Exelon Generation.

4300 Winfield Road
Warrenville, IL 60555
630 657 2000 Office

RS-16-229

November 21, 2016

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555-0001

Quad Cities Nuclear Power Station, Units 1 and 2
Renewed Facility Operating License Nos. DPR-29 and DPR-30
NRC Docket Nos. 50-254 and 50-265

Subject: Supplemental Information Regarding Request for License Amendment to Revise Loss of Voltage Relay Settings

References:

1. Letter from P. R. Simpson (Exelon Generation Company, LLC) to U.S. NRC, "Request for License Amendment to Revise Loss of Voltage Relay Settings," dated September 12, 2016

2. Letter from E. A. Brown (U.S. NRC) to B. C. Hanson (Exelon Generation Company, LLC), "Quad Cities Nuclear Power Station, Units 1 and 2 – Supplemental Information Needed for Acceptance Review Concerning Loss of Voltage Relay Setting (CAC Nos. MF8381 and MF8382) (PID L-LA-2016-29555) (RS-15-326)," dated November 8, 2016

In Reference 1, Exelon Generation Company, LLC (EGC) requested an amendment to Renewed Facility Operating License Nos. DPR-29 and DPR-30 for Quad Cities Nuclear Power Station (QCNPS), Units 1 and 2, respectively. The proposed change revises the allowable value for Function 1, "4160 V Essential Service System Bus Undervoltage (Loss of Voltage)," in Technical Specifications (TS) Table 3.3.8.1-1, "Loss of Power Instrumentation."

In Reference 2, the NRC requested additional information that is needed to support the acceptance review of the license amendment request. In response to this request, EGC is providing the attached information.

EGC has reviewed the information supporting a finding of no significant hazards consideration, and the environmental consideration, that were previously provided to the NRC in Attachment 1 of Reference 1. The additional information provided in this submittal does not affect the bases for concluding that the proposed license amendment does not involve a significant hazards consideration. In addition, the additional information provided in this submittal does not affect

the bases for concluding that neither an environmental impact statement nor an environmental assessment needs to be prepared in connection with the proposed amendment.

There are no regulatory commitments contained in this letter. Should you have any questions concerning this letter, please contact Mr. Kenneth M. Nicely at (630) 657-2803.

I declare under penalty of perjury that the foregoing is true and correct. Executed on the 21st day of November 2016.

Respectfully,

Patrick R. Simpson
Manager – Licensing

Attachments:
1. Response to Request for Supplemental Information
2. Calculation QDC-6700-I-0848, "Instrument Drift Analysis of General Electric Model 12IAV69A1A Voltage Relays for 4.16kV Emergency Bus (Loss of Voltage)," Revision 0
3. EC 394927, Attachment 13, "Drift Verification for QDC-6700-I-0848 Bus 13(23)-1-A/B U/V, Bus 13(23)-1-B/C U/V, Bus 14(24)-1-A/B U/V, Bus 14(24)-1-B/C U/V"
4. NES-EIC-20.04, Appendix I, "Negligible Uncertainties," Revision 6

cc: NRC Regional Administrator, Region III
NRC Senior Resident Inspector – Quad Cities Nuclear Power Station
Illinois Emergency Management Agency – Division of Nuclear Safety

bcc:

NRC Project Manager – NRR – Quad Cities
Director – Licensing West
Manager – Licensing, Quad Cities
Senior Vice President – Engineering and Technical Services
Site Vice President – Quad Cities
Regulatory Assurance Manager – Quad Cities
Exelon Document Control Desk Licensing (Hard Copy)
Exelon Document Control Desk Licensing (Electronic Copy)
Dave Ulozas – MidAmerican Energy Company (Electronic Copy)
DWULozas@midamerican.com
Commitment Coordinator – Cantera
Ken Nicely
Rachel Luebbe
Rick Swart
Jody Rathman

ATTACHMENT 1
Response to Request for Supplemental Information

NRC Request

The NRC staff has reviewed your application and concluded that additional information addressing the derivation of the instrument setpoint values associated with the loss of voltage relay setpoint is necessary to enable the staff to make an independent assessment regarding the acceptability of the proposed amendment/relief request in terms of regulatory requirements and the protection of public health and safety and the environment. The submittal should include information on all instrument uncertainty factors used to derive setpoints.

Response

Attachment 4 of Reference 1 provided design analysis QDC-6700-E-0939, "Loss of Voltage Relay Setpoint for Buses 13-1, 14-1, 23-1, and 24-1," which establishes the new loss of voltage relay setpoint, setting tolerances, expanded tolerances, and allowable values based on the new analytical limits. During a conference call with the NRC on November 3, 2016, the NRC clarified that additional justification was needed related to the methodology and acceptance criteria listed as Items 2.3, 2.4, and 2.5 on page 5 of design analysis QDC-6700-E-0939, which are listed below.

2.3 Vendor Specifications

Published instrument vendor specifications are considered to be based on sufficiently large samples so that the probability and confidence level meets the 2σ criteria, unless stated otherwise by the vendor.

2.4 Negligible Uncertainties

Per Appendix I of NES-EIC-20.04 (Ref. 5.1 .2), the effects of radiation (eR), humidity (eH), power supply (eV), calibration standard equipment (STD), and seismic (eS) under normal operating conditions may typically be considered negligible. For the evaluation of normal operating conditions, these errors are considered negligible unless otherwise noted.

2.5 Other Environmental Effects

For environmental effects not considered negligible (Section 2.4), if the vendor does not provide a separate specification but the environmental limits are bounded by the vendor operating limits, then the effect is considered included in the reference accuracy.

Calculation QDC-6700-I-0848, Revision 0, "Instrument Drift Analysis of General Electric Model 12IAV69A1A Voltage Relays for 4.16kV Emergency Bus (Loss of Voltage)," as referenced in design analysis QDC-6700-E-0939, Section 4.6 "Calculated Drift Specifications," validates the 2σ drift for a 24 month surveillance interval (i.e., 30 months with late factor). Calculation QDC-6700-I-0848, Attachment A, documents seven years of raw data (i.e., 1993 through 1999) from surveillances of the voltage relays. Calculation QDC-6700-I-0848 is provided in Attachment 2.

In addition, Exelon Generation Company, LLC (EGC) procedure ER-AA-520, "Instrument Performance Trending," requires periodic updates of the drift analysis. The most recent periodic update was documented in EC 394927, "Prepare a Drift Analysis Per ER-AA-520 (2013)," which further validated the 2σ drift with 11 years of empirical data from 2002 through 2013. Attachment 13 of EC 394927, which addresses the calculation QDC-6700-I-0848 drift analysis, is provided in Attachment 3.

Section 6.2 of design analysis QDC-6700-E-0939 provides justification for the random errors for the Loss of Voltage relay. The justification for negligible uncertainties is provided in Section 2.0, "Negligible Uncertainties," and Table I1, "Negligible Errors and Uncertainties for Relays and Timers," of Appendix I to NES-EIC-20.04, "Analysis of Instrument Channel Setpoint Error and Instrument Loop Accuracy." Appendix I to NES-EIC-20.04 is provided in Attachment 4.

NES-EIC-20.04 defines an acceptable method for establishing the uncertainties associated with instruments, instrument loops, and instrument setpoints and for applying these uncertainties in the determination of instrument loop accuracy, allowable values, and calculated setpoints at several EGC nuclear stations. The NRC has approved use of this methodology for Quad Cities Nuclear Power Station (QCNPS) as discussed below.

In Reference 2, the NRC issued license amendments for QCNPS, Units 1 and 2, to support the conversion of the QCNPS Technical Specifications to a set of improved Technical Specifications based on NUREG-1433, Revision 1, "Standard Technical Specifications, General Electric Plants BWR/4." The Technical Specifications changes included increases to surveillance frequencies to support the transition to 24-month fuel cycles. The associated NRC safety evaluation documents the NRC's review of Revisions 1 (ADAMS Accession No. ML003698624) and 2 (ADAMS Accession No. ML003721342) of NES-EIC-20.04. In addition, as stated in the NRC's safety evaluation, EGC also provided Revision 3 of NES-EIC-20.04 to the NRC. In the safety evaluation, the NRC concluded that "The staff also finds that the instrument setpoint methodology used by the licensee to determine the allowable values is acceptable."

Subsequent to the issuance of the Reference 2 license amendments and associated safety evaluation, EGC issued Revisions 4, 5, and 6 to NES-EIC-20.04. None of these revisions impacted Appendix I to NES-EIC-20.04. Therefore, the methodology for treatment of negligible uncertainties used in determining the loss of voltage relay settings is the same methodology reviewed by the NRC in 2001.

References

1. Letter from P. R. Simpson (Exelon Generation Company, LLC) to U.S. NRC, "Request for License Amendment to Revise Loss of Voltage Relay Settings," dated September 12, 2016

2. Letter from S. N. Bailey (U.S. NRC) to O. D. Kingsley (Exelon Generation Company, LLC), "Issuance of Amendment (TAC Nos. MA8378 and mA8379)," dated March 30, 2001

ATTACHMENT 2

Calculation QDC-6700-I-0848, "Instrument Drift Analysis of General Electric Model 12IAV69A1A Voltage Relays for 4.16kV Emergency Bus (Loss of Voltage)," Revision 0

ComEd

CALCULATION TITLE PAGE

CALCULATION NO: QDC-6700-I-0848 REV. 0
STATION/UNIT: **Quad Cities/1 and 2**
TITLE: **Instrument Drift Analysis of General Electric Model 12IAV69A1A Voltage Relays for 4.16kV Emergency Bus (Loss of Voltage)**

DESCRIPTION CODE: **I03** SYSTEM CODE: **B67 (6700)**
DISCIPLINE CODE: **I** ELEVATION CODE: **Misc.**

☒ **Safety Related** ☐ **Augmented Quality Related** ☐ **Non-Safety Related**

REFERENCE NUMBERS:

Type	Number
PROJ	105260

COMPONENT EPN:

EPN	Comp Type
See Section 1.2	

DOCUMENT NUMBERS:

Doc Type/ SubType		Document Number
		None

PEPP-E FORM

CALCULATION NO: QDC-6700-I-0848
STATION/UNIT: **Quad Cities/1 and 2**
TITLE: **Instrument Drift Analysis of General Electric Model 12IAV69A1A Voltage Relays for 4.16kV Emergency Bus (Loss of Voltage)**

REVISION SUMMARY:

Original Issue

Program Library Number: N/A

Electronic Calculation Data Files: Microsoft Excel 97/QDC-6700-I-0848 Rev 0.xls/1.70MB/2-22-00/13:50
(Program Name, Version, File name ext/size/date/hour:min)

Type of Review: ☒ Detailed ☐ Alternate ☐ Test ☐ Repetitive Calc Review

DO ANY ASSUMPTIONS IN THIS CALCULATION REQUIRE LATER VERIFICATION? ☐ YES ☒ NO

Tracked by: (NTS#, AT#, EWCS #, etc.) N/A
Approvals required when initiating Calc Revision in accordance with Section C.5.4

	Print/Sign/Initial	Org.	Date
Prepared by:	Bruce L. Crabbs / Bruce L. Crabbs / BLC	EXCEL	2/22/00
Reviewed by:	Richard J. Hannigan / Richard J. Hannigan / RJH	EXCEL	2/23/00
Approved by	Joe P. Taft / JPTaft / JPT	ComEd	3/23/00

Supplemental Review Required ☑ Yes (NEP-12-05 documentation attached) ☐ No
Supervisor JPTaft / 3/23/00 (ComEd USE ONLY)

PEPP-E FORM

ATTACHMENT B (Page 1 of 3)

REVIEW CHECKLIST FOR CONTROLLED WORK

Title of Controlled Work product: QDC-6700-I-0848 REV. 0 INSTRUMENT DRIFT ANALYSIS OF GENERAL ELECTRIC MODEL 121AV69A1A VOLTAGE RELAYS FOR 4.16kV EMERGENCY BUS (LOSS OF VOLTAGE)

1) Check type of Controlled Work Review being performed (check all that apply):

Type of Controlled Work		Type of Review
Safety Evaluation or Reload Design Eval.		Independent/Acceptance Review
NRC Submittal or License Amendment		Independent/Acceptance Review
Recomm. Important to Safety in Design or Oper.		Independent/Acceptance Review
Other routine Controlled Work (specify)		Independent/Acceptance Review

Other non-routine Controlled Work (specify)		Supplemental Review
Special Controlled Analysis (SCA) from NEP-12-02	✓	Supplemental Review (go to Section 3 – do not complete Section 2)

2) Check applicable box for each verification upon completion:

Required Verifications

	Controlled Work package (all pages incl. cover letter) reviewed & verified to be internally consistent.
N/A	Verify that any controlled documents (such as NDITs) are to be transmitted directly to Central Files. Mark N/A box if the transmittal package does not contain any controlled docs.
N/A	If this Controlled Work revises an existing document(s), verify that the transmittal package explicitly identifies the doc(s) to be superseded. Mark N/A box if no doc. revisions involved.
	Verify that CW Traveler (Att. A) was initiated.
N/A	If this Controlled Work includes a 50.59 Safety Evaluation (NSWP-A-04), ensure that all the items required by the procedure for preparing 50.59 Safety Evaluations are included. These items include all the applicable forms, all the questions are answered, any required attached documents, etc.

ATTACHMENT B (Page 2 of 3)

3) Review Scope (Initial if applicable and verified):

RT ______ Conformance to design requirements

RT ______ Conformance to applicable codes, standards, and regulatory requirements

______ Identification of applicable design and safety limits

RT ______ Appropriateness of analysis method

RT ______ Conservative method used/recommendations given relative to design and safety limits

RT ______ Validity and justification of any assumptions

______ Identification of appropriately verified computer codes and versions

______ *Conformance of code application with NRC SER or similar document*

(1) RT ______ Correct incorporation of input into the analysis

______ Completeness of key input review by all appropriate ComEd areas

RT ______ Reasonableness of analysis output/conclusion compared to input/assumptions

______ Reasonableness of recommendations/results based on previous experience

______ Correctness of calculations or analyses by alternate methods

______ Correctness and traceability of any data used

______ Consistency of analysis results with proposed licensed amendment

______ Specification of any review requirements for an Interface organization

______ Effect on plant drawings, procedures, data bases, plant simulator

______ System interactions

______ Identification of any changes in other controlled documents (e.g. UFSAR, Technical Specifications, COLR).

ATTACHMENT B (Page 3 of 3)

4) Description of Verification - Activities, Findings and Resolutions:

① PARTIAL, RANDOM VERIFICATION OF DATA INPUT

Reviewer's Signature (N/A for SCA's):	N/A	Date	
Additional Reviewer's Signature:	RE Thom RT	Date	3-16-00
Supervisor (for SCA's only):	[signature]	Date	3/23/00

Independent Review for QDC-6700-I-0848, Rev. 0

During the independent review of calculation QDC-6700-I-0848 (Rev. 0) IPASS and Lotus 1-2-3 were used to validate the results generated by MS Excel in the calculation. In the table below the results of the validation for the QDC-6700-I-0848 values and the values produced by IPASS and Lotus 1-2-3 are illustrated. The results from IPASS and Lotus 1-2-3 validated the calculation QDC-6700-I-0848 results generated by MS Excel. Minor differences in the values between the MS Excel generated results and the IPASS and Lotus 1-2-3 generated results were reviewed and can be attributed to rounding and conversion between applications. Below is a partial listing of some of the values from QDC-6700-I-0848 that were validated:

Parameter	QDC-6700-I-0848 value	Validation value	Validation application	Valid?
Mean	0.035	0.035	Lotus 1-2-3, IPASS	Yes
Median	0.040	0.040	Lotus 1-2-3, IPASS	Yes
Std Dev	0.452	0.452	Lotus 1-2-3, IPASS	Yes
Count	31	31	Lotus 1-2-3, IPASS	Yes
Max	0.700	0.700	Lotus 1-2-3	Yes
Min	-1.300	-1.300	Lotus 1-2-3	Yes
Range	2.000	2.000	Lotus 1-2-3	Yes
Sum	1.090	1.090	Lotus 1-2-3	Yes
Kurtosis	1.047	1.047	Lotus 1-2-3	Yes
Skewness	-0.748	-0.748	Lotus 1-2-3	Yes
Drift scatter plot including prediction line	N/A	Visual inspection shows agreement between the scatter plots and prediction lines	Lotus 1-2-3, IPASS	Yes
Drift scatter plot prediction line	Y = -0.0002x + 0.1459	Y = -0.000249x + 0.146	Lotus 1-2-3	Yes
Chi-Squared value	15.135 (does not confirm normality)	15.13297 (does not confirm normality)	Lotus 1-2-3	Yes
W Test statistic	0.9500 (confirms normality)	0.9500 (confirms normality)	Lotus 1-2-3	Yes
Outliers	Data ID # 45	Data ID # 45	Lotus 1-2-3	Yes
Histogram	N/A	Visual inspection shows agreement between the two histograms	IPASS	Yes

