NVLAP Gap Analysis

Federal Manufacturing & Technologies

K. A. Shroyer

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NVLAP GAP ANALYSIS

K. A. Shroyer

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Final Report
K. A. Shroyer, Project Leader

Project Team:
Metrology

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Abstract

The capabilities of AlliedSignal Metrology were compared to the requirements contained in the National Voluntary Laboratory Accreditation Program (NVLAP) Calibration Laboratories Handbook and NVLAP Calibration Laboratories Technical Guide. The initial analyses demonstrated a need for improved measurement uncertainty analyses, additional control artifacts, and improved statistical process control. The analysis also revealed the need for a formalized customer complaint system and a calibration quality manual.

Summary

A gap analysis between current capabilities and NVLAP (National Voluntary Laboratory Accreditation Program) requirements was completed for the following measurement parameters: Force, Alternating Current, Vibration, Mass, Humidity, Temperature, Pressure, DC Resistance, RF Power, S-parameters, Photometry, Frequency, and Time. The overall review of these analyses revealed a readiness for certification in the measurement parameters of Force, Shock, and Vibration. The analysis also demonstrated the need to develop a formal customer complaint system and a calibration quality manual

The customer complaint system and the calibration quality manual were designed, written, and incorporated into Command Media. A formal application for NVLAP certification in Force, Shock, and Vibration was submitted with evaluation of AlliedSignal Metrology expected in calendar year 1997.

Discussion

Scope and Purpose

The planned technical approach was to evaluate AlliedSignal Metrology against the general accreditation requirements contained in the NVLAP (National Voluntary Laboratory Accreditation Program) Calibration Laboratories Handbook and to evaluate specific measurement parameters against the technical criteria contained in the NVLAP Calibration Laboratories Technical Guide.

These evaluations provided AlliedSignal Metrology with an analysis of our capabilities as compared with the most current industry information on calibration of measurement standards related to accreditation. It provided a basis by which our calibration program could be assessed for competency.

Additional goals were to correct general deficiencies and select measurement parameters for possible accreditation in accordance with the National Voluntary Laboratory Accreditation Program.

Activity

Development of Evaluation Methodology

A small team of engineers and technologists was formed to review the two NVLAP documents and develop a method to be used to document the analysis for each measurement parameter. An Excel spreadsheet was developed which identified each of the general requirements for any measurement parameter. The spreadsheet also established the format to report all of the technical requirements for the selected measurement parameters and allowed the team to identify additional capital equipment needed and an estimate of any additional personnel costs over our current operating methods.

The technical parameters were selected to provide an overview of all of the Metrology capabilities. The specific technical parameters selected were

- Force,
- Alternating Current,
- Vibration,
- Humidity,
- Temperature,
- Pressure,
- Direct Current Resistance,
- RF Power,
- S-parameters,
- Photometry,
- Frequency, and
- Time.

Evaluation of General Requirements

The requirements for organization and management were already in place, except for the formal naming of the "Quality" and "Technical" managers. The documentation to support AlliedSignal compliance with these requirements was in the existing Command Media for the calibration organizations. The naming of these managers was included as a part of the Calibration Quality Manual.

The general requirements under the "Quality System, Audit and Review" portion required generation of a formal Customer Complaint System and the Calibration Quality Manual, even though many of the requirements were already in place in Command Media and other documents.

All of the personnel and training requirements contained in the NVLAP requirements were satisfied by existing Command Media and the KCD Qualification & Training System.

The current Metrology calibration areas met all of the accommodation and environmental requirements, including those to monitor and record appropriate environmental conditions.

The general requirements for equipment control and reference materials were easily met with the current operating practices, including the record keeping requirements. There was one potential area of conflict identified, which was the requirement to affix tamper-resistant seals to operator-accessible controls. The current Metrology practice is to affix these seals only on those controls which can be "inadvertently" changed during operation of the measurement standard.

The measurement traceability and calibration requirements mirror the current Department of Energy requirements for traceability and control of measurement standards and reference materials. The requirement for documented uncertainty analyses which are based upon the methodology of ISO/TAG 4/WG3: June 1992 is not currently in place for all calibrations. The uncertainty analysis technique utilized by Metrology is based upon the National Institute of Standards and Technology Technical Note 1297: 1994 Guidelines for Evaluating and Expressing the Uncertainty of NIST Measurement Results. Work is under way to complete these analyses for all calibrations performed by Metrology.

The general requirements associated with calibration methods were already in place due primarily to previous efforts to meet ISO 9001 requirements and the Department of Energy software quality assurance requirements.

The existing methods for handling, identifying, storing, and shipping of measurement standards met the requirements and were already documented in Command Media.

A separate requirement for maintaining a record system and record storage system was met by the existing systems.

The general NVLAP requirements for certificates and reports mirror the requirements contained in ANSI/NCSL Z540-1-1994, which is a recent requirement placed on AlliedSignal. All reports generated after June 30, 1996, were required to meet the requirements of this American National Standard for Calibration. Work Instruction 04.06.03.01.02 (How to Prepare and Revise a Metrology Report) was revised to include the requirements of these documents.

The requirements concerning subcontracting of calibrations is more than adequately covered by the current program to control Designated Calibration Sources and Commercial Calibration Laboratories. This program is defined in Work Instruction 04.06.04.03.02 (How to Prepare, Conduct and Report CCL/DCS Technical Surveys).

The general requirements for control of outside support services and supplies raised the question of what supplies were actually covered by this document. After discussion with NVLAP personnel, it was decided that only those supplies which could significantly affect the calibration needed to meet these requirements. The current AlliedSignal material procurement system, with some additional testing by our materials test laboratory, meets this need.

The last set of general requirements covered complaints. This was identified as an area of noncompliance because no formal customer complaint system existed.

Calibration Quality Manual

The overall review of general requirements pointed out the need to develop a comprehensive Calibration Quality Manual. A team was developed to review this need. The manual was formatted to match the requirements in the NVLAP Calibration Laboratories Draft Handbook, which provided ease of review by NVLAP personnel. A draft manual was completed and submitted to NVLAP for their review. The review resulted in some changes to the manual. The completed manual was then incorporated into Command Media as Process Description 04.06.00.00 (Calibration Quality Manual). The use of the Command Media solved the two major problems associated with the document, which were to ensure that the right issue was used and to make the document visible to those associates who needed to comply with it.

Customer Complaint System

The NVLAP document requires the calibration laboratory to have documented policies and procedures for the resolution of complaints received from clients or other parties about the laboratory's activities. There were policies and procedures in place to cover survey findings, measurement audit findings, and any complaint serious enough to enter into the plant Root Cause Analysis Report (RCAR) System. There were no formal documentation requirements for other types of issues.

A total quality team was formed by Metrology which was cross functional to the extent that it included members from the other calibration organizations. This team was charged with the responsibility to develop a customer complaint system which would be applicable to any complaint covering the calibration functions. The team reviewed other complaint systems and generated a system which was approved by management as meeting the needs of the overall calibration program. This system was entered into Command Media as Work Instruction 04.06.04.01.01 (How to Process a Customer Complaint).

Evaluation of Technical Requirements

The technical requirements for each measurement parameter are contained in the NVLAP Calibration Laboratories Technical Guide. This guide is organized into eight fields of calibration and the associated parameters covered by this program.

An Excel spreadsheet was developed to document our compliance with the requirements and to record any additional capital equipment or associate hours needed for compliance. This analysis was completed on twelve parameters. Each requirement associated with the parameter was identified and entered on the spreadsheet. An analysis was then performed to determine the degree of compliance which existed. An evaluation was also performed to determine what was needed to come to compliance and what the equipment and personnel costs were estimated to be.

