Temperature Tests:

Temperature	Pickup Voltage	Variation from Room Temperature	Dropout Voltage	Variation from Room Temperature
25°C	100.04v	----	99.95v	----
0	100.04	0.00 %	99.94	-0.01%
-20	100.04	0.00 %	99.94	-0.01%
40	100.11	+0.07 %	99.93	-0.02%
55	100.15	+0.11 %	99.96	+0.01%
70	100.21	+0.17 %	100.10	+0.15%

Temperature	Time Delay	Variation from Room Temperature
25°C	0.997 sec	------
0	0.996	-0.1%
-20	0.993	-0.4%
+40	0.998	+0.1%
+55	1.007	+1.0%
+70	1.013	+1.6%

Results of Test: relay characteristics are stable with temperature and within published specifications.

Relay Tested: 211T6175 Date of Test: 10/15/82
Tester: W.C. Martin

Temperature Test with Harmonic Filter Option:

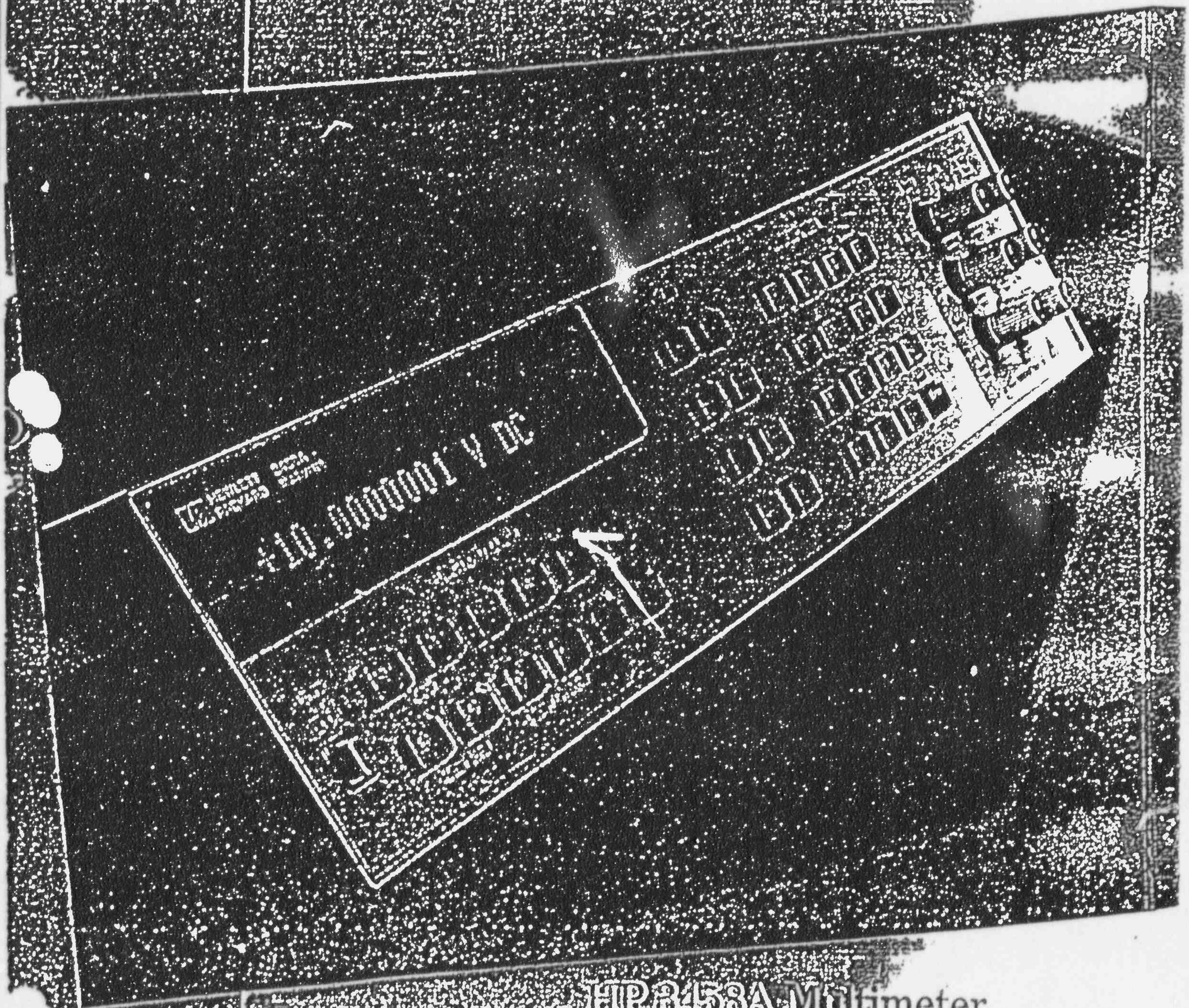
Temperature	Pickup Voltage	Variation from Room Temperature	Dropout Voltage	Variation from Room Temperature
22°C	100.12v	----	100.03v	----
-3	100.53	+0.41%	100.43	+0.40%
-20	100.90	+0.78%	100.81	+0.78%
+40	100.14	+0.02%	100.05	+0.02%
+55	99.88	-0.24%	99.79	-0.24%
+70	99.30	-0.82%	99.25	-0.78%

Results of Test: relay operation is stable with temperature and within published specifications.

Relay Tested: 211T0175-HF Date of Test: 3/6/84
Tester: C.L. Downs

Attachment 5 CALCULATION [illegible] VOLUME E
DEPT/DIV [illegible]

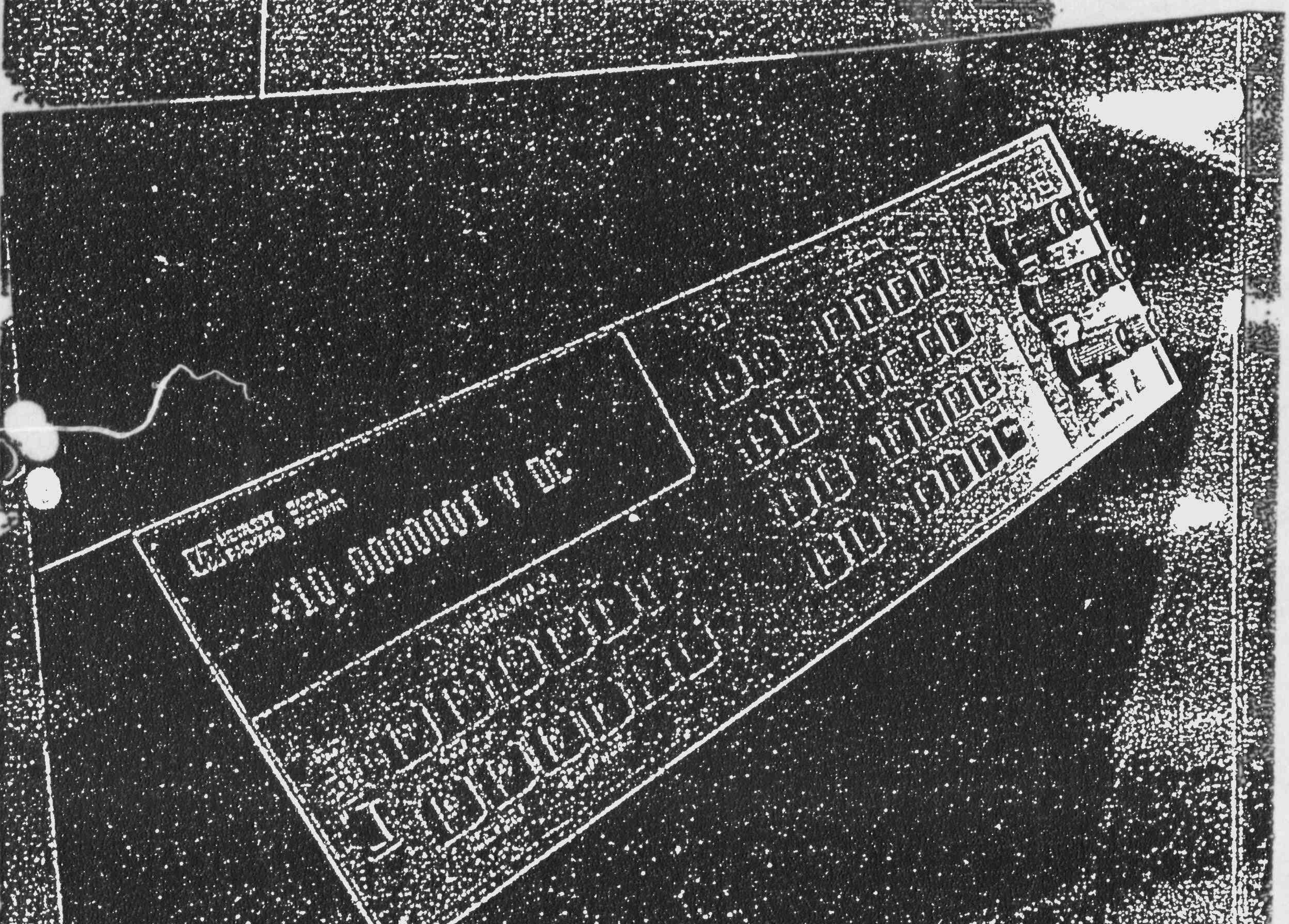
HEWLETT PACKARD



HP 3458A Multimeter

Data Sheet
May 1991

Attachment 5 CALCULATION 19-AN-19 REV 2 VOLUME E
DEPT/DIV. [illegible]



HP 3458A Multimeter

Data Sheet
May 1991

For Calibration Lab Precision

- 8 1/2 Digits resolution
- 0.1 ppm dcV linearity
- 100 ppm acV absolute accuracy
- 4 ppm/year optional stability

In the calibration lab, you'll find the HP 3458A's 8 1/2 digits to have extraordinary linearity, low internal noise, and excellent short term stability. The linearity of the HP 3458A's Multislope A to D converter has been characterized with state-of-the-art precision. Using Josephsen Junction Array intrinsic standards, linearity has been measured within ±0.05 ppm of 10 Volts. The HP 3458A's transfer accuracy for 10 Volts dc is 0.1 ppm over 1 hour ± 0.5°C. Internal noise has been reduced to less than 0.01 ppm rms yielding 8 1/2 digits of usable resolution. So, the right choice for your calibration standard dmm is the HP 3458A.

dcV stability

The long term accuracy of the HP 3458A is a remarkable 8 ppm per year -- more accurate than many system dmms are after only a day. Option 002 gives you a higher stability voltage reference specified to 4 ppm/year for the ultimate performance.

