AIM

Association for Information and Image Management

1100 Wayne Avenue, Suite 1100
Silver Spring, Maryland 20910
301/587-8202

Centimeter

Inches

MANUFACTURED TO AIM STANDARDS
BY APPLIED IMAGE, INC.

1 of 1

SAND94-0929
Unlimited Release
Printed May 1994

Distribution
Category UC-900

Primary Standards Laboratory Report 2nd Half 1993

Measurement Standards Department
Sandia National Laboratories
Albuquerque, NM 87185

Abstract

Sandia National Laboratories operates the Primary Standards Laboratory for the Department of Energy, Albuquerque Operations Office (DOE/AL). This report summarizes metrology activities that received emphasis in the second half of 1993 and provides information pertinent to the operation of the DOE/AL system-wide Standards and Calibration Program.

EDITION OF THIS DOCUMENT IS 1.0

Foreword

This report was compiled and edited by W. G. T. Levy, Sandia National Laboratories. Additional information on the activities covered in this report may be obtained by contacting W. G. T. Levy, Measurements Standards Department 1743, Sandia National Laboratories, PO Box 5800, Albuquerque, New Mexico 87185-0823, telephone (505) 845-8268.

Contents

1	Introduction	7
2	Development Projects	7
3	Improvement Projects	9
4	Calibration and Special Measurements	10
5	Surveys and Audits	11
6	Customer Service	11
7	Significant Events	11
APPENDIX A—Certificates and Reports Issued		13
APPENDIX B—Commercial Calibration Laboratories (CCLs)		15
APPENDIX C—Listing of PSL Memoranda (PSLM)		17
APPENDIX D—NIST/NBS Test Numbers		19
APPENDIX E—DOE/PSL Memoranda on Standards and Calibration Program		21

Primary Standards Laboratory Report

2nd Half 1993

1. Introduction

The Primary Standards Laboratory (PSL) operates a system-wide primary standards and calibration program for the U.S. Department of Energy, Albuquerque Field Office (DOE/AL). The PSL mission is as follows: to develop and maintain primary standards; to calibrate electrical, physical, and radiation reference standards for customer laboratories (DOE/AL nuclear weapon contractors); to conduct the technical surveys and measurement audits of these laboratories; and to recommend and implement system-wide improvements.

This report summarizes activities of the PSL for the second half of 1993 and provides information pertinent to the operation of the DOE/AL Standards and Calibration Program. Specific areas covered include development projects, improvement projects, calibration and special measurements, surveys and audits, customer service, and significant events. Appendixes include certifications and reports; a discussion about commercial calibration laboratories; PSL memoranda (PSLM); test numbers from the National Institute of Standards and Technology (NIST), formerly the National Bureau of Standards (NBS); and DOE/PSL memoranda on the Standards and Calibration Program with emphasis on traceability of PSL calibrations.

2. Development Projects

Intermediate Range Vacuum Standard

The Intermediate Range Vacuum Standard under development at NIST has been assembled and leak-tested. The standard is a fundamental state-of-the-art system for vacuum calibrations in the intermediate range from the molecular to viscous gas flow regime. The calibration pressures that will be generated in the standard range from 10^{-5} to 10^{-1} torr. Three conductance elements were developed for the system: a "knife-edge" orifice of about 1 cm diameter,

a conductance "tube" of about 2 mm diameter by 2 mm length, and a microchannel plate element. The conductance of the first orifice has been established by calculation for molecular flow, while the latter two elements will have empirically derived conductances. The knife-edged orifice element will be used for generating the lowest pressures in the molecular flow regime, and the conductance tube will be used primarily to span the transition flow regime based on results showing that it has shorter equilibration times associated with it than the microchannel plate. The possible range of use for the microchannel element is still under study. This system is ready for calibration in conjunction with the Low-Range Flow Generator, which is currently under development at NIST and is scheduled to be completed and both systems delivered to Sandia by the end of 1994.

Compare-III Leak Calibration System

Preliminary technical verification efforts for the Compare-III Leak Calibration System show good agreement between fundamental He leak measurements on the Accumulate-Dump and P-delta-V Leak Calibration Systems and direct comparison measurements on the Compare-III System. Comparisons of He leak rates in the range of 10^{-6} cc/s STP (for PSL leak File Nos. 4457, 6978, and 6977) show variation within 1.8% between the two calibration methods. These data will be used in the first phase, i.e., for He gas leak specimens, of the technical review process for Compare-III, to be completed by the end of 1994.

Ultrahigh Vacuum Calibration System

The orifice configuration on the Ultrahigh Vacuum Calibration System is currently being modified to minimize leakage around the orifice plate when it is lowered into place to separate the two vacuum chambers in the system. The plate will be raised during pump-down and bakeout and lowered for calibrations. The modification includes use of a metal collar

between the two vacuum chambers. The collar has a groove into which a gallium-indium eutectic is placed. The eutectic acts as the seal between the lowered orifice plate and the chamber. This modification will improve the accuracy and repeatability associated with the conductance value of the orifice.

Improved Zener Data Analysis and Reference Standards

The development of an automated data-handling system, mentioned in an earlier semiannual report, for the DC Zener measurement system has been implemented. In this process, data are imported from an automated measurement system to an Excel worksheet for analysis. The development of several "macros," which will automate the data analysis process, has also begun. The first data analysis Macro has been completed for the Zener system.

The standard cells used as reference standards in our Zener calibration system have been replaced with a set of four Zener voltage standards. This replacement is part of a continuing effort to reduce our dependence on standard cells, which contain hazardous chemicals.

