NBL-375

U.S. DEPARTMENT OF ENERGY

SAFEGUARDS MEASUREMENT EVALUATION PROGRAM

URANIUM AND PLUTONIUM SAMPLES EXCHANGE REPORT

FY 2003

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NBL: HISTORY AND MISSION

The New Brunswick Laboratory (NBL) is owned and operated by the United States Department of Energy through the offices of Security and Safety Performance Assurance (SP-1) and Materials Inventory and Technology Development (SO-20.3). The laboratory was established in 1949 as an analytical chemistry laboratory in New Brunswick in New Jersey to provide support to the Unites States Atomic Energy Commission. At that time, it was staffed by scientists from the National Bureau of Standards who had contributed significantly to nuclear material measurement programs in the Manhattan Project. At the New Brunswick Laboratory, they provided the technical expertise and skills to solve problems related to quantitative analyses of uranium-bearing materials. Over the years, these scientists and others following them have expanded the capabilities of the laboratory to include chemical and mass spectrometric analyses of plutonium and other trans-uranium elements, research and development activities in chemical analyses techniques, preparation of certified reference materials, and operation of the nuclear safeguards measurement evaluation program. In 1977, the laboratory moved from New Jersey to its present location at the Argonne National Laboratory site in Illinois.

The major mission of the New Brunswick Laboratory is to provide technical assistance to the Department of Energy in the following areas: measurement evaluation program operation, certified (nuclear) reference materials preparation, measurement techniques development, and actual measurements of special nuclear materials. In addition to fulfilling these tasks, the laboratory helps the Department in three other areas: conducting technical audits, resolving shipper/receiver differences in material transfers, and assisting in nuclear nonproliferation programs within the United States and internationally.

ACKNOWLEDGEMENTS

The Safeguards Measurement Evaluation Program is administered by the United States Department of Energy, Office of Materials Inventory and Technology Development (SO-20.3) in the Office of Security and Safety Performance Assurance (SP-1). The authors of the FY 2003 Safeguards Measurement Evaluation Program report extend their thanks to Usha Narayanan, Michael Soriano and Irene Spaletto for review and comments on earlier drafts of this report.

ABSTRACT

The New Brunswick Laboratory has been tasked by the United States Department of Energy, through the offices of Security and Safety Performance Assurance (SP-1) and Materials Inventory and Technology Development (SO-20.3), to assess and evaluate the quality of measurement technology in nuclear materials accounting as practiced in the Department of Energy facilities. Both destructive and non-destructive methods of analyses come under this purview. The destructive methods are evaluated in the Safeguards Measurement Evaluation program. The non-destructive methods, at present confined to calorimetric measurements only, are evaluated in a separate program, known as the CALEX program. This report describes FY 2003 Safeguards Measurement Evaluation program accomplishments only. The report on the CALEX program will be issued separately.

Several Department of Energy facilities (mainly contractor operated laboratories) participated in the FY 2003 Safeguards Measurement Evaluation program to satisfy a Department of Energy requirement on “independent verification of internal analytical control” in their measurements. In addition, a Nuclear Regulatory Commission licensee and laboratories in Argentina, Brazil and Japan participated, on a voluntary basis. All these laboratories analyzed uranium and plutonium samples sent by the New Brunswick Laboratory for elemental concentrations and isotopic compositions. They reported the analyses results to the New Brunswick Laboratory for statistical evaluation. Bias and precision in the measurement results were calculated and compared against the respective international target values for these two quantities. Measurement results falling within the international target values indicated satisfactory performance; those falling outside indicated the need for improvements. The participating laboratories received feed back of their performance through reports sent after evaluation of each set of results.

A. INTRODUCTION

The New Brunswick Laboratory (NBL) is a nuclear material measurement laboratory of the U.S. Department of Energy (DOE). NBL reports to the DOE office of Security and Safety Performance Assurance (SP-1) through the office of Materials Inventory and Technology Development (SO-20.3). NBL conducts the measurement evaluation program thereby providing technical assistance to the department in safeguarding nuclear materials.

In the measurement evaluation program, NBL evaluates the capabilities of the DOE contractor-operated laboratories in making nuclear material measurements using destructive (e.g. titration, isotope dilution mass spectrometry) and non-destructive (e.g. calorimetry, gamma spectrometry) methods of analyses. The program is organized in two parts; a safeguards measurement evaluation (SME) program for evaluating destructive analyses results, and a calorimetric exchange (CALEX) program for evaluating calorimetric measurements results, a non-destructive method of analysis. Within the next few years, NBL plans to expand the latter program to include other non-destructive methods (e.g. active well coincidence, passive well coincidence, and californium shuffler measurements).

B. SAFEGUARDS MEASUREMENT EVALAUTION PROGRAM

Nuclear material measurements are routinely carried out at DOE contractor-operated facilities to account for materials in processing, in storage and in transit. The experimental measurements must be done within acceptable limits of accuracy and precision. Large errors in measurements will compromise the ability to detect material loss (in processing, by theft/diversion etc.).

The SME program is designed to check the ability of laboratories in making elemental concentrations and isotopic composition measurements of uranium and plutonium bearing materials using destructive methods of analyses. The laboratories participating in the program receive well characterized samples of these two elements, and analyze them as a part of their routine work using well documented techniques. They validate the experimental results through quality control (QC) standards analyzed along with the samples. The laboratories are free to choose their own measurement methods and QC control standards. The methods used are expected to meet the accuracy and precision required by the oversight organizations/agencies – those supervising the work at the laboratories.

Despite the use of well established methods and experimental practices, inter-laboratory and even intra-laboratory differences do occur in (replicate) measurements of the samples. Ideally, such differences must remain within acceptable statistical limits. If the differences exceed the limits, then efforts must be made to understand the causes and rectify the defects.

The SME program provides the laboratories with periodic evaluations of bias and precision in their measurements of nuclear materials. The evaluations are done by comparing the results from the laboratories against international target values (ITVs) for bias and precision. Results falling within the ITVs indicate satisfactory performance, and those falling outside indicate the need for improvements. Thus, the main objective of the SME program is to monitor the quality of nuclear materials measurements and help the laboratories maintain their abilities to make accurate and precise measurements. In this regard, the SME program complements the physical security programs of the facilities in safeguarding nuclear materials.

C. FY 2003 SAFEGUARDS MEASUREMENT EVALUATION PROGRAM

The FY 2003 SME program was confined to evaluation of results of destructive analyses of uranium and plutonium bearing materials only. At the beginning of the year, NBL sent well characterized samples of these two elements to laboratories participating in the program. The participants analyzed the samples using a well defined plan, several times during the year, for elemental concentrations and isotopic compositions. After each set of analyses, the participants communicated the results to NBL for statistical evaluation and performance assessment.

NBL evaluated each set of measurement results using statistical methods of analyses. Specifically, bias and precision obtained in the measurements were evaluated. The results of statistical evaluation were communicated to the participants with comments on whether they made measurements satisfying the ITVs. In addition, the FY 2003 results were discussed at the measurement evaluation program meeting on July 17, 2004, held in conjunction with the 45th meeting of the Institute of Nuclear Materials Management (INMM), in Orlando, Florida. NBL personnel, DOE-HQ personnel and participating laboratory personnel attended the meeting.

C.1. Participants

Several DOE contractor-operated laboratories participated in the FY 2003 SME program. Their participation is mandated by the requirement in Chapter II.4.e.(7) of DOE Manual 474.1-1 of November 2000: *"Each facility's measurement control program must include participation in appropriate inter-laboratory control programs to provide independent verification of internal analytical quality control."* In addition, one Nuclear Regulatory Commission (NRC) licensee and several laboratories in Argentina, Brazil and Japan participated on a voluntary and cost recovery basis, with prior approval from DOE. The lists of participants in the FY 2003 SME program are shown in Tables 1 and 2, the former listing the uranium samples analyses participants, and the latter listing the participants in the plutonium samples analyses.

Table 1. FY 2003 SME program: Participants in uranium samples analyses

ABACC LABORATORIES (a group of 9 laboratories in Argentina and Brazil)
LOS ALAMOS NATIONAL LABORATORY (DOE contractor laboratory)
NEW BRUNSWICK LABORATORY (DOE laboratory)
NUCLEAR FUEL SERVICES (NRC licensee)
SAVANNAH RIVER SITE (DOE contractor laboratory)
TOKAI SAFEGUARDS ANALYTICAL LABORATORY (in Japan)
Y-12 NATIONAL SECURITY COMPLEX (DOE contractor laboratory)

Table 2. FY 2003 program: Participants in plutonium samples analyses

LOS ALAMOS NATIONAL LABORATORY (DOE contractor laboratory)
NEW BRUNSWICK LABORATORY (DOE laboratory)
SAVANNAH RIVER SITE (DOE contractor laboratory)
TOKAI SAFEGUARDS ANALYTICAL LABORATORY (in Japan)

Note that in FY 2003 only one NRC licensee participated (Table 1), whereas prior to FY 2001 several licensees were active participants. Apparently, the NRC licensees dropped out because of financial constraints. In the future, NBL intends to work towards increasing NRC participation because nuclear material transfers occur frequently between NRC and DOE facilities. If both NRC and DOE laboratories participate in a common SME program, then shipper and receiver differences that may occur in these transfers may be resolved speedily and efficiently. For a different reason, NBL would like increased participation of international laboratories – such participation is likely to assist DOE in nuclear safeguards work on a global scale.

C.2. Materials and Measurement Methods

The FY 2003 SME program participants analyzed uranium and plutonium bearing materials for elemental concentrations (Table 3) and/or isotopic compositions (Table 4). The participants are identified by code letters only to provide confidentiality.

Table 3. Elemental concentration determination of uranium and plutonium samples: materials, methods and participating laboratories. The laboratories are identified by code letters only. Numbers next to codes refer to number of times the laboratory participated in FY 2003 program. For example, B4 means laboratory B participated in the program four times during the year.

Method	UNH Solutions	UO_2 Pellets	UO_3 Powder	UF_6	Pu Sulfate
Dichromate Titration	B4 F3 G4 U1	AA1 AC1 AD1 AE1 BA1 BC1 BD1 BF1 F1 T2	F1		
Ceric Titration	G4				
ICP/MS		BE1			
High Precision Titration		F2		F1	
IDMS	A4 B2 G1		A3		B1 G1
XRF	A4		A6		

Notes: UNH, uranyl nitrate solutions. UO_2, uranium dioxide pellets. UO_3, uranium trioxide powder. UF_6, uranium hexafluoride (solid at normal room temperature). Pu sulfate, dried material.

Table 4. Isotopic composition determination of uranium and plutonium: materials, methods and laboratories. The laboratories are identified by code letters only. Numbers next to codes refer to number of times the laboratory participated in FY 2003 program. For example, A2 means laboratory A participated in the program two times during the year.

Method	LEU	HEU	Pu sulfate
TIMS	A2 AC1 B3 BC1 F1 G1 T2	A3 B4 G1 U1	B2 G1 T2
ICP/MS	BE1		

Notes. LEU is low-enriched uranium containing <20 wt % ^{235}U. HEU is high-enriched uranium containing ≥20 wt % ^{235}U. Pu sulfate: dried material of either high burn up or low burn up composition.

C. 3. Test Materials Characterization and Shipping

Test materials used in the FY 2003 SME program were derived from certified reference materials (CRMs) or working reference materials (WRMs) or materials specially made for the program. All these materials were characterized for elemental concentrations and/or isotopic compositions through experimental measurements. When CRMs and WRMs were used, the characterization experiments verified the certified values to be true.

The characterization experiments were performed according to statistical plans. Quality assurance and traceability to these measurements were provided through analyses of other appropriate certified reference materials.

A sufficiently large number of splits of test materials were prepared from the characterized/verified materials. The splits were used in the FY 2003 program and the excess reserved for future use. The FY 2003 test materials were shipped to the participating laboratories at the beginning of the fiscal year. Typically, laboratories received 8 splits of each type of test material, not necessarily from a single source, and analyzed the samples according to the following schedule: two samples in duplicate every quarter on two different days, thereby producing 8 results every quarter. Some laboratories were not able to analyze the samples every quarter; these laboratories analyzed the test samples at a lesser frequency, once or twice a year.

C. 4. Statistical Evaluation

The participating laboratories soon after completion of each set of analysis submitted the results to NBL for statistical analysis and performance evaluation. The results were manually entered into a FoxPro® data base. The data-base program has been in continuous use since 1995. It was

modified in 1999 to become Y2K compliant. The entered data were checked for errors, again manually. Both data entry and verification of the entered data remain as labor-intensive operations. NBL intends to automate data entry operation to facilitate speedy and error-free entry.

The percent relative difference (% RD) of each experimental result submitted by the laboratories was calculated with respect to the corresponding reference values obtained from the results of characterization/verification experiments. The % RD is defined in the equation below:

$$\% \text{ RD} = 100 \text{ X } \{(\text{observed value} - \text{reference value})/\text{reference value}\}.$$

Each set of % RD results was examined for outliers using a number of different statistical tests. A result was judged to be an outlying value, if at least two of the tests identified it as a possible statistical outlier at the 99% significance level or higher. Results so judged were eliminated from further consideration.

Each data set, sans outlying values, was examined to identify significant sources of variations attributable to analyses protocols: e.g. day-to-day, and analyst-to-analyst. At the end of these evaluations, an arithmetic mean was calculated for each set of % RD results, along with an expanded uncertainty for the mean. In this report, the half-width of this uncertainty is labeled 95% confidence limit (C.L.) of mean. It was calculated by multiplying the standard uncertainty of the mean value by an appropriate coverage factor. The value of the coverage factor was obtained from tables of the Student's "t" distribution with 95% confidence and appropriate degrees of freedom.

The 95% confidence interval (C.I.) of the mean was constructed from the half-width. It represents the interval containing all values between the mean % RD minus the half-width, and the mean % RD plus the half-width. Thus, the 95% C.L. of the mean are just the two end points of the C.I., namely the mean minus the half-width and the mean plus the half-width.

Day-to-day variation and/or analyst-to-analyst variation was studied using standard one-factor analysis of variance (ANOVA) with analysis day (or analyst) as the factor. If the ANOVA results indicated no significant variation, then the standard uncertainty was calculated from the standard deviation of all results. It was the simple standard deviation of the results divided by the square root of n, where n was the number of measurements. The coverage factor used was the 95% Student's "t" factor with n-1 degrees of freedom. For example, the degree of

freedom is 7 and the coverage factor is 2.36, for a set of 8 results showing no day-to-day variation.

If the ANOVA results indicated significant (≥95%) day-to-day and/or analyst-to-analyst variation, then the standard uncertainty was estimated from the square root of the mean square for the "model" quantity that was obtained from ANOVA results. In this case, the coverage factor was the 95% Student's "t" factor with (k-1) degrees of freedom, where k was the number of days over which the analyses were performed. For example, for a set of 8 results obtained over a period of 2 days and showing day-to-day variation, the degree of freedom is 1 and the coverage factor is12.71.

If the 95% C.I. of the mean % RD included zero, then the measurement was considered to be bias-free. Otherwise, measurement bias was indicated. The standard deviation of the % RD results represented the precision (± 1σ) of the analyses.

Two examples of the statistical analysis reports are shown in Figures 1 and 2 below. Figure 1 results were obtained from Davies-Gray titration, and Figure 2 results from isotope dilution mass spectrometry (IDMS). Each report contains 8 results for uranium assay. The results represent replicate measurements of two samples, each sample analyzed in duplicate on two different days.

There are no outliers in Figure 1 results, and no evidence for significant day-to-day variation. The mean % RD value with its uncertainty at 95% C.I. is -0.154 ± 0.070. The uncertainty is calculated using a coverage factor of 2.36 corresponding to 7 degrees of freedom. The mean value extended by the confidence interval does not include zero, thereby indicating negative bias in the measurements. The value for the standard deviation (± 1σ) is 0.083.

The results in Figure 2 also show no outliers, but exhibit significant day-to-day variation. The mean % RD value with its uncertainty at 95% C.I. is 0.015 ± 1.319. The uncertainty is calculated using a coverage factor of 12.7 corresponding to 1 degree of freedom. The mean value extended by the confidence interval overlaps with zero indicating no bias in the measurements. Nonetheless this conclusion is not meaningful since the uncertainty accompanying the % RD is very large. The value for the standard deviation (± 1σ) is 0.149, about twice higher than that reported in Figure 1.

The bias and standard deviation from the experiments may be compared against bias and precision international target values (ITVs) specified for the material/method combination given at the bottom of the tabular data in Figures 1 and 2. The data in Figure 1 did not satisfy the bias ITV but satisfied the precision ITV. The data in Fig.2 satisfied both bias and precision ITVs, but suffered from a large uncertainty because of day to day variation. The data in Figures 1 and 2 are presented in two separate graphs that follow the numerical listing and the statistical evaluation of the data. These graphs are visual aids in the performance evaluation.

Note that ITVs are available for some of the materials/methods used in the FY 2003 program but not for all. For example, ITVs are available for uranium determinations by Davies-Gray titration and IDMS methods, but not for uranium assay by x-ray fluorescence. In those cases, where ITVs have not been specified, DOE target values or international target values for comparable methods were used as substitutes.

The participating laboratories received reports such as those shown in Figures 1 and 2 for each set of results submitted by the laboratory. Cover letters accompanying the reports stated the conclusions of the report. Copies of reports and cover letters were also sent to the respective agencies that oversee the activities of the laboratories.

Laboratories were asked to take action if they failed to meet the ITVs. Corrective action is usually done through review of experimental procedures, and modifying them suitably to obtain results with less bias and increased precision.

Figure 1

SAMPLE DATA EVALUATION REPORT

No significant excess difference due to analysis day

U.S. Department of Energy
New Brunswick Laboratory
Safeguards Measurement Evaluation Program
Data Evaluation Report

Day to Day ANOVA analysis

Report for Laboratory: XX

U02 Pellet – U Concentration

Davies-Gray Titration

Date of Report: July 30, 2003

Sample Number	Aliquant Number	Analysis Date	Reported %U	% Relative Difference	Analyst Code
95EU0079-1	1	06/25/00	88.126	-0.0034	XXX
95EU0079-1	2	06/25/00	87.990	-0.1577	XXX
95EU0079-2	1	06/25/00	88.031	-0.1112	XXX
95EU0079-2	2	06/25/00	87.892	-0.2689	XXX
95EU0079-1	3	06/26/00	88.030	-0.1123	XXX
95EU0079-1	4	06/26/00	87.950	-0.2031	XXX
95EU0079-2	3	06/26/00	87.922	-0.2349	XXX
95EU0079-2	4	06/26/00	88.002	-0.1441	XXX

Number of Results Analyzed	8
Mean % Difference	-0.154
Mean Absolute % Difference	0.154
95% C.L. of Mean (df = 7)	0.070
Standard Deviation	0.083
Between-Day Standard Deviation (df = 1)	0.054
Within-Day Standard Deviation (df = 6)	0.087
Statistical Significance of Between-Day Standard Deviation	44.3%

International target value for bias in Davies-Gray Titration is 0.1%.

International target value for precision in Davies-Gray Titration is 0.1% .

Laboratory XX
UO2 Pellet -- Davies-Gray Titration

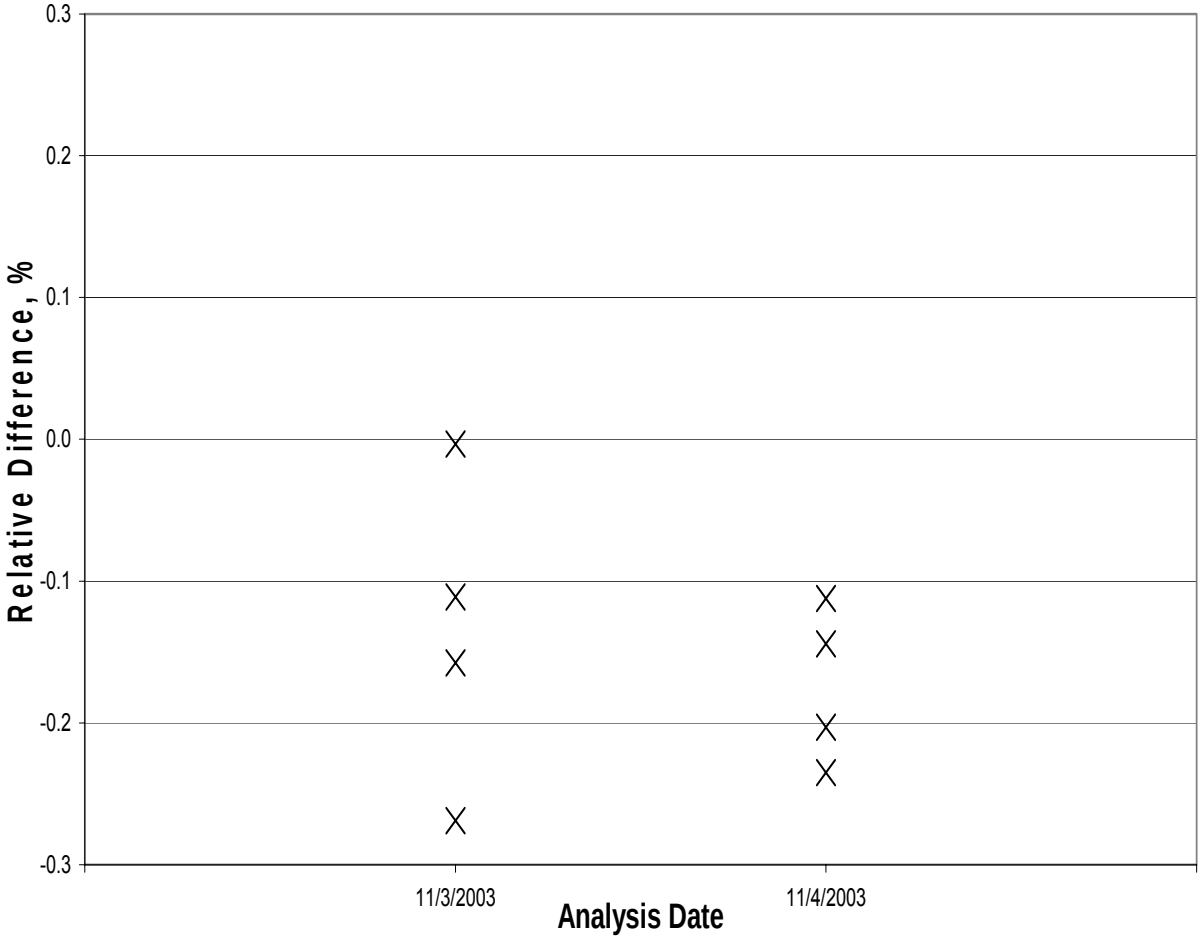


Figure 2

SAMPLE DATA EVALUATION REPORT

Significant excess difference due to analysis day

U.S. Department of Energy
New Brunswick Laboratory
Safeguards Measurement Evaluation Program
Data Evaluation Report

Day to Day ANOVA analysis

Report for Laboratory: XX

UNH Solution – U Concentration

IDMS

Date of Report: May 8, 2003

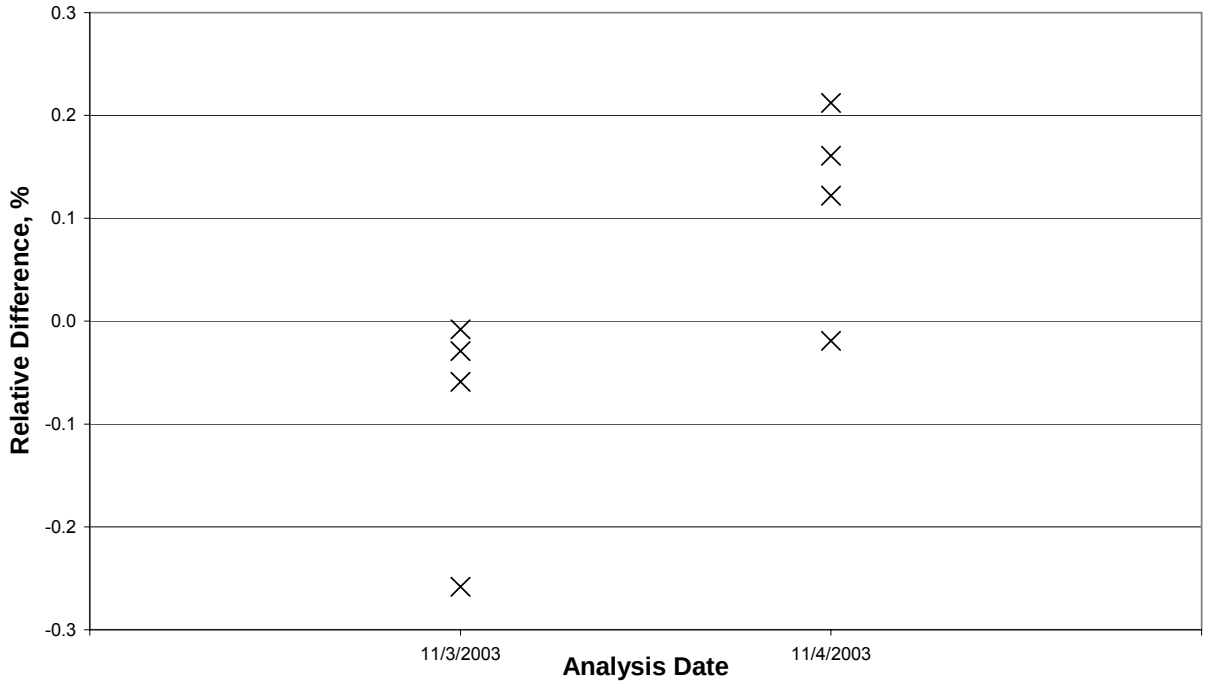
Sample Number	Aliquant Number	Analysis Date	Reported %U	% Relative Difference	Analyst Code
94NU0021-023	1	04/11/00	1.0000	-0.0590	XXX
94NU0021-023	2	04/11/00	1.0003	-0.0290	XXX
94NU0023-079	1	04/11/00	0.9991	-0.0080	XXX
94NU0023-079	2	04/11/00	0.9996	-0.2582	XXX
94NU0021-023	3	04/15/00	1.0022	0.1609	XXX
94NU0021-023	4	04/15/00	1.0004	-0.0190	XXX
94NU0023-079	3	04/15/00	1.0004	0.1221	XXX
94NU0023-079	4	04/15/00	1.0013	0.2122	XXX

Number of Results Analyzed	8
Mean % Difference	0.015
Mean Absolute % Difference	0.109
95% C.L. of Mean (df = 1)	1.319
Standard Deviation	0.149
Between-Day Standard Deviation (df = 1)	0.294
Within-Day Standard Deviation (df = 6)	0.107
Statistical Significance of Between-Day Standard Deviation	96.6%

International target value for bias in IDMS is 0.1%.

International target value for precision in IDMS is 0.15% .

Laboratory XX
UNH Solution -- IDMS



D. FY 2003 ANALYSES RESULTS AND REPORTING FORMAT

The FY 2003 experimental results submitted by the participating laboratories are shown in the appendices A to E to this report along with %RD calculated for each result. The results are arranged according to the types of materials analyzed (uranium, plutonium), and also by types of analyses (elemental concentration, isotopic composition). Laboratories are identified by code letters only.

In section E of this report, a summary of FY 2003 results are presented, arranged according to the types of material analyzed (e.g. uranyl nitrate solution, uranium oxide pellets, plutonium) and also by the types of analyses (elemental concentration or isotopic composition measurements). The results from each participating laboratory are presented in terms of grand mean of % RDs and the associated uncertainties, calculated separately from all results submitted during the year for any particular material/method combination (e.g. uranyl nitrate solution by Davies-Gray titration, plutonium assay by IDMS). The numerical values for % RDs and standard deviations are presented in Tables 5 to 13 along with bias and precision ITVs for the material/method combinations. The same results are presented graphically in Figures 3 to 20, to facilitate visual comparison with the respective ITVs. Some explanatory notes for the information contained in the tables and figures follow.

The data in Tables 5 to 13 contain the following: the laboratory performing the analysis, the method of analysis, the number of good results (with outliers removed) submitted during the year, the (grand) mean % RD, the standard deviation (± 1σ), bias ITVs and precision ITVs. The performance of any given laboratory can be assessed through comparison of the mean % RD and standard deviation of the experimental results against the respective ITVs given in that row.

The data presented in the tables are also shown in Figures 3 to 20. The figures are of two types: the material-measurement skeletal figures and the material-measurement line figures, the former drawn to aid in the evaluation of bias in the measurements, and the latter drawn to aid in the evaluation of precision.

In the material-measurement skeletal figures (all odd number figures from Figure 3 to 19), the % RD results are shown as diamonds. The vertical line passing through each diamond represents the standard deviation for that particular set of results. The bias ITVs are shown as dotted horizontal lines. If the diamonds (extended by the respective standard deviation of the results) fall

within the horizontal lines, then the measurements are said to satisfy the bias ITV; those falling outside fail. The magnitude of bias (if any) can be estimated only with reference to the mean %RD value taken along with its uncertainty at 95% C.L. No bias is indicated if the mean % RD extended by the uncertainty at 95% C.L. includes zero. If it fails to include zero, bias is indicated; above zero indicates positive bias and below zero indicates negative bias.

The material-measurement line figures (all even numbered figures from Figure 4 to 20) show whether the measurements meet the precision criteria. The vertical line represents the standard deviation for each % RD result. If the top of the vertical line is below the corresponding precision ITV limit - shown as a dotted horizontal line - then the laboratory has satisfied the precision ITV for that material/method combination. If the vertical line extends beyond the horizontal, then the laboratory has failed the precision criterion. In the material-measurement line figures, the diamonds represent the absolute values of the mean % RDs. The position of the diamonds in the figures show whether the measurements suffer from bias. The measurements are assumed to be bias-free if the diamonds fall on the abscissa (taken in conjunction with the respective uncertainties); if they fall above, then measurement bias is indicated.

The FY 2003 report contains not only a summary of results submitted during FY 2003, but also a summary of results gathered in the past three years (FY 2001, FY 2002 and FY 2003) arranged laboratory-by-laboratory/material-by-material. The three year summary is presented in Section F in graphical form in Figures 21 to 60. The three year evaluation is confined to uranium measurement results only, each graph representing the three year results from a laboratory for a material (e.g. FY 2001-2003 results of uranium analysis by IDMS at facility A).

E. FY 2003 PERFORMANCE EVALUATION: MATERIAL BY MATERIAL

The FY 2003 uranium and plutonium measurements results are evaluated in this section. The results are presented according to the type of material analyzed, with uranium assay results in sections E.1 to E.4, followed by uranium isotopic composition results in E.5, and finally plutonium abundance and isotopic composition results in E.6. Laboratories failing to meet the bias and/or the precision target values are specifically mentioned. They are urged to review their current analytical procedures and practices towards making improvements.

E.1. Uranyl Nitrate Solutions

Test materials of uranyl nitrate solutions were made from enriched as well as natural isotopic composition materials; the enrichment refers to ^{235}U content. The concentrations of uranium solutions ranged from 7 to 10 mg uranium/g solution. The natural uranium isotopic composition solutions were sent to those laboratories that were not permitted to receive enriched materials.

The following uranyl nitrate solutions are available for use in the SME program: one solution made from 50% enrichment material, three solutions made from 90% enriched material, and three solutions made from uranium of natural isotopic composition (CRM 112-A, a uranium assay standard was the parent material). The uranium concentrations in the solutions made from CRM 112-A vary within 0.2% of each other. Similarly, the uranium concentrations in the three 90% solutions also vary within 0.2% of each other. With good analytical skills, 0.2% concentration difference is easily measurable.

E.1.1. Preparation and packaging for shipment

The uranyl nitrate solutions were sent to participating laboratories in glass ampoules, flame sealed and provided with break-off tips for easy removal. Each ampoule was sealed in a plastic bag. The sealed bag was wrapped in absorbent cushioning material and sealed again in another plastic bag. The bag was kept inside screw-cap fiberboard can for shipping.

E.1.2. Reference values and uncertainties

NBL characterized the test materials in the ampoules for uranium concentrations. The NBL-modified Davies and Gray titration procedure was used. In a separate experiment, it was shown that the solutions did not suffer concentration changes during the time it took to prepare the samples - aliquant the samples and flame sealing the ampoules. The experiment was done using samples from the three solutions made from CRM 112-A; samples were withdrawn from the sealed ampoules as well as from the stock solutions, and analyzed for uranium concentrations. The results showed little or no difference between samples from the two sources, agreeing within a few hundredths of one percent.

The uncertainties at 95% C.L. in the characterization analyses were as follows: ± 0.1% for the 50% enriched solution, ± 0.02% for the 90% enriched solutions, and ± 0.02% to ± 0.05% for the natural isotopic composition solutions.

E.1.3. Performance evaluation

The participating laboratories determined the uranium concentrations of the test samples using a variety of methods: ceric titration, Davies-Gray titration, IDMS, and x-ray fluorescence (XRF). The results, in terms of (grand) mean % RDs, are shown in Table 5. The ITVs for each method is also shown in the table. The ITVs for XRF correspond to DOE target values, since international values are yet to be established. The %RD results along with standard deviations are shown in Figure 3 to evaluate bias and in Figure 4 to evaluate precision.

Laboratories B and G did not meet both bias and precision target values for IDMS. Laboratories B and U did not meet precision target values for titration. All other laboratories satisfied both bias and precision target values.

Table 5
Inter-laboratory Performance Summary
UNH – Percent U

Method	Lab code	Mean % RD	Standard deviation	N	ITV (%)	
					Bias	Precision
Ceric titration	G	0.003	0.024	32	0.1	0.1
Davies-Gray titration	B	-0.117	0.457	37	0.1	0.1
	F	-0.019	0.046	31	0.1	0.1
	U	-0.070	0.157	12	0.1	0.1
IDMS	A	-0.041	0.108	32	0.1	0.15
	B	0.895	0.652	24	0.1	0.15
	G*	0.892	0.215	4	0.1	0.15
X-Ray Fluorescence	A*	0.274	0.412	32	0.5*	0.5*

* For XRF, International Target Values are not available, and therefore DOE target values are shown.

Figure 3

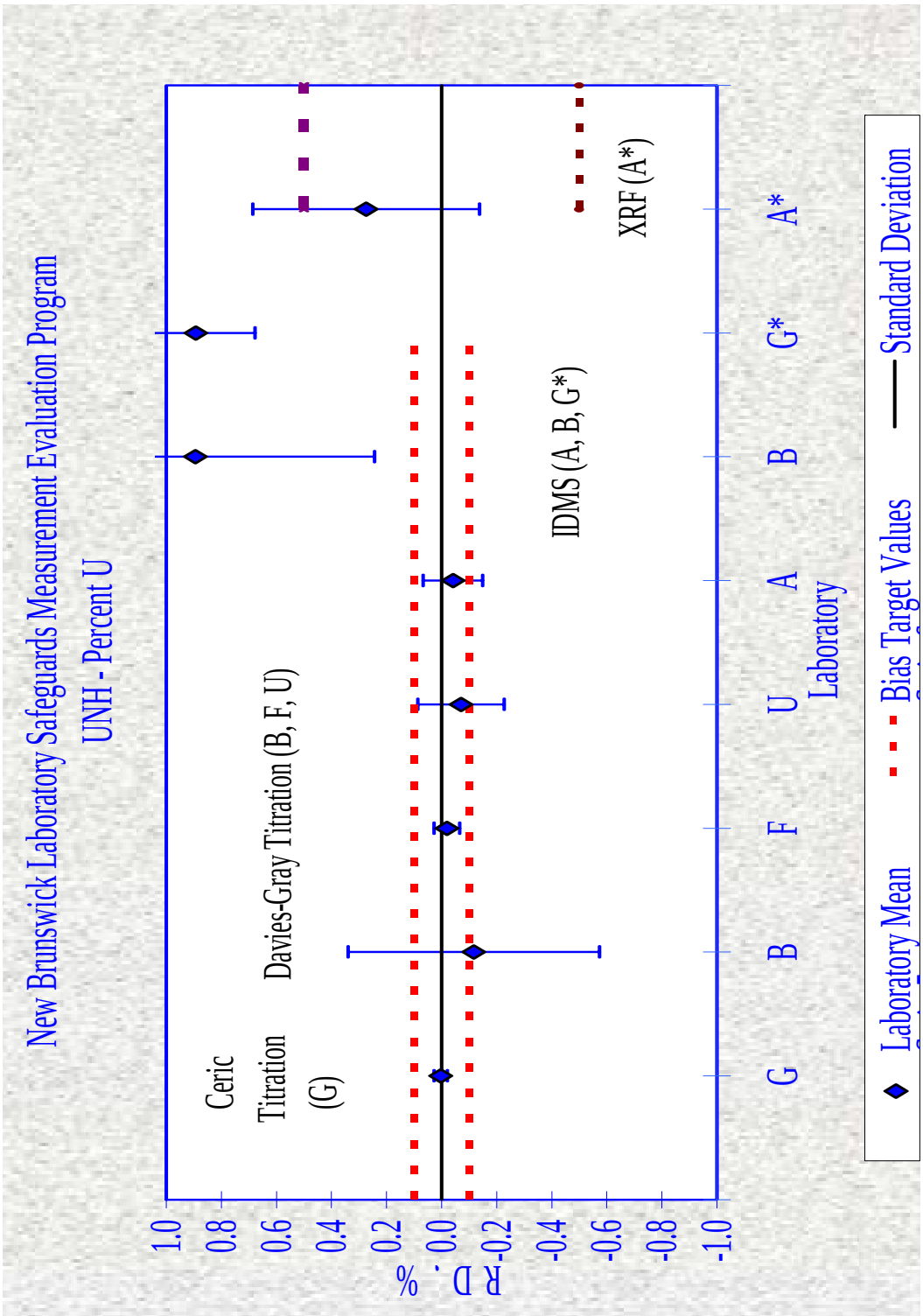
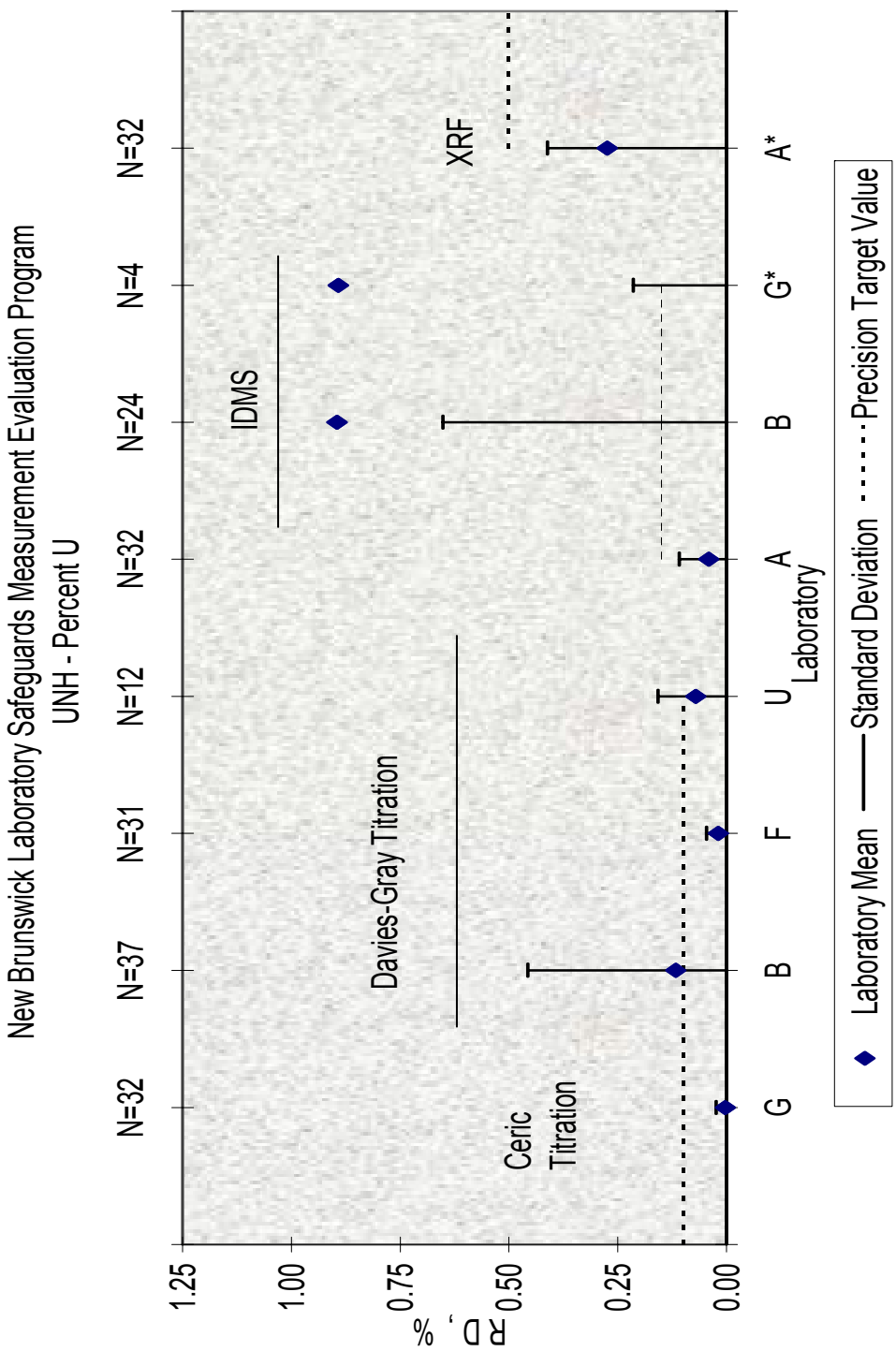

New Brunswick Laboratory Safeguards Measurement Evaluation Program
UNH - Percent U
Ceric Titration (G)
Davies-Gray Titration (B, F, U)
IDMS (A, B, G*)
XRF (A*)
R D , %
1.0
0.8
0.6
0.4
0.2
0.0
-0.2
-0.4
-0.6
-0.8
-1.0
G B F U A B G* A*
Laboratory
Laboratory Mean
Bias Target Values
Standard Deviation

Figure 4


New Brunswick Laboratory Safeguards Measurement Evaluation Program
UNH - Percent U
RD, %
1.25
1.00
0.75
0.50
0.25
0.00
N=32
N=37
N=31
N=12
N=32
N=24
N=4
N=32
IDMS
XRF
Davies-Gray Titration
Ceric Titration
G
B
F
U
A
B
G*
A*
Laboratory
Laboratory Mean
Standard Deviation
Precision Target Value

E.2. Enriched Uranium Dioxide Pellet

The test material is the same as the Certified Reference Material 125-A, uranium dioxide pellet. The pellets were originally made in a single batch at the Westinghouse Commercial Nuclear Fuel Division (a NRC licensee), using a high temperature sintering process at 1700°C for 20 hours in a reducing atmosphere. The pellets are known to be stable; they suffer no compositional change on exposure to air and are resistant to moisture uptake. The pellets serve as a test material for uranium assay as well as for uranium isotopic composition measurements. The ^{235}U content of the pellets is about 4.5%.

E.2.1. Preparation and packaging for shipment

The UO_2 pellets were wrapped in low-lint tissue to prevent chipping, placed in snap-cap glass bottles, and the bottles sealed in plastic bags. The bottles were shipped in cardboard tube containers.

E.2.2. Reference value and uncertainty

The elemental uranium concentration of the pellets was obtained by the NBL high-precision titration method. CRM 112-A, a uranium metal assay standard, was used for quality control and traceability. The uranium concentration was measured with an uncertainty of about ± 0.02% at 95% C.L.

E.2.3. Performance evaluation

Three different laboratories analyzed the uranium oxide pellets for uranium concentration using three different methods: ICP/MS, high precision titration and Davies-Gray titration. The (grand) mean of % RD results along with uncertainties are shown in Table 6. The ITVs for each method are also shown in the table. Note that ITVs are not available for ICP/MS and high precision methods. The ICP/MS target values are assumed to be the same as those for the IDMS method, and the high precision method target values are assumed to be the same as those for the gravimetric method. The % RD results along with standard deviations are shown in Figure 5 to evaluate bias and in Figure 6 to evaluate precision.

Laboratory BD shows high negative bias with poor precision. Laboratory BC shows positive bias with poor precision. Laboratory BA shows negative bias with precision barely exceeding

the ITV. Laboratory BE shows no bias, but poor precision. All other laboratories met both bias and precision criteria.

Table 6

Inter-laboratory Performance Summary

UO_2 Pellets – Percent U

Method	Lab code	Mean %RD	Standard deviation	N	ITV (%)	
					Bias	Precision
ICP/MS	BE	-0.002	0.652	16	0.1*	0.15*
High Precision titration	F	-0.042	0.033	15	0.05**	0.05**
Davies-Gray titration	AA	0.004	0.064	21	0.1	0.1
Davies-Gray titration	AC	-0.043	0.062	16	0.1	0.1
Davies-Gray titration	AD	-0.032	0.022	16	0.1	0.1
Davies-Gray titration	AE	0.013	0.056	16	0.1	0.1
Davies-Gray titration	BA	-0.224	0.111	24	0.1	0.1
Davies-Gray titration	BC	0.423	0.169	15	0.1	0.1
Davies-Gray titration	BD	-3.818	3.082	12	0.1	0.1
Davies-Gray titration	BF	-0.061	0.055	16	0.1	0.1
Davies-Gray titration	F*	-0.018	0.044	30	0.1	0.1
Davies-Gray titration	T	-0.015	0.090	16	0.1	0.1

* No ITVs available, but assumed to be the same as IDMS method.