This analysis was documented for each of the selected parameters. During this time period, the Primary Standards Laboratory (PSL) at Sandia National Laboratories applied for NVLAP accreditation. Additional evaluations were placed on hold until data could be shared as to what was actually needed to achieve accreditation. The information shared by the PSL eliminated the need for us to compare our technical measurement capability for any other parameters. NVLAP personnel had agreed to accredit a laboratory based upon their documented uncertainty, rather than upon the uncertainties listed in the guide. As a result, work was suspended on the gap analysis and concentrated instead on completing the customer complaint system and the Calibration Quality Manual.

Accomplishments

A thorough gap analysis was completed to determine the degree of compliance with the accreditation requirements contained in NVLAP Calibration Laboratories Draft Handbook and in the NVLAP Calibration Laboratories Technical guide, as it relates to the overall general requirements and twelve measurement parameters.

A formalized customer complaint system was developed as a result of this project which will include all of the calibrating organizations at AlliedSignal Federal Manufacturing & Technologies (FM&T).

A Calibration Quality Manual was completed which documents all of the requirements needed to meet those general requirements of NVLAP accreditation.

Conclusions

The gap analysis demonstrated that AlliedSignal Metrology was ready to pursue NVLAP accreditation in several of the measurement parameters. Other measurement parameters will have to be postponed until additional equipment or process changes can be incorporated.

A formal application for accreditation in the Mechanical field, covering the parameters of Force, Vibration, and Shock, was submitted to the NIST personnel who administer the NVLAP program.

Appendix
NVLAP Gap Analysis Excel Spreadsheets

TECHNICAL NVLAP GAP ANALYSIS

LAB: Force	AREA: Mechanical	PARAMETER: Force	ENGINEER:	TECHNOLOGIST:
KCD Capabilities	0 to 5 lbf., $\pm 0.1\%$; 5 to 300 lbf., $\pm 0.005\%$; 300 to 2400 lbf., $\pm 0.01\%$; 2400 to 3000 lbf., ± 0.375 lbf.; 3000 to 5000 lbf., ± 0.625 lbf.; 5000 to 10000 lbf., ± 1.5 lbf.; 10000 to 20000 lbf., ± 2.5 lbf.; 20000 to 30000 lbf., ± 4.5 lbf.; 30000 to 60000 lbf., ± 7.5 lbf.; 60000 to 100000 lbf., ± 15 lbf., 100000 to 300000 lbf., ± 150 lbf.; 300000 to 500000 lbf., ± 500 lbf.			
Manual Statement:				
Desired NVLAP Statement:	Same as KCD Capabilities. Force calibrations to meet ASTM E 74-91, Standard Practice of Calibration of Force Measuring Instruments for Verifying the Force Indication of Testing Machines.			

Requirement	Reference Para.	Met (Y/N)	Action (s) required to meet	Estimated Cost to Meet			
				M/H	Dept	Equip	Cost(\$)
1) Documented uncertainty analysis per NIST Technical Note 1297.		N	Need to document uncertainty analysis for both dead weight testers and proving ring calibrations.	80	423		5796
2) Recommended room temperature 23 ± 2.0 °C.	2.7.6.3.1	N	Recommendation only, no action required.				
3) Temperature stable to ± 0.5 °C during calibration.	2.7.6.3.2	Y	Need to document this requirement in calibration procedure.	1			72
4) Calibration data corrected if temperature changes more than ± 0.2 °C during calibration for non-temperature compensated devices.	2.7.6.3.2	Y					
5) Primary Standard weight construction.	2.7.6.4.2	N	Do not meet all req'ts. Would try accred. with current equip.				
6) Mass of primary weights known to within 0.005% of nominal.	2.7.6.4.3	N	Would have to calibrate weights more often to verify our calibration process (Start with 1/ year) or buy new balance.	15	421		858/yr.
7) Calibration records of weights retained.	2.7.6.4.3	Y	Require on KCD-1442.	15	423		1087/yr.
8) Uncertainty of vertical comp. of force known.	2.7.6.4.3	Y	Document in uncertainty analysis.				
9) Primary standards calibrated every 5 years.	2.7.6.4.4	Y					
10) Loading system exhibits no losses during use.	2.7.6.4.5	Y	Document in uncertainty analysis and in CP.	5	423		362
11) Secondary standard uncertainty $\pm 0.05\%$ of force. Lower load limit 2000 times uncertainty.	2.7.6.4.6	?	We don't currently use lower load limit but we could. The cost would be determined by number of cal's done per year.				
12) Secondary standards calibrated every 2 years.	2.7.6.4.7	N	Send to NIST. Current cost for cal is 11600 every 3 years.				2000/yr.
13) T.I.s used to calibrate testing machines to have uncertainty of 0.25% and lower limit of 400 x uncertainty based on calibration data.	2.7.6.4.8	?	We could do this but we don't currently. Additional cost would depend on number of cal's/year.				
14) T.I. cal interval to be 2 years max. provided cal curve change $\leq 0.1\%$ F.S.	2.7.6.4.9	?	We don't certify this way but we could.				
15) Plan for overloaded instruments between cal's.	2.7.6.4.10	?	Would only be a reporting change.				
16) Accessories marked for load capacity.	2.7.6.4.11	N	Would require load testing for all adapters.				3000
15) Electrical instruments max interval 12 months.	2.7.6.4.12	?	We would require this on whatever instrument used.				
16) Process control for electrical instr.	2.7.6.4.12	N	Would have to set up.	12	421		700/yr.
17) Elect. instr. uncertainty < 0.1 μ volt/volt..	2.7.6.4.13	N	Would require state of the art supply and DVM.				
			Other option would be to not perform this type of calibration.				
				Total Cost (\$)			

Recommendations: Complete uncertainty analysis, CP changes, and develop software (potential new business applications) even if NVLAP accreditation is not pursued. Review additional calibration dollars with Metrology management.	Estimated uncertainty level that would require no further action:	Not applicable.
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*Note: For calculating cost of manpower, use rates based on using Paid Project - Non- Weapon Overhead: D/421 Rate is \$57.20/hour, D/423 Rate is \$72.45/hour.

TECHNICAL NVLAP GAP ANALYSIS

LAB: Force AREA: Mechanical PARAMETER: Force ENGINEER: TECHNOLOGIST:

KCD Capabilities Manual Statement: See first page.

Desired NVLAP Statement: See first page.

Requirement	Reference	Met (Y/N)	Action (s) required to meet	Estimated Cost to Meet			
				M/H	Dept	Equip	Cost(\$)
(18) Calibration methods to be per ASTM E 74-91.	2.7.6.5	N	Only thing we don't meet is switching between tension and compression loading in middle of run. Additional cal time.				
(19) Calibration record maintenance per 2.7.6.6.	2.7.6.6	Y					
(20) Records maintained for 5 years.	2.7.6.6	N					
(21) Calibration reports per 2.7.6.7.	2.7.6.7	?					
(22) Measurement assurance or process control in place to support level of uncertainty desired.		?	We would just have to start doing this. (Require on 1442). the calibration data. We have capability to report this way, but would best be accomplished by writing new software to perform all calculations and statistics during the calibration. Investigate feasibility of round robin.	100	423		7245
				Total Cost (\$)			
				16475 +			

Recommendations: Estimated uncertainty level that would require no further action: \$4645/year.

* Note: For calculating cost of manpower, use rates based on using Paid Project - Non-Weapon Overhead: D/421 Rate is \$57.20/hour, D/423 Rate is \$72.45/hour.