Digitally Synthesized Source

NIST is developing for the PSL an improved version of the Digitally Synthesized Source (DSS) that will provide IEEE 488 bus control of the frequency, waveform, and RMS output voltage level, as well as improved resolution, dc offset adjustment, and less harmonics in the output signal. This version of the DSS will be placed in service at the PSL to provide improved calibrations of ac voltages at lower frequencies and lower voltages than are presently attainable through the use of thermal voltage converters. The DSS will operate over the frequency range from 1 Hz to 5 kHz and voltages from 1 mV to 7 V. There will be an overlap with thermal voltage converters from 0.5 to 6 V and from 100 Hz to 1 kHz. The first unit has been delivered to the PSL and placed in operation. The remaining units are in the process of being shipped from NIST to the PSL.

NIST has developed a calibration process for the routine operation of the DSS up to 1 kHz, including a calibration procedure and any special noncommercial hardware required for calibrating frequency flatness at higher frequencies. NIST has already trained PSL personnel to operate and calibrate the DSS. The PSL still plans to place DSS units in service at the CSL sites to provide improved low-frequency/low-voltage calibration capabilities at the CSL workstations. This

transfer of technology should start during the first half of calendar year 1994.

Sandia's Safety and Engineering Department reviewed one DSS at the PSL for electrical safety. The overall DSS design, components used, and construction were approved. One suggestion was made for improved routing of wiring, which has been implemented in this unit and will be incorporated in the remaining DSSs before they leave the PSL for use at other locations.

Development of Techniques for Calibrating Waveform Recorders

The development of techniques for calibrating waveform recorders (transient waveform digitizers) is proceeding. Work performed earlier in the year on sine wave calibrations was discussed in the paper "The Use of DFT Windows in Signal-to-Noise Ratio and Harmonic Distortion Computations," which has been accepted for publication in IEEE transactions on *Instrumentation and Measurement*. NIST is still characterizing, for the PSL, the NIST Model C6-D1 sampling comparator probe with respect to static linearity, harmonic distortion, gain flatness, and temperature coefficient. NIST is also investigating the effect of time-base errors on measurements with the probe. A paper on this method titled "Polynomial Modelling of Analog-to-Digital Converters" was presented at the 1994 Measurement Sciences Conference. A joint paper with NIST was also written for presentation at IMTC94. This paper discusses how harmonic distortion affects the uncertainties of the parameters from a sine fit. Recent work has concentrated on developing a calibration procedure based on sine wave calibrations. The calibrated parameters of the waveform recorder will be input amplifier gain and offset and time-base jitter and sample rate.

Inductive Voltage Divider Calibration System

NIST is developing for the PSL an automated system for the calibration of Inductive Voltage Dividers (IVD) (or ratio transformers). This system is modelled on the system that NIST recently completed for the NASA ZENO experiment. The new PSL system will provide calibration of ratios to 10 parts per billion and is computer controlled. NIST expects to deliver the complete system before June 1994. Training on the system will be at NIST or at the PSL, depending on our mutual schedules.

UCMM Status

The X axis of the PSL's Moore M48Z universal coordinate measuring machine has been certified and used to perform linear calibrations. Also, the X-Y plane of the machine has been characterized sufficiently for limited certification.

3. Improvement Projects

P-Delta-V Leak Calibration System

The electronics console and computer system for the new P-Delta-V Calibration System, has been acquired. The pumping system, which includes an Alcatel hybrid micropumping station, has been designed and purchased. A contract has been awarded to Sigma Corp. to fabricate the temperature-control enclosure for the system manifold, which should be completed mid-1994. Computer control of the system and data acquisition is being programmed in Visual Basic, and program modules are complete for the valve controller and timers.

Accumulate-Dump Leak Calibration System

The rotary vane fore pumps for the turbomolecular pumps in the Accumulate-Dump Leak Calibration System have been replaced with oil-free pumps. This upgrade makes the system compatible with ES&H requirements for the WPPSL and reduces potential sources of contamination to the system.

Automatic Medium-Vacuum Calibration System (AMVS)

In response to customer requests, the capability to calibrate 0.1-torr capacitance diaphragm gages has been added to the operation of the AMVS. This enables higher accuracy in lower pressure ranges for customer transfer standards.

Upgraded Certification of HP8510 VANA Performance

Following an improved certification program for the Hewlett Packard 8753 Vector Automatic Network Analyzer (HP8753 VANA), an improved program (CERT8510B1) for certifying the scattering parameter measurement uncertainties of the HP8510 VANA has been developed and placed into service. As with

the HP8753 upgrade, the major improvements for reflection coefficient measurement uncertainties offered by the improved program include:

- HP8510 VANA uncertainties (at frequencies where air lines may be used) on large reflection coefficient measurements are now about 0.02, compared with previous values as large as 0.2.
- The operator may now specify the level of confidence, which should be between 81% and 99%, at which reflection coefficient uncertainties (at any frequency) are reported. Computer computation time requirements are significantly greater for the higher levels of confidence.

The first improvement resulted from use of the Thru-Reflect-Line (TRL) technique for evaluation of error model parameters. The TRL technique requires the use of only three certified values and their three small associated uncertainties. On the other hand, the prior technique required the same three certified values in addition to three other certified values, two of which had large uncertainties. Furthermore, the prior technique required "ideal characteristics" assumptions about two other "calculable standards"; TRL requires no such assumptions. Elimination of the two large uncertainties accounts for most of the uncertainty reduction.

The second improvement resulted from (a) the use of a more focused method for incorporating the effects of uncertainties on the standards used in the certification process and (b) the use of nonparametric statistics to characterize the effects of those uncertainties.

Other significant changes in the program include the new ability to replicate standards measurements when certifying transmission magnitude and phase. In addition, computer memory requirements for the program have been substantially reduced by combining the function of several large data arrays.