** No ITVs available, but assumed to be the same as gravimetric method.

Figure 5

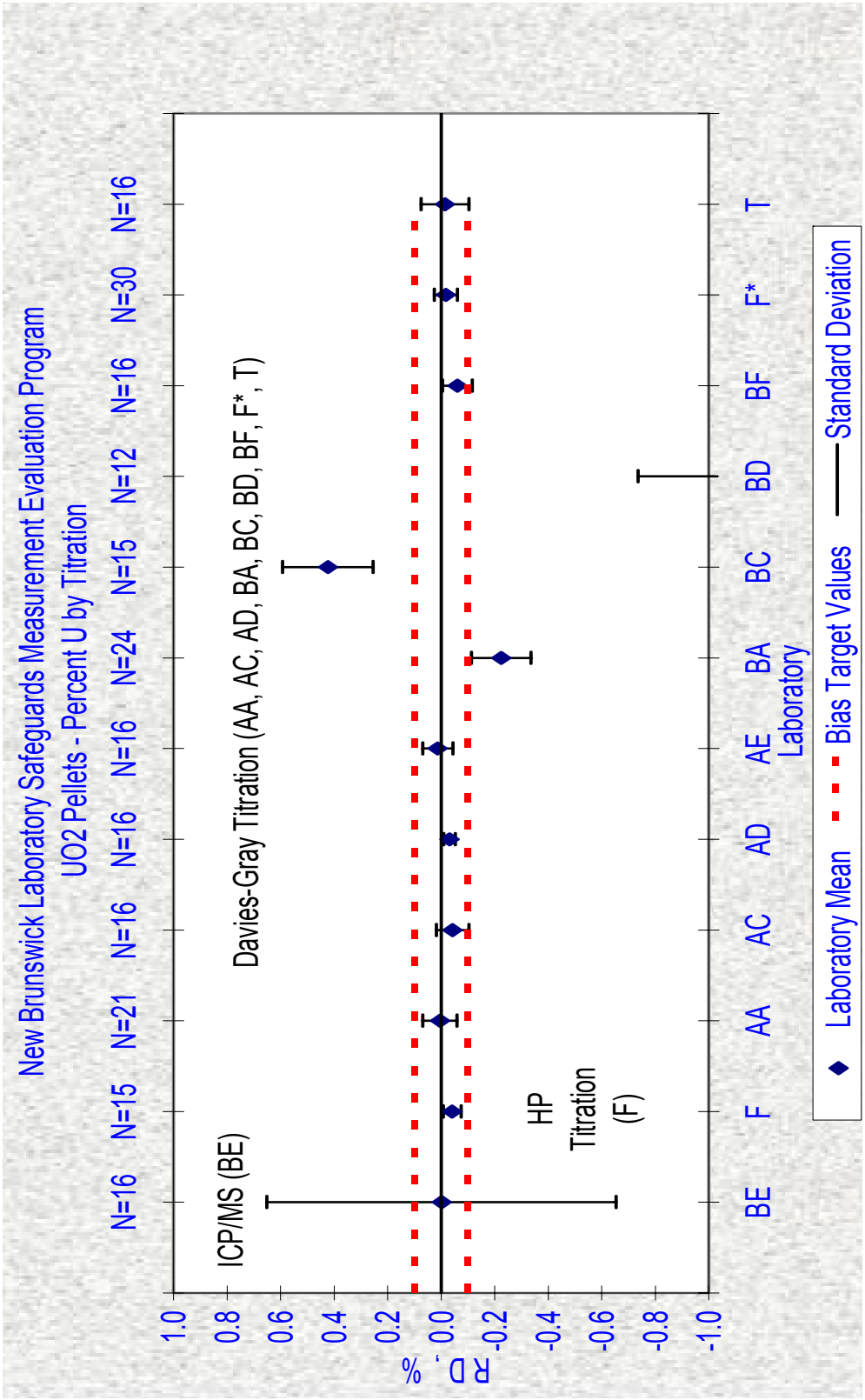
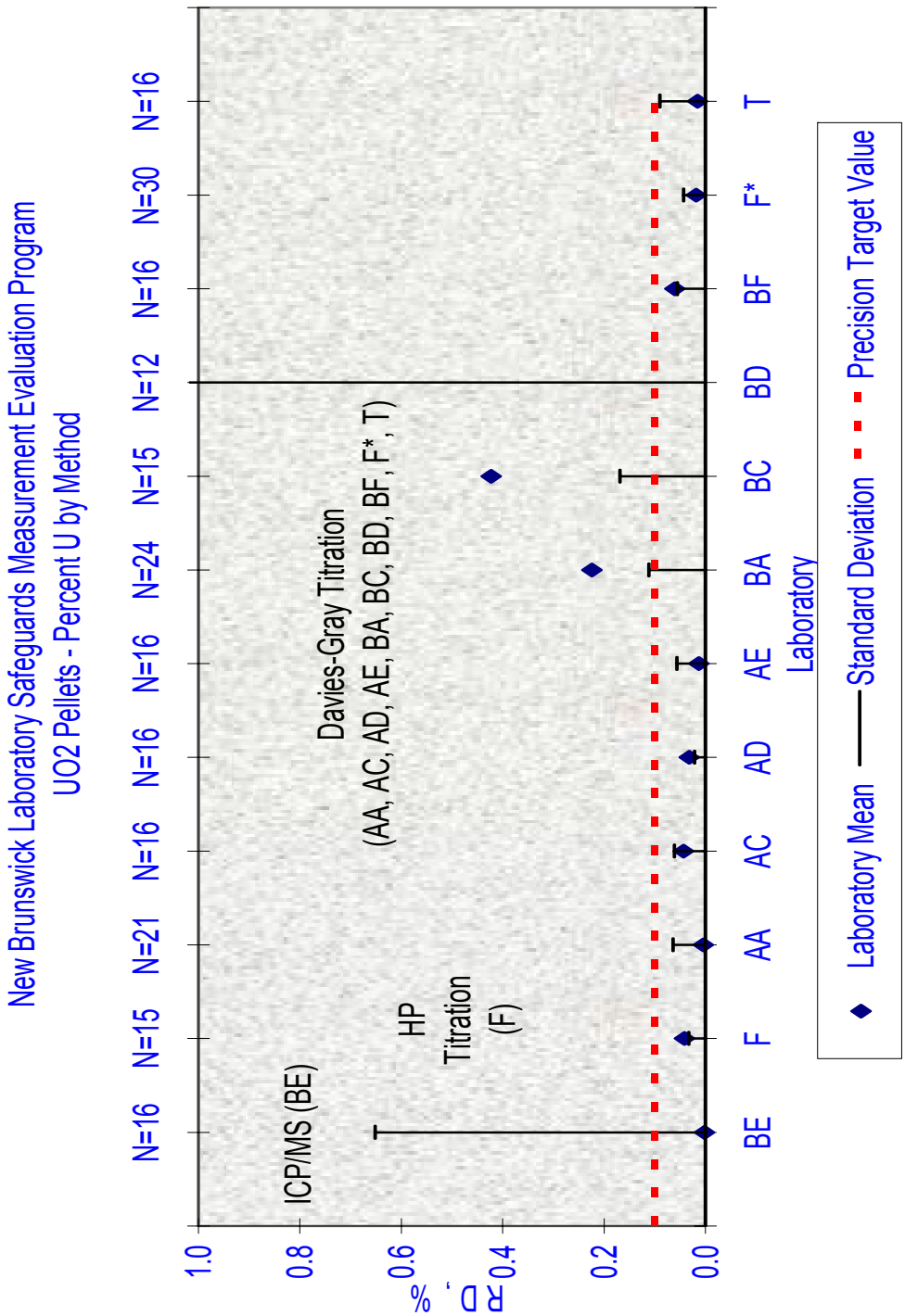

New Brunswick Laboratory Safeguards Measurement Evaluation Program
UO2 Pellets - Percent U by Titration
N=16 N=15 N=21 N=16 N=16 N=16 N=24 N=15 N=12 N=16 N=30 N=16
ICP/MS (BE)
Davies-Gray Titration (AA, AC, AD, BA, BC, BD, BF, F*, T)
HP Titration (F)
RD, %
1.0
0.8
0.6
0.4
0.2
0.0
-0.2
-0.4
-0.6
-0.8
-1.0
BE F AA AC AD AE BA BC BD BF F* T
Laboratory
Laboratory Mean
Bias Target Values
Standard Deviation

Figure 6


New Brunswick Laboratory Safeguards Measurement Evaluation Program
UO2 Pellets - Percent U by Method
N=16 N=15 N=21 N=16 N=16 N=16 N=24 N=15 N=12 N=16 N=30 N=16
ICP/MS (BE)
HP Titration (F)
Davies-Gray Titration (AA, AC, AD, AE, BA, BC, BD, BF, F*, T)
1.0
0.8
0.6
0.4
0.2
0.0
% U
BE F AA AC AD AE BA BC BD BF F* T
Laboratory
Laboratory Mean
Standard Deviation
Precision Target Value

E.3. Uranium Hexafluoride

In FY 1993, Portsmouth Gaseous Diffusion Plant donated two sampling manifolds to NBL for transferring UF_6 from 2S cylinders to P-10 tubes, the latter used as the containment vessel for the samples. One of the two manifolds was used for uranium material of natural isotopic composition, and the other for enriched material. These manifolds have been taken out of service. Now, NBL is relying on Portsmouth Gaseous Diffusion facility to prepare the SME samples. The samples are withdrawn from one or more of the fifteen 2S containers that belong to NBL, but in the custody of Portsmouth.

E.3.1. Preparation and packaging for shipment

The Portsmouth Gaseous Diffusion facility prepared and packaged test samples made from CRM 113-B – parent material stored in 2S containers at the Portsmouth facility. The P-10 sample tubes containing UF_6 were shipped to NBL for characterization and distribution to SME program participants. Each test sample contained 7 to 12 g of UF_6.

E.3.2. Reference value and uncertainty

The CRM 113-B samples in the P-10 tubes were characterized for uranium elemental concentration using the NBL high-precision titration method. The uranium metal assay standard, CRM 112-A, was used for quality control and traceability. Samples of normal UF_6 were also analyzed to provide additional checks on quality control. The uranium concentration was defined with an uncertainty (95% C.L.) of ± 0.033%. The isotopic composition (about 4% enriched uranium) of the test samples was also measured.

E.3.3. Performance evaluation

In FY 2003, only one laboratory participated in UF_6 analysis. The elemental uranium concentration was measured using high precision titration method of analysis. The result (in terms of % RD) is shown in Table 7. The ITVs for the high precision titration method have not been established. Therefore, the ITVs for gravimetric method are used. Note that both gravimetric and high precision titration methods determine uranium concentrations with comparable levels of accuracy and precision. The %RD result along with the standard deviation is shown in Figure 7 to evaluate bias and in Figure 8 to evaluate precision.

Laboratory F result showed negative bias and failed to meet the precision target value.

Table 7

Inter-laboratory Performance Summary

UF_6 – Percent U

Method	Lab code	Mean % RD	Standard deviation	N	ITV (%)*	
					Bias	Precision
High Precision titration	F	-0.130	0.089	8	0.05	0.05

* ITVs for high precision titration not available. Gravimetric ITVs are used instead.

Figure 7

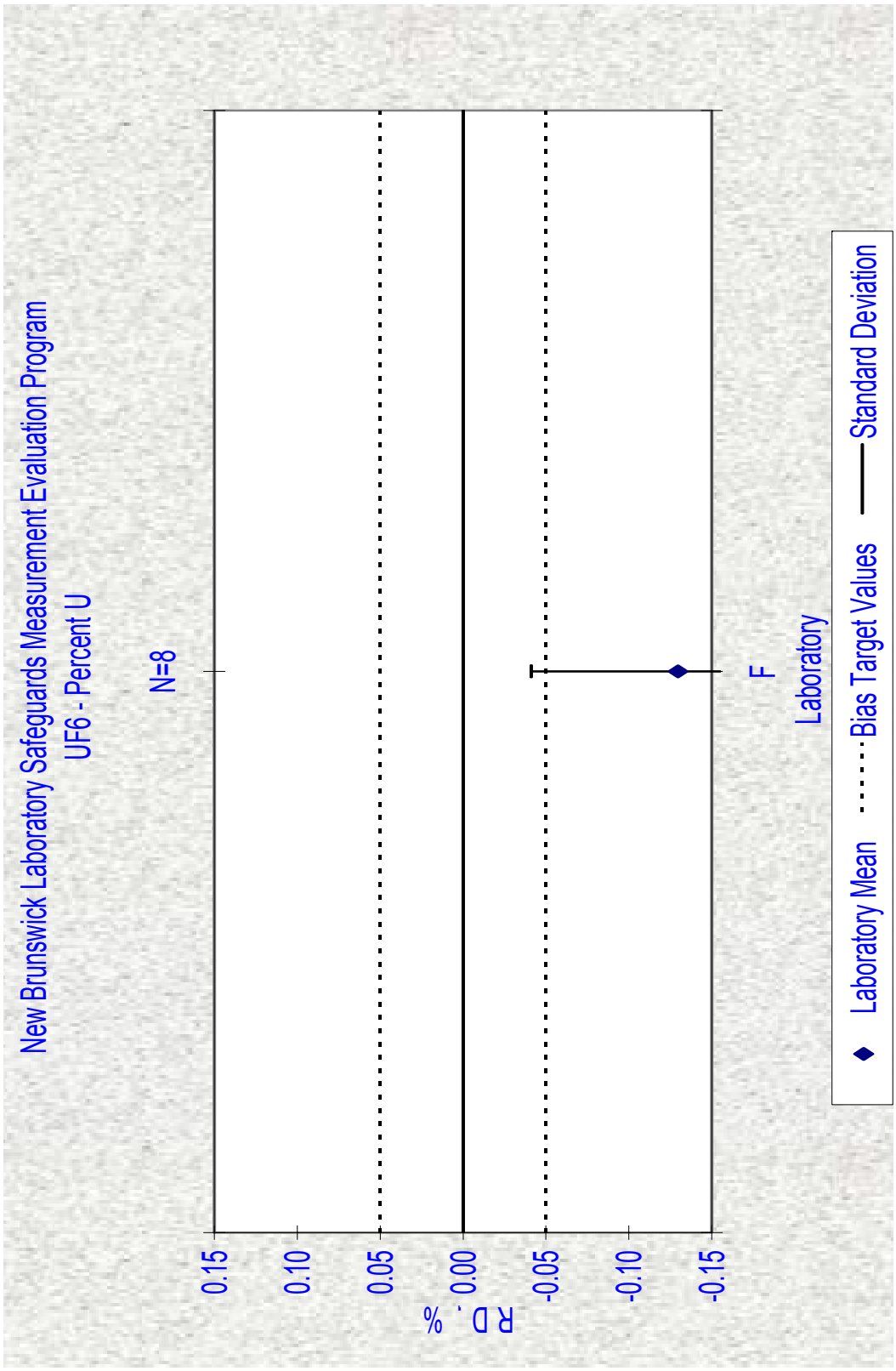
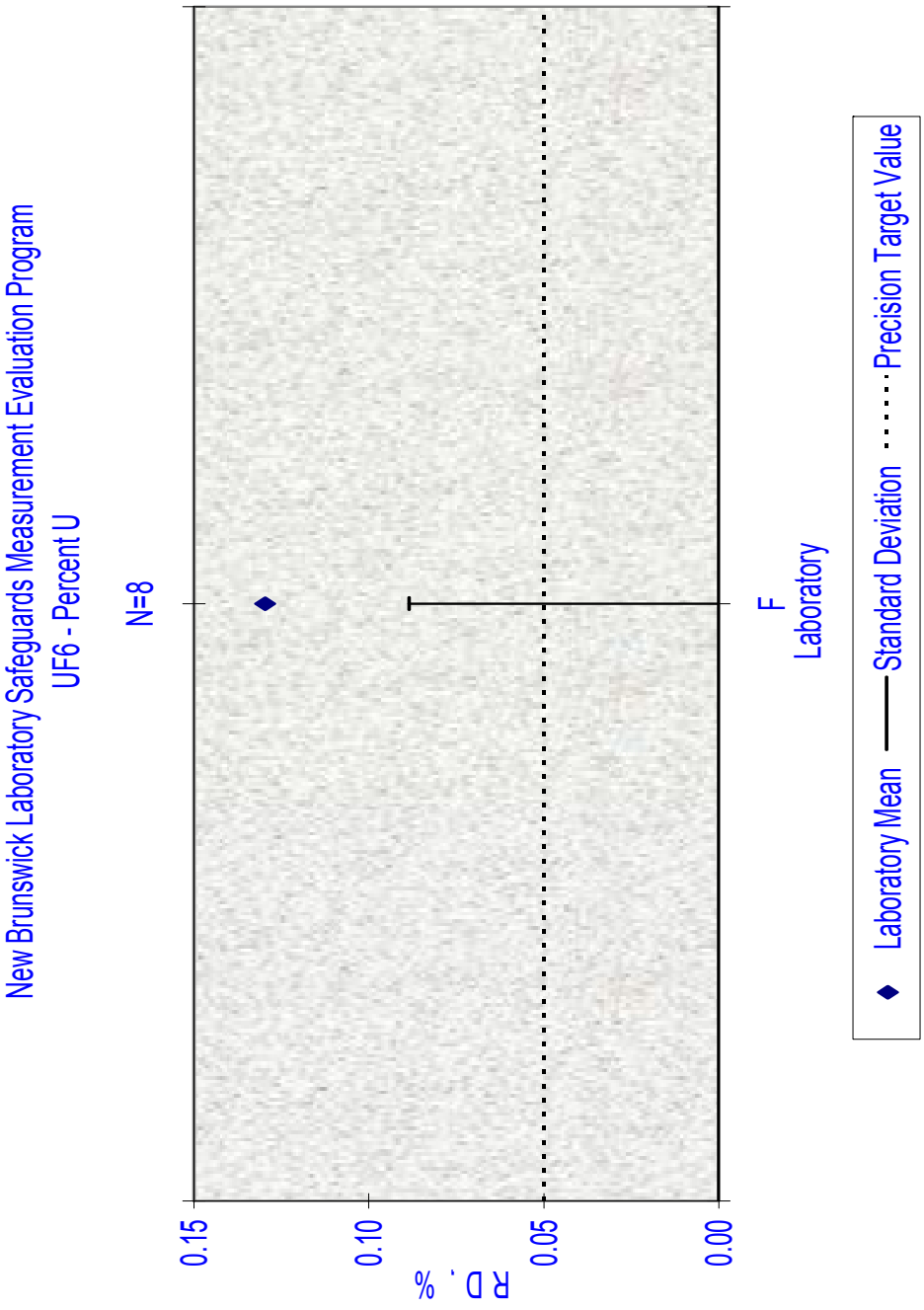

New Brunswick Laboratory Safeguards Measurement Evaluation Program
UF6 - Percent U
N=8
RD, %
0.15
0.10
0.05
0.00
-0.05
-0.10
-0.15
F
Laboratory
Laboratory Mean
Bias Target Values
Standard Deviation

Figure 8


New Brunswick Laboratory Safeguards Measurement Evaluation Program
UF6 - Percent U
N=8
0.15
0.10
0.05
0.00
R D , %
F
Laboratory
Laboratory Mean
Standard Deviation
Precision Target Value

E.4. Uranium Oxide (UO_3) Powder

UO_3 powder is an ideal test material to monitor the capability of a laboratory in analyzing hygroscopic materials. It was used as a test material several years ago, but was discontinued for sometime in between because of a perceived lack of interest in this material. However, at the request of a participant laboratory, UO_3 powder was reintroduced as a test material. It was analyzed by two different laboratories in the FY 2003 program.

E.4.1. Preparation and packaging for shipment

The FY 2003 UO_3 test materials came from preparations done several years ago. At that time, the material was packaged under dry nitrogen atmosphere into pharmaceutical vials. The vials were closed with Teflon-lined stoppers and then crimp sealed. The vials were then sealed in plastic, packaged in cardboard tubes and kept ready for shipping.

E.4.2. Reference value and uncertainty

The elemental concentration of uranium in UO_3 material, packaged several years ago, was characterized through analysis of 8 different samples. The NBL-modified Davies and Gray titration method was used for uranium determination. The uranium content of the material differed from the original value by about 0.064%, the new value being lower. The uncertainty (95% C.L.) in knowing this value was 0.012%. Apparently, the concentration of uranium in the UO_3 material was not altered to a significant extent during the long storage period. The newly determined uranium value was used as the characterized value. Quality control and traceability to uranium measurements were provided through analysis of samples of CRM 112-A, a uranium metal assay standard.

E.4.3. Performance evaluation

Two laboratories analyzed the UO_3 test samples for uranium concentration using four different methods: Davies-Gray titration, IDMS, XRF (liquid), and XRF (solid). The results for (grand) mean % RD are shown in Table 8 along with the ITVs for each method. Note that ITVs are available for titration and IDMS methods, but not for XRF. DOE target values are shown for XRF. The %RD results along with the standard deviations are shown in Figure 9 to evaluate bias and in Figure 10 to evaluate precision. Both laboratories satisfactorily met the bias as well as precision target values.

Table 8

Inter-laboratory Performance Summary

UO_3 – Percent U

Method	Lab code	Mean	Standard deviation	N	ITV (%)*	
					Bias	Precision
Davies-Gray Titration	F	-0.055	0.020	14	0.1	0.1
IDMS	A	-0.027	0.116	32	0.1	0.15
X-Ray Fluorescence, Liquid	A*	-0.019	0.251	24	0.5	0.5
X-Ray Fluorescence, Solid	A**	-0.124	0.235	24	0.5	0.5

*ITVs are not available for XRF methods; DOE values were used instead.

Figure 9

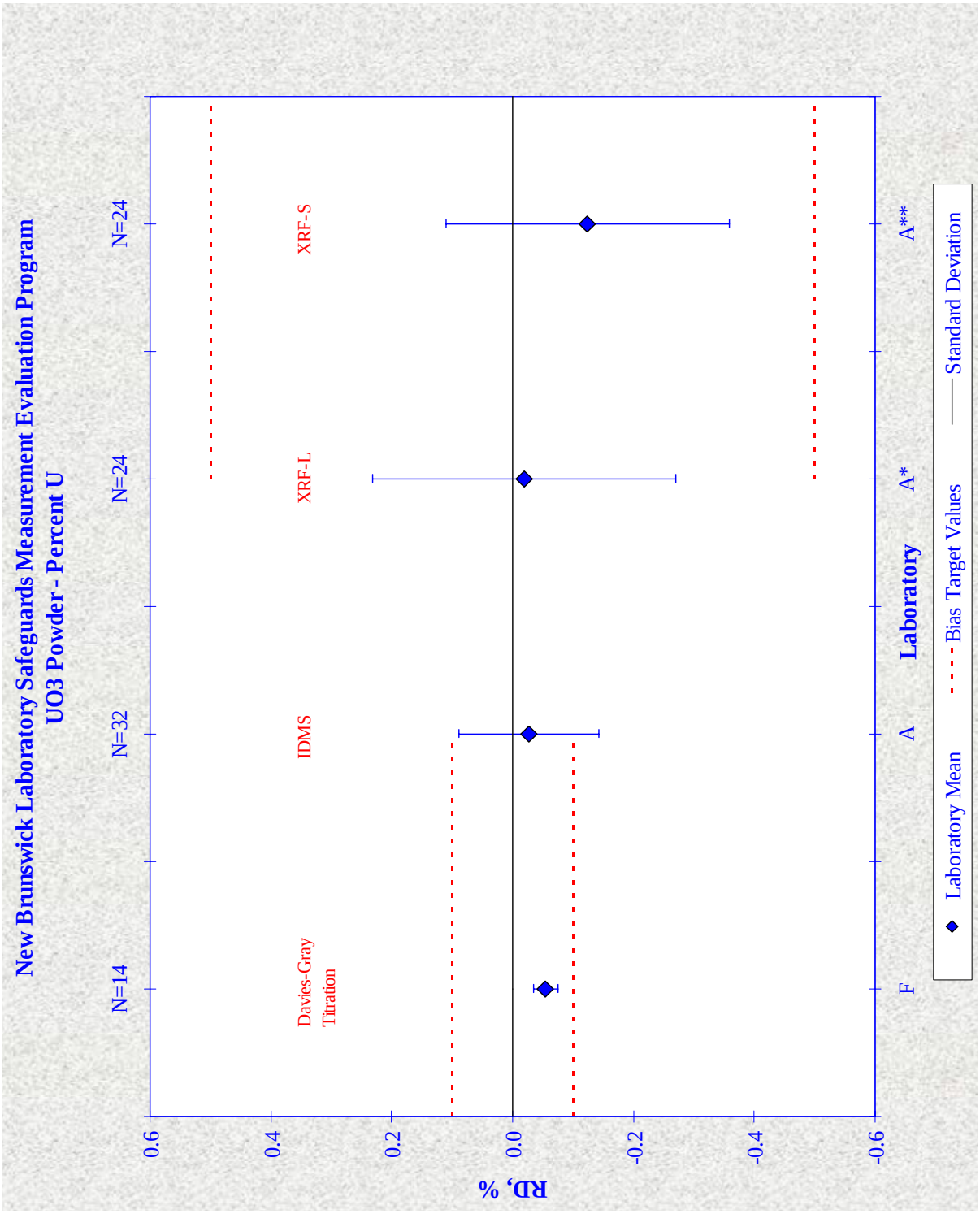
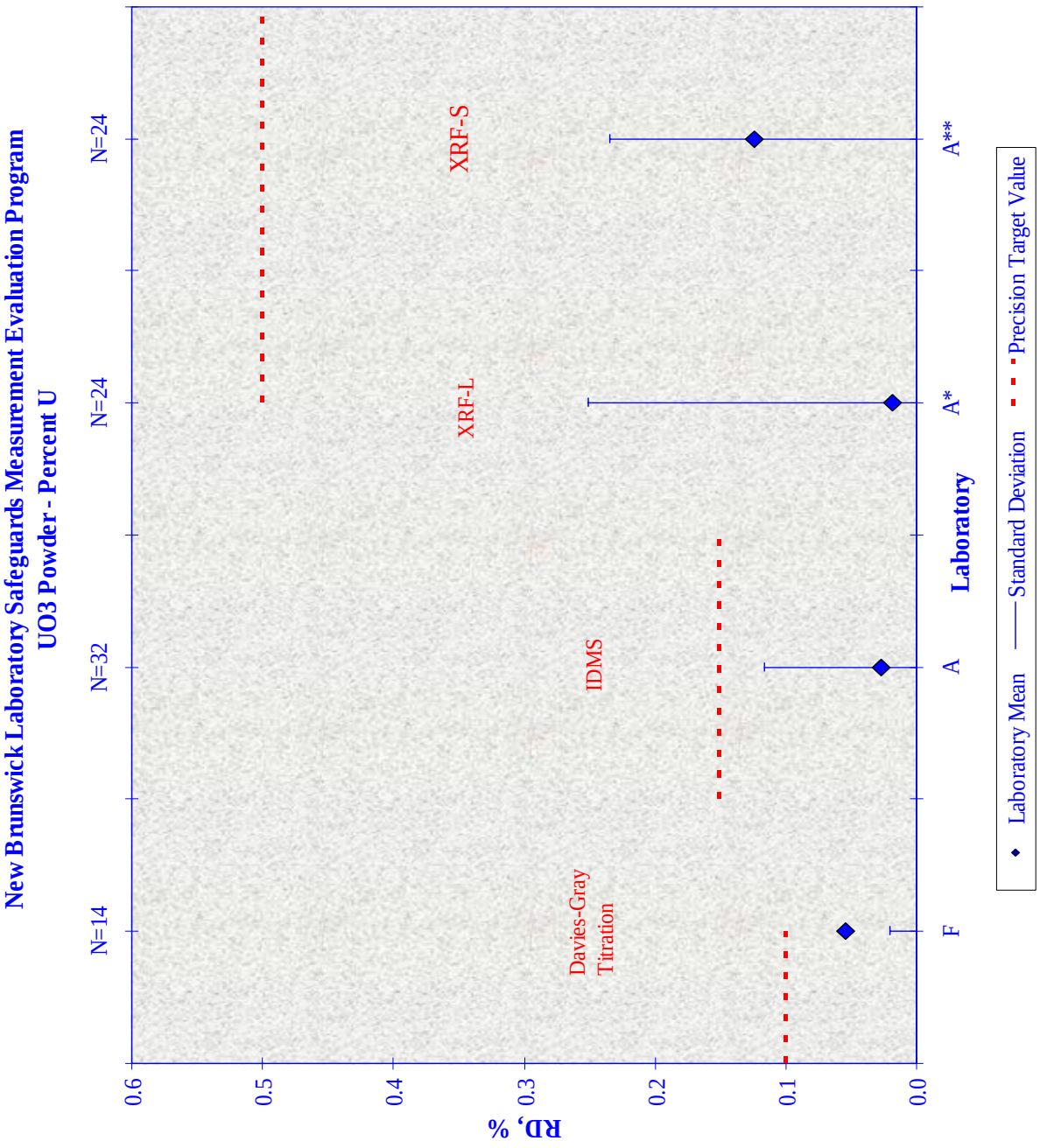

New Brunswick Laboratory Safeguards Measurement Evaluation Program
UO3 Powder - Percent U
RD, %
0.6
0.4
0.2
0.0
-0.2
-0.4
-0.6
N=14
N=32
N=24
N=24
Davies-Gray
Titration
IDMS
XRF-L
XRF-S
F
A
A*
A**
Laboratory
Laboratory Mean
Bias Target Values
Standard Deviation

Figure 10


New Brunswick Laboratory Safeguards Measurement Evaluation Program
UO3 Powder - Percent U
RD, %
0.0
0.1
0.2
0.3
0.4
0.5
0.6
N=14
N=32
N=24
N=24
Davies-Gray Titration
IDMS
XRF-L
XRF-S
F
A
A*
A**
Laboratory
Laboratory Mean
Standard Deviation
Precision Target Value

E.5. ^{235}U Enrichment

The following uranium samples are available for use as test materials in uranium enrichment measurements: three uranyl nitrate solutions with 90% enrichment, one uranyl nitrate solution with 50% enrichment, one uranyl nitrate solution with 4% enrichment, solid UO_2 pellets of about 4% enrichment, and UF_6 solid of about 4.5% enrichment.

E.5.1. Preparation and packaging for shipment

The uranyl nitrate solutions were packaged in flame-sealed glass ampoules with a break-off tip. The ampoules were sealed in plastic, wrapped in absorbent cushioning, sealed in plastic again, and packaged in cardboard tubes for shipping. Each solution contained 5-10 mg uranium/g solution.

The UO_2 pellets were packaged in a snap-cap glass bottle with a low-lint tissue for cushioning to prevent chipping. The glass bottles are sealed in plastic, and packaged in cardboard tubes for shipping.

The UF_6 material is currently in 2S cylinders at Portsmouth. Test samples were made by Portsmouth personnel by transferring the material into P-10 tubes.

E.5.2. Reference value and uncertainties

The uranium isotopic compositions in the test materials were characterized by thermal ionization mass spectrometry (TIMS). In the case of UF_6, the material was dissolved (i.e. hydrolyzed) first and then the resulting solution was analyzed by TIMS using the total evaporation technique. The experimental results were corrected for mass fractionation effects. The correction factors were determined through analyses of appropriate certified reference materials done under the same conditions as the test materials. The $^{235}U/^{238}U$ ratio was characterized by gas mass spectrometry also.

The uncertainties (95% C.L.) in ^{235}U abundance of the test materials prepared from uranyl nitrate solutions were 0.02% for the 4% solution, and < 0.01% for the 50% and 90% solutions. The uncertainties do not include the uncertainties in determining the mass fractionation correction factors. The uncertainty (95% C.L.) for ^{235}U abundance in UO_2 pellets (CRM 125-A) is 0.07%. It includes the uncertainty in determining the mass fractionation correction factor. The uncertainty

(95% C.I.) for ^{235}U abundance in UF_6 (CRM 113-B) determined by thermal ionization mass spectrometry is 0.053%. It includes the uncertainty in determining the mass fractionation correction factor.

E.5.3. Performance evaluation

The participating laboratories analyzed the test materials by two different methods: TIMS and ICP/MS. The grand (mean) % RD results for HEU material (≥ 20% enriched in ^{235}U) are shown in Table 9; for the LEU material (<20% enriched in ^{235}U) the results are shown in Table 10. The ITVs are also shown in the tables. The ITVs for the HEU material are more stringent than those for LEU material. The ITVs for ICP/MS are assumed to be the same as those for TIMS.

The HEU results along with standard deviations are shown in Figure 11 to evaluate bias and in Figure 12 to evaluate precision. The LEU results along with standard deviations are shown in Figure 13 to evaluate bias and in Figure 14 to evaluate precision.

Four laboratories analyzed the HEU samples (Figures 11 and 12). All of them satisfied both bias and precision target values.

Eight laboratories participated in LEU samples analyses (Figures 13 and 14). Two of the eight laboratories (laboratories AC and BC) did not meet the bias target values and three of the eight laboratories did not meet the precision target values (laboratories AC, BC and BE). All other laboratories satisfactorily met both bias and precision target values.

Table 9

Inter-laboratory Performance Summary

U^{235} Enrichment – HEU

Method	Lab code	Mean	Standard deviation	N	ITV (%)	
					Bias	Precision
TIMS	A	0.010	0.018	24	0.05	0.05
TIMS	B	0.009	0.030	36	0.05	0.05
TIMS	G	0.012	0.013	6	0.05	0.05
TIMS	U	0.029	0.010	11	0.05	0.05

Table 10

Inter-laboratory Performance Summary

U^{235} Enrichment – LEU

Method	Lab code	Mean	Standard deviation	N	ITV (%)	
					Bias	Precision
TIMS	A	0.033	0.060	8	0.1	0.1
TIMS	AC	-0.218	0.134	4	0.1	0.1
TIMS	B	0.095	0.071	12	0.1	0.1
TIMS	BC	0.540	0.267	16	0.1	0.1
ICP/MS	BE	-0.060	0.299	48	0.1*	0.1*
TIMS	F	-0.014	0.015	6	0.1	0.1
TIMS	G	0.023	0.005	2	0.1	0.1
TIMS	T	0.051	0.025	16	0.1	0.1

*ITVs are not available for ICP/MS; assumed to be the same as those of TIMS.

Figure 11

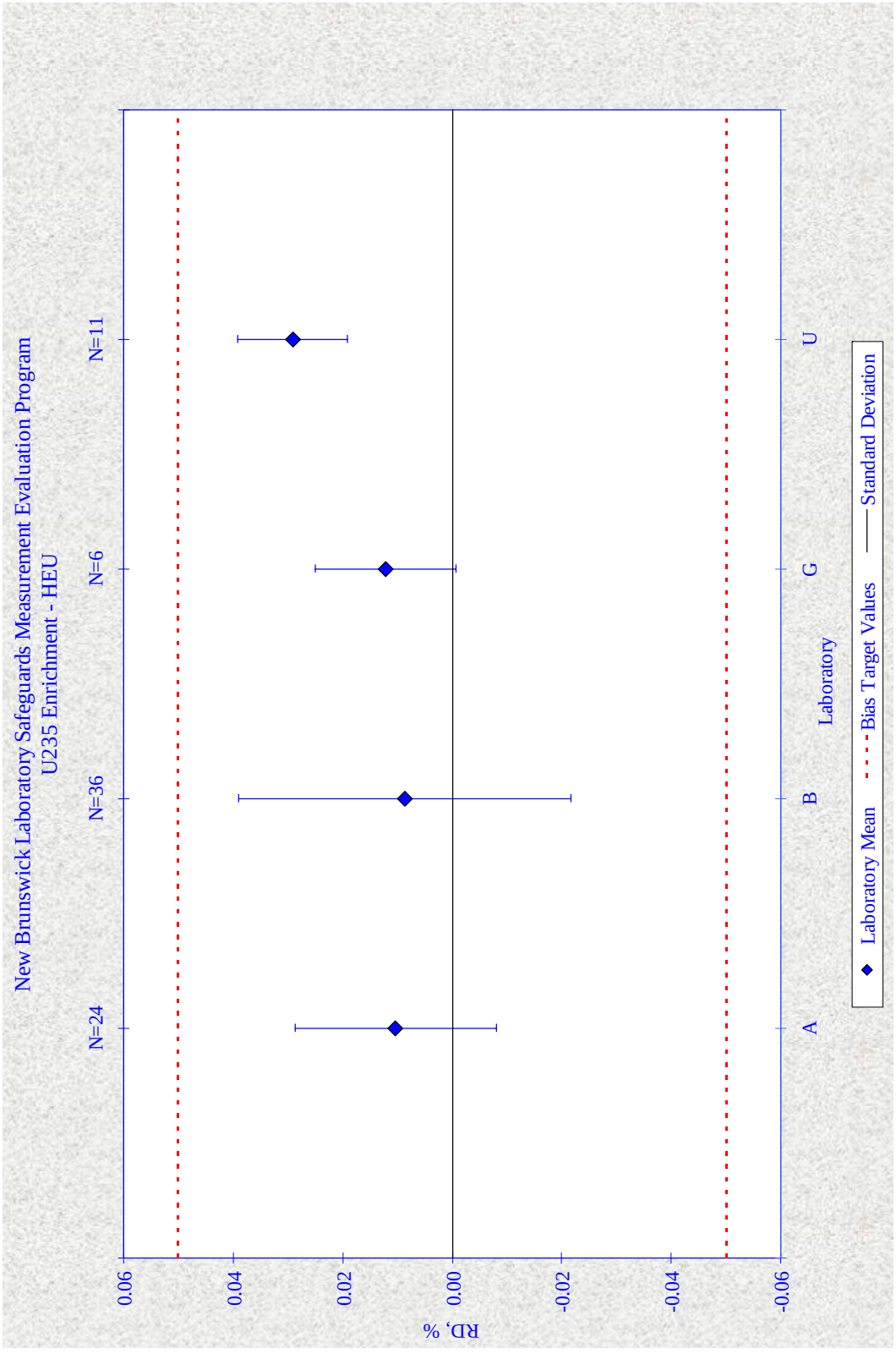

New Brunswick Laboratory Safeguards Measurement Evaluation Program
U235 Enrichment - HEU
N=24
N=36
N=6
N=11
A
B
G
U
Laboratory
RD, %
0.06
0.04
0.02
0.00
-0.02
-0.04
-0.06
Laboratory Mean
Bias Target Values
Standard Deviation

Figure 12

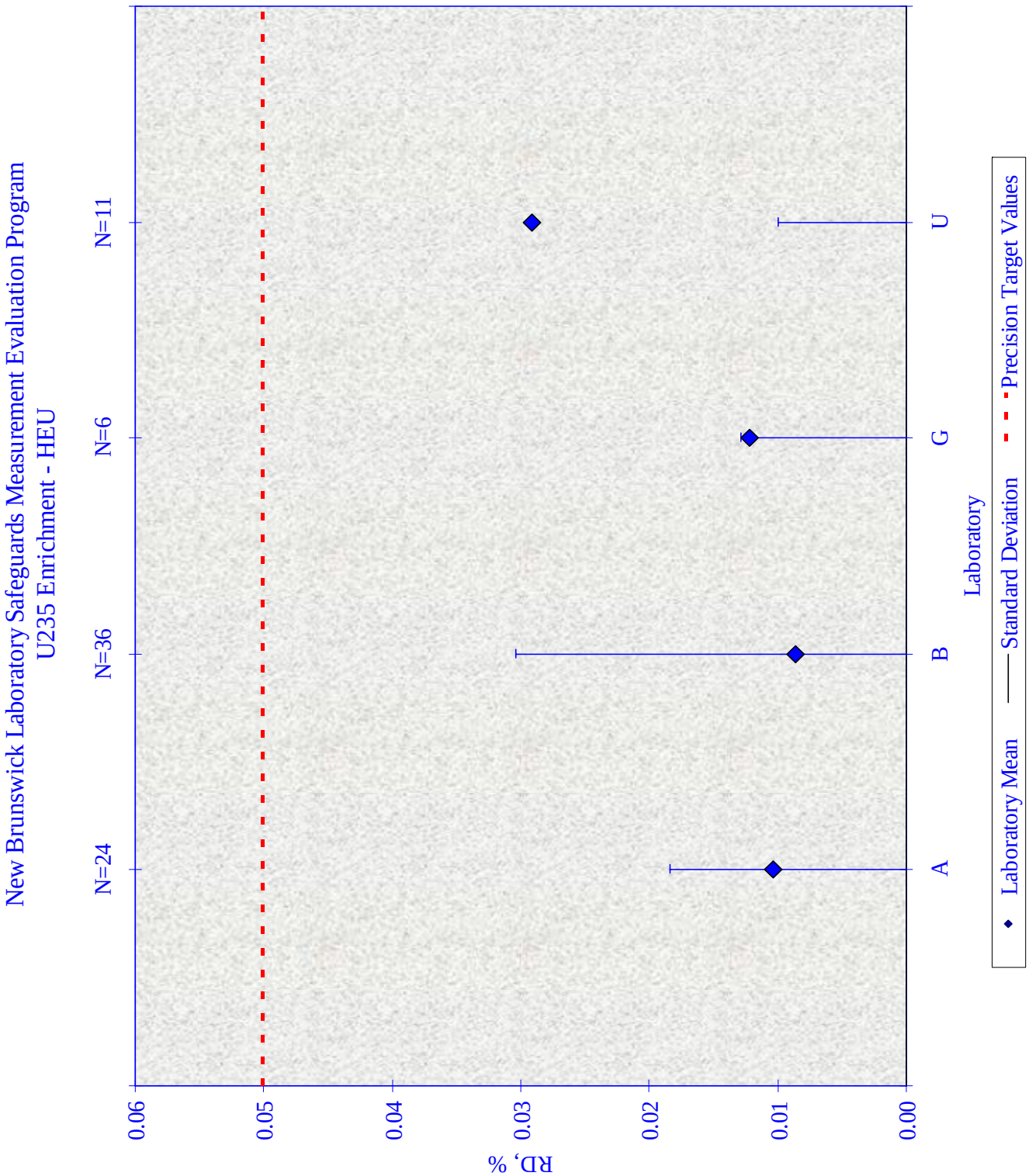

New Brunswick Laboratory Safeguards Measurement Evaluation Program
U235 Enrichment - HEU
N=24
N=36
N=6
N=11
A
B
G
U
Laboratory
RD, %
0.06
0.05
0.04
0.03
0.02
0.01
0.00
Laboratory Mean
Standard Deviation
Precision Target Values

Figure 13

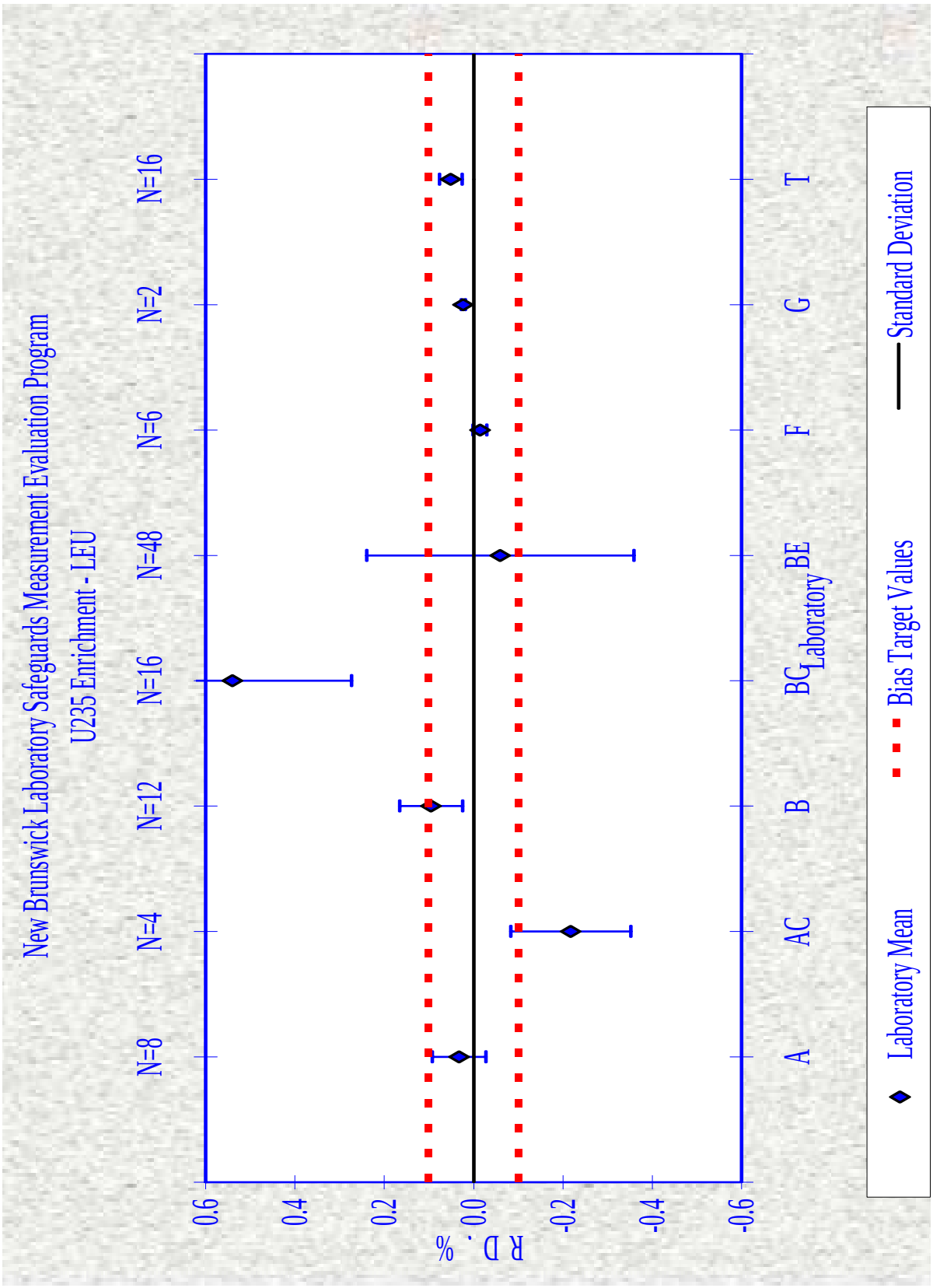
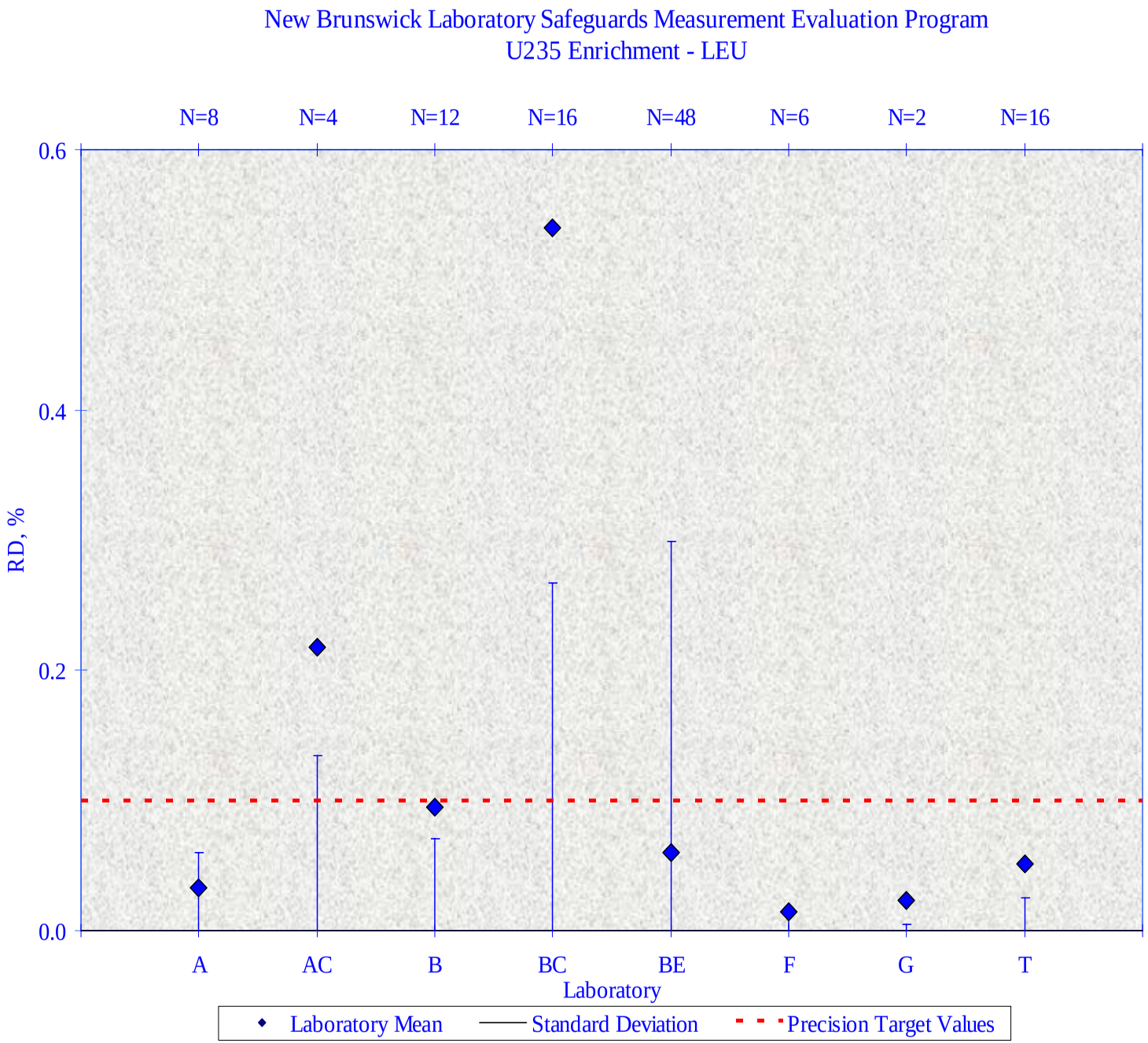


Figure 14


New Brunswick Laboratory Safeguards Measurement Evaluation Program
U235 Enrichment - LEU
N=8
N=4
N=12
N=16
N=48
N=6
N=2
N=16
0.6
0.4
0.2
0.0
RD, %
A
AC
B
BC
BE
F
G
T
Laboratory
Laboratory Mean
Standard Deviation
Precision Target Values

E.6. Plutonium Assay and Isotopic Abundance

Test materials for plutonium assay came from two different certified reference materials: CRM 126, a plutonium metal standard, and CRM 122, a plutonium oxide standard. The CRMs were dissolved, and diluted to the required concentrations using 8M nitric acid. Aliquants containing approximately 20 and 40 micrograms of plutonium were placed in glass bottles and fumed to dryness in the presence of sulfuric acid.