Parameter	QDC-6700-I-0848 value	Validation value	Validation application	Valid?
Data w/i 1 raw std dev	20	20	Lotus 1-2-3	Yes
Data w/i 2 raw std dev	30	30	Lotus 1-2-3	Yes
Bin 3 count	8	8	Lotus 1-2-3	Yes
Bin 3 drift std dev	0.279	0.279	Lotus 1-2-3	Yes
Bin 3 drift mean	-0.039	-0.039	Lotus 1-2-3	Yes
Bin 3 interval mean	173.3	173.3	Lotus 1-2-3	Yes
Bin 4 count	12	12	Lotus 1-2-3	Yes
Bin 4 drift std dev	0.388	0.388	Lotus 1-2-3	Yes
Bin 4 drift mean	0.183	0.183	Lotus 1-2-3	Yes
Bin 4 interval mean	381.3	381.3	Lotus 1-2-3	Yes
Bin 5 count	1	1	Lotus 1-2-3	Yes
Bin 5 drift std dev	N/A	N/A	Lotus 1-2-3	Yes
Bin 5 drift mean	0.040	0.040	Lotus 1-2-3	Yes
Bin 5 interval mean	649.0	649.0	Lotus 1-2-3	Yes
Bin 6 count	10	10	Lotus 1-2-3	Yes
Bin 6 drift std dev	0.623	0.623	Lotus 1-2-3	Yes
Bin 6 drift mean	-0.084	-0.084	Lotus 1-2-3	Yes
Bin 6 interval mean	720.2	720.2	Lotus 1-2-3	Yes

Parameter	QDC-6700-I-0848 value	Validation value	Validation application	Valid?
Bins 3 – 6 drift scatter plot including prediction line	N/A	Visual inspection shows agreement between the two scatter plots and prediction lines	Lotus 1-2-3	Yes
Bins 3 – 6 drift scatter plot prediction line	Y = -0.0002485x + 0.145902	Y = -0.000249x + 0.146	Lotus 1-2-3	Yes
Bins 3 – 6 drift absolute value scatter plot including prediction line	N/A	Visual inspection shows agreement between the two scatter plots and prediction lines	Lotus 1-2-3	Yes
Bins 3 – 6 drift absolute value scatter plot prediction line	Y = 0.00048497x + 0.129391	Y = 0.000485x + 0.129	Lotus 1-2-3	Yes
Bins 3, 4, and 6 drift standard deviation scatter plot including prediction line	N/A	Visual inspection shows agreement between the two scatter plots and prediction lines	Lotus 1-2-3	Yes
Bins 3, 4, and 6 drift standard deviation scatter plot prediction line	Y = 0.000635x + 0.16	Y = 0.000635x + 0.16	Lotus 1-2-3	Yes

Other values, including those based on the above parameters, were checked using hand calculations.

Independent Review performed by: R J Hannigan 12/23/00
R. J. Hannigan

CALCULATION NO: QDC-6700-I-0848 REV. 0

Table of Contents

PEPP-E FORM

CALCULATIONS:

1.0 PURPOSE / OBJECTIVE

1.1 In order to support a new 24-month operating cycle, the base calibration interval for the instrumentation addressed by this calculation needs to be increased from 18 to 24 months. The purpose of this calculation is to establish the drift uncertainty values and characteristics that will be used by instrument uncertainty calculations for determination of setpoints and allowable values for the subject instrumentation. The drift values will be determined for a maximum surveillance interval of 30 months, because of the extra 25% grace period allowed by Technical Specifications. (24 Months x 1.25 = 30 Months)

1.2 Specifically, this calculation addresses the voltage function of General Electric Model 12IAV69A1A Voltage Relays, with tag numbers as shown in Table 1.2-1 below. Also shown in the table are the calibration procedure numbers and functions, associated uncertainty calculations, and applicable Tech Spec sections.

TABLE 1.2-1
COMPONENT LIST

PROCEDURE NO.	TAG NO.	PROCEDURE FUNCTION	TECH SPEC	UNCERTAINTY CALCULATIONS
QCOADS 0100-19; QCOADS 0100-1	Bus 13-1-A/B U/V, Bus 13-1-B/C U/V	4Kv Bus Degraded Voltage and Undervoltage Relay Calibration	Table 4.2.B-1 Item 5.a; TS 4.2.B.1	N/A
QCOADS 0100-20; QCOADS 0100-1	Bus 14-1-A/B U/V, Bus 14-1-B/C U/V	4Kv Bus Degraded Voltage and Undervoltage Relay Calibration	Table 4.2.B-1 Item 5.a; TS 4.2.B.1	N/A
QCOADS 0200-19	Bus 23-1-A/B U/V, Bus 23-1-B/C U/V	4Kv Bus Degraded Voltage and Undervoltage Relay Calibration	Table 4.2.B-1 Item 5.a; TS 4.2.B.1	N/A
QCOADS 0200-20	Bus 24-1-A/B U/V, Bus 24-1-B/C U/V	4Kv Bus Degraded Voltage and Undervoltage Relay Calibration	Table 4.2.B-1 Item 5.a; TS 4.2.B.1	N/A

2.0 METHODOLOGY AND ACCEPTANCE CRITERIA

2.1 The methodology used for this calculation is based on Appendix J of NES-EIC-20.04, "Analysis of Instrument Channel Setpoint Error and Instrument Loop Accuracy", Rev. 1 (Reference 5.1.2), EPRI TR-103335, "Guidelines for Instrument Calibration Extension / Reduction Programs", Revision 1 (Reference 5.1.3), and the Improved Technical Specifications (ITS) and 24-Month Technical Specifications Project Technical Plan, Revision 1 (Reference 5.1.4). A summarized description of the methodology is listed under this section, but the detailed references for criteria, equations, and values used are detailed in Section 6 and within the attachments.

2.2 The methodology of analyzing As Found / As Left drift data is made up of several general steps. The steps for the analysis are listed herein, but are explained more fully in References 5.1.2 and 5.1.3. The mathematical computations of the statistical analysis are performed within an EXCEL spreadsheet. All data within the spreadsheet are printed out in the form of the Attachments to this calculation.

2.2.1 As Found and As Left data from historical calibration records are entered into a spreadsheet, from which drift uncertainty is derived. The date of calibration is also recorded.

2.2.2 Drift uncertainty for each calibration point is computed by subtracting the As Left data of one calibration from the As Found data of the next calibration. Time between calibrations is computed from the calibration dates.

2.3 Initial T-tests for outliers are performed to identify potential invalid or inappropriate data for the analysis. The data identified as outliers are researched to determine if the data should be excluded from the rest of the analysis. A small portion of outliers may be excluded from the analysis based on being purely statistical outliers in accordance with Appendix J to Reference 5.1.2.

2.4 In order to characterize the drift uncertainty, normality and time dependency are analyzed through a series of steps.

2.5 The drift data is checked through standard statistical means for determination of the normality of the data set. The Chi-Square Goodness of Fit test or either the W or D Prime test is used, depending on sample size. If these approaches do not confirm that the data is normally distributed, then visual examinations are used with a normality plot and coverage analysis to determine if a normal distribution is conservative with respect to the data. The coverage analysis consists of a histogram and a bin-by-bin comparison of actual data to expectations for a normal distribution. If the data cannot be determined to be normally distributed, or conservatively treated as normal, the drift is considered as a systematic (bias) error in the instrument uncertainty calculations.

2.6 Time dependency of the instrument drift will be assessed via a scatter plot, a binning analysis, and linear regression analyses on the drift data and the absolute value of the drift data as functions of time interval. Finally, regression analyses are also performed for the mean and standard deviations of the bins that were selected for use in the binning analyses, if a sufficient number of bins are selected.

2.7 A drift tolerance interval, to be used for instrument uncertainty analysis, is determined, based on the results of the tests above. The drift data is characterized as normal or systematic, or as part bias and part random, or random.

2.8 Acceptance Criteria: Since the conclusion of the calculation will be to generate a value and description of the characteristics of the drift of the device, there are no acceptance criteria.

3.0 ASSUMPTIONS / ENGINEERING JUDGEMENTS

3.1 None

4.0 DESIGN INPUTS

4.1 Attachment A is a listing of the historical raw input data as recorded from the calibration procedures to be used for this drift analysis. (References are contained in section 5.2.) All dates of calibration are also entered to provide time intervals between calibrations.

4.2 Attachment B is a listing of the historical As Left and As Found data from Attachment A, with any data exclusions or modifications noted. All dates of calibration are also entered to provide time intervals between calibrations.

4.3 Attachment C contains the model numbers and the As Found/As Left data taken from Attachment B. Attachment C calculates the drift values for each applicable point and the calibration intervals in days and months.

4.4 Data not entered into the analysis is listed in the table below, showing the reasoning used in not entering the data.

Table 4.4-1
Data Not Entered in the Drift Analysis

Procedure Number	Tag Number	Calibration Date	Comments/Disposition
QCOADS 0100-20	BUS 14-1-B/C U/V	02/19/96	Statistical Outlier – See Section 6.2.1 below.

4.5 A walk-down of the plant-installed instruments was performed in verify the manufacturer and model number of the relays contained within this calculation. The results of the walk-down are contained in Reference 5.4.2.

5.0 REFERENCES

5.1 METHODOLOGY

5.1.1 ANSI/ISA-S67.04-Part I-1994, "Setpoints for Nuclear Safety Related Instrumentation"

5.1.2 NES-EIC-20.04, "Analysis of Instrument Channel Setpoint Error and Instrument Loop Accuracy," Rev. 1

5.1.3 EPRI TR-103335, "Guidelines for Instrument Calibration Extension / Reduction Programs," Rev. 1

5.1.4 DG99-001245, Improved Technical Specifications (ITS) and 24-Month Technical Specifications Project Technical Plan, Revision 1, November 8, 1999

5.1.5 DOE Research and Development Report No. WAPD-TM-1292, "Statistics for Nuclear Engineers and Scientists Part 1: Basic Statistical Inference," February 1981

5.1.6 NRC Generic Letter 91-04, "Changes in Technical Specification Surveillance Requirements to Accommodate a 24 Month Fuel Cycle," April 2, 1991

5.1.7 ISA-RP67.04-Part II-1994, "Methodologies for the Determination of Setpoints for Nuclear Safety-Related Instrumentation," Second Printing, June 12, 1995

5.1.8 American National Standard N15.15-1974, "Assessment of the Assumption of Normality (Employing Individual Observed Values)"

5.2 PROCEDURES

5.2.1 Historical Records from Quad Cities Station Surveillance Procedure QCOADS 0100-19, Quad Cities OAD Undervoltage Relay Calibration Bus 13-1

5.2.2 Historical Records from Quad Cities Station Surveillance Procedure QCOADS 0100-20, Quad Cities OAD Undervoltage Relay Calibration Bus 14-1

5.2.3 Historical Records from Quad Cities Station Surveillance Procedure QCOADS 0200-19, Quad Cities OAD Undervoltage Relay Calibration Bus 23-1

5.2.4 Historical Records from Quad Cities Station Surveillance Procedure QCOADS 0200-20, Quad Cities OAD Undervoltage Relay Calibration Bus 24-1

5.2.5 Historical Records from Quad Cities Station Surveillance Procedure QCOADS 0100-1, Quad Cities OAD Undervoltage Relay Calibration Bus 13-1 and 14-1

5.3 CALCULATIONS

5.3.1 None

5.4 MISCELLANEOUS REFERENCES

5.4.1 EWCS Database Listings

5.4.2 NDIT No. QDC-00-0014, Walkdown Results Which Support the ITS Project, February 7, 2000

6.0 CALCULATIONS

6.1 Gather and Generate Raw Drift Data

6.1.1 Specifically, this calculation addresses the voltage function of General Electric Model 12IAV69A1A Voltage Relays, with the tag numbers as shown in Table 1.2-1 of this calculation.

6.1.2 After the statistical outlier test described in section 6.2.1 below and removal of any outliers, a pooling test was performed as described in Sections 2.3.1.4 through 2.3.1.6 of Appendix J to Reference 5.1.2 and as directed in Reference 5.1.4. A critical T-test was performed, with the Critical T value reduced incrementally until 10% of the data population were outliers, to determine if proper pooling techniques were used. The critical T value had to be reduced significantly to show significant additional outliers. Outliers appeared across the data set, without any evident correlation to improper pooling of the data. Therefore, it is concluded that the data within the initial data set is from the same statistical pool, and therefore has been combined properly for analysis.

6.1.3 Attachment B is a listing of the As Found and As Left data from available historical plant calibration records. Note that the calibration dates are also recorded, and notes are provided to clarify the activities performed. This data was entered into an EXCEL spreadsheet for computation of the drift values, time intervals between calibrations and the statistical analysis of the data.

6.1.4 Drift uncertainty is computed by subtracting the As Left data of one calibration from the As Found data of the next calibration, as documented in Attachment C. Attachment C also shows the computation of the time intervals between calibrations.

6.2 Determination of Outliers

6.2.1 The outlier analysis is recorded in Attachment D to this calculation. One outlier was removed from the data set. One outlier represents 3.125% of the initial data set. Since this is less than 5% of the initial data set allowed per the guidelines of Reference 5.1.2, this outlier was removed from the analysis. The critical T values for various sample sizes are tabulated in Attachment E.

6.3 Tests for Normality

6.3.1 The Chi-Square Goodness of Fit test was performed on the data to test for normality. Since the result of the Chi-Square computation, 15.135, is greater than the degrees of freedom, 9, the Chi-Square test cannot confirm normality of the data. (See Appendix C, Section C.1 of Reference 5.1.3 for methodology.) The results of this test are tabulated in Attachment F.

6.3.2 Since the final data set consists of 31 data points, the W Test was performed on the data, per the requirements of Reference 5.1.3. The W Test confirms that the data is a sample from a normal distribution. A summary of the results of the test is included in Attachment G.

6.3.3 For Information Only, a normality plot and histogram are included in this analysis. The Normality Plot for this data is displayed in Attachment H. The function displayed by the Normality Plot is not a linear function however, one cannot fully confirm normality with this plot alone.

6.3.4 For the coverage analysis, a histogram shows the distribution of points in the actual drift data versus that which would be observed if the data ideally conformed to the normal curve. To generate the histogram data, the drift values are categorized into 12 bins, in relation to the mean and standard deviation. In addition, expected numbers of data points are calculated, assuming that the data was a normal distribution and that the data set was exactly representative of a normal curve. The histogram is documented in Attachment I.

6.3.5 By visual inspection, the following items are noted. Although the data does not tend to reasonably follow a linear model as shown in the normality plot, the data is relatively close to a normal distribution as shown in the histogram, so the data is near normal. From looking at the histogram and bins within Attachment I, the data appears to generally resemble a normal distribution with a larger than normal concentration of data around the mean, which is supported by a moderate kurtosis. The data does have adequate population within ± 2 standard deviations to provide the required coverage for normality. Therefore, the histogram and normality plot provide additional visual evidence of normality of this data set, as confirmed by the W Test in Attachment G.

6.4 Time Dependency

6.4.1 In order to determine time dependency of the drift data, the data is first plotted as a scatter plot in Attachment J. The trendline within this scatter plot shows a slight decreasing trend from a small initial positive value to a small negative value, but no specific conclusions can be made from the scatter plot alone.

6.4.2 To continue on with time dependency analysis, the binning analysis is performed. The data is divided into bins, based on the intervals between calibrations as defined in section 2.5.2.1 of Appendix J to Reference 5.1.2. Statistical summaries for each bin, including count, mean, standard deviation, and mean time interval are computed. This information is given in Attachment K to this calculation.

