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NRC ITS TRACKING

NRC Reviewer

ID	200510281240 Conference Call Requested? No
Category	Discussion
ITS Information	ITS Section: 3.3 DOC Number: M.3 JFD Number: None Page Number(s): 683 ITS Number: BSI 1h Bases JFD Number: None
Comment	This is a Beyond Scope Issue (TAC No. MC7604) 1. In the ITS, Table 3.3.8.1-1, the allowable value of Loss of Voltage Protection is between greater than or equal to 2345 V and less than or equal to 2905 V. This corresponds to an equivalent trip setting of 2625 plus or minus 280 V. In the Current Technical Specifications (CTS), the trip setting is 2625 plus or minus 175 V. Please provide a copy of the drift calculation based upon which the proposed allowable value for Loss of Voltage Protection (change in drift value) in the ITS has been proposed. 2. In the ITS, Table 3.3.8.1-1, the allowable value of Degraded Voltage Protection is between greater than or equal to 3909 V and less than or equal to 3921 V with a time delay of greater than or equal to 8.8 seconds and less than or equal to 9.2 seconds. This corresponds to an equivalent trip setting of 3915 plus or minus 6 V and a time delay of 9.0 plus or minus 0.2 seconds. In the CTS, the trip setting is 3915 plus or minus 18 V and a time delay of 9.0 plus or minus 1.0 second. Please provide a copy of the drift calculation based upon which the proposed allowable values for Degraded Voltage Protection (change in the drift values) in the ITS have been proposed.
Issue Date	10/28/2005

Close Date	Resolution requires change to: None Docket Response Required? No

Responses

Date Created: 10/28/2005 12:40 PM by Terry Beltz
Last Modified: 11/29/2005 01:34 PM

Close	View By\NRC Owner	View By\Item Number

LICENSEE COMMENTS

ID	200510281240	Validation Required? No
Response Submitted	11/15/2005	
Comment	The NRC reviewer requested a copy of the drift calculation supporting the new Allowable Values for the Loss of Voltage and Degraded Voltage Functions. The NRC reviewer identified the Allowable Values for both of these Functions are being changed as part of the conversion to the Monticello Improved Technical Specifications (ITS). However, the Loss of Voltage Function Allowable Value is not being changed as part of the Monticello ITS conversion. The change to the Current Technical Specifications (CTS) Table 3.2.6 Loss of Voltage Protection Function (Attachment 1, Volume 8, Rev. 0, Page 683 of 760) identifies the change to the Allowable Value is justified in Discussion of Change (DOC) A.7. DOC A.7 (Page 690 of 760) states that the change in the Allowable Value is consistent with the Technical Specifications Change Request submitted to the NRC for approval in NMC letter L-MT-04-036, from Thomas J. Palmisano (NMC) to NRC, dated June 30, 2004. This change has subsequently been approved by the NRC as part of Monticello License Amendment 143, dated September 30, 2005. Therefore, since the Loss of Voltage Allowable Value change has already been approved by the NRC, it is not part of the Monticello ITS conversion and should not be considered a beyond scope issue. Thus, no drift calculations are being provided. The changes to the Degraded Voltage Allowable Values (Page 683 of 760) are justified by DOC M.3 (Page 691 of 760), and are being changed as part of the Monticello ITS conversion. The instrument drift analysis for both the Voltage Function and the Time Delay Function will be provided to the NRC reviewer. [added on 11/17/05] Based on a e-mail from the NRC to Monticello, the NRC reviewer requested the setpoint calculation in addition to the drift analysis. Therefore, the setpoint calculation for the Degraded Voltage Function (voltage and time delay) will be provided to the NRC reviewer. [added on 12/7/05] The setpoint calculation has been provided in the attachment to this response.	

Date Created: 11/15/2005 10:18 AM by Jerry Jones
Last Modified: 12/07/2005 11:13 AM

CA-92-220 Rev 1.pdf

1. PURPOSE

The purpose of this calculation is to assure that the current setpoints and Allowable Values are conservative or to establish new setpoints and Allowable Values for the Degraded Voltage Relays listed below. This calculation establishes the bases for these settings and provides tolerances to be used in calibration procedures.

- 127-5A
- 127-5B
- 127-5C
- 127-6A
- 127-6B
- 127-6C

The Potential Transformers (PTs) addressed by this study are BUS-15/POT and BUS-16/POT.

Revision 1 of this calculation is produced to support the Improved Technical Specifications project. This calculation derives the necessary Allowable Values and associated setpoints.

2. METHODOLOGY

This calculation is performed in accordance with General Electric Setpoint Methodology (ESM-03.02-APP-I -- Input 4.1) and and the project Drift Analysis Methodology (ESM-03.02-APP-III – Input 4.13).

The General Electric Setpoint Methodology is a statistically based methodology. It recognizes that most of the uncertainties that affect instrument performance are subject to random behavior, and utilize statistical (probability) estimates of the various uncertainties to achieve conservative, but reasonable, predictions of instrument channel uncertainties. The objective of the statistical approach to setpoint calculations is to achieve a workable compromise between the need to ensure instrument trips when appropriate, and the need to avoid spurious trips that may unnecessarily challenge safety systems or disrupt plant operation.

The project Drift Analysis Methodology prescribes how actual As Found/As Left data is used to characterize instrument performance such that instrument and loop accuracy performance can be based on actual field observations to provide the most realistic modeling of instrument performance.

Drift values for the relays covered by this calculation were determined in Attachments 1 and 3 (voltage function) and Attachments 2 and 4 (time delay). The determination of relay drift values used in this calculation is performed in accordance with ESM-03.02-APP-III (Input 4.13). Since calibration intervals are not changing for the relays covered by this calculation, a time dependency analysis is not required.

<u>Voltage Function</u>
Note that Section 6.2.1 of Input 4.13 (drift analysis ESM-03.02-APP-III) states that "Only the Vendor Drift and Drift Temperature Effect terms may be replaced with the analyzed drift value for the Technical Specifications calculations performed per the GE setpoint methodology". For the voltage function for this calculation, the Vendor Accuracy term was computed using 2 methods:

(1) Using the vendor accuracy components from Input 4.8 (vendor technical manual) per the restriction imposed on Technical Specification calculations by Input 4.13 described above.

The vendor technical manual (Input 4.8) for these relays provides 3 different components for the VA term. Based on the calibration method of Input 4.4, only 2 of the terms are applicable to this calculation – the pickup and dropout setting repeatability at constant temperature and constant voltage and the pickup and dropout repeatability over dc power range of 100-140 volts. The pickup and dropout settings with respect to printed dial markings is not applicable because the setting is based on the measured value rather than the printed dial markings. Conservatively combining the two applicable terms using the square root of the sum of the squares yields a VA result of ±0.424 Vac (refer to Section 6.2.1.3).

(2) Using the broader guidance, also from Section 6.2.1 of Input 4.13, that allows the Analyzed Drift (AD) to characterize not only Vendor Drift (VD) but also Vendor Accuracy (VA) and M&TE (or calibration error).

Using actual As Found/As Left data for the installed relays yields a random accuracy term of ±0.0552 Vac with a negligible bias.

Thus, the vendor specified accuracy exceeded the observed installed accuracy by a factor of approximately 8 to 1.

Although method (1) is specifically prescribed by Input 4.13 for Technical Specification calculations, for this calculation method (2) is justified because:

- Method (1) results in an unrealistic and substantially greater error than has actually been observed; and
- Method (2) provides a Vendor Accuracy (VA) term based on actual observed behavior that is conservatively considered to be a more accurate characterization of relay performance.

<u>Time Delay Function</u>

- The method used to determine the time delay Vendor Accuracy (VA) is consistent with the methodology of 6.2.1 of Input 4.13 (drift analysis ESM-03.02-APP-III) for Technical Specifications calculations. Vendor Accuracy is derived from vendor specifications.

The methodology for determining instrument setpoints is not described in the USAR or its references.

3. ACCEPTANCE CRITERIA

The setpoint and instrument settings must provide assurance that the Analytical Limit will not be exceeded when all applicable instrumentation uncertainties are considered.

4. INPUTS

4.1 Engineering Standards Manual ESM-03.02-APP-I, Appendix I (GE Methodology Instrumentation & Controls), Revision 3. The ESM provides plant specific guidance on the implementation of the General Electric guidelines (Reference 10.1) and methodology (Reference 10.2).

4.2 Monticello Technical Specifications, Amendment 138a.

Section	Setting	Function
Table 3.2.6 Item 1	3915 ±18 Volts 9 ± 1 Seconds	Safeguards Bus Degraded Voltage Protection
Bases Section 3.2 Deviation Table	≥ 3897 Volts (trip) ≤ 3975 Volts (reset) 5 Sec. ≤ Time delay and 10 Sec. ≥ Time delay	Instrumentation for Safeguards Bus Protection – Degraded Voltage
Table 4.2.1 Safeguards Bus Voltage, Item 1	Quarterly	Calibration

Per the surveillance procedures (Input 4.4), calibration of the Degraded Voltage relays fulfills the requirements of Technical Specification Table 4.2.1, Item 1, for calibration, and is to be performed Quarterly.

4.3 Monticello Component Master List (CML). The CML contains instrument information relating to the installed equipment as listed in Sections 6.2.1.1 and 6.6.1.1.

4.4 0302, Revision 17, Safeguard Bus Degraded Voltage Protection-Relay Unit Calibration

Voltage Function	
Nominal Setpoint (127-5A, 5B, 5C, 6A, 6B, 6C)	111.96 Volts
As Found Values	≥111.34 Volts ≥3897 Bus Voltage
As Left Range	111.96 ± 0.05 Volts or 111.91 ≤ DO ≤ 112.01 Volts
Time Delay	
Nominal Setpoint (127-5A, 5B, 5C, 6A, 6B, 6C)	9.0 Seconds
As Found Range	5.0 ≤ time delay ≤ 10.0 Sec.
As Left Range	9.0 ± 0.10 Seconds or 8.9 ≤ time delay ≤ 9.1 Sec.

4.5 NX-9532-1, Revision 0, "600 V Through 15 KV Butyl-Molded & Compound Filled Transformers," GEH-230AA, "Instructions - Instrument Transformers – Butyl-Molded and Compound-Filled, 600-V Through 15-KV," Dated May, 1968. This manual shows that the Potential Transformers, which supply the input signal to the Loss of Voltage relays, were produced in accordance with the American Standards for Instrument Transformers, ASA C57.13.

4.6 American National Standard ANSI/IEEE C57.13-1978, "Requirements for Instrument Transformers." Per Section 5 of this standard, "Accuracy Classes for Metering Service", Table 6 lists the metering accuracy classes as 0.3%, 0.6% and 1.2%.

4.7 NF-36397, Revision Y, "Monticello Nuclear Generating Plant Schematic – Meter & Relay Diagram – 4160V System – Buses #11, #12, #13, #14, #15, #16." This diagram shows that the potential transformers used for buses 15 and 16 for the Degraded Voltage relays is 4200-120V, or has a winding ratio of 35:1.

4.8 NX-16951, Revision 0, "Single Phase Undervoltage Relays, Brown Boveri, Inc.," ITE-27N Undervoltage Relay. This vendor technical manual provides the following accuracy terms.