Plutonium isotopic composition test materials were prepared from three different certified reference materials: CRM 122 (plutonium oxide), CRM 136, and CRM 137 (these two in the form of dried plutonium sulfate tetrahydrate). The CRMs were dissolved, and diluted to the required concentration using 8M nitric acid. Each aliquant of the test material containing about one milligram of plutonium was placed in a glass bottle and fumed to dryness in the presence of sulfuric acid.

The dried test materials (for assay as well as isotopic composition measurements) were sent as such (i.e. without purification by anion exchange) to the participating laboratories. Note that unpurified test materials contain isobaric nuclides (^{238}U and ^{241}Am) that may interfere in plutonium isotopic composition determinations if analyzed without purification.

E.6.1. Preparation and packaging for shipment

The plutonium assay samples were contained in glass bottles (20 mL scintillation vials) to facilitate direct addition of IDMS spikes into the test materials. The isotopic test samples were also kept in glass bottles of similar size. The bottles were heat-sealed in two plastic bags, and then shipped in produce cans.

E.6.2. Reference value uncertainties

The characterized values for plutonium concentrations in the test samples were calculated from the certified values knowing the amounts of materials dissolved in making the solutions. The uncertainties (95% C.L.) in plutonium concentration were about 0.02% for CRM 126, and about 0.04% for CRM 122.

The characterized values for plutonium isotopic abundance in the test materials were assumed to be the same as those in the certificate with appropriate correction for radioactive decay. The ranges of isotopic abundances of plutonium nuclides in the three test materials were as follows: ^{238}Pu varied from 0.05% to 0.25%; ^{239}Pu varied from 78% to 88%; ^{240}Pu varied from 12% to 19%; ^{241}Pu varied from 0.05% to 1.3%; and ^{242}Pu varied from 0.2% to 1.2%. Test materials with higher abundance of ^{239}Pu (and lower ^{240}Pu) are characterized as low burn-up materials, whereas those with lower abundance of ^{239}Pu (and higher ^{240}Pu) are characterized as high burn-up material. The uncertainties (95% C.L.) in the characterized values were assumed to be the same as those reported in the respective certificates.

E.6.3. Performance evaluation

The participating laboratories determined the plutonium concentrations in the test samples using the IDMS method, and the plutonium isotopic compositions using TIMS.

E.6.3.1. Plutonium assay

Only two laboratories (B and G) participated in plutonium assay measurements. The (grand) mean of % RD results are shown in Table 11 along with the ITVs.

The % RD results and the standard deviations are shown in Figure 15 to evaluate bias and in Figure 16 to evaluate precision. The results from the two laboratories show negative bias. As far as precision is concerned, laboratory G met the precision criterion, and laboratory B did not meet it.

Table 11
Inter-laboratory Performance Summary
Pu Sulfate – Pu Mass

Method	Lab code	Mean	Standard deviation	N	ITV (%)	
					Bias	Precision
IDMS	B	-1.433	0.737	16	0.1	0.15
IDMS	G	-0.126	0.037	4	0.1	0.15

Figure 15

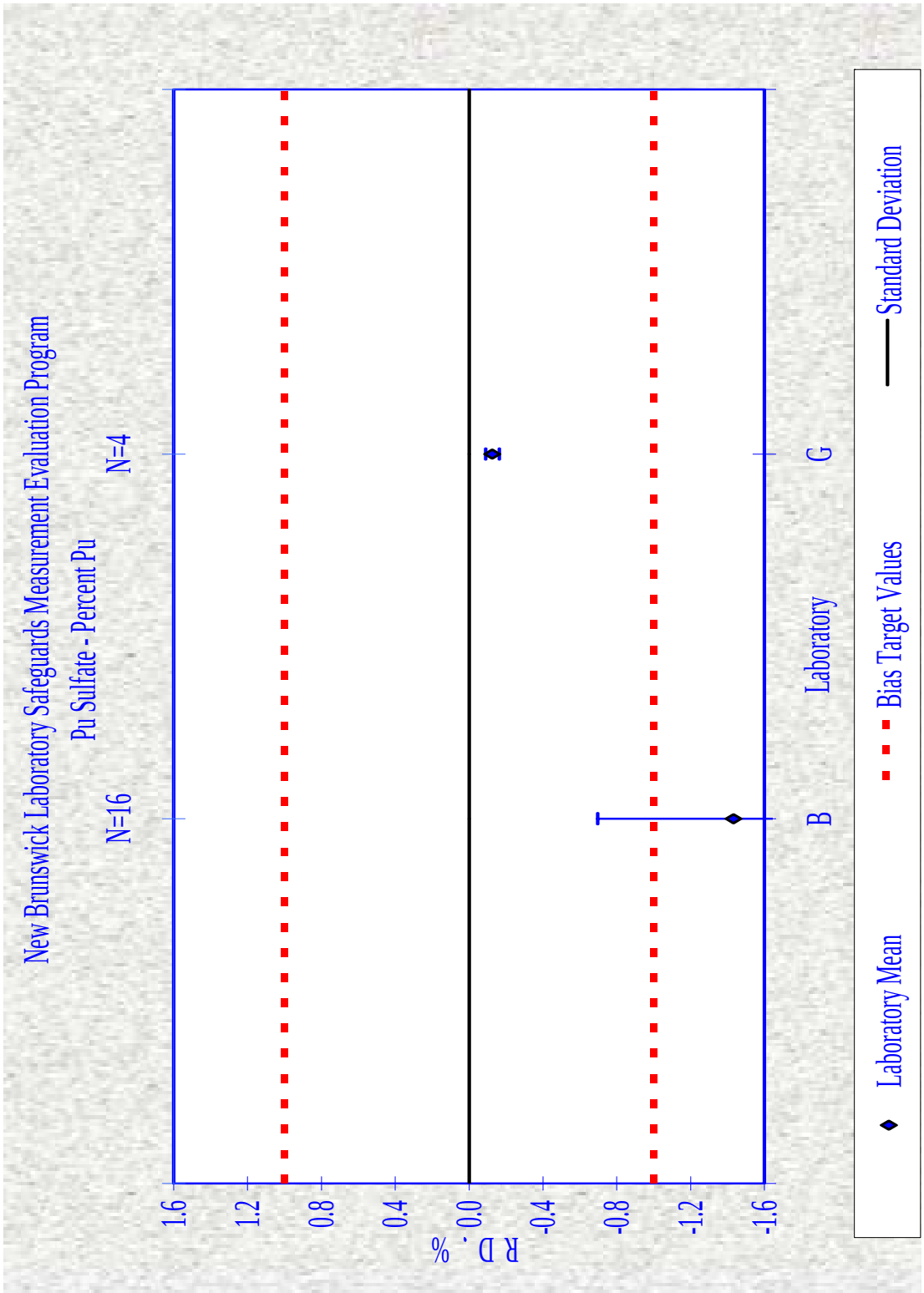
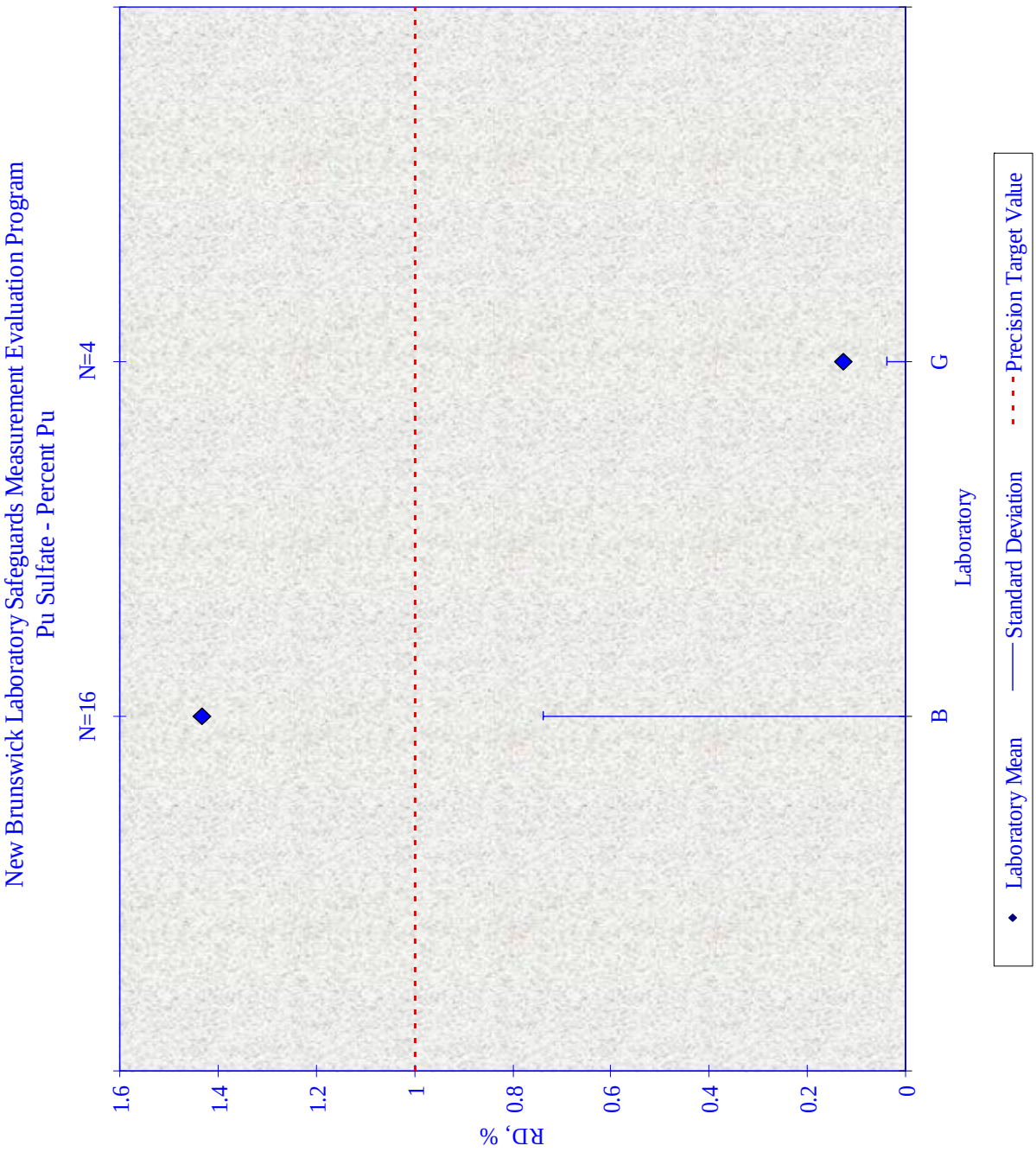

New Brunswick Laboratory Safeguards Measurement Evaluation Program
Pu Sulfate - Percent Pu
N=16
N=4
RD - %
1.6
1.2
0.8
0.4
0.0
-0.4
-0.8
-1.2
-1.6
B
G
Laboratory
Laboratory Mean
Bias Target Values
Standard Deviation

Figure 16


New Brunswick Laboratory Safeguards Measurement Evaluation Program
Pu Sulfate - Percent Pu
N=16
N=4
RD, %
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
B
G
Laboratory
Laboratory Mean
Standard Deviation
Precision Target Value

E.6.3.2. ^{239}Pu Abundance

Three laboratories analyzed the test materials for isotopic composition. ^{239}Pu and ^{240}Pu are the major isotopes in the test materials; other isotopes occur in small abundance.

The (grand) mean % RD results for ^{239}Pu are shown in Table 12. The results from high burn-up and low burn-up plutonium samples are presented in the table without making any distinction between them. However, the ITVs for high burn-up material are shown separately from those for low burn-up material. The results were judged against ITVs for the low burn-up material since they were more stringent.

The % RD results for ^{239}Pu and the standard deviations are shown in Figure 17 to evaluate bias, and again in Figure 18 to evaluate precision. In both figures, the ITVs corresponding to low burn-up material (more stringent criteria) only are shown. Laboratories G and T satisfied both bias and precision ITVs, and laboratory B missed both.

Table 12
Inter-laboratory Performance Summary
Pu^{239} Abundance

Method	Lab code	Mean	Standard deviation	N	Bias ITV (%)		Precision ITV (%)	
					High Burn-up	Low Burn-up	High Burn-up	Low Burn-up
TIMS	B	0.066	0.085	32	0.04	0.01	0.06	0.01
TIMS	G	0.003	0.003	6	0.04	0.01	0.06	0.01
TIMS	T	0.009	0.005	16	0.04	0.01	0.06	0.01

Figure 17

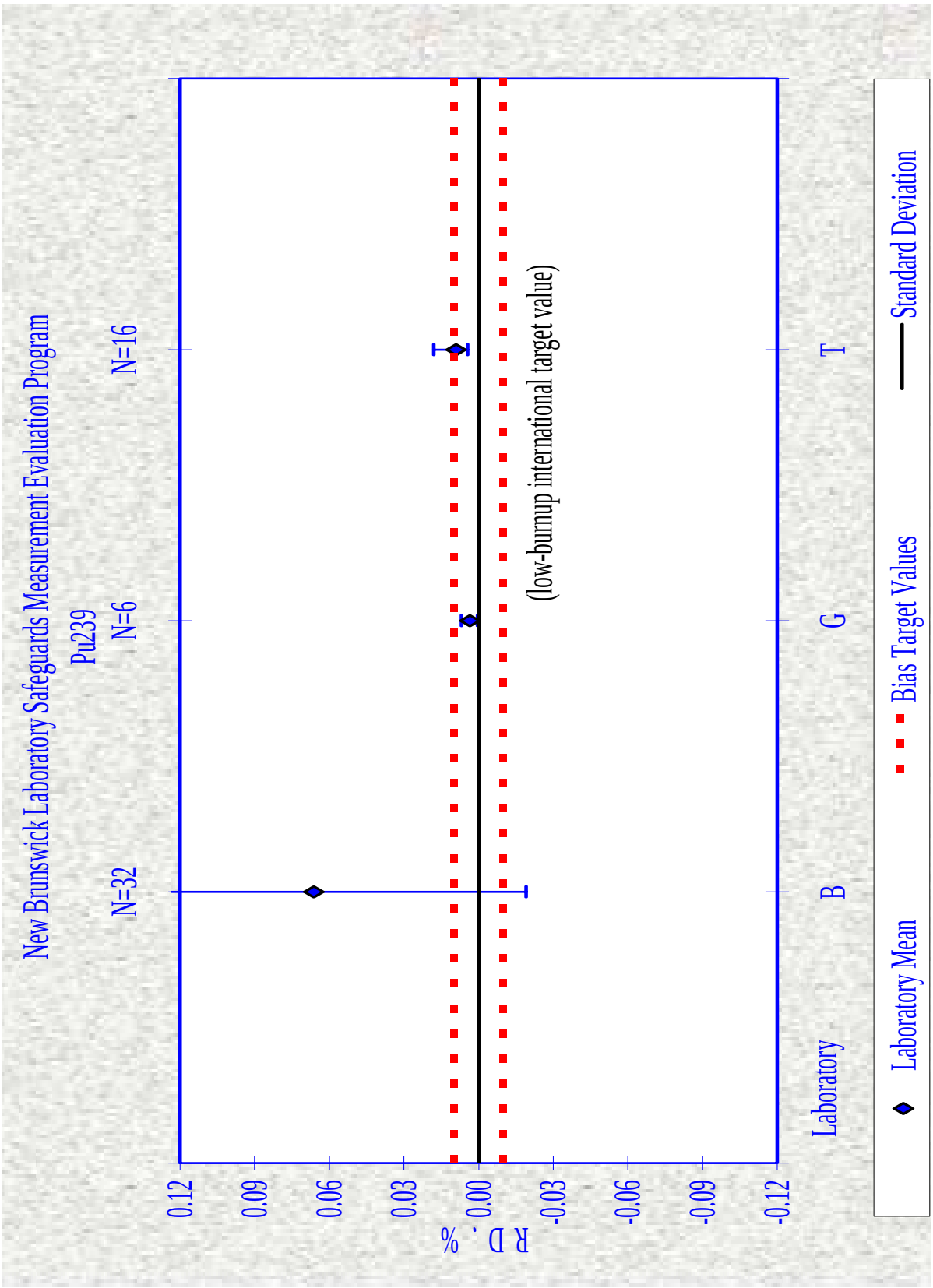
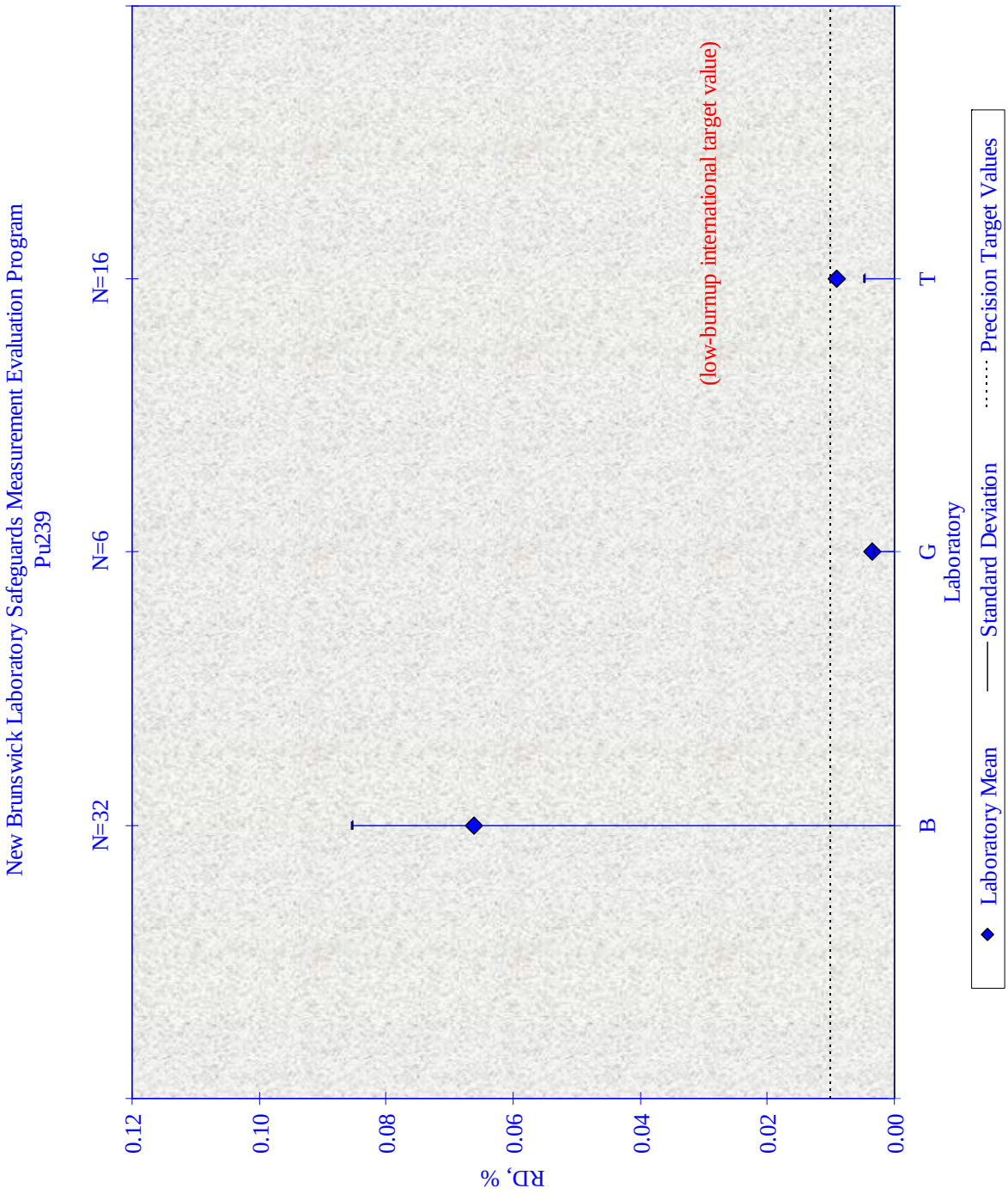

New Brunswick Laboratory Safeguards Measurement Evaluation Program
Pu239
N=32
N=6
N=16
(low-burnup international target value)
R D , %
0.12
0.09
0.06
0.03
0.00
-0.03
-0.06
-0.09
-0.12
Laboratory
B
G
T
Laboratory Mean
Bias Target Values
Standard Deviation

Figure 18


New Brunswick Laboratory Safeguards Measurement Evaluation Program
Pu239
N=32
N=6
N=16
(low-burnup international target value)
RD, %
0.12
0.10
0.08
0.06
0.04
0.02
0.00
B
G
T
Laboratory
Laboratory Mean
Standard Deviation
Precision Target Values

E.6.3.3. ^{240}Pu abundance

The % RD results for ^{240}Pu are shown in Table 13. The results from high burn-up and low burn-up plutonium samples are presented in the table without making any distinction between them. However, the ITVS for high and low burn-up plutonium are shown separately. The results were judged against ITVs for the high burn-up material since they were more stringent..

The % RD results for ^{240}Pu and the standard deviations are shown in Figure 19 to evaluate bias, and again in Figure 20 to evaluate precision. In both figures only the most stringent ITVs (corresponding to high burn-up) are shown. Laboratories G and T satisfied both bias and precision ITVs, and laboratory B satisfied bias ITV but not the precision ITV.

Table 13

Inter-laboratory Performance Summary

Pu^{240} Abundance

Method	Lab code	Mean	Standard deviation	N	Bias ITV (%)		Precision ITV (%)	
					High Burn-up	Low Burn-up	High Burn-up	Low Burn-up
TIMS	B	-0.111	0.718	32	0.12	0.15	0.07	0.10
TIMS	G	-0.010	0.015	6	0.12	0.15	0.07	0.10
TIMS	T	-0.046	0.024	16	0.12	0.15	0.07	0.10

Figure 19

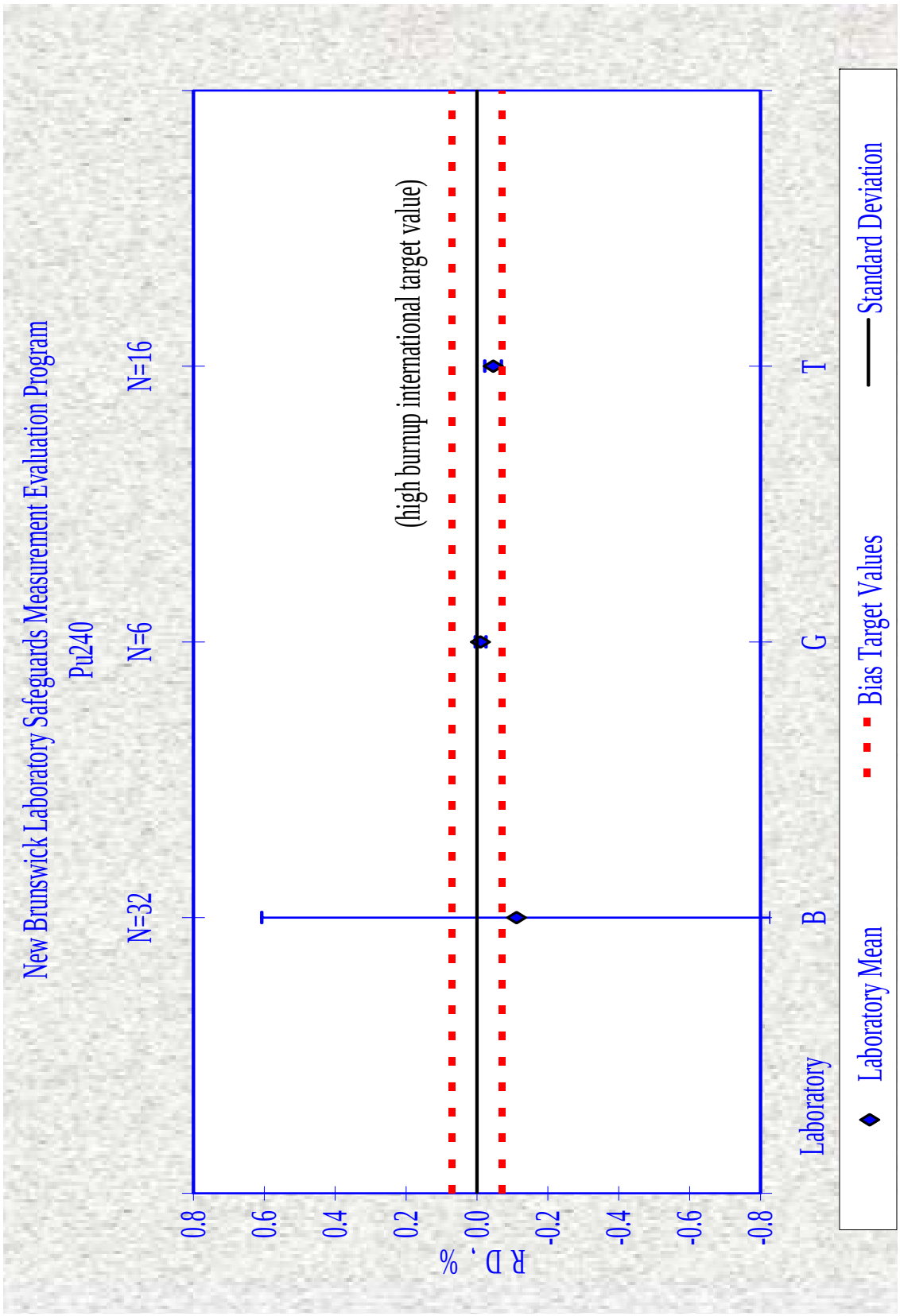
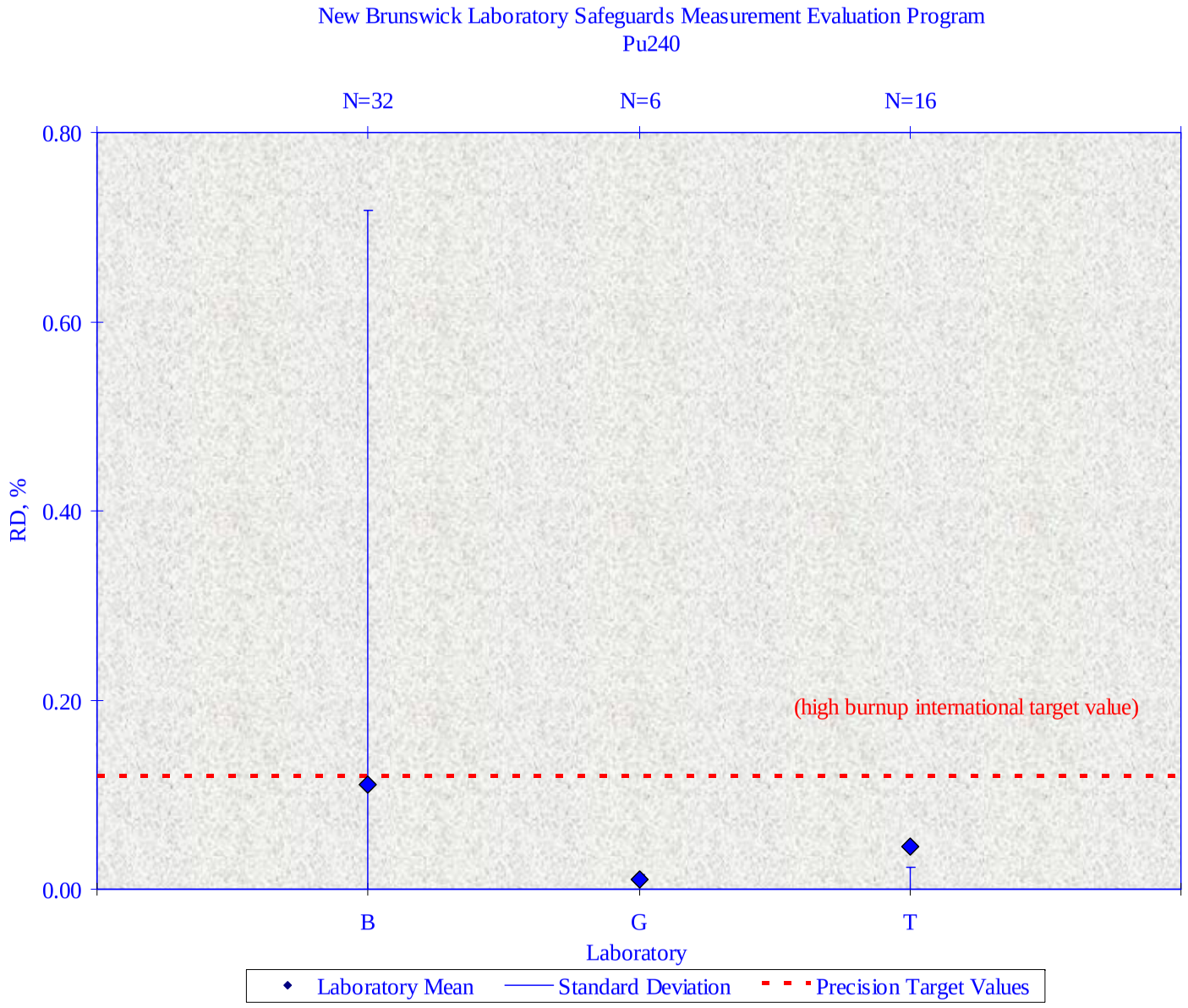


Figure 20


New Brunswick Laboratory Safeguards Measurement Evaluation Program
Pu240
N=32
N=6
N=16
0.80
0.60
0.40
0.20
0.00
RD, %
(high burnup international target value)
B
G
T
Laboratory
Laboratory Mean
Standard Deviation
Precision Target Values

F. LONG TERM EVALUTION OF URANIUM MEASUREMENTS: FY 2001-2003

The uranium measurement results gathered by the participating laboratories during FY 2001 to FY 2003 are evaluated in this section. The % RD results are shown in Figures 21 to 60, for each laboratory arranged material by material. These figures show the long-term performance level for each laboratory.

Figure 21

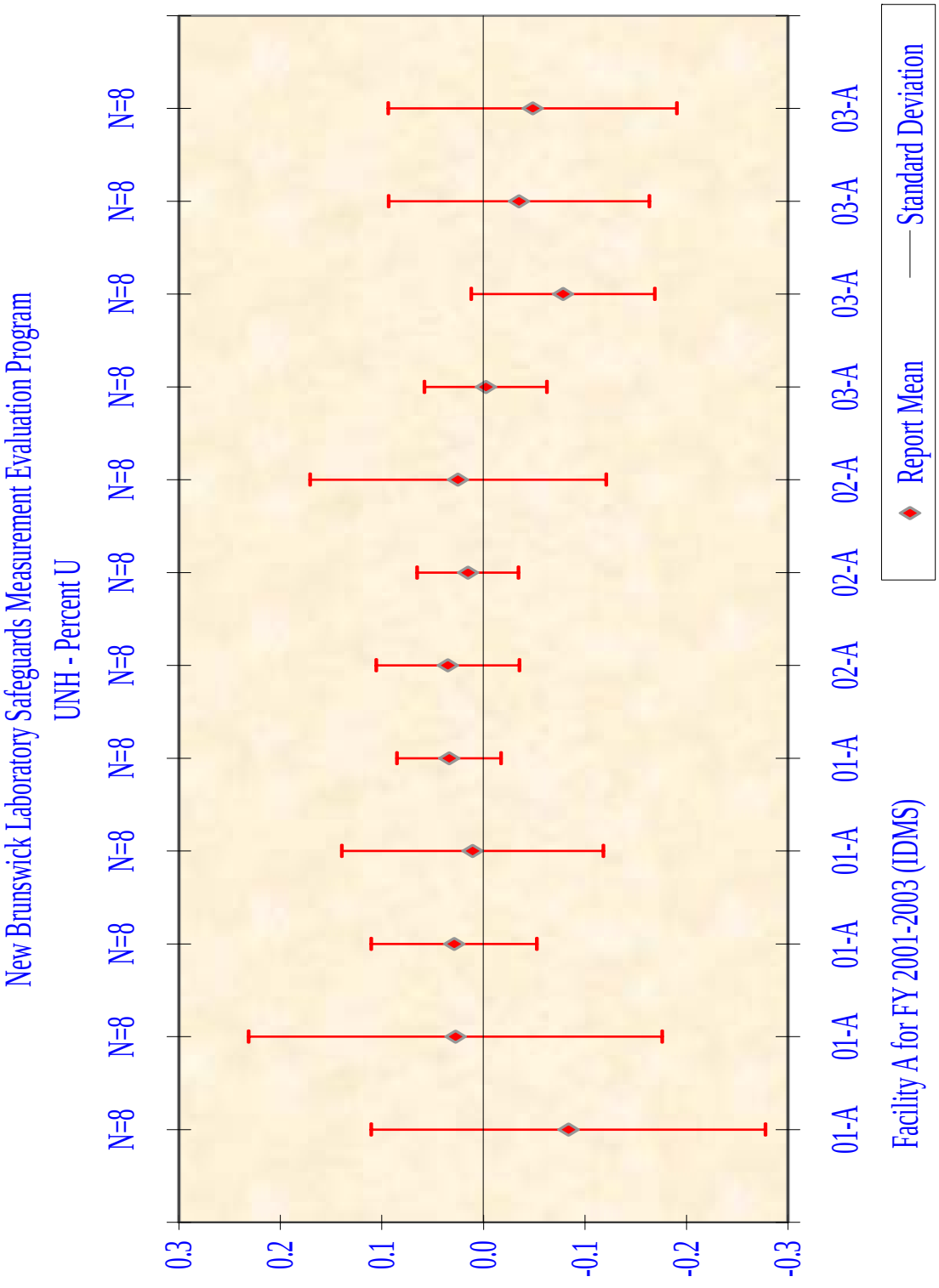

New Brunswick Laboratory Safeguards Measurement Evaluation Program
UNH - Percent U
N=8
0.3
0.2
0.1
0.0
-0.1
-0.2
-0.3
01-A
01-A
01-A
01-A
02-A
02-A
03-A
03-A
Facility A for FY 2001-2003 (IDMS)
Report Mean
Standard Deviation

Figure 22

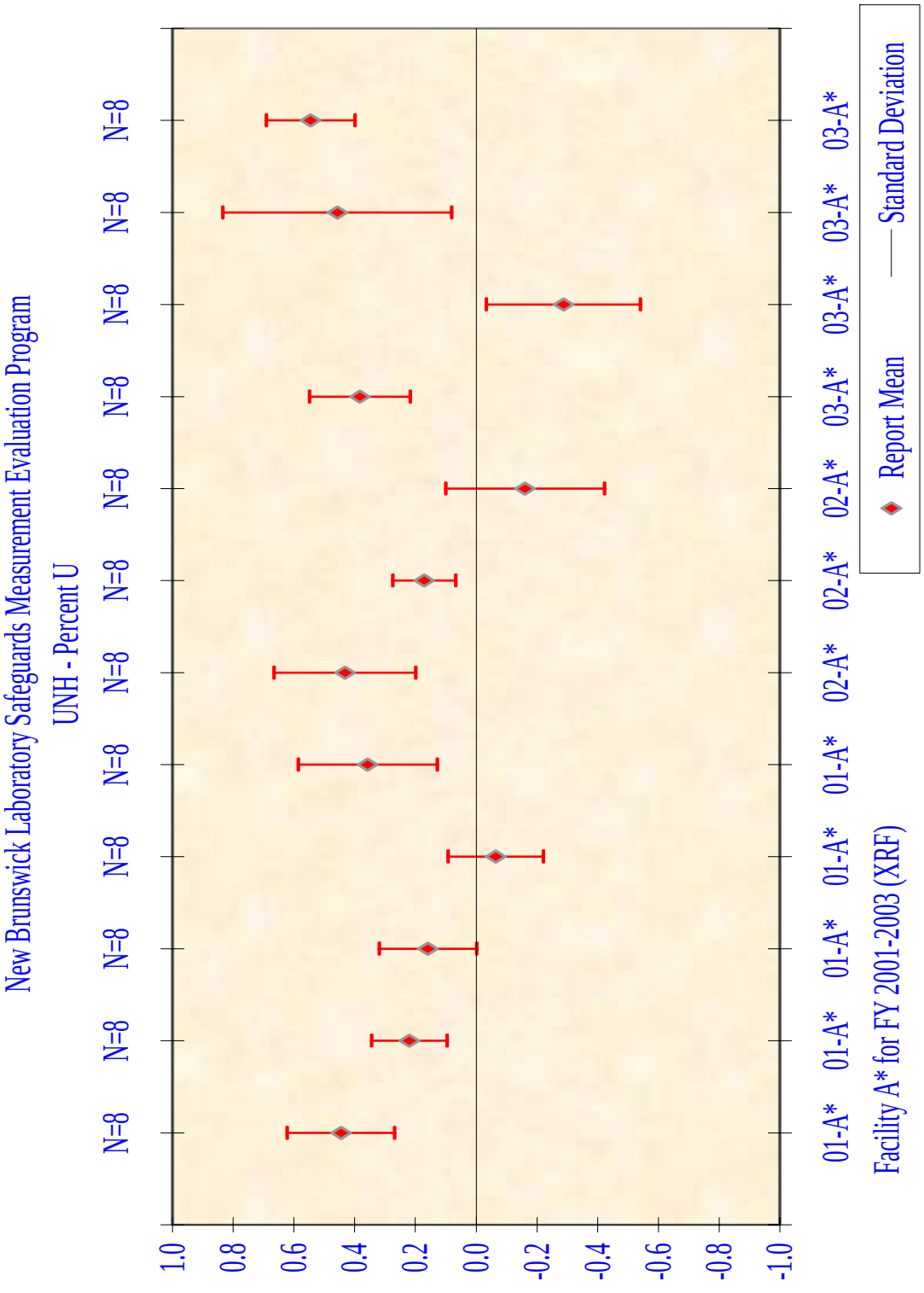

New Brunswick Laboratory Safeguards Measurement Evaluation Program
UNH - Percent U
N=8
1.0
0.8
0.6
0.4
0.2
0.0
-0.2
-0.4
-0.6
-0.8
-1.0
01-A* 01-A* 01-A* 01-A* 01-A* 02-A* 02-A* 02-A* 03-A* 03-A* 03-A*
Facility A* for FY 2001-2003 (XRF)
Report Mean
Standard Deviation

