NBSIR 80-2026

Coordinated Measurement Services at the National Bureau of Standards

Authors:
Brian C. Belanger
David E. Edgerly
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(Introduction by Arthur O. McCoubrey)

Directorate of Measurement Services
National Measurement Laboratory
National Bureau of Standards
U.S. Department of Commerce
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U.S. DEPARTMENT OF COMMERCE, Philip M. Klutznick, *Secretary*

Luther H. Hodges, Jr., *Deputy Secretary*
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NATIONAL BUREAU OF STANDARDS, Ernest Ambler, *Director*

Coordinated Measurement Services at the National Bureau of Standards

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Coordinated Measurement Services

at the

National Bureau of Standards

Introduction

The realization of accuracy for measurements made throughout the United States requires traceability to national reference standards which are maintained by the National Bureau of Standards (NBS). The services of NBS which are necessary for traceability, broadly classified as measurement services, are generated in the scientific and technical Centers of the National Measurement Laboratory (NML) and the National Engineering Laboratory (NEL), the major operating units of NBS having measurement related assignments. NBS measurement services flow from their many internal sources outward to meet the needs of users widely distributed throughout the nation. Special program offices within NML function to coordinate these services and to provide responsive points of contact for those who need them. Functions of these offices include calibrations, services for the assurance of measurement quality, measurement practice publications, assistance to external institutions in the training and education of metrologists and the promotion of good measurement system operations throughout the United States. These coordinating offices are[1]:

- Office of Weights and Measures (OWM) - responsible for the measurement service requirements of state and local government agencies.

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[1]Additional NML measurement service program offices discussed elsewhere are:

- Office of Standard Reference Materials
- Office of Standard Reference Data

- o Office of Measurement Services (OMS) - responsible for the measurement service requirements of private industry and other agencies of the Federal Government.

The programs of NML also include, in addition to measurement reference standards and related measurement services, the participation of many professional staff members in the work of voluntary standards writing committees, the development of international standards for legal measurement practice, and international cooperative research. The objectives of these activities are to promote the incorporation of good measurement practice into domestic voluntary standards for products and methods, the incorporation of United States practices in international voluntary and legal measurement standards and domestic benefits from measurement related research in other nations. The coordination of all of these activities within NML[2] is the responsibility of the following:

- o Office of Domestic and International Measurements Standards (ODIMS) - responsible for oversight and coordination of NML participation in domestic and international voluntary standards development, international standards of legal measurement practice, and research cooperation with foreign institutions.

The coordinating activities of OWM, OMS, and ODIMS are integrated together through close association of all programs within the Directorate for Measurement Services (DMS). The following pages of this document describe the activities, objectives and plans for each of these three

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[2]The coordination of domestic standards activities in NEL is the responsibility of the Office of Engineering Standards.

offices in detail. This information was prepared for the DMS Evaluation Panel of the National Academy of Sciences/National Academy of Engineering. It is published here with the hope that it will also be useful to a wider interested readership.

10. Office of Weights and Measures

Technical Activities

1. Introduction

1.1. Problem on National Level

Although the Constitution empowers Congress "...to fix the standards of weights and measures," the United States is unique among the nations of the world in that no compliance method for controlling weights and measures is exercised at the national level. The only basic actions of the Federal Government in this field have been the Mint Act of 1828 establishing early standards and an act of 1866 legalizing the metric system of measurement in this country. Many courts, both State and Federal, have ruled that as long as Congress does not exercise its power in this area, the rights of the individual States are not diminished. Thus, the regulation of weights and measures in commerce and industry has been left largely to the States and their political subdivisions to administer.

More than 775 separate jurisdictions exist in this country including States, countries, and cities. It is the responsibility of the State and local officials to see that equity prevails in all commercial transactions.

1.2. NBS Responsibility

The task of monitoring our national standards remained in the Treasury Department throughout the nineteenth century under the direct supervision of a small office known as the Office of Standard Weights and Measures. In 1901 Congress renamed this small office the National Bureau of Standards and greatly increased its functions and activities. The functions of NBS that are directly related to weights and measures fall into three categories; (1) the custody of the standards, (2) the metrological services, and (3) the advisory services to the States and industry. The Bureau provides the States, without charge, calibration services that result in precise values for their basic reference standards of mass, length, and capacity.

Since NBS has no enforcement authority in the weights and measures area, it consequently, plays a unique role in weights and measures administration. The primary goal of the States is enforcement while the primary goal of NBS is to provide technical services to the States necessary to bring about nationwide uniformity in weights and measures enforcement. The Bureau provides this technical service to the States through its Office of Weights and Measures. This service is all the more important today considering the revolution in technology taking place. For example, weights and measures officials are being faced with

certifying the accuracy of scales tied to laser product code scanners and price computers or of digital readout gasoline pumps with microprocessor interfacing. The Office of Weights and Measures must provide technical leadership in these areas. Uniform testing equipment and procedures must be developed, model legal requirements provided, and a training program carried on with the guidance of the National Bureau of Standards.

Under our system of State and local enforcement of weights and measures laws and regulations, it would seem that nonuniformity would be inevitable. Such is not the case largely due to the program of cooperation with the States carried on by NBS through the Office of Weights and Measures. Most notably, OWM sponsors the National Conference on Weights and Measures, a voluntary organization of Federal, State, and local officials and has annually conducted this national forum since 1905. This office, through the National Conference on Weights and Measures, plans and conducts a program of assistance to State and local weights and measures officials and business and industry in the many phases of weights and measures supervision. The range of services provided includes drafting of new legislation, interpretation of laws, development of specifications, tolerances, and testing methods and the design of testing equipment.

In the Directorate for Measurement Services today, there is great potential for synergism as a result of the combined efforts of the Office of Weights and Measures with the Office of Measurement Services and the Office of Domestic and International Measurement Standards. For example, the National Conference on Weights and Measures will influence and be influenced by the International Organization of Weights and Measures in many aspects of U.S. legal metrology. In addition, the National Conference of Standards Laboratories will be increasingly called upon (as was the National Conference on Weights and Measures in the past) to serve as a forum for State metrology laboratories serving their industries. Weights and measures has a long history and a bright future.

1.3. OWM Mission

The State Weights and Measures Program provides technical services to ensure accurate and equitable commercial transactions involving quantity measurements and standard weights and measures regulations, procedures, and associated devices used in the 50 States. The Organic Act of the National Bureau of Standards (15USC271) specifically authorizes:

- the testing, calibration, and certification of standards and standard measuring apparatus;
- the study and improvement of instruments and methods of measurements;
- the investigation and testing of railroad track scales, elevator scales, and other scales used in weighing commodities for interstate shipment;
- cooperation with the States in securing uniformity in weights and measures laws and methods of inspection;
- the preparation and distribution of standard samples such as those used in checking chemical analyses, temperature, color, viscosity, heat of combustion, and other basic properties of materials; also the preparation and sale or other distribution of standard instruments, apparatus and materials for calibration of measuring equipment.

The major functions of the office are delineated on the organization chart:

(1) National Conference on Weights and Measures (NCWM). The Office of Weights and Measures (OWM) sponsors the NCWM, a voluntary organization of weights and measures officials who meet annually to study and resolve weights and measures issues. The keys to the weights and measures system in the U.S. are cooperation and communication. Thus, a major part of this function is the facilitation of communication and information among the individual regulatory jurisdictions and NBS. A training program and numerous publications for the NCWM membership are important parts of this program.

(2) Metric Assistance and Model Law Development. The Metric Conversion Act of 1975 specifically requests the Secretary of Commerce to work with the NCWM to "assure that State and local weights and measures officials are (i) appropriately involved in metric conversion activities and (ii) assisted in their efforts to bring about timely amendments to weights and measures laws..."

The OWM, working with the newly established U.S. Metric Board, has transferred many of its activities to the Board especially those involving response to the enormous public request for information.

One of the most important methods of achieving uniformity in weights and measures laws is to negotiate, under the auspices of the NCWM, standardized or "model" regulations with the jurisdictions who must enforce such regulations and industries and public affected by such regulations. States can then voluntarily adopt such models for their own use and have confidence that such regulations represent concensus standards and will not interfere with interstate commerce. These model regulations are studied and updated or added to annually through the NCWM.

(3) Advanced Science and Technology Applications. The OWM provides technical expertise to State and local weights and measures agencies and their constituency in new technological areas. A technological revolution is now taking place. High speed dynamic measurements using microprocessor control and other sophisticated electronic component systems are becoming common in the marketplace. State weights and measures officials are being faced with certifying the accuracy of scales tied to laser product code scanners and price computers, grain moisture measurement devices, digital readout gasoline pumps, all of which may or may not be electromagnetically or otherwise compatible with their environments. OWM provides the technical leadership for dealing with these challenges.

(4) State Traceability Services. In 1966, Congress appropriated funds to equip the 50 States, D.C., Puerto Rico, and the Virgin Islands with artifact standards and equipment for mass length and volume measurements in U.S. customary and metric units. This program was completed October 1978. A program to train State metrologiests and examine these laboratories has been in existence since 1966. In order to maintain credibility in these laboratories as traceable to NBS and to prepare them for measurement demands by their local industries in the future, a new Laboratory Auditing Program has been designed.

(5) Special Technical Services for States. Many consider the major output of the NCWM to be Handbook 44 "Specifications, Tolerances and Other Technical Requirements for Commercial Weighing and Measuring Devices." This code book is modified, added to, and updated continually. NBS publishes it for the NCWM and OWM provides interpretations and other consultation on it and the devices to which it pertains on a daily basis. OWM also provides evaluations on a cost recovery basis of new device designs with respect to the performance standards contained in Handbook 44. Test procedures and techniques are developed for such devices through this program.

1.4. Interactions

Within NBS: OWM interacts with many technical groups within NBS, providing a delivery mechanism for their work and translating their scientific and technical products into understandable, problem specific responses for OWM constituency. For example, the artifact standards and equipment now in the possession of the States were calibrated by NBS experts. The codes and handbook on LPG vapor and liquid test and equipment were developed in

close cooperation with the cryogenics experts at NBS Boulder. The handbook on package testing methods was developed with the Statistical Engineering Division. The methods developed for testing grain moisture meters were devised with humidity experts at NBS.

Currently, coordination is directed toward development of new technology for laboratory and field use at the State level specifically: (1) a mass comparitor, and (2) fluid meter proving.

The Office of Weights and Measures is developing an increasing programmatic relationship with a large number of organizational units within NBS, particularly those involved in research which might lead to improved and new capabilities for use by States in their laboratory and field activities. These organizations are:

Office of the Director of Administrative and Information Systems
(Particularly Divisions 341, 344 and 346) Development of new MAP computer programs, and conversion of publications to word processing.

Center for Absolute Physical Quantities
(Particularly Divisions 521, 522, and 523) Electrical and temperature calibration services at the State level. Development of mass comparator.

Center for Thermodynamics and Molecular Science
(Particularly Division 544) Assistance to States in establishing pressure calibration services.

Center for Electronics and Electrical Engineering
(Particularly Division 723) Assisting States in dealing with EMI/RFI phenomena.

Center for Mechanical Engineering and Process Technology
(Particularly Division 732) Need by States for technology to deal with high speed, high quantity fluid measurement and meter proving.

Center for Consumer Product Technology
(Center Headquarters) OWM subcontracting for services of Eric Vadelund in FPLA and Model Laws and Regulations development.

Office of International Relations
Participants in visits of foreign weights and measures and standards officials. Conducts annual weights and measures workshops for foreign weights and measures officials.

OWM works with a multitude of businesses and associations (mailing list numbers approximately 8,000), other Federal agencies and departments (including USDA, FGIS, FTC, FDA, DoT, DoD and OIML).

Outside NBS: OWM's constituency is the State and local weights and measures jurisdictions. As a result, there is very close and continuous interaction with regulatory officials, regulated industries, device manufacturers, service companies, other Federal agencies and the public. For example, packaging and food manufacturers, scale companies, device repair firms, consumer organizations, fabric and grain mills, railroads, the U.S. Department of Agriculture, and a host of other groups contact OWM and are contacted by OWM and working with OWM on issues of specific interest throughout the year. Internationally, OWM coordinates U.S. weights and measures input of International Organization of Legal Metrology (OIML) actions. OWM is technical advisor for OIML Pilot Secretariat 7 "Measure of Mass."

2. Program Activity

Major resources of OWM are devoted to providing technical leadership to weights and measures agencies and their impacted industries. Besides sponsoring the National Conference on Weights and Measures, OWM participates in and addresses all the regional weights and measures association conferences, many State meetings, a great number of trade and consumer association conferences and individual industry meetings (see appendix, section a.). An enormous amount of written correspondence on general and specific weights and measures issues is produced by the staff of OWM. For example, in the category of information, over 1500 letters were composed in FY 1979 (see appendix, section e.). In FY 1979, training was conducted involving most of the 50 States with nearly 1500 industry and government officials participating (see appendix, section d.).

2.1. Major Objectives

(1) NCWM: to make legal metrology uniform among the States and local jurisdictions by providing delivery mechanisms for weights and measures technical and standards information.

(2) Metric Assistance and Model Law Development: to make legal metrology uniform among the States and local jurisdictions by developing and assisting in adoption of model legislation and guidelines and assisting the States in their metrication activities.

(3) Advanced Science and Technology Applications: to make legal metrology uniform among the States and local jurisdictions by developing technical procedures, measurement techniques and devices for use by state agencies

(4) State Traceability Services: to provide traceability to national reference standards by providing oversight, evaluation, and guidance to State weights and measures laboratories.

(5) Special Technical Services for States: to make legal metrology uniform among the States by developing device and user codes, and specifications and guidelines.

2.2. Technical Activities

2.2.1. Railroad Track Scale Calibration Program

Operation of the Railroad Track Scale Calibration Program has been transferred to the U.S. Department of Agriculture, Federal Grain Inspection Service (FGIS) as of October 1, 1979. Plans have been developed, and letters of intent written whereby the State of Illinois' Bureau of Product Inspection and Standards will assume operation of the NBS Clearing facilities (and master scale) on July 1, 1980; Illinois will operate Clearing as an extention of their metrology laboratory and provide calibration services to FGIS in support of the railroad track scale program.

Detailed planning for transfer of Clearing facility (and master scale) to Illinois Bureau of Product Inspection and Standards effective July 1, 1980; planning will include training of State metrology laboratory personnel in calibration of large mass standards and establishment of related measurement assurance program.

2.2.2. Education Programs

Progress has been made toward establishment of measurement services curriculum at the university level, both in undergraduate and graduate programs. The primary effort involves planning involving NBS, the NCWM, the NCSC, Texas A&M University, State officials and business interests. Development of an education program in measurement sciences will include the conduct of a workshop involving university, industry, Federal, and State regulatory officials and the establishment of an Advisory Council on Education.

