 355	0.02 0.02 0.02	0.08 0.08 0.08	0.12 0.12 0.11	0.25 0.26 0.24	1.28 0.66 0.41

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Table 2.4. 10th Percentile, Median, Mean, 90th Percentile, and Maximum Output Variable Values from the PAVT and CCA Simulations for Scenario S4 (E2 Intrusion at 350 Years).

Output Variable Description	Time (yrs)	PAVT Simulation (R1,R2,R3)					CCA Simulation (R1,R2,R3)				
		10th	Median	Mean	90th	Max.	10th	Median	Mean	90th	Max
Average Pressure in Waste Panel (MPa)	10000	1.7 1.7 1.7	6.4 6.4 6.2	6.5 6.5 6.3	12.5 12.1 11.4	13.9 15.9 15.8	1.4 1.4 1.4	3.3 3.4 3.4	3.9 3.9 3.9	6.7 6.4 6.4	9.0 10.0 9.3
Average Brine Saturation in Waste Panel	350	0.04 0.05 0.05	0.16 0.15 0.15	0.23 0.23 0.23	0.52 0.51 0.51	0.98 0.92 0.94	0.12 0.09 0.09	0.22 0.23 0.23	0.27 0.27 0.27	0.50 0.42 0.55	0.80 0.75 0.88
Cum. Brine Flow up Borehole at Rustler/Cul. (m^3)	10000	0.0 0.0 0.0	2.3 2.3 2.3	151 137 144	238 95 86	4774 4420 5700	0.0 0.0 0.0	0.0 0.0 0.0	638 330 250	110 93 70	40000 17800 13700
Cumulative Brine Flow out of MBs Across LWB (m^3)	10000	0.0 0.0 0.0	0.0 0.0 0.0	26 0.0 0.0	0.0 0.0 0.0	2640 0.01 0.54	0.02 0.02 0.02	0.08 0.08 0.08	0.11 0.11 0.10	0.25 0.23 0.22	0.73 0.42 0.35

Table 2.5. 10th Percentile, Median, Mean, 90th Percentile, and Maximum Output Variable Values from the PAVT and CCA Simulations for Scenario S5 (E2 Intrusion at 1000 Years).

Output Variable Description	Time (yrs)	PAVT Simulation (R1,R2,R3)					CCA Simulation (R1,R2,R3)				
		10th	Median	Mean	90th	Max.	10th	Median	Mean	90th	Max
Average Pressure in Waste Panel (MPa)	10000	1.6 1.6 1.5	6.4 6.4 6.2	6.5 6.5 6.3	12.5 12.2 11.5	14.1 15.9 15.8	1.4 1.4 1.4	3.3 3.4 3.2	3.9 3.9 3.9	6.8 6.4 6.4	9.0 10.2 9.3
Average Brine Saturation in Waste Panel	1000	0.00 0.01 0.01	0.17 0.15 0.17	0.26 0.25 0.27	0.70 0.66 0.83	0.98 0.96 0.98	0.10 0.07 0.08	0.26 0.27 0.28	0.33 0.34 0.34	0.77 0.67 0.85	0.98 0.91 0.98
Cum. Brine Flow up Borehole at Rustler/Cul. (m^3)	10000	0.0 0.0 0.0	1.8 1.8 1.8	133 115 124	160 93 78	4472 3700 6100	0.0 0.0 0.0	0.0 0.0 0.0	563 270 210	100 75 70	36100 13000 13000
Cumulative Brine Flow out of MBs Across LWB (m^3)	10000	0.0 0.0 0.0	0.0 0.0 0.0	27 0.0 0.3	0.0 0.0 0.0	2735 0.06 23	0.02 0.02 0.02	0.08 0.08 0.08	0.12 0.11 0.11	0.25 0.25 0.23	1.28 0.71 0.38

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Table 2.6. 10th Percentile, Median, Mean, 90th Percentile, and Maximum Output Variable Values from the PAVT and CCA Simulations for Scenario S6 (E2E1 Intrusion).

Output Variable Description	Time (yrs)	PAVT Simulation (R1,R2,R3)					CCA Simulation (R1,R2,R3)				
		10th	Median	Mean	90th	Max.	10th	Median	Mean	90th	Max
Average Pressure in Waste Panel (MPa)	10000	4.8 5.5 4.5	7.5 8.0 7.2	8.4 8.5 8.7	12.9 12.7 13.3	14.5 15.3 15.9	1.5 1.5 1.5	4.8 5.1 5.2	4.5 4.5 4.6	7.2 6.9 7.3	9.1 10.2 9.5
Average Brine Saturation in Waste Panel	1000	0.00 0.01 0.01	0.17 0.15 0.17	0.26 0.25 0.27	0.70 0.66 0.83	0.98 0.96 0.94	0.10 0.07 0.08	0.26 0.27 0.28	0.33 0.34 0.34	0.77 0.67 0.85	0.98 0.91 0.98
Cum. Brine Flow up Borehole at Rustler/Cul. (m^3)	10000	0.0 0.0 0.0	66 71 41	7108 5950 7397	22000 22700 21400	108960 68641 115700	0.0 0.0 0.0	20 20 20	950 1280 620	780 340 1700	37100 62000 14000
Cumulative Brine Flow out of MBs Across LWB (m^3)	10000	0.0 0.0 0.0	0.0 0.0 0.0	32 0.0 1.0	0.0 0.0 0.0	3203 0.10 86	0.02 0.02 0.02	0.08 0.08 0.09	0.12 0.11 0.11	0.25 0.25 0.23	1.65 0.56 0.39

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3.0 SALADO TRANSPORT CALCULATIONS

This section provides a summary comparison of PAVT and CCA Salado transport results. A discussion of differences between PAVT replicate results is also provided. The key performance measure for comparing PAVT and CCA Salado transport results is cumulative radionuclide release to the Culebra via the intruding borehole. Transport of radionuclides to the accessible environment via the shaft and interbeds was insignificant in both the PAVT and the CCA.

3.1 Comparison Between PAVT and CCA Replicates

A screening analysis using a hypothetical inert tracer was conducted to reduce the large number of potential Salado transport simulations to a tractable number. An identical screening analysis was conducted previously for the CCA. For the screening analysis, a source concentration of 1 kg/m^3 was applied to the source region. All realizations that transported a cumulative mass of inert tracer greater than or equal to 10^{-7} kg to the accessible environment over 10,000 years were considered significant and retained for complete transport analysis. The number of realizations screened in for scenarios S1, S2, S3, S4, and S5 in each replicate are summarized in Table 3.1. A total of 435 runs were screened in for further analysis in the three PAVT replicates compared to 174 runs in the three CCA replicates. Note that in scenario S6, all 100 realizations were analyzed.

Table 3.1. Summary of Realizations Screened In

Scenario	PAVT			CCA		
	R1	R2	R3	R1	R2	R3
S1	4	6	5	1	5	3
S2	68	70	66	23	17	22
S3	50	51	50	21	21	25
S4	15	10	9	6	5	7
S5	14	9	8	6	5	7

3.1.1 Undisturbed Performance

The Salado flow analysis showed that only one PAVT undisturbed scenario (S1) vector (R1V38) produced significant flow (3326 m^3) outward across the LWB. This vector was the only realization that had a total integrated discharge greater than 1E-10 EPA units across the LWB (see Appendix B). These releases occurred at the LWB to the south of the repository in Marker Bed 139, with a total integrated discharge of 4.84E-10 EPA units out of all interbeds (see Section 3 in prior report, WPO # 46674). The majority of this activity was due to ^{239}Pu (3.4E-10 EPA units) and ^{241}Am (8.67E-11 EPA units). These results are similar to the CCA results where a total activity of 3.33E-10 EPA units was released. Further, as in the CCA, these releases were likely due to numerical dispersion that was caused by the coarse lateral gridding between the repository and lateral LWB, and large time steps at later times in the calculation. This conclusion is also supported by the fact that the pore volume of Marker Bed 139 (which provides most of the flow in vector R1V38) between the repository and LWB is greater than 155,000 m^3.

3.1.2 Disturbed Performance (E1, E2, and E2E1 Intrusions)

The integrated discharges (in EPA units) up the borehole and into the Culebra from the Salado transport calculations for all screened-in realizations were sorted by the total EPA units discharged to the Culebra summed over all 5 transported isotopes. In each replicate, releases in scenarios S2 through S5 decreased with later intrusion times because of ^{241}Am decay. Releases also decreased with later intrusion time because of less time for long-term flow after the intrusion. Like the E1 intrusions, the E2E1 intrusion (S6) was ^{241}Am dominated for the first 3000 to 4000 years, after which radioactive decay of ^{241}Am results in ^{239}Pu dominance. In the S2 and S3 scenarios, a small amount of brine (<1.2 m^3) flowed upward in the borehole beyond the top of Rustler (see Appendix A, Sections A.2.1.1 and A.2.1.2). Salado transport results show that this brine was uncontaminated.

A summary of statistical measures (10th percentile, median, mean, 90th percentile, and maximum) for the three PAVT replicates (individually and combined) for total releases to the Culebra (in EPA units) for each scenario and intrusion time is shown in Table 3.2. Equivalent information for the three CCA replicates combined is shown in Table 3.3

For the E1 scenarios (S2, S3, S6) with early time (<2000 years after closure) intrusions, larger upward borehole flows in the PAVT relative to the CCA, were offset by the reduced ^{241}Am solubility. As a consequence, radionuclide releases to the Culebra from early time E1 intrusions (Table 3.2) were more frequent and, on average, comparable to those in the CCA (Table 3.3). For later E1 intrusion times, PAVT releases tended to be slightly larger than those in the CCA. The larger PAVT flows were not offset as much at later times because the ^{239}Pu solubilities were similar to the CCA. Releases to the Culebra from later E1 intrusion times were much less than from early intrusions. For E1 intrusions, maximum releases tended to be lower in the PAVT.

For E2 intrusions (S4, S5) at all times, radionuclide releases to the Culebra tended to be much less than in the CCA due to both lower upward borehole flows and reduced solubilities of both ^{241}Am and ^{239}Pu in Salado brine. For E2 intrusions, maximum releases were also significantly lower in the PAVT.

3.2 Summary of Differences Between PAVT Replicates

As shown in Tables 3.2 and 3.3, all three PAVT replicates yield similar release results for the mean and percentile values. The maximum values varied somewhat among replicates, indicating an increased variation among these outlier values.

Table 3.2. Statistical Summary of PAVT Total 10,000 Year Integrated Release (EPA units) up the Borehole to the Culebra For Each Scenario (Replicates 1,2, and 3).

Scenario	Intrusion Time (yrs)	10th Percentile	Median	Mean	90th Percentile	Maximum
S2	100	0.00	8.00E-06	0.164	0.621	2.9
		0.00	1.27E-05	0.173	0.650	2.1
		0.00	5.44E-06	0.188	0.797	2.5
		0.00	**6.98E-06**	**0.175**	**0.672**	**2.9**
	350	0.00	7.97E-06	0.146	0.597	2.5
		0.00	1.15E-05	0.159	0.562	2.0
		0.00	5.16E-06	0.166	0.715	2.5
		0.00	**6.88E-06**	**0.157**	**0.619**	**2.5**
S3	1000	0.00	0.00	6.65E-02	0.270	1.1
		0.00	0.00	4.91E-02	0.187	0.8
		0.00	0.00	7.46E-02	0.291	1.1
		0.00	**0.00**	**6.34E-02**	0.25	**1.1**
	3000	0.00	0.00	4.13E-02	0.174	0.65
		0.00	0.00	2.55E-02	0.069	0.55
		0.00	0.00	3.70E-02	0.117	0.75
		0.00	**0.00**	**3.46E-02**	**0.107**	**0.75**
	5000	0.00	0.00	3.15E-02	0.128	0.52
		0.00	0.00	1.81E-02	0.044	0.41
		0.00	0.00	2.91E-02	0.089	0.57
		0.00	**0.00**	**2.63E-02**	**0.077**	**0.57**
	7000	0.00	0.00	2.20E-02	0.077	0.29
		0.00	0.00	1.33E-02	0.035	0.34
		0.00	0.00	2.23E-02	0.069	0.47
		0.00	**0.00**	**1.92E-02**	**0.058**	**0.47**
	9000	0.00	0.00	1.27E-02	0.040	0.23
		0.00	0.00	7.61E-03	0.020	0.23
		0.00	0.00	1.15E-02	0.031	0.25
		0.00	**0.00**	**1.06E-02**	**0.028**	**0.25**

* Values in bold are for all 3 replicates combined.

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Table 3.2 (cont'd). Statistical Summary of PAVT Total 10,000 Year Integrated Release (EPA units) up the Borehole to the Culebra For Each Scenario (Replicates 1,2, and 3).

Scenario	Intrusion Time (yrs)	10th Percentile	Median	Mean	90th Percentile	Maximum
S4	100	0.00 0.00 0.00 **0.00**	0.00 0.00 0.00 **0.00**	3.77E-03 2.75E-03 8.57E-04 **2.46E-03**	1.28E-03 0.00 0.00 **3.65E-05**	0.20 0.23 0.03 **0.23**
	350	0.00 0.00 0.00 **0.00**	0.00 0.00 0.00 **0.00**	3.43E-03 2.45E-03 7.81E-04 **2.22E-03**	1.09E-03 0.00 0.00 **3.6E-05**	0.19 0.21 0.02 **0.21**
S5	1000	0.00 0.00 0.00 **0.00**	0.00 0.00 0.00 **0.00**	1.52E-03 1.98E-03 5.22E-04 **1.34E-03**	6.37E-04 0.00 0.00 **0.00**	0.061 0.173 0.024 **0.173**
	3000	0.00 0.00 0.00 **0.00**	0.00 0.00 0.00 **0.00**	5.22E-04 3.67E-04 2.18E-04 **3.69E-04**	0.00 0.00 0.00 **0.00**	0.014 0.027 0.013 **0.027**
	5000	0.00 0.00 0.00 **0.00**	0.00 0.00 0.00 **0.00**	2.24E-04 1.73E-05 4.24E-05 **9.45E-05**	0.00 0.00 0.00 **0.00**	0.011 0.001 0.002 **0.011**
	7000	0.00 0.00 0.00 **0.00**	0.00 0.00 0.00 **0.00**	1.14E-04 0.00 1.12E-06 **3.82E-05**	0.00 0.00 0.00 **0.00**	0.011 0.00 9.19E-05 **0.011**
	9000	0.00 0.00 0.00 **0.00**	0.00 0.00 0.00 **0.00**	0.00 0.00 0.00 **0.00**	0.00 0.00 0.00 **0.00**	0.00 0.00 0.00 **0.00**

* Values in bold are for all 3 replicates combined.

Table 3.2 (cont'd). Statistical Summary of PAVT Total 10,000 Year Integrated Release (EPA units) up the Borehole to the Culebra* For Each Scenario (Replicates 1,2, and 3).

Scenario	Intrusion Time (yrs)	10th Percentile	Median	Mean	90th Percentile	Maximum
S6	100	0.00 0.00 0.00 **0.00**	3.31E-03 1.50E-03 3.05E-03 **2.20E-03**	1.38 0.88 0.12 **1.16**	4.26 3.40 4.49 **4.15**	28.9 10.0 27.1 **28.9**
	350	0.00 0.00 0.00 **0.00**	3.25E-03 1.45E-03 1.52E-03 **2.17E-03**	1.30 0.84 1.13 **1.09**	4.07 3.25 4.30 **3.93**	27.1 9.7 24.1 **27.1**
	1000	0.00 0.00 0.00 **0.00**	3.23E-03 1.44E-03 1.51E-03 **2.16E-03**	1.03 0.72 0.92 **0.89**	3.64 2.95 3.80 **3.26**	18.2 8.6 15.4 **18.2**
	2000	0.00 0.00 0.00 **0.00**	3.04E-03 1.42E-03 1.42E-03 **2.12E-03**	0.567 0.462 0.504 **0.511**	2.40 1.77 2.24 **2.16**	7.11 5.26 5.01 **7.11**
	4000	0.00 0.00 0.00 **0.00**	6.03E-04 8.46E-04 4.93E-04 **5.97E-04**	0.150 0.099 0.098 **0.115**	0.408 0.279 0.350 **0.318**	2.46 3.51 1.91 **3.51**
	6000	0.00 0.00 0.00 **0.00**	1.25E-04 1.92E-04 1.52E-04 **1.47E-04**	9.74E-02 5.69E-02 5.63E-02 **7.03E-02**	0.207 0.109 0.162 **0.152**	1.82 2.72 1.35 **2.72**
	9000	0.00 0.00 0.00 **0.00**	7.60E-05 1.06E-04 1.09E-04 **9.82E-05**	4.96E-02 3.07E-02 3.08E-02 **3.70E-02**	0.0951 0.0633 0.0798 **0.0751**	1.01 1.55 0.75 **1.55**

* Values in bold are for all 3 replicates combined.

Table 3.3. Statistical Summary of CCA Total 10,000 Year Integrated Release (EPA units) up the Borehole to the Culebra For Each Scenario (All 3 Replicates Combined).

Scenario	Intrusion Time (yrs)	10th Percentile	Median	Mean	90th Percentile	Maximum
S2	100	0.00	0.00	0.0750	0.0395	6.62
	350	0.00	0.00	0.0650	0.0323	6.04
S3	1000	0.00	0.00	2.66E-02	2.53E-02	2.19
	3000	0.00	0.00	4.69E-03	5.10E-03	0.36
	5000	0.00	0.00	1.76E-03	1.98E-03	0.24
	7000	0.00	0.00	9.63E-04	7.50E-04	0.14
	9000	0.00	0.00	3.00E-04	1.04E-04	0.035
S4	100	0.00	0.00	9.25E-02	0.00	21.1
	350	0.00	0.00	8.83E-02	0.00	20.4
S5	1000	0.00	0.00	7.68E-02	0.00	18.4
	3000	0.00	0.00	4.76E-02	0.00	11.6
	5000	0.00	0.00	2.14E-02	0.00	5.62
	7000	0.00	0.00	5.48E-03	0.00	1.10
	9000	0.00	0.00	1.43E-04	0.00	0.027
S6	100	0.00	2.06E-03	0.728	0.629	95.0
	350	0.00	2.05E-03	0.603	0.555	68.7
	1000	0.00	2.05E-03	0.368	0.479	26.0
	2000	0.00	1.76E-03	0.165	0.384	5.57
	4000	0.00	2.68E-04	0.0162	0.0408	0.792
	6000	0.00	4.63E-05	6.52E-03	8.85E-03	0.491
	9000	0.00	2.75E-05	3.16E-03	4.98E-03	0.195

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4.0 CULEBRA TRANSPORT CALCULATIONS

This section provides a summary comparison of PAVT and CCA Culebra transport results. A discussion of differences between PAVT replicate results is also provided. The key performance measure for comparing PAVT and CCA Culebra transport results is the cumulative discharge of radionuclides across the LWB.

4.1 Comparison Between PAVT and CCA Replicates

In the CCA, only two realizations in all three replicates resulted in conditional releases[1] across the LWB. In these two realizations, only two radionuclides were released, ^{234}U and negligible amounts of ^{230}Th (less than 3.0E-7 kg). Because a loguniform distribution for k_d was used in the PAVT, sampled k_d values tended to be much smaller than those used in the CCA. As a consequence, several realizations resulted in the conditional releases of ^{234}U and insignificant amounts of ^{230}Th (less than 4.0E-6 kg) at the LWB.

The PAVT realizations were ranked according to the conditional release of ^{234}U. PAVT replicate 1 results are listed in WPO #46674. Results for PAVT replicates 2 and 3 are provided in Appendix C for both the partial mining and full mining scenarios. Also provided are corresponding values of the following parameters; MINP_FAC (mining impact factor), CLIMTIDX (climate index), APOROS (fracture porosity), DPOROS (matrix porosity), HMBLKT (half block length of the matrix), OXSTAT (actinide oxidation state parameter), and MKD_U (k_d value for matrix sorption). The tabulated results show that in replicate 2, 7 partial mining and 10 full mining scenarios produced a conditional ^{234}U release greater than 0.1 kg. In replicate 3, 7 partial mining and 4 full mining scenarios produced a conditional ^{234}U release greater than 0.1 kg. In replicate 1, 7 partial mining and 8 full mining scenarios produced a conditional release greater than 0.1 kg (WPO #46674).

Statistical summaries of PAVT and CCA Culebra conditional ^{234}U releases are shown in Tables 4.1 and 4.2, respectively. Mean, 90th percentile, and maximum discharges are all higher in the PAVT. Even with the maximum PAVT conditional discharge of about 1 kg, releases of ^{234}U to the Culebra predicted by the Salado transport analysis were small. The corresponding mean Culebra normalized releases to the accessible environment are insignificant (on the order of 10^{-3} EPA units) for the PAVT replicates (see Section 7.2).

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[1]The computational strategy used in the Culebra transport analysis takes advantage of the linearity of the system of partial differential equations that underlies SECOTP2D. Transport calculations were performed for unit kg releases to the Culebra. These calculations identify conditional releases. Using the linearity of the system, the conditional releases are then used to construct transport results for arbitrary time-dependent releases into the Culebra using NUTS and PANEL calculated radionuclide sources.

4.2 Summary of Differences Between PAVT Replicates

The mean, and maximum values are similar in all three replicates, while the 90th percentile shows greater variation among replicates. The median and 10th percentile values were 0.0 in all three replicates.

Table 4.1. Statistical Summary of PAVT Conditional ^{234}U Release (kg) Through the Culebra to the LWB from a 1 kg Source (All 3 Replicates)

Mining	10th Percentile	Median	Mean	90th Percentile	Maximum
Full	0.0	0.0	0.057	0.027	1.00
	0.0	0.0	0.055	0.097	0.92
	0.0	0.0	0.035	2E-4	1.02
	0.0	**0.0**	**0.049**	**0.0076**	**1.02**
Partial	0.0	0.0	0.035	0.047	0.92
	0.0	0.0	0.025	0.002	0.91
	0.0	0.0	0.041	3E-4	0.98
	0.0	**0.0**	**0.034**	**0.0076**	**0.98**

* Values in bold are statistics for all 3 replicates combined

Table 4.2. Statistical Summary of CCA Conditional ^{234}U Release (kg) Through the Culebra to the LWB from a 1 kg Source (All 3 Replicates)

Mining	10th Percentile	Median	Mean	90th Percentile	Maximum
Full	**0.0**	**0.0**	**0.003**	**0.0**	**0.91**
Partial	**0.0**	**0.0**	**0.0004**	**0.0**	**0.11**

* Values in bold are statistics for all 3 replicates combined

5.0 CUTTINGS, CAVINGS, AND SPALLINGS CALCULATIONS

This section provides a comparison of the cuttings, cavings, and spallings releases obtained in the PAVT and CCA calculations and a discussion of differences between the PAVT replicates.

The key performance measure for comparing PAVT and CCA direct releases due to cuttings, cavings, and spallings is the volume of waste released at the ground surface. Volume of waste released is passed on to CCDF_GF (Section 7) where this information is combined with activity data and scenario probabilities to compute direct radionuclide releases due to cuttings, cavings, and spallings.

5.1 Comparison Between PAVT and CCA Replicates

Statistical measures of cuttings and cavings results and spallings results are presented in Table 5.1 (S1 scenario with an intrusion at 10,000 years) and Table 5.2 (S2 scenario with a second intrusion into the same panel at 10,000 years). The results in Table 5.1 are indicative S1 (undisturbed) results for all intrusion times. Similarly, the results in Table 5.2 are indicative of all disturbed scenarios for all intrusion times.

Cuttings and cavings release volumes are the same for all scenarios and intrusion times (see Tables 5.1 and 5.2) because cuttings and cavings volumes are not influenced by repository conditions at the time of intrusion and are therefore scenario independent. Cuttings and cavings volumes depend only on sampled parameters such as waste shear strength and drill string angular velocity. Cuttings and cavings releases for the PAVT range from approximately 0.3 to 3.9 m^3. Releases for the CCA range from approximately 0.4 to 2.9 m^3. The PAVT results show larger mean, 90th percentile, and maximum values, reflecting an increased number of releases greater than 1.0 m^3 as compared to the CCA. However, the PAVT results also show smaller 10th percentile values. In the PAVT, the range of TAUFAIL (waste shear strength) values was increased and the distribution was changed from a uniform to a loguniform distribution. The impact of the higher maximum TAUFAIL value resulted in more small releases while the impact of converting the distribution to loguniform resulted in more large releases (more TAUFAIL values near zero were sampled).

Spallings releases occur only if the repository pressure exceeds 8 MPa at the time of intrusion. Spallings releases in both the PAVT and the CCA ranged from 0.0 m to 4.0 m^3. For scenario S1, repository pressures were similar in the PAVT and CCA, therefore, spallings volumes removed were also similar (see Table 5.1). For the disturbed scenarios (S2 and others), there were more repository pressures greater than 8 MPa in the PAVT than in the CCA. As a result, many more vectors produced spallings volume releases. The increased spallings releases (volume removed and normalized release) in the PAVT are evident in the statistical comparison in Table 5.2 which shows that the mean and 90th percentile values were much higher in the PAVT than in the CCA.

5.2 Summary of Differences Between PAVT Replicates

As shown in Tables 5.1 and 5.2, all three PAVT replicates yield very similar cuttings, cavings, and spallings results for the mean and percentile quantities. The maximum values varied somewhat among replicates, indicating an increased variation among these outlier values. For further comparison, box plots showing volume removed and normalized release (EPA units) for all scenarios and intrusion times are provided in Appendix D: Figures D.1 through D.12 for replicate 2; Figures D.13 through D.24 for replicate 3; and Figures D.25 through D.36 for all three replicates combined. Box plots for replicate 1 are given in WPO #46674. These box plots show that the results from all three replicates are very similar.

Table 5.1. 10th Percentile, Median, Mean, 90th Percentile, and Maximum Output Variable Values from the PAVT and CCA Simulations for Scenario S1 (initial E2 intrusion at 10,000 years)

Output Variable Description	Time (yrs)	PAVT Simulation (R1, R2, R3, and all 3 replicates combined)					CCA Simulation (all 3 replicates combined)				
		10th	Median	Mean	90th	Max.	10th	Median	Mean	90th	Max
Cuttings and Cavings Volume (m^3)	10000	0.32 0.30 0.30	0.67 0.71 0.71	1.0 1.0 1.0	2.3 2.3 2.2	3.9 3.5 3.4					
(combined)		**0.30**	**0.71**	**1.0**	**2.2**	**3.9**	**0.43**	**0.51**	**0.60**	**0.87**	**2.9**
Spallings Volume (m^3)	10000	0.0 0.0 0.0	1.6 1.8 1.7	1.7 1.7 1.8	3.5 3.6 3.5	4.0 3.9 4.0					
(combined)		**0.0**	**1.7**	**1.7**	**3.5**	**4.0**	**0.0**	**2.1**	**2.1**	**3.7**	**3.9**
Spallings Release (EPA units)	10000	0.0 0.0 0.0	0.0072 0.0080 0.0078	0.0074 0.0078 0.0078	0.015 0.016 0.016	0.018 0.018 0.018					
(combined)		**0.0**	**0.0075**	**0.0076**	**0.016**	**0.0018**	**0.0**	**0.0093**	**0.0091**	**0.016**	**0.017**

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Table 5.2. 10th Percentile, Median, Mean, 90th Percentile, and Maximum Output Variable Values from the PAVT and CCA Simulations for Scenario S2 (E1 intrusion at 350 yrs, E2 intrusion at 10,000 years, same panel)

Output Variable Description	Time (yrs)	PAVT Simulation (R1, R2, R3, and all 3 replicates combined)					CCA Simulation (all 3 replicates combined)				
		10th	Median	Mean	90th	Max.	10th	Median	Mean	90th	Max.
Cuttings and Cavings Volume (m^3)	10000	0.32 0.30 0.30	0.67 0.71 0.71	1.0 1.0 1.0	2.3 2.3 2.2	3.9 3.5 3.4					
(combined)		**0.30**	**0.71**	**1.0**	**2.2**	**3.9**	**0.43**	**0.51**	**0.60**	**0.87**	**2.9**
Spallings Volume (m^3)	10000	0.0 0.0 0.0	0.0 0.0 0.0	1.2 1.1 1.0	3.3 3.2 3.4	4.0 3.5 4.0					
(combined)		**0.0**	**0.0**	**1.1**	**3.3**	**4.0**	**0.0**	**0.0**	**0.19**	**0.0**	**3.7**
Spallings Release (EPA) units	10000	0.0 0.0 0.0	0.0 0.0 0.0	0.0051 0.0049 0.0047	0.015 0.015 0.015	0.018 0.018 0.018					
(combined)		**0.0**	**0.0**	**0.0048**	**0.015**	**0.018**	**0.0**	**0.0**	**0.0009**	**0.0**	**0.016**

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6.0 DIRECT BRINE RELEASE CALCULATIONS

This section provides a comparison of direct brine release (DBR) results obtained in the PAVT and CCA calculations and a discussion of differences between the PAVT replicates. The key performance measures for comparing PAVT and CCA direct brine release results are volume of brine and quantity of dissolved radionuclides released at the surface within a time period of up to eleven days.

6.1 Comparison Between PAVT and CCA Replicates

Table 6.1 provides a summary of the number of PAVT calculations that produced a direct brine release for each replicate. In each PAVT replicate, nearly as many calculations resulted in brine release (R1=821, R2=934, R3=817, Total=2572) as in all three CCA replicates combined (Total=907). This increase in the number of releases was primarily due to the increased repository pressures in the disturbed scenarios and to a lesser extent the increased waste permeability.

Brine release volumes in all PAVT replicates were, in general, larger than release volumes in the CCA. These larger release volumes were due in part to the increased waste permeability. As in the CCA, the PAVT data shows a tendency for releases to increase with increasing pressure. Pressures ranged up to 17 MPa in the PAVT with a maximum release of about 180 m^3 in replicate 1, 200 m^3 in replicate 2, and 105 m^3 in replicate 3. In the CCA the maximum release was approximately 55 m^3 at a pressure of 15 MPa. In addition, there were many more calculations that released brine in volumes greater than 10 m^3 in the PAVT than in the CCA.

Statistical measures for direct brine releases (brine volumes and radionuclides) are given in Tables 6.2 and 6.3. Results are presented for a single intrusion into the lower panel of an undisturbed repository (S1) at 5000 and 10000 years (Table 6.2) and for an E1 intrusion at 1000 years (S3) followed by a second intrusion at 1200, 5000, and 10000 years (Table 6.3). Results for all scenarios and all intrusion times, in the form of box plots, are included in Appendix E.

Results show that, for the S1 scenario, released brine volumes tended to be slightly larger in the PAVT than in the CCA, but radionuclide releases tended to be smaller in the PAVT than in the CCA. These differences are summarized with a statistical comparison in Table 6.2. The reduced radionuclide releases in the PAVT were due to the reduced solubilities of ^{241}Am and ^{239}Pu in Salado brine.

In the E1 intrusion scenarios (S2 and S3), released brine volumes were much higher (about an order of magnitude on average) in the PAVT than in the CCA. Corresponding radionuclide releases were less than an order of magnitude larger, on average, in the PAVT at early intrusion times and more than an order of magnitude larger at later intrusion times. At early time, the higher brine volumes released in the PAVT were counteracted by the lower ^{241}Am solubilities in

Castile brine. The later time PAVT radionuclide releases were influenced by ^{239}Pu solubilities in Castile brine; these solubilities were comparable (sometimes larger, sometimes smaller, depending on oxidation state) in the PAVT and CCA. These differences are summarized with a statistical comparison in Table 6.3.

In the E2 intrusion scenarios (S4 and S5), released brine volumes were also about an order of magnitude larger on average in the PAVT than in the CCA. Corresponding PAVT radionuclide releases were generally less than an order of magnitude larger, and at later times were actually smaller than CCA releases. In these scenarios, the larger brine volumes were counteracted by the reduced Salado brine solubilities.

6.2 Summary of Differences Between PAVT Replicates

As shown in Tables 6.2 and 6.3, all three PAVT replicates yield very similar direct brine release results for the mean and percentile quantities. The maximum values varied somewhat among replicates, indicating an increased variation among these outlier values. For further comparison between replicates, box plots showing brine volume released (m^3) and normalized release (EPA units) for all PAVT scenarios and intrusion times are provided in Appendix E. Figures E.1 through E.10 are for replicate 2, Figures E.11 through E.20 are for replicate 3, and Figures E.21 through E.30 are for all 3 replicates combined. Box plots for replicate 1 are given in WPO #46674. These box plots show that results from each replicate are in good agreement with each other.

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Table 6.1 Summary of PAVT Calculations that Produced Direct Brine Releases by Scenario and Replicate

Scenario	Down-Dip		Up-Dip	
	Number of Calculations with Releases	Total Number of Calculations	Number of Calculations with Releases	Total Number of Calculations
S1	96 86 87	600	12 3 3	600
S2	272 270 275	500	85 86 81	500
S3	202 208 207	500	48 42 41	500
S4	37 46 49	500	7 2 4	500
S5	53 54 67	500	9 2 3	500
Total	660 799 685	2600	161 135 132	2600

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Table 6.2. 10th Percentile, Median, Mean, 90th Percentile, and Maximum Output Variable Values from the PAVT and CCA Simulations for Scenario S1 (initial intrusion at time specified in lower panel)

Output Variable Description	Intrusion Time (yrs)	PAVT Simulation (R1, R2, R3, and combined)					CCA Simulation (all 3 replicates combined)				
		10th	Median	Mean	90th	Max.	10th	Median	Mean	90th	Max.
Brine Volume (m^3)	5000	0.0	0.0	3.8	12	93					
		0.0	0.0	2.9	1.6	122					
		0.0	0.0	3.5	4.4	106					
(combined)		**0.0**	**0.0**	**3.4**	**6.1**	**122**	**0.0**	**0.0**	**1.0**	**1.2**	**28**
Release (EPA units)	5000	0.0	0.0	2.1E-4	3.9E-4	1.0E-2					
		0.0	0.0	8.7E-5	4.9E-5	3.5E-3					
		0.0	0.0	1.3E-4	2.5E-4	3.3E-3					
(combined)		**0.0**	**0.0**	**1.4E-4**	**2.7E-4**	**1.0E-2**	**0.0**	**0.0**	**7.4E-4**	**2.9E-4**	**5.1E-2**
Brine Volume (m^3)	10000	0.0	0.0	4.0	15	51					
		0.0	0.0	4.4	7.8	119					
		0.0	0.0	4.7	12	106					
(combined)		**0.0**	**0.0**	**4.4**	**12**	**119**	**0.0**	**0.0**	**1.9**	**5.5**	**37**
Release (EPA units)	10000	0.0	0.0	1.1E-4	3.4E-4	3.5E-3					
		0.0	0.0	6.2E-5	1.1E-4	1.4E-3					
		0.0	0.0	1.0E-4	2.2E-4	2.2E-3					
(combined)		**0.0**	**0.0**	**9.2E-5**	**2.3E-4**	**3.5E-3**	**0.0**	**0.0**	**1.0E-3**	**9.2E-4**	**5.2E-2**

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Table 6.3. 10th Percentile, Median, Mean, 90th Percentile, and Maximum Output Variable Values from the PAVT and CCA Simulations for Scenario S3 (E1 intrusion at 1000 yrs followed by a second intrusion at time specified in same panel)

Output Variable Description	Intrusion Time (yrs)	PAVT Simulation (R1, R2, R3, and combined)					CCA Simulation (all 3 replicates combined)				
		10th	Median	Mean	90th	Max.	10th	Median	Mean	90th	Max.
Brine Volume (m^3)	1200	0.0	2.5	5.5	15	76					
		0.0	4.0	5.5	15	23					
		0.0	3.3	5.2	14	48					
(combined)		**0.0**	**3.2**	**5.4**	**15**	**76**	**0.0**	**0.0**	**0.62**	**0.43**	**15**
Release (EPA units)	1200	0.0	5.1E-4	1.6E-3	3.5E-3	1.9E-2					
		0.0	8.2E-4	1.7E-3	5.4E-3	1.4E-2					
		0.0	5.3E-4	1.4E-3	3.8E-3	1.3E-2					
(combined)		**0.0**	**6.2E-4**	**1.6E-3**	**4.1E-3**	**1.9E-2**	**0.0**	**0.0**	**8.1E-4**	**3.3E-4**	**5.8E-2**
Brine Volume (m^3)	5000	0.0	0.0	3.7	13	64					
		0.0	0.0	3.8	8.9	104					
		0.0	0.0	3.9	12	57					
(combined)		**0.0**	**0.0**	**3.8**	**11**	**104**	**0.0**	**0.0**	**0.25**	**0.0**	**13**
Release (EPA units)	5000	0.0	0.0	1.3E-4	6.2E-4	1.9E-3					
		0.0	0.0	1.5E-4	3.6E-4	3.5E-3					
		0.0	0.0	1.2E-4	4.8E-4	1.9E-3					
(combined)		**0.0**	**0.0**	**1.3E-4**	**4.8E-4**	**3.5E-3**	**0.0**	**0.0**	**9.9E-6**	**0.0**	**5.6E-4**

Table 6.3 (cont'd). 10th Percentile, Median, Mean, 90th Percentile, and Maximum Output Variable Values from the PAVT and CCA Simulations for Scenario S3 (E1 intrusion at 1000 yrs followed by a second intrusion at time specified in same panel)

Output Variable Description	Intrusion Time (yrs)	PAVT Simulation (R1, R2, R3, and combined)					CCA Simulation (all 3 replicates combined)				
		10th	Median	Mean	90th	Max.	10th	Median	Mean	90th	Max.
Brine Volume (m^3)	10000	0.0	0.0	4.0	8.6	100					
		0.0	0.0	2.8	12	40					
		0.0	0.0	2.8	7.5	57					
(combined)		**0.0**	**0.0**	**3.2**	**8.5**	**100**	0.0	0.0	0.18	0.0	11
Release (EPA units)	10000	0.0	0.0	6.3E-5	1.6E-4	1.9E-3					
		0.0	0.0	6.1E-5	1.9E-4	1.4E-3					
		0.0	0.0	5.2E-5	1.1E-4	9.6E-4					
(combined)		**0.0**	**0.0**	**5.9E-5**	**1.4E-4**	**1.9E-3**	0.0	0.0	3.7E-6	0.0	2.3E-4

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7.0 CCDF CALCULATIONS

This section provides a comparison between the PAVT and CCA results and summarizes the differences in CCDFs between the PAVT replicates. The computer code CCDF_GF used the results of calculations performed in Sections 2 through 6 to produce the CCDFs. The key performance measure for comparing PAVT and CCA results is total normalized releases in EPA units as compared with EPA Limits.

7.1 Comparison Between PAVT and CCA Replicates

A comparison of CCDF results is presented in this section. Figures 7.1 through 7.5 compare mean and overall mean normalized releases for the PAVT and the CCA. Means for each of the three PAVT and CCA replicates as well as overall PAVT and CCA means are shown. The overall mean curves are constructed by combining all three replicates (R1, R2, and R3) to obtain a sample size of 300. The total releases (combined total contributions from all release modes) for the PAVT mean CCDFs are a factor of 2 to 3 larger than the CCA values for all probabilities of exceedance (Figure 7.1). For a specific release, the probability of exceedance has increased by as much as a factor of 10. These increases were primarily due to the increase in cuttings releases (Figure 7.2). Other contributors to total releases include spallings (Figure 7.3), direct brine release (Figure 7.4), and Culebra (Figure 7.5) releases. Note that mean CCDFs for all of these components of the total normalized releases are greater than (to the right of) the CCA mean CCDFs. The absence of passive institutional controls (PICs) and the change in the probability of a borehole encountering a pressurized Castile brine reservoir (PBRINE) were also minor contributors to the change in releases. Even with the slightly higher releases, the PAVT mean CCDFs do not exceed or come within an order of magnitude of the EPA Limit.

Figures 7.6 through 7.10 show additional statistical information for total normalized releases and releases due to cuttings, spallings, direct brine, and Culebra transport for each of the three PAVT and CCA replicates. CCDFs representing the mean, median, 10th, and 90th percentiles for each replicate are shown in addition to the overall mean. As shown in Figure 7.6, the location of the 90th quantile substantially below and to the left of the EPA limit line in both the PAVT and CCA provides a high degree of confidence that the WIPP meets the regulatory standard.

7.2 Summary of Differences Between PAVT Replicates

The three replicates in both the PAVT and CCA provide a check on the stability of the results. The mean and quantiles curves for each replicate nearly overlay (Figure 7.6). This indicates that the PAVT results are quite stable across the three replicates (i.e., there are only small variations in mean and quantile values across the three replicates).

The distribution of CCDFs for cuttings releases is relatively tight (small difference between 10th

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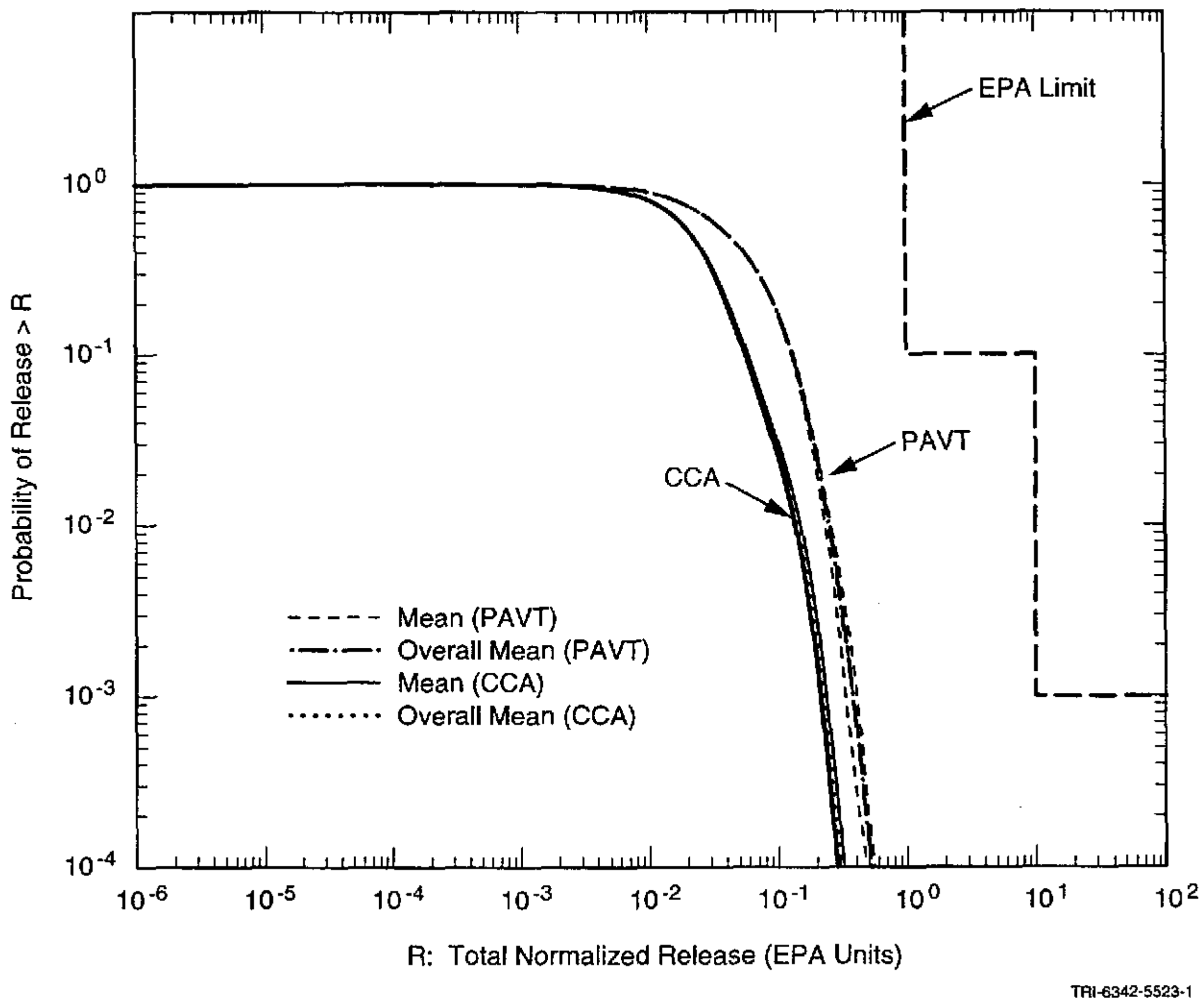
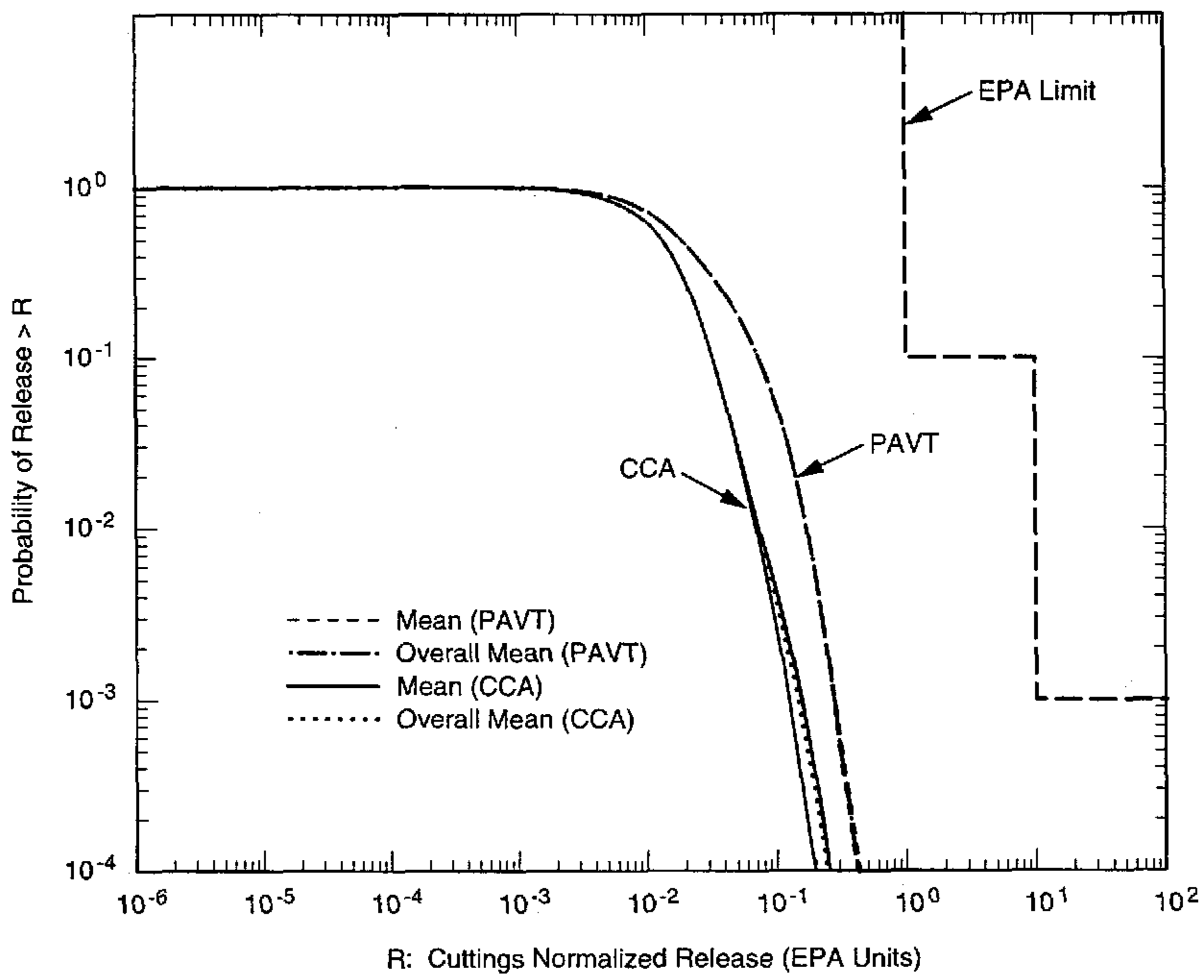
and 90th quantile curves), and the mean and quantile curves are quite stable across replicates (Figure 7.7). The spallings CCDFs (Figure 7.8) tend to be further from the EPA Limit and also have more variability than the cuttings CCDFs. The spallings CCDFs are quite stable across all three replicates. The direct brine release CCDFs (Figure 7.9) tend to be even further from the EPA Limit and more scattered than the CCDFs for cuttings and spallings. Again, the CCDFs are quite stable across all three replicates. The CCDFs for releases from the Culebra (Figure 7.10) are much further from the EPA Limit than the other releases modes. The mean curves are dominated by a few vectors, which is why the 90th and other quantile curves do not show on the plot. Again, the CCDFs are quite stable across all three replicates.



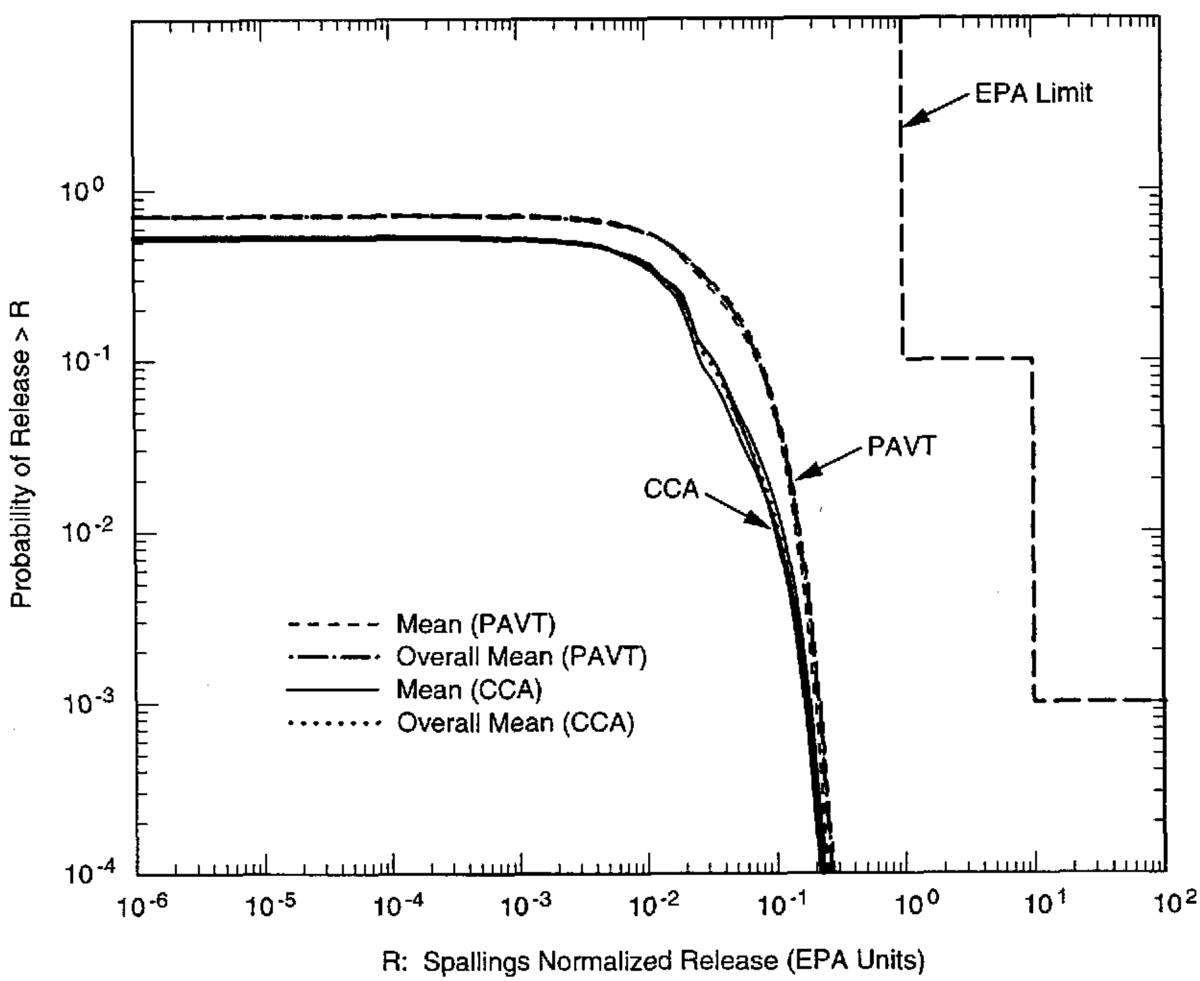
Note: Four CCDFs are shown for both the CCA and PAVT, including three individual mean CCDFs calculated for each of the three distributions of CCDFs calculated for the three replicates and an overall mean CCDF that is the arithmetic mean of the three individual mean CCDFs.

Figure 7.1 Mean CCDFs for Total Normalized Radionuclide Releases to the Accessible Environment



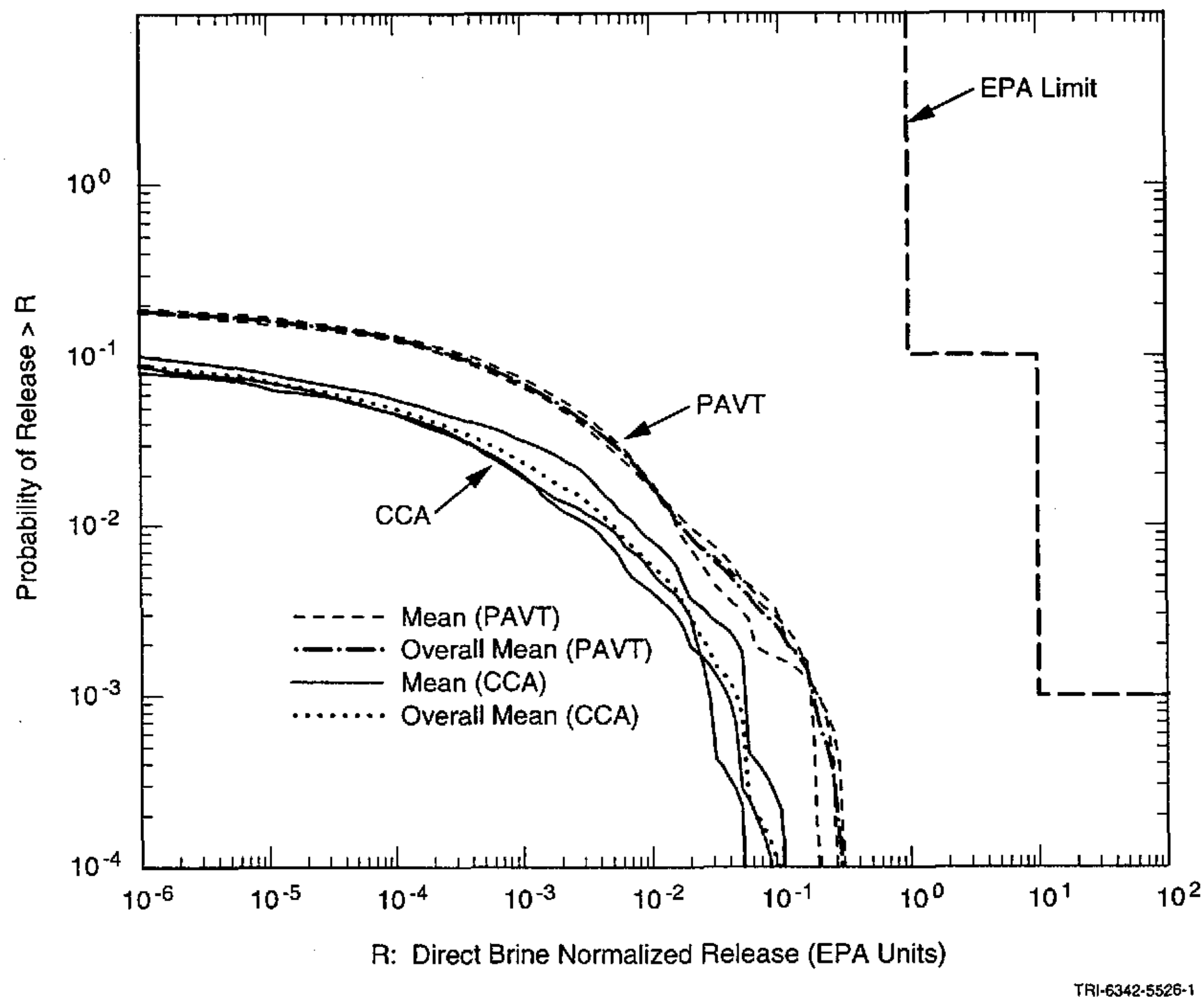
Note: Four CCDFs are shown for both the CCA and PAVT, including three individual mean CCDFs calculated for each of the three distributions of CCDFs calculated for the three replicates and an overall mean CCDF that is the arithmetic mean of the three individual mean CCDFs.

Figure 7.2 Mean CCDFs for Cuttings Normalized Radionuclide Releases to the Accessible Environment



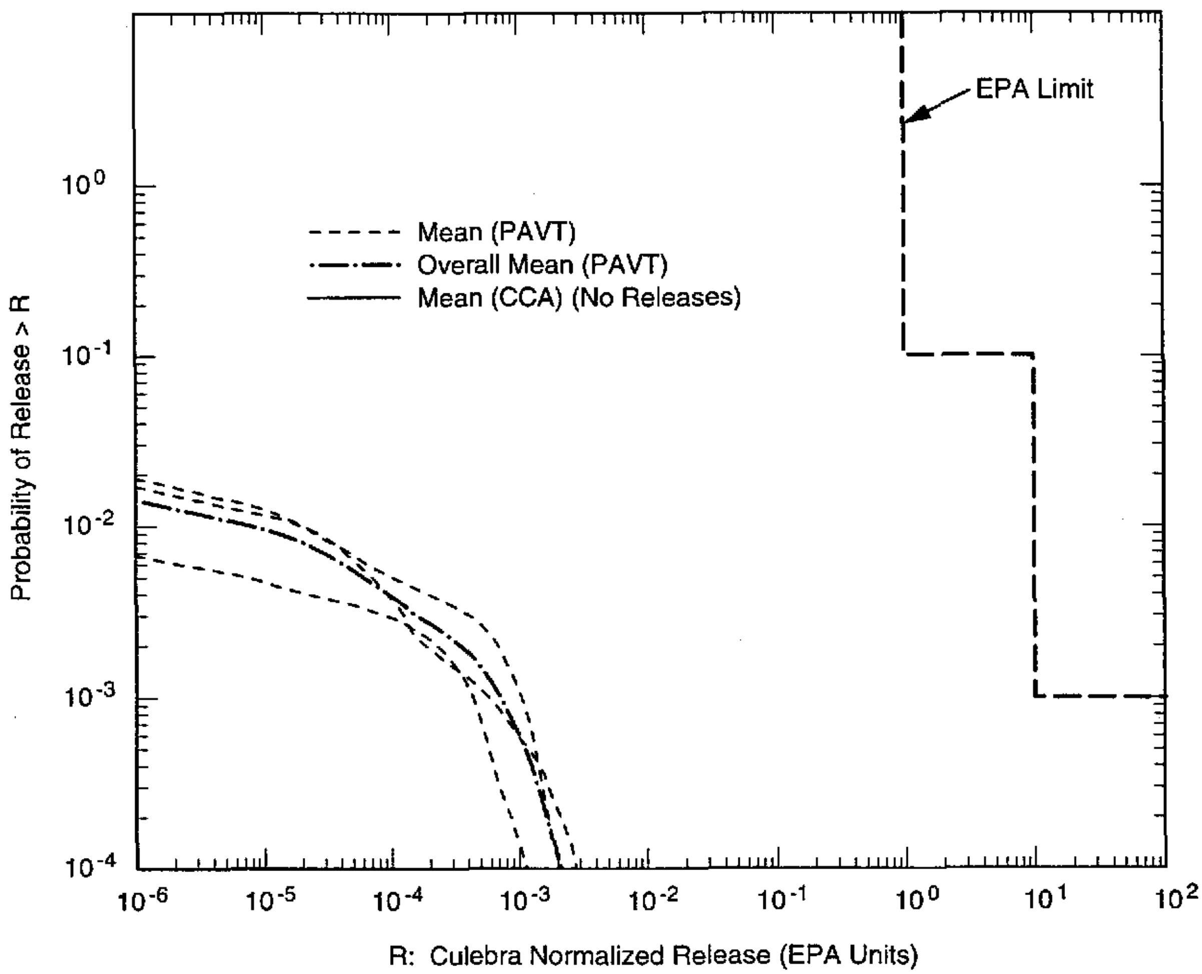
Note: Four CCDFs are shown for both the CCA and PAVT, including three individual mean CCDFs calculated for each of the three distributions of CCDFs calculated for the three replicates and an overall mean CCDF that is the arithmetic mean of the three individual mean CCDFs.

Figure 7.3 Mean CCDFs for Spallings Normalized Radionuclide Releases to the Accessible Environment



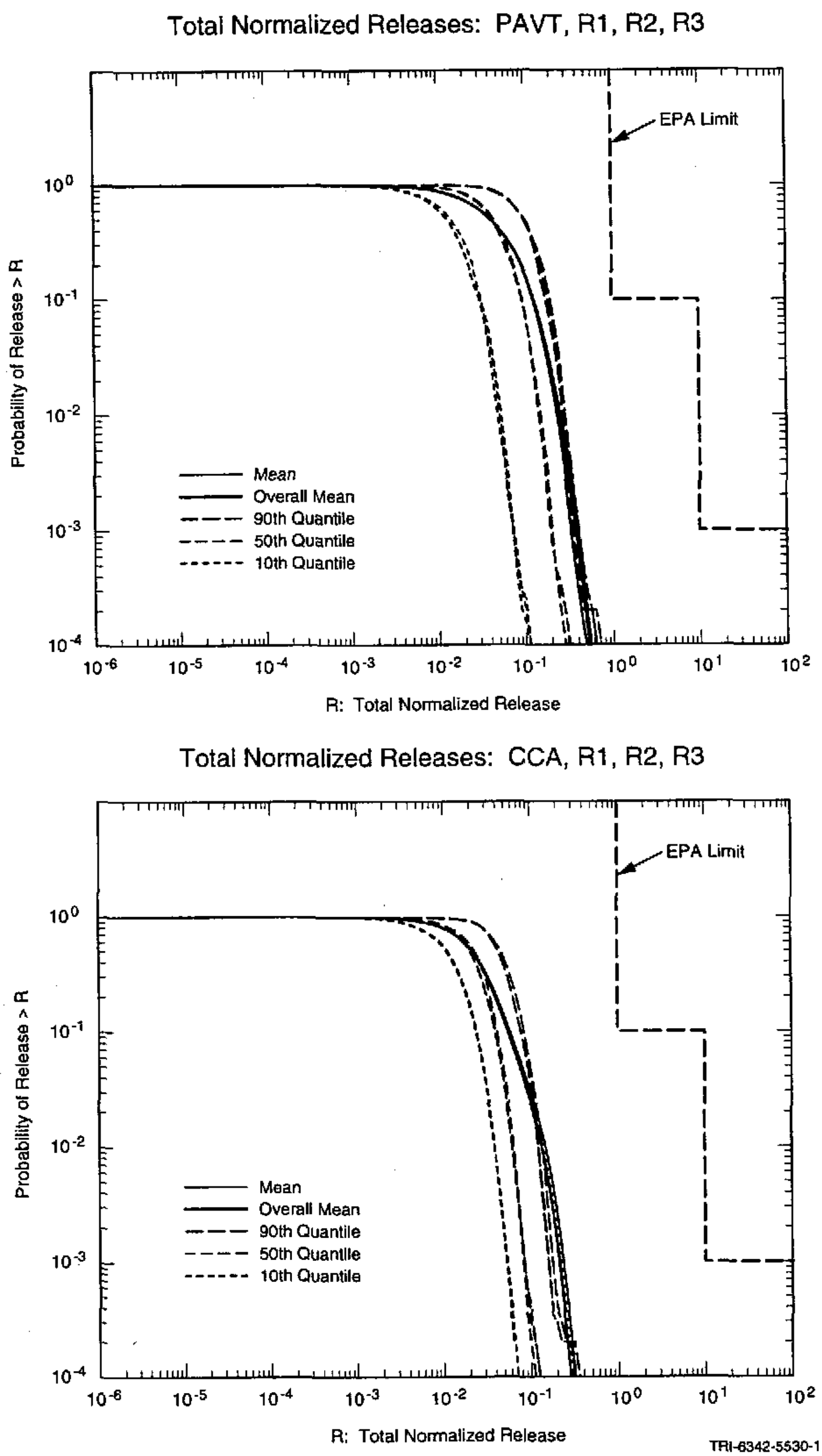
Note: Four CCDFs are shown for both the CCA and PAVT, including three individual mean CCDFs calculated for each of the three distributions of CCDFs calculated for the three replicates and an overall mean CCDF that is the arithmetic mean of the three individual mean CCDFs.

Figure 7.4 Mean CCDFs for Direct Brine Normalized Radionuclide Releases to the Accessible Environment



Note: Four CCDFs are shown for both the CCA and PAVT, including three individual mean CCDFs calculated for each of the three distributions of CCDFs calculated for the three replicates and an overall mean CCDF that is the arithmetic mean of the three individual mean CCDFs.

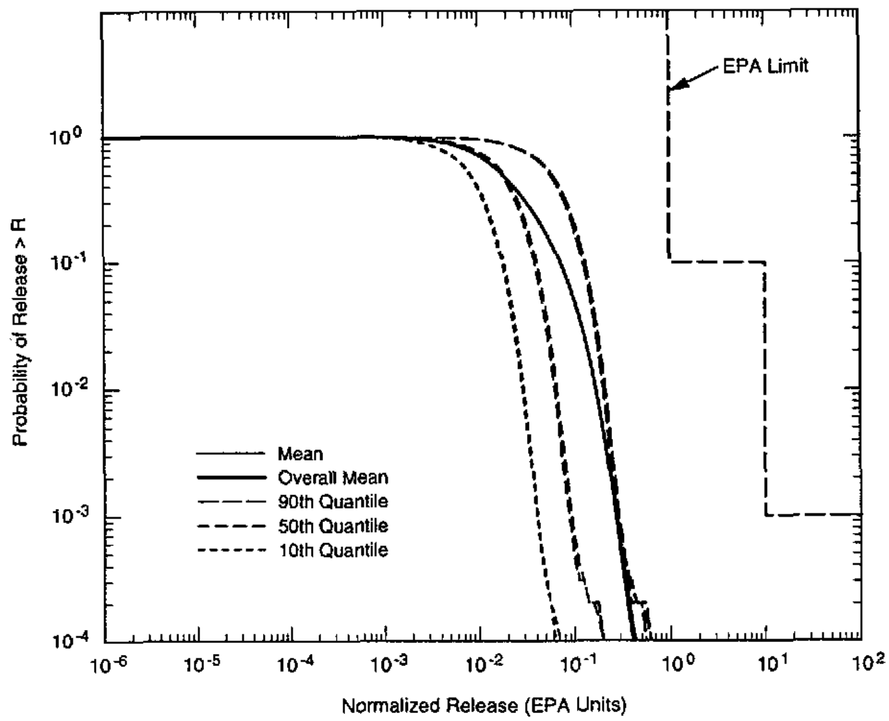
Figure 7.5 Mean CCDFs for Culebra Normalized Radionuclide Releases to the Accessible Environment



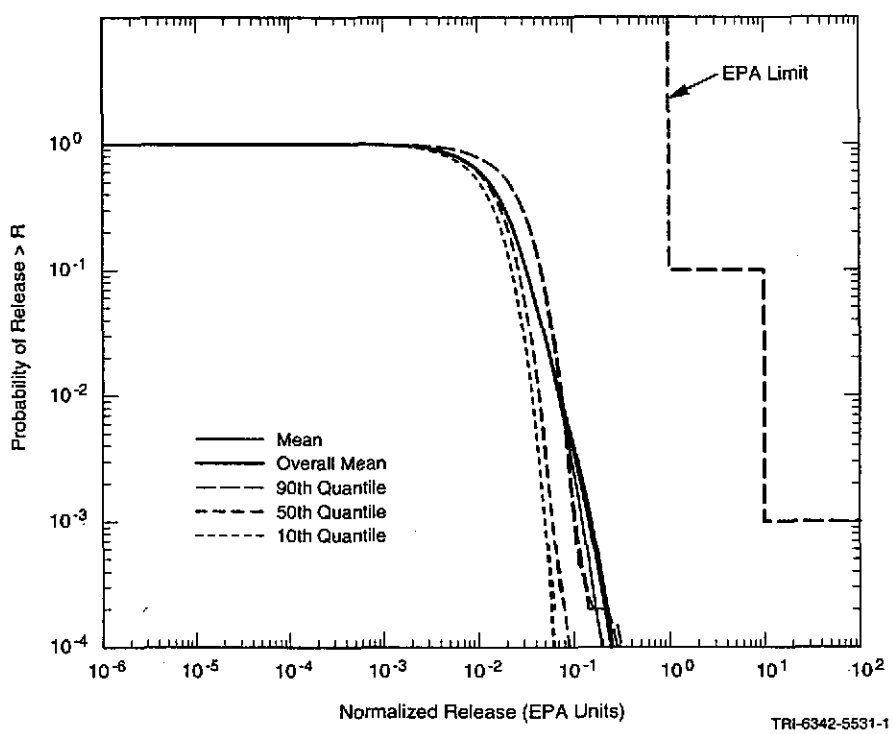
Note: Mean, median, and 10th and 90th percentile CCDFs are shown together for each replicate with the overall mean.