Figure 23

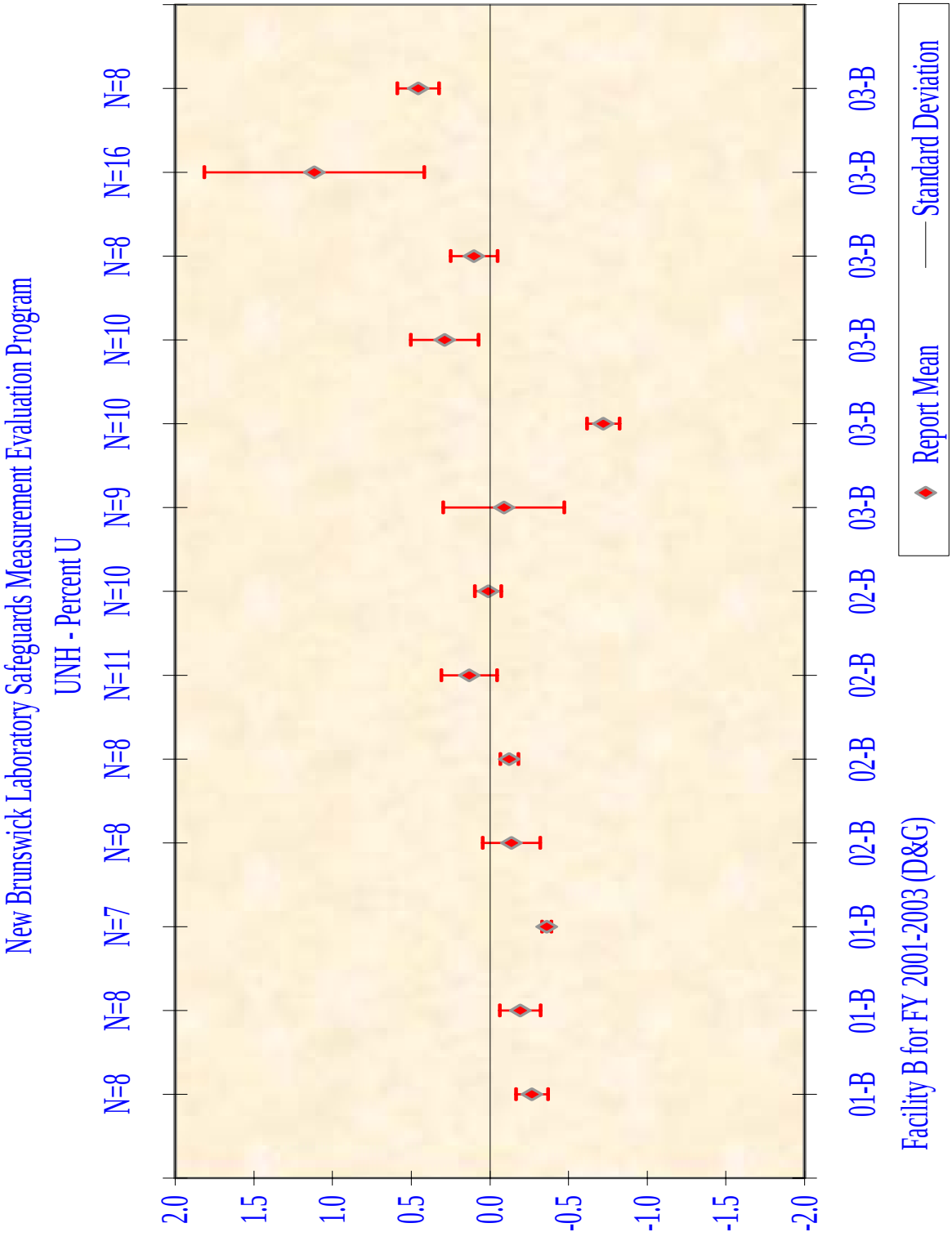

New Brunswick Laboratory Safeguards Measurement Evaluation Program
UNH - Percent U
Facility B for FY 2001-2003 (D&G)
Report Mean
Standard Deviation
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
-2.0
N=8 N=8 N=7 N=8 N=8 N=11 N=10 N=9 N=10 N=10 N=8 N=16 N=8
01-B 01-B 01-B 02-B 02-B 02-B 02-B 03-B 03-B 03-B 03-B 03-B 03-B

Figure 24

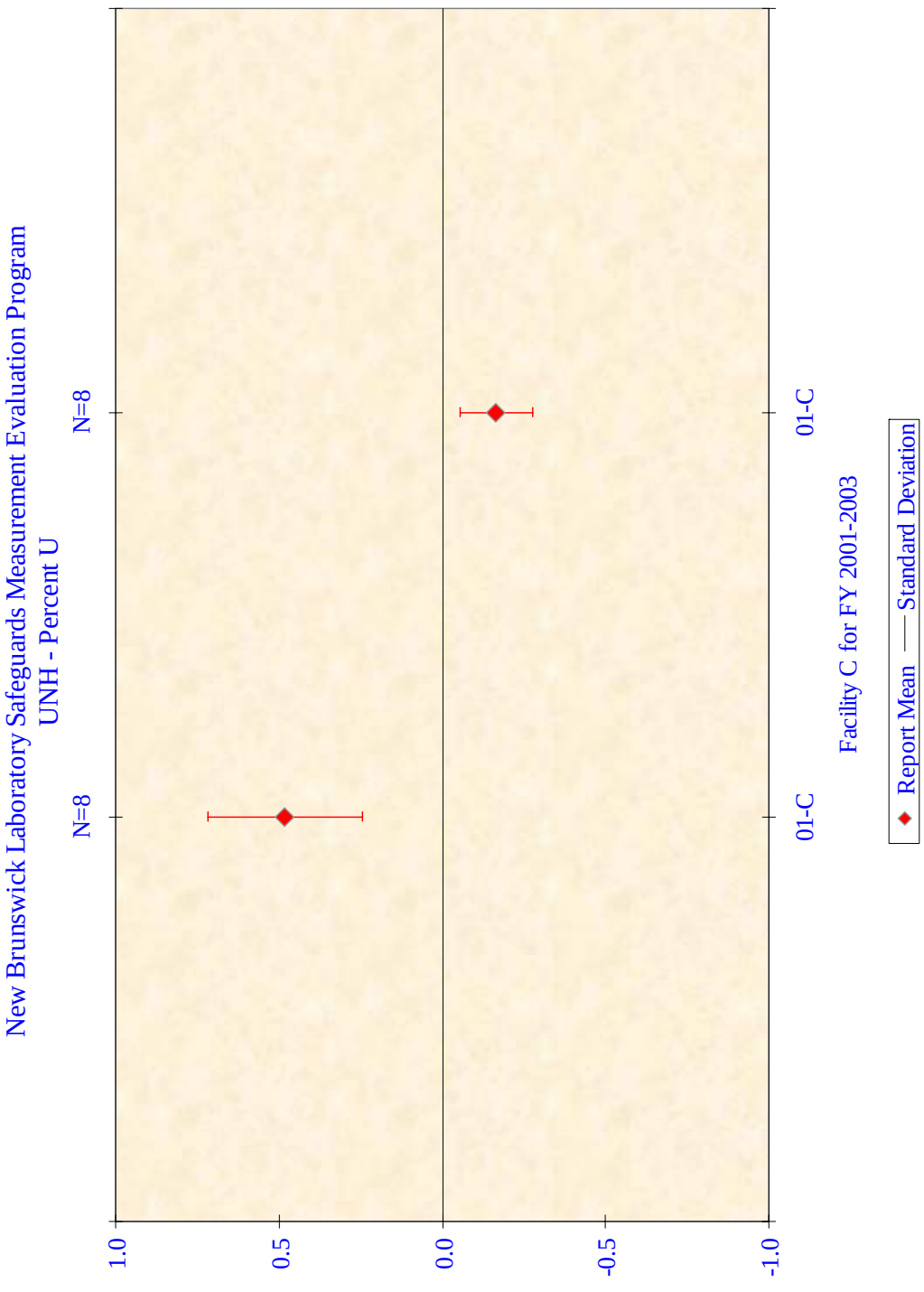

New Brunswick Laboratory Safeguards Measurement Evaluation Program
UNH - Percent U
N=8
N=8
01-C
01-C
Facility C for FY 2001-2003
Report Mean
Standard Deviation
1.0
0.5
0.0
-0.5
-1.0

Figure 25

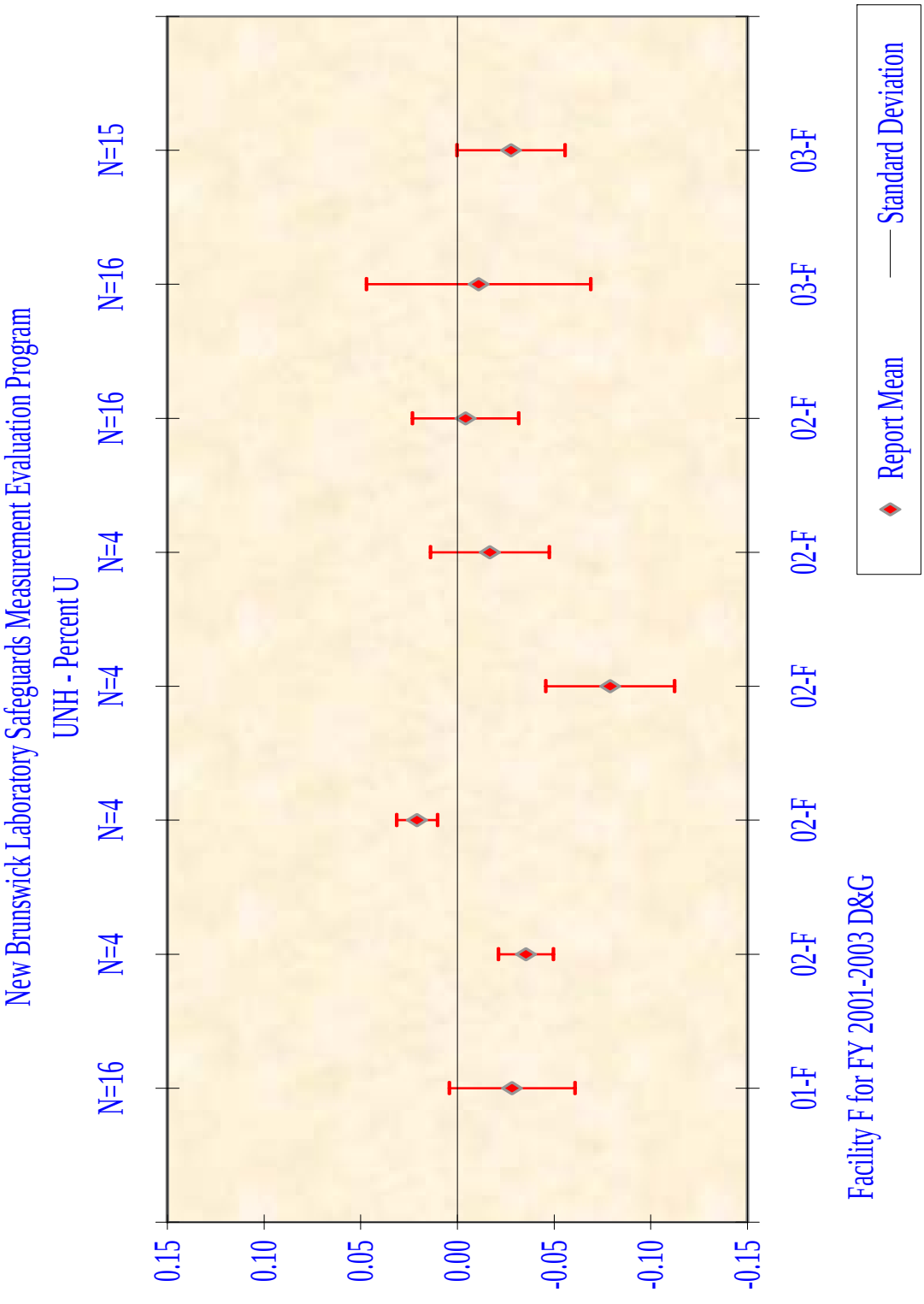

New Brunswick Laboratory Safeguards Measurement Evaluation Program
UNH - Percent U
Facility F for FY 2001-2003 D&G
Report Mean
Standard Deviation
0.15
0.10
0.05
0.00
-0.05
-0.10
-0.15
N=16
N=4
N=4
N=4
N=4
N=16
N=16
N=15
01-F
02-F
02-F
02-F
02-F
02-F
03-F
03-F

Figure 26

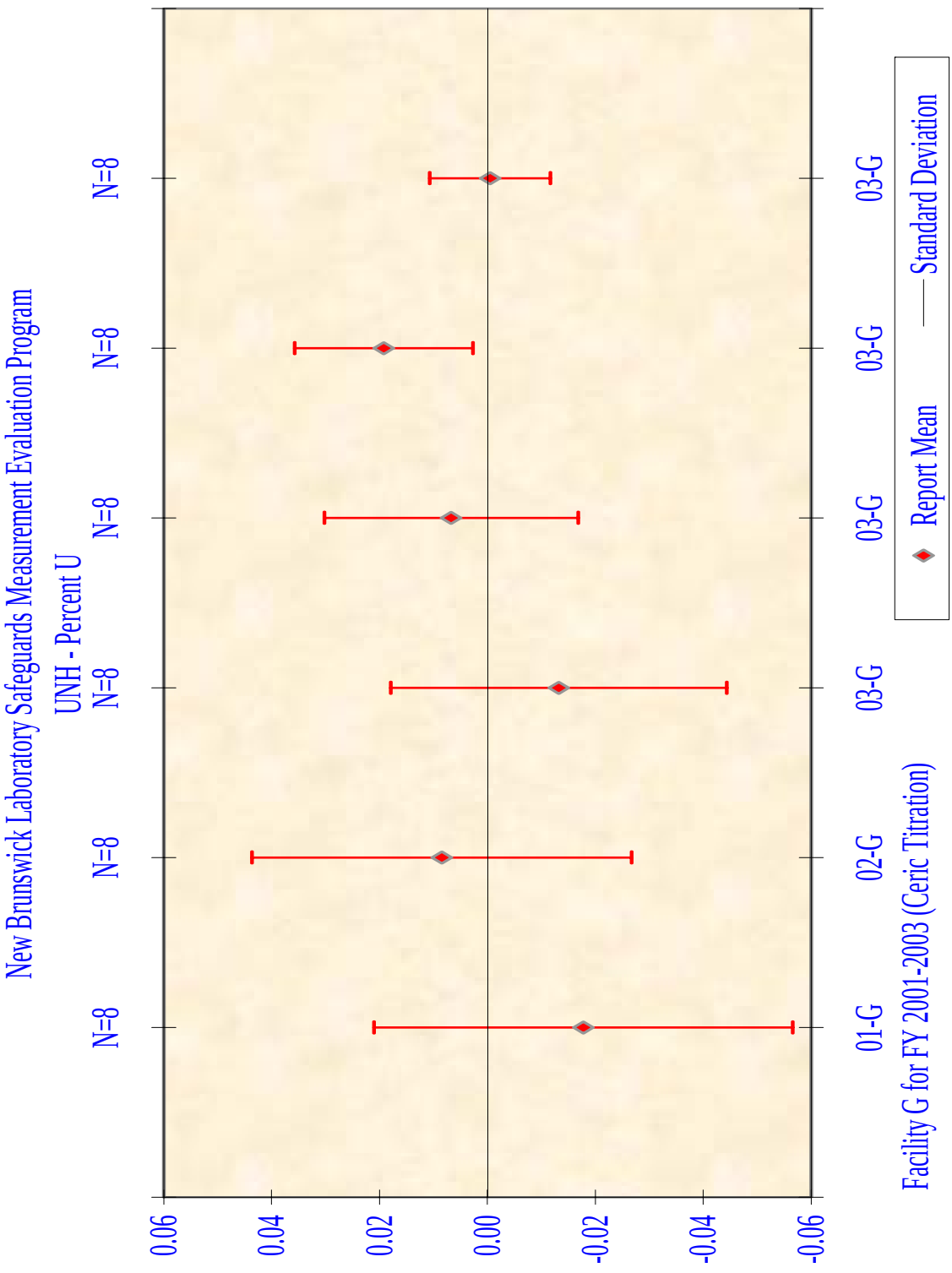

New Brunswick Laboratory Safeguards Measurement Evaluation Program
UNH - Percent U
Facility G for FY 2001-2003 (Ceric Titration)
N=8
N=8
N=8
N=8
N=8
01-G
02-G
03-G
03-G
03-G
0.06
0.04
0.02
0.00
-0.02
-0.04
-0.06
Report Mean
Standard Deviation

Figure 26a

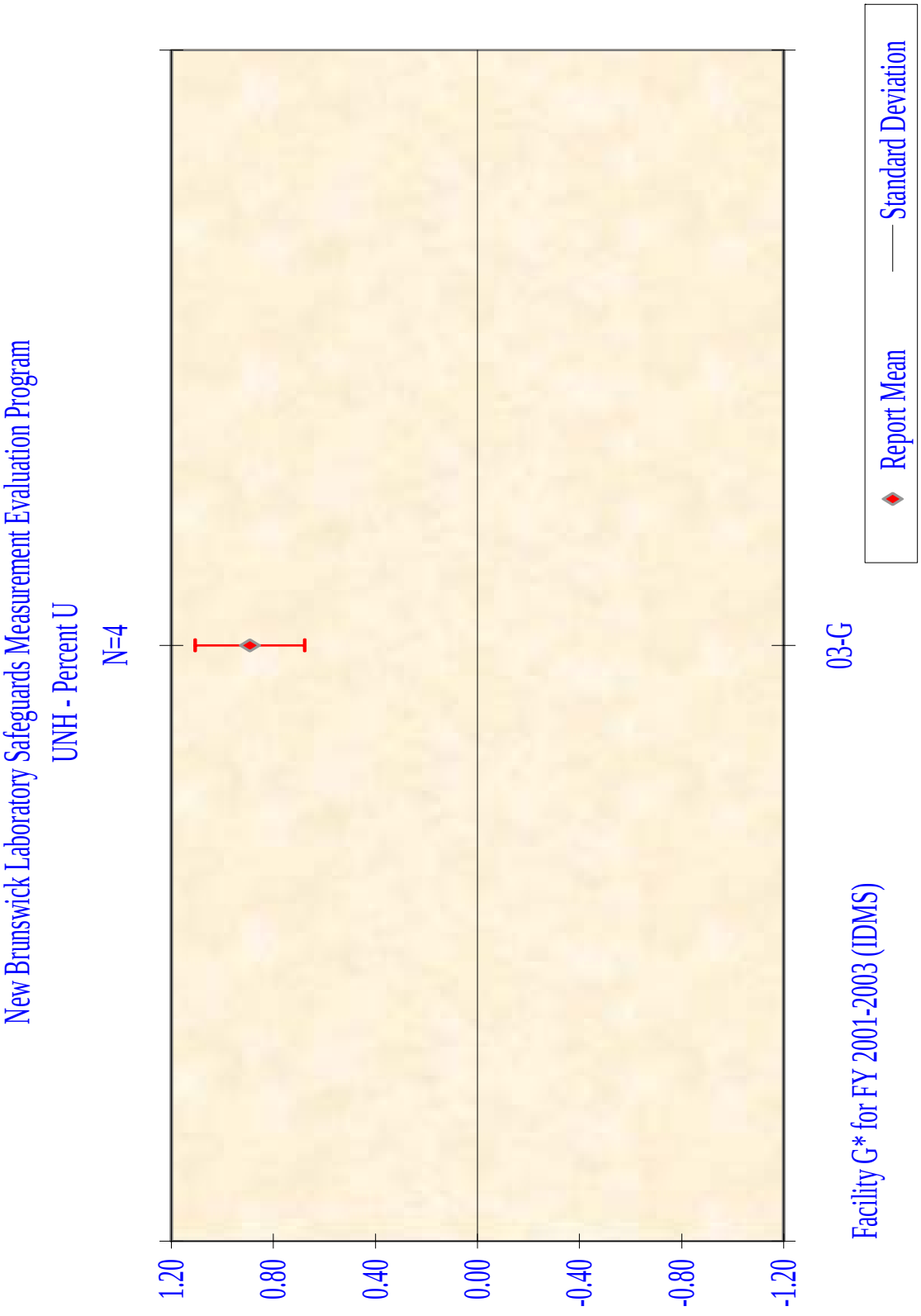

New Brunswick Laboratory Safeguards Measurement Evaluation Program
UNH - Percent U
N=4
1.20
0.80
0.40
0.00
-0.40
-0.80
-1.20
03-G
Facility G* for FY 2001-2003 (IDMS)
Report Mean
Standard Deviation

Figure 27

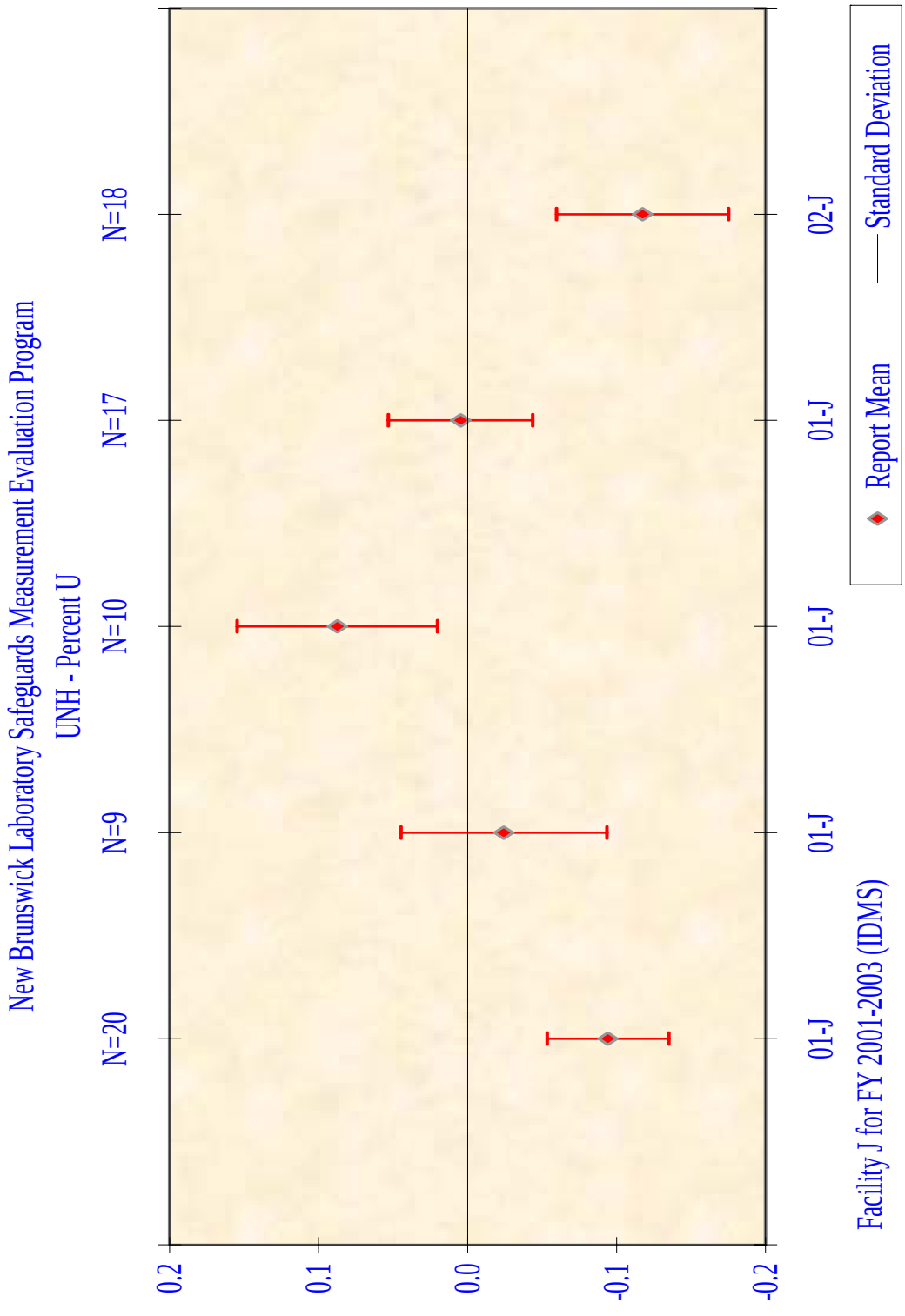

New Brunswick Laboratory Safeguards Measurement Evaluation Program
UNH - Percent U
N=20
N=9
N=10
N=17
N=18
01-J
01-J
01-J
01-J
02-J
0.2
0.1
0.0
-0.1
-0.2
Report Mean
Standard Deviation
Facility J for FY 2001-2003 (IDMS)

Figure 28

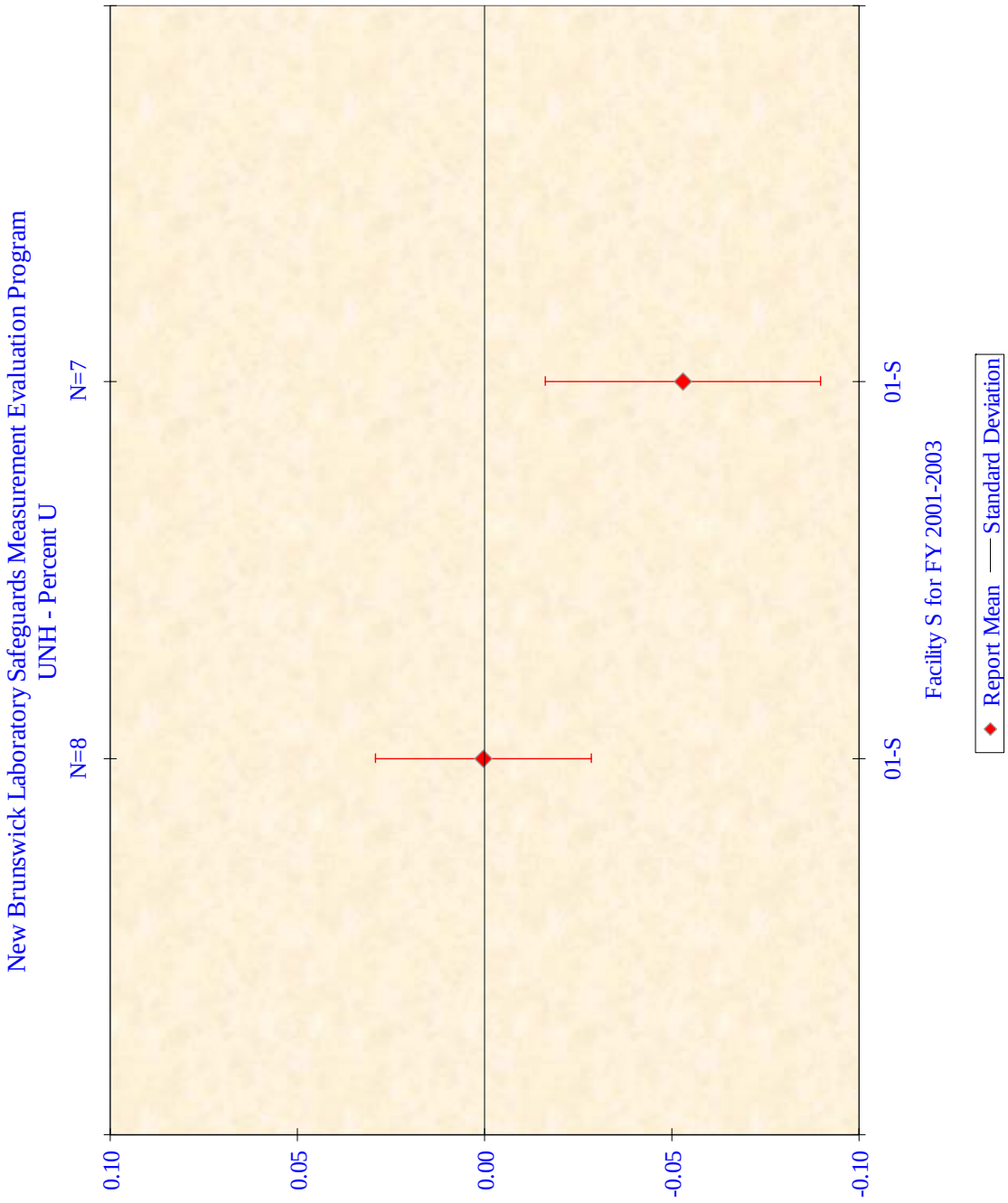

New Brunswick Laboratory Safeguards Measurement Evaluation Program
UNH - Percent U
N=8
N=7
0.10
0.05
0.00
-0.05
-0.10
01-S
01-S
Facility S for FY 2001-2003
Report Mean
Standard Deviation

Figure 29

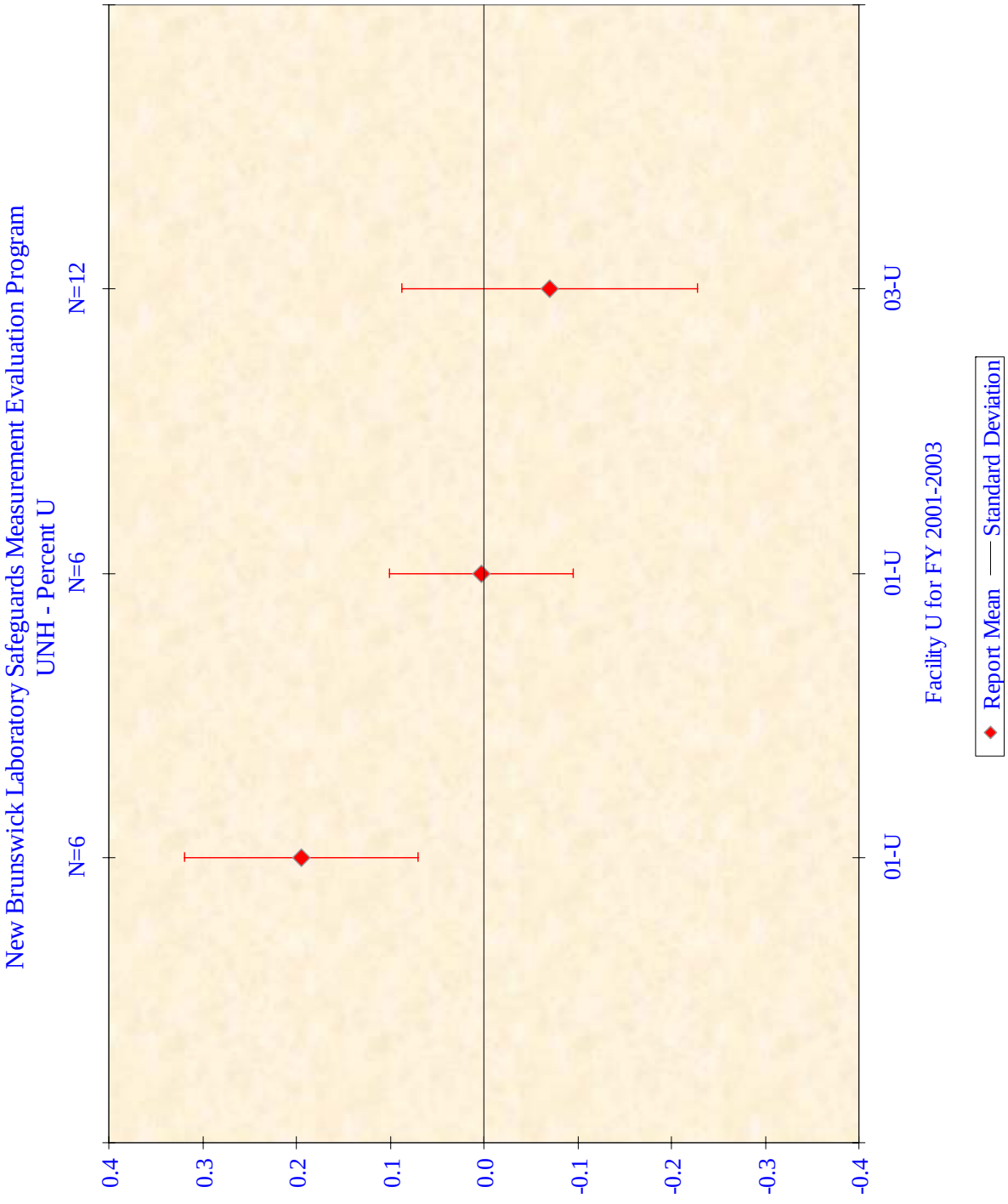

New Brunswick Laboratory Safeguards Measurement Evaluation Program
UNH - Percent U
N=6
N=6
N=12
01-U
01-U
03-U
0.4
0.3
0.2
0.1
0.0
-0.1
-0.2
-0.3
-0.4
Facility U for FY 2001-2003
Report Mean
Standard Deviation

Figure 30

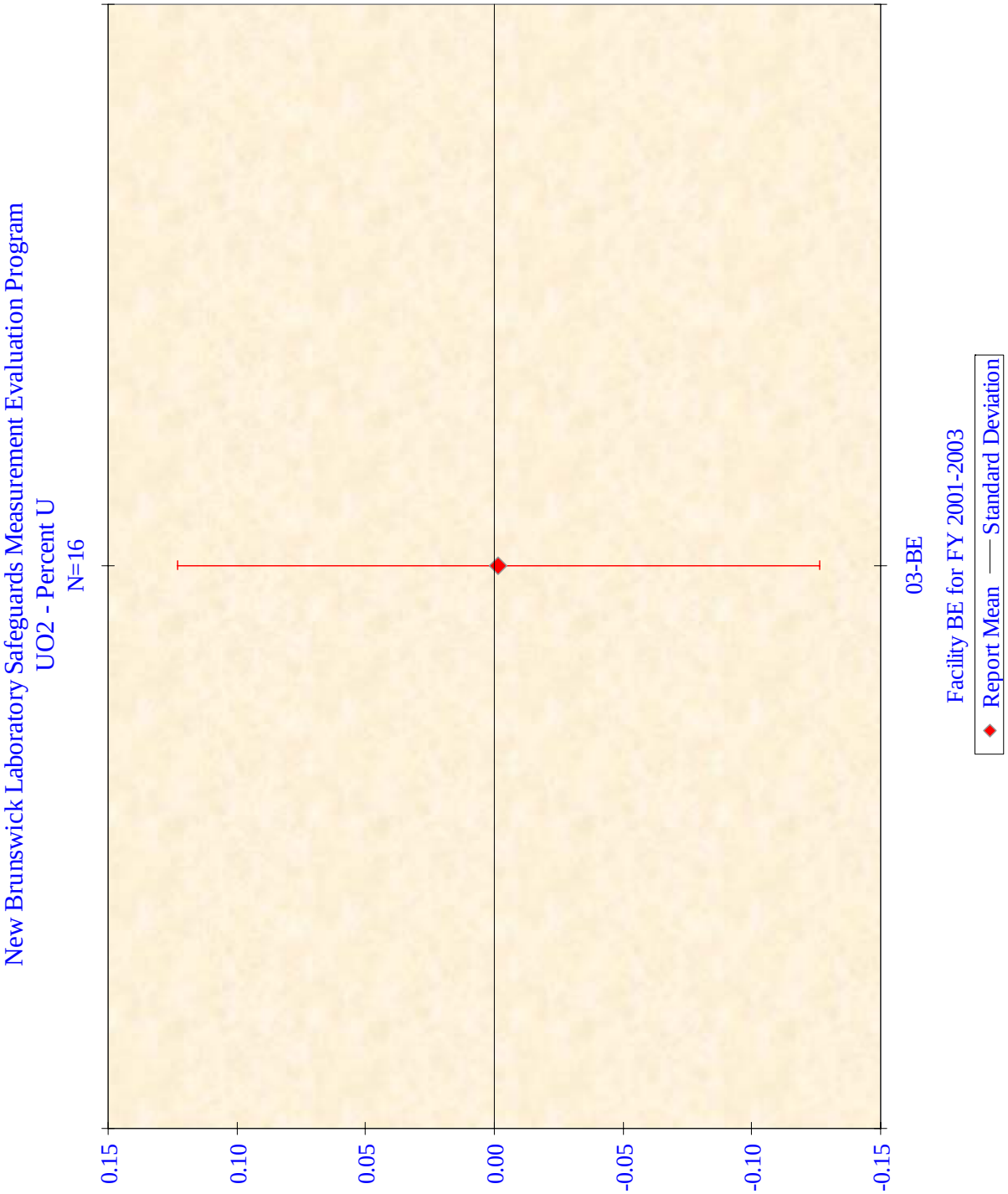

New Brunswick Laboratory Safeguards Measurement Evaluation Program
UO2 - Percent U
N=16
0.15
0.10
0.05
0.00
-0.05
-0.10
-0.15
03-BE
Facility BE for FY 2001-2003
Report Mean
Standard Deviation

Figure 31

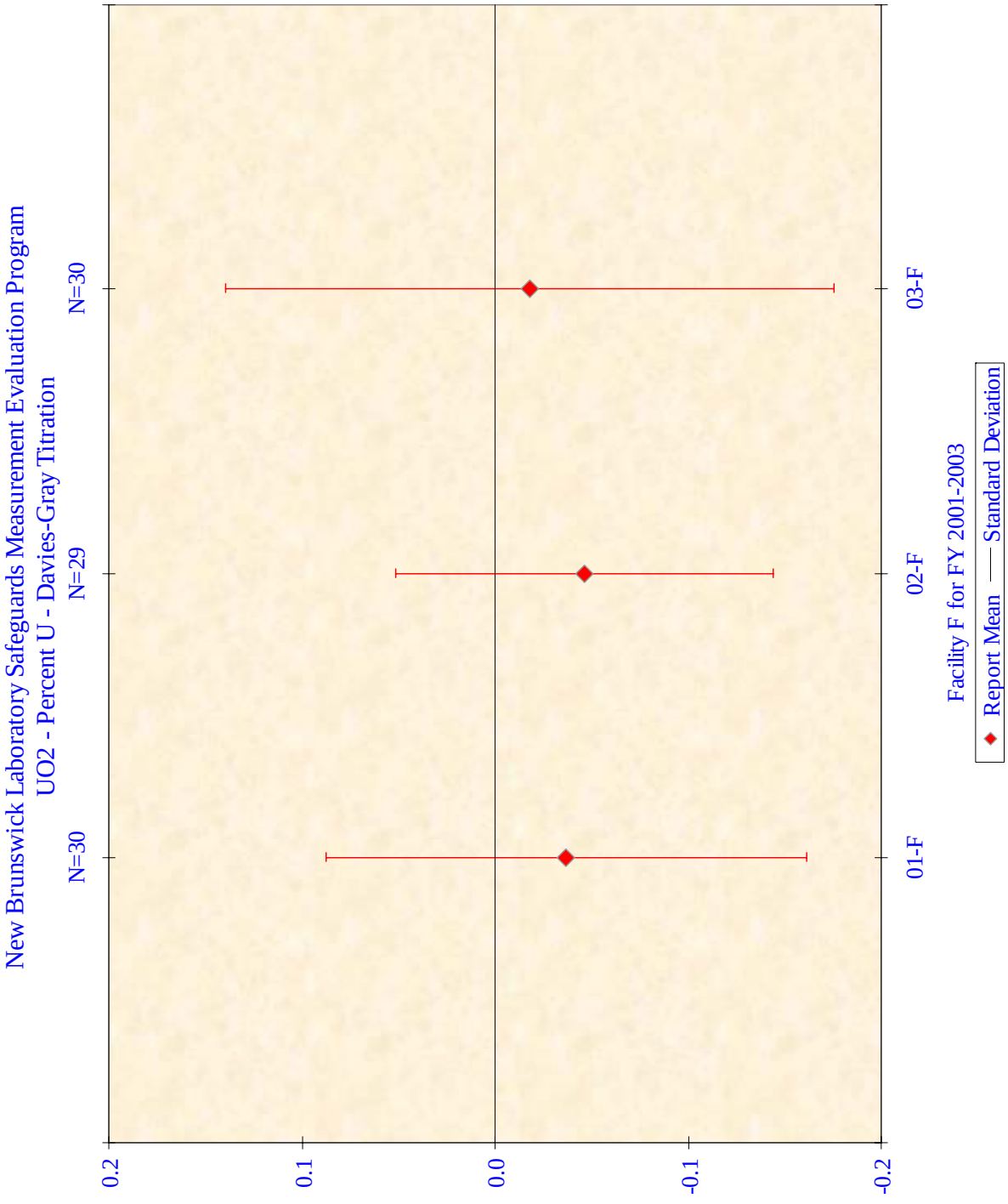

New Brunswick Laboratory Safeguards Measurement Evaluation Program
UO2 - Percent U - Davies-Gray Titration
N=30
N=29
N=30
0.2
0.1
0.0
-0.1
-0.2
01-F
02-F
03-F
Facility F for FY 2001-2003
Report Mean
Standard Deviation

Figure 32

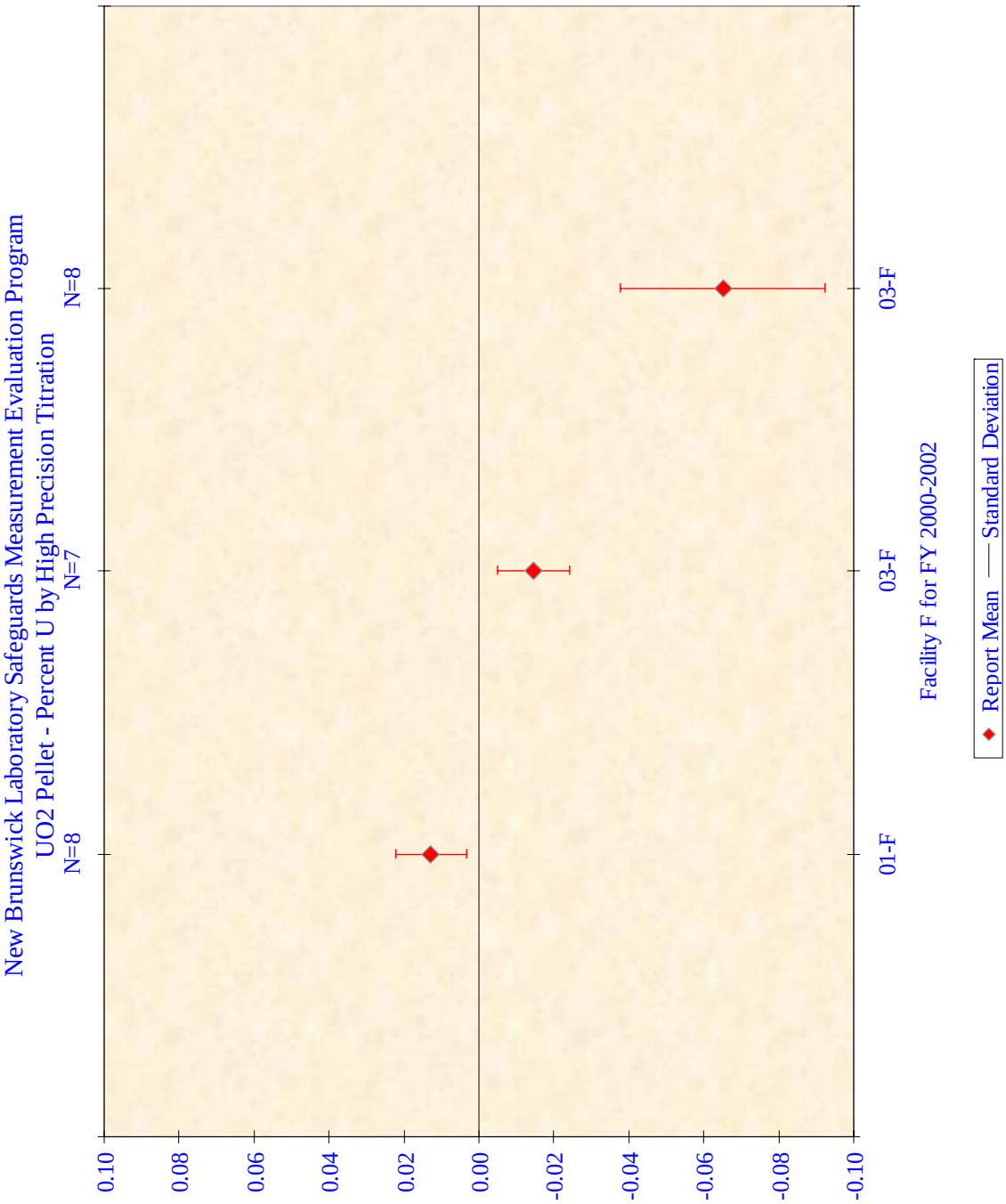

New Brunswick Laboratory Safeguards Measurement Evaluation Program
UO2 Pellet - Percent U by High Precision Titration
N=8
N=7
N=8
0.10
0.08
0.06
0.04
0.02
0.00
-0.02
-0.04
-0.06
-0.08
-0.10
01-F
03-F
03-F
Facility F for FY 2000-2002
Report Mean
Standard Deviation