Reduced-error resistance

The HP 3458A doesn't stop with accurate dcV. Similar measurement accuracy is achieved for resistance, acV, and current. You can measure resistance from 10 µΩ to 1 GΩ with midrange accuracy of 2.2 ppm.

Finally, the HP 3458A, like its HP dmm predecessors, offers offset-compensated Ohms on the 10 Ω to 100 kΩ ranges to eliminate the errors introduced by small series voltage offsets. Usable for both two- and four-wire ohms, the HP 3458A supplies a current through the unknown resistance, measures the voltage drop, sets the current to zero, and measures the voltage drop again. The result is reduced error for resistance measurements.

Precision acV

The HP 3458A introduces new heights of true rms ac volts performance with a choice of traditional analog or a new sampling technique for higher accuracy. For calibration sources and periodic waveforms from 1 Hz to 10 MHz, the HP 3458A's precision sampling technique offers extraordinary accuracy. With 100 ppm absolute accuracy for 45 Hz to 1 kHz or 170 ppm absolute accuracy to 20 kHz, the HP 3458A will enhance your measurement capabilities. Accuracy is maintained for up to 2 years with only a single 10 Volt dc precision standard. No ac standards are necessary. For higher speed and less accuracy, the analog true rms ac technique has a midband absolute measurement accuracy of 300 ppm using the same simple calibration procedure. With a bandwidth of 10 Hz to 2 MHz and reading rates to 50/second, the analog technique is an excellent choice for high throughput computer-aided testing.

Easy calibration

The HP 3458A gives you low cost of ownership with a simple, two-source electronic calibration. With its superior linearity, the HP 3458A is fully calibrated, including ac, from a precision 10 V dc source and a precision 10 kΩ resistor. All ranges and functions are automatically calibrated using precise internal ratio transfer measurements relative to these external standards. In addition, the HP 3458A's internal voltage standard and resistance standard are calibrated. Now you can perform a self-verifying, self- or auto-calibration relative to the HP 3458A's low drift internal standards at any time with the ACAL command. So, if your dmm's environment changes, auto-calibration optimizes your measurement accuracy.

Calibration security

Unlike other dmms, the HP 3458A goes to great lengths to assure calibration security. First, a password security code "locks" calibration values and the self-calibration function. Next, you can easily store and recall a secured message for noting items, such as calibration date and due date. Plus, the HP 3458A automatically increments a calibration counter each time you "unlock" the dmm -- another safeguard against calibration tampering. If you have a unique situation or desire ultimate security, use the internal dmm hardwired switch to force removal of the instrument covers to perform calibration.

ntents

Introduction

The HP 3458A accuracy is specified as a part per million (ppm) of the reading plus a ppm of range for dcV, Ohms, and dcI. In acV and acI, the specification is percent of reading plus percent of range. Range means the name of the scale, e.g. 1 V, 10 V, etc.; range does not mean the full scale reading, e.g. 1.2 V, 12 V, etc. These accuracies are valid for a specific time from the last calibration.

Absolute versus Relative Accuracy

All HP 3458A accuracy specifications are relative to the calibration standards. Absolute accuracy of the HP 3458A is determined by adding these relative accuracies to the traceability of your calibration standard. For dcV, 2 ppm is the traceability error from the HP factory. That means that the absolute error relative to the U.S. National Institute of Standards and Technology (NIST) is 2 ppm in addition to the dcV accuracy specifications. When recalibrate the HP 3458A, your actual ability error will depend upon the errors from calibration standards. These errors will likely be erent from the HP error of 2ppm.

Example 1: Relative Accuracy; 24 Hour Operating temperature is Tcal ±1°C

Assume that the ambient temperature for the measurement is within ±1°C of the temperature of calibration (Tcal). The 24 hour accuracy specification for a 10 V dc measurement on the 10 V range is 0.5 ppm + 0.05 ppm. That accuracy specification means:

0.5 ppm of Reading + 0.05 ppm of Range

For relative accuracy, the error associated with the measurement is:

(0.5 / 1,000,000 x 10V) + (0.05 / 1,000,000 x 10V) = ± 5.5 µV or 0.55 ppm of 10V

Errors from temperature changes

The optimum technical specifications of the HP 3458A are based on auto-calibration (ACAL) of the instrument within the previous 24 hours and following ambient temperature changes of less than ±1° C. The HP 3458A's ACAL capability corrects for measurement errors resulting from the drift of critical components from time and temperature.

The following examples illustrate the error correction of auto-calibration by computing the relative measurement error of the HP 3458A for various temperature conditions. Constant conditions for each example are:

10 V DC input
10 V DC range
Tcal = 23° C
90 day accuracy specifications

Example 2: Operating temperature is 28° C; With ACAL

This example shows basic accuracy of the HP 3458A using auto-calibration with an operating temperature of 28°C. Results are rounded to 2 digits.

(4.1 ppm x 10V) + (0.05 ppm x 10V) = 42 µV
Total relative error = 42 µV

Example 3: Operating temperature is 38°C; Without ACAL

The operating temperature of the HP 3458A is 38°C, 14°C beyond the range of Tcal ±1°C. Additional measurement errors result because of the added temperature coefficient without using ACAL.

(4.1 ppm x 10V) + (0.05 ppm x 10V) = 42 µV
Temperature Coefficient (specification is per °C):
(0.5 ppm x 10V + 0.01 ppm x 10V) x 14°C = 71 µV

Total error = 113 µV

Example 4: Operating temperature is 38° C; With ACAL

Assuming the same conditions as Example 3, but using ACAL significantly reduces the error due to temperature difference from calibration temperature. Operating temperature is 10°C beyond the standard range of Tcal ±5°C.

(4.1 ppm x 10V) + (0.05 ppm x 10V) = 42 µV
Temperature Coefficient (specification is per °C):
(0.15 ppm x 10V + 0.01 ppm x 10V) x 10°C = 16 µV

Total error = 58 µV

Example 5: Absolute Accuracy; 90 Day

Assuming the same conditions as Example 4, but now add the traceability error to establish absolute accuracy.

(4.1 ppm x 10V) + (0.05 ppm x 10V) = 42 µV
Temperature Coefficient (specification is per °C):
(0.15 ppm x 10V + 0.01 ppm x 10V) x 10°C = 16 µV
HP factory traceability error of 2 ppm:
(2 ppm x 10V) = 20 µV

Total absolute error = 78 µV

Additional errors

When the HP 3458A is operated at power line cycles below 100, additional errors due to noise and gain become significant. Example 6 illustrates the error correction at 0.1 PLC.

Example 6: Operating temperature is 28°C; 0.1 PLC

Assuming the same conditions as Example 2, but now add additional error.

(4.1 ppm x 10V) + (0.05ppm x 10V) = 42 µV

Referring to the Additional Errors chart and RMS Noise Multiplier table, additional error at 0.1 PLC is:
(2 ppm x 10V) + (0.4ppm x 1 x 3 x 10V) = 32 µV

Total relative error = 74 µV

General Information

The HP3458A supports three techniques for measuring true rms AC voltage, each offering unique capabilities. The desired measurement technique is selected through the SETACV command. The ACV functions will then apply the chosen method for subsequent measurements.

The following section provides a brief description of the three operation modes along with a summary table helpful in choosing the technique best suited to your specific measurement need.

SETACV SYNC Synchronously Sub-sampled Computed true rms technique.

This technique provides excellent linearity and the most accurate measurement results. It does require that the input signal be repetitive (not random noise for example). The bandwidth in this mode is from 1 Hz to 10 MHz.

SETACV ANA Analog Computing true rms conversion technique.

This is the measurement technique at power-up or following an instrument reset. This mode works well with any signal within its 10 Hz to 2 MHz bandwidth and provides the fastest measurement speeds.

SETACV RNDM Random Sampled Computed true rms technique.

This technique again provides excellent linearity, however the overall accuracy is the lowest of the three modes. It does not require a repetitive input signal and is therefore well suited to wideband noise measurements. The bandwidth in this mode is from 20 Hz to 10 MHz.