TECHNICAL NVLAP GAP ANALYSIS

LAB: Temp/Hum	AREA: Metrology	PARAMETER: Humidity	ENGINEER:	TECHNOLOGIST:			
KCD Capabilities	-70°C to 0.0°C	±0.5°C					
Manual Statement:	5% RH to 95% RH	±0.5% RH					
Desired NVLAP Statement: Same as above							
Requirement	Reference Para.	Met (Y/N)	Action (s) required to meet	Estimated Cost to Meet			
				M/H	Dept	Equip	Cost(\$)
1. SPRT's calibrated per good laboratory practice. (e.g. every six months)	2.8.1.3.1	N	Calibrate every six months instead of every year.	4	421		228.80
2. Pressure gages calibrated per good laboratory practice. (e.g. every six months)	2.8.1.3.1	N	Calibrate every six months instead of every year.	3	421		171.60
3. Resistance measurements made with std resistors	2.8.1.3.3	Y					
4. Personnel trained in math and physics.	2.8.1.4	Y					
5. Laboratory vibration, temp. and ventilation adeq.	2.8.1.5	Y					
6. Lab should have sufficient accuracy to make measurements of voltage, current, resistance, gas flow, pressure and temperature to achieve the desired moisture uncertainty.	2.8.1.6	Y					
7. Temperature standards traceable to NIST.	2.8.1.7.1	Y					
8. Pressure standards traceable to NIST.	2.8.1.7.2	Y					
9. All computer programs should be documented.	2.8.1.8.1	Y					
10. Mirror surfaces cleaned with ethanol before cal	2.8.1.8.3	Y					
11. Mirror chambers maintained at proper temp.	2.8.1.8.4	Y					
12. Allow humidity gen. to stabilize before using.	2.8.1.8.5	Y					
13. Measurement not taken until equilibrium.	2.8.1.8.6	Y					
14. Hygrometers connected in parallel to gas inlet.	2.8.1.8.7	Y					
15. Sensors installed in the test chamber of gen.	2.8.1.8.9	Y					
16. Test chamber stabilized before measurements.	2.8.1.8.10	Y					
17. Water vapor equilibrium reached before use.	2.8.1.8.11	Y					
18. Use only distilled or high purity water.	2.8.1.8.13	Y					
19. Sensor heads installed in humidity chamber.	2.8.1.8.14	Y					
20. Test chamber stabilized before measurements.	2.8.1.8.15	Y					
21. Flow rate on psychrometers should be approx. 140 liters per minute.	2.8.1.8.16	Y/N	We use flow rates recommended by the manufacturer for different humidity levels. (Thunder Scientific)	none			0.00
				Total Cost (\$)			400.40
Recommendations:			Estimated uncertainty level that would require no further action:				

* Note: For calculating cost of manpower, use rates based on using Paid Project - Non- Weapon Overhead: D/421 Rate is \$57.20/hour, D/423 Rate is \$72.45/hour.

TECHNICAL NVLAP GAP ANALYSIS

LAB: Temp/Hum	AREA: Metrology	PARAMETER: Temperature	ENGINEER:	TECHNOLOGIST:			
KCD Capabilities ± 0.01 °C to 0.05 °C (-183 °C to +500 °C) Manual Statement: $\pm 0.4\%$ of reading (500 °C to 1093 °C)							
Desired NVLAP Statement: ± 0.01 °C to 0.05 °C (-183 °C to -40 °C) ± 0.005 °C (-40 °C to 420 °C) Class 1 Fixed Points and SPRT's $\pm 0.2\%$ of reading (420 °C to 1700 °C)							
Requirement	Reference Para.	Met (Y/N)	Action (s) required to meet	Estimated Cost to Meet			
				M/H	Dept	Equip	Cost(\$)
1. Documented uncertainty analysis per NIST Technical Note 1297		N	Need to document uncertainty analysis for fixed point cells, SPRTs, resistance bridges and digital readouts	60	421		
2. Record of phase equilibrium plateaus for each fixed point cell upon receipt and every 6 months	2.8.2.4.1.1	N	Need to change requirements on cell usage	30	421		
3. Separate check thermometer for each cell and control charts maintained	2.8.2.4.1.2	N	Requires more calibration time, SPRTs and resistance bridge.	20	421		
4. Control charts for triple point of water resistance change no more than table specification for class.	2.8.2.4.2.1	N	Need to create control charts	10	423		
5. Thermocouple as reference standard have control charts for fixed point cells.	2.8.2.4.4	N	Need control charts	20	421		
6. Liquid in glass as ref. std. Maintain records and daily ice pt. check after use.	2.8.2.4.5.1	N	Check ice pt. after each use	10	421		
7. Personnel attend NIST Precision Thermometry workshop	2.8.2.5	Y	None				
8. Controlled environment	2.8.2.6.1	Y	None				
9. Temperature stable within ± 5 °C.	2.8.2.6.2	Y	None				
10. Humidity between 30 and 50% RH	2.8.2.6.3	N	Install better system	?			
11. Vibrations minimized	2.8.2.6.4	Y	None				
12. Acceptable ref. standard for each thermometer class.	2.8.2.7.1	Y/N	Limited fixed point cells	?			
13. Purity of fixed pt. material and sealed/unsealed cells.	2.8.2.7.2.1	Y					
14. Fixed pts define ITS-90 or well characterized secondary points	2.8.2.7.2.2	Y/N	Low temp. comparison device not characterized	10	421		
15. Resistance bridge with adequate uncertainty per table per class.	2.8.2.7.3.2	N	Obtain an automated DC Bridge and std. resistors/bath			\$90k	
16. DVM or DMM per table (alternate to 15)	2.8.2.7.3.3	N	Not required if above bridge is obtained				
17. Cells evaluated by NIST	2.8.2.8.1.1	Y/N	Not all of the cells have been evaluated	?			
18. Cells evaluated by supplier traceable to NIST	2.8.2.8.1.2	Y	None				
19. Cells evaluated by NVLAP accredited supplier	2.8.2.8.1.3	N	The supplier must obtain NVLAP approval				
				Total Cost (\$)			
Recommendations:			Estimated uncertainty level that would require no further action:				

* Note: For calculating cost of manpower, use rates based on using Paid Project - Non- Weapon Overhead: D/421 Rate is \$57.20/hour, D/423 Rate is \$72.45/hour.

TECHNICAL NVLAP GAP ANALYSIS

LAB: Temp/ Hum AREA: Metrology

PARAMETER: Temperature ENGINEER:

TECHNOLOGIST:

KCD Capabilities
Manual Statement:

Desired NVLAP
Statement:

Requirement	Reference Para.	Met (Y/N)	Action (s) required to meet	Estimated Cost to Meet			
				M/H	Dept	Equip	Cost(\$)
20. Uncertainty of cell per table	2.8.2.8.1.4	Y/N	Some cells meet uncertainty and others may not	10	421		
21. SPRT calibrated by NIST or NVLAP lab every 2 yrs. or 2-5 yrs. if SPC is evident (Class 1-4)	2.8.2.8.2.1	Y/N	Only 1 SPRT calibrated by NIST	?			
22. SPRT calibrated every 2 yrs or 2-5 yrs. if SPC is evident (Class 5)	2.8.2.8.2.2	Y	none				
23. Bridge cal'd yearly, resistors traceable to NIST	2.8.2.8.2.3	Y	none				
24. DVM calibrated annually							
25. T/C referenc std. documentation, show cal is traceable to NIST and annealing process	2.8.2.8.4	N	document annealing process	5	423		
26. Liquid in glass thermometers traceable to NIST	2.8.2.8.5	Y	none				
27. Computer programs are documented	2.8.2.9.1	Y	none				
28. Comp. block used in vig. stirred bath (Class 1,2)	2.8.2.9.2.1	Y	none				
29. Comp block used in adeq stirred bath (Class 3,4)	2.8.2.9.2.2	Y	none				
30. Stirred bath (Class 5)	2.8.2.9.2.3	Y	none				
31. Temperature stability per table	2.8.2.4.2.5	N	We need to measure stability	10	421		
32. Corrections applied to mercury therm at all temp	2.8.2.9.3	N	Apply corrections	2	421		
				Total Cost (\$)			
Recommendations:			Estimated uncertainty level that would require no further action:				
*Note: For calculating cost of manpower, use rates based on using Paid Project - Non- Weapon Overhead: D/421 Rate is \$57.20/hour, D/423 Rate is \$72.45/hour.							