Figure 33

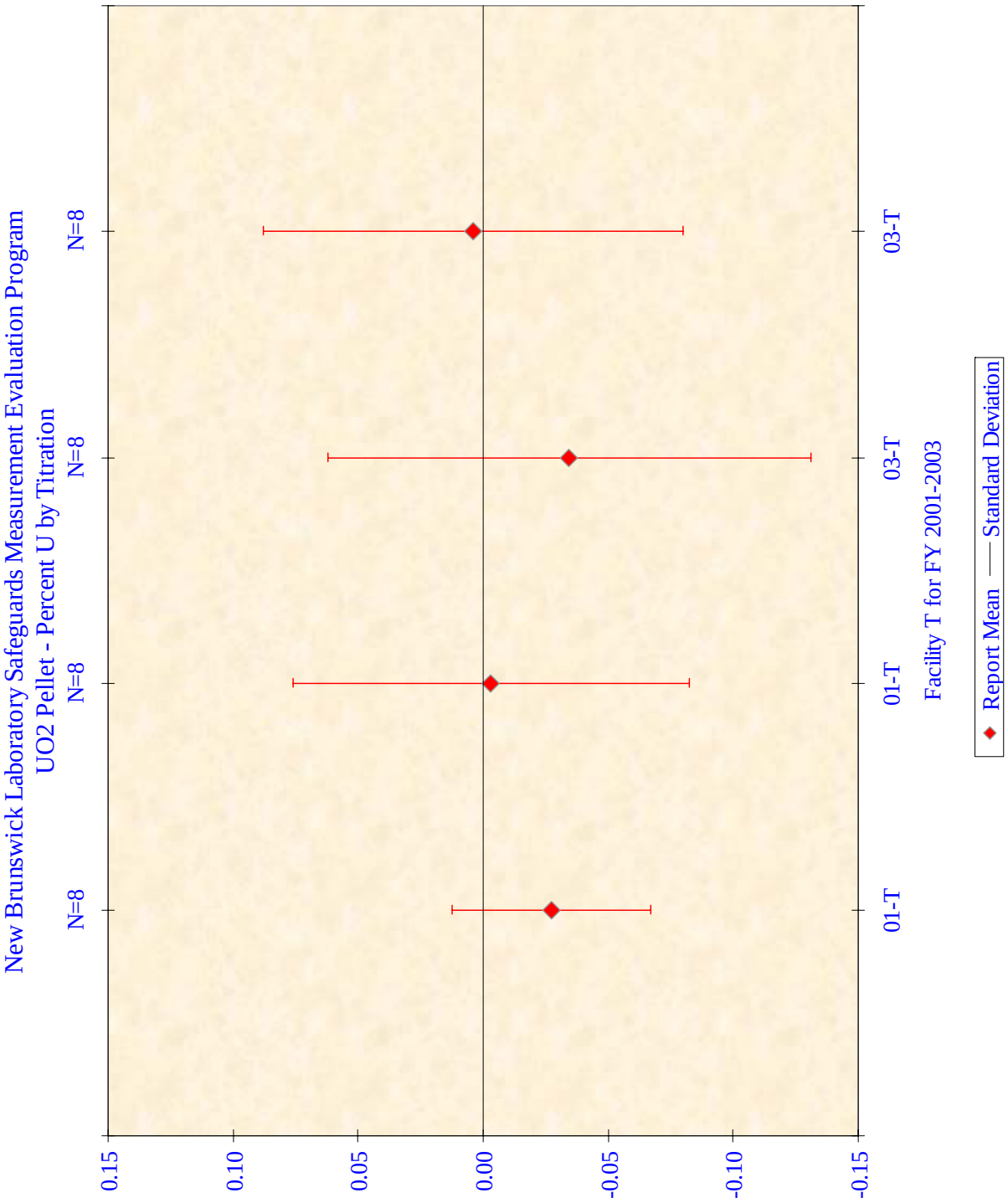

New Brunswick Laboratory Safeguards Measurement Evaluation Program
UO2 Pellet - Percent U by Titration
N=8
N=8
N=8
N=8
0.15
0.10
0.05
0.00
-0.05
-0.10
-0.15
01-T
01-T
03-T
03-T
Facility T for FY 2001-2003
Report Mean
Standard Deviation

Figure 34

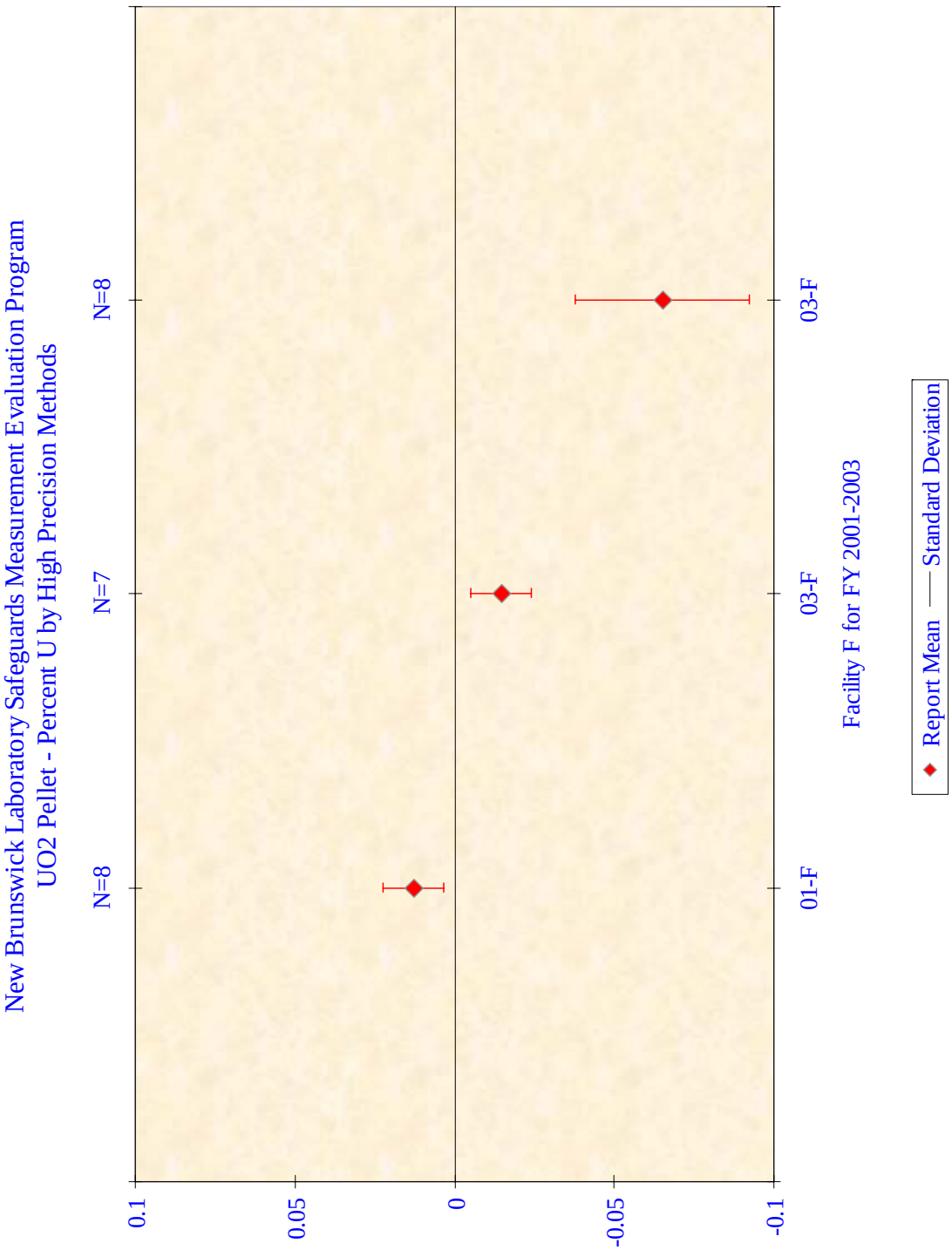

New Brunswick Laboratory Safeguards Measurement Evaluation Program
UO2 Pellet - Percent U by High Precision Methods
N=8
N=7
N=8
0.1
0.05
0
-0.05
-0.1
01-F
03-F
03-F
Facility F for FY 2001-2003
Report Mean
Standard Deviation

Figure 35

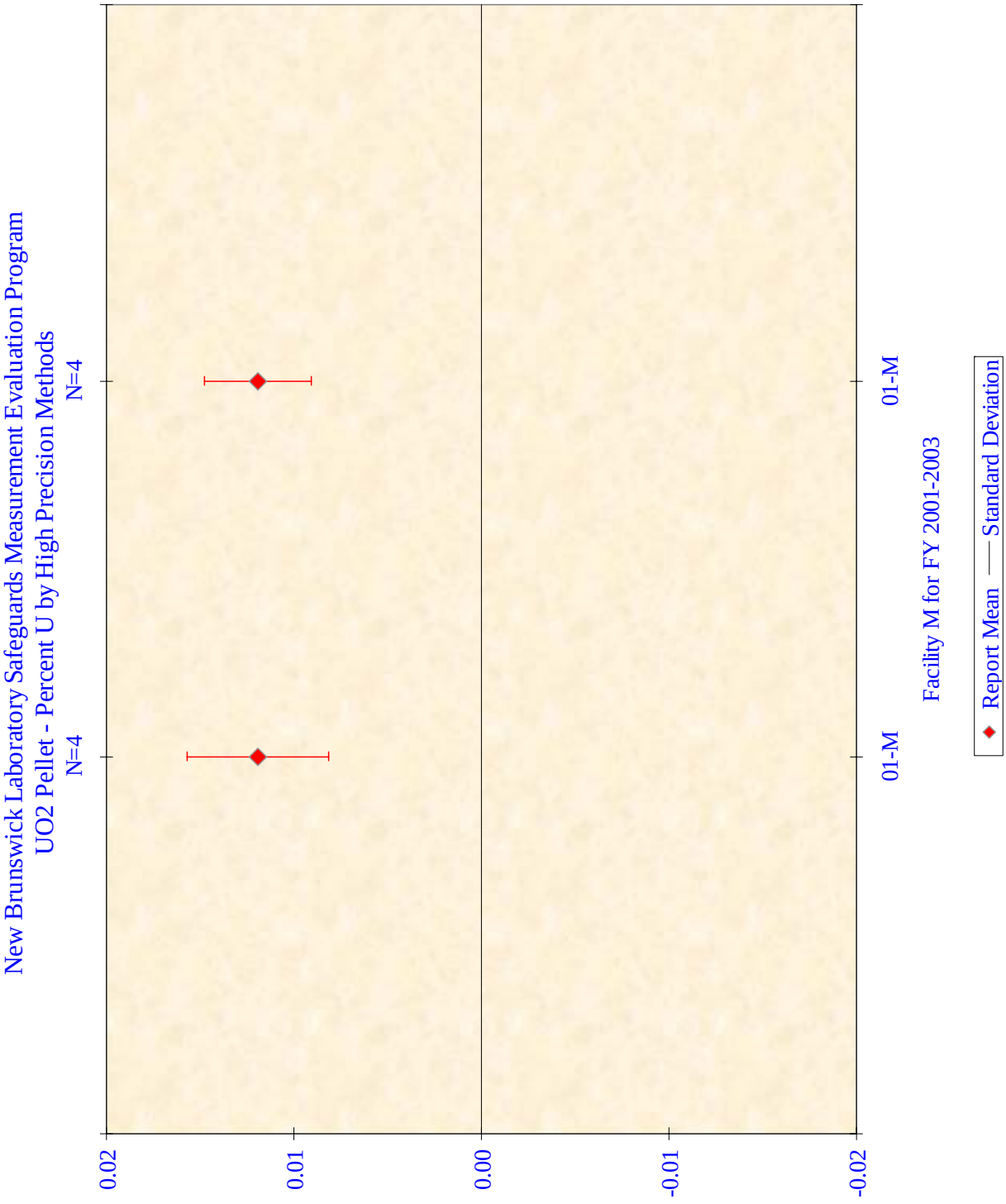

New Brunswick Laboratory Safeguards Measurement Evaluation Program
UO2 Pellet - Percent U by High Precision Methods
N=4
N=4
0.02
0.01
0.00
-0.01
-0.02
01-M
01-M
Facility M for FY 2001-2003
Report Mean
Standard Deviation

Figure 36

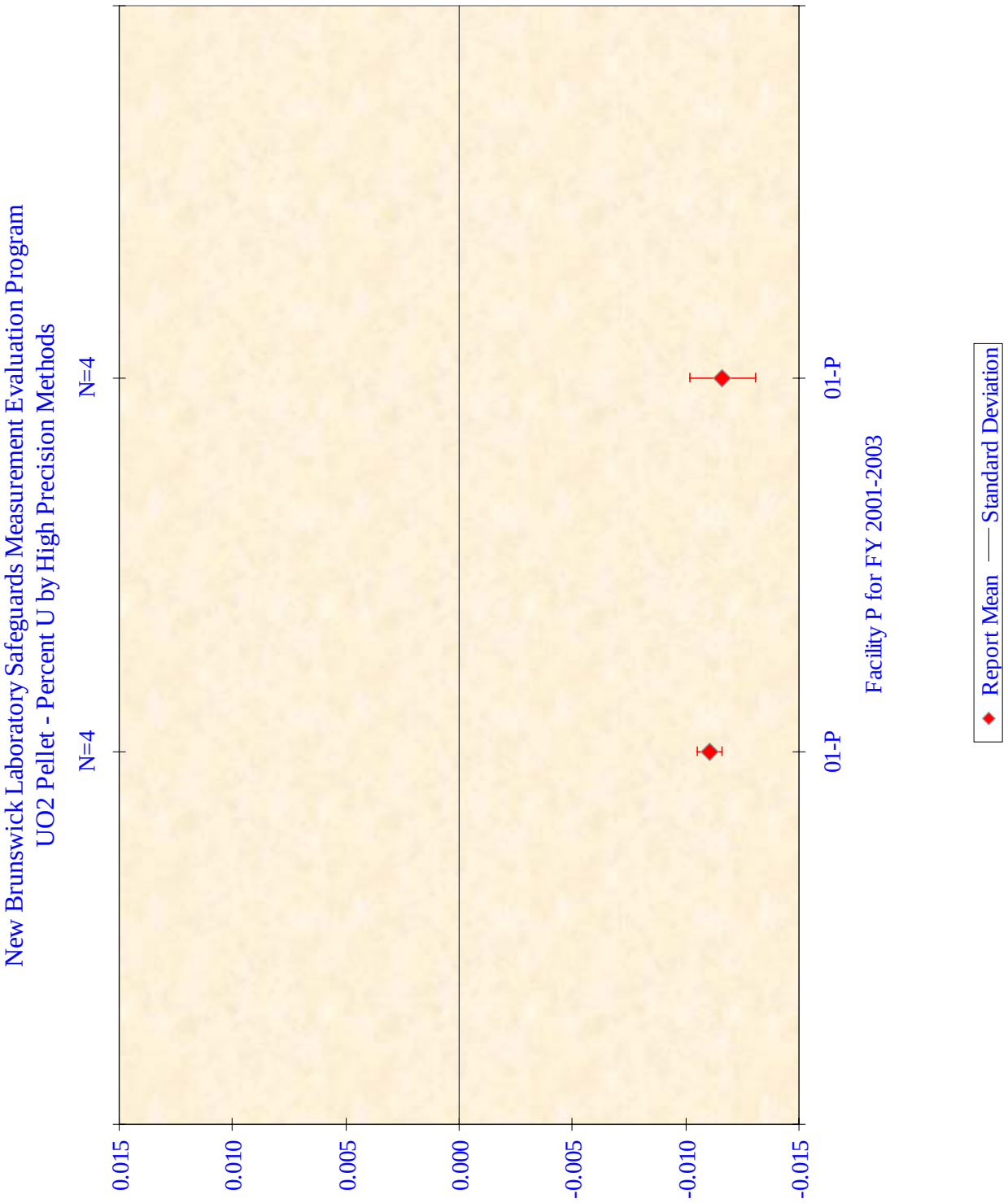

New Brunswick Laboratory Safeguards Measurement Evaluation Program
UO2 Pellet - Percent U by High Precision Methods
N=4
N=4
0.015
0.010
0.005
0.000
-0.005
-0.010
-0.015
01-P
01-P
Facility P for FY 2001-2003
Report Mean
Standard Deviation

Figure 37

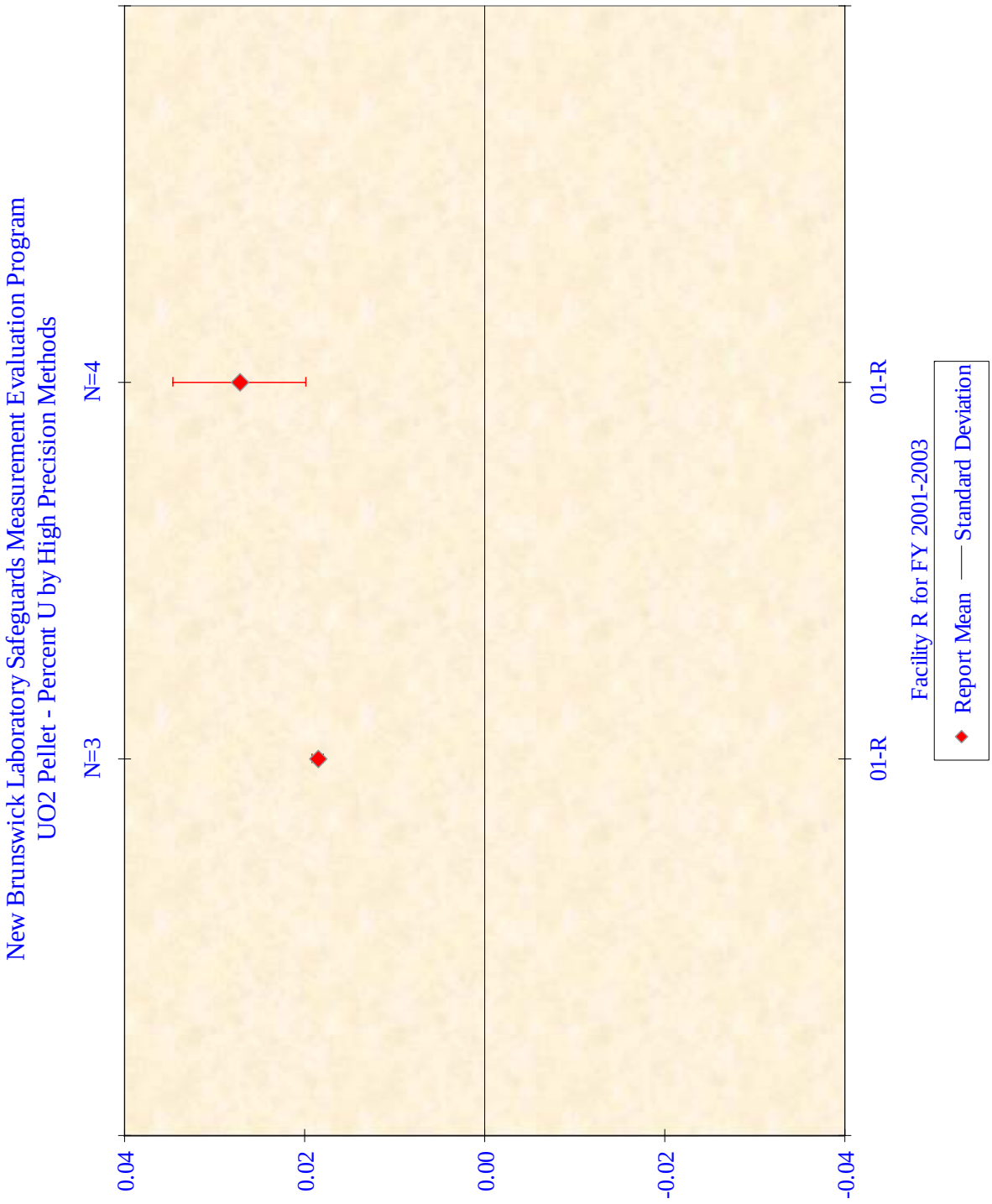

New Brunswick Laboratory Safeguards Measurement Evaluation Program
UO2 Pellet - Percent U by High Precision Methods
N=3
N=4
0.04
0.02
0.00
-0.02
-0.04
01-R
01-R
Facility R for FY 2001-2003
Report Mean
Standard Deviation

Figure 38a

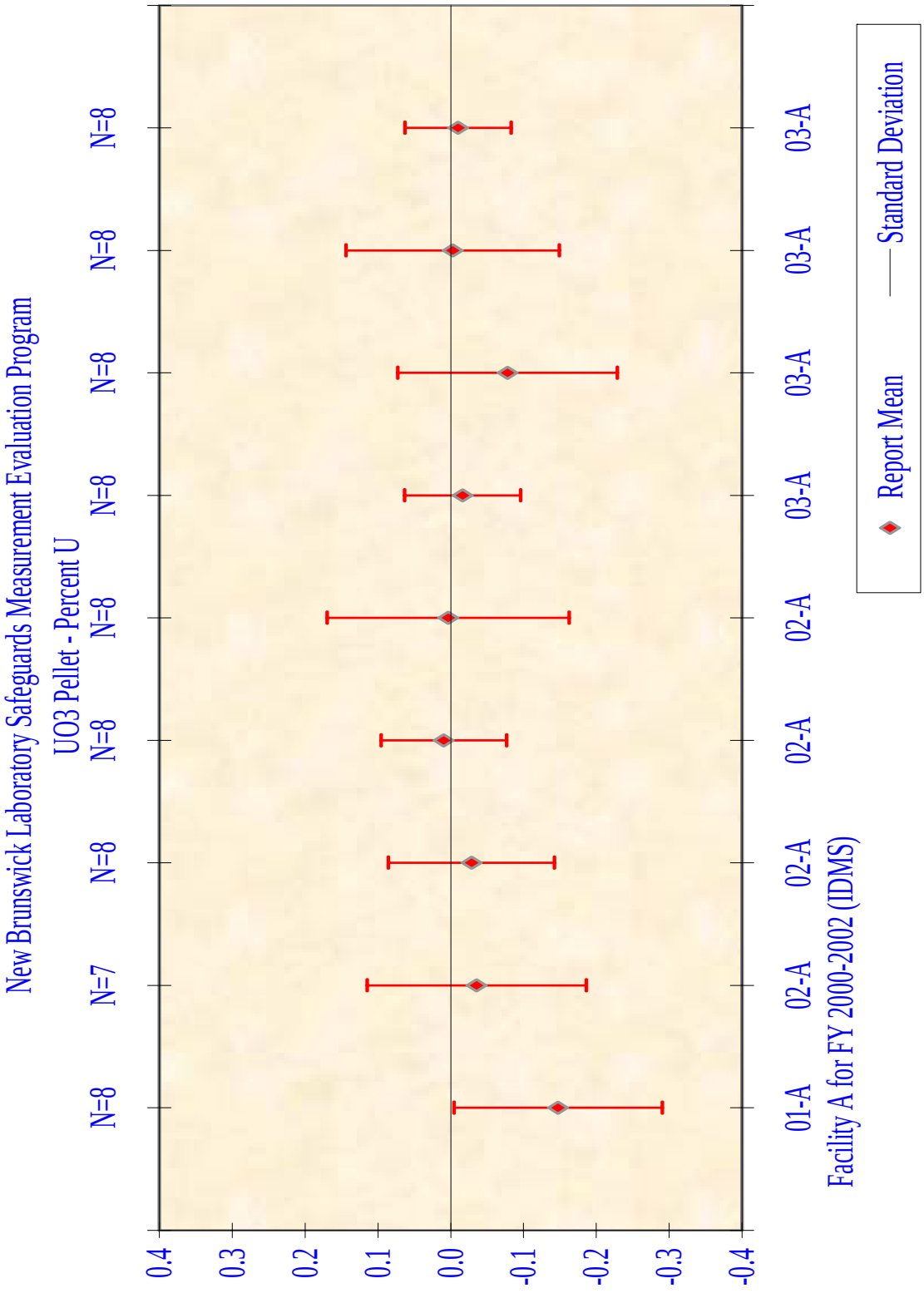

New Brunswick Laboratory Safeguards Measurement Evaluation Program
UO3 Pellet - Percent U
N=8
N=7
N=8
N=8
N=8
N=8
N=8
N=8
0.4
0.3
0.2
0.1
0.0
-0.1
-0.2
-0.3
-0.4
01-A
02-A
02-A
02-A
02-A
03-A
03-A
03-A
03-A
Facility A for FY 2000-2002 (IDMS)
Report Mean
Standard Deviation

Figure 38a*

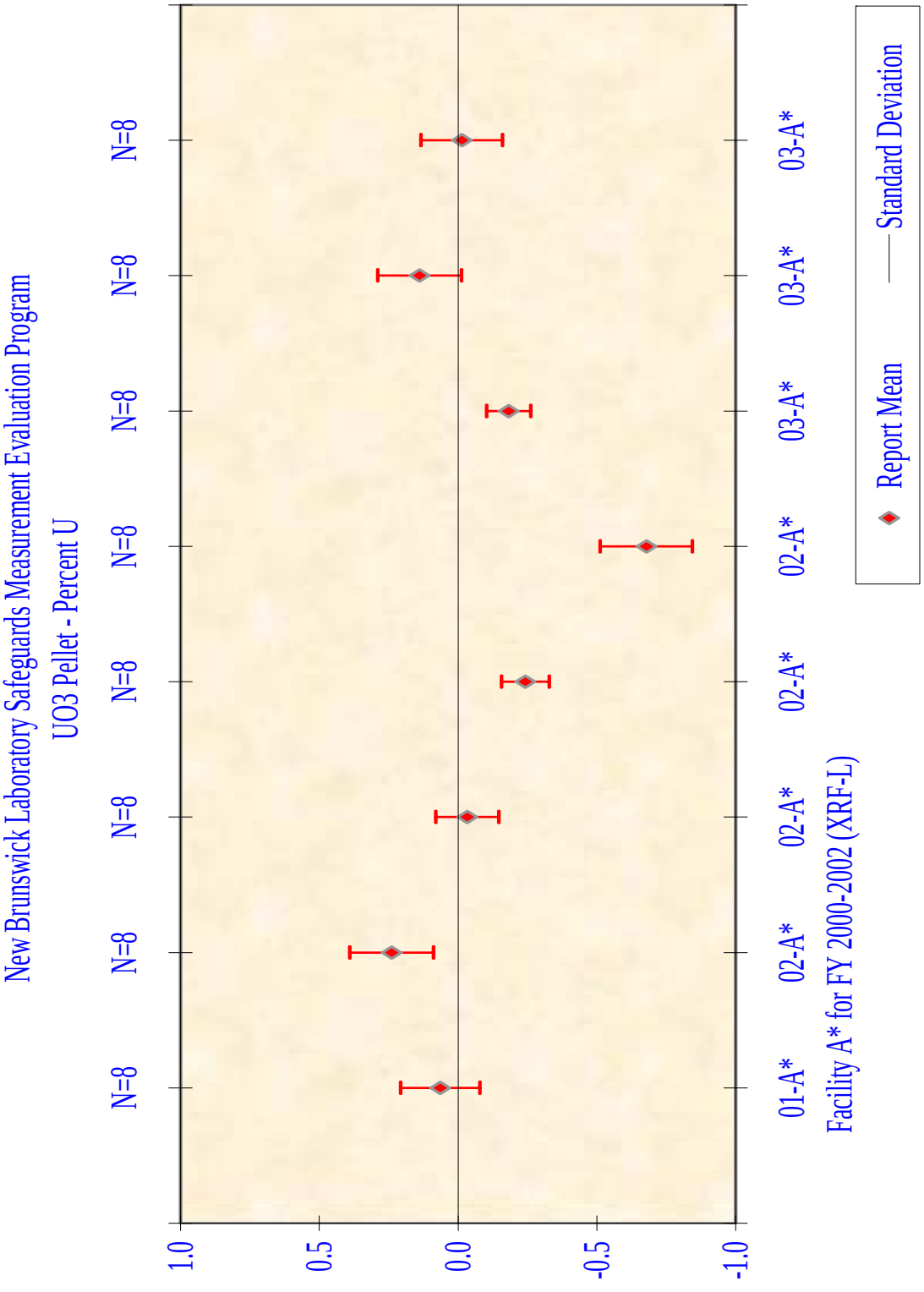

New Brunswick Laboratory Safeguards Measurement Evaluation Program
UO3 Pellet - Percent U
N=8
N=8
N=8
N=8
N=8
N=8
N=8
N=8
1.0
0.5
0.0
-0.5
-1.0
01-A*
02-A*
02-A*
02-A*
02-A*
03-A*
03-A*
03-A*
Facility A* for FY 2000-2002 (XRF-L)
Report Mean
Standard Deviation

Figure 38a**

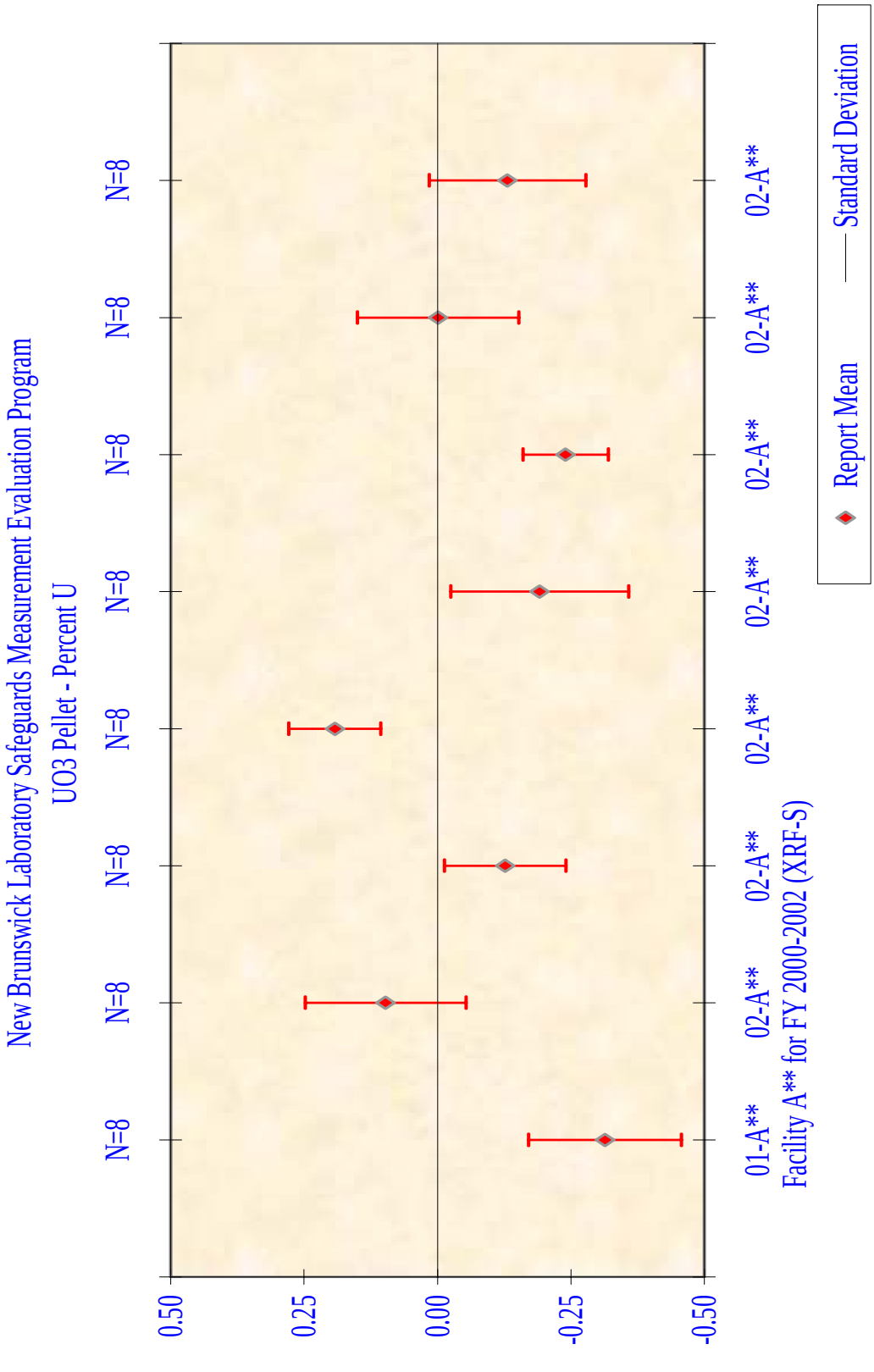

New Brunswick Laboratory Safeguards Measurement Evaluation Program
UO3 Pellet - Percent U
N=8
N=8
N=8
N=8
N=8
0.50
0.25
0.00
-0.25
-0.50
01-A**
02-A**
02-A**
02-A**
02-A**
02-A**
Facility A** for FY 2000-2002 (XRF-S)
Report Mean
Standard Deviation

Figure 39

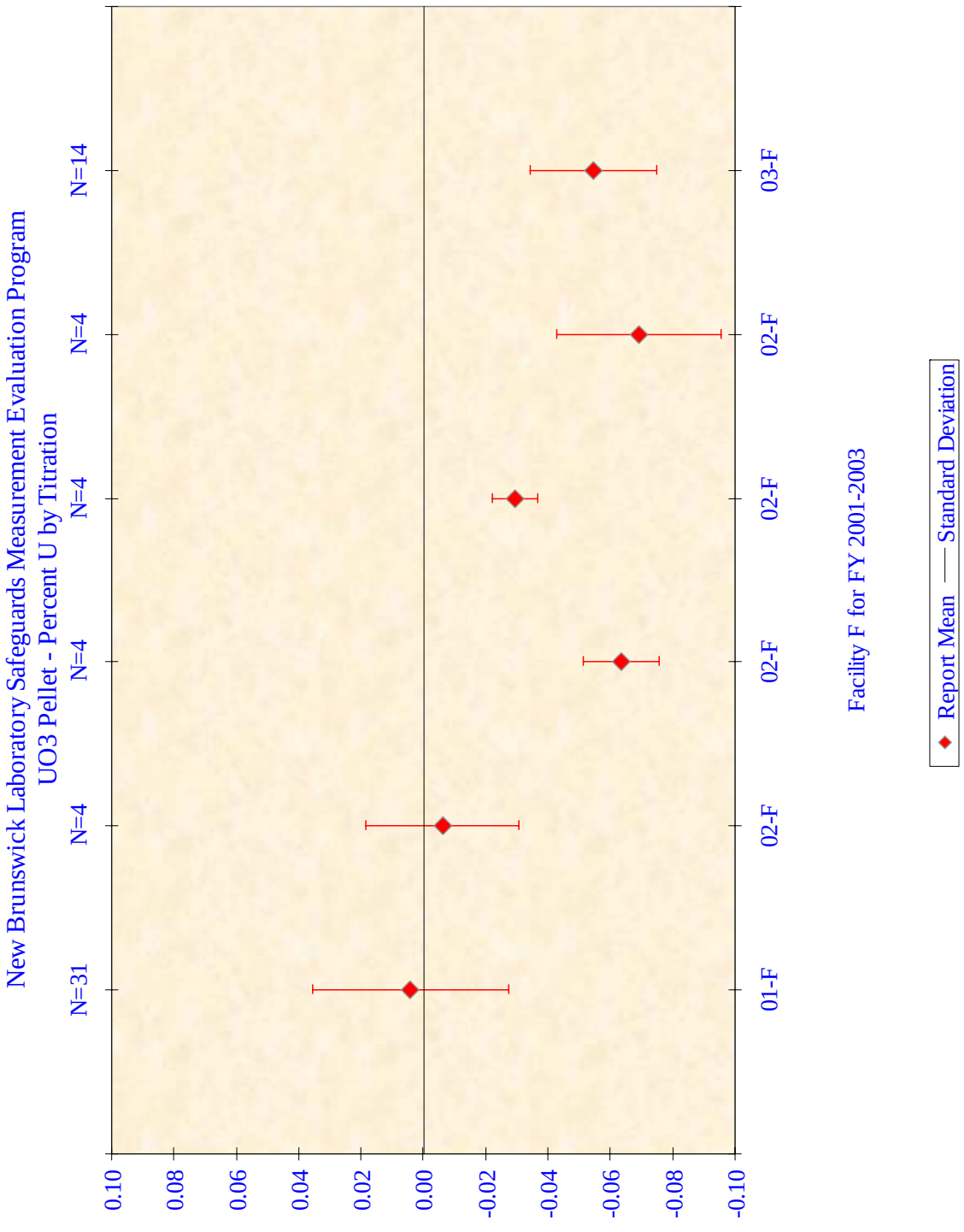

New Brunswick Laboratory Safeguards Measurement Evaluation Program
UO3 Pellet - Percent U by Titration
N=31
N=4
N=4
N=4
N=4
N=14
0.10
0.08
0.06
0.04
0.02
0.00
-0.02
-0.04
-0.06
-0.08
-0.10
01-F
02-F
02-F
02-F
02-F
03-F
Facility F for FY 2001-2003
Report Mean
Standard Deviation

Figure 40

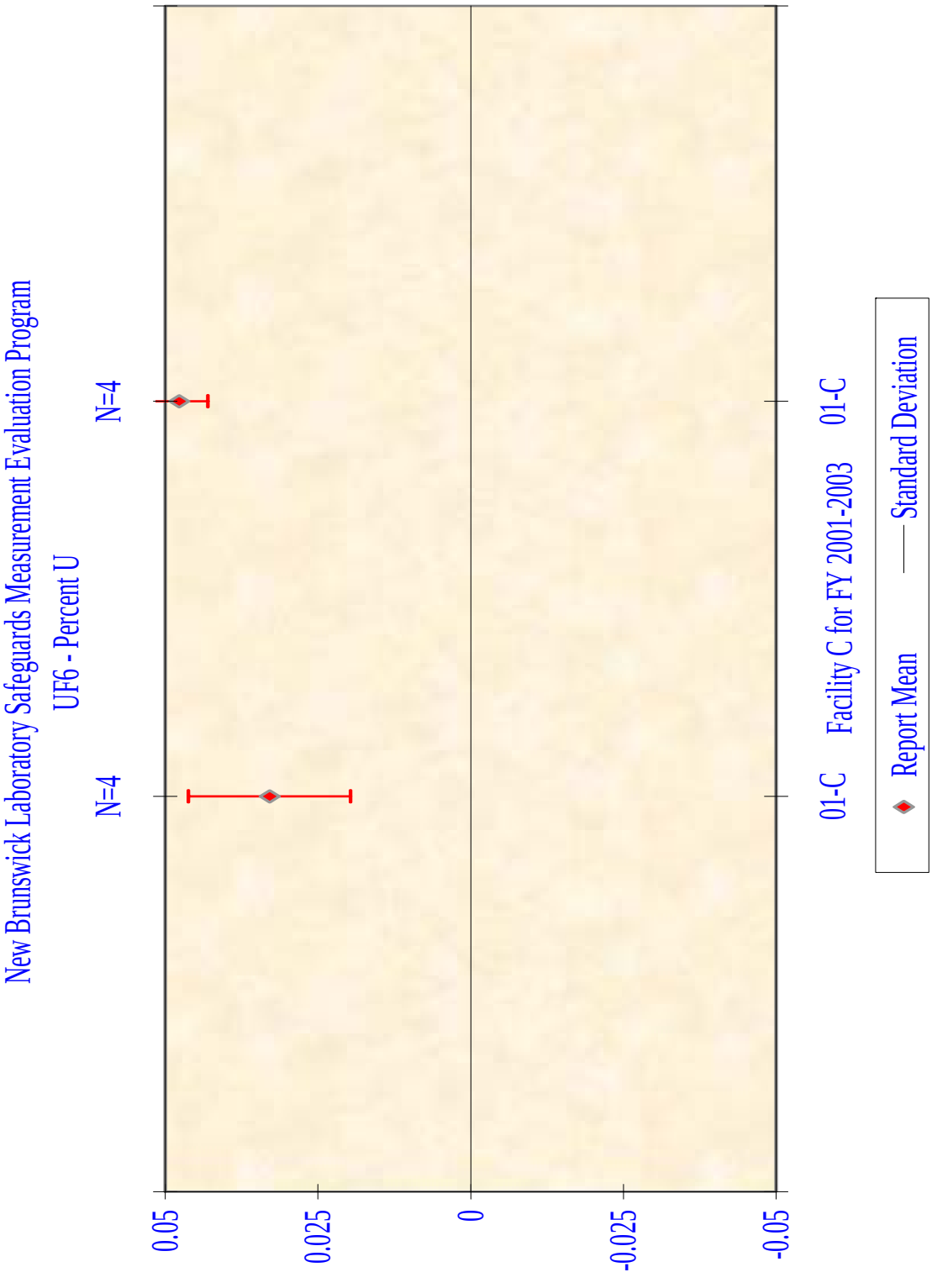

New Brunswick Laboratory Safeguards Measurement Evaluation Program
UF6 - Percent U
N=4
N=4
0.05
0.025
0
-0.025
-0.05
01-C
Facility C for FY 2001-2003
01-C
Report Mean
Standard Deviation

Figure 41

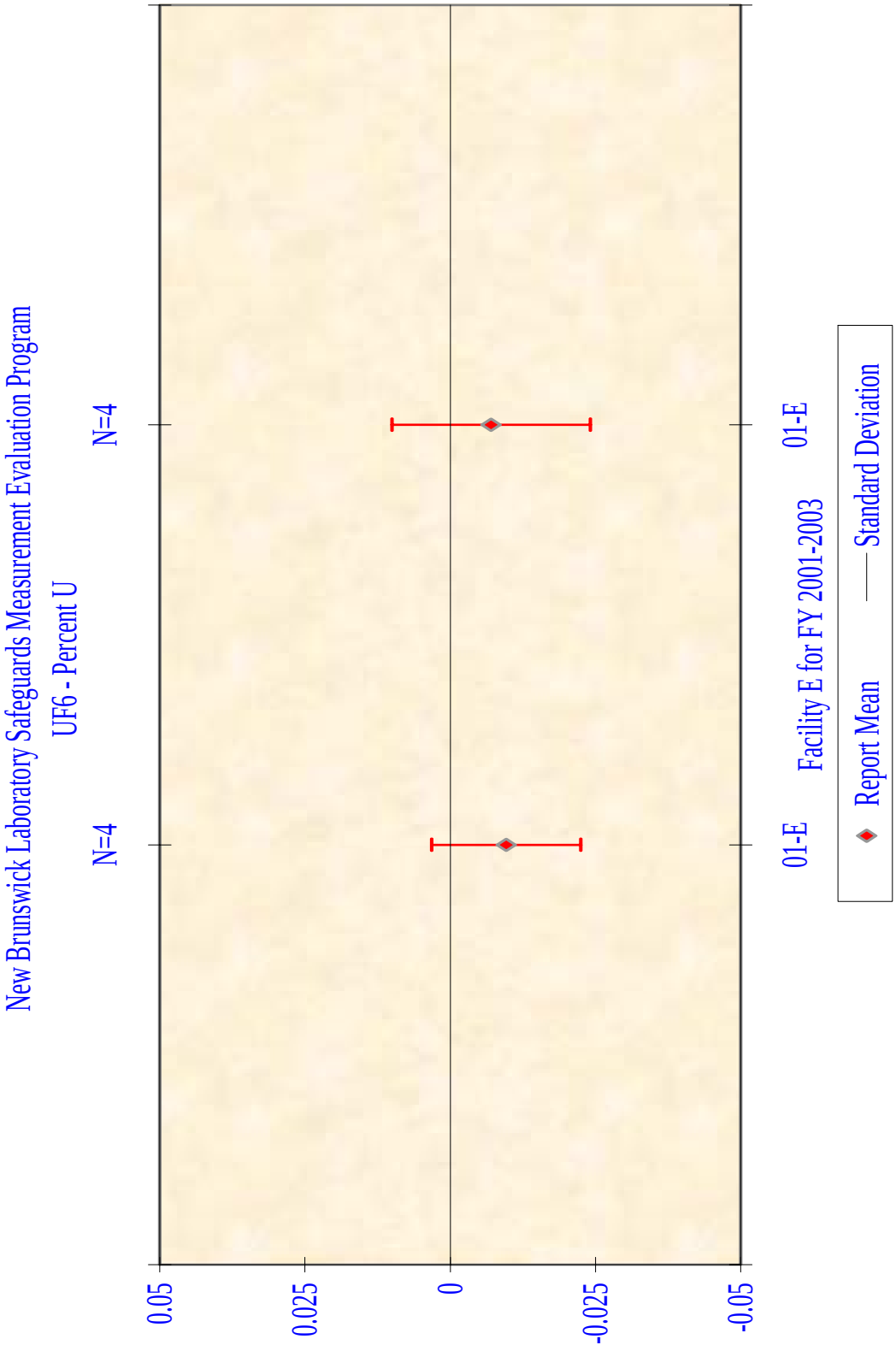

New Brunswick Laboratory Safeguards Measurement Evaluation Program
UF6 - Percent U
N=4
N=4
01-E
01-E
Facility E for FY 2001-2003
0.05
0.025
0
-0.025
-0.05
Report Mean
Standard Deviation

Figure 42

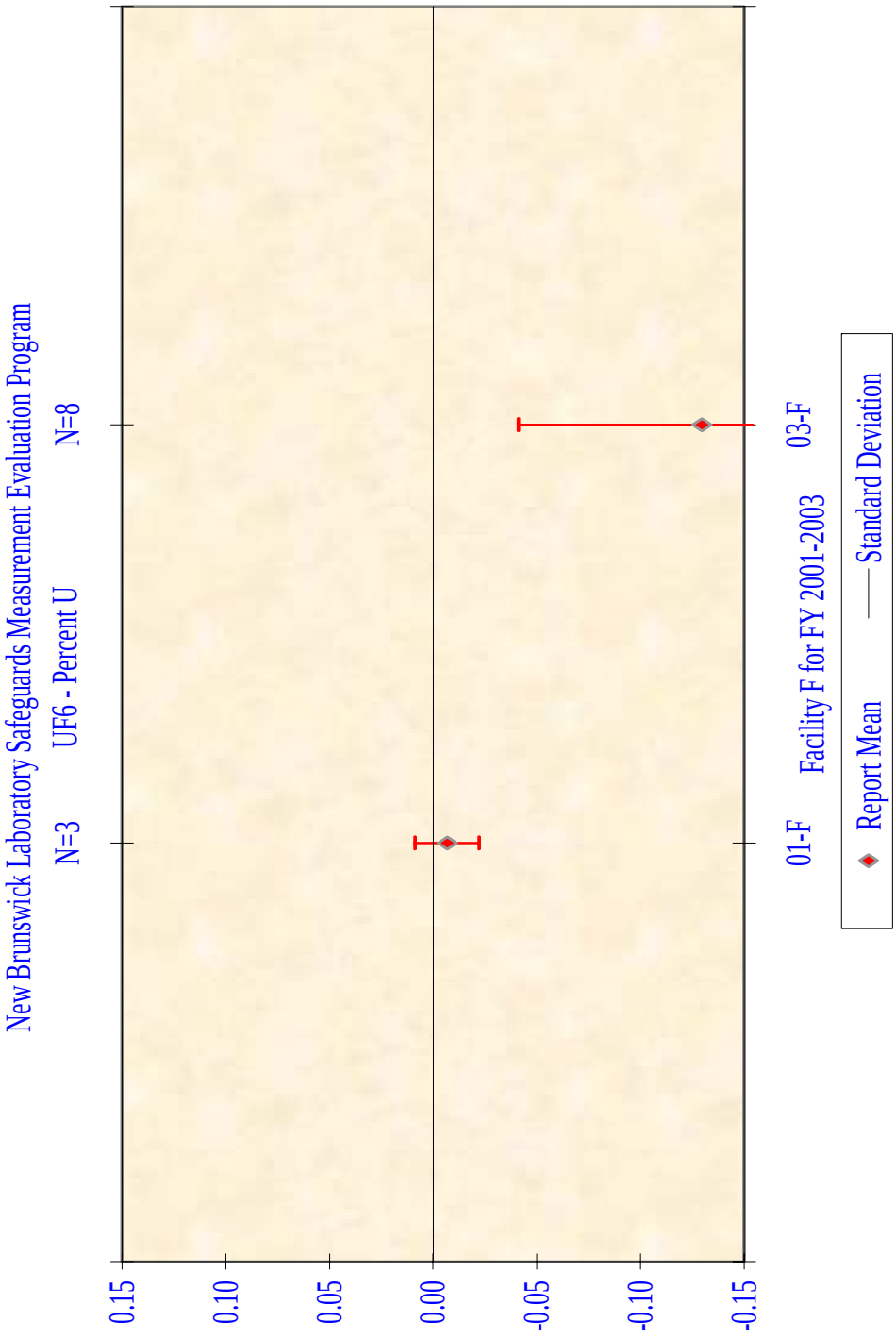

New Brunswick Laboratory Safeguards Measurement Evaluation Program
UF6 - Percent U
N=3
N=8
01-F
Facility F for FY 2001-2003
03-F
Report Mean
Standard Deviation
0.15
0.10
0.05
0.00
-0.05
-0.10
-0.15