Figure 7.6 Mean and Percentile CCDFs for Total Normalized Releases

Cuttings Normalized Releases: PAVT, R1, R2, R3



Cuttings Normalized Releases: CCA, R1, R2, R3



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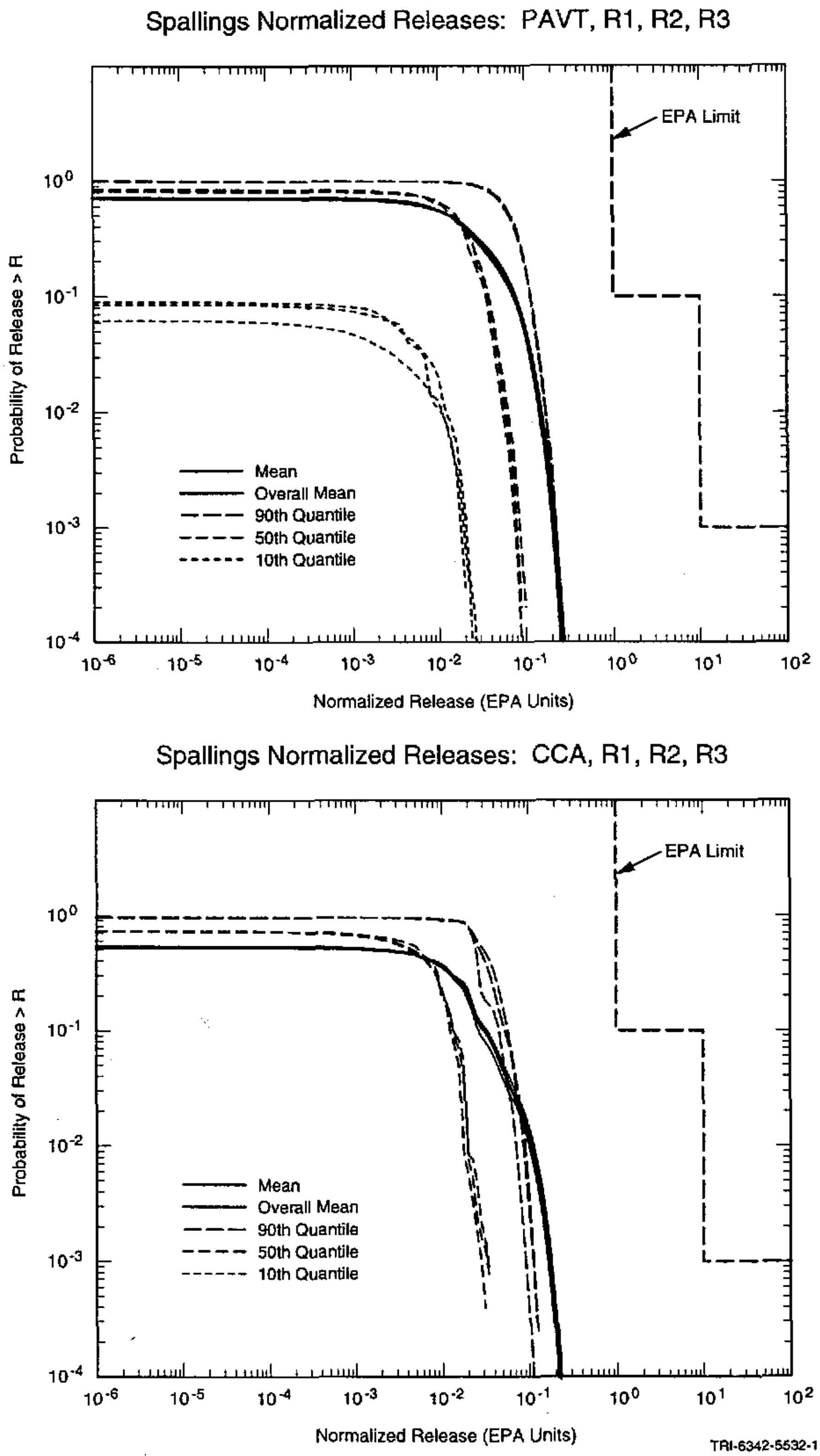
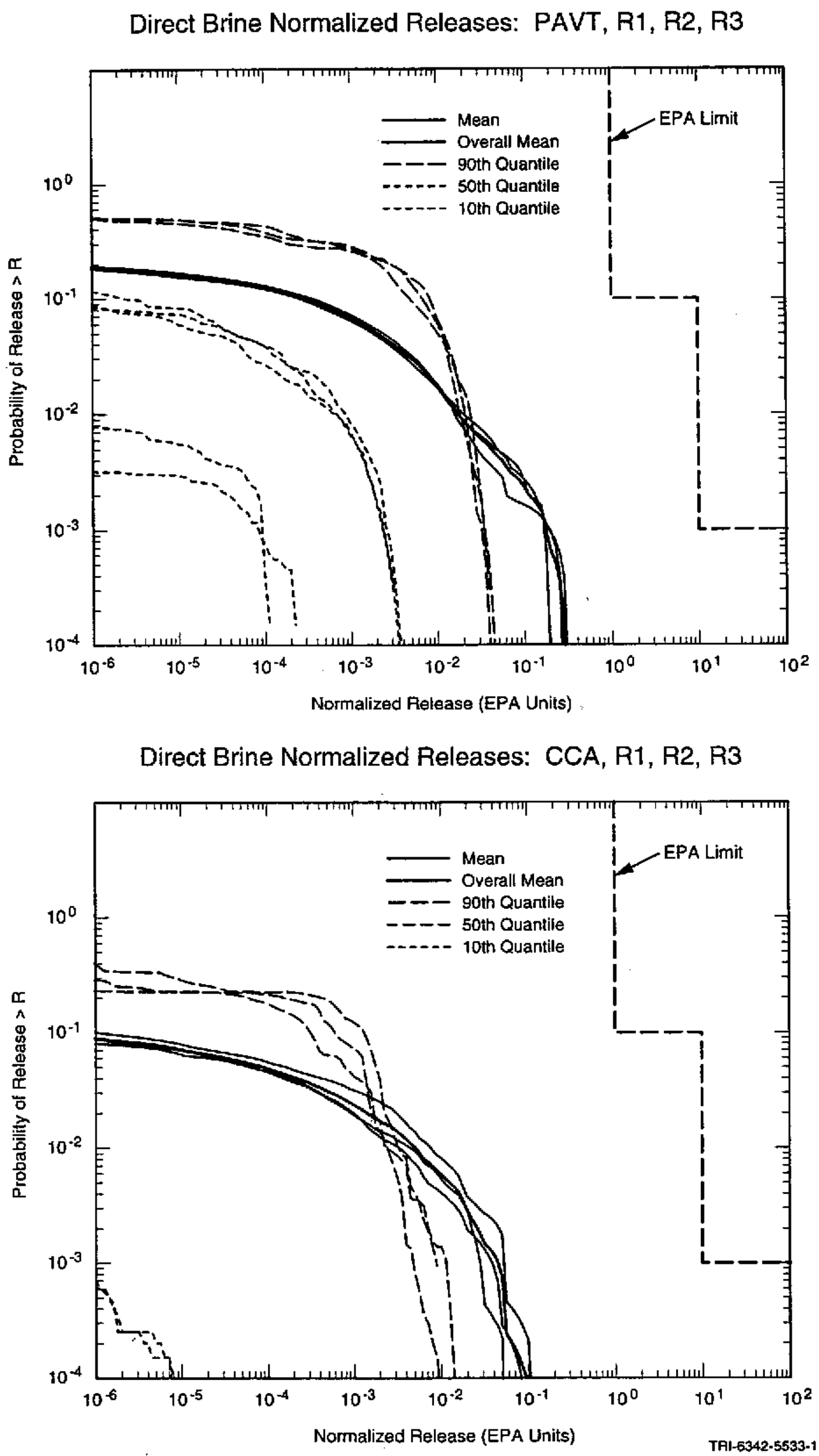
Note: Mean, median, and 10th and 90th percentile CCDFs are shown together for each replicate with the overall mean.

Figure 7.7 Mean and Percentile CCDFs for Cuttings Normalized Releases



Note: Mean, median, and 10th and 90th percentile CCDFs are shown together for each replicate with the overall mean.

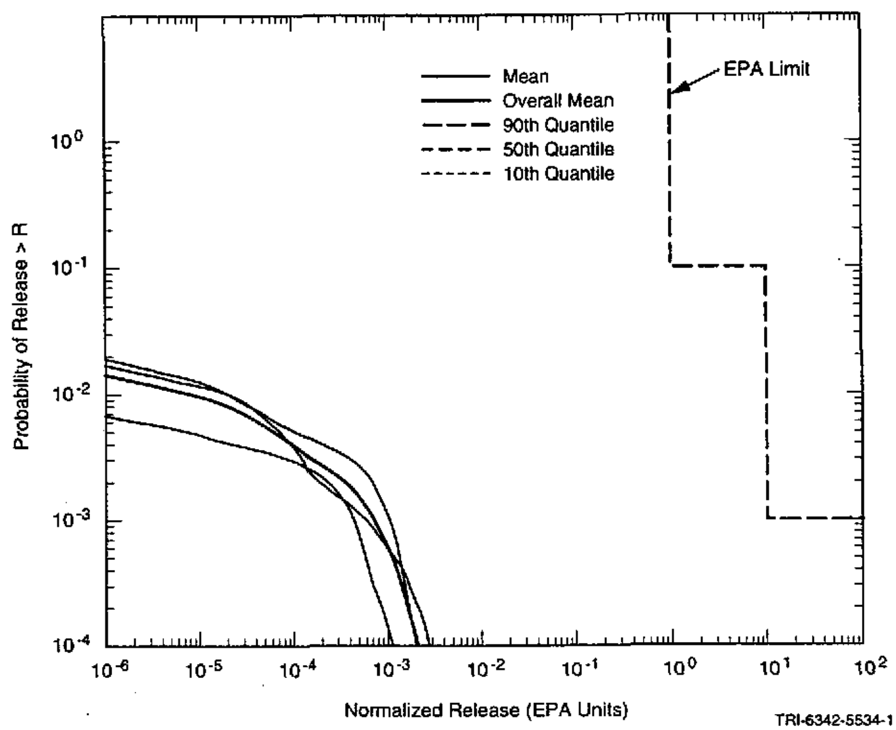
Figure 7.8 Mean and Percentile CCDFs for Spallings Normalized Releases



Note: Mean, median, and 10th and 90th percentile CCDFs are shown together for each replicate with the overall mean.

Figure 7.9 Mean and Percentile CCDFs for Direct Brine Normalized Releases

Total From Culebra Normalized Releases: PAVT, R1, R2, R3



Note: Mean, median, and 10th and 90th percentile CCDFs are shown together for each replicate with the overall mean.

Figure 7.10 Mean and Percentile CCDFs for Total Normalized Releases from Culebra

8.0 REFERENCES

Summary of EPA-Mandated Performance Assessment Verification Test (Replicate 1) and Comparison With the Compliance Certification Application Calculations, WPO # 46674.

Analysis Package for the Salado Flow Calculations (Task 1) of the Performance Assessment Analysis Supporting the Compliance Certification Application, WPO # 40514.

Analysis Package for the Salado Transport Calculations (Task 2) of the Performance Assessment Analysis Supporting the Compliance Certification Application, WPO # 40515.

Analysis Package for the Culebra Flow and Transport Calculations (Task 3) of the Performance Assessment Analysis Supporting the Compliance Certification Application, WPO # 40516.

Analysis Package for the BRAGFLO Direct Brine Release Calculations (Task 4) of the Performance Assessment Analysis Supporting the Compliance Certification Application, WPO # 40520.

Analysis Package for the Cuttings and Spallings Calculations (Tasks 5 and 6) of the Performance Assessment Analysis Supporting the Compliance Certification Application, WPO # 40521.

Analysis Package for CCDF Construction (Task 7) of the Performance Assessment Analysis Supporting the Compliance Certification Application, WPO #40524

APPENDIX A

SALADO FLOW (GAS AND BRINE MIGRATION) COMPARISON BETWEEN PAVT REPLICATES

This appendix provides a summary comparison of PAVT results for replicates 1, 2, and 3. A detailed discussion of PAVT replicate 1 results is presented in Appendix A of WPO #46674. CCA results are discussed in WPO #40514. Statistical summary plots corresponding to performance measures tabulated in Section 2 are presented in the following sections. In these plots, four curves are shown for each replicate: the mean, the median, the 10th percentile, and the 90th percentile. The mean curve represents the mean value of the dependent variable at each point in time among all 100 realizations. The 10th percentile curve is the value of the dependent variable at each point in time which is larger than 10 percent and smaller than 90 percent of the 100 realizations. The 90th percentile curve is the value of the dependent variable at each point in time which is larger than 90 percent and smaller than 10 percent of the 100 realizations. The median (50th percentile) curve is similarly constructed. Generally, all of these statistical measures were similar between replicates. The 90th percentile showed the most variation across replicates because it was influenced the most by outlier values. Mean values were also sometimes influenced by extreme outlier values. 10th percentile values were often zero and were therefore not as strongly influenced by outliers.

A.1 UNDISTURBED PERFORMANCE

Differences between the PAVT replicates for important performance measures are summarized in this section for undisturbed repository performance.

A.1.1 Agreement With Other Replicates (S1 Scenario)

Volume-Averaged Pressure in Waste Panel

The mean values of pressure in the waste panel (Figure A.1 [GVAR_023_S]) were similar in all three PAVT replicates at all simulation times. The other statistical measures, the median and 10th and 90th percentile values, also showed close agreement among replicates.

Volume-Averaged Brine Saturation in Waste Panel

The mean brine saturation was very similar in all three replicates (Figure A.2 [GVAR_101_S]). The median brine saturations also showed good agreement. The 10th percentile values were zero after 1000 years in all replicates. The 90th percentile values varied somewhat among replicates, indicating increased variation among outliers.

Cumulative Brine Flow Out of All Marker Beds Across Land Withdrawal Boundary

Brine flow across the land withdrawal boundary (Figure A.3 [GVAR_174_S]) showed a large difference between the mean values of replicate 1 as compared with replicates 2 and 3. This difference was due to the single vector (#38) in replicate 1 that produced significant flow. In addition, the means in all three replicates were dominated by a few outliers, as indicated by the mean values being larger than the 90th percentile values. The median values were zero because there was no flow across the land-withdrawal boundary in more than half of the realizations in all three replicates.

Total Gas Volume Generated

The mean value curves follow each other very closely for the entire 10,000 years (Figure A.4 [GVAR_022_S]). The median and 10th percentile values also showed close agreement. At times greater than 5000 years, the 90th percentile values varied somewhat among replicates indicating an increased variation among outliers.

Cumulative Brine Flow into Repository

Cumulative brine flow into the repository (Figure A.5 [GVAR_085_S]) shows good agreement among all replicates for all statistical measures.

A.2 DISTURBED PERFORMANCE

Differences between the PAVT replicates for important performance measures are summarized in the following sections for disturbed repository performance. Three types of intrusions are examined: the E1 intrusions (S2 and S3 scenarios), the E2 intrusions (S4 and S5 scenarios), and the E2E1 intrusion (S6 scenario). Replicates 2 and 3 agree very well with replicate 1. For each performance measure, the statistical summary plots are presented. These plots show that essentially the same behavior occurs in every replicate.

A.2.1 E1 Intrusions

A.2.1.1 Agreement With Other Replicates For E1 Intrusion at 350 Years (S2 Scenario)

Volume-Averaged Pressure in Waste Panel

The mean values of pressure in the waste panel (Figure A.6 [GVAR_023_S]) were very similar among the three replicates at all simulation times. The other statistical measures, the median and 10th and 90th percentile values, also showed close agreement among replicates.

Volume-Averaged Brine Saturation in Waste Panel

The mean brine saturation was similar in all three replicates (Figure A.7 [GVAR_101_S]). The median and 90th percentile values also showed good agreement. The 10th percentile values varied somewhat among replicates, indicating increased variation among the low valued saturations.

Cumulative Brine Flow up Borehole at Rustler/Culebra Interface

Brine flow up the borehole at the Rustler/Culebra interface agrees well among replicates, the means differing by less than 20% (Figure A.8 [GVAR_074_S]). The 90th percentile values varied somewhat among replicates, indicating increased variation among the large valued flows. The medians were zero because there was no upward flow to the Culebra in more than half of the realizations in all three replicates.

Cumulative Brine Flow up Borehole at Top of Rustler

The amount of brine that flows up the borehole at the top of the Salado (Figure A.9 [GVAR_075_S]) is minor (90th percentile value is less than 0.2 m^3) in all replicates. This brine originates in the borehole, not in the repository, and is uncontaminated.

Cumulative Brine Flow Out of All Marker Beds Across Land Withdrawal Boundary

Brine flow across the land withdrawal boundary (Figure A.10 [GVAR_174_S]) showed a large difference between the mean values for replicate 1 and the mean values for replicates 2 and 3. This difference was due to the single vector (#38) in replicate 1 that produced significant flow across the land withdrawal boundary. In addition, the means in all three replicates were dominated by a few outliers, as indicated by the means having larger values than the 90th percentiles, which were zero. The medians were also zero because there was no flow across the land-withdrawal boundary in more than half of the realizations in all three replicates.

Total Gas Volume Generated

The mean values of gas volume generated (Figure A.11 [GVAR_022_S]) were very similar among the three replicates at all times. The other statistical measures, the medians and 10th and 90th percentiles, also showed close agreement among replicates.

A.2.1.2 Agreement With Other Replicates For E1 Intrusion at 1000 Years (S3 Scenario)

Volume-Averaged Pressure in Waste Panel

The mean values of pressure in the waste panel (Figure A.12 [GVAR_023_S]) were very similar among the three replicates. Median and 90th percentile values also showed close agreement among replicates. The 10th percentile values varied somewhat among replicates after 5000 years, indicating increased variation among the low valued pressures at later times.

Volume-Averaged Brine Saturation in Waste Panel

The mean brine saturation showed close agreement in all three replicates (Figure A.13 [GVAR_101_S]). The median and 90th percentile values also showed good agreement. The

10th percentile values varied somewhat among replicates, indicating increased variation among the low valued saturations.

Cumulative Brine Flow up Borehole at Rustler/Culebra Interface

Brine flow up the borehole at the Rustler/Culebra interface agrees well among replicates, the means differing by less than 20% (Figure A.14 [GVAR_074_S]). The 90th percentile values varied somewhat among replicates, indicating increased variation among the large valued flows. The medians were zero because there was no upward flow to the Culebra in more than half of the realizations in all three replicates.

Cumulative Brine Flow up Borehole at Top of Rustler

The amount of brine that flows up the borehole at the top of the Salado (Figure A.15 [GVAR_075_S]) is minor (90th percentile value is less than 0.2 m^3) in all replicates. This brine originates in the borehole, not in the repository, and is uncontaminated.

Cumulative Brine Flow Out of All Marker Beds Across Land Withdrawal Boundary

Brine flow across the land withdrawal boundary (Figure A.16 [GVAR_174_S]) showed a large difference between the mean values of replicate 1 as compared with replicates 2 and 3. This difference was due to the single vector (#38) in replicate 1 that produced significant flow across the land withdrawal boundary. However, the means in all three replicates were dominated by a few outliers, as indicated by the means having larger values than the 90th percentiles, which were zero. The medians were also zero because there was no flow across the land-withdrawal boundary in more than half of the realizations in all three replicates.

Total Gas Volume Generated

The mean values of gas volume generated (Figure A.17 [GVAR_022_S]) were very similar among the three replicates. The median and 10th percentile values, also showed close agreement among replicates. The 90th percentile values varied somewhat among replicates, indicating increased variation among the large valued gas volumes.

A.2.2 E2 Intrusions

A.2.2.1 Agreement With Other Replicates For E2 Intrusion at 350 Years (S4 Scenario)

Volume-Averaged Pressure in Waste Panel

The mean values of pressure in the waste panel (Figure A.18 [GVAR_023_S]) were very similar among the three replicates. Median and 10th percentile values also showed close agreement among replicates. The 90th percentile values showed slightly more variation among replicates

SX

after 3000 years, indicating increased variation among the higher valued pressures at later times.

Volume-Averaged Brine Saturation in Waste Panel

The mean brine saturation showed close agreement in all three replicates (Figure A.19 [GVAR_101_S]). The 10th and 90th percentile values also showed good agreement, with the 10th percentile values near zero during most of the 10000 year period. The median values varied somewhat among replicates, indicating increased variation among the midrange valued saturations.

Cumulative Brine Flow up Borehole at Rustler/Culebra Interface

Brine flow up the borehole to the Culebra varied among replicates (Figure A.20 [GVAR_074_S]). The degree of variation was large because brine flowed upwards in relatively few realizations in each replicate. The 90th percentile curves, while showing considerable variation among replicates, are all very low (90th percentile less than 250 m^3 at 10,000 years).

Cumulative Brine Flow up Borehole at Top of Rustler

The amount of brine that flows up the borehole at the top of the Salado (Figure A.21 [GVAR_075_S]) is minor (90th percentile value is less than 0.2 m^3) in all replicates. This brine originates in the borehole, not in the repository, and is uncontaminated.

Cumulative Brine Flow Out of All Marker Beds Across Land Withdrawal Boundary

Brine flow across the land withdrawal boundary (Figure A.22 [GVAR_174_S]) showed a large difference between the mean values for of replicate 1 and the mean values of zero for replicates 2 and 3. This difference was due to the single vector (#38) in replicate 1 that produced significant flow across the land withdrawal boundary. The medians were also zero because there was no flow across the land-withdrawal boundary in more than half of the realizations in all three replicates.

Total Gas Volume Generated

The mean values of gas volume generated (Figure A.23 [GVAR_022_S]) were very similar among the three replicates. The median and 10th percentile values, also showed close agreement among replicates. The 90th percentile values varied somewhat among replicates, indicating increased variation among the large valued gas volumes.

A.2.2.2 Agreement With Other Replicates For E2 Intrusion at 1000 Years (S5 Scenario)

Volume-Averaged Pressure in Waste Panel

The mean values of pressure in the waste panel (Figure A.24 [GVAR_023_S]) were very similar among the three replicates. Median and 10th percentile values also showed close agreement among replicates. The 90th percentile values showed slightly more variation among replicates after 3000 years, indicating increased variation among the higher valued pressures at later times.

Volume-Averaged Brine Saturation in Waste Panel

The mean brine saturation showed close agreement in all three replicates (Figure A.25 [GVAR_101_S]). The 10th and 90th percentile values also showed good agreement, with the 10th percentile values near zero during most of the 10000 year period. The median values varied somewhat among replicates, indicating increased variation among the midrange valued saturations.

Cumulative Brine Flow up Borehole at Rustler/Culebra Interface

Brine flow up the borehole to the Culebra varied among replicates (Figure A.26 [GVAR_074_S]). The degree of variation was large because brine flowed upwards in relatively few realizations in each replicate. The 90th percentile curves, while showing considerable variation among replicates, are all very low (90th percentile less than 200 m^3 at 10,000 years).

Cumulative Brine Flow up Borehole at Top of Rustler

The amount of brine that flows up the borehole at the top of the Salado (Figure A.27 [GVAR_075_S]) is minor (90th percentile value is less than 0.22 m^3) in all replicates. This brine originates in the borehole, not in the repository, and is uncontaminated.

Cumulative Brine Flow Out of All Marker Beds Across Land Withdrawal Boundary

Brine flow across the land withdrawal boundary (Figure A.28 [GVAR_174_S]) showed a large difference between the mean values of replicate 1 and the near zero mean values of replicates 2 and 3. This difference was due to the single vector (#38) in replicate 1 that produced significant flow across the land withdrawal boundary. The medians were also zero because there was no flow across the land-withdrawal boundary in more than half of the realizations in all three replicates.

Total Gas Volume Generated

The mean values of gas volume generated (Figure A.29 [GVAR_022_S]) were very similar among the three replicates. The median and 10th percentile values, also showed close agreement among replicates. The 90th percentile values varied somewhat among replicates, indicating increased variation among the large valued gas volumes.

A.2.3 E2E1 Intrusion

A.2.3.1 Agreement With Other Replicates (S6 Scenario)

Volume-Averaged Pressure in Waste Panel

The mean values of pressure in the waste panel (Figure A.30 [GVAR_023_S]) were very similar among the three replicates. The median and 10th and 90th percentile values also showed close agreement among replicates.

Volume-Averaged Brine Saturation in Waste Panel

The mean brine saturation showed close agreement in all three replicates (Figure A.31 [GVAR_101_S]). The median and 90th percentile values also showed good agreement. The 10th percentile values varied somewhat among replicates, indicating increased variation among the low valued saturations.

Cumulative Brine Flow up Borehole at Rustler/Culebra Interface

Brine flow up the borehole at the Rustler/Culebra interface agrees well among replicates, the means and 90th percentile values differing by less than 20% (Figure A.32 [GVAR_074_S]). The medians were very near zero because there was no appreciable upward flow to the Culebra in almost half of the realizations in all three replicates.

Cumulative Brine Flow up Borehole at Top of Rustler

The amount of brine that flows up the borehole at the top of the Salado (Figure A.33 [GVAR_075_S]) was negligible in all three replicates.

Cumulative Brine Flow Out of All Marker Beds Across Land Withdrawal Boundary

Brine flow across the land withdrawal boundary (Figure A.34 [GVAR_174_S]) showed a large difference between the mean values of replicate 1 and the near zero mean values of replicates 2 and 3. This difference was due to the single vector (#38) in replicate 1 that produced significant flow across the land withdrawal boundary. The medians were also zero because there was no flow across the land-withdrawal boundary in more than half of the realizations in all three replicates.

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Total Gas Volume Generated

The mean values of gas volume generated (Figure A.35 [GVAR_022_S]) were very similar among the three replicates. The median and 10th percentile values, also showed close agreement among replicates. The 90th percentile values varied somewhat among replicates, indicating increased variation among the large valued gas volumes.

SNL WIPP C97: BF STATISTICAL SUMMARY (C97 Scenario 1)

Volume-Averaged Pressure in Waste Panel

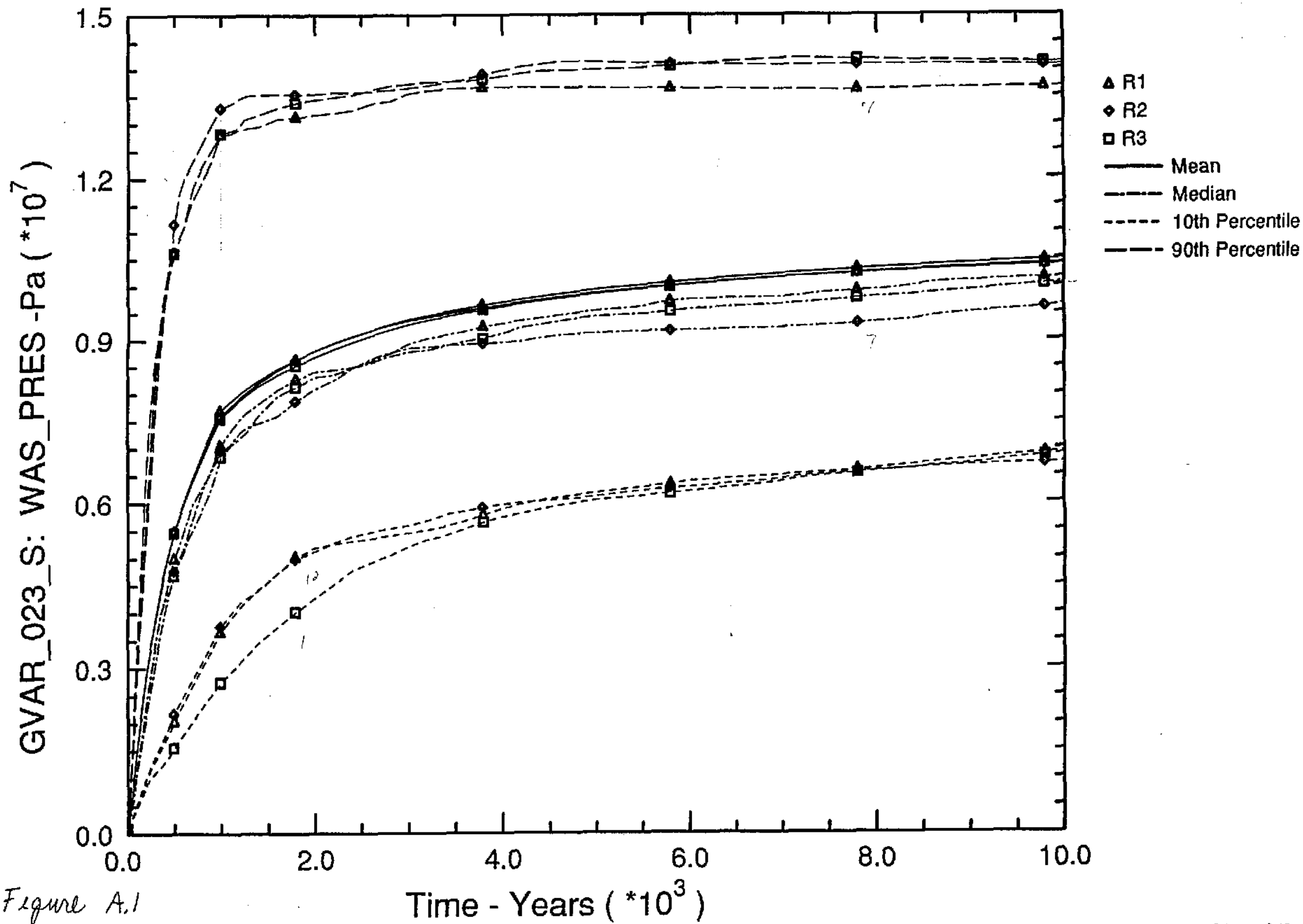


Figure A.1

59

1DRA1:[JEBEAN.C97.SUMMZ.STATS.S1]SPLAT_ST_S1_H023.INP;1

SPLAT_PA96_2 1.02 07/02/97 14:12:45

SNL WIPP C97: BF STATISTICAL SUMMARY (C97 Scenario 1)

Volume-Averaged Brine Saturation in Waste Panel

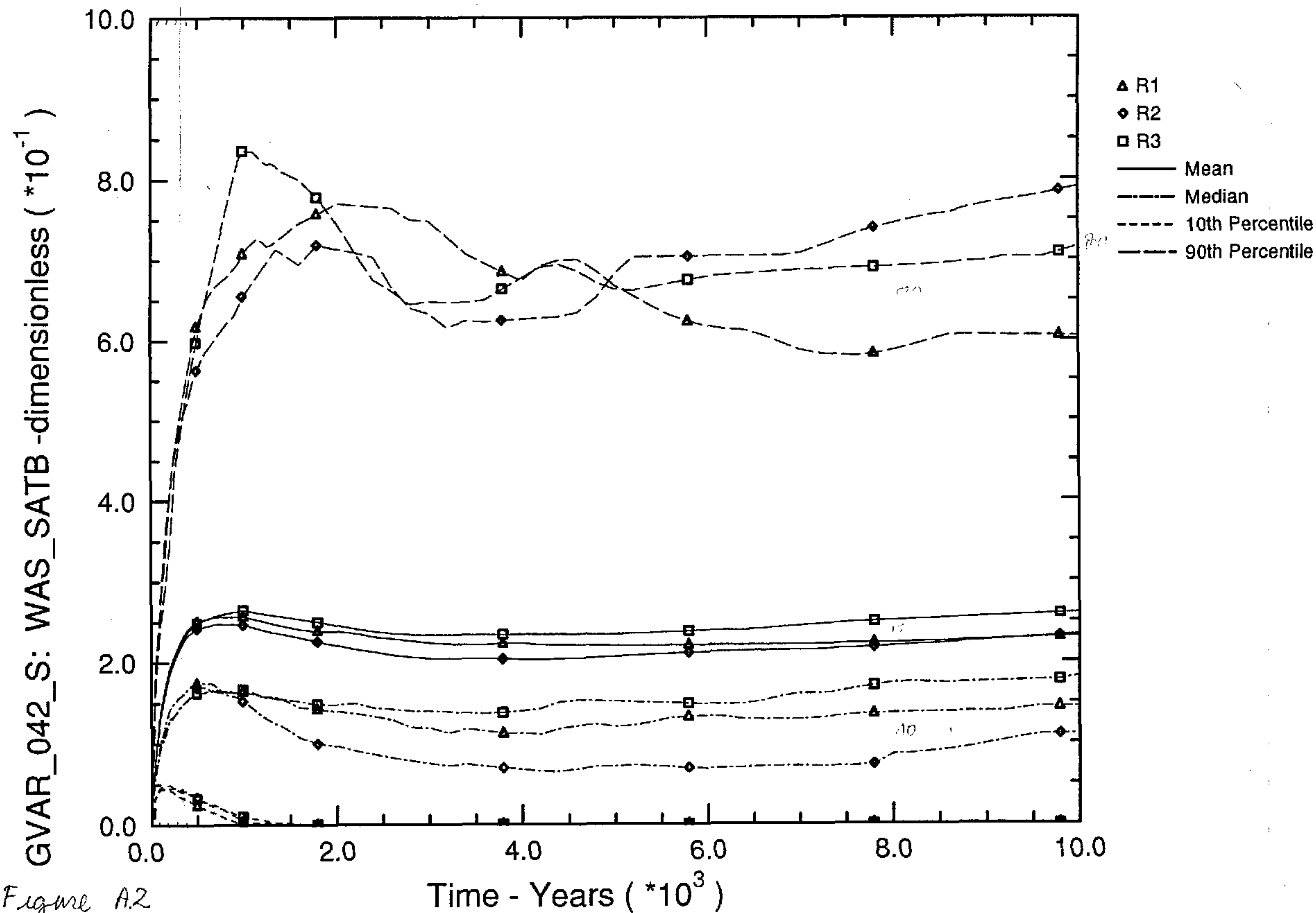


Figure A.2

1DRA1:[JEBEAN.C97.SUMMZ.STATS.S1]SPLAT_ST_S1_H042.INP;1

SPLAT_PA96_2 1.02 07/02/97 14:14:03

SNL WIPP C97: BF STATISTICAL SUMMARY (C97 Scenario 1)

Cumulative Brine Flow Out of All Marker Beds Across Land-Withdrawal Boundary

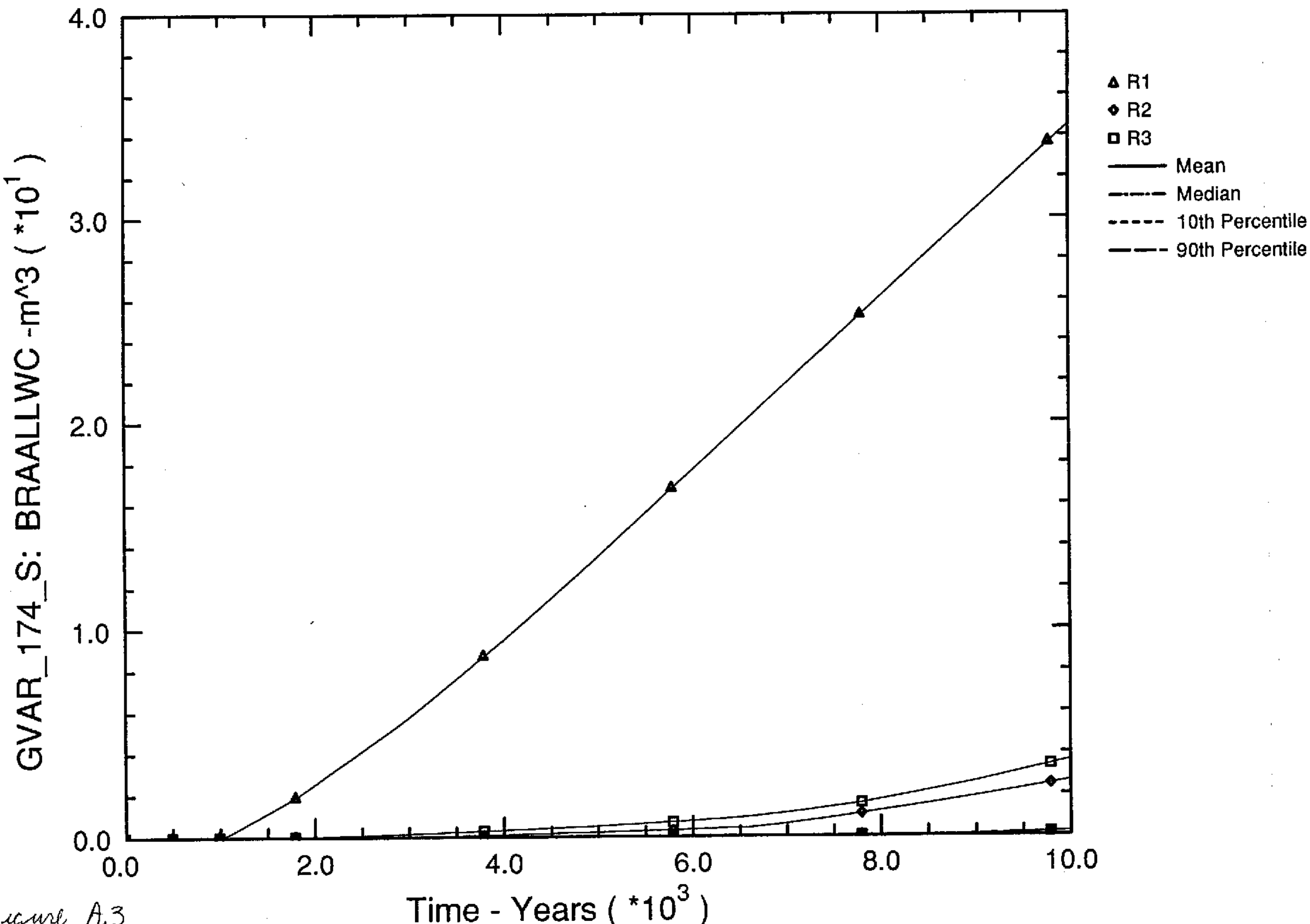


Figure A.3

1DRA1:[JEBEAN.C97.SUMMZ.STATS.S1]SPLAT_ST_S1_H174.INP;1

SPLAT_PA96_2 1.02 07/02/97 14:22:42

61

SNL WIPP C97: BF STATISTICAL SUMMARY (C97 Scenario 1)

Total Gas Volume Generated

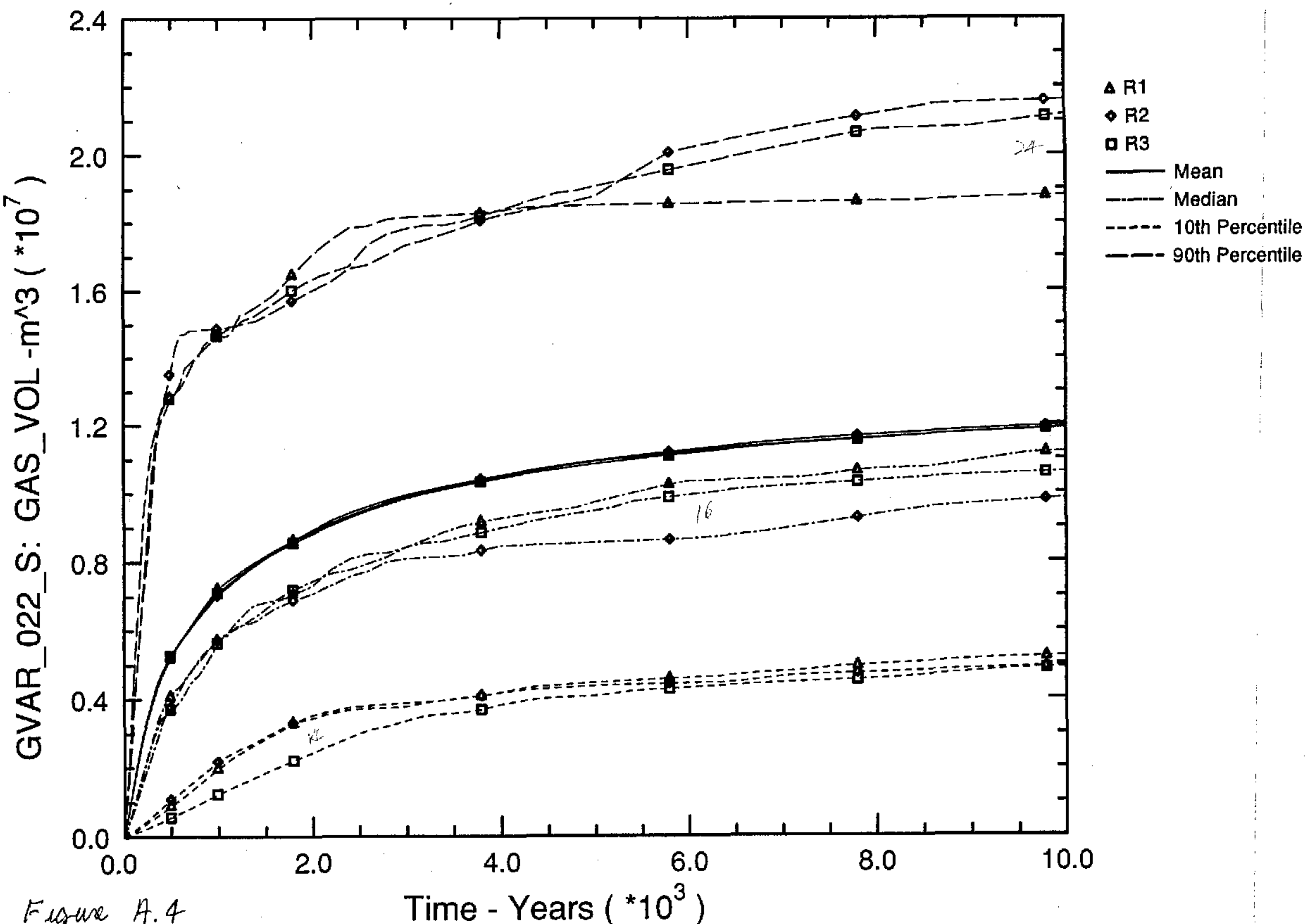


Figure A.4

1DRA1:[JEBEAN.C97.SUMMZ.STATS.S1]SPLAT_ST_S1_H022.INP;1

SPLAT_PA96_2 1.02 07/02/97 14:12:41

SNL WIPP C97: BF STATISTICAL SUMMARY (C97 Scenario 1)

Cumulative Brine Flow into Repository

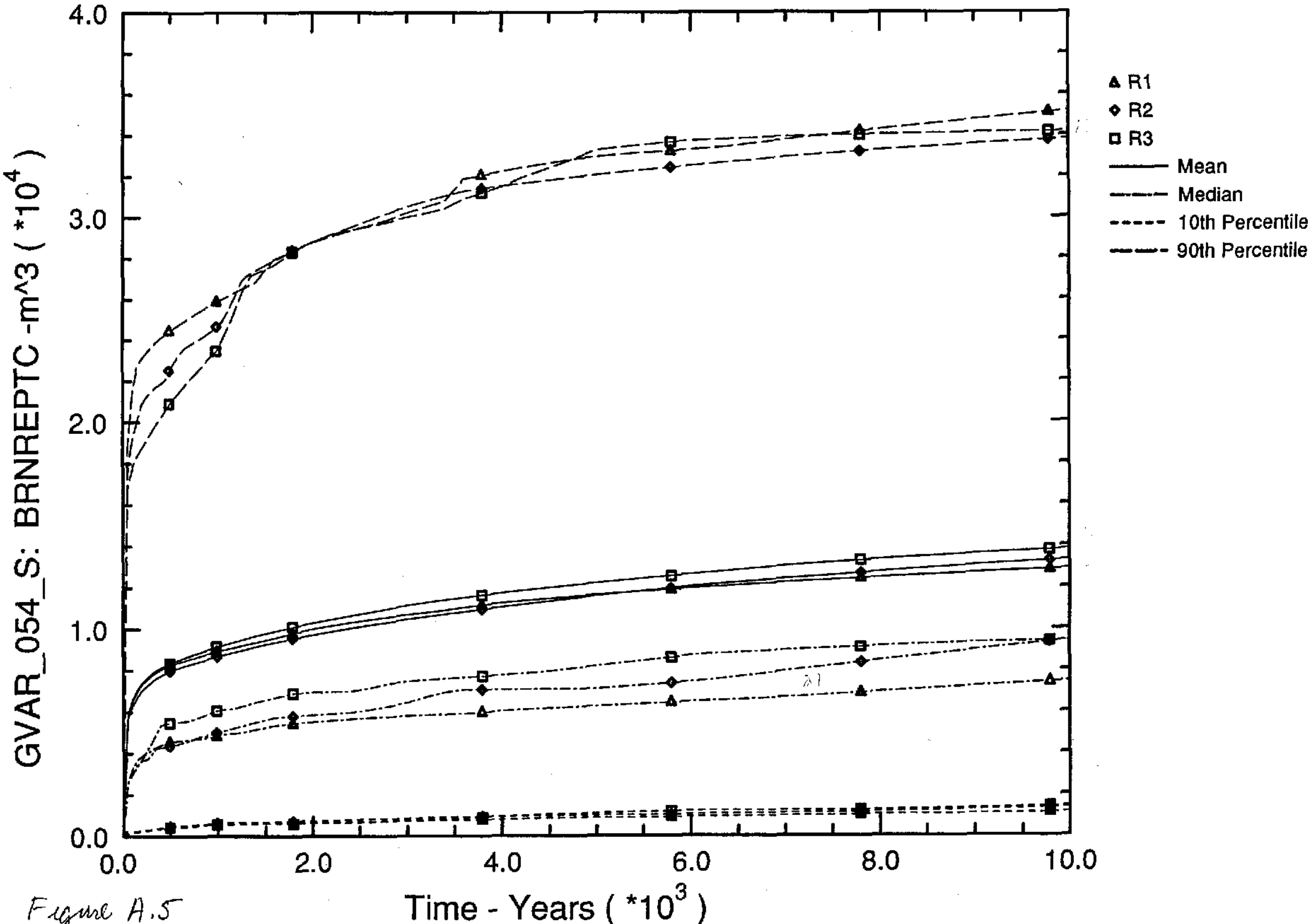


Figure A.5

1DRA1:[JEBEAN.C97.SUMMZ.STATS.S1]SPLAT_ST_S1_H054.INP;1

SPLAT_PA96_2 1.02 07/02/97 14:14:51

SNL WIPP C97: BF STATISTICAL SUMMARY (C97 Scenario 2)

Volume-Averaged Pressure in Waste Panel

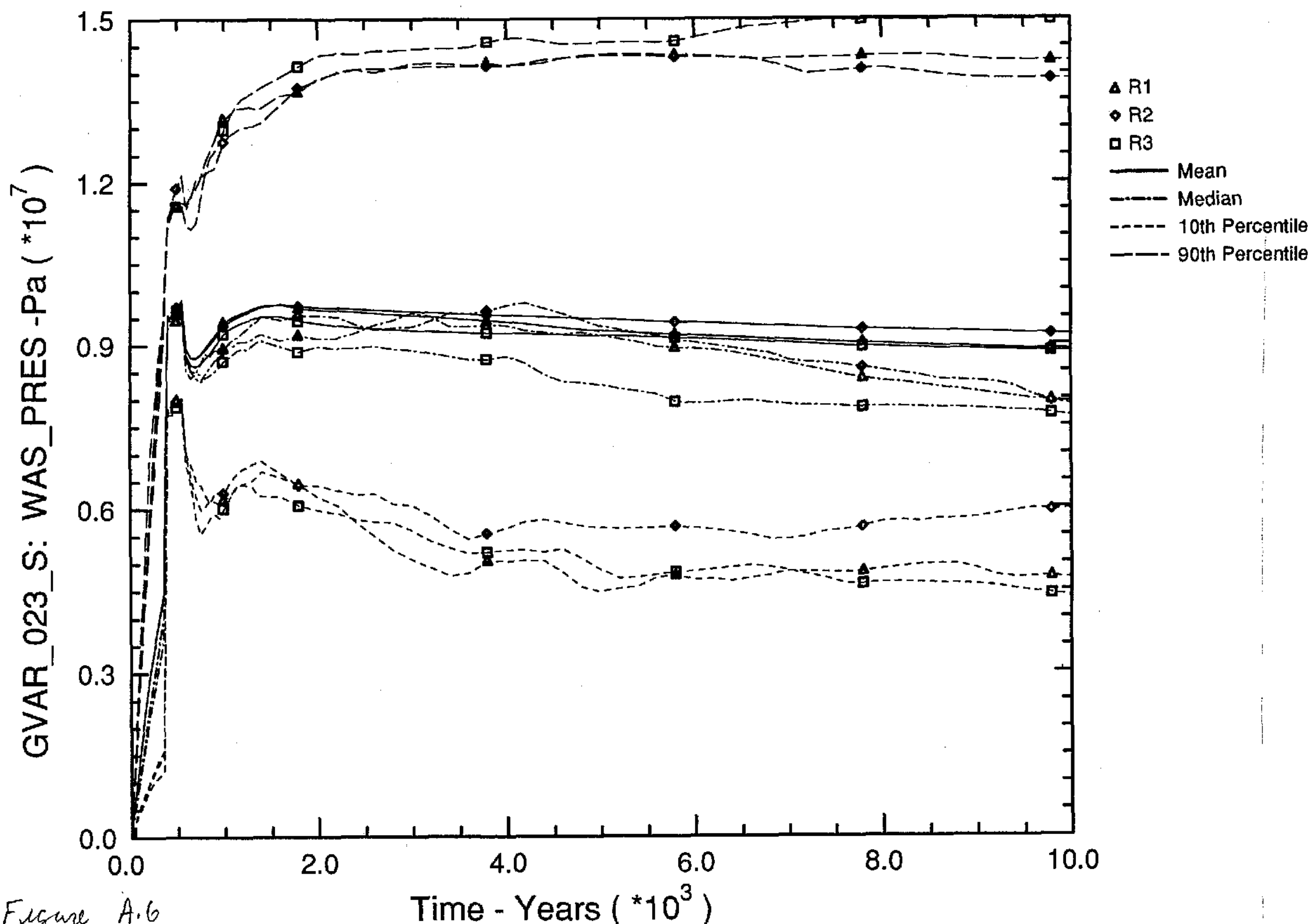


Figure A.6

1DRA1:[JEBEAN.C97.SUMMZ.STATS.S2]SPLAT_ST_S2_H023.INP;1

SPLAT_PA96_2 1.02 07/14/97 14:43:30

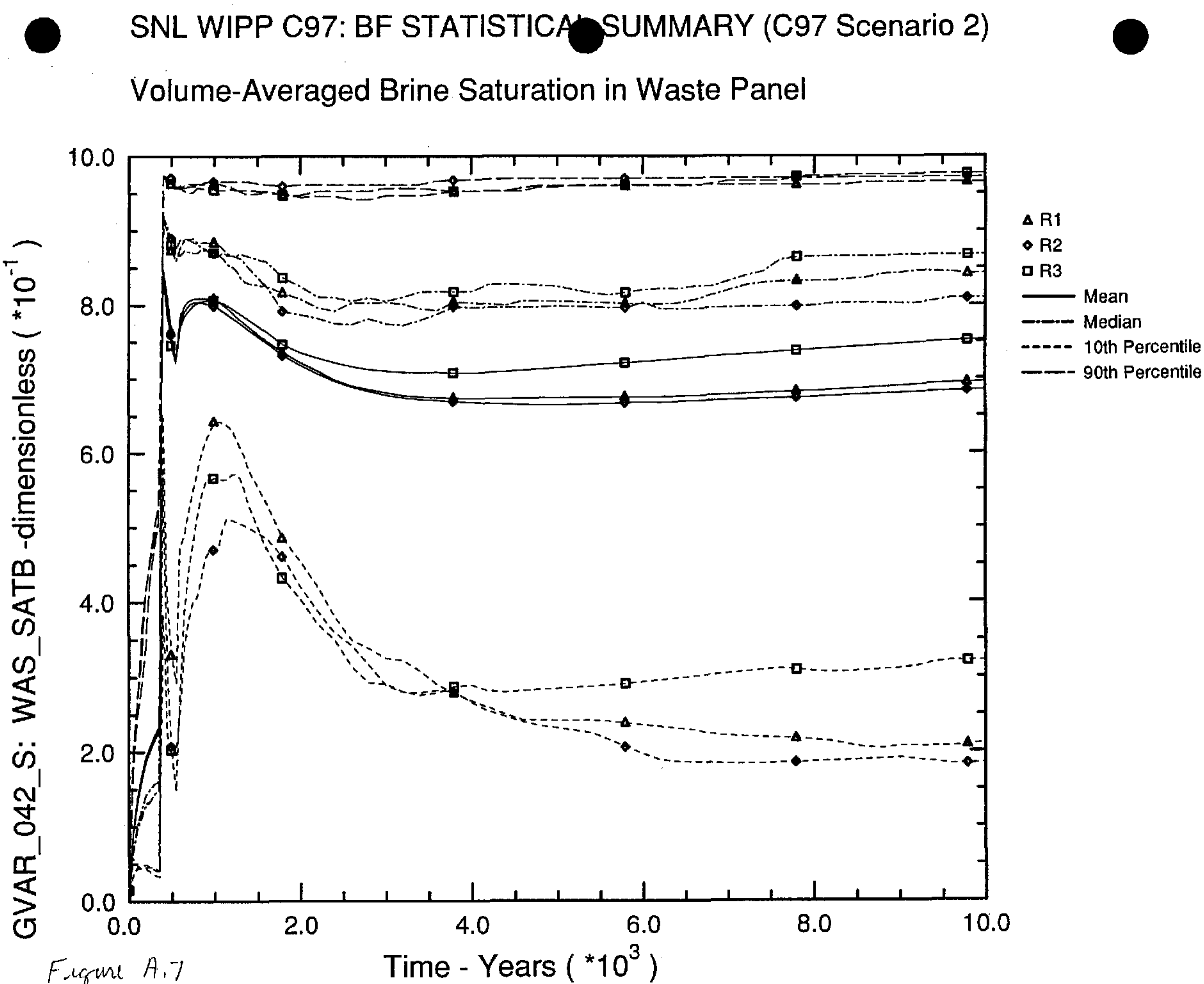


Figure A.7

1DRA1:[JEBEAN.C97.SUMMZ.STATS.S2]SPLAT_ST_S2_H042.INP;1

SPLAT_PA96_2 1.02 07/14/97 14:45:34

SNL WIPP C97: BF STATISTICAL SUMMARY (C97 Scenario 2)

Cumulative Brine Flow up Borehole at Rustler/Culebra Interface (E:713)

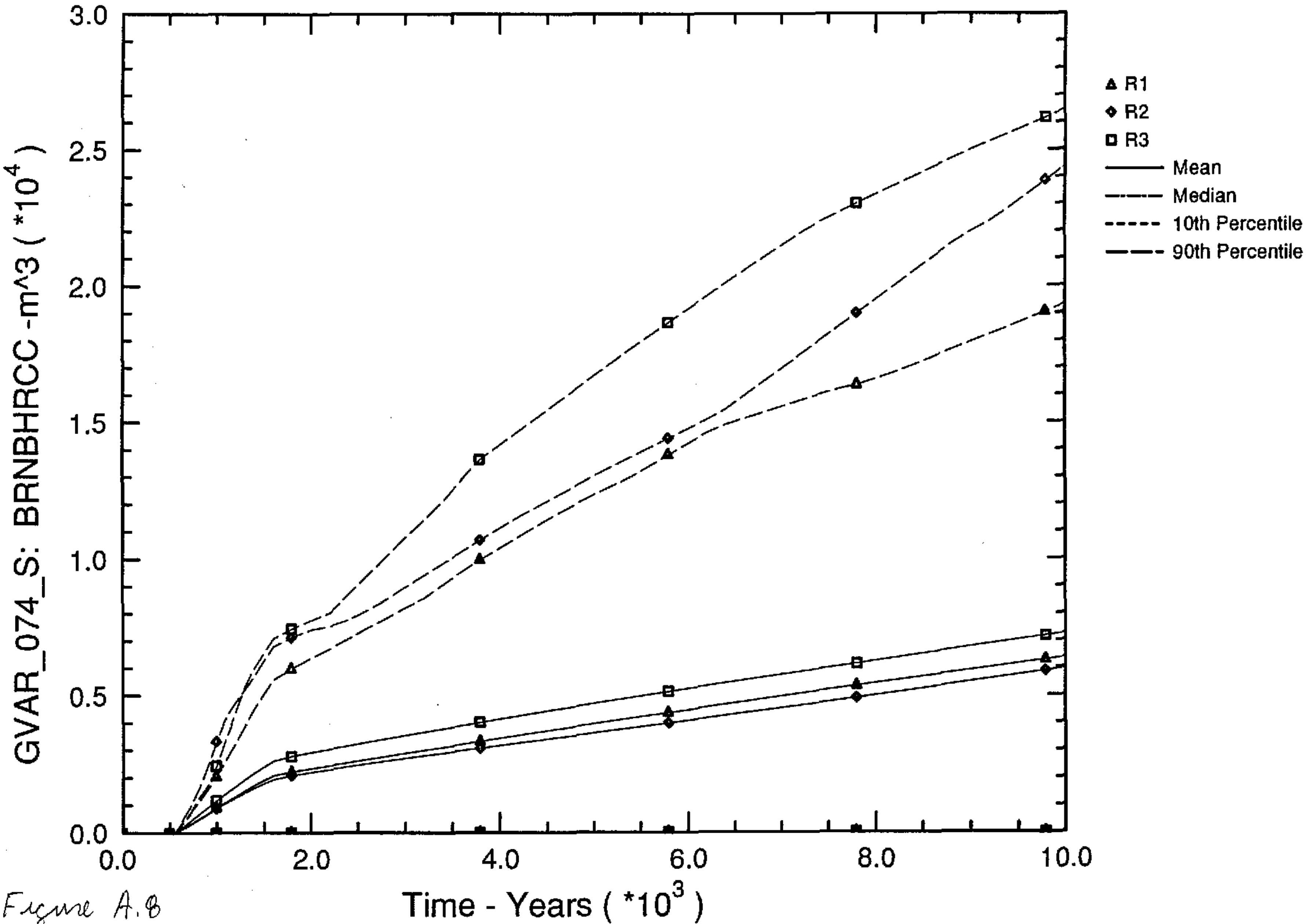


Figure A.8

1DRA1:[JEBEAN.C97.SUMMZ.STATS.S2]SPLAT_ST_S2_H074.INP;1

SPLAT_PA96_2 1.02 07/14/97 14:48:28

SNL WIPP C97: BF STATISTICAL SUMMARY (C97 Scenario 2)

Cumulative Brine Flow up Borehole at Top of Rustler (E:841)

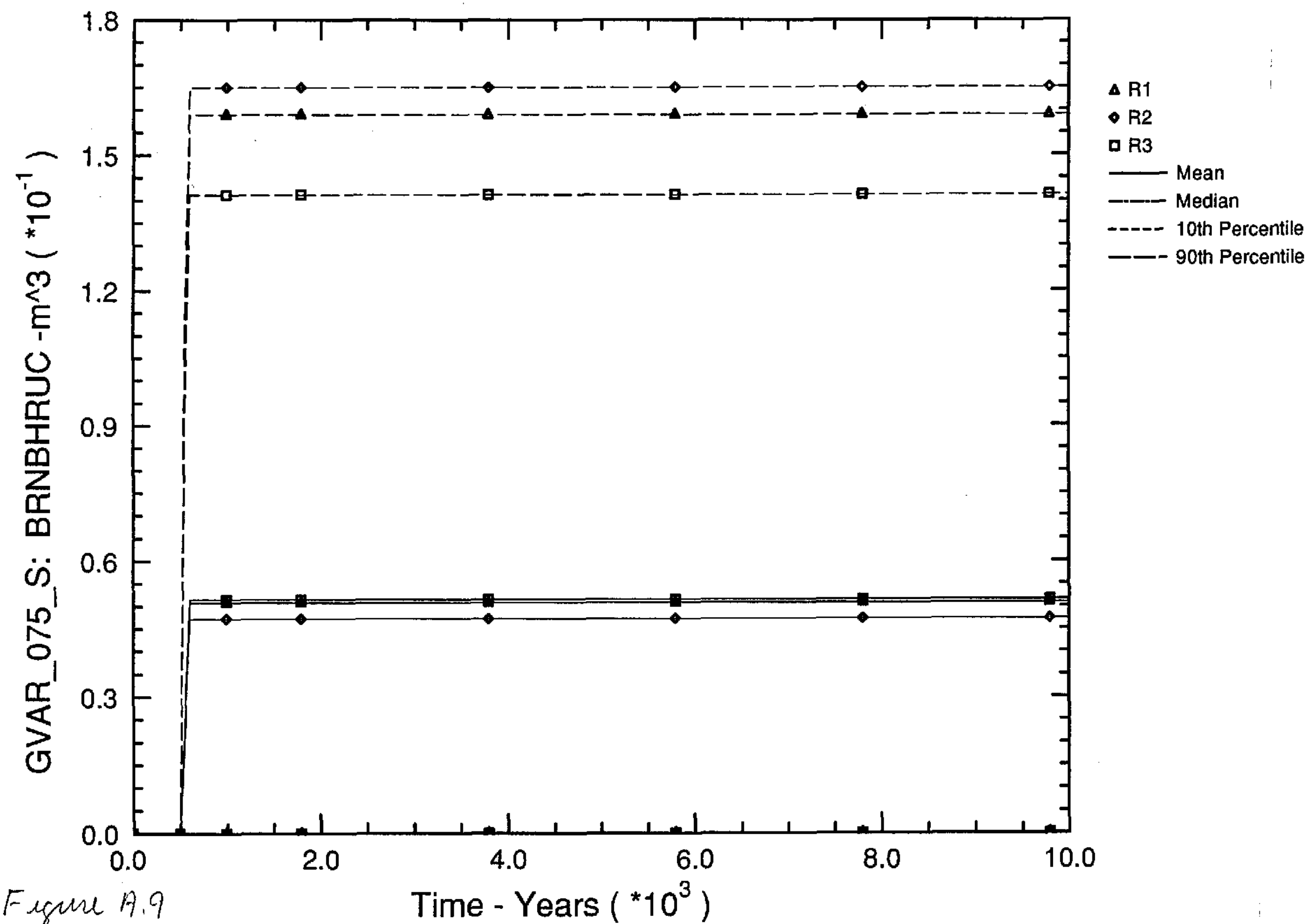


Figure A.9

1DRA1:[JEBEAN.C97.SUMMZ.STATS.S2]SPLAT_ST_S2_H075.INP;1

SPLAT_PA96_2 1.02 07/14/97 14:48:35

SNL WIPP C97: BF STATISTICAL SUMMARY (C97 Scenario 2)

Cumulative Brine Flow Out of All Marker Beds Across Land-Withdrawal Boundary

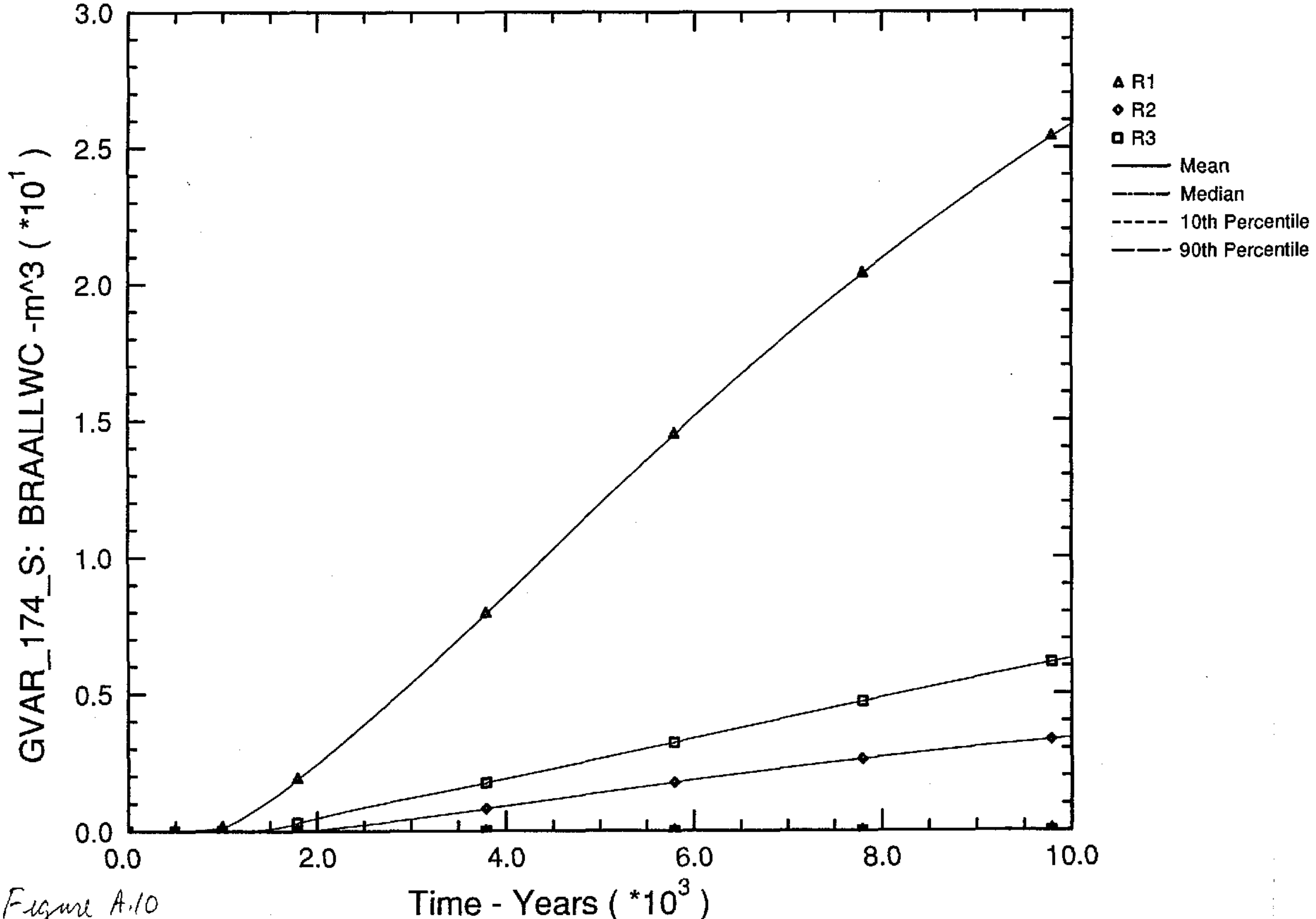


Figure A.10

1DRA1:[JEBEAN.C97.SUMMZ.STATS.S2]SPLAT_ST_S2_H174.INP;1

SPLAT_PA96_2 1.02 07/14/97 14:58:13

SNL WIPP C97: BF STATISTICAL SUMMARY (C97 Scenario 2)