*Note: For calculating cost of manpower, use rates based on using Paid Project - Non- Weapon Overhead: D/421 Rate is \$57.20/hour, D/423 Rate is \$72.45/hour.

TECHNICAL NVLAP GAP ANALYSIS

LAB: Vibration **AREA:** Mechanical **PARAMETER:** Accelerometers **ENGINEER:** **TECHNOLOGIST:**

KCD Capabilities: 10g at 100, 159, 300, 400, 500, 600, 700, 800, 900, 1000, 1500, 1700, 2000 Hz; 5g at 100, 2000 Hz; Sensitivity approximately $\pm 1.7\%$

Manual Statement: 10g at 30, 50, 2500-10000 Hz step 500 Hz; 5g at 15 Hz; 2g at 10, 100 Hz; 1g at 30, 100 Hz; 0.3g at 40 Hz; Sensitivity approximately $\pm 2.7\%$

Desired NVLAP Statement: Same as KCD Capabilities, except uncertainty approximately $\pm 1.7\%$ from 100 to 2000 Hz.

Requirement	Reference Para.	Met (Y/N)	Action (s) required to meet	Estimated Cost to Meet			
				M/H	Dept	Equip	Cost(\$)
1) Documented uncertainty analysis per NIST Technical Note 129.		N	50% complete. Complete uncertainty analysis on charge amplifiers, DVM's, source, and vibration system.	40	423		2898
2) No exposure to large temperature extremes.	2.7.2.5.1	Y	None				
3) No exposure to other mechanical signals.	2.7.2.5.1	Y	None				
4) Accelerometers stabilize at ambient test conditions.	2.7.2.5.1	Y	None				
5) Lab temperature approximately 23°C.	2.7.2.5.1	Y	None				
6) Lab Humidity $\leq 55\%$.	2.7.2.5.1	Y	None				
7) Lab should not exhibit small levels of airborne and structural noise.	2.7.2.5.1	Y	None				
8) Vibration isolation of exciter be adequate for measurements.	2.7.2.5.1	Y	None				
9) Standard calibrated under same nominal ambient conditions as those present when in use.	2.7.2.5.1	Y	None				
10) Electrical Power should be conditioned and measurement systems grounded.	2.7.2.5.2	Y	None				
11) Coaxial cables connected to accelerometers be secured in way to minimize triboelectric effects and effects from cable strain.	2.7.2.5.2	Y	None				
12) Reference standards should be calibrated periodically by NIST, or accredited lab, on a time interval appropriate for the uncertainty.	2.7.2.6.1	Y	None				
13) Maintain at least one transfer standard periodically calibrated on a statistically appropriate time interval at either NIST, or accredited lab.	2.7.2.6.1	N	Complete statistical analysis.	8	423		580
14) Demonstrate, statistically, that reference standards can be used and maintained within the stated statistical estimates of uncertainty using the transfer std. that is sent to NIST.	2.7.2.6.1	N	Measure transfer standard and evaluate the data statistically.	8/yr 50/yr	423 421		580/yr 2860/yr
				Total Cost (\$)			
Recommendations: Complete uncertainty and statistical analyses, report changes, and software/CP revisions if NVLAP accreditation is not pursued. Review additional calibration dollars with Metrology management.			Estimated uncertainty level that would require no further action:		Not applicable.		

*Note: For calculating cost of manpower, use rates based on using Paid Project - Non- Weapon Overhead: D/421 Rate is \$57.20/hour, D/423 Rate is \$72.45/hour.

TECHNICAL NVLAP GAP ANALYSIS

LAB: Vibration	AREA: Mechanical	PARAMETER: Accelerometers	ENGINEER:	TECHNOLOGIST:
KCD Capabilities	10g at 100, 159, 300, 400, 500, 600, 700, 800, 900, 1000, 1500, 1700, 2000 Hz; 5g at 100, 2000 Hz; Sensitivity approximately $\pm 1.7\%$			
Manual Statement:	10g at 30, 50, 2500-10000 Hz step 500 Hz; 5g at 15 Hz; 2g at 10, 100 Hz; 1g at 30, 100 Hz; 0.3g at 40 Hz; Sensitivity approximately $\pm 2.7\%$			
Desired NVLAP Statement:	Same as KCD Capabilities, except uncertainty approximately $\pm 1.7\%$ from 100 to 2000 Hz.			

Requirement	Reference Para.	Met (Y/N)	Action (s) required to meet	Estimated Cost to Meet			
				M/H	Dept	Equip	Cost(\$)
15) Secondary and working standards should be calibrated periodically on a time interval appropriate to the uncertainty statement.	2.7.2.6.2	Y	None				
16) Instruments critical to maintaining uncertainty associated systems of calibration should be calibrated by NIST or accredited lab.	2.7.2.6.3	N	Instruments calibrated by NIST or an accredited lab. (\$0 if PSL or KCD is accredited lab)				3000/yr
17) The instruments described in 16 should be calibrated over the typical amplitudes and frequencies these instruments encounter when in use.	2.7.2.6.3	N	Calibrate instruments over the full range of amplitudes and frequencies.	40	423		2898
18) Comparison calibrations require that the standards be calibrated over the same amplitudes and frequencies produced by the calibration system.	2.7.2.6.3	N	Change software amplitudes and frequencies to the same as NIST. Change software to make multiple runs and calculate the average and standard deviation of the mean. SQA. D/422 rate: \$61.03/hr	80	422		4883
19) Documentation on the calibration of standards and calibration-system instruments should be retained for and indefinite period of time.	2.7.2.7	N	Will retain what currently have.				
20) Records should be made that document the specific instruments included in the calibration system each time the system is used to perform a calibration.	2.7.2.7	N	Record all instruments used. (Develop standard cover sheet)	8	423		580
21) If calibration system or measurement procedure changes, the performance of the system shall be verified and documented adequately.	2.7.2.7	Y	None				
22) Calibration reports should include: a. sensitivity as a function of frequency, the approximate amplitude and a statement of estimated uncertainty over the entire frequency range, the cal. lab., manuf., S/N, of all instruments, instrument settings, and Cal. Date.	2.7.2.7	Y	None				
				Total Cost (\$)			
Recommendations:	Complete uncertainty and statistical analyses, report changes, and software/CP revisions if NVLAP accreditation is not pursued. Review additional calibration dollars with Metrology management.			Estimated uncertainty level that would require no further action:		Not applicable.	

*** Note:** For calculating cost of manpower, use rates based on using Paid Project - Non- Weapon Overhead: D/421 Rate is \$57.20/hour, D/423 Rate is \$72.45/hour.