Upgrade of HP8510 VANA Certification of One or Two Port Devices

An improved program, F102P85-A6, for certifying one or two port devices using a Hewlett Packard 8510 Vector Automatic Network Analyzer (HP8510 VANA) was developed and placed into service. Among the improvements included in this updated program is an option to store the certification parameter files and the certification uncertainties in a DOS directory residing on either the user's PC or a network. Another

change is that certification parameter files stored with prior versions of this program are no longer used (however, the program will read and use the other data in the file). This change was incorporated because of a potential problem with the size of the learn string used in the VANA. Finally, all input/output to the VANA from all subprograms within this program was moved to only one of two subprograms. Subsequent versions of this program will use this change so that the same program may be used for either the HP8510 VANA or the HP8753 VANA.

Time and Frequency

A second Global Positioning System (GPS) clock has been obtained and placed in service in the PSL. This clock does not have the number of features that the number one GPS clock has, but it provides adequate backup. The new GPS clock provides time of day to an uncertainty of about 1 microsecond versus 10 to 100 microseconds for the Geostationary Operational Environmental Satellite receiver, which it replaces.

The Hewlett Packard 5071A cesium-beam frequency standards units, which were placed in service in 1993, are providing standard frequencies to an uncertainty of approximately 1 part in 10^{12} with no problems in operation.

The design for the frequency distribution system for the Weapons Program Primary Standards Laboratory (WPPSL) has been completed. The design specifications have been released to SNL's purchasing department. This redesign incorporates considerations for the shielding of the laboratory modules; improved, low-loss cables; and a common set of frequencies to be delivered to each laboratory. The antenna system for the WPPSL is being redesigned to ensure that it meets safety standards.

In addition, M. G. Daniel attended the NIST training for operation of the Frequency Measurement System (1 day) and the Seminar on Time and Frequency (3 days).

Laser Power and Energy Measurements

A 1-kW laser power meter has been purchased and partially tested. Calibrations at 150 W and 250 W show the meter to be 5% to 10% lower than the present standard for use with a CW YAG laser. The meter appears linear to 550 W after waiting 40 sec for thermal equilibrium at any one power reading. Further tests on detector uniformity, linearity, and effects of cooling water temperature will be carried out before obtaining a calibration at NIST. On the other

end of the power spectrum, the PSL's low power standard was calibrated against two absolute Si trap devices using 0.3 mW of laser power. This calibration route allowed the standard's uncertainty to be decreased from 0.9% to 0.6%. Linearity tests of the PSL's laser pulse energy meter showed that a low-energy roll-off found during long-pulse (0.1 sec) electrical and optical calibration of the device also occurred for 15 nsec YAG laser pulses. Furthermore, the roll-off was the same on the 10 mJ and 100 mJ scales but different on the higher ranges. Absolute offset of the device above the roll-off was excellent: 0% to 3% on the 100 mJ scale. Older models of the device showed the same roll-off but a different dependence on scales, and the absolute calibration was linearly dependent on the time constant measured by the meter after the first laser shot.

4. Calibration and Special Measurements

New Microwave Materials Measurement Capability

New HP 85071B Materials Measurement Software is now operational on the HP8510 VANA and the HP8753 VANA. This software, operating in the Microsoft Windows environment, is a significant upgrade and improvement on the previous version of the software. With the new software, the complex permittivity (ϵ) and permeability (μ) of solid materials can be determined using a variety of sample shapes and measurement techniques. The measurement techniques include transmission, reflection, reflection backed by a short circuit, and reflection backed by an arbitrary termination (suitable for thin film measurements). Samples must be sized to fit in either a coaxial or waveguide transmission line.

Oil Bath Resistance Characterization

A resistance measuring system is being developed to monitor the resistance of the oil in the DC Project's constant temperature oil baths. This system is being developed with funding from the SNL Process Waste Assessment/Waste Minimization Project. Instead of changing the oil in these baths every 1 to 2 years as in the past, the oil will be used until measurements indicate that the oil resistance has decreased to a level that will impact the precision of standard resistance

calibrations. All of the equipment for the measurement system has been purchased and proof of principal has been demonstrated. Final testing and system documentation is currently in process.

NIST Ball Plate

The PSL's Moore M48Z universal coordinate measuring machine has been used to measure the NIST round-robin ball plate. While NIST has not yet sent back a report, a comparison between the PSL's results and those obtained on the M48Z at SNL/CA show excellent agreement.

5. Surveys and Audits

Technical Surveys

During this period, the PSL conducted one technical survey of a CSL (in December), and a survey report was written for three of the technical surveys conducted near the end of the last reporting period.

Measurement Audits

Ten measurement audits were initiated with the CSLs during this period. Eleven measurement audit reports were written on audits previously completed.

6. Customer Service

PSL Customer Service Representative - Inquiries

The Customer Service Representative received 27 inquiries during the period, all of which have been resolved.

7. Significant Events

Chemical Standards Development Project

The Chemical Standards Development Project has been suspended because of FY94 budget limitations. A draft PSLM on chemical standards has been prepared and filed for future reference.

New Weapons Production Primary Standards Laboratory

The building shell is complete with the exception of a list of deficiencies reported by SNL inspectors.

The contractor left the site on November 30, 1993. Sandia has contracted with a different contractor to make up the deficiencies. Sandia personnel from the Facilities Operations & Maintenance Department are working on the air handlers to correct deficiencies. Test and balance are being done by a separate contractor. Temperature recorders have been placed in two of the labs to acquire data on temperature stability. Remarkably the temperature is stable night and day at about 80°F without any heat added to the building even though the outdoor nighttime lows fall below freezing.

The Occupancy Contract was put out for bid on September 9, 1993. After some extensions, bids were received on November 9, 1993. The low bidder, K L House, was awarded the contract on January 3, 1994.