Total Gas Volume Generated

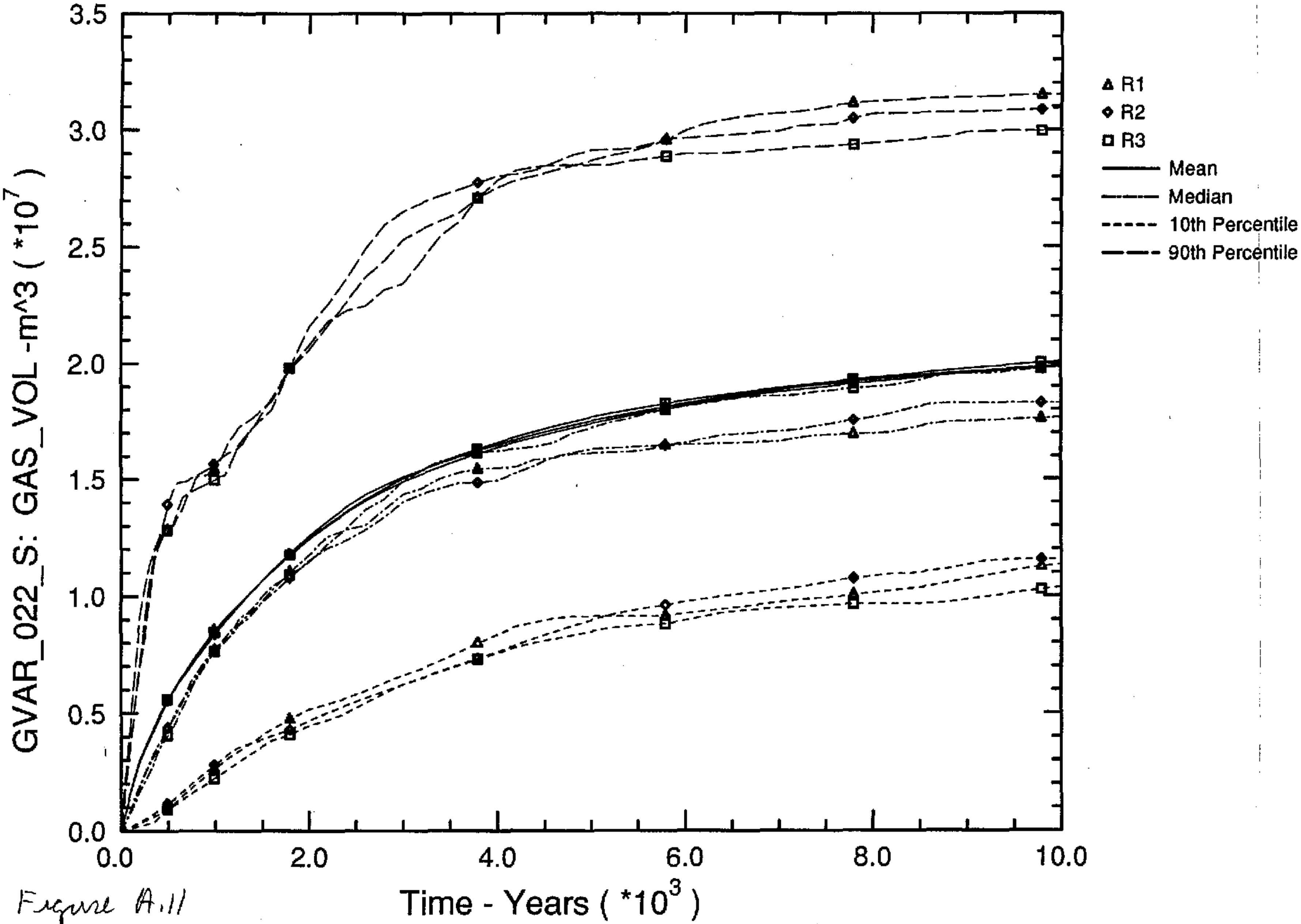


Figure A.11

1DRA1:[JEBEAN.C97.SUMMZ.STATS.S2]SPLAT_ST_S2_H022.INP;1

SPLAT_PA96_2 1.02 07/14/97 14:43:22

SNL WIPP C97: BF STATISTICAL SUMMARY (C97 Scenario 3)

Volume-Averaged Pressure in Waste Panel

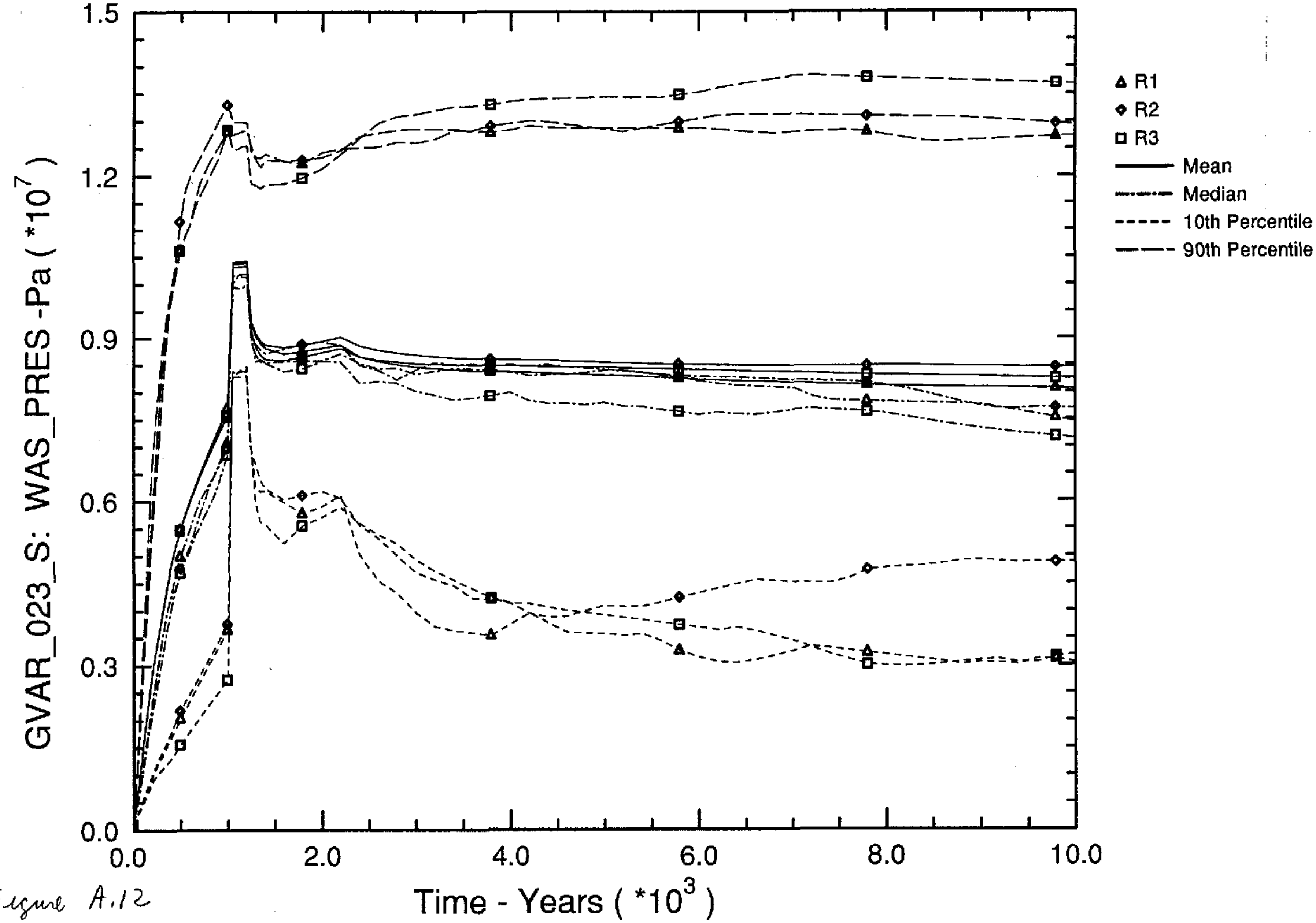


Figure A.12

1DRA1:[JEBEAN.C97.SUMMZ.STATS.S3]SPLAT_ST_S3_H023.INP;1

SPLAT_PA96_2 1.02 07/02/97 15:50:01

SNL WIPP C97: BF STATISTICAL SUMMARY (C97 Scenario 3)

Volume-Averaged Brine Saturation in Waste Panel

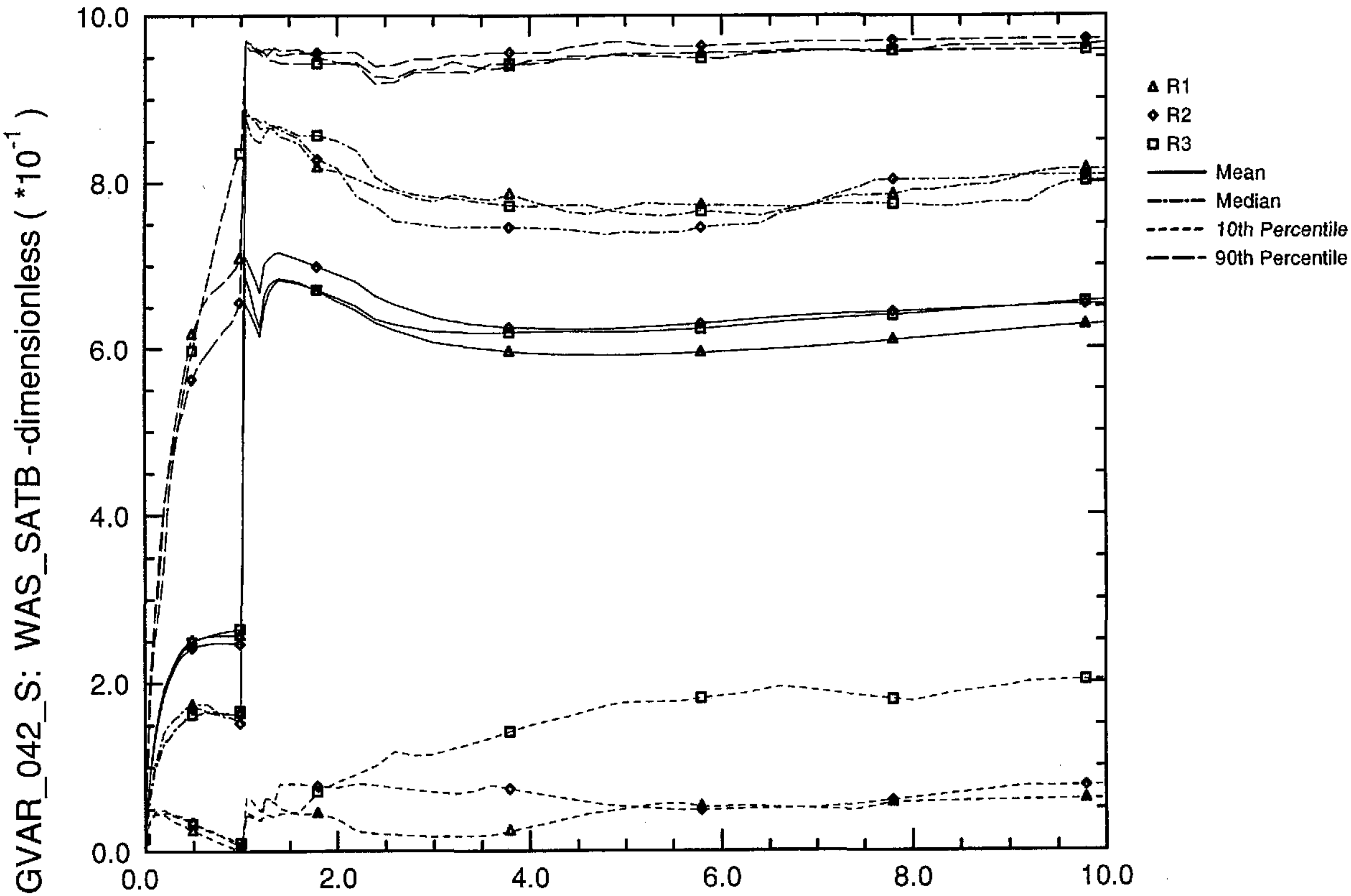


Figure A.13

1DRA1:[JEBEAN.C97.SUMMZ.STATS.S3]SPLAT_ST_S3_H042.INP;1

SPLAT_PA96_2 1.02 07/02/97 15:51:32

SNL WIPP C97: BF STATISTICAL SUMMARY (C97 Scenario 3)

Cumulative Brine Flow up Borehole at Rustler/Culebra Interface (E:713)

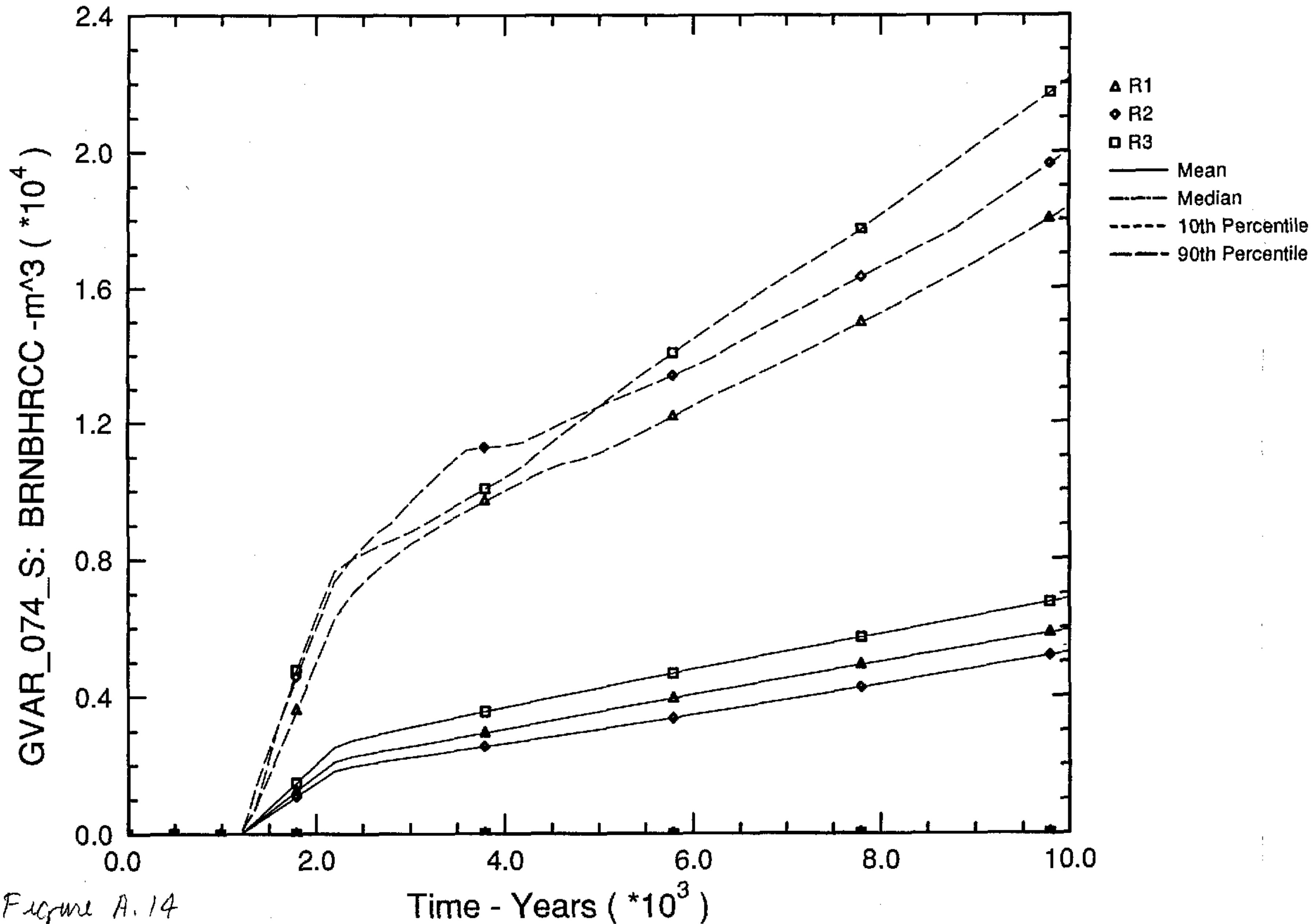


Figure A.14

1DRA1:[JEBEAN.C97.SUMMZ.STATS.S3]SPLAT_ST_S3_H074.INP;1

SPLAT_PA96_2 1.02 07/02/97 15:54:07

SNL WIPP C97: BF STATISTICAL SUMMARY (C97 Scenario 3)

Cumulative Brine Flow up Borehole at Top of Rustler (E:841)

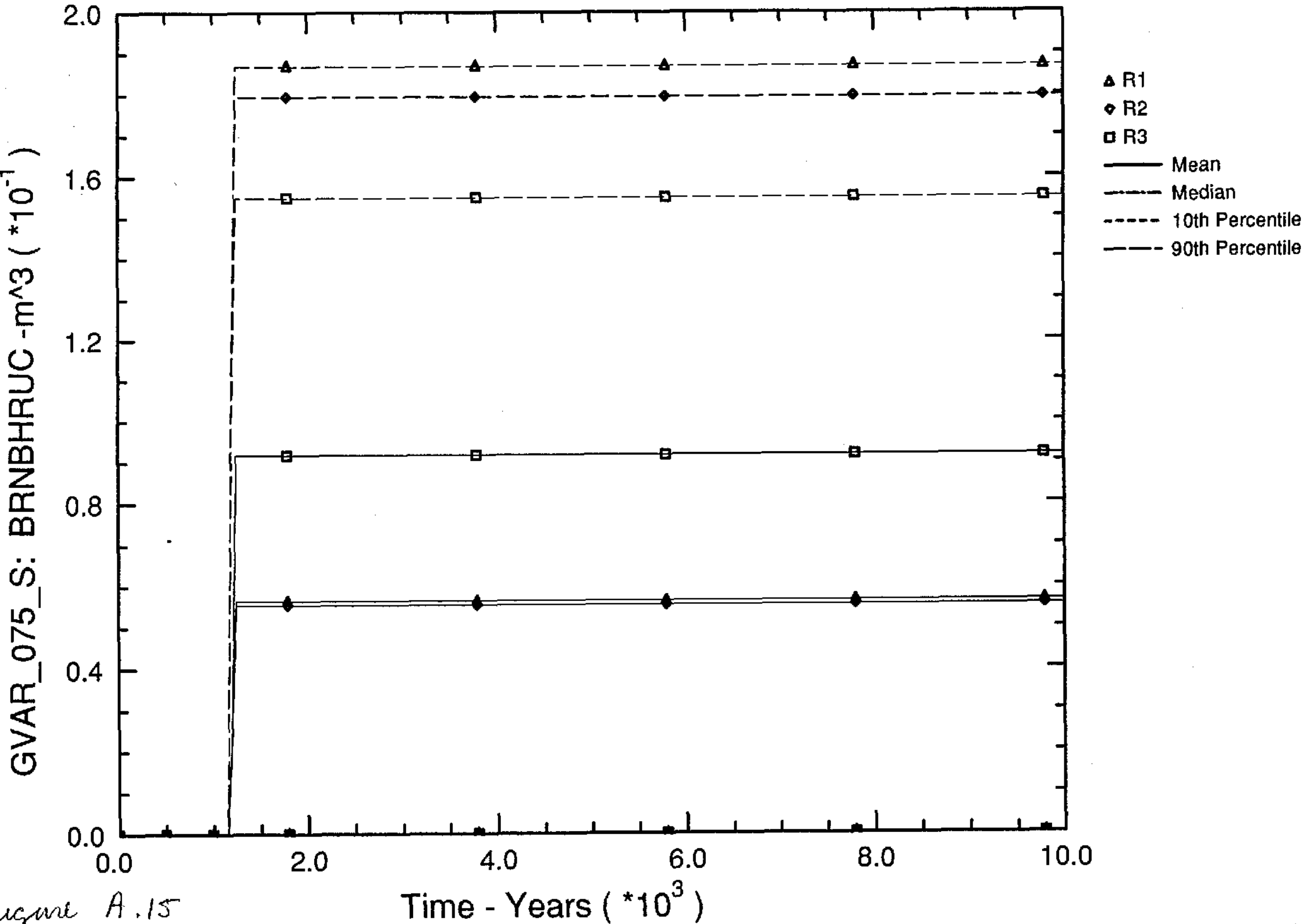


Figure A.15

1DRA1:[JEBEAN.C97.SUMMZ.STATS.S3]SPLAT_ST_S3_H075.INP;1

SPLAT_PA96_2 1.02 07/02/97 15:54:11

73

SNL WIPP C97: BF STATISTICAL SUMMARY (C97 Scenario 3)

Cumulative Brine Flow Out of All Marker Beds Across Land-Withdrawal Boundary

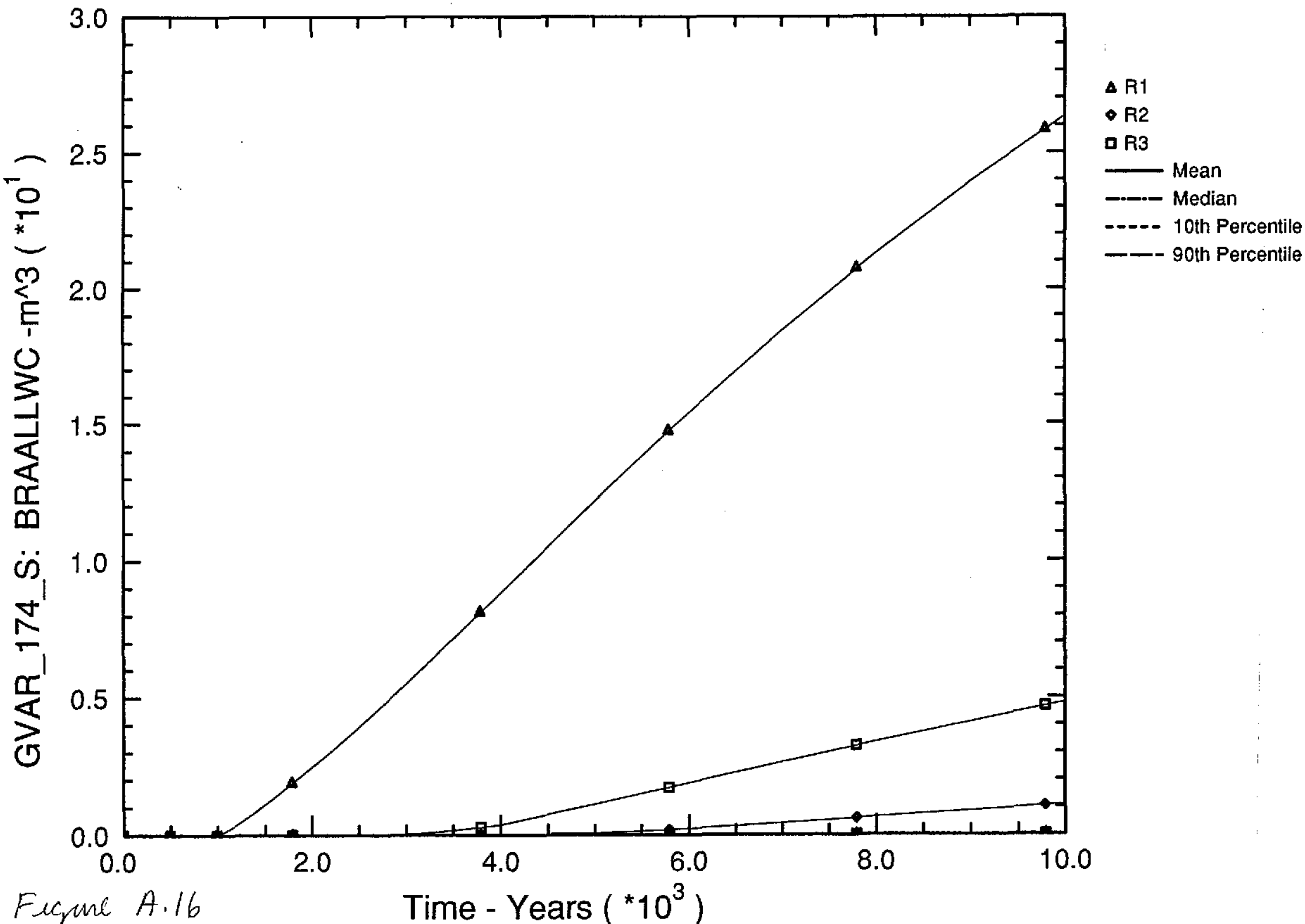


Figure A.16

1DRA1:[JEBEAN.C97.SUMMZ.STATS.S3]SPLAT_ST_S3_H174.INP;1

SPLAT_PA96_2 1.02 07/02/97 16:01:39

SNL WIPP C97: BF STATISTICAL SUMMARY (C97 Scenario 3)

Total Gas Volume Generated

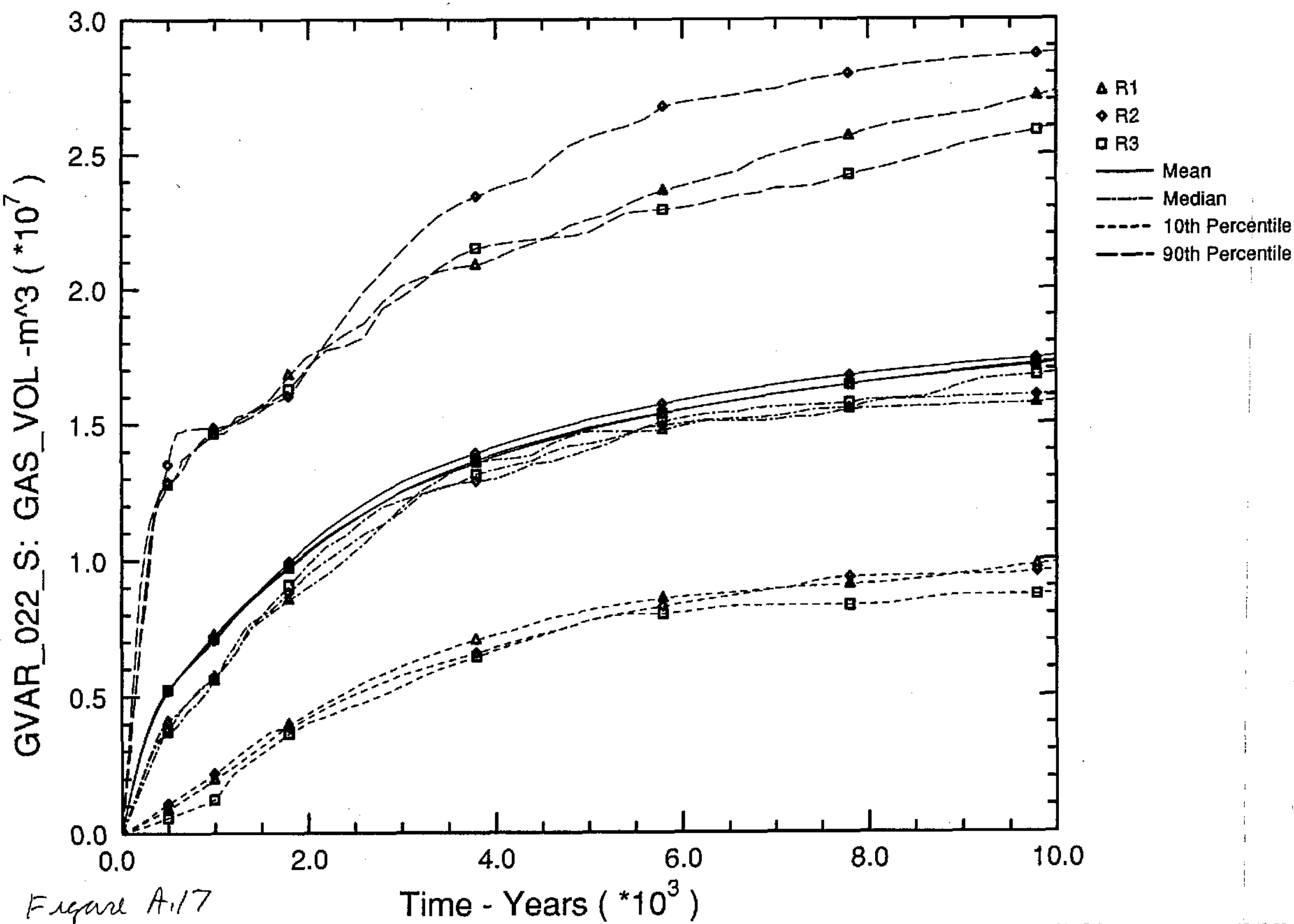


Figure A.17

1DRA1:[JEBEAN.C97.SUMMZ.STATS.S3]SPLAT_ST_S3_H022.INP;1

SPLAT_PA96_2 1.02 07/02/97 15:49:56

SNL WIPP C97: BF STATISTICAL SUMMARY (C97 Scenario 4)

Volume-Averaged Pressure in Waste Panel

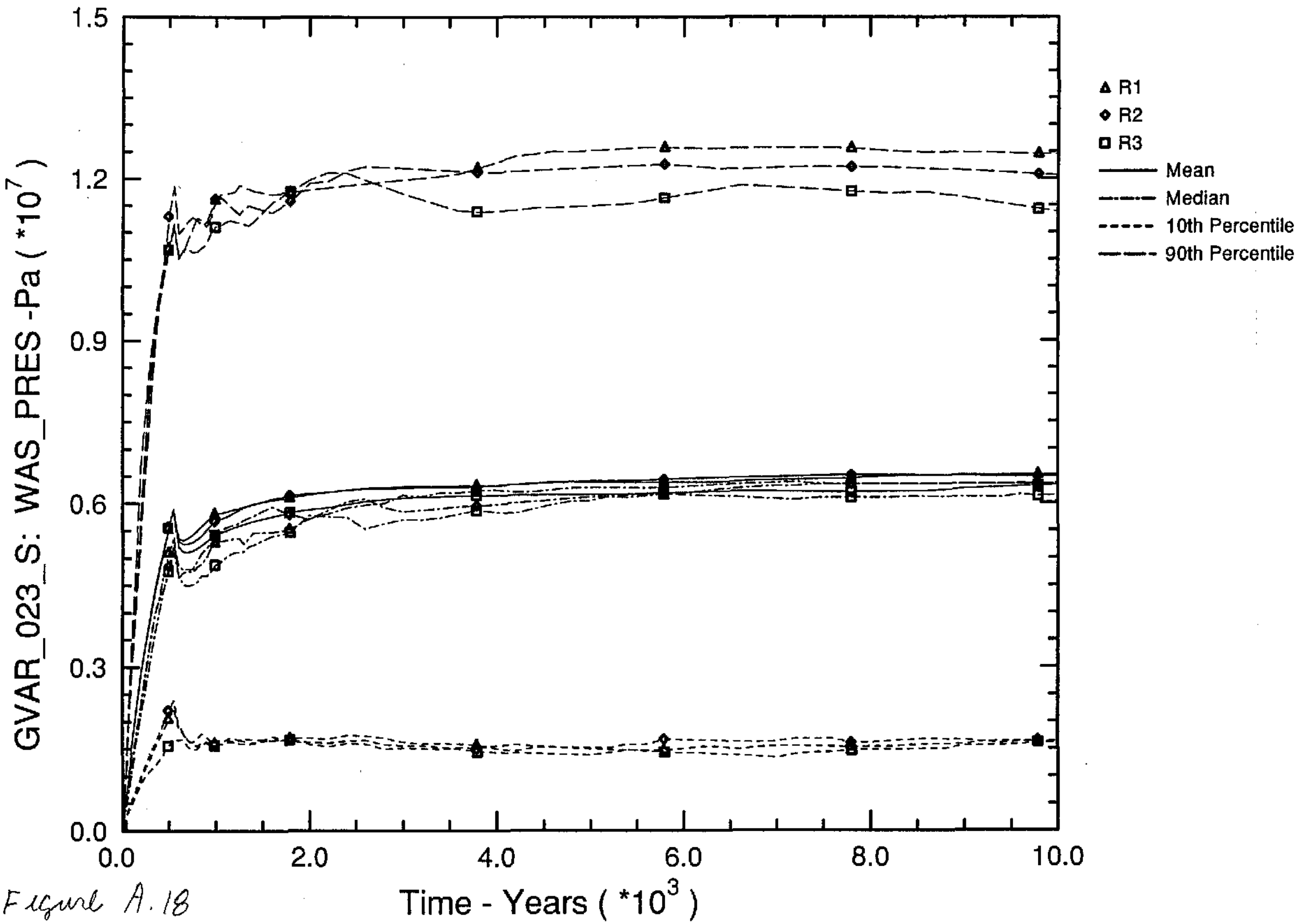


Figure A.18

1DRA1:[JEBEAN.C97.SUMMZ.STATS.S4]SPLAT_ST_S4_H023.INP;1

SPLAT_PA96_2 1.02 07/02/97 16:08:07

SNL WIPP C97: BF STATISTICAL SUMMARY (C97 Scenario 4)

Volume-Averaged Brine Saturation in Waste Panel

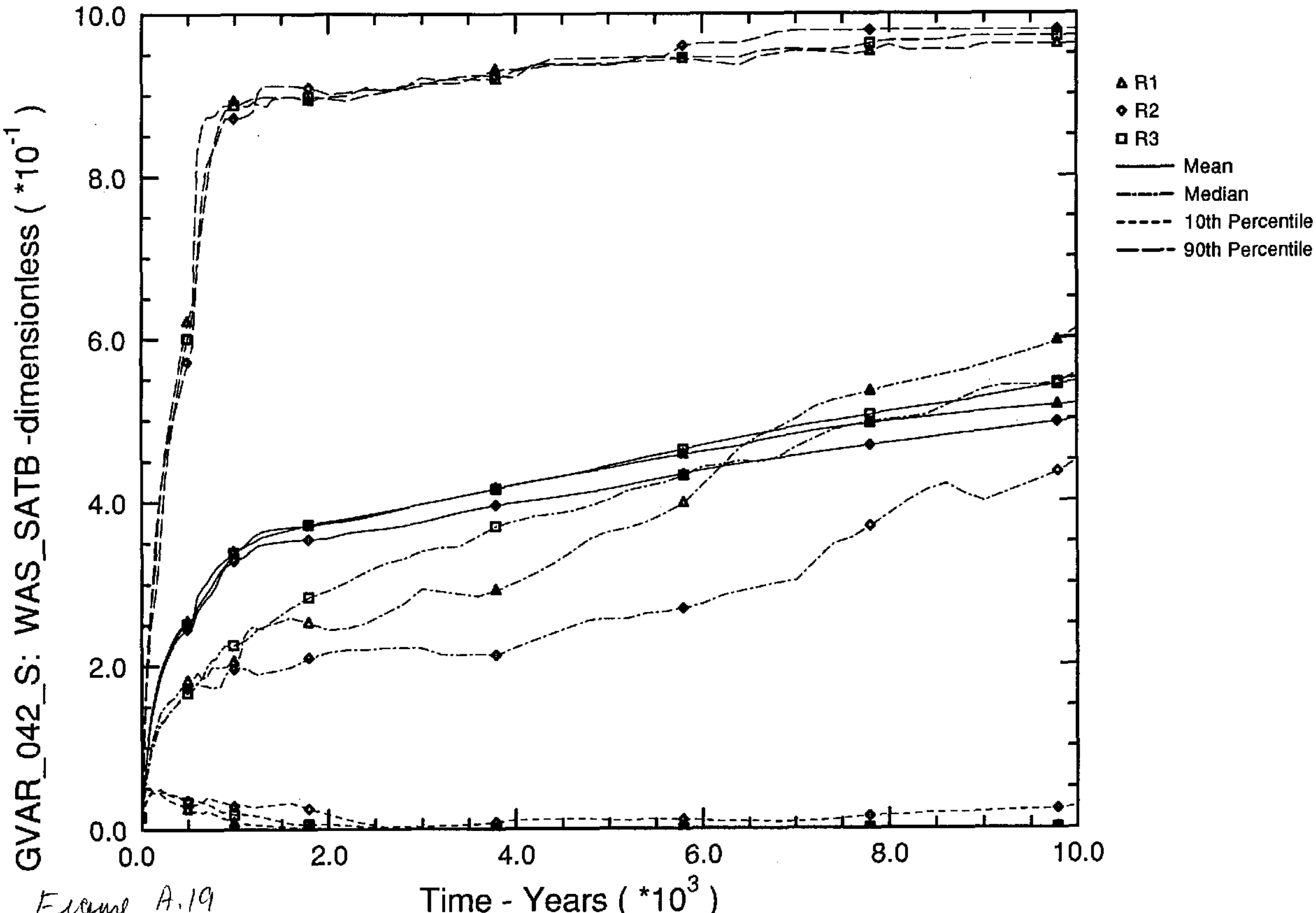


Figure A.19

1DRA1:[JEBEAN.C97.SUMMZ.STATS.S4]SPLAT_ST_S4_H042.INP;1

SPLAT_PA96_2 1.02 07/02/97 16:09:22

SNL WIPP C97: BF STATISTICAL SUMMARY (C97 Scenario 4)

Cumulative Brine Flow up Borehole at Rustler/Culebra Interface (E:713)

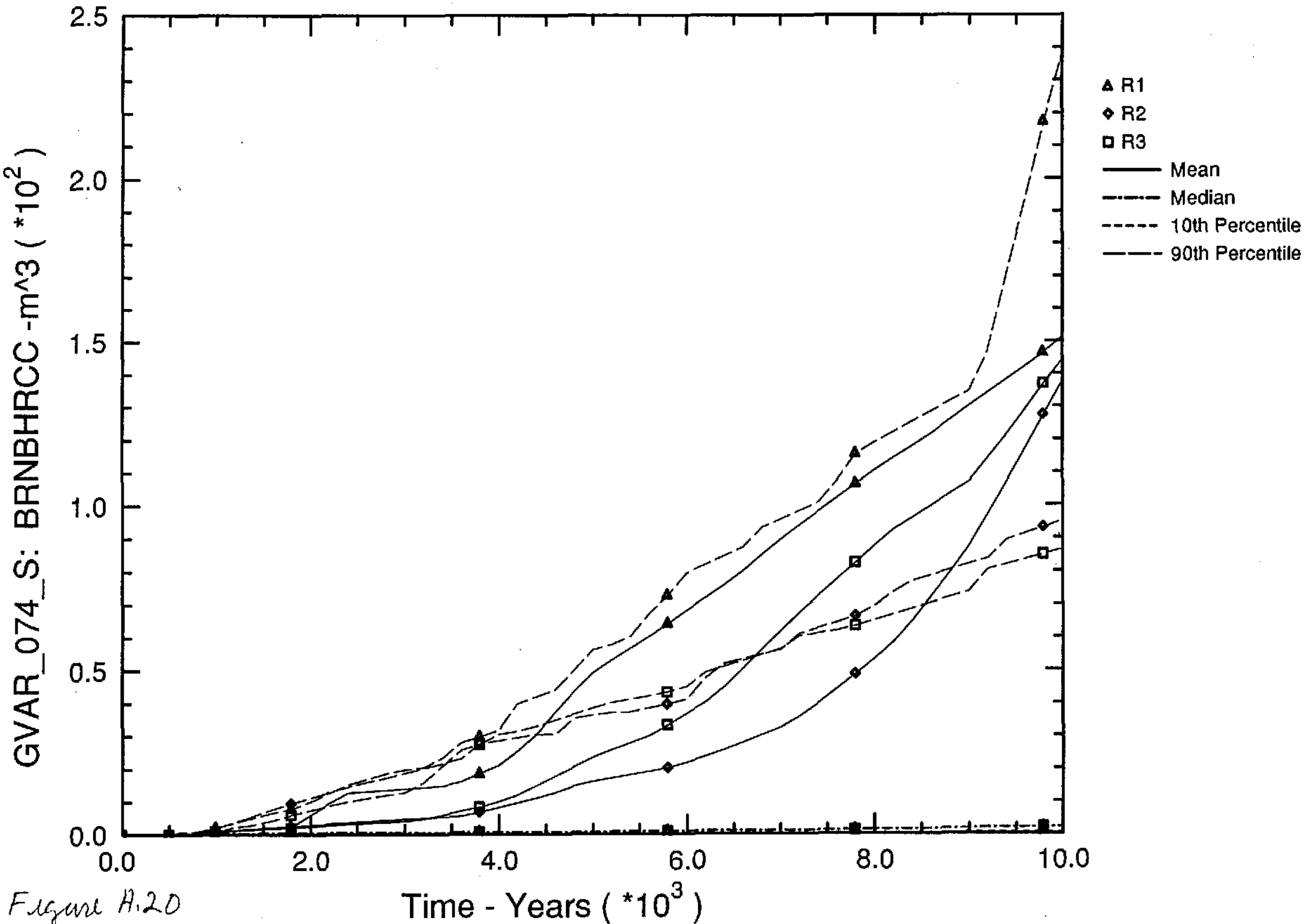


Figure A.20

1DRA1:[JEBEAN.C97.SUMMZ.STATS.S4]SPLAT_ST_S4_H074.INP;1

SPLAT_PA96_2 1.02 07/02/97 16:18:54

SNL WIPP C97: BF STATISTICAL SUMMARY (C97 Scenario 4)

Cumulative Brine Flow up Borehole at Top of Rustler (E:841)

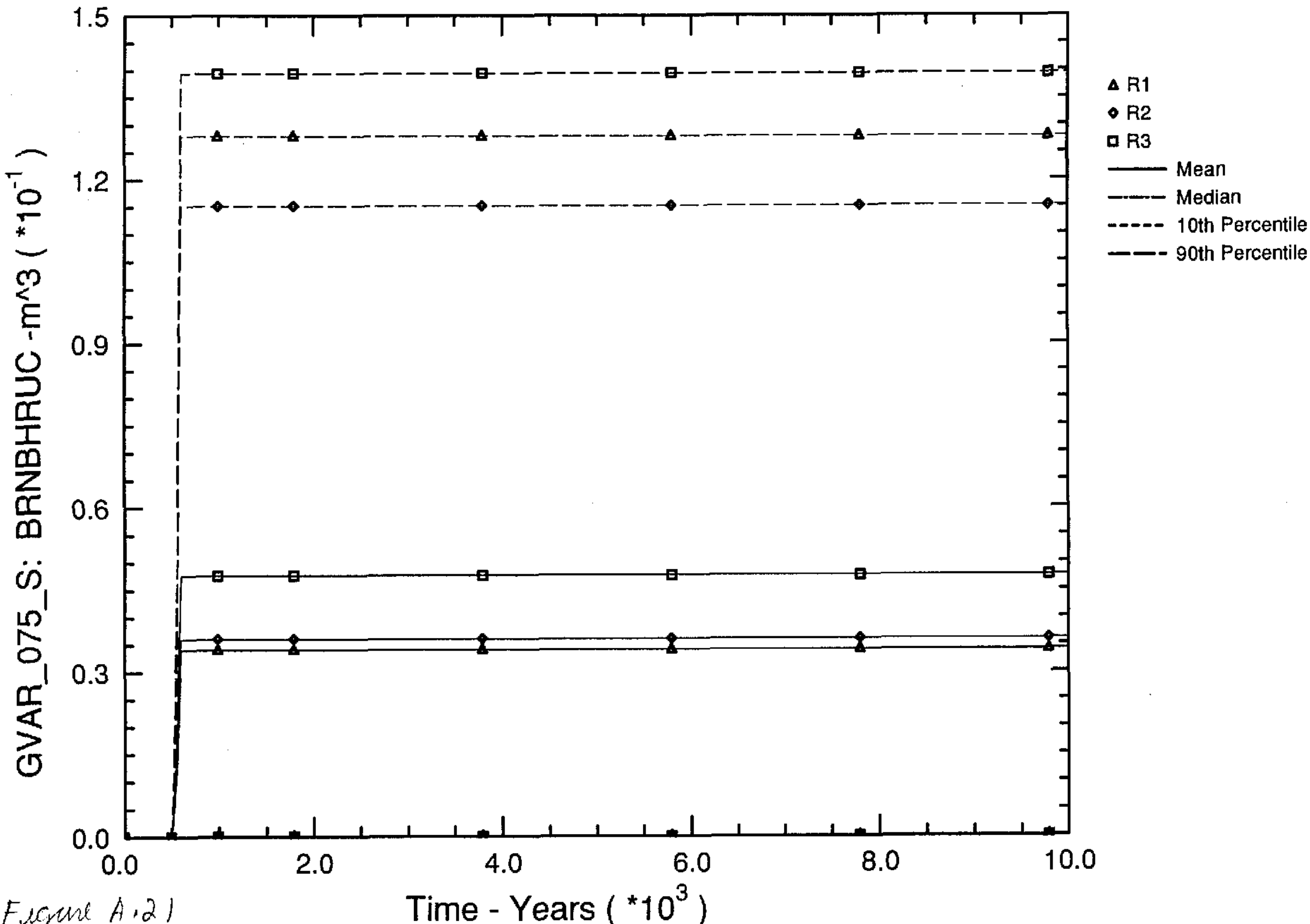


Figure A.21

1DRA1:[JEBEAN.C97.SUMMZ.STATS.S4]SPLAT_ST_S4_H075.INP;1

SPLAT_PA96_2 1.02 07/02/97 16:19:02

SNL WIPP C97: BF STATISTICAL SUMMARY (C97 Scenario 4)

Cumulative Brine Flow Out of All Marker Beds Across Land-Withdrawal Boundary

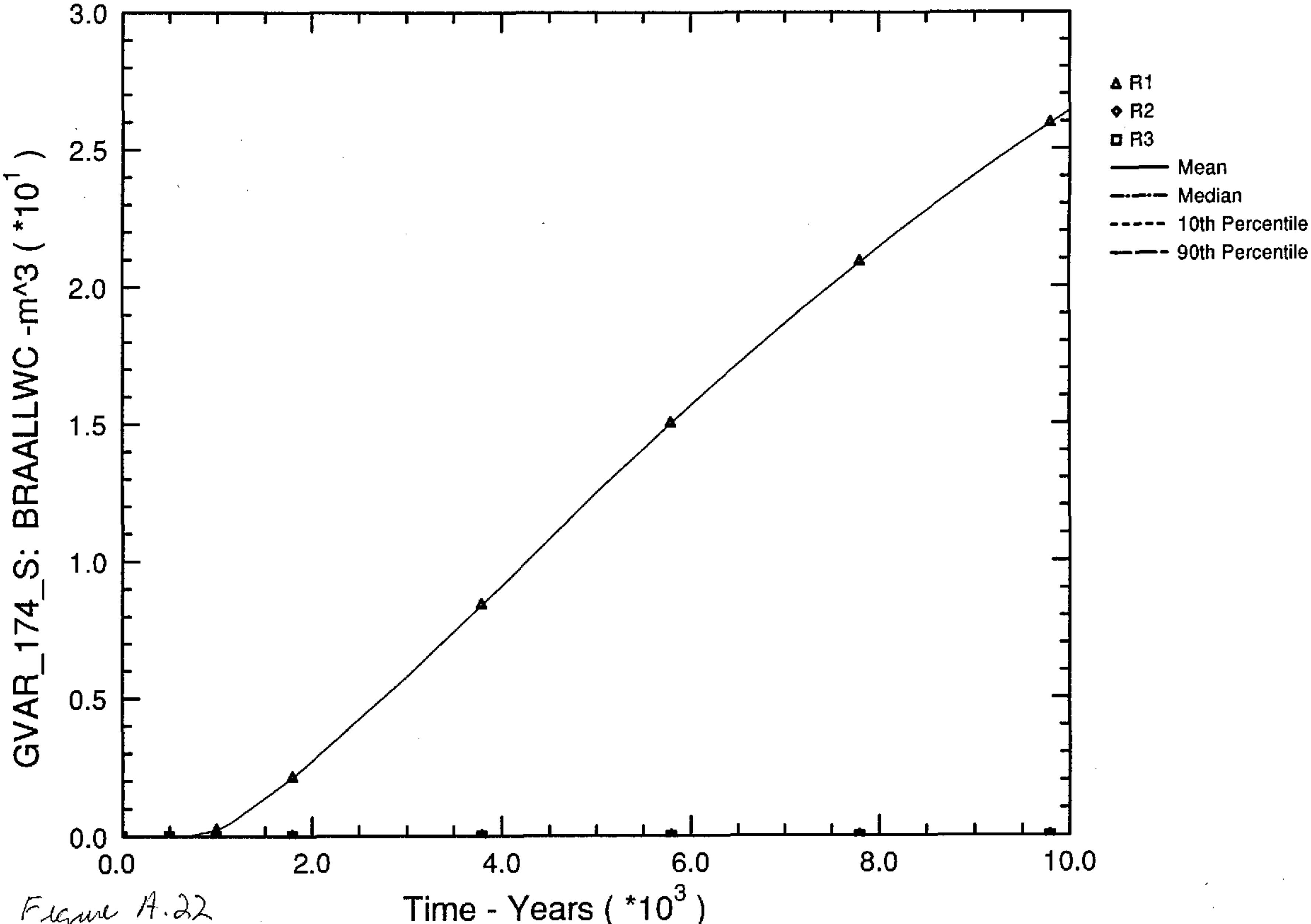


Figure A.22

1DRA1:[JEBEAN.C97.SUMMZ.STATS.S4]SPLAT_ST_S4_H174.INP;1

SPLAT_PA96_2 1.02 07/02/97 16:27:15

SNL WIPP C97: BF STATISTICAL SUMMARY (C97 Scenario 4)

Total Gas Volume Generated

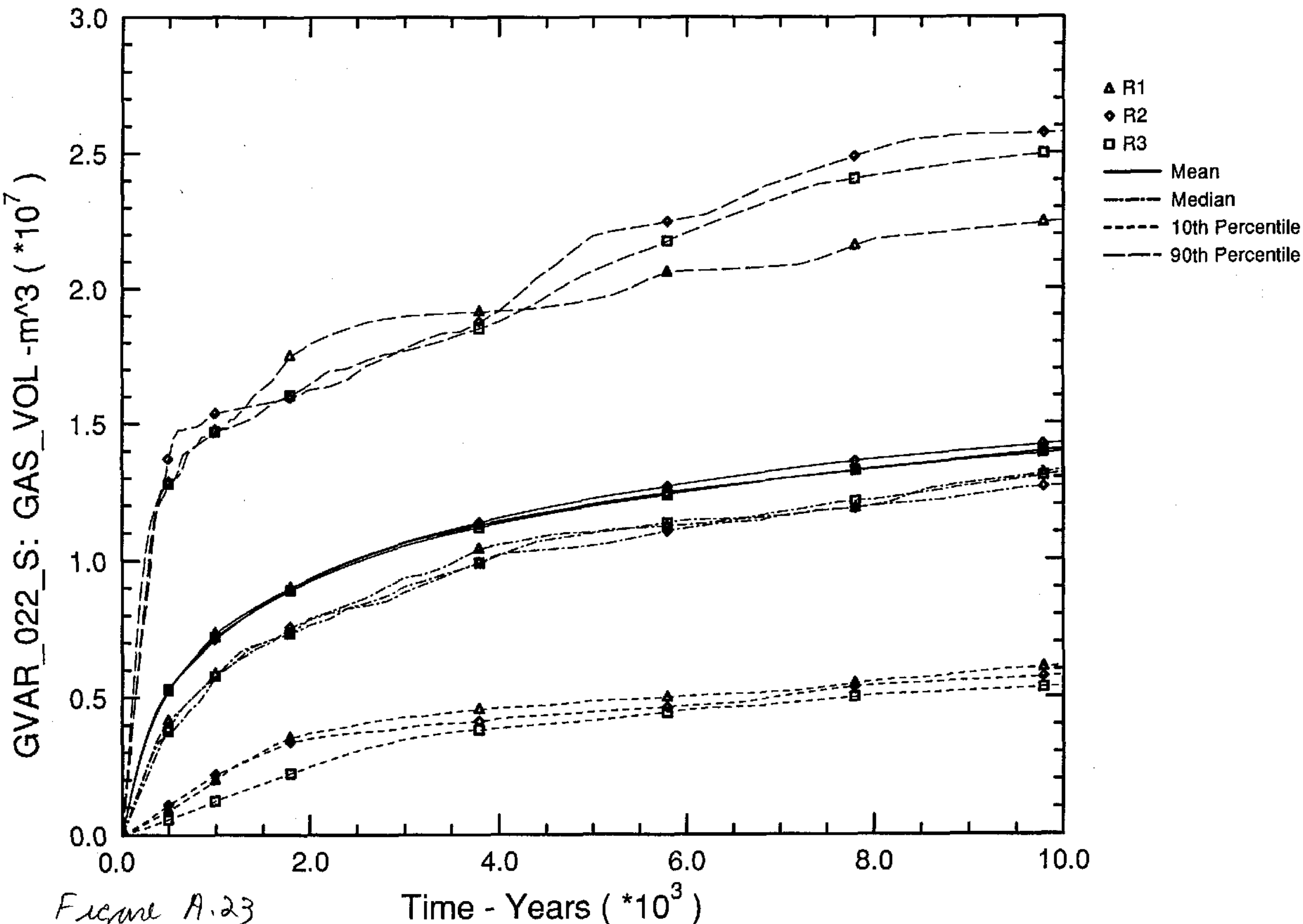


Figure A.23

1DRA1:[JEBEAN.C97.SUMMZ.STATS.S4]SPLAT_ST_S4_H022.INP;1

SPLAT_PA96_2 1.02 07/02/97 16:08:03

SNL WIPP C97: BF STATISTICAL SUMMARY (C97 Scenario 5)

Volume-Averaged Pressure in Waste Panel

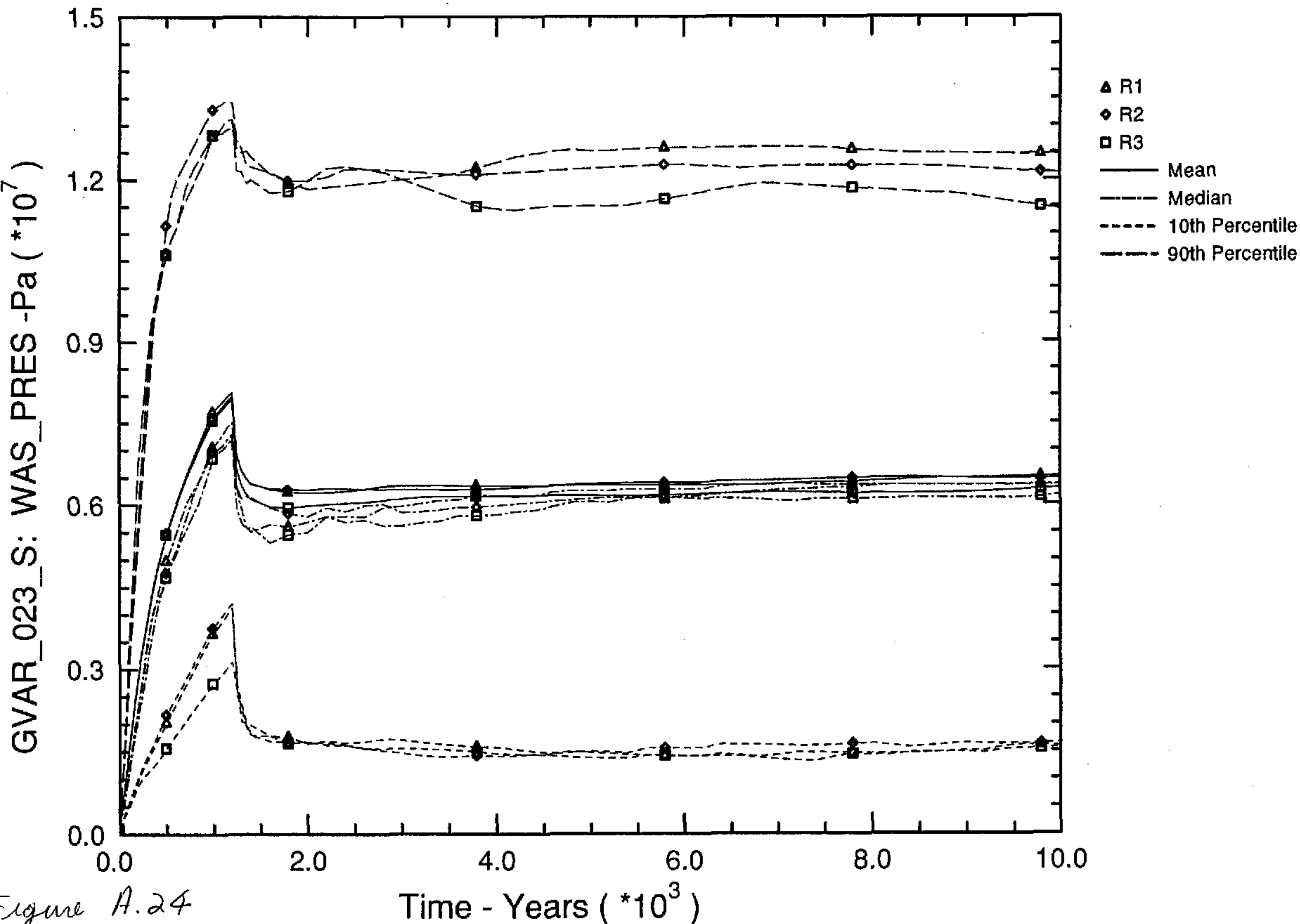


Figure A.24

1DRA1:[JEBEAN.C97.SUMMZ.STATS.S5]SPLAT_ST_S5_H023.INP;1

07/02/97 17:11:17

SNL WIPP C97: BF STATISTICAL SUMMARY (C97 Scenario 5)

Volume-Averaged Brine Saturation in Waste Panel

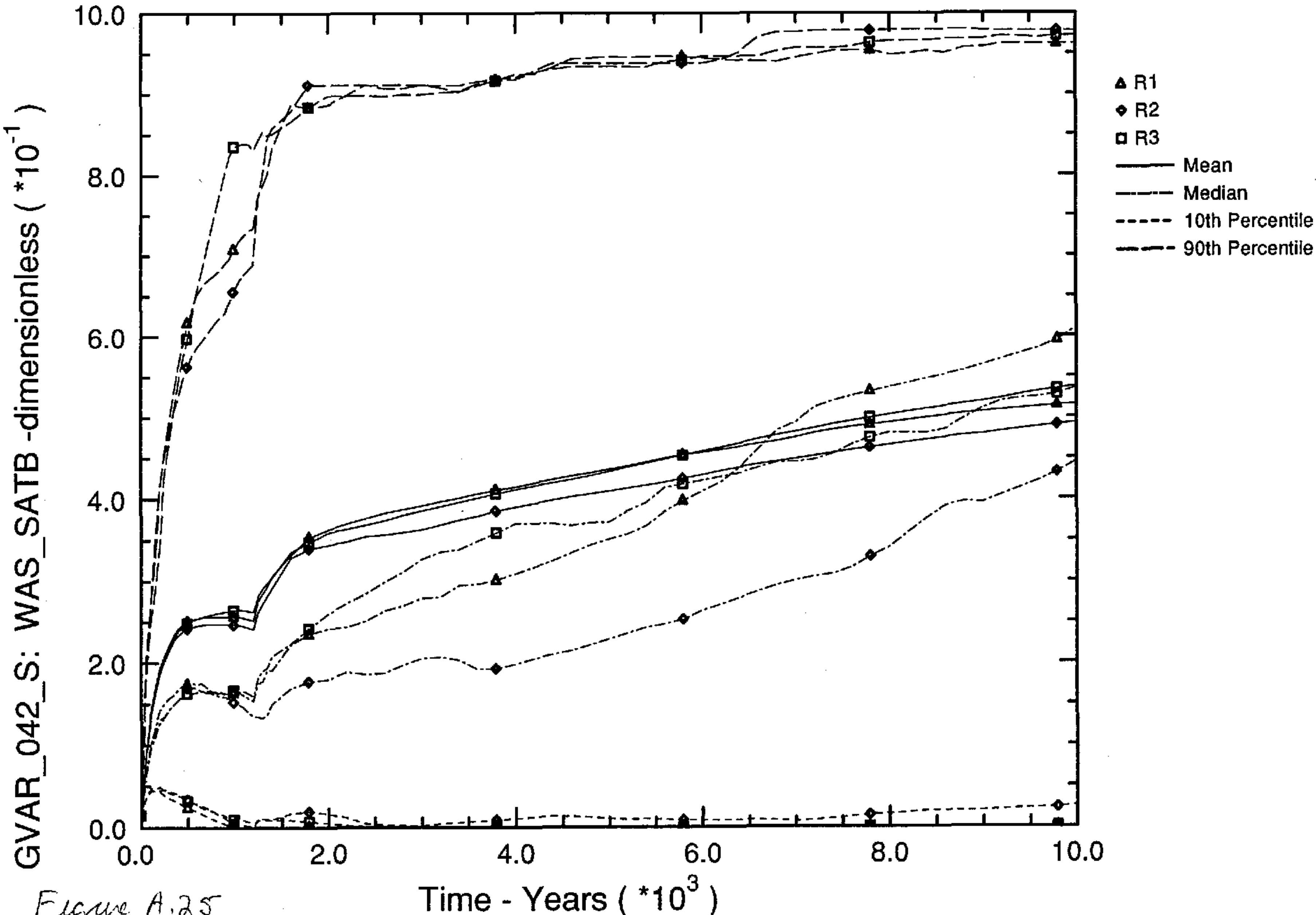


Figure A.25

1DRA1:[JEBEAN.C97.SUMMZ.STATS.S5]SPLAT_ST_S5_H042.INP;1

SPLAT_PA96_2 1.02 07/02/97 17:12:35

SNL WIPP C97: BF STATISTICAL SUMMARY (C97 Scenario 5)

Cumulative Brine Flow up Borehole at Rustler/Culebra Interface (E:713)

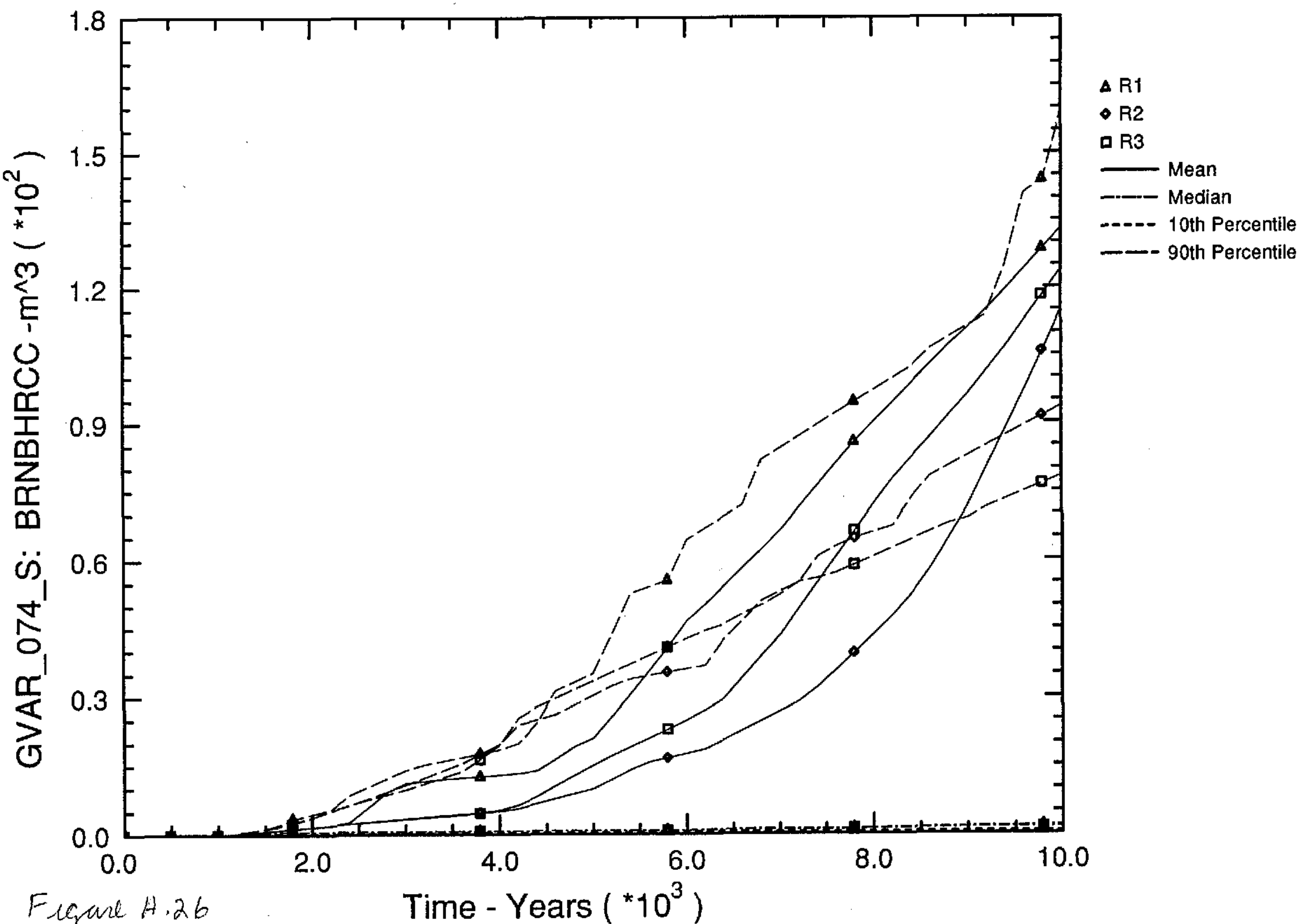


Figure H.26

1DRA1:[JEBEAN.C97.SUMMZ.STATS.S5]SPLAT_ST_S5_H074.INP;1

SPLAT_PA96_2 1.02 07/02/97 17:14:36

SNL WIPP C97: BF STATISTICAL SUMMARY (C97 Scenario 5)

Cumulative Brine Flow up Borehole at Top of Rustler (E:841)

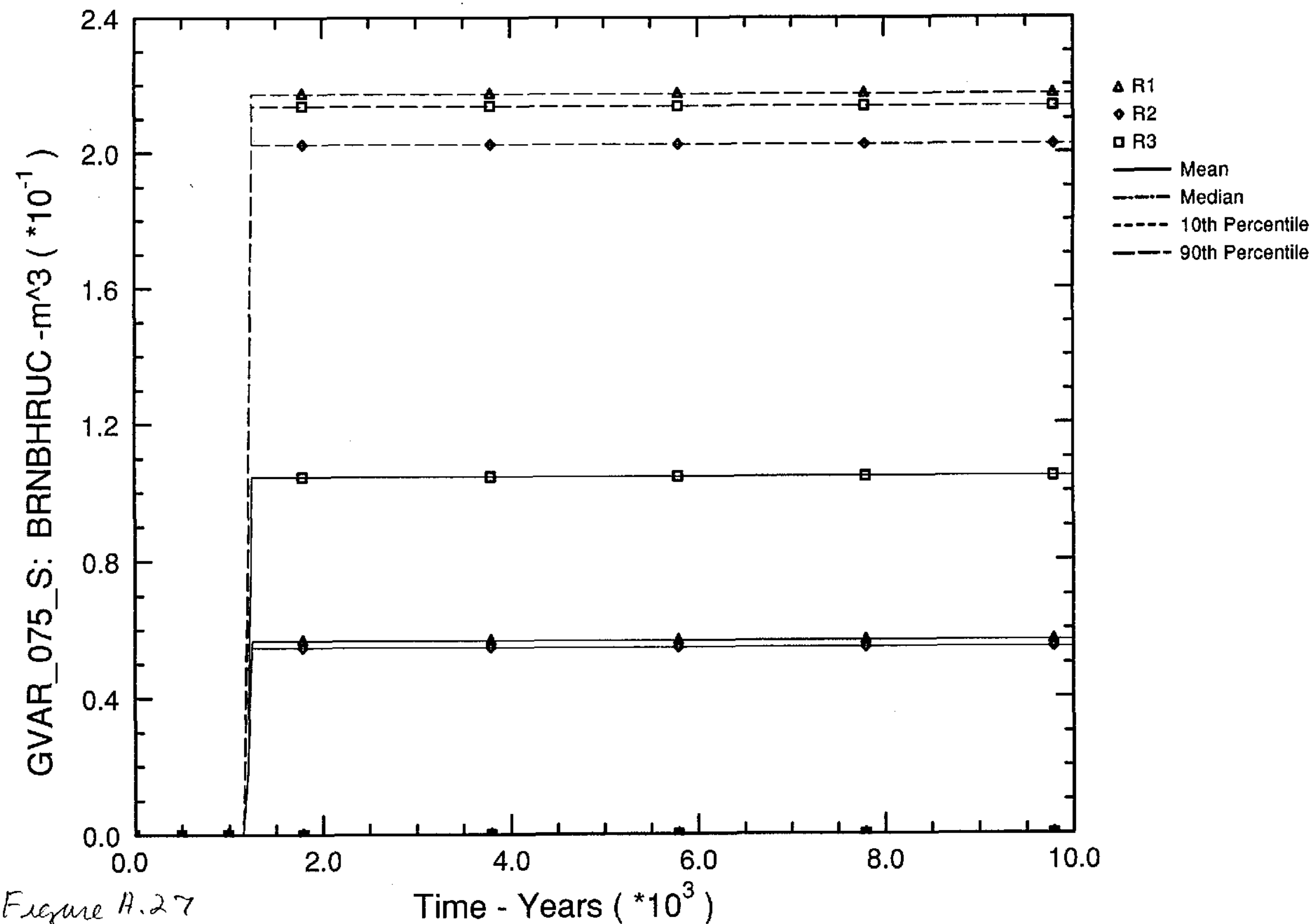


Figure A.27

1DRA1:[JEBEAN.C97.SUMMZ.STATS.S5]SPLAT_ST_S5_H075.INP;1

SPLAT_PA96_2 1.02 07/02/97 17:14:41

SNL WIPP C97: BF STATISTICAL SUMMARY (C97 Scenario 5)