For the voltage function, these accuracy terms are all given as %. For the purposes of this calculation the % is set as % of span.

Accuracy Term	Value
Pickup and dropout settings, repeatability at constant temperature and constant control voltage	±0.2% of 150 Volt Span = 0.3 Volts
Pickup and dropout settings, repeatability over dc power range of 100-140 volts	±0.2% of 150 Volt Span = 0.3 Volts
Pickup and dropout settings, repeatability over temperature range of 32°F to 104°F	±0.2% of 150 Volt Span = 0.3 Volts over 72°F or 0.00417 Volts/°F

For the time delay function, the accuracy terms for the definite time relays is specified as ± 20 milliseconds or ± 10%, whichever is greater.

The ± 10% is based on the use of the printed dial settings during the calibration, while ± 20 milliseconds is based on using the measured value. Since the measured value is used, per Input 4.4, the value for VA is:

VA = ± 20 milliseconds

There is not an accuracy temperature effect specified for the time delay function.

4.9 Monticello USAR Section 8.3, "Auxiliary Power System," and Section 8.4, Revision 21P, "Plant Standby Diesel Generator Systems." These sections of the USAR provide description of the functions involved with Degraded Voltage protection and information related to the bases for the settings.

4.10 Letter from R. C. Anderson of Bechtel Power Corporation to D. Antony of Northern States Power Company, Subject: Job 10040, Monticello Nuclear Generating Plant – Unit 1, Northern States Power Company - Equipment Performance Under Degraded Grid Voltage Conditions, Dated October 7, 1976. This document provides the majority of the bases for the logic in establishment of the Degraded Voltage relay settings.

4.11 MWI-3-M-2.01, Revision 7, "AC Electrical Load Study."

Per Appendix II, Note 2 of the AC Electrical Load Study, the Degraded Voltage limits are established as follows:

The upper Degraded Voltage limit for motor starting studies is the Technical Specification Setpoint plus the high side setting tolerance:

3915 + 18 = 3933 Vac (Bus Voltage);
Converting to relay voltage yields:
3933/35 = 112.3714 Vac

The lower Degraded Voltage limit for motor starting studies is the Technical Specification Setpoint minus the low side setting tolerance:

3915 - 18 = 3897 Vac (Bus Voltage);
Converting to relay voltage yields:
3897/35 = 111.3429 Vac

These limits are established as the Lower and Upper Analytical Limits for the Degraded Voltage Function.

4.12 CHAMPS Equipment Database. This database contains the manufacturers and model numbers of the Loss of Voltage relays analyzed in this calculation.

4.13 Engineering Standards Manual ESM-03.02-APP-III, Appendix I (Drift Analysis (Instrumentation and Controls), Revision 3. Section 6.2.1 of this ESM states that the Analyzed Drift term may be incorporated into the calculation, setting the Vendor Accuracy, M&TE (or calibration error), and the drift terms for the analyzed devices to zero.

4.14 Revision 14, Bechtel Specification M-118, Heating, Ventilating, and Air Conditioning Systems. Given the values shown below, this calculation conservatively uses an ambient temperature range of 60°F to 104°F for the development of instrument uncertainties for the Degraded Voltage Relays.

Temperature	
Winter	60°F
Summer	104°F

4.15 Letter from D. Musolf, NSP, TO Director NRR, "Reanalysis of Adequacy of Station Electric Distribution System Voltages," dated December 30, 1983

As described in Section 3.2 of Input 4.15, the plant electrical distribution system was modeled using a computer application that used the Newton-Raphson iterative program for load analysis. Various cases were then run using the calculated load distribution for the LOCA, maximum and minimum auxiliary loads. The results of this effort established 3897 Vac (bus voltage) as the voltage necessary on the essential safeguards buses 15 and 16 to maintain the minimum allowable voltage on the 120 Volt instrument buses with:

1. Full station auxiliary load
2. ECCS actuation
3. Load shed per plant design

Using the assumed ±18 Vac (bus voltage) setting tolerance, a relay setpoint of 3915 Vac (3897 + 18 Vac) was derived. To assure relay reset in subsequent analysis, the 18 Vac positive side tolerance and the 42 Vac reset band were added on, resulting in a 4 KV bus voltage of 3975 Vac or above. Thus any transient case which results in a voltage recovery to 3975 Vac or above in less than 10 seconds will assure that the Degraded Voltage protective scheme will not be actuated.

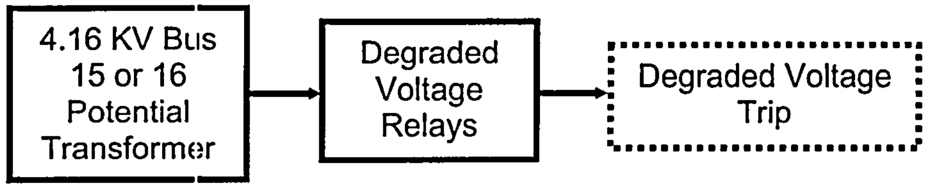
5. ASSUMPTIONS

5.1 Per Input 4.5, the technical manual, the Potential Transformers for these circuits are produced in accordance with American Standards for Instrument Transformers, ASA C57.13. Input 4.6 is the current version of that standard. Per Section 5 of the standard, "Accuracy Classes for Metering Service", Table 6 lists the metering accuracy classes as 0.3%, 0.6%, and 1.2%. Specific documentation of the accuracy class of this transformer is not available, but per Input 4.5, the accuracy class is denoted on the transformer nameplate. At the time of the preparation of this calculation, the transformer is not available for inspection. Based on experience of the accuracy classes for the transformers in this service at Fitzpatrick and Prairie Island, it is highly likely that the accuracy class of this transformer is 0.3%. Therefore, it is assumed that the accuracy class of this transformer is 0.3%.

6. ANALYSIS

6.1 Instrument Channel Arrangement

Channel Diagram:



Definition of Channel: The Potential Transformer, with a 35:1 winding ratio, produces an approximate 120 Vac signal from a 4.2 KV voltage on the 4.16 KV bus. This voltage is sensed by the Degraded Voltage relays, which provide the Degraded Voltage trip.

Functional Description: The Degraded Voltage relays monitor and detect the degraded voltage condition on the offsite power system and initiate the necessary actions required to transfer the essential buses #15 and #16 to the onsite system. The following description is derived from Input 4.10 and sub-sections of Reference 10.5.

Starting of the EDGs is initiated by a degradation or loss of voltage on an essential 4160 Vac bus. Automatic starting is also initiated by low-low reactor water level or high drywell pressure.

Although an automatic start of the EDGs has been initiated, there may have been no loss of voltage on the safety related 4 KV buses, or an automatic transfer to another source may have been effected, in which case the running generators are held in reserve during the emergency period. Manual control is then employed for additional load switching.

Transfer of the essential buses to either of the emergency power sources, the reserve auxiliary transformer (1AR) or the EDGs, will occur due to loss of essential bus voltage or degraded voltage conditions on the essential bus. Transfer of the essential buses to the 1AR transformer will normally occur on loss of voltage or degraded voltage conditions. If the 1AR no-load voltage is unacceptable, or if the essential buses are being supplied from the 1AR transformer when the loss of voltage or degraded voltage condition occurs, a transfer to the EDGs will take place.

If the essential buses are still de-energized when the diesels have accelerated, automatic relaying will remove unnecessary loads and disconnect the essential buses from the normal auxiliary system prior to energizing the essential buses from the EDGs. If a loss of coolant accident condition is indicated, Core Spray and RHR Systems are started. These pumps are started in sequence in order to prevent stalling of the diesel engine.

6.2 Instrument Definition and Determination of Device Error Terms – Voltage Function

6.2.1 DEVICE 1

6.2.1.1 Instrument Definition:

		Reference
Component ID:	**BUS-15/POT**	
Location:	Turbine Building, Elevation 911', Lower Level, Lower 4KV Room	4.3
Manufacturer:	General Electric	4.5
Model Number:	No Specific – Manual GEH-230AA	4.5
Ratio:	35:1	4.7
Input Signal:	4200 Vac - Nominal	4.7
Output Signal:	120 Vac - Nominal	4.7

		Reference
Component ID:	**BUS-16/POT**	
Location:	Turbine Building, Elevation 931', Ground Floor, Upper 4KV Area	4.3
Manufacturer:	General Electric	4.5
Model Number:	No Specific – Manual GEH-230AA	4.5
Ratio:	35:1	4.7
Input Signal:	4200 Vac - Nominal	4.7
Output Signal:	120 Vac - Nominal	4.7

		Reference
Component ID:	**127-5A, -5B, -5C**	
Location:	Turbine Building, Elevation 911', Lower Level, Lower 4KV Room, Cubicle 152-510	4.3
Manufacturer:	ITE	4.12
Model Number:	27N211T4175	4.12
Setpoint:	3918.6 Volts AC 3918.6/35:1 = 111.96 Volts AC	4.4
Output Signal:	Contact Output	4.4

		Reference
Component ID:	**127-6A, -6B, -6C**	
Location:	Turbine Building, Elevation 931', Lower Level, Ground Floor 4KV Room, Cubicle 152-601	4.3
Manufacturer:	ITE	4.12
Model Number:	27N211T4175	4.12
Setpoint:	3918.6 Volts AC 3918.6/35:1 = 111.96 Volts AC	4.4
Output Signal:	Contact Output	4.4

6.2.1.2 Process and Physical Interfaces:

Calibration Conditions:		Reference
Temperature:	65 to 90°F	10.1
Current Surveillance Interval for Loss of Voltage Relays:	Quarterly	4.2
Proposed Surveillance Interval for Degraded Voltage Relays:	Quarterly	Note: The Degraded Voltage Relay calibration interval is not being extended based on this calculation.

Normal / Trip Plant Environmental Conditions:		Reference
Temperature Range:	60°F to 104°F	4.14

Seismic Conditions:		Reference
OBE Prior to Function:	N/A	N/A
OBE During Function:	N/A	N/A

These relays respond to a degraded voltage condition that is not related to any DBA or seismic event. Therefore, seismic conditions are not required to be determined for the Degraded Voltage relays.

Process Conditions:		Reference
During Calibration:	N/A	N/A
Worst Case:	N/A	N/A
During Function:	N/A	N/A

During the event when these devices are required, the Degraded Voltage relays are not subjected to process conditions (static pressure, overpressure, elevated temperatures, etc.) that would affect the accuracy of the instrument.

6.2.1.3 Individual Device Accuracy:

Term	Value	Sigma	Reference
VA:	±0.0552 Vac	2	Attachment 1, Section A1.8; Note 1
ATE:	±0.1835 Vac	2	Note 2
OPE:	NA	NA	Note 3
SPE:	NA	NA	Note 6
SE:	0	NA	Note 5
RE:	0	NA	Note 5
HE:	0	NA	Note 5
PSE:	NA	NA	Note 4
REE:	NA	NA	Note 4

Note 1: Per Input 4.8, there are two vendor accuracy components encompassed by VA:

- Pickup and dropout settings at constant temperature and constant control voltage.
- Pickup and dropout settings over the dc power range of 100-140 volts.

