TODAY, EVERY MAN IS AT THE MERCY
OF HIS TECHNOLOGY

This is the theme that is being repeated over and over again. Speaking at the recent conference of the Scientific Apparatus Makers Association held at NBS-Gaithersburg, the Assistant Secretary of Commerce for Science and Technology, John F. Kincaid, made the statement above. In addition he had said:

"We must improve the interface between man and machine. Human engineering, in its over-concentration of problems of emotional and philosophical accommodation, has neglected the problems of emotional and philosophical accommodation. Design in the future must concern itself with the total nature of man if an approximate symbiotic relationship is to be achieved."

"We must adapt the machine to the environment. In our preoccupation with the machine as machine, and with its enormous productivity, we have granted ourselves the dangerous luxury of ignoring its effect on the environment. Consequently, we have fouled the air and the water, overcrowded our highways and cities, and made a bedlam of the electromagnetic spectrum."

"The time for study and planning, looking to massive changes in the short range future, is now.

"In all these areas of emerging need THE ROLE OF MEASUREMENT and tools of science will be crucial."

Mr. Kincaid has said it for us, as have other leading figures in government, industry, and education. It boils down to one very fundamental fact—our world needs new standards in a hurry—new standards which will permit us to measure the devastation we heap upon ourselves and hopefully, to take corrective measures.

C. E. White
As part of the events held in conjunction with the 1968 Standards Laboratory Conference, Chairman WHITE conducted a Board meeting on August 25. Apart from routine business items, the Chairman noted the following:

- Appointment in July of J.R. VAN de HOUTEN as Acting Treasurer until October 1 to substitute for D.I. HERVIG who had suddenly found himself pressured by his work in the start of the Sentinel Program.

- The sudden and untimely death of Dr. M. WALLENSTEIN, Sponsor's Delegate on July 1 (reported elsewhere) and replacement as Delegate by Dr. E. AMBLER, Director of NBS/IBS.

- Cessation of direct NCSL efforts with Congress to establish a National Measurements Standards Week, and shifting of effort emphasis to the Scientific Apparatus Makers Association, which has offices in the capitol.

- Appointment of a special Awards Committee consisting of M. ANGELO, Chmn., O. LINEBRINK, and R. VERITY to investigate desirability, eligibility, and types of honorary recognition to be accorded for eminence in the measurement field, or for other services within the field of metrology. Chairman Angelo was empowered to appoint two more members to his committee if desired.

- Appointment of a special Long Range Planning Committee consisting of J.R. VAN de HOUTEN, Chmn., R. BAILEY, and E. ARSENAULT to formulate a master plan for growth of NCSL and to conduct a review of services rendered by the organization to its members. It could also consider the prospect of obtaining a full time paid executive director to conduct the affairs of NCSL.

Secretary HADLEY reported NCSL membership at a high of 195 members as of August 9, 1968 (as of September 30, the total passed 213 members when the Australian Defence Standards Laboratory was accepted for membership).

Speaking for Dr. Ambler who was in Europe on a business trip, H. LANCE noted several changes in NBS administrative structure and introduced B. BIRMINGHAM, Deputy Director for NBS/IBS at Boulder. Lance also noted formation of the new Office of Measurement Services at Gaithersburg, headed by J. Cameron.

Meetings Chairman ARSENAULT noted that plans for a Workshop session prior to May 1, 1969 would be started, if sufficient support and enthusiasm was developed by members.

On August 29, the Board reconvened to pass on the proposed budget for Fiscal Year 1969, enabling Chmn-elect LANCE to plan in advance for his administration, effective October 1, 1968. At this time also, Lance noted that his first Board Meeting would be held in New York, October 31 at 7:30 PM, at the New York Hilton unless members were notified otherwise.
NCSL DELEGATES ASSEMBLY

It has been customary to hold the official Delegates Assembly during the time of the biennial Standards Laboratory Conferences, to conduct regular business including election of officers. Accordingly, NCSL Chmn. WHITE called the Assembly to order at 3:00 PM, August 28, in the auditorium of the NBS-Boulder facilities. The first order of business was the report of the Nominating Committee (J.R. VAN de HOUTEN, Chmn.) who submitted nominees as follows:

*H. W. Lance (NBS) Chmn.
*R. B. Ernst (NARC/Auconetics) V-Chmn. (2 yr)
*J. L. Hayes (USN MEC-Pomona) V-Chmn. (2 yr)
*J. F. Hadley (Bendix-K.C.) V-Chmn. (1 yr)
*P. H. Hunter (W.E.Co.Winston-Salem) Sec. (2 yr)

Member Delegates Nominees

*M. T. Angelo (Lockheed-California)  *W. H. McPhee (M.I.T. Inst. Lab)
W. E. Boyes (Sandia-Albuquerque)  D. B. Sharp (IBM-San Jose)
*H. S. Ingraham (RCA-Camden)  M. J. Steinberg (Hallmark)
*O. L. Linebrink (Battelle Inst.)  R. H. Verity (Leeds & Northrup)
R. Littlefield (Hewlett-Packard)  *A. J. Woodington (Gen.Dyn/Convair)

Voting was conducted after no nominations for office were received from the floor. Officers elected are indicated above by means of an asterisk before their names.

Chairman WHITE gave a preliminary report on activities during his second term of office, then thanked all members who had allowed their names to be presented as nominees for office. Following this business and noting the early hour, Chmn. White then challenged the Delegates present to add to the program of the meeting by suggestions, constructive criticisms, or other verbal means to let the NCSL Board know that its work was recognized. He reminded all present that no organization could function for the good of all unless the "all" made itself heard. Chmn. White's challenge was accepted and from the lively debates that ensued, the following points were recorded:

- The Long-Range Planning Committee be made permanent
- More information on NCSL Committee activities be made known to NCSL Members (Committee Chairmen take note--communicate more often with the NCSL Newsletter Editor)
- The biennial conference be supplemented by more regional NCSL symposia or conferences (proposed by Chmn. White in 1967)
- Plan for an increased rate of growth (21% in 1967-68)
- Simplify NCSL Committee structure
- Attack existing MIL specs affecting calibrations; rewrite to combine and replace present multiplicity
- Study environmental conditions affecting standards and calibration laboratories, to bring out more realistic controls.

Following these points which Chmn. WHITE directed to Chmn-elect LANCE for study and possible incorporation into his administrative year, the meeting adjourned at 4:50 PM.
From the opening greetings to the simple closing remarks by Program Chairman E. ARSENAULT, which formalized the 1968 Standards Laboratory Conference program, it was apparent that the attendees were completely aware of the conference theme--"Making Valuable Measurements". The challenge to the Member Delegates, by NCSL Chairman WHITE, that each member work hard to carry back to his own management the unequivocal fact that measurements are valuable, was quickly followed and amplified by the address given by Dr. A.V. ASTIN entitled "Value of Precision Measurements and the Role of NBS".

During the second morning of activity, the groundwork was laid for stressing the emphasis placed upon the value of compatible international measurement systems, by several speakers from overseas. From this framework came the support upon which Wednesday's luncheon speaker built his theme. Mr. J.L. SLOOP, speaking on the topic "Measurements and Society" expanded upon a theme expressed on Tuesday by NCSL Chairman WHITE, that valuable measurements are not restricted solely to the routine of mensuration but are a living and vital part of society in general as evidenced by growing concern with our environment and behavior.

On Wednesday afternoon, the Delegates Assembly conducted the business meeting of NCSL and elected a slate of officers for 1968/69 headed by H.W. LANCE. The closing minutes of the Assembly were marked by an active participation by Member Delegates in discussions related to the future role and activity of NCSL. It was evident that the organization, far from being complacent with its record during seven years of life, was prepared to take an ever-increasing role in the battle for recognition of the basic importance of measurements engineering.

The last day of morning sessions was devoted to highlights of laboratory management practices, including the need and practical value of measurement agreement comparisons, and the control of instrumentation and pertinent data. The closing afternoon session was livened by a satirical skit put on by R. PARR AND H. WERNER, exposing some of the problems encountered in R & D measurement programs. In addition several speakers spoke on methods of control of measurements as seen through the eyes of government and industrial management.

Of increasing importance to NCSL is the growing awareness both within and outside the United States, of the need for a forum provided by an organization such as NCSL. The slow but steady growth of US membership has been matched by the quality of the work resulting from the volunteer labor of its several committees. In addition, the presence within the program of 8 papers from 6 foreign countries gives substance to the international aspects of measurements, particularly controlled measurements.

NCSL ELECTIONS

HARVEY W. LANCE, assistant chief for Program Planning and Development in the Boulder National Bureau of Standards Institute for Basic Standards, was elected chairman of the National Conference of Standards Laboratories for
The registration desk was quiet at 8:25 AM, but was slightly overwhelmed at 8:30 AM.

Member Delegates presented credentials for attending...

While the Local Arrangements Committee prepared for speakers.....

Who needed projection services.

Meanwhile H. Lane & E. Arensland hoped speeches would start on time...

Triggering HC&D Chem White, who urged delegates to make measurements VALUABLE....

Information Retrieval actions....

Were followed by refreshments....

And information dissemination by V. Holmes & M. Freuchtenight...
requires assistance from Information
Center manager M. Anson....
who satisfies needs of English
speaker E. Parr.
But all the hard work of listening...

requires more refreshment, indoors... or outdoors at the bazaar on Flagstaff where A. Bausman, M. Fawcett, and M. Angelo display talents....

which are watched with disdain
by W. Kesha....

while R. Birmingham and other late
arrivals wait in line for food.

Meanwhile, back at the ranch
life goes on!

And on!
And on!!
And on!!!
O. Linebrink gives a stirring introduction to luncheon speaker...
J. Sloop (NASA) who spoke on "Measurements Per Society"—a timely topic.

NCSL Past Chair Woodington introduced...

A. L. Hart, who talked on managing valuable measurements.
and R. Foxell gave the British viewpoint on advantages of a common measurement space.