2.2.3. Study of State Needs

A proposal has been developed, funds obligated, and bids requested for a study of the needs for accurate and uniform physical or chemical measurements at the State level which derived from Government laws and regulations. The most important and critical factor for planning for the future of OWM is the need to obtain a clear understanding of the weights and measures system (regulatory, industrial and public) in the U.S. and how NBS can maximixe its services within such a system. No one knows exactly how the sectors interact from State to State, what methods and legal arrangements are superior, and how such a system should develop or change in the coming years. As a result, OWM reacts to perceived needs without a perfect grasp on where to lead the Nation in the future. A carefully planned and comprehensive study of weights and measures in the U.S. is critically needed. It is difficult to discuss any definite long range plans of the OWM without the information which such a study would provide.

A contract will be awarded for conduct of the study on the needs for accurate and uniform physical or chemical measurements at the State level with completion of the first phase of the 36 month study during the next 12 months.

An initiative was also developed and considered by the NBS management dealing with expansion of State capabilities beyond mass, volume, and length; specifically establishing measurement skills and facilities at the State level to support regulatory activities in the safety, health, and environmental areas.

NBS is currently assisting the State of Nebraska establish the capability to provide services in pressure calibration for industry in Nebraska and contiguous States.

2.2.4. Redesign of Delivery Mechanisms

Plans have been made, and the first results realized, for use of word processing in the production and updating of OWM publications (Handbook 44, and the new Handbook 130 are the initial products). Additional NBS publications (including replacement for Handbook 67, NCWM proceedings, and Handbook 112) will be put into word processing; all will be updated annually as a result of this new capability (Handbook 67 was issued March 1959 and not updated since, Handbook 112 was issued in June 1973 and not updated since).

A reorganization of training programs has been initiated based on regionalized training sessions, formalization of State training programs, and planning for the use of audio-visual techniques for development and use of training aids. Complete organization for the regional training concept and identification of State training officers is underway. The first audio-visual tape for use by States in training inspectors will be produced and delivered this year.

2.2.5. State Laboratory Programs

The State metrology program has been redesigned to incorporate measurement assurance techniques and regionalization including computing routines for processing and exchange of State developed data describing the effectiveness of the new techniques and the services delivered by the States.

2.2.6. Type Approval

Completion of a bilateral agreement between NBS and California in which each will recognize results of prototype examinations (thus avoiding duplicative examinations) and through which California has initiated action through its legislature to permit reciprocity with

other jurisdictions. Plans have been made to extend bilateral agreements to other States and agencies (i.e., FGIS) for conduct of prototype examination of devices patterned after the NBS/California agreement.

2.2.7. Transfer of Metric Activities

Metric information activities formerly performed by the OWM were transferred to the U.S. Metric Board. Formal working liaison has been established for coordination of assistance to the States by the OWM as called for under the Metric Conversion Act of 1975.

2.8. Impact of New Technology

OWM has several "optimization tasks" underway (see prior pages). OWM is developing a systematic approach to its measurement services and measurement standards which recognizes the revolution in technology now taking place. High speed dynamic measurements featuring A/D conversion and microprocessors are becoming commonplace in industry and in the marketplace. Some weights and measures officials are being faced with certifying the accuracy of scales tied to laser product code scanners and price computers, of digital-readout gasoline pumps and fabric meters, etc., all of which may or may not be electromagnetically or otherwise compatible. They look to OWM to provide technical leadership for dealing with these challenges.

The small computer revolution will impact OWM activities in a variety of ways. Data handling for measurement assurance programs via computer networks (already implemented) and centralized data collection and analysis to facilitate uniformity in weights and measures enforcement are only two promising areas where such technological changes could favorably alter the way in which NBS deals with those who need traceability to National Standards and those who wish to insure uniformity of national and international measurement standards.

3. Critical Issues

A study of the weights and measures system is being commissioned to identify changing needs, roles, and alternatives and to provide the basis for long range planning.

Issues within such a study of great importance to the weights and measures community are:

(1) Type approval for measuring devices. A comprehensive plan will be prepared with the NCWM identifying the tools of State and Federal agencies, industry, and others. Mechanising and financing options will be identified.

(2) Expansion of State weights and measures laboratory capabilities. State measurement centers interlinking Federal, regional and industrial measurement capabilities are being planned and the Laboratory Audit Program is being redesigned.

4. Activity Summary

4.1. Sponsored Conferences

- National Conference on Weights and Measures Interim Committee Meetings - January 22-26, 1979 - NBS
  (1) 6 Committees
  (2) 2 Task Forces

- Temperature Compensation Seminar - April 2-3, 1979, NBS

- National Conference on Weights and Measures - July 22-27, 1979, Portland, Oregon

Supported Conferences

- Southern Weights and Measures Association Conference - October 23, 1978, Little Rock, Arkansas

- Northwest Weights and Measures Association Conference - March 4, 1979, Madison, Wisconsin

- Northeastern Weights and Measures Association Conference - April 24, 1979, Hartford, Connecticut

- Western Weights and Measures Association Conference - August 8-10, 1979, Phoenix, Arizona

4.2. Invited Talks

10/4/78	"Update on Office of Weights and Measures' Activities"	Oppermann	Wisconsin Weights and Measures Conference
10/23/78	"Program for Accurate NBS-State Cooperative Grain Moisture Measurement"	Brickenkamp	Southern Weights and Measures Conference
10/24/78	"Office of Weights and Measures and its Planned Program Changes"	Tholen	Southern Weights and Measures Conference
10/24/78	"Role of National Conference on Weights and Measures in Development of State Programs"	Wollin	Southern Weights and Measures Conference
11/14/78	"The Role of OWM in Device Technology"	Tholen	Scale Manufacturers Assoc.
11/14/78	"OIML/PS7 Update"	Warnlof	Scale Manufacturers Assoc.
3/5/79	"Expansion of State Metrology Services"	Tholen	Northwestern Weights and Measures Conference
3/5/79	"Temperature Compensation of Petroleum Products"	Warnlof	Northwestern Weights and Measures Conference
3/5/79	"The Testing of Grain Moisture Meters by State Regulatory Agencies"	Brickenkamp	Northwestern Weights and Measures Conference
3/5/79	"OWM National Training Program"	Smith	Northwestern Weights and Measures Conference
3/21/79	"How to Conduct a Prototype Examination"	Oppermann	Virginia 25th Annual Tech. Training School
3/22/79	"Compliance Sampling of Packaged Goods"	Brickenkamp	American Society for Quality Control

4/4/79	"The Implications of the New Methodology for Package Inspection"	Hasko	Indiana Weights and Measures Association
4/24/79	"OWM National Training Program"	Smith	Northeast Regional W & M Association
5/9/79	"OIML Tolerances - Theory and Application"	Oppermann	National Scale Men's Association
5/23/79	"Gasoline Pumps Price Posting and Computing - A Looming Problem!"	Warnlof	American Petroleum Institute
5/29/79	"Hope Springs Eternal"	Tholen	Michigan Assoc. of W & M Association
5/30/79	"Handbook 44 Considerations for Electronic Cash Registers"	Oppermann	Michigan Association of Weights & Measures Assoc.
6/5/79	"Alternatives in the Gas Pump Crisis"	Wollin	National Assoc. of State Dept. of Agriculture
6/26/79	"Hope Springs Eternal"	Tholen	New York Weights and Measures Association
6/27/79	"Checking Milk and Other Liquid Commodities"	Smith	New York Weights and Measures Assoc.
7/23/79	"Weights and Measures Enforcement in the United States"	Tholen	64th National Conference on Weights & Measures Workshop
7/24/79	"Confidence in Package Checking Results"	Hasko	64th National Conference on Weights & Measures
7/25/79	"Air Buoyancy Correction Equation"	Oppermann	64th National Conference on Weights & Measures Metrologists' Workshop

7/25/79	"Revisions of the OWM Laboratory Auditing Program"	Oppermann	64th National Conference on Weights & Measures Metrologists' Workshop
7/25/79	"Tradition in Transition"	Tholen	64th National Conference on Weights & Measures
8/8/79	"OWM National Training Program"	Smith	Western Regional Weights and Measures Assoc.
8/9/79	"Where Do We Go From Here"	Tholen	Western Regional Weights and Measures Assoc.
8/9/79	"Report on the National Conference on Weights and Measures"	Wollin	Western Regional Weights and Measures Assoc.
9/5/79	"OWM National Training Program"	Smith	New Jersey Weights and Measures Association

4.3. Office of Weights and Measures' Publications
FY 1979

- NBS Special Publication (Number Unknown) - Report of the 64th National Conference on Weights and Measures 1979, Report Editors - Harold F. Wollin, Louis E. Barbrow, and Ann P. Heffernan, Government Printing Office

- NBS Handbook 130 (Draft), Model State Laws and Regulations 1979, Government Printing Office

- NBS Handbook 44 (Draft), Specifications, Tolerances, and Other Technical Requirements for Weighing and Measuring Devices, Government Printing Office

- NBS Handbook 105-3, Specifications and Tolerances for Reference Standards and Field Standard Weights and Measures (Revised 1979), Author - Blayne C. Keysar, Government Printing Office

4.4. Seminars

FY 1979

Workshop on Field & Lab Procedures in Moisture Meter Evaluation	February 6-8, 1979 Springfield, IL
Northeast Regional Taximeter & Odometer Proving Seminar	March 20-22, 1979 Harrisburg, PA
Midwestern Regional Taximeter & Proving Seminar	April 3, 1979 New Albany, IN
Midland Regional Liquefied Petroleum Gas Liquid and Vapor Meter Proving Seminar	May 1-3, 1979 Lincoln, NE
Western Regional Taximeter & Odometer Proving Seminar	July 19-20, 1979 Olympia, WA
Grain Moisture Meter Evaluation Procedures - 12 States	September 11-13, 1979 Atlanta, GA
Seminar on Karl Fischer Titration for California	December 11-12, 1979 NBS

4.5. Training Schools

FY 1978

General (Laws & Regulations, Handbook 44, and Test Procedures)	September 18-22, 1979 Honolulu, HI
General (Laws & Regulations, Handbook 44, and Test Procedures) New England Region	October 4-6, 1979 Concord, NH
General (Laws & Regulations, Handbook 44 and Test Procedures)	October 10-11, 1979 Prudenville, MI
General (Laws & Regulations, Handbook 44, and Test Procedures) USDA	November 1-3, 1979 Sioux Falls, SD
Basic Metrology	November 13-17, 1979 NBS
General (Laws & Regulations, Handbook 44, and Test Procedures)	November 14-16, 197 Boston, MA
General (Laws & Regulations, Handbook 44, and Test Procedures) Western Region	November 28-30, 1979 Billings, MT

FY 1979

Basic Metrology	January 8-19, 1979 Jackson, MS
General (Laws & Regulations, Handbook 44, and Test Procedures)	January 10-12, 1979 Spencer, IN
General (Laws & Regulations, Handbook 44, and Test Procedures)	February 5-9, 1979 Springfield, IL
Basic Metrology	February 12-15, 1979 NBS
General (Laws & Regulations, Handbook 44, and Test Procedures)	February 20-23, 1979 Anchorage, AK
General (Laws & Regulations, Handbook 44, and Test Procedures) Southern Region	February 27-Mar.1,1979 Nashville, TN
General (Laws & Regulations, Handbook 44, and Test Procedures)	March 12-15, 1979 St. Louis, MO
General (Laws & Regulations, Handbook 44, and Test Procedures) Western Region	March 20-22, 1979 Moscow, ID

Basic Metrology	April 23-May 4, 1979 Philadelphia, PA
General (Laws & Regulations, Handbook 44, and Test Procedures)	May 16-18, 1979 Hartford, CT
General (Laws & Regulations, Handbook 44, and Test Procedures)	May 22-25, 1979 Orlando, FL
Basic Metrology	June 18-29, 1979 NBS
Basic Metrology	July 22-26, 1979 Portland, OR
General (Laws & Regulations, Handbook 44, and Test Procedures)	August 13-17, 1979 Morrisville, NY

4.6. Office of Weights and Measures' Special Reports
FY 1979

- NBSIR 79-1776 (R) Transcript of Proceedings of Symposium on Temperature Compensated Volumes in the Sale of Petroleum Products, Sponsored by the National Conference on Weights and Measures on April 3-4, 1979 at NBS

4.7. Special Activities

	Letters Answered			
	General	Technical	Control	Total
1st Quarter	288	72	1	361
2nd Quarter	231	57	4	292
3rd Quarter	396	99	3	498
4th Quarter	186	48	4	238
TOTAL FY 1979				1389

	Metric Letters Answered			
	General	Technical	Control	Total
1st Quarter	36	13	5	108
2nd Quarter	40	33	33	106
3rd Quarter	2	9	11	22
4th Quarter	15	3	0	18
TOTAL FY 1979				254

4.8. Technical and Professional Committee Participation and Leadership

Name		
Barbrow, L.E.	American Society for Testing & Materials	E43 Metric Practice E43.10 Technical SC F43.10.01 Units Sec.
	American National Metric Council	Metric Practice Com. (Secretary)
Brickenkamp, C.	International Organization for Legal Metrology	U.S. Advisory Com. U.S. Technical Advisor on P.S. 18, P.S. 1 Chairman
	Interagency Committee on Net Wt.(members: USDA,FDA,FTC,NBS)	
	American Institute of Physics	
	American Assn. for the Advancement of Science	
	American Crystallographic Assn.	
	National Conference on Weights & Measures(Liaison Committee)	Task Force on Grain Moisture Measurement
Hasko, Stephen	Society of Automotive Engineers, Inc.	Fuel Supply Systems Speedometer & Tachometer
	American Nat'l Standards Inst.	R109 Gas Displacement Metering
	Interagency Committee on Net Wt.	
	Compressed Gas Association	Cryogenic Flowmetering Monitoring Committee
	National Conference on Weights & Measures	Committee on Liaison
Keysar, B.C.	American National Standards Institute	Z11, Petroleum Products and Lubricants
	American Petroleum Institute	Committee on Dynamic Measurement (Metering Systems W/G)
Odom, Jeffrey	American Nat'l Standards Inst.	Z61 Household Kitchen
	NBS Metric Committee	
	DoC Metric Committee	
	ICSP Metrication Subcommittee	
	ICSP Metrication Subcommittee; Executive Board	
	ICSP Metric Practice & Preferred Units Division	
	Consumer Liaison Committee; ANMC	
	Consumer Products Coordinating Committee; ANMC	
	Weights & Measures Sector Committee; ANMC	
	Packaging Advisory Committee; ANMC	

Oppermann, H.	International Organization of Legal Metrology	Pilot Secretariat 7 "Measures of Masses"; U.S. National Working Group "Scales & Weighing Systems"
		Pilot Secretariat 7 "Measures of Masses"/ Reporting Secretariat 7; U.S. National Working Group "In-Service Exam."
Smith, R.N.	National Conference on Weights and Measures	Committee on Education, Administration, and Consumer Affairs
Tholen, A.D.	American Association for the Advancement of Science	
	Operations Research Society of America	
	Institute of Management Science	
Warnlof, O.K.	International Organization of Legal Metrology	U.S. Technical Advisor; Pilot Secretariat 7 Pilot Secretariat 22
	National Scale Men's Association	Scholorship Committee
	Alfred Tech	Advisory Committee
	American Society of Mechanical Engineers	Scale Committee
	National Conference on Weights and Measures	Committee on Specifications and Tolerances
Wollin, H.F.	International Organization of Legal Metrology	U.S. Advisory Committee
	American National Metric Council	Weights and Measures Sector Committee

4.9. Consulting and Advisory Centers

State agency representatives and industry call upon the Office of Weights and Measures' staff on a continuous basis to consult and advise them on general and specific issues in weights and measures. The Office of Weights and Measures (OWM) is the consulting center for weights and measures issues, problems and advice nationwide. An estimated 25% of the time of the staff is involved in this support service.