These two terms, and their associated values are:

Accuracy Term	Value	Designated
Pickup and dropout settings, repeatability at constant temperature and constant control voltage	±0.2% of 150 Vac Span = 0.3 Vac	VA_1
Pickup and dropout settings, repeatability over dc power range of 100-140 volts	±0.2% of 150 Vac Span = 0.3 Vac	VA_2

$$VA = \pm\sqrt{VA_1^2 + VA_2^2}$$

$$VA = \pm\sqrt{0.3^2 + 0.3^2}$$

$$VA = \pm 0.424 \text{ Vac}$$

The Analyzed Drift from actual observed relay performance (based on analysis of Attachments 1 and 3) is:

AD_{Random} = ±0.0552 Vac

AD_{Bias} = 0 Vac

Per Section 6.2.1 of Input 4.13, the Analyzed Drift (AD) characterizes not only the Vendor Drift (VD) but also the Vendor Accuracy (VA) and M&TE (or calibration error). Therefore, it can be conservatively stated that Analyzed Drift (AD) is equal to Vendor Accuracy (VA).

As demonstrated above, Analyzed Drift based on actual observed relay performance is substantially less than the Vendor Accuracy specified by Input 4.8. Since Analyzed Drift is based on actual observed behavior it is considered a more realistic characterization of relay performance. Therefore the Analyzed Drift (AD) will be used for Vendor Accuracy (VA) and also again for Vendor Drift (VD). Refer to Section 2, Methodology, for additional discussion.

A Monticello specific drift analysis of ITE 27N211T4175 relays' voltage function was performed (Attachments 1 and 3) to determine AD.

AD_{Random} = ±0.0552 Vac

AD_{Bias} = 0 Vac

Therefore VA = $AD_{Random} + AD_{Bias}$ = ±0.0552 Vac + 0.0 Vac

Note that the bias term is 0 Vac.

Note 2: Per Input 4.8, the temperature error is characterized as a repeatability error of 0.3 Volts over 72°F range (32°F to 104°F) or 0.00417 Volts/°F. Based on Input 4.14, the Turbine Building Switchgear Rooms have a 44°F temperature range (104°F - 60°F) °F. Therefore, the Accuracy Temperature Effect (ATE) is:

ATE = (0.00417 Vac/°F) x 44°F = 0.1835 Vac

Note 3: Overpressure Effects (OPE) are not applicable to the Degraded Voltage relays.

Note 4: Error effects due to Power Supply Effects (PSE) and RFI/EMI Effects (REE) are considered negligible for bi-stable electro-mechanical devices (Reference 10.1).

Note 5: Seismic Effects (SE), Radiation Effects (RE), and Humidity Effects (HE) are not specified for these relays. Minor performance variations due to seismic, radiation, or humidity effects would show up in the As Found/As Left data. Therefore, any effects due to these factors are accounted for in the Analyzed Drift, which is being used for the Vendor Accuracy. It should also be noted that the Turbine Building Switchgear Room is not considered to be a harsh environment. Therefore these effects are not considered significant, and Seismic Effects (SE), Radiation Effects (RE), and Humidity Effects (HE) are set to 0.

Note 6: Static Pressure Effects (SPE) do not apply to bi-stable electro-mechanical devices (Reference 10.1).

$$A_L = \pm\sqrt{VA^2 + ATE^2 + OPE^2 + SPE^2 + SE^2 + RE^2 + HE^2 + PSE^2 + REE^2}$$

$$A_L = \pm\sqrt{0.0552^2 + 0.1835^2 + 0^2 + 0^2 + 0^2 + 0^2 + 0^2 + 0^2 + 0^2}$$

$$A_L = \pm 0.1916 \text{ Vac}$$

6.2.1.4 Individual Device Drift:

Term	Value
VD:	Not Specified
DTE:	Not Specified

Vendor Drift (VD) is not specified for the ITE relays. A Monticello specific drift analysis of ITE 27N211T4175 relays' voltage function was performed (Attachments 1 and 3) to determine AD. The AD is used in place of both the VD and the DTE (Drift Temperature Effect).

AD_{Random} = ±0.0552 Vac

AD_{Bias} = 0 Vac

There are no other instruments associated with the Degraded Voltage Relays, therefore, the loop consists of only the relays. Therefore Loop Drift is:

$$D_L = AD_{Random} + AD_{Bias} = \pm 0.0552 \text{ Vac} + 0 \text{ Vac} = \pm 0.0552 \text{ Vac}$$

6.2.1.5 As-Left Tolerance (ALT):

Per the ESM instructions (Section 4.3.3 of Input 4.1), a suggested ALT is determined with the following equation:

$$ALT = \pm\frac{3}{2} \times VA = \pm\frac{3}{2} \times 0.0552 \text{ Vac} = \pm 0.0828 \text{ Vac}$$

Per Input 4.4, the following As Left tolerances are currently being used for these relays:

ALT = ±0.05 Vac

The current ALT of ±0.05 is conservative and will be retained.

6.2.1.6 Device Calibration Error:

Term	Value	Sigma	Reference
C_1:	±0.0552 Vac	3	Note 1
C_{1STD}:	±0.0552 Vac	3	Note 2
ALT:	±0.05 Vac	3	6.2.1.5

Note 1: Calibration of the subject relays is performed by a corporate electrical maintenance and calibration organization, not onsite personnel. The corporate organization is specialized for electrical device calibrations and maintenance, and the precision of the calibration performed is anticipated to be high. The calibration tool is judged to be at least as accurate as the devices being calibrated. Per Section 6.2.1.3, the Calibration Tool Error is established as follows.

$C_1 = \pm VA = \pm 0.0552$ Vac

Note 2: In accordance with Input 4.1, the calibration standard error (C_{1STD}) is considered to be equal to C_1.

Since calibration term values are controlled by 100% testing, they represent 3-sigma values. Individual calibration error terms are combined using the SRSS method and normalized to a 2-sigma confidence level.

$$C_L = \pm\frac{2}{3}\sqrt{C_1^2 + C_{1STD}^2 + ALT^2}$$

$$C_L = \pm\frac{2}{3}\sqrt{0.0552^2 + 0.0552^2 + 0.05^2}$$

$$C_L = \pm 0.0618 \text{ Vac}$$

6.3 Determination of Primary Element Accuracy (PEA) and Process Measurement Accuracy (PMA) -- Voltage Function

There are no PMA inaccuracies associated with the Degraded Voltage function.

$$PMA = 0$$

The Potential Transformers for these Degraded Voltage relays are considered to be the Primary Element. Per Input 4.5, the technical manual, the transformers are produced in accordance with American Standards for Instrument Transformers, ASA C57.13. Input 4.6 is the current version of that standard. Per Section 5 of this standard, "Accuracy Classes for Metering Service", Table 6 lists the metering accuracy classes as 0.3%, 0.6%, and 1.2%. Specific documentation of the accuracy class of this transformer is not available, but per Input 4.5, the accuracy class is denoted on the transformer nameplate. At the time of the preparation of this calculation, the transformer is not available for inspection. Based on experience of the accuracy classes for the transformers in this service at Fitzpatrick and Prairie Island, it is highly likely that the accuracy class of this transformer is 0.3%. The only loads served by this transformer are undervoltage and degraded voltage relays. Therefore, the Primary Element Effect is computed as follows.

$$PEA = \pm 0.3\% \text{x}\left(\frac{120 \text{ Vac}}{100\%}\right) = \pm 0.36 \text{ Vac}$$

6.4 Determination of Other Error Terms – Voltage Function

No other errors are applicable to the Degraded Voltage function.

6.5 Calculation of Allowable Value and Operating Setpoint – Voltage Function

6.5.1 Allowable Value (AV):

Per Input 4.2, the Technical Specifications provide ± limits on the Degraded Voltage setting, thus establishing two Allowable Values. Per Section 6.1, the function of the Degraded Voltage relay is to provide a transfer to onsite power sources in the event offsite grid voltage declines to a sustained level such that, under maximum load conditions, the offsite grid voltage does not provide the capability to start and run all Class 1E equipment within the equipment voltage ratings.

Per the AC Electrical Load Study (Input 4.11 – Appendix II Note 2), the Degraded Voltage limits are established as follows:

The upper Degraded Voltage limit for motor starting studies is the Technical Specification Setpoint plus the high side setting tolerance:

3915 + 18 = 3933 Vac (Bus Voltage);
Converting to relay voltage yields:
3933/35 = 112.3714 Vac

The lower Degraded Voltage limit for motor starting studies is the Technical Specification Setpoint minus the low side setting tolerance:

3915 - 18 = 3897 Vac (Bus Voltage);
Converting to relay voltage yields:
3897/35 = 111.3429 Vac

Using these limits as the Lower and Upper Analytical Limits yields:

	References
Lower Analytical Limit (AL_L): ≥ 111.3429 Vac	Input 4.11
Upper Analytical Limit (AL_U): ≤ 112.3714 Vac	Input 4.11

The Allowable Values can now be computed:

Term	Value (Vac) (relay voltage)	Sigma	Reference
A_L	±0.1916	2	Section 6.2.1.3
C_L	±0.0618	2	Section 6.2.1.6
PMA	0.0000	2	Section 6.3
PEA	±0.3600	2	Section 6.3

$$AV_U \leq ALU - \frac{1.645}{2}\left(\sqrt{A_L^2 + C_L^2 + PMA^2 + PEA^2}\right) - \text{bias terms}$$

$$AV_U \leq 112.3714 - \frac{1.645}{2}\left(\sqrt{0.1916^2 + 0.0618^2 + 0.0000^2 + 0.3600^2}\right) - 0$$

$$AV_U \leq 112.3714 - 0.3393 - 0$$

$$AV_U \leq 112.0322 \text{ Vac}$$

AV_U (Bus Voltage) = 112.0322 x 35 = 3921.127 Vac Bus Voltage

AV_U (Bus Voltage) = 3921 Vac Bus Voltage (after rounding)

$$AV_L \geq AL_L + \frac{1.645}{2}\left(\sqrt{A_L^2 + C_L^2 + PMA^2 + PEA^2}\right) + \text{bias terms}$$

$$AV_L \geq 111.3429 + \frac{1.645}{2}\left(\sqrt{0.1916^2 + 0.0618^2 + 0.000^2 + 0.360^2}\right) - 0$$

$$AV_L \geq 111.3429 + 0.3393 + 0$$

$$AV_L \geq 111.6821 \text{ Vac}$$

AV_L (Bus Voltage) = 111. 6821 = 3908.874 Vac Bus Voltage

AV_L (Bus Voltage) = 3909 Vac Bus Voltage(after rounding)

Currently, per Input 4.2, the allowed limits from the Technical Specification Deviation Table are ≥ 3897 Vac Bus Voltage (trip) and ≤3975 Vac Bus Voltage (reset). The calculated lower limit Allowable Value is more conservative than the ≥ 3897 Vac Bus Voltage (trip) value.

AV_U = 3921 Vac Bus Voltage;

AV_L = 3909 Vac Bus Voltage

These values should be used as the Improved Technical Specifications Allowable Values.

