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Measurement Capabilities of the

DOE Contractors' Standards Laboratories

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Abstract

This report list the measurement capabilities of the Department of Energy Contractors' Standard Laboratories within the Nuclear Weapon Complex. It is intended to foster cross-utilization of measurements between laboratories and provides a guide for survey and audit activities. Although this report was prepared by Sandia Primary Standards Laboratory (PSL), the PSL was intentionally omitted. Capabilities of the PSL are documented in SAND88-3402. UC-700.

MASTER

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Introduction.

This report is organized by discipline, then in alphabetical order within in that discipline. Information for Los Alamos National Laboratory, Lawrence Livermore Laboratory and EG&G REECO was not available at time of printing.

The following is a list of DOE Contract Laboratories within the DOE Nuclear Weapons Complex that are included in this report.

Allied Signal Aero-Space Co.
Kansas City Division
PO Box 419159
Kansas City, MO 64141-6159

EG&G Energy Measurement, Inc.
PO Box 1912
Las Vegas, NV 89125

EG&G Mound Applied Technologies, Inc.
Bldg 93
PC Box 32
Miamisburg, OH 45342

EG&G Rocky Flats, Inc.
Rocky Flats Plant
PO Box 464
Golden, CO 80401

General Electric Company
Neutron Device Department
PO Box 2903, MS-037
Largo, FL 34649

Martin Marietta Energy Systems, Inc.
PO Box Y
Oak Ridge, TN 37832

Mason & Hangar-Silas Mason Co.
PO Box 30020
Amarillo, TX 79177

EG&G Rocky Flats Inc.
Rocky Flats Plant
PO Box 464
Golden, CO 80401

Sandia National Laboratory Albuquerque
Division 7414
PO Box 5800, Albuquerque NM 87185

Sandia National Laboratory Livermore
Division 8285
Livermore, CA 94550

Westinghouse Savannah River Co.
PO Box 1970
Richland, WA 99352

Contents

Definitions/Abbreviations.....	1
Physical Standards.....	2
Acceleration.....	3
Acceleration, Linear.....	4
Angle.....	5
Diameters, Internal.....	6
Density/Specific Gravity.....	7
Flow and Viscosity.....	8
Force.....	9
Humidity.....	11
Leak Rate.....	12
Length and Coordinate Measurements.....	13
Length, Gage Blocks.....	15
Mass.....	17
Pressure.....	19
Roundness.....	21
Shock.....	22
Surface, Optical Flatness.....	23
Surface Plate Flatness.....	24
Surface Roughness.....	25
Temperature.....	26
Thread Lead and Helix.....	28
Threadwires.....	29
Torque.....	30
Volume.....	31
Electrical Quantities, dc.....	32
Direct Current and Voltage.....	33
DC Resistance.....	36
Electrical Quantities, ac.....	39
Alternating Current and Voltage.....	40
Capacitance.....	43
Frequency.....	44
Inductance.....	45
Time of Day.....	46

Electrical Quantities, Pulse.....	47
High Voltage Pulse.....	48
Electrical Quantities, Microwave.....	49
Attenuation.....	50
RF Power.....	51
VSWR/Reflection Coefficient.....	52
Radiation Quantities.....	53
Laser Power.....	54
Power, LED.....	55
Power, Solar.....	55
Power, Ultraviolet.....	55
Radiation.....	56
X-Ray Film Density.....	57
Optical Spectral Response.....	58
Photometric.....	58
Magnetics.....	59
Magnets, Reference.....	60
DC Magnetic Field Density.....	60
Sound.....	61
Sound Level.....	62
Chemistry Quantities.....	63
Chemistry Standards.....	64
NDA Standards.....	65
PH.....	65
Specific Resistance.....	66
Fabricated Standards.....	66

Definitions/Abbreviations

A - ampere
AA - arithmetic average
AC - alternating current
°C - celsius
cc - cubic centimeter
cm - centimeter
dB - decibel
DC - direct current
dia - diameter
d point - dew point
°F - Fahrenheit t
F - farad
f - femto
FPM - feet per minute
f point - frost point
FS - full scale
ft - feet
G - giga
g - gram
GHz - gigahertz
GPM - gallons per minute
H - henry
Hg - mercury
Hz - hertz
in - inch
kg - kilograms
kHz - kilohertz
L - liter
lb - pound
lbf - foot pound
m - meter
mg - milligram
MHz - megahertz
min - minute
mm - millimeter
MPa - megapascal
ms - millisecond

N - newton
n - nano
nm - nanometer
oz - ounce
P - poise
p - pico
ppm - parts per million
psi - pounds per square inch
psia - pounds per square inch absolute
psig - pounds per square inch gage
RDG - reading
RH - relative humidity
s - second
sec - second
SCCS - standard cubic centimeter per second
SCFH - standard cubic feet per hour
SCFM - standard cubic feet per minute
sq - square
TPI - threads per inch
V - volt
W - watt
μ - micro
Ω - ohm
° - degree
GENE - General Electric Neutron Division
SNL - Sandia National Laboratories
Y-12 - Martin Marietta Energy Systems Inc.
EG&G Las Vegas - EG&G Energy Measurements

Physical Standards

Acceleration

Laboratory	Range	Measuring Accuracy ($\pm$)
Allied Signal	5 - 500 m/sec ² (75°F) 10 Hz - 10 kHz	2.5%
	5 - 400 m/sec ² (-100 - +350°F) 100 Hz - 3 kHz	3.0%
EG&G LasVegas	To 500 m/sec ² 10 Hz - 10 kHz	2.5%
GENE	100 m/sec ² peak, nominal (>30 Hz) 10 Hz - 10 kHz	5.0%
Mound	100 m/sec ² 10 Hz - 10 kHz	5.0%
Pantex	100 m/sec ² 10 Hz - 10 kHz	10%
SNL Albuquerque	100 m/sec ² peak, nominal (-40 - +150°F) 10 Hz - 10 kHz 6-in stroke 0.2 - 50 Hz	4.0% 5.0%
Y-12	To 10 m/sec ² 10 Hz - 3 kHz	2.0 - 4.0%

Acceleration, Linear

Laboratory	Range	Measuring Accuracy ($\pm$)
EG&G Las Vegas	100 - 20 000 m/sec ²	2.0%
	-10 - +10 m/sec ²	0.1%
SNL Albuquerque	10 - 50 000 m/sec ²	0.3%

Angle

Laboratory	Range	Measuring Accuracy ($\pm$)
Allied Signal	0° - 360°	1 s of arc
EG&G Las Vegas	1 s - 45°	$\pm$ 0.7 s of arc
GEND	0° - 360°	5 s of arc
Mound	0° - 360°	1 s of arc
Pantex	0° - 360°	1 s of arc
Rocky Flats	0.2 s - 360°	0.1 to 4 s of arc
Savannah River	0° - 360°	30 s
SNL Albuquerque	0° - 360°	1.5 s of arc
SNL Livermore	1 arc s - 45°	2 s of arc
Y-12	0° - 360°	0.5 s of arc

* s = second

Diameters, Internal

Laboratory	Range	Measuring Accuracy ($\pm$)
Allied Signal	0.20 - 15 in.	1 ppm + 10 μ in.
EG&G Las Vegas	0.2 - 8 in.	40 μ in. to 80 μ in.
GEND	To 0.2 in. 0.2 - 8.0 in.	40 μ in. 10 μ in.
Mound	0.017 - 11 in.	10 μ in. + 2 μ in./in.
Pantex	To 1 in. 1 - 4 in. 4 - 10 in.	15 μ in. 40 μ in. 75 μ in.
Rocky Flats	.01 - 12 in.	20 μ in. - 40 μ in.
Savannah River	0.04 - 1 in. 1 - 12 in.	15 μ in. 25 μ in.
SNL Albuquerque	0 - 6 in.	1 μ in. + 2 μ in./in.
Y-12	To 48 in.	15 μ in. + 5 μ in./in.