STAFFING PLAN

As of 10-4-79

OFFICE OF WEIGHTS AND MEASURES (511)

Pos. #	Position Title	Incumbent	Responsibilities
1	Supervisory General Physical Scientist (Chief, OWM)	Tholen, A.D.	Plans, directs, coordinates, and administers scientific and technical programs.
2	Supervisory General Engineer (Asst. Chief, NCWM Exec. Secty.)	Wollin, H.F.	Manages Conference activities (NCWM and related publications; coordinates training and communications (States and Federal agencies).
4	Weights and Measures Coordinator (Program Mgr. Technology Services)	Warnlof, O.K.	Manages ongoing support of State inspection and enforcement programs; coordinates S&T and OIML and prototype activities.
3	General Physical Scientist (Program Manager, R&D)	Brickenkamp, C.S.	Manages R&D interfaces with NBS, industry, private laboratories, and universities.
	Program Coordinator (W&M Laws and Regulations)[1]	Vadelund, E.	Manages development and promulgation of model laws and regulations; coordinates metrication with States.
13	Weights and Measures Coordinator (Technical Coordinator)	Smith, R.N.	Manages W&M training program among States; conducts selected training sessions.
12	General Engineer (General Engineer)	Hasko, S.	Studies special measurement problems; prepares special technical papers and handbooks; conducts special training.

[1]On staff of Center for Consumer Product Technology; funded by OWM.

Pos. #	Position Title	Incumbent	Responsibilities
14	General Physical Scientist (General Physical Scientist)	Oppermann, H.V.	Manages special calibration State metrology programs including LAP and metrology training sessions, and prototype exam program.
18	General Physical Scientist[2] (Electronic Engineer)	Kim, J.	Studies special electronic related measurement problems; prepares technical papers and handbooks; conducts special training.
15	Engineering Technician (Engineering Technician)	Keysar, B.C.	Administers calibration and fluid measurement programs in support of State laboratories.
16	Engineering Technician	-	Vacant[3] - to be reprogrammed.
17	Engineering Technician	-	Vacant[4] - to be reprogrammed.
11	Metric Information Specialist (Metric Specialist)	Rozsics, E.F.	Provides responses to inquiries from general public re: metrication; being phased out.
6	Secretary, Stenographer (Secretary to Chief)	Tallerico, E.B.	Coordinates administration of the Office of Weights and Measures.
10	Conference Coordinator (NCWM Coordinator)	Heffernan, A.P.	Plans for and coordinates logistics operation of interim and annual meeting of the NCWM and other special meetings and seminars.
7	Secretary, Typing (Secretary)	Chapwick, N.C.	Assists OWM Secretary; specifically supports Program Chief, R & D.
5	Program Coordinator (W&M Metric) (Program Chief, W&M Metric)	-	Vacant; former incumbent Jeffrey Odom; many functions reassigned within NBS or transferred to U.S. Metric Board; position to be reprogrammed.

[2] Reprogrammed Engineering Technician (vice Banks, B.)
[3] Former incumbent Harry Johnson
[4] Former incumbent Allen Banks

Pos. #	Position Title	Incumbent	Responsibilities
8	Clerk-Stenographer (Secretary)	-	Vacant, recruitment pending.
9	Clerk-Stenographer (Secretary)	-	Vacant, recruitment pending.
19-22	Engineering Technician (4)	-	Two coop students were recruited in FY 79 and spent period working in OWM. Plan is to continue the program and expand it if funds are adequate.

FTP	Other
16	6

Technical Activities
Office of Measurement Services

INTRODUCTION - MISSION, FUNCTIONS, AND INTERACTIONS

The Office of Measurement Services continues to play an important role as a coordinator and catalyst within NBS and to a considerable extent within the broader measurement community for issues involving traceability, measurement accuracy, and efficient management of precision measurement and test equipment (PMTE). OMS provides leadership to industry, scientific and technical institutions, and to other Federal agencies with respect to improving their measurement activities. OMS coordinates measurement traceability services for physical, dimensional, electrical, electromagnetic, and radiometric measurements.

In discharging these responsibilities, OMS must be fully cognizant of new trends in measurement science such as the proliferation of complex automated testing equipment (ATE), requirements for dynamic rather than static measurements, requirements for new types of measurements (e.g., optical fiber characteristics), the increasing use of microprocessors in "smart" instruments, and new approaches to measurement standards (e.g., NMR thermometry). Trends such as these will, in the long run, be likely to lead to restructuring of the ways in which NBS disseminates measurement services. By serving on committees, participating in technical conferences, and arranging workshops, etc., the OMS staff strives to maintain a high level of awareness of the direction in which the measurement community is heading and to use this information effectively in working with NBS line management to insure that NBS' services are responsive to the changing needs of the measurement community.

The principal responsibilities of OMS are:

- To administer the NBS calibration program.
- To manage a program for the development of new Measurement Assurance Programs (MAP's).
- To coordinate improvements in the management and use of precision measurement and test equipment in the Federal Government.
- To address and disseminate information on NBS-wide policy issues on subjects such as traceability, calibrations, and MAP's.
- To serve as the NBS focal point for key outside organizations concerned with the above issues, such as the National Conference of Standards Laboratories (NCSL), and the Joint Technical Coordinating Group on Metrology and Calibration of the Department of Defense.

The principal interactions between OMS and NBS technical activities fall within the Center for Absolute Physical Quantities (CAPQ), the Center for Electronics and Electrical Engineering (CEEE), the Center for Mechanical Engineering and Process Technology (CMEPT), the Center for Applied Mathematics (CAM), the Center for Radiation Research (CRR), and the Center for Thermodynamics and Molecular Science (CTMS). Joint activities with these centers are described in the sections which follow.

OMS' contacts outside NBS are wide-ranging. The National Conference of Standards Laboratories (NCSL) is the organization that best represents OMS' customers, hence OMS maintains close liaison with the NCSL Board of Directors and with the NCSL membership. The Department of Defense is the largest single user of NBS measurement services. Accordingly, OMS maintains close ties with the DOD calibration community through the Calibration Coordination Group (CCG) and its subgroups. OMS also interacts with the higher level DOD group, the Joint Technical Coordinating Group on Metrology and Calibration (JTCG-METCAL) of the Joint Logistics Commanders. In addition, OMS is represented on the JLC's Panel on Automatic Testing.

The NBS PMTE Project was formed just over a year ago to coordinate improvements in the management and use of PMTE in the Federal Government. (A description of the activities of the PMTE Project is given later in this report.) From time to time the PMTE Project provides information to the Office of Management and Budget and the General Accounting Office concerning progress with this activity. The PMTE Project maintains a continuing liaison with the headquarters level people responsible for precision measurement and test equipment in other Federal agencies.

Other organizations with which OMS interacts include:

- The Industry/Joint Services Automatic Test Project (IJSATP)
- Voluntary Standards Organizations (ASTM, ANSI, ASQC, OIML)
- The Government-Industry Data Exchange Program (GIDEP)
- Individual users of measurement services (consulting and assistance on measurement traceability problems)
- Other national standards laboratories (e.g., exploring the "reciprocal traceability" issue with the National Physical Laboratory in England)

An important part of OMS' function is to increase awareness within the technical community of NBS' programs and philosophy in the calibration and measurement assurance areas. In particular, it is felt that the MAP philosophy can be important to a variety of standards writing groups concerned with measurement quality control. Accordingly, OMS places a high priority on disseminating information on the MAP approach to measurement quality by participating actively in standards committees and other groups concerned with measurement quality.

Program Activity
Office of Measurement Services

CALIBRATION AND MEASUREMENT SERVICES

The improvements in the administration of the calibration program reported in last year's report are still in effect. The OMS surcharge on calibrations for FY 80 will continue to be 6 percent. No further reductions seem possible without reducing administrative services provided by OMS.

Policy issues dominated the activity in this area during FY 79. As pointed out in last year's report, the NBS policy statement on Measurement Services as embodied in the NBS Administrative Manual Subchapter 14.01 was obsolete. Since under the new NBS organization measurement services are now being provided by two major operating units (NML and NEL) rather than one, many difficult policy questions had to be resolved. A completely revised policy statement has been developed by OMS and submitted to NBS management for approval. This statement includes the first formal policy statement on providing measurement services for foreign entities since the Bureau was given expanded authority to provide such services in 1972.

In last year's report two major issues were raised regarding NBS management of measurement services: (a) how NBS management should assess user requirements in setting priorities for services; and (b) what additional quality assurance for NBS measurement services should be used. OMS extensively discussed these issues with our users and with NBS managers. As a result of these discussions a subpanel, consisting of Hayes and Belanger, was appointed to study the issues and make recommendations. The report of this subpanel is included in the report as Appendix E-5.

Last Fall NBS received a report from the National Measurement Requirements Committee of the National Conference of Standards Laboratories on user satisfaction with NBS services (Appendix E-6). The Committee was trying to determine what effect the reductions in NBS services had on the NCSL members and whether the services were still adequate to meet their needs. Services in several areas were singled out by the authors as inadequate now or in the future. OMS reviewed the data gathered by NCSL in detail. OMS evaluation concluded that although there were clearly identified problems, NCSL users generally were satisfied with NBS services. OMS contacted the line managers responsible for the services singled out as inadequate and reviewed the comments made about their services. In most cases we concluded that the services either had not been reduced, or if they had, were subsequently restored. In two areas, 2.9 Aerodynamics and 7.9 Pressure and Vacuum, the managers agreed services needed were not available. The problems seemed to be questions of priority. OMS will obtain summaries of the current services in these areas for publication in the NCSL Newsletter. If the proposed calibration services plan in Appendix E-5, or a similar plan, is eventually approved, it should be possible to avoid most of the problems that have arisen from reductions in services that have taken place over the past few years.

CALIBRATION WORKLOAD SUMMARY

FY 1979

TOTAL ACTIVITY AND INCOME

	71	72	73	74	75	76	TQ	77	78	79
Total Dollars (Millions)	1.7	1.6	1.8	1.8	1.8	2.1	0.4	1.8	1.8	2.1
No. of Calibrations	5957	5122	5267	4649	4127	4085	809	3723	3488	3817

PERCENTAGE OF CALIBRATIONS DONE FOR GOVERNMENT AGENCIES

	71	72	73	74	75	76*	77*	78	79
Boulder	63%	57%	61%	66%	53%	50%	35%	39%	44%
Washington	22%	24%	22%	19%	17%	18%	16%	17%	18%
NBS	36%	34%	37%	35%	31%	31%	21%	22%	23%

*Data given do not include transition quarter.

Calibration Income

Division	Amount	Percentage
511	$ 29,825	1.41
521	375,454	17.74
522	167,898	7.93
524	1,500	.07
531	4,500	.21
532	18,370	.87
533	92,526	4.37
534	115,680	5.47
544	69,743	3.30
565	10,384	.50
652	1,380	.06
721	4,742	.22
722	68,857	3.25
723	82,500	3.90
724	332,193	15.70
731	244,569	11.56
732	418,761	19.79
733	16,437	.78
735	60,802	2.87
Totals	$ 2,116,121	100.00
MOU		
NML (500's)	$ 885,880	41.86
NEL (700's)	1,228,861	58.08
ICST (600's)	1,380	.06
Totals	$ 2,116,121	100.00

MAP PROGRAM DEVELOPMENT

Funds available for this program increased both in FY 1979 and FY 1980. During FY 1979 (October 1, 1979 - September 1980) the Bureau sought the approval of Congress to reprogram about $500K and 8 positions from other areas into MAP activities. This request was approved by Congress in April 1979. In addition, the budget initiative OMS put forward to develop regional MAP's was funded by Congress for FY 1980. This increased the program by an additional $500K and 4 positions. Thus, the past year was a period of enormous growth with the expected challanges for management. OMS, in conjunction with the technical divisions, had to make plans for redirecting three technical groups (electrical, temperature, and photometry) as as well as for the initiation of new projects.

Policy and Planning

When it became evident that OMS would likely receive greatly increased funding to support MAP development, it was clear that guidelines for priority setting were needed. During FY 79 OMS developed a set of guidelines for setting priorities after discussions with appropriate NBS managers. A statement of these guidelines is given in Appendix E-7. These guidelines will be used by OMS in making funding decisions about proposed MAP development projects and by the technical divisions in their planning process. At the time of the reprogramming in FY 1979, NML management set priorities for those funds.

For some time our customers have been urging us to prepare a comprehensive document describing the NBS philosophy of measurement assurance, the techniques used, and a general description of our current services. The documents currently available, of a general nature, discuss only the first point, and the documents describing the specific technical services are too difficult for a general audience. This has made it difficult to communicate the essential ideas in these programs. OMS set for itself an objective in FY 1979 to prepare a first draft of this important document.

Milestones in FY 1979 for these activities are:

- Completion of first draft of "A Guide to NBS Measurement Assurance Program Services".
- Issuance of Guidelines for Priority Setting of MAP Development Projects.

Statistical Consulting

OMS has had a tradition of offering statistical consulting services to the technical divisions. At the time of the recent NBS reorganization, the personnel who offered these services were transfered to the Statistical Engineering Division, but still provide these services which are managed as

part of OMS MAP programs and funded by OMS. These services are expanding this year from 1.2 WY (work years) to 2.2 WY. OMS regards expansion of these services as one of its highest priorities.

Highlights from these activities for FY 1979 are:

- Publication of NBS Monograph 163 "Measurement Assurance for Gage Blocks".

- Consulting for Metal Science and Standards Division resulting in issuance of SRM 484 to be used to calibrate scanning electron microscopes.

- Completion of NBS Monograph manuscript on "NBS Mass Calibration Computer Software".