6.5.2 Nominal Trip Setpoint ($NTSP_1$):

The Nominal Trip Setpoint ($NTSP_1$) can now be computed:

Term	Value (Vac) (relay voltage)	Sigma	Reference
A_L	±0.1916	2	Section 6.2.1.3
AD_{Random}	±0.0552	2	Section 6.2.1.3
C_L	±0.0618	2	Section 6.2.1.6
PMA	0.0000	2	Section 6.3
PEA	±0.3600	2	Section 6.3

$$NTSP_{1U} \geq AL_U - \frac{1.645}{2}\left(\sqrt{A_L^2 + C_L^2 + AD_{Random} + PMA^2 + PEA^2}\right) - bias$$

$$NTSP_{1U} \geq 112.3714 - \frac{1.645}{2}\left(\sqrt{0.1916^2 + 0.0618^2 + 0.0552^2 + 0.0000^2 + 0.3600^2}\right) - 0$$

$$NTSP_{1U} \geq 112.3714 - 0.3423 - 0$$

$$NTSP_{1U} \geq 112.0291 \text{ Vac}$$

$$NTSP_{1L} \geq AL_L + \frac{1.645}{2}\left(\sqrt{A_L^2 + C_L^2 + AD_{Random} + PMA^2 + PEA^2}\right) + bias$$

$$NTSP_{1L} \geq 111.3429 + \frac{1.645}{2}\left(\sqrt{0.1916^2 + 0.0618^2 + 0.0552^2 + 0.0000^2 + 0.3600^2}\right) - 0$$

$$NTSP_{1L} \geq 111.3429 + 0.3423 + 0$$

$$NTSP_{1L} \geq 111.6851 \text{ Vac}$$

Therefore, the Nominal Trip Setpoints are:

$NTSP_{1U}$ = 112.0291 Vac

$NTSP_{1L}$ = 111.6851 Vac

6.5.3 Licensee Event Report (LER) Avoidance Evaluation:

The purpose of the LER Avoidance Evaluation is to assure that there is sufficient margin provided between the AV and the NTSP to reasonably avoid violations of the AV. Any Z value greater than 1.29 provides sufficient margin between the NTSP and the AV. Therefore, $NTSP_2$ is calculated to provide bounds for the NTSP based on LER avoidance criteria.

$$\text{Sigma(LER)} = \left(\frac{1}{2}\right)\left(\sqrt{A_L^{\,2} + C_L^{\,2} + AD_{Random}^{\,2}}\right)$$

$$\text{Sigma(LER)} = \left(\frac{1}{2}\right)\left(\sqrt{0.1916^2 + 0.0618^2 + 0.0552^2}\right)$$

$$\text{Sigma(LER)} = 0.1044 \text{ Vac}$$

$$NTSP_{2L} = AV_L + (Z \times \text{Sigma(LER)}) + D_{L.Bias}$$

$$NTSP_{2L} = 111.6821 + (1.29 \times 0.1044) + 0$$

$$NTSP_{2L} = 111.8168 \text{ Vac}$$

$$NTSP_{2U} = AV_U - (Z \times \text{Sigma(LER)}) + D_{U.Bias}$$

$$NTSP_{2U} = 112.0322 - (1.29 \times 0.1044) + 0$$

$$NTSP_{2U} = 111.8975 \text{ Vac}$$

Therefore, an $NTSP_2 \geq 111.8168$ Vac and ≤ 111.8975 Vac results in a Z greater than 1.29 and provides sufficient margin between the NTSP and the Allowable Values.

6.5.4 Selection of Operating Setpoint:

Per Section 5.6.4 of Input 4.1, the operating setpoint of 111.8571 Vac, rounded to 111.86 Vac, is chosen between the $NTSP_2$ limits. This value will also be the Technical Specification Setpoint:

TS Setpoint = 111.86 Vac; or 35 x 111.86 Vac = 3915 Vac Bus Voltage;

Note that the TS Setpoint of 111.86 combined with the ALT of ±0.05 slightly exceeds the difference between the TS Setpoint and $NTSP_{2U}$ and $NTSP_{2L}$. This will increase the probability of the As Found value exceeding an Allowable Value. However, when the ALT is added to the TS Setpoint it does lie within $NTSP_{1U}$ and $NTSP_{1L}$. Therefore, the Analytical Limits are protected so the TS Setpoint is acceptable.

6.5.5 Leave Alone Zone:
Leave Alone Zones/Tolerances as described in the GE documents are not used at Monticello Plant.

6.5.6 Establishing As-Found Tolerance (AFT):

The AFT is established to meet the Allowable values. Therefore the AFT will be established as the smallest difference between the TS Setpoint 111.86 and the two Allowable Values.

AV_U – TS Setpoint = (3921/35 – 111.86) Vac = 0.1686 VAC

AV_L – TS Setpoint = (3909/35 – 111.86) Vac = -0.1745 VAC

The AFT is therefore the set equal to AV_U – TS Setpoint and conservatively rounded to 2 decimal places. Therefore,

AFT = ± 0.16

6.5.7 Required Limits Evaluation:

The purpose of a Required Limits Evaluation is to assure that the combination of errors present during calibration of each device in the channel is accounted for while allowing for the possibility that the devices may not be recalibrated. Since Leave Alone Zones are not used at MNGP, the devices are always verified or recalibrated to be within the As Left Zone. Therefore, a Required Limits Evaluation as discussed in the GE methodology is not applicable.

6.5.8 Spurious Trip Avoidance Evaluation:

The purpose of a spurious trip avoidance evaluation is to assure that there is a reasonable probability that spurious trips will not occur using the selected setpoint. The Upper Allowable Value and Setpoint evaluations in this calculation are performed to ensure that potential transients on the grid system and voltage drop due to starting of large motors would not cause spurious trips. Therefore, no separate evaluation is necessary.

6.5.9 Elevation Correction:

Not applicable.

6.5.10 Determination of Actual Setpoint / Instrument Scaling:

The setpoint of 111.86 Vac, or 3915 Vac Bus Voltage is used. Note that a loop scaling factor of 35/1 is applicable between the relay setting and the bus voltage. Attachment 5 is a Setpoint Relationship Diagram for the Degraded Voltage Relay Voltage Function.

6.6 Instrument Definition and Determination of Device Error Terms – Time Delay Function

6.6.1 DEVICE 2

6.6.1.1 Instrument Definition:

		Reference
Component ID:	**127-5A, -5B, -5C**	
Location:	Turbine Building, Elevation 911', Lower Level, Lower 4KV Room, Cubicle 152-510	4.3
Manufacturer:	ITE	4.12
Model Number:	27N211T4175	4.12
Setpoint:	9.0 seconds	4.4
Output Signal:	Contact Output	4.4

		Reference
Component ID:	**127-6A, -6B, -6C**	
Location:	Turbine Building, Elevation 931', Lower Level, Ground Floor 4KV Room, Cubicle 152-601	4.3
Manufacturer:	ITE	4.12
Model Number:	27N211T4175	4.12
Setpoint:	9.0 seconds	4.4
Output Signal:	Contact Output	4.4

6.6.1.2 6.6.1.2 Process and Physical Interfaces:

Calibration Conditions:		**Reference**
Temperature:	65 to 90°F	10.1
Current Surveillance Interval for Loss of Voltage Relays:	Quarterly	4.2
Proposed Surveillance Interval for Degraded Voltage Relays:	Quarterly	Note: The Degraded Voltage Relay calibration interval is not being extended based on this calculation.

Normal / Trip Plant Environmental Conditions:		Reference
Average Temperature:	60°F to 104°F	4.14

Seismic Conditions:		Reference
OBE Prior to Function:	N/A	N/A
OBE During Function:	N/A	N/A

These relays respond to a degraded voltage condition that is not related to any DBA or seismic event. Therefore, seismic conditions are not required to be determined for the Degraded Voltage relays.

Process Conditions:		Reference
During Calibration:	N/A	N/A
Worst Case:	N/A	N/A
During Function:	N/A	N/A

During the event when these devices are required, the Degraded Voltage relays are not subjected to process conditions (static pressure, overpressure, elevated temperatures, etc.) that would affect the accuracy of the instrument.

6.6.1.3 Individual Device Accuracy:

Term	Value	Sigma	Reference
VA:	±0.020 Seconds	2	Input 4.8; Note 1
ATE:	0	N/A	Note 2
OPE:	NA	N/A	Note 3
SPE:	NA	N/A	Note 6
SE:	0	N/A	Note 5
RE:	0	N/A	Note 5
HE:	0	N/A	Note 5
PSE:	NA	N/A	Note 4
REE:	NA	N/A	Note 4

Note 1: Per Input 4.8, the Vendor Accuracy is:
VA = ± 0.020 Seconds.

Note 2: Per Input 4.8, there is not an Accuracy Temperature Effect (ATE) specified. Therefore, any temperature effect is encompassed in the Vendor Accuracy, which is included in the Analyzed Drift data. These relays are not located in an area with extreme temperature variations – therefore any temperature effect would be reflected in the Analyzed Drift term. Therefore no additional uncertainty is applied due to ATE.

Note 3: Overpressure Effects (OPE) are not applicable to the Degraded Voltage relays.

Note 4: Error effects due to Power Supply Effects (PSE) and RFI/EMI Effects (REE) are considered negligible for bi-stable electro-mechanical devices (Reference 10.1).

Note 5: Seismic Effects (SE), Radiation Effects (RE), and Humidity Effects (HE) are not specified for these relays. Minor performance variations due to seismic, radiation, or humidity effects would show up in the As Found/As Left data. Therefore, any effects due to these factors are accounted for in the Analyzed Drift, which is being used for the Vendor Accuracy. It should also be noted that the Turbine Building Switchgear Room is not considered to be a harsh environment. Therefore these effects are not considered significant, and Seismic Effects (SE), Radiation Effects (RE), and Humidity Effects (HE) are set to 0.

Note 6: Static Pressure Effects (SPE) do not apply to time delay devices (Reference 10.1).

$$A_L = \pm\sqrt{VA^2 + ATE^2 + OPE^2 + SPE^2 + SE^2 + RE^2 + HE^2 + PSE^2 + REE^2}$$

$$A_L = \pm\sqrt{0.020^2 + 0^2 + 0^2 + 0^2 + 0^2 + 0^2 + 0^2 + 0^2 + 0^2}$$

$$A_L = \pm 0.020 \text{ Seconds}$$

6.6.1.4 Individual Device Drift:

Term	Value
VD:	Not Specified
DTE:	Not Specified

Vendor Drift (VD) is not specified for the relays. A Monticello specific drift analysis of ITE 27N211T4175 relays' time delay function was performed (Attachments 2 and 4) to determine AD. The AD is used in place of both the VD and the DTE (Drift Temperature Effect).