Figure 43

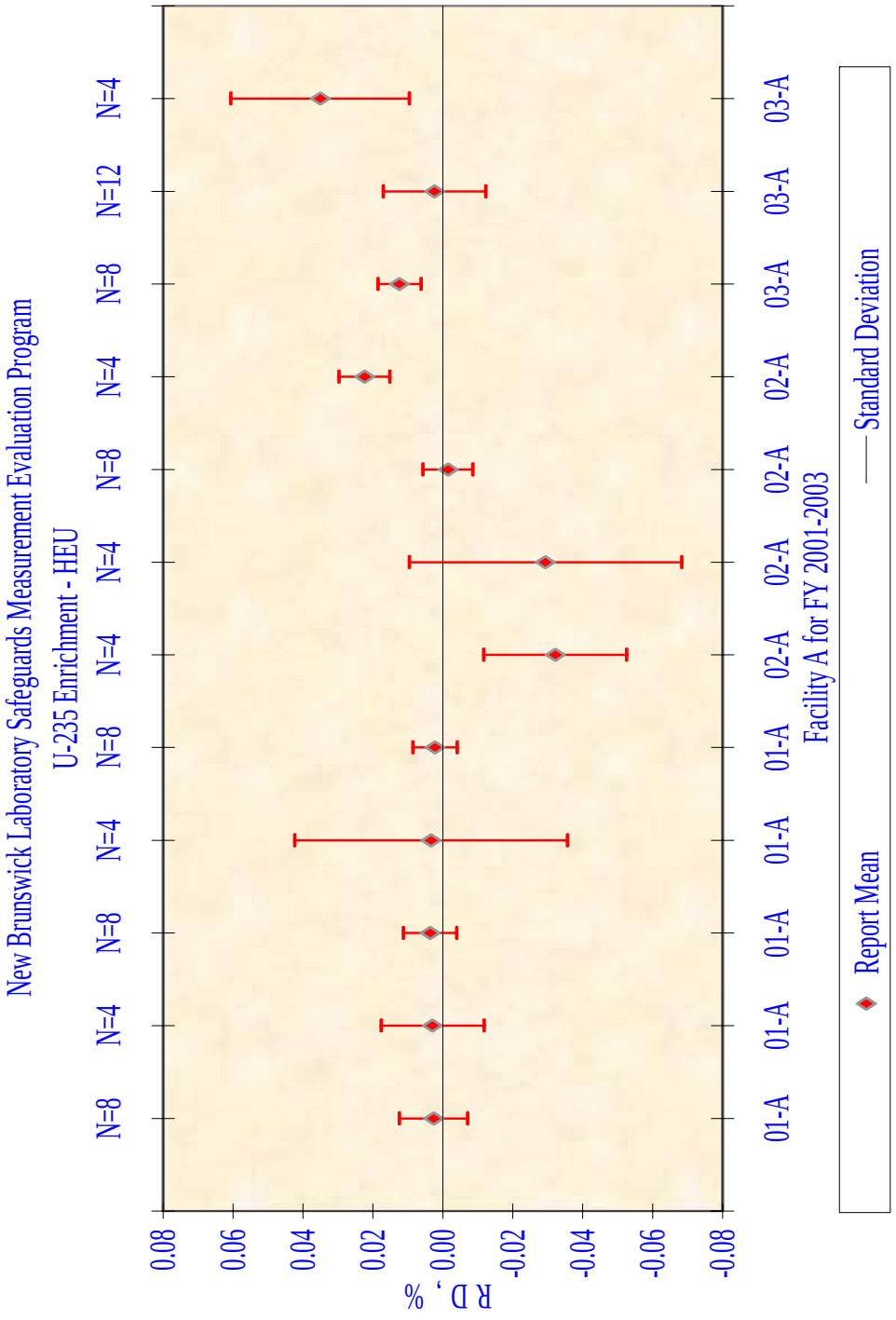

New Brunswick Laboratory Safeguards Measurement Evaluation Program
U-235 Enrichment - HEU
Facility A for FY 2001-2003
R D , %
0.08
0.06
0.04
0.02
0.00
-0.02
-0.04
-0.06
-0.08
N=8 N=4 N=8 N=4 N=8 N=4 N=4 N=8 N=4 N=8 N=12 N=4
01-A 01-A 01-A 01-A 01-A 02-A 02-A 02-A 02-A 03-A 03-A 03-A
Report Mean
Standard Deviation

Figure 44

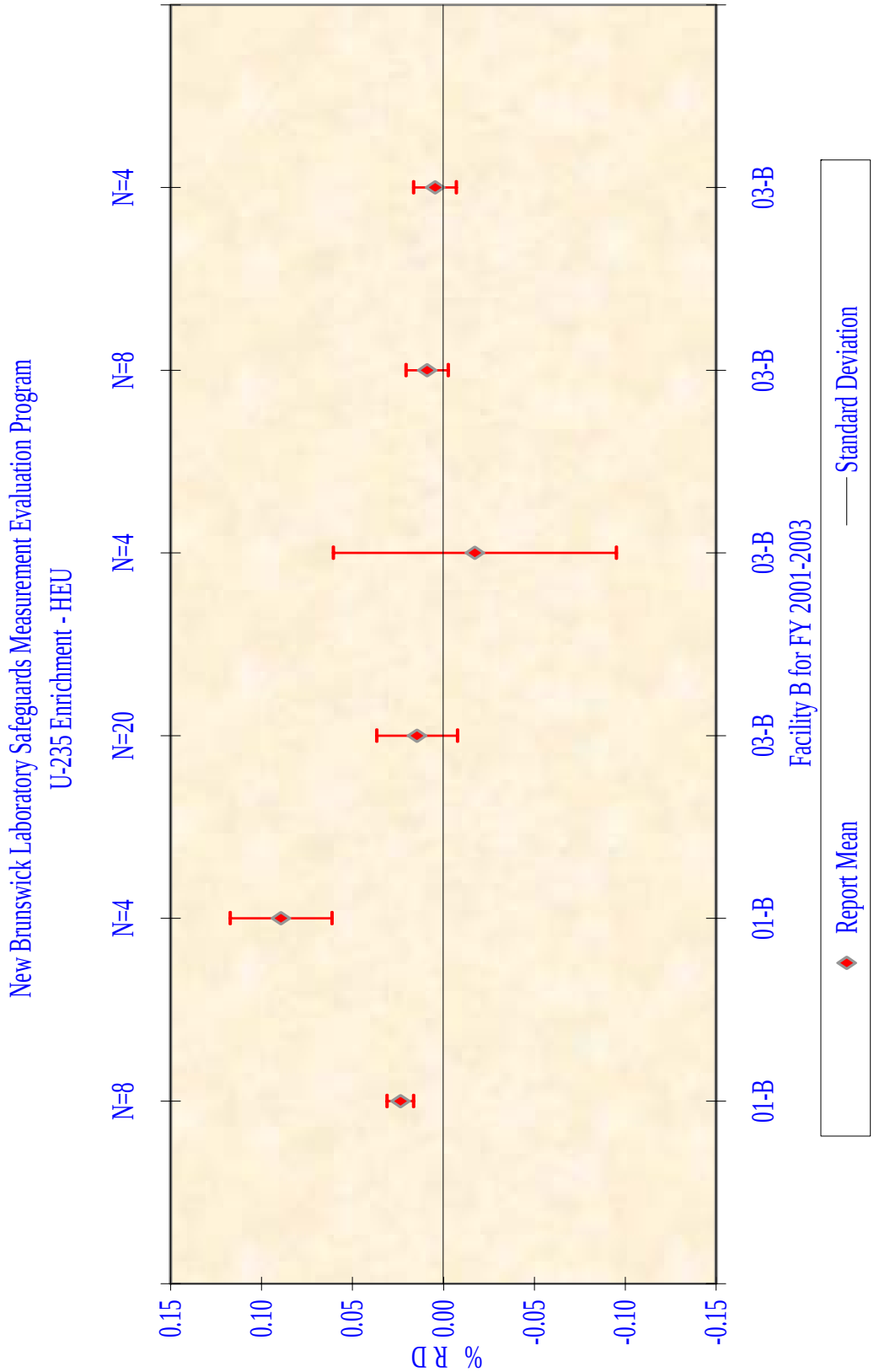

New Brunswick Laboratory Safeguards Measurement Evaluation Program
U-235 Enrichment - HEU
Facility B for FY 2001-2003
% RD
0.15
0.10
0.05
0.00
-0.05
-0.10
-0.15
N=8
N=4
N=20
N=4
N=8
N=4
01-B
01-B
03-B
03-B
03-B
03-B
Report Mean
Standard Deviation

Figure 45

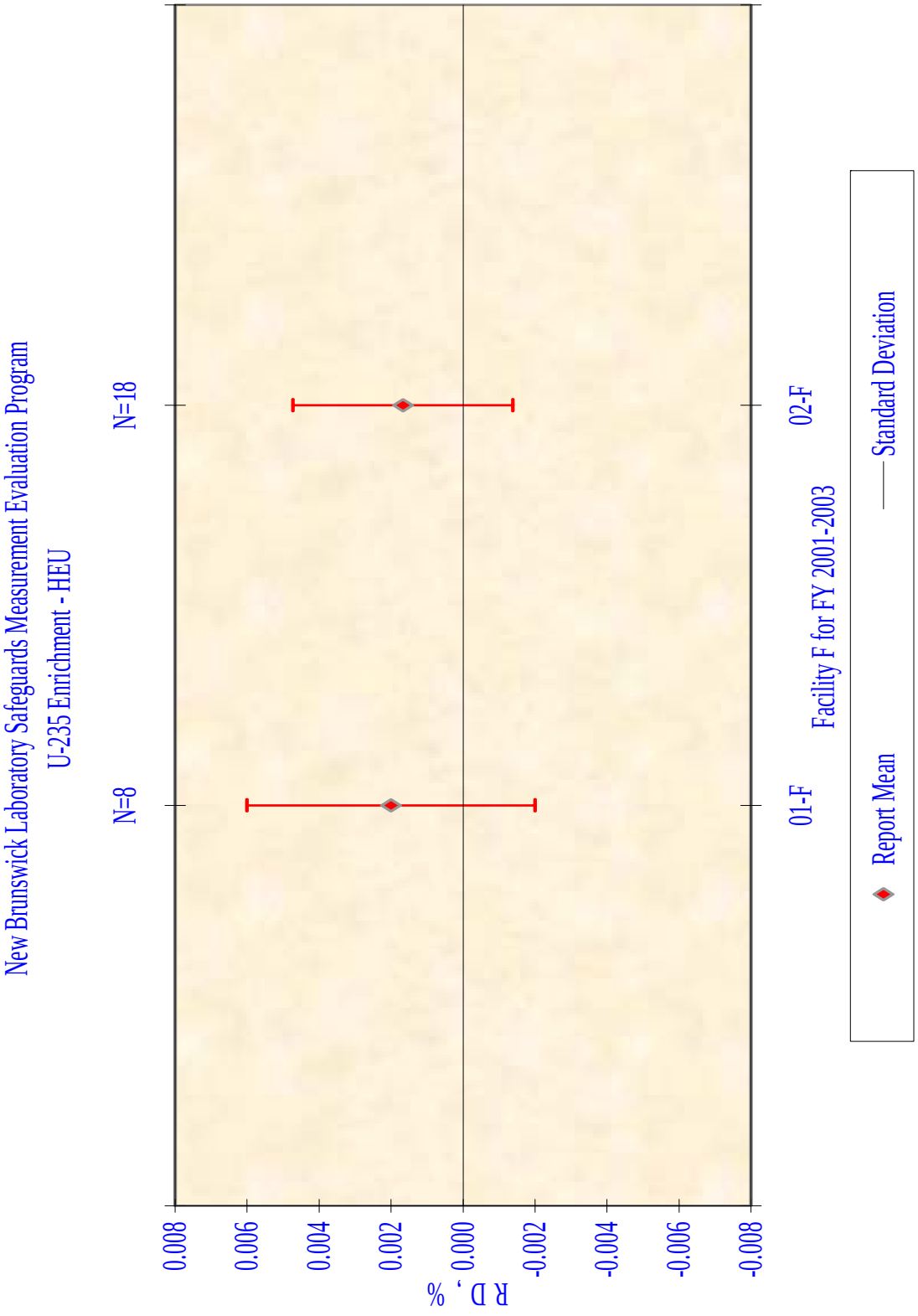

New Brunswick Laboratory Safeguards Measurement Evaluation Program
U-235 Enrichment - HEU
Facility F for FY 2001-2003
N=8
N=18
01-F
02-F
RD, %
0.008
0.006
0.004
0.002
0.000
-0.002
-0.004
-0.006
-0.008
Report Mean
Standard Deviation

Figure 46

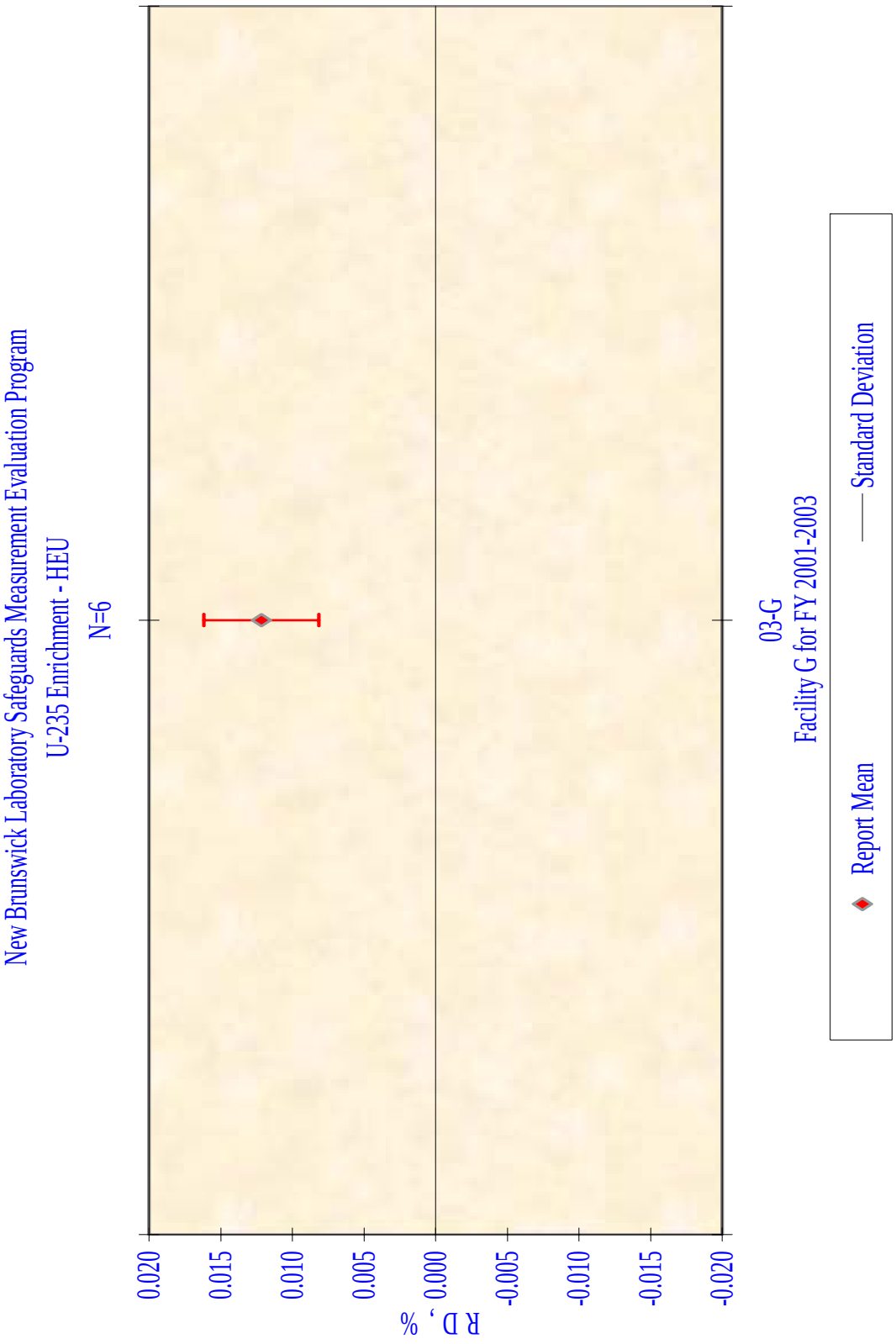

New Brunswick Laboratory Safeguards Measurement Evaluation Program
U-235 Enrichment - HEU
N=6
03-G
Facility G for FY 2001-2003
Report Mean
Standard Deviation
R D , %
0.020
0.015
0.010
0.005
0.000
-0.005
-0.010
-0.015
-0.020

Figure 47

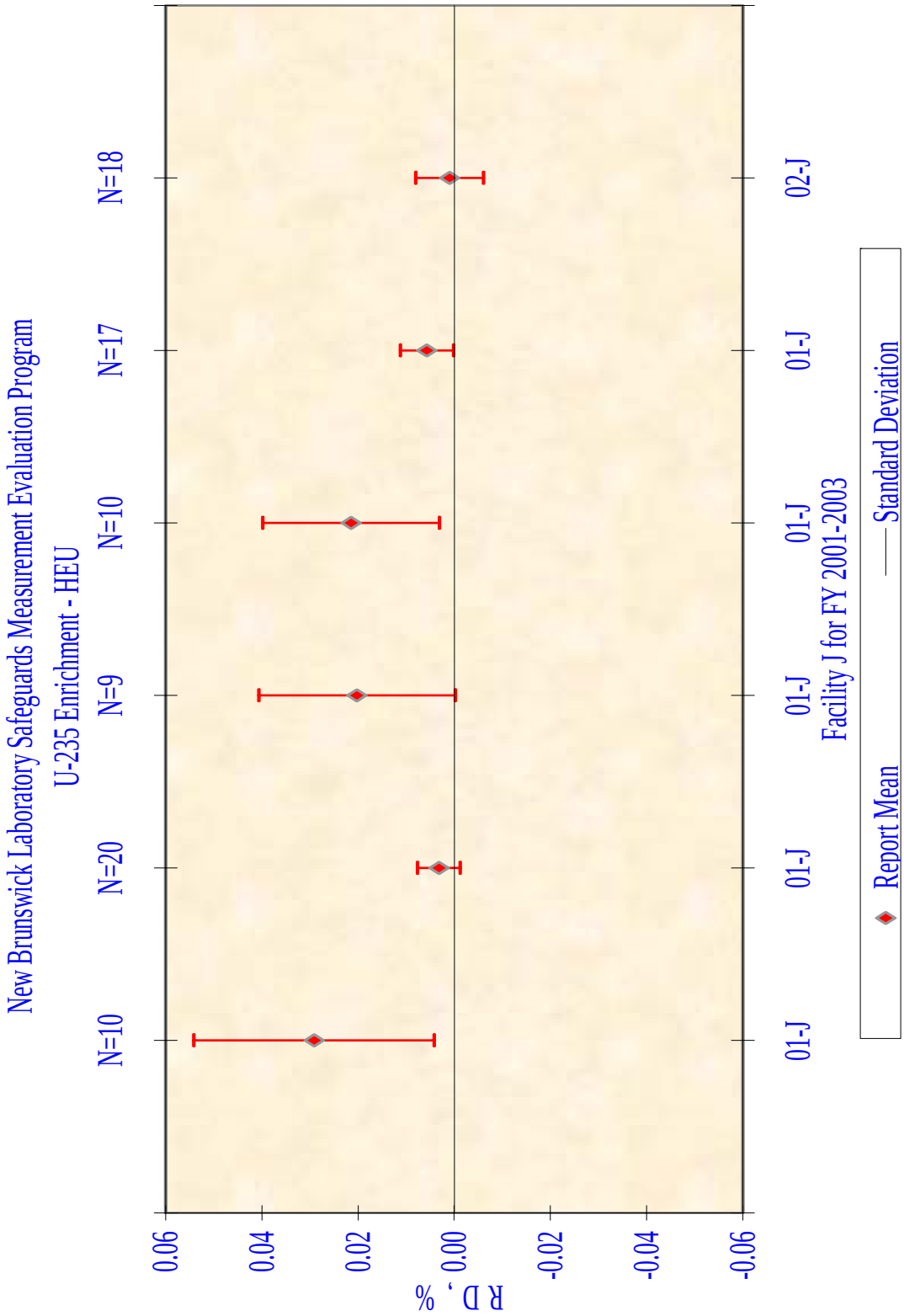

New Brunswick Laboratory Safeguards Measurement Evaluation Program
U-235 Enrichment - HEU
Facility J for FY 2001-2003
R D , %
0.06
0.04
0.02
0.00
-0.02
-0.04
-0.06
N=10
N=20
N=9
N=10
N=17
N=18
01-J
01-J
01-J
01-J
01-J
02-J
Report Mean
Standard Deviation

Figure 48

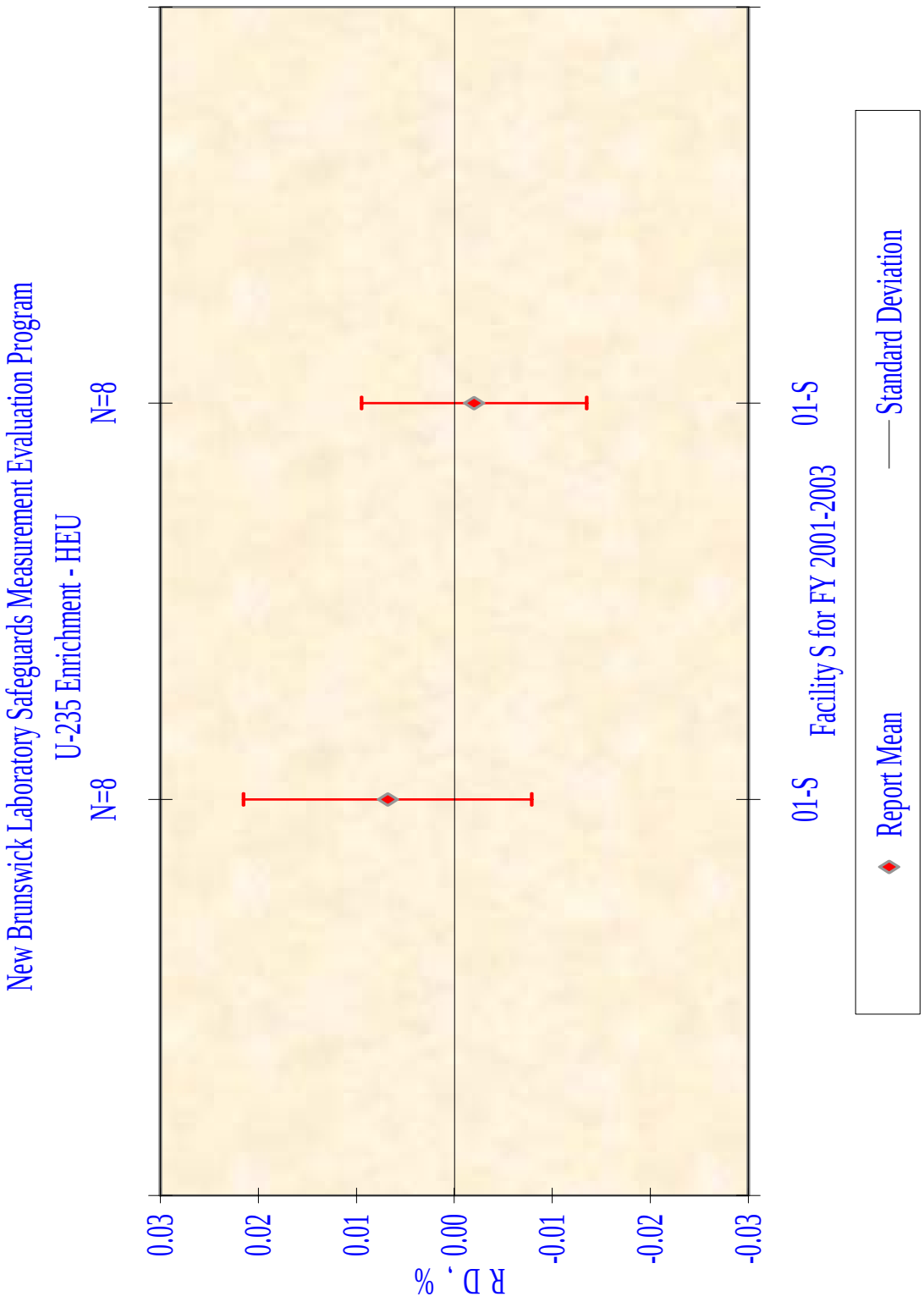

New Brunswick Laboratory Safeguards Measurement Evaluation Program
U-235 Enrichment - HEU
N=8
N=8
01-S
Facility S for FY 2001-2003
01-S
R D , %
0.03
0.02
0.01
0.00
-0.01
-0.02
-0.03
Report Mean
Standard Deviation

Figure 49

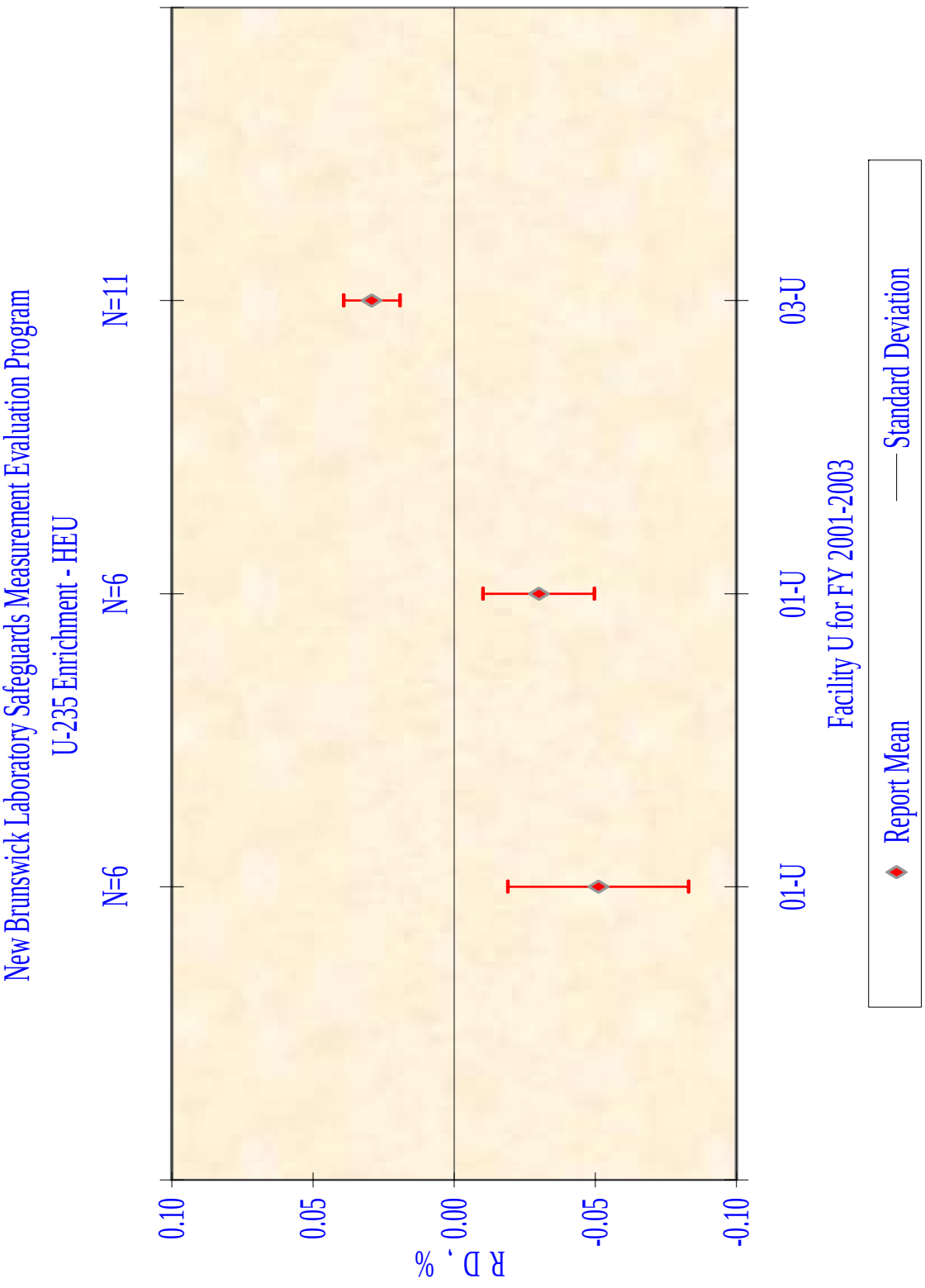

New Brunswick Laboratory Safeguards Measurement Evaluation Program
U-235 Enrichment - HEU
N=6
N=6
N=11
01-U
01-U
03-U
Facility U for FY 2001-2003
0.10
0.05
0.00
-0.05
-0.10
R D , %
Report Mean
Standard Deviation

Figure 50

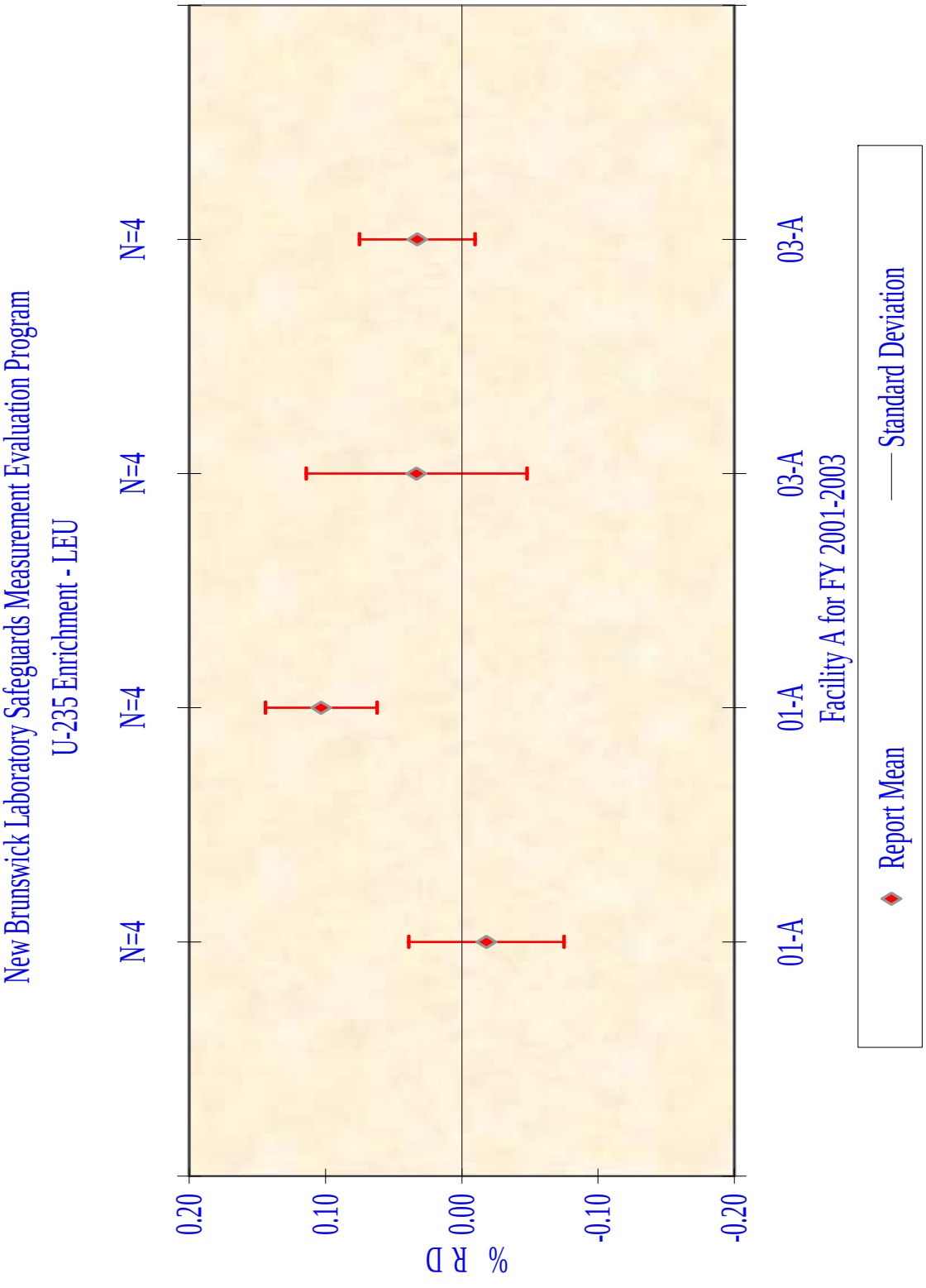

New Brunswick Laboratory Safeguards Measurement Evaluation Program
U-235 Enrichment - LEU
Facility A for FY 2001-2003
% R D
0.20
0.10
0.00
-0.10
-0.20
N=4
N=4
N=4
N=4
01-A
01-A
03-A
03-A
Report Mean
Standard Deviation

Figure 51

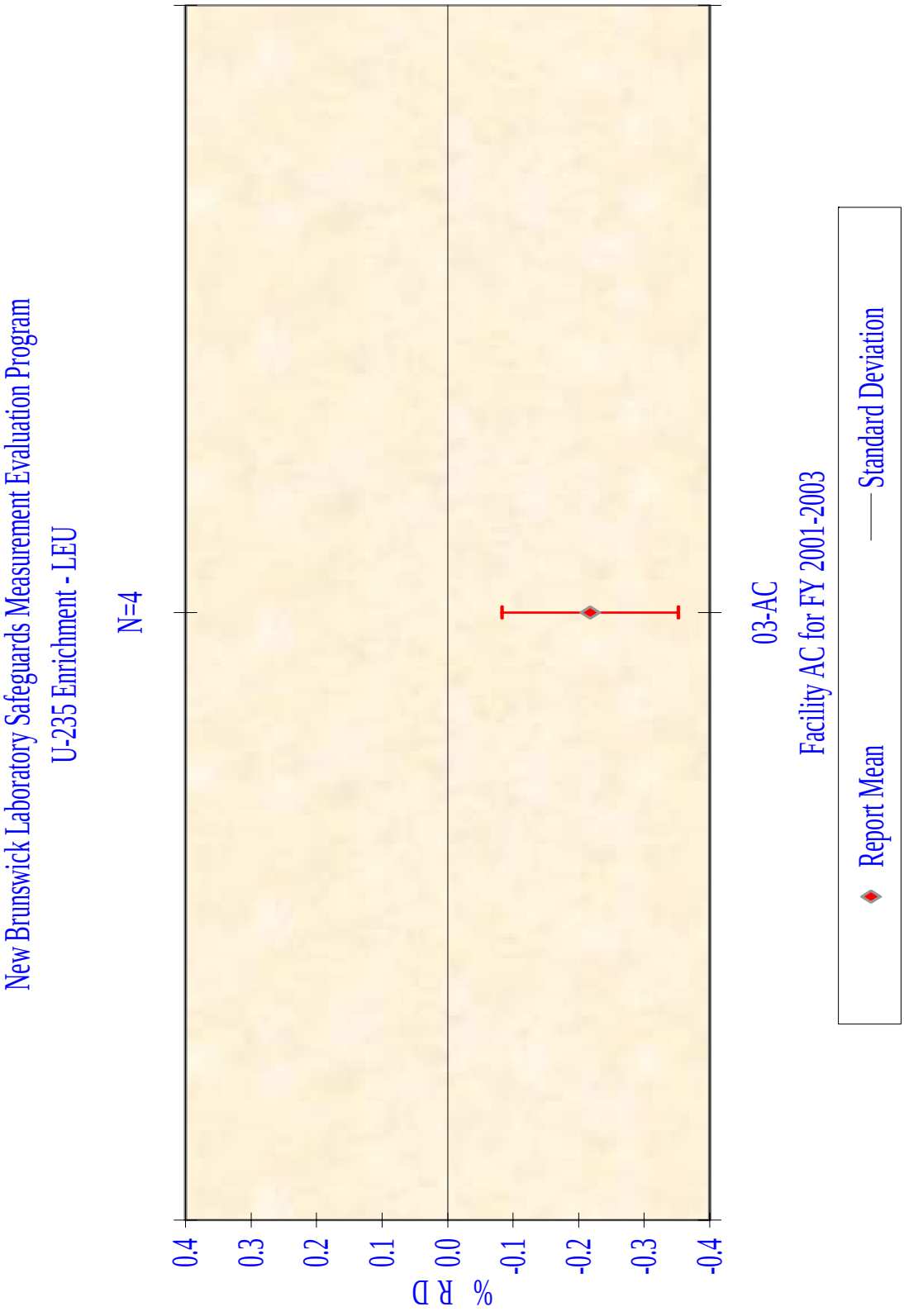

New Brunswick Laboratory Safeguards Measurement Evaluation Program
U-235 Enrichment - LEU
N=4
03-AC
Facility AC for FY 2001-2003
Report Mean
Standard Deviation
% R D
0.4
0.3
0.2
0.1
0.0
-0.1
-0.2
-0.3
-0.4

Figure 52

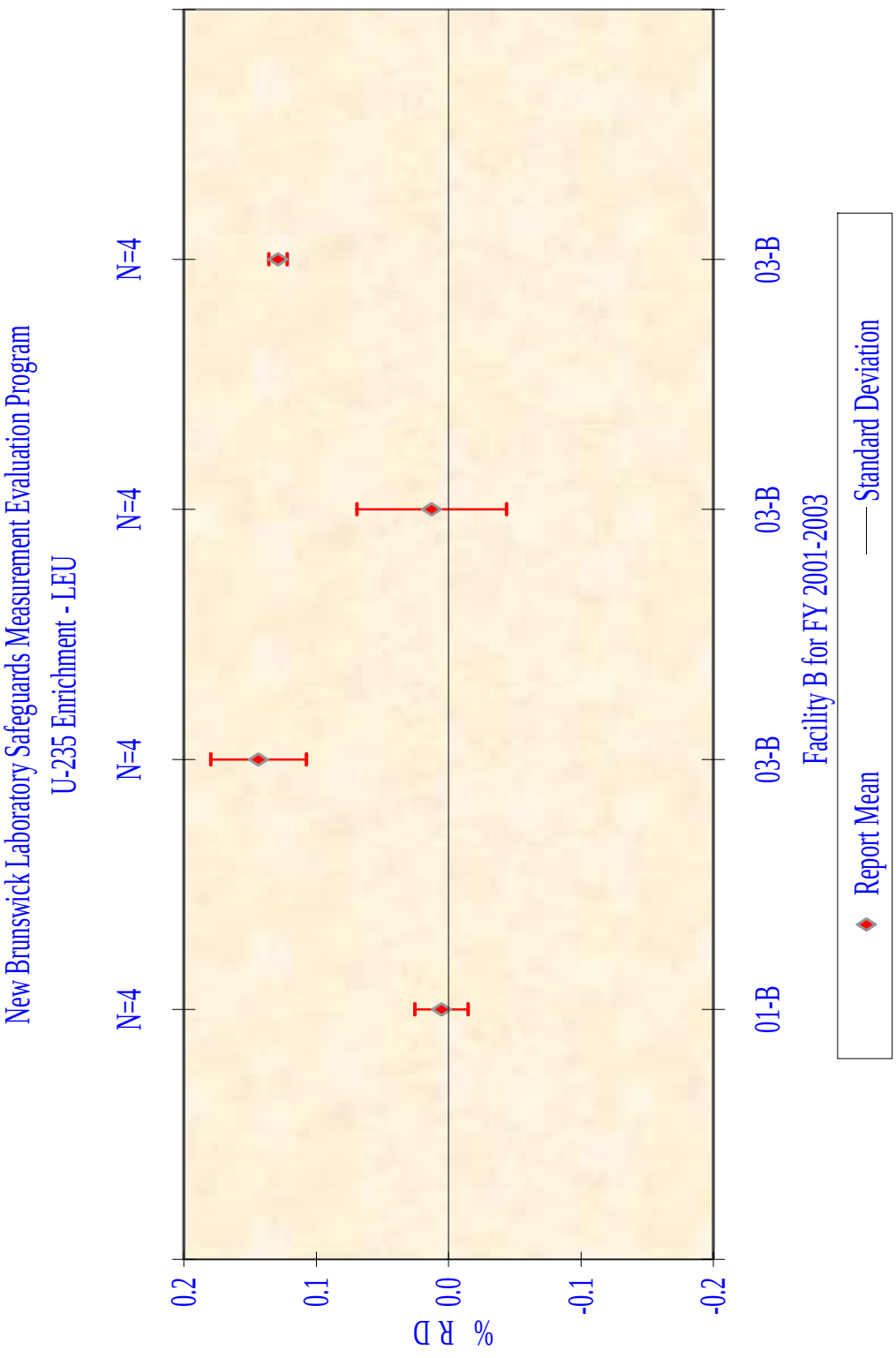

New Brunswick Laboratory Safeguards Measurement Evaluation Program
U-235 Enrichment - LEU
Facility B for FY 2001-2003
% R D
0.2
0.1
0.0
-0.1
-0.2
N=4
N=4
N=4
01-B
03-B
03-B
03-B
Report Mean
Standard Deviation

Figure 53

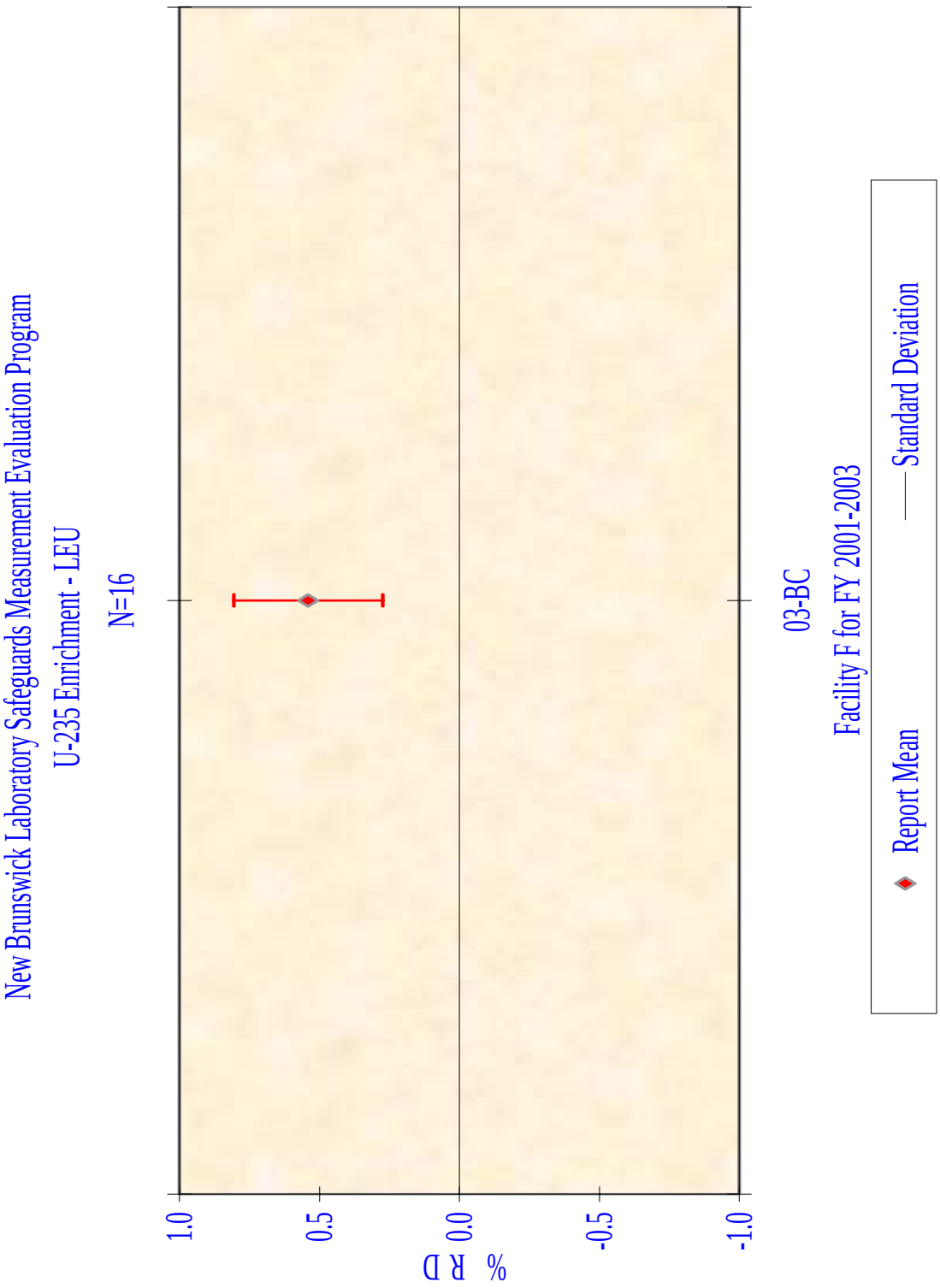

New Brunswick Laboratory Safeguards Measurement Evaluation Program
U-235 Enrichment - LEU
N=16
03-BC
Facility F for FY 2001-2003
Report Mean
Standard Deviation
% RD
1.0
0.5
0.0
-0.5
-1.0