- Consulting and data analysis for round robin on line width standards for the microcircuit industry with the ultimate objective of certifying an NBS line width SRM.

- Presentation of a three-day seminar on "Precision and Accuracy in Measurement and Calibration".

- Lectures on statistical problems at the NBS Seminar on "Measurement Assurance for Gage Blocks".

Electrical Measurement Assurance Development Projects

This activity includes dc and low-frequency electrical measurements carried out in the Electrical Measurements and Standards Division (EMSD). The FY 1979 reprogramming redirected $234K and 4 WY from Physical Measurements and Standards into Measurement Assurance Programs. The purpose of this change was to reduce R&D on new standards and increase efforts to improve our services by improving and/or developing measurement assurance services. EMSD currently offers to the public four measurement assurance services, DC Voltage, DC Voltage Ratio, Resistance, and Capacitance (See Appendix E-8). EMSD prepared and revised plans to reflect the program changes which were mandated. OMS reviewed the current status of EMSD measurement assurance services and their proposed plans. OMS concluded:

- There is an urgent need to document in published form the measurement assurance services currently offered to the public.

- Additional software needs to be written to efficiently analyze data being sent for analysis to NBS by our customers.

- AC Voltage has been identified by our customers, especially by the National Conference of Standards Laboratories, as a parameter for which there is a need for measurement assurance services.

OMS & EMSD reached final agreement on plans to reflect the high priority placed by OMS on the items mentioned above. Final plans have been completed for FY 1980 which include an increase in funding to support almost an additional 2 WY in EMSD.

A significant improvement in measurement assurance services for disseminating dc voltage was achieved this year. Detailed NBS analysis of the data resulting from seven voltage comparisons since 1971 resulted in the original southern California regional MAP group extending the interval between such comparisons with NBS from one to five years, thereby reducing NBS calibration support by a factor of five. The analysis showed that, although the individual units of voltage maintained by various group members occasionally underwent changes as large as 0.7 ppm, the mean of those units remained adequately stable to support a 0.36 ppm uncertainty for such a five year period. Periodic intercomparisons among the group at 12 to 18 month intervals will enable the members to use the stability of the mean unit to achieve the 0.6 ppm accuracy they require over that five-year period. The intercomparisons will also point out the need for an earlier transfer with NBS, should such a need arise. NBS and the RMAP group are presently investigating the use of solid state devices to effect the intercomparison in more convenient, cost effective ways.

Additional information on the development of regional MAP's can be found in the NCSL Measurement Assurance Committee Report contained in Appendix E-9

Temperature Measurement Assurance Development Projects

The Temperature Measurements and Standards Division currently offers measurement assurance services for standard platinum resistance thermometers (SPRT). These thermometers are specified as one of the devices for realizing the International Practical Temperature Scale 1968 (IPTS 68). The scale is defined by fixed points and the SPRT from 13.81K to 903.89K.

The resources redirected in the temperature area were $141K and 2 WY. OMS and TMSD personnel reviewed the status of their program and concluded:

- Their current measurement assurance service needs to be documented in published form.

- TMSD, in collaboration with ASTM, needs to develop a MAP for use with industrial quality platinum resistance thermometers.

- TMSD needs to begin round robin checks at low temperatures (below the current IPTS 68) with cryogenic sensor manufacturers and some government agencies in anticipation that a measurement assurance service will be needed as soon as a new international cryogenic scale is agreed to.

The need for a MAP was highlighted recently by a collaborative program between NBS and ASTM. The ASTM, for the first time, issued a test standard for industrial resistance thermometers (see 1979 Annual Book of ASTM Standards, Part 44). A specification standard for platinum resistance thermometers is now being prepared. The repeatability and reproducibility figures for the standard are not yet specified. The NBS, in cooperation with the ASTM, has recently initiated round-robin measurements with over twenty industrial testing laboratories to obtain the repeatability and reproducibility figures for the future revised edition of the test standard. Preliminary results show that a temperature MAP for industrial test laboratories is essential so that U.S. thermometer manufacturers can sell in international markets.

Spectrophotometry Measurement Assurance Development Projects

In this area $124K and 2 WY were redirected to measurement assurance. No formal measurement assurance program exists in this area. OMS is working closely with the Radiometric Physics Division personnel assigned to this project to assist them in identifying the measurement assurance techniques needed.

A plan for redirecting these resources in FY 1980 has been completed. This planning was carried out with personnel from the Collaborative Reference Program for Color and Appearance which is jointly sponsored by the Manufacturer's Council on Color and Appearance and NBS. The areas selected for MAP development are retroreflectance and diffuse reflectance.

In order to characterize artifacts to be used in MAP services, a new instrument had to be built. This instrument was completed in FY 1979, and a manuscript describing this instrument has been submitted to Applied Optics. ("The NBS Reference Reflectometer," by K. L. Eckerle, J. J. Hsia, V. R. Weidner, and W. H. Venable, Jr.)

REGIONAL MAP (RMAP) DEVELOPMENT

There is no doubt that a properly designed measurement assurance program is a very effective quality control mechanism. However, NBS experience is that they are expensive, both for NBS and our customers. The Electrical Measurements and Standards Division has developed a mechanism for disseminating the unit of voltage using measurement assurance services which does not degrade the quality of the transfer (but in fact improves it, note the discussion in the earlier discussion of MAP development in EMSD) but considerably reduces the cost per customer. NBS, of course, has

a great interest in reducing costs given the continued pressure on the allocation of resources.

With this information in hand, OMS proposed to NBS management that we be given added resources to set up pilot RMAP projects to investigate if this technique was applicable to other measurement areas and if it would reduce costs. OMS expects that this program will develop a large amount of management information which will greatly aid NBS in planning its measurement services. NBS requested funds for this program and Congress appropriated them in the FY 1980 Budget.

OMS has developed plans for implementing RMAP projects in four technical areas: microwave power, x-ray radiation to 150 KeV, force, and dc voltage, resistance and capacitance.

Microwave Power

This calibration activity is the largest of the NBS calibration activities in the electromagnetic measurements area. Hence, it represents a significant opportunity for reducing our routine calibration workload. The metrology laboratories making microwave power measurements tend to be located in high technology electronics companies who should be able to implement MAP techniques rather easily.

The plan for this project is to purchase and characterize three sets of microwave bolometers and circulate them to five industrial laboratories who have agreed to participate, for measurement against their local standards. This initial round-robin will be used to evaluate the laboratories' measurement process and detect any biases that are present and determine what the precision of their measurement process is. NBS will analyze the data, report back to the participants, and assist them in taking any corrective actions that may be necessary. In addition to the above and in parallel, the development of the six port system will continue. This new system will be used to calibrate the bolometers for the MAP services.

X-Ray Radiation Exposure to 150 KeV

Ionizing radiation of this type for medical diagnostic purposes represents the largest, by far, source of exposure to the general public of man made radiation. The states by and large are responsible for regulating these exposures. A well-developed measurement system traceable to national standards does not exist throughout the states. It is the objective of this project to determine if a highly leveraged regional measurement assurance system can work.

Activities in this project will be broken into two parts. The Radiation Physics Division will identify and characterize ionization chambers and associated electrical equipment to be used as transport standards for the proposed measurement assurance services.

In parallel with the above, OMS and the Office of Radiation Measurement will work with a regional group of States to develop a detailed technical and financial plan to implement a measurement assurance program in their laboratories.

Force

Force calibrations are the largest dollar volume service NBS offers. So here again, there is enormous opportunity for reducing routine calibration. In addition, ASTM has indicated an interest in developing a joint program with NBS for force measurements. The Fluid Engineering Division, responsible for force calibrations, has agreed to carry out a study and laboratory investigation with the following objectives:

- demonstrate and document customer need;
- identify and characterize force transducers which may be suitable as transport standards;
- determine what role ASTM might play in helping implement a joint program;
- identify what potential there is for reducing NBS calibration workload.

D-C Electrical Measurements

The Electrical Measurements and Standards Division has already had great success in using the regional approach to dissemination of measurement assurance services. Activities this year will concentrate on increasing the number of regional groups for the quantities dc voltage, resistance, and capacitance. Also, additional and improved software will be written to analyze customer data from these programs.

PMTE PROJECT

Background

During May and June 1977, the U.S. General Accounting Office (GAO) issued two comprehensive reports on Federal Government precision measuring and test equipment (PMTE) activities. The first report, titled: "A Centralized Manager is Needed to Coordinate the Military Diagnostic and Calibration Program" (GAO Report #LCD-426), complimented the Department of Defense for having an advanced PMTE Program, with a sophisticated system for coordination among the many elements of DOD, but was critical of DOD's slow progress toward consolidating its duplicative facilities and foot-dragging on its other efforts to standardize among the military departments.

The second GAO report, titled: "Centralized Direction Needed for Calibration Program" (GAO Report #LCD-426), was aimed at the civil agencies of the Government and charged that those agencies have failed to conduct their PMTE activities in an efficient and economical manner. From these two reports, the GAO concluded that improvements could be achieved and significant savings realized through improved coordination of the Government's management and use of PMTE.

In a June 13, 1977, letter to the Director, U.S. Office of Management and Budget (OMB), the GAO recommended that OMB "(1) provide for central program direction and coordination of civil agencies' calibration systems, and (2) require closer coordination with the Department of Defense for standardization and consolidation of the total Federal calibration program."

On August 17, 1977, the Director, OMB, asked the Secretary of Commerce to have the National Bureau of Standards (NBS) take the following actions relative to the Government's use of precision measurement and test equipment (PMTE):

- Assume the lead for coordinating improvements in the management and use of such equipment.
- Assist agencies as necessary to identify areas for improvement.
- Recommend to OMB such actions as are needed to improve the management and use of such equipment.

Within NBS, the Office of Measurement Services (OMS) was given responsibility for preparing and implementing an NBS action plan to respond to the OMB directive. The plan was completed by OMS on April 5, 1978, and approved by OMB on May 24, 1978.

As a first step toward implementing the approved plan, OMS established the "PMTE Project" consisting of a project manager, two technical

coordinators, and administrative aides. Staffing of the PMTE Project was completed on November 5, 1978.

Objectives

The PMTE Project has established as its principal goal "to improve the effectiveness and reduce the cost of Federal-wide PMTE operations". This goal has been defined by the project as including the following specific objectives related to the coordinating of improvements to Federal-wide PMTE operations:

- To improve the communications and exchange of information (management and technical) among individuals and facilities involved in management or use of PMTE.
- To identify and gain broad adoption within Federal agencies of particularly effective existing technologies and management techniques.
- To increase use of other agency and/or contractor metrology and calibration capabilities.
- To reduce the growth rate of Federal metrology and calibration facilities.
- To assess the effectiveness of current PMTE programs of other agencies.
- To identify, and develop joint plans for addressing the high priority problems or needs common among several agencies.
- To recommend to OMB and the other agencies actions needed to improve the management and use of PMTE.

Actions to Date

In its first full year of operation, the PMTE Project has directed most of its resources toward short-term actions aimed at optimizing existing systems. However, a high priority has also been given to longer term actions which will hopefully lead to the development and introduction of new and innovative approaches toward accomplishing the calibration function and other management and technical functions related to PMTE management and use.

Accomplishments during FY 1979 are:

- Capabilities Catalog. Prepared and published the first edition of the "Catalog of Federal Metrology and Calibration Capabilities," NBS Special Publication 546. The catalog is intended to encourage cooperation among agencies, to promote the exchange of services or

equipment, and to reduce the growth rate of Federal metrology and calibration facilities. The catalog lists laboratories, their locations, capability, and names and telephone numbers of points of contact. To provide geographical distribution, the laboratories are listed by States, and are also shown on a single map by coded number. The catalog will eventually include all Federal metrology and calibration laboratories; however, this first edition contains only information submitted by four major agencies (DOD, DOE, DOT, & NASA) at time of publication. Some 260 laboratories are presently listed in the catalog.

- Newsletter. Prepared and published first and second issues of "PMTE UPDATE," a newsletter which is distributed to Federal metrology and calibration laboratories, laboratory and staff level managers, and other interested parties throughout the Federal PMTE community, including several U.S. military organizations in Japan, Korea, Okinawa, and Germany. The "PMTE UPDATE" is intended to improve communications within the PMTE community by providing timely information on new developments, publications and meetings, describing successful strategies of PMTE management and use, and by providing a forum for discussing issues of current interest to the community. For example, the first two issues included informative articles on:

  - Recent changes to Army philosophy for setting/adjusting calibration intervals resulting in an initial one-time savings of over $2 million and recurring annual savings in excess of $2 million. Data compiled one year after implementation substantiated these savings and indicated that equipment "up-time" had been maintained at or near 90 percent. Based on this article, the authors were invited to participate in an important NCSL workshop and have since briefed calibration managers from all NASA Centers on the Army philosophy.

  - Test equipment rentals as a key to cutting skyrocketing costs for purchase of general purpose electronic test equipment. This article summarized the highly successful test equipment rental program operated by the FAA's National Aviation Facilities Experimental Center, Atlantic City, New Jersey.

  - How a NASA Center (Langley) has developed and used systems for automatically calibrating electrical and non-electrical (pyrometers, accelerometers, pressure transducers, and wind tunnel model force balances) instruments to reduce calibration time by as much as 50%, reduce total turn-around time, and provide a better and more uniform calibration.

  - An Air Force program to compare barometric pressure measurements made at various government facilities. This

article pointed out that barometers approximately 30 miles apart have been compared and observed to consistently differ by as much as 0.020 inches of mercury during stable weather conditions when they should have agreed. The article also invited other organizations to participate in the comparison program.

- How other agencies can apply to obtain calibration training at the Lowry Technical Training Center, Lowry Air Force Base, Colorado, the DOD's central source of such training.

- Changes to NBS measurement services.

- Origin and objectives of the PMTE Project.

The "PMTE UPDATE" has been well received by its many readers, and several have taken the time to send written comments on its benefits to the PMTE community. Circulation was initially just under 600. It has since risen to approximately 750 and is expected to exceed 1000 by mid 1980.

- Cost-Effectiveness Studies. On September 5, 1979, a $117,523 contract was awarded to the Raytheon Service Company, Burlington, Massachusetts, to study the following two issues:

  - Feasibility and cost-effectiveness of increasing the use of in-situ calibrations, calibration checks, measurement assurance programs or other alternatives to out-of-service equipment calibrations for measurement quality assurance and control in the Federal government.

  - Cost-effectiveness of optimizing calibration recall intervals and algorithms for PMTE.

  In the first study successful alternatives to out-of-service equipment calibrations will be identified and evaluated to determine the cost and/or benefits of Federal-wide adoption. Both cost savings and improvements (or adverse effects) to measurement quality will be quantified to the extent possible. This study is scheduled for completion July 1980.