Cumulative Brine Flow Out of All Marker Beds Across Land-Withdrawal Boundary

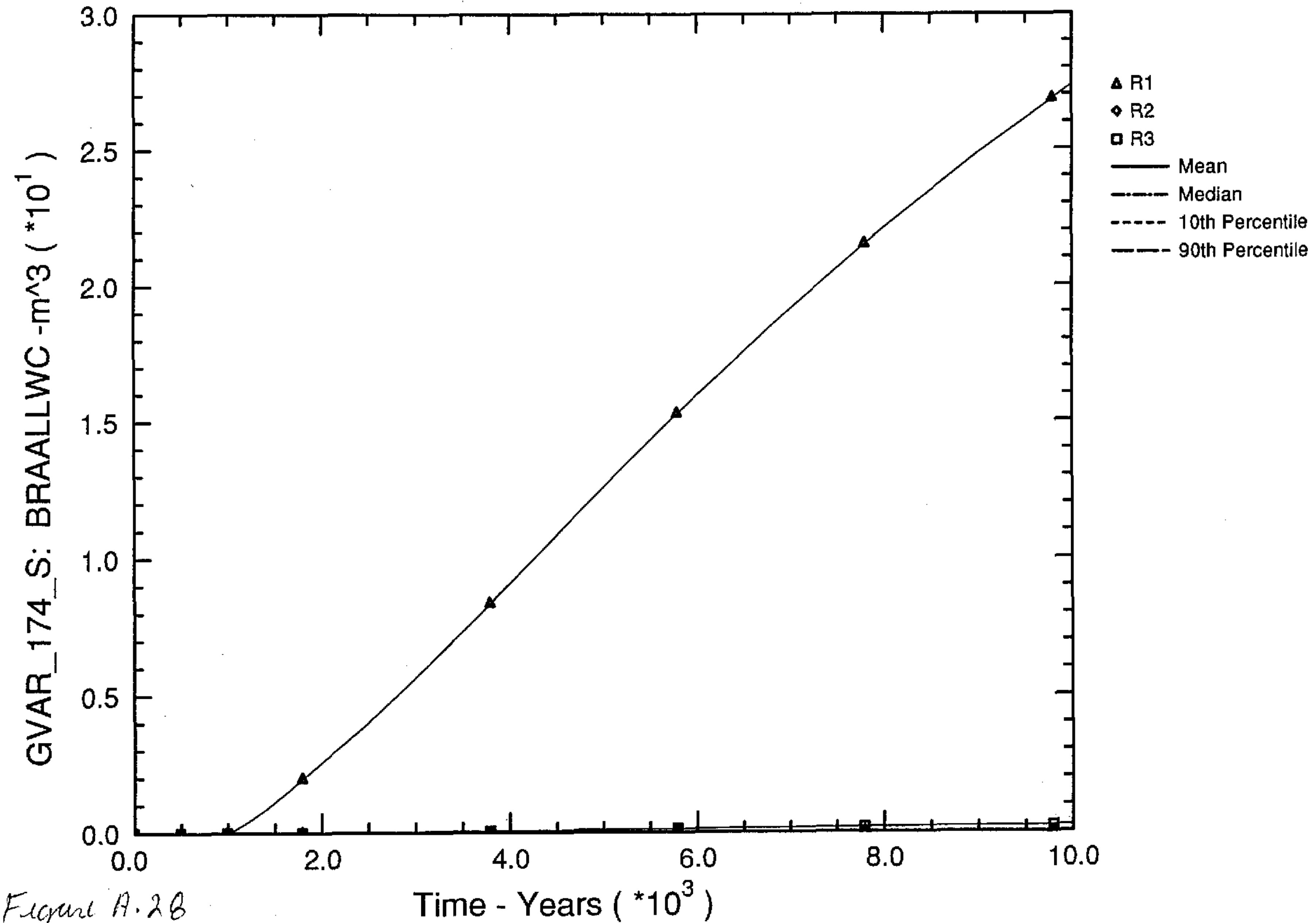


Figure A.28

1DRA1:[JEBEAN.C97.SUMMZ.STATS.S5]SPLAT_ST_S5_H174.INP;1

SPLAT_PA96_2 1.02 07/02/97 17:21:55

SNL WIPP C97: BF STATISTICAL SUMMARY (C97 Scenario 5)

Total Gas Volume Generated

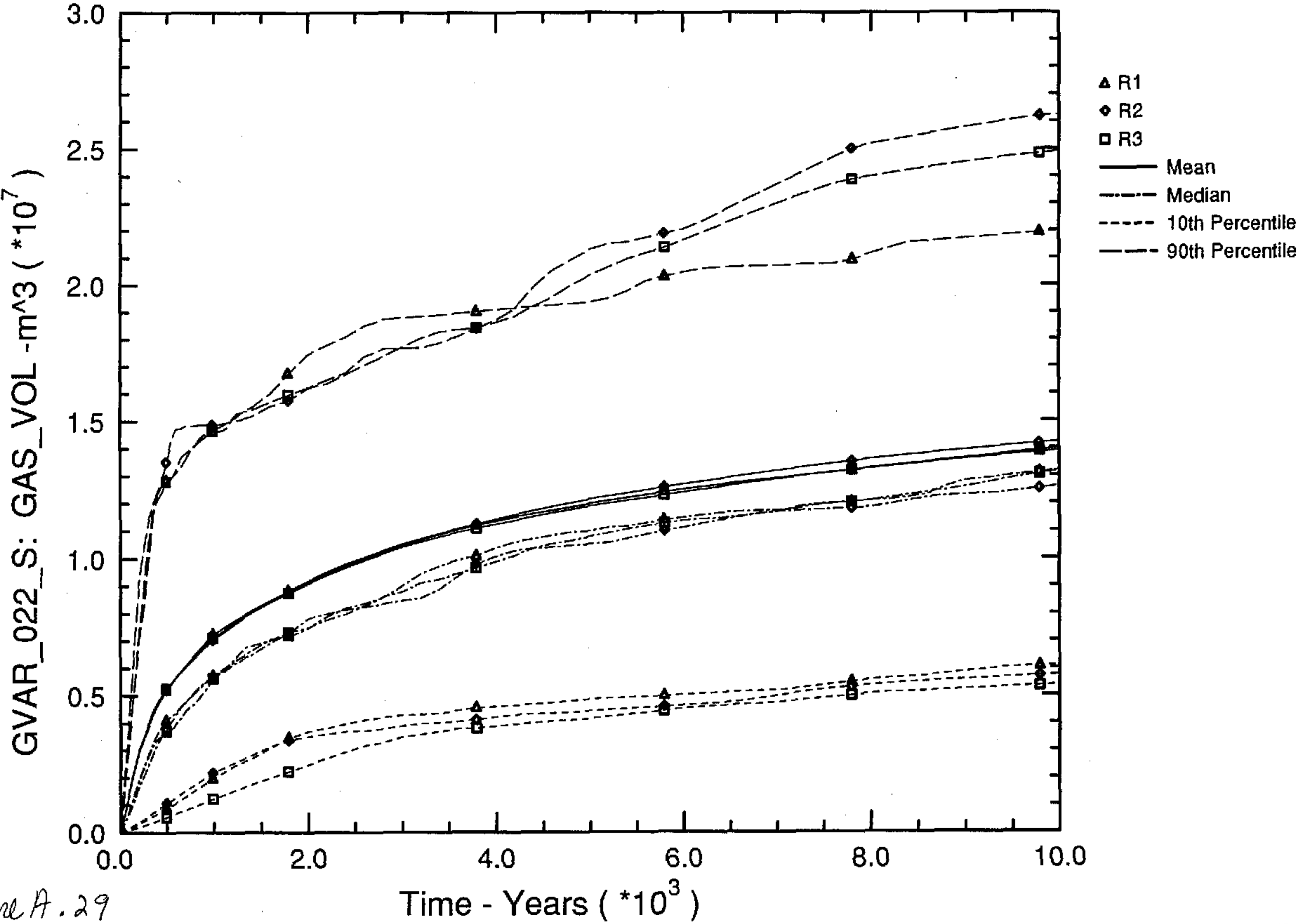


Figure A.29

1DRA1:[JEBEAN.C97.SUMMZ.STATS.S5]SPLAT_ST_S5_H022.INP;1

SPLAT_PA96_2 1.02 07/02/97 17:11:13

89

SNL WIPP C97: BF STATISTICAL SUMMARY (C97 Scenario 6)

Volume-Averaged Pressure in Waste Panel

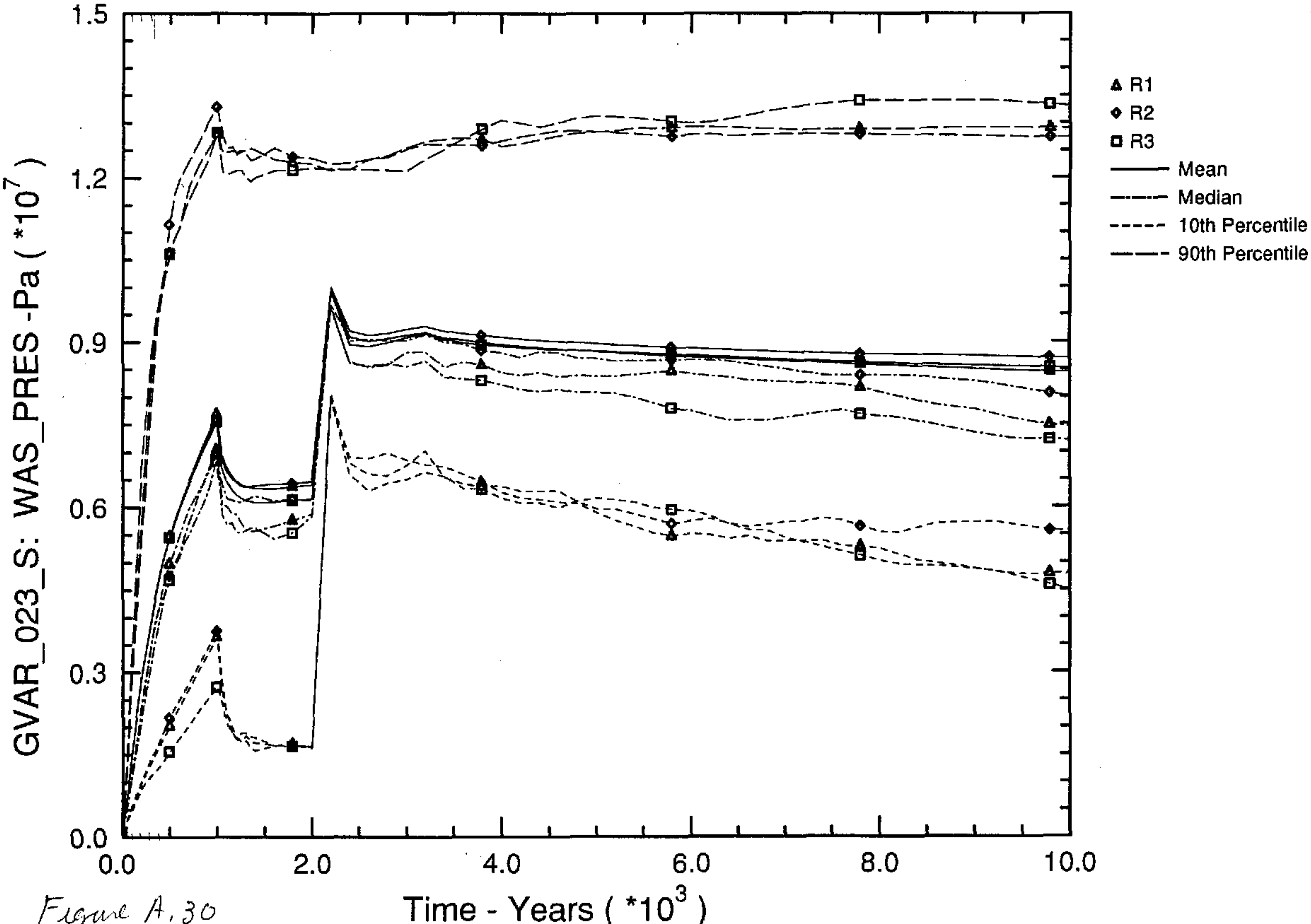


Figure A.30

1DRA1:[JEBEAN.C97.SUMMZ.STATS.S6]SPLAT_ST_S6_H023.INP;1

SPLAT_PA96_2 1.02 07/02/97 17:11:23

SNL WIPP C97: BF STATISTICAL SUMMARY (C97 Scenario 6)

Volume-Averaged Brine Saturation in Waste Panel

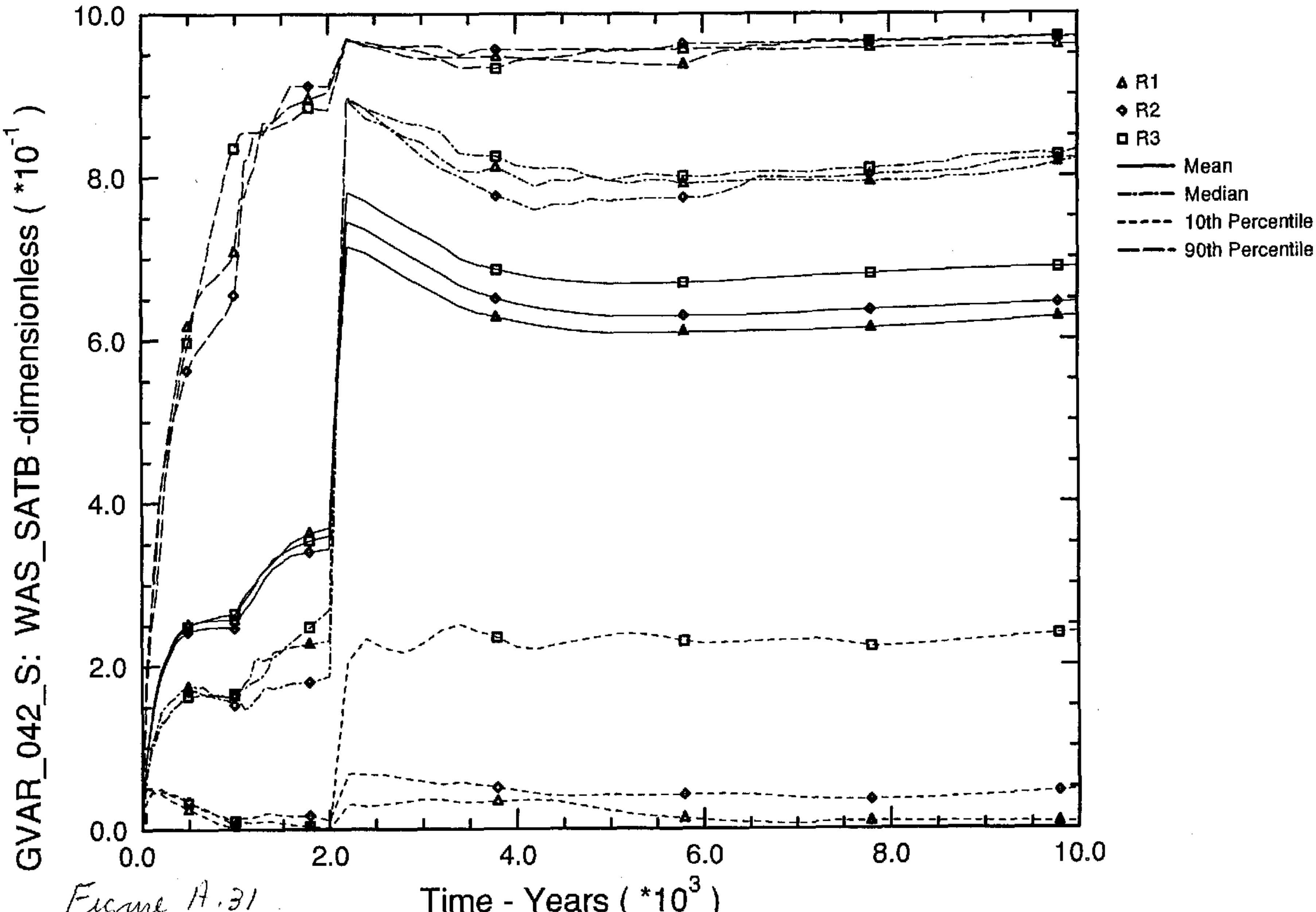


Figure A.31

1DRA1:[JEBEAN.C97.SUMMZ.STATS.S6]SPLAT_ST_S6_H042.INP;1

SPLAT_PA96_2 1.02 07/02/97 17:12:49

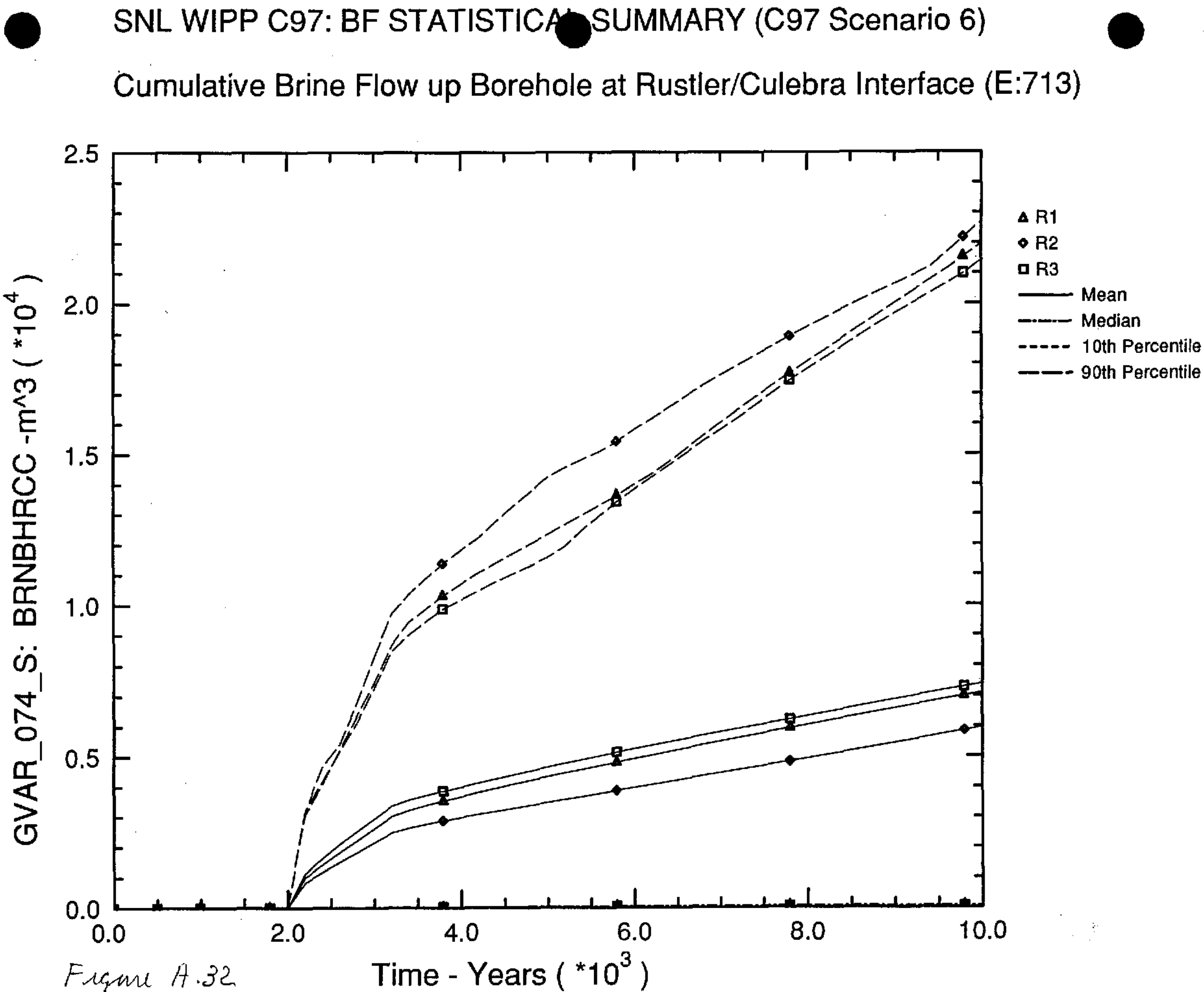


Figure A.32

1DRA1:[JEBEAN.C97.SUMMZ.STATS.S6]SPLAT_ST_S6_H074.INP;1

SPLAT_PA96_2 1.02 07/02/97 17:15:17

SNL WIPP C97: BF STATISTICAL SUMMARY (C97 Scenario 6)

Cumulative Brine Flow up Borehole at Top of Rustler (E:841)

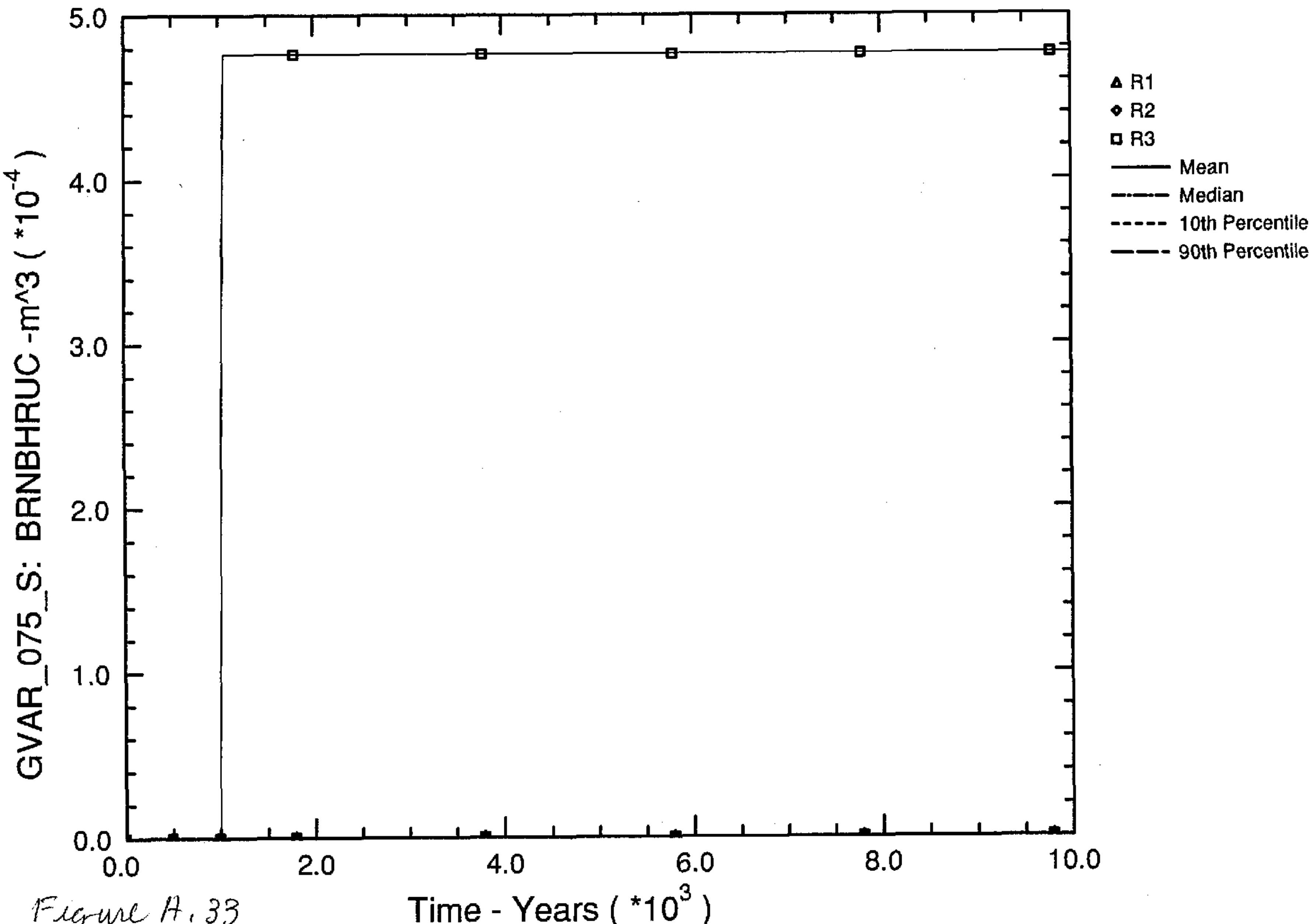


Figure A.33

1DRA1:[JEBEAN.C97.SUMMZ.STATS.S6]SPLAT_ST_S6_H075.INP;1

SPLAT_PA96_2 1.02 07/02/97 17:15:22

SNL WIPP C97: BF STATISTICAL SUMMARY (C97 Scenario 6)

Cumulative Brine Flow Out of All Marker Beds Across Land-Withdrawal Boundary

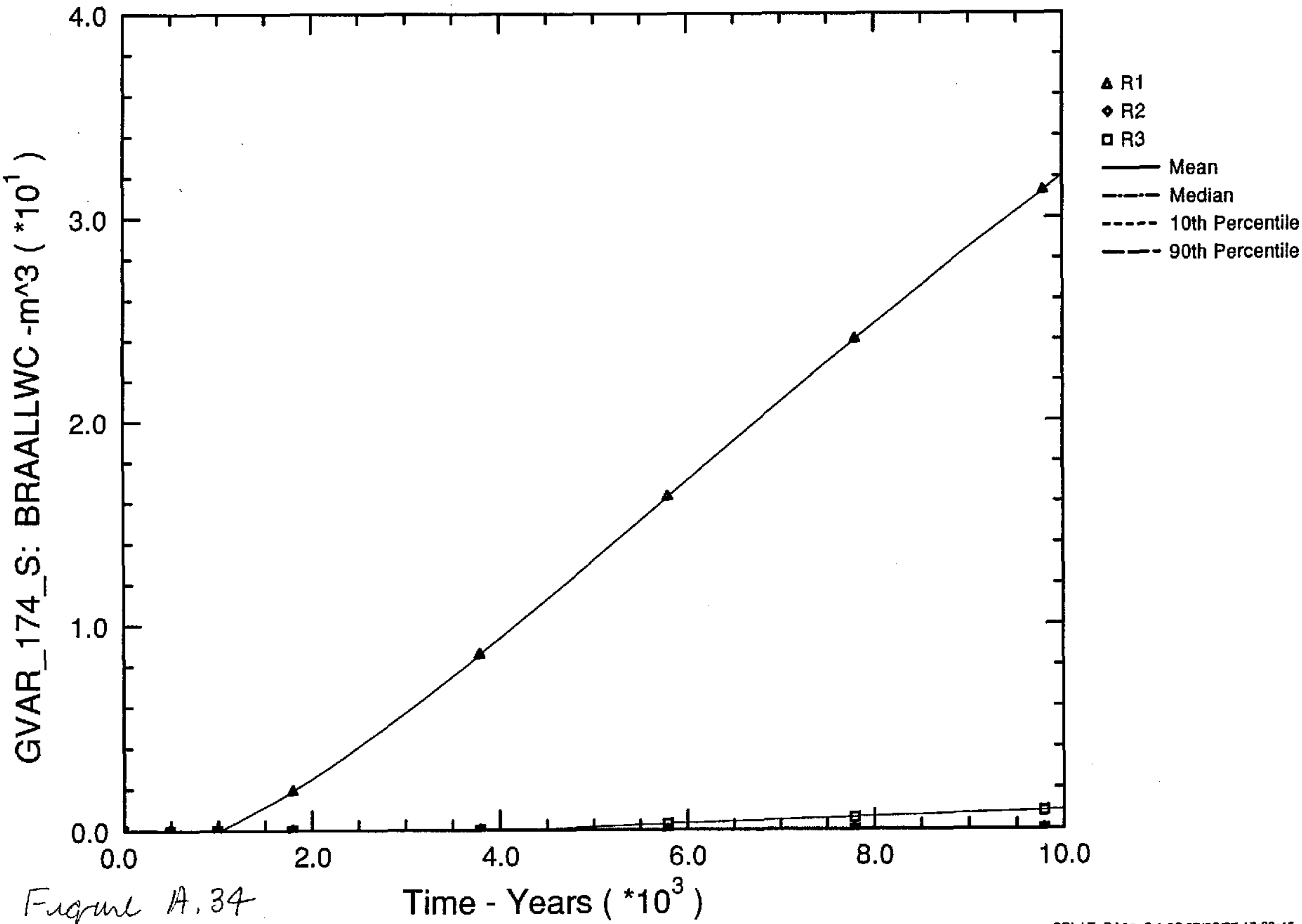


Figure A.34

1DRA1:[JEBEAN.C97.SUMMZ.STATS.S6]SPLAT_ST_S6_H174.INP;1

SPLAT_PA96_2 1.02 07/02/97 17:23:45

SNL WIPP C97: BF STATISTICAL SUMMARY (C97 Scenario 6)

Total Gas Volume Generated

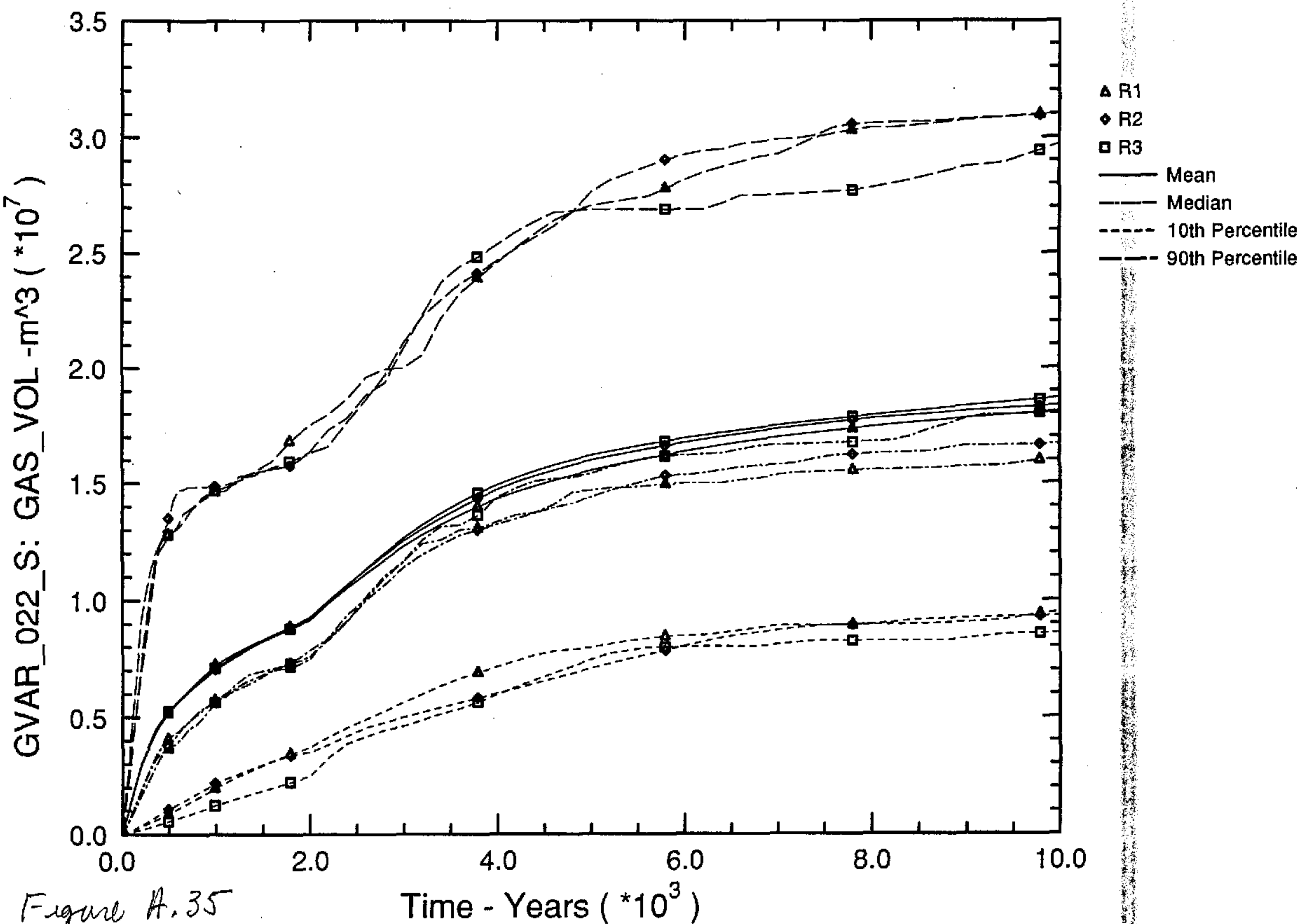


Figure A.35

1DRA1:[JEBEAN.C97.SUMMZ.STATS.S6]SPLAT_ST_S6_H022.INP;1

SPLAT_PA96_2 1.02 07/02/97 17:11:18

APPENDIX B

RESULTS FOR
SALADO TRANSPORT

Appendix B includes the Table B.1 which contains combined results from all three PAVT replicates (R1, R2 and R3) for Salado transport through interbeds to the LWB for the S1 scenario. Note that Table B.1 contains discharges for screened in vectors only.

Table B.1. S1		241Am	239Pu	238Pu	234U	230Th	Total - All MB	Total - MB139S
	vector	E1LW_MBS	E2LW_MBS	E3LW_MBS	E4LW_MBS	E5LW_MBS	EPALWMBT	EPALWM9S
R1	38	8.6691E-11	3.4037E-10	2.0451E-17	2.7435E-11	2.9575E-11	4.84071E-10	4.84071E-10
R2	64	1.3085E-16	2.5978E-13	7.1078E-30	2.2049E-14	1.2584E-14	2.94548E-13	2.94548E-13
R3	53	1.7329E-17	1.1757E-14	3.1828E-31	1.1717E-17	2.6115E-16	1.20473E-14	1.20473E-14
R3	52	6.1545E-19	5.3011E-15	0	1.8324E-18	3.2598E-17	5.33618E-15	5.33618E-15
R2	49	3.002E-18	1.3851E-15	6.1081E-30	7.9472E-19	5.0316E-18	1.39395E-15	1.39395E-15
R3	11	4.9326E-20	4.2027E-16	0	5.0537E-18	4.0372E-18	4.29415E-16	4.29415E-16
R2	65	3.6676E-20	2.8512E-17	0	3.4549E-18	2.8976E-18	3.49012E-17	3.49012E-17
R1	58	3.1549E-20	1.8717E-17	3.5227E-30	1.3801E-19	3.8034E-19	1.92671E-17	1.92671E-17
R2	92	2.961E-20	1.4348E-17	1.2545E-30	8.4211E-19	8.599E-19	1.60797E-17	1.60797E-17
R1	26	8.9425E-23	1.125E-17	0	2.8177E-21	2.3508E-20	1.12764E-17	1.12764E-17
R1	8	1.4556E-21	3.5858E-19	0	2.5561E-20	2.8008E-20	4.13603E-19	4.13603E-19
R2	23	3.5113E-23	4.9273E-20	0	1.6177E-20	1.3782E-20	7.92668E-20	7.92668E-20
R3	76	2.3605E-23	6.9135E-20	0	2.0375E-21	2.1127E-21	7.33084E-20	7.33084E-20
R2	47	0	0	0	0	0	0	0
R3	77	0	0	0	0	0	0	0

APPENDIX C

RESULTS FOR CULEBRA TRANSPORT

Appendix C includes Tables which contain results from Culebra transport calculations for PAVT replicates 2 and 3.

Figures

Tables

Each Table contains the following values:

Column	Description
1	Rank according to ^{234}U discharge
2	Vector number
3	Integrated discharge of ^{234}U (kg) to LWB from a 1 kg source (Conditional Fraction of Source Released)
4	MINP_FAC - mining impact factor
5	CLIMTIDX - climate index
6	APOROS - fracture porosity
7	DPOROS - matrix porosity
8	HMBLKT - half-block length of the matrix
9	OXSTAT - actinide oxidation state parameter
10	MKD_U - k_d value for matrix sorption

TABLE C.1

U234 CUMULATIVE RELEASE R2 PARTIALLY MINED (Replicate 2)

R[illegible]	VEC	CUM REL	MINP_FAC	CLIMTIDX	APOROS	DPOROS	HMBLKT	OXSTAT	MKD_U
1	19	9.14E-01	578.7	1.09	3.25E-04	0.187	0.335	0.768	4.54E-05
2	12	6.47E-01	602.6	2.15	1.90E-04	0.118	0.101	0.940	1.21E-04
3	60	3.66E-01	50.4	1.78	1.62E-04	0.131	0.118	0.801	6.06E-05
4	8	1.59E-01	862.6	1.20	5.21E-03	0.121	0.127	0.963	3.55E-05
5	40	1.51E-01	97.4	1.23	7.97E-04	0.137	0.251	0.687	9.24E-05
6	89	1.40E-01	382.2	1.17	4.66E-04	0.185	0.131	0.505	1.09E-04
7	75	1.24E-01	29.8	1.02	1.57E-04	0.169	0.169	0.709	8.77E-05
8	94	7.92E-03	473.2	1.07	2.50E-04	0.111	0.106	0.915	1.29E-04
9	87	7.21E-03	232.9	1.95	3.47E-03	0.130	0.141	0.787	1.72E-04
10	58	3.11E-03	878.2	2.22	6.43E-04	0.163	0.364	0.923	3.26E-04
11	45	4.00E-05	772.6	1.59	2.62E-04	0.166	0.359	0.752	8.54E-04
12	92	2.86E-05	310.8	1.14	1.46E-04	0.181	0.464	0.587	8.25E-05
13	98	2.37E-06	570.0	1.13	1.51E-03	0.211	0.437	0.896	3.91E-05
14	1	1.19E-06	502.6	2.03	7.86E-04	0.125	0.343	0.750	6.87E-04
15	24	5.29E-07	71.1	1.19	1.34E-03	0.155	0.298	0.955	5.00E-04
16	20	4.87E-08	63.5	1.03	3.06E-03	0.188	0.424	0.544	5.80E-05
17	56	2.35E-08	178.6	1.19	1.08E-04	0.103	0.415	0.848	2.43E-04
18	82	5.03E-10	762.8	1.17	7.37E-03	0.153	0.231	0.513	3.92E-04
19	5	2.69E-11	920.3	1.01	3.97E-03	0.112	0.061	0.557	3.97E-05
20	51	6.86E-13	194.5	1.06	2.11E-03	0.114	0.483	0.667	3.05E-03
21	90	1.38E-14	954.1	1.76	8.81E-04	0.224	0.478	0.854	8.02E-03
22	55	2.72E-15	938.6	1.20	9.84E-04	0.116	0.286	0.736	2.66E-03
23	96	1.00E-15	807.7	1.07	1.80E-04	0.171	0.147	0.876	2.20E-03
24	84	1.00E-15	966.7	1.00	5.31E-03	0.100	0.467	0.027	1.31E+00
[illegible]	97	1.00E-15	497.0	1.62	1.19E-03	0.117	0.160	0.531	2.49E-03
[illegible]	78	1.00E-15	701.3	1.90	4.52E-03	0.219	0.375	0.909	5.91E-03
27	86	1.00E-15	739.4	1.03	3.42E-04	0.123	0.436	0.983	2.84E-02
28	91	1.00E-15	520.2	1.04	6.18E-03	0.246	0.431	0.672	3.20E-03
29	72	1.00E-15	457.5	1.88	6.90E-03	0.107	0.098	0.399	1.29E+01
30	71	1.00E-15	164.3	1.02	2.54E-03	0.160	0.182	0.092	1.44E+00
31	73	1.00E-15	19.6	1.25	1.74E-04	0.164	0.354	0.770	1.26E-02
32	93	1.00E-15	845.0	1.51	3.93E-04	0.190	0.191	0.494	4.08E+00
33	68	1.00E-15	784.3	1.12	5.80E-04	0.114	0.290	0.336	1.38E+00
34	79	1.00E-15	829.5	1.04	1.04E-04	0.183	0.246	0.465	2.98E+00
35	66	1.00E-15	369.7	1.07	1.02E-03	0.174	0.273	0.436	1.96E+01
36	77	1.00E-15	113.7	1.23	1.08E-03	0.186	0.350	0.992	1.42E-02
37	88	1.00E-15	228.7	1.14	1.37E-04	0.182	0.209	0.008	1.02E+00
38	100	1.00E-15	657.7	1.09	1.15E-04	0.166	0.180	0.289	5.12E+00
39	99	1.00E-15	642.4	1.12	1.26E-04	0.125	0.406	0.252	1.82E+01
40	61	1.00E-15	854.5	1.05	3.80E-03	0.186	0.223	0.860	1.77E-03
41	85	1.00E-15	349.7	1.64	2.72E-04	0.129	0.366	0.369	1.16E+00
42	59	1.00E-15	276.5	1.00	4.03E-04	0.169	0.282	0.565	1.11E-02
43	64	1.00E-15	668.7	1.21	1.89E-03	0.107	0.338	0.622	3.05E-05
44	57	1.00E-15	441.0	1.14	5.58E-03	0.127	0.051	0.372	1.72E+00
45	81	1.00E-15	244.4	1.83	3.42E-03	0.112	0.261	0.103	2.80E+00
46	67	1.00E-15	689.4	1.72	1.44E-03	0.190	0.471	0.386	3.06E+00
47	54	1.00E-15	335.4	1.15	2.22E-04	0.116	0.071	0.633	5.38E-03
48	53	1.00E-15	481.6	1.12	2.32E-04	0.180	0.242	0.191	4.16E+00
49	52	1.00E-15	461.1	1.94	4.99E-04	0.135	0.400	0.205	2.73E+00
50	63	1.00E-15	631.0	1.01	4.19E-03	0.164	0.455	0.136	1.90E+01

U234 CUMULATIVE RELEASE R2 PARTIALLY MINED (Replicate 2)

R[illegible]	VEC	CUM REL	MINP_FAC	CLIMTIDX	APOROS	DPOROS	HMBLKT	OXSTAT	MKD_U
51	50	1.00E-15	2.2	1.66	2.06E-03	0.189	0.154	0.011	1.48E+01
52	49	1.00E-15	534.9	1.09	1.14E-03	0.161	0.458	0.151	6.68E+00
53	48	1.00E-15	205.4	1.18	2.99E-03	0.202	0.055	0.698	2.18E-02
54	47	1.00E-15	754.3	1.24	9.94E-03	0.173	0.235	0.275	8.04E+00
55	46	1.00E-15	525.4	1.18	3.53E-04	0.138	0.270	0.244	1.14E+01
56	95	1.00E-15	329.9	1.14	8.36E-03	0.198	0.174	0.580	5.42E-04
57	44	1.00E-15	294.0	1.13	1.70E-03	0.106	0.122	0.524	1.38E-04
58	43	1.00E-15	690.8	1.10	8.03E-03	0.110	0.381	0.039	1.45E+01
59	42	1.00E-15	437.1	1.02	5.38E-04	0.141	0.082	0.979	1.86E-04
60	41	1.00E-15	81.8	2.10	1.54E-03	0.170	0.255	0.348	3.54E+00
61	65	1.00E-15	992.9	1.16	1.30E-03	0.188	0.137	0.819	2.02E-03
62	39	1.00E-15	287.1	1.23	4.89E-03	0.159	0.207	0.185	1.02E+01
63	38	1.00E-15	719.4	1.06	1.80E-03	0.178	0.297	0.420	1.67E+00
64	37	1.00E-15	880.6	1.99	4.04E-03	0.152	0.195	0.729	8.97E-04
65	36	1.00E-15	916.4	1.09	7.21E-03	0.102	0.374	0.884	1.18E-02
66	35	1.00E-15	897.6	1.68	2.88E-04	0.162	0.109	0.069	6.55E+00
67	34	1.00E-15	724.7	1.15	6.61E-04	0.146	0.078	0.314	1.06E+00
68	83	1.00E-15	837.1	1.10	7.04E-04	0.227	0.317	0.832	2.75E-03
69	32	1.00E-15	155.4	1.18	2.02E-04	0.113	0.091	0.329	2.35E+00
70	31	1.00E-15	40.0	1.17	6.50E-03	0.109	0.450	0.472	6.28E+00
71	80	1.00E-15	677.7	1.16	4.48E-04	0.155	0.331	0.411	1.51E+00
72	29	1.00E-15	989.4	1.22	1.10E-04	0.149	0.200	0.452	1.87E+01
73	28	1.00E-15	814.0	1.20	2.47E-03	0.175	0.476	0.354	1.95E+00
74	27	1.00E-15	309.3	1.24	1.61E-03	0.179	0.216	0.164	2.17E+00
[illegible]	76	1.00E-15	748.6	1.03	3.10E-04	0.150	0.187	0.824	1.02E-03
76	25	1.00E-15	107.8	1.05	2.26E-03	0.173	0.116	0.409	1.84E+00
77	74	1.00E-15	942.0	1.03	1.94E-04	0.175	0.444	0.072	1.42E+01
78	23	1.00E-15	142.0	1.20	2.82E-04	0.119	0.394	0.618	1.56E-02
79	22	1.00E-15	909.9	2.08	3.24E-03	0.118	0.494	0.085	1.57E+01
80	21	1.00E-15	140.8	1.08	1.97E-03	0.180	0.390	0.292	4.83E+00
81	70	1.00E-15	430.0	1.05	3.65E-04	0.234	0.150	0.145	1.59E+00
82	69	1.00E-15	354.4	1.18	7.61E-03	0.143	0.229	0.792	1.72E-03
83	18	1.00E-15	978.7	1.25	2.64E-03	0.111	0.065	0.052	2.44E+00
84	17	1.00E-15	554.9	1.11	1.27E-04	0.185	0.305	0.127	2.00E+00
85	16	1.00E-15	373.9	1.10	6.07E-04	0.158	0.076	0.483	6.82E+00
86	15	1.00E-15	796.3	1.85	8.70E-04	0.176	0.264	0.658	1.03E-02
87	14	1.00E-15	598.6	1.24	7.37E-04	0.145	0.323	0.235	4.51E+00
88	13	1.00E-15	583.0	1.21	5.69E-04	0.119	0.278	0.600	4.65E-03
89	62	1.00E-15	54.7	1.15	4.78E-03	0.177	0.421	0.607	3.30E-05
90	11	1.00E-15	626.2	1.53	9.17E-04	0.182	0.487	0.049	9.38E-01
91	10	1.00E-15	392.5	2.17	4.25E-04	0.165	0.163	0.116	1.69E+01
92	9	1.00E-15	252.7	2.22	1.43E-04	0.103	0.410	0.263	2.07E+00
93	33	1.00E-15	265.4	1.06	2.36E-03	0.133	0.325	0.715	1.85E-02
94	7	1.00E-15	545.2	1.06	8.83E-03	0.115	0.220	0.171	2.65E+00
95	6	1.00E-15	404.5	1.22	2.18E-04	0.184	0.405	0.303	8.25E+00
96	30	1.00E-15	184.3	1.08	5.15E-04	0.140	0.311	0.449	2.54E+00
97	4	1.00E-15	619.4	2.07	2.83E-03	0.243	0.089	0.217	4.53E+00
98	3	1.00E-15	211.7	1.21	9.45E-03	0.171	0.384	0.648	3.53E-03
99	2	1.00E-15	125.3	1.11	1.21E-03	0.104	0.498	0.940	2.55E-02
100	26	1.00E-15	414.0	1.12	5.90E-03	0.167	0.309	0.230	7.75E+00

TABLE C.2

_249DKA0:[BF.MJSHORT.JLR]SRTR2.OUT;1 25-JUL-1997 10:28 Page ~~0~~ 1

U234 CUMULATIVE RELEASE R2 FULLY MINED (Replicate 2)

R[illegible]	VEC	CUM REL	MINP_FAC	CLIMTIDX	APOROS	DPOROS	HMBLKT	OXSTAT	MKD_U
1	89	9.17E-01	382.2	1.17	4.66E-04	0.185	0.131	0.505	1.09E-04
2	19	9.14E-01	578.7	1.09	3.25E-04	0.187	0.335	0.768	4.54E-05
3	60	8.64E-01	50.4	1.78	1.62E-04	0.131	0.118	0.801	6.06E-05
4	58	7.77E-01	878.2	2.22	6.43E-04	0.163	0.364	0.923	3.26E-04
5	12	5.63E-01	602.6	2.15	1.90E-04	0.118	0.101	0.940	1.21E-04
6	82	5.60E-01	762.8	1.17	7.37E-03	0.153	0.231	0.513	3.92E-04
7	75	2.91E-01	29.8	1.02	1.57E-04	0.169	0.169	0.709	8.77E-05
8	40	2.61E-01	97.4	1.23	7.97E-04	0.137	0.251	0.687	9.24E-05
9	20	1.91E-01	63.5	1.03	3.06E-03	0.188	0.424	0.544	5.80E-05
10	94	1.54E-01	473.2	1.07	2.50E-04	0.111	0.106	0.915	1.29E-04
11	1	3.98E-02	502.6	2.03	7.86E-04	0.125	0.343	0.750	6.87E-04
12	56	4.37E-04	178.6	1.19	1.08E-04	0.103	0.415	0.848	2.43E-04
13	90	1.46E-05	954.1	1.76	8.81E-04	0.224	0.478	0.854	8.02E-03
14	8	7.03E-06	862.6	1.20	5.21E-03	0.121	0.127	0.963	3.55E-05
15	83	1.23E-06	837.1	1.10	7.04E-04	0.227	0.317	0.832	2.75E-03
16	45	7.88E-07	772.6	1.59	2.62E-04	0.166	0.359	0.752	8.54E-04
17	51	9.99E-09	194.5	1.06	2.11E-03	0.114	0.483	0.667	3.05E-03
18	5	1.07E-10	920.3	1.01	3.97E-03	0.112	0.061	0.557	3.97E-05
19	65	8.70E-11	992.9	1.16	1.30E-03	0.188	0.137	0.819	2.02E-03
20	55	3.69E-11	938.6	1.20	9.84E-04	0.116	0.286	0.736	2.66E-03
21	92	6.69E-15	310.8	1.14	1.46E-04	0.181	0.464	0.587	8.25E-05
22	96	1.00E-15	807.7	1.07	1.80E-04	0.171	0.147	0.876	2.20E-03
23	98	1.00E-15	570.0	1.13	1.51E-03	0.211	0.437	0.896	3.91E-05
24	84	1.00E-15	966.7	1.00	5.31E-03	0.100	0.467	0.027	1.31E+00
[illegible]	86	1.00E-15	739.4	1.03	3.42E-04	0.123	0.436	0.983	2.84E-02
[illegible]	78	1.00E-15	701.3	1.90	4.52E-03	0.219	0.375	0.909	5.91E-03
27	74	1.00E-15	942.0	1.03	1.94E-04	0.175	0.444	0.072	1.42E+01
28	97	1.00E-15	497.0	1.62	1.19E-03	0.117	0.160	0.531	2.49E-03
29	72	1.00E-15	457.5	1.88	6.90E-03	0.107	0.098	0.399	1.29E+01
30	71	1.00E-15	164.3	1.02	2.54E-03	0.160	0.182	0.092	1.44E+00
31	91	1.00E-15	520.2	1.04	6.18E-03	0.246	0.431	0.672	3.20E-03
32	99	1.00E-15	642.4	1.12	1.26E-04	0.125	0.406	0.252	1.82E+01
33	68	1.00E-15	784.3	1.12	5.80E-04	0.114	0.290	0.336	1.38E+00
34	73	1.00E-15	19.6	1.25	1.74E-04	0.164	0.354	0.770	1.26E-02
35	66	1.00E-15	369.7	1.07	1.02E-03	0.174	0.273	0.436	1.96E+01
36	77	1.00E-15	113.7	1.23	1.08E-03	0.186	0.350	0.992	1.42E-02
37	79	1.00E-15	829.5	1.04	1.04E-04	0.183	0.246	0.465	2.98E+00
38	100	1.00E-15	657.7	1.09	1.15E-04	0.166	0.180	0.289	5.12E+00
39	87	1.00E-15	232.9	1.95	3.47E-03	0.130	0.141	0.787	1.72E-04
40	61	1.00E-15	854.5	1.05	3.80E-03	0.186	0.223	0.860	1.77E-03
41	85	1.00E-15	349.7	1.64	2.72E-04	0.129	0.366	0.369	1.16E+00
42	59	1.00E-15	276.5	1.00	4.03E-04	0.169	0.282	0.565	1.11E-02
43	88	1.00E-15	228.7	1.14	1.37E-04	0.182	0.209	0.008	1.02E+00
44	93	1.00E-15	845.0	1.51	3.93E-04	0.190	0.191	0.494	4.08E+00
45	81	1.00E-15	244.4	1.83	3.42E-03	0.112	0.261	0.103	2.80E+00
46	67	1.00E-15	689.4	1.72	1.44E-03	0.190	0.471	0.386	3.06E+00
47	54	1.00E-15	335.4	1.15	2.22E-04	0.116	0.071	0.633	5.38E-03
48	53	1.00E-15	481.6	1.12	2.32E-04	0.180	0.242	0.191	4.16E+00
49	64	1.00E-15	668.7	1.21	1.89E-03	0.107	0.338	0.622	3.05E-05
50	63	1.00E-15	631.0	1.01	4.19E-03	0.164	0.455	0.136	1.90E+01

U234 CUMULATIVE RELEASE R2 FULLY MINED (Replicate 2)

RUN	VEC	CUM REL	MINP_FAC	CLIMTIDX	APOROS	DPOROS	HMBLKT	OXSTAT	MKD_U
51	50	1.00E-15	2.2	1.66	2.06E-03	0.189	0.154	0.011	1.48E+01
52	49	1.00E-15	534.9	1.09	1.14E-03	0.161	0.458	0.151	6.68E+00
53	48	1.00E-15	205.4	1.18	2.99E-03	0.202	0.055	0.698	2.18E-02
54	47	1.00E-15	754.3	1.24	9.94E-03	0.173	0.235	0.275	8.04E+00
55	46	1.00E-15	525.4	1.18	3.53E-04	0.138	0.270	0.244	1.14E+01
56	57	1.00E-15	441.0	1.14	5.58E-03	0.127	0.051	0.372	1.72E+00
57	44	1.00E-15	294.0	1.13	1.70E-03	0.106	0.122	0.524	1.38E-04
58	43	1.00E-15	690.8	1.10	8.03E-03	0.110	0.381	0.039	1.45E+01
59	42	1.00E-15	437.1	1.02	5.38E-04	0.141	0.082	0.979	1.86E-04
60	41	1.00E-15	81.8	2.10	1.54E-03	0.170	0.255	0.348	3.54E+00
61	52	1.00E-15	461.1	1.94	4.99E-04	0.135	0.400	0.205	2.73E+00
62	39	1.00E-15	287.1	1.23	4.89E-03	0.159	0.207	0.185	1.02E+01
63	38	1.00E-15	719.4	1.06	1.80E-03	0.178	0.297	0.420	1.67E+00
64	37	1.00E-15	880.6	1.99	4.04E-03	0.152	0.195	0.729	8.97E-04
65	36	1.00E-15	916.4	1.09	7.21E-03	0.102	0.374	0.884	1.18E-02
66	35	1.00E-15	897.6	1.68	2.88E-04	0.162	0.109	0.069	6.55E+00
67	34	1.00E-15	724.7	1.15	6.61E-04	0.146	0.078	0.314	1.06E+00
68	95	1.00E-15	329.9	1.14	8.36E-03	0.198	0.174	0.580	5.42E-04
69	32	1.00E-15	155.4	1.18	2.02E-04	0.113	0.091	0.329	2.35E+00
70	31	1.00E-15	40.0	1.17	6.50E-03	0.109	0.450	0.472	6.28E+00
71	80	1.00E-15	677.7	1.16	4.48E-04	0.155	0.331	0.411	1.51E+00
72	29	1.00E-15	989.4	1.22	1.10E-04	0.149	0.200	0.452	1.87E+01
73	28	1.00E-15	814.0	1.20	2.47E-03	0.175	0.476	0.354	1.95E+00
74	27	1.00E-15	309.3	1.24	1.61E-03	0.179	0.216	0.164	2.17E+00
75	76	1.00E-15	748.6	1.03	3.10E-04	0.150	0.187	0.824	1.02E-03
76	25	1.00E-15	107.8	1.05	2.26E-03	0.173	0.116	0.409	1.84E+00
77	24	1.00E-15	71.1	1.19	1.34E-03	0.155	0.298	0.955	5.00E-04
78	23	1.00E-15	142.0	1.20	2.82E-04	0.119	0.394	0.618	1.56E-02
79	22	1.00E-15	909.9	2.08	3.24E-03	0.118	0.494	0.085	1.57E+01
80	21	1.00E-15	140.8	1.08	1.97E-03	0.180	0.390	0.292	4.83E+00
81	70	1.00E-15	430.0	1.05	3.65E-04	0.234	0.150	0.145	1.59E+00
82	69	1.00E-15	354.4	1.18	7.61E-03	0.143	0.229	0.792	1.72E-03
83	18	1.00E-15	978.7	1.25	2.64E-03	0.111	0.065	0.052	2.44E+00
84	17	1.00E-15	554.9	1.11	1.27E-04	0.185	0.305	0.127	2.00E+00
85	16	1.00E-15	373.9	1.10	6.07E-04	0.158	0.076	0.483	6.82E+00
86	15	1.00E-15	796.3	1.85	8.70E-04	0.176	0.264	0.658	1.03E-02
87	14	1.00E-15	598.6	1.24	7.37E-04	0.145	0.323	0.235	4.51E+00
88	13	1.00E-15	583.0	1.21	5.69E-04	0.119	0.278	0.600	4.65E-03
89	62	1.00E-15	54.7	1.15	4.78E-03	0.177	0.421	0.607	3.30E-05
90	11	1.00E-15	626.2	1.53	9.17E-04	0.182	0.487	0.049	9.38E-01
91	10	1.00E-15	392.5	2.17	4.25E-04	0.165	0.163	0.116	1.69E+01
92	9	1.00E-15	252.7	2.22	1.43E-04	0.103	0.410	0.263	2.07E+00
93	33	1.00E-15	265.4	1.06	2.36E-03	0.133	0.325	0.715	1.85E-02
94	7	1.00E-15	545.2	1.06	8.83E-03	0.115	0.220	0.171	2.65E+00
95	6	1.00E-15	404.5	1.22	2.18E-04	0.184	0.405	0.303	8.25E+00
96	30	1.00E-15	184.3	1.08	5.15E-04	0.140	0.311	0.449	2.54E+00
97	4	1.00E-15	619.4	2.07	2.83E-03	0.243	0.089	0.217	4.53E+00
98	3	1.00E-15	211.7	1.21	9.45E-03	0.171	0.384	0.648	3.53E-03
99	2	1.00E-15	125.3	1.11	1.21E-03	0.104	0.498	0.940	2.55E-02
100	26	1.00E-15	414.0	1.12	5.90E-03	0.167	0.309	0.230	7.75E+00

U234 CUMULATIVE RELEASE R3 PARTIALLY MINED (Replicate 3)

R[illegible]	VEC	CUM REL	MINP_FAC	CLIMTIDX	APOROS	DPOROS	HMBLKT	OXSTAT	MKD_U
1	48	9.83E-01	371.7	1.04	5.38E-04	0.114	0.168	0.598	4.11E-05
2	16	8.97E-01	915.0	1.06	1.75E-03	0.176	0.210	0.769	6.15E-05
3	41	8.31E-01	926.8	2.06	3.55E-04	0.183	0.113	0.701	1.13E-04
4	14	4.57E-01	784.7	1.13	7.53E-04	0.139	0.303	0.612	5.93E-05
5	60	3.98E-01	511.9	1.89	1.30E-04	0.124	0.093	0.634	5.22E-05
6	73	3.22E-01	903.1	1.20	6.07E-03	0.136	0.350	0.924	7.69E-05
7	15	1.21E-01	533.6	1.03	2.57E-04	0.120	0.280	0.965	7.98E-05
8	69	6.97E-02	970.2	1.97	6.79E-03	0.106	0.050	0.775	2.49E-04
9	62	6.59E-02	264.2	1.06	7.59E-03	0.118	0.463	0.733	3.56E-05
10	11	5.08E-04	144.6	2.20	3.05E-04	0.106	0.140	0.799	1.44E-04
11	74	1.07E-04	199.4	1.23	1.07E-04	0.151	0.161	0.939	2.95E-04
12	28	2.52E-05	203.1	1.11	4.04E-04	0.160	0.184	0.502	3.13E-05
13	50	2.46E-06	832.6	1.19	5.70E-04	0.185	0.490	0.645	4.32E-04
14	76	1.56E-06	882.4	1.20	1.82E-04	0.149	0.165	0.721	5.38E-04
15	79	8.99E-07	862.9	1.74	3.28E-04	0.178	0.257	0.904	2.86E-04
16	46	4.96E-07	952.7	1.71	2.40E-04	0.207	0.376	0.740	1.64E-03
17	32	3.13E-10	284.4	1.16	3.33E-04	0.113	0.400	0.529	6.13E-04
18	61	4.48E-12	801.1	1.21	2.04E-04	0.180	0.232	0.754	3.16E-04
19	25	8.02E-13	380.8	1.22	1.67E-04	0.245	0.299	0.514	2.61E-03
20	35	3.75E-13	945.9	1.02	2.31E-04	0.146	0.173	0.916	1.24E-04
21	64	3.47E-14	245.4	1.23	1.23E-04	0.171	0.465	0.807	4.86E-04
22	63	4.28E-15	620.2	1.01	1.71E-03	0.103	0.292	0.679	6.44E-04
23	54	2.18E-15	481.9	1.06	2.27E-04	0.122	0.273	0.531	1.82E-03
24	95	1.00E-15	117.7	1.14	1.44E-04	0.117	0.262	0.187	3.49E+00
25	92	1.00E-15	709.8	1.61	1.15E-04	0.153	0.200	0.214	1.48E+00
[illegible]	83	1.00E-15	103.8	1.21	2.09E-04	0.113	0.379	0.828	1.70E-03
27	80	1.00E-15	53.3	1.78	2.77E-03	0.181	0.448	0.229	4.88E+00
28	77	1.00E-15	609.5	1.19	1.23E-03	0.184	0.156	0.978	2.75E-02
29	99	1.00E-15	752.1	1.66	2.94E-04	0.116	0.294	0.209	2.76E+00
30	93	1.00E-15	403.9	1.11	9.58E-03	0.108	0.410	0.474	8.48E+00
31	71	1.00E-15	571.0	1.93	1.34E-04	0.236	0.224	0.328	2.96E+00
32	81	1.00E-15	184.6	1.85	8.09E-03	0.173	0.317	0.099	1.67E+01
33	68	1.00E-15	529.6	1.24	2.64E-04	0.169	0.241	0.302	9.48E-01
34	67	1.00E-15	135.2	1.17	2.08E-03	0.155	0.099	0.165	6.66E+00
35	94	1.00E-15	932.6	1.65	5.88E-04	0.111	0.185	0.069	2.50E+00
36	90	1.00E-15	622.2	1.15	5.21E-04	0.176	0.266	0.334	1.39E+00
37	70	1.00E-15	738.2	1.11	8.08E-04	0.189	0.250	0.013	9.39E+00
38	88	1.00E-15	649.6	1.11	1.82E-03	0.162	0.134	0.118	3.68E+00
39	87	1.00E-15	843.0	1.01	1.29E-03	0.131	0.368	0.357	1.16E+00
40	97	1.00E-15	312.8	1.04	4.62E-03	0.143	0.069	0.053	2.34E+00
41	84	1.00E-15	90.3	1.01	4.84E-04	0.187	0.415	0.191	1.25E+01
42	59	1.00E-15	745.2	1.58	1.97E-03	0.105	0.257	0.657	3.67E-04
43	58	1.00E-15	321.4	1.13	1.99E-04	0.164	0.143	0.241	9.87E+00
44	57	1.00E-15	236.4	1.16	6.13E-04	0.129	0.325	0.949	1.91E-03
45	56	1.00E-15	857.4	1.53	1.53E-04	0.140	0.357	0.076	6.05E+00
46	55	1.00E-15	496.6	1.10	5.74E-03	0.188	0.084	0.714	1.90E-02
47	72	1.00E-15	367.0	1.14	2.40E-03	0.173	0.076	0.684	3.05E-03
48	53	1.00E-15	335.2	1.08	8.35E-03	0.186	0.062	0.250	9.86E-01
49	52	1.00E-15	965.2	1.01	4.21E-04	0.171	0.386	0.147	4.50E+00
50	51	1.00E-15	774.4	1.09	2.21E-03	0.118	0.391	0.987	2.24E-03

J234 CUMULATIVE RELEASE R3 PARTIALLY MINED (Replicate 3)

R[illegible]	VEC	CUM REL	MINP_FAC	CLIMTIDX	APOROS	DPOROS	HMBLKT	OXSTAT	MKD_U
51	100	1.00E-15	416.7	1.76	2.92E-03	0.141	0.432	0.234	2.22E+00
52	49	1.00E-15	542.0	1.05	6.36E-03	0.190	0.411	0.547	1.37E-03
53	98	1.00E-15	250.8	1.12	1.14E-03	0.230	0.443	0.882	3.11E-03
54	47	1.00E-15	392.1	1.88	5.31E-03	0.174	0.423	0.465	5.70E+00
55	96	1.00E-15	792.7	1.10	5.83E-03	0.175	0.088	0.811	3.41E-03
56	45	1.00E-15	657.9	1.13	3.35E-03	0.156	0.193	0.272	2.55E+00
57	44	1.00E-15	822.6	1.00	3.88E-04	0.169	0.278	0.153	1.08E+01
58	43	1.00E-15	592.8	1.14	9.60E-04	0.163	0.433	0.693	4.35E-03
59	42	1.00E-15	68.4	1.22	1.06E-03	0.162	0.344	0.401	1.87E+00
60	91	1.00E-15	463.8	2.14	9.20E-03	0.158	0.113	0.864	8.42E-03
61	40	1.00E-15	671.0	1.08	3.59E-03	0.107	0.307	0.875	2.92E-02
62	89	1.00E-15	25.8	2.17	1.35E-03	0.134	0.215	0.581	2.12E-03
63	38	1.00E-15	38.5	1.22	6.56E-04	0.179	0.287	0.347	1.59E+00
64	37	1.00E-15	632.7	1.17	2.09E-03	0.166	0.485	0.315	5.45E+00
65	86	1.00E-15	729.7	2.00	7.46E-03	0.132	0.457	0.665	1.73E-02
66	85	1.00E-15	478.8	1.16	3.13E-03	0.127	0.056	0.176	1.76E+01
67	34	1.00E-15	128.6	1.24	3.73E-04	0.218	0.123	0.036	6.76E+00
68	33	1.00E-15	993.0	1.21	4.39E-04	0.165	0.237	0.103	4.28E+00
69	82	1.00E-15	501.6	1.18	7.01E-03	0.148	0.229	0.960	7.87E-04
70	31	1.00E-15	43.6	1.02	1.01E-04	0.104	0.151	0.833	2.70E-03
71	30	1.00E-15	989.7	1.21	1.65E-04	0.112	0.491	0.621	1.29E-02
72	29	1.00E-15	694.8	1.07	2.88E-04	0.198	0.364	0.995	4.74E-03
73	78	1.00E-15	174.3	1.09	4.38E-03	0.182	0.119	0.782	9.67E-05
74	27	1.00E-15	353.6	1.24	1.48E-04	0.222	0.324	0.858	1.22E-02
75	26	1.00E-15	568.1	1.52	3.74E-03	0.136	0.146	0.374	1.98E+00
[illegible]	75	1.00E-15	445.7	2.09	7.10E-04	0.126	0.337	0.413	1.81E+00
77	24	1.00E-15	349.1	1.05	4.21E-03	0.161	0.452	0.288	4.04E+00
78	23	1.00E-15	665.5	1.10	1.52E-03	0.178	0.205	0.603	2.38E-04
79	22	1.00E-15	769.2	1.02	3.17E-03	0.160	0.105	0.264	1.78E+00
80	21	1.00E-15	299.7	2.11	9.44E-04	0.119	0.355	0.489	1.07E+00
81	20	1.00E-15	453.2	1.15	1.38E-03	0.188	0.180	0.133	1.42E+00
82	19	1.00E-15	585.5	1.05	1.77E-04	0.110	0.129	0.088	1.96E+01
83	18	1.00E-15	558.3	1.13	5.23E-03	0.179	0.476	0.290	2.07E+00
84	17	1.00E-15	872.7	1.08	1.50E-03	0.115	0.405	0.128	1.11E+01
85	66	1.00E-15	428.3	1.81	8.75E-04	0.187	0.370	0.493	1.02E+01
86	65	1.00E-15	714.8	2.22	1.01E-03	0.110	0.339	0.007	1.48E+01
87	39	1.00E-15	898.5	1.25	7.75E-04	0.170	0.068	0.396	4.78E+00
88	13	1.00E-15	100.4	1.04	1.10E-04	0.167	0.195	0.568	1.42E-02
89	12	1.00E-15	225.7	1.03	2.63E-03	0.117	0.470	0.573	7.53E-03
90	36	1.00E-15	13.8	1.18	1.17E-03	0.101	0.330	0.451	2.60E+00
91	10	1.00E-15	685.8	1.07	8.46E-04	0.181	0.426	0.043	2.38E+00
92	9	1.00E-15	9.5	1.04	4.61E-04	0.101	0.100	0.426	9.08E-01
93	8	1.00E-15	162.8	1.12	6.80E-04	0.121	0.311	0.434	2.18E+00
94	7	1.00E-15	213.1	1.17	4.90E-03	0.190	0.221	0.894	6.99E-04
95	6	1.00E-15	278.4	1.19	2.34E-03	0.211	0.244	0.841	8.48E-04
96	5	1.00E-15	436.8	1.09	2.52E-03	0.167	0.440	0.022	4.19E+00
97	4	1.00E-15	812.1	1.24	8.87E-03	0.144	0.395	0.555	2.14E-02
98	3	1.00E-15	73.1	1.16	4.10E-03	0.239	0.079	0.443	5.81E+00
99	2	1.00E-15	307.0	1.20	1.62E-03	0.184	0.497	0.363	1.56E+00
100	1	1.00E-15	153.4	2.02	3.95E-03	0.112	0.481	0.386	6.99E+00