Density/Specific Gravity

Laboratory	Range	Measuring Accuracy ($\pm$)
Allied Signal	Specific gravity: 1.190 - 1.260	0.005 mg/cm ³
GEND	Specific gravity: 1.050 - 1.500	0.005 mg/cm ³
Rocky Flats	Density measurement of liquids: 0.7 - 20.0 g/cm ³ Density measurement of solids: 1.7 - 20 g/cm ³	0.6 mg/cm ³ 5.0 mg/cm ³ - 15 mg/cm ³
Y-12	Density measurement of liquids: 0.760 - 2.0 g/cm ³ Density measurement of solids: 1.6 (or greater) g/cm ³	0.0005 g/cm ³ varies with material porosity, etc.

Flow and Viscosity

Laboratory	Range	Measuring Accuracy ($\pm$)
Allied Signal	Viscosity: 0.2 - 1900 P	0.2% - 0.5%
	Gas flow: 0.01 - 0.2 SCCS 0.2 - 40 SCCS 16 - 1380 SCFH	10% 2.0% 2.0%
Mound	Air velocity: 30 - 500 SCFM Gas Flow: To 50 SCFH	10% RDG 5.0%
Rocky Flats	Gas Flow: 0.002 - 125 SCFM Liquid Flow: 0 - 8 GPM	1.5 - 4.0% of reading 4.0%
SNL Albuquerque	Gas flow: 0.1 SCCM - 30 SCFM (inert gas) 0.5 - 10 SCFM (air)	0.5% 0.8%
SNL Livermore	1 - 50 L/min	0.2%
Y-12	Gas Flow: 2.5 - 24 000 SCCM 0.8 - 40 SCFM 200 - 3000 FPM Liquid Flow: 25 - 250 gal/min	0.4% 1.0% 2.0% + 50 FPM 0.8%

*P = Poise

Force

Laboratory	Range	Measuring Accuracy ($\pm$)
Allied Signal	0.0625 - 5 lbf	0.1% of reading
	5 - 300 lbf	0.005% of reading
	300 - 2400 lbf	.01% of reading
	2400 - 3000 lbf (compression/tension)	0.375 lbf
	3000 - 5000 lbf	0.625 lbf
	5000 - 10 000 lbf	1.25 lbf
	10 000 - 20 000 lbf	2.5 lbf
	20 000 - 30 000 lbf	3.75 lbf
	30 000 - 60 000 lbf	7.5 lbf
	60 000 - 100 000 lbf	12.5 lbf
	100 000 - 300 000 lbf	150 lbf
EG&G Las Vegas	0 - 5000 lb (compression)	0.1% + 2.5 lb
	0 - 20 000 lb (compression)	0.1% + 10 lb
	0 - 100 000 (compression)	0.251% $\pm$ 25 lb
	0 - 1 500 000 lb (tension)	1.0% of full scale
GEND	0 - 50 000 lb (5 ranges)	0.35% of range
Mound	0 - 5000 lb	0.3% of range + 0.2% of load
	5000 - 60 000 lb	0.05% FS + 0.1% of load
Pantex	0 - 60 000 lb	0.4% + 0.0155 of range
Rocky Flats	30 - 300 000 lb	0.1%
Savannah River	0 - 10 000 lb (compression)	0.05%
	0 - 100 000 lbf	16 lbf
	0 - 1000 lbf	0.25 lbf

Force

Laboratory	Range	Measuring Accuracy ($\pm$)
SNL Albuquerque	0 - 10 000 lb	0.5% - 0.1% of selected range
	0 - 500 000 lb	0.5% of applied force
	250 - 20 000 lbs static	0.5%
	10 - 60 000 lbs static	2.5%
SNL Livermore	20 - 100 000 lbf	0.1%
Y-12	0 - 500 lb	1% or 1 lb (best of two)
	200 - 2000 lb	2 lb
	600 - 6000 lb	6 lb
	2000 - 20 000 lb	20 lb
	6000 - 60 000 lb	60 lb
	10 000 - 100 000 lb	100 lb
	20 000 - 200 000 lb	200 lb
	30 000 - 300 000 lb	300 lb

Humidity

Laboratory	Range	Measuring Accuracy ($\pm$)
<p>Allied Signal</p> <p>EG&G Las Vegas</p> <p>GEND</p> <p>Nound</p> <p>Pantex</p> <p>Rocky Flats</p> <p>SNL Albuquerque</p> <p>SNL Livermore</p> <p>W-12</p>	<p>-75°C - 0°C d/f point 5% - 95% RH</p> <p>10.0% - 80.0% RH 80 - 90% RH</p> <p>11.0% - 75.0% RH -75°C - 0° d/f point</p> <p>8.0% - 95.0% RH 10°C - 65°C 30°C - -70°C d/f point</p> <p>0 - 18°C -20 - 0°C -70°C - -20°C F point</p> <p>0% - 100% RH</p> <p>8 - 95% RH</p> <p>8 - 80% RH</p> <p>-70°C - +25°C d/f point 3.0% - 85% (16°C - +27°C) 3.0 - 100 ppm moisture by volume</p>	<p>0.5°C 1.0%</p> <p>1.0% 2.0%</p> <p>5.0% 1.25°C dp</p> <p>1.0% 1.0°C</p> <p>2°C 4°C 2°C</p> <p>2 - 6.0%</p> <p>1.0%</p> <p>4.0%</p> <p>0.7 - 0.6 °C 2.5% 10% value + 4 ppm</p>

* d/f - dew or frost

* RH - Relative Humidity

Leak Rate

Laboratory	Range	Measuring Accuracy ($\pm$)
Allied Signal	2 X 10 ⁻² - 5 X 10 ⁻⁹ std cm ³ /s 10 ⁻¹⁰ std cm ³ /s	15% - 20% 25% - 30%
GEND	10 ⁻⁶ - 10 ⁻⁹ std cm ³ /s	10 - 20%
Mound	10 ⁻⁴ - 2 X 10 ⁻⁹ std cm ³ /s (Helium)	30% of RDG
Pantex	10 ⁻⁴ - 10 ⁻⁸ std cc/s	20%
Rocky Flats	Helium: 10 ⁻¹⁰ - 10 ⁻⁵ Nitrogen: 10 ⁻⁶	50% - 25% 35%
W-12	4.5 X 10 ⁻¹³ - 4.5 X 10 ⁻¹⁰ moles/sec (for leak rates <10 ⁻⁶ accuracy decreases linearly)	6.0% and greater

Length and Coordinate Measurement

Laboratory	Range	Measuring Accuracy ($\pm$)
Allied-Signal*	Single axis (0 - 48 inch) x-y plane (48 X 32 in.) x-y-z space (48 X 32 X 12 in.)	2 ppm + 20 μ in. 4 ppm + 20 μ in. 5 ppm + 20 μ in.
EG&G Las Vegas	0 - 10 in. (length) 0 - 8 in. (length)	30 μ in. 20 μ in.
GEND	0 - 10 in. 0 - 24 in.	100 μ in. 200 μ in.
Mound	x-y 0 - 7 in. x-y-z to 40 in.	30 μ in. 300 μ in.
Pantex	2 - axis 18 - 11 in. 3 - axis 48 x 24 x 12 in. 0 - 36 in.	75 μ in. 300 μ in. 65 μ in.
Rocky Flats	To 40 in.	4 μ in. - 1 min.
Savannah River	$\leq$ 6 in. > 6 in.	20 μ in. 30 μ in.