  The second study will examine situations where adjustment of calibration recall intervals for different types of PMTE has improved measurement quality, or reduced costs without degrading measurement quality, and will also examine the advantages of Federal-wide guidelines for setting and adjusting PMTE calibration intervals. This study will be completed March 1980.

  In the performance of these studies, we have distributed questionnaires to some 55 Federal activities and will visit

approximately 20 Federal calibration facilities to gather technical and cost data related to the government's management and use of PMTE. Members of the PMTE Project staff will accompany the contractor on many of these visits and will monitor the company's performance throughout the contract.

The results of these studies are expected to point the way towards significant improvements and cost reductions in the management and use of PMTE throughout the Federal government.

- Hosted ATE Meetings. As part of a continuing effort to evaluate and analyze the NBS role in automatic test equipment (ATE), we hosted two key meetings of ATE representatives from industry, the Department of Defense, and NBS technical divisions.

The meetings, held on February 15 and March 14, 1979, were attended by people from Sperry Corporation, Westinghouse, Air Force, Navy, and Army, as well as representatives from several NBS centers and offices. Dr. Thomas A. Dillon, welcomed the attendees and emphasized the importance of outside input to the process of defining the NBS role in ATE. Col. Kenneth Wilkinson, Project Manager for the Air Force modular automatic test equipment (MATE) program, pointed out that the Air Force spends approximately $1.1 billion per year on test equipment, including about $900 million on ATE. The MATE Program will expend some $100 million through 1984 in order to develop a family of modular automatic test equipment, plus supporting tools, to support all future Air Force weapon/electronic systems at all levels of maintenance. Sperry and Westinghouse Corporations are currently under contract to the Air Force through 1983 to quantify requirements, provide a better definition of MATE (e.g., desired levels of modularity, optimum human interface factors, etc.), and develop guides for building in testability, trade-off models for evaluating use of ATE vs. manual test equipment, and determining optimum time-phasing for applying MATE to specific USAF systems. At both meetings, there was concern expressed about calibration of complex ATE systems and about traceability for such calibrations. It was noted that calibration of the individual parts of the ATE system is not an adequate calibration of the system as a whole.

These meetings provided a good forum for discussion of Department of Defense and industry needs in ATE and the proper role for NBS in addressing these needs. Of equal importance, the meetings served to improve the interaction and cooperation between NBS, these key members of the ATE design community and DOD metrologists. The PMTE Project is currently exploring the possibility of a coordinated effort with several NBS divisions and the Department of Defense.

- Participated in a NASA HQ survey of the Lyndon B. Johnson Space Center (JSC), Houston, Texas. At NASA request, Jack Vogt assumed complete responsibility for the metrology/calibration part of the survey. As a result of the survey, several areas were identified for improvement (e.g., intervals, interval adjustment, turn-around time and production controls), and positive improvement actions are being taken by JSC.

- Led joint NBS/DOD (JLC) revision to the JLC Panel on Automatic Testing subtask on calibration of ATE. This revised subtask recognizes the need for:

  - better definition of the problem as it affects both existing and future ATE systems.

  - investigation of existing technology to determine the extent to which it can be applied to satisfy the problem(s).

  - identification of requirements for advanced technology.

  - short and long term research leading to development and application of the technology required to satisfy the problem(s).

- Provided assistance/guidance to other agencies:

  - Arranged for an Army mobile calibration team to provide calibration services to the Federal Aviation Administration (FAA) site at Pittsburgh Airport. (The Army team was already stopping at the Airport to support an Air National Guard unit.)

  - Provided instructions and guidance on how to achieve measurements traceability to the FAA Northwest Region.

  - Assisted Department of Transportation and FAA in developing forms/questionnaires and initiating a survey of the "grass-roots" PMTE calibration requirements and calibration capabilities throughout DOT.

  - Co-hosted the Third Annual NASA Calibration Managers Workshop, October 17-19, 1979, to improve interactions among the NASA Centers, identify common problems, and develop a plan of action for 1980.

  - Assisted the U.S. Postal Service (USPS) in identifying its PMTE calibration requirements (locations, items, etc.) and started up an effort to match USPS requirements against the capabilities of nearby private sector and/or other agency calibration facilities.

- Chaired three quarterly meetings of the Interagency PMTE Committee, which afforded policy and planning level representatives of the DOD, DOT, DOE, NASA, and USPS, an opportunity to exchange information on PMTE problems and successes. These meetings were also used to identify and prioritize problems for action or investigation by the PMTE Project. For example:

  . Manpower slots for interagency agreements--Most agencies are willing to do work for another agency, but only if the work is accompanied by the additional manpower slots required to do it. The manpower ceiling for each agency is tightly controlled, therefore, the additional slots may have to be transferred from the benefitting agency. The PMTE Project has identified procedures for transfer of slots, for the duration of the interagency agreement, between the DOD and civil agencies. We are presently attempting to conduct a test case which will involve transfer of slots from the FAA to an Army calibration facility. The outcome of this test case may well determine the extent to which calibration work can be exchanged among the Federal agencies.

  . Need for exchange of management and technical information. In response to requests for guidance or information on how "other" agencies and/or the private sector have handled certain problems, the PMTE Project has disseminated documented policy and procedures on the following areas:

    --DOD's draft standard calibration label/tag system.

    --Army calibration quality assurance inspections.

    --Army management information system.

    --Army technical measurement audit program.

    --Air Force criteria for calibration laboratory construction.

    --Private sector information on special containers for shipping fragile instruments or calibration standards.

    --DOD and private sector calibration training.

    --JLC five year plan for ATE.

    --NBS computerized data bank of standards.

--Government-Industry Data Exchange Program (GIDEP) activities (benefits and how to use it).

--National Conference of Standards Laboratories.

- Briefed top level managers of the Defense Retail Interservice Support (DRIS) Program on the origin/objectives of the PMTE Project and the need for improved coordination between DOD and the civil agencies. Jack Vogt has become a member of the DRIS Executive Steering Group and will surface interagency PMTE support agreement problems at annual meetings of the Steering Group.

- Developed a draft PMTE Program Development Plan (PDP) which describes project objectives and goals and outlines planned and proposed actions over the next five years. The PDP ties each action to a specific objective or goal and estimates the resources required each year to accomplish the actions.

- Visited five major Federal metrology and calibration facilities.

  - FAA's National Aviation Facilities Experimental Center, Atlantic City, NJ.

  - Army Metrology and Calibration Center, Redstone Arsenal, Alabama.

  - Army Area Calibration Facility, Letterkenny Army Depot, Pennsylvania.

  - NASA's Langley Research Center, Norfolk, Virginia.

  - NASA's Johnson Space Center, Houston, Texas.

- Identified the following several areas for improvement as a result of the above visits and other interactions with the Federal agencies:

  - Productivity ranges from 1200 to 100 calibrations per person per year.

  - Intervals are not adjusted at many facilities.

  - Recall of PMTE for periodic recalibration is not mandatory or performance-based at many facilities.

  - Management Practices are weak or virtually non-existent at some facilities.

  - Proliferation of PMTE, procedures, terms, definitions, etc., is apparent throughout the Federal agencies.

- Duplication appears to exist, as there are several cases where more than one agency is located at the same installation and two or more agencies each have their own calibration facility.

- ATE Traceability is an issue receiving little attention. Even though vast investments are being made by the Federal agencies to acquire, program, and operate ATE systems, few resources are being devoted to the issue of ATE measurement traceability. The ability to verify the performance of these expensive ATE systems hinges, to a great extent, upon timely resolution of the traceability issue. Specifically, the issue involves:

  . Overall strategy for achieving traceability

    --component vs. systems calibration.

    --self-calibration vs. dynamic transport standards.

  . Impact on Federal calibration facilities.

    --as a user of automated calibration systems.

    --as a calibrator of ATE.

  . Leadership in the effort to plan, develop and apply the proper strategy for ATE traceability.

- Training for calibration technicians is difficult to obtain, and trained technicians are hard to retain.

Plans for FY 1980

In addition to continuing present efforts (e.g., interagency meetings/workshops, updates to capability catalog, PMTE UPDATE, visits, etc.), the PMTE Project will undertake the following tasks or actions during FY 1980:

- The contracted-out cost-effectiveness studies will be completed, coordinated with other agencies, and an action plan for improvement developed. Actions resulting from these studies may include long-term improvements extending over the next 5-10 years.

- Special reports/handbooks will be developed and issued on:

  - Baseline assessment and progress of Federal agency PMTE programs.

- Standardization of calibration procedures. This report will examine and compare differences between multiple procedures written/published by several agencies for the same item, assess the technical and economic significance of the differences, and attempt to estimate the benefits/costs of total or partial standardization. This report will require assistance from the other agencies and selected elements of the private sector.

- Standard terms and definitions. The initial issue of this handbook will essentially be a compilation of the many PMTE terms and definitions currently published and used by the Federal agencies. Subsequent issues will indicate the preferred definition for each term and eventually may only include one standard definition for each term.

- Projects will be initiated for the development of a series of "How To" handbooks, e.g.,

  . How to establish a calibration laboratory.

  . How to systematically determine whether a PMTE item requires calibration.

  . How to apply "Limited Calibration" or "calibrate Before Use (only)".

- SP 546, "Catalog of Federal Metrology and Calibration Capabilities," will be expanded to include other laboratories which are identified during the year.

- Increase the number of Federal agencies involved in the PMTE Coordination to include all agencies having significant PMTE activities. The need for formal chartering of the Interagency PMTE Committee will be examined in-depth. If the need exists, a formal charter will be drafted, coordinated within NBS and with other agencies, and forwarded for approval/signature at the DOC or OMB level.

- Specific goals (short and long-term) for improvement will be developed for each problem or opportunity discussed herein or surfaced during the year (e.g., productivity, intervals, recall, management practices, ATE traceability, etc.).

- A positive feedback or management indicator system will be developed for measuring the effectiveness of the PMTE Project and other agency PMTE programs.

OTHER OMS ACTIVITIES

On a number of occasions OMS was called upon during FY 79 to provide special assistance to the NBS Executive Board, the Director's Office, and other parts of NBS and DOC. For example, DMS, together with CEEE, was asked by the Executive Board to prepare a report on "The Impact of Microprocessor-Based Technology on NBS Measurement Services." This report was completed on schedule on December 15, 1978, with Kathryn Leedy of OMS serving as principal investigator and providing a major editorial contribution. As a second example, Brian Belanger provided assistance to Deputy Director Dillon in generating material on quality assurance and measurement control for a presentation by Dillon to the Fall Joint NSIA-AIA Government-Industry Meeting (Williamsburg, VA, October 1979).

OMS has been deeply involved in the new ASTM Committee E-46 on Quality Systems since its inception. (Brian Belanger will be Chairman of the E-46 Interface Committee for the coming term.) E-46 intends to provide guidelines to all of ASTM concerning the incorporation of adequate quality provisions in ASTM standards and test methods. Among other topics, E-46 will be concerned with measurement quality and calibration, and thus, NBS will have an excellent opportunity to contribute to the development of guidelines on measurement quality control that will be widely used.

The ANSI Z-1 Committee on Quality Systems, for which ASQC holds the secretariat, has recently formed a new writing group for quality standards for calibration systems and measurements. This activity is being carred out under the auspices of the Metrology Technical Committee (MTC) of ASQC. Brian Belanger of OMS is a member of both the standards writing group and the MTC. Both in this activity and in the E-46 work, the role of OMS is to contribute whatever technical input it can directly and to keep interested parties in other parts of NBS appraised of the progress of the work and involve those NBS persons having relevant expertise in this work as appropriate. Two meetings of the standards writing group have been held during the past year and a considerable volume of correspondence has been exchanged, including a first draft of a new standard.

Brian Belanger of OMS serves as Chairman of the U.S. Working Group for Reporting Secretariat 6 of Pilot Secretariat 22 of the International Organization of Legal Metrology (OIML). During the past year, other commitments within OMS have prevented the standards writing activities of RS 6 from making progress; however, activity in this area is now picking up, with meetings of the U.S. Working Group scheduled during the month of November and meetings with other collaborating countries scheduled for Spring 1980 in Paris. One goal of OMS' involvement in RS 6 is to make the recommendations which it ultimately will develop as consistent as possible with U.S. domestic standards such as those under development in ASQC and ASTM. Additionally, OMS will strive to incorporate the views of key U.S. organizations such as the Scale Manufacturers Association and the Scientific Apparatus Manufacturers Association.

OMS also feels that it is important to work with other Federal agencies to encourage uniformity and efficiency in measurement control and equipment management. Many of the activities of the PMTE Project, as described earlier in this report, are directed towards this end. During the past year, Brian Belanger was asked by the Food and Drug Administration to participate in a training course for new auditors who will be auditing medical device manufacturers for compliance with the Good Manufacturing Practices. The training materials on calibration, traceability, and measurement assurance presented to these auditors were well received, and it will continue to be important for OMS to use every opportunity to provide such assistance to other agencies.

During the past year OMS has worked with ASTM Headquarters staff to prepare a plan for expanded NBS/ASTM collaboration (Appendix E-2). This plan includes a consideration of joint interests in four areas:

- NBS participation in ASTM Committees:

  NBS would strive to increase the effectiveness of its participation in key ASTM committees.

- Accelerated development of MAP services:

  ASTM and NBS have already demonstrated a common interest in generating new NBS MAP services needed by the ASTM membership. For example, NBS has worked effectively with the E-20.03 Committee of ASTM to explore MAP approaches to industrial grade platinum resistance thermometry. Opportunities exist for ASTM Committees to assist NBS in accelerating the development of new MAP services, possibly through the vehicle of ASTM Research Associates. There is considerable precedent for this approach in the development of new SRM's by ASTM Research Associates.

- Legal Metrology:

  ASTM does not currently have a major role in U.S. participation in OIML, yet it appears that through the formation of new ASTM Committees and/or the expansion of the role of existing ASTM Committees, ASTM might facilitate the prepartion of U.S. positions to be incorporated into the OIML standards writing process.

- Alternatives to NBS calibration services:

  From time to time NBS finds it necessary to reduce low priority calibration services. The adverse impact of such reductions might be lessened if it were possible to generate ASTM standard test methods incorporating calibration methods used by NBS, so that other laboratories would be able to perform calibrations with a quality comparable to those performed at NBS. As in Item 2, ASTM Research Associates working at NBS to develop more comprehensive

documentation and exploring alternatives to NBS calibration might be considered as a means for increasing industry's self-sufficiency in calibration areas targeted for future reduction by NBS. ASTM can also assist NBS in priority setting by providing a forum in which measurement requirements can be discussed.

The draft NBS/ASTM Plan has not been approved by either organization at the time of this writing. It is anticipated that during the coming year both ASTM and NBS will give this plan serious consideration. Comments from the Evaluation Panel Members on this draft plan would be welcomed by OMS.