TECHNICAL NVLAP GAP ANALYSIS							
LAB: Vibration	AREA: Mechanical	PARAMETER: Accelerometers	ENGINEER:	TECHNOLOGIST:			
KCD Capabilities	10g at 100, 159, 300, 400, 500, 600, 700, 800, 900, 1000, 1500, 1700, 2000 Hz; 5g at 100, 2000Hz; Sensitivity approximately ± 1.7%						
Manual Statement:	10g at 30, 50, 2500-10000Hz step 500Hz; 5g at 15Hz; 2g at 10, 100Hz; 1g at 30, 100Hz; 0.3g at 40Hz; Sensitivity approximately ± 2.7%						
Desired NVLAP Statement:	Same as KCD Capabilities, except uncertainty approximately ±1.7% from 100 to 2000Hz.						
Requirement	Reference Para.	Met (Y/N)	Action (s) required to meet	Estimated Cost to Meet			
				M/H	Dept	Equip	Cost(\$)
b. The method of calibration, mounting torque, the condition of the mating surfaces of accelerometer and vibration exciter, the test the date of calibration, the test number, the number, names and signatures of the people performing and responsible for the calibration, and the environmental conditions if significantly different than stated above. IT SHOULD BE NOTED THAT THE REQUIREMENTS LISTED ON THESE THREE PAGES MAY POSSIBLY NOT BE AN ACTUAL REQUIREMENT BUT JUST RECOMMENDED.	2.7.2.7	N	Include in report.				
				Total Cost (\$)			11,839+
Recommendations:	Complete uncertainty and statistical analyses, report changes, and software/CP revisions if NVLAP accreditation is not pursued. Review additional calibration dollars with Metrology management.		Estimated uncertainty level that would require no further action:	Not applicable.			6440/yr
* Note: For calculating cost of manpower, use rates based on using Paid Project - Non- Weapon Overhead: D/421 Rate is \$57.20/hour, D/423 Rate is \$72.45/hour.							

TECHNICAL NVLAP GAP ANALYSIS

LAB: Optics	AREA: Optical Rad.	PARAMETER: Photometry	ENGINEER:	TECHNOLOGIST:
KCD Capabilities	Standard lamps: +4.1%, 98.8 to 739 candela			
Manual Statement	Standard photometer: +1%, 1 to 1000 footcandles			
Desired NVLAP Statement	NVLAP requirements and KCD capabilities are in agreement.			

Requirement	Reference Para.	Met (Y/N)	Action (s) required to meet	Estimated Cost to Meet			
				M/H	Dept	Equip	Cost(\$)
1) Adequate control standards and working standards are used in the calibration process.	2.5.3.3	Y					
2) Temperature and Humidity of the lab environment are monitored and declared in test reports.	2.5.3.4.1	Y					
3) Air drafts are considered and controlled.	2.5.3.4.2	Y					
4) Lab should have standard shunts, stable DC power supplies, high accuracy dvm's, and stable mounting fixtures and other equipment necessary to make high accuracy electrical and photometric measurements.	2.5.3.5.1	Y					
5) Laboratory that makes luminous intensity and/or illuminance measurements should have luminous intensity standard lamps or standard photometers that are traceable to NIST.	2.5.3.5.2	Y	Our older standards are NIST calibrated standard lamps and our more recently acquired standards are NIST calibrated standard photometers.				
6) Laboratory that makes total luminous flux measurements normally uses an integrating sphere and total luminous flux standard lamps that are traceable to NIST.	2.5.3.5.3	N	We do not presently have a NIST certified total luminous flux standard lamp.				
7) Spectral flux and light source color measurements.	2.5.3.5.4	N	We do not offer these measurements.				
8) Laboratory that makes luminance measurements should have either standard sources or standard photometers which are traceable to NIST.	2.5.3.5.5	Y					
9) In the calibration process, laboratory may use instrumentation and procedures described in the reference documents or may use other well derived and documented procedures.	2.5.3.6	Y					
10) Proper care is exercised when handling lamps.	2.5.3.7.1	Y					
11) Proper turn-on, stabilization, and turn-off of incandescent lamps is exercised.	2.5.3.7.2	Y					
				Total Cost (\$)			

Recommendations: Complete actions required to conform to NVLAP requirements. This action will increase New Business possibilities for the Optics Lab.	Estimated uncertainty level that would require no further action:
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* Note: For calculating cost of manpower, use rates based on using Paid Project - Non- Weapon Overhead: D/421 Rate is \$57.20/hour, D/423 Rate is \$72.45/hour.

TECHNICAL NVLAP GAP ANALYSIS

LAB: Optics **AREA:** Optical Rad. **PARAMETER:** Photometry **ENGINEER:** **TECHNOLOGIST:**
KCD Capabilities Manual Statement See first page

Desired NVLAP Statement See first page

Requirement	Reference Para.	Met (Y/N)	Action (s) required to meet	Estimated Cost to Meet			
				M/H	Dept	Equip	Cost(\$)
12) Discharge lamps should be operated with specified reference ballasts.	2.5.3.7.3	N	We do not use discharge lamps.				
13) Measurements should be made only after lamps have been properly stabilized.	2.5.3.7.4	Y					
14) Reports on lamps should include lamp operating conditions and photometric values.	2.5.3.8.1	N	We can do this if a calibration is requested on a lamp, but presently, the only lamps that we have are NIST-calibrated lamps that are used as sources.				
15) Contents of reports on luminous intensity.	2.5.3.8.2	N	We could comply if needed, but we do not presently calibrate any luminous intensity devices.				
16) Reports on photometers should include the reference point of the photometer, specification of the light source, and the ambient temperature.	2.5.3.8.3	N	This would only be a reporting change.				
17) The reproducibility of photometric values of lamps should be included in the calibration uncertainty.	2.5.3.8.4	N	We can do this if a calibration is requested on a lamp, but presently, the only lamps that we have are NIST-calibrated lamps that are used as sources.				
				Total Cost (\$)			
Recommendations: Complete actions required to conform to NVLAP requirements. This action will increase New Business possibilities for the Optics Lab.			Estimated uncertainty level that would require no further action:				
* Note: For calculating cost of manpower, use rates based on using Paid Project - Non- Weapon Overhead: D/421 Rate is \$57.20/hour, D/423 Rate is \$72.45/hour.							

TECHNICAL NVLAP GAP ANALYSIS

LAB: Pressure	AREA: Thermodynamic	PARAMETER: Pressure	ENGINEER:	TECHNOLOGIST:
KCD Capabilities	1.5-500 psi			
Manual Statement	AIR: 1.5-500 psi., $\pm 0.15\%$; 500-1800psi., $\pm 0.25\%$; 1800-15000 psi., $\pm 0.3\%$ OIL: 30-15000 psi., $\pm 0.3\%$; 15000-100000 psi., $\pm 0.5\%$			
Desired NVLAP Statement	Same as KCP capabilities			