Length and Coordinate Measurement (cont)

Laboratory	Range	Measuring Accuracy ($\pm$)
SNL Albuquerque	0 - 40 in.	4 μ in. + μ in./in.
	24 X 48	150 μ in.
SNL Livermore	3 - axis: 18 in. X 11 in. X 16 in.	3 μ in./in.
	2 - axis: 48 in. X 24 in.	8 - 12 μ in.
Y-12 Plant	To 84 in. (End Standards)	50 - 200 μ in.
	0 - 20 ft (Laser)	2 μ in./in.
	To 55 X 40 X 42 in.	100 μ in.

Length - Gage Blocks

Laboratory	Range	Measuring Accuracy ($\pm$)
Allied Signal	To 1 in.	5 μ in.
	1 - 2 in.	6 μ in.
	2 - 3 in.	7 μ in.
	4 - 5 in.	8 μ in.
	5 - 7 in.	9 μ in.
	8 - 10 in.	10 μ in.
	12 in.	11 μ in.
	16 in.	12 μ in.
	20 in.	13 μ in.
EG&G Las Vegas	0.05 - 1 in.	9 μ in.
	2 in.	10 μ in.
	3 in.	11 μ in.
	4 in.	12 μ in.
	20 in.	58 μ in.
	.5 mm - 25 mm	$\pm$ 0.075 mm
	50 mm	$\pm$ 0.1 mm
	75 mm	$\pm$ 0.125 mm
	100 mm	$\pm$ 0.15 mm
GEND	To 1 in.	4 μ in.
	1 - 4 in.	8 μ in.
	4 - 10 in.	60 μ in.
	10 - 20 in.	100 μ in.
Mound	To 1 in.	4 μ in.
	1 - 2 in.	6 μ in.
	2 - 3 in.	8 μ in.
	3 - 4 in.	10 μ in.
	5 - 10 in.	12 - 17 μ in.
	10 - 20 in.	17 - 22 μ in.

Length - Gage Blocks (cont)

Laboratory	Range	Measuring Accuracy ($\pm$)
Pantex	0.01 - 1 in. 1 - 4 in. 4 - 10 in. 10 - 20 in. 5 - 25 mm 25 - 100 mm 100 - 500 mm	6 μ in. 10 μ in. 15 μ in. 20 μ in. 0.15 μ m 0.25 μ m 0.50 μ m
Rocky Flats	0.010 - 20 in. 25 - 500 mm	3 μ in. to 11 μ in. .075 - .275 in.
Savannah River	1 - 6 in. 6 - 9 in. 9 - 12 in. 12 - 20 in. ≤ 1 in.	10 μ in. 12 μ in. 14 μ in. 20 μ in. 8 μ in.
SNL Albuquerque	0.010 - 1.000 in. 2.000 in. 3.000 in. 4.000 in. 5.000 - 10.000 in. 12.000 - 20.000 in.	4 μ in. 6 μ in. 7 μ in. 8 μ in. 10 μ in. 15 μ in.
SNL Livermore	0 - 4 in. 4 - 20 in.	4 - 7 μ in. 8 - 12 μ in.
Y-12	< 0.1 in. 0.1 - 2 in. 3 in. 4 in. 5 - 20 in.	6 μ in. 3 μ in. 4 μ in. 5 μ in 1.5 μ in. per in.

Mass

Laboratory	Range	Measuring Accuracy ($\pm$)
Allied Signal	To 15 mg	2 μ g
	15 - 100 mg	7 μ g
	100 mg - 1 g	17 μ g
	1 - 3 g	37 μ g
	3 - 20 g	4 ppm + 0.04 mg
	20 - 100 g	3 ppm + 0.1 mg
	100 - 1000 g	3 ppm + 0.2 mg
	1000 - 5000 g	3 ppm + 1.0 mg
	5000 - 20 000 g	2 g
EG&G Las Vegas	To 100 g	0.01 mg
GEND	1 mg - 1 g	0.006 - 0.02 mg
	1 - 20 g	0.02 mg
	20 - 200 g	0.5 mg
	200 - 1000 g	0.5 mg
	1000 g - 16 kg	150 mg
Mound	0.1 - 200 mg	0.6 μ g
	200 mg - 20 g	0.6 μ g - 0.012 mg
	20 - 100 g	0.012 - 0.034 mg
	100 g - 1 kg	0.034 - 0.09 mg
	2 - 10 kg	3.1 - 14 mg
	10 - 25 kg	14 - 54 mg
Pantex	1 mg - 1 g	0.015 mg
	1 - 10 g	0.090 mg
	> 10 g	10 ppm
	>100 - 250 lbs	100 ppm
	>250 lbs	500 ppm

Mass (cont)

Laboratory	Range	Measuring Accuracy ($\pm$)
Rocky Flats	1 mg - 500 lb	0.007 mg to 0.02 lb
Savannah River	1 mg - 100 g 100 g - 3000 g 3000 - 30 000 g 30 000 - 100 000 g	0.01 - 0.1 mg 0.1 - 10 mg 10 - 50 mg 50 - 100 mg
SNL Albuquerque	0.05 - 500 mg 500 - 1 g 1 - 500 g 1 - 10 kg	0.01 mg 0.03 mg 0.04 - 4 mg 6 - 60 mg
SNL Livermore	0 - 20 g 20 - 100 g 100 g - 1 kg 1 - 20 kg 20 - 100 kg 50 - 1000 lb	0.010 mg 3 ppm 2 mg + 3 ppm 5 ppm 10 ppm 0.1%
Y-12	To 0.5 g 0.5 - 5 g 5 - 30 g 30 g - 25 kg	0.02 mg 0.07 mg 0.15 mg 5 ppm

Pressure

Laboratory	Range	Measuring Accuracy ($\pm$)
Allied Signal	Absolute:	
	10 ⁻⁷ - 10 ⁻³ mm Hg	5%
	10 ⁻³ - 1 mm Hg	0.75%
	1 - 790 mm Hg	0.2 mm Hg
	0.5 - 600 psia	0.02%
	Gages:	
	0.5 - 600 psi	0.02%
	600 - 15 000 psi	0.03%
	15 000 - 100 000 psi	0.05%
		0.016% - 0.021%
EG&G Las Vegas	0.3 - 50 psi	0.021%
	15 - 500 psi	0.017%
	30 - 12 000 psi	0.1%
	100 - 30 000 psi	
GENE	0 - 1 torr	30 mtorr
	0 - 750 torr	9 torr
	0.3 - 500 psig or psia	0.1%
	0 - 50 000 psig	0.1%
Mound	10 ⁻⁷ - 10 ⁻⁴ torr	50%
	0.2 - 2 psi	0.0001 psi or 0.5% RDG
	0.2 - 600 psia	0.02% of RDG
	30 - 12 000 psi	0.2% of RDG
	10 000 - 100 000 psi	0.5%

Pressure (cont)