U234 CUMULATIVE RELEASE R3 FULLY MINED (Replicate 3)

R[illegible]	VEC	CUM REL	MINP_FAC	CLIMTIDX	APOROS	DPOROS	HMBLKT	OXSTAT	MKD_U
1	48	1.02E+00	371.7	1.04	5.38E-04	0.114	0.168	0.598	4.11E-05
2	16	8.90E-01	915.0	1.06	1.75E-03	0.176	0.210	0.769	6.15E-05
3	60	8.02E-01	511.9	1.89	1.30E-04	0.124	0.093	0.634	5.22E-05
4	41	7.28E-01	926.8	2.06	3.55E-04	0.183	0.113	0.701	1.13E-04
5	11	3.99E-02	144.6	2.20	3.05E-04	0.106	0.140	0.799	1.44E-04
6	69	8.66E-03	970.2	1.97	6.79E-03	0.106	0.050	0.775	2.49E-04
7	62	6.55E-03	264.2	1.06	7.59E-03	0.118	0.463	0.733	3.56E-05
8	14	3.07E-03	784.7	1.13	7.53E-04	0.139	0.303	0.612	5.93E-05
9	74	2.38E-03	199.4	1.23	1.07E-04	0.151	0.161	0.939	2.95E-04
10	46	3.00E-04	952.7	1.71	2.40E-04	0.207	0.376	0.740	1.64E-03
11	15	1.02E-04	533.6	1.03	2.57E-04	0.120	0.280	0.965	7.98E-05
12	25	2.48E-05	380.8	1.22	1.67E-04	0.245	0.299	0.514	2.61E-03
13	79	5.47E-06	862.9	1.74	3.28E-04	0.178	0.257	0.904	2.86E-04
14	54	2.86E-07	481.9	1.06	2.27E-04	0.122	0.273	0.531	1.82E-03
15	51	1.18E-07	774.4	1.09	2.21E-03	0.118	0.391	0.987	2.24E-03
16	61	7.84E-08	801.1	1.21	2.04E-04	0.180	0.232	0.754	3.16E-04
17	30	3.20E-09	989.7	1.21	1.65E-04	0.112	0.491	0.621	1.29E-02
18	73	5.23E-15	903.1	1.20	6.07E-03	0.136	0.350	0.924	7.69E-05
19	95	1.00E-15	117.7	1.14	1.44E-04	0.117	0.262	0.187	3.49E+00
20	83	1.00E-15	103.8	1.21	2.09E-04	0.113	0.379	0.828	1.70E-03
21	93	1.00E-15	403.9	1.11	9.58E-03	0.108	0.410	0.474	8.48E+00
22	92	1.00E-15	709.8	1.61	1.15E-04	0.153	0.200	0.214	1.48E+00
23	81	1.00E-15	184.6	1.85	8.09E-03	0.173	0.317	0.099	1.67E+01
24	77	1.00E-15	609.5	1.19	1.23E-03	0.184	0.156	0.978	2.75E-02
25	82	1.00E-15	501.6	1.18	7.01E-03	0.148	0.229	0.960	7.87E-04
[illegible]	100	1.00E-15	416.7	1.76	2.92E-03	0.141	0.432	0.234	2.22E+00
27	99	1.00E-15	752.1	1.66	2.94E-04	0.116	0.294	0.209	2.76E+00
28	88	1.00E-15	649.6	1.11	1.82E-03	0.162	0.134	0.118	3.68E+00
29	84	1.00E-15	90.3	1.01	4.84E-04	0.187	0.415	0.191	1.25E+01
30	71	1.00E-15	571.0	1.93	1.34E-04	0.236	0.224	0.328	2.96E+00
31	70	1.00E-15	738.2	1.11	8.08E-04	0.189	0.250	0.013	9.39E+00
32	94	1.00E-15	932.6	1.65	5.88E-04	0.111	0.185	0.069	2.50E+00
33	68	1.00E-15	529.6	1.24	2.64E-04	0.169	0.241	0.302	9.48E-01
34	67	1.00E-15	135.2	1.17	2.08E-03	0.155	0.099	0.165	6.66E+00
35	72	1.00E-15	367.0	1.14	2.40E-03	0.173	0.076	0.684	3.05E-03
36	90	1.00E-15	622.2	1.15	5.21E-04	0.176	0.266	0.334	1.39E+00
37	89	1.00E-15	25.8	2.17	1.35E-03	0.134	0.215	0.581	2.12E-03
38	63	1.00E-15	620.2	1.01	1.71E-03	0.103	0.292	0.679	6.44E-04
39	87	1.00E-15	843.0	1.01	1.29E-03	0.131	0.368	0.357	1.16E+00
40	97	1.00E-15	312.8	1.04	4.62E-03	0.143	0.069	0.053	2.34E+00
41	85	1.00E-15	478.8	1.16	3.13E-03	0.127	0.056	0.176	1.76E+01
42	59	1.00E-15	745.2	1.58	1.97E-03	0.105	0.257	0.657	3.67E-04
43	58	1.00E-15	321.4	1.13	1.99E-04	0.164	0.143	0.241	9.87E+00
44	57	1.00E-15	236.4	1.16	6.13E-04	0.129	0.325	0.949	1.91E-03
45	56	1.00E-15	857.4	1.53	1.53E-04	0.140	0.357	0.076	6.05E+00
46	55	1.00E-15	496.6	1.10	5.74E-03	0.188	0.084	0.714	1.90E-02
47	78	1.00E-15	174.3	1.09	4.38E-03	0.182	0.119	0.782	9.67E-05
48	53	1.00E-15	335.2	1.08	8.35E-03	0.186	0.062	0.250	9.86E-01
49	52	1.00E-15	965.2	1.01	4.21E-04	0.171	0.386	0.147	4.50E+00
50	76	1.00E-15	882.4	1.20	1.82E-04	0.149	0.165	0.721	5.38E-04

U234 CUMULATIVE RELEASE R3 FULLY MINED (Replicate 3)

R[illegible]	VEC	CUM REL	MINP_FAC	CLIMTIDX	APOROS	DPOROS	HMBLKT	OXSTAT	MKD_U
51	50	1.00E-15	832.6	1.19	5.70E-04	0.185	0.490	0.645	4.32E-04
52	49	1.00E-15	542.0	1.05	6.36E-03	0.190	0.411	0.547	1.37E-03
53	98	1.00E-15	250.8	1.12	1.14E-03	0.230	0.443	0.882	3.11E-03
54	47	1.00E-15	392.1	1.88	5.31E-03	0.174	0.423	0.465	5.70E+00
55	96	1.00E-15	792.7	1.10	5.83E-03	0.175	0.088	0.811	3.41E-03
56	45	1.00E-15	657.9	1.13	3.35E-03	0.156	0.193	0.272	2.55E+00
57	44	1.00E-15	822.6	1.00	3.88E-04	0.169	0.278	0.153	1.08E+01
58	43	1.00E-15	592.8	1.14	9.60E-04	0.163	0.433	0.693	4.35E-03
59	42	1.00E-15	68.4	1.22	1.06E-03	0.162	0.344	0.401	1.87E+00
60	91	1.00E-15	463.8	2.14	9.20E-03	0.158	0.113	0.864	8.42E-03
61	40	1.00E-15	671.0	1.08	3.59E-03	0.107	0.307	0.875	2.92E-02
62	39	1.00E-15	898.5	1.25	7.75E-04	0.170	0.068	0.396	4.78E+00
63	38	1.00E-15	38.5	1.22	6.56E-04	0.179	0.287	0.347	1.59E+00
64	37	1.00E-15	632.7	1.17	2.09E-03	0.166	0.485	0.315	5.45E+00
65	86	1.00E-15	729.7	2.00	7.46E-03	0.132	0.457	0.665	1.73E-02
66	35	1.00E-15	945.9	1.02	2.31E-04	0.146	0.173	0.916	1.24E-04
67	34	1.00E-15	128.6	1.24	3.73E-04	0.218	0.123	0.036	6.76E+00
68	33	1.00E-15	993.0	1.21	4.39E-04	0.165	0.237	0.103	4.28E+00
69	32	1.00E-15	284.4	1.16	3.33E-04	0.113	0.400	0.529	6.13E-04
70	31	1.00E-15	43.6	1.02	1.01E-04	0.104	0.151	0.833	2.70E-03
71	80	1.00E-15	53.3	1.78	2.77E-03	0.181	0.448	0.229	4.88E+00
72	29	1.00E-15	694.8	1.07	2.88E-04	0.198	0.364	0.995	4.74E-03
73	28	1.00E-15	203.1	1.11	4.04E-04	0.160	0.184	0.502	3.13E-05
74	27	1.00E-15	353.6	1.24	1.48E-04	0.222	0.324	0.858	1.22E-02
75	26	1.00E-15	568.1	1.52	3.74E-03	0.136	0.146	0.374	1.98E+00
[illegible]	75	1.00E-15	445.7	2.09	7.10E-04	0.126	0.337	0.413	1.81E+00
[illegible]	24	1.00E-15	349.1	1.05	4.21E-03	0.161	0.452	0.288	4.04E+00
78	23	1.00E-15	665.5	1.10	1.52E-03	0.178	0.205	0.603	2.38E-04
79	22	1.00E-15	769.2	1.02	3.17E-03	0.160	0.105	0.264	1.78E+00
80	21	1.00E-15	299.7	2.11	9.44E-04	0.119	0.355	0.489	1.07E+00
81	20	1.00E-15	453.2	1.15	1.38E-03	0.188	0.180	0.133	1.42E+00
82	19	1.00E-15	585.5	1.05	1.77E-04	0.110	0.129	0.088	1.96E+01
83	18	1.00E-15	558.3	1.13	5.23E-03	0.179	0.476	0.290	2.07E+00
84	17	1.00E-15	872.7	1.08	1.50E-03	0.115	0.405	0.128	1.11E+01
85	66	1.00E-15	428.3	1.81	8.75E-04	0.187	0.370	0.493	1.02E+01
86	65	1.00E-15	714.8	2.22	1.01E-03	0.110	0.339	0.007	1.48E+01
87	64	1.00E-15	245.4	1.23	1.23E-04	0.171	0.465	0.807	4.86E-04
88	13	1.00E-15	100.4	1.04	1.10E-04	0.167	0.195	0.568	1.42E-02
89	12	1.00E-15	225.7	1.03	2.63E-03	0.117	0.470	0.573	7.53E-03
90	36	1.00E-15	13.8	1.18	1.17E-03	0.101	0.330	0.451	2.60E+00
91	10	1.00E-15	685.8	1.07	8.46E-04	0.181	0.426	0.043	2.38E+00
92	9	1.00E-15	9.5	1.04	4.61E-04	0.101	0.100	0.426	9.08E-01
93	8	1.00E-15	162.8	1.12	6.80E-04	0.121	0.311	0.434	2.18E+00
94	7	1.00E-15	213.1	1.17	4.90E-03	0.190	0.221	0.894	6.99E-04
95	6	1.00E-15	278.4	1.19	2.34E-03	0.211	0.244	0.841	8.48E-04
96	5	1.00E-15	436.8	1.09	2.52E-03	0.167	0.440	0.022	4.19E+00
97	4	1.00E-15	812.1	1.24	8.87E-03	0.144	0.395	0.555	2.14E-02
98	3	1.00E-15	73.1	1.16	4.10E-03	0.239	0.079	0.443	5.81E+00
99	2	1.00E-15	307.0	1.20	1.62E-03	0.184	0.497	0.363	1.56E+00
100	1	1.00E-15	153.4	2.02	3.95E-03	0.112	0.481	0.386	6.99E+00

APPENDIX D

RESULTS FOR
CUTTINGS, CAVINGS, AND SPALLINGS RELEASES

Appendix D includes Figures which contain results from cuttings, cavings, and spallings calculations for PAVT replicates 2 and 3.

<u>Figures</u>

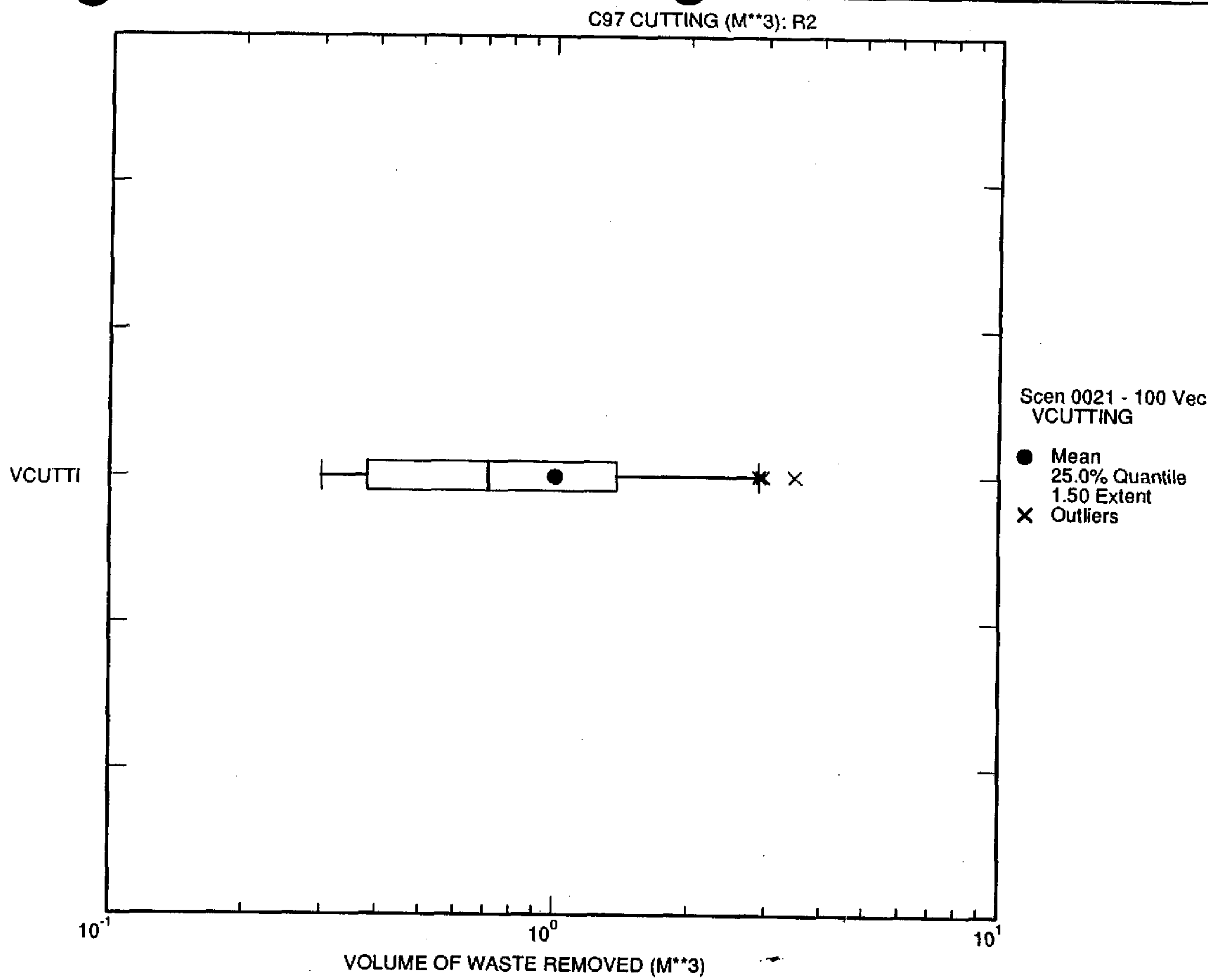
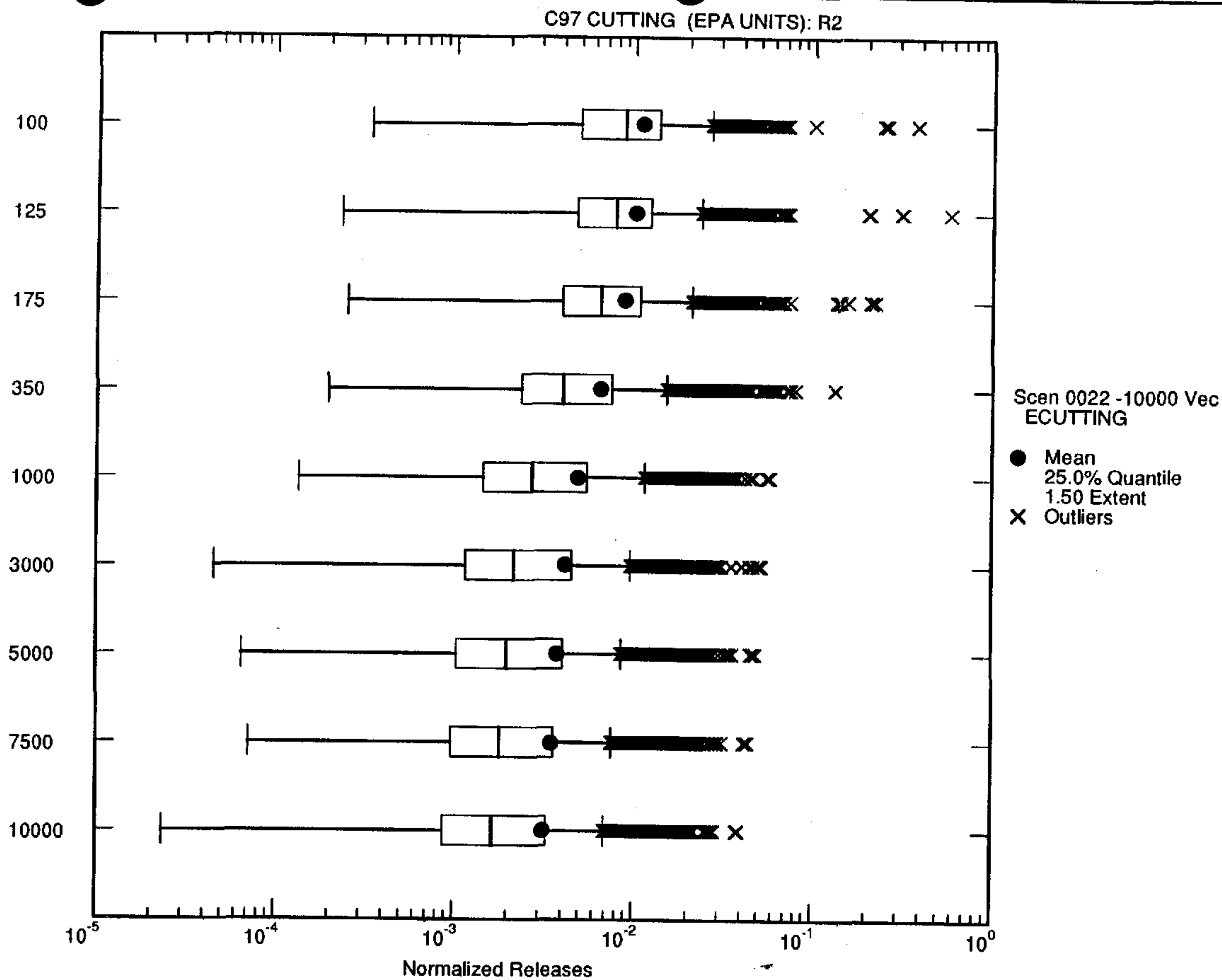


Figure D.1

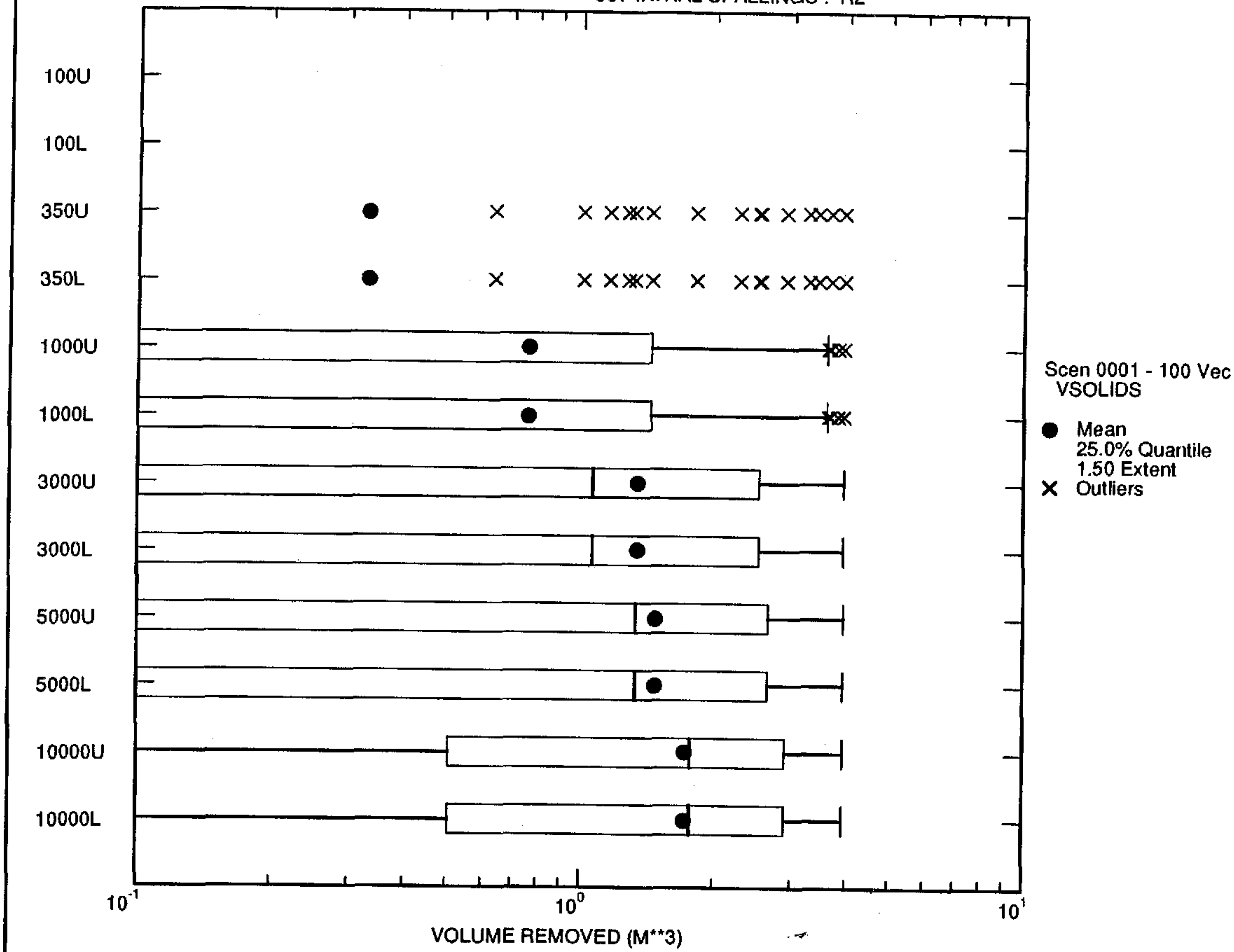
NUCPLOT PA96 1.19 07/31/97 14:32



0.2.

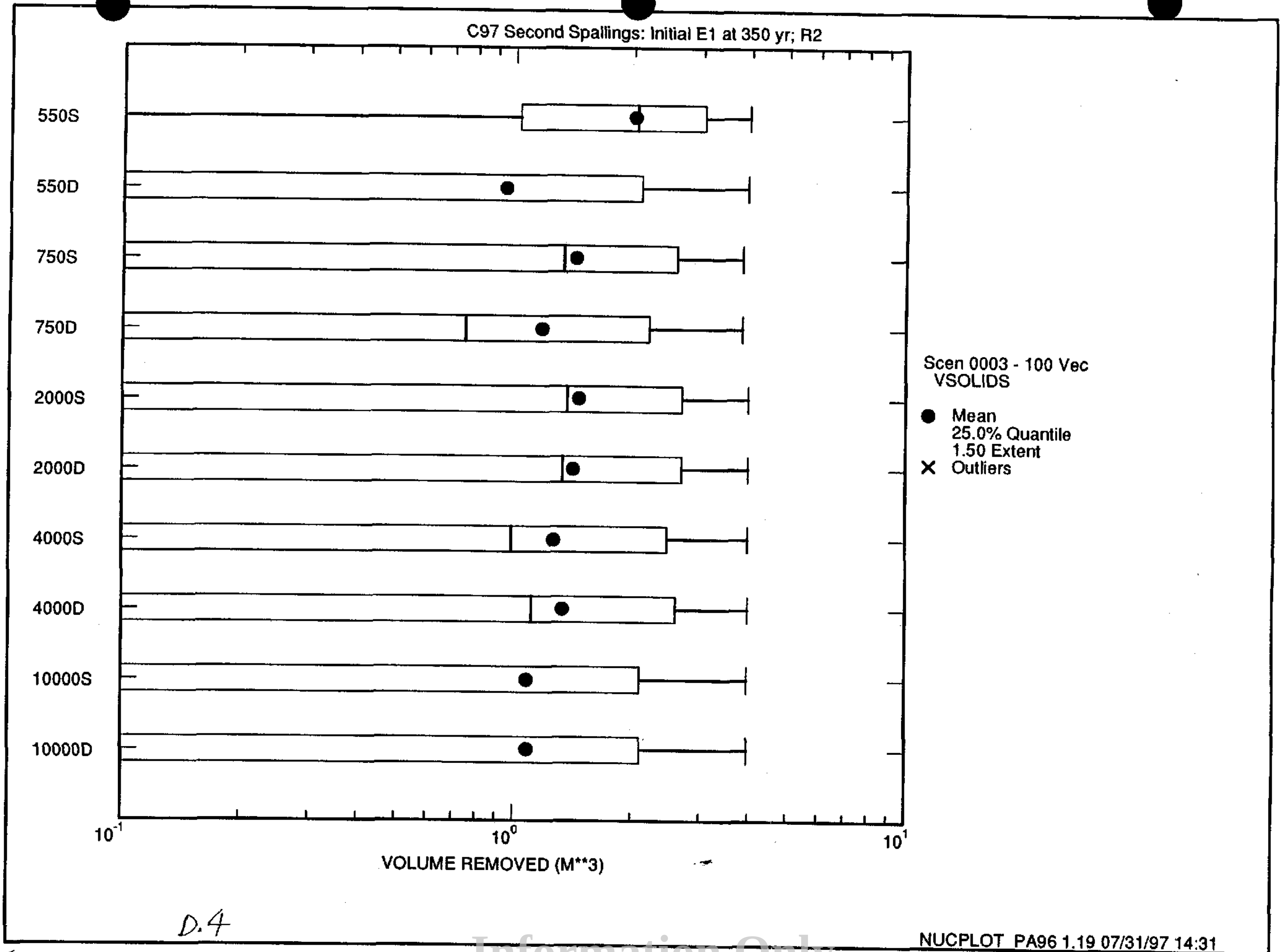
NUCPLOT PA96 1.19 07/31/97 14:31

C97 INITIAL SPALLINGS : R2

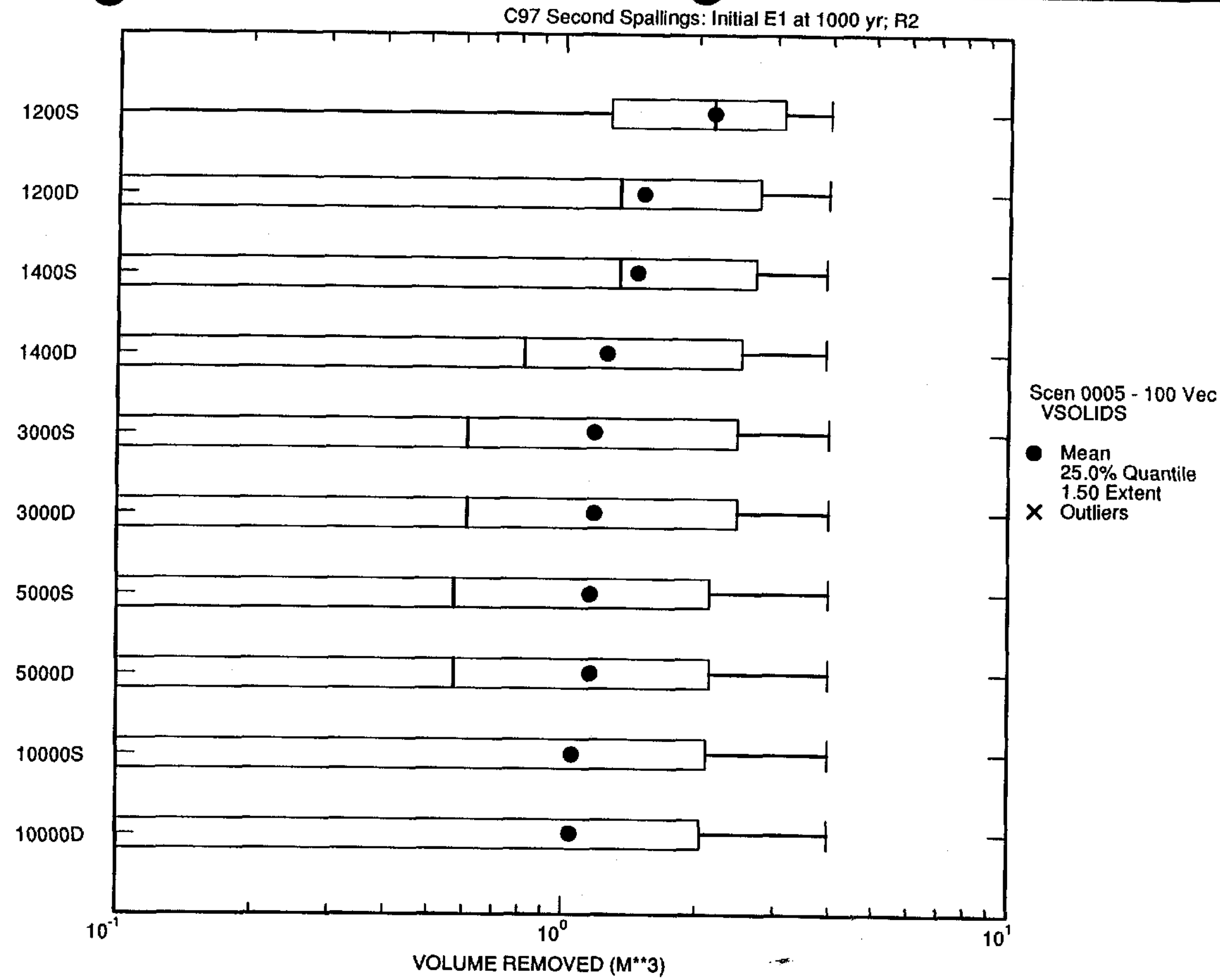


D.3

NUCPLOT PA96 1.19 07/31/97 14:31


C97 Second Spallings: Initial E1 at 350 yr; R2
550S
550D
750S
750D
2000S
2000D
4000S
4000D
10000S
10000D
10^{-1}
10^{0}
10^{1}
VOLUME REMOVED (M**3)
Scen 0003 - 100 Vec
VSOLIDS
Mean
25.0% Quantile
1.50 Extent
Outliers
NUCPLOT PA96 1.19 07/31/97 14:31

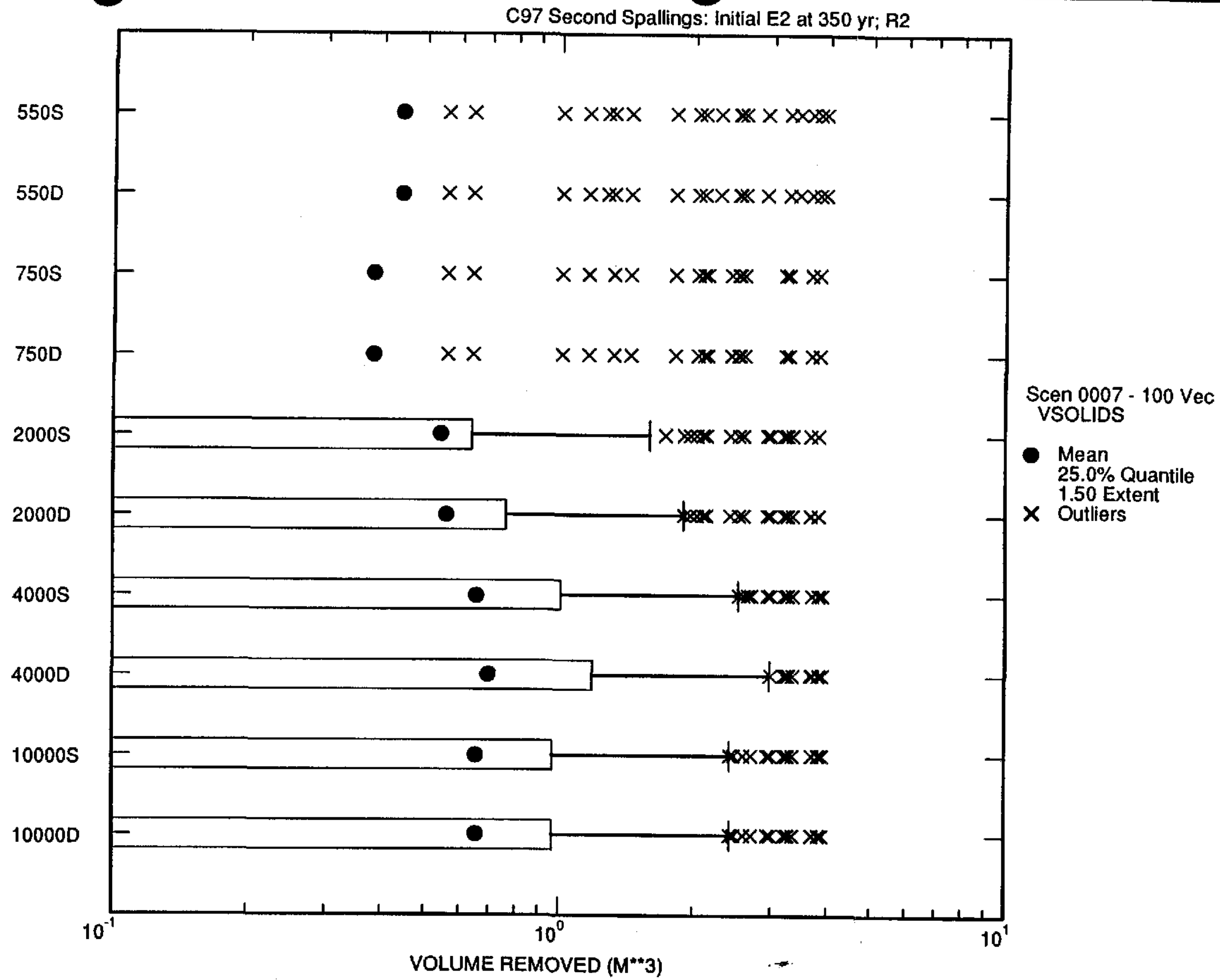
D.4



0.5

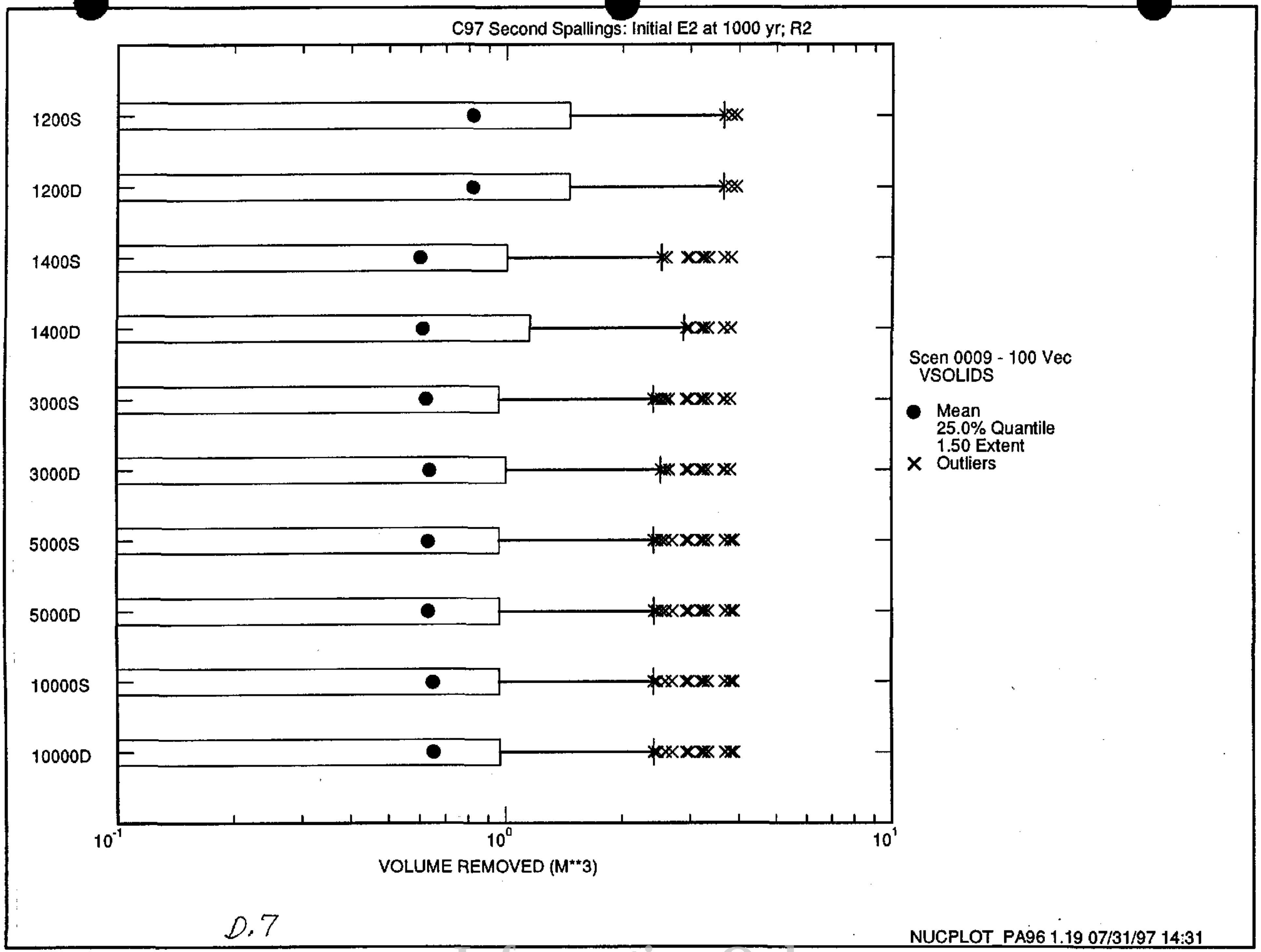
NUCPLOT PA96 1.19 07/31/97 14:31

113



D.6

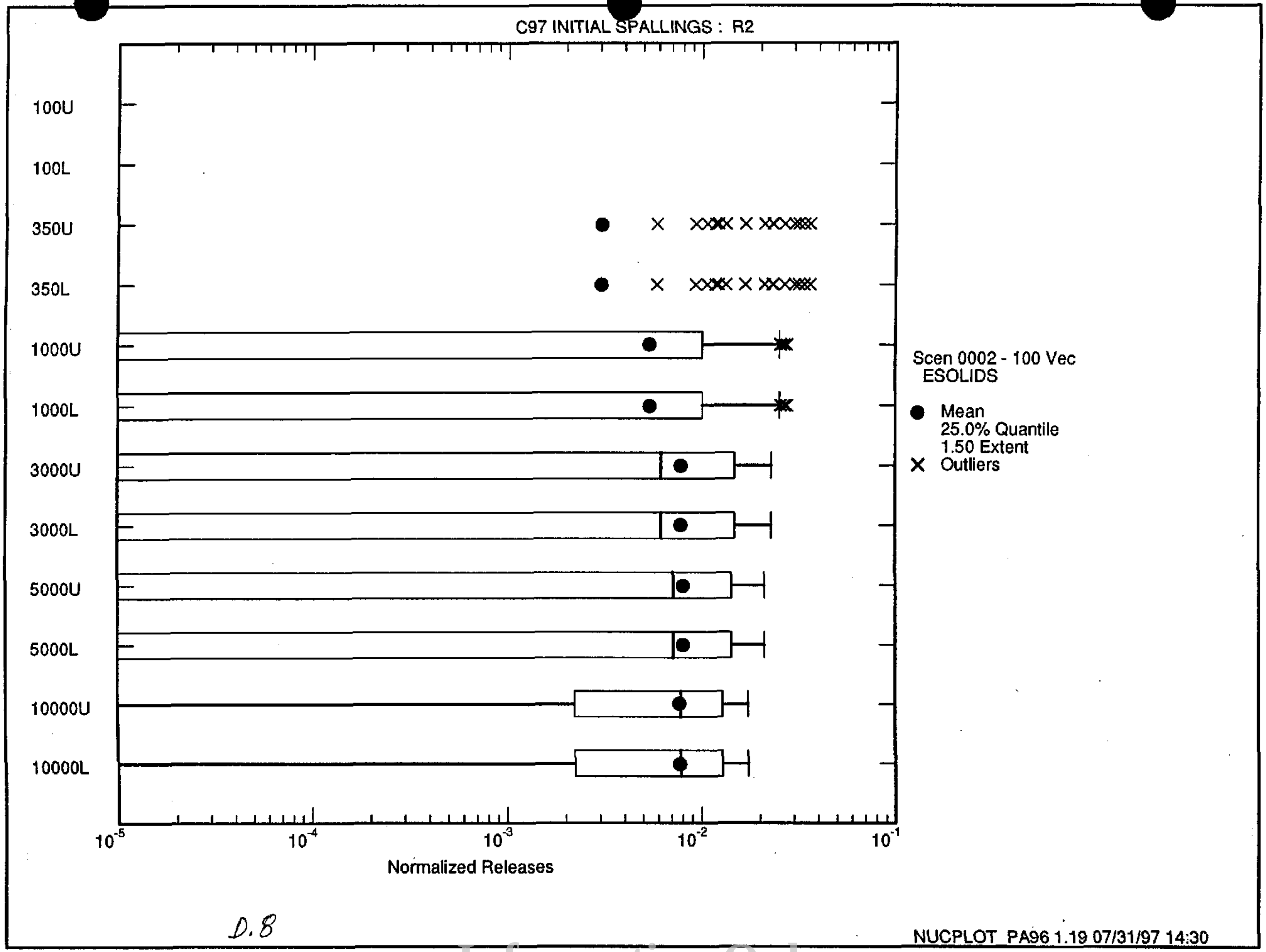
NUCPLOT PA96 1.19 07/31/97 14:31



C97 Second Spallings: Initial E2 at 1000 yr; R2
1200S
1200D
1400S
1400D
3000S
3000D
5000S
5000D
10000S
10000D
10^{-1}
10^{0}
10^{1}
VOLUME REMOVED (M**3)
Scen 0009 - 100 Vec
VSOLIDS
Mean
25.0% Quantile
1.50 Extent
Outliers
NUCPLOT_PA96 1.19 07/31/97 14:31

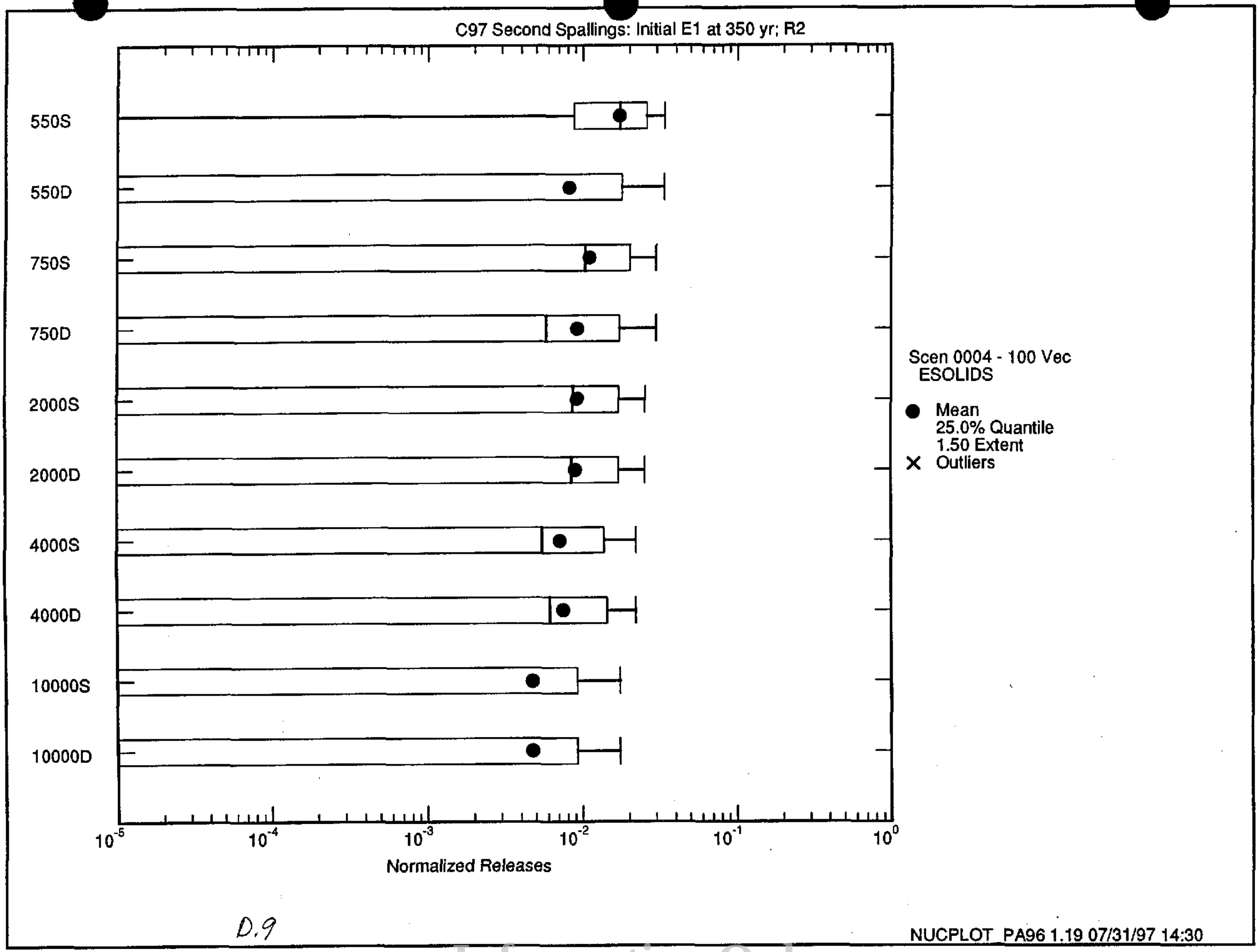
D.7

115


C97 INITIAL SPALLINGS : R2
100U
100L
350U
350L
1000U
1000L
3000U
3000L
5000U
5000L
10000U
10000L
10^{-5}
10^{-4}
10^{-3}
10^{-2}
10^{-1}
Normalized Releases
Scen 0002 - 100 Vec
ESOLIDS
Mean
25.0% Quantile
1.50 Extent
Outliers
NUCPLOT PA96 1.19 07/31/97 14:30

D.8

116

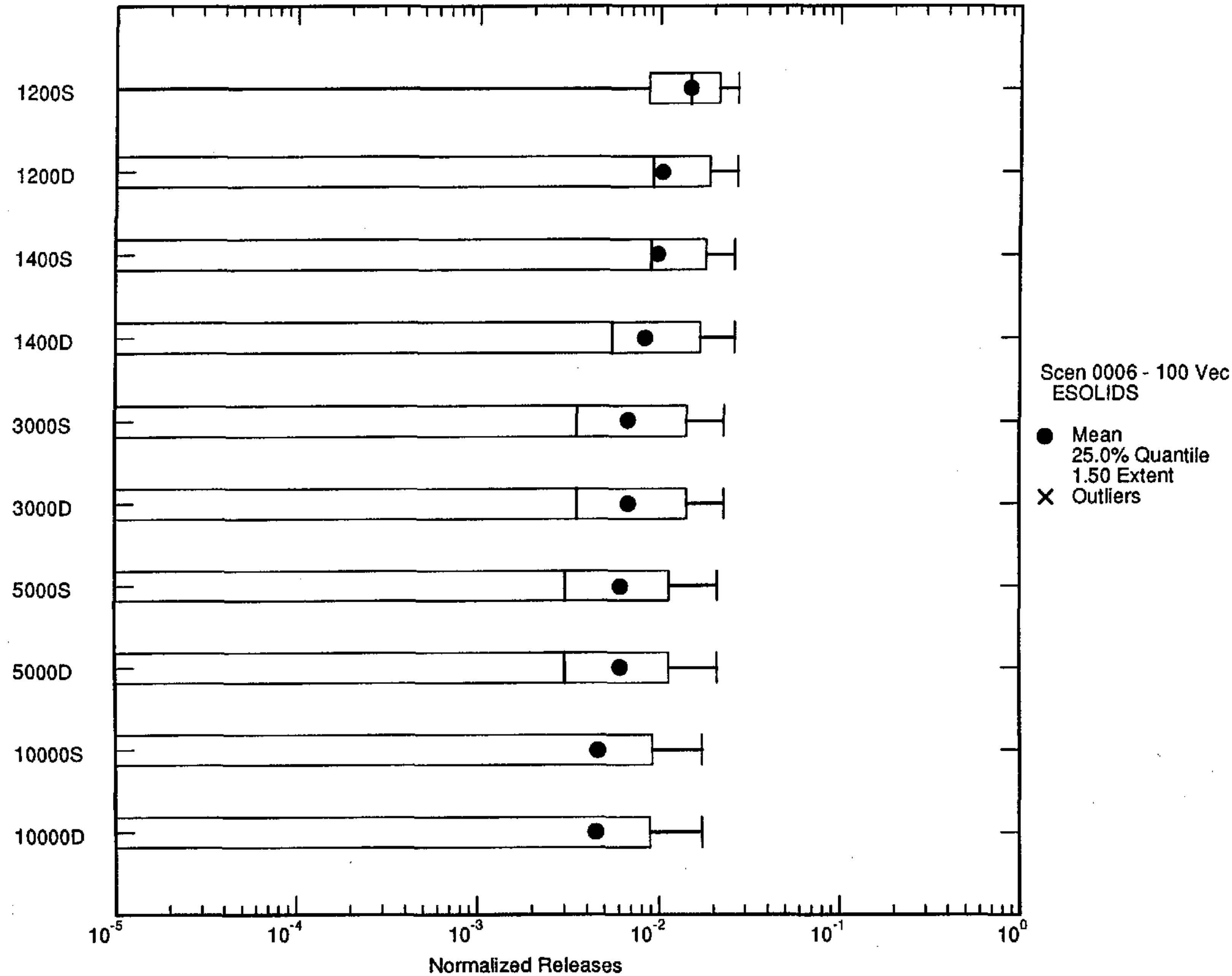


C97 Second Spallings: Initial E1 at 350 yr; R2
550S
550D
750S
750D
2000S
2000D
4000S
4000D
10000S
10000D
10-5
10-4
10-3
10-2
10-1
10-0
Normalized Releases
Scen 0004 - 100 Vec
ESOLIDS
Mean
25.0% Quantile
1.50 Extent
Outliers
NUCPLOT_PA96 1.19 07/31/97 14:30

D.9

117

C97 Second Spallings: Initial E1 at 1000 yr; R2



D.10

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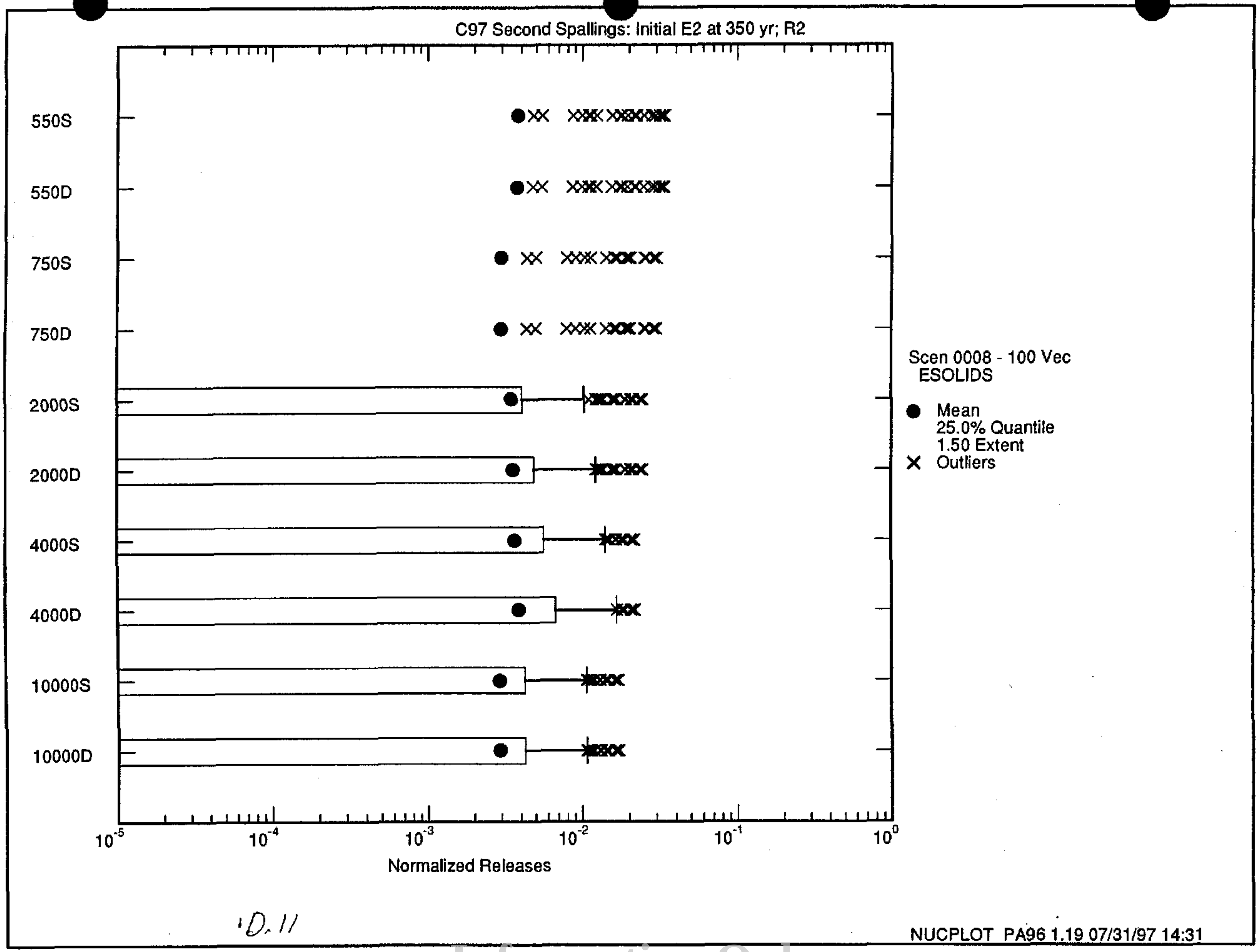
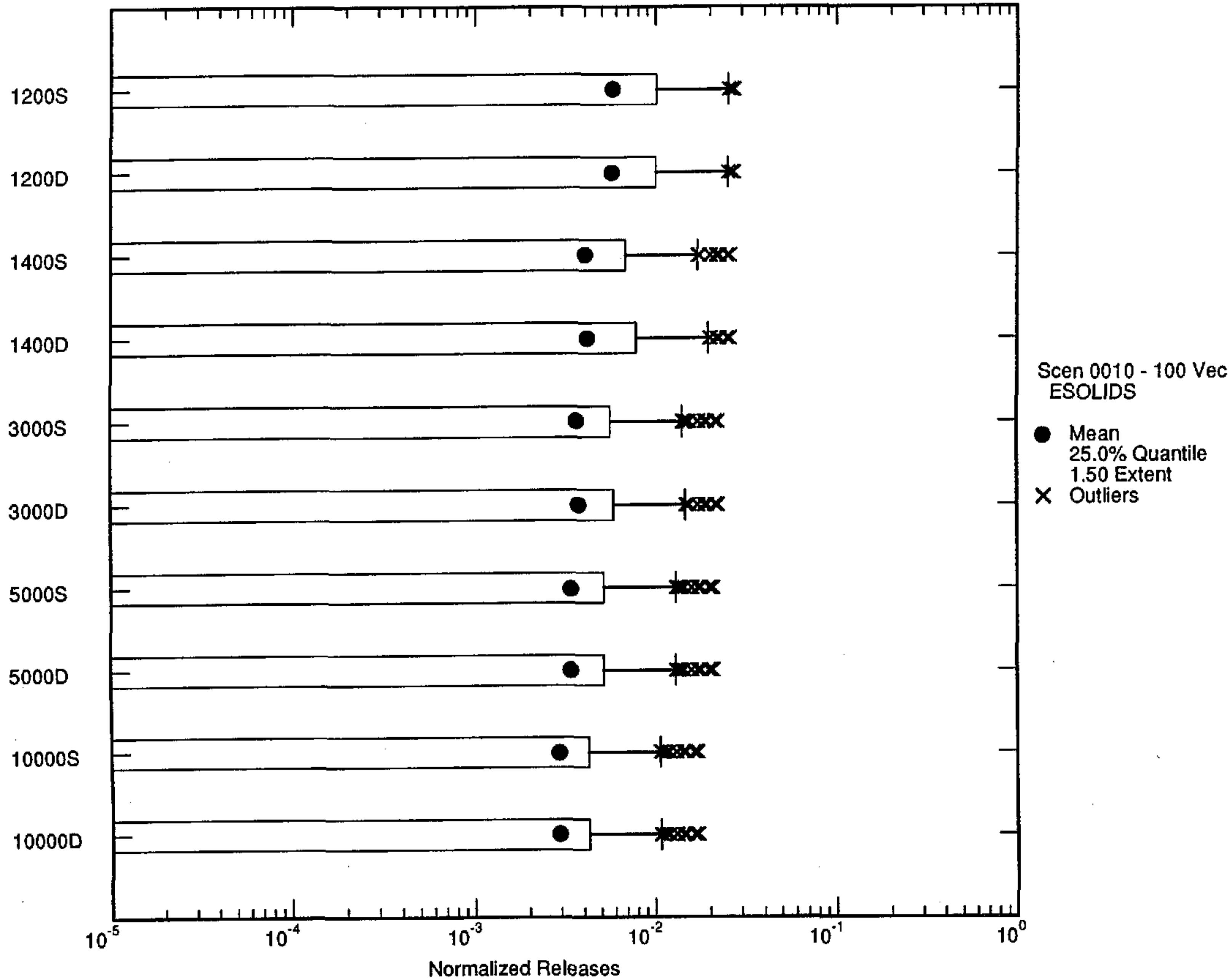


C97 Second Spallings: Initial E2 at 350 yr; R2
550S
550D
750S
750D
2000S
2000D
4000S
4000D
10000S
10000D
10^{-5}
10^{-4}
10^{-3}
10^{-2}
10^{-1}
10^{0}
Normalized Releases
Scen 0008 - 100 Vec
ESOLIDS
Mean
25.0% Quantile
1.50 Extent
Outliers
NUCPLOT PA96 1.19 07/31/97 14:31

D.11

C97 Second Spallings: Initial E2 at 1000 yr; R2

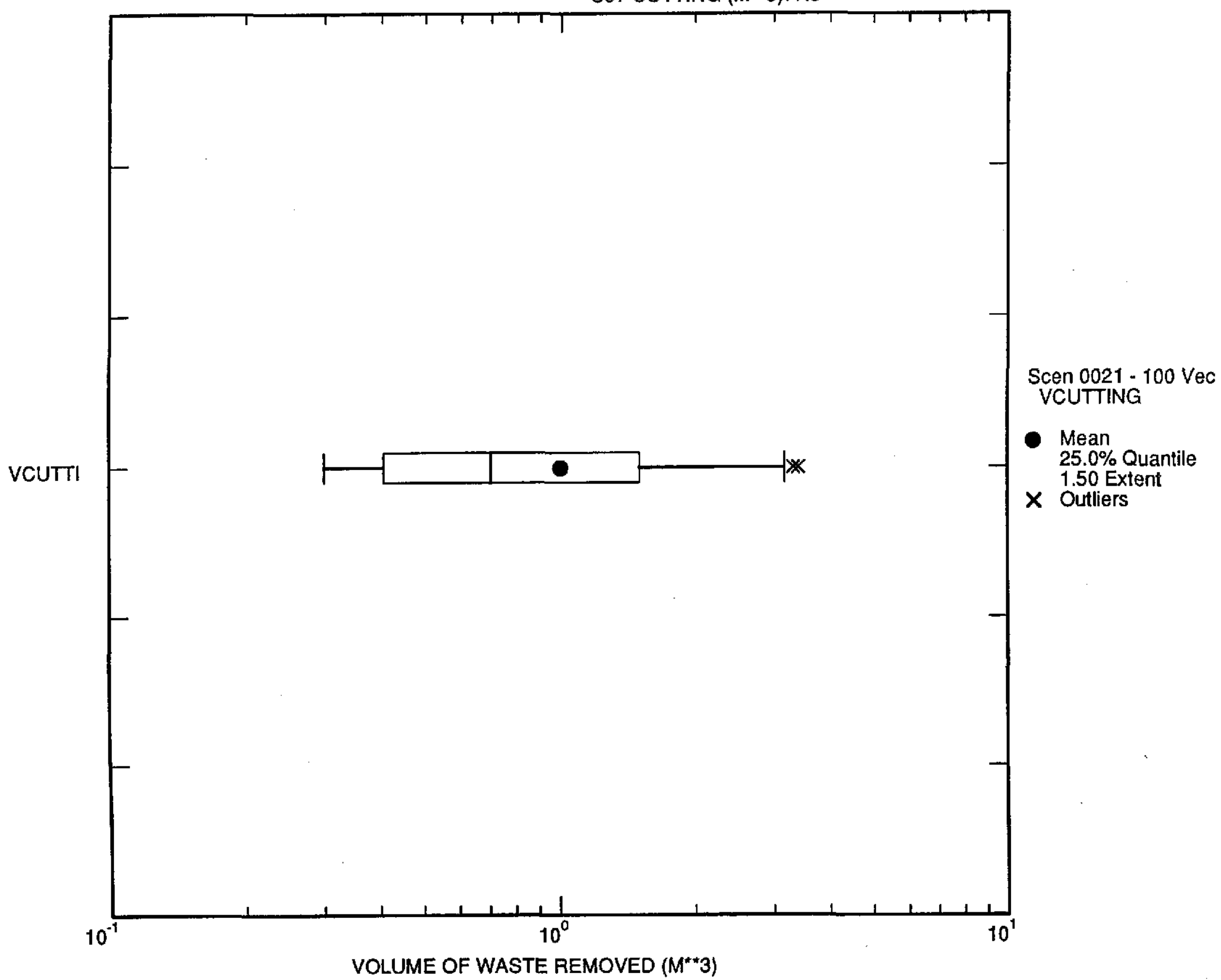


p. 12

NUCPLOT_PA96 1.19 07/31/97 14:31

120

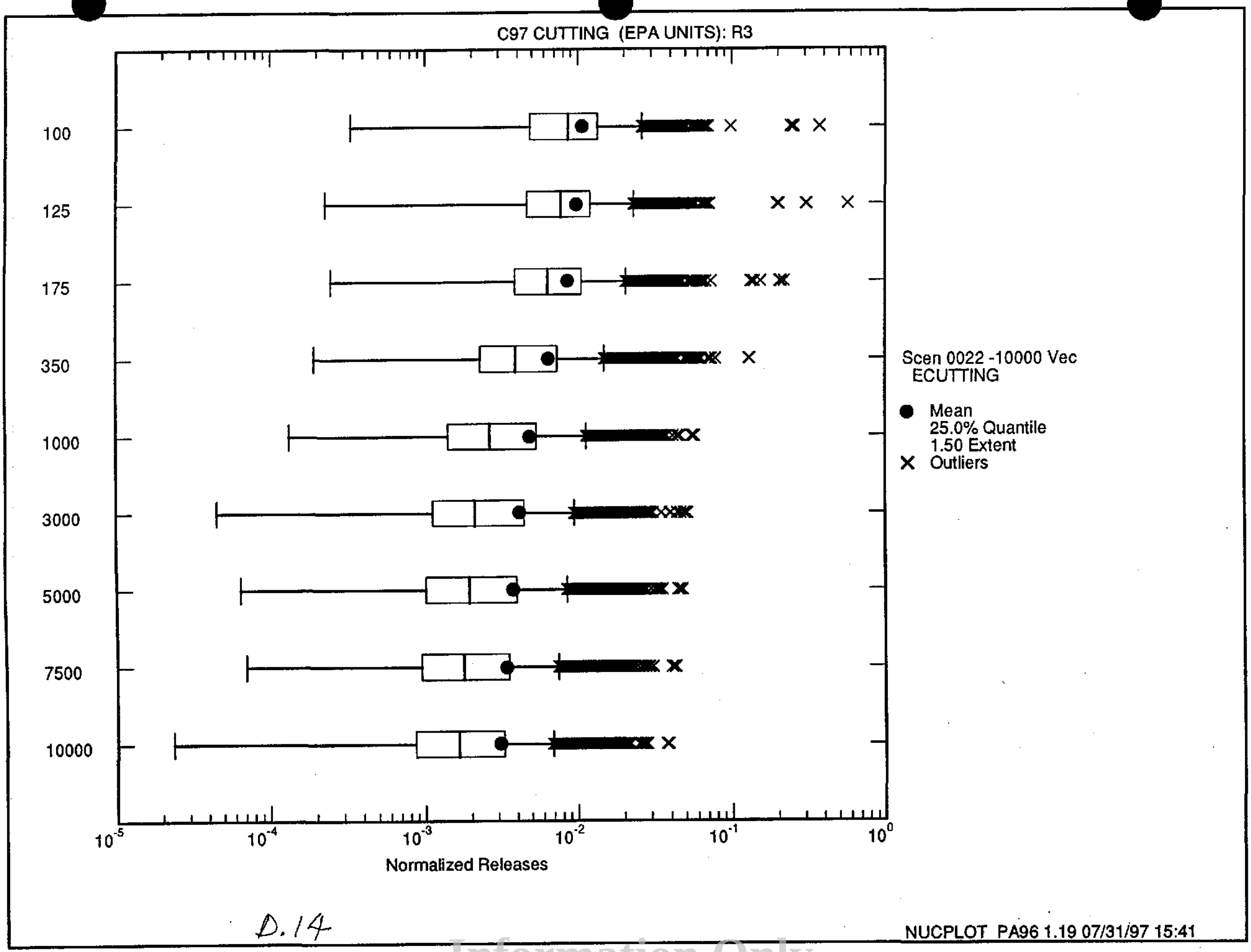
C97 CUTTING (M**3): R3



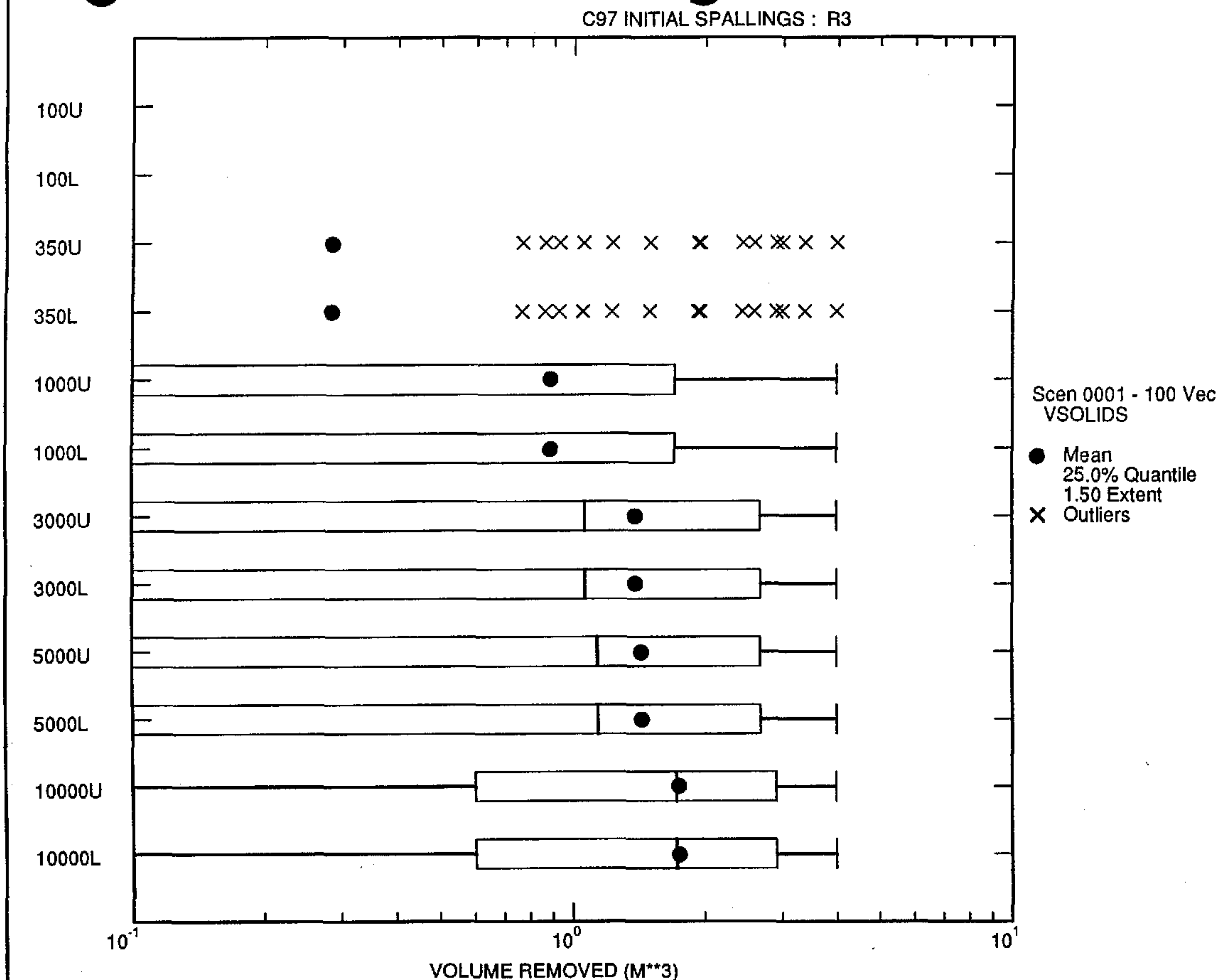
D.13

NUCPLOT_PA96 1.19 07/31/97 15:42

121


C97 CUTTING (EPA UNITS): R3
100
125
175
350
1000
3000
5000
7500
10000
10^{-5}
10^{-4}
10^{-3}
10^{-2}
10^{-1}
10^{0}
Normalized Releases
Scen 0022 -10000 Vec
ECUTTING
Mean
25.0% Quantile
1.50 Extent
Outliers
NUCPLOT PA96 1.19 07/31/97 15:41