I. B. Orbison reported on Calibration Proc. Library...
R. Barra & M. Verrier vividly described problems of instrument control in BNC activities,convincing the audience...

after which J. Vandenbrouken called for nominations during Delegates Assembly...
and Chris White reviewed the vote tally with candidate Lance...
then congratulated Champ-elect Lance.

For old time's sake the 1967-68 Board of Directors posed for their formal picture...
and not to be outdone, the 1968-69 Board promptly repeated, closing the 1968 SLC.
1969-70 at the NCSL Delegates' Assembly last week. He succeeds CHARLES E. WHITE, formerly of Avco Missile Systems Division, who was chairman from 1966 through 1968.

Elected vice-chairmen for two years were RICHARD B. ERNST, Autonetics Division of North American Rockwell Corp., Anaheim Calif., and JERRY L. HAYES, Navy Metrology Engineering Center, Pomona, Calif.; and for one year, JAMES F. HADLEY, Bendix Corporation, Kansas City, Mo. E.J. ARSENALoyal, General Electric ReEntry System, Philadelphia, Pa., will fill out the remaining year of his two-year term. PAUL H. HUNTER, Western Electric Co., Winston-Salem, N.C., was elected secretary, and DON I. HERVIG, U.S. Army Sentinel System, Huntsville, Ala., continues a two-year term as treasurer. Sponsor's delegate is Dr. ERNEST AMBLER, Director of the Institute for Basic Standards, Washington, D.C.

LANCE, who has been with the National Bureau of Standards since 1948, is one of the original founders of the National Conference of Standards Laboratories. He has been associated with the NCSL since it was organized in 1961 under the sponsorship of NBS. LANCE has held several positions with the organization and in 1968 was one of its vice-chairmen.

SUMMER MEASUREMENT WORKSHOP PROGRAMS

Two major universities and a leading government research center have launched a series of summer workshop programs to disseminate information on research applications of modern DC technology and to introduce new curricula and techniques for the teaching of modern DC measurement in science and engineering courses at colleges, universities, technical institutes and junior colleges.

The first weeklong workshop was held on June 3-7 at the City College of CUNY, New York City, one of the sponsors. The other sponsors, Argonne National Laboratory, Chicago, Illinois, and the University of California in Irvine, held workshops on July 22-26 and August 5-9, respectively.

Staff and special lecturers for the workshop series included: Abraham Abramowitz, professor of electrical engineering, City College of CUNY; Loeb Julie, president of Loebl Research Laboratories, Inc., New York City; Robert Lewis and C. M. Stevens of Argonne National Laboratory; Dr. William H. Parker, University of California in Irvine.

Warren Little, MIT Instrumentation Laboratory; Dr. Barry Taylor, RCA Laboratory for Physical Sciences; Dr. William M. Fairbank, Stanford University; Dr. E. Richard Cohen, associate director, North American Rockwell Corp. Science Center; Dr. John M. Donhowe, University of Wisconsin; John Hammond, senior design engineer, AAI Corporation; Dr. Robert L. Powell, Cryogenics Division, National Bureau of Standards, Boulder; Dr. Albert V. Crewe, Enrico Fermi Institute, University of Chicago, and Dr. William Gregory, Georgetown University.

The special lectures included the following topics: Magnetic Moments of Atoms; Our Knowledge of the Numerical Values of the Fundamental Physical Constants; Electron Microscopy; Measurement of Nuclear Resonance Widths and Resonance Energies in Nuclear Reactions; Cryogenics; The Use of Superconductors as
High Precision Secondary Standards of Temperature from 0° to 20° K; A Precision Large Scale Magnetic Environment Simulator; Determination of E/H Using the AC Josephson Effect; Modern Measurement and Control of High DC Voltages; The Polaris, Poseidon, and Apollo Missile Programs; Precision Nanovolt Measurements in the Determination of the Fundamental Physical Constant E/H; Numerical Analysis of Noisy Data--a graph theory approach to calibration; Mass Spectrometry and The Use of AC Josephson Effect to Maintain Standards of Electromotive Force.

NCSL PERSONAL NOTES

Many persons have inquired of your editor concerning the health of BILL WILDHACK (NBS), since we reported on his operation last December. We ran into him at Gaithersburg during the SAMA meetings, Sept. 17-18 and chided him for not acknowledging his return to health and to work to all his good friends in NCSL. With his usual self-effacement, he couldn't believe that any persons other than bill-collectors could have been looking for him. So, we take this opportunity to notify all and sundry who inquired about Bill, at the 1968 Standards Laboratory Conference--Bill is up and around, and is surprised to learn that people are still asking about his health and well-being.

Another one of those quiet fellows also was encountered at the SAMA meetings--BILL BOSTWICK. At our request he sent us these few lines for insertion in this issue

"Bill Bostwick not dead or retired"

Although he is no longer directly connected with NCSL, Bill is still very much alive and active. He is still in precision measurements work at Lawrence Radiation Laboratory in Livermore, and a member of the SAMA/USASI C-100 Committee. Any time left over goes to PMA activity.

AL SCHMIDT, seen at Boulder with his pretty wife Noriko and the two youngsters, seems to be contented to be back in the States once more, after his stint of many years in the Japanese area. He has located at McClellan AFB and among other things is looking for a new home site.

Your editor (and Session Chairman at the 1968 SLC) takes this opportunity to thank HARVEY LANCE for his splendid cooperation in persuading A. RAJIAL of the India Atomic Energy Commission and C. J. LEANEY of Ball Bros. Research, to present the Indian and Australian papers respectively on the "international" session in place of the authors who were unable to make the trips in person. Also, to the two gentlemen named, a "Well Done" and thanks. The other stateside substitute speakers, F. HERMACH (Ireland), and M. ANGELO (for Jack Weber) did splendidly likewise and on short notice, too. Thanks, fellows.
TECHNICAL NEWS

COAXIAL LINE STANDARDIZATION

The Joint Industry Research Committee on Standardization of Miniature Precision Coaxial Connectors has recommended the standardization of the 3.5-mm, 50-ohm, air dielectric coaxial line. This recommendation resulted from the Committee's June 1968 meeting held at the National Bureau of Standards' laboratories in Boulder, Colorado.

The Joint Committee is chaired by Andrew Alford of Alford Manufacturing Company, and is composed of representatives from industry and government. It is concerned with improving the performance of miniature electronic coaxial connectors, which are extensively used in aerospace and electronic instrumentation applications. The Committee is also concerned with reducing the wide variety of non-interchangeable coaxial connectors now in use due to a lack of standardization.

At previous Committee meetings it was determined that two sizes of standardized miniature air-dielectric lines were necessary for precision electronic measurements in coaxial systems operating at frequencies up to 40 GHz.

The recommended 3.5-mm size will fit in well with the present IEEE standardized 7-mm and 14-mm line sizes. A smaller bore (less than 3.5-mm) line size will be recommended by the Committee in the near future when more data are available concerning the performance of miniature precision coaxial connectors.

The Committee is now working to develop precision connectors for the recommended 3.5-mm, 50-ohm, coaxial line. These connectors are to have no bead resonances at frequencies below 28 GHz and they will be recommended for use in systems operating at frequencies ranging from dc to 26.5 GHz. The 3.5-mm coaxial line can be used at frequencies up to 36 GHz; however, at such higher frequencies the beaded connectors can generate undesirable modes of propagation. This multimoding restricts the upper frequency limit of the connectors.

The recommendations approved by the Committee will form the basis of a voluntary standard to be developed under the Product Standards procedures issued by the Department of Commerce. The Bureau's Office of Engineering Standards Services will cooperate with the Committee in the development of the standard or standards that result from the Committee's activities in this area.

SAMA/NBS MEASUREMENT TECHNOLOGY CONFERENCE

A Conference on Measurement Technology, jointly sponsored by the Scientific Apparatus Makers Association and the National Bureau of Standards was held at the NBS facilities in Gaithersburg, Md., September 17-18, 1968. At this two-day program, attendees were informed of the Bureau's resources, programs, and competences within the broad areas of measurement and calibration.

SAMA is a trade association of manufacturers whose primary activity is to provide scientific apparatus to the technical and scientific communities. The Association is therefore interested in learning more about the facilities, people, services, and technical programs of the Nation's central measurement laboratory.
Following opening remarks by SAMA President Pro Tem Nathan Cohn and NBS Director Allen V. Astin, NBS personnel reviewed the services that the Bureau extends to industry—calibration and measurement, standard reference materials, engineering standards, and technical information dissemination. John F. Kincaid, Assistant Secretary of Commerce for Science and Technology, was the luncheon speaker. That afternoon, in simultaneous seminars, NBS scientists discussed their laboratories' competences in the fields of polymers, analytical chemistry, physical chemistry, inorganic materials, optics, electronics, heat, and electrical measurements.

The following day was designed to follow SAMA's 50th anniversary year theme "In League with Tomorrow's Science and Technology." Topics for this day featured the National Measurement System and the International System of Units, and included discussions of international standards and computer technology. The activities of the National Conference of Standards Laboratories were described by Chairman C. E. White. SAMA President Herbert J. Moosien participated in this second day of the conference.

IEEE PULSE TECHNIQUES SUBCOMMITTEE

The Technical Subcommittee on Pulse Techniques, appointed by the IEEE Group on Instrumentation and Measurements (F. L. Hermach, Chmn.), under the chairmanship of John C. Hubbs and coordination of Phil Painchaud, Secretary, has produced a second draft of a Glossary of Pulse Terms and Definitions to be considered for inclusion in the revision of IEEE Standard 194. This subcommittee, activated in September 1966 as a functioning arm of the G-IM Technical Committee on High Frequency Instruments and Measurements (R. A. Soderman, Chmn.), has met often and discussed heatedly, much of what has gone into this draft. The subject of pulses is, of course, very broad in discipline and a subject of much interest to groups who regard it as their private domain. Consequently, much preliminary work was done within the subcommittee to assure equal treatment of all factions. It is very much to the credit of committee members that consensus of opinion on so many definitive terms has been reached in the comparatively short space of 16 months of meetings. It is anticipated that meetings scheduled for October 27-28 in New York will pave the way for a Third (and final?) Draft for balloting and forwarding to the IEEE Standards Committee by the end of February 1969.