Selection Table

Technique	Frequency Range	Best Accuracy	Repetitive Signal Required	Readings / Sec Minimum	Readings / Sec Maximum
Synchronous Sub-sampled	1 Hz - 10 MHz	0.010%	Yes	0.025	10
Analog	10 Hz - 2 MHz	0.03%	No	0.8	50
Random Sampled	20 Hz - 10 MHz	0.1%	No	0.025	45

- 60060 -

Synchronous Sub-sampled Mode (ACV Function, SETACV SYNC)

Range	Full Scale	Maximum Resolution	Input Impedance	Temperature Coefficient[1] (% of Reading + % of Range) / °C
10 mV	12.00000	10 nV	1 MΩ ± 15% with <140pF	0.002 + 0.02
100 mV	120.00000	10nV	1 MΩ ± 15% with <140pF	0.001 + 0.0001
1 V	1.2000000	100 nV	1 MΩ ± 15% with <140pF	0.001 + 0.0001
10 V	12.000000	1 µV	1 MΩ ± 2% with <140pF	0.001 + 0.0001
100 V	120.00000	10 µV	1 MΩ ± 2% with <140pF	0.001 + 0.0001
1000 V	700.0000	100 µV	1 MΩ ± 2% with <140pF	0.001 + 0.0001

AC Accuracy [2]

24 Hour to 2 Year (% of Reading + % of Range)

Range	ACBAND ≤ 2MHz: 1 Hz to[3] 40 Hz	40 Hz to[3] 1 kHz	1 kHz to[3] 20 kHz	20 kHz to[3] 50 kHz	50 kHz to 100 kHz	100 kHz to 300 kHz	300 kHz to 1 MHz	1 MHz to 2 MHz
10 mV	0.03 + 0.03	0.02 + 0.011	0.03 + 0.011	0.1 + 0.011	0.5 + 0.011	4.0 + 0.02		
100 mV - 10V	0.007 + 0.004	0.007 + 0.002	0.014 + 0.002	0.03 + 0.002	0.08 + 0.002	0.3 + 0.01	1 + 0.01	1.5 + 0.01
100 V	0.02 + 0.004	0.02 + 0.002	0.02 + 0.002	0.035 + 0.002	0.12 + 0.002	0.4 + 0.01	1.5 + 0.01	
1000 V	0.04+ 0.004	0.04 + 0.002	0.06 + 0.002	0.12 + 0.002	0.3 + 0.002			

1 Additional error beyond ± 1°C, but within + 5°C of last ACAL.

For ACBAND > 2MHz, use 10 mV range temperature coefficient for all ranges.

2 Specifications apply full scale to 10% of full scale, DC < 10% of AC, sine wave input, crest factor = 1.4, and PRESET. Within 24 hours and ± 1° C of last ACAL. Lo to Guard Switch on.

Peak (AC + DC) input limited to 5 x full scale for all ranges in ACV function.

Add 2 ppm of reading additional error for HP factory traceability of 10V DC to US NIST.

3 LFILTER ON recommended.

AC Accuracy continued on following page

HEWLETT PACKARD

Test & Measurement Catalog

Rob Hansen
Field Engineer
Electronic Instruments
309/664-4053
Fax 309/664-4100

HEWLETT* PACKARD

Hewlett-Packard Company
2205 East Empire Street
PO Box 1607
Bloomington, Illinois 61702-1607

Parts I.D. 916/783-0804
HP Direct 800/452-4844

rob_hansen@hpatc2.desk.hp.com

1994

Published by the
Test & Measurement Sector
Santa Clara, California

Produced by
Redgate Communications
San Francisco, California

Printed by
R.R. Donnelley & Sons
Willard, Ohio

Composition services by
Stibo Datagraphics
Marietta, Georgia

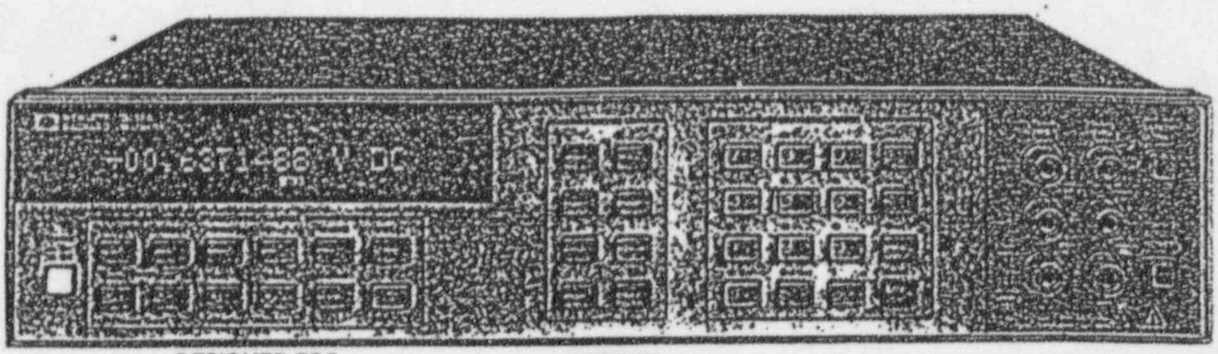
Design of introductory pages
MetaWest Design Corp.
San Francisco, California

The body of this book
is printed on recycled paper
5091-8952EUS

DIGITAL MULTIMETERS

A System Multimeter with Both High Speed and High Accuracy

HP 3458A



DESIGNED FOR MATE SYSTEMS

HP-IB SYSTEMS

HP 3458A

The HP 3458A multimeter shatters longstanding performance barriers of speed and accuracy on the production test floor, in research and development, and in the calibration lab. The HP 3458A is the fastest, most flexible, and most accurate multimeter offered by Hewlett-Packard. In your system or on the bench, the HP 3458A saves you time and money with unprecedented test system throughput and accuracy, seven-function measurement flexibility, and low cost of ownership.

Select a rate of 100,000 readings per second for maximal t throughput. Or achieve highest levels of precision with up to 8½ di of measurement resolution and 0.1 part per million transfer accur: Add to this the HP 3458A's simplicity of operation, and you have ideal multimeter for your most demanding applications.

High-Test System Throughput

Faster Testing
- Up to 100,000 readings/s
- Internal test setups >340/s
- Programmable integration times from 500 ns to 1 s

Greater Test Yield
- More accuracy for tighter test margins
- Up to 8½ digits resolution

Longer Uptime
- Two-source (10 V, 100 kΩ) calibration, including ac
- Self-adjusting, self-verifying autocalibration for all functions and ranges, including ac

High-Resolution Digitizing

Greater Waveform Resolution and Accuracy
- 16 to 24 bits resolution
- 100,000 to 0.2 samples/s
- 12 MHz bandwidth
- Timing resolution to 10 ns
- Less than 100 ps time jitter
- Over 75,000 reading internal memory

Flexible Digitizing Software
- Powerful, easy-to-use analysis software for HP 9000 Series 200/300 computers or HP Vectra with measurement coprocessor
- Subprograms for waveform acquisition, data transfer, FFT, IFT, and data presentation

Calibration Lab Precision

Superb Transfer Measurements
- 8½ digits resolution
- 0.1 ppm dc volts linearity
- 0.1 ppm dc volts transfer capability
- 0.01 ppm rms internal noise

Extraordinary Accuracy
- 0.6 ppm for 24 hours in dc volts
- 2.2 ppm for 24 hours in Ω
- 100 ppm mid-band ac volts
- 8 ppm (4 ppm optional) per year voltage reference stability

HP 3458A Multimeter Performance Features

dc Volts
- 5 ranges: 0.1 V to 1000 V
- 8½ to 4½ digits resolution
- Up to 100,000 readings/s (4½ digits)
- Maximum sensitivity: 10 nV
- 0.6 ppm 24-hour accuracy
- 8 ppm (4 ppm optional)/year voltage reference stability

Ω
- 9 ranges: 10 Ω to 1 GΩ
- 2-wire and 4-wire Ω with offset compensation
- Up to 50,000 readings/s (5½ digits)
- Maximum sensitivity: 10 μΩ
- 2.2 ppm 24-hour accuracy

ac Volts
- 6 ranges: 10 mV to 1000 V
- 1 Hz to 10 MHz bandwidth
- Up to 50 readings/s with all readings to specified accuracy
- Choice of sampling or analog true rms techniques
- 100 ppm best accuracy

dc Current
- 8 ranges: 100 nA to 1 A
- Up to 1,350 readings/s (5½ digits)
- Maximum sensitivity: 1 pA
- 14 ppm 24-hour accuracy

ac Current
- 5 ranges: 100 μA to 1 A
- 10 Hz to 100 kHz bandwidth
- Up to 50 readings/s
- 500 ppm 24-hour accuracy

Frequency and Period
- Voltage or current ranges
- Frequency: 1 Hz to 10 MHz
- Period: 100 ns to 1 s
- 0.01 % accuracy
- ac or dc coupled

Attachment 5 CALCULATION 19-AN-19 REV 2 VOLUME E
DEPT./DIV. E/EPED

167

Throughput

Maximum Reading Rates
[illegible]00,000 readings/s at 4½ digits (16 bits)
[illegible]000 readings/s at 5½ digits
[illegible]000 readings/s at 6½ digits
[illegible] readings/s at 7½ digits
[illegible] readings/s at 8½ digits

Measurement System Speed
[illegible]00,000 readings/s over HP-IB or with internal memory
[illegible] autoranges/s
[illegible] function or range changes/s
[illegible] postprocessed math from internal memory

Abbreviated Technical Specifications

dc Voltage

Range	Full scale	Maximum resolution	1-Year* accuracy	Transfer accuracy 10 min, Tref ±0.5° C	Input impedance
			ppm of reading + ppm of range		
100 mV	120.00000	10 nV	9(5) + 3	0.5 + 0.5	> 10 GΩ
[illegible]	1.20000000	10 nV	8(4) + 0.3	0.3 + 0.1	> 10 GΩ
[illegible]	12.0000000	100 nV	8(4) + 0.05	0.05 + 0.05	> 10 GΩ
[illegible]	120.000000	1 µV	10(6) + 0.3	0.5 + 0.1	10 MΩ ±1%
[illegible]	1050.00000	10 µV	10(6) + 0.1	1.5 + 0.05	10 MΩ ±1%

[illegible] specifications for NPLC 100 within 24 hours and ± 1° C of last ACAL, Tcal ± 5° C, [illegible] fixed range. Add 2 ppm of reading additional error for HP factory traceability of 10 V [illegible] NIST. Traceability error is the absolute error relative to National Standards associated [illegible] source of last external calibration. Transfer specifications for NPLC 100, following 4-hour [illegible] scale to 10% of full scale. Measurements on the 1000 V range are within 5% of the [illegible] measurement value and following measurement settling. Tref is the starting ambient [illegible]. Measurements are made on a fixed range using accepted metrology practices. [illegible] (Option 002) ppm of reading in parentheses.