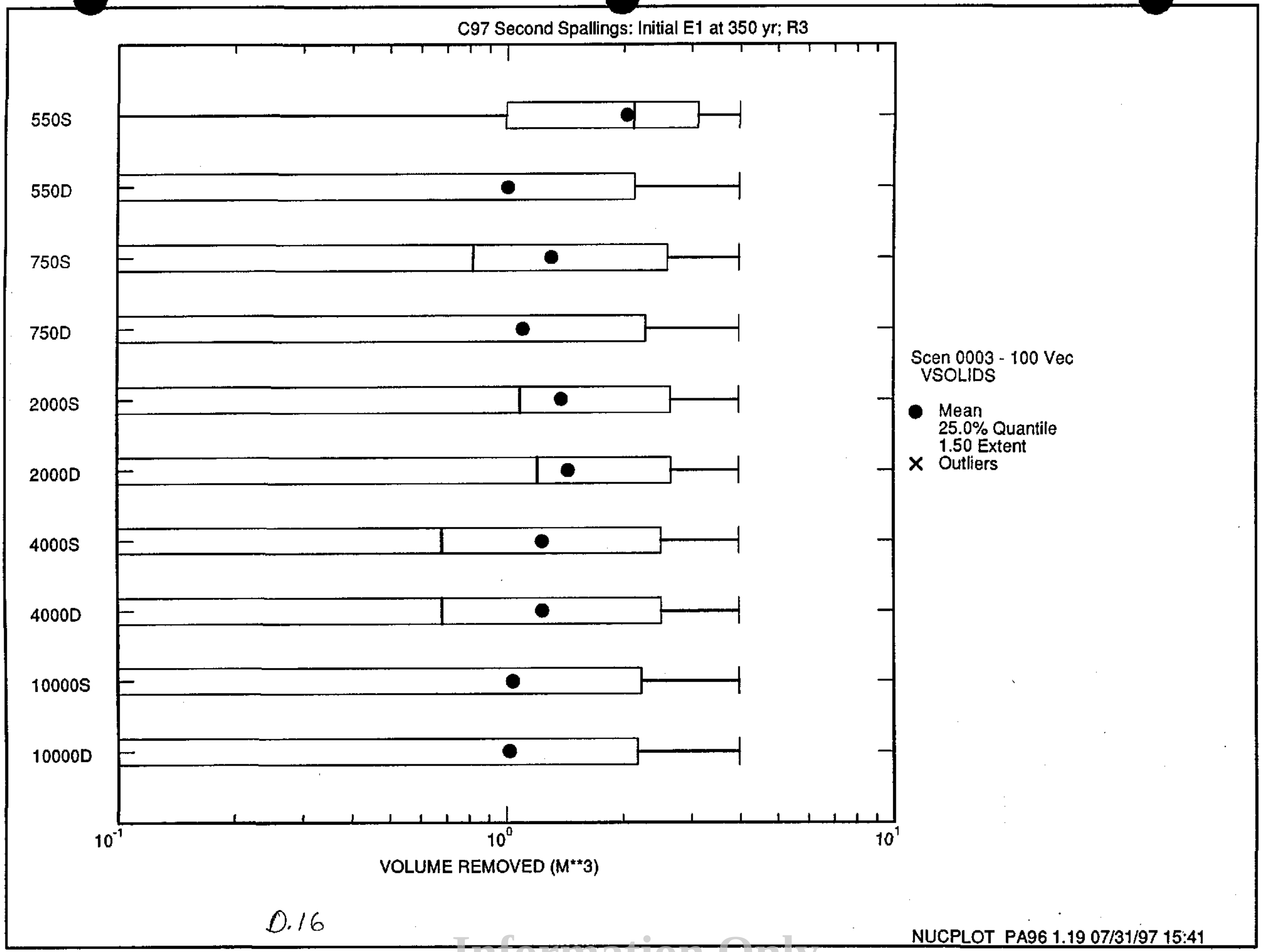
D.14



NUCPLOT PA96 1.19 07/31/97 15:41

D.15

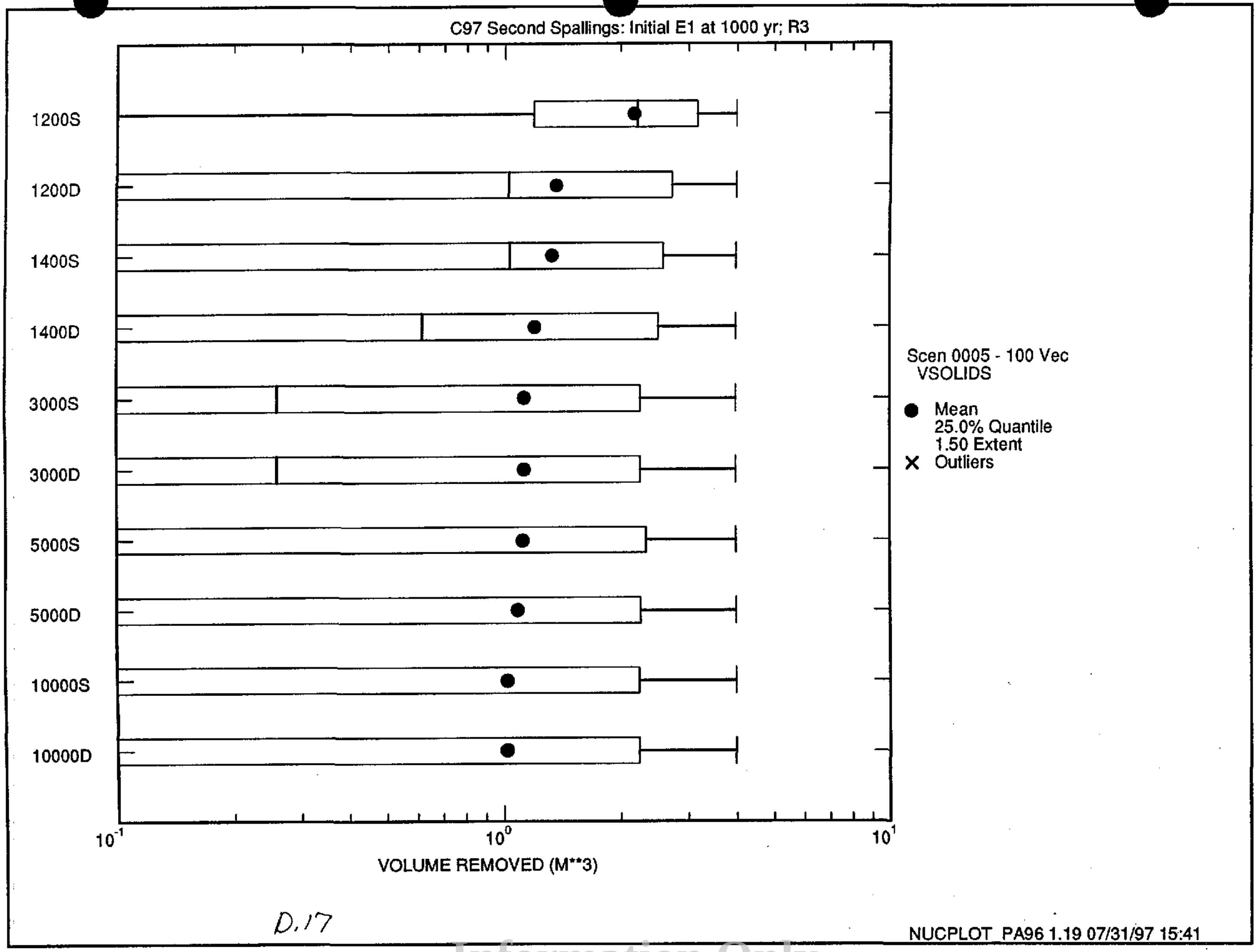
123



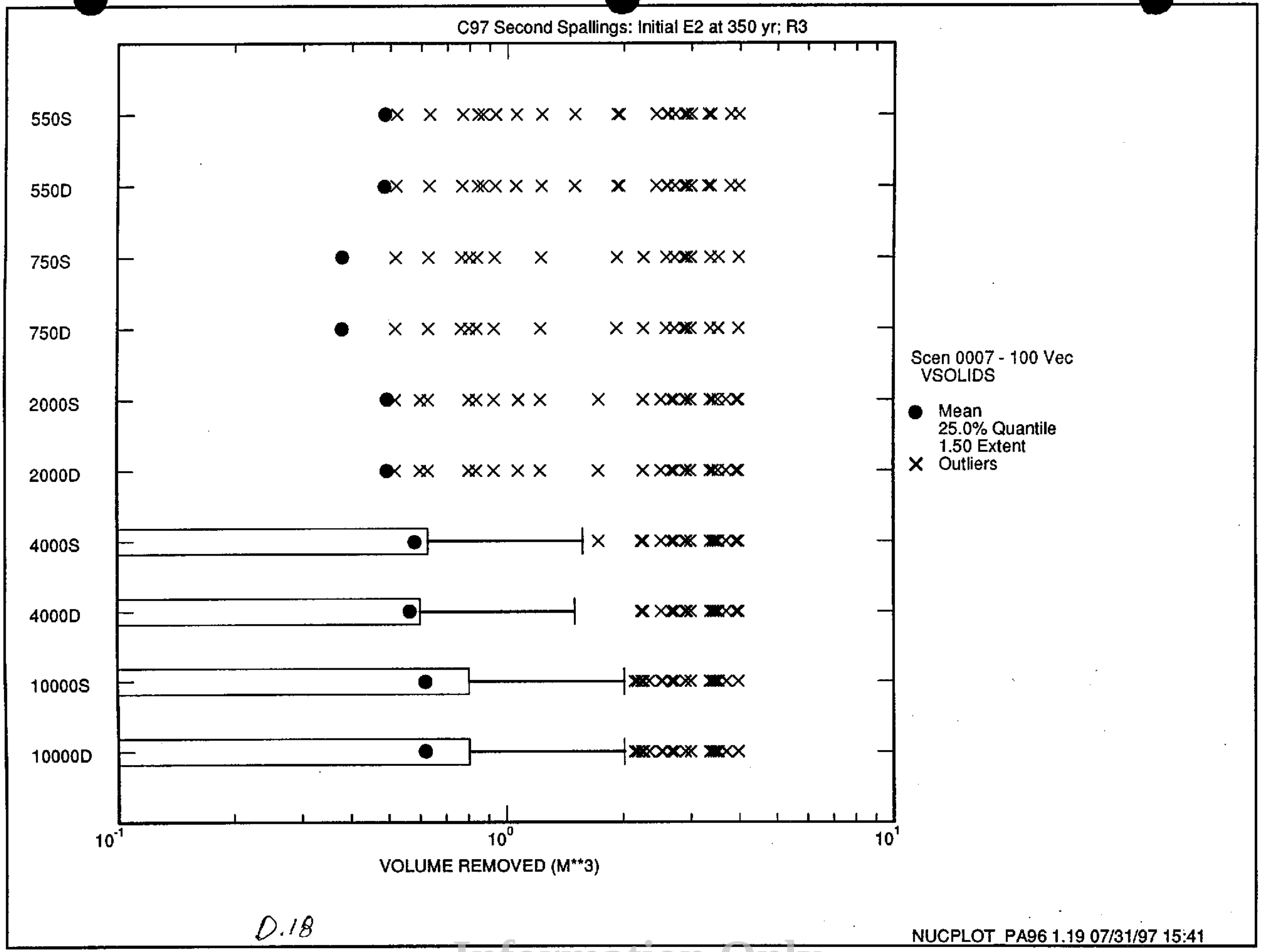
C97 Second Spallings: Initial E1 at 350 yr; R3
550S
550D
750S
750D
2000S
2000D
4000S
4000D
10000S
10000D
10^{-1}
10^{0}
10^{1}
VOLUME REMOVED (M**3)
Scen 0003 - 100 Vec
VSOLIDS
Mean
25.0% Quantile
1.50 Extent
Outliers
NUCPLOT PA96 1.19 07/31/97 15:41

D.16

124

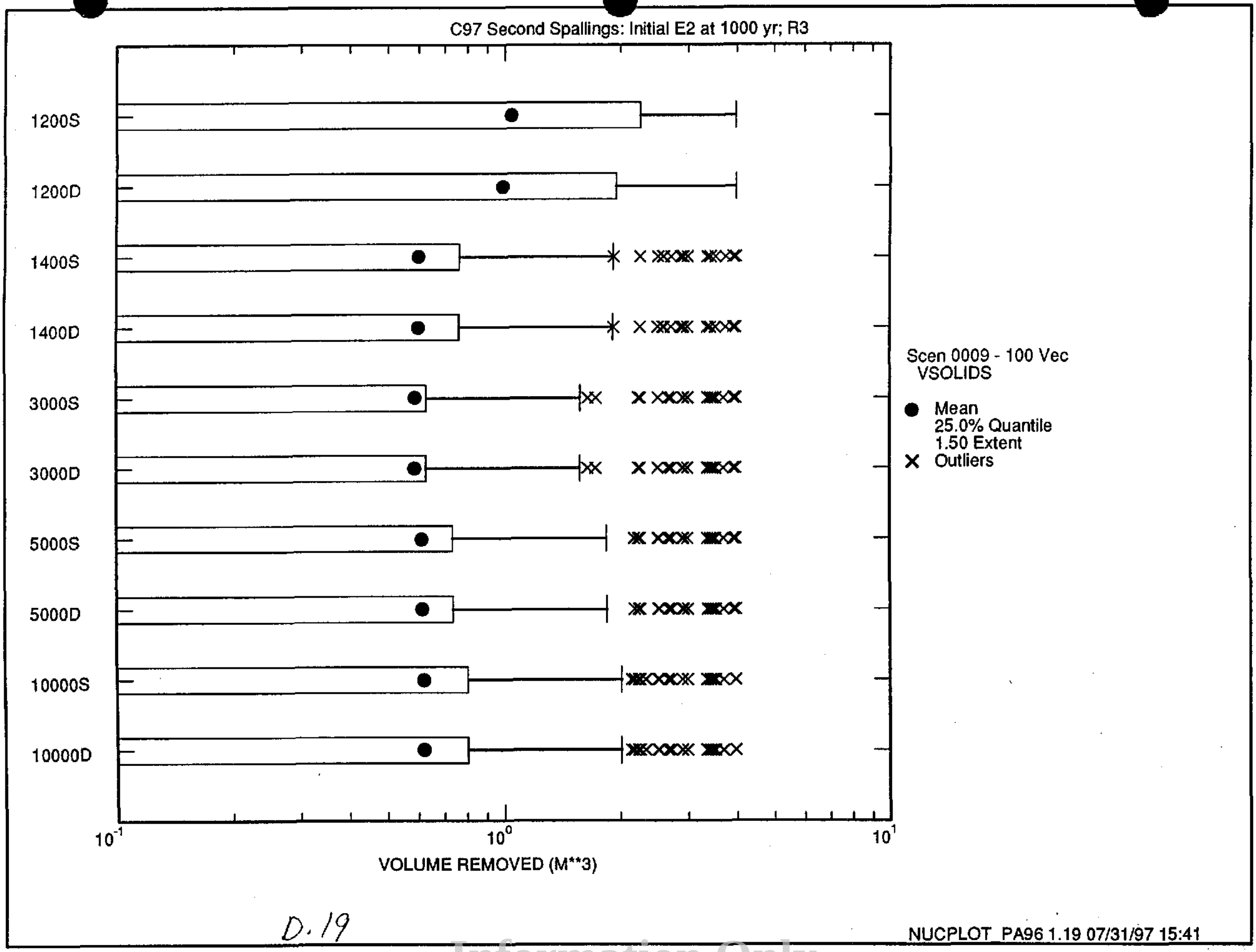

C97 Second Spallings: Initial E1 at 1000 yr; R3
1200S
1200D
1400S
1400D
3000S
3000D
5000S
5000D
10000S
10000D
10^{-1}
10^{0}
10^{1}
VOLUME REMOVED (M**3)
Scen 0005 - 100 Vec
VSOLIDS
Mean
25.0% Quantile
1.50 Extent
Outliers
NUCPLOT_PA96 1.19 07/31/97 15:41

D.17


C97 Second Spallings: Initial E2 at 350 yr; R3
550S
550D
750S
750D
2000S
2000D
4000S
4000D
10000S
10000D
10^{-1}
10^{0}
10^{1}
VOLUME REMOVED (M**3)
Scen 0007 - 100 Vec
VSOLIDS
Mean
25.0% Quantile
1.50 Extent
Outliers
NUCPLOT_PA96 1.19 07/31/97 15:41

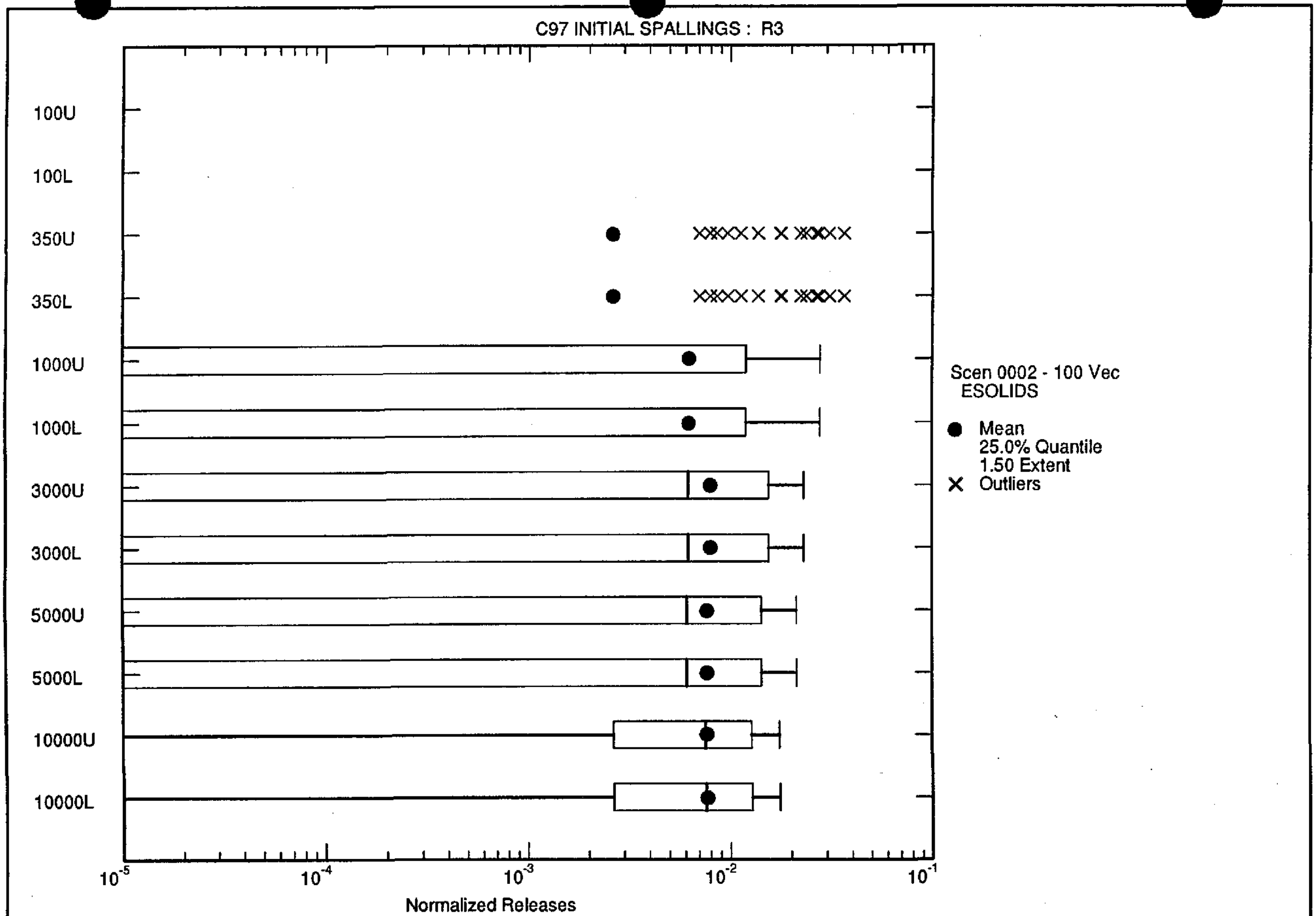
D.18

126


C97 Second Spallings: Initial E2 at 1000 yr; R3
1200S
1200D
1400S
1400D
3000S
3000D
5000S
5000D
10000S
10000D
10^{-1}
10^{0}
10^{1}
VOLUME REMOVED (M**3)
Scen 0009 - 100 Vec
VSOLIDS
Mean
25.0% Quantile
1.50 Extent
Outliers
NUCPLOT_PA96 1.19 07/31/97 15:41

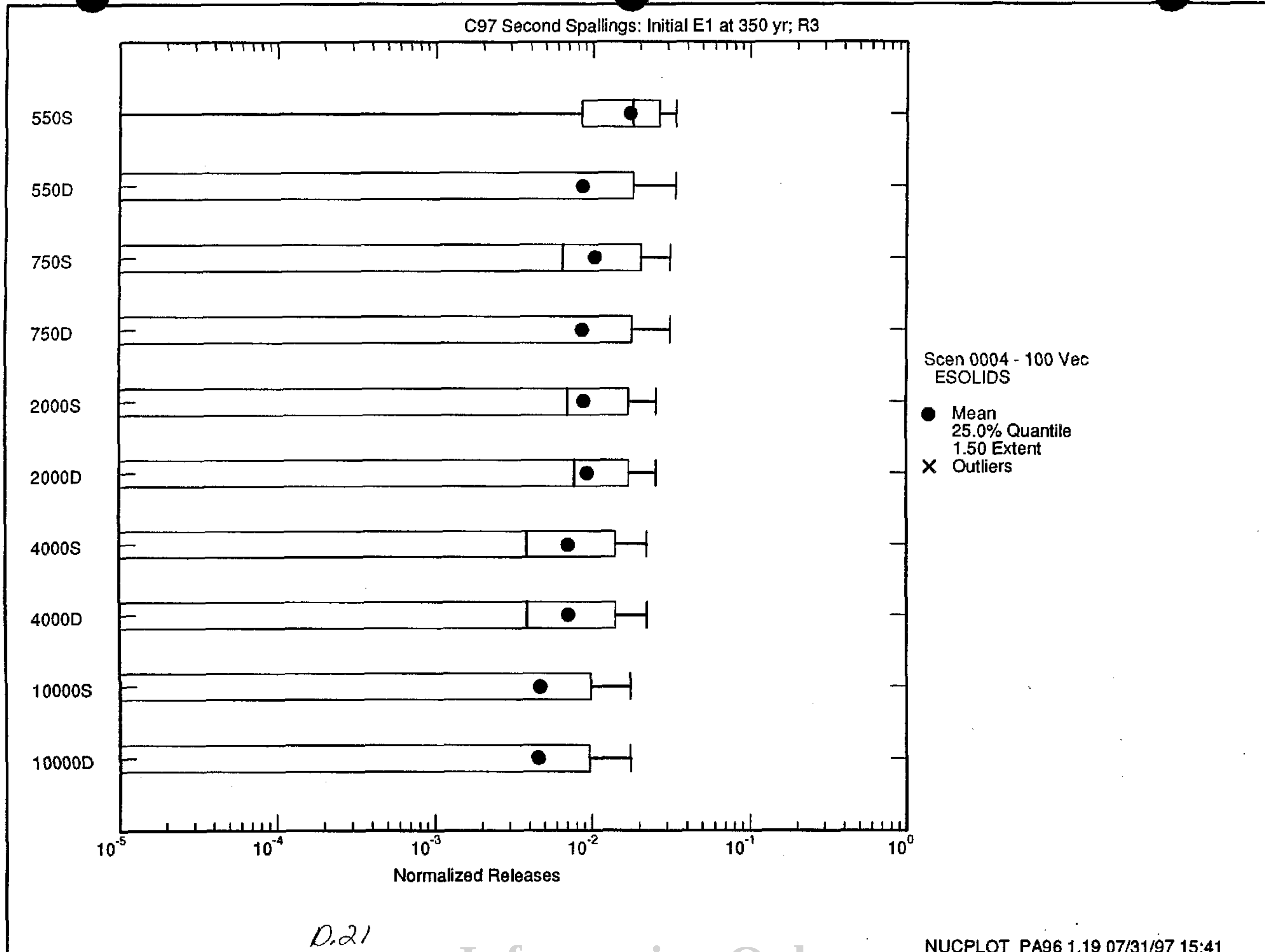
D.19

127



D.20

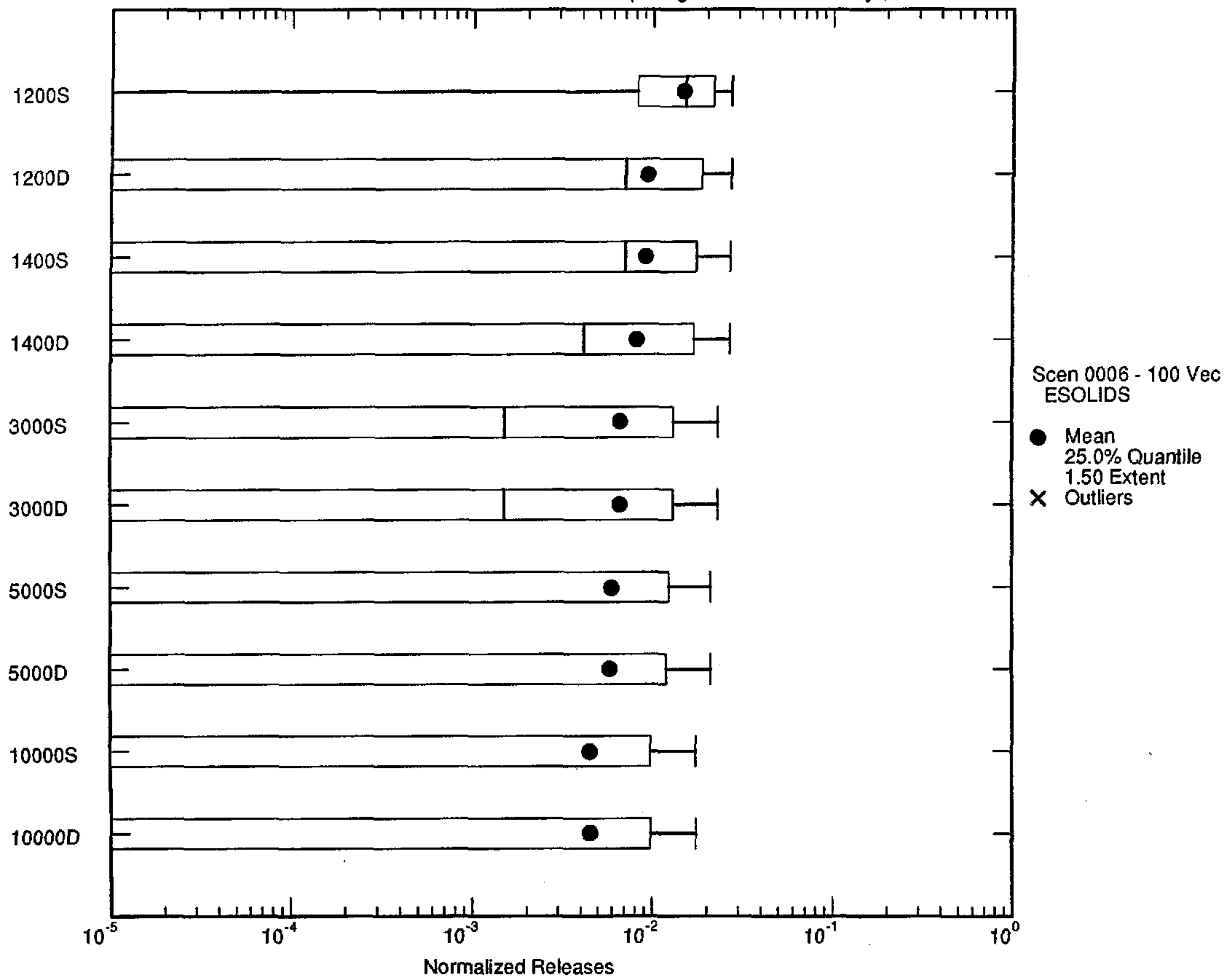
NUCPLOT PA96 1.19 07/31/97 15:41


C97 Second Spallings: Initial E1 at 350 yr; R3
550S
550D
750S
750D
2000S
2000D
4000S
4000D
10000S
10000D
10^{-5}
10^{-4}
10^{-3}
10^{-2}
10^{-1}
10^{0}
Normalized Releases
Scen 0004 - 100 Vec
ESOLIDS
Mean
25.0% Quantile
1.50 Extent
Outliers
NUCPLOT PA96 1.19 07/31/97 15:41