Laboratory	Range	Measuring Accuracy ($\pm$)
Pantex	0.01 - 1 torr	0.05 torr or 10% of reading
	1 - 10 torr	0.5 torr or 10% of reading
	10 - 100 torr	5 torr or 10% of reading
	100 - 1000 torr	10% of reading
	0 - 50 psi	0.2% of full scale
	50 - 500 psi	0.2% of full scale
	500 - 20 000 psi	0.2% of full scale
Rocky Flats	20 000 - 40 000 psi	0.2% of full scale
	0 - 62 in. Hg	0.0002 in Hg
Savannah River	0.5 psi to 122 200 psi	450 ppm
	0.2 - 600 psi (Gas)	0.02%
	0 - 100 000 psi (Oil)	0.075%
	≤ 1 mmHg	0.56% + 0.00016 mmHg
	1 mmHg - 1000 mmHg	0.55% + 0.02 mmHg
	10 ⁻⁷ mBar - 1 mBar	1.0% - 10%
	1 mTorr - 100 Torr static inert gas	3.0%
SNL Albuquerque	1 - 10 000 psi gas -40 - +150°F	0.1%
	25 - 10 000 psi oil	0.1%
	To 100 000 psi 4 ms rise, pulse, oil	5.0%
	To 1000 psi 0.1 ms rise, step, gas	1.0%
	0 - 790 mmHg	0.2 mmHg
	1 - 10 000 Torr	0.08%
	5 - 600 psi	0.015%
SNL Livermore	600 - 40 000 psig (Oil)	0.01%
	10 ⁻⁷ - 10 ⁻³ torr	4.0% + 3 X 10 ⁻⁸
Y-12	10 ⁻³ - 2.26 torr	up to 0.002 torr
	0.2 - 16 psia	0.0025 psia or 0.05%
	16 - 600 psia	0.05% of value
	580 - 40 000 psig	0.02% of value
	40 000 - 100 000 psig	750 psig

Roundness

Laboratory	Range	Measuring Accuracy ($\pm$)
Allied Signal	To 21 in. dia	3 μ in.
GEND	To 6 in. dia	10 μ in.
Mound	To - 11.5 in. dia	5 μ in.
Pantex	To 10 in. dia	10 μ in.
Rocky Flats	2 μ in. - .02 in. dia	3 μ in. to 30 μ in.
Savannah River	1/16 - 1 in. dia 1 - 6 in. dia	10 μ in. 25 μ in.
SNL Albuquerque	0 - 12 in. dia	10 μ in.
SNL Livermore	To 12 in. dia	10 μ in.
Y-12	To 14 in. dia	3 μ in.

Shock

Laboratory	Range	Measuring Accuracy ($\pm$)
Allied Signal	500 - 50 000 m/sec ² (75°F) 30 000 - 100 000 m/sec ²	5% 5%
GEND	0 - 45 000 m/sec ²	5%
Mound	To 10 000 m/sec ²	8%
SNL Albuquerque	40 000 - 150 000 m/sec ² 3 ms pulse	8%
Y-12	10 - 10 000 m/sec ²	5%

Surface, Optical Flatness

Laboratory	Range	Measuring Accuracy ($\pm$)
Allied Signal	To 3 in. dia. 3 to 12 in. dia	2 μ in. 4 μ in.
EG&G Las Vegas	0.5 in. dia 3 in. dia 4 in. dia	2 μ in. 1 μ in. 2 μ in.
GEND	To 4 in. dia	4 μ in.
Mound	To 10 in. dia	6 μ in.
Pantex	To 4 in. dia	5 μ in.
Rocky Flats	To 12 in.	1 μ in.
Savannah River	To 3 in. dia	2 μ in.
SNL Albuquerque	To 10 in. dia	4 μ in.
SNL Livermore	To 10 in. dia	3 μ in.
Y-12	To 4 in. dia	2 μ in.

Surface Plate, Flatness

Laboratory	Range	Measuring Accuracy ($\pm$)
Allied Signal	12 in. sq 4 X 6 ft 5 X 10 ft	50 μ in. 75 μ in. 100 μ in.
EG&G Las Vegas	To 4 X 8 ft	$\pm$ 0.2% of displaced value
GEND	To 4 X 8 ft	50 μ in.
Mound	Open	50 μ in.
Pantex	To 48 X 72 in.	100 μ in.
Savannah River	To 12 in. sq	35 μ in.
SNL Albuquerque	18 X 24 in. 48 X 72 in. 60 X 120 in. 96 X 192 in.	30 μ in. 80 μ in. 130 μ in. 200 μ in.
SNL Livermore	0 - 120 in.	20 μ in.
Y-12	To 6 sq ft >6 sq ft	25 μ in. 5 μ in./sq ft

Surface, Roughness

Laboratory	Range	Measuring Accuracy ($\pm$)
Allied Signal	0 - 400 μ in. AA	1.4 - 11 μ in.
GEND	0 - 60 μ in. AA	4 μ in.
Mound	To 5 μ in. AA 7 - 35 μ in. AA 35 - 60 μ in. AA 60 - 125 μ in. AA	4 μ in. 6 μ in. 10 μ in. 14 μ in.
Pantex	100 μ in. dia To 31 μ in. AA	30% 30%
Rocky Flats	5 μ in. - 0.2 in.	3 μ in. - 30 μ in.
Savannah River	5 - 125 μ in. AA	4 μ in.
SNL Albuquerque	To 10 μ in. AA 10 - 35 μ in. AA 35 - 60 μ in. AA 60 - 125 μ in. AA	2 μ in. 3 μ in. 5 μ in. 7 μ in.
SNL Livermore	0.2 - 2000 μ in. AA	1.0%
Y-12	12 - 125 μ in.	4 - 6 μ in.

* AA - Arithmetic Average

Temperature

Laboratory	Range	Measuring Accuracy ($\pm$)
Allied Signal	-183°C - +500°C	0.05°C - 0.1°C
	500°C - 1093°C	0.4%
	Fixed Points:	
	0.01°C	0.001°C
	122°C	0.01°C
	419°C	0.01°C
EG&G Las Vegas	To - 100°C	0.21°C
	-186°C - 500°C	0.05°C
GEND	-45°C - 0°C	0.02%
	500°C - 1200°C	2.0°C - 2.4°C
Mound	-100°C - +200°C	0.01°C
	200°C - 500°C	0.05°C
	500°C - 1300°C	0.2% of RDG
	1300°C - 2300°C	1.0% of RDG
Pantex	-80 - -40°C	1°C
	-40 - 0°C	0.5°C
	0 - 100°C	0.1°C
	-100°C - +400°C	1°C
Rocky Flats	-186 °C - +2000 °C	0.05 °C - .75% of reading

Temperature (cont)

Laboratory	Range	Measuring Accuracy ($\pm$)
Savannah River	-183°C - 0°C	0.01°C
	0°C - 630°C	0.01°C
	630°C - 1100°C	1.0°C
	800°C - 1064°C	2°C
	1064°C - 3200°C	20°C
SNL Albuquerque	0°C - 100°C	0.02°C
	-100°C - 0°C	0.05°C
	100°C - 600°C	0.05°C
	600°C - 1200°C	0.05°C or 2.0% of reading
	-100°C - +600°C	0.05°C
SNL Livermore		
Y-12	Fixed Points:	
	0.01°C	0.001°C
	231.968°C	0.05°C
	327.502°C	0.05°C
	419.58°C	0.1°C
	650.37°C	0.2°C
	961.93°C	0.5°C
	1084.5°C	0.5°C
	-100°C - +800°C	0.01°C platinum resistance therm.
	0°C - 400°C	2.0°C TC
	400°C - 1450°C	0.5% of reading
	800°C - 4200°C	6.0°C - 50°C optical pyrometers