Noise Rejection (dB)[1]

	ac NMR[2]	ac ECMR	dc ECMR
NPLC [illegible]	0	90	140
NPLC [illegible]	60	150	140
NPLC ≥ 10	60	150	140
NPLC ≥ 100	70	160	140
NPLC ≥ 1000	80	170	140

[illegible] 1 kΩ imbalance in the LO lead and ±0.1% of the line frequency currently set for [illegible]

[illegible] frequency ±1%, ACNMR is 40 dB for NPLC ≥ 1, or 80 dB for NPLC ≥ 100. For line [illegible] ±5%, ACNMR is 65 dB for NPLC ≥ 100.

Maximum Input

	Rated Input	Nondestructive
HI to LO	±1000 V pk	±1200 V pk
LO to guard	±200 V pk	±350 V pk
Guard to earth	±500 V pk	±1000 V pk

[illegible] rms ac Voltage
([illegible]chronous Subsampled Mode)

Range	Full scale	Maximum resolution	Accuracy* 24 hour–2 year 40 Hz to 1 kHz % of reading + % of range	Input impedance
10 mV	12.00000	10 nV	0.02 + 0.011	1MΩ ±15% with < 140 pf
100 mV	120.00000	10 nV	0.007 + 0.002	1MΩ ±15% with < 140 pf
[illegible]	1.2000000	100 nV	0.007 + 0.002	1MΩ ±15% with < 140 pf
[illegible]	12.000000	1 µV	0.007 + 0.002	1MΩ ±2% with < 140 pf
[illegible]	120.00000	10 µV	0.02 + 0.002	1MΩ ±2% with < 140 pf
1000 V	700.0000	100 µV	0.04 + 0.002	1MΩ ±2% with < 140 pf

[illegible] specifications apply for full scale to 10% of full scale, dc < 10% of ac, sine wave input, crest [illegible]. Within 24 hours and ± 1° C of last ACAL. Peak (ac + dc) input limited to 5 × full [illegible] for all ranges. Add [illegible] ppm of reading additional error for HP factory traceability of 10 V dc [illegible] US NIST.

Maximum Input

	Rated Input	Nondestructive
HI to LO	± 1000 V pk	± 1200 V pk
LO to guard	± 200 V pk	± 350 V pk
Guard to earth	± 500 V pk	± 1000 V pk
Volt-Hz product	1 × 10⁸	

Resistance

Range	Full scale	Maximum resolution	Current through unknown	1-Year Accuracy* (4-wire Ω) ppm of rdg + ppm of range
10 Ω	12.00000	10 µΩ	10 mA	15 + 5
100 Ω	120.00000	10 µΩ	1 mA	12 + 5
1 kΩ	1.2000000	100 µΩ	1 mA	10 + 0.5
10 kΩ	12.000000	1 mΩ	100 µA	10 + 0.5
100 kΩ	120.00000	10 mΩ	50 µA	10 + 0.5
1 MΩ	1.2000000	100 mΩ	5 µA	15 + 2
10 MΩ	12.000000	1 Ω	500 nA	50 + 10
100 MΩ	120.00000	10 Ω	500 nA	500 + 10
1 GΩ	1.2000000	100 Ω	500 nA	0.5% + 10

*Specifications for 100 NPLC, offset compensation on, within 24 hours and ± 1° C of last ACAL, Tcal ±5° C. Add 3 ppm of reading additional error for HP factory traceability of 10 kΩ to US NIST.

Memory

	Standard		Option 001	
	Readings	Bytes	Readings	Bytes
Reading storage (16 bit)	10,240	20 k	+65,536	+128 k
Non-volatile, for subprograms and/or state storage		14 k		

Math Functions: The HP 3458A performs the following math functions on measurements: NULL, SCALE, OFFSET, RMS FILTER, SINGLE POLE FILTER, THERMISTOR LINEARIZATION, DB, DBM, % ERROR, PASS/FAIL LIMIT TESTING, and STATISTICS. Two math functions may be used at one time.

General Specifications

Operating Temperature: 0° to 55° C
Warmup Time: Four hours to all specifications except where noted
Humidity Range: 95% RH, 0° to 40° C
Storage Temperature: −40° to +75° C
Power: 100/120 V, 220/240 V ± 10%, 48 to 66 Hz, 360 to 420 Hz automatically sensed. Fused at 1.5 A @ 115 V or 0.5 A @ 230 V. <30 W, < 80 VA (peak).
Size: 425.5 mm W × 88.9 mm H × 502.9 mm D (16.75 in × 3.5 in × 19.8 in)
Weight: Net, 12 kg (26.5 lb); shipping, 14.8 kg (32.5 lb)

Ordering Information

	Price
HP 3458A Multimeter (with HP-IB, 20 KB reading memory, and 8 ppm stability)	$6,595
Opt 001 Extended Reading Memory (expands total to 148 KB)	$570
Opt 002 High Stability (4 ppm/year) Reference	$1,080
Opt 005 Waveform Analysis Library for HP Series 300 computers with BASIC 4.0 or greater and HP Vectra with Measurement Coprocessor	$430
Opt 1BN MIL-STD-45662A Certificate of Calibration	$200
Opt 1BP MIL-STD-45662A Certificate of Calibration with data	$300
Opt W30 Two additional years return-to-HP hardware support (see page 624)	$160
Opt W32 Three-year customer return calibration coverage	
Opt 700 CIIL Language	$1,080
Opt 907 Front Handle Kit	$60
Opt 908 Rack Flange Kit	$40
Opt 909 Rack Flange Kit (with handles)	$90

For the most current prices and product information, contact your local Hewlett-Packard sales office — see page 654

Westinghouse Electric Corporation
Sharon Transformer Division
Sharon, Pa. 16146

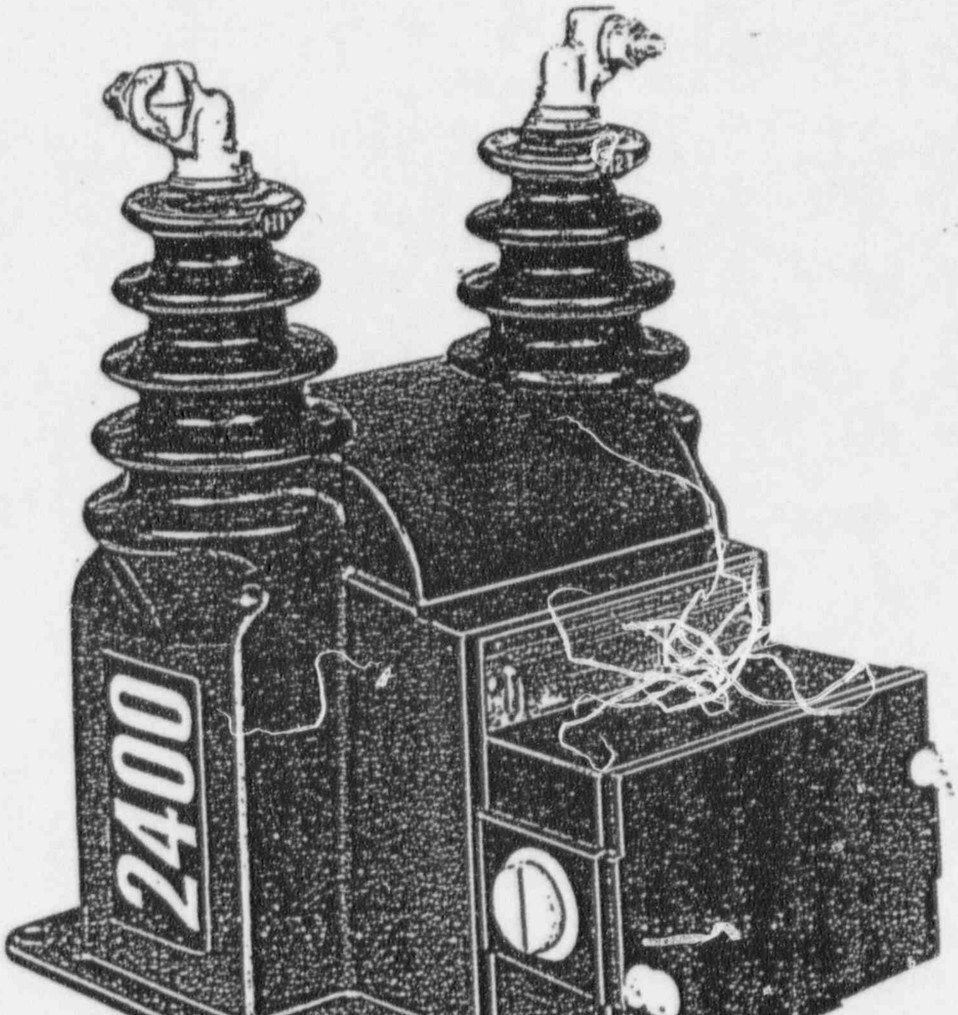
44-215 D WE A
Product Bulletin

Attachment 6 CALCULATION 19-AN-19 REV 2 VOLUME E
DEPT./DIV. E/EPED

July 16, 1976
New Information
Mailed to: E, D, C/2047/DB

2400 Through 4800 Volts, Outdoor
60 Kv BIL
60 Hertz

Type PCO-60 Voltage Transformers



Attachment 6 CALCULATION 19-AN-19 REV 2 VOLUME E
DEPT./DIV. E/EPED.

44-215 Q.WE A
Product Bulletin

1 2

Application
The type PCO-60 voltage transformer is a cast epoxy resin unit designed for outdoor metering and relaying circuits. Small and compact, light in weight, it is particularly suitable for pole top cluster bracket mounting.