Requirement	Reference Para.	Met (Y/N)	Action (s) required to meet	Estimated Cost to Meet			
				M/H	Dept	Equip	Cost(\$)
1) Documented uncertainty analysis per NIST 1297		N	Complete Uncertainty Analysis for Ruska and Harwood. CEC & DHII are complete.	30	423	0	2175
2) Statistical Process Control	2.8.4.14.3	N	Select and Procure Control Check Standard. Develop procedures and software to support SPC.	60	423		7347
3) Recommended mean temperature 23°C	2.8.4.14.4	Y					
4) Recommended Relative Humidity (40-60%)	2.8.4.14.4	Y					
5) Excessive vibration shall be avoided	2.8.4.14.4	Y					
6) Setup and other influences	2.8.4.14.4	N	Hysteresis check is currently performed as required not always at each calibration.	50	421		2860
7) Equipment and reference materials needed for calibration	2.8.4.14.5	Y					
8) Calibration methods. A manual outlining the procedures to be followed should be maintained and used.	2.8.4.14.6	N	Write a cal. procedure preamble for CEC calibrations.	15	423		1087
9) Specific guidelines for handling setup and use of calibration items must be provided.	2.8.14.7	N	Add a statement to the cal. procedure and certified software suggesting reference to the manufacturer's recommendations for these areas such as warm-up time, handling, etc.	10	423		725
10) Uncertainty in the calibration of TI should be derived from the uncertainty of the previously derived Standard including all variables that effect the calibration.	2.8.4.14.8.1	Y					
11) The determination of TI uncertainty shall include Type A & B errors from the Standard.	2.8.4.14.8.2	Y					
12) The TI should be operated per the manufacturer's operation manual	2.8.4.14.8.3	Y					
Recommendations: Complete the Uncertainty Analysis on the CEC and Ruska DWPG regardless if NVLAP accreditation is not pursued.				Estimated uncertainty level that would require no further action: Not Applicable			

* Note: For calculating cost of manpower, use rates based on using Paid Project - Non- Weapon Overhead: D/421 Rate is \$57.20/hour, D/423 Rate is \$72.45/hour.

TECHNICAL NVLAP GAP ANALYSIS

LAB: RF/Microwave	AREA: RF/Microwave	PARAMETER: Power	ENGINEER:	TECHNOLOGIST:			
KCD Capabilities Manual Statement: Thermistor Mounts: 1 MHz to 18.0 GHz ; Cal. Factor approximate uncertainty = ± 0.5 to 3.0%							
Desired NVLAP Statement: Same as KCD Capabilities.							
Requirement	Reference Para.	Met (Y/N)	Action (s) required to meet	Estimated Cost to Meet			
				M/H	Dept	Equip	Cost(\$)
1) Document uncertainty analysis per CIPM or NIST Tech. Note 1297.	2.2.1.3.2	N	Complete uncertainty analysis per CIPM or NIST Tech. Note 1297.	80	423		5796
2) SPC commensurate with the accuracy levels based on measuring check standards and repeatability of multiple measurements.	2.2.1.4	N	Establish a high frequency (8.5 to 18.0 GHz) check standard and measure once a week. Check standards from 1 MHz to 8.5 GHz are established.	8/yr 30/yr	423 421		580/yr 1716/yr
3) Personnel understand basic concepts, statistical analysis, error analysis, electrical principles and calibration.	2.2.1.5	Y	None				
4) Lab temperature maintained at nominal 23°C. Record abnormal temp. and retain for period no less 1 yr.	2.2.1.6.1	Y	None				
5) Reference standards with stated accuracy's should be documented and proven to perform at the level for which accreditation is requested.	2.2.1.7	Y	None				
6) Calibration Methods	2.2.3.3	Y	None				
7) Uncertainty analysis should include standards uncertainty, mismatch errors, and instrument uncertainty.	2.2.3.4	Y	None				
8) Software programs/revisions.		N	Write software or make revisions to existing software. D/422 rate \$61.03/hour	80	422		4883
IT SHOULD BE NOTED THAT THE REQUIREMENTS LISTED ABOVE MAY NOT BE AN ACTUAL REQUIREMENT BUT JUST A RECOMMENDATION.				Total Cost (\$)			10,679+
Recommendations: Complete uncertainty analysis if NVLAP accreditation not pursued. Review other requirements.			Estimated uncertainty level that would require no further action:	Not Applicable		2296/yr	
* Note: For calculating cost of manpower, use rates based on using Paid Project - Non- Weapon Overhead: D/421 Rate is \$57.20/hour, D/423 Rate is \$72.45/hour.							

TECHNICAL NVLAP GAP ANALYSIS

LAB: RF/Microwave AREA: RF/Microwave PARAMETER: Noise ENGINEER: TECHNOLOGIST:

KCD Capabilities
Manual Statement:

Desired NVLAP
Statement:

Requirement	Reference Para.	Met (Y/N)	Action (s) required to meet	Estimated Cost to Meet			
				M/H	Dept	Equip	Cost(\$)
1) Document uncertainty analysis per CIPM or NIST Tech. Note 1297.	2.2.1.3.1	N					
2) SPC commensurate with the accuracy levels based on measuring check standards and repeatability of multiple measurements.	2.2.1.4	N					
3) Personnel understand basic concepts, statistical analysis, error analysis, electrical principles and calibration.	2.2.1.5	Y					
4) Lab temperature maintained at nominal 23°C. Record temp. and retain for period no less 1 yr.	2.2.1.6.1						
5) Reference standards with stated accuracies should be documented and proven to perform at the level for which accreditation is requested.	2.2.1.7						
6)							
				Total Cost (\$)			
Recommendations:			Estimated uncertainty level that would require no further action:				
* Note: For calculating cost of manpower, use rates based on using Paid Project - Non- Weapon Overhead: D/421 Rate is \$57.20/hour, D/423 Rate is \$72.45/hour.							

TECHNICAL NVLAP GAP ANALYSIS

LAB:	RF/Microwave	AREA:	RF/Microwave	PARAMETER:	S-parameter (HP8510 and HP8753 ANA's)	ENGINEER:	TECHNOLOGIST:
KCD Capabilities	S11/S22 Magnitude and Phase; Γ approximately ±.004 to .200; Phase approximately ±1.0 to 180°						
Manual Statement:	S21/S12 Magnitude and Phase; 0 to 100dB, approximately ±.01 to 2.0; Phase approximately ±0.5 to 5.0° Frequency Range, 300 kHz to 50 GHz; Delay, Electrical Length						
Desired NVLAP Statement:	Same as KCD capabilities.						

Requirement	Reference Para.	Met (Y/N)	Action (s) required to meet	Estimated Cost to Meet			
				M/H	Dept	Equip	Cost(\$)
1) Document uncertainty analysis per CIPM or NIST Tech. Note 1297.	2.2.1.3.2	N	Complete uncertainty analysis per CIPM or NIST Tech. Note 1297. (Possibly more than 1000 M/H)	1000	423		72450
2) SPC commensurate with the accuracy levels based on measuring check standards and repeatability of multiple measurements.	2.2.1.4	N	Establish check standards for each connector type and measure once a week.	40/yr 100/yr	423 421		2898/yr 5720/yr
3) Personnel understand basic concepts, statistical analysis, error analysis, electrical principles and calibration.	2.2.1.5	Y	None				
4) Lab temperature maintained at nominal 23°C. Record abnormal temp. and retain for period no less 1 yr.	2.2.1.6.1	Y	None				
5) Reference standards with stated accuracy's should be documented and proven to perform at the level for which accreditation is requested.	2.2.1.7	N	Complete CIPM uncertainty analysis on reference standards.	40	423		2898
6) Calibration Methods	2.2.3.3	Y	None				
7) Software programs/revisions.		N	Write software or make revisions to existing software.	500	423		36225
IT SHOULD BE NOTED THAT THE REQUIREMENTS LISTED ABOVE MAY NOT BE AN ACTUAL REQUIREMENT BUT JUST A RECOMMENDATION.							
				Total Cost (\$)			111,573+
Recommendations:	Complete uncertainty analyses, software, and SPC of check standards in all connector types if NVLAP accreditation not pursued.			Estimated uncertainty level that would require no further action:		Not Applicable 8618/yr	

* Note: For calculating cost of manpower, use rates based on using Paid Project - Non- Weapon Overhead: D/421 Rate is \$57.20/hour, D/423 Rate is \$72.45/hour.