6.4.3 Per section 2.5.2.3 of Appendix J to Reference 5.1.2, after removing those bins with 5 or less data points and those with 10% or less of the total population, the remaining bins are 3, 4 and 6. A T-test was not performed between any bins being considered, because the bin count difference between bins is less than 20% of the total data count. The valid interval, as defined by Section 2.6.1.4 of Appendix J of Reference 5.1.2, for the binning regressions is from bin 3 through bin 6, or 136 to 800 days.

6.4.4 Attachment K shows a plot of the mean and standard deviations of the drift data versus the average time interval between calibrations for the subject bins. It also provides all of the binning parameters and statistics that are a part of the binning analysis. The plot reveals that the mean of the drift data exhibits a non-linear function by varying up and down over the analyzed period, starting at a negative value in bin 3, going to a positive value in bin 4, and returning to a negative value in bin 6. The standard deviation of the drift data does increase over the analyzed period.

6.4.5 Per section 2.5.2.4 of Appendix J of Reference 5.1.2, a drift regression analysis was performed on the drift data that was included in the selected bins above and the data in between them. In this case, 100% of the drift data was included because no data is contained in bins 1, 2, 7 and 8. The regression analysis included as Attachment L displays an R Squared value is much less than 0.3, thereby exhibiting no linear time dependency of the mean. An additional regression analysis was performed on the absolute value of the drift data, and is included as Attachment M. The regression analysis for the absolute value of the drift data displays an increasing trend, but the R Squared value for the absolute value is much less than 0.3, indicating no linear time dependency.

6.4.6 The scatter, binning analysis and drift regression plots all indicate a slightly sloping mean value over time, which crosses zero towards the end of the analysis. Because of these plots, and since the R-Squared value within Attachment L is much less than 0.3, the mean will be conservatively treated as time independent per the criteria of Section 2.5.2.6 of Appendix J to Reference 5.1.2.

6.4.7 Although the regression analyses showed no particular *linear* time dependency per the R Squared value in Attachment M, visual assessments of the data in the scatter plot, the binning plot and absolute value regression plot indicate that the standard deviation of the data tends to increase over time. Since the most conservative treatment of drift is linear (Reference 5.1.7, Section 6.2.7), the standard deviation of the drift is conservatively treated as linearly time dependent in this analysis.

6.5 Drift Tolerance Interval and Characterization

6.5.1 This analysis of drift for General Electric Model 12IAV69A1A Voltage Relays confirms that the random portion of the drift is normally distributed (Section 6.3.2), but the analysis also identified increasing random drift over time (Section 6.4.7). The calculation also determined the drift bias term to be time independent per Section 6.4.6 above.

6.5.2 The drift bias term for time independent drift is determined from the mean of the final data set, per Section 2.6.1.1 of Appendix J to Reference 5.1.2. The mean of the final data set is computed in Attachment D to be +0.035 volts. This value equates to 0.042 percent of full scale when using 83.7 volts (the lowest voltage setpoint value of the relays covered by this calculation per Attachment A) as full scale. Per the guidelines established in Section 2.6.1.1 of Appendix J to Reference 5.1.2, this value can be considered negligible. Therefore, a drift bias term will not be considered in this calculation.

6.5.3 The random portion of the drift is determined by linearly extrapolating the standard deviation of the data to the required calibration interval of 915 days. This is done in Attachment N by extrapolating the standard deviation line from bins 3, 4, and 6. The standard deviation line of those bins is extrapolated to 915 days by using the regression "intercept" and "X variable 1" coefficients listed in the ANOVA Table on Attachment N. To determine the random portion of the drift, per section 2.6.1.3 of Appendix J of Reference 5.1.2, the extrapolated standard deviation value is multiplied by a confidence multiplier (2.549) for 95/95 for 30 data points (the total within the subject bins). The 95/95 confidence factor multiplier is selected because the instruments under analysis provide an ECCS protection function. The confidence multiplier comes from tables in Reference 5.1.4, which are copied from Reference 5.1.5.

Random Drift Tolerance Interval (95/95% Bound) = $\pm KS$

where: K = 2.549 (Confidence Multiplier for 30 data points) (Ref. 5.1.4)
S = 0.741 volts (Extrapolated Standard Deviation – Attachment N)

Random Drift Tolerance Int. (95/95% Bound) = ± (2.549)(0.741)
= ± 1.889 volts (915 Days)

7.0 SUMMARY AND CONCLUSIONS

7.1 The bounding 915 day drift value for the voltage function of the General Electric Model 12IAV69A1A Voltage Relays (See Table 1.2-1), has been determined to be a random ±1.889 volts, with a negligible bias value. The random portion of the drift term is confirmed as normally distributed, and should be treated as a 2σ value for uncertainty analysis. The random portion of drift is conservatively treated as linearly time dependent.

7.2 The results of this calculation can be conservatively applied to the voltage function of any General Electric Model 12IAV69A1A Voltage Relay which meets the criteria listed in Section 5.3, "Considerations When Combining Instruments Into a Single Group", of Reference 5.1.3.

PEPP-E FORM

8.0 ATTACHMENTS

A. Raw Data
B. Input Data
C. AF - AL Data
D. Outliers
E. T-Values
F. Chi-Square
G. W Test
H. Normality Plot
I. Histogram
J. Scatter Plot
K. Binning Analysis
L. Regression – Drift
M. Regression – AV of Drift
N. Regression - Bin Std. Dev.

Surveillance	Tag Number	Date	Point	Desired	AF	AL	Units	Comments
QCOADS 0100-19	BUS 13-1-A/B U/V	04/19/99	1	83.7	84.74	84.74	VAC	
QCOADS 0100-19	BUS 13-1-A/B U/V	11/14/98	1	83.7	84.8	84.8	VAC	
QCOADS 0100-19	BUS 13-1-A/B U/V	04/30/98	1	83.7	85.2	84.3	VAC	
QCOADS 0100-19	BUS 13-1-A/B U/V	04/14/97	1	83.7	84.7	84.7	VAC	
QCOADS 0100-19	BUS 13-1-A/B U/V	03/28/96	1	87	85	85	VAC	
QCOADS 0100-1	BUS 13-1-A/B U/V	03/29/94	1	87	84.6	84.68	VAC	
QCOADS 0100-19	BUS 13-1-B/C U/V	04/19/99	1	83.7	83.75	83.75	VAC	
QCOADS 0100-19	BUS 13-1-B/C U/V	11/14/98	1	83.7	84.1	84.1	VAC	
QCOADS 0100-19	BUS 13-1-B/C U/V	04/30/98	1	83.70	84.10	84.10	VAC	
QCOADS 0100-19	BUS 13-1-B/C U/V	04/14/97	1	83.7	87.2	83.9	VAC	
QCOADS 0100-19	BUS 13-1-B/C U/V	03/28/96	1	87	84.6	87	VAC	
QCOADS 0100-1	BUS 13-1-B/C U/V	03/29/94	1	87	83.7	84.36	VAC	
QCOADS 0100-20	BUS 14-1-A/B U/V	04/16/99	1	83.7	82.9	82.9	VAC	
QCOADS 0100-20	BUS 14-1-A/B U/V	11/13/98	1	83.7	83	83	VAC	
QCOADS 0100-20	BUS 14-1-A/B U/V	05/12/98	1	83.7	83	83	VAC	
QCOADS 0100-20	BUS 14-1-A/B U/V	05/12/98	1	83.7	83	83	VAC	
QCOADS 0100-20	BUS 14-1-A/B U/V	04/14/97	1	83.7	87	82.8	VAC	
QCOADS 0100-20	BUS 14-1-A/B U/V	02/19/96	1	87	85.1	87	VAC	
QCOADS 0100-1	BUS 14-1-A/B U/V	05/11/94	1	87	84.71	85.06	VAC	
QCOADS 0100-20	BUS 14-1-B/C U/V	04/16/99	1	83.7	83.6	83.6	VAC	
QCOADS 0100-20	BUS 14-1-B/C U/V	11/13/98	1	83.7	83.5	83.5	VAC	
QCOADS 0100-20	BUS 14-1-B/C U/V	05/12/98	1	83.7	84.1	83.9	VAC	
QCOADS 0100-20	BUS 14-1-B/C U/V	05/12/98	1	83.7	84.1	83.9	VAC	
QCOADS 0100-20	BUS 14-1-B/C U/V	04/14/97	1	83.7	87	83.6	VAC	
QCOADS 0100-20	BUS 14-1-B/C U/V	02/19/96	1	87	83	87	VAC	
QCOADS 0100-1	BUS 14-1-B/C U/V	05/11/94	1	87	83.81	86.03	VAC	
QCOADS 0200-19	BUS 23-1-A/B U/V	02/20/99	1	83.7	85.1	85.1	VAC	
QCOADS 0200-19	BUS 23-1-A/B U/V	04/29/98	1	83.7	84.4	84.4	VAC	
QCOADS 0200-19	BUS 23-1-A/B U/V	03/10/97	1	83.7	85	85	VAC	
QCOADS 0200-19	BUS 23-1-A/B U/V	03/29/95	1	87	86.3	86.3	VAC	
QCOADS 0200-19	BUS 23-1-B/C U/V	02/20/99	1	83.7	84.2	84.2	VAC	
QCOADS 0200-19	BUS 23-1-B/C U/V	04/29/98	1	83.7	85	84.1	VAC	
QCOADS 0200-19	BUS 23-1-B/C U/V	03/10/97	1	83.7	84.3	84.3	VAC	
QCOADS 0200-19	BUS 23-1-B/C U/V	03/29/95	1	87	84.9	84.9	VAC	
QCOADS 0200-20	BUS 24-1-A/B U/V	02/25/99	1	83.7	85.8	85.1	VAC	
QCOADS 0200-20	BUS 24-1-A/B U/V	05/02/97	1	87	85.1	85.1	VAC	
QCOADS 0200-20	BUS 24-1-A/B U/V	03/18/95	1	87	83.3	85.5	VAC	
QCOADS 0200-20	BUS 24-1-A/B U/V	03/29/93	1	83.7	83.8	83.8	VAC	
QCOADS 0200-20	BUS 24-1-B/C U/V	02/25/99	1	83.7	86.2	85.9	VAC	
QCOADS 0200-20	BUS 24-1-B/C U/V	04/28/97	1	87	85.7	85.7	VAC	
QCOADS 0200-20	BUS 24-1-B/C U/V	03/18/95	1	87	83.6	85.3	VAC	
QCOADS 0200-20	BUS 24-1-B/C U/V	03/29/93	1	83.7	83.8	83.8	VAC	

Surveillance	Tag Number	Date	Point	Desired	AF	AL	Units	Exclude	Comments
QCOADS 0100-19	BUS 13-1-A/B U/V	04/19/99	1	83.7	84.74	84.74	VAC		
QCOADS 0100-19	BUS 13-1-A/B U/V	11/14/98	1	83.7	84.8	84.8	VAC		
QCOADS 0100-19	BUS 13-1-A/B U/V	04/30/98	1	83.7	85.2	84.3	VAC		
QCOADS 0100-19	BUS 13-1-A/B U/V	04/14/97	1	83.7	84.7	84.7	VAC		
QCOADS 0100-19	BUS 13-1-A/B U/V	03/28/96	1	87	85	85	VAC		
QCOADS 0100-1	BUS 13-1-A/B U/V	03/29/94	1	87	84.6	84.68	VAC		
QCOADS 0100-19	BUS 13-1-B/C U/V	04/19/99	1	83.7	83.75	83.75	VAC		
QCOADS 0100-19	BUS 13-1-B/C U/V	11/14/98	1	83.7	84.1	84.1	VAC		
QCOADS 0100-19	BUS 13-1-B/C U/V	04/30/98	1	83.7	84.1	84.1	VAC		
QCOADS 0100-19	BUS 13-1-B/C U/V	04/14/97	1	83.7	87.2	83.9	VAC		
QCOADS 0100-19	BUS 13-1-B/C U/V	03/28/96	1	87	84.6	87	VAC		
QCOADS 0100-1	BUS 13-1-B/C U/V	03/29/94	1	87	83.7	84.36	VAC		
QCOADS 0100-20	BUS 14-1-A/B U/V	04/16/99	1	83.7	82.9	82.9	VAC		
QCOADS 0100-20	BUS 14-1-A/B U/V	11/13/98	1	83.7	83	83	VAC		
QCOADS 0100-20	BUS 14-1-A/B U/V	05/12/98	1	83.7	83	83	VAC		
QCOADS 0100-20	BUS 14-1-A/B U/V	05/12/98	1	83.7	83	83	VAC		
QCOADS 0100-20	BUS 14-1-A/B U/V	04/14/97	1	83.70	87.00	82.80	VAC		
QCOADS 0100-20	BUS 14-1-A/B U/V	02/19/96	1	87	85.1	87	VAC		
QCOADS 0100-1	BUS 14-1-A/B U/V	05/11/94	1	87	84.71	85.06	VAC		
QCOADS 0100-20	BUS 14-1-B/C U/V	04/16/99	1	83.7	83.6	83.6	VAC		
QCOADS 0100-20	BUS 14-1-B/C U/V	11/13/98	1	83.7	83.5	83.5	VAC		
QCOADS 0100-20	BUS 14-1-B/C U/V	05/12/98	1	83.7	84.1	83.9	VAC		
QCOADS 0100-20	BUS 14-1-B/C U/V	05/12/98	1	83.7	84.1	83.9	VAC		
QCOADS 0100-20	BUS 14-1-B/C U/V	04/14/97	1	83.7	87	83.6	VAC		
QCOADS 0100-20	BUS 14-1-B/C U/V	02/19/96	1	87	83	87	VAC		
QCOADS 0100-1	BUS 14-1-B/C U/V	05/11/94	1	87	83.81	86.03	VAC		
QCOADS 0200-19	BUS 23-1-A/B U/V	02/20/99	1	83.7	85.1	85.1	VAC		
QCOADS 0200-19	BUS 23-1-A/B U/V	04/29/98	1	83.7	84.4	84.4	VAC		
QCOADS 0200-19	BUS 23-1-A/B U/V	03/10/97	1	83.7	85	85	VAC		
QCOADS 0200-19	BUS 23-1-A/B U/V	03/29/95	1	87	86.3	86.3	VAC		
QCOADS 0200-19	BUS 23-1-B/C U/V	02/20/99	1	83.7	84.2	84.2	VAC		
QCOADS 0200-19	BUS 23-1-B/C U/V	04/29/98	1	83.7	85	84.1	VAC		
QCOADS 0200-19	BUS 23-1-B/C U/V	03/10/97	1	83.7	84.3	84.3	VAC		
QCOADS 0200-19	BUS 23-1-B/C U/V	03/29/95	1	87	84.9	84.9	VAC		
QCOADS 0200-20	BUS 24-1-A/B U/V	02/25/99	1	83.7	85.8	85.1	VAC		
QCOADS 0200-20	BUS 24-1-A/B U/V	05/02/97	1	87	85.1	85.1	VAC		
QCOADS 0200-20	BUS 24-1-A/B U/V	03/18/95	1	87	83.3	85.5	VAC		
QCOADS 0200-20	BUS 24-1-A/B U/V	03/29/93	1	83.7	83.8	83.8	VAC		
QCOADS 0200-20	BUS 24-1-B/C U/V	02/25/99	1	83.7	86.2	85.9	VAC		
QCOADS 0200-20	BUS 24-1-B/C U/V	04/28/97	1	87.00	85.70	85.70	VAC		
QCOADS 0200-20	BUS 24-1-B/C U/V	03/18/95	1	87	83.6	85.3	VAC		
QCOADS 0200-20	BUS 24-1-B/C U/V	03/29/93	1	83.7	83.8	83.8	VAC		