Thread Lead and Helix

Laboratory	Range	Measuring Accuracy ($\pm$)
EG&G Las Vegas	4 - 80 TPI	30 μ in.
Mound	Thread lead (internal) To 3 in.	200 μ in.
Rocky Flats	4 - 120 TPI	20 - 200 μ in.
Savannah River	All standard pitches	100 μ in.
SNL Albuquerque	All standard pitches (thread lead)	25 μ in.
Y-12	All standard pitches	30 μ in

Threadwires

Laboratory	Range	Measuring Accuracy ($\pm$)
Allied Signal	All standard pitches	10 μ in.
EG&G Las Vegas	4 - 80 TPI	30 μ in.
GEND	6 - 80 TPI	18 μ in.
Mound	All standard 60° pitches	12 μ in.
Fantex	All pitches	45 μ in.
Rocky Flats	40 - 120 TPI	20 - 30 μ in.
Savannah River	All standard pitches	35 μ in.
SNL Albuquerque	All pitches	15 μ in.
SNL Livermore	All pitches	10 μ in.
Y-12	Standard pitches: 60° English threadwires 60° metric threadwires Gear wires Acme threadwires Buttress threadwires	10 μ in. 10 μ in. 10 μ in. 20 μ in. 20 μ in.

*TPI - Threads per Inch

Torque

Laboratory	Range	Measuring Accuracy ($\pm$)
Allied Signal	1 - 160 in.-oz	0.15% of reading
	1 - 5 ft.-lb	0.15% of reading
	5 - 50 ft.-lb	0.25% of reading
	50 - 750 ft.-lb	0.3% of reading
EG&G Las Vegas	0 - 200 in.-lb (in several ranges)	7%, 4%, and 5%
GEND	0.5 - 215 in.oz	0.2%
	To 50 in.-lb	4%
	50 - 600 in.-lb	1%
Mound	0 - 3800 in.	10% clockwise only
	0 - 250 in.-lb	1%
	0 - 160 in.-lb	0.5%
Pantex	5 in.-oz - 600 ft.-lb	3%
Rocky Flats	0.1 in.-lb - 200 ft.-lb	0.01 - 0.5% of reading
Savannah River	0 - 20 in.-lb	0.25 in.-lb
	20 - 1980 in.-lb	0.25%
	165 - 750 ft.-lb	.25 ft.-lb
SNL Albuquerque	2 - 150 000 ft.-lb	3%
SNL Livermore	0 - 1000 ft.-lb	2% of applied torque
Y-12	0 - 100 in.-oz	2 in.-oz
	0 - 400 in.-lb	1.0% + 2 in.-lb
	0 - 1000 lb.-ft	0.2% of reading + 0.2 lb.-ft

Volume

Laboratory	Range	Measuring Accuracy ($\pm$)
Allied Signal	0.5 - 10 cm ³ 10 cm ³ - 30 L	1.0% 0.1%
Mound	To 10 cm ³ 10 cm ³ - 10 L To 1000 L	0.15% 0.1% 0.15%
Pantex	To 148 cc	0.1 cc
Rocky Flats	0.1 cm ³ to 5 L	0.005 cm ³ - 1 cm ³
SNL Livermore	0 - 2000 cm ³	0.05% or 0.02 cc whichever is greater
Y-12	Internal: 0.1 cm ³ - 50 000 L	1.0% + 0.1 cm ³

Electrical Quantities, dc

Direct Current and Voltage

Laboratory	Range	Measuring Accuracy ($\pm$)
Allied Signal	0 - 0.016 V	20 ppm + 0.1 μ V
	0.016 - 0.16 V	15 ppm + 0.5 μ V
	0.16 - 1.6 V	10 ppm + 5 μ V
	1.6 - 1500 V	0.0025%
	1.5 - 10 kV	0.04%
	10 - 100 kV	0.075%
	10 ⁻⁹ A	0.5%
	10 ⁻⁸ A	0.4%
	10 ⁻⁷ - 10 ⁻⁶ A	0.2%
	10 ⁻⁵ - 0.3 A	0.005%
	0.3 - 30 A	0.007%
	30 - 100 A	0.03%
	100 - 300 A	0.05%
EG&G Las Vegas	0 - 0.1 V	.1 μ V
	0.1 - 1000 V	2.5 ppm
	1 kV - 10 kV	0.05%
	10 kV - 100 kV	0.1%
	10 μ A - 1 A	0.04 - 0.01%
	1 - 20 A	0.02%
	20 - 150 A	0.04%
	250 - 400 A	5.0%
	150 - 250 A	1.5 A
	10 ⁻¹² A	.375% + 10 fA
	10 ⁻¹¹ A	.325% + 10 fA
	10 ⁻¹⁰ A	0.2% + 30 fA
	10 ⁻⁹ A	0.0625% + 1 pA
	10 ⁻⁸ A	0.035% + 10 i
	10 ⁻⁷ A	0.025% + 100 pA

Direct Current and Voltage (cont)

Laboratory	Range	Measuring Accuracy ($\pm$)
GEND	To 1.6 V	9 ppm + 1 μ V
	1.0 - 1000 V	11 ppm
	1000 V - 140 kV	0.047%
	10-12 - 10 ⁻⁵ A	0.1 - 5%
	10 ⁻⁹ - 2 A	32 ppm
	2 A - 20 A	50 ppm
	15 A - 100 A	0.04%
Mound	1.018 V	0.0003%
	0 - 1.6 V	0.0004% + 1 μ V
	1.6 - 11 V	0.0013%
	11 - 1100 V	0.0016%
	1100 - 100 000 V	0.05%
	0 - .75 A	0.01%
	.75 - 150 A	0.05%
	150 - 300 A	0.1%
Pantex	To 2 V	16 ppm + 0.1 μ V
	2 - 1500 V	31 ppm
	1500 V - 10 kV	0.25%
	1 μ A - 2 A	0.02%
	2 - 15 A	0.02%
Rocky Flats	0 - 150 kV	15 μ V - 3 X 10 ⁻⁵
	0.075 - 500 A	0.01% - 0.05%
Savannah River	1 μ V - 1.8 V	25 ppm + 5 μ V
	1.8 V - 500 V	25 ppm + 5 μ V
	500 - 1500 V	25 ppm + 400 μ V
	0 - 100 A	0.05%

Direct Current and Voltage (cont)

Laboratory	Range	Measuring Accuracy ($\pm$)
SNL Albuquerque	0 - 1 V	10 ppm
	10 - 1000 V	20 ppm
	1 kV - 30 kV	0.25%
	1 pA - 1 nA	0.4%
	1 nA - 1 μ A	0.025%
	1 μ A - 10 μ A	0.0125%
	10 μ A - 1 A	0.01%
	1 A - 100 A	0.015%
SNL Livermore	10 μ V - 2.1 V	0.003%
	2 - 1500 V	0.02%
	1500 - 5000 V	0.1%
	5000 - 30 000 V	0.2%
	300 μ A - 1 A	0.04%
	1 - 15 A	0.03%
	15 - 100 A	0.06%
	100 - 1000 A	0.2%
Y-12	Fixed 1.018 V	3 ppm
	Fixed 10.0 V	1.5 ppm
	1 mV - 11 V	10 ppm + 1 μ V
	11 - 1500 V	20 ppm
	1 - 100 kV	0.1%
	10 pA - 1 mA	1.0% + 0.5 pA
	1 mA - 500 A	0.02% + 1 μ A
	500 - 3000 A	0.1%