Figure 54

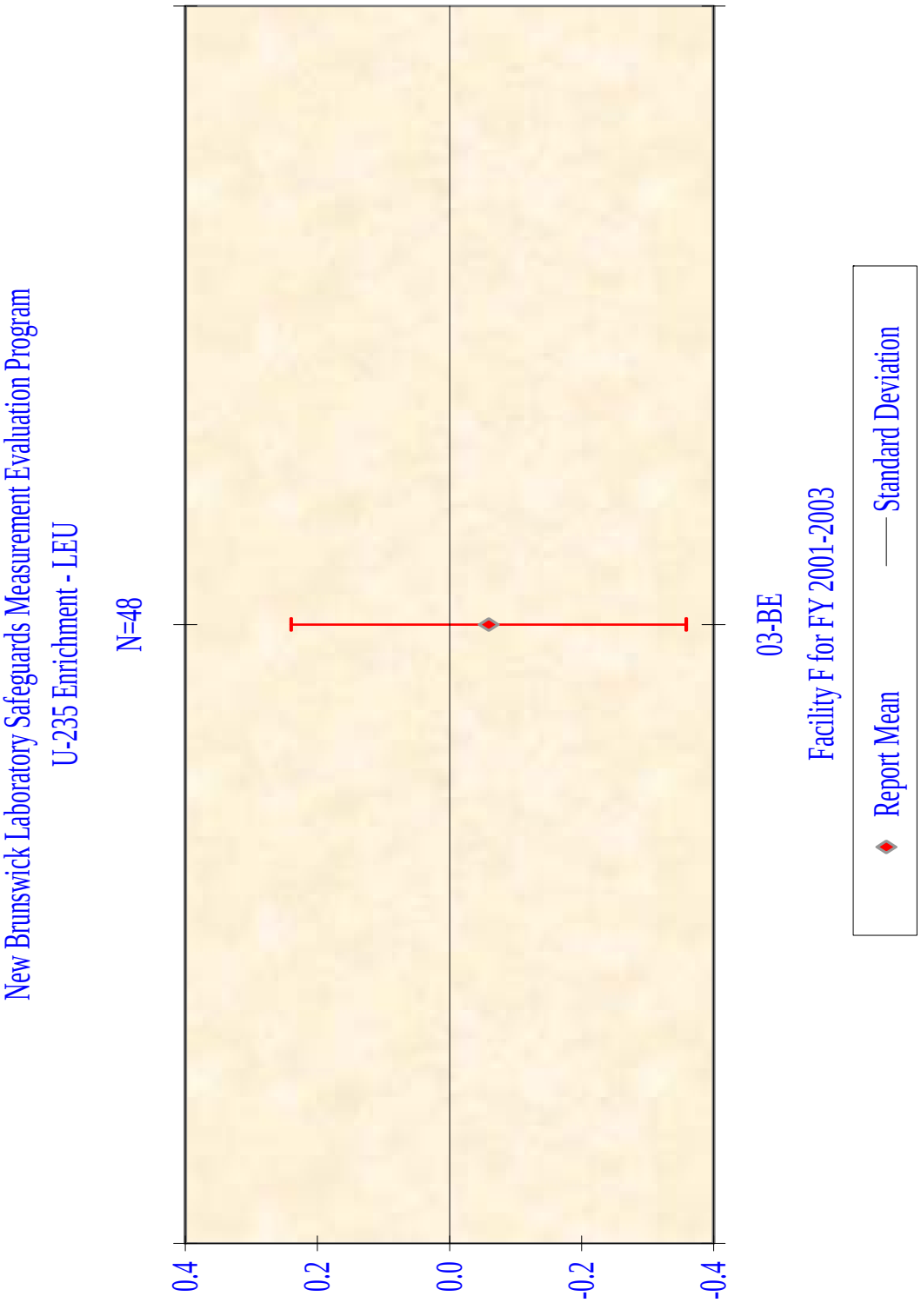

New Brunswick Laboratory Safeguards Measurement Evaluation Program
U-235 Enrichment - LEU
N=48
03-BE
Facility F for FY 2001-2003
Report Mean
Standard Deviation
0.4
0.2
0.0
-0.2
-0.4

Figure 55

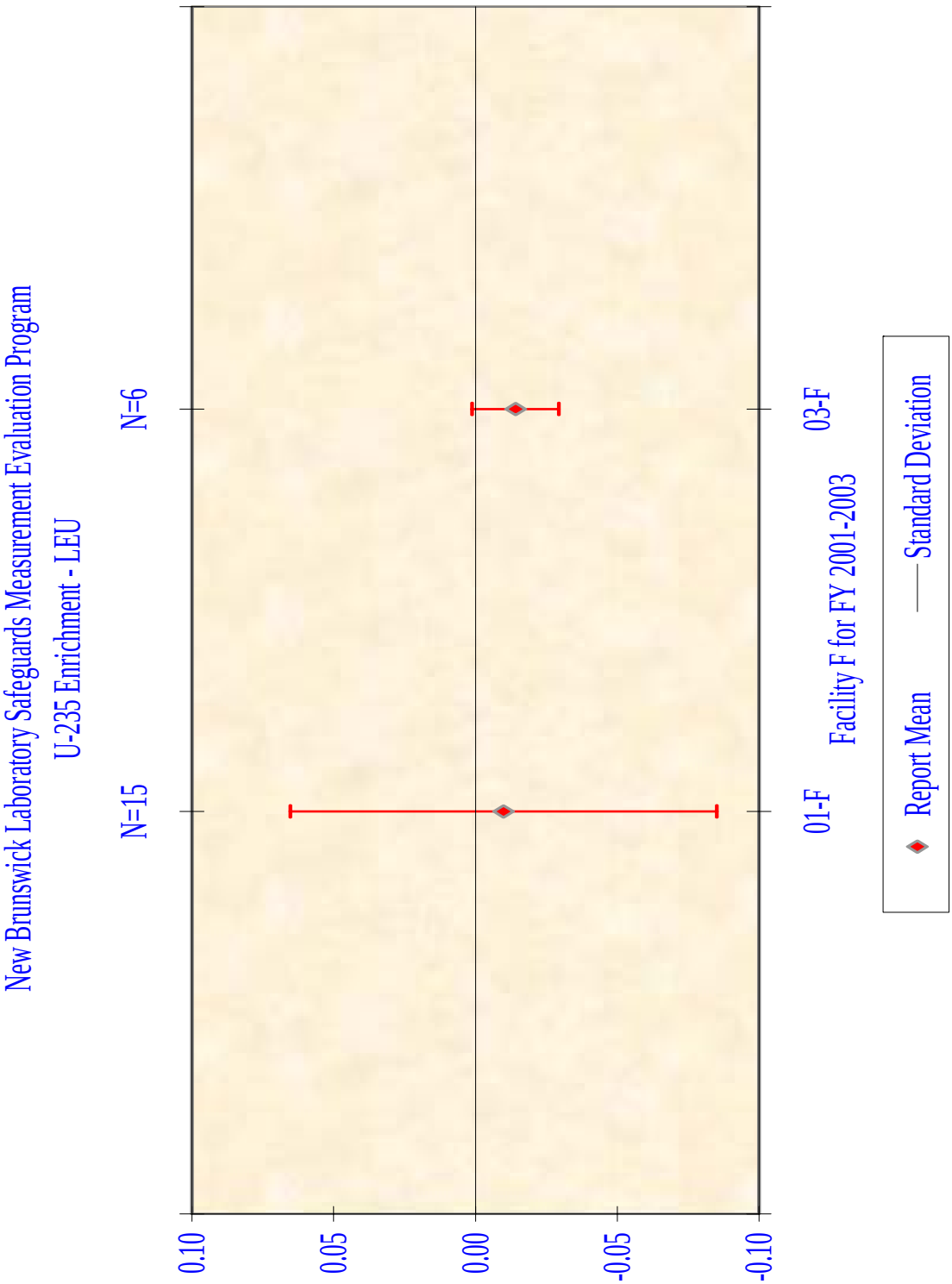

New Brunswick Laboratory Safeguards Measurement Evaluation Program
U-235 Enrichment - LEU
N=15
N=6
0.10
0.05
0.00
-0.05
-0.10
01-F
03-F
Facility F for FY 2001-2003
Report Mean
Standard Deviation

Figure 56

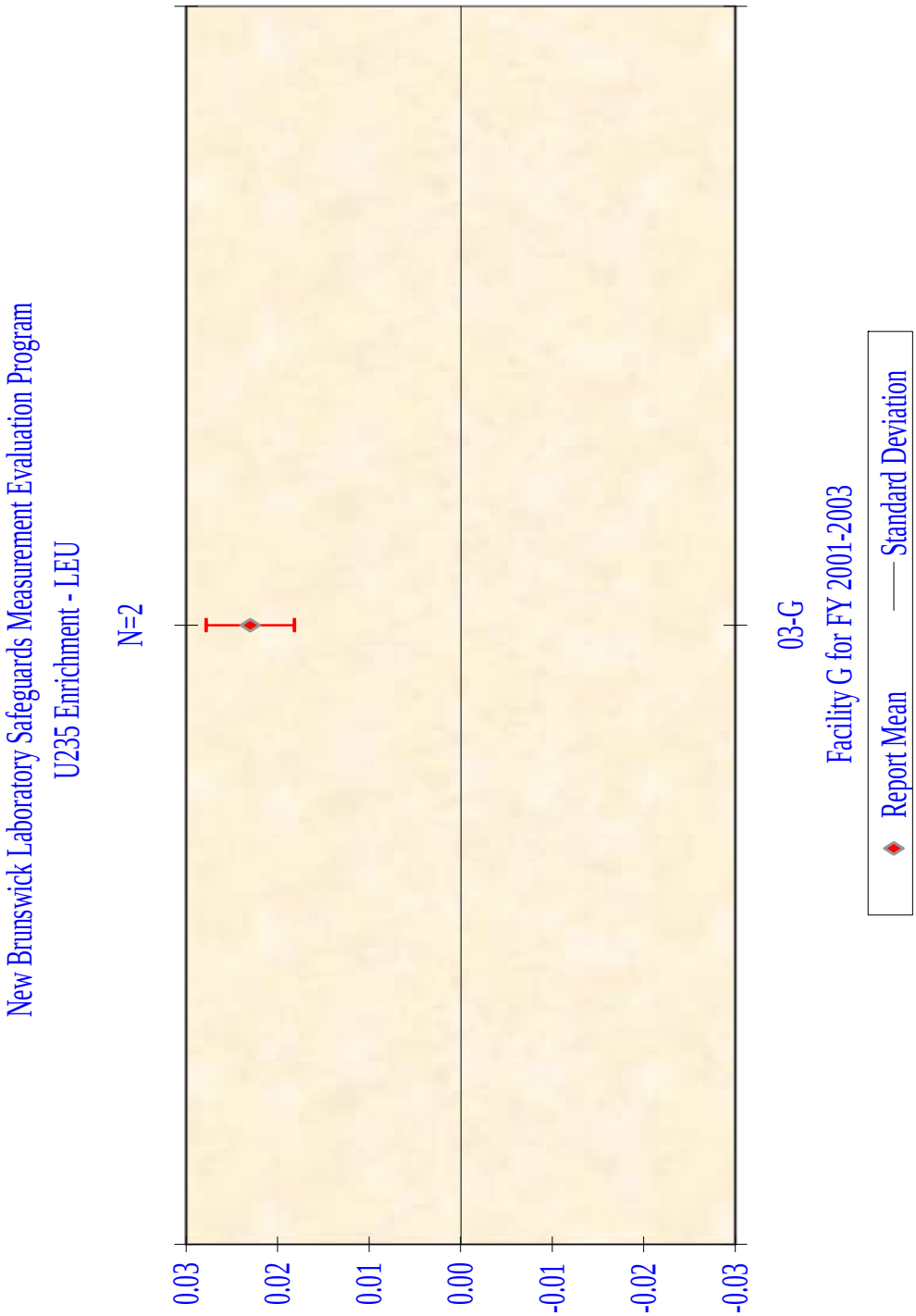

New Brunswick Laboratory Safeguards Measurement Evaluation Program
U235 Enrichment - LEU
N=2
03-G
Facility G for FY 2001-2003
Report Mean
Standard Deviation
0.03
0.02
0.01
0.00
-0.01
-0.02
-0.03

Figure 57

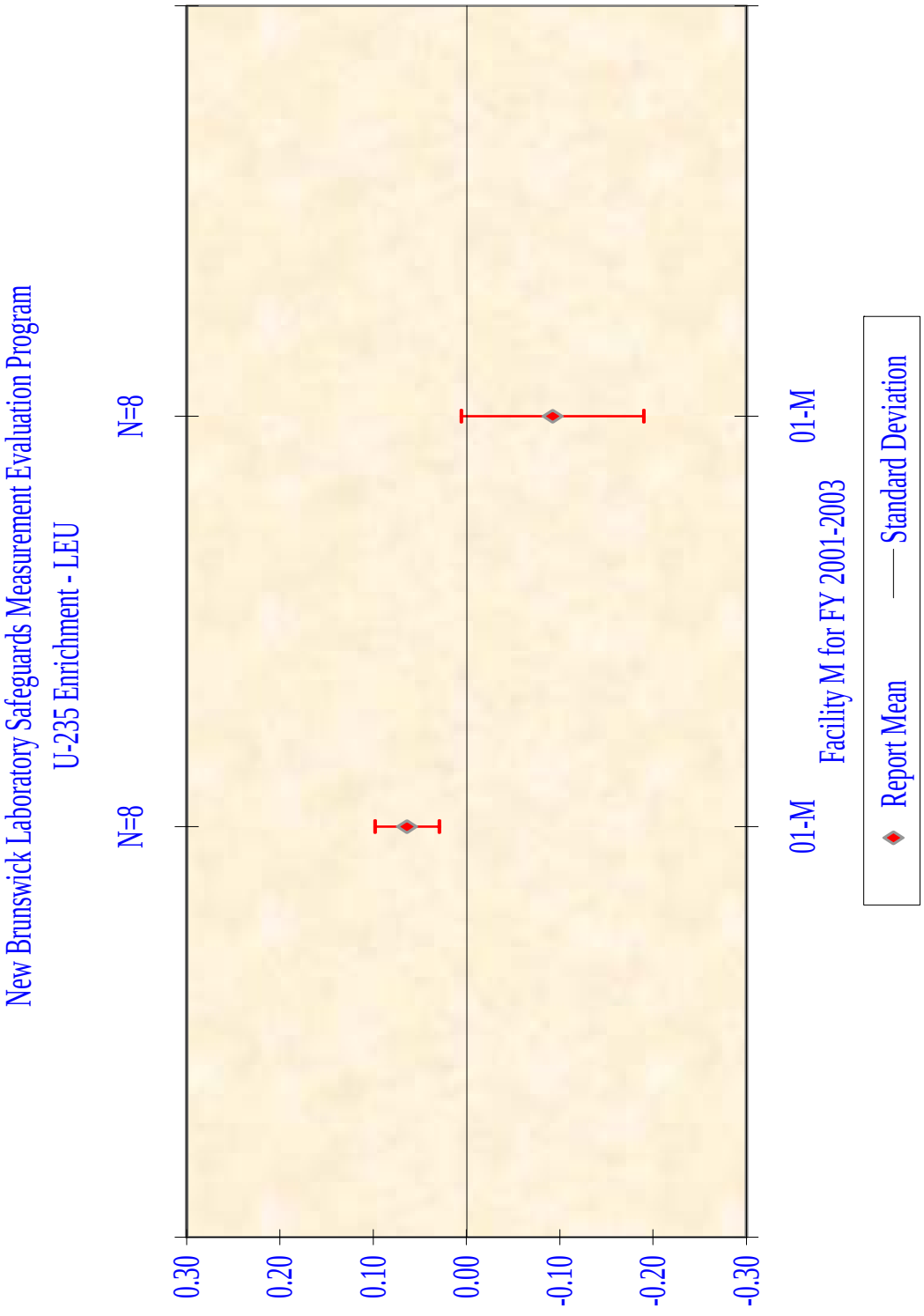

New Brunswick Laboratory Safeguards Measurement Evaluation Program
U-235 Enrichment - LEU
N=8
N=8
01-M
01-M
Facility M for FY 2001-2003
0.30
0.20
0.10
0.00
-0.10
-0.20
-0.30
Report Mean
Standard Deviation

Figure 58

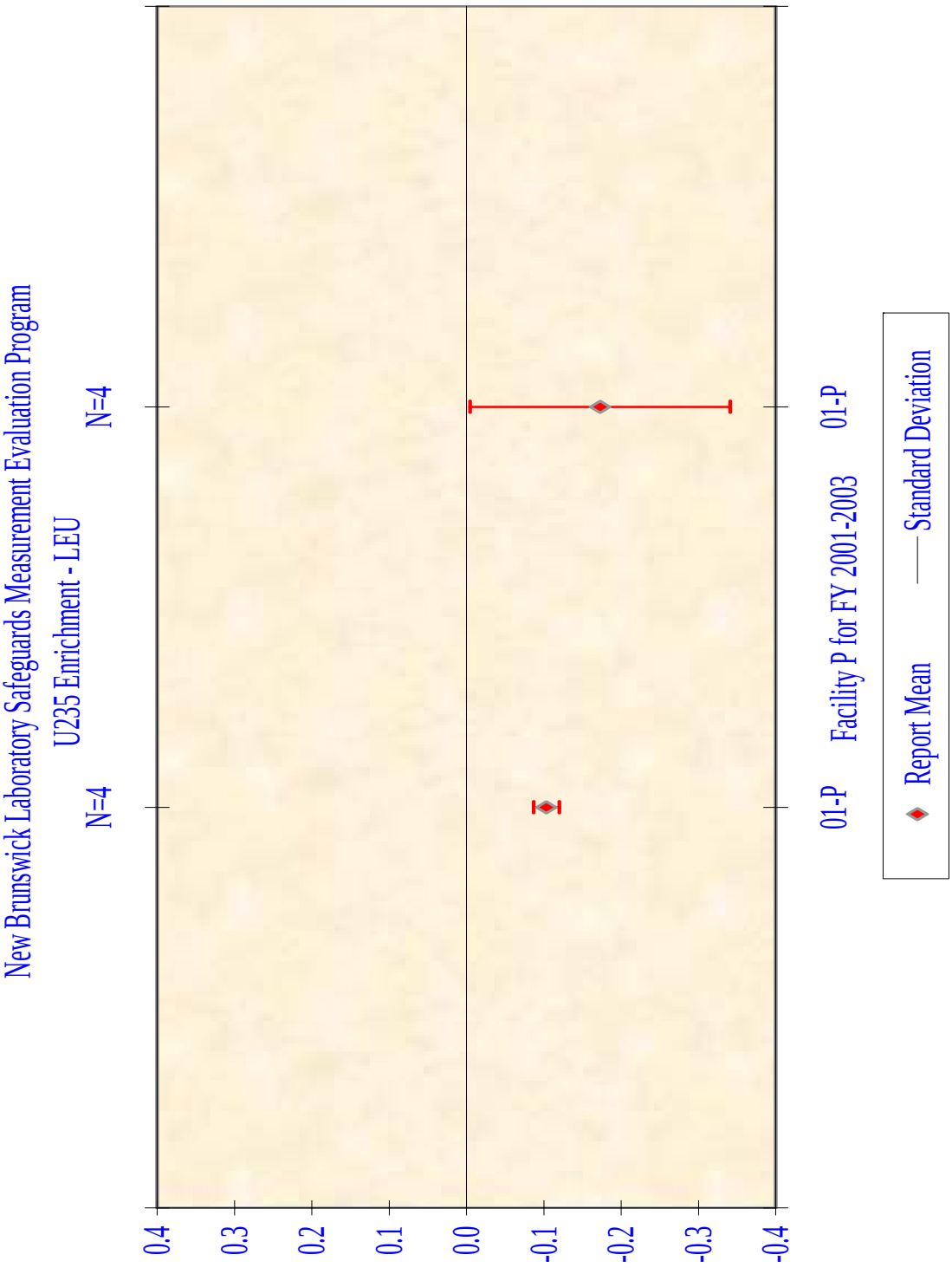

New Brunswick Laboratory Safeguards Measurement Evaluation Program
U235 Enrichment - LEU
N=4
N=4
01-P
Facility P for FY 2001-2003
01-P
Report Mean
Standard Deviation
0.4
0.3
0.2
0.1
0.0
-0.1
-0.2
-0.3
-0.4

Figure 59

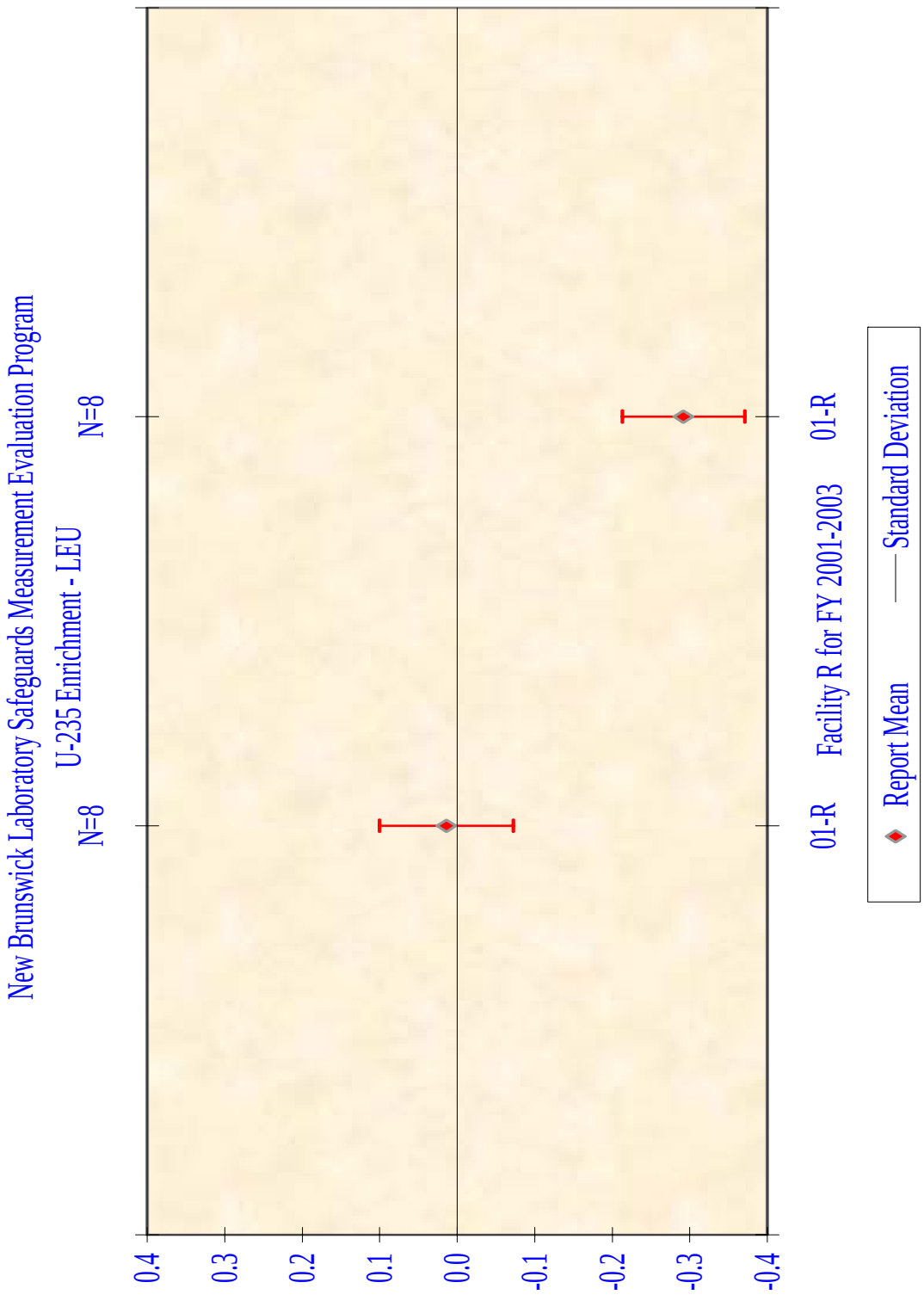
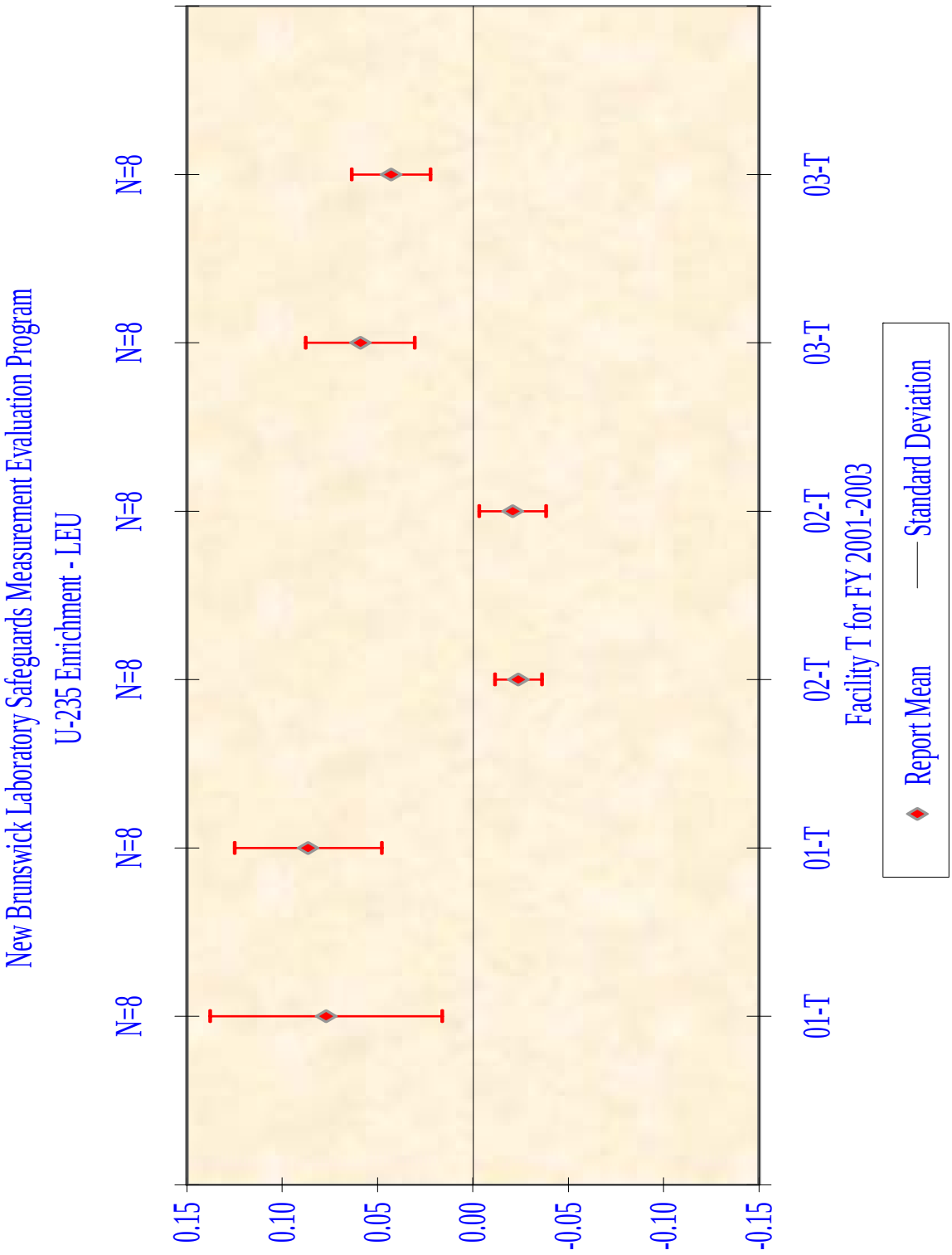

New Brunswick Laboratory Safeguards Measurement Evaluation Program
U-235 Enrichment - LEU
N=8
N=8
01-R
Facility R for FY 2001-2003
01-R
0.4
0.3
0.2
0.1
0.0
-0.1
-0.2
-0.3
-0.4
Report Mean
Standard Deviation

Figure 60


New Brunswick Laboratory Safeguards Measurement Evaluation Program
U-235 Enrichment - LEU
N=8
N=8
N=8
N=8
N=8
01-T
01-T
02-T
02-T
03-T
03-T
Facility T for FY 2001-2003
0.15
0.10
0.05
0.00
-0.05
-0.10
-0.15
Report Mean
Standard Deviation

APPENDICES

RESULTS ARRANGED MATERIAL BY MATERIAL AND LABORATORY BY LABORATORY

Appendix A: Uranium Assay Results

Appendix B: Uranium Isotopic Results

Appendix C: Plutonium Assay Results

Appendix D: ^{239}Pu Isotopic Results

Appendix E: ^{240}Pu Isotopic Results

Key to symbols in the tables in the appendices

Material Type Symbols

UNH	Uranyl Nitrate Solution
UO2	Uranium Dioxide Pellet
HEU	Uranium Enrichment (High)
LEU	Uranium Enrichment (Low)
PU	Dried Plutonium Sulfate
PUXXX	Plutonium Isotope
UO3	Uranium Trioxide
UF6	Uranium Hexafluoride

Method Type Symbols

IDMS	Isotope Dilution Mass Spectrometry
XRFL	X-Ray Fluorescence - Liquid
XRFS	X-Ray Fluorescence - Solid
DG	Davies-Gray Titration
Ceric	Ceric Titration
TIM	Thermal Ionization Mass Spectrometry
HPT	High Precision Titration
ICP-MS	ICP Mass Spectrometry

Appendix A: Uranium Assay Results

Material	Method Type	Facility	Analysis Date	Reported Result	% RD	Analyst
UF6	HPT	F	3/11/03	67.4563	-0.180	197
UF6	HPT	F	3/11/03	67.5358	-0.062	197
UF6	HPT	F	3/11/03	67.4201	-0.234	197
UF6	HPT	F	3/11/03	67.5446	-0.049	197
UF6	HPT	F	3/13/03	67.4550	-0.182	197
UF6	HPT	F	3/13/03	67.5412	-0.054	197
UF6	HPT	F	3/13/03	67.4141	-0.243	197
UF6	HPT	F	3/13/03	67.5559	-0.033	197
UNH	Ceric	G	1/9/03	1.00440	0.038	
UNH	Ceric	G	1/9/03	1.00373	-0.029	
UNH	Ceric	G	1/9/03	1.00182	-0.048	
UNH	Ceric	G	1/9/03	1.00173	-0.057	
UNH	Ceric	G	1/13/03	1.00397	-0.005	
UNH	Ceric	G	1/13/03	1.00386	-0.016	
UNH	Ceric	G	1/13/03	1.00240	0.010	
UNH	Ceric	G	1/13/03	1.00231	0.001	
UNH	Ceric	G	3/17/03	1.00387	-0.015	
UNH	Ceric	G	3/17/03	1.00418	0.016	
UNH	Ceric	G	3/17/03	1.00061	0.006	
UNH	Ceric	G	3/17/03	1.0004	-0.015	
UNH	Ceric	G	3/18/03	1.00379	-0.023	
UNH	Ceric	G	3/18/03	1.00437	0.035	
UNH	Ceric	G	3/18/03	1.00096	0.041	
UNH	Ceric	G	3/18/03	1.00064	0.009	
UNH	Ceric	G	5/20/03	1.00244	0.014	
UNH	Ceric	G	5/20/03	1.00263	0.033	
UNH	Ceric	G	5/20/03	1.00068	0.013	
UNH	Ceric	G	5/20/03	1.00051	-0.004	
UNH	Ceric	G	5/21/03	1.00273	0.043	
UNH	Ceric	G	5/21/03	1.00246	0.016	
UNH	Ceric	G	5/21/03	1.00058	0.003	
UNH	Ceric	G	5/21/03	1.00091	0.036	
UNH	DG	B	1/15/03	1.0071	0.307	MH
UNH	DG	B	1/15/03	1.0005	-0.351	MH
UNH	DG	B	1/15/03	0.9993	-0.470	MH
UNH	DG	B	1/16/03	1.0086	0.456	TJ
UNH	DG	B	1/16/03	1.0029	-0.112	MH
UNH	DG	B	1/16/03	1.0068	0.277	MH
UNH	DG	B	1/16/03	0.9937	-0.685	MH
UNH	DG	B	1/17/03	1.0006	0.005	TJ
UNH	DG	B	1/17/03	0.9983	-0.225	TJ
UNH	DG	B	3/25/03	0.9960	-0.799	JM
UNH	DG	B	3/25/03	0.9983	-0.570	JR
UNH	DG	B	3/25/03	0.9955	-0.678	JM
UNH	DG	B	3/25/03	0.9935	-0.878	JR
UNH	DG	B	3/26/03	0.9986	-0.540	JR
UNH	DG	B	3/26/03	0.9947	-0.758	JR
UNH	DG	B	3/26/03	0.9946	-0.768	JM

Material	Method Type	Facility	Analysis Date	Reported Result	% RD	Analyst
UNH	DG	B	3/27/03	0.9970	-0.699	JR
UNH	DG	B	3/27/03	0.9944	-0.788	JM
UNH	DG	B	3/27/03	0.9950	-0.728	JR
UNH	DG	B	7/11/03	1.00314	0.084	6219
UNH	DG	B	7/11/03	1.00350	0.120	6219
UNH	DG	B	7/12/03	1.00503	0.448	6861
UNH	DG	B	7/12/03	1.00751	0.696	6861
UNH	DG	B	7/20/03	1.00576	0.345	1921
UNH	DG	B	7/20/03	1.00400	0.170	1921
UNH	DG	B	7/20/03	1.00762	0.531	0960
UNH	DG	B	7/20/03	1.00275	0.045	0960
UNH	DG	B	7/22/03	1.00204	0.149	0960
UNH	DG	B	7/22/03	1.00330	0.275	0960
UNH	DG	B	10/1/03	1.00331	0.101	L1002
UNH	DG	B	10/1/03	1.00434	0.204	L1002
UNH	DG	B	10/1/03	0.99991	-0.064	L1002
UNH	DG	B	10/1/03	.99991	-0.064	L1002
UNH	DG	B	10/16/03	1.00334	0.104	L1002
UNH	DG	B	10/16/03	1.00200	-0.030	L1002
UNH	DG	B	10/16/03	1.00265	0.210	L1002
UNH	DG	B	10/16/03	1.00405	0.350	L1002
UNH	DG	F	4/1/03	1.0031	-0.092	164
UNH	DG	F	4/1/03	1.0034	-0.062	164
UNH	DG	F	4/1/03	1.0016	-0.070	164
UNH	DG	F	4/1/03	1.0018	-0.050	164
UNH	DG	F	4/10/03	1.0030	-0.102	164
UNH	DG	F	4/10/03	1.0033	-0.072	164
UNH	DG	F	4/10/03	1.0019	-0.040	164
UNH	DG	F	4/10/03	1.0021	-0.020	164
UNH	DG	F	4/24/03	1.0044	0.038	231
UNH	DG	F	4/24/03	1.0046	0.058	231
UNH	DG	F	4/24/03	1.0028	0.050	231
UNH	DG	F	4/24/03	1.0029	0.060	231
UNH	DG	F	4/25/03	1.0045	0.048	231
UNH	DG	F	4/25/03	1.0043	0.028	231
UNH	DG	F	4/25/03	1.0025	0.020	231
UNH	DG	F	4/25/03	1.0026	0.030	231
UNH	DG	F	9/5/03	1.0042	0.018	231
UNH	DG	F	9/5/03	1.0043	0.028	231
UNH	DG	F	9/5/03	1.0020	-0.030	231
UNH	DG	F	9/5/03	1.0020	-0.030	231
UNH	DG	F	9/8/03	1.0035	-0.052	231
UNH	DG	F	9/8/03	1.0037	-0.032	231
UNH	DG	F	9/8/03	1.0020	-0.030	231
UNH	DG	F	9/8/03	1.0019	-0.040	231
UNH	DG	F	9/9/03	1.0041	0.008	164
UNH	DG	F	9/9/03	1.0034	-0.062	164
UNH	DG	F	9/9/03	1.0019	-0.040	164
UNH	DG	F	9/9/03	1.0022	-0.010	164
UNH	DG	F	9/10/03	1.0036	-0.042	164

Material	Method Type	Facility	Analysis Date	Reported Result	% RD	Analyst
UNH	DG	F	9/10/03	1.0033	-0.072	164
UNH	DG	F	9/10/03	1.0020	-0.030	164
UNH	DG	G	9/3/03	1.00414	0.012	
UNH	DG	G	9/3/03	1.00393	-0.009	
UNH	DG	G	9/3/03	1.00041	-0.014	
UNH	DG	G	9/3/03	1.00047	-0.008	
UNH	DG	G	9/4/03	1.00409	0.007	
UNH	DG	G	9/4/03	1.00411	0.009	
UNH	DG	G	9/4/03	1.00043	-0.012	
UNH	DG	G	9/4/03	1.00066	0.011	
UNH	DG	U	7/24/03	1.001	-0.301	AUT
UNH	DG	U	7/24/03	1.003	-0.102	MAN
UNH	DG	U	7/24/03	0.999	-0.329	AUT
UNH	DG	U	7/24/03	1.001	-0.130	MAN
UNH	DG	U	7/24/03	0.998	-0.255	AUT
UNH	DG	U	7/24/03	1.000	-0.055	MAN
UNH	DG	U	7/25/03	1.004	-0.002	AUT
UNH	DG	U	7/25/03	1.005	0.098	MAN
UNH	DG	U	7/25/03	1.002	-0.030	AUT
UNH	DG	U	7/25/03	1.003	0.070	MAN
UNH	DG	U	7/25/03	1.001	0.045	AUT
UNH	DG	U	7/25/03	1.002	0.145	MAN
UNH	IDMS	A	10/11/02	1.0041	0.008	MJH
UNH	IDMS	A	10/11/02	1.0046	0.058	MJH
UNH	IDMS	A	10/11/02	1.0002	-0.035	MJH
UNH	IDMS	A	10/11/02	1.0010	0.045	MJH
UNH	IDMS	A	10/14/02	1.0031	-0.092	MJH
UNH	IDMS	A	10/14/02	1.0048	0.078	MJH
UNH	IDMS	A	10/14/02	0.9999	-0.065	MJH
UNH	IDMS	A	10/14/02	1.0004	-0.015	MJH
UNH	IDMS	A	1/27/03	1.0040	-0.002	MJH
UNH	IDMS	A	1/27/03	1.0028	-0.122	MJH
UNH	IDMS	A	1/27/03	1.0027	0.040	MJH
UNH	IDMS	A	1/27/03	1.0011	-0.120	MJH
UNH	IDMS	A	2/5/03	1.0044	0.038	MJH
UNH	IDMS	A	2/5/03	1.0026	-0.141	MJH
UNH	IDMS	A	2/5/03	1.0003	-0.200	MJH
UNH	IDMS	A	2/5/03	1.0011	-0.120	MJH
UNH	IDMS	A	6/24/03	1.0041	0.180	MJH
UNH	IDMS	A	6/24/03	1.0031	0.080	MJH
UNH	IDMS	A	6/24/03	1	-0.055	MJH
UNH	IDMS	A	6/24/03	1.0005	-0.005	MJH
UNH	IDMS	A	6/26/03	1.0025	0.020	MJH
UNH	IDMS	A	6/26/03	1.0005	-0.180	MJH
UNH	IDMS	A	6/26/03	0.999	-0.155	MJH
UNH	IDMS	A	6/26/03	.9989	-0.165	MJH
UNH	IDMS	A	9/3/03	1.0018	0.125	MJH
UNH	IDMS	A	9/3/03	.9972	-0.335	MJH
UNH	IDMS	A	9/3/03	1.0045	0.048	MJH
UNH	IDMS	A	9/3/03	1.0042	0.018	MJH

Material	Method Type	Facility	Analysis Date	Reported Result	% RD	Analyst
UNH	IDMS	A	9/4/03	.9993	-0.125	MJH
UNH	IDMS	A	9/4/03	1.0002	-0.035	MJH
UNH	IDMS	A	9/4/03	1.0029	-0.112	MJH
UNH	IDMS	A	9/4/03	1.0043	0.028	MJH
UNH	IDMS	B	12/19/02	0.9399	0.092	ADF
UNH	IDMS	B	12/19/02	0.9422	0.337	ADF
UNH	IDMS	B	12/19/02	0.9506	2.697	ADF
UNH	IDMS	B	12/19/02	0.9441	1.995	ADF
UNH	IDMS	B	12/19/02	0.9503	1.199	ADF
UNH	IDMS	B	12/19/02	0.9487	1.029	ADF
UNH	IDMS	B	12/19/02	0.9511	1.285	JLB
UNH	IDMS	B	12/19/02	0.9520	1.380	JLB
UNH	IDMS	B	1/8/03	0.9389	0.855	HET
UNH	IDMS	B	1/8/03	0.9427	1.263	HET
UNH	IDMS	B	1/12/03	0.9464	0.784	JLB
UNH	IDMS	B	1/12/03	0.9380	-0.111	JLB
UNH	IDMS	B	1/12/03	0.9401	0.984	JBL
UNH	IDMS	B	1/12/03	0.9400	0.973	JBL
UNH	IDMS	B	1/12/03	0.9427	1.844	JLB
UNH	IDMS	B	1/12/03	0.9370	1.228	JLB
UNH	IDMS	B	6/5/03	.4726	0.528	JLB
UNH	IDMS	B	6/5/03	.4723	0.464	JLB
UNH	IDMS	B	6/5/03	.4657	0.592	JLB
UNH	IDMS	B	6/5/03	.4654	0.527	JLB
UNH	IDMS	B	6/10/03	.4715	0.294	ADF
UNH	IDMS	B	6/10/03	.4717	0.336	ADF
UNH	IDMS	B	6/10/03	.4658	0.613	ADF
UNH	IDMS	B	6/10/03	.4643	0.289	ADF
UNH	IDMS	G	6/20/03	.4685	0.681	ELC
UNH	IDMS	G	6/20/03	.4743	0.889	ELC
UNH	IDMS	G	6/20/03	.4757	1.187	ELC
UNH	IDMS	G	6/20/03	0.4691	0.810	ELC
UNH	XRFL	A	10/7/02	1.009	0.496	ACB/RBD
UNH	XRFL	A	10/7/02	1.010	0.596	ACB/RBD
UNH	XRFL	A	10/7/02	1.004	0.170	ACB/RBD
UNH	XRFL	A	10/7/02	1.006	0.369	ACB/RBD
UNH	XRFL	A	10/22/02	1.008	0.396	ACB/RBD
UNH	XRFL	A	10/22/02	1.007	0.297	ACB/RBD
UNH	XRFL	A	10/22/02	1.004	0.170	ACB/RBD
UNH	XRFL	A	10/22/02	1.008	0.569	ACB/RBD
UNH	XRFL	A	1/27/03	1.000	-0.400	ACB/RBD
UNH	XRFL	A	1/27/03	1.001	-0.301	ACB/RBD
UNH	XRFL	A	1/27/03	0.9986	-0.369	ACB/RBD
UNH	XRFL	A	1/27/03	0.9946	-0.768	ACB/RBD
UNH	XRFL	A	2/4/03	1.002	-0.201	ACB/RBD
UNH	XRFL	A	2/4/03	1.001	-0.301	ACB/RBD
UNH	XRFL	A	2/4/03	1.002	-0.030	ACB/RBD
UNH	XRFL	A	2/4/03	1.003	0.070	ACB/RBD
UNH	XRFL	A	4/17/03	1.002	-0.030	ACB/RDB
UNH	XRFL	A	4/17/03	1.003	0.070	ACB/RDB