AD_{Random} = ±0.0801 Seconds

AD_{Bias} = 0 Seconds

There are no other instruments associated with the Degraded Voltage Relays, therefore, the loop consists of only the relays. Therefore Loop Drift is:

$D_L = AD_{Random} + AD_{Bias}$ = ±0.0801 Seconds + 0 Seconds = ±0.0801 Seconds

6.6.1.5 As-Left Tolerance (ALT):

Per the ESM instructions (Section 4.3.3 of Input 4.1), a suggested ALT is determined with the following equation:

$$ALT = \pm\frac{3}{2}\times VA = \pm\frac{3}{2}\times 0.0801\text{ Seconds} = \pm 0.1202\text{ Seconds}$$

Per Input 4.4, the following As Left tolerances are currently being used for these relays, and will be retained.

ALT = ±0.10 Seconds

6.6.1.6 Device Calibration Error:

Term	Value	Sigma	Reference
C_1:	±0.0200 Seconds	3	Note 1
C_{1STD}:	±0.0200 Seconds	3	Note 2
ALT:	±0.1000 Seconds	3	6.2.1.5

Note 1: Calibration of the subject relays is performed by a corporate electrical maintenance and calibration organization, not onsite personnel. The corporate organization is specialized for electrical device calibrations and maintenance, and the precision of the calibration performed is anticipated to be high. The calibration tool is judged to be at least as accurate as the devices being calibrated. Per Section 0, the Calibration Tool Error is established as follows.

$C_1 = \pm VA = \pm 0.020$ Seconds

Note 2: In accordance with Input 4.1, the calibration standard error (C_{1STD}) is considered to be equal to C_1.

Since calibration term values are controlled by 100% testing, they represent 3-sigma values. Individual calibration error terms are combined using the SRSS method and normalized to a 2-sigma confidence level.

$$C_L = \pm \frac{2}{3}\sqrt{C_1^{\ 2} + C_{1STD}^{\ 2} + ALT^2}$$

$$C_L = \pm \frac{2}{3}\sqrt{0.0200^2 + 0.0200^2 + 0.1000^2}$$

$$C_L = \pm 0.0693 \text{ Seconds}$$

6.7 Determination of Primary Element Accuracy (PEA) and Process Measurement Accuracy (PMA) – Voltage Function

There are no PMA inaccuracies associated with the time delay function.

PMA = 0

There are no PEA inaccuracies associated with the time delay function.

PEA = 0

6.8 Determination of Other Error Terms – Time Delay Function

No other errors are applicable to the Degraded Voltage time delay function.

6.9 Calculation of Allowable Value and Operating Setpoint – Time Delay Function

6.9.1 Allowable Value (AV):
Per Input 4.2, the Technical Specifications provide ± limits on the time delay setting, thus establishing two Allowable Values. Per Section 6.1, the function of the Degraded Voltage relay time delay function is to provide a transfer to onsite power sources in the event offsite grid voltage declines to a sustained level such that, under maximum load conditions, the offsite grid voltage does not provide the capability to start and run all Class 1E equipment within the equipment voltage ratings.

The Degraded Voltage time delay setpoint and setting tolerance established in the plant Technical Specifications is:

9 ± 1 Seconds

Input 4.15 provides the basis for the 10 second upper limit. Section 2.4.2 of Input 4.15 requires a bus transfer on a degraded voltage condition in less than or equal to 10 seconds. The 8 second lower limit is designed to minimize or prevent the transfer during short voltage transients.

Using these limits as the Lower and Upper Analytical Limits yields:

Lower Analytical Limit (AL_L): ≥ 8 Sec
Upper Analytical Limit (AL_U): ≤ 10 Sec

In order to maintain the current field setting of 9 Seconds a margin of ±0.7407 Seconds is included (although not required) in the computation of the Allowable Value and the Nominal Trip Setpoint ($NTSP_1$).

The Allowable Values can now be computed:

Term	Value (Vac) (relay voltage)	Sigma	Reference
A_L	±0.0200	2	Section 6.2.1.3
C_L	±0.0693	2	Section 6.6.1.6
PMA	0	2	Section 6.7
PEA	0	2	Section 6.7
Margin	±0.7407	2	Section 6.9.1

$$AV_L \geq AL_L + \frac{1.645}{2}\left(\sqrt{A_L{}^2 + C_L{}^2 + PMA^2 + PEA^2}\right) + \text{margin} + \text{bias terms}$$

$$AV_L \geq 8.0000 + \frac{1.645}{2}\left(\sqrt{0.0200^2 + 0.0693^2 + 0.0000^2 + 0.0000^2}\right) + 0.7407 - 0$$

$$AV_L \geq 8.0000 + 0.0593 + 0.7407 + 0$$

$$AV_L \geq 8.80\,\text{Seconds}$$

$$AV_U \leq AL_L - \frac{1.645}{2}\left(\sqrt{A_L{}^2 + C_L{}^2 + PMA^2 + PEA^2}\right) - \text{margin} - \text{bias terms}$$

$$AV_U \leq 10.0000 - \frac{1.645}{2}\left(\sqrt{0.0200^2 + 0.0693^2 + 0.0000^2 + 0.0000^2}\right) - 0.7407 - 0$$

$$AV_U \leq 10.0000 - 0.0593 - 0.7407 + 0$$

$$AV_U \leq 9.20\,\text{Seconds}$$

Currently, per Input 4.2, the allowed limits from the Technical Specification Deviation Table are ≥ 5 Seconds and ≤ 10 Seconds. The calculated Allowable Values are more conservative than the ≥ 5 Seconds and ≤ 10 Seconds.

AV_U = 9.20 Seconds;

AV_L = 8.80 Seconds

These values should be used as the Improved Technical Specifications Allowable Value.

6.9.2 Nominal Trip Setpoint ($NTSP_1$):

The Nominal Trip Setpoint (NTSP·) can now be computed:

Term	Value (Vac) (relay voltage)	Sigma	Reference
A_L	±0.0200	2	Section 6.6.1.3
AD_{Random}	±0.0801	2	Section 6.6.1.4
C_L	±0.0693	2	Section 6.6.1.6
PMA	0.0000	2	Section 6.7
PEA	0.0000	2	Section 6.7
Margin	±0.7407	2	Section 6.9.1

$$NTSP_{1U} \le AL_U - \frac{1.645}{2}\left(\sqrt{A_L^2 + C_L^2 + AD_{Random} + PMA^2 + PEA^2}\right) - margin - bias$$

$$NTSP_{1U} \le 10.0000 - \frac{1.645}{2}\left(\sqrt{0.0200^2 + 0.0693^2 + 0.0801^2 + 0.0000^2 + 0.0000^2}\right) - 0.7407 - 0$$

$$NTSP_{1U} \le 10.0000 - 0.0886 - 0.7407 - 0$$

$$NTSP_{1U} \le 9.1707 \text{ Seconds}$$

$$NTSP_{1L} \ge AL_L + \frac{1.645}{2}\left(\sqrt{A_L^2 + C_L^2 + AD_{Random} + PMA^2 + PEA^2}\right) + margin + bias$$

$$NTSP_{1L} \ge 8.0000 + \frac{1.645}{2}\left(\sqrt{0.0200^2 + 0.0693^2 + 0.0801^2 + 0.0000^2 + 0.0000^2}\right) + 0.7407 + 0$$

$$NTSP_{1L} \ge 8.0000 + 0.0886 + 0.7407 + 0$$

$$NTSP_{1L} \ge 8.8293 \text{ Seconds}$$

Therefore, the Nominal Trip Setpoints are:

$NTSP_{1U}$ = 9.1707 Seconds
$NTSP_{1L}$ = 8.8293 Seconds

6.9.3 Licensee Event Report (LER) Avoidance Evaluation:

The purpose of the LER Avoidance Evaluation is to assure that there is sufficient margin provided between the AV and the NTSP to reasonably avoid violations of the AV. Any Z value greater than 1.29 provides sufficient margin between the NTSP and the AV. Therefore, $NTSP_2$ is calculated to provide bounds for the NTSP based on LER avoidance criteria.

$$\text{Sigma(LER)} = \left(\frac{1}{2}\right)\left(\sqrt{A_L{}^2 + C_L{}^2 + AD_{Random}{}^2}\right)$$

$$\text{Sigma(LER)} = \left(\frac{1}{2}\right)\left(\sqrt{0.0200^2 + 0.0693^2 + 0.0801^2}\right)$$

$$\text{Sigma(LER)} = 0.0539 \text{ Seconds}$$

$$NTSP_{2L} = AV_L + (Z \times \text{Sigma(LER)}) + D_{L.Bias}$$

$$NTSP_{2L} = 8.80 + (1.29 \times 0.0539) + 0$$

$$NTSP_{2L} = 8.8695 \text{ Seconds}$$

$$NTSP_{2U} = AV_U - (Z \times \text{Sigma(LER)}) - D_{U.Bias}$$

$$NTSP_{2U} = 9.20 - (1.29 \times 0.0539) - 0$$

$$NTSP_{2U} = 9.1305 \text{ Seconds}$$

Therefore, an $NTSP_2 \geq 8.8695$ Seconds and ≤ 9.1305 Seconds results in a Z greater than 1.29 and provides sufficient margin between the NTSP and the Allowable Values.

6.9.4 Selection of Operating Setpoint:

Per Section 5.6.4 of Input 4.1, the operating setpoint of 9.0 Seconds is chosen between the $NTSP_2$ limits. This value will also be the Technical Specification Setpoint:

TS Setpoint = 9.0 Seconds; Therefore the current time delay setting is retained.

6.9.5 Leave Alone Zone:

Leave Alone Zones/Tolerances as described in the GE documents are not used at Monticello Plant.

6.9.6 Establishing As-Found Tolerance (AFT):

The AFT is established to meet the Allowable Values. Therefore the AFT will be established as the difference between the TS Setpoint of 9.0 Seconds and the two Allowable Values.

AV_U – TS Setpoint = 9.20 – 9.00 = 0.20 Seconds

AV_L – TS Setpoint = 8.80 – 9.00 = -0.20 Seconds

AFT = ± 0.20 Seconds

6.9.7 Required Limits Evaluation:

The purpose of a Required Limits Evaluation is to assure that the combination of errors present during calibration of each device in the channel is accounted for while allowing for the possibility that the devices may not be recalibrated. Since Leave Alone Zones are not used at MNGP, the devices are always verified or ≥Evaluation as discussed in the GE methodology is not applicable. Because the calibrated portion of this instrument loop consists only of the Degraded Voltage Relays, the Loop As Found Tolerance is equal to the AFT from Section 6.9.6 above.

AFT = ± 0.20 Seconds

Given the following terms:

Term	Value (Vac) (relay voltage)	Sigma	Reference
AV_U	9.20 Seconds	NA	Section 6.9.1
Setpoint	9.00 Seconds	NA	Section 6.9.4
AV_L	8.80 Seconds	NA	Section 6.9.1

AFT Upper Limit = Setpoint + AFT = 9.00 + 0.20 Sec = 9.20 Seconds;
which is ≤ 9.2 Seconds (AV_U)

AFT Lower Limit = Setpoint - AFT = 9.00 - 0.20 Sec = 8.80 Seconds
which is ≥ 8.80 Seconds (AV_L)

6.9.8 Spurious Trip Avoidance Evaluation:

The purpose of a spurious trip avoidance evaluation is to assure that there is a reasonable probability that spurious trips will not occur using the selected setpoint. The Upper Allowable Value and Setpoint evaluations in this calculation are performed to ensure that potential transients on the grid system and voltage drop due to starting of large motors would not cause spurious trips. Therefore, no separate evaluation is necessary.