TECHNICAL NVLAP GAP ANALYSIS

LAB: AC	AREA: Electrical	PARAMETER: Freq. & Time	ENGINEER:	TECHNOLOGIST:
KCD Capabilities Manual Statement:	The output of a rubidium frequency standard is compared with the frequency transmitted by NIST on station WWVB. The frequency standard is used to calibrate frequency counters and to drive a digital clock. An electronic counter is used to calibrate frequency sources and for time interval measurements. Frequency uncertainty is ± 1 part in 10^5 .			
Desired NVLAP Statement:	NVLAP requirements and KCD capabilities are in agreement.			

Requirement	Reference Para.	Met (Y/N)	Action (s) required to meet	Estimated Cost to Meet			
				M/H	Dept	Equip	Cost(\$)
1)Outdoor mounted antenna, with receiver reasonably close. Isolate receiver from radio interference.	2.3.1.2.1	Y	Obtain an isolation amplifier	2.0	423	HP	2k -6.2k
2)Lab main oscillator supplied with battery backup.	2.3.1.2.2	Y					
3)Isolation amp to distribute signals from main oscillator within and outside lab.	2.3.1.2.2	N					
4)Choose reference signal capable of meeting performance level for traceable calibrations.	2.3.1.3	Y					
5)Frequency of calibration of lab oscillator can be made periodically or at continuous intervals.	2.3.1.4.1	Y					
6)The oscillator(standard) can be part of another instrument or a stand alone, based on quartz, rubidium,or cesium.	2.3.1.4.1	Y					
7)The frequency reference for a measurement should perform at a level at least an order of magnitude better than oscillator being calibrated.	2.3.1.4.2	Y	Same as #3				
8)External reference signal used: VLF and LF Radio service WWVB from NIST.(1part in 10 ¹¹)	2.3.1.4.5	Y					
9)Distribution of frequency signals(degradation)	2.3.1.4.8	N					
10)Measurement errors(average out radio propagation delays) (Note: Time of Day not a standard)	2.3.1.4.9	Y	Not done at this time, but can be added to cal report Same as #13				
11) Accuracy of timekeeping depends on how often the system is synchronized to the freq. reference.	2.3.1.4.10.	1 Y					
12)It is the responsibility of the Lab to account for all propagation and equipment delays.	2.3.1.4.10.	2 Y					
13) Calibration Reports.	2.3.1.5.1.1	N					
14)Relative frequency expressed in scientific notation.		N					
15) The averaging time used to determine frequency should be reported.	2.3.1.5.1.2	Y					
				Total Cost (\$)			2k - 6.2k
Recommendations:	Complete actions required to conform to NVLAP requirements. This action will increase New Business possibilities and upgrade the Time and Frequency area of the AC Lab.		Estimated uncertainty level that would require no further action:	± 1 part in 10 ⁹			
* Note: For calculating cost of manpower, use rates based on using Paid Project - Non- Weapon Overhead: D/421 Rate is \$57.20/hour, D/423 Rate is \$72.45/hour.							

* Note: For calculating cost of manpower, use rates based on using Paid Project - Non- Weapon Overhead: D/421 Rate is \$57.20/hour, D/423 Rate is \$72.45/hour.

TECHNICAL NVLAP GAP ANALYSIS

LAB: DC	AREA: Electrical	PARAMETER: DcResistance	ENGINEER:	TECHNOLOGIST:			
KCD Capabilities 10^{-4} to 10^{-1} ohms $\pm 0.007\%$; 10^0 to 10^7 ohms $\pm 0.005\%$; $>10^7$ to 10^8 ohms $\pm 0.01\%$; $>10^8$ to 10^9 ohms $\pm 0.2\%$; 10^{10} to 10^{12} ohms $\pm 0.5\%$; Manual Statement: $>10^{12}$ to 10^{13} ohms $\pm 1.0\%$							
Desired NVLAP Statement: Situation 4: Fixed decade value standard resistors: 10^0 to 10^6 ohms ± 22 ppm.							
<i>nvlpres.doc</i> Requirement	Reference Para.	Met (Y/N)	Action (s) required to meet	Estimated Cost to Meet			
				M/H	Dept	Equip	Cost(\$)
Situation 4: 4 to 1 ratios are met or exceeded History of the standard System to ensure integrity of standard Check independence from operator effects	2.1.1.4.4.1 a b c	Y Y N	Perform a statistical study to determine operator effects.	40	423	2898	
Personnel Requirements Formal statistics training Access to statistician specializing in experimental data analysis; or Permanent, trained QA specialist on staff	2.1.1.5.1 a b or c	Y Y Y					
Basic statistic training for people in Situation 1,2or3	2.1.1.5.2	N/A	None; Certification is for Situation 4				
Responsible person for intrinsic std or system Trained on an accredited or NIST intrinsic std or system, 3-4 days hands-on experience	2.1.1.5.3	N/A	None; Intrinsic standards are not used				
Responsible person for cal of secondary & working std and instruments of highest accuracy Good experimental skills, understand low level measurements	2.1.1.5.4	Y					
Responsible person for cal of lower level std & TE Same as listed under secondary & working stds Understand the metrological, chemical, & thermal properties of the items under test & their interaction with circuits & instrumentation	2.1.1.5.5	Y Y					
				Total Cost (\$) page 1 2898			
Recommendations: See final page.			Estimated uncertainty level that would require no further action:		± 22 ppm		

* Note: For calculating cost of manpower, use rates based on using Paid Project - Non- Weapon Overhead: D/421 Rate is \$57.20/hour, D/423 Rate is \$72.45/hour.

TECHNICAL NVLAP GAP ANALYSIS

LAB: DC **AREA:** Electrical **PARAMETER:** DC Resistance **ENGINEER:** **TECHNOLOGIST:**
KCD Capabilities 10^{-4} to 10^{-1} ohms $\pm 0.007\%$; 10^0 to 10^7 ohms $\pm 0.005\%$; $>10^7$ to 10^8 ohms $\pm 0.01\%$; $>10^8$ to 10^9 ohms $\pm 0.2\%$; 10^{10} to 10^{12} ohms $\pm 0.5\%$;
Manual Statement: $>10^{12}$ to 10^{13} ohms $\pm 1.0\%$

Desired NVLAP Statement: Situation 4: Fixed decade value standard resistors: 10^0 to 10^6 ohms $\pm 22\text{ppm}$.

nvlpres.doc Requirement	Reference Para.	Met (Y/N)	Action (s) required to meet	Estimated Cost to Meet			
				M/H	Dept	Equip	Cost(\$)
Accommodation & Environment Lab controlled per NCSL RP #7 Relative humidity ≤ 55% Temp & RH recorded on continuous or sample basis Records of abnormal conditions retained (≥1year) Electrical Power Electric mains per NCSL RP#7 or uninterruptible power supplies Ground DC ground required; specs per NCSL RP #7 Electromagnetic Interference Electrical & magnetic fields controlled per NCSL RP#7 Equipment & Reference Material Equipment selections supported by adequate historical data, uncertainty analysis & SPC Measurement Traceability & Calibration Situation 4: Ref stds calibrated at NIST regularly or by accredited cal lab with capability to sustain required accuracy	2.1.1.6	N N Y Y	Perform study to determine needs. See 2.1.7.3.2	80	423		5796
	2.1.1.6.2	Y N/A					
	2.1.1.6.3	N	Perform study to determine needs	40	423		2898
	2.1.1.6.4	N					
	2.1.1.7	Y					
	2.1.1.8						
	2.1.1.8.4	N	1Ω thru 1MΩ standard resistors calibrated by NIST annually Perform before and after cross checks	8	423		6692 580
							Total Cost (\$)page 2
Recommendations: See final page.			Estimated uncertainty level that would require no further action:		±22ppm		
* Note: For calculating cost of manpower, use rates based on using Paid Project - Non- Weapon Overhead: D/421 Rate is \$57.20/hour, D/423 Rate is \$72.45/hour.							