D.21

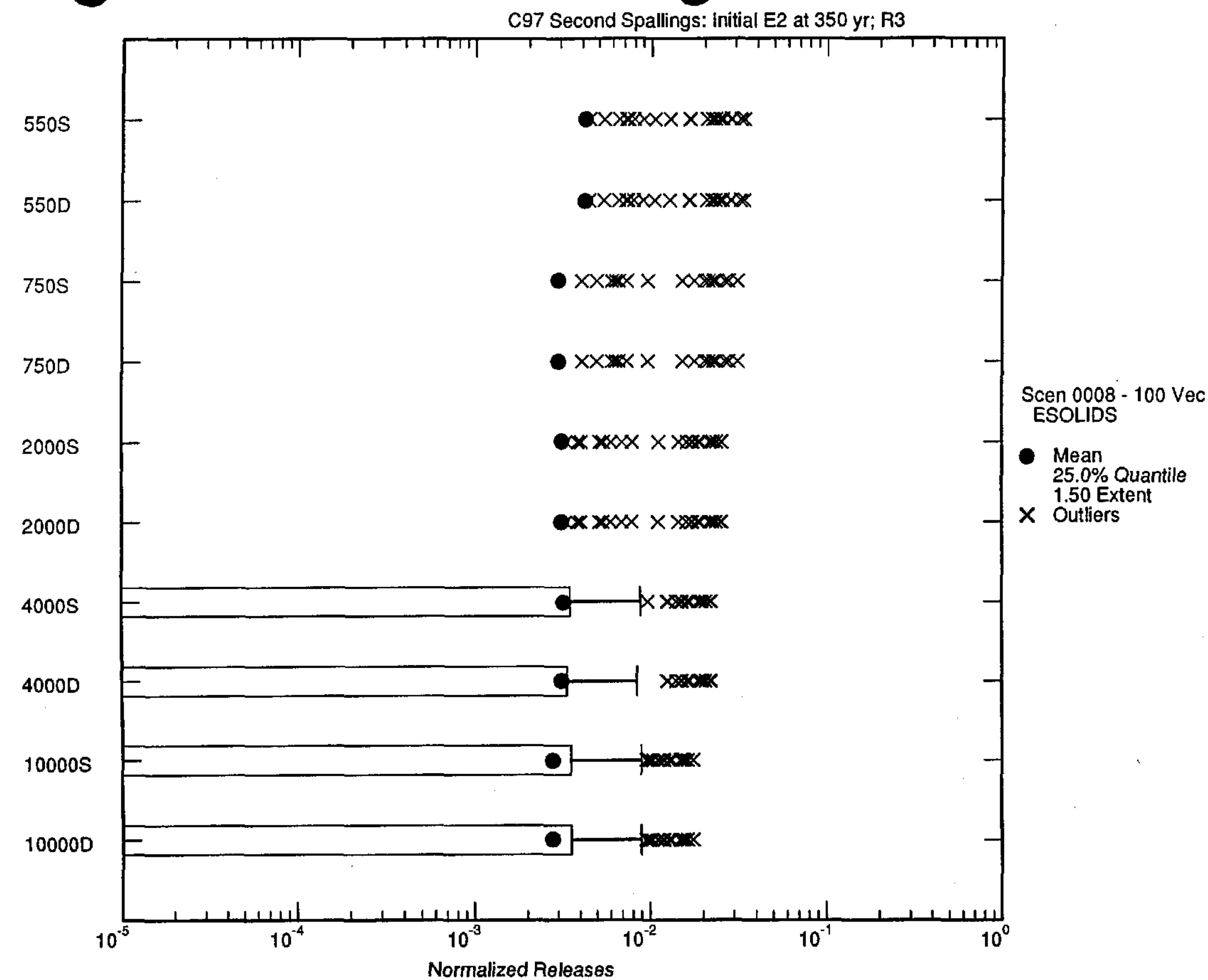
129

C97 Second Spallings: Initial E1 at 1000 yr; R3



D.22

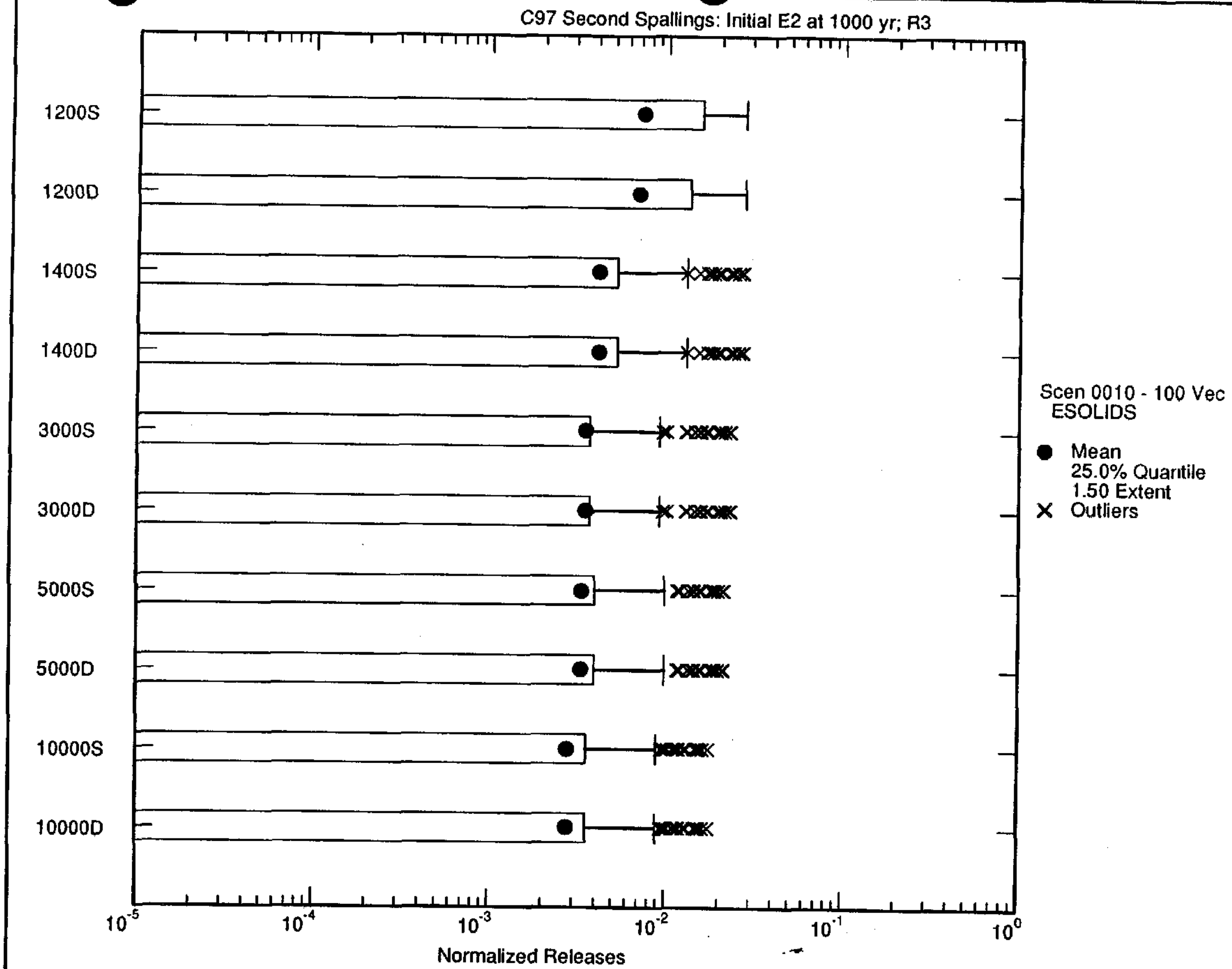
NUCPLOT PA96 1.19 07/31/97 15:41



D.23

NUCPLOT_PA96 1.19 07/31/97 15:41

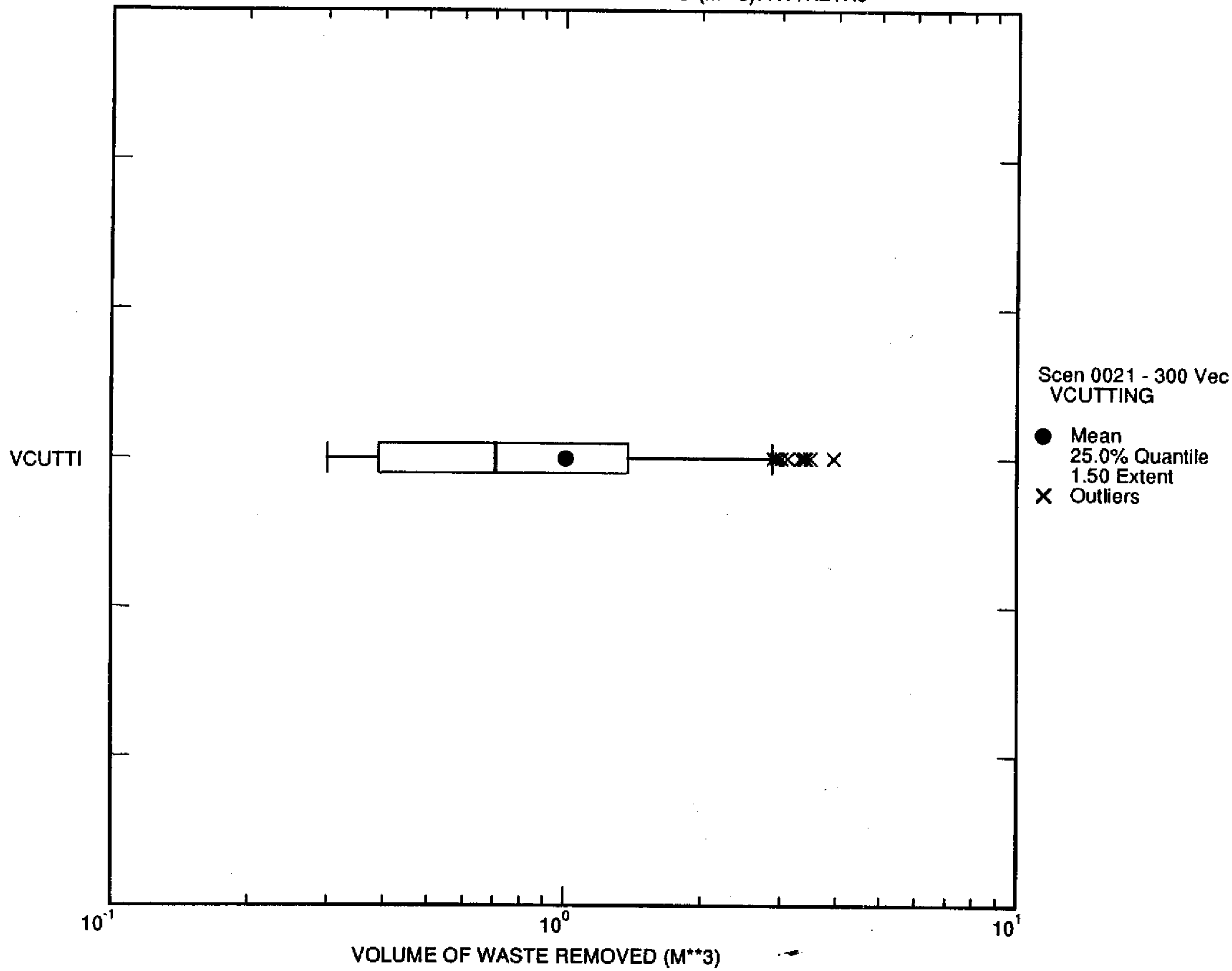
131



0.24

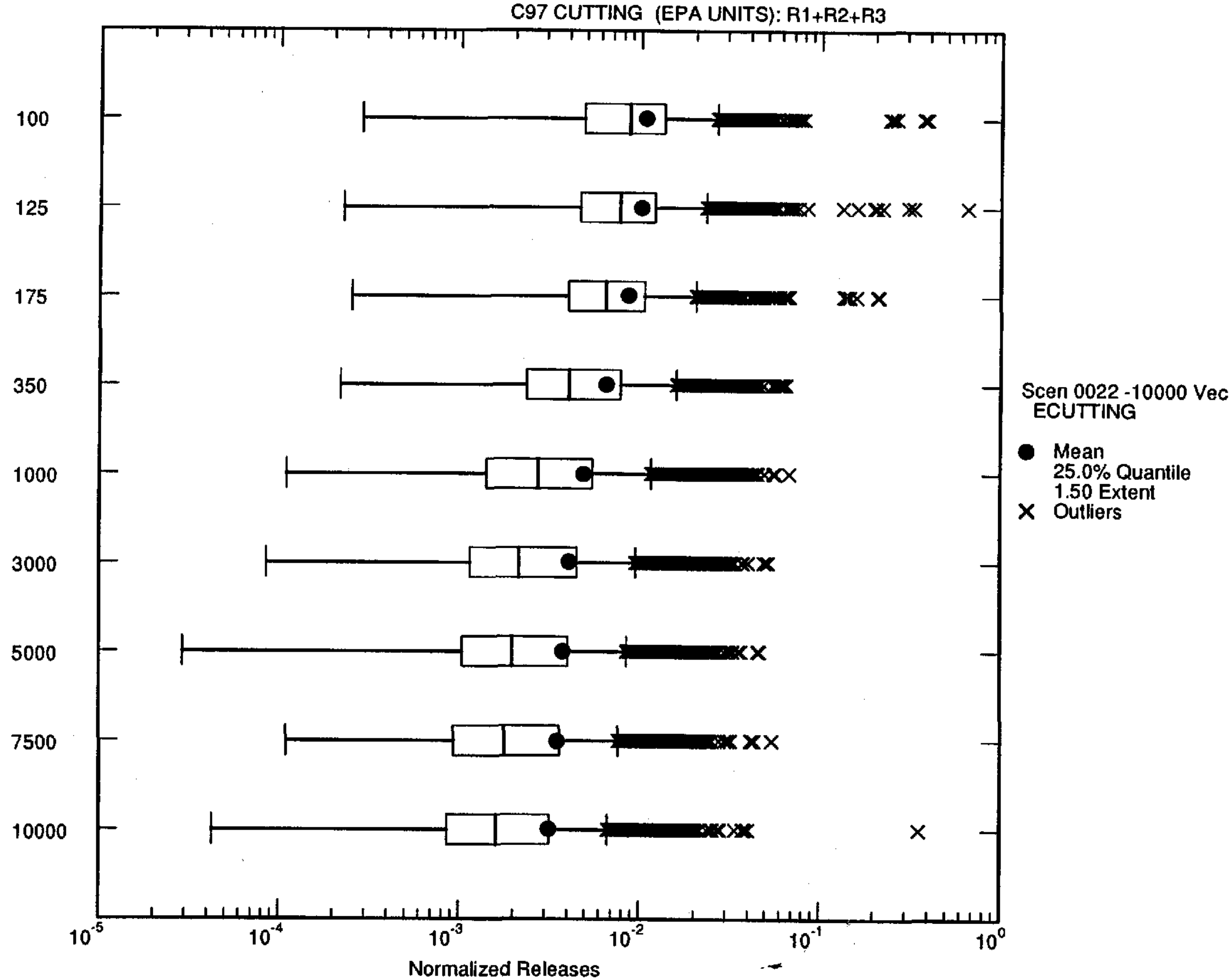
NUCPLOT PA96 1.19 07/31/97 15:41

C97 CUTTING (M**3): R1+R2+R3



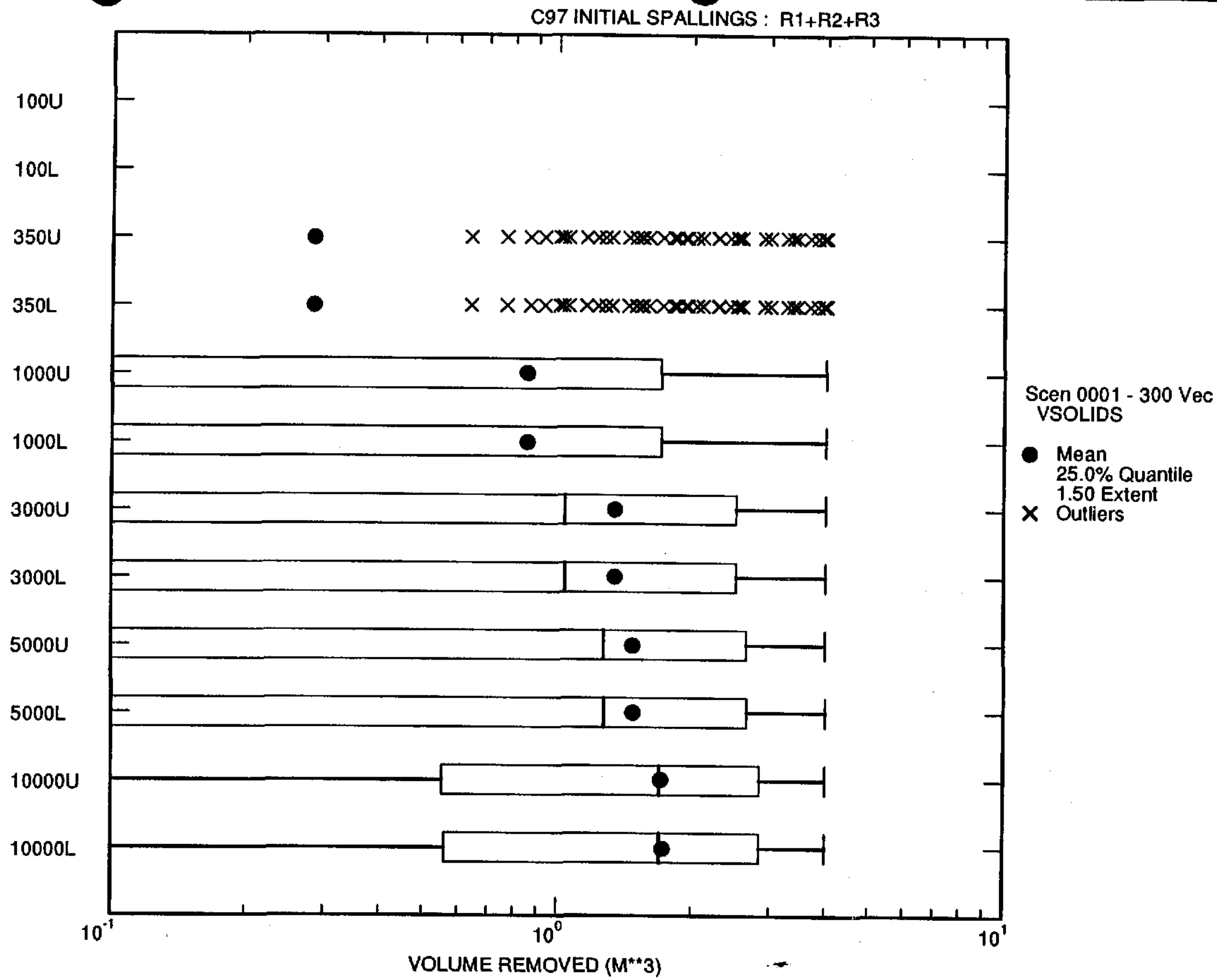
0.25

NUCPLOT_PA96 1.19 07/31/97 13:51



D.26

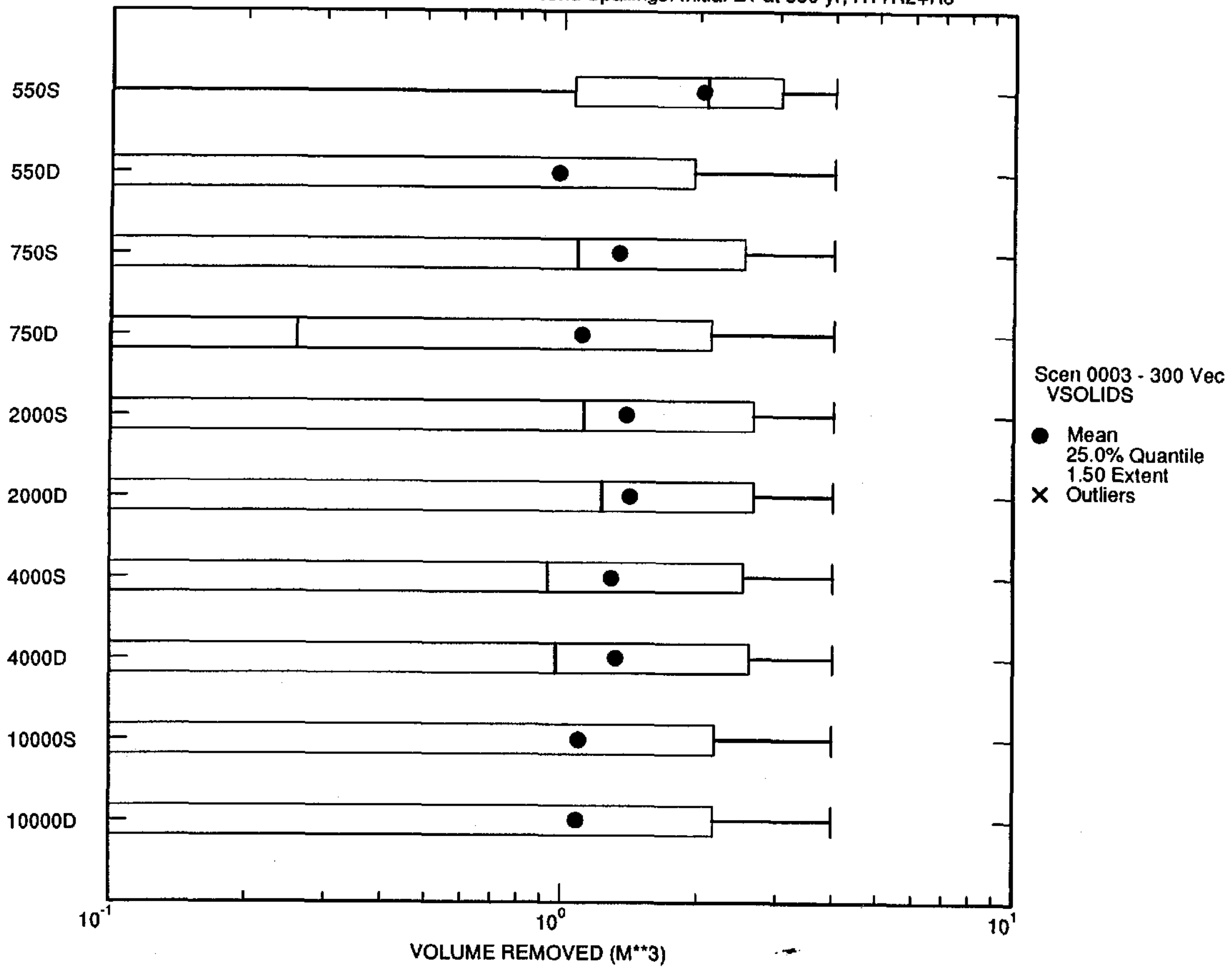
NUCPLOT PA96 1.19 07/31/97 13:49



0.27

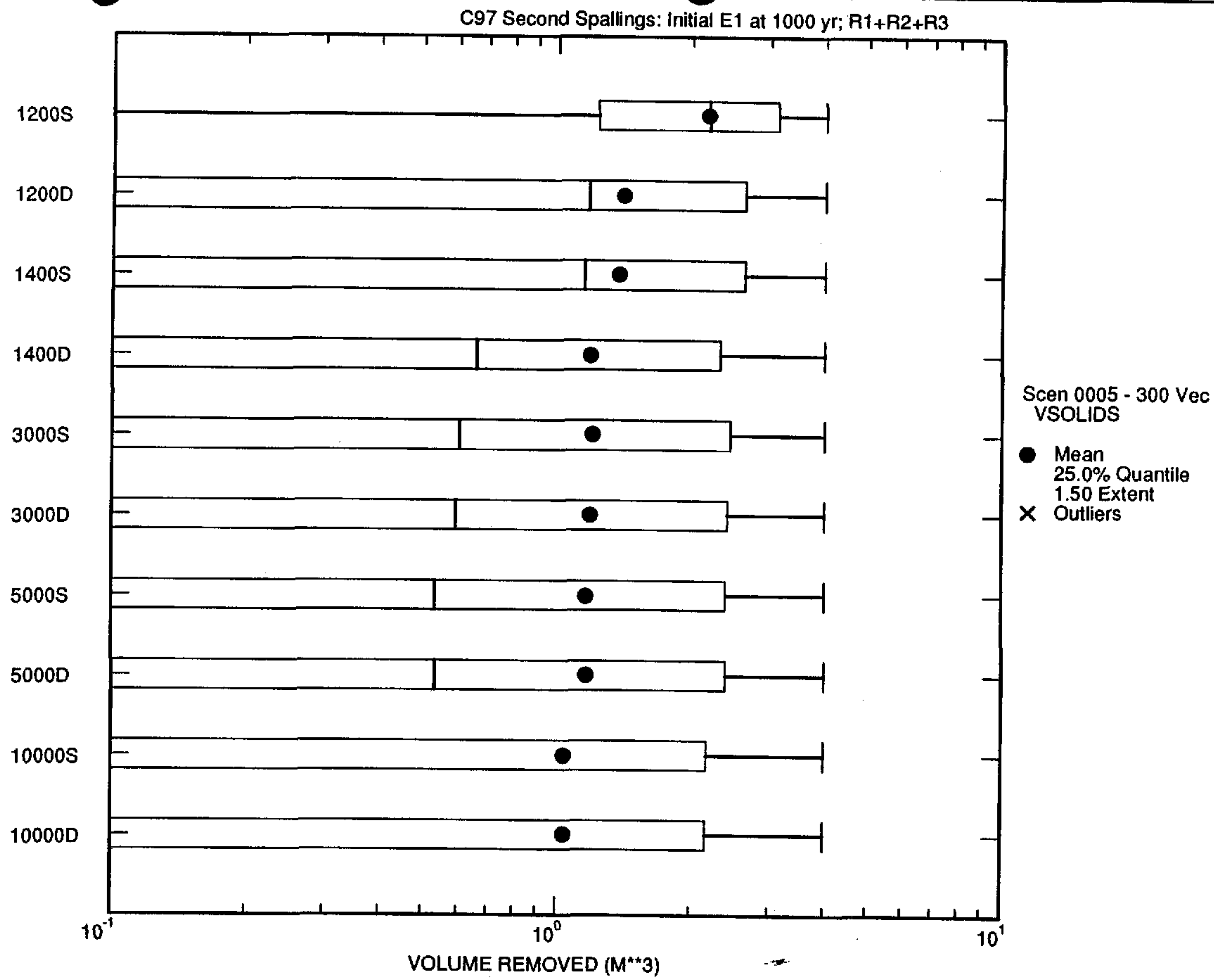
NUCPLOT PA96 1.19 07/31/97 13:58

C97 Second Spallings: Initial E1 at 350 yr; R1+R2+R3



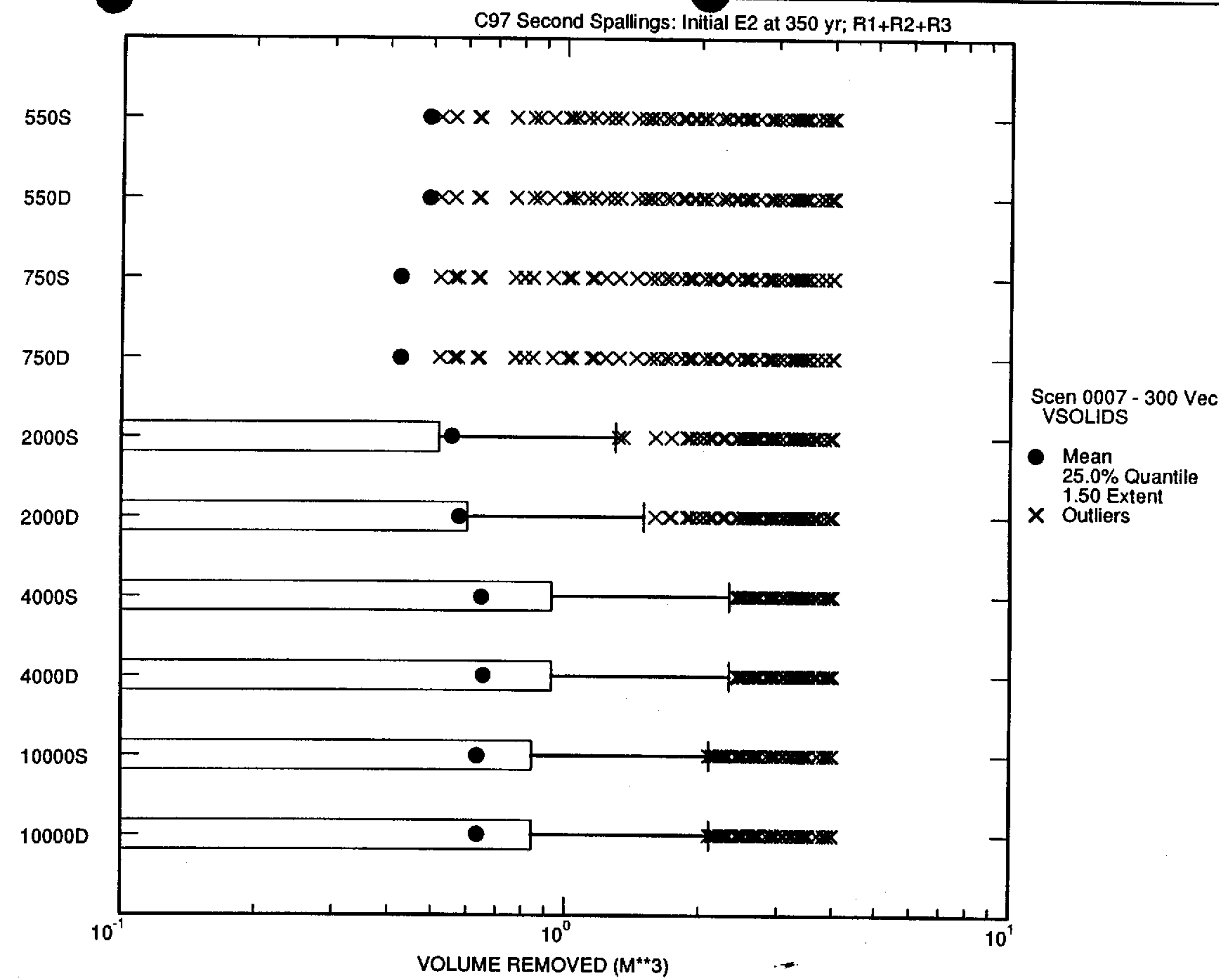
NUCPLOT PA96 1.19 07/31/97 13:58

D.28



0.29

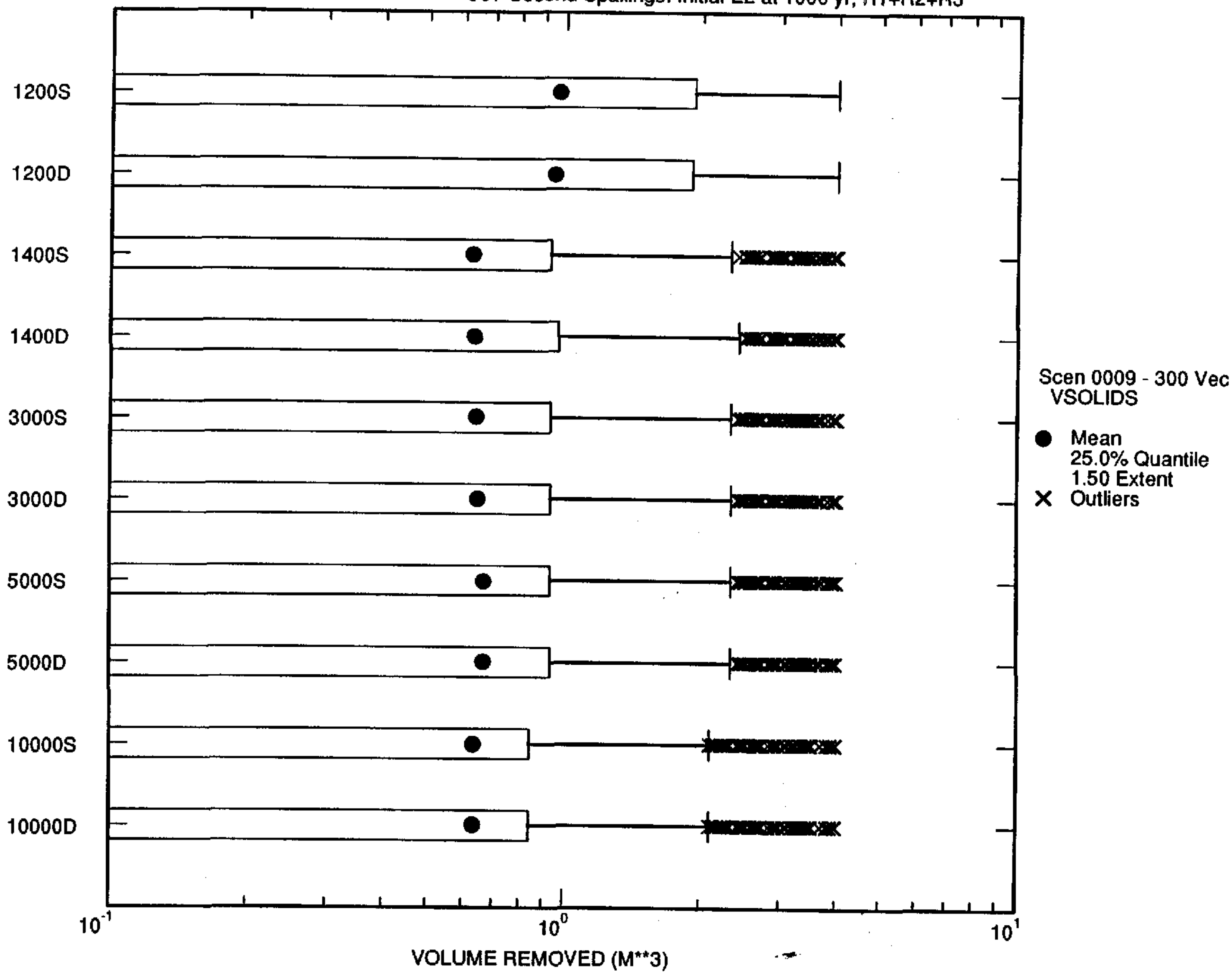
NUCPLOT_PA96 1.19 07/31/97 13:58



D.30

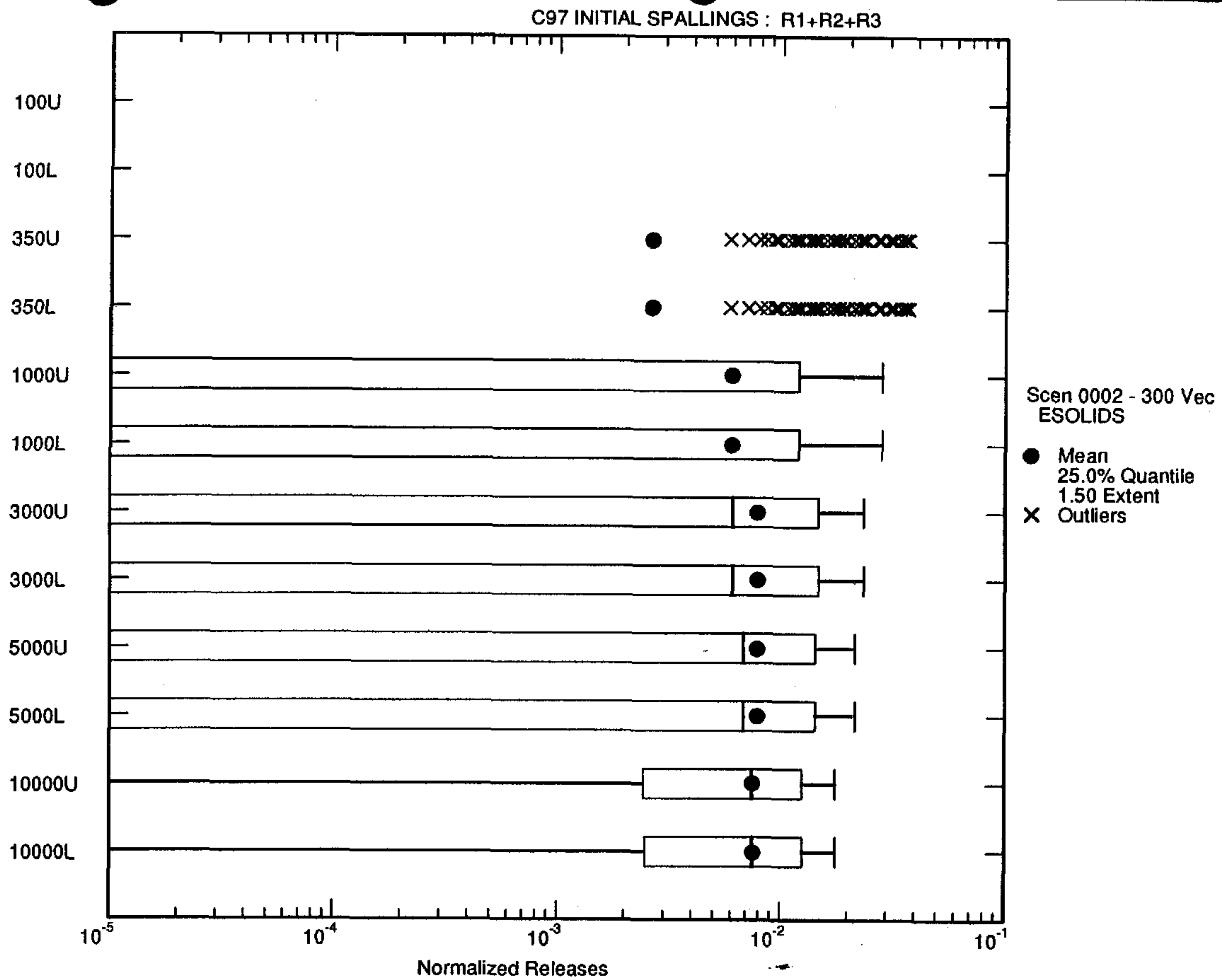
NUCPLOT PA96 1.19 07/31/97 13:58

C97 Second Spallings: Initial E2 at 1000 yr; R1+R2+R3



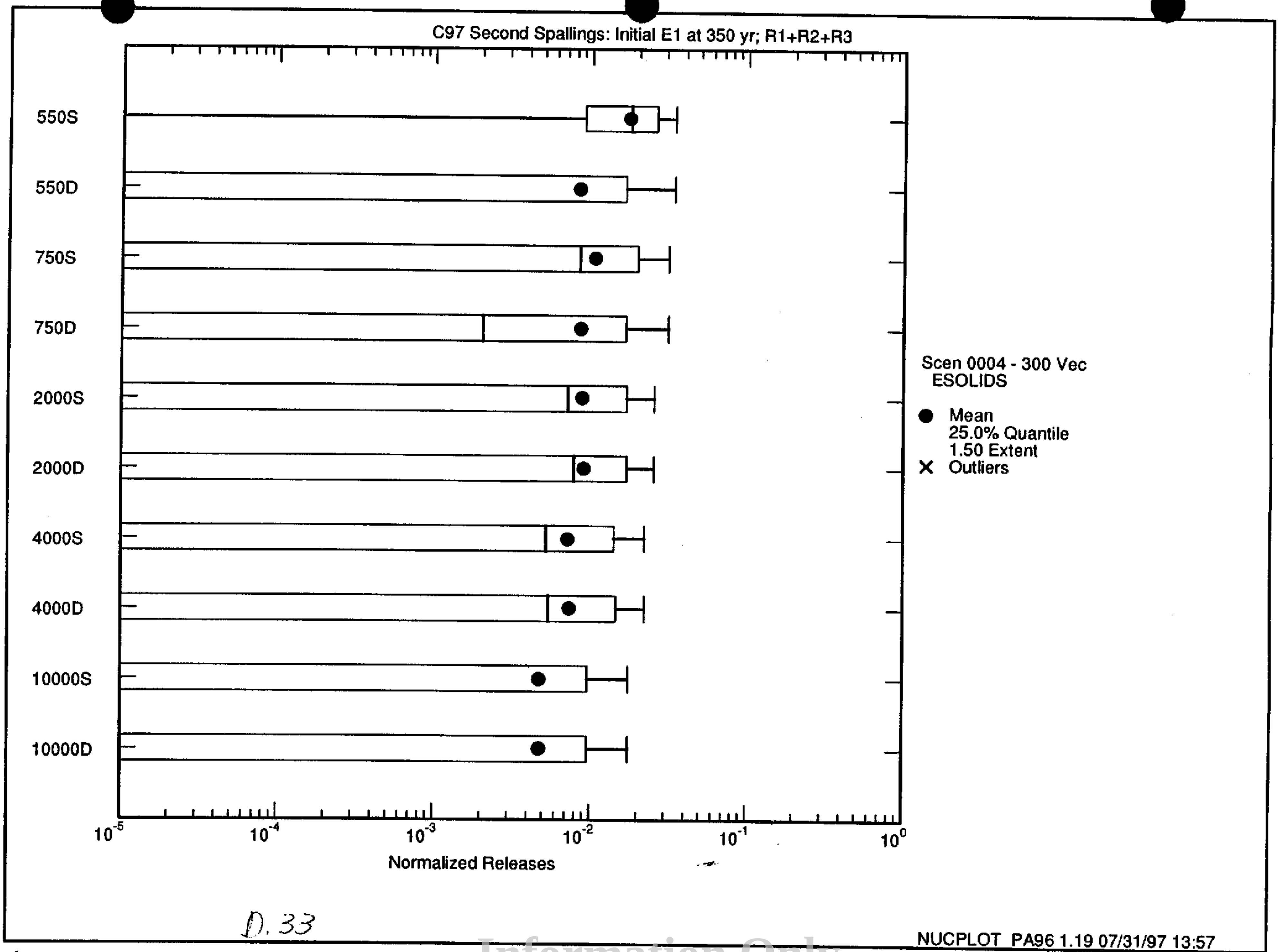
D. 31

NUCPLOT PA96 1.19 07/31/97 13:58



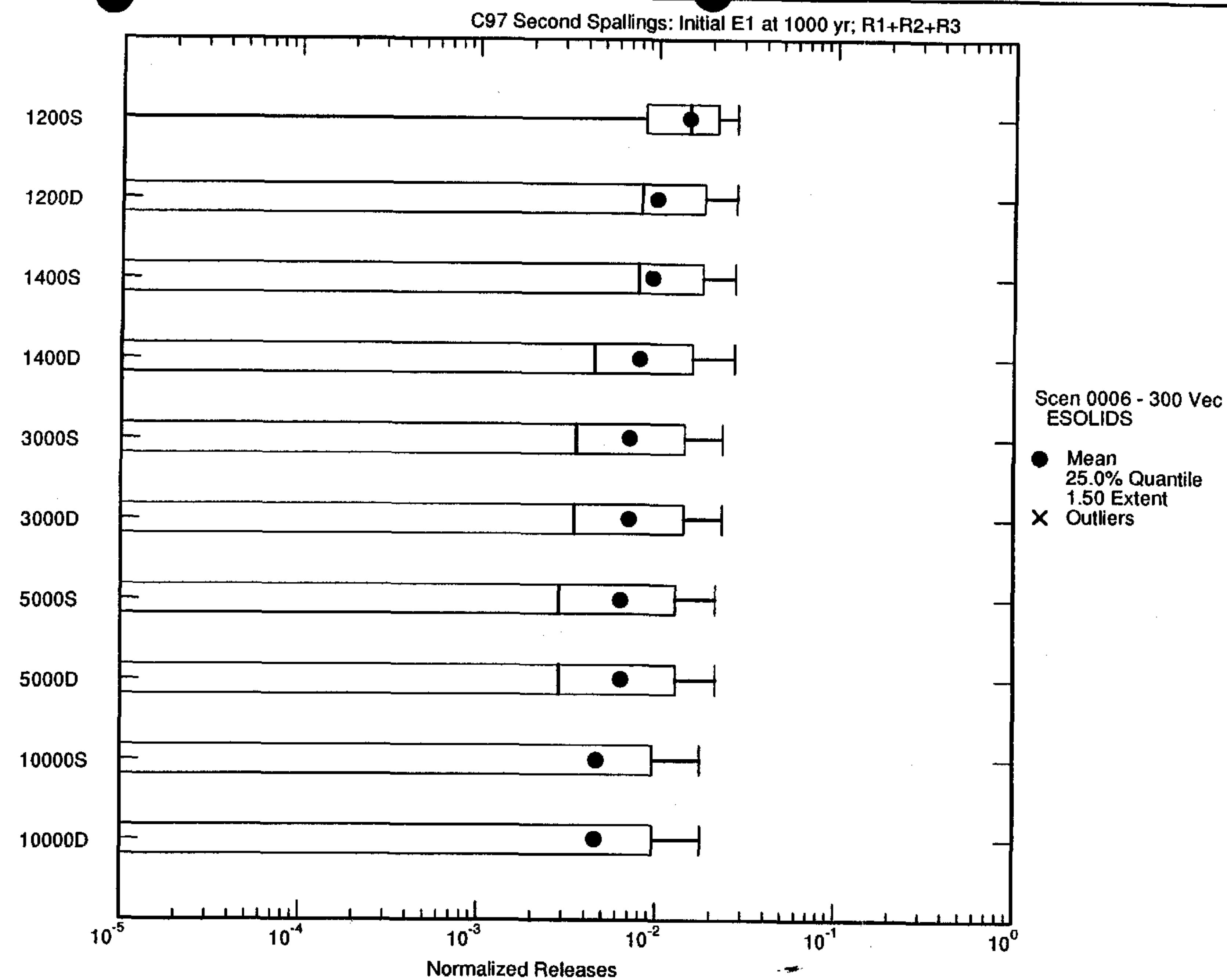
D.32

NUCPLOT PA96 1.19 07/31/97 13:57



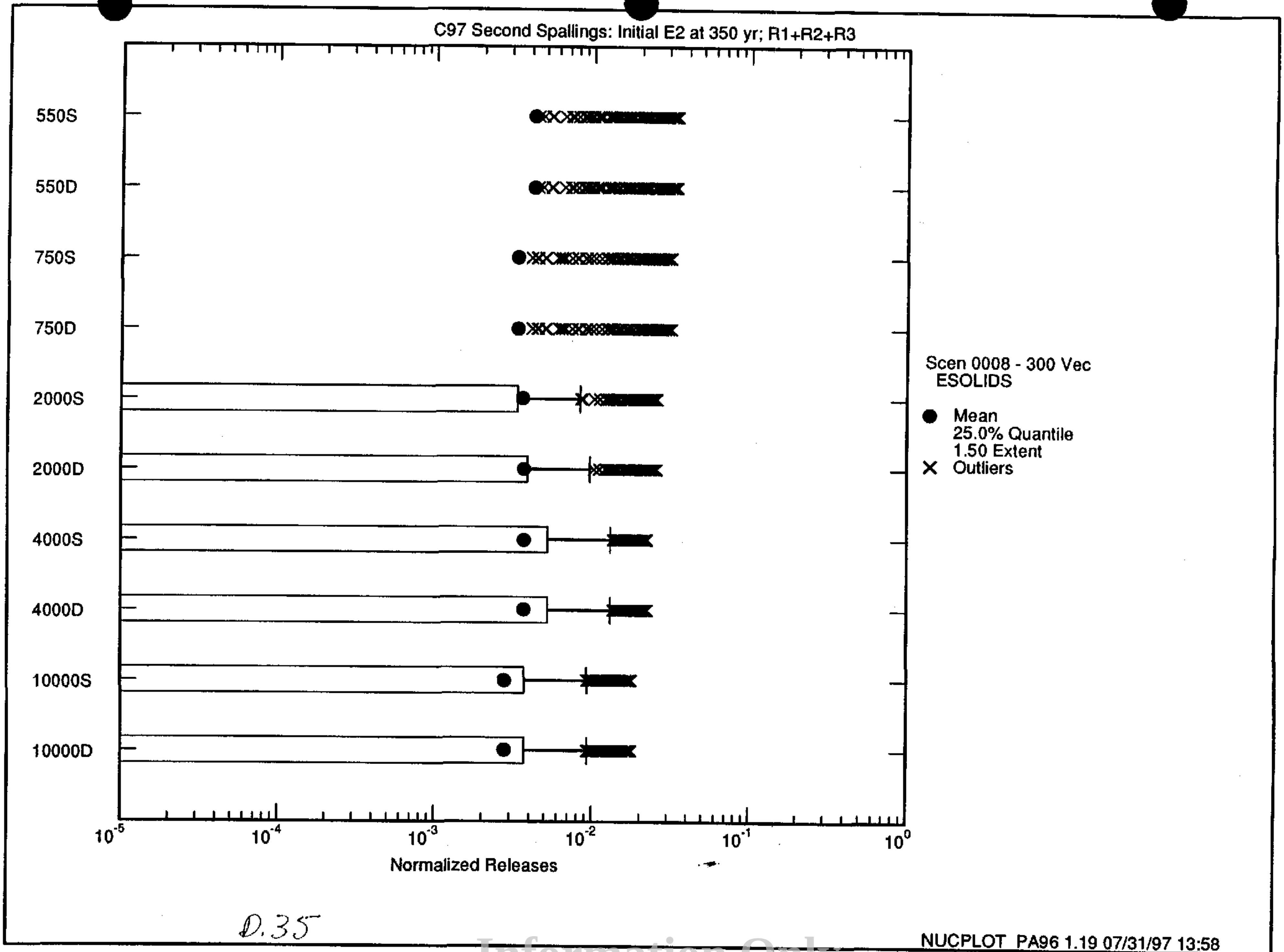
C97 Second Spallings: Initial E1 at 350 yr; R1+R2+R3
550S
550D
750S
750D
2000S
2000D
4000S
4000D
10000S
10000D
10^{-5}
10^{-4}
10^{-3}
10^{-2}
10^{-1}
10^{0}
Normalized Releases
Scen 0004 - 300 Vec
ESOLIDS
Mean
25.0% Quantile
1.50 Extent
Outliers
NUCPLOT PA96 1.19 07/31/97 13:57

D.33



D.34

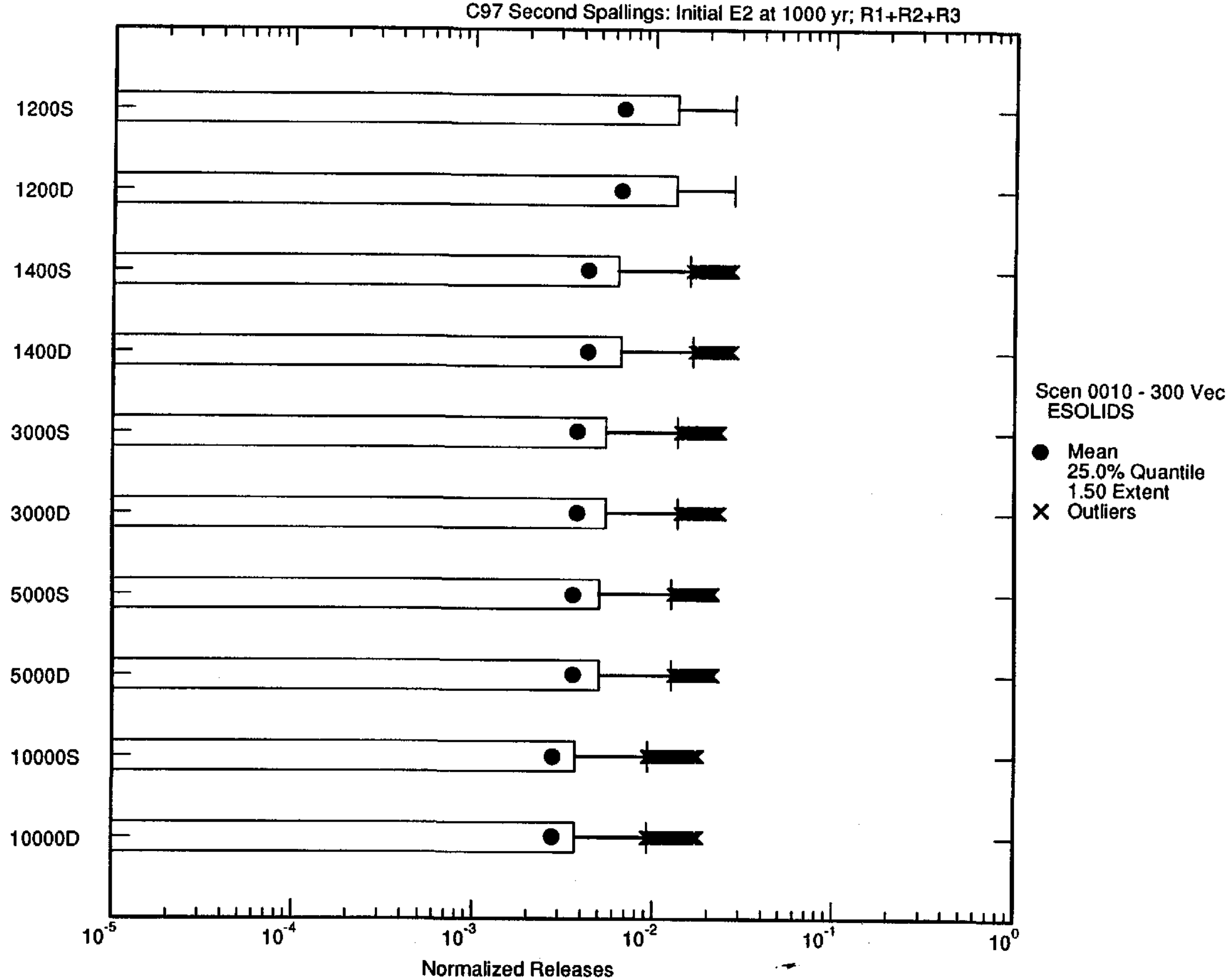
NUCPLOT PA96 1.19 07/31/97 13:57



C97 Second Spallings: Initial E2 at 350 yr; R1+R2+R3
550S
550D
750S
750D
2000S
2000D
4000S
4000D
10000S
10000D
10^{-5}
10^{-4}
10^{-3}
10^{-2}
10^{-1}
10^{0}
Normalized Releases
Scen 0008 - 300 Vec
ESOLIDS
Mean
25.0% Quantile
1.50 Extent
Outliers
NUCPLOT PA96 1.19 07/31/97 13:58

D.35

143



NUCPLOT PA96 1.19 07/31/97 13:58

D.36

APPENDIX E

RESULTS FOR DIRECT BRINE RELEASE (DBR)

Appendix E includes Figures which contain results from direct brine release calculations for PAVT replicates 2 and 3.

Figures

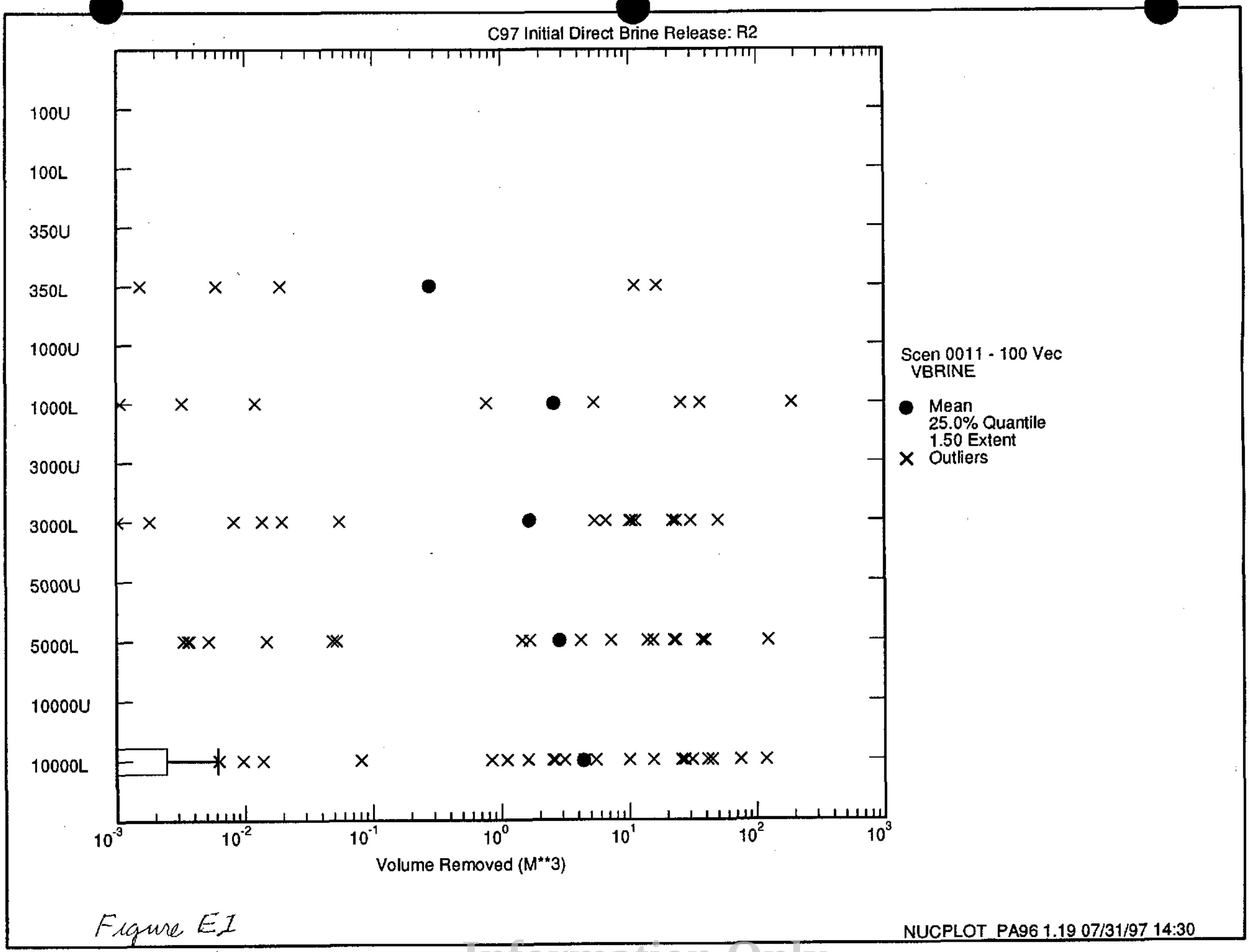
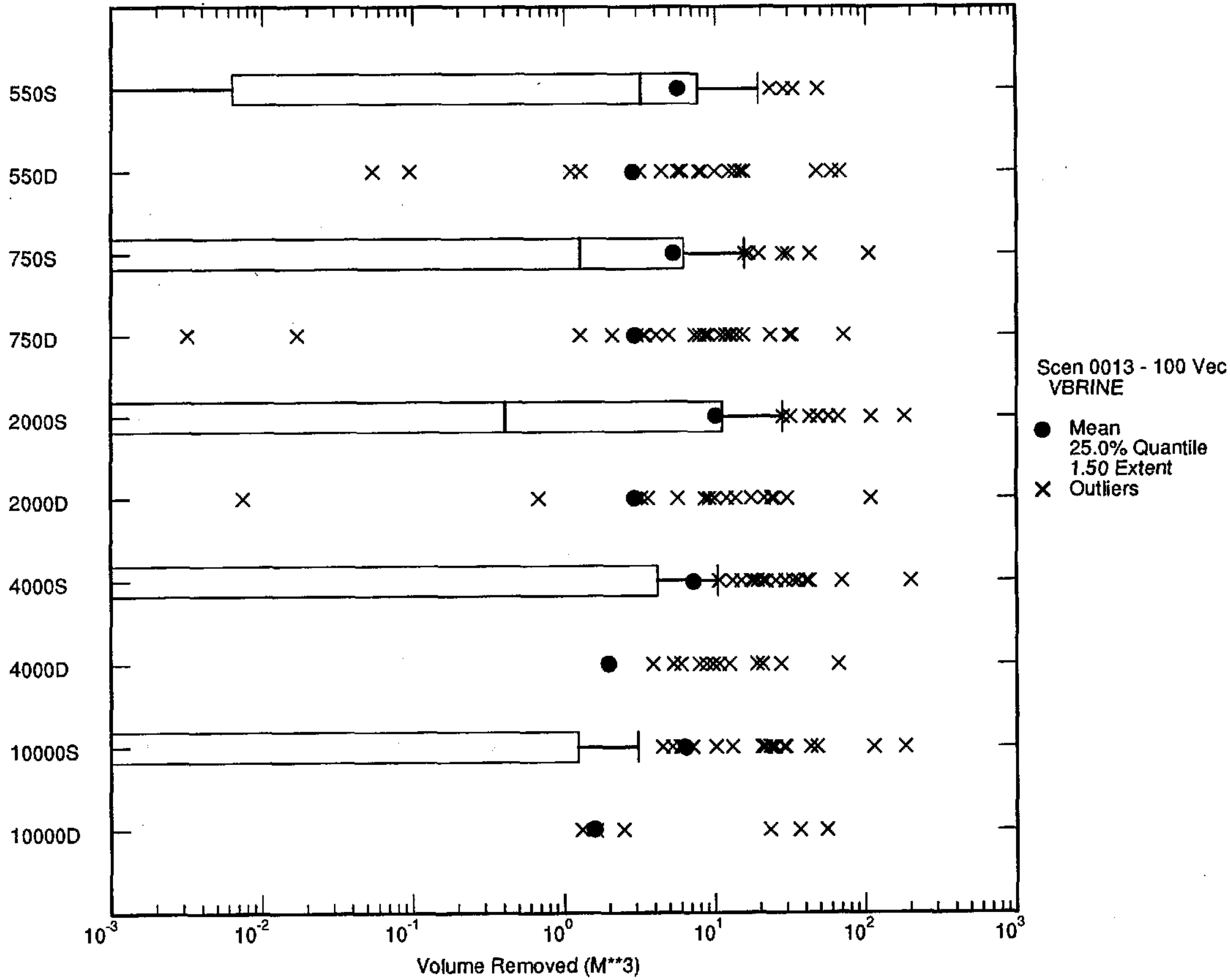

C97 Initial Direct Brine Release: R2
100U
100L
350U
350L
1000U
1000L
3000U
3000L
5000U
5000L
10000U
10000L
10^{-3}
10^{-2}
10^{-1}
10^{0}
10^{1}
10^{2}
10^{3}
Volume Removed (M**3)
Scen 0011 - 100 Vec
VBRINE
Mean
25.0% Quantile
1.50 Extent
Outliers
NUCPLOT PA96 1.19 07/31/97 14:30

Figure E1

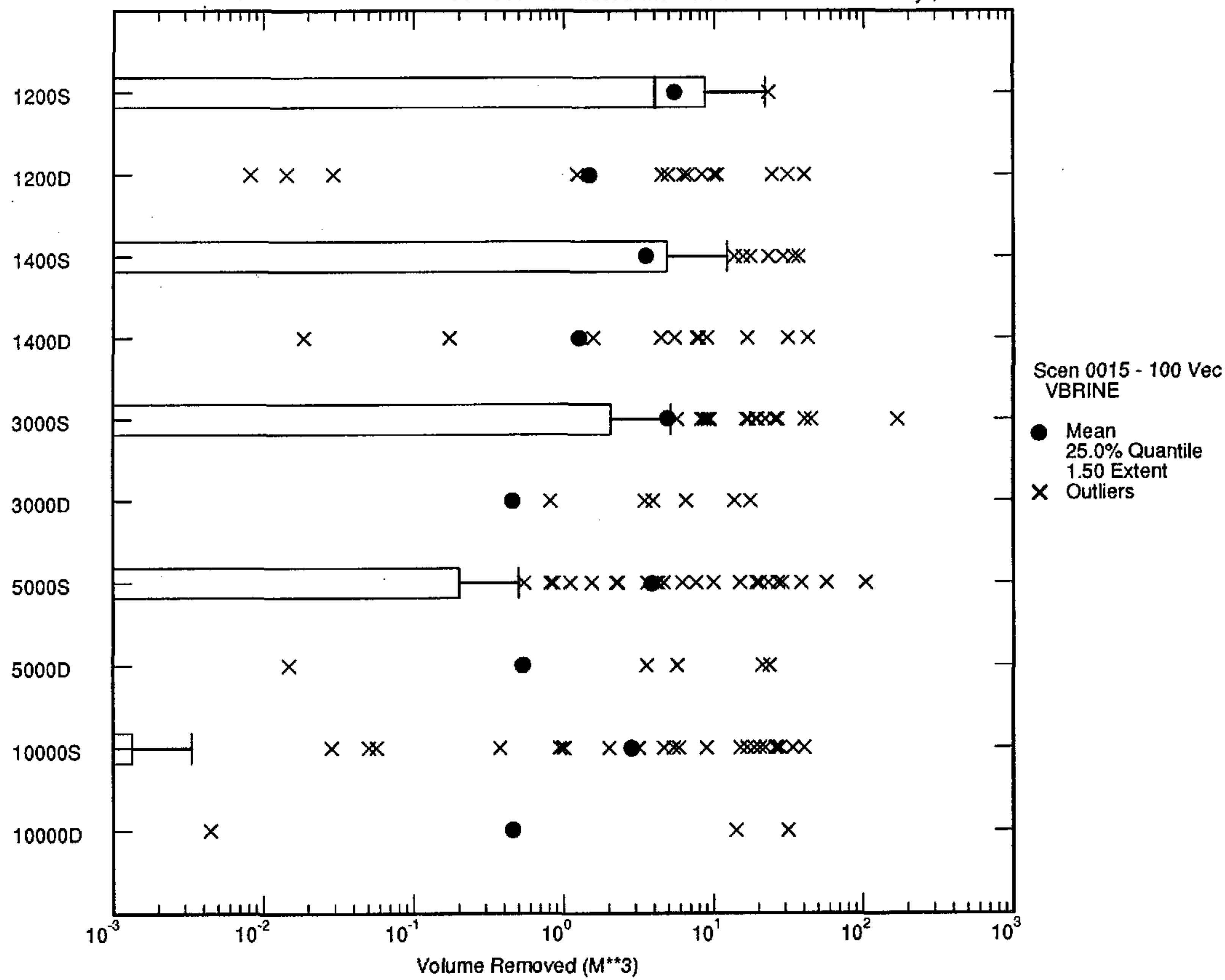
C97 Second Direct Brine Release: Initial E1 at 350 yr; R2



E.2

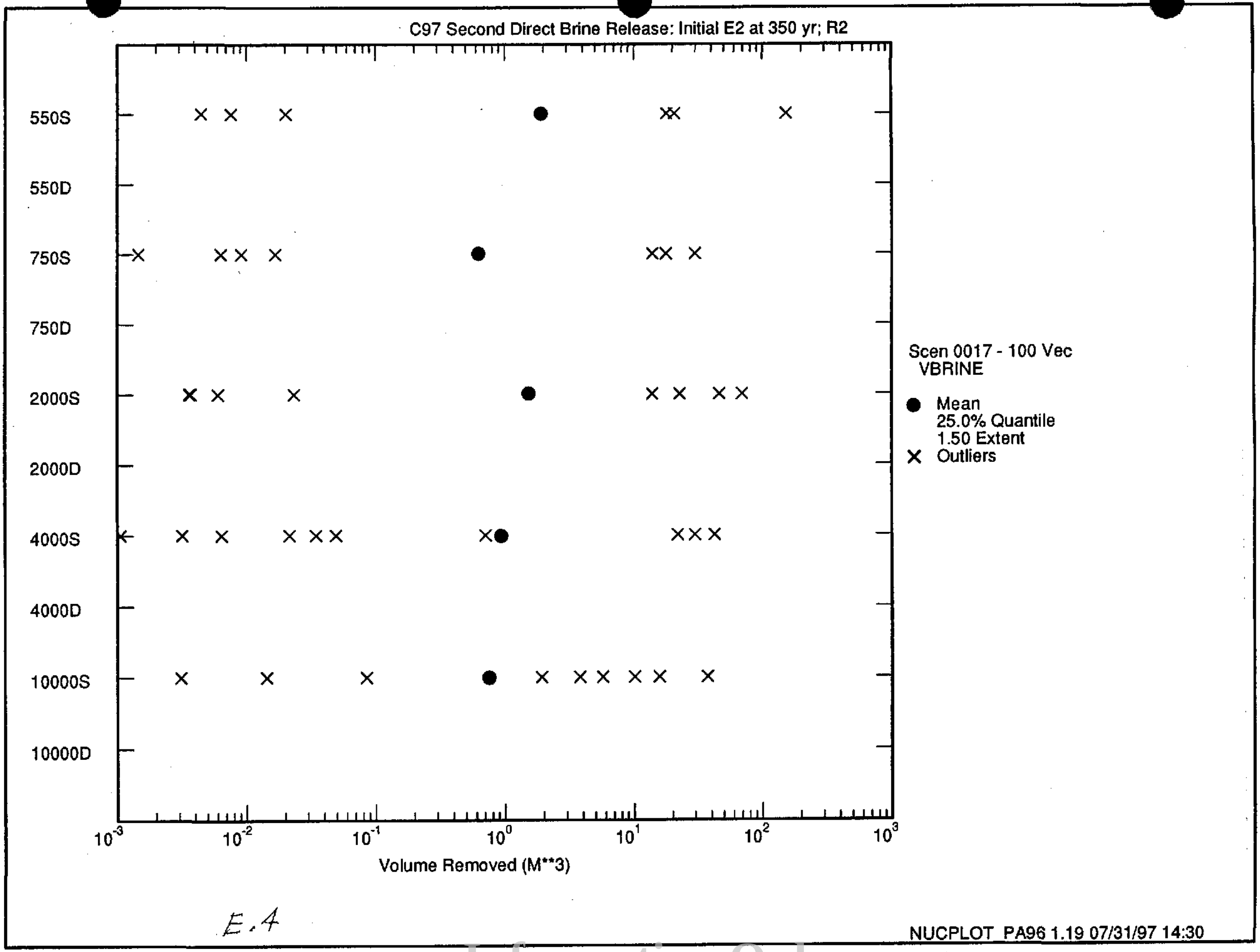
NUCPLOT PA96 1.19 07/31/97 14:30

C97 Second Direct Brine Release: Initial E1 at 1000 yr; R2



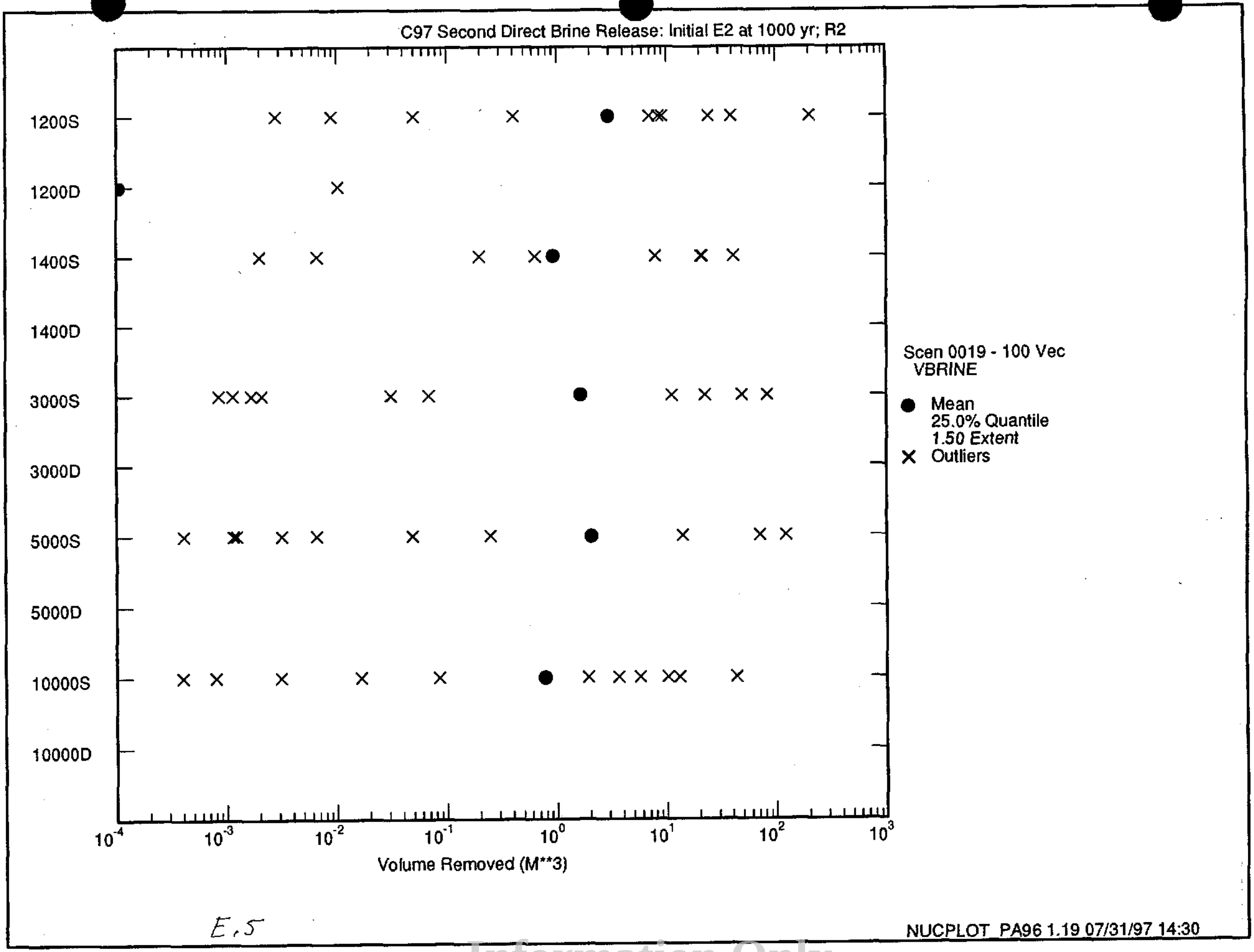
E.3

NUCPLOT_PA96 1.19 07/31/97 14:30


C97 Second Direct Brine Release: Initial E2 at 350 yr; R2
550S
550D
750S
750D
2000S
2000D
4000S
4000D
10000S
10000D
10^{-3}
10^{-2}
10^{-1}
10^{0}
10^{1}
10^{2}
10^{3}
Volume Removed (M**3)
Scen 0017 - 100 Vec
VBRINE
Mean
25.0% Quantile
1.50 Extent
Outliers
NUCPLOT PA96 1.19 07/31/97 14:30

E.4

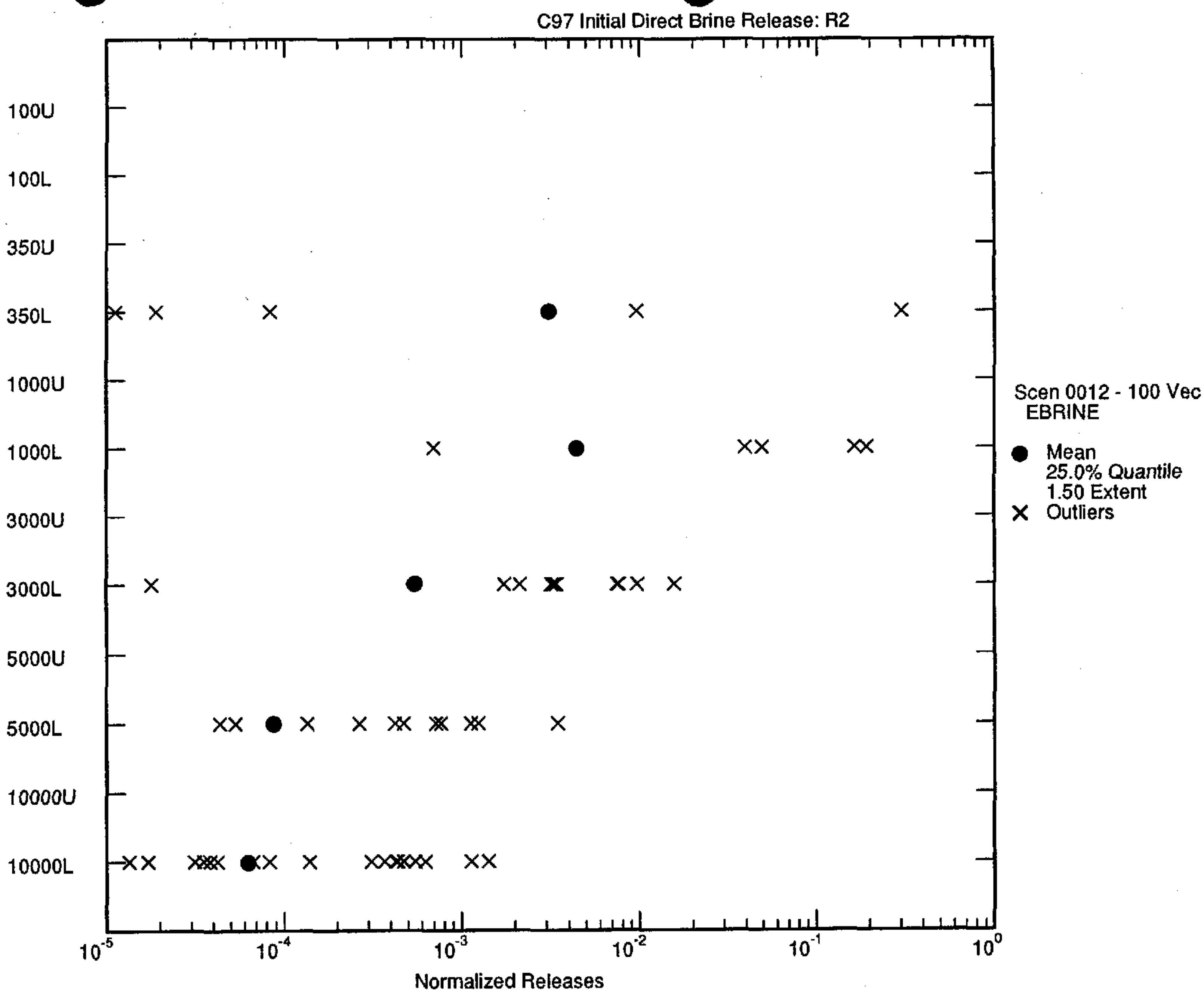
150



E.5

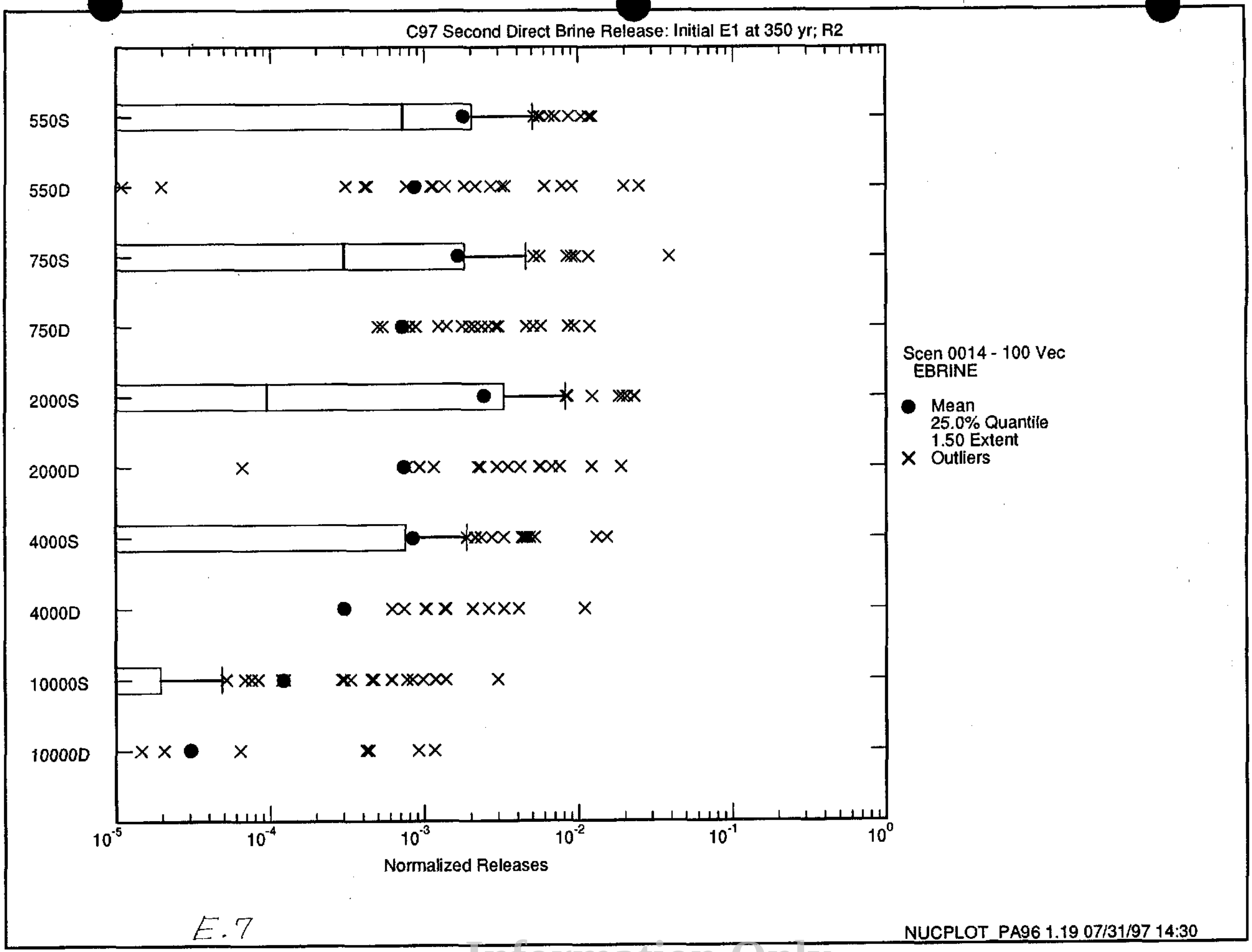
NUCPLOT_PA96 1.19 07/31/97 14:30

151



E.6

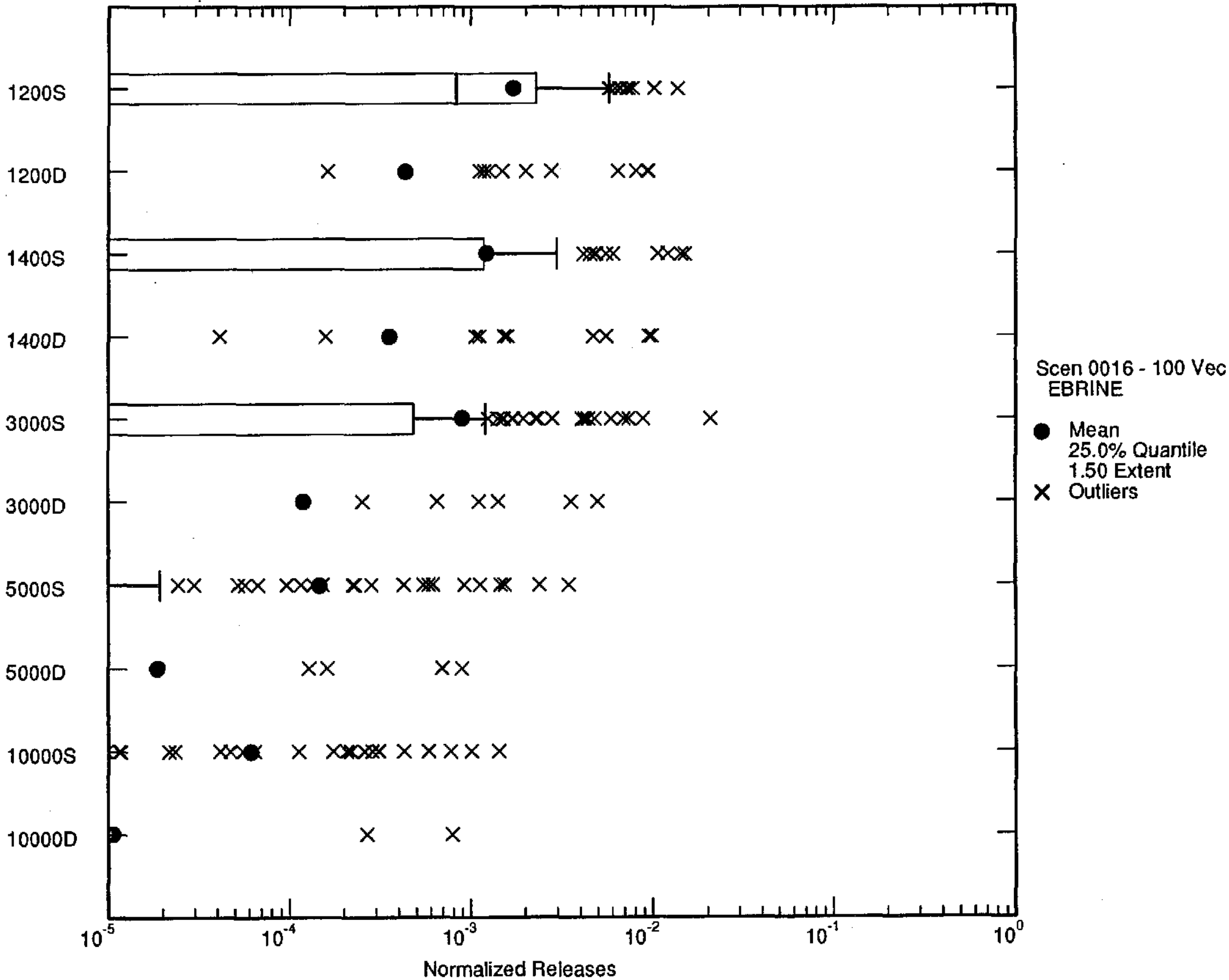
NUCPLOT PA96 1.19 07/31/97 14:30



C97 Second Direct Brine Release: Initial E1 at 350 yr; R2
550S
550D
750S
750D
2000S
2000D
4000S
4000D
10000S
10000D
10^-5
10^-4
10^-3
10^-2
10^-1
10^0
Normalized Releases
Scen 0014 - 100 Vec
EBRINE
Mean
25.0% Quantile
1.50 Extent
Outliers
NUCPLOT_PA96 1.19 07/31/97 14:30

E.7

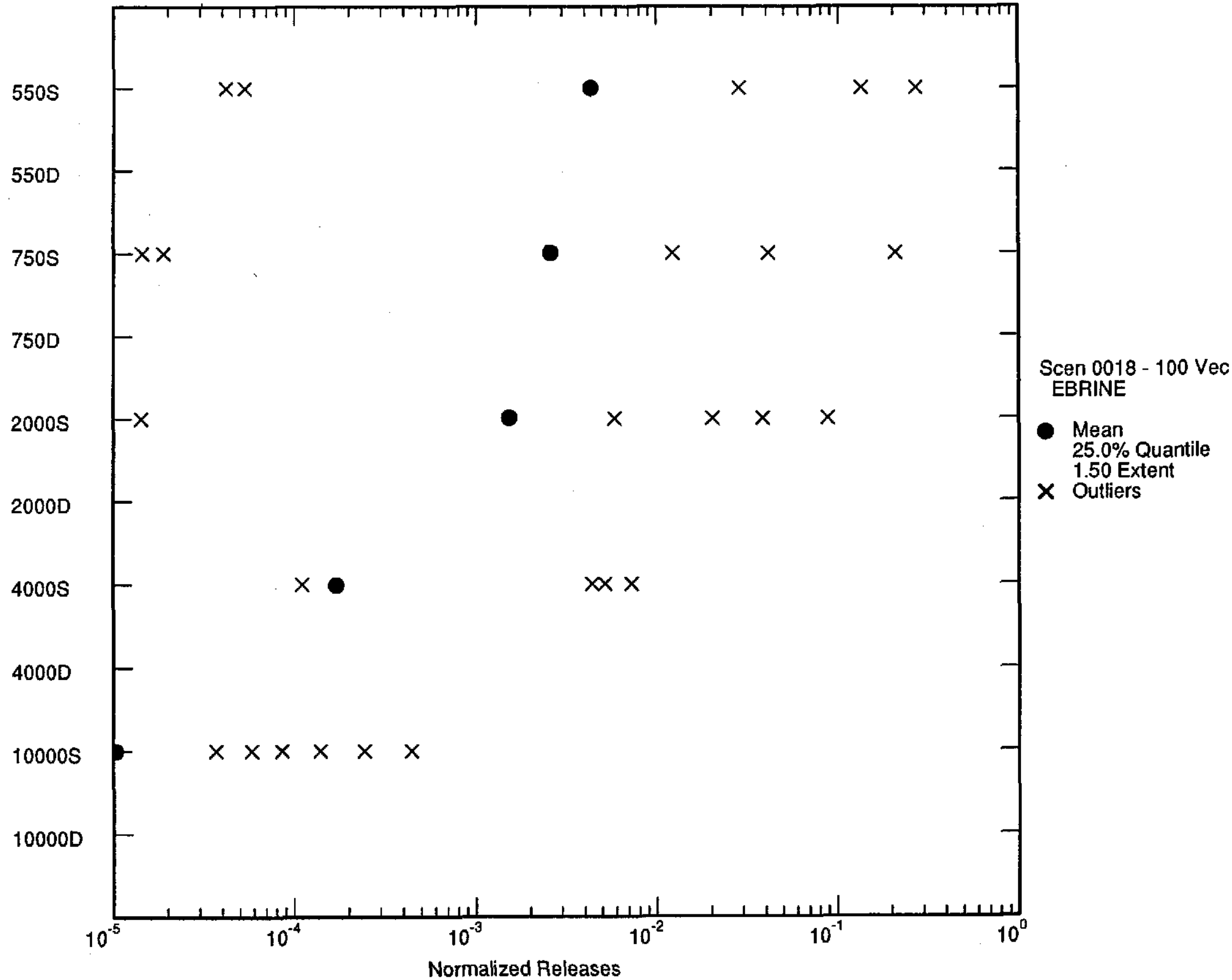
C97 Second Direct Brine Release: Initial E1 at 1000 yr; R2



E.8

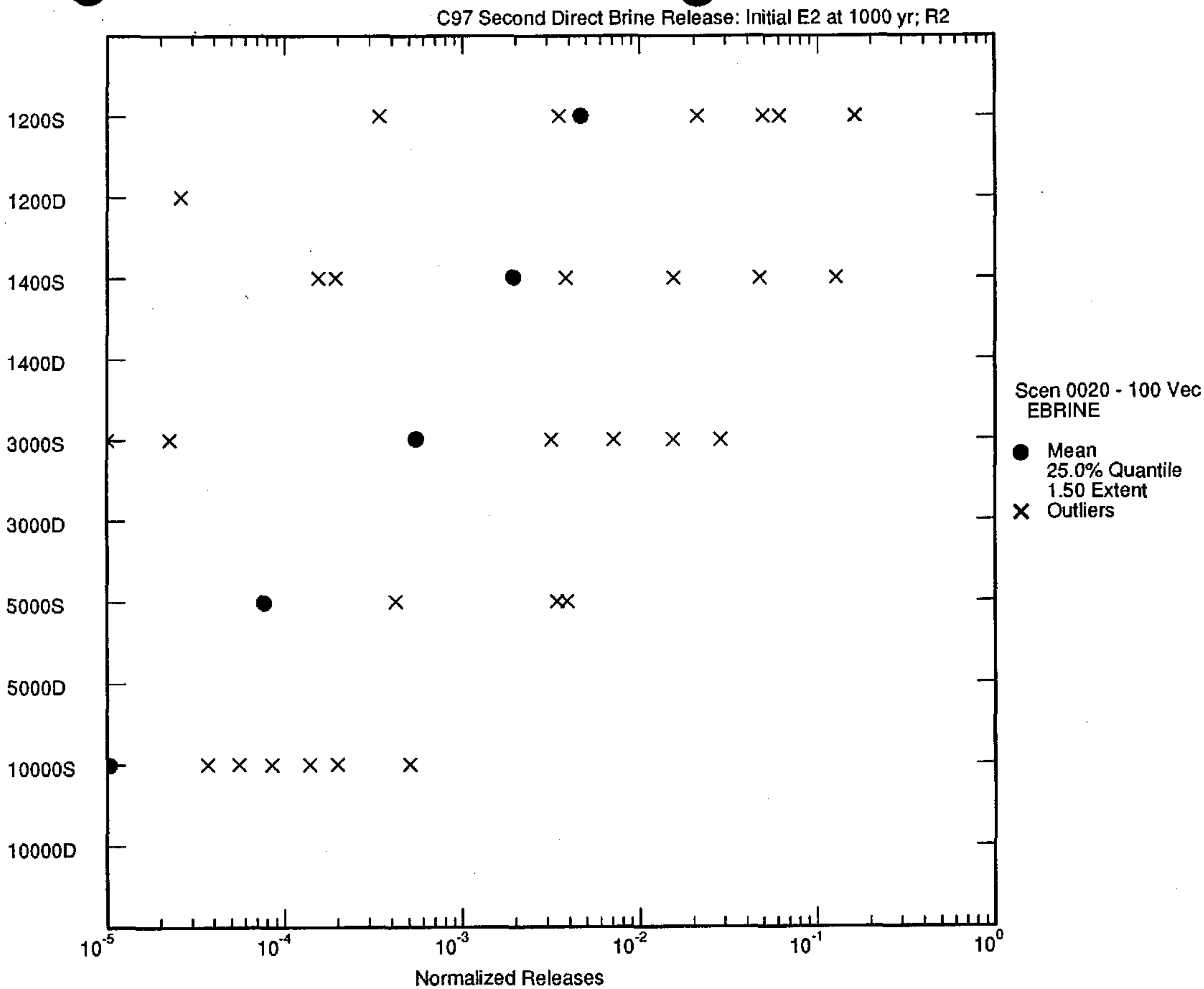
NUCPLOT PA96 1.19 07/31/97 14:30

C97 Second Direct Brine Release: Initial E2 at 350 yr; R2



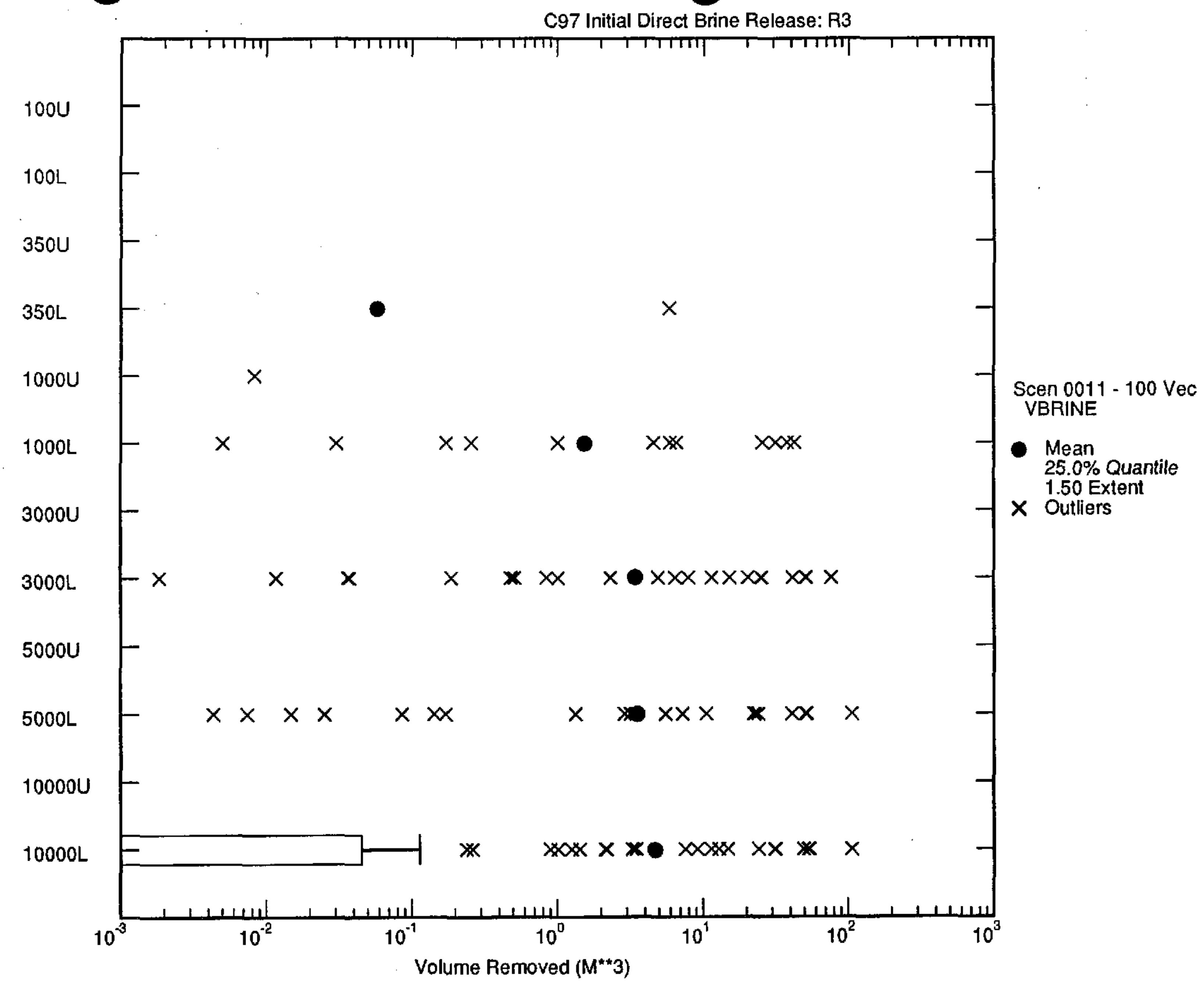
E.9

NUCPLOT PA96 1.19 07/31/97 14:30



E.10

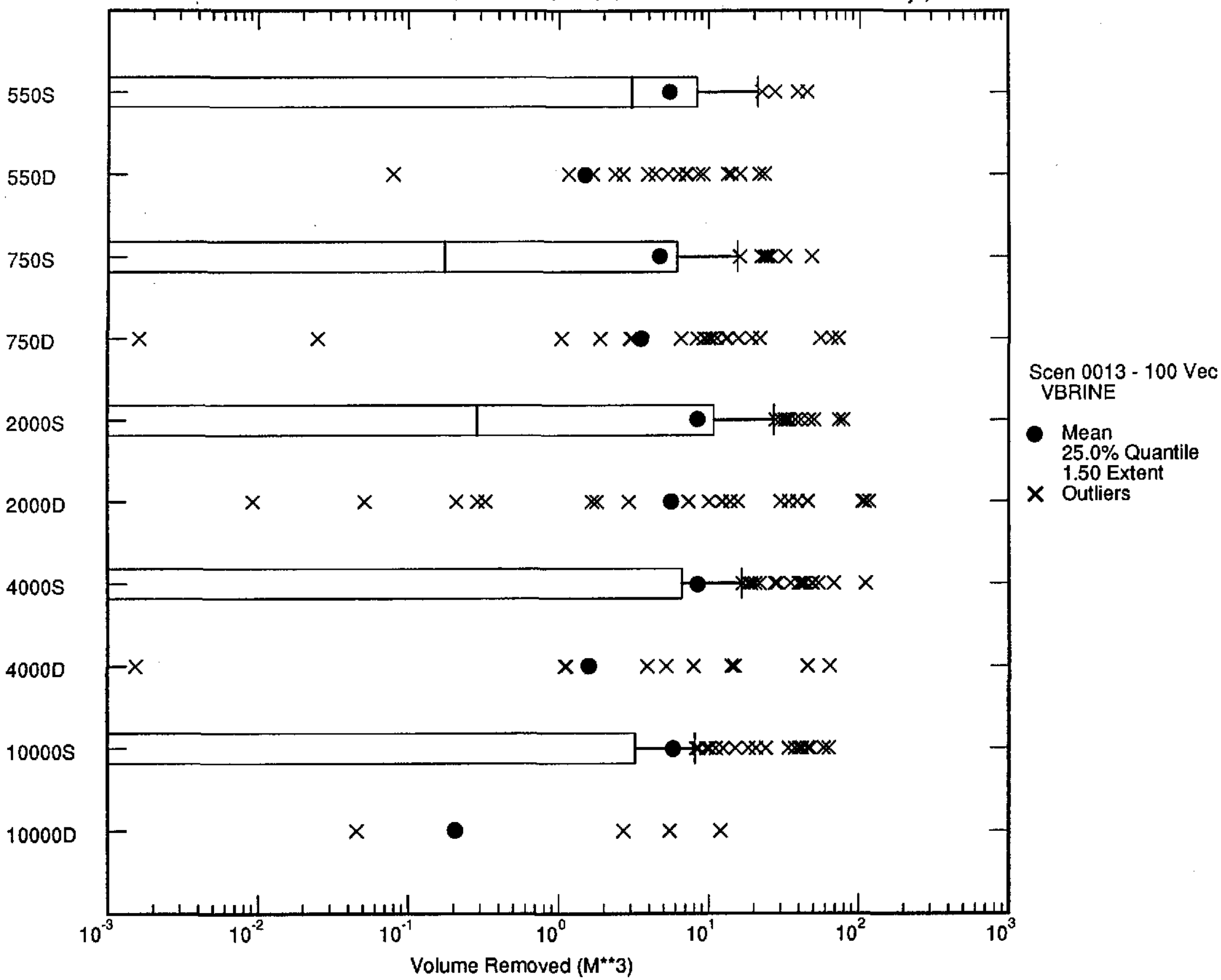
NUCPLOT PA96 1.19 07/31/97 14:30



E.11

NUCPLOT PA96 1.19 07/31/97 15:40

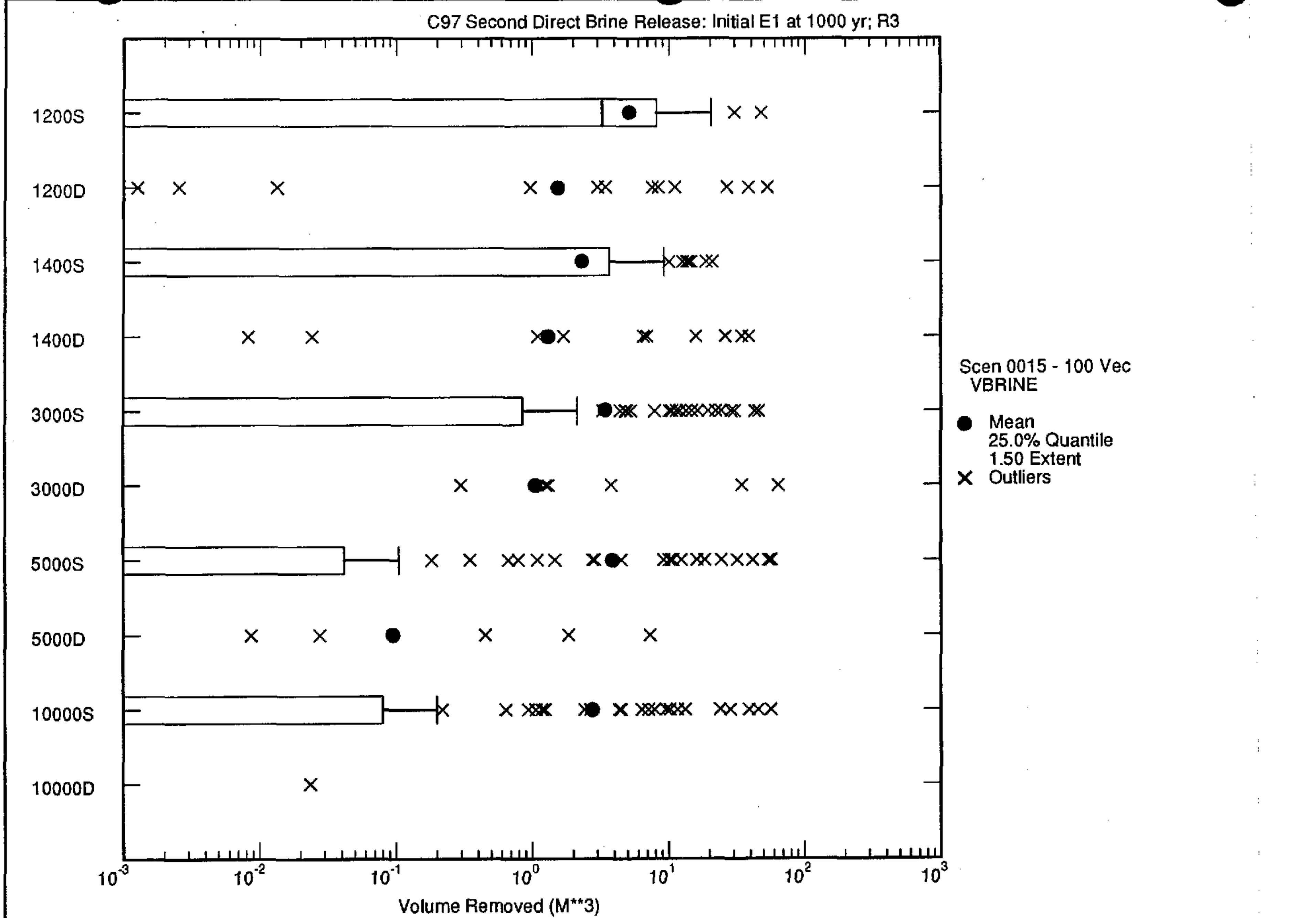
C97 Second Direct Brine Release: Initial E1 at 350 yr; R3