PEAK PULSE POWER SWITCH

Pulse power at high frequencies makes possible such systems as radar, aircraft navigational systems (TACAN), aircraft crash locators, orbiting satellite telemetry, and air traffic control. By and large, the principal users of these systems are the national defense agencies and the aerospace industry. To meet the needs of these and other users for improved accuracy in the measurement of peak-pulse power, the National Bureau of Standards maintains a pulse-power measurement system and calibration service at its Boulder laboratories.

An important component in this measurement system is a fast-acting diode switch. Recently, A. R. Ondrejka and J. R. Benes of the Radio Standards Engineering Division developed an improved switch which extends the frequency range of the NBS pulse-power standard up to 2.4 GHz from the previous 1.3 GHz level. The switch has a maximum voltage standing wave ratio, (VSWR) of 1.10.
in the frequency range of 0.1 to 2.4 GHz as compared to typical VSWR's of 1.5 to 2.0 for other available switches. It has a switching time of less than 5 nanoseconds and can be used to calibrate rf power levels from 1 milliwatt up to 2 kilowatts.

Pulse Power Measurement

Measurements of peak-pulse power are made for a number of reasons, one of which is to determine if a pulse-power system is delivering the amount of power for which the system is designed. To make such measurements NBS uses the sampling-comparison method which is based on the well-established principle of comparing one quantity against a second whose value is known or can be measured with the desired degree of accuracy. Comparison is made between peak-pulse power at a given carrier frequency and continuous wave (cw) power at the same frequency.

The sampling-comparison method requires a fast SPDT diode switch having one output biased normally closed and second output biased normally open. The diodes in the switch are arranged so that a negative pulse from a switching pulser reverses the open-closed conditions of the switch outputs. The pulser is synchronized with a main pulse generator which modulates the rf source. During the time the switching pulse is impressed upon the switch, the rf pulse power is switched from one output to another. By adjusting the width of the sampling pulse to a small fraction, typically one-tenth of the rf pulse width, a true time sample of the rf pulse power is fed to an average power detector.

A variable delay network allows the time sample to be taken anywhere along the rf pulse width; hence it may be taken at the peak of the pulse by simply varying the delay for maximum dc output from the average power detector. This output value is measured with a precision millivolt potentiometer and recorded. The switch is then connected to a source of cw power. While all parameters of the sampling pulse are kept fixed, the cw power is varied until the average power detector output is equal to the previously recorded value. Under these conditions the switch samples the cw power at the same rate and for the same time interval as for the pulse power.

The heart of the NBS pulse-power calibration system is the fast-acting, coaxial SPDT diode switch. A particular requirement of this switch is that it possess a low VSWR, as close to a value of unity as is possible. A low VSWR signifies that the switch is accepting very nearly all of the energy applied to it. Energy which is not accepted, but reflected instead, represents an uncertainty in energy measurement. The switch must also have a wide and a continuous frequency range to extend the measurement capability of the calibration system. It should also have a short sample time to secure a rectangular sample of the pulse to be measured. This rectangular sample is desired to assure complete sampling of the amplitude, good stability, and sufficient average power to the detector.

The new diode switch is of compact size measuring only one inch by one inch by three inches. The diodes, six in number are miniature sized type IN 4153 which are only 0.073 inch in diameter by 0.140 inch long. The diodes are series connected. The switch housing, developed and built by Benes, employs precision, hand-fitted aluminum parts. Because of its small size, the switch is assembled with the aid of a microscope.
The low VSWR is achieved by a strict dimensional control of the switch's mechanical components. The diode electrical parameters are compensated for by adjustable shunt capacitors and shunt resistors.

Use of the switch in the NBS pulse-power measurement system extends the frequency range of the NBS pulse-power standard upward to 2.4 GHz to include the new unified telemetering band at 2.2 to 2.3 GHz. The frequency range, starting at 0.1 GHz, is continuous.

The switch represents the state-of-the-art in rf sampling switches. In its present form it is primarily suited for standards-laboratory applications where pulse-power transfer standards are calibrated for eventual field use.

1-MHz INDUCTIVE VOLTAGE DIVIDER

A binary inductive voltage divider is a device that divides its input voltage into two equal parts and is a convenient means of providing definite, known lesser voltages. Such devices are in considerable demand by the electronics industry and electronics standards laboratories. Binary dividers are simple yet accurate, inexpensive, and easy to construct. They have simple "exact" circuits, so that combinations of binary dividers are relatively easy to analyze.

Recently National Bureau of Standards scientists developed a decade voltage divider usable at a frequency of 100 kHz. Now, C. A. Hoer and W. L. Smith, of the Radio Standards Engineering Division, NBS Institute for Basic Standards at Boulder, Colorado, have developed an accurate binary voltage divider with ratios of $2^n:1$ or $6n$ dB by cascading $n$ binary dividers designed to operate at
1 MHz. A theoretical and experimental study yielded expressions for each error encountered. The individual error equations were then used to give an expression for the ratio error.

The internal loading error, caused by the small but significant voltage drop across the short-circuit output impedance, can be either compensated for, or eliminated. Most of the internal loading error can be eliminated by an adjustable admittance connected across the top half of each section. This admittance is adjusted to be equal to the total admittance across the bottom half of the section.

Hoer and Smith constructed and tested an experimental seven-section voltage divider with a total of approximately 42 dB in seven 6-dB steps. (The divider gives voltage ratios of \(1/2\) to \(1/(2^7)\).) The seven-unit assembly, designed to operate at 1 MHz, has an estimated uncertainty of ±0.007 percent per section.

The individual binary dividers were constructed with cables made by folding a length of No. 24 copper thermocouple wire in half and twisting the pair fairly tightly with a hand drill. After winding the cable on a bobbin, the bobbin was inserted in low-loss cup cores having an effective permeability of about 30. The number of turns of twisted cable on the bobbin was chosen so that the self resonant frequency was slightly above 1 MHz. A resistor (100-kΩ variable cermet trimmer) and a capacitor (10-pF variable piston trimmer) were included in the circuit of each divider in order to obtain equal, purely resistive loads across the top and bottom on the divider.

External loading errors are compensated through the use of a voltage comparator developed by C. Hoer and W. Smith, which is similar to the current comparator developed by R. A. Lawton and C. M. Allred. The voltage comparator was used to compare the output of a binary voltage divider with the output of a precision waveguide below-cutoff piston attenuator at 1 MHz using the parallel direct-substitution method. Through use of the voltage comparator, the binary voltage divider and the precision attenuator were terminated in the impedance for which they were designed. The results of this comparison agreed within the uncertainty of the attenuator (0.003 dB/10 dB) and the divider (0.001 dB/10 dB).

According to Hoer and Smith, binary voltage dividers of this type could be very accurate at frequencies well above 1 MHz. Experiments at NBS show that at 30 MHz, the divider error can be as small as 1 part per ten thousand—an indication that binary voltage dividers should be useful at even higher frequencies.

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**BOLOMETER SUBSTITUTION ERROR**

An experimental and theoretical verification of the magnitude of one of the most important errors in bolometric power measurements, the RF-DC SUBSTITUTION ERROR OF A BOLOMETER with a Wollaston-wire (fine platinum wire) element, has been achieved at the NBS Institute for Basic Standards, Boulder, Colo. A mathematical analysis for determining the value of the substitution error has been developed by Stephen Jarvis, Jr., and John W. Adams of the NBS staff. It is a solution to a nonlinear heat flow differential equation. The analysis reflects all significant nonlinearities in the heat flow and includes all appreciable heat transfer mechanisms simultaneously.
In the measurement of microwave and millimeter-wave power (rf power) by substitution techniques, substitution error is of great concern. A common measurement technique is to replace a known amount of dc power with an unknown amount of rf power in a bolometer. Unfortunately, the different current distributions generate different temperature fields which give the bolometer elements slightly different values of total resistance for equal amounts of power. For balanced-bridge methods the resistance is maintained constant, which causes some non-equivalence of power. In this case, substitution error is defined as

\[ E = \frac{W_{\text{sub}} - W_{\text{rf}}}{W_{\text{rf}}} \]

Although a bolometer can be used to measure relative powers without calibration, it must be calibrated to measure absolute power. An accurate method of calibration is by the use of a calorimeter in which the ratio of substituted dc power to the net rf power flowing across an arbitrary plane into the bolometer is measured. This quantity is called the effective efficiency. Effective efficiency in the 7 to 40 GHz frequency range can be determined by precision calorimeters, which serve as reference standards. Efficiency in the 4 to 7 GHz frequency range can be determined using waveguide impedance systems. The effective efficiency is related to efficiency by

\[ N_e = N (1+E) \]

where \( E \) is the substitution error. While the magnitude of the substitution error is relatively small in the 4 to 7 GHz frequency range, a knowledge of its magnitude permits greater confidence in a calibration. As frequency increases, the magnitude of the substitution error becomes progressively greater. At frequencies above 40 GHz, where calorimetric standards are not yet available, substitution error becomes particularly significant. Here the amount of the error must be known so that effective efficiencies may be calculated.
The analysis by Jarvis and Adams of the substitution error required a knowledge of the current distribution in a Wollaston-wire bolometer element. A scaled-up (approximately 20 times with respect to X-band) bolometer mount was used with a 700-MHz rf signal to measure this distribution directly. A current probe, consisting of a tiny coil and rectifier, was moved along the wire (which simulated the bolometer element) to monitor the current distribution. The dc output from the rectifier was conducted to meters outside the waveguide on high-resistance wire. The use of the high resistance wire substantially reduces the relative perturbation of the rf field in the waveguide. Measured values of rf current distributed axially along the wire revealed a maximum near the middle of the wire while the remainder, in general, described a sinusoidal shape. The amount of curvature was frequency dependent. The current magnitude varied greatly but the distribution varied only slightly as the position (with respect to the bolometer) of the shorting end-plate was tilted even a few degrees from perpendicular. Variations in the shape and the size of the wire supporting structure caused variations in the current amplitude profile but these seemed related to changes in the wire length.