Josephson System Round Robin and Upgrade

Preliminary results from the Josephson Array Round Robin, which involved all of the 10-volt Josephson calibration systems in the United States, indicate extremely good agreement for the PSL system. While final results have not been officially published, the PSL values agreed to within 1 part in 10^8 of the predicted value. In addition, a successful intercomparison between the NIST and PSL 10-volt Josephson calibration systems was completed in August. These two results indicate that the PSL Josephson system is functioning well within its uncertainty limits of 1 part in 10^7 .

Two main software/hardware arrangements in this country are used for operating Josephson Array voltage calibration systems. The PSL has been operating with one of these arrangements for the past several years. However, recently the PSL obtained the necessary software and hardware for the implementation of the second arrangement on our Josephson system. Having both options will give us the opportunity to compare the ease of use, reliability, and special features of each arrangement and to select the one that is most suitable for a particular type of workload or other operating constraints.

NIST Resistance MAP

The DC Project has successfully completed a NIST resistance accreditation study that is a part of our collaboration with the NVLAP program. The study is similar to a NIST resistance map and used four 1- Ω (L&N Model 4210) and four 10,000- Ω (2 ea. ElectroScientific SR104; 1 ea. L&N Model 4214; 1 ea. GR Model 1444-A) standard resistors. The mean value for the 1- Ω resistors assigned by the PSL was

within 0.014 ppm of the NIST-assigned value. For the 10,000- Ω resistors, the PSL mean value assigned using the Hamon Transfer Method was within 0.13 ppm of the NIST assigned value.

CSL Metrologist Training

A CSL metrologist visited the DC Project for a total of 2 weeks this summer and received hands-on training in volt box and potentiometer calibration techniques. During the training, the PSL updated its documentation of the calibration procedure for the volt box standard.

Publication

R. B. Pettit and P. D. Thacher, "Calibration of Beam Power Monitors for Laser Welders," Appendix

in NCSL Recommended Practice RP-12, *Determining and Reporting Measurement Uncertainties*, February 1, 1994.

Presentations

1. P. D. Thacher, "Uncertainties," Standards Laboratory Managers' Meeting, Albuquerque, NM, October 1994.

2. O. M. Solomon, "Calibration of Waveform Digitizers," Standards Laboratory Managers' Meeting, Albuquerque, NM, October 1994.

3. O. M. Solomon, "Estimation of Timing Jitter in Digitized Sine Waves," 1993 NCSL Conference, Albuquerque, NM, July 1993.

APPENDIX A

Certificates and Reports Issued

The certificates and reports issued by the PSL are summarized in this appendix.

Reference Standards for

Allied Signal, Inc., Kansas City Division	60
EG&G Energy Measurements Inc., Las Vegas, NV	68
Martin Marietta Specialty Components, Inc.	44
Lawrence Livermore National Laboratory	11
Los Alamos National Laboratory	29
Mason and Hanger-Silas Mason Co.	49
EG&G Mound Applied Technologies, Inc.	57
Martin Marietta Energy System Inc., Oak Ridge Y-12 Plant	3
EG&G Rocky Flats Plant	20
Sandia National Laboratories/New Mexico	71
Sandia National Laboratories/California	24
Westinghouse Savannah River Laboratory	9
Subtotal	445
Other Reference Standards and Delegated Instruments	327
Special Measurements	19
Subtotal	346
Total	791
Total Active Items Currently in Recall System	5,376

APPENDIX B

Commercial Calibration Laboratories (CCLs)

The latest revision to AL56XA (Rev. 2, May 28, 1993) reestablished much of the guidance for the approval and oversight of commercial suppliers of calibrations for the Nuclear Weapons Complex. This guidance had been removed from the previous revision (Rev. 1). However, Rev. 2 still left room for additional guidance in the form of a Primary Standards Laboratory Memorandum (PSLM) to be issued with DOE approval. Release of this PSLM (PSLM 28) is expected during the first half of CY 1994.

Rev. 2 of AL57XA provided for two types of commercial suppliers whose standards and calibration programs require approval by the contractors' metrology group. These are:

- **Commercial Calibration Laboratory (CCL).** A commercial subcontractor whose primary business is to perform calibration services and who has been approved by either the PSL or the Contractor Standards Laboratory (CSL) to perform calibrations on measurement standards and M&TE of the DOE Nuclear Weapon (NW) contractor or another subcontractor.
- **Designated Calibration Source (DCS).** A subcontractor whose primary business is to provide products or services and who has been approved by either the PSL or a CSL to perform calibrations on its own measurement standards and M&TE, those of the DOE NW contractor, or another subcontractor.

Since the contractor programs are still currently evolving at various rates and have not yet achieved sufficient commonality between programs (including Revision 2 and proposed PSLM 28 requirements) to permit unrestricted use of CCLs or DCSs between contractors, and because of legal issues that must be resolved, the usual list of commercial sources of calibration services is not included in this issue of the PSL Semiannual Report.

Questions regarding this matter should be addressed to W. G. T. Levy of the PSL Surveys and Audits Project, (505) 845-8268.

APPENDIX C

Listing of PSL Memoranda (PSLM)

Over the years the PSL has issued various memoranda that provide general technical requirements and standards of good practice for the CSLs. These memoranda are listed here by number. A review for possible update, addition and/or obsolescence of these PSLMs is continually under way at the PSL. A copy of the latest index of the PSLM will appear in each semiannual report. The current issue reflected herein is Rev. 5 dated 7/19/89. (No changes have occurred through this reporting period.)

PSLM No.*	Date	Title
1A	7/09/80	Exceptions to Recall Requirements
2	1/14/70	(standard leak terminations)**
3B	5/16/88	Laboratory Environments
5E**	7/19/89	Calibration Obtained from Other than the Primary Standards Laboratory
11A	3/06/72	Gage Block Materials
13B	11/20/86	Packaging Requirements for Shipment of Standards
14	11/20/74	Designated Commercial Standards Laboratories
20B	1/30/89	Rating and/or Reporting for Technical Surveys and Measurement Audits
23	6/05/80	NBS Calibrated Standards
24A	7/18/86	Weights to be Calibrated by the PSL
26	3/30/83	Checking and Cross-Checking of Standards
27**	7/19/89	Reference Materials

* Missing PSLM numbers were obsoleted in Rev. 5 or earlier revisions.