E.12

NUCPLOT_PA96 1.19 07/31/97 15:40

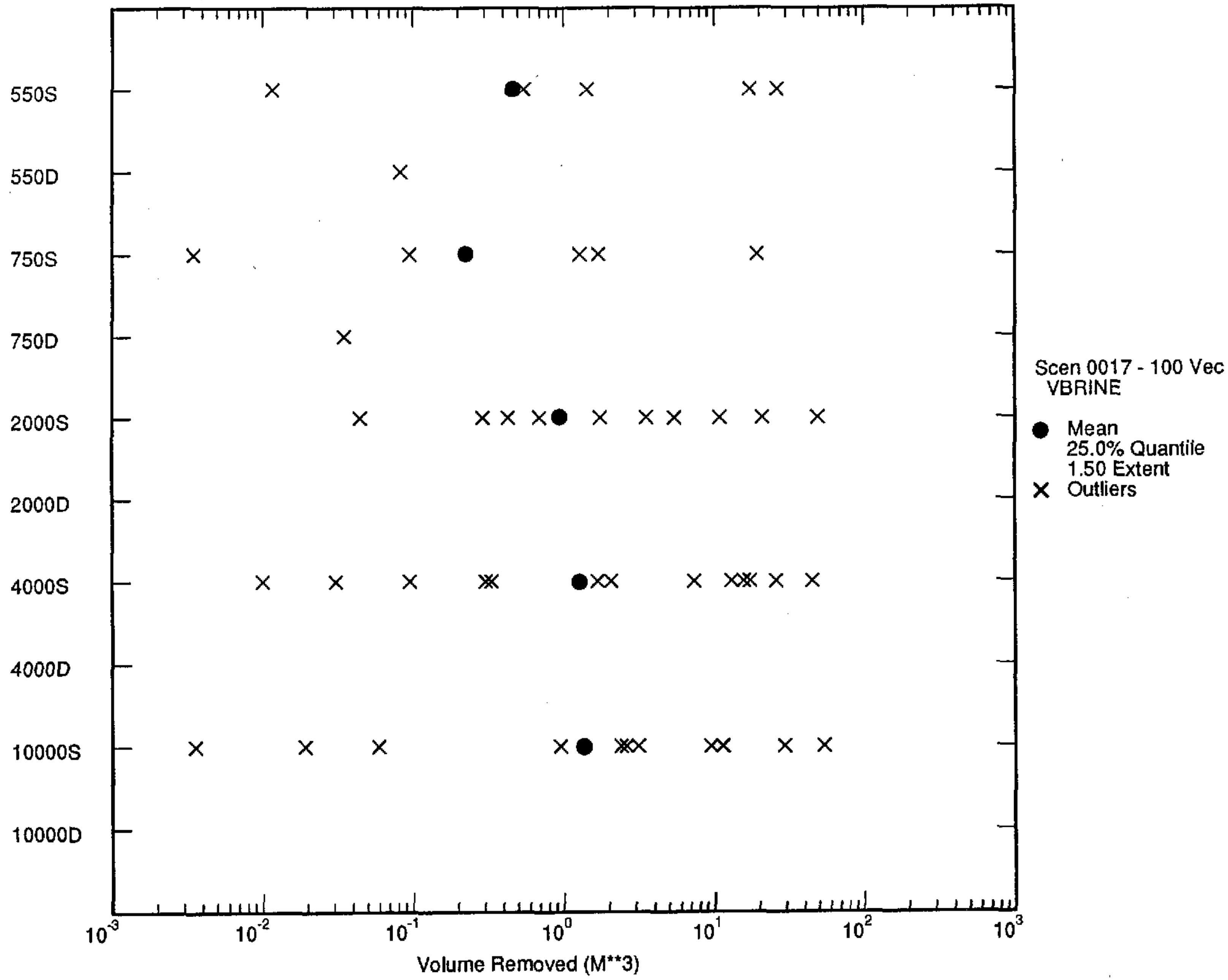
158



E.13

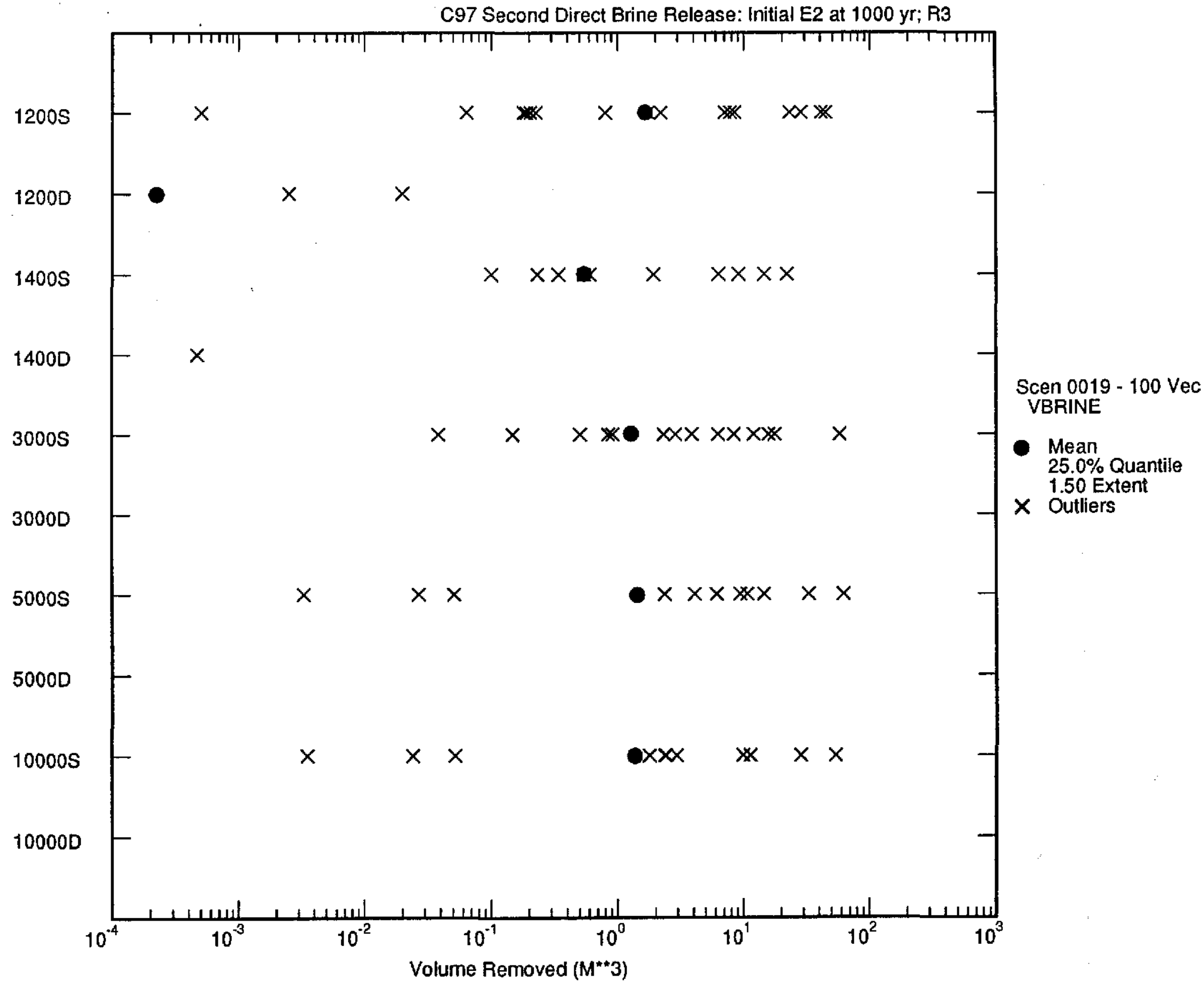
NUCPLOT PA96 1.19 07/31/97 15:40

C97 Second Direct Brine Release: Initial E2 at 350 yr; R3



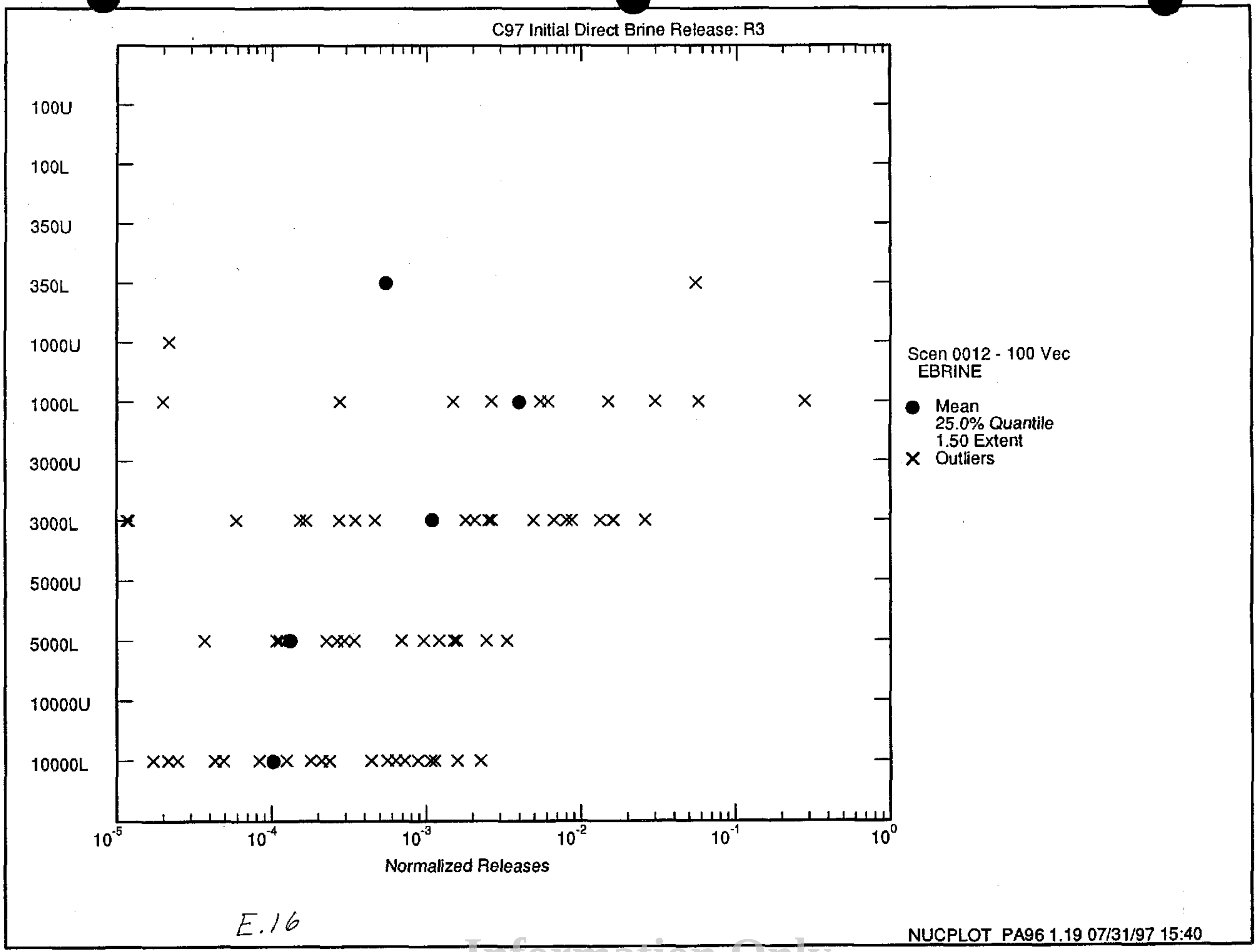
E.14

NUCPLOT_PA96 1.19 07/31/97 15:40



E.15

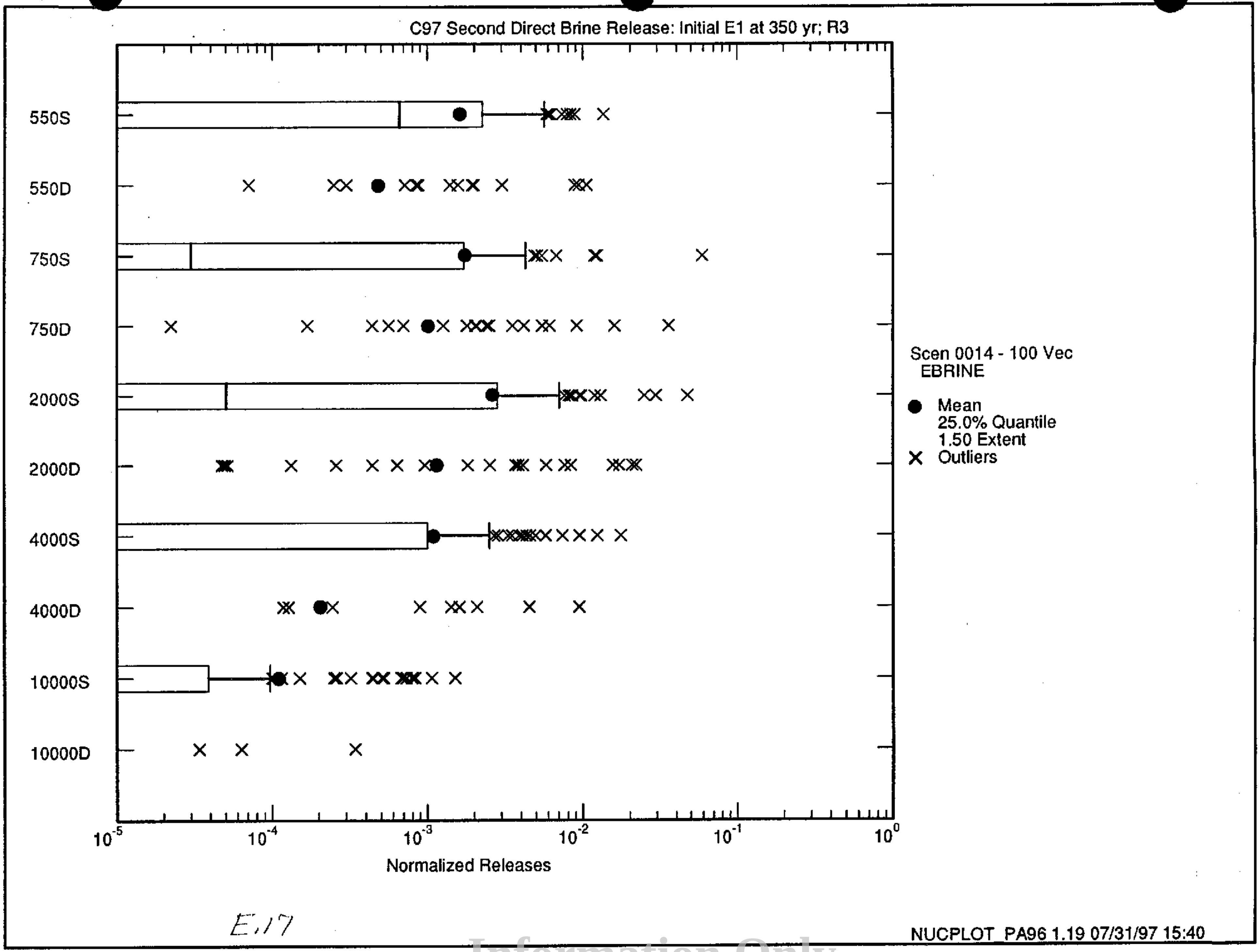
NUCPLOT PA96 1.19 07/31/97 15:40



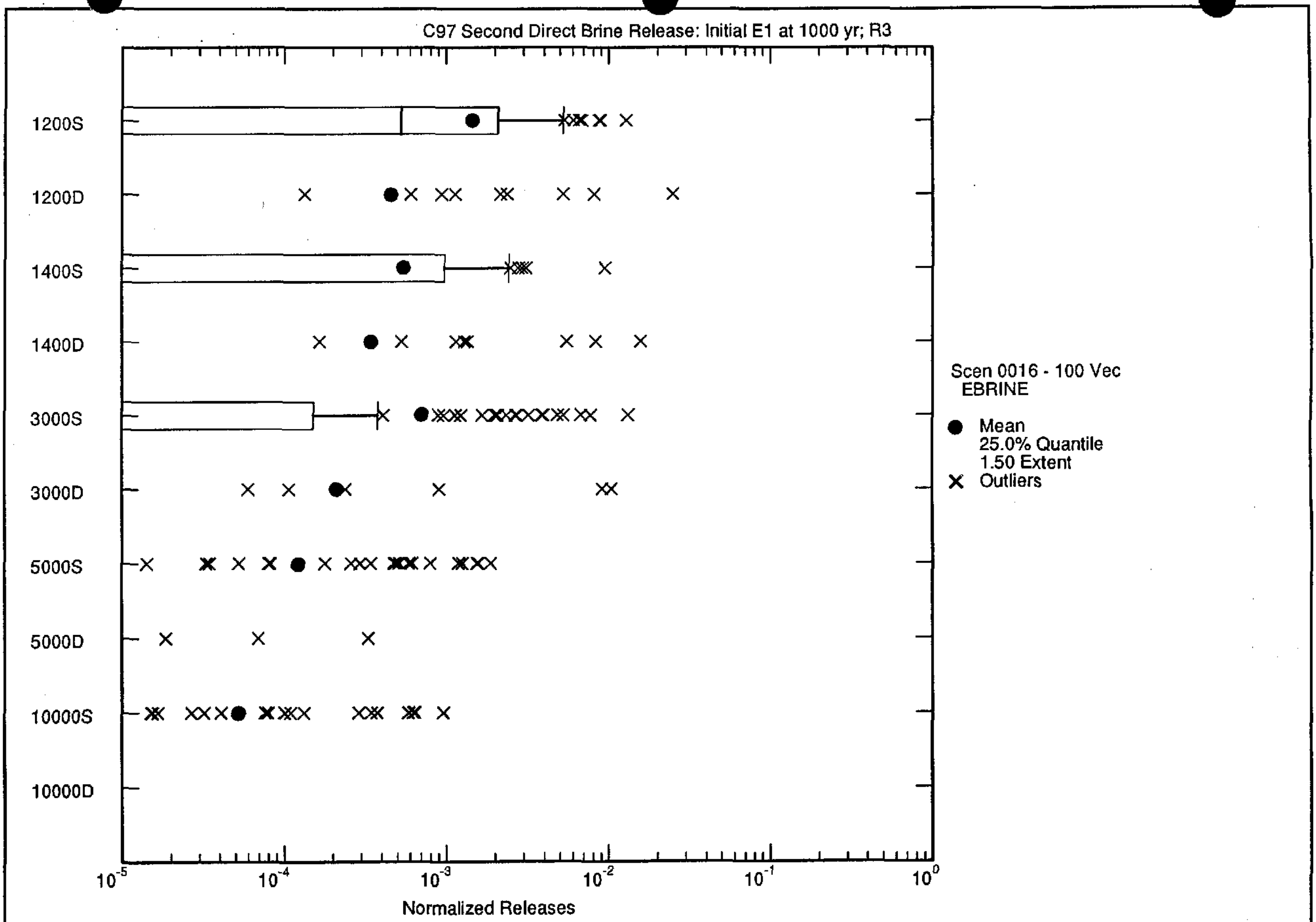
C97 Initial Direct Brine Release: R3
100U
100L
350U
350L
1000U
1000L
3000U
3000L
5000U
5000L
10000U
10000L
10-5
10-4
10-3
10-2
10-1
10-0
Normalized Releases
Scen 0012 - 100 Vec
EBRINE
Mean
25.0% Quantile
1.50 Extent
Outliers
NUCPLOT PA96 1.19 07/31/97 15:40

E.16

162


C97 Second Direct Brine Release: Initial E1 at 350 yr; R3
550S
550D
750S
750D
2000S
2000D
4000S
4000D
10000S
10000D
10-5
10-4
10-3
10-2
10-1
100
Normalized Releases
Scen 0014 - 100 Vec
EBRINE
Mean
25.0% Quantile
1.50 Extent
Outliers
NUCPLOT_PA96 1.19 07/31/97 15:40

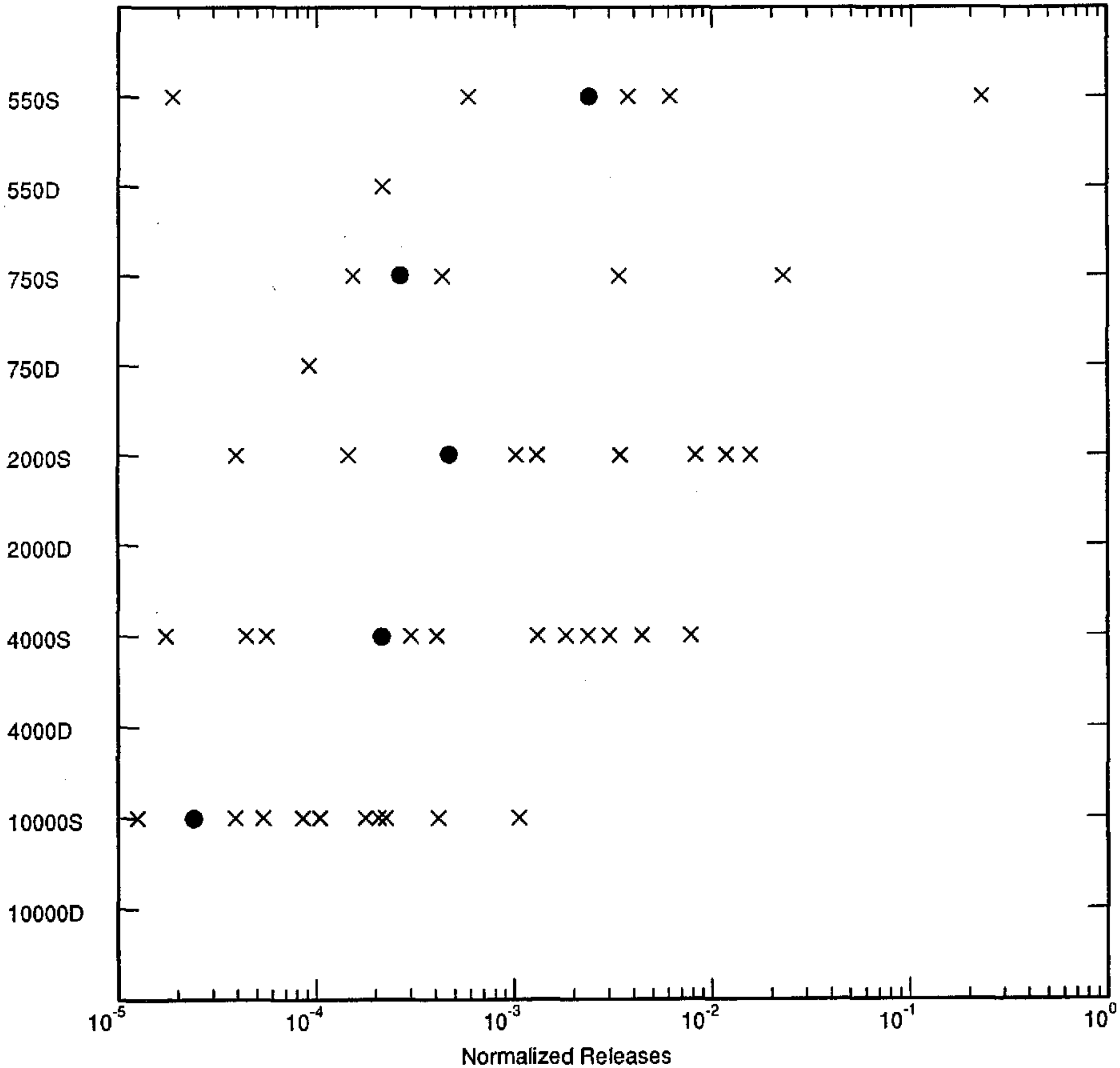
E.17



E.18

NUCPLOT_PA96 1.19 07/31/97 15:40

C97 Second Direct Brine Release: Initial E2 at 350 yr; R3

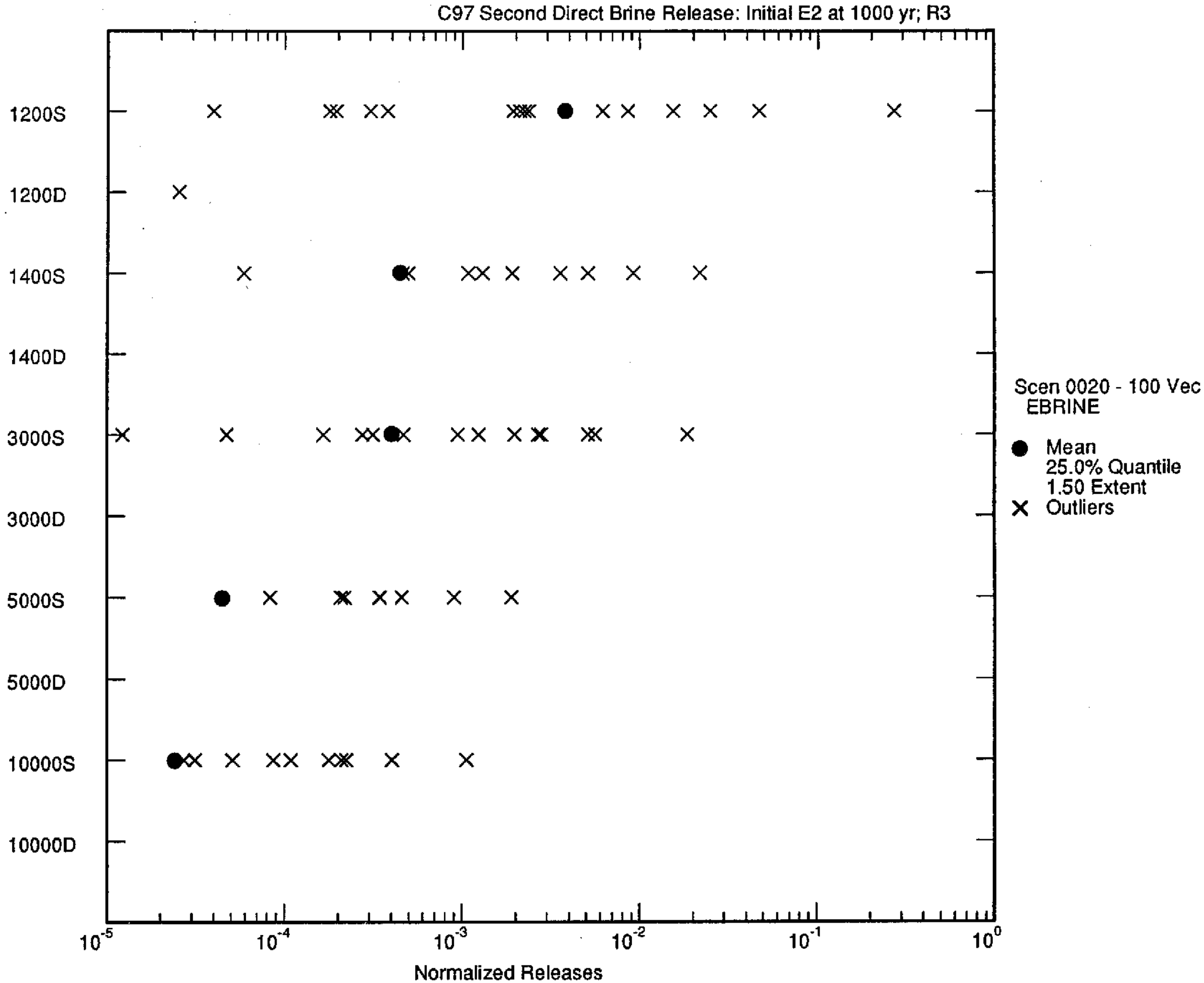


Scen 0018 - 100 Vec
EBRINE

● Mean
25.0% Quantile
1.50 Extent
× Outliers

E.19

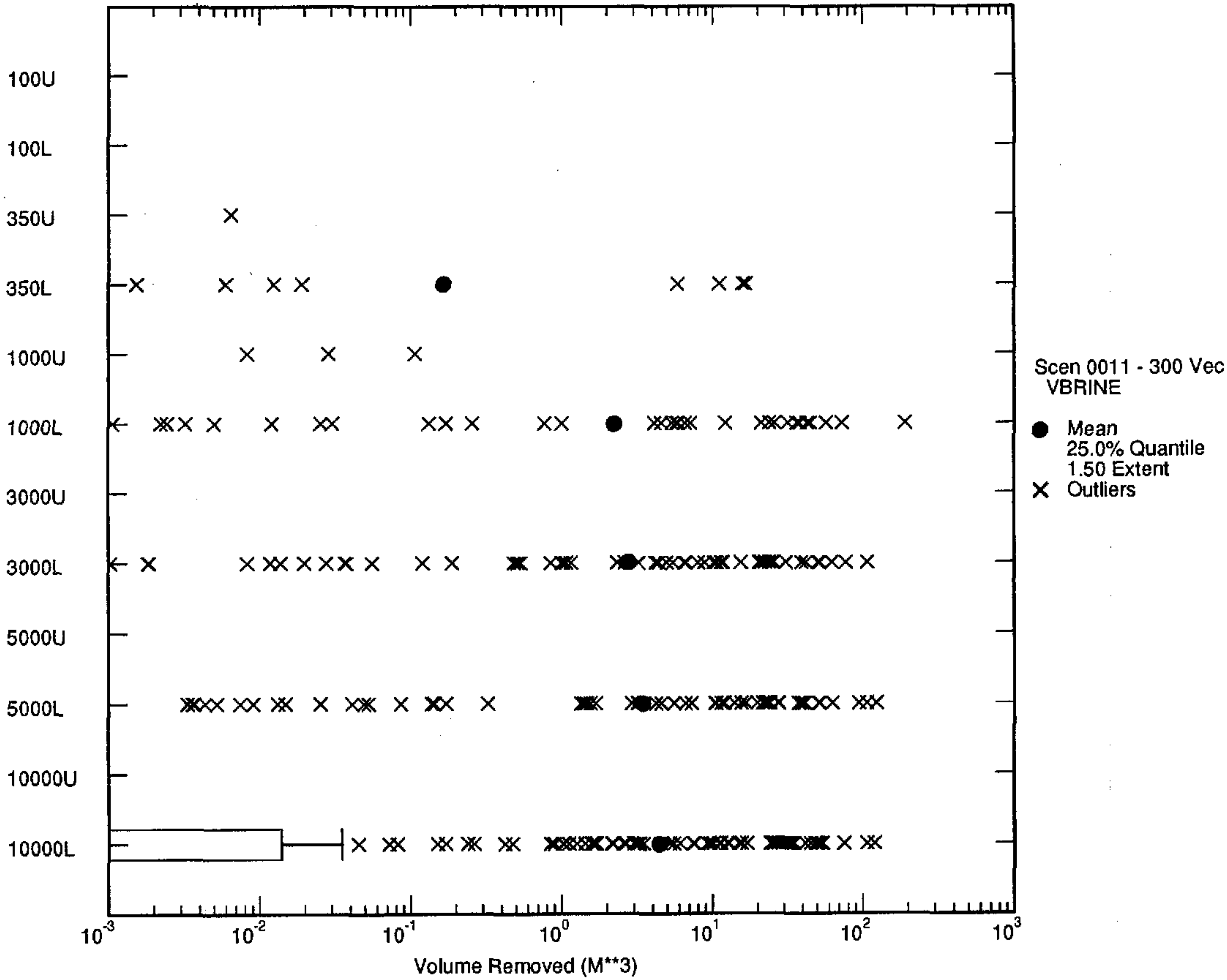
NUCPLOT_PA96 1.19 07/31/97 15:40



E.20

NUCPLOT PA96 1.19 07/31/97 15:40

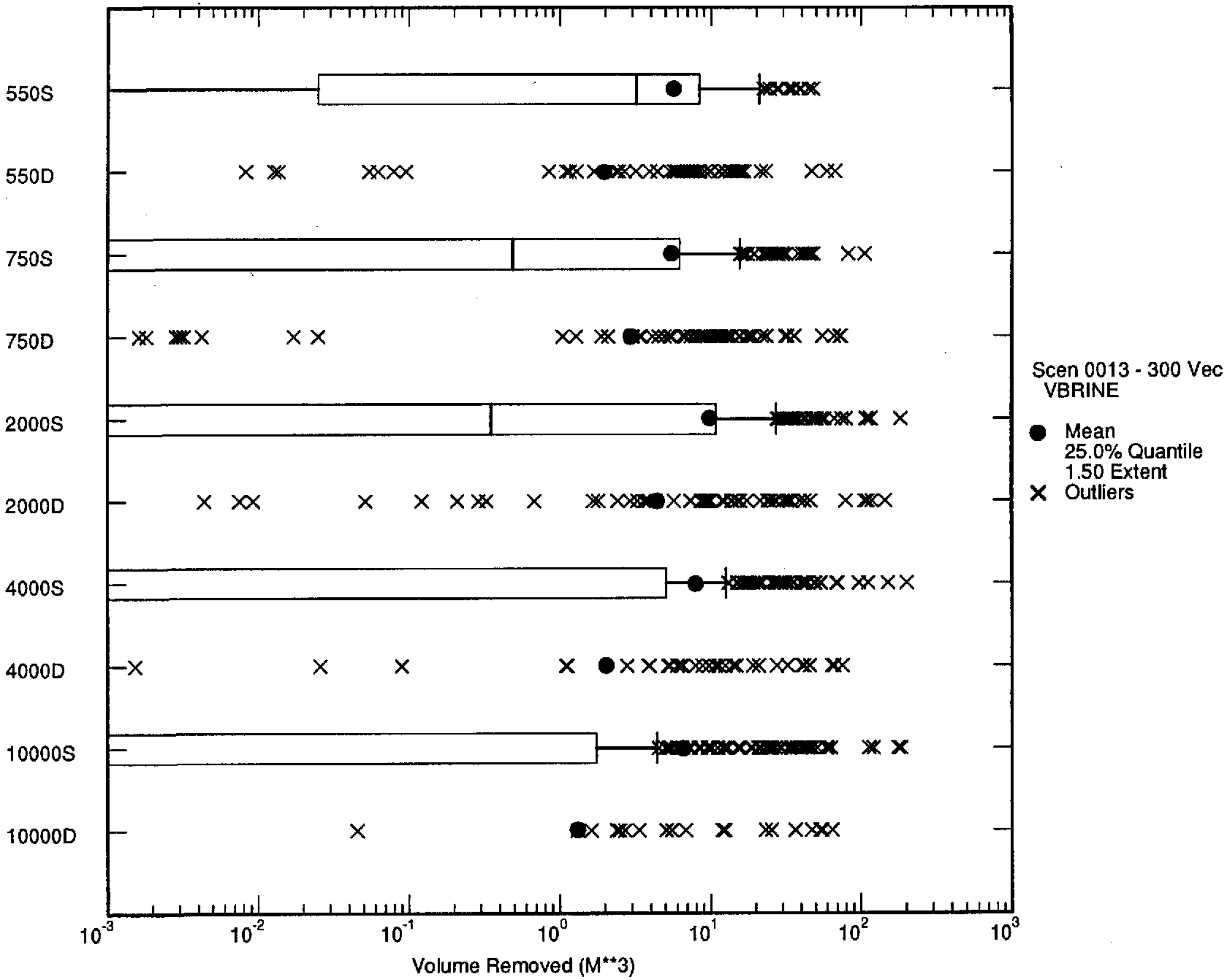
C97 Initial Direct Brine Release: R1+R2+R3



E.21

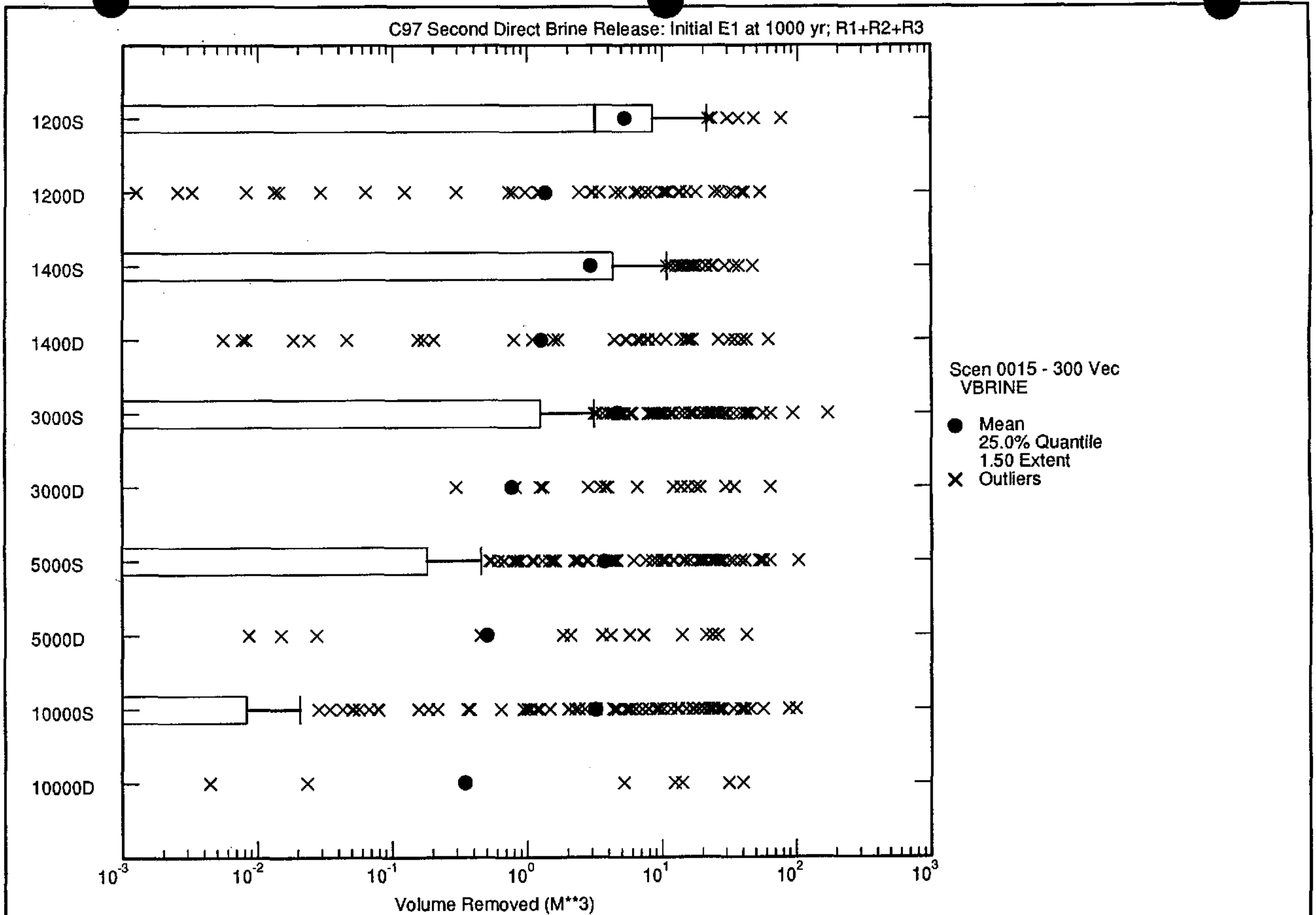
NUCPLOT PA96 1.19 07/31/97 13:47

C97 Second Direct Brine Release: Initial E1 at 350 yr; R1+R2+R3



E.22

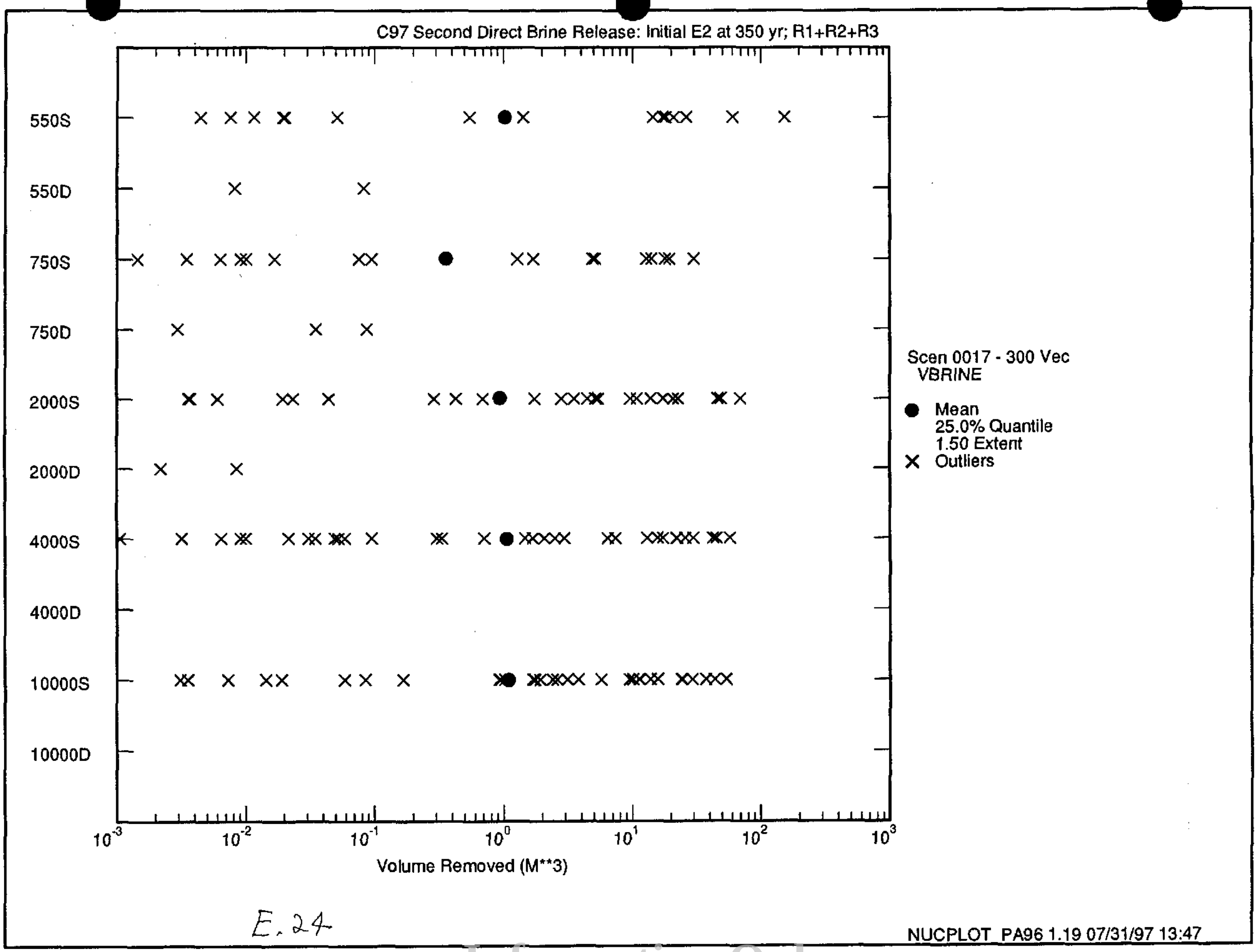
NUCPLOT PA96 1.19 07/31/97 13:47



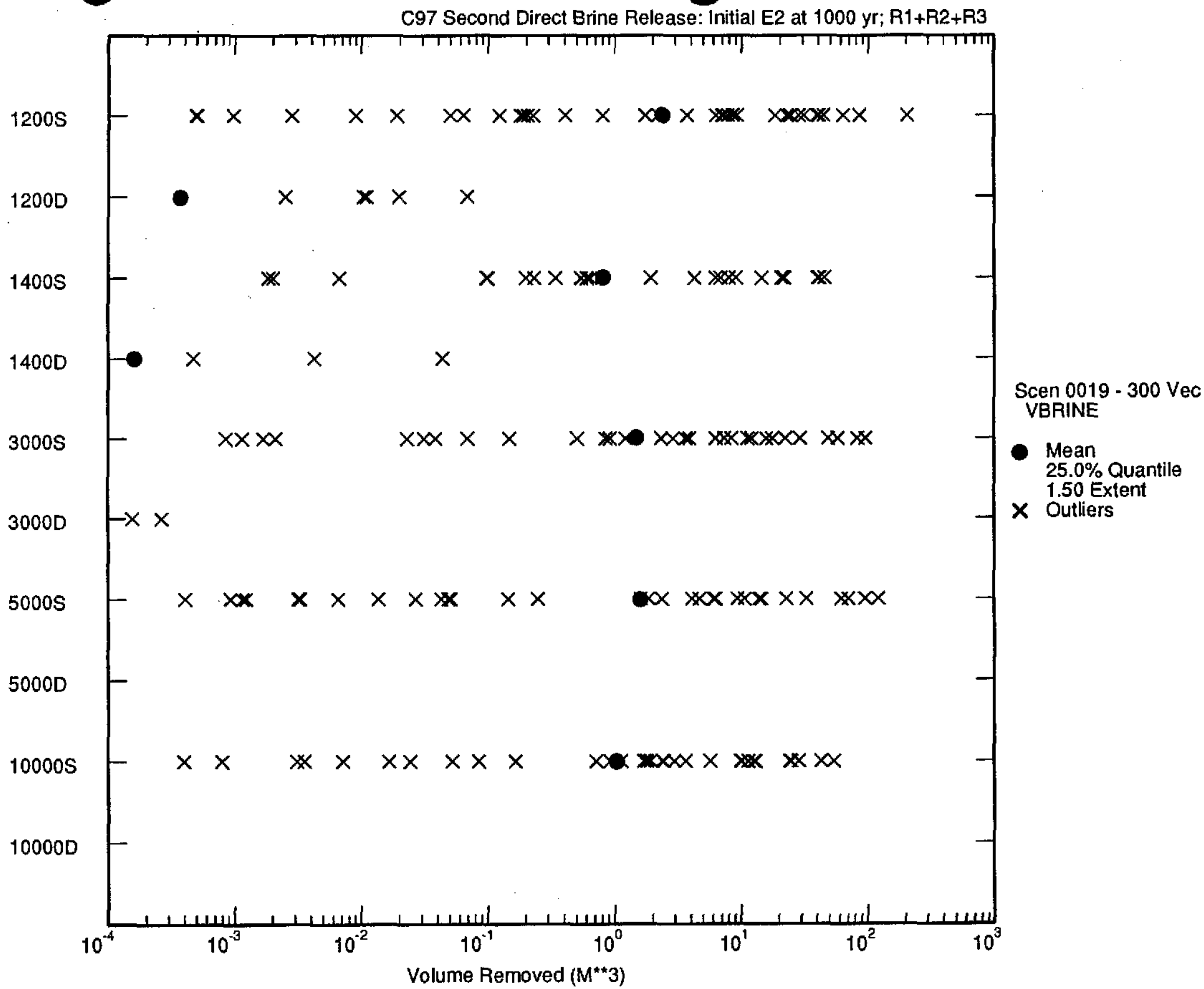
NUCPLOT PA96 1.19 07/31/97 13:47

E.23

169


C97 Second Direct Brine Release: Initial E2 at 350 yr; R1+R2+R3
550S
550D
750S
750D
2000S
2000D
4000S
4000D
10000S
10000D
10^{-3}
10^{-2}
10^{-1}
10^{0}
10^{1}
10^{2}
10^{3}
Volume Removed (M**3)
Scen 0017 - 300 Vec
VBRINE
Mean
25.0% Quantile
1.50 Extent
Outliers
NUCPLOT_PA96 1.19 07/31/97 13:47

E.24



E.25

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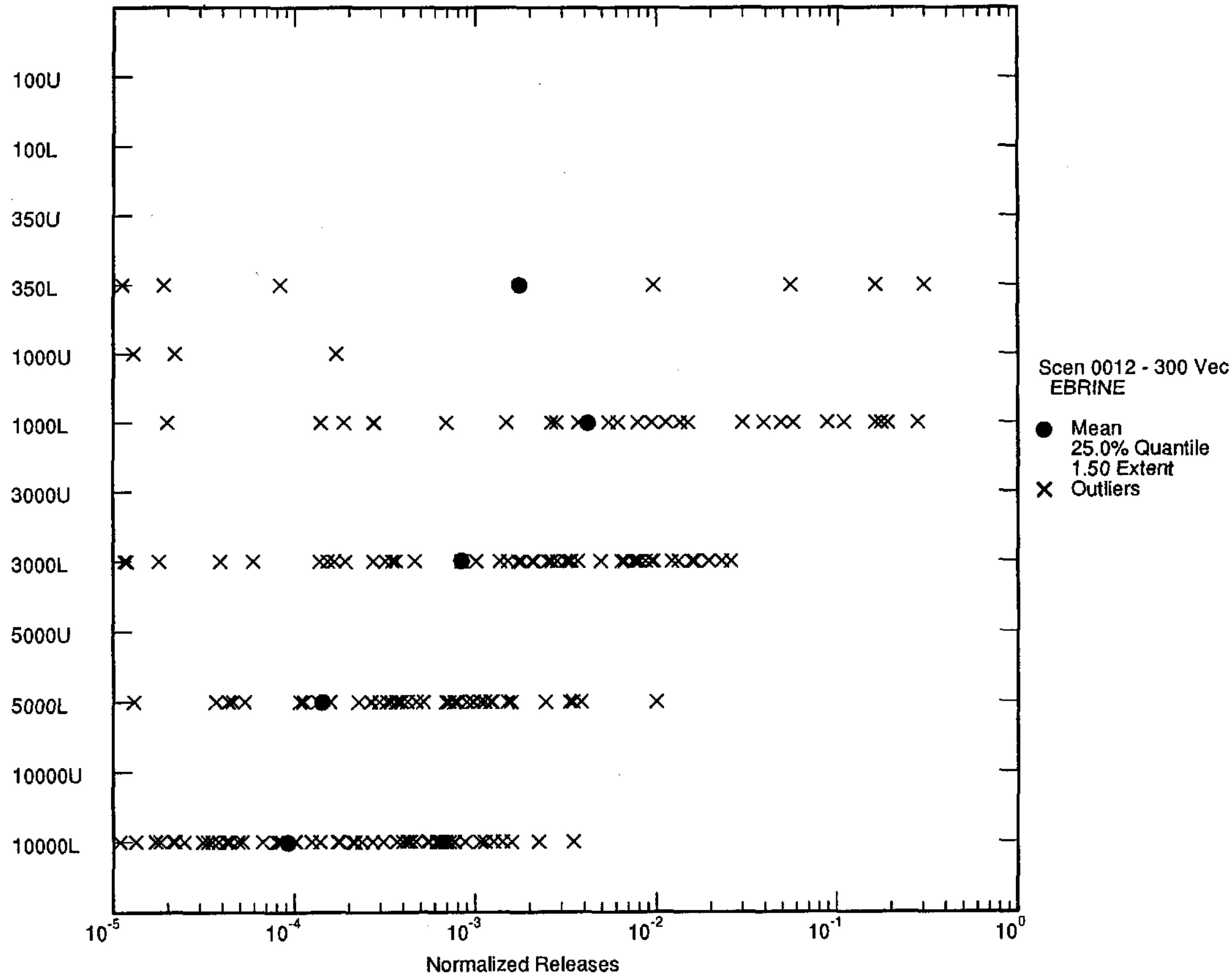
171

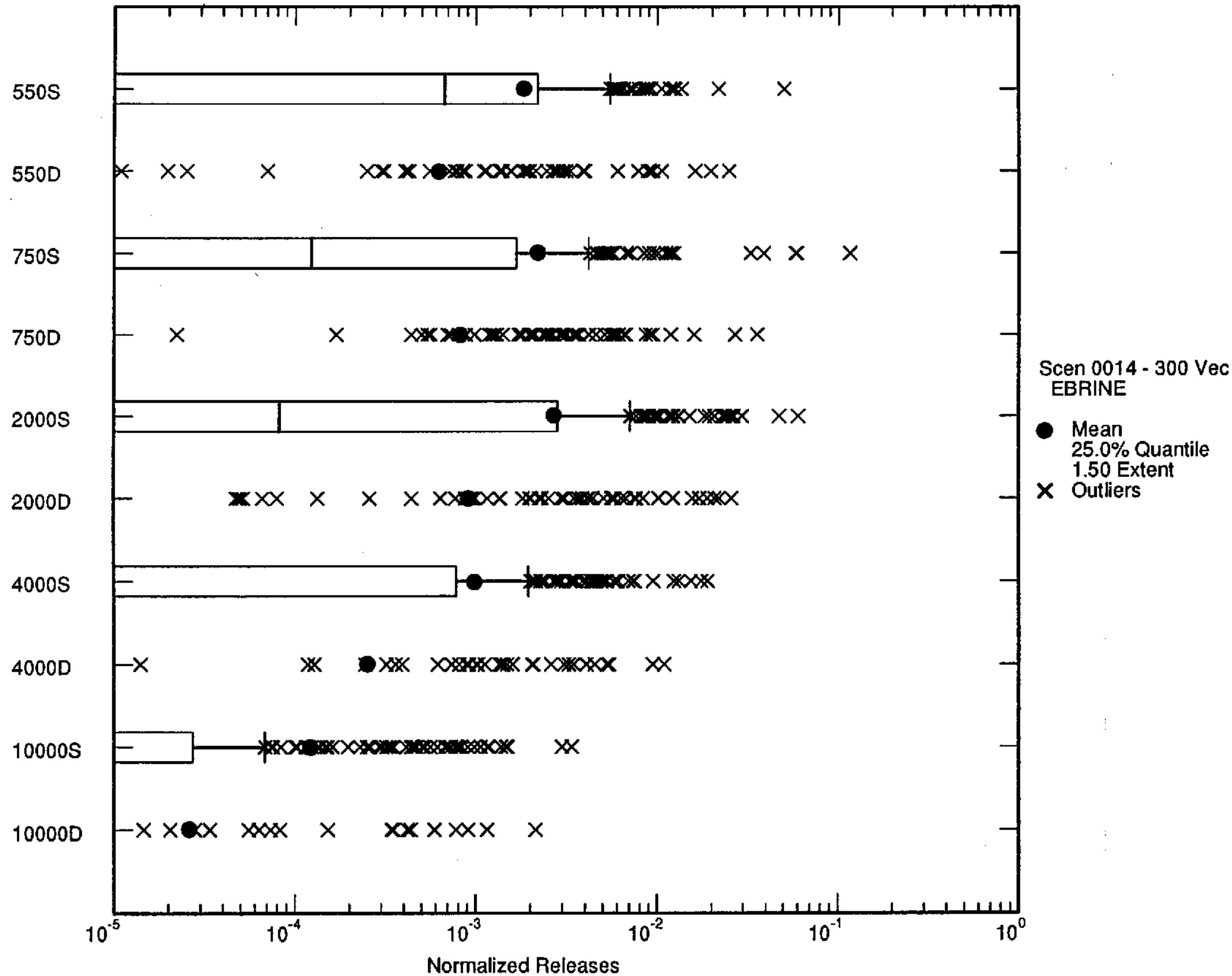
C97 Initial Direct Brine Release: R1+R2+R3



E.26

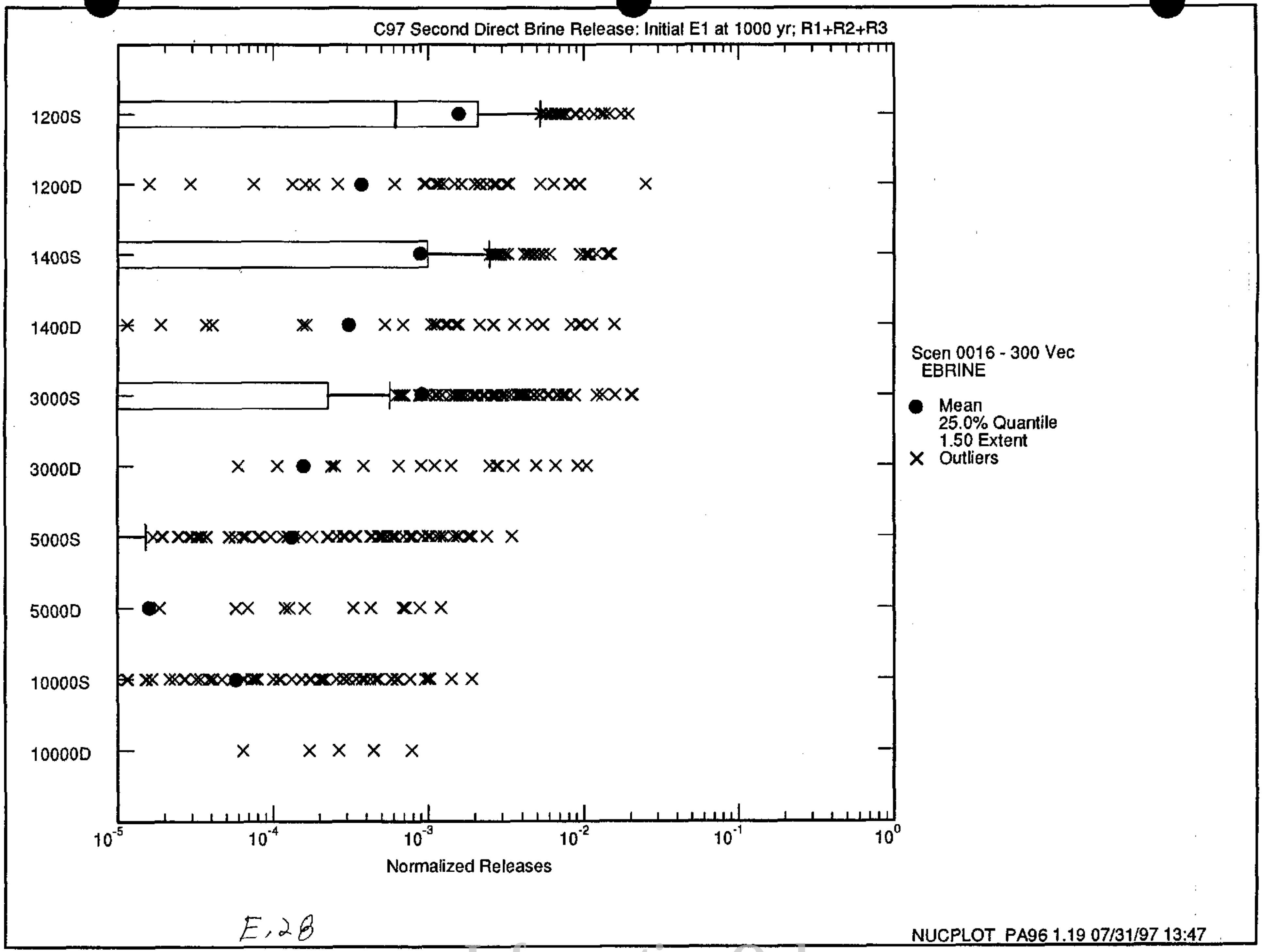
NUCPLOT PA96 1.19 07/31/97 13:46

C97 Second Direct Brine Release: Initial E1 at 350 yr; R1+R2+R3



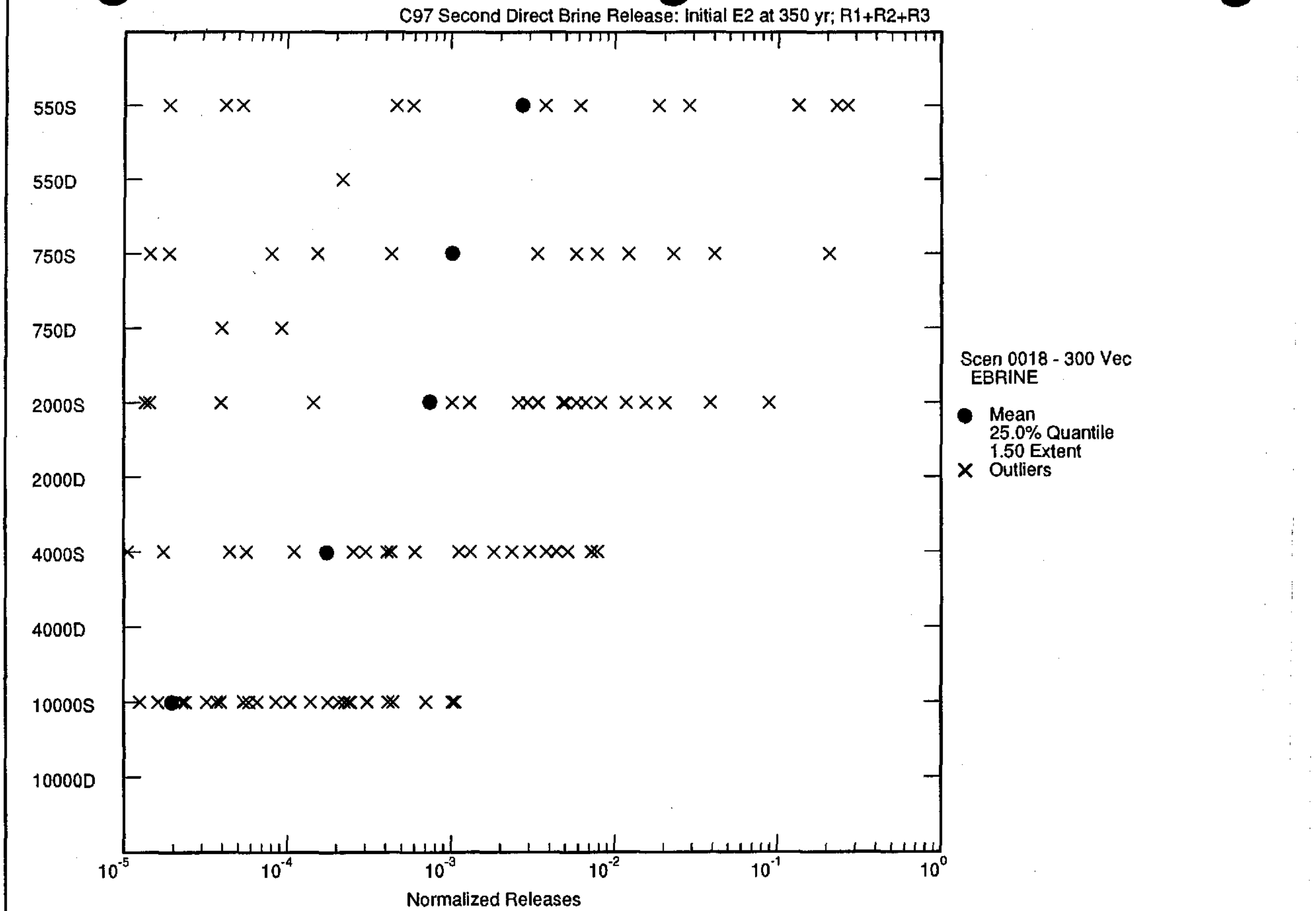
E.27

NUCPLOT PA96 1.19 07/31/97 13:46


C97 Second Direct Brine Release: Initial E1 at 1000 yr; R1+R2+R3
1200S
1200D
1400S
1400D
3000S
3000D
5000S
5000D
10000S
10000D
10^{-5}
10^{-4}
10^{-3}
10^{-2}
10^{-1}
10^{0}
Normalized Releases
Scen 0016 - 300 Vec
EBRINE
Mean
25.0% Quantile
1.50 Extent
Outliers
NUCPLOT PA96 1.19 07/31/97 13:47

E,2B

174



E.29

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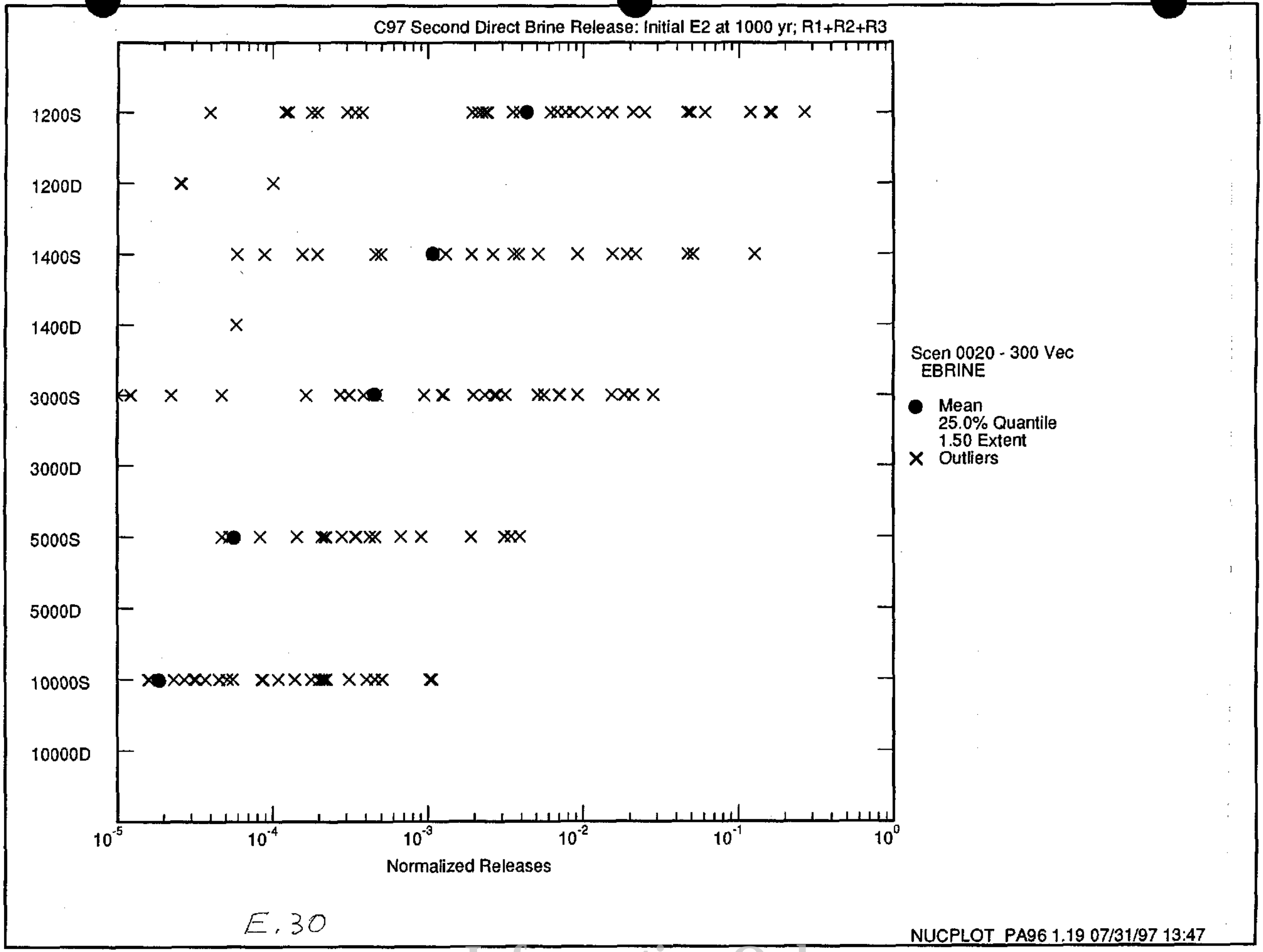
175



C97 Second Direct Brine Release: Initial E2 at 1000 yr; R1+R2+R3
1200S
1200D
1400S
1400D
3000S
3000D
5000S
5000D
10000S
10000D
10^{-5} 10^{-4} 10^{-3} 10^{-2} 10^{-1} 10^{0}
Normalized Releases
Scen 0020 - 300 Vec
EBRINE
Mean
25.0% Quantile
1.50 Extent
Outliers
NUCPLOT PA96 1.19 07/31/97 13:47

E.30