The results of this NBS research will benefit the Nation's industry and commerce by allowing bolometer mount efficiency calibrations with greater confidence in the 4 to 7 GHz frequency range. The use of the impedance technique coupled with the results of this analysis may also prove to be a satisfactory calibration method at frequencies in the millimeter-wave (above 40 GHz) region.

Stimulating Topics Are Paramount to Success as a Speaker.  
Most Speakers Consider Criticism a Vital Part of the Toastmasters Club.
TEMPERATURE SCALE CHANGES

On September 17, 1968 NBS scientists from the Heat Division of the Institute for Basic Standards announced forthcoming changes in temperature scales which will have a small effect upon precision temperature measurements. The announcement was unofficial in the sense that the changes will be taken up as an agenda item for approval during the meetings of the BIPM (Bureau of International Weights and Measures) at Paris the latter part of October. The following brief information is based solely upon notes taken by your editor while listening to a seminar directed to SAMA representatives. NBS did not confirm the data after the seminar for protocol reasons.

Dr. H. Plumb noted that the International Temperature Scale, defined at several points by invariable physical phenomena such as the Triple Point of Water, Boiling Point of Water, etc., would be altered by assignment of a new value for the freezing point of gold. Because of experience gained during the past years in work done at the higher temperatures on the Scale, it will be possible to assign a more accurate value for the gold point by designating the temperature as approximately one degree Celsius higher than the presently assigned value of 1063° C. In addition it is expected that constants presently used in equations employed in calculating temperatures derived by use of the standard thermocouple, will be changed slightly.

Dr. L. Guildner announced a proposed change in the Thermodynamic Scale which would be revised downward to 13.81 K (as defined by the triple point of equilibrium of H2). An intermediate point would be established at 20.28 K (defined as the boiling point of H2).

Further news concerning the scale changes will be officially released by the Bureau in December.
SAMA CONFERENCE ON MEASUREMENT TECHNOLOGY

On September 17-18 the Gaithersburg facilities of the National Bureau of Standards were opened to members of the Scientific Apparatus Makers Association (SAMA) for a briefing on the facilities, people, and technical resources of this Nation's official measurements standards laboratories. The Assistant Secretary of Commerce, J. F. Kincaid addressed the attendees on the subject of "Science, Technology, and Everyman" in which he stressed that today, man is at the mercy of his technology. He also pointed out that "The isolation of the individual from the technology which underpins his society is, in the long run, a potentially more difficult and dangerous problem (than the achievement of a near-zero defects production technology)". Also, "We must improve the interface between man and machine. Human engineering, in its over-concentration on problems of physical accommodation, has neglected the problems of emotional and philosophical accommodation".

The first day's formal presentations, following a welcome by Dr. A.V. Astin, Director of NBS, included an explanation of the services for industry which are performed by NBS, followed by special seminars on various aspects of the technical work carried on by NBS. On the second day, the international aspects of the Bureau's work were outlined, followed by a short talk by C. E. WHITE, NCSL Chairman, on the significance and impact of the activities of NCSL upon NBS and the combined interrelationships with the National Measurement System. The final hours of the conference were devoted to a tour of the facilities by SAMA representatives.
NBS PUBLICATIONS

NBS Standard Frequency and Time Services


The National Bureau of Standards--through radio stations WWV, WWVH, WWVB, and WWVL--provides eight vital technical services to the public. This publication gives detailed descriptions of each of these services: standard radio frequencies, standard audio frequencies, standard musical pitch, standard time intervals, time signals UT2 corrections, radio propagation forecasts, and geophysical alerts.

Changes are made in broadcast schedules from time to time, in order to provide users with the best possible service. Special Publication 236 is revised annually to reflect these changes. This edition shows the schedules in effect on January 1, 1968.

Two major developments occurred during 1967. In October, the International Committee of Weights and Measures, at its thirteenth General Conference, designated the exact value of the atomic frequency standard to be the international physical standard of time. Also, on January 1, 1968, a new coding system was instituted for broadcasting Geoalerts, superseding previous codes. This new system makes possible the dissemination of larger quantities of information resulting from improved techniques in observation and prediction of geophysical alerts.

Charts, tables, and illustrations highlight the technical aspects of this publication, making it useful to a wide audience--both technical and non-technical.

Acceleration Due To Gravity At The NBS


A determination of the absolute value of the acceleration due to gravity was completed in June 1965 at the National Bureau of Standards. This publication describes in detail the apparatus and the techniques employed and presents the summarized data from which the value was derived. The result was first published in the Journal of Research of the National Bureau of Standards, Engineering and Instrumentation, April-June 1966. The determination resulted in a value of 980.1018 centimeters per second squared for a reference point on the first floor of the Engineering Mechanics Building at NBS.
TECHNICAL REFERENCES


BACKGROUND REFERENCES


E. "Defining The Engineering Profession", M. Williamson, Research/Development, Sep 1968. How can the engineer help solve the problems of mankind if he doesn't know himself?


G. "Vectors and Phase", home study course in Measurements & Data, May-June 1968. Another refresher course of a continuing series designed to stimulate the technician and reawaken the engineer.


L. "The User's Perspective on Microwave Instrumentation", Cooke and Sobol, The Microwave Journal, May 1968. Viewpoints on key advances in past several years and suggested new developments in instrumentation or techniques.

NBS "WATCHDOGS"

As part of the continuing program of "soul-searching" practiced by the management of the National Bureau of Standards, the National Academy of Sciences Panel 272.00, Advisory to the NBS Radio Standards Engineering Division met with personnel and management on September 4-6. In accordance with previously established format, the panel members were briefed on the various programs, projects, and problems of the Division and then offered advice in as many areas as appeared suitable.

Few people outside the Bureau are aware that some 27 panels, appointed by the National Academy of Sciences, meet regularly with representatives of the Bureau activity for which they have advisory responsibility, and in close cooperation endeavor to help the Bureau meet its responsibilities to the public. The costs of these panels are met out of the regular operating budget of the Bureau. The Bureau's Director is to be congratulated for his continued efforts to search out problems within the Bureau which are exposed to the Panels for review, constructive criticism, and advice.

Panel 272.00 is pictured below in two scenes, left, for formal records (with Stu Bailey missing), and on the right an action scene. NCSL members are familiar with some of the Panel members. Going from Stu Bailey's empty chair left in Figure 1, we have DR. A. GOLD (D.O.D.), C. WHITE (NCSL), L. WILSON (substituting for F. McGinnis of Sperry), DR. E. AMBLER (NBS), DR. R. SAWYER (NAS), T. SAAD (Sage Lab.), R. BAILEY (USAF-Newark, Ohio), PROF. H. CARLIN (Cornell), and DR. H. ALTSHULER (NBS-272.00). It should be noted that both Prof. Coleman and Stuart Bailey (Jansky and Bailey) are seated for action in the informal picture.
The W. D. GEORGE MEMORIAL AWARD, given annually for the best undergraduate student project on instrumentation, will henceforth be offered under liberalized rules. Previously nominations were required to be based on papers published in journals of the Institute of Electrical and Electronics Engineers. Because few undergraduate projects are reported in these journals, nominations based on unpublished student papers and laboratory reports also will now be accepted. Professors and students are advised to retain any papers which might be the basis for nomination for the 1969 Award.

The W. D. George Memorial Award was announced in July 1964 to honor the memory of William D. George, a distinguished radio scientist and a 33-year veteran with the National Bureau of Standards. He died in a 1963 automobile accident while serving as a U.S. delegate to International Radio Consultative Committee meetings in Switzerland. The IEEE Instrumentation and Measurement Group administers the fund, from which annual awards of $100 will be made, without regard to nationality, as long as funds permit.

The Award is given for the best undergraduate project nominated in a field related to the activities of the IEEE. The project may be construction and operation of an instrument, or the theoretical discussion of the principles and limitations of an instrument.

Nominations are to be made by a letter from one of the student's professors in his major field. The letter must give the date of the student's degree, verify the subject matter of the work on which the nomination is based, and be accompanied by evidence of the work in either of two forms:

1. For nominations based on an unpublished report written by the candidate and giving a definite conclusion, at least one copy (six, if available) of the report. The work must have been completed within the academic year preceding the award (1967-68 for the 1969 award).

2. For nominations based on a paper accepted for publication in an IEEE journal during the 18 months preceding the year of the award (1 July 1967 to 31 December 1968 for the 1969 award), one (six, if available) reprint or preprint copies of the candidate's paper on his student project. In the case of multiple authorship only one author will be accepted as a candidate and the nominating letter must specify the degree of his participation.

Each student project may be used to support nomination for only one year. Letters and evidence for nominations should be received by 15 January of the award year by: Dr. A. F. Dunn, Secretary, IEEE Instrumentation & Measurement Group, Division of Applied Physics, National Research Council, Ottawa, Quebec, Canada.

The Selection Committee, headed by Dr. Yardley Beers of the National Bureau of Standards, may withhold the award for years when it believes no nomination has sufficient merit. The other members of the Selection Committee are: Prof. George E. Anner (University of Illinois), Prof. Bruce B. Lusigan (Stanford University), Prof. A. G. Jordan (Carnegie-Mellon University), Prof. William J. Barclay (N. Carolina State University), and Prof. Donald T. Hess (Polytechnic Institute of Brooklyn). Submitted material will not be returned unless accompanied by a self-addressed and stamped envelope.
DR. ROBERT D. HUNTOON retired from NBS on July 30, after some 27 years of service with the Bureau. His most recent position was Chief of the Office of Program Development and Evaluation.

Dr. Huntoon joined the staff of the NBS in 1941, and played a key role in the development of proximity fuzes. Near the end of World War II he was detailed as a consultant to the Secretary of War to assist in the evaluation of proximity fuzes and other electronic aids to bombing effectiveness. In the European Theatre of Operations, he arranged for the training of combat crews and officers in the capabilities and use of these new weapons.