** PSLMs still in force affected in Rev. 5 (PSLMs 5E and 27, together, replace PSLM 5D, Calibration Service Not Available from the Primary Laboratory; PSLM 15, Cross Utilization of Contractor Standards Laboratories; and PSLM 22, Calibration Below Reference Standard Level).

APPENDIX D

NIST/NBS Test Numbers

Following is a list of some of the presently valid NIST/NBS test numbers assigned to reports of tests performed for the PSL, including some of the more frequently used standards. However, where traceability is questioned by first-tier suppliers and others outside the DOE/AL Weapons Complex, it is the position of both the DOE/AL and PSL that the memorandum on traceability dated November 25, 1991, written with the concurrence of the DOE/AL, be used to answer such questions. A copy of this memorandum along with DOE's cover memorandum and transmittal letter are reprinted herein for ready reference.

Standard	NIST/NBS Test No.
ac Voltage	809920
ac Current	521/240751
High-Frequency Inductance	808351
Capacitance	249663
High-Frequency Capacitance	811439
Self-Inductance	253058
dc Resistance (Thomas 1 Ω)	811/250261
(hi value resistors)	811/250182
High Voltage Resistor	881/250161-92
High-Voltage Pulse	728/250161-92
Gage Blocks, Long English	821/251200-93
Gage Blocks, Long Metric	821/251200-93
Gage Blocks, Angle	821/249554-92
End Standards	821/250779-92
Threadwires (English)	821/249762-92
Threadwires (Metric)	821/252109-93
Master Steel Balls (English)	821/251866-93
Master Steel Balls (Metric)	821/247725-91
Optical Flats	731/244765-89

Standard	NIST/NBS Test No.
Surface Roughness Standards	821/252241-93
Force (Proving Rings)	
5,000 lbf	822.07/248918
10,000 lbf	822.07/248127
20,000 lbf	822.07/252526
60,000 lbf	732.07/245921
100,000 lbf	732.07/244961
Pressure, Air (Ruska-F/N 4174)	P-8388
Pressure, Air (Ruska-F/N 2409)	P-8468
Pressure, Oil (Ruska-F/N 10029)	P-8387
Pressure, Oil (Ruska-F/N 5327)	P-8288
Ion Gages	
(Granville Philips-F/N 8738)	HV 136A
(Granville Philips-F/N 6508)	NV 161
Spinning Rotor Gages (SRG)	
MKS-11172H	HV 134A
MKS-8696H	HV 134B
MKS Capacitance Diaphragm Gages	
F/Ns 8537, 8549, 8547	V195
F/Ns 7889, 7890, 7893, 10618	V183
Accelerometer (Vibration)	
6830	732/246233-90
6829	822/250465-92
11298	
11299	
Lamps Tungsten Strip	
7005	534/242010-88-1
7002	534/242010-88-2
Thermocouple (Type S)	248034

Note: The voltage maintained by the DC Project since December 4, 1991, has been defined by the Sandia National Laboratories Josephson Voltage System, an intrinsic standard. Proper operation of this standard is checked through periodic intercomparison experiments with NIST. The system converts fre-

quency to voltage by means of a superconducting solid-state array of Josephson junctions. The frequency used is traceable to NIST through the AC Project by means of the NIST Frequency Measurement System.

APPENDIX E

DOE/PSL Memoranda on Standards and Calibration Program

United States Government

Department of Energy

memorandum

Albuquerque Operations Office

DATE: DEC 17 1991
REPLY TO:
ATTN OF: WQD:QOB:ALF(192)
SUBJECT: AL Standards and Calibration Program

TO: Those on Attached List

There have been some inquiries of the Department of Energy (DOE) Albuquerque Field Office (AL) contractors from other federal offices and contractors concerning how traceability of calibrated items is accomplished at their facilities. For continued and up-to-date response to these questions, the Primary Standards Laboratory has revised a memo (originally prepared on November 12, 1986) describing how traceability is accomplished throughout the AL complex, and this office has prepared a memo identifying each contractor facility participating in the AL calibration system. These memos are attached and should be provided to your contractor(s) for answering future inquiries.

A. E. Whiteman
Director
Weapons Quality Division

Attachments

Addressees - Memorandum dated **DEC 17 1991**

J. LaGrone, Manager, OR
D. J. Bostock, Y-12 Plant Manager & Vice President, MMES, Inc., Y-12
P. M. Hekman, Manager, SR
A. L. Schwallie, Executive Vice President, WSRC, SR
N. C. Aquilina, Manager, NV
R. Grant, EG&G Measurement Inc. Las Vegas, NV
S. Metta, Reynolds Engineering & Electric Co., Mercury, NV
P. M. Ramey, Area Manager, AAO
C. C. Alley, Plant Manager, M&H-SM Co., Inc.
J. A. Morley, Area Manager, DAO
D. E. Michel, President, EG&G-Mound
R. M. Nelson, Jr., Manager, RFO
J. O. Zane, General Manager, EG&G, RF
E. W. Bean, Area Manager, KCAO
L. W. Smith, President & General Manager, AS-KCD
G. W. Johnson, Area Manager, PAO
R. C. Abington, General Manager, GEND
J. L. Bellows, Area Manager, LAAO
R. D. Patterson, Office Leader, QOO, MS-K307, LANL
K. A. Carlson, Area Manager, KAO
C. M. Tapp, Director, Org. 4300, SNL
A. E. Hunt, Project Manager, WIPP
A. L. Trego, General Manager, W

memorandum

Albuquerque Operations Office

DATE: DEC 17 1981

REPLY TO
ATTN OF: WQD:QOB:ALF(201)