Accuracy
ANSI metering accuracy class (60 Hertz):
0.3 Class for Standard Burdens W, X, M, Y
1.2 Class for Standard Burden Z

Thermal Rating
1000 VA at 30°C ambient

Selector Guide

Primary Voltage	Winding Ratio	Style Number
2400/4160Y	20:1	4421A84G01
4200/4200Y	35:1	4421A84G02
4800/4800Y	40:1	4421A84G03

Construction Features

Cast Core and Coil
The coil assembly is a progressive winding, with the high voltage wound directly over the low voltage coil. An octagonal WESCOR® core loop, and end frames, are then cushioned with the coil assembly, after which the unit is encapsulated in epoxy resin. The epoxy compound used has high mechanical strength, resistance to electrical arcing and tracking, and can withstand the adverse effects of weathering. The result is a light and compact outdoor unit, with no sacrifice in performance.

Terminals
Primary terminals are clamp type connectors, cast of a bronze alloy and electro-tin plated for compatibility with aluminum or copper.

Secondary terminals are brass inserts with .190-32 tapped holes, complete with washers and screws.

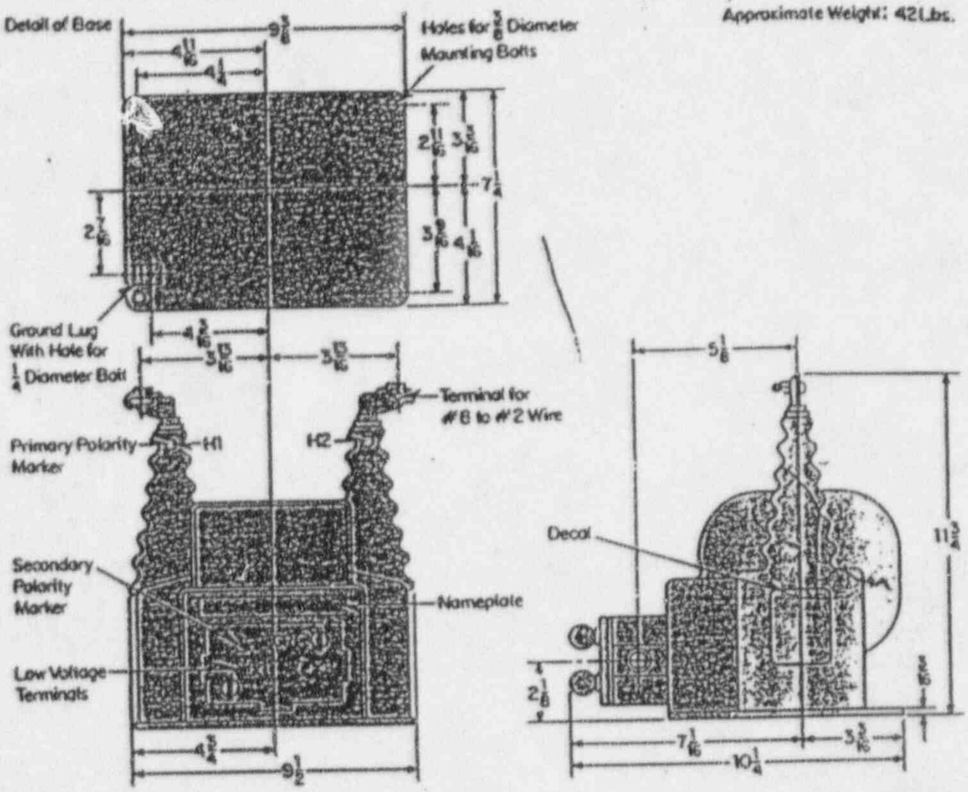
A ground terminal, located above the X_2 secondary terminal, is also provided for grounding the secondary circuit at the transformer.

Secondary Junction Box
The secondary box is an anodized aluminum casting and has three one-inch conduit hubs. It is anchored to the body of the transformer with screws, and can easily be detached, simplifying installation and changeout procedures.

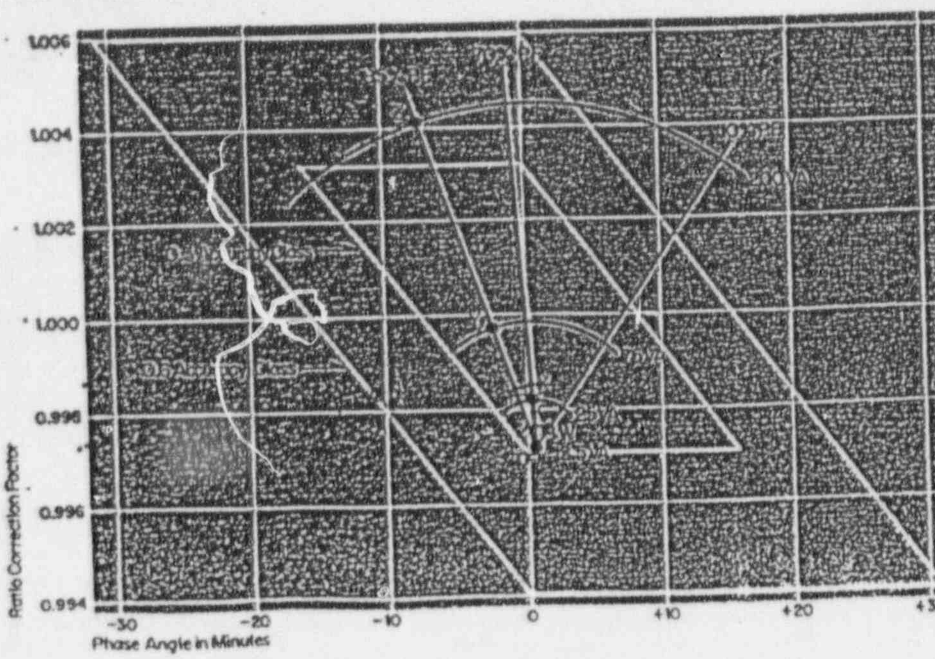
Identification
A stainless steel nameplate with all pertinent data is attached on the front of the unit, directly above the box. A large, easy to read vinyl decal for ratio identification is placed on each side.

Dimensions and Weights

Approximate Weight: 42 Lbs.



Performance Curve
Typical ratio correction factors and phase angle values plotted for standard burdens, using the Farber Method ("The Analytical and Graphical Determination of Complete Potential Transformer Characteristics" — Settles, Farber, Conner — AIEE Transaction Paper 60-1246, October, 1960).



**Attached Marked-Up
Technical Specification Page**

3.3 INSTRUMENTATION

3.3.8.1 Loss of Power (LOP) Instrumentation

LCO 3.3.8.1 The LOP instrumentation for each Function in Table 3.3.8.1-1 shall be OPERABLE.

APPLICABILITY: MODES 1, 2, and 3,
When the associated diesel generator (DG) is required to be OPERABLE by LCO 3.8.2, "AC Sources—Shutdown."

ACTIONS

------------------------------------NOTE------------------------------------
Separate Condition entry is allowed for each channel.

CONDITION	REQUIRED ACTION		COMPLETION TIME
A. One or more channels inoperable.	A.1	Place channel in trip.	1 hour
	<u>AND</u>		
	A.2	--------NOTE-------- Only applicable for Functions 1.c, 1.d, 1.e, 2.c, 2.d, and 2.e after Release for Operations (RFO) of the corresponding plant modification. -------------------- Restore channel to OPERABLE status.	7 days
B. Required Action and associated Completion Time not met.	B.1	Declare associated DG inoperable.	Immediately

SURVEILLANCE REQUIREMENTS

NOTES

1. Refer to Table 3.3.8.1-1 to determine which SRs apply for each LOP Function.

2. When a channel is placed in an inoperable status solely for performance of required Surveillances, entry into associated Conditions and Required Actions may be delayed for up to 2 hours provided the associated Function maintains DG initiation capability.

	SURVEILLANCE	FREQUENCY
SR 3.3.8.1.1	Deleted ~~Perform CHANNEL CHECK.~~	~~12 hours~~
SR 3.3.8.1.2	Perform CHANNEL FUNCTIONAL TEST.	31 days
SR 3.3.8.1.3	Perform CHANNEL CALIBRATION.	18 months
SR 3.3.8.1.4	Perform LOGIC SYSTEM FUNCTIONAL TEST.	18 months

Table 3.3.8.1-1 (page 1 of 1)
Loss of Power Instrumentation

FUNCTION	REQUIRED CHANNELS PER DIVISION	SURVEILLANCE REQUIREMENTS	ALLOWABLE VALUE
1. Divisions 1 and 2 - 4.16 kV Emergency Bus Undervoltage			
a. Loss of Voltage - 4.16 kV basis	6	SR 3.3.8.1.3 SR 3.3.8.1.4	≥ 2345 V and ≤ 3395 V
b. Loss of Voltage - Time Delay	6	SR 3.3.8.1.3 SR 3.3.8.1.4	≤ 10 seconds
c. Degraded Voltage Reset - 4.16 kV basis	***2***	***SR 3.3.8.1.2 SR 3.3.8.1.3 SR 3.3.8.1.4***	***≥ 3876 V and ≤ 3901 V (a)***
d ~~e.~~ ***Degraded Voltage Dropout - 4.16 kV basis***	***2***	~~SR 3.3.8.1.1~~ SR 3.3.8.1.2 SR 3.3.8.1.3 SR 3.3.8.1.4	≥ ***3848*** ~~3762~~ V and ≤ ***3876*** ~~3832~~ V ***(b)***
e ~~d.~~ Degraded Voltage - Time Delay	1	SR 3.3.8.1.2 SR 3.3.8.1.3 SR 3.3.8.1.4	≥ 14 seconds and ≤ 16 seconds
2. Divisions 3 - 4.16 kV Emergency Bus Undervoltage			
a. Loss of Voltage - 4.16 kV basis	4	SR 3.3.8.1.3 SR 3.3.8.1.4	≥ 2345 V and ≤ 2730 V
b. Loss of Voltage - Time Delay	1	SR 3.3.8.1.3 SR 3.3.8.1.4	≤ 3.0 seconds
c. Degraded Voltage Reset - 4.16 kV basis	***2***	***SR 3.3.8.1.2 SR 3.3.8.1.3 SR 3.3.8.1.4***	***≥ 3876 V and ≤ 3901 V (a)***
~~e.~~ ***Degraded Voltage Dropout - 4.16 kV basis***	***2*** ~~3~~ (***c*** ~~b~~)	~~SR 3.3.8.1.1~~ SR 3.3.8.1.2 SR 3.3.8.1.3 SR 3.3.8.1.4	≥ ***3848*** ~~3762~~ V and ≤ ***3876*** ~~3832~~ V ***(b)***
e ~~d.~~ Degraded Voltage - Time Delay	1	SR 3.3.8.1.2 SR 3.3.8.1.3 SR 3.3.8.1.4	≥ 14 seconds and ≤ 16 seconds

(a) This Function is to be used after RFO of the corresponding plant modification. Prior to RFO of the corresponding plant modification this Function is not applicable.