			CAL DATE	AF/AL	DATA CAL POINT		OUTLIERS COMMENTS	CAL INTERVAL	
ID	Make/Model Number	Tag Number	mm/dd/yy	Status	1	Units		Days	Months
1	GE / 12IAV69A1A	BUS 13-1-A/B U/V	04/19/99	AF	84.740	VAC		156	5
2	GE / 12IAV69A1A	BUS 13-1-A/B U/V	04/19/99	AL	84.740	VAC			
3	GE / 12IAV69A1A	BUS 13-1-A/B U/V	11/14/98	AF	84.800	VAC		198	6
4	GE / 12IAV69A1A	BUS 13-1-A/B U/V	11/14/98	AL	84.800	VAC			
5	GE / 12IAV69A1A	BUS 13-1-A/B U/V	04/30/98	AF	85.200	VAC		381	12
6	GE / 12IAV69A1A	BUS 13-1-A/B U/V	04/30/98	AL	84.300	VAC			
7	GE / 12IAV69A1A	BUS 13-1-A/B U/V	04/14/97	AF	84.700	VAC		382	13
8	GE / 12IAV69A1A	BUS 13-1-A/B U/V	04/14/97	AL	84.700	VAC			
9	GE / 12IAV69A1A	BUS 13-1-A/B U/V	03/28/96	AF	85.000	VAC		730	24
10	GE / 12IAV69A1A	BUS 13-1-A/B U/V	03/28/96	AL	85.000	VAC			
11	GE / 12IAV69A1A	BUS 13-1-A/B U/V	03/29/94	AF	84.600	VAC			
12	GE / 12IAV69A1A	BUS 13-1-A/B U/V	03/29/94	AL	84.680	VAC			
13	GE / 12IAV69A1A	BUS 13-1-B/C U/V	04/19/99	AF	83.750	VAC		156	5
14	GE / 12IAV69A1A	BUS 13-1-B/C U/V	04/19/99	AL	83.750	VAC			
15	GE / 12IAV69A1A	BUS 13-1-B/C U/V	11/14/98	AF	84.100	VAC		198	6
16	GE / 12IAV69A1A	BUS 13-1-B/C U/V	11/14/98	AL	84.100	VAC			
17	GE / 12IAV69A1A	BUS 13-1-B/C U/V	04/30/98	AF	84.100	VAC		381	12
18	GE / 12IAV69A1A	BUS 13-1-B/C U/V	04/30/98	AL	84.100	VAC			
19	GE / 12IAV69A1A	BUS 13-1-B/C U/V	04/14/97	AF	87.200	VAC		382	13
20	GE / 12IAV69A1A	BUS 13-1-B/C U/V	04/14/97	AL	83.900	VAC			
21	GE / 12IAV69A1A	BUS 13-1-B/C U/V	03/28/96	AF	84.600	VAC		730	24
22	GE / 12IAV69A1A	BUS 13-1-B/C U/V	03/28/96	AL	87.000	VAC			
23	GE / 12IAV69A1A	BUS 13-1-B/C U/V	03/29/94	AF	83.700	VAC			
24	GE / 12IAV69A1A	BUS 13-1-B/C U/V	03/29/94	AL	84.360	VAC			
25	GE / 12IAV69A1A	BUS 14-1-A/B U/V	04/16/99	AF	82.900	VAC		154	5
26	GE / 12IAV69A1A	BUS 14-1-A/B U/V	04/16/99	AL	82.900	VAC			
27	GE / 12IAV69A1A	BUS 14-1-A/B U/V	11/13/98	AF	83.000	VAC		185	6
28	GE / 12IAV69A1A	BUS 14-1-A/B U/V	11/13/98	AL	83.000	VAC			
29	GE / 12IAV69A1A	BUS 14-1-A/B U/V	05/12/98	AF	83.000	VAC		393	13
30	GE / 12IAV69A1A	BUS 14-1-A/B U/V	05/12/98	AL	83.000	VAC			
31	GE / 12IAV69A1A	BUS 14-1-A/B U/V	04/14/97	AF	87.000	VAC		420	14
32	GE / 12IAV69A1A	BUS 14-1-A/B U/V	04/14/97	AL	82.800	VAC			
33	GE / 12IAV69A1A	BUS 14-1-A/B U/V	02/19/96	AF	85.100	VAC		649	21
34	GE / 12IAV69A1A	BUS 14-1-A/B U/V	02/19/96	AL	87.000	VAC			
35	GE / 12IAV69A1A	BUS 14-1-A/B U/V	05/11/94	AF	84.710	VAC			
36	GE / 12IAV69A1A	BUS 14-1-A/B U/V	05/11/94	AL	85.060	VAC			
37	GE / 12IAV69A1A	BUS 14-1-B/C U/V	04/16/99	AF	83.600	VAC		154	5
38	GE / 12IAV69A1A	BUS 14-1-B/C U/V	04/16/99	AL	83.600	VAC			
39	GE / 12IAV69A1A	BUS 14-1-B/C U/V	11/13/98	AF	83.500	VAC		185	6
40	GE / 12IAV69A1A	BUS 14-1-B/C U/V	11/13/98	AL	83.500	VAC			
41	GE / 12IAV69A1A	BUS 14-1-B/C U/V	05/12/98	AF	84.100	VAC		393	13
42	GE / 12IAV69A1A	BUS 14-1-B/C U/V	05/12/98	AL	83.900	VAC			
43	GE / 12IAV69A1A	BUS 14-1-B/C U/V	04/14/97	AF	87.000	VAC		420	14
44	GE / 12IAV69A1A	BUS 14-1-B/C U/V	04/14/97	AL	83.600	VAC			
45	GE / 12IAV69A1A	BUS 14-1-B/C U/V	02/19/96	AF	83.000	VAC	Statistical Outlier per T-Test	649	21
46	GE / 12IAV69A1A	BUS 14-1-B/C U/V	02/19/96	AL	87.000	VAC			
47	GE / 12IAV69A1A	BUS 14-1-B/C U/V	05/11/94	AF	83.810	VAC			
48	GE / 12IAV69A1A	BUS 14-1-B/C U/V	05/11/94	AL	86.030	VAC			
49	GE / 12IAV69A1A	BUS 23-1-A/B U/V	02/20/99	AF	85.100	VAC		297	10
50	GE / 12IAV69A1A	BUS 23-1-A/B U/V	02/20/99	AL	85.100	VAC			
51	GE / 12IAV69A1A	BUS 23-1-A/B U/V	04/29/98	AF	84.400	VAC		415	14
52	GE / 12IAV69A1A	BUS 23-1-A/B U/V	04/29/98	AL	84.400	VAC			
53	GE / 12IAV69A1A	BUS 23-1-A/B U/V	03/10/97	AF	85.000	VAC		712	23
54	GE / 12IAV69A1A	BUS 23-1-A/B U/V	03/10/97	AL	85.000	VAC			

			CAL DATE	AF/AL	DATA CAL POINT		OUTLIERS COMMENTS	CAL INTERVAL	
ID	Make/Model Number	Tag Number	mm/dd/yy	Status	1	Units		Days	Months
55	GE / 12IAV69A1A	BUS 23-1-A/B U/V	03/29/95	AF	86.300	VAC			
56	GE / 12IAV69A1A	BUS 23-1-A/B U/V	03/29/95	AL	86.300	VAC			
57	GE / 12IAV69A1A	BUS 23-1-B/C U/V	02/20/99	AF	84.200	VAC		297	10
58	GE / 12IAV69A1A	BUS 23-1-B/C U/V	02/20/99	AL	84.200	VAC			
59	GE / 12IAV69A1A	BUS 23-1-B/C U/V	04/29/98	AF	85.000	VAC		415	14
60	GE / 12IAV69A1A	BUS 23-1-B/C U/V	04/29/98	AL	84.100	VAC			
61	GE / 12IAV69A1A	BUS 23-1-B/C U/V	03/10/97	AF	84.300	VAC		712	23
62	GE / 12IAV69A1A	BUS 23-1-B/C U/V	03/10/97	AL	84.300	VAC			
63	GE / 12IAV69A1A	BUS 23-1-B/C U/V	03/29/95	AF	84.900	VAC			
64	GE / 12IAV69A1A	BUS 23-1-B/C U/V	03/29/95	AL	84.900	VAC			
65	GE / 12IAV69A1A	BUS 24-1-A/B U/V	02/25/99	AF	85.800	VAC		664	22
66	GE / 12IAV69A1A	BUS 24-1-A/B U/V	02/25/99	AL	85.100	VAC			
67	GE / 12IAV69A1A	BUS 24-1-A/B U/V	05/02/97	AF	85.100	VAC		776	25
68	GE / 12IAV69A1A	BUS 24-1-A/B U/V	05/02/97	AL	85.100	VAC			
69	GE / 12IAV69A1A	BUS 24-1-A/B U/V	03/18/95	AF	83.300	VAC		719	24
70	GE / 12IAV69A1A	BUS 24-1-A/B U/V	03/18/95	AL	85.500	VAC			
71	GE / 12IAV69A1A	BUS 24-1-A/B U/V	03/29/93	AF	83.800	VAC			
72	GE / 12IAV69A1A	BUS 24-1-A/B U/V	03/29/93	AL	83.800	VAC			
73	GE / 12IAV69A1A	BUS 24-1-B/C U/V	02/25/99	AF	86.200	VAC		668	22
74	GE / 12IAV69A1A	BUS 24-1-B/C U/V	02/25/99	AL	85.900	VAC			
75	GE / 12IAV69A1A	BUS 24-1-B/C U/V	04/28/97	AF	85.700	VAC		772	25
76	GE / 12IAV69A1A	BUS 24-1-B/C U/V	04/28/97	AL	85.700	VAC			
77	GE / 12IAV69A1A	BUS 24-1-B/C U/V	03/18/95	AF	83.600	VAC		719	24
78	GE / 12IAV69A1A	BUS 24-1-B/C U/V	03/18/95	AL	85.300	VAC			
79	GE / 12IAV69A1A	BUS 24-1-B/C U/V	03/29/93	AF	83.800	VAC			
80	GE / 12IAV69A1A	BUS 24-1-B/C U/V	03/29/93	AL	83.800	VAC			

		CAL DATE	DRIFT CAL POINT	CAL INTERVAL	
ID	Tag Number	mm/dd/yy	1	Days	Months
1	BUS 13-1-A/B U/V	4/19/99	-0.060	156	5
3	BUS 13-1-A/B U/V	11/14/98	0.500	198	6
5	BUS 13-1-A/B U/V	4/30/98	0.500	381	12
7	BUS 13-1-A/B U/V	4/14/97	-0.300	382	13
9	BUS 13-1-A/B U/V	3/28/96	0.320	730	24
13	BUS 13-1-B/C U/V	4/19/99	-0.350	156	5
15	BUS 13-1-B/C U/V	11/14/98	0.000	198	6
17	BUS 13-1-B/C U/V	4/30/98	0.200	381	12
19	BUS 13-1-B/C U/V	4/14/97	0.200	382	13
21	BUS 13-1-B/C U/V	3/28/96	0.240	730	24
25	BUS 14-1-A/B U/V	4/16/99	-0.100	154	5
27	BUS 14-1-A/B U/V	11/13/98	0.000	185	6
29	BUS 14-1-A/B U/V	5/12/98	0.200	393	13
31	BUS 14-1-A/B U/V	4/14/97	0.000	420	14
33	BUS 14-1-A/B U/V	2/19/96	0.040	649	21
37	BUS 14-1-B/C U/V	4/16/99	0.100	154	5
39	BUS 14-1-B/C U/V	11/13/98	-0.400	185	6
41	BUS 14-1-B/C U/V	5/12/98	0.500	393	13
43	BUS 14-1-B/C U/V	4/14/97	0.000	420	14
45	BUS 14-1-B/C U/V	2/19/96	-3.030	649	21
49	BUS 23-1-A/B U/V	2/20/99	0.700	297	10
51	BUS 23-1-A/B U/V	4/29/98	-0.600	415	14
53	BUS 23-1-A/B U/V	3/10/97	-1.300	712	23
57	BUS 23-1-B/C U/V	2/20/99	0.100	297	10
59	BUS 23-1-B/C U/V	4/29/98	0.700	415	14
61	BUS 23-1-B/C U/V	3/10/97	-0.600	712	23
65	BUS 24-1-A/B U/V	2/25/99	0.700	664	22
67	BUS 24-1-A/B U/V	5/2/97	-0.400	776	25
69	BUS 24-1-A/B U/V	3/18/95	-0.500	719	24
73	BUS 24-1-B/C U/V	2/25/99	0.500	668	22
75	BUS 24-1-B/C U/V	4/28/97	0.400	772	25
77	BUS 24-1-B/C U/V	3/18/95	-0.200	719	24

ID#	Tag Number	Drift (volts)	Cal Interval (Days)	Extreme Studentized Deviate (T)
1	BUS 13-1-A/B U/V	-0.060	156	0.001
3	BUS 13-1-A/B U/V	0.500	198	0.800
5	BUS 13-1-A/B U/V	0.500	381	0.800
7	BUS 13-1-A/B U/V	-0.300	382	0.341
9	BUS 13-1-A/B U/V	0.320	730	0.543
13	BUS 13-1-B/C U/V	-0.350	156	0.413
15	BUS 13-1-B/C U/V	0.000	198	0.086
17	BUS 13-1-B/C U/V	0.200	381	0.372
19	BUS 13-1-B/C U/V	0.200	382	0.372
21	BUS 13-1-B/C U/V	0.240	730	0.429
25	BUS 14-1-A/B U/V	-0.100	154	0.056
27	BUS 14-1-A/B U/V	0.000	185	0.086
29	BUS 14-1-A/B U/V	0.200	393	0.372
31	BUS 14-1-A/B U/V	0.000	420	0.086
33	BUS 14-1-A/B U/V	0.040	649	0.144
37	BUS 14-1-B/C U/V	0.100	154	0.229
39	BUS 14-1-B/C U/V	-0.400	185	0.484
41	BUS 14-1-B/C U/V	0.500	393	0.800
43	BUS 14-1-B/C U/V	0.000	420	0.086
45	BUS 14-1-B/C U/V	-3.030	649	4.235
49	BUS 23-1-A/B U/V	0.700	297	1.085
51	BUS 23-1-A/B U/V	-0.600	415	0.769
53	BUS 23-1-A/B U/V	-1.300	712	1.768
57	BUS 23-1-B/C U/V	0.100	297	0.229
59	BUS 23-1-B/C U/V	0.700	415	1.085
61	BUS 23-1-B/C U/V	-0.600	712	0.769
65	BUS 24-1-A/B U/V	0.700	664	1.085
67	BUS 24-1-A/B U/V	-0.400	776	0.484
69	BUS 24-1-A/B U/V	-0.500	719	0.627
73	BUS 24-1-B/C U/V	0.500	668	0.800
75	BUS 24-1-B/C U/V	0.400	772	0.657
77	BUS 24-1-B/C U/V	-0.200	719	0.199

Raw Drift Data Statistics Summary (Initial Data Set)	
Mean	-0.061
Median	0.020
Std. Dev.	0.701
Sample Size	32
Maximum	0.700
Minimum	-3.030
Range	3.730
Sum	-1.940
Kurtosis	9.942
Skewness	-2.629
Critical T-Value (Upper 2.5% Signif.)	2.91

Equation for Each Studentized Deviate: T= |Drift-Mean|/Std. Dev.
(Per Reference 2.3.1.1 of Appendix J of Reference 5.1.2)
Outliers will be Denoted as such in "Final Data Set" column.

One Outlier Detected - ID # 45

Drift Data Statistics Summary (Final Data Set)	
Mean	0.035
Median	0.040
Std. Dev.	0.452
Sample Size	31
Maximum	0.700
Minimum	-1.300
Range	2.000
Sum	1.090
Kurtosis	1.047
Skewness	-0.748

Final Drift Data Set (volts)	Cal Interval (Days)
-0.060	156
0.500	198
0.500	381
-0.300	382
0.320	730
-0.350	156
0.000	198
0.200	381
0.200	382
0.240	730
-0.100	154
0.000	185
0.200	393
0.000	420
0.040	649
0.100	154
-0.400	185
0.500	393
0.000	420
OUTLIER	OUTLIER
0.700	297
-0.600	415
-1.300	712
0.100	297
0.700	415
-0.600	712
0.700	664
-0.400	776
-0.500	719
0.500	668
0.400	772
-0.200	719

Table For Critical Values Of T			
Sample Size	Upper 5% Significance Level	Upper 2.5% Significance Level	Upper 1% Significance Level
10	2.18	2.29	2.41
20	2.56	2.71	2.88
30	2.75	2.91	3.10
40	2.87	3.04	3.24
50	2.96	3.13	3.34
75	3.10	3.28	3.50
100	3.21	3.38	3.60
125	3.28	3.46	3.68
150	3.33	3.51	3.73
151	4.00	4.00	4.00

Information was taken from Section 7.2 of Reference 5.1.3, and Section 2.3.1.1 of Appendix J of Reference 5.1.2.