In 1946, he was named Chief of the Electronics Section of the NBS Ordnance Development Division. In 1947, he was appointed Assistant Chief of the Atomic and Radiation Physics Division, becoming its Chief one year later. In 1949, he assumed the additional responsibility of Coordinator of Atomic Energy Commission projects at NBS, and, in 1950, Acting Chief of the newly created Electronics Division. He served as Director of the new NBS Corona Laboratories in California from 1951 to 1953, after which he returned to NBS Washington headquarters as Associate Director for Physics. In 1958, he was appointed Deputy Director, and in 1964 he became Director of the Institute for Basic Standards.

Dr. Huntoon is a Fellow of the Institute of Radio Engineers and of the American Physical Society, and a member of the Washington Academy of Sciences, the Philosophical Society of Washington, Sigma Xi, and Kappa Delta Pi.

He was born in Waterloo, Iowa in 1909. He received the B.A. degree from Iowa State Teachers College in 1932, and the M.S. and Ph.D. degrees in experimental nuclear physics from the State University of Iowa in 1935 and 1938.

He served as an instructor in physics at New York University from 1938 to 1940 when he was appointed a research physicist in physical electronics at Sylvania Electric Products, Inc.

NBS SPECIAL PUBLICATION 250, 1968 Edition has been substantially altered by a supplement—Measurement Users Bulletin No. 2. If you haven't received your copy yet, contact the NBS Office of Technical Information and Publications, National Bureau of Standards, Washington, D.C. 20234.

On January 1, 1969, the National Bureau of Standards expects to introduce a new base of reference for the volt, the practical unit of electromotive force (emf) or voltage. Under this change, the value of the U.S. legal volt, as maintained by a group of standard cells at NBS, will differ by about 10 parts per million from its previous value. The new value represents a better measurement of the voltage of these cells in terms of the theoretical unit of emf derived from the basic mechanical units of length (meter), mass (kilogram), and time (second).
The proposed action by NBS will be coordinated with planned international action to bring the volt units of 10 countries into agreement. This action is expected to be taken by the International Committee on Weights and Measures, at its meeting during October 1968, on the recommendation of its Advisory Committee for Electricity. It will be the first change in the volt that the International Committee has made since 1946, when it recommended a conversion from the "international" electrical units to the "absolute" system. The recommendation of 1946 was universally adopted on January 1, 1948.

The "international" units in use before 1948 were defined in terms of the so-called "reproducible" units adopted internationally near the turn of the century—the ohm, defined as the resistance of a specified mercury column; and the ampere, defined as the current that would deposit silver at a certain rate under specified conditions. These units should not be confused with the present "absolute" units of the "Systeme International" (international system) which are defined in terms of the meter, kilogram, second, and an assigned value of space permeability (magnetic constant), $4\pi \times 10^{-7}$ henries per meter.

The expected change in the U.S. volt is being announced at this time so that those who provide calibration services for standard cells and who issue calibration reports can make preliminary plans for the necessary changes in their reports, pending the official action on the change in the base of
reference for the volt. This announcement is also being made so that those
who are engaged in work of the highest precision, such as determinations of
physical constants which directly or indirectly involve electrical units,
may have advance knowledge of the change. In calibration reports issued by
NBS during 1969, values will be given on both the old and the new basis.

At its meeting in Paris in October 1946, the International Committee on
Weights and Measures accepted the relation:

\[ 1 \text{ mean international volt} = 1.00034 \text{ absolute volts}. \]

The mean international volt to which this equation referred was the average
of the units maintained in the national laboratories of the six countries—
France, Germany, Great Britain, Japan, the Soviet Union, and the United
States—which took part in this work before World War II. The unit of emf
maintained by NBS at that time differed from this average by 10 ppm, as
evidenced by the international comparisons made at the Bureau International
des Poids et Mesures (BIPM), Sevres, France. Accordingly, the conversion
factor for the volt adopted in the United States, as of January 1, 1948 was

\[ 1 \text{ international volt (U.S.)} = 1.00033 \text{ absolute volts}. \]

The new change will be considerably smaller than the one of 1948. It will
mean that

\[ 1 \text{ present volt (U.S.) will be about} \]
\[ 1.000010 \text{ new volt (U.S.)} \]

This factor does not represent an adjustment for a drift in the U.S. emf
standard, i.e., for a drift in the emf of the group of standard cells used to
maintain the unit. Rather it represents the improvement since World War II
in the accuracy with which the voltage of these cells can be measured in
terms of the absolute volt.

The factor required to bring the volt unit into international agreement will
differ only slightly among the ten countries—Australia, Canada, France,
Germany (East), Germany (West), Great Britain, Italy, Japan, the Soviet
Union, and the United States—which now participate every third year in
international comparisons of standard cells and standard resistors at BIPM.
The International Bureau has ascertained these small differences by inter-
comparing the values of the standard cells and standard resistors that define
the units of current of the various nations in terms of the BIPM ampere.

The increasing importance of precision measurements has made it evident that
a more accurate realization of the defined volt is needed. New measurements
of the ohm and the ampere in terms of the basic mechanical units (absolute
measurements) have been made in various national laboratories. The ohm
determinations show that the values of the standard resistors used to maintain
the unit of resistance are substantially correct (to better than 1 ppm) in
terms of the basic mechanical units. On the other hand, the recent ampere
determinations indicate that the absolute ampere is smaller by about 11 ppm
than the ampere determined by the standard cells and standard resistors used
to maintain the standards for the volt and ohm, respectively, at BIPM. Since
these measurements indicate that no adjustment in the ohm is called for, it
is evident that an adjustment in the base of reference for the volt is needed
to account for the results obtained in the ampere determinations.
The recent absolute measurements at NBS include an ohm determination in terms of a computable capacitor Fig. 1, and three ampere determinations, one in 1958 with the NBS current balance Fig 2 and two with a Pellat-type dynamometer Fig. 3 and Fig. 4. The results of the latest ampere determinations, not yet published, are in excellent agreement with the 1958 current balance value. Since an ampere determination necessarily involves a force measurement, the final assignment of the ampere value must take account of recent determinations of the acceleration due to gravity, one of which was made at NBS.

Final announcement of the actual factor to be used in defining the new base of reference for the volt will be made after the International Committee meeting in October.
BETTER VENDOR COMMUNICATIONS

In an editorial entitled "Let's Have better Manuals", Electronic Products editor George Flynn, had quite a bit to say on the subject in the July 1968 issue. Among other things he stated:

"Users of ELECTRONIC EQUIPMENT of all types have one universal complaint--the instruction or maintenance manuals are unclear, inadequate, and in many instances almost useless.

The reason for poor manuals is obvious--good manuals cost time and money to prepare, out-of-pocket money to print or reproduce, and unless they are part of a military contract, they don't bring in a dime of revenue. And as advertising, they are subliminal at best.

The flaws that mar too many manuals are all too obvious:

• schematics are lacking, or not up to date;
• schematics or block diagrams do not show waveforms or nominal voltage levels;
• parts lists too often give the manufacturer's part number and not the registered component number that will enable a user to get an instrument back on the air;
• troubleshooting lists too often tell you how to discover burnt-out fuses and what to do about them--replace the fuse, incredible!--but neglect to mention that a particular conjunction of switch settings will produce uncontrollable oscillations or put the instrument out of action; or some ominous warning is included to the effect that the instrument must never be turned on unless it is connected to a load, or unless it is not connected to a load;
• calibration procedures are often not included, and if included, may just be a wild guess at how the job should be done and have little relation to how a knowledgeable engineer would actually calibrate;
• discussions of how the instrument operates too often are either trivial, or obscure, or incomprehensible, and sometimes just plain wrong;
• some manuals are breezeylittle 4" x 5" booklets, while others are impenetrable tomes that defeat themselves by overkill...........

The source of poor manuals is not the tech writer, it's management, management that sees no profit in good manuals or in a good name, that will not allot the engineering time required to brief a tech writer or to review a manual.

A good manual, after all, need not be elaborate. Start with a good schematic, a good one, and add waveforms and voltages and test points. Use house numbers for special parts if you have to, but give users a fighting chance by listing one or two substitutes, with derating if necessary. In many cases, you won't need to provide much more. Give it the acid test: if a technician can install, operate and repair the instrument by following the manual, the job is done........"
stones. We firmly believe that those stone-hearted instrument manufacturers are, for the most part, getting the message and trying some reforms in writing.

ON SELLING MANAGEMENT

Electronic Design carries a column entitled "Management and Careers" guest-edited by various experts. In the June 20 issue, P. D. Wickersham presented an interesting approach to the problem of convincing management that the expense of new laboratory equipment is justified. He uses the principle of return investment, the same method taught by your own editor at the George Washington University courses in standards laboratories. Read it for some good guidance in sales psychology.

"ACCURACY IS OUR MOTTO"

Lea Mason (NBS/IBS) was good enough to tell us that the captions were reversed for the pictures related to the "poor man's shock tube" pages 14, 15 of the June issue. We hope that Messrs. Leder and Hilten of NBS will pardon the error.

If a test installation functions perfectly, all subsequent production units will malfunction.

Parts that positively cannot be assembled in improper order will be.
MORE NBS NEWS

A new CRYOGENIC FLOW RESEARCH FACILITY, sponsored jointly by the National Bureau of Standards and the Compressed Gas Association, has recently been established at the Boulder (Colo.) laboratories of the NBS Institute for Basic Standards. The design, construction, and operational planning for the facility have been under the direction of D. B. Mann, J. W. Dean, and J. A. Brennan of NBS.

This experimental facility, unique to cryogenics, will allow the study of fluid metering and fluid metering practices under controlled conditions and over a wide range of temperatures and pressures. It is expected that from these studies a uniform methodology for flow measurement of cryogenic fluids can be defined and new flow-measurement techniques evaluated.