(b) This value is to be used after RFO of the corresponding plant modification. Prior to RFO of the corresponding plant modification the Degraded Voltage Dropout - 4.16 kV basis Allowable Value shall be ≥ 3762 V and ≤ 3832 V.

(c) This value is to be used after RFO of the corresponding plant modification. Prior to RFO of the corresponding plant modification the Degraded Voltage Dropout - 4.16 kV basis Required Channels Per Division shall be 3.

ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
G. Three or more required AC sources inoperable.	G.1 Enter LCO 3.0.3.	Immediately

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
SR 3.8.1.1	Verify correct breaker alignment and indicated power availability for each offsite circuit.	7 days
SR 3.8.1.2	-------------------NOTES------------------ 1. Performance of SR 3.8.1.7 satisfies this SR. 2. All DG starts may be preceded by an engine prelube period and followed by a warmup period prior to loading. 3. A modified DG start involving idling and gradual acceleration to synchronous speed may be used for this SR as recommended by the manufacturer. When modified start procedures are not used, the time, voltage, and frequency tolerances of SR 3.8.1.7 must be met. -- Verify each DG starts from standby conditions and achieves steady state voltage ≥ ~~3740~~ 3870 V and ≤ 4580 V and frequency ≥ 58.8 Hz and ≤ 61.2 Hz.	As specified in Table 3.8.1-1

(continued)

SURVEILLANCE REQUIREMENTS (continued)

	SURVEILLANCE	FREQUENCY
SR 3.8.1.7	------------------NOTE------------------ All DG starts may be preceded by an engine prelube period. -- Verify each DG starts from standby condition and achieves, in ≤ 12 seconds, voltage ≥ ~~3740~~ 3870 V and ≤ 4580 V and frequency ≥ 58.8 Hz and ≤ 61.2 Hz.	184 days
SR 3.8.1.8	------------------NOTE------------------ This Surveillance shall not be performed in MODE 1 or 2. However, credit may be taken for unplanned events that satisfy this SR. -- Verify automatic and manual transfer of unit power supply from the normal offsite circuit to the alternate offsite circuit.	18 months
SR 3.8.1.9	------------------NOTES------------------ 1. This Surveillance shall not be performed in MODE 1 or 2. However, credit may be taken for unplanned events that satisfy this SR. 2. If performed with DG synchronized with offsite power, it shall be performed at a power factor ≤ 0.9. -- Verify each DG rejects a load greater than or equal to its associated single largest post accident load and following load rejection, the engine speed is maintained less than nominal plus 75% of the difference between nominal speed and the overspeed trip setpoint or 15% above nominal, whichever is lower.	18 months

(continued)

SURVEILLANCE REQUIREMENTS (continued)

SURVEILLANCE		FREQUENCY
SR 3.8.1.11	------------------NOTES------------------ 1. All DG starts may be preceded by an engine prelube period. 2. This Surveillance shall not be performed in MODE 1, 2, or 3. However, credit may be taken for unplanned events that satisfy this SR. --- Verify on an actual or simulated loss of offsite power signal: a. De-energization of emergency buses; b. Load shedding from emergency buses for Divisions 1 and 2; and c. DG auto-starts from standby condition and: 1. energizes permanently connected loads in ≤ 12 seconds, 2. energizes auto-connected shutdown loads, 3. maintains steady state voltage ≥ ~~3740~~ 3870 V and ≤ 4580 V, 4. maintains steady state frequency ≥ 58.8 Hz and ≤ 61.2 Hz, and 5. supplies permanently connected and auto-connected shutdown loads for ≥ 5 minutes.	18 months

(continued)

SURVEILLANCE REQUIREMENTS (continued)

SURVEILLANCE	FREQUENCY
SR 3.8.1.12 ------------------NOTES------------------ 1. All DG starts may be preceded by an engine prelube period. 2. This Surveillance shall not be performed in MODE 1 or 2. However, credit may be taken for unplanned events that satisfy this SR. --- Verify on an actual or simulated Emergency Core Cooling System (ECCS) initiation signal each DG auto-starts from standby condition and: a. In ≤ 12 seconds after auto-start and during tests, achieves voltage ≥ ~~3740~~ 3870 V and ≤ 4580 V; b. In ≤ 12 seconds after auto-start and during tests, achieves frequency ≥ 58.8 Hz and ≤ 61.2 Hz; and c. Operates for ≥ 5 minutes.	18 months
SR 3.8.1.13 ------------------NOTE------------------ This Surveillance shall not be performed in MODE 1, 2, or 3. However, credit may be taken for unplanned events that satisfy this SR. --- Verify each DG's automatic trips are bypassed on an actual or simulated ECCS initiation signal except: a. Engine overspeed; b. Generator differential current; and c. Overcrank for DG 1A and DG 1B.	18 months

(continued)

SURVEILLANCE REQUIREMENTS (continued)

SURVEILLANCE		FREQUENCY
SR 3.8.1.14	-------------------NOTES------------------ 1. Momentary transients outside the load and power factor ranges do not invalidate this test. 2. This Surveillance shall not be performed in MODE 1 or 2. However, credit may be taken for unplanned events that satisfy this SR. -- Verify each DG operating at a power factor ≤ 0.9 operates for ≥ 24 hours: a. For ≥ 2 hours loaded ≥ 4256 kW for DG 1A, ≥ 4263 kW for DG 1B, and ≥ 2420 kW for DG 1C; and b. For the remaining hours of the test loaded ≥ 3869 kW for DG 1A, ≥ 3875 kW for DG 1B, and ≥ 2200 kW for DG 1C.	18 months
SR 3.8.1.15	-------------------NOTES------------------ 1. This Surveillance shall be performed within 5 minutes of shutting down the DG after the DG has operated ≥ 1 hour loaded ≥ 3869 kW for DG 1A, ≥ 3875 kW for DG 1B, and ≥ 2200 kW for DG 1C. Momentary transients outside of the load range do not invalidate this test. 2. All DG starts may be preceded by an engine prelube period. -- 3870 Verify each DG starts and achieves, in ≤ 12 seconds, voltage ≥ ~~3740~~ V and ≤ 4580 V and frequency ≥ 58.8 Hz and ≤ 61.2 Hz.	18 months

(continued)

SURVEILLANCE REQUIREMENTS (continued)

	SURVEILLANCE	FREQUENCY
SR 3.8.1.19	-------------------NOTES------------------- 1. All DG starts may be preceded by an engine prelube period. 2. This Surveillance shall not be performed in MODE 1, 2, or 3. However, credit may be taken for unplanned events that satisfy this SR. ---	
	Verify, on an actual or simulated loss of offsite power signal in conjunction with an actual or simulated ECCS initiation signal: a. De-energization of emergency buses; b. Load shedding from emergency buses for Divisions 1 and 2; and c. DG auto-starts from standby condition and: 1. energizes permanently connected loads in ≤ 12 seconds, 2. energizes auto-connected emergency loads, 3. achieves steady state voltage ≥ ~~3740~~ 3870 V and ≤ 4580 V, 4. achieves steady state frequency ≥ 58.8 Hz and ≤ 61.2 Hz, and 5. supplies permanently connected and auto-connected emergency loads for ≥ 5 minutes.	18 months

(continued)

SURVEILLANCE REQUIREMENTS (continued)

SURVEILLANCE		FREQUENCY
SR 3.8.1.20	-------------------NOTE------------------- All DG starts may be preceded by an engine prelube period. -- Verify, when started simultaneously from standby condition, each DG achieves, in ≤ 12 seconds, voltage ≥ ~~3740~~ 3870 V and ≤ 4580 V and frequency ≥ 58.8 Hz and ≤ 61.2 Hz.	10 years

Attached Marked-Up
Pages of the Technical Specification Bases

B 3.3 INSTRUMENTATION

B 3.3.8.1 Loss of Power (LOP) Instrumentation

BASES

BACKGROUND

Successful operation of the required safety functions of the Emergency Core Cooling Systems (ECCS) is dependent upon the availability of adequate power sources for energizing the various components such as pump motors, motor operated valves, and the associated control components. The LOP instrumentation monitors the 4.16 kV emergency buses. Offsite power is the preferred source of power for the 4.16 kV emergency buses. If the monitors determine that insufficient power is available, the buses are disconnected from the offsite power sources and connected to the onsite diesel generator (DG) power sources.

Each 4.16 kV emergency bus has its own independent LOP instrumentation and associated trip logic. The voltage for the Division 1, 2, and 3 buses is monitored at two levels, which can be considered as two different undervoltage functions: loss of voltage and degraded voltage.