SUBJECT: AL Standards and Calibration Program: Traceability

TO:

One of the responsibilities of the Albuquerque Field Office (AL) is to insure the accuracy of test and measurement equipment used for weapons design, development, and production throughout the AL complex. To assist us in meeting this responsibility, AL has tasked the Primary Standards Laboratory (PSL) at Sandia National Laboratories, Albuquerque, to provide calibration traceability for each of the following contractors:

Allied Signal Inc., Kansas City Division
General Electric Neutron Devices Department, Pinellas Plant
Los Alamos National Laboratory
Mason & Hanger Silas-Mason Co., Inc., Pantex Plant
EG&G, Mound
EG&G, Rocky Flats Plant
Sandia National Laboratories, Albuquerque
Sandia National Laboratories, Livermore
EG&G Idaho, Inc.
EG&G Energy Measurements, Inc.
Reynolds Electrical & Engineers Co., Inc.
Martin Marietta Energy Systems, Inc., Y-12 Plant
Westinghouse Hanford
Westinghouse, Savannah River
Lawrence Livermore National Laboratory

Attached is a memo prepared by the PSL which contains excerpts from AL Order 57XA, "Standards and Calibration Program." It describes how traceability is achieved throughout the AL complex. If you have any further questions concerning this matter, please contact this office.

A. E. Whiteman
Director
Weapons Quality Division

Attachment

PRIMARY STANDARDS LABORATORY

Sandia National Laboratories, Albuquerque, New Mexico 87185

November 25, 1991

To Whom It May Concern:

The Department of Energy (DOE) has the overall responsibility for all phases of the design and production of nuclear weapons, and it has placed the specific responsibility for these activities with its Albuquerque Field Office, DOE/AL.

Considering the nature of these nuclear devices, the reliability requirement is extremely high. All aspects of Quality Assurance are given high priority by DOE/AL in carrying out its responsibilities for the nuclear weapons program. One of the particularly important quality elements is the assurance that measuring and test equipment used throughout all phases of the program are providing proper measurements and are properly calibrated.

One of the documents relating to the requirements for the prime contractors engaged in the various phases of the nuclear weapons program is AL Order 57XA, Rev. 1, "Standards and Calibration Program" dated October 22, 1990, which addresses in substantial detail the means for assuring that proper measurement results are being obtained. This Order provides that Sandia National Laboratories (SNL) establish a Primary Standards Laboratory (PSL) and that reference level calibration laboratories be established at each of the prime contractors. These calibration laboratories are termed Contractor Standards Laboratories (CSLs). It also states the requirements for the PSL and CSL, as well as DOE/AL, their Area Offices, and other DOE Field Offices, relative to the implementation of the standards and calibration program which insures the accuracy of measurements made for the nuclear weapons program.

The purpose and scope of AL Order 57XA as stated therein is as follows:

"PURPOSE. This Order assigns responsibilities and sets forth the minimum requirements for the management and operation of the Nuclear Weapons Standards and Calibration Program (NWSCP). This program provides for a system to ensure the accuracy of measurement standards and measuring and test equipment (M&TE) used in nuclear weapons activities."

"SCOPE This order is applicable to the Department of Energy (DOE) and their contractors who are engaged in activities related to the research, design, development, preproduction, production, testing, stockpile evaluation, and retirement of nuclear weapons. Requests for deviation from any part of this Order must be submitted to DOE Albuquerque Operations [Field]* Office (AL)."

*Information enclosed in brackets ([]) does not appear as such in AL57XA but is added here for clarity.

One of the most important aspects of the AL Standards and Calibration Program is "Traceability", which is defined in paragraph 5.s. as follows:

"Traceability. The ability to relate individual measurement results through an unbroken series of calibrations to one or more of the following: 1) U. S. national standards maintained by the National Institute of Standards and Technology; 2) national standards of other countries which are correlated with U. S. national standards; 3) accepted values of fundamental physical constants; 4) values derived by the ratio type of self calibration techniques; 5) values obtained using nationally accepted measurement systems; or 6) comparison with consensus standards."

Paragraph 6.d. of AL Order 57XA establishes Sandia National Laboratories as the location of the Primary Standards Laboratory for the DOE/AL Weapons Complex as follows:

"SNL

- "(1) Establishes the highest level metrology organization for the Nuclear Weapons Program, the PSL, by providing facilities, staff, equipment, and management for implementation of the NWSCP.**
- "(2) Ensures the PSL maintains an effective standards and calibration program in accordance with this Order."**

The requirements most closely concerned with traceability for the PSL and CSLs in this regard are covered in paragraphs 6.e. (1) and 6.e. (2), respectively as follows:

"(1) Primary Standards Laboratory

- (a) coordinates the system-wide NWSCP for the DOE and their contractors by providing technical guidance, training, and consultation;**
- (b) publishes the PSLM; [Primary Standards Laboratory Memoranda].**
- (c) provides a research and development program in the area of measurement technology to enable the timely provision of new measurement standards and M&TE for a properly balanced program and measurement compatibility;**
- (d) develops, maintains, or specifies primary standards;**

November 25, 1991

- (e) provides the certification of reference standards, when they are within their capacity and capability, to the contractors; [when neither the PSL or NIST have the capability, the PSL oversees the CSL source of outside calibration].
- (f) provides technical oversight of the contractors by:
 - 1 performing and reporting the results of technical surveys of the contractor's standards and calibration programs;
 - 2 periodically attending contractor surveys of current and potential CCLs; [Commercial Calibration Laboratories]; and
 - 3 conducting and reporting the results of measurement audits of the contractor's metrology organization.
- (g) provides immediate feedback to the appropriate DOE office when any deficiencies are identified during the technical survey; and
- (h) reviews the contractor's procedures for approval and oversight of CCLs."