DC Resistance

Laboratory	Range	Measuring Accuracy ($\pm$)
Allied Signal	10 ⁻⁴ - 10 ⁻¹ Ω	0.007%
	10 - 10 ⁶ Ω	0.005%
	10 ⁶ - 10 ⁸ Ω	0.01%
	10 ⁸ - 10 ⁹ Ω	0.2%
	10 ¹⁰ - 10 ¹² Ω	0.5%
	10 ¹² - 10 ¹³ Ω	1.0%
EG&G Las Vegas	10 ⁻⁴ - 10 ⁻³ Ω	10.0%
	10 ⁻³ - 10 ⁻² Ω	1.5%
	10 ⁻² - 10 ⁰ Ω	0.15% - 0.005%
	10 ⁰ - 10 ⁶ Ω	2 - 20 ppm
	10 ⁷	30 ppm
	10 ⁸ Ω	0.03%
	10 ⁹ Ω	0.05%
	10 ¹⁰ Ω	0.07%
	10 ¹¹ Ω	0.1%
	10 ¹² Ω	0.2%
GEND	0.001 - 0.1 Ω	0.005%
	(decade values)	
	1 Ω	20 ppm
	10 Ω	30 ppm
	100 Ω - 10 k Ω	20 ppm
	100 k Ω - 1 M Ω	30 ppm
	0.001 - 111 Ω	0.005% or 0.0002 Ω
	To 1 M Ω	0.01% + 0.001 Ω
	1 - 110 M Ω	0.02%
	110 - 1100 M Ω	0.2%
	1100 - 11 000 M Ω	2.0%
	1011 - 1015 Ω	0.1 - 1.0%

DC Resistance (cont)

Laboratory	Range	Measuring Accuracy ($\pm$)
Mound	0 - 1 M Ω	0.01%
	1 M Ω - 12 G Ω	0.1%
Pantex	10 ⁻⁵ Ω	0.2%
	10 ⁻⁴ - 1 Ω	0.02%
	1 - 10 ⁶ Ω	0.0035%
	10 ⁶ - 111 M Ω	0.02%
	111 - 1111 M Ω	0.2%
	>1111 M Ω	2.0%
Rocky Flats	0.001 - 1 M Ω	0.003% - .005%
Savannah River	0.001 10 ⁴ Ω (decade values)	30 ppm
	0.001 - 10 ⁵ Ω (nondecade values)	50 ppm
	10 ⁵ Ω (decade values)	50 ppm
	10 ⁶ - 10 ¹² Ω (decade values)	2.5%

DC Resistance (cont)

Laboratory	Range	Measuring Accuracy ($\pm$)
SNL Albuquerque	10 m Ω - 1 Ω	10 ppm or .1 m Ω whichever is greater
	10 Ω - 1M Ω	10 ppm
	107 Ω	0.025%
	108 Ω	0.035%
	109 Ω	0.05%
	1010 Ω	0.07
	1011 Ω	0.1%
	1012 Ω	0.2%
	1013 Ω	0.3%
	1014 Ω	0.5%
	1015 Ω	1.0%
	1016 Ω	10.0%
SNL Livermore	10 ⁻⁴ - 100 Ω	0.05%
	1 - 110 Ω	0.005%
	1 - 1 M Ω	0.01% + 0.001 Ω
	1 - 100 M Ω	0.2%
	100 - 1000 M Ω	0.02%
	1000 - 10 000 M Ω	2.0%
Y-12	0.001 - 0.1 Ω (decade values)	30 ppm
	1 - 100 k Ω	10 ppm
	(decade values) 1 M Ω	30 ppm
	To 100 G Ω	3.0%

Electrical Quantities, ac

Alternating Current and Voltage

Laboratory	Range	Measuring Accuracy ($\pm$)	
		0.01% - 0.5%	Depending on Range and Frequency
Allied Signal	0.5 - 1000 V	0.01%	
	0.5 - 250 V	0.035%	
	0.5 - 16 V	0.05% - 0.1%	
	0.5 - 10 V	0.2% - 1.2%	
	1 - 70 kV	0.3%	
	10 mA - 20 A	0.05% - 0.07%	
	0.01 - 0.5 V	0.25%	
	0.5 - 1000 V	0.005%	
	0.5 - 200 V	0.01%	
EG&G Las Vegas	200 - 1000 V	0.05%	
	0.5 - 100 V	0.02%	
	100 - 1000 V	0.05%	
	.5 - 50 V	0.05%	
	.5 - 10 V	0.05%	
	10 μ A - 10 mA	0.2%	
	10 mA - 5 A	0.02%	
	20 - 400 A	6.0%	
	5 - 20 A	0.155% - 1.0%	
	50 Hz - 1 kHz	0.5%	
	50 Hz - 10 kHz	0.1%	
	50 Hz - 10 kHz	0.05%	
	10 Hz	0.02%	
	100 Hz - 50 kHz	0.004%	
GEND	1 - 1000 V	0.006%	
	1 - 100 V	0.02%	
	100 V - 1000 V	0.1%	
	3 V	0.085% - 0.45%	
	2 A	0.05%	
	10 A	0.06%	
	20 A	0.05%	
	20 A - 100 A	0.1%	
	50 Hz - 1 kHz		

Alternating Current and Voltage (cont)

Laboratory	Range		Measuring Accuracy ($\pm$)
Mound	0.5 V - 1 kV	5 Hz - 20 kHz	0.02%
	0.5 V - 1 kV	20 - 50 kHz	0.03%
	1000 - 80 KV	60 Hz	3.0%
	5 mA - 10 A	10 Hz - 50 kHz	0.03%
	10 - 20 A	10 Hz - 50 kHz	0.05%
Pantex	0.5 - 1000 V	To 20 kHz	0.025%
	0.5 - 300 V	To 50 kHz	0.035%
	0.5 - 30 V	To 1 MHz	0.06%
	0.5 - 30 V	To 10 MHz	0.12%
	0.5 - 30 V	To 30 MHz	0.22%
	1 μ A - 15 A	To 100 MHz	0.4%
Rocky Flats	0 - 1100 VRMS	20 k - 50 kHz	0.1% - 0.005% RDG
	2.5 nA - 20 A	50 Hz - 1 kHz	0.05% - 0.2%
Savannah River	0.5 - 100 V	60 Hz - 100 Hz	0.07% + 5 μ V
	1000 V	5 Hz - 20 kHz	0.07% + 40 μ V
	1000 V	20 - 100 kHz	0.25% + 400 μ V

* RDG - Reading

Alternating Current and Voltage (cont)

Laboratory	Range		Measuring Accuracy ($\pm$)
SNL Albuquerque	0.1 - 5 V	100 kHz - 30 MHz	0.5%
	1 - 10 V	1 kHz - 20 kHz	0.01% of output
		20 - 100 kHz	0.03% of output
		100 kHz - 1 MHz	0.06% of output
	100 V	1 - 20 kHz	0.01% of output
		20 - 100 kHz	0.03% of output
	To 700 V	30 - 100 kHz	0.07% of output
	1000 V	1 - 30 kHz	0.03% of output
	10 nA - 1 μ A	50 Hz - 5 kHz	0.09%
	1 μ A - 1 A	50 Hz - 5 kHz	0.06%
	10 mA - 5 A	5 - 50 kHz	0.08%
	5 A - 10 A	5 - 50 kHz	0.09%
	10 A - 20 A	50 Hz - 1 kHz	0.1%
	20 A - 100 A	50 - 400 Hz	0.1%
SNL Livermore	10 μ A - 20 A		0.1%
	0.5 - 1000 V	20 Hz - 100 kHz	0.07%
	0.1 - 5 V	100 kHz - 30 MHz	0.5%
Y-12	100 μ V - 0.5 V	50 Hz - 5 kHz	0.1% + 1 μ V
	0.5 - 1000 V	50 Hz - 5 kHz	0.03%
	0.5 - 20 A	50 Hz - 10 kHz	0.05%