The LOP instrumentation causes various bus transfers and disconnects. Each Division 1 and 2 emergency bus Loss of Voltage Function is monitored by two undervoltage relays on the emergency bus and two undervoltage relays on each of the two offsite power sources. The outputs of these relays are arranged in a two-out-of-two taken three times logic configuration. Each of these relays is an inverse time delay relay. Each Division 1 and Division 2 emergency bus Degraded Voltage Function is monitored by two undervoltage relays for each emergency bus whose outputs are arranged in a two-out-of-two logic configuration. The output of this logic inputs to a time delay relay (Ref. 1). The Division 3 emergency bus Loss of Voltage Function is monitored by

(continued)

Each Division 1, Division 2, and Division 3 emergency bus Degraded Voltage Function is monitored by two undervoltage relays for each emergency bus whose outputs are arranged in a two-out-of-two logic configuration. The output of this logic inputs to a time delay relay (Ref. 1).

BASES

BACKGROUND (continued)

four undervoltage relays whose outputs are arranged in a one-out-of-two taken twice logic configuration. The output of this logic inputs to a time delay relay. The Division 3 emergency bus Degraded Voltage Function is monitored by one undervoltage relay with three output contacts arranged in a three-out-of-three logic configuration. The output of this logic inputs to a time delay relay.

INSERT

APPLICABLE SAFETY ANALYSES, LCO, and APPLICABILITY

The LOP instrumentation is required for the Engineered Safety Features to function in any accident with a loss of offsite power. The required channels of LOP instrumentation ensure that the ECCS and other assumed systems powered from the DGs provide plant protection in the event of any of the analyzed accidents in References 2, 3, and 4 in which a loss of offsite power is assumed. The initiation of the DGs on loss of offsite power, and subsequent initiation of the ECCS, ensure that the fuel peak cladding temperature remains below the limits of 10 CFR 50.46.

Accident analyses credit the loading of the DG based on the loss of offsite power during a loss of coolant accident (LOCA). The diesel starting and loading times have been included in the delay time associated with each safety system component requiring DG supplied power following a loss of offsite power.

The LOP instrumentation satisfies Criterion 3 of the NRC Policy Statement.

The OPERABILITY of the LOP instrumentation is dependent upon the OPERABILITY of the individual instrumentation channel Functions specified in Table 3.3.8.1-1. Each Function must have a required number of OPERABLE channels per 4.16 kV emergency bus, with their setpoints within the specified Allowable Values. A channel is inoperable if its actual trip setpoint is not within its required Allowable Value. The actual setpoint is calibrated consistent with applicable setpoint methodology assumptions.

The Allowable Values are specified for each Function in the Table. Nominal trip setpoints are specified in the setpoint calculations. The nominal setpoints are selected to ensure that the setpoint does not exceed the Allowable Value between CHANNEL CALIBRATIONS. Operation with a trip setpoint less conservative than the nominal trip setpoint,

(continued)

INSERT for TS Bases at page B 3.3-223

Prior to Release for Operations (RFO) of the associated plant modification (i.e., modification AP-027 for Division 1 or AP-028 for Division 2), each Division 1 and Division 2 emergency bus Degraded Voltage Function is monitored by two undervoltage relays for each emergency bus whose outputs are arranged in a two-out-of-two logic configuration. The output of this logic inputs to a time delay relay for each emergency bus (Ref. 1). Prior to RFO of modification AP-029, the Division 3 emergency bus Degraded Voltage Function is monitored by one undervoltage relay with three output contacts arranged in a three-out-of-three logic configuration. The output of this logic inputs to a time delay relay. Following RFO of the associated plant modification, each Division 1, Division 2, and Division 3 emergency bus Degraded Voltage Function is monitored by two undervoltage relays for each emergency bus whose outputs are arranged in a two-out-of-two logic configuration. The output of this logic inputs to a time delay relay for each emergency bus.

BASES

APPLICABLE SAFETY ANALYSES, LCO, and APPLICABILITY

1.a, 1.b, 2.a, 2.b. 4.16 kV Emergency Bus Undervoltage (Loss of Voltage) (continued)

required equipment. The time delay specified for the Divisions 1 and 2 4.16 kV Emergency Bus Loss of Voltage Functions corresponds to a voltage at the 120-volt Basis trip setpoint of ≥ 67 volts and ≤ 97 volts. Lower voltage conditions will result in decreased trip times. The Division 3 4.16 kV Emergency Bus Loss of Voltage Function 120-volt Basis trip setpoint is ≥ 67 volts and ≤ 78 volts.

Six channels of 4.16 kV Emergency Bus Undervoltage (Loss of Voltage) Function per associated emergency bus for Divisions 1 and 2 and four channels for Division 3 are only required to be OPERABLE when the associated DG is required to be OPERABLE to ensure that no single instrument failure can preclude the DG function. (Six channels input to each of the Division 1 and Division 2 DGs and four channels input to the Division 3 DG. Each of the six channels for Division 1 and six channels for Division 2 is an inverse time delay relay. Each of these time delays are considered to be separate channels. For Division 3, the Loss of Voltage Function logic inputs to a single time delay relay. Thus, only one time delay channel is associated with Division 3.) Refer to LCO 3.8.1, "AC Sources—Operating," and LCO 3.8.2, "AC Sources—Shutdown," for Applicability Bases for the DGs.

1.c, 1.d, (1.e,) 2.c, 2.d, (2.e, 3.A) 4.16 kV Emergency Bus Undervoltage (Degraded Voltage)

A reduced voltage condition on a 4.16 kV emergency bus indicates that while offsite power may not be completely lost to the respective emergency bus, power may be insufficient for starting large motors without risking damage to the motors that could disable the ECCS function. Therefore, power supply to the bus is transferred from offsite power to onsite DG power when the voltage on the bus drops below the Degraded Voltage Function Allowable Values (degraded voltage with a time delay). This ensures that adequate power will be available to the required equipment.

The Bus Undervoltage Allowable Values are low enough to prevent inadvertent power supply transfer, but high enough to ensure that sufficient power is available to the required equipment. INSERT ~~The Allowable Values have a 120 volt Basis of ≥ 107.5 volts and ≤ 109.5 volts.~~ The Time Delay Allowable

(continued)

INSERT for TS Bases at page B 3.3-225

As stated above, the purpose of this instrumentation is to ensure that sufficient power will be available to support the ECCS function during a LOCA. During a LOCA, the ECCS and other safety systems will be initiated at the start of the event. This large loading of the safety buses results in a voltage transient of sufficient magnitude to start the degraded voltage timers. If the degraded voltage relays do not reset, which requires the voltage to be restored to a level above the relay reset setpoint, the bus undervoltage time delay relays will trip, resulting in bus transfer to the DGs. Thus, the relay reset (pick-up) setpoint must be high enough to ensure adequate voltage for the safety-related loads.

Prior to RFO of the corresponding plant modification (i.e., modification AP-027 for Division 1, AP-028 for Division 2, or AP-29 for Division 3), the Degraded Voltage Function Allowable Value specified is the allowable value for the relay dropout ~~setpoint~~. ~~The Allowable Value has a 120-volt basis of ≥ 107.5 volts and ≤109.5 volts (Ref. 5).~~ Following RFO of the corresponding plant modification, the Degraded Voltage Function Allowable Values specified are ~~is the~~ for the relay dropout and the relay reset ~~setpoint~~. Because the dropout and reset settings are not independently adjustable for the relays utilized for the Degraded Voltage instrumentation prior to RFO of the associated modification, only the dropout setting is applicable as explained in Table 3.3.3-1 by footnote (a). ~~The Allowable Value has a 120-volt basis of ≥111.08 volts and ≤111.82 as specified in IP Calculation 19-AN-19 (Ref. 5).~~

The Allowable Values to be used after RFO are as determined within IP Calculation 19-AN-19 (Ref. 5). The basis for the reset Allowable Value upper limit is the avoidance of shifting to the onsite source when the offsite source is acceptable as specified within GDC 17. The basis for the reset Allowable Value lower limit is the minimum voltage required to support the LOCA loads. The basis for the dropout Allowable Value upper limit is the practical limit of the reset Allowable Value lower limit. The basis for the dropout Allowable Value lower limit ensures adequate voltage to start plant equipment under non-LOCA loading conditions. Because of the voltage transient experienced at the start of a LOCA, the specified Degraded Voltage drop-out Allowable Value lower limit provides significant margin to the setting required to mitigate a LOCA. This value was selected based on other licensing basis events descussed in USAR, Section 8.3.1.1.2 (Ref. 1) and calculated in IP Calculation 19-AN-19.

BASES

APPLICABLE SAFETY ANALYSES, LCO, and APPLICABILITY

1.c, 1.d, 1.e, 2.c, 2.d, 2.e, 4.16 kV Emergency Bus Undervoltage (Degraded Voltage) (continued)

Values are long enough to provide time for the offsite power supply to recover to normal voltages, but short enough to ensure that sufficient power is available to the required equipment.

INSERT A

Two channels of 4.16 kV Emergency Bus Undervoltage (Degraded Voltage) Function per associated emergency bus for Divisions 1, ~~and~~ 2 and ~~three channels for Division~~ 3 are only required to be OPERABLE when the associated DG is required to be OPERABLE to ensure that no single instrument failure can preclude the DG function. (Two channels input to each of the Division 1, ~~and Division~~ 2, ~~DGs~~ and ~~three channels input to the Division~~ 3 DGs.) The Degraded Voltage Function logic for each Division inputs to a single time delay relay. Thus, only one time delay channel is associated with each Division.) Refer to LCO 3.8.1 and LCO 3.8.2 for Applicability Bases for the DGs.