Impetus for such a facility came from a growing awareness by those working in the cryogenic field that direct application of the classical methods of fluid metering to cryogenics was failing to give the precision and accuracy required, mainly because of a lack of definition as to how meters should be installed and operated. Also, recent interest by industrial and regulatory agencies, in the area of commercial transfer measurement of cryogenic fluids, has pointed up the lack of quality research in this area.

Through the use of the test facility, NBS will carry out an extensive cryogenic fluid metering program oriented towards satisfying the commercial transfer needs. Thus, the focus will be on investigating problems arising from the quantity-type, moderate-flow-rate metering of cryogenic fluids associated with commercial transfer. The program is expected to be concentrated in the following three areas: (1) The study of the performance of existing, classical meters under well-defined reproducible conditions; (2) the development of recommended practices for the most effective transfer of cryogenic fluids of interest in commerce; and (3) the investigation of new commercial transfer metering devices.

The facility consists of a pumped cryogenic flow loop, designed to give continuous; steady-state operation. The working fluid, either liquid nitrogen or liquid argon, is pumped out of a storage or catch tank into a heat exchanger, where the pump and heat energy is removed, and then back into the catch tank. This provides for thermal equilibrium and the operation of a closed system without liquid loss.

Flow rates will range from 20 to 200 gallons per minute, which is the rate area of prime interest to industry. Pressures and temperatures may be varied within the system from 63 K, 94 mm Hg (1.25 x 10^4 N/m^2) to 115 K, 275 psia (1.9 x 10^6 N/m^2), by a combination of subcooler operation and nitrogen or helium gas pressurization.

The facility has the capability, with some modification, for the study of combined states such as liquid-vapor and liquid-solid. This was deemed necessary, since cryogenic fluids are nearly always boiling, two-phase mixtures, and because there is potential for no-loss storage by using liquid-solid mixtures (slush).
Although the facility is basically designed for flow research, a sophisticated calibration system is necessary to indicate meter performance. Thus, a dynamic gravimetric calibration technique is used to determine the fluid mass flow rate or totalized flow. Thermophysical property data are being used, initially, to convert to volume flow rates.

The NBS Cyrogenic Flow Research Facility will benefit the compressed gas industry and users by providing them with a common ground of recommended practices for the commercial transfer of important cryogenic fluids. It will also provide regulatory agencies a common place for type testing of cryogenic fluid metering devices. In addition, the facility will be of benefit to the entire cryogenics field by providing a better understanding of cryogenic fluid flow for the more efficient and economical operation of all types of cryogenic processes.

The FIFTY-THIRD NATIONAL CONFERENCE ON WEIGHTS AND MEASURES was held June 17-21 at the Sheraton-Park Hotel in Washington, D.C. More than 500 representatives--State and local weights and measures officials, Federal officials, and representatives from consumers, industry, and business--were in attendance.

This year's Conference had a strong consumer orientation; one of its most important actions was the adoption of a new Model State Packaging Regulation. The promulgation of packaging and labeling regulations by the Food and Drug Administration and the Federal Trade Commission, in line with their responsibilities under the Fair Packaging and Labeling Act, necessitated a complete rewriting of the Model State Regulation pertaining to packages.

Founded and sponsored by the National Bureau of Standards, the Conference is one of the principal forums for discussion of consumer affairs in the Nation. It is a meeting ground for all levels of government concerned with weights and measures administration, industries associated with weighing and measuring equipment and packaging, and industries that offer their products for sale in weighed and measured quantities. The concern of the Conference is in protecting both buyer and seller. To this end, the Conference considers both weights and measures laws and regulations and the technology of weighing and measuring.

Dr. A. V. Astin, Director of the National Bureau of Standards and President of the Conference, spoke on the responsibilities of the Bureau in its leadership role in the National Measurement System and in facilitating applications of technology to the achievement of national goals.

Conference Chairman C. C. Morgan addressed the general session; he explained that while the National Conference on Weights and Measures has no regulatory authority, state regulation of weights and measures could bring chaos in interstate commerce without the Conference's unifying presence. "The Conference," he emphasized, "is dedicated to the promotion of the principles of fairness, impartiality, uniformity, and equity in all matters pertaining to weights and measures administration."

On Friday, July 19, KENTUCKY received a new set of weights and measures standards under a program to replace the standards of all 50 states.
Dr. Allen V. Astin, Director of the U.S. Department of Commerce's National Bureau of Standards, presented the set to Kentucky Governor Louie B. Nunn in a 10:00 A.M. Ceremony at The Department of Agriculture Building in Frankfort.

On Friday, August 2, HAWAII received a new set of weights and measures standards. The set included standards of both the customary and metric measurement systems.

Dr. I. C. Schoonover, Deputy Director of the U.S. Department of Commerce's National Bureau of Standards, presented the set to Hawaii's Governor John A. Burns in a 10:00 A.M. Ceremony at the Department of Agriculture in Honolulu.

DR. WALLENSTEIN DIES AT 48

Dr. Merrill B. Wallenstein, Manager of Data Programs, died on July 1, 1968. He was 48. Dr. Wallenstein joined the Bureau in 1953. He had served as Chief of the Physical Chemistry Division, Deputy Director of the NBS Institute for Basic Standards, and Acting Director of the Institute.

Dr. Wallenstein was a native of St. Anthony, Idaho and was born in Idaho Falls in 1920. In 1939, he entered the University of Utah at Salt Lake City, but his undergraduate work was interrupted by World War II. During the period 1941-45, he served as a communications instructor with the U.S. Army Air Force. Returning to the University of Utah after the war, Dr. Wallenstein earned his bachelor's degree in 1948, and his Ph.D. in 1951. He worked as a research associate at the University until 1953, when he joined the Thermochimistry Section of NBS to work on theoretical molecular structure and thermodynamics problems.

Dr. Wallenstein left NBS in 1955 to accept a position as senior physicist with Operations Research, Inc. in Silver Spring. He became Vice President and Technical Staff Director of ORI late in 1955 and remained there until 1958 when he became Vice President of the W. H. Johnston Laboratories, Inc. at West Lafayette, Indiana. In that position, he was primarily concerned with conducting and directing research in radiation chemistry and the uses of high level radiation sources.

In August 1959, Dr. Wallenstein returned to the National Bureau of Standards as a consultant in physical chemistry to Dr. Edward Wickers, the NBS Associate Director for Chemistry. In October 1960, Dr. Wallenstein was appointed Chief of the Physical Chemistry Division. His research activities covered a broad range of subjects, including theory of rate processes, surface chemistry and heterogeneous catalysis, theory of mass spectra, statistical mechanics, detonation phenomena, and equations of state for gases at extreme high pressure and temperature. In July 1964 Dr. Wallenstein joined the Institute for Basic Standards and served as Acting Deputy Director, Deputy Director, and Acting Director. On January 23 of this year he became manager of Data Programs in the Office of the Director of NBS. His professional and honorary memberships included the American Chemical Society, Phi Kappa Phi, Sigma Pi Sigma, and Sigma Xi.
The Administrative Committee (governing body) of the IEEE GROUP ON INSTRUMENTATION AND MEASUREMENT, met in Boulder on June 27, during the Conference on Precision Electromagnetic Measurements. Chairman F. L. HERMACH reported on the following activities of interest to NCSL members:

- New rules governing W. D. George Memorial Award (reported under NBS NEWS)
- Strict budgeting of pages in the G-IM Transactions in order to cope with rising printing costs.
- NORBERT KUSTERS (NRC-Ottawa) appointed Editor for EEMTIC Conference in Ottawa (see COMING EVENTS).
- The G-IM Technical Committee on Fundamental Electrical Standards reported through Chairman J. RILEY that the standard on resistors was in final stages of approval by IEEE and USASI; standards on capacitors and on reference sources of emf are progressing.
- Chairman R. ESTOPPEY, reporting for the G-IMTC on Low Frequency Instrumentation and Measurements noted its first meeting was held on Mar. 20, 1968 and a review given to several revised or proposed standards—dc instrument shunts, volume measurements of electrical speech and program waves (IEEE Std 152), and the meter test code for resistance measurements (IEEE-118).
- Chairman R. SODERMAN, reported on the activities of several subcommittees of his TC on High Frequency Instrumentation and Measurements. The precision connector standard (IEEE Std 287) is in publication. Bolometric power measurement techniques report is almost ready for the IEEE Standards Committee. Standard on oscilloscopes is almost ready for review by the Technical Committee. Pulse subcommittee activity reported under TECHNICAL NEWS.
- Chairman M. SELBY of the TC on Electromagnetic Measurements noted that the reports on field strength and on phase were being published as Standards. Other state-of-the-art reports by the TC will be published shortly in the IEEE Spectrum. Subcommittee work is continuing satisfactorily on pulsed field strength measurements.
- Chairman A. R. CHI noted that the TC on Frequency and Time has much subcommittee work. Among items of interest to NCSL is that of revision of IEEE 176 (Piezoelectric Crystals-1949), IEEE 177 (Standard Definitions and Methods of Measurement for Piezoelectric Vibrations), the IRE Standards on Determination of the Elastic, Piezoelectric, and Dielectric Constants of Piezoelectric Crystals, and the IEEE 178 Standard on Electromechanical Coupling Factors. In ferroelectric crystal work, development of definitions is underway as also is measurement techniques. Frequency stability studies have produced a draft of standard definitions and measurement techniques for submission to the TC Chairmen. Standards for high frequency crystals have reached the final draft stage.
COMING EVENTS

ELECTRICAL & ELECTRONIC MEASUREMENT & TEST INSTRUMENT CONFERENCE (EEMTIC)

The 1969 Electrical and Electronic Measurement and Test Instrument Conference will be held May 5, 6, and 7, 1969, at the Skyline Hotel, Ottawa, Canada. This is the first I & M symposium to be held in conjunction with the Electrical and Electronic Measurement and Test Instrument Conference.