Capacitance

Laboratory	Range		Measuring Accuracy ($\pm$)
Allied Signal	0.001 pF - 1 μ F	1 kHz	0.01% + 0.000 05 pF
	1 - 10 μ F	1 kHz	0.02%
	10 - 100 μ F	1 kHz	0.5%
	1.0 - 1000 pF	1 MHz	0.1 - 0.2%
EG&G Las Vegas	0.01 pF - 10 μ F	1 kHz	15 - 250 ppm
	10 - 100 μ F	1 kHz	0.25%
GEND	10 aF - 11 μ F	50 Hz - 1 kHz	0.01% + 30 aF
	100 - 1150 pF	1 kHz - 1 MHz	0.1% + 1 pF
Nound	10 pF 1 μ F	1 kHz	0.01% + 0.00003 pF
Pantex	10 pF - 1.11110 μ F 1 kHz		0.01% + 0.0003 pF
	1.11110 - 11.11110 μ F 1 kHz		0.2% + 0.00003 pF
Rocky Flats	1 pF - 100 μ F	1 kHz	0.2% Range
SNL Albuquerque	1 pF - 1 μ F	1 kHz	5 ppm
	1 pF - 10 μ F	1 kHz	0.01%
SNL Livermore	10 ⁻⁶ F - 1111 F	100 Hz - 10 kHz	0.02%
X-12	1 pF - 1 μ F	1 kHz	0.02% + 0.0003 pF

Frequency

Laboratory	Range	Measuring Accuracy ($\pm$)
Allied Signal	1 Hz - 12.4 GHz	1 part in 10^9
EG&G Las Vegas	20 Hz - 18 GHz	4 X 10^{-12}
GEND	To 10 MHz	1 part in 10^9
Mound	To 250 MHz 1, 5, 10 MHz	1 part in 10^8 1 part in 10^{10}
Pantex	To 12.4 GHz	5 parts in 10^{10}
Rocky Flats	DC to 10^8 Hz	3 parts in 10^8 - 6 parts in 10^8
Sanannah River	DC to 10^7 Hz	10×10^{-10}
SNL Albuquerque	1 Hz - 26.5 GHz	2 parts in 10^{10}
SNL Livermore	1 - 100 Hz 100 Hz - 12.4×10^{10} Hz	0.015% 7.0 - 10%
Y-12	1, 5, and 10 MHz (fixed) 1 Hz - 1050 MHz	1 part in 10^{10} 1 part in 10^7

Inductance

Laboratory	Range	Measuring Accuracy ($\pm$)
Allied Signal	0.05 - 2 μ H	0.6% - 10%, depending on inductance and frequency
	1 - 100 μ H	0.4 - 3%, depending on inductance and frequency
	100 μ H - 10 H	0.06% - 0.4%, depending on inductance and frequency
SG&S Las Vegas	0.1 μ H - 10 H	0.01% - 1% depending on inductance and frequency
	.1 μ H - 1111 H	Frequency dependent
GEND	10 μ H - 10 H	0.1%
Mound	0.2 mH - 100 mH	0.3%
	100 - 1000 μ H	0.5%
Pantex	111 μ H - 1111 H	0.1%
SNL Albuquerque	1 mH - 100 H	0.05%
	100 Hz - 10 kHz	
SNL Livermore	0.1 μ H - 1 kH	0.1%
	0.2 nH - 110 mH	1.0%
	5 - 500 kHz	
Y-12	1 μ H - 10 H	0.2%
	100 Hz - 1 kHz	

Time of Day

Laboratory	Measuring Accuracy ($\pm$)
Allied Signal	1.0 s
EG&G Las Vegas	100 ms
Mound	1 s
Pantex	1 s
Savannah River	1 s
SNL Albuquerque	1 s
SNL Livermore	0.05 s
Y-12	1 s

Electrical Quantities, Pulse

High-Voltage Pulse

Laboratory	Range	Measuring Accuracy ($\pm$)
Allied Signal	10 - 100 V	70.2 μ s
	100 - 10 000 V	70.5 μ s
GEND	50 - 200 kV	3.5%

Electrical Quantities, Microwave

Attenuation

Laboratory	Range		Measuring Accuracy ($\pm$)
Allied Signal	0 - 80 dB	.01 - 1.999 GHz	0.03 dB or 0.3 dB/10 dB *
	0 - 90 dB	.01 - 1 GHz	0.03 dB or .03 dB/10 dB *
	0 - 100 dB	.01 - .03 GHz	0.03 dB or .03 dB/10 dB *
	0 - 80 dB	2 - 8 GHz	0.03 dB or .03 dB/10 dB *
	20 - 120 dB	.03 GHz	0.014 dB to 0.083 dB *
			* Whichever is greater + mismatch
EG&G Las Vegas	+20 - -100dB	200 Hz - 32.5 MHz	± 0.75 dB
	+16 - -70 dB	10 MHz - 26.5 GHz	± 0.04 dB + mismatch
	+10 - -30 dB	100 kHz - 4 GHz	$\pm 4.0\%$ + mismatch
GEND	0 - 12 dB	DC - 30 MHz	0.1 dB
	0 - 60 dB	DC - 30 MHz	0.25 dB
	3 dB	10 MHz - 200 MHz	0.065 dB
	10 dB	10 MHz - 200 MHz	0.08 dB
	20 dB	10 MHz - 200 MHz	0.12 dB
Pantex	0.0 - 70 dB, 30 Hz		(0.02 + 0.1%) dB
	0.0 - 60 dB, 500 - 1000 MHz		(0.2 + 0.3%) dB + mismatch
	0.0 - 60 dB, 2 - 6 GHz		(0.2 + 0.3%) dB + mismatch
SNL Albuquerque	DC - 1 GHz		0.5 dB

RF Power

Laboratory	Range		Measuring Accuracy ($\pm$)
Allied Signal	10 μ W - 100 mW	1 - 10 MHz	4% - 7%
	1 mW	1 MHz - 8.5 GHz	1.0% - 2.5%
	10 μ W - 10 mW	10 MHz - 8.5 GHz	1.5% - 3.0%
	1 nW - 10 μ W	10 MHz - 8.5 GHz	3.8% - 6.0%
	10 mW - 100 mW	10 MHz - 8.5 GHz	6% - 7%
	10 μ W - 10 mW	10, 12, 15, & 18 GHz	4% - 5%
	30 mW - 12 W	1509.5 MHz and	4.0%
		2.2 - 2.3 GHz	
EG&G Las Vegas	0.3 nW - 25 W	0.05 - 12.4 GHz	3% + mismatch
	0.3 μ W - 100 mW	100 kHz - 4 GHz	3% + mismatch
	0.3 μ W - 15 mW	12.4 - 18.0 GHz	3% + mismatch
Pantex	0.001 - 10 mW	2, 3, 4 GHz	3%
	10 mW - 3 W	2, 2.5, 3 GHz	3%
Y-12	10 - 100 mW	1 MHz - 1 GHz	5.0% - 10%