Material	Method Type	Facility	Analysis Date	Reported Result	% RD	Analyst
UNH	XRFL	A	4/17/03	1.007	0.645	ACB/RDB
UNH	XRFL	A	4/17/03	1.007	0.645	ACB/RDB
UNH	XRFL	A	4/24/03	1.003	0.070	ACB/RDB
UNH	XRFL	A	4/24/03	1.007	0.469	ACB/RDB
UNH	XRFL	A	4/24/03	1.01	0.944	ACB/RDB
UNH	XRFL	A	4/24/03	1.009	0.845	ACB/RDB
UNH	XRFL	A	9/25/03	1.009	0.496	ACB/RBD
UNH	XRFL	A	9/25/03	1.010	0.596	ACB/RBD
UNH	XRFL	A	9/25/03	1.007	0.645	ACB/RBD
UNH	XRFL	A	9/25/03	1.005	0.445	ACB/RBD
UNH	XRFL	A	9/30/03	1.007	0.297	ACB/RBD
UNH	XRFL	A	9/30/03	1.012	0.795	ACB/RBD
UNH	XRFL	A	9/30/03	1.006	0.545	ACB/RBD
UNH	XRFL	A	9/30/03	1.006	0.545	ACB/RBD
UO2	DG	AA	10/2/02	88.1430	0.012	A
UO2	DG	AA	10/2/02	88.0991	-0.037	A
UO2	DG	AA	10/2/02	88.0651	-0.076	A
UO2	DG	AA	10/2/02	88.1008	-0.035	A
UO2	DG	AA	10/2/02	88.1235	-0.010	A
UO2	DG	AA	10/2/02	88.0617	-0.011	B
UO2	DG	AA	10/2/02	88.1493	0.089	B
UO2	DG	AA	10/2/02	88.1222	0.058	B
UO2	DG	AA	10/2/02	88.0920	0.024	B
UO2	DG	AA	10/2/02	88.0853	0.016	B
UO2	DG	AA	10/3/02	88.0329	-0.112	A
UO2	DG	AA	10/3/02	88.0555	-0.087	A
UO2	DG	AA	10/3/02	88.0634	-0.078	A
UO2	DG	AA	10/3/02	88.1596	0.031	A
UO2	DG	AA	10/3/02	88.0937	-0.043	A
UO2	DG	AA	10/3/02	88.0648	-0.007	B
UO2	DG	AA	10/3/02	88.1891	0.134	B
UO2	DG	AA	10/3/02	88.1266	0.063	B
UO2	DG	AA	10/3/02	88.1147	0.050	B
UO2	DG	AA	10/3/02	88.0935	0.026	B
UO2	DG	AA	10/3/02	88.1475	0.087	B
UO2	DG	AC	10/2/02	88.114	-0.020	NDAL
UO2	DG	AC	10/2/02	88.090	-0.048	NDAL
UO2	DG	AC	10/2/02	88.014	-0.134	NDAL
UO2	DG	AC	10/2/02	88.029	-0.117	NDAL
UO2	DG	AC	10/2/02	88.121	0.057	NDAL
UO2	DG	AC	10/2/02	88.147	0.086	NDAL
UO2	DG	AC	10/2/02	88.034	-0.042	NDAL
UO2	DG	AC	10/2/02	88.057	-0.016	NDAL
UO2	DG	AC	10/3/02	88.021	-0.126	ALND
UO2	DG	AC	10/3/02	88.057	-0.085	ALND
UO2	DG	AC	10/3/02	88.064	-0.077	ALND
UO2	DG	AC	10/3/02	88.075	-0.065	ALND
UO2	DG	AC	10/3/02	88.053	-0.020	ALND
UO2	DG	AC	10/3/02	88.051	-0.023	ALND
UO2	DG	AC	10/3/02	88.082	0.012	ALND

Material	Method Type	Facility	Analysis Date	Reported Result	% RD	Analyst
UO2	DG	AC	10/3/02	88.006	-0.074	ALND
UO2	DG	AD	11/29/02	88.124	-0.009	A
UO2	DG	AD	11/29/02	88.122	-0.011	A
UO2	DG	AD	11/29/02	88.090	-0.048	A
UO2	DG	AD	11/29/02	88.104	-0.032	A
UO2	DG	AD	11/29/02	88.063	-0.009	B
UO2	DG	AD	11/29/02	88.078	0.008	B
UO2	DG	AD	11/29/02	88.020	-0.058	B
UO2	DG	AD	11/29/02	88.015	-0.064	B
UO2	DG	AD	12/2/02	88.116	-0.018	A
UO2	DG	AD	12/2/02	88.109	-0.026	A
UO2	DG	AD	12/2/02	88.091	-0.047	A
UO2	DG	AD	12/2/02	88.098	-0.039	A
UO2	DG	AD	12/2/02	88.049	-0.025	B
UO2	DG	AD	12/2/02	88.058	-0.015	B
UO2	DG	AD	12/2/02	88.022	-0.056	B
UO2	DG	AD	12/2/02	88.019	-0.059	B
UO2	DG	AE	10/30/02	88.180	0.054	A
UO2	DG	AE	10/30/02	88.125	-0.008	A
UO2	DG	AE	10/30/02	88.135	0.003	A
UO2	DG	AE	10/30/02	88.115	-0.019	A
UO2	DG	AE	10/30/02	88.166	0.108	B
UO2	DG	AE	10/30/02	88.126	0.062	B
UO2	DG	AE	10/30/02	88.092	0.024	B
UO2	DG	AE	10/30/02	88.083	0.014	B
UO2	DG	AE	10/31/02	88.094	-0.043	A
UO2	DG	AE	10/31/02	88.041	-0.103	A
UO2	DG	AE	10/31/02	88.132	0.000	A
UO2	DG	AE	10/31/02	88.087	-0.051	A
UO2	DG	AE	10/31/02	88.178	0.121	B
UO2	DG	AE	10/31/02	88.084	0.015	B
UO2	DG	AE	10/31/02	88.087	0.018	B
UO2	DG	AE	10/31/02	88.079	0.009	B
UO2	DG	BA	9/27/02	87.943	-0.214	A
UO2	DG	BA	9/27/02	88.114	-0.020	A
UO2	DG	BA	9/27/02	87.744	-0.440	A
UO2	DG	BA	9/27/02	88.064	-0.077	A
UO2	DG	BA	9/27/02	87.976	-0.177	A
UO2	DG	BA	9/27/02	88.000	-0.150	A
UO2	DG	BA	9/27/02	88.015	-0.064	B
UO2	DG	BA	9/27/02	87.830	-0.274	B
UO2	DG	BA	9/27/02	88.032	-0.044	B
UO2	DG	BA	9/27/02	87.983	-0.100	B
UO2	DG	BA	9/27/02	87.955	-0.132	B
UO2	DG	BA	9/27/02	87.881	-0.216	B
UO2	DG	BA	9/30/02	87.847	-0.323	A
UO2	DG	BA	9/30/02	87.897	-0.267	A
UO2	DG	BA	9/30/02	87.817	-0.357	A
UO2	DG	BA	9/30/02	87.836	-0.336	A
UO2	DG	BA	9/30/02	87.891	-0.273	A

Material	Method Type	Facility	Analysis Date	Reported Result	% RD	Analyst
UO2	DG	BA	9/30/02	87.842	-0.329	A
UO2	DG	BA	9/30/02	87.878	-0.219	B
UO2	DG	BA	9/30/02	87.767	-0.345	B
UO2	DG	BA	9/30/02	87.825	-0.279	B
UO2	DG	BA	9/30/02	87.917	-0.175	B
UO2	DG	BA	9/30/02	87.822	-0.283	B
UO2	DG	BA	9/30/02	87.824	-0.280	B
UO2	DG	BC	9/5/02	88.3126	0.205	A
UO2	DG	BC	9/5/02	88.5865	0.516	A
UO2	DG	BC	9/5/02	88.4429	0.353	A
UO2	DG	BC	9/5/02	88.3565	0.324	B
UO2	DG	BC	9/5/02	88.5276	0.518	B
UO2	DG	BC	9/5/02	88.6593	0.668	B
UO2	DG	BC	9/5/02	88.4789	0.463	B
UO2	DG	BC	9/12/02	88.6218	0.556	A
UO2	DG	BC	9/12/02	88.3693	0.269	A
UO2	DG	BC	9/12/02	88.5335	0.456	A
UO2	DG	BC	9/12/02	88.2843	0.173	A
UO2	DG	BC	9/12/02	88.4631	0.445	B
UO2	DG	BC	9/12/02	88.2161	0.165	B
UO2	DG	BC	9/12/02	88.6757	0.687	B
UO2	DG	BC	9/12/02	88.5519	0.546	B
UO2	DG	BD	10/23/02	82.1971	-6.734	A
UO2	DG	BD	10/23/02	82.051	-6.900	A
UO2	DG	BD	10/23/02	82.167	-6.768	A
UO2	DG	BD	10/23/02	87.342	-0.828	B
UO2	DG	BD	10/23/02	87.326	-0.846	B
UO2	DG	BD	10/23/02	87.362	-0.805	B
UO2	DG	BD	10/30/02	82.194	-6.738	A
UO2	DG	BD	10/30/02	82.240	-6.685	A
UO2	DG	BD	10/30/02	82.153	-6.784	A
UO2	DG	BD	10/30/02	87.329	-0.843	B
UO2	DG	BD	10/30/02	87.273	-0.906	B
UO2	DG	BD	10/30/02	87.212	-0.975	B
UO2	DG	BF	8/20/02	88.122	-0.011	A
UO2	DG	BF	8/20/02	88.131	-0.001	A
UO2	DG	BF	8/20/02	88.093	-0.044	A
UO2	DG	BF	8/20/02	88.089	-0.049	A
UO2	DG	BF	8/20/02	88.003	-0.077	B
UO2	DG	BF	8/20/02	88.005	-0.075	B
UO2	DG	BF	8/20/02	88.058	-0.015	B
UO2	DG	BF	8/20/02	88.032	-0.044	B
UO2	DG	BF	9/27/02	88.094	-0.043	A
UO2	DG	BF	9/27/02	88.094	-0.043	A
UO2	DG	BF	9/27/02	88.002	-0.148	A
UO2	DG	BF	9/27/02	88.021	-0.126	A
UO2	DG	BF	9/27/02	87.938	-0.151	B
UO2	DG	BF	9/27/02	87.941	-0.148	B
UO2	DG	BF	9/27/02	88.054	-0.019	B
UO2	DG	BF	9/27/02	88.089	0.020	B

Material	Method Type	Facility	Analysis Date	Reported Result	% RD	Analyst
UO2	DG	F	7/18/03	88.0973	-0.036	164
UO2	DG	F	7/18/03	88.0673	-0.070	164
UO2	DG	F	7/18/03	88.0799	-0.056	164
UO2	DG	F	7/18/03	88.0841	-0.051	164
UO2	DG	F	7/18/03	88.0704	-0.066	164
UO2	DG	F	7/18/03	88.1970	0.077	164
UO2	DG	F	7/23/03	88.0505	-0.089	231
UO2	DG	F	7/23/03	88.1438	0.017	231
UO2	DG	F	7/23/03	88.1227	-0.007	231
UO2	DG	F	7/23/03	88.1749	0.052	231
UO2	DG	F	7/23/03	88.1357	0.008	231
UO2	DG	F	7/23/03	88.0893	-0.045	231
UO2	DG	F	7/23/03	88.1763	0.054	231
UO2	DG	F	7/23/03	88.0978	-0.035	231
UO2	DG	F	7/24/03	88.1556	0.030	231
UO2	DG	F	7/24/03	88.1671	0.043	231
UO2	DG	F	7/24/03	88.0669	-0.070	231
UO2	DG	F	7/24/03	88.0944	-0.039	231
UO2	DG	F	7/24/03	88.0836	-0.052	231
UO2	DG	F	7/24/03	88.1550	0.030	231
UO2	DG	F	7/24/03	88.1224	-0.007	231
UO2	DG	F	7/24/03	88.1639	0.040	231
UO2	DG	F	7/30/03	88.1151	-0.016	164
UO2	DG	F	7/30/03	88.1146	-0.016	164
UO2	DG	F	7/30/03	88.1046	-0.028	164
UO2	DG	F	7/30/03	88.0760	-0.060	164
UO2	DG	F	7/30/03	88.0982	-0.035	164
UO2	DG	F	7/30/03	88.0937	-0.040	164
UO2	DG	F	7/30/03	88.1076	-0.024	164
UO2	DG	F	7/30/03	88.0834	-0.052	164
UO2	DG	T	12/16/02	88.11	-0.022	
UO2	DG	T	12/16/02	88.15	0.024	
UO2	DG	T	12/16/02	88.2	0.081	
UO2	DG	T	12/16/02	88.18	0.058	
UO2	DG	T	3/17/03	88.04	-0.101	
UO2	DG	T	3/17/03	87.98	-0.169	
UO2	DG	T	3/17/03	87.99	-0.158	
UO2	DG	T	3/17/03	88.14	0.012	
UO2	DG	T	6/19/03	88.13	0.001	
UO2	DG	T	6/19/03	88.2	0.081	
UO2	DG	T	6/19/03	88.27	0.160	
UO2	DG	T	6/19/03	88.16	0.035	
UO2	DG	T	9/9/03	88.08	-0.056	
UO2	DG	T	9/9/03	88.09	-0.044	
UO2	DG	T	9/18/03	88.05	-0.090	
UO2	DG	T	9/18/03	88.08	-0.056	
UO2	HPT	F	3/20/03	88.1102	-0.021	025
UO2	HPT	F	3/20/03	88.1123	-0.019	025
UO2	HPT	F	3/20/03	88.1311	-0.021	025
UO2	HPT	F	3/24/03	88.1156	-0.015	025

Material	Method Type	Facility	Analysis Date	Reported Result	% RD	Analyst
UO2	HPT	F	3/24/03	88.1337	0.005	025
UO2	HPT	F	3/24/03	88.1114	-0.020	025
UO2	HPT	F	3/24/03	88.1197	-0.011	025
UO2	HPT	F	7/22/03	88.0833	-0.052	197
UO2	HPT	F	7/22/03	88.0784	-0.057	197
UO2	HPT	F	7/22/03	88.0552	-0.084	197
UO2	HPT	F	7/22/03	88.0969	-0.036	197
UO2	HPT	F	7/24/03	88.0900	-0.044	025
UO2	HPT	F	7/24/03	88.0334	-0.108	025
UO2	HPT	F	7/24/03	88.0915	-0.043	025
UO2	HPT	F	7/24/03	88.0444	-0.096	025
UO2	ICP-MS	BE	12/12/02	87.7	-0.490	A
UO2	ICP-MS	BE	12/12/02	87.9	-0.263	A
UO2	ICP-MS	BE	12/12/02	88.2	0.077	A
UO2	ICP-MS	BE	12/12/02	87.4	-0.831	A
UO2	ICP-MS	BE	12/12/02	88.5	0.487	B
UO2	ICP-MS	BE	12/12/02	88.1	0.033	B
UO2	ICP-MS	BE	12/12/02	88.8	0.828	B
UO2	ICP-MS	BE	12/12/02	88.3	0.260	B
UO2	ICP-MS	BE	12/13/02	88.8	0.758	A
UO2	ICP-MS	BE	12/13/02	87.9	-0.263	A
UO2	ICP-MS	BE	12/13/02	86.8	-1.511	A
UO2	ICP-MS	BE	12/13/02	87.5	-0.717	A
UO2	ICP-MS	BE	12/13/02	88.6	0.601	B
UO2	ICP-MS	BE	12/13/02	88.7	0.714	B
UO2	ICP-MS	BE	12/13/02	88.1	0.033	B
UO2	ICP-MS	BE	12/13/02	88.3	0.260	B
UO3	DG	F	2/19/03	82.6322	-0.047	164
UO3	DG	F	2/19/03	82.6272	-0.053	164
UO3	DG	F	2/19/03	82.6055	-0.079	164
UO3	DG	F	2/19/03	82.6194	-0.062	164
UO3	DG	F	2/20/03	82.6279	-0.052	164
UO3	DG	F	2/20/03	82.6236	-0.057	164
UO3	DG	F	2/20/03	82.6384	-0.039	164
UO3	DG	F	2/20/03	82.6492	-0.026	164
UO3	DG	F	3/21/03	82.6219	-0.059	190
UO3	DG	F	3/21/03	82.6544	-0.020	190
UO3	DG	F	3/21/03	82.6358	-0.043	190
UO3	DG	F	3/21/03	82.6270	-0.053	190
UO3	DG	F	3/24/03	82.5905	-0.097	190
UO3	DG	F	3/24/03	82.6090	-0.075	190
UO3	IDMS	A	10/2/02	82.56	-0.134	MJH
UO3	IDMS	A	10/2/02	82.63	-0.050	MJH
UO3	IDMS	A	10/2/02	82.75	0.096	MJH
UO3	IDMS	A	10/2/02	82.71	0.047	MJH
UO3	IDMS	A	10/11/02	82.71	0.047	DLB
UO3	IDMS	A	10/11/02	82.58	-0.110	DLB
UO3	IDMS	A	10/11/02	82.67	-0.001	DLB
UO3	IDMS	A	10/11/02	82.65	-0.025	DLB
UO3	IDMS	A	2/11/03	82.7	0.035	MJH

Material	Method Type	Facility	Analysis Date	Reported Result	% RD	Analyst
UO3	IDMS	A	2/11/03	82.49	-0.219	MJH
UO3	IDMS	A	2/11/03	82.56	-0.134	MJH
UO3	IDMS	A	2/11/03	82.74	0.083	MJH
UO3	IDMS	A	2/17/03	82.5	-0.207	DLB
UO3	IDMS	A	2/17/03	82.51	-0.195	DLB
UO3	IDMS	A	2/17/03	82.81	0.168	DLB
UO3	IDMS	A	2/17/03	82.54	-0.158	DLB
UO3	IDMS	A	4/28/03	82.64	-0.037	MJH
UO3	IDMS	A	4/28/03	82.87	0.241	MJH
UO3	IDMS	A	4/28/03	82.61	-0.074	MJH
UO3	IDMS	A	4/28/03	82.82	0.180	MJH
UO3	IDMS	A	4/29/03	82.64	-0.037	DLB
UO3	IDMS	A	4/29/03	82.62	-0.062	DLB
UO3	IDMS	A	4/29/03	82.66	-0.013	DLB
UO3	IDMS	A	4/29/03	82.49	-0.219	DLB
UO3	IDMS	A	8/13/03	82.66	-0.013	MJH
UO3	IDMS	A	8/13/03	82.72	0.059	MJH
UO3	IDMS	A	8/13/03	82.60	-0.086	MJH
UO3	IDMS	A	8/13/03	82.73	0.071	MJH
UO3	IDMS	A	8/29/03	82.56	-0.134	DLB
UO3	IDMS	A	8/29/03	82.71	0.047	DLB
UO3	IDMS	A	8/29/03	82.64	-0.037	DLB
UO3	IDMS	A	8/29/03	82.68	0.011	DLB
UO3	XRFL	A	10/7/02	82.27	-0.485	ACB/RBD
UO3	XRFL	A	10/7/02	82.82	0.180	ACB/RBD
UO3	XRFL	A	10/7/02	82.32	-0.425	ACB/RBD
UO3	XRFL	A	10/7/02	82.28	-0.473	ACB/RBD
UO3	XRFL	A	10/22/02	82.58	-0.110	ACB/RBD
UO3	XRFL	A	10/22/02	82.72	0.059	ACB/RBD
UO3	XRFL	A	10/22/02	82.50	-0.207	ACB/RBD
UO3	XRFL	A	10/22/02	82.67	-0.001	ACB/RBD
UO3	XRFL	A	4/17/03	82.67	-0.001	ACB/RBD
UO3	XRFL	A	4/17/03	83.05	0.458	ACB/RBD
UO3	XRFL	A	4/17/03	82.53	-0.171	ACB/RBD
UO3	XRFL	A	4/17/03	82.82	0.180	ACB/RBD
UO3	XRFL	A	4/24/03	82.84	0.204	ACB/RBD
UO3	XRFL	A	4/24/03	82.95	0.337	ACB/RBD
UO3	XRFL	A	4/24/03	82.93	0.313	ACB/RBD
UO3	XRFL	A	4/24/03	82.50	-0.207	ACB/RBD
UO3	XRFL	A	9/23/03	82.53	-0.171	ACB/RBD
UO3	XRFL	A	9/23/03	82.71	0.047	ACB/RBD
UO3	XRFL	A	9/23/03	82.70	0.035	ACB/RBD
UO3	XRFL	A	9/23/03	82.85	0.217	ACB/RBD
UO3	XRFL	A	9/30/03	82.70	0.035	ACB/RBD
UO3	XRFL	A	9/30/03	82.46	-0.255	ACB/RBD
UO3	XRFL	A	9/30/03	82.72	0.059	ACB/RBD
UO3	XRFL	A	9/30/03	82.61	-0.074	ACB/RBD
UO3	XRFS	A	11/18/02	82.17	-0.606	ACB/RBD
UO3	XRFS	A	11/18/02	82.62	-0.062	ACB/RBD
UO3	XRFS	A	11/18/02	82.31	-0.437	ACB/RBD

Material	Method Type	Facility	Analysis Date	Reported Result	% RD	Analyst
UO3	XRFS	A	11/18/02	82.66	-0.013	ACB/RBD
UO3	XRFS	A	11/19/02	82.67	-0.001	ACB/RBD
UO3	XRFS	A	11/19/02	82.41	-0.316	ACB/RBD
UO3	XRFS	A	11/19/02	82.25	-0.509	ACB/RBD
UO3	XRFS	A	11/19/02	82.69	0.023	ACB/RBD
UO3	XRFS	A	4/17/03	82.63	-0.050	ACB/RBD
UO3	XRFS	A	4/17/03	82.72	0.059	ACB/RBD
UO3	XRFS	A	4/17/03	82.35	-0.388	ACB/RBD
UO3	XRFS	A	4/17/03	82.71	0.047	ACB/RBD
UO3	XRFS	A	4/24/03	82.60	-0.086	ACB/RBD
UO3	XRFS	A	4/24/03	83.00	0.398	ACB/RBD
UO3	XRFS	A	4/24/03	82.46	-0.255	ACB/RBD
UO3	XRFS	A	4/24/03	82.89	0.265	ACB/RBD
UO3	XRFS	A	8/21/03	82.56	-0.134	ACB/RBD
UO3	XRFS	A	8/21/03	82.58	-0.110	ACB/RBD
UO3	XRFS	A	8/21/03	82.77	0.120	ACB/RBD
UO3	XRFS	A	8/21/03	82.54	-0.158	ACB/RBD
UO3	XRFS	A	9/23/03	82.42	-0.304	ACB/RBD
UO3	XRFS	A	9/23/03	82.45	-0.267	ACB/RBD
UO3	XRFS	A	9/23/03	82.61	-0.074	ACB/RBD
UO3	XRFS	A	9/23/03	82.57	-0.122	ACB/RBD

Appendix B – Uranium Isotopic Results

Material	Method	Facility	Analysis Date	Reported Result	% RD	Analyst
HEU	TIMS	A	10/15/02	89.692	0.015	MJH
HEU	TIMS	A	10/15/02	89.693	0.016	MJH
HEU	TIMS	A	10/16/02	89.686	0.008	MJH
HEU	TIMS	A	10/16/02	89.678	-0.001	MJH
HEU	TIMS	A	10/15/02	90.348	0.012	MJH
HEU	TIMS	A	10/15/02	90.353	0.018	MJH
HEU	TIMS	A	10/16/02	90.342	0.005	MJH
HEU	TIMS	A	10/16/02	90.344	0.008	MJH
HEU	TIMS	A	1/29/03	51.339	0.028	MJH
HEU	TIMS	A	1/29/03	51.334	0.019	MJH
HEU	TIMS	A	2/17/03	51.321	-0.007	MJH
HEU	TIMS	A	2/17/03	51.315	-0.019	MJH
HEU	TIMS	A	5/6/03	89.683	0.005	MJH
HEU	TIMS	A	5/6/03	89.671	-0.009	MJH
HEU	TIMS	A	7/2/03	89.689	0.011	MJH
HEU	TIMS	A	7/2/03	89.678	-0.001	MJH
HEU	TIMS	A	5/6/03	89.888	-0.003	MJH
HEU	TIMS	A	5/6/03	89.875	-0.018	MJH
HEU	TIMS	A	7/2/03	89.907	0.018	MJH
HEU	TIMS	A	7/2/03	89.895	0.004	MJH
HEU	TIMS	A	9/4/03	51.333	0.017	MJH
HEU	TIMS	A	9/4/03	51.347	0.044	MJH
HEU	TIMS	A	9/12/03	51.331	0.013	MJH
HEU	TIMS	A	9/12/03	51.359	0.067	MJH
HEU	TIMS	B	12/19/02	89.6950	0.018	ADF
HEU	TIMS	B	12/19/02	89.6942	0.017	ADF
HEU	TIMS	B	1/12/03	89.6756	-0.004	JLB
HEU	TIMS	B	1/12/03	89.6589	-0.022	JLB
HEU	TIMS	B	1/8/03	90.3504	0.015	HET
HEU	TIMS	B	1/8/03	90.3474	0.011	HET
HEU	TIMS	B	1/12/03	90.3582	0.023	JLB
HEU	TIMS	B	1/12/03	90.3433	0.007	JLB
HEU	TIMS	B	12/19/02	89.9058	0.016	ADF
HEU	TIMS	B	12/19/02	89.9052	0.016	ADF
HEU	TIMS	B	1/12/03	89.8723	-0.021	JLB
HEU	TIMS	B	1/12/03	89.9180	0.030	JLB
HEU	TIMS	B	12/19/02	89.6943	0.017	ADF
HEU	TIMS	B	12/19/02	89.6928	0.016	ADF
HEU	TIMS	B	12/19/02	89.6729	-0.007	JLB
HEU	TIMS	B	12/19/02	89.6838	0.006	JLB
HEU	TIMS	B	12/19/02	51.3624	0.074	ADF
HEU	TIMS	B	12/19/02	51.3213	-0.006	ADF
HEU	TIMS	B	10/14/02	51.3463	0.042	NSH
HEU	TIMS	B	10/14/02	51.3455	0.041	NSH
HEU	TIMS	B	3/29/03	51.3315	0.014	JLB
HEU	TIMS	B	3/29/03	51.2562	-0.133	JLB
HEU	TIMS	B	3/30/03	51.3321	0.015	ADF

Material	Method	Facility	Analysis Date	Reported Result	% RD	Analyst
HEU	TIMS	B	3/30/03	51.3427	0.035	ADF
HEU	TIMS	B	6/5/03	89.6834	0.005	JLB
HEU	TIMS	B	6/5/03	89.6825	0.004	JLB
HEU	TIMS	B	6/10/03	89.6954	0.018	ADF
HEU	TIMS	B	6/10/03	89.6986	0.022	ADF
HEU	TIMS	B	6/5/03	89.8820	-0.010	JLB
HEU	TIMS	B	6/5/03	89.8893	-0.002	JLB
HEU	TIMS	B	6/10/03	89.9024	0.013	ADF
HEU	TIMS	B	6/10/03	89.9102	0.021	ADF
HEU	TIMS	B	9/17/03	51.3295	0.010	JLB
HEU	TIMS	B	9/17/03	51.3301	0.011	JLB
HEU	TIMS	B	9/26/03	51.3300	0.011	DDB
HEU	TIMS	B	9/26/03	51.3179	-0.013	DDB
HEU	TIMS	G	5/22/03	89.6830	0.005	ELC
HEU	TIMS	G	5/22/03	89.6816	0.003	ELC
HEU	TIMS	G	5/22/03	90.3393	0.002	ELC
HEU	TIMS	G	5/22/03	90.3420	0.005	ELC
HEU	TIMS	G	5/22/03	51.3395	0.029	ELC
HEU	TIMS	G	5/22/03	51.3390	0.028	ELC
HEU	TIMS	U	4/15/03	89.695	0.018	GV
HEU	TIMS	U	4/15/03	89.696	0.019	GV
HEU	TIMS	U	4/15/03	89.910	0.021	GV
HEU	TIMS	U	4/15/03	89.906	0.017	GV
HEU	TIMS	U	4/15/03	89.919	0.031	GV
HEU	TIMS	U	4/24/03	89.716	0.041	GV
HEU	TIMS	U	4/24/03	89.715	0.040	GV
HEU	TIMS	U	4/24/03	89.698	0.021	GV
HEU	TIMS	U	4/24/03	89.925	0.038	GV
HEU	TIMS	U	4/24/03	89.924	0.037	GV
HEU	TIMS	U	4/24/03	89.925	0.038	GV
LEU	ICP-MS	BE	12/19/02	.713	0.098	A
LEU	ICP-MS	BE	12/19/02	.712	-0.042	A
LEU	ICP-MS	BE	12/19/02	.714	0.239	A
LEU	ICP-MS	BE	12/19/02	.710	-0.323	A
LEU	ICP-MS	BE	12/19/02	.709	-0.463	A
LEU	ICP-MS	BE	12/19/02	.710	-0.323	A
LEU	ICP-MS	BE	12/19/02	.711	-0.183	A
LEU	ICP-MS	BE	12/19/02	.710	-0.323	A
LEU	ICP-MS	BE	12/19/02	.706	-0.884	A
LEU	ICP-MS	BE	12/19/02	0.712	-0.042	A
LEU	ICP-MS	BE	12/19/02	.711	-0.183	A
LEU	ICP-MS	BE	12/19/02	.710	-0.323	A
LEU	ICP-MS	BE	12/19/02	.709	-0.463	B
LEU	ICP-MS	BE	12/19/02	.710	-0.323	B
LEU	ICP-MS	BE	12/19/02	.711	-0.183	B
LEU	ICP-MS	BE	12/19/02	.710	-0.323	B
LEU	ICP-MS	BE	12/19/02	.711	-0.183	B
LEU	ICP-MS	BE	12/19/02	.709	-0.463	B
LEU	ICP-MS	BE	12/19/02	.712	-0.042	B
LEU	ICP-MS	BE	12/19/02	.710	-0.323	B

Material	Method	Facility	Analysis Date	Reported Result	% RD	Analyst
LEU	ICP-MS	BE	12/19/02	.713	0.098	B
LEU	ICP-MS	BE	12/19/02	.709	-0.463	B
LEU	ICP-MS	BE	12/19/02	.712	-0.042	B
LEU	ICP-MS	BE	12/19/02	.710	-0.323	B
LEU	ICP-MS	BE	12/26/02	.712	-0.042	A
LEU	ICP-MS	BE	12/26/02	.710	-0.323	A
LEU	ICP-MS	BE	12/26/02	.714	0.239	A
LEU	ICP-MS	BE	12/26/02	.713	0.098	A
LEU	ICP-MS	BE	12/26/02	.712	-0.042	A
LEU	ICP-MS	BE	12/26/02	.714	0.239	A
LEU	ICP-MS	BE	12/26/02	.716	0.519	A
LEU	ICP-MS	BE	12/26/02	.714	0.239	A
LEU	ICP-MS	BE	12/26/02	.711	-0.183	A
LEU	ICP-MS	BE	12/26/02	.712	-0.042	A
LEU	ICP-MS	BE	12/26/02	.709	-0.463	A
LEU	ICP-MS	BE	12/26/02	.713	0.098	A
LEU	ICP-MS	BE	12/26/02	.714	0.239	B
LEU	ICP-MS	BE	12/26/02	.716	0.519	B
LEU	ICP-MS	BE	12/26/02	.714	0.239	B
LEU	ICP-MS	BE	12/26/02	.714	0.239	B
LEU	ICP-MS	BE	12/26/02	.715	0.379	B
LEU	ICP-MS	BE	12/26/02	.715	0.379	B
LEU	ICP-MS	BE	12/26/02	.713	0.098	B
LEU	ICP-MS	BE	12/26/02	.712	-0.042	B
LEU	ICP-MS	BE	12/26/02	.713	0.098	B
LEU	ICP-MS	BE	12/26/02	.712	-0.042	B
LEU	ICP-MS	BE	12/26/02	.714	0.239	B
LEU	ICP-MS	BE	12/26/02	.714	0.239	B
LEU	TIMS	A	1/29/03	4.396	0.102	MJH
LEU	TIMS	A	1/29/03	4.388	-0.081	MJH
LEU	TIMS	A	2/11/03	4.395	0.079	MJH
LEU	TIMS	A	2/11/03	4.393	0.033	MJH
LEU	TIMS	A	9/4/03	4.461	0.027	MJH
LEU	TIMS	A	9/4/03	4.464	0.094	MJH
LEU	TIMS	A	9/12/03	4.460	0.004	MJH
LEU	TIMS	A	9/12/03	4.460	0.004	MJH
LEU	TIMS	AC	11/4/02	0.711	-0.183	A
LEU	TIMS	AC	11/5/02	0.712	-0.042	A
LEU	TIMS	AC	11/1/02	0.710	-0.323	B
LEU	TIMS	AC	11/5/02	0.710	-0.323	B
LEU	TIMS	B	12/19/02	4.4668	0.157	ADF
LEU	TIMS	B	12/19/02	4.4672	0.166	ADF
LEU	TIMS	B	10/14/02	4.4638	0.090	NSH
LEU	TIMS	B	10/14/02	4.4670	0.161	NSH
LEU	TIMS	B	3/29/03	4.3926	0.024	JLB
LEU	TIMS	B	3/29/03	4.3941	0.058	JLB
LEU	TIMS	B	3/30/03	4.3885	-0.069	ADF
LEU	TIMS	B	3/30/03	4.3932	0.038	ADF
LEU	TIMS	B	9/17/03	4.4652	0.121	JLB
LEU	TIMS	B	9/17/03	4.4654	0.126	JLB

Material	Method	Facility	Analysis Date	Reported Result	% RD	Analyst
LEU	TIMS	B	9/26/03	4.4657	0.132	DDB
LEU	TIMS	B	9/26/03	4.4659	0.137	DDB
LEU	TIMS	BC	9/23/02	0.7167	0.618	A
LEU	TIMS	BC	9/23/02	0.7147	0.337	A
LEU	TIMS	BC	9/23/02	0.7170	0.660	A
LEU	TIMS	BC	9/23/02	0.7177	0.758	A
LEU	TIMS	BC	9/23/02	0.7166	0.604	B
LEU	TIMS	BC	9/23/02	0.7118	-0.070	B
LEU	TIMS	BC	9/23/02	0.7138	0.211	B
LEU	TIMS	BC	9/23/02	0.7143	0.281	B
LEU	TIMS	BC	10/1/02	0.7164	0.576	A
LEU	TIMS	BC	10/1/02	0.7183	0.842	A
LEU	TIMS	BC	10/1/02	0.7171	0.674	A
LEU	TIMS	BC	10/1/02	0.7163	0.562	A
LEU	TIMS	BC	10/1/02	0.7166	0.604	B
LEU	TIMS	BC	10/1/02	0.7168	0.632	B
LEU	TIMS	BC	10/1/02	0.7196	1.025	B
LEU	TIMS	BC	10/1/02	0.7146	0.323	B
LEU	TIMS	F	12/3/03	4.3904	-0.026	247
LEU	TIMS	F	12/3/03	4.3910	-0.012	247
LEU	TIMS	F	12/3/03	4.3900	-0.035	247
LEU	TIMS	F	12/3/03	4.4602	0.009	247
LEU	TIMS	F	12/3/03	4.4592	-0.013	247
LEU	TIMS	F	12/3/03	4.4595	-0.007	247
LEU	TIMS	G	5/22/03	4.3924	0.020	ELC
LEU	TIMS	G	5/22/03	4.3927	0.026	ELC
LEU	TIMS	T	3/14/03	4.0098	0.040	
LEU	TIMS	T	3/14/03	4.0108	0.065	
LEU	TIMS	T	3/14/03	4.0108	0.065	
LEU	TIMS	T	3/14/03	4.0128	0.115	
LEU	TIMS	T	12/18/02	4.01084	0.066	
LEU	TIMS	T	12/18/02	4.0108	0.065	
LEU	TIMS	T	12/18/02	4.0089	0.017	
LEU	TIMS	T	12/18/02	4.0098	0.040	
LEU	TIMS	T	6/23/03	4.01076	0.064	
LEU	TIMS	T	6/23/03	4.0088	0.015	
LEU	TIMS	T	6/23/03	4.0098	0.040	
LEU	TIMS	T	6/23/03	4.0108	0.065	
LEU	TIMS	T	9/16/03	4.0088	0.015	
LEU	TIMS	T	9/16/03	4.0098	0.040	
LEU	TIMS	T	9/17/03	4.0108	0.065	
LEU	TIMS	T	9/17/03	4.0098	0.040	

Appendix C – Plutonium Assay Results

Material	Method	Analysis Date	Reported Result	% RD	Analyst
Pu sulfate	IDMS	9/13/03	40.6	-1.847	NSH
Pu sulfate	IDMS	9/13/03	40.5	-2.089	NSH

Material	Method	Analysis Date	Reported Result	% RD	Analyst
Pu sulfate	IDMS	9/14/03	40.8	-1.364	CPT
Pu sulfate	IDMS	9/14/03	40.3	-2.572	CPT
Pu sulfate	IDMS	9/13/03	42.6	-0.672	NSH
Pu sulfate	IDMS	9/13/03	42.1	-1.837	NSH
Pu sulfate	IDMS	9/14/03	42.6	-0.672	CPT
Pu sulfate	IDMS	9/14/03	42.1	-1.837	CPT
Pu sulfate	IDMS	9/13/03	45.2	-0.541	NSH
Pu sulfate	IDMS	9/13/03	44.9	-1.201	NSH
Pu sulfate	IDMS	9/14/03	44.9	-1.201	CPT
Pu sulfate	IDMS	9/14/03	44.1	-2.962	CPT
Pu sulfate	IDMS	9/13/03	43.1	-0.632	NSH
Pu sulfate	IDMS	9/13/03	43.1	-0.632	NSH
Pu sulfate	IDMS	9/14/03	42.6	-1.784	CPT
Pu sulfate	IDMS	9/14/03	42.9	-1.093	CPT
Pu sulfate	IDMS	1/16/03	42.782	-0.092	C,M
Pu sulfate	IDMS	1/16/03	42.751	-0.164	C,M
Pu sulfate	IDMS	1/16/03	43.046	-0.096	C,M
Pu sulfate	IDMS	1/16/03	43.022	-0.152	C,M

Appendix D: ^{239}Pu Isotopic Results

Material	Method	Facility	Analysis Date	% RD	Analyst
PU239	TIMS	B	9/13/03	-0.002	NSH
PU239	TIMS	B	9/13/03	-0.013	NSH
PU239	TIMS	B	9/14/03	-0.022	CPT
PU239	TIMS	B	9/14/03	-0.023	CPT
PU239	TIMS	B	9/13/03	0.003	NSH
PU239	TIMS	B	9/13/03	-0.022	NSH
PU239	TIMS	B	9/14/03	0.007	CPT
PU239	TIMS	B	9/14/03	-0.034	CPT
PU239	TIMS	B	9/13/03	-0.011	NSH
PU239	TIMS	B	9/13/03	-0.041	NSH
PU239	TIMS	B	9/14/03	0.175	CPT
PU239	TIMS	B	9/14/03	0.105	CPT
PU239	TIMS	B	9/13/03	-0.038	NSH
PU239	TIMS	B	9/13/03	-0.010	NSH
PU239	TIMS	B	9/14/03	-0.079	CPT
PU239	TIMS	B	9/14/03	0.255	CPT
PU239	TIMS	B	9/17/03	0.088	NSH
PU239	TIMS	B	9/17/03	0.088	NSH
PU239	TIMS	B	9/22/03	0.077	CDN
PU239	TIMS	B	9/22/03	0.080	CDN
PU239	TIMS	B	9/17/03	0.122	NSH
PU239	TIMS	B	9/17/03	0.121	NSH
PU239	TIMS	B	9/22/03	0.055	CDN
PU239	TIMS	B	9/22/03	0.059	CDN
PU239	TIMS	B	9/17/03	0.173	NSH
PU239	TIMS	B	9/17/03	0.156	NSH
PU239	TIMS	B	9/22/03	0.185	CDN
PU239	TIMS	B	9/22/03	0.171	CDN
PU239	TIMS	B	9/17/03	0.149	NSH
PU239	TIMS	B	9/17/03	0.153	NSH
PU239	TIMS	B	9/22/03	0.115	CDN
PU239	TIMS	B	9/22/03	0.078	CDN
PU239	TIMS	G	1/16/03	0.004	C,M
PU239	TIMS	G	1/16/03	0.004	C,M
PU239	TIMS	G	1/16/03	0.006	C,M
PU239	TIMS	G	1/16/03	0.007	C,M
PU239	TIMS	G	1/16/03	-0.001	C,M
PU239	TIMS	G	1/16/03	0.000	C,M
PU239	TIMS	T	12/12/02	0.006	
PU239	TIMS	T	12/12/02	0.005	
PU239	TIMS	T	12/12/02	0.001	
PU239	TIMS	T	12/12/02	0.002	
PU239	TIMS	T	3/12/03	0.014	
PU239	TIMS	T	3/12/03	0.011	
PU239	TIMS	T	3/12/03	0.005	
PU239	TIMS	T	3/12/03	0.007	
PU239	TIMS	T	6/16/03	0.014	
PU239	TIMS	T	6/16/03	0.014	

Material	Method	Facility	Analysis Date	% RD	Analyst
PU239	TIMS	T	6/16/03	0.014	
PU239	TIMS	T	6/16/03	0.010	
PU239	TIMS	T	9/4/03	0.005	
PU239	TIMS	T	9/4/03	0.009	
PU239	TIMS	T	9/4/03	0.014	
PU239	TIMS	T	9/4/03	0.013	

Appendix E: ^{240}Pu Isotopic Results

Material	Method	Facility	Analysis Date	% RD	Analyst
PU240	TIMS	B	9/13/03	0.252	NSH
PU240	TIMS	B	9/13/03	0.833	NSH
PU240	TIMS	B	9/14/03	1.124	CPT
PU240	TIMS	B	9/14/03	1.124	CPT
PU240	TIMS	B	9/13/03	-0.039	NSH
PU240	TIMS	B	9/13/03	1.076	NSH
PU240	TIMS	B	9/14/03	-0.185	CPT
PU240	TIMS	B	9/14/03	1.754	CPT
PU240	TIMS	B	9/13/03	0.141	NSH
PU240	TIMS	B	9/13/03	0.365	NSH
PU240	TIMS	B	9/14/03	-1.200	CPT
PU240	TIMS	B	9/14/03	-0.701	CPT
PU240	TIMS	B	9/13/03	0.279	NSH
PU240	TIMS	B	9/13/03	0.055	NSH
PU240	TIMS	B	9/14/03	0.657	CPT
PU240	TIMS	B	9/14/03	-1.578	CPT
PU240	TIMS	B	9/17/03	-0.502	NSH
PU240	TIMS	B	9/17/03	-0.509	NSH
PU240	TIMS	B	9/22/03	-0.434	CDN
PU240	TIMS	B	9/22/03	-0.430	CDN
PU240	TIMS	B	9/17/03	-0.452	NSH
PU240	TIMS	B	9/17/03	-0.433	NSH
PU240	TIMS	B	9/22/03	-0.274	CDN
PU240	TIMS	B	9/22/03	-0.292	CDN
PU240	TIMS	B	9/17/03	-0.642	NSH
PU240	TIMS	B	9/17/03	-0.600	NSH
PU240	TIMS	B	9/22/03	-0.571	CDN
PU240	TIMS	B	9/22/03	-0.584	CDN
PU240	TIMS	B	9/17/03	-0.627	NSH
PU240	TIMS	B	9/17/03	-0.501	NSH
PU240	TIMS	B	9/22/03	-0.311	CDN
PU240	TIMS	B	9/22/03	-0.348	CDN
PU240	TIMS	G	1/16/03	-0.034	C,M
PU240	TIMS	G	1/16/03	-0.022	C,M
PU240	TIMS	G	1/16/03	-0.002	C,M
PU240	TIMS	G	1/16/03	-0.008	C,M
PU240	TIMS	G	1/16/03	0.004	C,M
PU240	TIMS	G	1/16/03	0.003	C,M
PU240	TIMS	T	12/12/02	-0.040	
PU240	TIMS	T	12/12/02	-0.032	
PU240	TIMS	T	12/12/02	-0.010	
PU240	TIMS	T	12/12/02	-0.010	
PU240	TIMS	T	3/12/03	-0.082	
PU240	TIMS	T	3/12/03	-0.066	
PU240	TIMS	T	3/12/03	-0.040	
PU240	TIMS	T	3/12/03	-0.047	
PU240	TIMS	T	6/16/03	-0.083	
PU240	TIMS	T	6/16/03	-0.083	

Material	Method	Facility	Analysis Date	% RD	Analyst
PU240	TIMS	T	6/16/03	-0.042	
PU240	TIMS	T	6/16/03	-0.043	
PU240	TIMS	T	9/4/03	-0.019	
PU240	TIMS	T	9/4/03	-0.061	
PU240	TIMS	T	9/4/03	-0.038	
PU240	TIMS	T	9/4/03	-0.031	