The aim of the symposium is the advancement of electromagnetic measurements and instrumentation broadly useful in engineering application. Test and calibration instrumentation in the d-c, l-f, h-f, and microwave regions forms the core of the symposium. Measurements and instruments directed toward the solution of the technical aspects of broad social problems will be emphasized. For 1969, major emphases will be on automated test and calibration instruments and measurement techniques, and on instruments and measurement techniques applicable to the broad fields of observing, evaluating, and utilizing earth resources. International participation in this conference is encouraged since many of the problems such as national interests in ocean resources will require international agreement on methods of measurement.

The conference is sponsored by the Ottawa section and the Group on Instrumentation and Measurement, both of The Institute of Electrical and Electronics Engineers.

Original papers on measurement techniques, instrumentation, and calibration techniques, in the following areas, will be considered:

(1) Automated Systems at d-c, l-f, h-f, and microwave frequencies
(2) Applications to studying earth resources (land, ocean, or atmosphere)
(3) New measurements and techniques
(4) General test and evaluation applications

Presentations will be limited to 20 to 30 minutes with time allowed for discussion. Sessions will be organized to reflect the response and interests indicated by the contributed papers. Papers should be submitted to the Chairman of the Technical Program Committee, Dr. George E. Schafer, Institute for Basic Standards, National Bureau of Standards, Boulder, Colorado 80302.

Six copies of an abstract and summary of each contributed paper should be included. The abstract should contain no more than 200 words. The abstracts of accepted papers will be used for publicity and program purposes. Corrections will be accepted prior to printing deadlines in late February, 1969. The summary should be limited to 500-1000 words and be designed to assist the Technical Program Committee in selecting suitable papers for the conference. Summaries will be used only for selection purposes. The deadline for receipt of abstracts and summaries is January 15, 1969. It is planned to publish conference papers in a special issue of the IEEE Transactions on Instrumentation and Measurement. Three copies of the complete manuscript, including original illustrations, must be submitted to the Conference Editor before or during the conference for normal review and possible publication in this issue. General questions concerning the conference should be addressed to Mr. W.J.M. Moore, Conference Chairman, 797 Dunloe Avenue, Ottawa 7, Ontario, Canada.
NCII SPONSORED MEASUREMENT SEMINAR

The first in the 1968-69 series of NBS Measurement Seminars will be held October 7-9, 1968 on the campus of the West Coast University, Orange, California. Its subject will be: Precision and Accuracy in Measurement and Calibration. Members of the staff of the National Bureau of Standards will present the seminar under the auspices of the National Conference of Standards Laboratories (NCSL). The fee per person is $100.

Topics announced for the 3-day seminar are as follows: measurement--qualitative and quantitative aspects; errors, residuals, precision, accuracy; quality control of a measurement process; expression of the uncertainties affecting a measurement value; propagation of error, recording of data, protection against outlying data; experimental designs for calibration; computer procedures.

Applicants must have undergraduate college training in engineering or physics and must be currently engaged at a professional level in metrology or calibration. Preparation for the seminar should include review of ASTM Manual on Quality Control of Materials, Special Publication 15-c; E.B. Wilson, An Introduction to Scientific Research, chapters 7,8, and 9; Churchill Eisenhart, Realistic Evaluation of the Precision and Accuracy of Instrument Calibration Systems, NBS Journal of Research 67C, pp. 161-187 (April-June 1963).

Laboratory Directors who wish to have members of their staff attend are urged to send, as soon as possible, a letter of application to NCSL Secretariat, c/o National Bureau of Standards, Washington, D.C. 20234. The letter should indicate, for each applicant, his name and address, college level training, title of position in company or agency, and supervisory or laboratory experience related to precision measurement. Applications should be accompanied by a check to cover the fee which is $100 per person, payable to National Conference of Standards Laboratories.

NBS MEASUREMENT SEMINARS & WORKSHOPS--1968/69

Seminars and workshops on 12 topics, listed below, have been announced for the 1968-1969 series of NBS Measurement Seminars and Workshops. Except for the last one in the list, these are scheduled to be given either at the NBS laboratories in Gaithersburg, Md., indicated by (G), or in Boulder, Colo., indicated by (B). The announced topics are as follows:

- Problems in Metrication (G), Thermometry and Pyrometry (G), Low Frequency Electrical Standards (G), Colorimetry and Spectrophotometry (G), Photometry (G), Length, Angle, and Geometry Measurements (G), Fundamentals for Gas-Laser Length Measurements (G), Frequency and Time Stability (B), Laser Power and Energy Measurements (B), High-Frequency and Microwave Power (B), High-Frequency Calibration Workshop (B), High-Frequency and Microwave Impedance.

Each course (seminar or workshop) lasts from three to five days and its meetings are devoted to lectures, group discussions, and laboratory demonstrations. A course may be cancelled if registration is insufficient. However, in the past, requests for enrollment have nearly always exceeded the numbers that could be accommodated. Laboratory directors who wish to have members of their staff attend any of these courses are therefore urged
to send, as soon as possible, a letter of application to the individual named in the course descriptions below. Letters should include details of the candidate's qualifications in terms of the stated prerequisites. Applications should also be accompanied by a check, billing authorization, or purchase order for the stated fee.

Acceptance of qualified applicants, on the basis of first come first served, other things being equal, will be made by letter not later than four weeks prior to the scheduled date of the course. Detailed information on schedules and housing will be available at that time. Those accepted will be expected to study the assigned reading material before coming to the course and should be prepared to discuss their own experiences with related problems.

Problems in Metrication (G)

Designed to partly fulfill the needs of design and research and development engineers and of scientists who are encountering or expect to encounter problems arising from increasing use of the metric system. Subjects covered will include history, structure, development and use of the International System of Units, thinking in metric terms, U.S. standards and metric standards, development of dual capability, problems of screw threads, discussion of special problems proposed by attendees.

Attendees must have a B.S. degree in engineering or one of the physical sciences or the equivalent in education and experience, and be engaged in design, research and development, measurement, planning, or managing activities that involve the subject matter of the seminar.


Thermometry and Pyrometry (G)

Deals with calibration of common types of thermocouples and thermocouple materials by the comparison method and the fixed point method; procedures for the calibration of refractory and noble metal thermocouples by direct comparison with an optical pyrometer; description and discussion of the thermodynamic Kelvin and International Practical Temperature Scales; the NBS acoustical thermometer and germanium resistance thermometers; platinum resistance thermometers from 13.8 to 1063 K; realization of IPTS and determination of brightness temperatures of nonblackbodies with an optical pyrometer; new problems and precautions with high-precision photoelectric pyrometers. Experimental apparatus and techniques used in primary and secondary calibrations will be discussed, and laboratory demonstrations will be included.

Applicants must have college-level training in engineering or physics, or equivalent experience, and must be currently engaged at a professional level in standards work involving precision temperature calibrations. Preparation should include a review of the NBS Special Publication 300, Vol.2, Temperature, and NBS Monographs 37 and 41.
Group will be limited to 30, selected on the basis of academic qualifications and technical experience. Fee: $175. Tentative dates: March 25, 26, 27, 28, 1969. Apply to: H.H. Plumb, NBS Heat Division, Washington, D.C. 20234.

Low-Frequency Electrical Standards (G)

Two 3-day seminars are planned to present information on the accurate measurement of electrical quantities and the calibration of electrical standards. Each will cover the measurement methods used by the Bureau to establish and maintain the basic electrical units and to calibrate customers’ standards of resistance, inductance, capacitance, voltage, current, and power from direct current up through 30 kHz. The program of each seminar will consist of lectures and demonstrations in the Electricity Division laboratories. Emphasis will be on measurement techniques, which should be useful to workers in standards and calibration laboratories.

Candidates must have college-level training in physics or electrical engineering and must be currently engaged in professional work in precise electrical measurements at a level involving the basic reference standards of a calibration or standards laboratory. Preference will be given to those whose position involves the training of others in precise electrical measurements.

Attendance at each seminar will be limited to 50 persons and, for laboratory demonstrations, each group will be divided into subgroups. Fee: $115. Dates: April 14, 15, 16 and April 28, 29, 30, 1969. Apply to: R.F. Dziuba, NBS Electricity Division, Washington, D.C. 20234.

Colorimetry and Spectrophotometry (G)

Deals with color measurement in its psychological and physical aspects. Subjects to be treated are: The psychophysics of color vision, uniform color space, color-order systems, spectrophotometry, photodetector response, photodetector colorimeters, automation of colorimetry, metamerism, variability of color measurement. The seminar will consist of lectures, discussions, and visits to NBS colorimetry and spectrophotometry laboratories.

Candidates must have college-level training in physics, chemistry, engineering, or psychology, and be involved in experimental colorimetry or spectrophotometry, either in a direct or supervisory capacity. Prior to the seminar, candidates will be furnished with a list of references and copies of selected articles.

Group will be limited to 50, selected on the basis of academic qualifications and experience. Fee: $150. Dates: May 5, 6, 7, 1969. Apply to: I. Nimeroff NBS Metrology Division, Washington, D.C. 20234.

Photometry (G)

The 4-day seminar will cover: Fundamentals and nomenclature; photometry and the eye; characteristics of photodetectors; measurement of illuminance and luminance; measurement of luminous flux; photometric standards; projection photometry; statistical control of photometric calibrations.
Applicants must have college-level training in physics or engineering and must be currently engaged at a professional level in photometry or fields related thereto. Preparation for the seminar should include review of J.W.T. Walsh, *Photometry*.


**Length, Angle, and Geometry Measurements (G)**

The first two days of this 5-day seminar will be shared with the participants attending the Seminar on Fundamentals for Gas-Laser Length Measurements. Additional topics to be covered include: Absolute and mechanical gage block measurement, polygon and angle block measurement; interferometric measurement of optical flats and diameter; survey tape calibration; surface plate; surface texture and gear metrology. Experimental and statistical programs for determination of systematic, random, and instrumental error will be discussed. Theoretical development will be supplemented with laboratory sessions where class members can use NBS calibration equipment. Speaker at dinner will discuss U.S. problems in metrification. One open session will be provided for special individual appointment visits to other areas of interest.