"(2) Contractors:

- (a) provide facilities, staff, equipment, and management for implementation of the NWSCP and establish the CSL function;
- (b) maintain certified reference standards; and certify and maintain working and transfer standards and M&TE, and any associated instruments used to perform calibrations;
- (c) consult with their CSL organization prior to procurement of M&TE which may require calibration to determine whether the procurement could impact the current calibration capability;
- (d) utilize the other Contractors, when necessary, to obtain calibrations that are not within their current capacity and/or capability;
- (e) consult with the PSL prior to procurement of measurement standards and M&TE which may impact the current PSL capability;

November 25, 1991

- (f) maintains and provides to the PSL, documented procedures for the approval and oversight of CCLs to ensure the integrity of procured products and/or services. The extent of the approval and oversight activities for each CCL will be dependent upon the complexity of the product or service provided. CCLs will be approved to perform calibrations within specific measurement fields, ranges, and uncertainties;"

The calibrations certified by the Primary Standards Laboratory and Contractor Standards Laboratories at their respective levels are covered by the above requirements.

In accordance with AL Order 57XA, the Director of DOE/AL's Weapons Quality Division reviews and performs periodic surveys of the operation of the PSL for conformance to these requirements. In addition, the PSL performs periodic technical surveys of the CSL operations and operates a technical measurement audit program for all of the CSLs per AL Order 57XA. The PSL also routinely participates in Measurement Assurance Programs (MAPs) sponsored by the NIST to insure that the continued calibration capabilities are maintained at a high point of proficiency.

Evidence of traceability is maintained on file in the Primary Standards Laboratory along with detailed documentation of each calibration. The Primary Standards Laboratory publishes a semi-annual report of its major activities which includes a section on typical National Institute of Standards and Technology Test Numbers. Each CSL also maintains detailed evidence of traceability in their files for instruments calibrated in their laboratory.

R. T. Johnson, Jr., Manager
Measurement Standards
Department 4340

WGTL:4343:gp
Semi AA0

DISTRIBUTION:

- 3 US Department of Energy
Albuquerque Operations Office
Attn: J. M. Eckart, Chief, QP Branch, WQ Div
J. H. Hines, Chief, PA Branch, OM Div
A. E. Whiteman, Director, WQ Div
PO Box 5400
Albuquerque, NM 87115
- 2 US Department of Energy
Amarillo Area Office
Attn: P. M. Ramey, Area Manager (AAO)
D. B. Buckridge, Chief, QA Branch
PO Box 30030
Amarillo, TX 79120-0030
- 2 US Department of Energy
Dayton Area Office
Attn: J. A. Morley, Area Manager (DAO)
I. H. Schmidt III, Chief
Weapons Quality Branch
PO Box 66
Miamisburg, OH 45343
- 2 US Department of Energy
Idaho Operations Office
Attn: A. A. Pitrolo, Manager (ID)
W. N. Sato, Director, Waste Mgmt Div
785 DOE Place
Idaho Falls, ID 83402
- 2 US Department of Energy
Kansas City Area Office
Attn: E. W. Bean, Area Manager (KCAO)
C. C. Ross, Chief, QA Branch
PO Box 202
Kansas City, MO 64141-0202
- 2 US Department of Energy
Kirtland Area Office
Attn: Kathleen A. Carlson,
Area Manager (KAO)
PO Box 5400
Albuquerque, NM 87115
- 2 US Department of Energy
Los Alamos Area Office
Attn: J. L. Bellows, Area Manager (LAAO)
528 35th Street
Los Alamos, NM 87544
- 2 US Department of Energy
Nevada Operations Office
Attn: N. C. Aquilina, Manager (NV)
M. P. Kunich, Director, QA Division
PO Box 98518
Las Vegas, NV 89193-8518
- 2 US Department of Energy
Oak Ridge Operations Office
Attn: J. W. LaGrone, Manager (OR)
G. L. Galloway, Assistant Manager
Weapons Programs
PO Box 2001
Oak Ridge, TN 37831-8764
- 2 US Department of Energy
Pinellas Area Office
Attn: G. W. Johnson, Area Manager (PAO)
H. F. Gregory, Chief, QA Branch
PO Box 2900
Largo, FL 34649
- 2 US Department of Energy
Richland Operations Office
Attn: John Wagner, Manager (RL)
R. E. Gerton, Director,
Environ, Safety, Health, and QA Div
PO Box 550
Richland, WA 99352
- 3 US Department of Energy
Rocky Flats Office
Attn: M. N. Silverman, Manager (RFO)
D. W. Sargent, Stds Performance
& Assurance Div
E. D. Robins, Quality Engr.
PO Box 928
Golden, CO 80401-0928
- 2 US Department of Energy
San Francisco Operations Office
Attn: D. W. Pearman Jr, Manager (SAN)
J. Davis, Director, Env. Safety & QA Div
1333 Broadway Wells Fargo Building
Oakland, CA 94612

DISTRIBUTION (Continued):