Note: Since the program chooses the next lower value to provide the critical value of T, and since both references require the use of 4 sigma for sample sizes greater than 150, the value of 151 was entered into the last sample size cell for use with large samples of data.

CHI-SQUARE TEST

Bin Descriptions	Bin Maximum Values (volts)	Normal Distribution Probability (Pnorm)	Cumulative Probability	Expected Frequency (Ei)	Observed Frequency (Oi)	$\frac{(O_i - E_i)^2}{E_i}$
Up to - 2.5 Standard Deviations from Mean	-1.096	0.0062	0.0062	0.192	1	3.395
-2.5 to -2.0 Standard Deviations from Mean	-0.870	0.0166	0.0228	0.513	0	0.513
-2.0 to -1.5 Standard Deviations from Mean	-0.643	0.0441	0.0668	1.366	0	1.366
-1.5 to -1.0 Standard Deviations from Mean	-0.417	0.0919	0.1587	2.847	3	0.008
-1.0 to -0.5 Standard Deviations from Mean	-0.191	0.1499	0.3086	4.647	5	0.027
-0.5 Standard Deviations from Mean to Mean	0.035	0.1915	0.5000	5.935	6	0.001
Mean to +0.5 Standard Deviations from Mean	0.261	0.1915	0.6915	5.935	7	0.191
+0.5 to +1.0 Standard Deviations from Mean	0.488	0.1499	0.8414	4.647	2	1.508
+1.0 to +1.5 Standard Deviations from Mean	0.714	0.0919	0.9332	2.847	7	6.056
+1.5 to +2.0 Standard Deviations from Mean	0.940	0.0441	0.9773	1.366	0	1.366
+2.0 to +2.5 Standard Deviations from Mean	1.166	0.0166	0.9938	0.513	0	0.513
More than Mean + 2.5 Standard Deviations	More	0.0062	1.0000	0.192	0	0.192
				31.000	31	15.135

Number of Bins	12
No. of Computed Values (Mean, St. Dev., Count)	3
Degrees of Freedom	9
# Points (N)	31

Specific Chi-Square Normality Test Methodology from Section C.1 of Reference 5.1.3.

1. Data is divided between 12 bins, based on the mean and standard deviation values. (See Attachment I.)
2. Probabilities are listed for each bin, based on Normal Distribution. Cumulative Probabilities are listed to verify that a total of 1.000 is obtained from the total probabilities from the segments. (These two columns were derived from Table B-2 of Reference 5.1.3.)
3. The Expected Frequency (Ei) is determined by multiplying the Normal Probabilities, Pnorm, by the Number of Drift Data Points (N), or "count", which comes from Attachment D.
4. The observed frequency is the number of actual drift data points which lie within the bins as defined above. This can be easily observed from the data within Attachment I.
5. The Chi-Square Statistic is computed by summing the terms on the right of the table: Per Section C.1.1 of Reference 5.1.3,

   $X^2 = \text{Sum}[(Oi-Ei)^2/Ei]$

6. **Conclusion: Since the result of the Chi-Square computation, 15.135, is greater than the degrees of freedom, 9, per Section C.1.3 of Reference 5.1.3, the Chi-Square cannot confirm the assumption of normality for this data set. See Attachment I.**

Drift Values	"i"	a_{n-i+1} *	b_i
-1.300	1	0.4220	0.8440
-0.600	2	0.2921	0.3797
-0.600	3	0.2475	0.3217
-0.500	4	0.2145	0.2145
-0.400	5	0.1874	0.1687
-0.400	6	0.1641	0.1477
-0.350	7	0.1433	0.1218
-0.300	8	0.1243	0.0870
-0.200	9	0.1066	0.0554
-0.100	10	0.0899	0.0306
-0.060	11	0.0739	0.0192
0.000	12	0.0585	0.0117
0.000	13	0.0435	0.0087
0.000	14	0.0289	0.0029
0.000	15	0.0144	0.0014
0.040			
0.100			
0.100			
0.200			
0.200		b =	2.4151
0.200			
0.240			
0.320			
0.400			
0.500			
0.500			
0.500			
0.500			
0.700			
0.700			
0.700			

* From Reference 5.1.8

Specific W Normality Test Methodology from Reference 5.1.8 and Section C.2 of Reference 5.1.3.

Steps to Perform:

1. Paste all final drift data (From Attachment D) into column 1.
2. Sort in ascending order.
3. Calculate S^2 taking the variance of the drift data adjusted by (Count-1)

$$S^2 = (n-1)(\text{Variance (Drift)})$$

where: n = Count
Variance (Drift) = Std. Dev. (Drift) Squared from Attachment D

4. Calculate the Quantity b:

$$b = \text{Sum}[(a_{n-i+1})(x_{n-i+1} - x_i)]$$

where: i = 1 to k
k = (n-1)/2 when "n" is odd; k = n/2 when "n" is even
x_i = Drift value at point number i
a_{n-i+1} values are taken from Reference 5.1.8.

5. Calculate b^2.
6. Compute the W Statistic and compare to the critical value at the 5% confidence level. The table of critical values is given as Table C-6 on page C-15 of Reference 5.1.3.

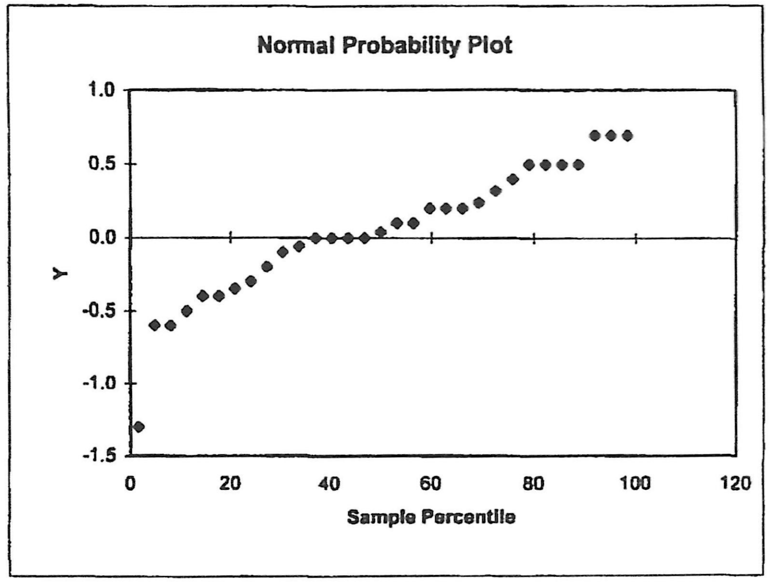
$$W = b^2/S^2$$

Computed Values

S^2 =	6.1394	
b =	2.4151	
b^2 =	5.8326	
Count (n):	31	
$W = b^2/S^2$ =	0.9500	
W Critical =	0.9290	5% Significance From Table C-6 of Reference 5.1.3.

Results:
Since the W statistic, 0.9500, is greater than the critical value for W, 0.9290, this test confirms that the data is a sample from a normal distribution.

ID	Tag	Drift	Number	PROBABILITY OUTPUT	
#	Number	Value	of Days	Percentile	Y
1	BUS 13-1-A/B U/V	-0.060	156	1.612903226	-1.300
3	BUS 13-1-A/B U/V	0.500	198	4.838709677	-0.600
5	BUS 13-1-A/B U/V	0.500	381	8.064516129	-0.600
7	BUS 13-1-A/B U/V	-0.300	382	11.29032258	-0.500
9	BUS 13-1-A/B U/V	0.320	730	14.51612903	-0.400
13	BUS 13-1-B/C U/V	-0.350	156	17.74193548	-0.400
15	BUS 13-1-B/C U/V	0.000	198	20.96774194	-0.350
17	BUS 13-1-B/C U/V	0.200	381	24.19354839	-0.300
19	BUS 13-1-B/C U/V	0.200	382	27.41935484	-0.200
21	BUS 13-1-B/C U/V	0.240	730	30.64516129	-0.100
25	BUS 14-1-A/B U/V	-0.100	154	33.87096774	-0.060
27	BUS 14-1-A/B U/V	0.000	185	37.09677419	0.000
29	BUS 14-1-A/B U/V	0.200	393	40.32258065	0.000
31	BUS 14-1-A/B U/V	0.000	420	43.5483871	0.000
33	BUS 14-1-A/B U/V	0.040	649	46.77419355	0.000
37	BUS 14-1-B/C U/V	0.100	154	50	0.040
39	BUS 14-1-B/C U/V	-0.400	185	53.22580645	0.100
41	BUS 14-1-B/C U/V	0.500	393	56.4516129	0.100
43	BUS 14-1-B/C U/V	0.000	420	59.67741935	0.200
49	BUS 23-1-A/B U/V	0.700	297	62.90322581	0.200
51	BUS 23-1-A/B U/V	-0.600	415	66.12903226	0.200
53	BUS 23-1-A/B U/V	-1.300	712	69.35483871	0.240
57	BUS 23-1-B/C U/V	0.100	297	72.58064516	0.320
59	BUS 23-1-B/C U/V	0.700	415	75.80645161	0.400
61	BUS 23-1-B/C U/V	-0.600	712	79.03225806	0.500
65	BUS 24-1-A/B U/V	0.700	664	82.25806452	0.500
67	BUS 24-1-A/B U/V	-0.400	776	85.48387097	0.500
69	BUS 24-1-A/B U/V	-0.500	719	88.70967742	0.500
73	BUS 24-1-B/C U/V	0.500	668	91.93548387	0.700
75	BUS 24-1-B/C U/V	0.400	772	95.16129032	0.700
77	BUS 24-1-B/C U/V	-0.200	719	98.38709677	0.700



Drift Data
-1.300
-0.600
-0.600
-0.500
-0.400
-0.400
-0.350
-0.300
-0.200
-0.100
-0.060
0.000
0.000
0.000
0.000
0.040
0.100
0.100
0.200
0.200
0.200
0.240
0.320
0.400
0.500
0.500
0.500
0.500
0.700
0.700
0.700

Bin Descriptions	Bin Maximums	Observed Frequency	Expected Frequency
Up to - 2.5 Standard Deviations from Mean	-1.096	1	0.1922
-2.5 to -2.0 Standard Deviations from Mean	-0.870	0	0.51305
-2.0 to -1.5 Standard Deviations from Mean	-0.643	0	1.36555
-1.5 to -1.0 Standard Deviations from Mean	-0.417	3	2.84735
-1.0 to -0.5 Standard Deviations from Mean	-0.191	5	4.6469
-0.5 Standard Deviations from Mean to Mean	0.035	6	5.93495
Mean to +0.5 Standard Deviations from Mean	0.261	7	5.93495
+0.5 to +1.0 Standard Deviations from Mean	0.488	2	4.6469
+1.0 to +1.5 Standard Deviations from Mean	0.714	7	2.84735
+1.5 to +2.0 Standard Deviations from Mean	0.940	0	1.36555
+2.0 to +2.5 Standard Deviations from Mean	1.166	0	0.51305
More than Mean + 2.5 Standard Deviations	More	0	0.1922
	Totals	31	31

+/- Sigma Bounds	Observed Drift Values	Percentages
2.5	30	96.774
2	30	96.774
1.5	30	96.774
1	20	64.516
0.5	13	41.935

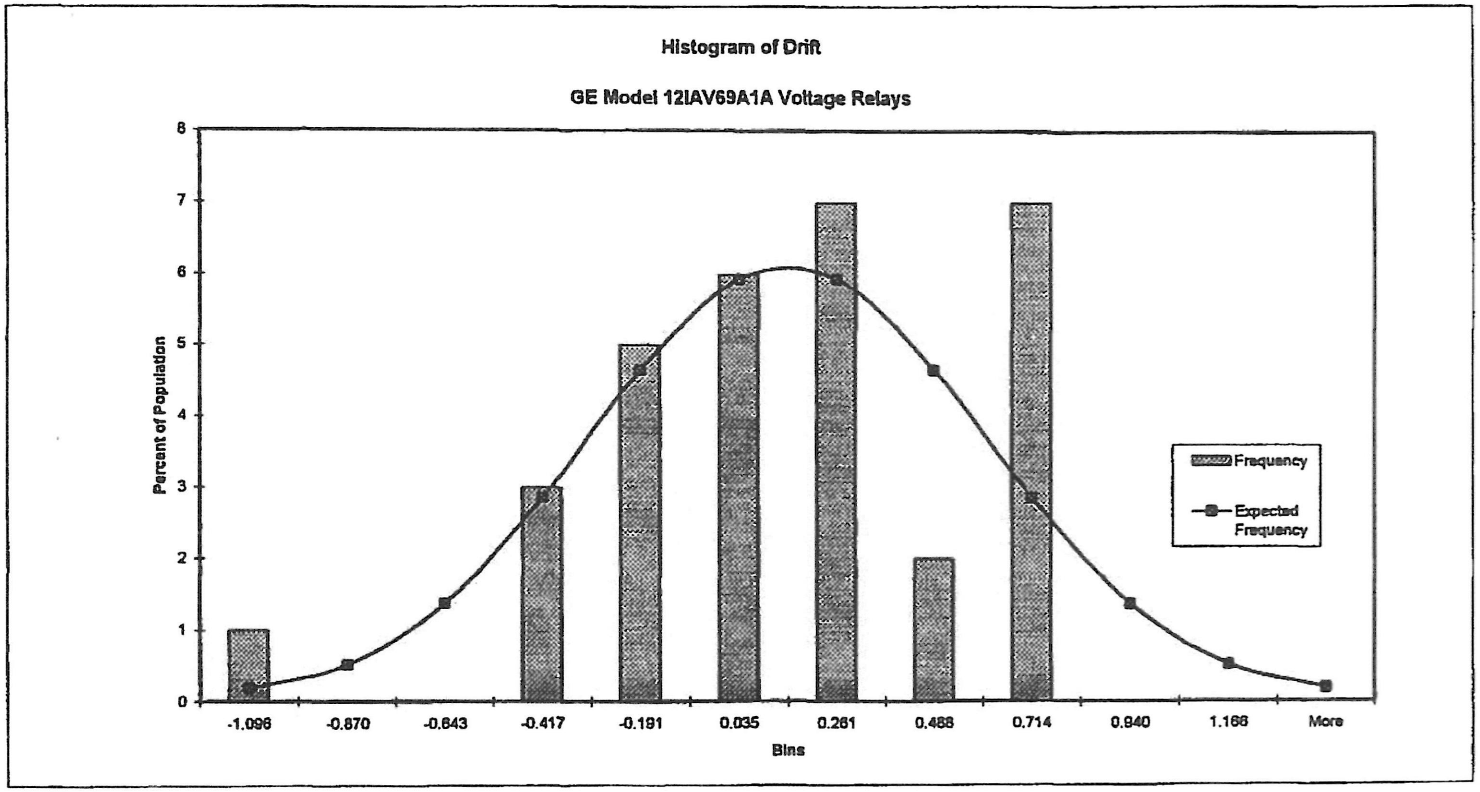
From Attachment D

Mean	0.035
Std. Dev.	0.452
Sample Size	31

Methodology for Histogram taken from Section C.5 of Reference 5.1.3 for Coverage Analysis

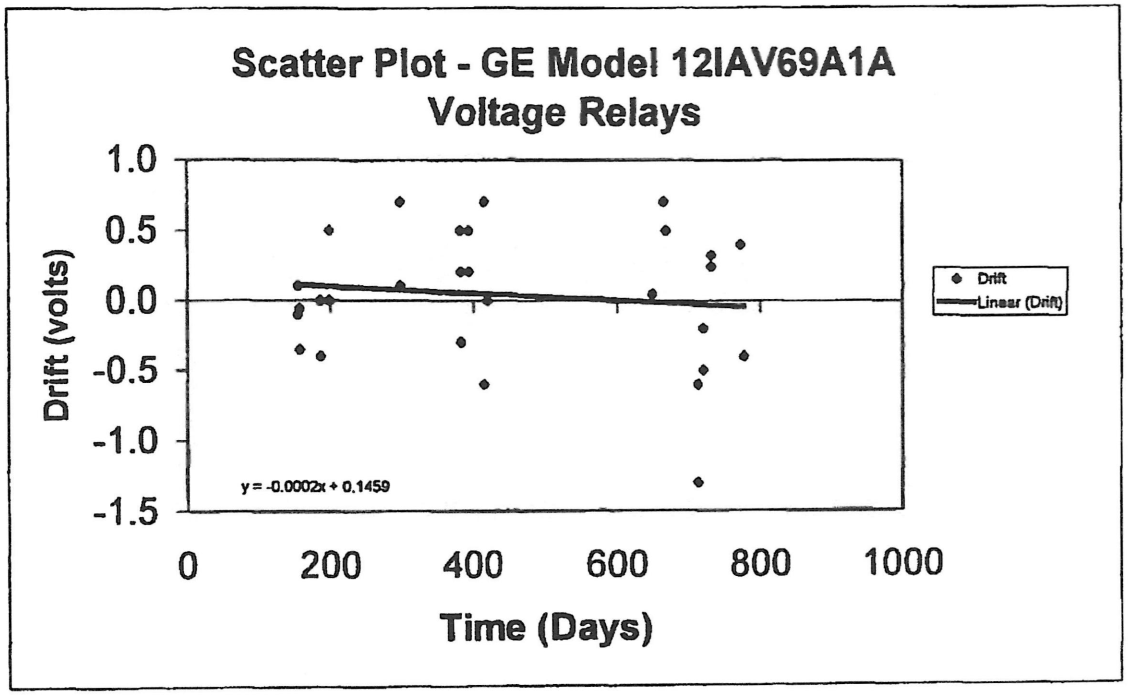
1. Order the drift data from Attachment D in ascending order in the first column.
2. Obtain mean, standard deviation, and sample size from Attachment D.
3. Establishing bins in 1/2 sigma increments from the mean to 2.5 sigma in both directions, derive the upper bin limits, in units of drift, based on the values of the mean and standard deviation.
4. Obtain expected frequency for a normal distribution in each bin from Attachment F.
5. Manually compute the number of observed drift data points within each bin, and list under observed frequency.
6. Plot the Expected Frequency and the Observed Frequency Data on the Histogram to compare.
7. Compute the total number of observed drift values within +/-0.5, 1.0, 1.5, 2.0, and 2.5 sigma bounds, based on the observed frequencies recorded earlier.
8. Compute the percentages of the observed drift values within the bounds idenfied, as compared to the total sample size.
9. If necessary and appropriate, adjust the standard deviation to provide the appropriate coverage.