OMS participated in the NBS/Montgomery County Public Schools Science and Technology Enrichment Program (Belanger and Leedy in FY 79). Lecture/demonstrations on measurement standards were made to several elementary and junior high schools during the school year. This activity will continue in FY 80.

Each year OMS publishes and distributes a brochure describing NBS measurement seminars given by NBS technical divisions.

During FY 79 OMS was asked by the NBS Director's Office to explore the issue of "bilateral reciprocal traceability (BRT)" with the National Physical Laboratory in England. BRT refers to a mutual agreement by two countries, to recognize for traceability purposes, each other's calibration certificates (or other specified evidence of traceability). Brian Belanger is coordinating this issue on behalf of NBS, and Duncan Thurnell is coordinating the issue on behalf of NPL. In the long run, such an agreement might cover reciprocity, both between NPL and NBS and also between lower level laboratories in each country. However, in the short run, attention is being focused on reciprocity between NBS and NPL only.

The principal technical consideration in implementing BRT is insuring continuing measurement compatibility between NBS and NPL for the measurement areas of interest. It appears that this can be done with a MAP-type approach with periodic intercomparisons of transport standards. One must also consider institutional problems. In the U.S., NBS is not a regulatory agency and therefore does not require traceability of anyone. Federal agencies which do require traceability include DOD, NASA, NRC, FDA, etc. Unless these and other agencies recognize NBS/NPL reciprocal traceability, such reciprocity will have no meaning. Accordingly, OMS will meet with the concerned agencies during the coming year and hopefully will obtain commitments from them to the effect that if NBS and NPL can come to agreement on an adequate technical plan for achieving measurement compatibility on a continuing basis, that they will recognize such reciprocity. It would appear that NBS's efforts to achieve reciprocal traceability are completely consistent with the GATT Code, which the U.S. must honor.

Belanger met with Thurnell in May of 1979, and NBS and NPL are now in agreement concerning how to proceed. It has been proposed that gage block

measurements serve as a test case, since this is a well established measurement area where we already have good indications that NBS and NPL are in agreement. During FY 80 NBS and NPL intend to firm up plans for gage block intercomparisons so as to form a firm technical basis for reciprocal traceability.

10b. Invited Talks

Belanger	IMEKO Conference, Moscow, May 1979, Invited talk on MAP's, "Regional Measurement Assurance Programs for Physical Measurements.
Belanger	Basic Medical Device Course, FDA, Minneapolis, MN, "Evaluating the Calibration of Device Manufacturing Equipment," July 23, 1979.
Belanger	International Laboratory Accreditation Conference, October 1978, "The Role of MAP's in International Laboratory Accreditation".
Belanger	Testing Laboratory Performance Evaluation and Accreditation Conference, "Laboratory Performance Evaluation Services of the U.S. National Bureau of Standards," together with J. Bryson and G. Uriano, September 25-26, 1979.
Belanger	NCSL Measurement Quality Requirements Workshop Panel, (discussion of traceability and MAP's) October 16, 1979.
Belanger	Measurement Science Conference, "Measurement Challenges for the 1980's," November 30, 1979.
Kieffer	National Conference on Quality Assurance of Environmental Measurements, "The NBS Role in Quality Assurance for Physical Measurements," November 27, 1978.

10c. Publications by OMS Personnel

1. "Measurement Assurance for Gage Blocks," M. C. Croarkin, J. Beers, and C. Tucker, NBS Monograph 163, February 1979.

2. "Calibration and Related Measurement Services of the National Bureau of Standards," B. Belanger editor, NBS Special Publication 250, April 1978.

3. "Catalog of Federal Metrology and Calibration Capabilities," K. Leedy, NBS Special Publication 546, Issued June 1979.

4. "Regional Measurement Assurance Programs for Physical Measurements," B. Belanger and L. Kieffer, to be published in ACTA IMEKO proceedings, (International Measurement Confederation), Moscow, May 1979.

5. "Traceability--An Evolving Concept," B. Belanger, to be published in ASTM Standardization News, (preprint).

6. "The NBS Role in Quality Assurance for Physical Measurements," B. Belanger and L. Kieffer, National Conference on Quality Assurance of Environmental Measurements, November 27-29, 1978.

7. "Challenges in Achieving ATE Traceability to NBS," AUTOTESTCON Conference, September 1979, Minneapolis, B. Bell, M. Souders, B. Belanger, and R. Kamper, to be published in proceedings.

8. "Laboratory Performance Evaluation Services of the U.S. National Bureau of Standards," B. Belanger, J. Bryson, and G. Uriano, Testing Laboratory Performance Evaluation and Accreditation Conference, September 25-26, 1979, to be published in proceedings.

10e. Special Reports

1. "The Impact of Microprocessor-Based Technology on NBS Measurement Services," Report to the Executive Board, December 1978, Principal Investigator, K. Leedy.

10f. Technical and Professional Committee Activity

Belanger	Member, ASTM Committee E-46--Quality Systems, (Chairman, Interface Committee, and Chairman, Nominating Committee).
Belanger	Member, U.S. National Working Group for OIML Pilot Secretariat 22, and U.S. National Advisory Committee for OIML, (Chairman, Reporting Secretariat 6).
Belanger	Member, ANSI Committee Z-1 Writing Group for Standards for Calibrations Systems and Measurements.
Belanger	Member, ASQC Metrology Technical Committee
Belanger	Member, Task Group 1I (Metrology and Calibration of Industry Joint Services Automatic Test Project.
Belanger & Kieffer	Members, NCSL Measurement Assurance Committee
Kieffer	Member, GIDEP Metrology Committee
Kieffer	Member, NCSL National Measurement Requirements Committee

Leedy	Member, Special Committee on General Purpose Electronic Test Equipment, Radio Technical Commission for Aeronautics.
Vogt	Invited Participant, Department of Defense Joint Logistics Commander's Panel on Automatic Testing.
Vogt	Member, Government Advisory Group, GIDEP, (Government Industry Data Exchange Program).

Office of Domestic and International Measurement Standards
(ODIMS)

Technical Activities

1. Introduction

1.1. Background

The National Bureau of Standards has traditionally been involved in standardization activities for a variety of reasons:

1. Staff scientists recognize standards as important delivery mechanisms for their research programs;

2. Standards committees bring together a core competence of technical and scientific interests from various institutions and segments of the economy that provide NBS scientists and programs valuable external linkage; and,

3. Standards organizations recognize the technical strength and objectivity of NBS scientists and actively seek their participation as an important balance between private sector and government interests.

At present, for example, twenty-three percent of the professional staff of NBS' National Measurement Laboratory (NML) hold memberships in standards-writing activities of national and international organizations, both in the private sector and in government. With increased government interest in the use of voluntary standards for regulatory and procurement purposes; in assuring openness and due process in standards development and certification procedures; and, in assuming a stronger more effective presence in international standards activities, NBS is committed to better plan and manage its standards interactions to respond to these pressures. Standards coordination offices exist within the three major organizational units of the Bureau. A centralized standards information system has been developed to identify levels of standards participation and to supply useful information to managers and participants. Additionally, a high level Standardization Advisory and Coordination Committee has been assembled to focus management attention on standards issues on a continuing basis.

1.2. ODIMS Mission

The Office plans, administers, and actively participates in an extensive program directed towards:

-- Managing assigned NBS responsibilities to represent the United States in the International Organization of Legal Metrology (OIML);

-- Coordinating the NML involvement in domestic and international voluntary standards activities, including maintaining current and complete information on such standards activities, especially as regards the commitment of NML resources;

-- Coordinating and facilitating NML staff participation in international cooperative scientific and technological programs in support of the Office of the Associate Director for International Affairs; and

-- Supporting, as required, the Associate Director for Measurement Services.

1.3. Interactions

In support of the objectives of United States participation in OIML, there is strong liaison with all interested and affected parties including: the National Conference on Weights and Measures; industry associations and private corporations involved or interested in scientific and measuring instruments; and, Federal agencies having legal metrology mandates. Some of these interactions are institutionalized through a U.S. Advisory Committee for International Legal Metrology with representation from the interests mentioned above. There is also strong liaison with the national metrology services of the 46 nations who are OIML members.

ODIMS supports and interacts with tasks and programs of NML Centers and Divisions where staff participate in domestic and international measurement standards activities. It establishes and maintains contacts with private sector standards bodies (ASTM, ANSI, SAE, NCCLS, etc.) as appropriate.

In support of bilateral/multilateral programs for cooperation in science and technology, there are interactions with NML tasks and programs to identify and establish appropriate projects, and there is interaction with the various counterpart scientific organizations and institutions of other nations. Contact with the Department of State and with various U.S. Embassies and Consulates is also necessary.

2. Program Activity

2.1. Major Objectives

-- Improve U.S. trade opportunities in the scientific and measuring instrument field by removing technical and administrative differences in legal metrology standards, and by promoting the harmonization of U.S. and OIML legal metrology requirements;

-- Improve the management and coordination of NML resources committed to standards activities;

-- Promote and facilitate NML participation in bilateral/multilateral cooperative exchanges in science and technology in support of U.S. foreign policy objectives and the basic mission of NBS.

2.2. Technical Activities

2.2.1. United States Participation in OIML

In carrying out the Bureau's assigned task of managing United States participation in OIML, the Office of Domestic and International Measurement Standards plans and directs a variety of activities intended to maintain a strong U.S. presence in OIML. Of priority effort is the development of positions (including preparing and accrediting delegations to OIML technical meetings) which satisfy U.S. interests as regards:

a. the identification of opportunities for U.S. measurement practices to be embodied in OIML International Recommendations;

b. the prevention of impediments to U.S. trade that can result from restrictive technical or administrative requirements in International Recommendations;

c. the development of International Recommendations which accommodate the reality of a decentralized system of legal metrology such as found in the United States (Europeans generally assume a centralized legal metrology system); and, as regards

d. the development of sound management and administrative policies which will ensure that OIML operates as a viable international organization and that it effectively coordinates its aims and objectives with those of other international organizations (BIPM, ISO, IEC) having similar objectives.

United States presence in OIML is geared to strong technical level participation in almost half of its 200 committees and subcommittees (called Pilot and Reporting Secretariats) that are studying measurement problems and that are preparing solutions to such problems in the form of model technical regulations proposed for adoption as International Recommendations. U.S. participation in OIML generally takes three forms:

a. Nation in Charge of a Secretariat

This commits the U.S. to form a national committee to study a particular measurement problem; to develop a first draft International Recommendation on the subject; and, to assume leadership in working with other interested OIML nations to move the draft International Recommendation to final adoption. The U.S. administers twenty-nine (29) such secretariats at present and ODIMS is responsible for organizing and monitoring the progress of the work of these secretariats in behalf of the U.S. Appointing technical advisors to direct the work; assistance in organizing National

Working Groups; contacting affected industry groups, Federal agencies, standards bodies, and State and local agencies; translation of documents; scheduling of international meetings; and, accrediting U.S. delegations to such meetings are typical activities carried out by ODIMS in directing this work. Highlights of the draft International Recommendations published by U.S. National Working Groups over the past year are presented in Appendix A.

b. Collaborating Nation Participating in the Work of an OIML Secretariat Administered by Another Nation

This commits the U.S. to active participation in the development of an International Recommendation for a given topic area including attendance at international meetings, commenting on the technical adequacy of prepared drafts, and voting. At present, the U.S. collaborates in the work of approximately seventy (70) such OIML Pilot and Reporting Secretariats. ODIMS manages this activity by receiving all drafts sent to the U.S. for comment, identifying appropriate technical experts to review such drafts, undertaking translations of documents where necessary, assembling, and coordinating U.S. positions where appropriate, and forwarding such positions to the respective OIML secretariat. When appropriate ODIMS staff play a direct or leading role in reviewing drafts, generating U.S. positions, and in serving on U.S. delegations. When international meetings are scheduled, ODIMS assembles, accredits, briefs and de-briefs U.S. delegations to such meetings. Over the past year the U.S. received thirty-six (36) draft International Recommendations for comment or vote and sent delegations to fifteen (15) OIML international working group meetings held throughout the world. Highlights of selected OIML drafts reviewed by the United States are provided in Appendix B.

c. National Representative in OIML Plenary Meetings and Conferences

The U.S. is an active member of the International Committee of Legal Metrology (CIML), the body that oversees and directs the technical program of OIML. Dr. Arthur McCoubrey, NML Associate Director for Measurement Services, is the U.S. Representative to this body. The CIML meets at least every eighteen months. The actions taken by the CIML do not obligate its members under the OIML Convention. The U.S. also participates as a full-voting member in meetings of the International Conference of Legal Metrology, which sets policy for OIML, adopts a quadrennial budget, and officially sanctions International Recommendations as final documents. The International Conference meets every four years and its decisions obligate member nations under the Convention. ODIMS oversees the development of U.S. positions to be taken during these plenary meetings. In carrying out these activities ODIMS works with the U.S. Advisory Committee for International Legal Metrology, with the various U.S. technical advisors and interest groups that have provided input to U.S. positions, and with the Department of State. The International Conference of Legal Metrology will meet June 16-20, 1980, in Washington, D.C. at the invitation of the United States Government. ODIMS is responsible, with assistance from the Department of State, for planning the Conference.

2.2.2. Coordinating NML Involvement in Domestic and International Voluntary Standards Activities

In June 1979, ODIMS published its first report on "Staff Participation in Standards Development Activities." The report is directed to NML managers and has the following objectives:

a. to provide information obtained during a nine-month survey of Centers and Divisions on levels of staff participation in national and international standards-writing activities in both private and governmental organizations;

b. to address the expectations of Bureau management regarding staff participation in standardization activities; and,

c. to report progress achieved and outstanding issues in meeting these expectations.

As a follow-up to the report, ODIMS has met individually with NML Division Chiefs and is completing meetings with Center Directors to discuss areas of standards activity where ODIMS could provide useful assistance to line managers and to standards participants.

NBS policy regarding staff participation in standards activities is that the line manager (Division Chief/Center Director) is responsible for deciding appropriate mission-related standards assignments and for allocating the necessary resources (labor and travel dollars) to support such assignments. The ODIMS role as the NML standards coordination office is to support these activities by focusing management attention on standards activities and by generating useful information upon which managers can base standards decisions.

From the data generated by the NML standards survey and from the resulting meetings of ODIMS staff with Division Chiefs and Center Directors it is clear that standards committee memberships are considered an important technical activity. Division Chiefs for the most part recognize standards committee assignments as a means of maintaining good technical liaisons with external interests, and often the incorporation of Bureau research into a voluntary standard is viewed as an important program objective. It is also clear that external organizations recognize the technical strength and objectivity of the Bureau staff as important assets and actively seek staff participation whenever possible. Data concerning how staff members become initially involved in standards activities indicate that in a majority of instances external organizations request the staff to participate on standards committees.