6.9.9 Elevation Correction:

Not applicable.

6.9.10 Determination of Actual Setpoint / Instrument Scaling:

The setpoint of 9.0 Seconds is used. No conversions of units are required for loop scaling purposes. Attachment 6 is a Setpoint Relationship Diagram for the Degraded Voltage Relay Time Delay Function.

7. CONCLUSIONS

Voltage Function calculation results:

Terms	Relay Voltage (Vac)	Bus Voltage (Vac)	Section
A_L:	±0.1916	±6.706	6.2.1.3
AD_{Random}:	±0.0552	±1.932	6.2.1.4
D_{Bias}:	0	0	6.2.1.4
ALT:	±0.050	±1.75	6.2.1.5
C_L:	±0.0618	±2.163	6.2.1.6
PEA:	±0.36	±12.6	6.3
PMA:	0	0	6.3
AL_L:	≥ 111.3429	≥ 3897.000	6.5.1
AL_U:	≤ 112.3714	≤ 3933.000	6.5.1
AV_L:	≥ 111.6821	≥ 3909	6.5.1
AV_U:	≤ 112.0322	≤ 3921	6.5.1
Current Technical Specification Trip Setting:	111.86 ±0.51	3915 ±18	4.2
Current Trip Setpoint:	111.96	3918.6	4.4
Proposed Technical Specification Trip Setting:	111.86	3915	6.5.4
Proposed Trip Setpoint:	111.86	3915	6.5.4
$NTSP_{1L}$:	≥ 111.6851	≥ 3908.98	6.5.2
$NTSP_{1U}$:	≤ 112.0291	≤ 3921.02	6.5.2
$NTSP_{2L}$:	≥ 111.8168	≥ 3913.59	6.5.3
$NTSP_{2U}$:	≤ 111.8975	≤ 3916.41	6.5.3
AFT:	±0.16	±5.6	6.5.6
AF Lower Limit:	≥ 111.70	≥ 3909.5	6.5.7
AF Upper Limit:	≤ 112.02	≤ 3920.7	6.5.7
Elevation Correction:	NA	NA	6.5.9

For the Degraded Voltage Relays Voltage Function this calculation determined the following Allowable Values for use in the MNGP Improved Technical Specifications:

AV_L: ≥ 3909 Vac (Bus Voltage)
AV_U: ≤ 3921Vac (Bus Voltage)

The new setpoint of 111.86 Vac (Relay Voltage)/3915 (Bus Voltage). The As Left Tolerance remains unchanged at ± 0.050 Vac (Relay Voltage). Following approval of the ITS Amendment request, the AFT will be changed to ±0.16 Vac (Relay Voltage)

Time Delay calculation results:

Terms	Time Delay (Seconds)	Section
A_L:	±0.0200	0
AD_{Random}:	±0.0801	6.6.1.4
D_{Bias}:	0	6.6.1.4
ALT:	±0.1000	6.6.1.5
C_L:	±0.0693	6.6.1.6
PEA:	±0.0000	6.7
PMA:	±0.0000	6.7
AL_L:	≥ 8.0	6.9.1
AL_U:	≤ 10.0	6.9.1
AV_L:	≥ 8.80	6.9.1
AV_U:	≤ 9.20	6.9.1
Current Technical Specification Trip Setting	9.0	6.9.4
Proposed Technical Specification Trip Setting	9.0	6.9.4
$NTSP_{1L}$:	≥ 8.8293	6.9.2
$NTSP_{1U}$:	≤ 9.1707	6.9.2
$NTSP_{2L}$:	≥ 8.8695	6.9.3
$NTSP_{2U}$:	≤ 9.1305	6.9.3
AFT:	±0.20	6.9.6
AF Lower Limit:	≥ 8.80	6.9.7
AF Upper Limit:	≤ 9.20	6.9.7
Elevation Correction:	NA	6.9.9

For the Degraded Voltage Relays Time Delay function this calculation determined the following Allowable Values for use in the MNGP Improved Technical Specifications:

AV_L: ≥ 8.80 Seconds
AV_U: ≤ 9.20 Seconds

The current setpoint of 9.0 Seconds and As Left Tolerance ± 0.1000 Seconds do not change. Following approval of the ITS Amendment request, the AFT will be changed to ±0.20 Seconds.

8. FUTURE NEEDS

8.1 Process Setpoint Change Request to implement the following changes/additions for the Degraded Voltage Relay Voltage and Time Delay Functions following approval of the ITS license amendment (EWR025050):

Voltage Function:

1. As Found Tolerance of ±0.16 Vac.
2. As Left Tolerance to ±0.050 Vac.
3. Allowable Value (Lower/Upper) of ≥3909 Vac /≤3921 Vac (Bus Voltage)

Time Delay Function:

1. As Found Tolerance of ±0.20 Seconds.
2. As Left Tolerance to ±0.10 Seconds.
3. Allowable Value (Lower/Upper) of ≥8.80 Seconds/≤9.20 Seconds.

8.2 For the Degraded Voltage Relay Voltage and Time Delay Functions include the following in the Improved Technical Specifications License Amendment Request (CA020285).

Voltage Function:

Allowable Value (Lower/Upper) of ≥3909 Vac/≤3921 Vac (Bus Voltage)

Time Delay Function:

Allowable Value (Lower/Upper) of ≥8.80 Seconds/≤9.20 Seconds

9. ATTACHMENTS

1. Instrument Drift Analysis ITE-27B Undervoltage Relays – 4KV Degraded Voltage (Voltage Function)
2. Instrument Drift Analysis ITE-27B Undervoltage Relays – 4KV Degraded Voltage (Time Delay Function)
3. Instrument Drift Analysis Computation Spreadsheet ITE-27B Undervoltage Relays – 4KV Degraded Voltage (Voltage Function)
4. Instrument Drift Analysis Computation Spreadsheet ITE-27B Undervoltage Relays – 4KV Degraded Voltage (Time Delay Function)
5. Setpoint Relationship Diagram (Voltage Function)
6. Setpoint Relationship Diagram (Time Delay Function)
7. Form 3495, Calculation / Analysis Verification Checklist

10. REFERENCES

10.1 GE-NE-901-021-0492, DRF A00-01932-1, Setpoint Calculation Guidelines for the Monticello Nuclear Generating Plant, October 1992.

10.2 General Electric Instrument Setpoint Methodology, NEDC-31336P-A, September 1996.

10.3 Generic Letter 91-04, Changes in Technical Specification Surveillance Intervals to Accommodate a 24-Month Fuel Cycle.

10.4 Condition Report 02001013, Documentation of NRC Resident Question Regarding the Application of Tech Spec Deviations in As-Found Acceptance Criteria.

10.5 DBD T-17, Design Basis Document for Electrical Design Considerations.

A1.1 Data Grouping

Data was imported to pages 1 through 6 of Attachment 3 from Input 4.4 for the following undervoltage relays:

- 127-5A
- 127-5B
- 127-5C
- 127-6A
- 127-6B
- 127-6C

A specific determination of proper data grouping is not necessary for this computation, since the six undervoltage relays are used in the same application, with the same setpoint, and similar environment.

A1.2 Spreadsheet Performance of Basic Statistics

As shown on pages 1 and 6 of Attachment 3, the following information was determined at each calibration point for each of the six undervoltage relay:

The average ($\bar{x}$) for the drift data was determined by using the "AVERAGE" function.

The standard deviation was determined by using the "STDEV" function. The Standard Deviation function returns the measure of how widely values are dispersed from the mean of the data. Formula used by Microsoft Excel to determine the standard deviation:

$$s = \sqrt{\frac{n\sum x^2 - \left(\sum x\right)^2}{n(n-1)}}$$

where:

x - Sample data values (x_1, x_2, x_3,...)
s - Standard deviation of all sample data points
n - Total number of data points

The variance (s^2) was determined by using the "VAR" function. The variance function returns the measure of how widely values are dispersed from the mean of the data. The variance can also be determined by taking the square of the standard deviation.

Formula used by Microsoft Excel to determine the variance:

$$s^2 = \frac{n\sum x^2 - \left(\sum x\right)^2}{n(n-1)}$$

where:

x - Sample data values (x_1, x_2, x_3,...)
s^2 - Variance of sample population
n - Total number of data points

The number of data points (n) was determined by using the "COUNT" function.

The largest positive drift value was determined by using the "MAX" function.

The largest negative drift value was determined by using the "MIN" function.

A Drift Trend Plot was developed by plotting the drift value versus calibration date. Bounds corresponding to ±2 Sigma (2 Standard Deviations) are shown on the plot.

Page 7 of Attachment 3 presents the combined drift data statistics for the subject undervoltage relay. The combined statistics were determined following the methods described above.

A1.3 Outlier Detection and Expulsion

The calibration interval and drift data were copied to the spreadsheet shown on Pages 8 through 10 of Attachment 3. The average, standard deviation, variance, largest positive drift, largest negative drift, and sample count for the data set is recalculated for use in the outlier detection portion of the calculation.

The T-Test Critical Value is utilized to detect the presence of outliers. The value used for the T-Test Critical Value is obtained from Table 9.2 of Input 4.1. Since there are 132 sample points for this calculation, a value of 3.330 is used.

T-Test Outlier Detection Equation:

$$T = \frac{|x_i - \bar{x}|}{s}$$

where:

- x_i - An individual sample data point
- $\bar{x}$ - Mean of all sample data points
- s - Standard deviation of all sample data points
- T - Calculated value of extreme studentized deviate that is compared to the critical value of t for the sample size.

If the calculated value of T exceeds the T-Test Critical Value for the sample size and desired significance level, then the evaluated data point is identified as an outlier. The spreadsheet is set up so that a blank is displayed in the Outlier Test column if the calculated T exceeds the T-Test Critical Value.

The T-Test identifies one potential outlier for this calculation. The data set without the outlier is copied to separate columns to allow for the removal of blank lines in the data set. The average, standard deviation, variance, largest positive drift, largest negative drift, and sample count for the data set are recalculated after removal of the outlier.

A1.4 Normality Tests

<u>The D-Prime (D') Test</u> - The D' Test calculates a test statistic value for the sample population and compares the calculated value to the values for the D' percentage points of the distribution, which are tabulated in Table 9.7 of Input 4.1. The D' Test is two-sided, which means that the two-sided percentage limits at the stated level of significance must bound the calculated D' value. For the given sample size, the calculated value of D' must lie within the two values provided in Table 9.7 in order to accept the hypothesis of normality.

The D' Test is included on pages 11 through 13 of Attachment 3 for the data set with the outlier included. It is included on pages 14 through 16 of Attachment 3 for the data set with the outlier removed.

To perform a D' Test, each of the data sets (with the outlier and with the outlier removed) is sorted and numbered in ascending order from smallest to largest.