<p>2 US Department of Energy
Savannah River Operations Office
Attn: M. P. Fiori, Manager (SR)
R. D. Rollins, Director
Quality Programs
Division
PO Box A
Aiken, SC 29801</p> <p>4 Allied-Signal Aerospace Co.
Kansas City Division
Attn: C. W. Berry Jr, D/400-BR28
PO Box 419159
Kansas City, MO 64141-6159</p> <p>3 EG&G Idaho, Inc.
Attn: H. J. Moody, CFA 698-MS 4137
PO Box 1625
Idaho Falls, ID 83415</p> <p>4 EG&G, Energy Meas., Inc.
Attn: W. Y. Endow, MS A13-10
PO Box 1912
Las Vegas, NV 89125</p> <p>3 Martin Marietta Specialty
Components, Inc.
Attn: Gayle Crist
PO Box 2908, MS-037
Largo, FL 34649</p> <p>3 Westinghouse Savannah River Co.
Savannah River Laboratory
Attn: R. A. Anderson, Bldg. 736A
Aiken, SC 29802</p> <p>3 Los Alamos National Laboratory
Attn: A. L. Gauler, MS D478 (2)
R. D. Patterson, K30-H
PO Box 1663
Los Alamos, NM 87544</p> | <p>5 Lawrence Livermore National Laboratory
Attn: R. E. Braley, L-228
Tom Miller
M. F. DeMicco, L-394
J. Sedlacek
R. C. Lucena
PO Box 808
Livermore, CA 94550</p> <p>1 National Aeronautics and Space Admin.
Kennedy Space Center
Attn: Kristen Riley
SI-PEI-1B
KSC, FL 32899</p> <p>1 National Aeronautics and Space Admin.
White Sands Test Facility
Attn: Troy J. Estes
PO Drawer MM
Las Cruces, NM 88004</p> <p>5 Mason & Hanger-Silas Mason Co.
Attn: D. R. Wilhelm
PO Box 30020
Amarillo, TX 79177</p> <p>6 EG&G Mound Applied Technologies, Inc.
Standards and Calibrations
Attn: R. L. DeHart, Bldg. 93
PO Box 3000
Miamisburg, OH 45343</p> <p>2 Reynolds Electrical & Engr. Co.
Attn: G. A. Erickson, MS628
PO Box 98521
Las Vegas, NV 89193-9821</p> <p>5 EG&G Rocky Flats Plant
Attn: T. R. Kawamoto, Manager
Standards Lab
PO Box 464
Golden, CO 80402-0464</p> |
|---|---|

DISTRIBUTION (Concluded):

4 Martin Marietta Energy Systems, Inc.
Attn: Jackie Hill, Bldg. 9111, MS-8234
PO Box 2009
Oak Ridge, TN 37831-2009

3 Westinghouse Hanford Company
Attn: Don Nelson, N1-67
PO Box 1970
Richland, WA 99352

1 MS0360 A. R. C. Westwood, 1000
30 MS0366 R. T. Johnson, Jr, 1740
1 MS0365 L. J. Azevedo, 1741
1 MS0365 R. B. Pettit, 1742
1 MS0823 B. E. Barnaby, 1743
2 MS1004 J. M. Simons, 1744
1 MS1004 L. M. Holmes, 1744-1
1 MS0960 J. Q. Searcy, 2400
1 MS0961 J. F. Gonzales, 2402
1 MS0957 J. A. Sayre, 2403
1 MS0958 C. L. Atwood, 2484-1
1 MS0958 K. J. Conrad, 2484-1
1 MS0511 G. N. Beeler, 2500
1 MS0985 J. H. Stichman, 2600
1 MS0507 R. A. David, 2700
1 MS0557 G. L. West, 2701
1 MS0555 V. Gabbard, 2707
1 MS0557 T. J. Baca, 2741
1 MS0557 D. O. Smallwood, 2741
1 MS0630 J. F. Jones, Actg, 2800
1 MS0467 K. D. Nokes, 5091
1 MS0429 W. C. Nickell, 5100
1 MS9006 E. E. Ives, 5200
1 MS9005 J. B. Wright, 5300
1 MS0473 H. J. Saxton, 5400
1 MS0461 D. L. McCoy, 5504
1 MS0571 R. L. Ewing, 5914
1 MS0574 C. S. Lee, 5941
1 MS1337 D. E. Ellis, 6300
1 MS1333 L. E. Shephard, 6302
1 MS1335 W. D. Weart, 6303

1 MS1333 R. R. Richards, 6319
1 MS0755 A. E. Verardo, 6612
1 MS1064 P. D. Yourick, Actg, 7001
1 MS0173 F. Gallegos, 7400
1 MS1315 Tom Blejwas, 7500
1 MS0651 C. J. Pigg, Actg, 7712
1 MS1095 D. J. Thompson, 7713
1 MS1093 H. N. Jow, 7714
1 MS0651 A. L. Stanley, 7715
1 MS1045 M. M. Carroll, 7732
1 MS1045 A. M. Fine, 7733
1 MS0935 M. I. Spitz, 7801
1 MS9037 R. J. Detry, 8200
4 MS9131 D. P. VanDyke, 8201
1 MS0970 T. A. Sellers, 9200
1 MS1165 J. E. Powell, 9300
2 MS1367 C. R. Arana, 10104
1 MS0631 R. L. Schwoebel, 12300
1 MS0632 G. T. Merren, 12302
1 MS0632 J. L. Duncan, 12303
1 MS0829 R. G. Easterling, 12323
1 MS0638 M. A. Blackledge, 12326
1 MS0490 S. D. Spray, 12331
1 MS0492 G. A. Sanders, 12332
1 MS0491 R. E. Smith, 12333
1 MS0627 G. C. Novotny, 12334
1 MS0830 J. M. Sjulín, 12335
1 MS0637 E. L. Saverino, 12336
1 MS1390 O. R. Hernandez, 12364
1 MS0635 E. A. Disch, 12365
1 MS0636 R. M. Oelsner, 12367
1 MS1369 C. M. Tapp, 12900
1 MS1365 J. K. Gabaldon, 12903
1 MS0149 R. R. Prairie, 12908
1 MS1359 D. W. Bushmire, 12911
1 MS9018 Central Technical Files, 8523-2
5 MS0899 Technical Library, 7141
1 MS0619 Technical Publications, 7151
10 MS0100 Document Processing, 7613-2
For DOE/OSTI

DATE

FILMED

6 / 29 / 94

END