Several problems are also apparent. For the most part, Division Chiefs cite ever increasing demands on their staff and resources as a limiting factor in pursuing standards activities. One result is an extremely low level of participation in international standards activities

because such participation consumes more resources (labor and travel of staff) than does national committee participation. Less than 7% of the total NML committee memberships are committed to participation in ISO and IEC, the two major international voluntary standards bodies. In view of current worldwide emphasis on the development and use of international standards, including the recent Trade Agreements Act of 1979 which commits the U.S. to the Standards Code developed under the Multilateral Trade Negotiations (MTN), some attention should be given to this problem. Secondly, it is apparent that no continuing effort is being made to identifying new opportunities for important standards committee memberships. In part, this reflects the feeling of most managers that resources for new activities are difficult to obtain particularly for standards activities, and, secondly, a reluctance on their part to spend time understanding the nuances, complexities, and politics of our present U.S. standards system. It is apparent that ODIMS, and the other Bureau standards coordination offices, can and should pursue this activity as a service to the Centers and Divisions. However, the question of additional resources to take on increased, particularly international standards committee memberships, is very complex and not easily addressed.

2.2.3. Supporting Bilateral and Multilateral Scientific and Technological Programs for NML Cooperation with Foreign Institutions

As the principal scientific and technical measurement laboratory in the United States, NBS is highly regarded both nationally and internationally for its competence, mission, and accomplishments. Much of NBS' good reputation internationally comes from active staff participation in international programs and forums. Benefits of these activities accrue to NBS and its staff through associated development of strong individual and institutional relationships and thereby strengthen NBS' national and international role in standardization.

International activities of NBS and the staff can be roughly categorized as follows:

o International Organizations. NBS staff widely participate in international topical conferences, meetings of scientific and technical organizations, and standards-writing organizations. Personal contacts in these forums often lead to frequent direct communications, visits, and collaborative working arrangements. At NBS, the Guest Worker Program facilitates long-term collaborative work assignments for foreign scientists and engineers.

o Bilateral and Multilateral Agreements. On behalf of the United States, the State Department maintains bilateral agreements and multilateral treaties in science and technology with many nations. NBS participates in several of these arrangements that afford international contacts for the staff. For example, NBS is the designated representative of the United States in the Treaty of the Meter that has more than 40 other member nations

as signatories. Bilateral scientific and technical agreements in which NBS has actively participated include those with Canada, Japan, France, Germany, Italy, the United Kingdom, Australia, Mexico, Spain, and Brazil. NBS represents the United States in the U.S./U.S.S.R. Working Group for Metrology which comes under the broad agreement in science and technology between the U.S. and the Soviet Union. Recently, a bilateral agreement in metrology was signed by the U.S. and the Peoples Republic of China and is expected to call forth specific activity by NBS and counterpart PRC institutions very soon. New bilateral agreements are in the final stages of negotiation individually with Yugoslavia and Hungary. The Yugoslav agreement is expected to strengthen and expand existing cooperative programs between NBS and Yugoslav institutions.

o Technical Assistance. Other agency support has been given to NBS by the Agency for International Development (AID) for infrastructure development in standardization for developing countries. In particular, AID has funded NBS programs for conducting workshops, surveys, seminars, and training in standardization for representatives from developing countries. Standards institutions in Korea and Brazil supported by AID funding have sought and obtained long-term training assignments at NBS. ODIMS, in cooperation with the Egyptian National Institute for Standards (NIS), has developed an NBS proposal to AID for assisting NIS over a 5-year period beginning in FY 81. Another area in which NBS anticipates new requests for activity in technical assistance is in connection with the implementation of the Trade Agreements Act of 1979. This Act covers the GATT Standards Code which among other things calls for assistance in standardization development by adherents of the Code who request such help.

o Grants. NBS has taken the opportunity to seek and apply funds under the Special Foreign Currency Program (SFCP; PL-480). These funds have been used in several countries to support projects that complement or supplement ongoing programs at NBS. To date, SFCP projects have been established in Egypt, India, Israel, Pakistan, Poland, and Yugoslavia. Funds are no longer available in Israel, Poland, or Yugoslavia but bilateral agreements have succeeded the SFCP in all three nations. ODIMS was instrumental in establishing 5 new NBS/SFCP projects in Egypt during 1979.

The NBS Associate Director for International Affairs has administrative and oversight responsibility for the whole range of foreign relations activities of the Bureau staff. ODIMS mainly provides assistance to NBS Management and staff in developing and coordinating bilateral and multilateral programs of interest to NML scientists and programs. Most of these programs generally require negotiations both within the United States and in other countries. Within the U.S., the State Department and other Federal agencies are often involved. In other countries, counterpart governmental agencies and scientific and technical institutions need to be consulted. Centralized staff support for NML in ODIMS provides an efficient and effective means for maximizing benefits to NBS through such agreements. Sometimes circumstances will dictate that it is more appropriate to involve NML staff outside ODIMS in establishing foreign

agreements; however, ODIMS must still maintain pertinent information on Bureau policy and internal resources for guiding effective negotiations. Other important services of ODIMS in this regard are in putting together proposals for both grants and other agency funding for foreign assistance programs.

2.3. Activity Summary

2.3.1. Draft OIML International Recommendations Reviewed by the United States

Secretariat	Title of Document and Responsible Nation
PS1/RS1	Vocabulary of legal metrology (Poland)
PS4/RS1	Gage blocks (U.S.S.R.)
PS5/RS13	Meters for liquids (other than water) equipped with measuring chambers (France/FRG)
PS5/RS13	Measuring systems for liquids other than water (France/FRG)
PS5/RS16	Water meters (UK)
PS6/RS4	Measurement of hydrocarbon gases distributed by pipeline (Czechoslovakia)
PS7/RS4	Metrological regulations for non-automatic weighing machines (France/FRG)
PS7/RS5	Checkweighing and weight grading machines (Belgium/UK)
PS7/RS5	Belt-conveyor weighing machines (Belgium/UK)
PS8/RS5	Hexagonal weights (UK)
PS10/RS2	Tachometers, mechanical odometers, and chronotachygraphs for automobiles (Poland)
PS11/RS3	Piston pressure gages (Czechoslovakia)
PS11/RS4	Indicating pressure gages (U.S.S.R.)
PS11/RS4	Recording pressure gages (U.S.S.R.)
PS11/RS4	Pressure gages with elastic sensing elements (U.S.S.R.)
PS11/RS7	Barometers (UK)
PS12/RS9	Methods of verification of standard thermocouples (Czechoslovakia)
PS18/RS1	Humidity meters for cereal grains and oilseeds (France)
PS21/RS1	Standardized metrological characteristics of measuring instruments (U.S.S.R.)
PS21/RS2	Standardized metrological characteristics of dynamic properties of measuring instruments (U.S.S.R.)
PS21/RS4	Metrological characteristics of measuring systems: regulation principles (U.S.S.R.)
PS21/RS5	Requirements for methods of control of metrological characteristics of measuring instruments (U.S.S.R.)
PS22/RS1	Fields of use and nomenclature of instruments subject to periodic verification (FRG)
PS22/RS2	Principles of the choice of instrument parameters and characteristics to be verified (DDR)

Secretariat	Title of Document and Responsible Nation
PS23/RS2	Rules for the determination, conservation and use of standards and calibration devices (Czechoslovakia)
PS27/RS1	Terminology relating to reference materials (U.S.S.R.)
PS27/RS3	Metrological properties of reference materials and their standardization (U.S.S.R.)
PS27/RS4	Principles for the determination of certified values in reference materials (U.S.S.R.)
PS27/RS5	Principles for the use of reference materials (U.S.S.R.)
PS27/RS6	Requirements concerning the contents of certificates for reference materials (U.S.S.R.)
PS27/RS8	Information concerning reference materials (U.S.S.R.)
PS30/RS1	pH Measurement and ionometry (U.S.S.R.)
PS30/RS2	Measurement of electrical conductivity (U.S.S.R.)
PS30/RS7	Gas calorimetry (FRG)
PS30/RS8	Measurement of the concentration of liquid vapour in air and gases (U.S.S.R.)
PS31/RS1	Training of qualified metrological engineers (U.S.S.R.)

2.3.2. U.S. Participation in OIML International Meetings

Date	Committee	Title	Place
Sept. 78	PS21/RS1-2-4-5	Standardization of the Metrological Characteristics of Measuring Instruments	Uzhgorod, USSR
Oct. 78	PS5/RS16	Water Meters	Kyoto, Japan
Nov. 78	PS5/RS13	Measuring Systems for Liquids Other Than Water	Paris, France
Dec. 78	PS19/RS5	Strain Gages	Paris, France
Apr. 79	PS5/RS16	Water Meters	London, UK
Apr. 79	PS22/RS2	Principles of the Choice of Parameters and Measuring Instrument Characteristics to be Verified	Berlin, DDR
May 79	PS7/RS4	Non-Automatic Weighing Instruments	Strasbourg, France
May 79	PS7/RS5	Automatic Weighing Instruments	London, UK
June 79	PS7/RS8	Load Cells	Paris, France
June 79	-	OIML Developing Countries Council	Paris, France

June 79	-	OIML Mark Working Group	Paris, France
Sept. 79	PS7/RS4	Non-Automatic Weighing Instruments	Braunschweig, FRG
Sept. 79	-	OIML Presidential Council	Paris, France
Oct. 79	PS18/RS1	Instruments for Measuring the Moisture Content of Grain and Cereals	Paris, France
Oct. 79	PS26	Measuring Instruments Used in the Field of Public Health	Braunschweig, FRG

2.3.3. Meetings in Support of Bilateral Science and Technology Agreements

Joint U.S./U.S.S.R. Working Group on Metrology	June 24 - July 6, 1979	Moscow, U.S.S.R.
Joint U.S./Yugoslavia Cooperative Program	Sept. 24 - Sept. 30, 1978 April 9 - 13, 1979	Belgrade, Yugoslavia Washington, D.C.
Preliminary Discussion of Joint U.S./Hungary Cooperative Program	Jan. 26, 1979	Washington, D.C.

2.3.4. Meetings in Support of Technical Assistance Programs

Joint U.S./Egyptian Consultative Committee on the Applied Science and Technology Research Program	March 22 - 31, 1979	Cairo, Egypt

2.3.5. Meetings in Support of Special Foreign Currency Program Grants

Deliberations on four (4) SFCP Projects: Oct. 1 - 11, 1978, Cairo, Egypt

1. Development of measurement standards for large storage volumes and flow of fluids
2. Development of ionizing radiation dosimetry systems and standards for application in industrial radiation processing
3. Development of holographic interferometric techniques for industrial-gaging and quality control applications

4. Development of ultrasonic and acoustic emission calibration capability for non-destructive evaluation

2.3.6. Special Publications

Report on: NML Staff Participation in Standards Development Activities (June 1979).

Highlights of Draft OIML International Recommendations Published by U.S. National Working Groups

PS7/RS8 Load Cells - United States National Working Group
Chairman - John Elengo, Revere Corporation of America

This secretariat was created at the request of U.S. industry as a means of directing international requirements for load cells. These measuring transducers are now widely used in mass and force measuring devices and their application is expected to show continued strong growth as a result of rapid developments in electronics associated with measuring devices. U.S. industry claims the technological lead in load cells and is interested in assuming an influential role in the development of international standards for these products.

In developing the draft Recommendation on load cells the USNWG objective was to produce a draft that would provide government officials uniform means for determining the metrological characteristics of load cells used in measuring devices (scales and materials testing machines), which are subjected to regulation in most nations. In achieving this objective however, the USNWG wanted to ensure that the draft Recommendation would be performance oriented so as to permit maximum flexibility in the design and engineering of load cells. For example, the approach taken by the USNWG recognized that several load cell errors must be considered together when fitting load cell performance characteristics to the error envelope permitted in regulations. It must be recognized that it is possible to have low non-linearity and hysteresis errors and moderate temperature errors or, conversely, to have moderate non-linearity and hysteresis errors and low temperature errors. Thus, it is not considered appropriate to specify individual error limits for given characteristics (non-linearity, hysteresis, etc.), but rather to consider the total error envelope allowed for a load cell as the limiting factor. The use of an error envelope concept allows manufacturers the freedom of balancing individual contributors to total measuring error and to compensate for such with microprocessors or through other electronic means while still achieving the required performance.

This is a long overdue and welcome departure from traditional approaches, wherein each load cell characteristic is specified independent of the others. While traditional independent specifications are encompassing, they inherently do not lend themselves to being combined. The user must carefully interpret and select the results he desires. On paper, it is quite easy to demonstrate that if all of the individual specifications are at the extremes of tolerance, the load cell will not perform to the level that most are in fact capable of doing. The use of an error envelope simplifies the user's selection of load cells, and the regulator's task of evaluating their performance.

PS19/RS2 Materials Testing Machines - United States National Working Group Chairman - Milan Sebek, MTS Systems Corporation

This secretariat was taken by the U.S. as a means of ensuring that our industry would direct the development of international standards for materials testing machines. At the present time, ASTM Committee E-28 is actively engaged in preparing standard test methods for various types of materials (steel, concrete, etc.). A similar activity is going on within ISO Technical Committee 164 on mechanical testing. Neither ASTM nor ISO are, however, involved in developing standards for the testing machine itself which prescribe necessary technical specifications and performance requirements.

The work to be undertaken by the U.S. in OIML involves the writing of four International Recommendations under the following titles:

1. General Specifications for Materials Testing Machines

2. Specifications for Machines for Tension and Compression Testing of Materials

3. Specifications for Force-Measuring Instruments for Verifying the Load Indication of Materials Testing Machines

4. Specifications for Machines for Fatigue Testing of Materials

A draft of the first document on general specifications has been completed and is undergoing review by the U.S. National Working Group before circulating it to the international members of the secretariat. The Recommendation deals with testing machines and their essential accessories that are used to determine the mechanical properties of materials. It provides requirements for specifying the general performance characteristics of materials testing machines; for determining the metrological characteristics of materials testing machines; and for establishing metrological controls concerning the use of materials testing machines. The Recommendation is intended to apply to the fields of technology and industry where the control or surveillance of the performance of testing machines used to determine mechanical properties of materials is a government function. An example in the U.S. is the Nuclear Regulatory Commission's insistence that testing machines used to determine mechanical properties of materials used in building reactors be verified as to their performance.

PS19/RS5 Strain Gages - United States National Working Group Chairman - James Dorsey, Micro-Measurements, Inc.

The United States accepted this secretariat on the urging of industry who felt it important to provide leadership in the writing of an international standard for these devices. The draft that has been produced deals with metallic resistance strain gages of the type used for determining mechanical properties of materials, for stress analysis of structures, and as sensing elements in a variety of measuring instruments (e.g. load cells).