Calculate the estimated Variance of the sample:

$$s^2 = \frac{n\sum x^2 - \left(\sum x\right)^2}{n(n-1)}$$

Where:
s^2 - Unbiased estimate of the sample population variance
n - Total number of data points
x - Sample data point

Calculate the S^2 for the group:

$$S^2 = (n-1) \times s^2$$

Where:
S^2 - Sum of the Squares about the mean
s^2 - Unbiased estimate of the sample population variance
n - Total number of data points

Calculate the linear combination (T) of the sample group:

$$t_i = \left(i - \frac{n+1}{2}\right) \times x_i$$

$$T = \sum t_i$$

Where:
i - The number of the sample point
n - Total number of data points
x_i - An individual sample data point

Calculate the D' value for the sample group:

$$D' = \frac{T}{S}$$

Determine the critical D' values from Table 9.7 of Input 4.1. Since the calculated D' value is outside of the critical value limits for both sets of data, the assumption of normality is rejected for both sets of data.

Chi-Squared, χ^2, Goodness of Fit Test - ***This test is not relied upon to determine normality, but is included for information, as a part of the development of the coverage analysis.*** The χ^2 test compares the actual distribution of sample values to the expected distribution. The expected values are calculated by using the mean and standard deviation for the sample. If the distribution is normally or approximately normally distributed, the difference between the actual versus expected values should be very small. If the distribution is not normally distributed, the differences should be significant.

The Chi-Squared test for the initial data set and the data set with the outlier removed is included on pages 17 and 18 of Attachment 3. The Chi-Squared test is performed with 12 bins of data, starting from $-\infty$ to (mean-2.5σ), with bin increments of 0.5σ, ending at (mean+2.5σ) to $+\infty$.

The Chi-Squared test is performed using the Histogram function within Microsoft Excel. Excel counts the number of data points between the current bin value and the adjoining higher bin value. All values below the first bin are counted together, as are the values above the last bin value.

To establish the upper limit for each bin, the Standard Deviation of the data set is multiplied by the Multiples of Standard Deviation and added to the Average. The Excel Histogram function is performed with the data set used as the Input Range and the Bin Upper Limit used as the Bin Range. The result of the Histogram function is shown under the Bin and Observed Frequency columns.

The expected frequency percentage for each bin is taken from Table 9.3 of Input 4.1. The total number of samples is multiplied by the expected frequency percentage to obtain the expected frequency. The deviation between the expected frequency and the observed frequency is calculated for each bin and for the total sample:

$$\text{Deviation} = \frac{(O_i - E_i)^2}{E_i}$$

where:

E_i - Number of sample items expected in a bin

O_i - Observed number of sample items in a bin

and:

$$\chi^2 = \sum \frac{(O_i - E_i)^2}{E_i}$$

where:
χ^2 - Chi-squared result

Computing the chi-squared per degree of freedom term:

$$\chi_o^2 = \frac{\chi^2}{d}$$

where:
d - degrees of freedom

The degrees of freedom term is computed as the number of bins used for the chi-squared computation minus the constraints. For these drift calculations, the count, mean, and standard deviation are computed. Therefore, the constraints term is equal to 3 and the degrees of freedom term is equal to 9.

Since χ_o^2 is greater than 1 for each data set, another check is made. The degrees of freedom and obtained chi-squared value are used to look up the probability that the observed χ_o^2 exceeds the expected value. The degrees of freedom and the calculated χ_o^2 are used with Table 9.4 of Input 4.1 to determine the probability that the observed χ_o^2 exceeds the expected value. If the lookup value were greater than or equal to 5%, then the assumption of normality would not be rejected.

Since the lookup value is less than 5% for both sets of data, the assumption of normality is rejected for both sets of data.

Coverage Analysis - Since the assumption of normality was rejected by the D' tests for both sets of data, a coverage analysis is required for each. Histograms of each data set were created to plot the number of drift data points versus drift in multiples of standard deviations from the mean. These histograms are included on the same pages as the Chi-Squared analysis (pages 17 and 18 of Attachment 3). The histograms graphically show the difference between the expected normal distribution and the observed distribution based on the results of the Chi-Squared analysis.

Based on visual examination of the plots, the distribution of the data for each data set is highly peaked in the middle, but otherwise appears near normal. Therefore, a normal distribution model that adequately covers the sets of drift data as observed can be derived.

The coverage analysis for the data set with the outlier included is shown on page 17 of Attachment 3, and on page 18 of Attachment 3 for the data set with the outlier removed. The coverage analysis is performed similar to the Chi-Squared analysis described above, except that the bins are limited to ±2 standard deviations from zero. A Normality Adjustment Factor (NAF) is used to increase the calculated standard deviation until greater than 95.45% of the sample points are within ±2 adjusted, standard deviations from zero.

A1.5 Choice of Data Set

From the Drift Interval Plot with the outlier included (page 19 of Attachment 3), it is clear the outlier is far removed from the rest of the data, which skews the histogram data and the drift interval plot and could result in improper modeling of the drift. Therefore, per Section 4.6.4.A of Input 4.1, the single outlier is removed for the determination of the Analyzed Drift values. The remaining data is established as the final data set.

A1.6 Time Dependency Testing

Since the calibration interval for the undervoltage relay is not being extended as a part of this activity, no time dependency testing is necessary. For information only, Drift Interval Plots are produced to graphically observe the data for both data sets (with outlier and with outlier removed).

Drift Interval Plot - Drift interval plots, showing the drift data set plotted against the time interval between tests, for the data set including the outlier and the data set with the outlier removed, are included on pages 19 and 20 of Attachment 3. A prediction line is included on each chart, along with the equation of the prediction line. This plot provides visual indication of the trend of the mean and of any increases in the scatter of the data over time.

The tolerance interval for the original data set calculated above is added to the plots as a plus/minus band centered around zero.

Note that the trend line crosses the zero drift value within the studied surveillance intervals for both data sets. The data scatter does not appear to increase, and the bias of the data does not appear to increase over time. Therefore, the drift for these undervoltage relay does not appear to be time dependent.

A1.7 Drift Bias Determination

For undervoltage relay, per page 10 of Attachment 3, the drift average value, for the data set with the outlier removed, is +0.0002 Volts. This is converted to a percent of setpoint by the following formula.

$$AD_{bias} = +(0.0002 \text{ Volts}) \times \left(\frac{100\% \text{ setpoint}}{3915 \text{ Volt/35}} \right)$$

$$AD_{bias} = +0.00018\% \text{ setpoint} \ll 0.1\% \text{ setpoint}$$

Section 4.9 of Input 4.1 shows the criteria for consideration of the bias term to be 0.1% of span, and for this application, span is considered to be the setpoint. Therefore, the drift for these undervoltage relay does not contain a significant bias, and is not considered further.

A1.8 Calculate Analyzed Drift Value

Per Section A1.7, there is no significant bias term.

<u>Random Term</u>

Per Section 5.10.3 of Input 4.15, the random portion of the Analyzed Drift is calculated by multiplying the Standard Deviation (s) of the data set with the outlier removed, by the 95%/95% Tolerance Interval Factor ($TIF_{95/95}$) and the Normality Adjustment Factor (NAF). Refer to page 18 of Attachment 3 for the values for s, $TIF_{95/95}$, and NAF:

$$AD_{random} = \pm s \times TIF_{95/95} \times NAF$$

$$AD_{random} = \pm 0.0233 \times 2.194 \times 1.08$$

$$AD_{random} = \pm 0.0552 \text{ Volts}$$

This term applies for the current nominal calibration interval of three months.

A1.1 Data Grouping

Data was imported to pages 1 through 6 of Attachment 4 from Input 4.4 for the following undervoltage relays:

- 127-5A
- 127-5B
- 127-5C
- 127-6A
- 127-6B
- 127-6C

A specific determination of proper data grouping is not necessary for this computation, since the six undervoltage relays are used in the same application, with the same setpoint, and similar environment.

A1.2 Spreadsheet Performance of Basic Statistics

As shown on pages 1 and 6 of Attachment 4, the following information was determined at each calibration point for each of the six undervoltage relay:

The average ($\bar{x}$) for the drift data was determined by using the "AVERAGE" function.

The standard deviation was determined by using the "STDEV" function. The Standard Deviation function returns the measure of how widely values are dispersed from the mean of the data. Formula used by Microsoft Excel to determine the standard deviation:

$$s = \sqrt{\frac{n\sum x^2 - \left(\sum x\right)^2}{n(n-1)}}$$

where:

x - Sample data values (x_1, x_2, x_3,...)
s - Standard deviation of all sample data points
n - Total number of data points

The variance (s^2) was determined by using the "VAR" function. The variance function returns the measure of how widely values are dispersed from the mean of the data. The variance can also be determined by taking the square of the standard deviation.

Formula used by Microsoft Excel to determine the variance:

$$s^2 = \frac{n\sum x^2 - \left(\sum x\right)^2}{n(n-1)}$$

where:

x - Sample data values ($x_1, x_2, x_3, \ldots$)
s^2 - Variance of sample population
n - Total number of data points

The number of data points (n) was determined by using the "COUNT" function.

The largest positive drift value was determined by using the "MAX" function.

The largest negative drift value was determined by using the "MIN" function.

A Drift Trend Plot was developed by plotting the drift value versus calibration date. Bounds corresponding to ±2 Sigma (2 Standard Deviations) are shown on the plot.

Page 7 of Attachment 4 presents the combined drift data statistics for the subject undervoltage relay. The combined statistics were determined following the methods described above.

A1.3 Outlier Detection and Expulsion

The calibration interval and drift data were copied to the spreadsheet shown on Pages 8 through 10 of Attachment 4. The average, standard deviation, variance, largest positive drift, largest negative drift, and sample count for the data set is recalculated for use in the outlier detection portion of the calculation.

The T-Test Critical Value is utilized to detect the presence of outliers. The value used for the T-Test Critical Value is obtained from Table 9.2 of Input 4.1. Since there are 132 sample points for this calculation, a value of 3.330 is used.

T-Test Outlier Detection Equation:

$$T = \frac{|x_i - \bar{x}|}{s}$$

where:

x_i - An individual sample data point

$\bar{x}$ - Mean of all sample data points

s - Standard deviation of all sample data points

T - Calculated value of extreme studentized deviate that is compared to the critical value of t for the sample size.

If the calculated value of T exceeds the T-Test Critical Value for the sample size and desired significance level, then the evaluated data point is identified as an outlier. The spreadsheet is set up so that a blank is displayed in the Outlier Test column if the calculated T exceeds the T-Test Critical Value.

The T-Test did not identify any outliers in the data set.

A1.4 Normality Tests

The D-Prime (D') Test - The D' Test calculates a test statistic value for the sample population and compares the calculated value to the values for the D' percentage points of the distribution, which are tabulated in Table 9.7 of Input 4.1. The D' Test is two-sided, which means that the two-sided percentage limits at the stated level of significance must bound the calculated D' value. For the given sample size, the calculated value of D' must lie within the two values provided in Table 9.7 in order to accept the hypothesis of normality.

The D' Test is included on pages 11 through 13 of Attachment 4.

To perform a D' Test, the two data set is sorted and numbered in ascending order from smallest to largest.