VSWR/Reflection Coefficient

Laboratory	Range	Measuring Accuracy ($\pm$)
Allied Signal	0.0 - 1.0	0.005 - 0.012 *
	0.0 - 1.0	0.0021 - 0.05 *
		* Reflection coefficient magnitude (SWR calculated)
Pantex		
Reflection coefficient	0.001 - 0.09	0.02 - 0.03
	0.09 - 0.9	0.05

Radiation Quantities

Laser Power

Laboratory	γ	Range	Pulse Width	Measuring Accuracy ($\pm$)
Allied Signal Average Power	516 - 633 nm	1 - 100 μ W		5.0%
		100 μ W - 10 mW		3.0%
		10 mW - 10 W		4.0%
	1.064 μ m	0.1 mW - 10 W		5.0%
		10 - 100 W		7.5%
	10.6 μ m	1 mW - 10 W		5.0%
		10 - 1000 W		6.0%
Peak Power	514 - 633 nm 890 - 905 nm 1.064 μ m	1 - 10 W	50 ns - 1 ms	10.0%
		1 - 75 W	50 - 200 ns	15.0%
		0.1 - 10 W	50 ns - 1 ms	15.0%
		10 W - 10 kW	50 ns - 1 ms	20.0%
GEND	800 nm - 830 nm 632.8 nm	200 mW - 650 mW	200 ns	8.0%
		1 mW	CW	1.8%
SNL Livermore		1 mW - 10 W		2.0 - 3.0%

Power, LED

Laboratory	γ	Range	Pulse Length	Measuring Accuracy ($\pm$)
Allied Signal	570 - 910 nm	10 μ W - 10 mW	CW	5.0%
GEND	750 - 850 nm	370 μ W - 440 μ W	CW	8.0%

Power, Solar

Laboratory	Range	Measuring Accuracy ($\pm$)
Rocky Flats	0 - 200 W/cm ²	20.0% of reading

Power, Ultraviolet

Laboratory	γ	Range	Measuring Accuracy ($\pm$)
Allied Signal	365 nm	0.1 - 10 mW/cm ²	15.0%
Rocky Flats	230 - 400 nm	200 - 800 mW/cm ²	20.0% of reading

Radiation

Laboratory	Range	Measuring Accuracy ($\pm$)
Allied Signal	Alpha: 1570 - 1 540 000 particles/min	3.0%
	Neutron: 106 - 108 neutrons/pulse	10%
	Gamma: 0 - 250 R (CS-137)	8.0% + 10^{-4} - 2.5 R
	X-Ray: 0 - 2.5 R (H200)	8.0% + .25 10^{-2} R
	X-Ray: 0 - 2.5 R (H100)	8.0% + .25 10^{-2} R
Pantex	Alpha: 10^2 - 10^6 counts/min	8%
Rocky Flats	X-Ray: 10 - 200 Kev	0.5%
	X-Ray: 200 Kev - 4 Mev	1.0% - 2.0%
	CS-137: 0.03 to 0.700 R	5%
	0.5 - 800K d/m alpha	1.2% - 3.0% relative
	Alpha energy relative	0.2%
	⁴ - 7 mev	
	Pu240 0 -7 atom %	2.0% relative

X-Ray Film Density

Laboratory	Range	Measuring Accuracy ($\pm$)
Allied Signal	0 - 4 visual monochromatic optical density	0.03 density scale units
Rocky Flats	0.1 - 0.3 logarithmic density scale	0.01 to .003 scale units
Y-12	0 - 4 density scale	> 0.03 or 3.0% of reading

Optical Spectral Response, Reflectance and Transmittance

Laboratory	Range	Measuring Accuracy ($\pm$)
Allied Signal	Transmittance (nm):	
	350 - 400	10%
	400 - 500	4.0%
	500 - 1000	1.0%
	Spectral Response (nm):	
	350 - 400	15%
	400 - 500	5.0%
	500 - 1000	2.0%

Photometric

Laboratory	Range	Measuring Accuracy ($\pm$)
Allied Signal	Illuminance: 1 - 750 ftcandles	7.5%
	Specular Gloss: 1 - 90 units ASTM 60°	3 units
	Luminous Intensity: 10 - 1000 candles	5.0%
Rocky Flats	0 - 100, 250, 500 ftcandles	5.0% of reading

Magnetics

Magnets, Reference

Laboratory	Range	Measuring Accuracy ($\pm$)
Allied Signal	50 gauss - 10 kgauss	3.0%
SNL Albuquerque	100 gauss - 10 kgauss	1.2% - 2.0%

DC Magnetic Field Density

Laboratory	Range	Measuring Accuracy ($\pm$)
Allied Signal	Transverse: 20 - 100 000 gauss Axial: 40 - 500 gauss	3 - 7.5% 3 - 7.5 %
SNL Albuquerque	100 gauss - 10 kgauss	3%
SNL Livermore	100 - 50 000 K maxwell-turns	3%

Sound

Sound Level

Laboratory	Range	Measuring Accuracy ($\pm$)
Allied Signal	124 dB 250 Hz	0.2 dB
EG&G Las Vegas	124 dB 250 Hz	0.1 dB
	114 dB 125, 500, 1000, 2000 Hz	0.5 dB
	94 dB, 110 dB 250 Hz, 1 kHz	0.3 dB
	50 - 140 dB 50 Hz - 2 kHz	1.3 dB
Y-12	124 dB 250 Hz	0.6 dB
	114 dB 125, 500, 1000, 2000 Hz	1.5 dB
	60 - 130 dB 50 Hz - 10 kHz	5 dB

Chemistry Quantities

Chemistry Standards

Laboratory	Range	Measuring Accuracy ($\pm$)
Rocky Flats	Synthesis of uranium solution standard samples 1.0 X 10 ⁻⁸ - 2.4 X 10 ² g/L	1.0% - 0.1%
	Synthesis of uranium semisolid standard samples 100 - 500 μ g/g	0.2%
	Synthesis of uranium solid standard samples 10 - 1000 μ g/g	10% - 1.0%
	Synthesis of plutonium solution standard samples 1 X 10 ⁻⁵ - 2.5 X 10 ² g/L	1.0% - 0.1%
	Synthesis of plutonium semisolid standard samples 1 X 10 ⁻⁵ - 1 X 10 ⁻³ g/g	0.02%
	Synthesis of plutonium solid standard samples 1 X 10 ⁻⁴ - 0.88 g/g	0.1%
	Synthesis of americium 241 solution standard samples 5 X 10 ⁻⁵ - 5 X 10 ⁻¹ g/L	1.0% - 0.1%

NDA Standards

Laboratory	Std material or meas unit.	Measuring Accuracy ($\pm$)
Rocky Flats	Plutonium residue in 1 and 55-gal container.	
	10 - 700 g (synthesis)	0.1%
	50 - 1000 g by calorimetry	0.2%

Ph

Laboratory	Range	Measuring Accuracy ($\pm$)
Rocky Flats	2.0 - 10 ph	0.011 ph

Specific Resistance

Laboratory	Range	Measuring Accuracy ($\pm$)
Rocky Flats	0 - 15 M Ω /cm	10%

Fabricated Standards

Laboratory	Standard	Measuring Accuracy ($\pm$)
Rocky Flats	Standard: Ferri-te Content 0% - 20%	0.25%
	Gas Reference: 50 - 1000 ppm	5.0%
	1000 - 10 000 ppm	1.0%
	10 000 - 50%	0.5%

- END -

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