Strain gages are part of a complex system which includes structure, adhesive, gage, leadwires, instrumentation, and (often) environmental protection. As a result, many things affect the performance of strain gages, including user technique. A further complication is that strain gages once installed normally cannot be reinstalled in another location, so gage characteristics can be stated only on a statistical basis. While large numbers of strain gages are used, they are nonetheless a unique measuring transducer because they cannot be calibrated.

The approach taken by this Recommendation requires manufacturers of metallic resistance strain gages to specify important performance characteristics for their products and assure that the specified values of such characteristics are accompanied by properly stated uncertainties that have been arrived at using accepted statistical procedures. This approach is unique to the five or more strain gage "specifications" that already exist in the U.S., which call for a specific set of equipment and procedures that must be followed. In most cases those doing testing use other equipment and techniques which are often considered to be superior and usually involve expensive apparatus. As a result, most engineers believe that the existing U.S. standards are not useful. The draft OIML International Recommendation is very simple in scope and is intended to achieve common understanding and agreement on the important performance characteristics (resistance, gage factor, transverse sensitivity, gage factor versus temperature, and apparent strain-thermal) of metallic resistance strain gages.

Highlights of Selected OIML Draft International Recommendations Reviewed by the United States

PS1/RS1 Vocabulary of Legal Metrology, Fundamental Terms

Secretariat: Poland

U.S. Interests: All U.S. held OIML Secretariats, U.S. Representatives, Working Group Members.

U.S. Actions and Influence: In the late sixties OIML published a Vocabulary of Legal Metrology, which had been prepared by PS1/RS1. In 1971 this official French text was translated into English by the British Standards Institute and was in use until OIML republished it in both French and English with several small addenda in 1978. Recently PS1/RS1 circulated for comment a first preliminary draft of a revision of the Vocabulary (in French only). U.S. review of the draft revision indicated that it departed from the 1978 Vocabulary in its organization, definitions, and examples to an unnecessarily large extent and that it emphasized academic subject matter too strongly. The U.S. therefore took the position that the draft must be set aside, the 1978 Vocabulary given the status of a first preliminary draft, and the rationale, scope, organization, etc., of the Vocabulary be reexamined before PS1/RS1 can resume its work. At its September 1979 meeting, the OIML Presidential Council accepted the U.S. position and instructed PS1/RS1 to follow a more detailed course of action also sketched by the U.S.

PS4/RS5 Measurement of Angles

Secretariat: Poland

U.S. Interests: Manufacturers of angle measuring equipment, NBS Mechanical Processes Division.

U.S. Actions and Influence: PS4/RS5 circulated to the U.S., which is a "Collaborator" of PS4/RS5, a preliminary draft entitled "Echelon system for instruments used to measure angle." The draft specified traditional calibration chains starting with a national standard of angle and included specific methods and instruments in several steps down to the ordinary measuring instrument. In brief, U.S. review resulted in the following position which was communicated to PS4/RS5. The U.S. finds that the utility of a (national) hierarchy is particularly questionable in the case of angle because angle is a ratio quantity that can, and often should be, generated without reference to a higher echelon standard. The draft does not recognize modern

instruments for generating angles now manufactured and in use in the U.S. and fails to accord to angle blocks and indexing tables the accuracy of which they are capable. In consequence of these comments the U.S. hopes to gain recognition for the type of domestic high-technology angle measuring equipment available and greater acceptance of the flexible approach to angle standards practiced in the U.S. which contrasts sharply with the very objective of this draft.

PS5/RS13 Meters for Liquids (Other Than Water) With Measuring Chambers

Secretariat: France and Federal Republic of Germany

U.S. Interests: Meter manufacturers, manufacturers of fluid metering systems, State and local weights and measures officials, NBS Office of Weights and Measures.

U.S. Actions and Influence: This Recommendation was adopted by OIML in 1972 prior to the U.S. joining the Organization, and is now in the process of being revised. The Recommendation, which is now mandatory in most of Western Europe, requires that meters be manufactured with a 10 to 1 ratio between maximum and minimum rate of flow. The theory behind the requirement is that a 10 to 1 ratio meter performs better over its operating range than a 5 to 1 meter, the principal difference being that the 10 to 1 meter is more accurate at slow rates of flow. The 10 to 1 meter is also more expensive to produce. Within the U.S., 5 to 1 ratio meters are used in vehicle tank systems, loading rack (terminal) systems, and in liquified petroleum gas systems. Generally speaking, vehicle tank trucks in the U.S. make individual deliveries from 50 to 150 gallons into fuel oil tanks of 260 gallon capacity found in most private homes where fuel oil is used. Loading rack (terminal) systems gnerally make deliveries to vehicle tanks or railway tank cars having capacities of 1,000 gallons or more. Accordingly, the effect of slow flow on the accuracy curve of a vehicle tank or loading rack meter is not a major concern in the U.S. because such meters are largely operated well above minimum flow rates. If the U.S. were to change its practice and require 10 to 1 meters it would be subjecting the manufacturer and user to increase costs in order to avoid errors that might result from those few commercial applications where vehicle tank or loading rack meters are operated at or below minimum flow rates. At present, the U.S. position is not to accept the proposed revision and negotiations are underway to try and resolve this problem through an appropriate amendment to the draft Recommendation which would recognize the use of 5 to 1 ratio meters for vehicle tank truck, loading rack (terminal), and liquified petroleum gas applications.

PS6/RS4 Measurement of Hydrocarbon Gases Distributed by Pipeline

Secretariat: Czechoslovakia

U.S. Interests: Producers of natural gas, pipeline transmission companies, public utilities and their associations, and manufacturers of gas (bulk) quantity measuring equipment.

U.S. Actions and Influence: This Recommendation deals with questions relating to official government approval of measurement methods, station design, verification procedures, and of overall operations of gas pipeline measuring stations involved in the transmission and custody transfer of hydrocarbon gases. Various interests within the U.S. generated a large number of detailed comments on the draft, but the general thrust of the Recommendation is acceptable to the U.S. One of the contributing factors to this acceptance is the fact that the U.S. worked with Czechoslovakia in developing portions of the text. Detailed U.S. comments have been forwarded to the Secretariat and were discussed face-to-face during a visit to Bratislava by an ODIMS staff member. During this visit it was made clear that PS6/RS4 was very grateful for the help given by the U.S. and would consider U.S. comments most seriously.

PS11/RS4 Indicating and Recording Pressure Gages

Secretariat: U.S.S.R.

U.S. Interests: Manufacturers of pressure gages, NBS Pressure Section.

U.S. Actions and Influence: There are two International Recommendations involved that have been in effect since 1972 and are in the process of being revised. NBS and the Instrument Society of America, have worked diligently to incorporate U.S. practices into these documents. During a working group meeting in January 1978 in Moscow, the Soviets accepted U.S. proposed changes broadening the accuracy classes of gages and broadening maximum permissible errors of ± .8K and ± 1K to ± 1K for new and repaired gages and ± 2K for instruments in service. When the documents were balloted for approval these changes and others had not been incorporated and the U.S. strongly objected. An inquiry is now underway by the International Bureau of Legal Metrology (BIML) to determine why the Soviets have failed to respond to the majority opinion of the secretariat working group.

PS11/RS7 Barometers

Secretariat: United Kingdom

U.S. Interests: Manufacturers of barometers, National Weather Service (NOAA), NBS Pressure Section.

U.S. Actions and Influence: This is a first draft International Recommendation and there are problems which revolve around three principal issues. First, the draft covers barometers for meteorology and for pressure altimetry. The requirements for meteorology are much less stringent than those for altimeter setting indicators and it appears prudent to separate these two types of instrument applications. Secondly, the draft recommends a pressure range of 150 mbar. The National Weather Service uses aneroid instruments with a scale range of 190 mbar. Thirdly, the draft requires

tubes to be constructed with an internal bore of not less than 8 mm over the scale length. Tubes with 6.35 mm internal diameter are widely used in the U.S. Conversion to 8 mm diameter tubes might decrease the uncertainty of a single reading by 0.03 mbar and thus improve performance, but conversion will incur considerable cost and such improvement is not considered necessary for meteorological uses. A formal U.S. position containing these arguments has been submitted to the UK. No response has yet been received.

PS27/RS1-2-4-5 (4 drafts) Standardization of the Metrological Characteristics of Measuring Instruments

Secretariat: U.S.S.R. (all four)

U.S. Interests: All U.S. held OIML Secretariats, U.S. Representatives, Working Group Members, NBS.

U.S. Actions and Influence: In advance of a meeting of the International Working Group of PS21, of which the U.S. is a member, PS21 circulated four preliminary drafts: (1) Standardized metrological characteristics of measuring instruments (2) Standardized metrological characteristics of dynamic properties of measuring instruments, (4) Metrological characteristics of measuring systems: regulation principles, and (5) Requirements for methods of control of metrological characteristics of measuring instruments. The Secretariats had, as far as the U.S. has been able to determine, submitted existing U.S.S.R. standards as OIML drafts and were intent on their adoption without substantive changes. Prior to the meeting the U.S. coordinated its very critical position with the UK, FRG, and France. Some of the major problems were that the drafts were most difficult to understand, too all-encompassing in scope, too rigid in their intended applicability, too abstract in approach, and given to idealized assumptions that lead to impractical conclusions; they were poorly coordinated (between drafts) and provision of a perspective view of the subject as a whole was lacking. There were also many more detailed and more technical problems. While the U.S. and other Western countries pressed for discussion of especially the broader problems, the Soviet Secretariats did everything in their power to keep the discussion on the level of detail. In the course of the week's meeting the Soviets softened somewhat as personal relationships were established and translational obstacles identified and eliminated. The U.S.-led Western efforts resulted in the following major gains: The U.S. proposed softening of the drafts from International Recommendations to International Documents will be considered. (Note: International Documents are guidance documents and do not carry the obligation of national implementation as stated in the OIML Convention for International Recommendations.) A unifying preface to the whole group of drafts was agreed to and drafted jointly by the U.S. and U.S.S.R. Tutorial appendices will be written. Concrete examples to illuminate some abstract concepts will be included. The PS21 attempt to have the drafts adopted by the International Working Group was blocked, so that further modifications will be possible.

PS23/RS3 Documentation Recommended for Standards and Calibration Devices

Secretariat: Czechoslovakia

U.S. Interests: National Conference on Weights and Measures, NBS Office of Measurement Services, and NBS Office of Weights and Measures.

U.S. Actions and Influence: PS23/RS3 circulated both a French and a difficult English version of a draft entitled "Recommended documentation for physical standards." After improving the English draft, ODIMS circulated it for comment. Problems with this draft and U.S. comments concerning these were as follows. PS27 had stated its main objective as being international "uniformity" in documentation for standards and calibration devices. This was challenged on the basis that there is no international flow of the documents in question known to us. The U.S. suggested instead that the main objectives should be to stress good documentation and to support a minimum information content. The draft attempted to specify in minute detail both what should be documented and how this should be done. The U.S. commented that it was inappropriate to specify "how", though examples would be acceptable. The draft implicitly assumed that documentation must be in the form of paper. The U.S. suggested that modern means of information storage (microfilm, computer memory) be included. The draft was based on the assumption of only a classical calibration echelon system. The U.S. commented that other traceability systems must also be recognized. Beyond this, the U.S. urged that the standard be written so as to accommodate the different national practices as well as the documentation below the national level.

PS27/RS1-3-4-5-6-8 (6 drafts) General Principles for the Use of Reference Materials in Legal Metrology

Secretariat: U.S.S.R. (all six)

U.S. Interests: Regulatory agencies, NBS Office of Standards Reference Materials, and clinical (medical) laboratories and other users.

U.S. Actions and Influence: Each of the above six Secretariats circulated a preliminary draft relating to "Legal Certified Reference Materials" and addressing (1) Terms and definitions, (3) Metrological characteristics; general concepts and ratings, (4) Principles of determiniation of certified values, (5) General principles for application, (6) Contents of certificate, and (8) Information systems on Legal Certified Reference Materials. These drafts have been commented on especially within NBS and have been the subject of repeated, somewhat troubled discussions. In large part the present drafts are innocuous, but several real problems have been identified: (a) PS27 has distinguished legal certified reference materials (LCRM) from simply certified reference materials (CRM) and define LCRM as a CRM certified by a national metrological

organization; (b) Reference to or coordination with ISO's effort on CRM (REMCO) appears to be inadequate; and, (c) PS27, as evidenced especially by the RS8 draft, seems intent on expanding its scope of activity well beyond what appears to the U.S. to be appropriate in the OIML context. At the September 1979 Presidential Council meeting these concerns were voiced by the U.S., noted by the Council, and acknowledged by the U.S.S.R., with the understanding that the U.S. concerns will soon be communicated to PS27 in writing.

PS30/RS7 Gas Calorimetry

Secretariat: Federal Republic of Germany

U.S. Interests: Manufacturers of automatic gas calorimeters, producers of natural gas, transmission line companies, public utilities and their associations.

U.S. Actions and Influence: PS30/RS7 circulated two drafts, both in only French and German, to the U.S. for comment. Both drafts were translated from German by a commercial translation service, but required extensive correction of the translation and editing by ODIMS largely because the technical content suffered substantially at the hands of a translator without technical background. The drafts received extensive comments from a variety of U.S. interests. Automatic gas calorimeters are expensive instruments used to measure combustion value of transferred bulk gas. Their use ranges from that by local gas companies to that in international custody transfer. Their accuracy and reliability is critical because payments derive directly from measurements made with them. A specific U.S. produced type of calorimeter is used almost exclusively in the U.S. and is also exported to Europe. It measures one of the several "heating values" that can be defined. The drafts, though often lacking the necessary specificity required in a standard, were nevertheless not applicable to the major U.S. calorimeter but were presumably written to accommodate German calorimeters. Also they did not adequately consider the climatic variables that come into play in applications ranging from Alaska to Nigeria. The most telling and most forcefully made of the many comments by the U.S. requested better definitions and specificity, clear broadening of the scope to cover the U.S. systems, and much more careful attention to climatic variables. No response has yet been received on the U.S. comments.

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☐ Document describes a computer program; SF-185, FIPS Software Summary, is attached.

16. ABSTRACT *(A 200-word or less factual summary of most significant information. If document includes a significant bibliography or literature survey, mention it here.)*

The document provides an overview of the coordinating activities of the Directorate of Measurement Services as they are required to meet the needs of industry, State and local governments, and other Federal agencies. Critical issues are identified, accomplishments are highlighted, and plans for program development are reviewed.

17. KEY WORDS *(six to twelve entries; alphabetical order; capitalize only the first letter of the first key word unless a proper name; separated by semicolons)*

Calibrations; International standards; Measurement Assurance Programs (MAP's); Measurement services; OIML; Voluntary standards; Weights and measures.

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