Results: The data displays a moderate kurtosis, and appears to be near normal. The initial analysis showed that the observed data population within the +/- 2 sigma value contained the required population for a normal distribution. This analysis provides additional visual evidence of the normality of the data set which is confirmed in the W-Test (Attachment G) of this calculation.



Histogram of Drift
GE Model 12IAV69A1A Voltage Relays
Percent of Population
8
7
6
5
4
3
2
1
0
-1.096
-0.870
-0.643
-0.417
-0.191
0.035
0.261
0.488
0.714
0.940
1.166
More
Bins
Frequency
Expected Frequency

ID #	Tag Number	Drift Cal Point	Cal Int Days
1	BUS 13-1-A/B U/V	-0.080	156
3	BUS 13-1-A/B U/V	0.500	198
5	BUS 13-1-A/B U/V	0.500	381
7	BUS 13-1-A/B U/V	-0.300	382
9	BUS 13-1-A/B U/V	0.320	730
13	BUS 13-1-B/C U/V	-0.350	158
15	BUS 13-1-B/C U/V	0.000	198
17	BUS 13-1-B/C U/V	0.200	381
19	BUS 13-1-B/C U/V	0.200	382
21	BUS 13-1-B/C U/V	0.240	730
25	BUS 14-1-A/B U/V	-0.100	154
27	BUS 14-1-A/B U/V	0.000	185
29	BUS 14-1-A/B U/V	0.200	393
31	BUS 14-1-A/B U/V	0.000	420
33	BUS 14-1-A/B U/V	0.040	649
37	BUS 14-1-B/C U/V	0.100	154
39	BUS 14-1-B/C U/V	-0.400	185
41	BUS 14-1-B/C U/V	0.500	393
43	BUS 14-1-B/C U/V	0.000	420
49	BUS 23-1-A/B U/V	0.700	297
51	BUS 23-1-A/B U/V	-0.600	415
53	BUS 23-1-A/B U/V	-1.300	712
57	BUS 23-1-B/C U/V	0.100	297
59	BUS 23-1-B/C U/V	0.700	415
61	BUS 23-1-B/C U/V	-0.600	712
65	BUS 24-1-A/B U/V	0.700	664
67	BUS 24-1-A/B U/V	-0.400	776
69	BUS 24-1-A/B U/V	-0.500	719
73	BUS 24-1-B/C U/V	0.500	668
75	BUS 24-1-B/C U/V	0.400	772
77	BUS 24-1-B/C U/V	-0.200	719



Note: Equation on Scatter Plot is computer generated, based on the associated trend line.

Data ID	Drift Value (volts)	Time Interval (Days)	Bin 1		Bin 2		Bin 3		Bin 4		Bin 5		Bin 6		Bin 7		Bin 8		Regression Bin	
			Data	Time	Data	Time	Data	Time	Data	Time	Data	Time	Data	Time	Data	Time	Data	Time	Data	Time
1	-0.060	156					-0.06	156											-0.060	156
3	0.500	198					0.5	198											0.500	198
5	0.500	381							0.5	381									0.500	381
7	-0.300	382							-0.3	382									-0.300	382
9	0.320	730											0.32	730					0.320	730
13	-0.350	156					-0.35	156											-0.350	156
15	0.000	198					0	198											0.000	198
17	0.200	381							0.2	381									0.200	381
19	0.200	382							0.2	382									0.200	382
21	0.240	730											0.24	730					0.240	730
25	-0.100	154					-0.1	154											-0.100	154
27	0.000	185					0	185											0.000	185
29	0.200	393							0.2	393									0.200	393
31	0.000	420							0	420									0.000	420
33	0.040	649									0.04	649							0.040	649
37	0.100	154					0.1	154											0.100	154
39	-0.400	185					-0.4	185											-0.400	185
41	0.500	393							0.5	393									0.500	393
43	0.000	420							0	420									0.000	420
49	0.700	297							0.7	297									0.700	297
51	-0.600	415							-0.6	415									-0.600	415
53	-1.300	712											-1.3	712					-1.300	712
57	0.100	297							0.1	297									0.100	297
59	0.700	415							0.7	415									0.700	415
61	-0.600	712											-0.6	712					-0.600	712
65	0.700	664											0.7	664					0.700	664
67	-0.400	776											-0.4	776					-0.400	776
69	-0.500	719											-0.5	719					-0.500	719
73	0.500	668											0.5	668					0.500	668
75	0.400	772											0.4	772					0.400	772
77	-0.200	719											-0.2	719					-0.200	719

Bin Statistics

	Bin 1	Bin 2	Bin 3	Bin 4	Bin 5	Bin 6	Bin 7	Bin 8
Count	0	0	8	12	1	10	0	0
Standard Dev.			0.279	0.388		0.623		
Mean			-0.039	0.183	0.040	-0.084		
Mean Interval			173.3	381.3	649.0	720.2		

Bin Definition and Selection

Bins	Bin Hi Limit (Days)	Bin Count	Population Percentage	Bins Included
1	45	0	0.0%	
2	135	0	0.0%	
3	225	8	25.8%	3
4	445	12	38.7%	4
5	650	1	3.2%	
6	800	10	32.3%	6
7	999	0	0.0%	
8	Over	0	0.0%	

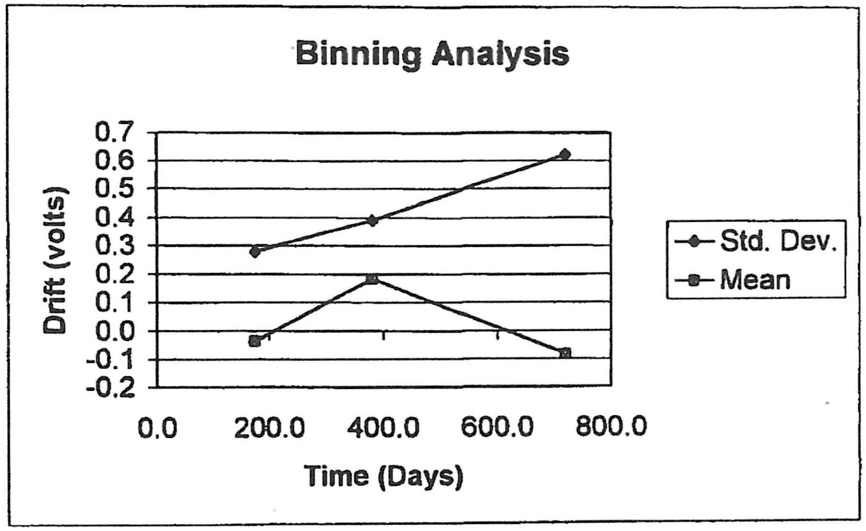
Total Count:		31	100%	

Bin and Time Limits to be Used for Regression Analysis

Limits for Regression	Bin Number	Valid Interval (Days)
Low	3	136
High	6	800

Graph Summary

Bin	Time	Std Dev	Mean
3	173.3	0.279	-0.039
4	381.3	0.388	0.183
6	720.2	0.623	-0.084



Regression Analysis - Drift

		RESIDUAL OUTPUT		
Drift	**Time**	***Observation***	***Predicted Y***	***Residuals***
-0.060	156	1	0.107131221	-0.167131221
0.500	198	2	0.096692895	0.403307105
0.500	381	3	0.051211619	0.448788381
-0.300	382	4	0.050963087	-0.350963087
0.320	730	5	-0.035525896	0.355525896
-0.350	156	6	0.107131221	-0.457131221
0.000	198	7	0.096692895	-0.096692895
0.200	381	8	0.051211619	0.148788381
0.200	382	9	0.050963087	0.149036913
0.240	730	10	-0.035525896	0.275525896
-0.100	154	11	0.107628284	-0.207628284
0.000	185	12	0.099923805	-0.099923805
0.200	393	13	0.04822924	0.15177076
0.000	420	14	0.041518888	-0.041518888
0.040	649	15	-0.01539484	0.05539484
0.100	154	16	0.107628284	-0.007628284
-0.400	185	17	0.099923805	-0.499923805
0.500	393	18	0.04822924	0.45177076
0.000	420	19	0.041518888	-0.041518888
0.700	297	20	0.07208827	0.62791173
-0.600	415	21	0.042761546	-0.642761546
-1.300	712	22	-0.031052328	-1.268947672
0.100	297	23	0.07208827	0.02791173
0.700	415	24	0.042761546	0.657238454
-0.600	712	25	-0.031052328	-0.568947672
0.700	664	26	-0.019122813	0.719122813
-0.400	776	27	-0.046958348	-0.353041652
-0.500	719	28	-0.032792049	-0.467207951
0.500	668	29	-0.02011694	0.52011694
0.400	772	30	-0.045964222	0.445964222
-0.200	719	31	-0.032792049	-0.167207951

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.121735837
R Square	0.014819614
Adjusted R Square	-0.019152123
Standard Error	0.4566894
Observations	31

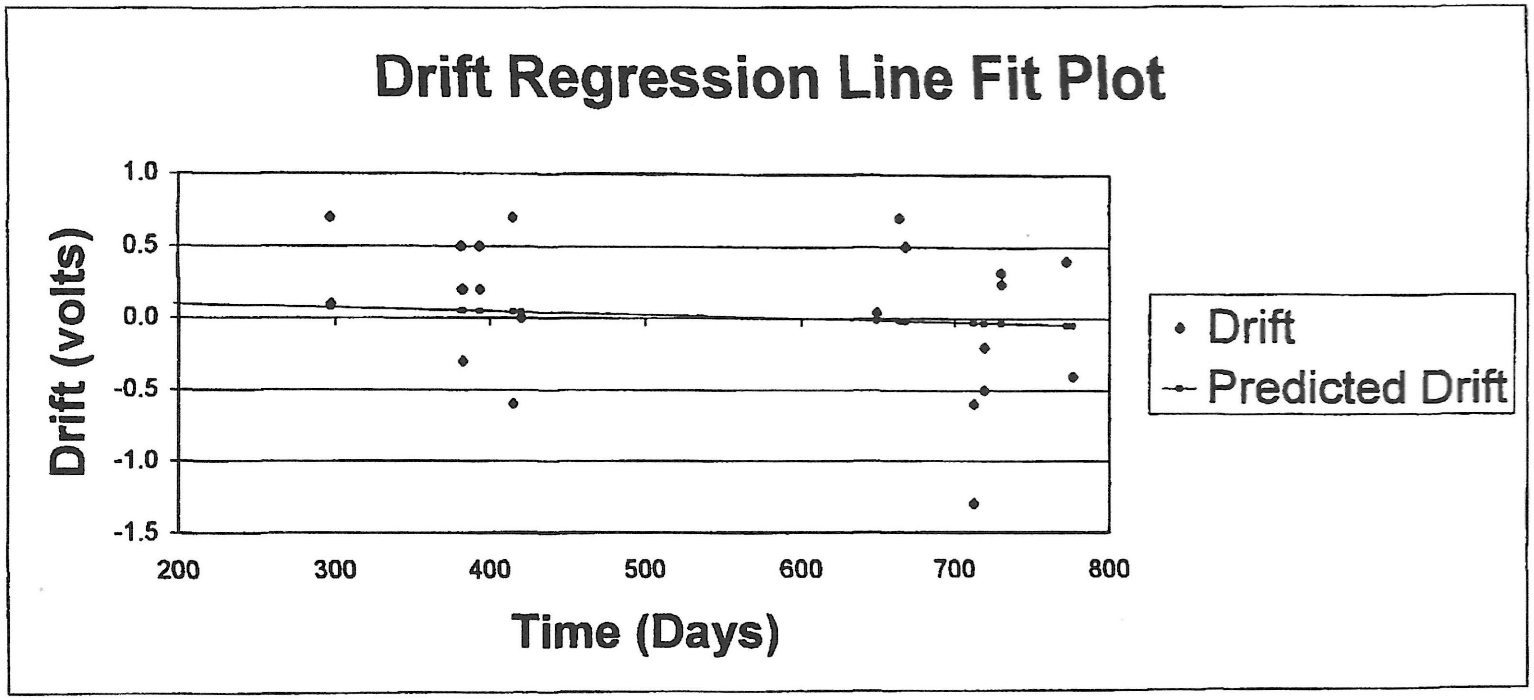
ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0.090983156	0.09098316	0.43623362	0.514158572
Residual	29	6.048391038	0.20856521		
Total	30	6.139374194			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	0.145902144	0.186655363	0.78166597	0.44074633	-0.235851145	0.527655434	-0.235851145	0.527655434
X Variable 1	-0.000248532	0.000376289	-0.66047984	0.51415857	-0.00101813	0.000521067	-0.00101813	0.000521067

Instructions:

1. Paste Data into first 2 columns from regression bin on the binning analysis.
2. Sort the first two columns to eliminate blanks.
3. Run regression analysis with output to right hand side of page printouts.
4. Reduce all output to 9 point font.
5. Copy Residual Output next to input data.
6. Copy Plot onto second page and Data Summary / ANOVA onto page 1 of printout.
7. Adjust Plot parameters and titles.