* Note: For calculating cost of manpower, use rates based on using Paid Project - Non- Weapon Overhead: D/421 Rate is \$57.20/hour, D/423 Rate is \$72.45/hour.

TECHNICAL NVLAP GAP ANALYSIS

LAB: DC	AREA: Electrical	PARAMETER: DcResistance	ENGINEER:	TECHNOLOGIST:
KCD Capabilities 10^{-4} to 10^{-1} ohms $\pm 0.007\%$; 10^0 to 10^7 ohms $\pm 0.005\%$; $>10^7$ to 10^8 ohms $\pm 0.01\%$; $>10^8$ to 10^9 ohms $\pm 0.2\%$; 10^{10} to 10^{12} ohms $\pm 0.5\%$; Manual Statement: $>10^{12}$ to 10^{13} ohms $\pm 1.0\%$				
Desired NVLAP Statement: Situation 4: Fixed decade value standard resistors: 10^0 to 10^6 ohms $\pm 22\text{ppm}$.				

nvlpres.doc Requirement	Para.	Met (Y/N)	Action (s) required to meet	Estimated Cost to Meet			
				M/H	Dept	Equip	Cost(\$)
Calibration Methods							
Eliminate or account for effects of: thermal emf's, leakage currents, electrostatic & electromagnetic interference, instrument offsets & short term temp. fluctuations	2.1.1.9.1	Y					
Test Accuracy Ratio Methods	2.1.1.9.2.3.		Modify procedure to include substitution measurements for 1 Ω and 10 Ω standard resistors	8	423		580
Procedures reflect T1 to Std ratios	2	N	Document T1 to SD ratios in procedures/worksheets	20	423		1449
Measurement philosophy is thruout DC lab	3	Y					
Accommodation & Environment							
Δ std resistor due to temp Δ s contribute $\leq 10\%$ to measurement uncertainty	2.1.7.3.1	Y	Temperature corrections are applied				
Relative Humidity $\leq 45\%$	2.1.7.3.2	N	Install or upgrade HVAC system			150000	
Barometric pressure monitored when measuring pressure sensitive resistors with uncertainties $\leq 0.5\text{ppm}$	2.1.7.3.3	N/A	None; Do not certify pressure sensitive resistors $\leq 0.5\text{ppm}$				
				Total Cost (\$)/page 3		152029	

Recommendations: See final page.	Estimated uncertainty level that would require no further action: $\pm 22\text{ppm}$
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* Note: For calculating cost of manpower, use rates based on using Paid Project - Non- Weapon Overhead: D/421 Rate is \$57.20/hour, D/423 Rate is \$72.45/hour.

TECHNICAL NVLAP GAP ANALYSIS

LAB: DC **AREA:** Electrical **PARAMETER:** DcResistance **ENGINEER:** **TECHNOLOGIST:**
KCD Capabilities 10^{-4} to 10^{-1} ohms $\pm 0.007\%$; 10^0 to 10^7 ohms $\pm 0.005\%$; $>10^7$ to 10^8 ohms $\pm 0.01\%$; $>10^8$ to 10^9 ohms $\pm 0.2\%$; 10^{10} to 10^{12} ohms $\pm 0.5\%$;
Manual Statement: $>10^{12}$ to 10^{13} ohms $\pm 1.0\%$

Desired NVLAP Statement: Situation 4: Fixed decade value standard resistors: 10^0 to 10^6 ohms $\pm 22\text{ppm}$.

nvlpres.doc Requirement	Reference Para.	Met (Y/N)	Action (s) required to meet	Estimated Cost to Meet			
				M/H	Dept	Equip	Cost(\$)
Equipment & Reference Materials							
≥3 std res traceable to Quantum Hall effect, 1 may be used as a check std during measurement	2.1.7.4.1	Y					
Capability to scale from local unit of resistance to other res levels which covers range of cal services	2.1.7.4.2	N/A	None; Calibrating fixed value resistors				
Maintain ≥1 std res for ranges covered; Using one as a check std during measurement	2.1.7.4.2	Y N/A	TI to STD ratio ≥ 4 to 1				
Calibration Methods							
Record TI temp during measurement	2.1.7.5.1	Y	TI temperature recorded for NBS type resistors Room temperature recorded for other types				
Barometric pressure recorded when measuring pressure sensitive resistors with uncertainties ≤ 0.5ppm	2.1.7.5.2	N/A	None; Do not certify resistors to ≤0.5ppm				
Measure & record depth TI is immersed in liquid		N/A	None; Do not certify resistors to ≤0.5ppm				
Calibration Methods							
Record voltage applied to voltage-sensitive res	2.1.7.5.3	N	Modify cal procedures to require recording of voltage	4	423		290
Record current applied to high-current shunts	2.1.7.5.4	N/A					
Use a check std during each measurement	2.1.7.5.5	N/A	TI to STD ratio ≥ 4 to 1				
				Total Cost (\$) page 4			290
Recommendations: See final page.			Estimated uncertainty level that would require no further action:	±22ppm			

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TECHNICAL NVLAP GAP ANALYSIS

LAB: DC **AREA:** Electrical **PARAMETER:** DcResistance **ENGINEER:** **TECHNOLOGIST:**
KCD Capabilities 10^{-4} to 10^{-1} ohms $\pm 0.007\%$; 10^0 to 10^7 ohms $\pm 0.005\%$; $>10^7$ to 10^8 ohms $\pm 0.01\%$; $>10^8$ to 10^9 ohms $\pm 0.2\%$; 10^{10} to 10^{12} ohms $\pm 0.5\%$;
Manual Statement: $>10^{12}$ to 10^{13} ohms $\pm 1.0\%$

Desired NVLAP Statement: Situation 4: Fixed decade value standard resistors: 10^0 to 10^6 ohms $\pm 22\text{ppm}$.

nvlpres.doc Requirement	Para.	Met (Y/N)	Action (s) required to meet	Estimated Cost to Meet			
				M/H	Dept	Equip	Cost(\$)
Statistical Process Control							
Examine the difference between the check std & its predicted value based on history to determine if measurement system is in statistical control	2.1.7.6	N/A	TI to STD ratio ≥ 4 to 1				
Std. deviation of a measurement run and TI history examined to determine quality of measured value	2.1.7.6	N	Implement SPC using TI history	40	423		2898
Certificates/Reports							
Calibration reports contain:	2.1.7.7			4	423		290
Name & address of lab requesting calibration	a	N	Add address of lab requesting certification to report				
Manufacturer, model # and serial # of resistor	b	Y					
Measurement date	c	Y					
Resistance value & measurement uncertainty	d	N	Add measurement uncertainty to report				
Resistor temperature	e	N	Add resistor temperature to report where applicable				
Effective pressure, if applicable	f	N/A					
Test voltage, if applicable	g	Y					
Test current, if applicable	h	Y					
Description of how uncertainty was evaluated	i	N	Add description to report				
				Total Cost (\$) Initially			175820
				Total Cost (\$) Annually			7272

Recommendations: Complete actions required to conform to NVLAP requirements.

Estimated uncertainty level that would require no further action: $\pm 22\text{ppm}$

*Note: For calculating cost of manpower, use rates based on using Paid Project - Non- Weapon Overhead: D/421 Rate is \$57.20/hour, D/423 Rate is \$72.45/hour.