Calculate the estimated Variance of the sample:

$$s^2 = \frac{n\sum x^2 - \left(\sum x\right)^2}{n(n-1)}$$

Where:
s^2 - Unbiased estimate of the sample population variance
n - Total number of data points
x - Sample data point

Calculate the S^2 for the group:

$$S^2 = (n-1) \times s^2$$

Where:
S^2 - Sum of the Squares about the mean
s^2 - Unbiased estimate of the sample population variance
n - Total number of data points

Calculate the linear combination (T) of the sample group:

$$t_i = \left(i - \frac{n+1}{2}\right) \times x_i$$

$$T = \sum t_i$$

Where:
i - The number of the sample point
n - Total number of data points
x_i - An individual sample data point

Calculate the D' value for the sample group:

$$D' = \frac{T}{S}$$

Determine the critical D' values from Table 9.7 of Input 4.1. Since the calculated D' value is outside of the critical value limits, the assumption of normality is rejected.

Chi-Squared, χ^2, Goodness of Fit Test - ***This test is not relied upon to determine normality, but is included for information, as a part of the development of the coverage analysis.*** The χ^2 test compares the actual distribution of sample values to the expected distribution. The expected values are calculated by using the mean and standard deviation for the sample. If the distribution is normally or approximately normally distributed, the difference between the actual versus expected values should be very small. If the distribution is not normally distributed, the differences should be significant.

The Chi-Squared test is included on pages 14 of Attachment 4. The Chi-Squared test is performed with 12 bins of data, starting from -∞ to (mean-2.5σ), with bin increments of 0.5σ, ending at (mean+2.5σ) to +∞.

The Chi-Squared test is performed using the Histogram function within Microsoft Excel. Excel counts the number of data points between the current bin value and the adjoining higher bin value. All values below the first bin are counted together, as are the values above the last bin value.

To establish the upper limit for each bin, the Standard Deviation of the data set is multiplied by the Multiples of Standard Deviation and added to the Average. The Excel Histogram function is performed with the data set used as the Input Range and the Bin Upper Limit used as the Bin Range. The result of the Histogram function is shown under the Bin and Observed Frequency columns.

The expected frequency percentage for each bin is taken from Table 9.3 of Input 4.1. The total number of samples is multiplied by the expected frequency percentage to obtain the expected frequency. The deviation between the expected frequency and the observed frequency is calculated for each bin and for the total sample:

$$\text{Deviation} = \frac{(O_i - E_i)^2}{E_i}$$

where:

E_i - Number of sample items expected in a bin

O_i - Observed number of sample items in a bin

and:

$$\chi^2 = \sum \frac{(O_i - E_i)^2}{E_i}$$

where:
χ^2 - Chi-squared result

Computing the chi-squared per degree of freedom term:

$$\chi_o^2 = \frac{\chi^2}{d}$$

where:
d - degrees of freedom

The degrees of freedom term is computed as the number of bins used for the chi-squared computation minus the constraints. For these drift calculations, the count, mean, and standard deviation are computed. Therefore, the constraints term is equal to 3 and the degrees of freedom term is equal to 9.

Since χ_o^2 is greater than 1 for each data set, another check is made. The degrees of freedom and obtained chi-squared value are used to look up the probability that the observed χ_o^2 exceeds the expected value. The degrees of freedom and the calculated χ_o^2 are used with Table 9.4 of Input 4.1 to determine the probability that the observed χ_o^2 exceeds the expected value. If the lookup value were greater than or equal to 5%, then the assumption of normality would not be rejected.

Since the lookup value is less than 5%, the assumption of normality is rejected.

<u>Coverage Analysis</u> - Since the assumption of normality was rejected by the D' tests, a coverage analysis is required. Histograms were created to plot the number of drift data points versus drift in multiples of standard deviations from the mean. These histograms are included on the same page as the Chi-Squared analysis (pages 14 Attachment 4). The histogram graphically shows the difference between the expected normal distribution and the observed distribution based on the results of the Chi-Squared analysis.

Based on visual examination of the plots, the distribution of the data approximates a normal distribution. Therefore, a normal distribution model that adequately covers the sets of drift data as observed can be derived.

The coverage analysis for the data set with the outlier included is shown on page 14 of Attachment 4. The coverage analysis is performed similar to the Chi-Squared analysis described above, except that the bins are limited to ±2 standard deviations from zero. A Normality Adjustment Factor (NAF) is used to increase the calculated standard deviation until greater than 95.45% of the sample points are within ±2 adjusted, standard deviations from zero. In this case a normality factor of 1.000 was sufficient.

A1.5 Choice of Data Set

For this analysis there were not any outliers, therefore the initial data is used for the analysis.

A1.6 Time Dependency Testing

Since the calibration interval for the undervoltage relay is not being extended as a part of this activity, no time dependency testing is necessary. For information only, a Drift Interval Plots is produced to graphically observe the data.

Drift Interval Plot - Drift interval plots, showing the drift data set plotted against the time interval between tests, for the data set is included on pages 15 of Attachment 4. A prediction line is included on each chart, along with the equation of the prediction line. This plot provides visual indication of the trend of the mean and of any increases in the scatter of the data over time.

The tolerance interval for the original data set calculated above is added to the plots as a plus/minus band centered around zero.

Note that the trend line crosses the zero drift value within the studied surveillance interval. The data scatter appear to increase over time, but since all of the is concentrated between 2.5 months and 3.5 months there is not enough diversity in the intervals to support a decision as to whether the data is time dependent. Also, since the surveillance interval is not being extended, a determination as to whether the drift is time dependent is not required.

A1.7 Drift Bias Determination

For undervoltage relay, per page 10 of Attachment 4, the drift average value, for the data set with the outlier removed, is +0.0011 Seconds. This is converted to a percent of setpoint by the following formula.

$$AD_{bias} = +(0.0011\ \text{Seconds}) \times \left(\frac{100\%\ \text{setpoint}}{9.00\ \text{Seconds}}\right)$$

$$AD_{bias} = +0.01222\%\ \text{setpoint} \ll 0.1\%\ \text{setpoint}$$

Section 4.9 of Input 4.1 shows the criteria for consideration of the bias term to be 0.1% of span, and for this application, span is considered to be the setpoint. Therefore, the drift for these undervoltage relay does not contain a significant bias, and is not considered further.

A1.8 Calculate Analyzed Drift Value

Per Section A1.7, there is no significant bias term.

Random Term

Per Section 5.10.3 of Input 4.15, the random portion of the Analyzed Drift is calculated by multiplying the Standard Deviation (s) of the data set with the outlier removed, by the 95%/95% Tolerance Interval Factor ($TIF_{95/95}$) and the Normality Adjustment Factor (NAF). Refer to page 14 of Attachment 4 for the values for s, $TIF_{95/95}$, and NAF:

$$AD_{random} = \pm s \times TIF_{95/95} \times NAF$$

$$AD_{random} = \pm 0.0365 \times 2.194 \times 1.00$$

$$AD_{random} = \pm 0.0801\ \text{Volts}$$

This term applies for the current nominal calibration interval of three months.

MONTICELLO NUCLEAR GENERATING PLANT		CA-92-220
TITLE:	**Attachment 5** **Setpoint Relationship Diagram** **Voltage Function**	Revision 1 Page 1 of 1

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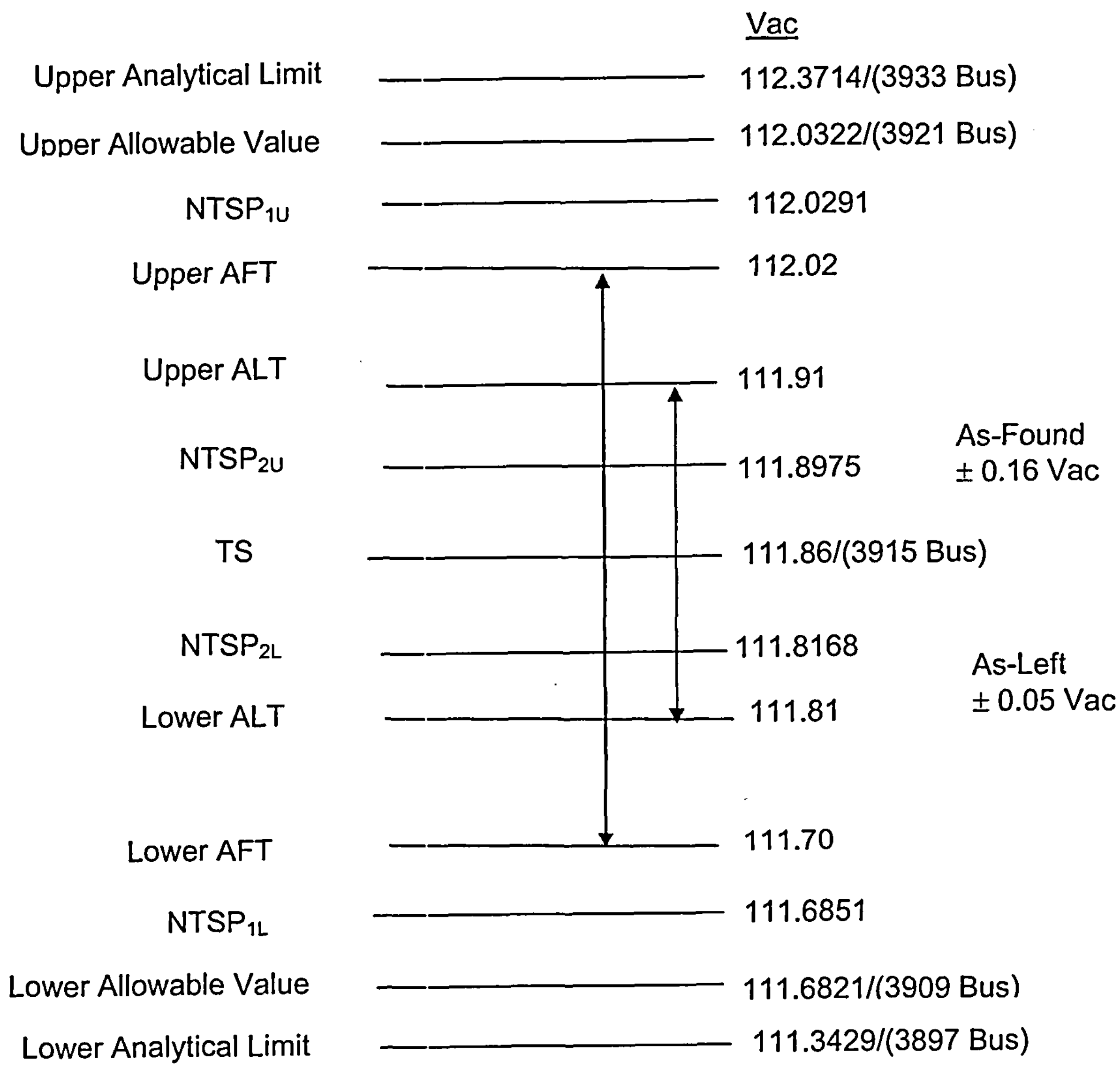

MONTICELLO NUCLEAR GENERATING PLANT		CA-92-220
TITLE:	Attachment 6 Setpoint Relationship Diagram Time Delay Function	Revision 1 Page 1 of 1

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