Drift Regression Line Fit Plot
Drift (volts)
1.0
0.5
0.0
-0.5
-1.0
-1.5
200
300
400
500
600
700
800
Time (Days)
Drift
Predicted Drift

Regression Analysis - AV of Drift

			RESIDUAL OUTPUT		
Drift	Time	AV Drift	*Observation*	*Predicted Y*	*Residuals*
-0.060	156	0.060	1	0.205046248	-0.145046248
0.500	198	0.500	2	0.225414945	0.274585055
0.500	381	0.500	3	0.314164263	0.185835737
-0.300	382	0.300	4	0.314649232	-0.014649232
0.320	730	0.320	5	0.483418428	-0.163418428
-0.350	156	0.350	6	0.205046248	0.144953752
0.000	198	0.000	7	0.225414945	-0.225414945
0.200	381	0.200	8	0.314164263	-0.114164263
0.200	382	0.200	9	0.314649232	-0.114649232
0.240	730	0.240	10	0.483418428	-0.243418428
-0.100	154	0.100	11	0.204076311	-0.104076311
0.000	185	0.000	12	0.219110348	-0.219110348
0.200	393	0.200	13	0.31998389	-0.11998389
0.000	420	0.000	14	0.333078052	-0.333078052
0.040	649	0.040	15	0.444135943	-0.404135943
0.100	154	0.100	16	0.204076311	-0.104076311
-0.400	185	0.400	17	0.219110348	0.180889652
0.500	393	0.500	18	0.31998389	0.18001611
0.000	420	0.000	19	0.333078052	-0.333078052
0.700	297	0.700	20	0.273426871	0.426573129
-0.600	415	0.600	21	0.330653207	0.269346793
-1.300	712	1.300	22	0.474688987	0.825311013
0.100	297	0.100	23	0.273426871	-0.173426871
0.700	415	0.700	24	0.330653207	0.369346793
-0.600	712	0.600	25	0.474688987	0.125311013
0.700	664	0.700	26	0.451410477	0.248589523
-0.400	776	0.400	27	0.505727	-0.105727
-0.500	719	0.500	28	0.478083769	0.021916231
0.500	668	0.500	29	0.453350353	0.046649647
0.400	772	0.400	30	0.503787124	-0.103787124
-0.200	719	0.200	31	0.478083769	-0.278083769

SUMMARY OUTPUT

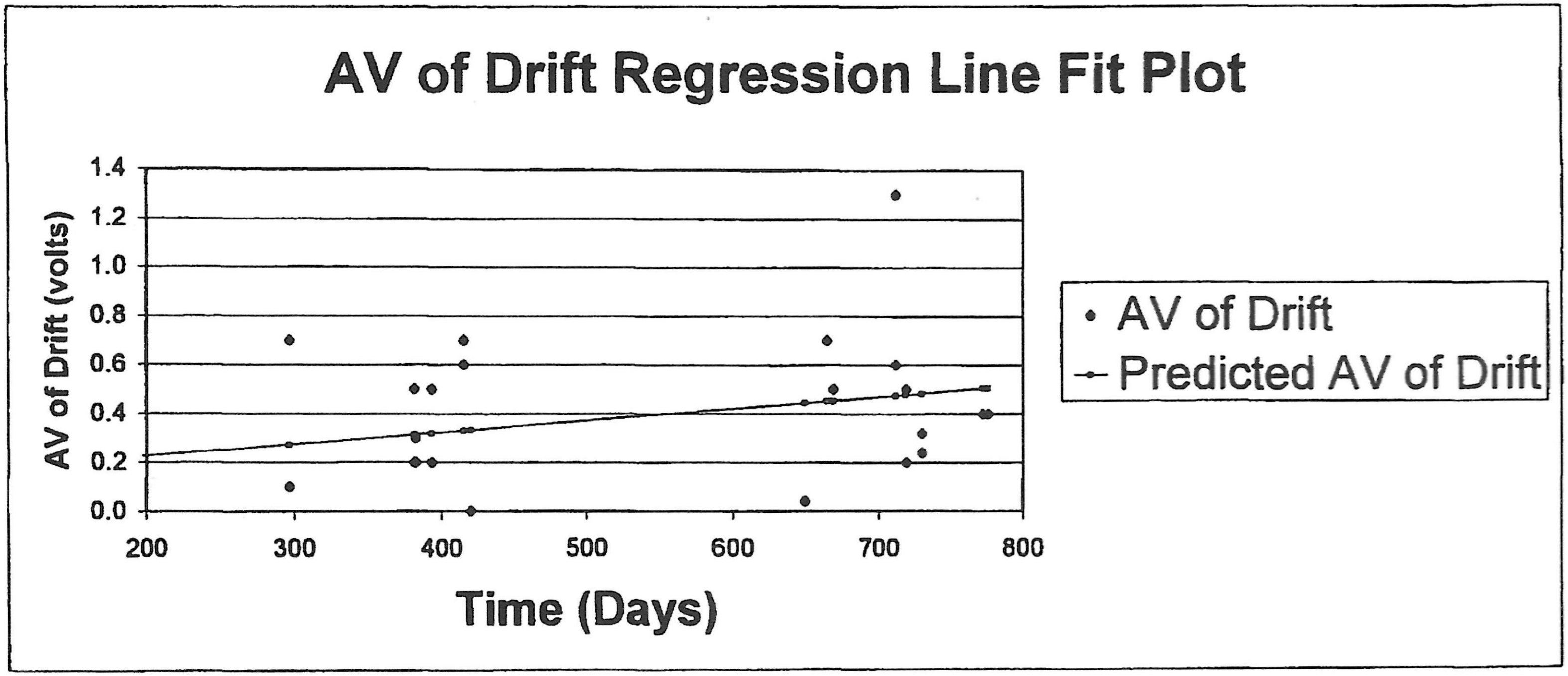
Regression Statistics	
Multiple R	0.373938444
R Square	0.13982996
Adjusted R Square	0.110168924
Standard Error	0.271085274
Observations	31

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0.346438198	0.346438198	4.714264211	0.038237581
Residual	29	2.131129544	0.073487228		
Total	30	2.477567742			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	0.129391092	0.110796353	1.167828072	0.252388163	-0.097213018	0.355995201	-0.097213018	0.355995201
X Variable 1	0.000484969	0.000223361	2.171235841	0.038237581	2.81446E-05	0.000941793	2.81446E-05	0.000941793

Instructions:
1. First 2 columns take absolute value of data from drift regression sheet.
2. Run regression analysis with output to right hand side of page printouts.
3. Reduce all output to 9 point font.
4. Copy Residual Output next to input data.
5. Copy Plot onto second page and Data Summary / ANOVA onto page 1 of printout.
6. Adjust Plot parameters and titles.


AV of Drift Regression Line Fit Plot
AV of Drift (volts)
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
200
300
400
500
600
700
800
Time (Days)
AV of Drift
Predicted AV of Drift

Regression Analysis - Bin Standard Deviation

		RESIDUAL OUTPUT		
Std. Dev.	**Time**	*Observation*	*Predicted Y*	*Residuals*
0.279	173.3	1	0.270065069	0.008730171
0.388	381.3	2	0.402170957	-0.01409099
0.623	720.2	3	0.617307275	0.00536082

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.997539044
R Square	0.995084145
Adjusted R Square	0.990168289
Standard Error	0.017421547
Observations	3

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0.061437583	0.061437583	202.4233999	0.044672076
Residual	1	0.00030351	0.00030351		
Total	2	0.061741094			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	0.160073823	0.021464006	7.457779603	0.084857028	-0.112651058	0.432798703	-0.112651058	0.432798703
X Variable 1	0.00063487	4.46226E-05	14.22755776	0.044672076	6.78891E-05	0.001201851	6.78891E-05	0.001201851

Extrapolated Standard Deviation (Random Drift) Determination

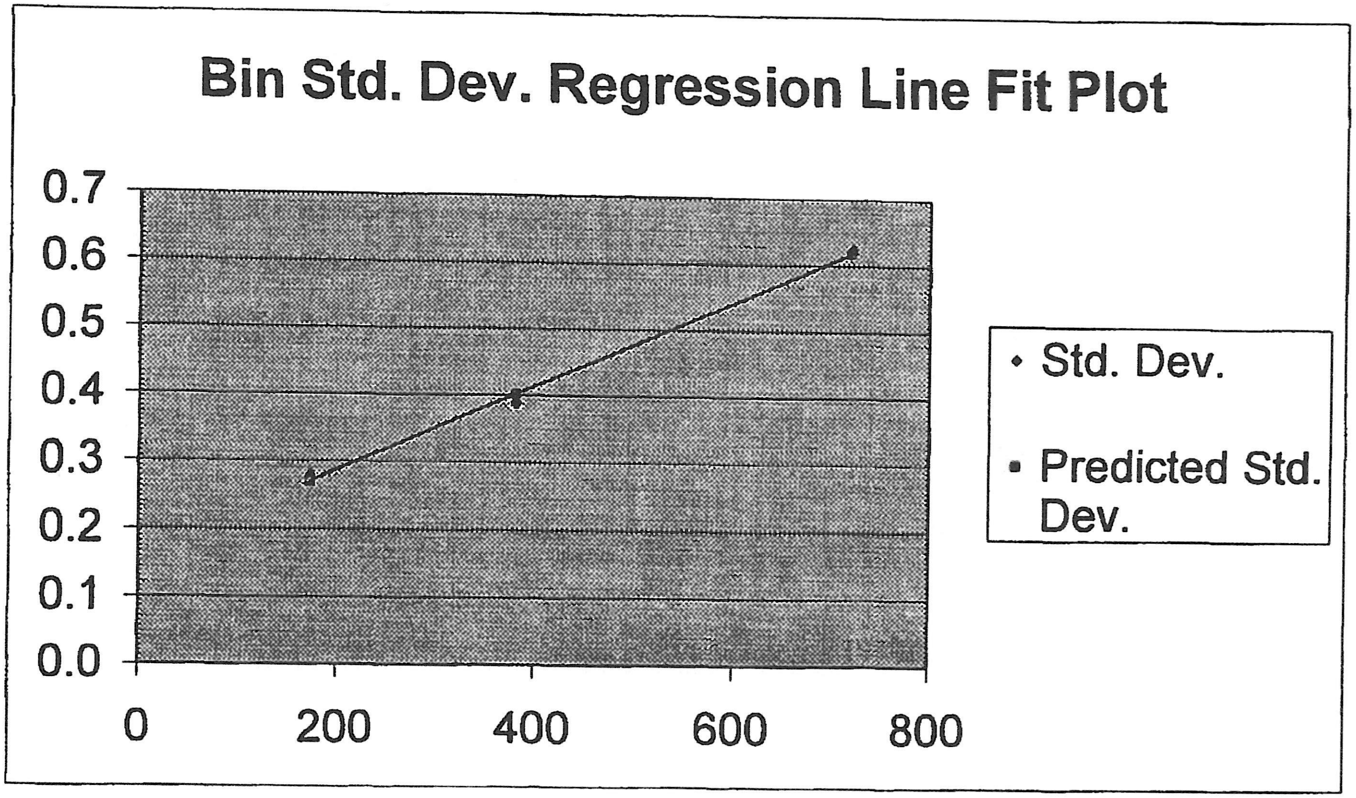
Prediction Line
(From ANOVA Table Above)

	Coefficients
Intercept (b)	0.160073823
X Variable 1 (Slope - m)	0.00063487

Extrapolated Standard Deviation to 915 Days

Drift Interval (t): 915 Days
Random Drift = mt + b

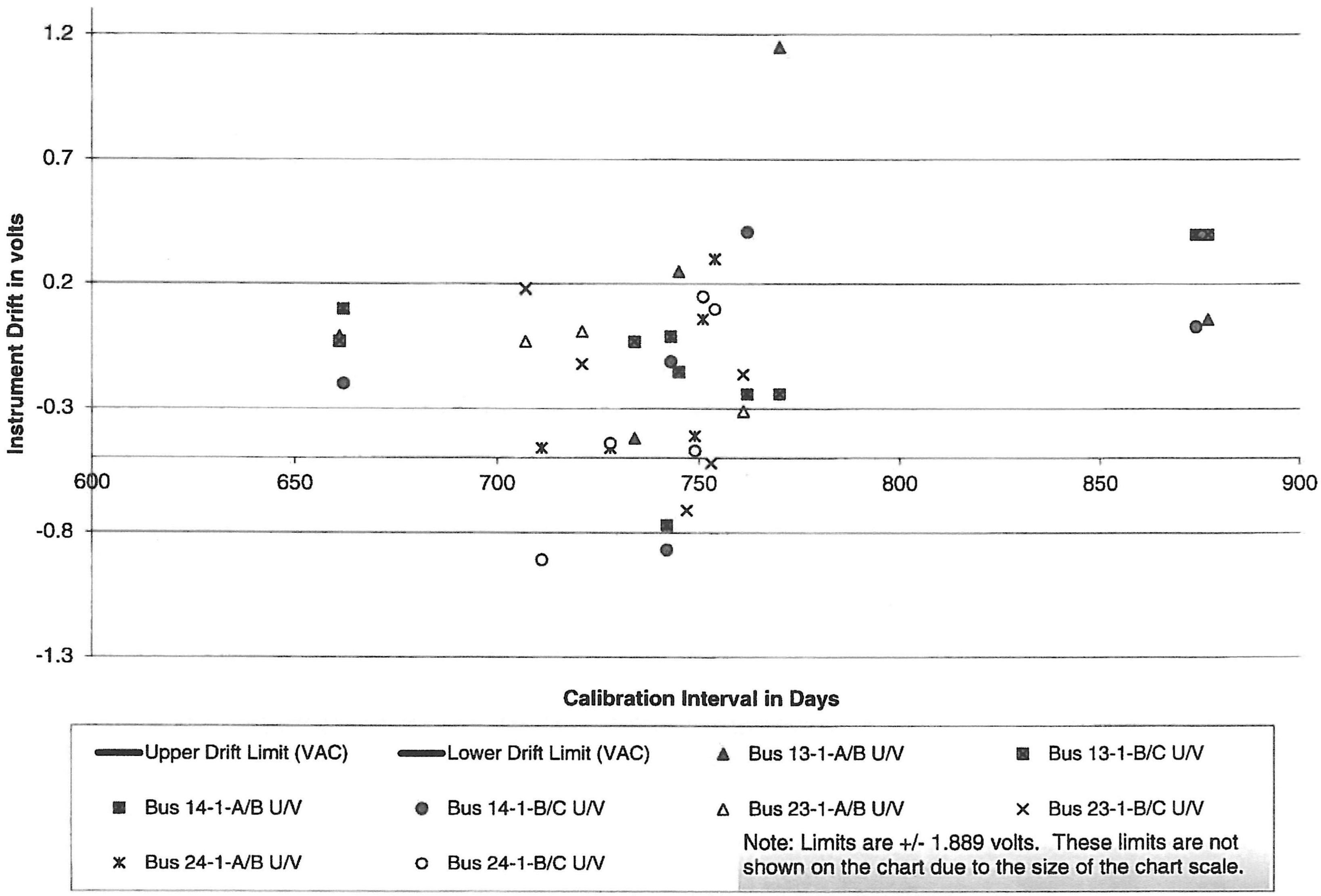
Extrapolated Std. Dev.:	*0.741 volts*


Bin Std. Dev. Regression Line Fit Plot
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0
200
400
600
800
Std. Dev.
Predicted Std. Dev.

ATTACHMENT 3

EC 394927, Attachment 13, "Drift Verification for QDC-6700-I-0848
Bus 13(23)-1-A/B U/V, Bus 13(23)-1-B/C U/V, Bus 14(24)-1-A/B U/V, Bus 14(24)-1-B/C U/V"

Drift Verification for QDC-6700-I-0848
Bus 13(23)-1-A/B U/V, Bus 13(23)-1-B/C U/V, Bus 14(24)-1-A/B U/V, Bus 14(24)-1-B/C U/V



Note: Limits are +/- 1.889 volts. These limits are not shown on the chart due to the size of the chart scale.