INSERT B

INSERT C

ACTIONS

A Note has been provided to modify the ACTIONS related to LOP instrumentation channels. Section 1.3, Completion Times, specifies that once a Condition has been entered, subsequent divisions, subsystems, components, or variables expressed in the Condition discovered to be inoperable or not within limits will not result in separate entry into the Condition. Section 1.3 also specifies that Required Actions of the Condition continue to apply for each additional failure, with Completion Times based on initial entry into the Condition. However, the Required Actions for inoperable LOP instrumentation channels provide appropriate compensatory measures for separate inoperable channels. As such, a Note has been provided that allows separate Condition entry for each inoperable LOP instrumentation channel.

A.1 and A.2

With one or more channels of a Function inoperable, the Function may not be capable of performing the intended function. Therefore, only 1 hour is allowed to restore the

(continued)

INSERT **A** for TS Bases at page B 3.3-226

(except 3 channels ~~are required~~ for Division 3 prior to RFO of modification AP-029)

INSERT **B** for TS Bases at page B 3.3-226

(except that 3 channels input to the Division 3 DG prior to RFO of modification AP-029)

INSERT **C** for TS Bases at page B 3.3-226

Footnotes (a), ~~and~~ (b), and (c) to Table 3.3.8.1-1 identify~~explain~~ that the TS changes are not effective until~~upon~~ RFO of the corresponding plant modification. The planned modifications are: AP-027 for Division 1, AP-028 for Division 2, and AP-029 for Division 3.

BASES

ACTIONS

A.1 and A.2 (continued)

For Loss of Voltage Functions

inoperable channel to OPERABLE status. If the inoperable channel cannot be restored to OPERABLE status within the allowable out of service time, the channel must be placed in the tripped condition per Required Action A.1. Placing the inoperable channel in trip would conservatively compensate for the inoperability and allow operation to continue. ← INSERT A ¶ Thus, ~~Alternately,~~ if it is not desired to place the channel in trip (e.g., as in the case where placing the channel in trip would result in a DG initiation), Condition B must be entered and its Required Action taken. INSERT B

The Completion Time is intended to allow the operator time to evaluate and repair any discovered inoperabilities. The ~~1 hour~~ Completion Times ~~is~~ are acceptable because ~~it~~ they minimize ~~s~~ risk while allowing time for restoration or tripping of channels.

← INSERT C

B.1

If any Required Action and associated Completion Time is not met, the associated Function may not be capable of performing the intended function. Therefore, the associated DG(s) are declared inoperable immediately. This requires entry into applicable Conditions and Required Actions of LCO 3.8.1 and LCO 3.8.2, which provide appropriate actions for the inoperable DG(s).

SURVEILLANCE REQUIREMENTS

As noted at the beginning of the SRs, the SRs for each LOP Instrumentation Function are located in the SRs column of Table 3.3.8.1-1.

The Surveillances are modified by a Note to indicate that when a channel is placed in an inoperable status solely for performance of required Surveillances, entry into associated Conditions and Required Actions may be delayed for up to 6 hours provided the associated Function maintains DG initiation capability. Upon completion of the Surveillance, or expiration of the 6 hour allowance, the channel must be returned to OPERABLE status or the applicable Condition entered and Required Actions taken.

(continued)

INSERT **A** for TS Bases at page B 3.3-227

However, for Degraded Voltage Functions, placing the inoperable channel in trip may not conservatively compensate for the inoperability. Because of the assumptions used in the setpoint calculations, the setpoint for the remaining OPERABLE channel(s) may not ensure reset of the relay within the required voltage range. As a result, operation with an inoperable Degraded Voltage channel(s) in trip is limited to 7 days.

INSERT **B** for TS Bases at page B 3.3-227

or if the inoperable channel(s) is not restored to operable status within the allowable out of service time

INSERT **C** for TS Bases at page B 3.3-227

Required Action A.2 is modified by a Note which states that the Required Action is only applicable for Functions 1.c, 1.d, 1.e, 2.c, ~~and~~ 2.d, and 2.e following RFO of the corresponding plant modification (i.e., modification AP-027, AP-028, or AP-029). The 7-day limitation is imposed as a result of assumptions associated with the setpoint calculations for the modified Degraded Voltage Function instrumentation.

BASES

SURVEILLANCE REQUIREMENTS (continued)

SR 3.3.8.1.1 *This SR has been deleted*

~~Performance of the CHANNEL CHECK once every 12 hours ensures that a gross failure of instrumentation has not occurred. A CHANNEL CHECK is normally a comparison of the parameter indicated on one channel to a similar parameter on other channels. It is based on the assumption that instrument channels monitoring the same parameter should read approximately the same value. Significant deviations between the instrument channels could be an indication of excessive instrument drift in one of the channels or something even more serious. A CHANNEL CHECK will detect gross channel failure; thus, it is key to verifying the instrumentation continues to operate properly between each CHANNEL CALIBRATION.~~

~~Agreement criteria are determined by the plant staff based on a combination of the channel instrument uncertainties, including indication and readability. If a channel is outside the criteria, it may be an indication that the instrument has drifted outside its limit.~~

~~The Frequency is based on operating experience that demonstrates channel failure is rare. The CHANNEL CHECK supplements less formal, but more frequent, checks of channels during normal operational use of the displays associated with the required channels of the LCO.~~

SR 3.3.8.1.2

A CHANNEL FUNCTIONAL TEST is performed on each required channel to ensure that the entire channel will perform the intended function. For Series Functions, a separate CHANNEL FUNCTIONAL TEST is not required for each Function, provided each Function is tested.

Any setpoint adjustment shall be consistent with the assumptions of the current plant specific setpoint methodology.

The Frequency of 31 days is based on plant operating experience with regard to channel OPERABILITY that demonstrates that failure in any 31 day interval is rare.

(continued)

BASES

SURVEILLANCE REQUIREMENTS (continued)

SR 3.3.8.1.3

A CHANNEL CALIBRATION is a complete check of the instrument loop and the sensor. This test verifies the channel responds to the measured parameter within the necessary range and accuracy. CHANNEL CALIBRATION leaves the channel adjusted to account for instrument drifts between successive calibrations consistent with the plant specific setpoint methodology.

The Frequency is based on the assumption of the magnitude of equipment drift in the setpoint analysis.

SR 3.3.8.1.4

The LOGIC SYSTEM FUNCTIONAL TEST demonstrates the OPERABILITY of the required actuation logic for a specific channel. The system functional testing performed in LCO 3.8.1 and LCO 3.8.2 overlaps this Surveillance to provide complete testing of the assumed safety functions.

The 18 month Frequency is based on the need to perform this Surveillance under the conditions that apply during a plant outage and the potential for an unplanned transient if the Surveillance were performed with the reactor at power. Operating experience has shown these components usually pass the Surveillance when performed at the 18 month Frequency.

REFERENCES

1. USAR, Section 8.3.1.1.2.
2. USAR, Section 5.2.2.
3. USAR, Section 6.3.3.
4. USAR, Chapter 15.
5. IP Calculation 19-AN-19

BASES (continued)

SURVEILLANCE REQUIREMENTS

The AC sources are designed to permit inspection and testing of all important areas and features, especially those that have a standby function, in accordance with 10 CFR 50, GDC 18 (Ref. 8). Periodic component tests are supplemented by extensive functional tests during refueling outages under simulated accident conditions. The SRs for demonstrating the OPERABILITY of the DGs are in accordance with the recommendations of Regulatory Guide 1.9 (Ref. 3), Regulatory Guide 1.108 (Ref. 9), and Regulatory Guide 1.137 (Ref. 10).

Where the SRs discussed herein specify voltage and frequency tolerances, the minimum and maximum steady state output voltages of ~~3740~~ 3870 V and 4580 V respectively, are equal to ~~±~~ -7% and + 10% of the nominal 4160 V output voltage. The specified minimum and maximum frequencies of the DG is 58.8 Hz and 61.2 Hz, respectively, are equal to ± 2% of the 60 Hz nominal frequency. The specified steady state voltage and frequency ranges are derived from the recommendations given in Regulatory Guide 1.9 (Ref. 3). However, the minimum voltage was increased to ensure adequate voltage to operate all safety-related loads during a DBA (Ref 14).

SR 3.8.1.1

This SR ensures proper circuit continuity for the offsite AC electrical power supply to the onsite distribution network and availability of offsite AC electrical power. The breaker alignment verifies that each breaker is in its correct position to ensure that distribution buses and loads are connected to their preferred power source and that appropriate independence of offsite circuits is maintained. The 7 day Frequency is adequate since breaker position is not likely to change without the operator being aware of it and because its status is displayed in the control room.

SR 3.8.1.2 and SR 3.8.1.7

These SRs help to ensure the availability of the standby electrical power supply to mitigate DBAs and transients and maintain the unit in a safe shutdown condition.

(continued)

BASES

SURVEILLANCE REQUIREMENTS

Diesel Generator Test Schedule (continued)

A test interval in excess of 7 days (or 31 days, as appropriate) constitutes a failure to meet SRs and results in the associated DG being declared inoperable. It does not, however, constitute a valid test or failure of the DG, and any consecutive test count is not reset.

REFERENCES

1. 10 CFR 50, Appendix A, GDC 17.
2. USAR, Chapter 8.
3. Regulatory Guide 1.9.
4. USAR, Chapter 6.
5. USAR, Chapter 15.
6. Regulatory Guide 1.93.
7. Generic Letter 84-15, July 2, 1984.
8. 10 CFR 50, Appendix A, GDC 18.
9. Regulatory Guide 1.108.
10. Regulatory Guide 1.137.
11. ANSI C84.1, 1982.
12. NUMARC 87-00, Revision 1, August 1991.
13. IEEE Standard 308.
14. IP Calculation 19-AN-19

IP Calculation 19-AN-19
(Revision 2, Volume E)