Evaluation Date	Total Number of Data Points	Points This Cycle	Total Number of Data Points Outside Limits	Outside Limits this Cycle	Total Percent Outside Limits	Percent Outside Limits This Cycle
Initial	8	8	0	0	0.00%	0.00%
4/1/2006	12	4	0	0	0.00%	0.00%
5/1/2007	16	4	0	0	0.00%	0.00%
11/23/2011	32	16	0	0	0.00%	0.00%
9/1/2013	40	8	0	0	0.00%	0.00%

Random Uncertainty Intercept	Random Uncertainty Slope	Positive Bias Uncertainty Intercept	Positive Bias Uncertainty Slope	Negative Bias Uncertainty Intercept	Negative Bias Uncertainty Slope
1.889	0	0	0	0	0

Instrument Values	Span VAC
Bus 13-1-A/B U/V	5
Bus 13-1-B/C U/V	5
Bus 14-1-A/B U/V	5
Bus 14-1-B/C U/V	5
Bus 23-1-A/B U/V	5
Bus 23-1-B/C U/V	5
Bus 24-1-A/B U/V	5
Bus 24-1-B/C U/V	5

Calibration Interval	Upper Drift Limit (VAC)	Lower Drift Limit (VAC)
725	1.889	-1.889
734	1.889	-1.889
743	1.889	-1.889
753	1.889	-1.889
762	1.889	-1.889
771	1.889	-1.889
780	1.889	-1.889
789	1.889	-1.889
799	1.889	-1.889
808	1.889	-1.889
817	1.889	-1.889
826	1.889	-1.889
836	1.889	-1.889
845	1.889	-1.889
854	1.889	-1.889
863	1.889	-1.889
872	1.889	-1.889
882	1.889	-1.889
891	1.889	-1.889
900	1.889	-1.889

Calibration Interval	Upper Drift Limit (VAC)	Lower Drift Limit (VAC)
600	1.889	-1.889
661	1.889	-1.889
662	1.889	-1.889
725	1.889	-1.889
734	1.889	-1.889
743	1.889	-1.889
753	1.889	-1.889
762	1.889	-1.889
771	1.889	-1.889
780	1.889	-1.889
789	1.889	-1.889
799	1.889	-1.889
808	1.889	-1.889
817	1.889	-1.889
826	1.889	-1.889
836	1.889	-1.889
845	1.889	-1.889
854	1.889	-1.889
863	1.889	-1.889
872	1.889	-1.889
882	1.889	-1.889
891	1.889	-1.889
900	1.889	-1.889

Bus 13-1-A/B U/V		Bus 13-1-B/C U/V		Bus 14-1-A/B U/V		Bus 14-1-B/C U/V		Out of Limits	Total
Cal Interval	Drift VAC	Cal Interval	Drift VAC	Cal Interval	Drift VAC	Cal Interval	Drift VAC		
877.00	0.06	877.00	0.40	874.00	0.40	874.00	0.03	0	4
770.00	1.15	770.00	-0.24	762.00	-0.24	762.00	0.41	0	4
734.00	-0.42	734.00	-0.03	742.00	-0.77	742.00	-0.87	0	4
745.00	0.25	745.00	-0.15	743.00	-0.01	743.00	-0.11	0	4
661.00	-0.01	661.00	-0.03	662.00	0.10	662.00	-0.20	0	4
							Sum	0	20
Bus 23-1-A/B U/V		**Bus 23-1-B/C U/V**		**Bus 24-1-A/B U/V**		**Bus 24-1-B/C U/V**		**Out of Limits**	**Total**
Cal Interval	Drift VAC	Cal Interval	Drift VAC	Cal Interval	Drift VAC	Cal Interval	Drift VAC		
747.00	-0.71	747.00	-0.71	754.00	0.30	754.00	0.10	0	4
753.00	-0.52	753.00	-0.52	749.00	-0.41	749.00	-0.47	0	4
707.00	-0.03	707.00	0.18	711.00	-0.46	711.00	-0.91	0	4
761.00	-0.31	761.00	-0.16	751.00	0.06	751.00	0.15	0	4
721.00	0.01	721.00	-0.12	728.00	-0.46	728.00	-0.44	0	4
							Sum	0	20

Calibration Date	Calibration Procedure	Instrument EPN	As Found	As Left	Calibration Interval	Drift
11/11/2002	MA-QC-773-523	Bus 13-1-A-B UV	84.44	84.44	N/A	N/A
4/6/2005	MA-QC-773-523	Bus 13-1-A-B UV	84.50	83.70	877	0.06
5/16/2007	MA-QC-773-523	Bus 13-1-A-B UV	84.85	83.71	770	1.15
5/19/2009	MA-QC-773-523	Bus 13-1-A-B UV	83.29	83.65	734	-0.42
6/3/2011	MA-QC-773-523	Bus 13-1-A-B UV	83.9	83.65	745	0.25
3/25/2013	MA-QC-773-523	Bus 13-1-A-B UV	83.64	83.64	661	-0.01

Calibration Date	Calibration Procedure	Instrument EPN	As Found	As Left	Calibration Interval	Drift
11/11/2002	MA-QC-773-523	Bus 13-1-B-C UV	83.70	83.70	N/A	N/A
4/6/2005	MA-QC-773-523	Bus 13-1-B-C UV	84.10	84.10	877	0.4
5/16/2007	MA-QC-773-523	Bus 13-1-B-C UV	83.86	83.86	770	-0.24
5/19/2009	MA-QC-773-523	Bus 13-1-B-C UV	83.83	83.71	734	-0.03
6/3/2011	MA-QC-773-523	Bus 13-1-B-C UV	83.56	83.43	745	-0.15
3/25/2013	MA-QC-773-523	Bus 13-1-B-C UV	83.4	83.4	661	-0.03

Calibration Date	Calibration Procedure	Instrument EPN	As Found	As Left	Calibration Interval	Drift
11/15/2002	MA-QC-773-523	Bus 14-1-A-B UV	82.8	83.8	N/A	N/A
4/7/2005	MA-QC-773-523	Bus 14-1-A-B UV	83.83	83.73	874	0.03
5/9/2007	MA-QC-773-523	Bus 14-1-A-B UV	84.14	84	762	0.41
5/20/2009	MA-QC-773-523	Bus 14-1-A-B UV	83.23	83.71	742	-0.77
6/2/2011	MA-QC-773-523	Bus 14-1-A-B UV	83.7	83.5	743	-0.01
3/25/2013	MA-QC-773-523	Bus 14-1-A-B UV	83.6	83.6	662	0.1

Calibration Date	Calibration Procedure	Instrument EPN	As Found	As Left	Calibration Interval	Drift
11/15/2002	MA-QC-773-523	Bus 14-1-B-C UV	83.7	83.7	N/A	N/A
4/7/2005	MA-QC-773-523	Bus 14-1-B-C UV	83.82	83.67	874	0.12
5/9/2007	MA-QC-773-523	Bus 14-1-B-C UV	84	83.57	762	0.33
5/20/2009	MA-QC-773-523	Bus 14-1-B-C UV	82.7	83.31	742	-0.87
6/2/2011	MA-QC-773-523	Bus 14-1-B-C UV	83.2	83.7	743	-0.11
3/25/2013	MA-QC-773-523	Bus 14-1-B-C UV	83.5	83.5	662	-0.2

Calibration Date	Calibration Procedure	Instrument EPN	As Found	As Left	Calibration Interval	Drift
2/21/2002	MA-QC-773-524	Bus 23-1-A-B UV	84.1	84.1	N/A	N/A
3/9/2004	MA-QC-773-524	Bus 23-1-A-B UV	83.39	83.92	747	-0.71
4/1/2006	MA-QC-773-524	Bus 23-1-A-B UV	83.4	83.7	753	-0.52
3/8/2008	MA-QC-773-524	Bus 23-1-A-B UV	83.67	83.67	707	-0.03
4/8/2010	MA-QC-773-524	Bus 23-1-A-B UV	83.36	83.65	761	-0.31
3/29/2012	MA-QC-773-524	Bus 23-1-A-B UV	83.66	83.73	721	0.01

Calibration Date	Calibration Procedure	Instrument EPN	As Found	As Left	Calibration Interval	Drift
2/21/2002	MA-QC-773-524	Bus 23-1-B-C UV	84.3	84.3	N/A	N/A
3/9/2004	MA-QC-773-524	Bus 23-1-B-C UV	84.31	84.31	747	0.01
4/1/2006	MA-QC-773-524	Bus 23-1-B-C UV	84.42	83.39	753	0.11
3/8/2008	MA-QC-773-524	Bus 23-1-B-C UV	83.57	83.72	707	0.18
4/8/2010	MA-QC-773-524	Bus 23-1-B-C UV	83.56	83.64	761	-0.16
3/29/2012	MA-QC-773-524	Bus 23-1-B-C UV	83.52	83.67	721	-0.12

Calibration Date	Calibration Procedure	Instrument EPN	As Found	As Left	Calibration Interval	Drift
2/19/2002	MA-QC-773-524	Bus 24-1-A-B UV	85	84	N/A	N/A
3/14/2004	MA-QC-773-524	Bus 24-1-A-B UV	84.3	83.8	754	0.3
4/2/2006	MA-QC-773-524	Bus 24-1-A-B UV	83.39	84.16	749	-0.41
3/13/2008	MA-QC-773-524	Bus 24-1-A-B UV	83.7	83.7	711	-0.46
4/3/2010	MA-QC-773-524	Bus 24-1-A-B UV	83.76	83.76	751	0.06
3/31/2012	MA-QC-773-524	Bus 24-1-A-B UV	83.3	83.7	728	-0.46

Calibration Date	Calibration Procedure	Instrument EPN	As Found	As Left	Calibration Interval	Drift
2/19/2002	MA-QC-773-524	Bus 24-1-B-C UV	85.8	83.9	N/A	N/A
3/14/2004	MA-QC-773-524	Bus 24-1-B-C UV	84	83.9	754	0.1
4/2/2006	MA-QC-773-524	Bus 24-1-B-C UV	83.43	84.21	749	-0.47
3/13/2008	MA-QC-773-524	Bus 24-1-B-C UV	83.3	83.4	711	-0.91
4/3/2010	MA-QC-773-524	Bus 24-1-B-C UV	83.55	83.55	751	0.15
3/31/2012	MA-QC-773-524	Bus 24-1-B-C UV	83.11	83.72	728	-0.44

ATTACHMENT 4

NES-EIC-20.04, Appendix I, "Negligible Uncertainties," Revision 6

APPENDIX I

NEGLIGIBLE UNCERTAINTIES

1.0 INTRODUCTION

The errors and uncertainties listed in this appendix have historically been found to be negligible under normal operating conditions. If the individual preparing an instrument loop accuracy calculation determines that the specific conditions apply, then these errors and uncertainties do not have to be evaluated in the calculation.

2.0 NEGLIGIBLE UNCERTAINTIES

2.1 Radiation Effects

The effects of normal radiation are small and accounted for in the periodic calibration process. Outside of containment there is not a creditable increase in radiation during normal operation. The uncertainty introduced by radiation effects on components is considered to be negligible.

If an as-found/as-left analysis has been performed based on historical calibration data, then normal radiation effects are considered to be included in the drift analysis results.

2.2 Humidity Effects

The uncertainty introduced by humidity effects during normal conditions is not typically addressed in vendor literature. Therefore humidity effects are considered to be negligible unless the manufacturer specifically mentions humidity effects in the applicable technical manual. The effects of changes in humidity on the components are considered to be calibrated out on a periodic basis. A condensing environment is regarded as an abnormal event that will require maintenance to the equipment. Humidity's below 10% are expected to occur very infrequently and are not considered.

If an as-found/as-left analysis has been performed based on historical calibration data, the humidity effect is assumed to be included in the drift analysis results.

2.3 Power Supply Effects

It is expected that regulated instrument power supplies have been designed to function within manufacturer's required voltage limits. The variations of voltage and frequency are expected to be small and the power supply voltage and frequency uncertainties are considered to be negligible with respect to other error terms.

If an as-found/as-left analysis has been performed based on historical calibration data, the power supply voltage and frequency effects are assumed to be included in the drift analysis results.

2.4 Calibration Standard Error (STD)

The calibration standards used by the station to maintain and calibrate station M&TE are expected to be maintained to manufacturer's specifications. These calibration standards are more accurate than the station M&TE by a ratio greater than 4:1. Therefore, the effects of the calibration standard error are considered to be negligible with respect to other error terms.

2.5 Seismic/Vibration Effects

The impact of Seismic Effects in the setpoint calculation should be consistent with the Licensing Design Basis of the specific station (e.g. assuming a design Seismic Event coincident with a Design Basis Accident).

For normal errors, seismic events less than or equal to an OBE are considered to cause no permanent shift in the input/output relationship of the device. For seismic events greater than an OBE, it should be verified that the affected instrumentation is recalibrated prior to any subsequent accident to negate any permanent shift, which may result from a post seismic shift.

Unlike Seismic effects, Vibration effects may not always be calibrated out or included in the statistical drift. Consideration must be made of the "normal operating" versus "calibration" conditions. If the relative vibration conditions of these two states are not the same, then the vibration effect must be considered. This effect is not calibrated out or included in the historical calibrations data.

If an as-found/as-left analysis has been performed based on historical calibration data, the vibration effect is considered to be included in the drift analysis results, if the normal operation conditions and the calibration conditions are similar.

2.6 Lead Wire Effects

Since the resistance of a wire is equal to the resistivity times the length divided by the cross sectional area, the very small differences in the length of wires between components does not contribute any significant resistance differences between wires. Therefore, the effect of lead wire resistance differences is considered negligible, except for RTD's and thermocouples.

If a system design requires that lead wire effects be considered as a component of uncertainty, that requirement must be included in the design basis. It is assumed that the general design standard is to eliminate lead wire effects as a concern in both equipment design and installation. Failure to do so is a design fault that should be corrected.

The lead wire effects for RTD's and thermocouples must be considered separately and must be evaluated for each specific application.

3.0 NEGLIGIBLE UNCERTAINTIES FOR RELAYS, TIMERS, LIMIT AND MECHANICAL DISPLACER-TYPE SWITCHES

3.1 Relays and Timers

Table I1, Negligible Errors and Uncertainties for Relays and Timers		
Error Type	Symbol	Justification
Process Errors	PE	These particular devices are not in direct contact with the process and are not subject to these types of errors or uncertainties.
Density Error		
Process Error		
Flow Element Error		
Temperature Error	eT	
Thermal Expansion Error		
Configuration or Installation Error		
Operational Errors		
Drift Error	D	Unless specifically prescribed by the Vendor, drift is assumed to be accounted for in the published Reference Accuracy for the device.
Static Pressure Error	eSP	These particular devices are not in direct contact with the process and are not subject to these types of errors or uncertainties.
Pressure Error	eP	There are no Pressure Errors associated with the function of these devices as the ambient pressure at the device location remains constant at normal atmospheric pressure.
Power Supply Error	eV	There are no Power Supply Errors associated with the function of these particular devices.
Environmental Errors		Unless specifically prescribed by the Vendor, environmental errors are assumed to be accounted for in the published Reference Accuracy for the device. Additionally, as these types of devices are typically installed in controlled environments and expected to perform their functions under normal operating conditions, the effects of these errors is considered negligible.
Temperature Error	eT	
Humidity Error	eH	
Seismic Error	eS	
Radiation Error	eR	
Other Errors		
Insulation Resistance	eIR	There are no Insulation Resistance Errors associated with the function of these particular devices
Random Input Errors		These devices function as separate modules and have no random input errors.

3.2 Limit Switches

Table I2, Negligible Errors and Uncertainties for Limit Switches		
Error Type	Symbol	Justification
Process Errors	PE	These particular devices are not in direct contact with the process and are not subject to these types of errors or uncertainties.
Density Error		
Process Error		
Flow Element Error		
Temperature Error	eT	
Thermal Expansion Error		
Configuration or Installation Error		
Operational Errors		
Drift Error	D	Unless specifically prescribed by the Vendor, drift is not applicable for these type of devices.
Static Pressure Error	eSP	These particular devices are not in direct contact with the process and are not subject to these types of errors or uncertainties.
Pressure Error	eP	There are no Pressure Errors associated with the function of these devices as the ambient pressure at the device location remains constant at normal atmospheric pressure.
Power Supply Error	eV	There are no Power Supply Errors associated with the function of these particular devices.
Environmental Errors		Unless specifically prescribed by the Vendor, environmental errors are assumed to be accounted for in the published Reference Accuracy for the device.
Temperature Error	eT	
Humidity Error	eH	
Seismic Error	eS	
Radiation Error	eR	
Other Errors		
Insulation Resistance	eIR	There are no Insulation Resistance Errors associated with the function of these particular devices
Random Input Errors		These devices function as separate modules and have no random input errors.

3.3 Mechanical Displacer-Type Switches (Float Switches)

Table I3, Negligible Errors and Uncertainties for Mechanical Displacer-Type Switches		
Error Type	Symbol	Justification
Operational Errors		
Drift Error	D	Unless specifically prescribed by the Vendor, drift is not applicable for these type of devices.
Pressure Error	eP	There are no Pressure Errors associated with the function of these devices as the ambient pressure at the device location remains constant at normal atmospheric pressure.
Power Supply Error	eV	There are no Power Supply Errors associated with the function of these particular devices.
Environmental Errors		Unless specifically prescribed by the Vendor, environmental errors are assumed to be accounted for in the published Reference Accuracy for the device.
Temperature Error	eT	
Humidity Error	eH	
Seismic Error	eS	
Radiation Error	eR	
Other Errors		
Insulation Resistance	eIR	There are no Insulation Resistance Errors associated with the function of these particular devices
Random Input Errors		These devices function as separate modules and have no random input errors.