Group will be limited to 30, selected on basis of need for the training. Fee: $280, which includes cost of one dinner and coffee breaks. Dates: May 12, 13, 14, 15, 16, 1969. Apply to: A. G. Strang, NBS Engineering Metrology Section, Washington, D.C. 20234.

**Fundamentals for Gas-Laser Length Measurements (G)**

Topics to be covered during the 2-day seminar are: Fundamental interferometry, length interferometry, light sources for interferometry, gas lasers, NBS laser instrumentation, practical pointers on use of lasers, laser alignment interferometers and holography.

It is desirable that applicants have college-level training in engineering or physics or equivalent practical experience in precise dimensional metrology. Preparation should include review of Ditchburn, *Light*, Ch. I-IX, XIII-XV.


**Frequency and Time Stability (B)**

Will develop a language that will allow clear characterization of the instabilities in atomic frequency standards and in atomic clocks. Definitions of precision, accuracy, and stability will be given allowing the supplier and the
user to communicate on the specifications and capabilities of precise frequency standards and clocks. The seminar will show how to measure and what to expect in the short-, intermediate-, and long-term stability of cesium beams, hydrogen masers, rubidium gas cells, and quartz crystal oscillators. Seminar material will be pertinent in the following areas: Time dispersion in atomic clocks; use of portable clocks; time synchronization of timing centers; measurement and analysis of frequency and time data as may be used in calibrations, with information on low-noise techniques.

Candidates must have college-level training in physics or electrical engineering, or equivalent experience, and must be working at a professional level with frequency standards or precise timing systems. Preparation for the seminar should include a review of pertinent parts of the February 1966 issue of the Proceedings of the IEEE. Other materials will be supplied at the time of acceptance notification and should be studied in preparation.

Attendance will be limited to 30. Tentative dates: February 18, 19, 20, 21, 1969. Apply to: D.W. Allan, NBS Atomic Frequency and Time Standards Section, Boulder, Colo. 80302.

**Laser Power and Energy Measurements (B)**

Will discuss the techniques used by NBS to calibrate various laser power and energy measuring devices. The wavelength range will be 488.0 nm to 10.6 μm; cw power levels will range up to 200 W and pulse energy to 100 J. Measurement of average power and peak power of high rep-rate lasers will also be discussed.

Candidates must have college-level training in engineering or physics, or equivalent experience, and must be currently engaged in precision measurements at a professional level.

Attendance will be limited to approximately 40. Approximate fee: $15. Tentative dates: March 3, 4, 1969. Apply to: Administrative Officer, NBS Radio Standards Physics Division, Boulder, Colo. 80302.

**High Frequency and Microwave Power (B)**

The 3-day program will include topics of interest to those concerned with rf power measurement and calibration in coaxial and rectangular waveguide systems. Areas to be covered include analysis and evaluation of calibration systems, mismatch and other transfer errors, and descriptions of NBS primary standards. Other topics such as measurement techniques and state-of-the-art instrumentation will be discussed. Accuracies and types of instruments used in Echelon I, II, and III laboratories will be given. Lectures and discussions will be supplemented by laboratory demonstrations.

Candidates must have college-level training in engineering or physics, or equivalent experience, and must be currently engaged in precision measurements at a professional level.

High-Frequency Calibration Workshop (B)

The 5-day workshop will cover quantities measured in presently available high-frequency calibration services from NBS. These will include cw power measurements; impedance and VSWR measurements; attenuation difference and insertion loss measurements; phase shift measurements; cw voltage measurements; antenna and field strength measurement techniques; effective noise temperature measurements; pulse voltage and power measurements. Oral presentations will include a discussion of the calibration techniques used at NBS, and the error analysis upon which NBS calibrations are based will be carefully explained. Extensive measurement theory will not be treated except as a necessary conceptual aid. Demonstrations of typical calibrations will be arranged and will compose a substantial portion of the program. Practical hints for solving some of the common high-frequency measurement problems will be included.

The workshop is aimed at the "practicing metrologist." This is intended to include the more experienced operating technical calibration people and first-line supervisory calibration people. Some of the higher-level supervisory engineers in calibration laboratories also may find some benefit from the workshop.


High-Frequency and Microwave Impedance

This is a 3-to 5-day seminar. While the discussion will include background material on measurement philosophy, errors and accuracy, standards, the connector problem, and the effect of impedance on quantities such as power and attenuation, the major emphasis will be on techniques for making meaningful impedance measurements. The treatment will be nonmathematical and practical rather than theoretical.

The seminar is aimed at "practicing metrologists"--the operating calibration technician and his first-line supervisor.

Approximate fee: $300. The seminar will be presented on the East Coast and on the West Coast in January, February, or March of 1969. The exact dates and sites are still open. Apply to: L.E. Huntley, NBS Radio Standards Engineering Division, Boulder, Colo. 80302.

STANDARDS & CALIBRATION LABORATORY COURSE AT GWU

The Continuing Engineering Education Division of the School of Engineering and Applied Science of George Washington University announces that the special short course offered annually in June for Standards laboratory personnel, will be presented again in December for qualified applicants.
MEASUREMENTS ENGINEERING SHORT COURSE AT ASU

This course will be presented for the eighth year at Arizona State University, Tempe, Arizona on January 27-31, 1969. The theme for instruction will be "How To Obtain Valid Data On Purpose-In 1979". It is aimed at the operation of measuring systems which do not exist today, at the use of transducing processes, materials, and instruments which have not been invented or discovered; dealing with test conditions and environments that have not been conceived yet.

Emphasis is slanted toward electrical measurement of mechanical quantities. The program is for engineers with a Bachelor's degree or higher and who are in theoretical, practicing or administrative positions. Fee is $250; registration closes January 17, 1969. Contact Prof. P. K. Stein at Arizona State University, Measurement Engineering Short Course, Engineering Center, Tempe, Arizona 85281 for further particulars.

NORTHEAST ELECTRONICS RESEARCH & ENGINEERING MEETING (NEREM)

The IEEE Northeast Electronics Research and Engineering Meeting will be held on November 6-8, 1968 at the War Memorial Auditorium and the Sheraton Boston Hotel. A major innovation in the 1968 program will be the addition of five "applications" sessions that will cover new developments in applied engineering, production, and testing. The main technical program will focus primarily on research and development and will consist of 26 formal sessions of four to six technical papers. A highlight will be a session devoted to the technical innovations resulting from the great electric car race in August which saw students from MIT and Cal Tech in competition across the United States. Special interest sessions include exploration of the ocean floor and underwater optics and acoustics, optical modulation techniques and holography, current status of artificial heart development, millimeter wave technology, and microsound circuit elements.

INTERNATIONAL SYSTEM OF UNITS

Washington University at St. Louis, on Oct. 17-18, 1968 will present a course discussing the advantages of the SI system of units to the mechanical engineer and to others working with measurements and phenomena outside of the electrical and electronic areas. Lecturers will be Prof. J. C. Georgian of Washington University, and A. G. McNish of NBS. Apply to Institute for Continuing Education, Box 1048, Washington University, St. Louis, Mo. 63130; fee is $135.

23rd ANNUAL ISA CONFERENCE

This year's Conference & Symposia program, held entirely at the Statler Hilton Hotel, New York City, features "New Technologies in Instrumentation. Exhibits will be on display at the Coliseum at Columbus Circle. The program will run from October 28 to 31, with the concurrent Symposia:

2nd Data Handling and Computation Instrumentation
5th Metrology Instrumentation
5th Test Instrument for Measurement
WEST COAST METROLOGY COURSES

Mr. Thomas Osborne, Dean of the Evening Division at Golden West College in Huntington Beach, California, has reported that they will offer the following metrology courses during the 1968 Fall Semester:

Introduction to Metrology (50)

Introduction to Metrology (the science of measurement) will include the fundamentals of Metrology and through them establish a basis for understanding specialized measurement disciplines. It surveys concepts and describes them in an easily comprehended manner so that the student may grasp the whole rather than lose himself in a mass of detail. Basic methods are demonstrated and analyzed, however, the course is not intended to provide instruction in measurement techniques. Emphasis is placed upon the national and international standards, the fundamental and derived units, the effects of environment and the interpretation of measurement data.

The instructor for this course will be Tom Martin, who is employed by Autonetics a division of North American Rockwell Corporation. His assignment requires him to design and conduct experiments leading to the determination of the measurement capability of the most precise measurement systems in existence. Mr. Martin, a retired U.S. Naval Commander, received his education at George Washington University and the University of Virginia. Throughout his 20 years of Naval service he was variously assigned to duties with the design, acceptance testing, and experimental proofing of a variety of Naval weapons. He is a member of Chi Beta Phi, national honorary scientific fraternity, and past president of the Orange Chapter, Precision Measurements Association.

Metrology, Direct Current (51)

Metrology, Direct Current is intended to aid the student to understand and use instrument specifications and to perform calibration tests of direct voltage and direct current measuring equipment. The evaluation of calibration data will also be covered. Upon completion of this course, the student should have gained sufficient insight to apply these basic measurement concepts to the calibration of more complex measuring equipment.

Metrology 51 will be taught by Dexter Franke who has had ten years of precision measurement experience in the Autonetics' Metrology Laboratory. Mr. Franke, a member of the Precision Measurements Association, has attended Orange Coast College, Santa Ana College, and the University of California at Los Angeles in pursuing this field.
AIA-QA PROJECT TEAM REPORTS ON MEASUREMENTS PROBLEMS

The Aerospace Industries Association Quality Assurance Committee Project Team chaired by F. McGinnis will be reporting to the 18th Annual National Meeting of the committee on October 9-10 in part, as follows:

- Passage of Public Law 90-472 by Congress, establishing a three-year program to determine the impact of increasing worldwide use of the metric system upon the United States, has been accomplished and the Secretary of Commerce has directed the National Bureau of Standards to conduct the study (no funds for this purpose have been appropriated-NCSL editor).

- If a decision is made within the U.S. to go metric, quality organizations will bear the brunt of measuring strangely dimensioned parts. Much of the strangeness can be avoided if familiarization programs are instituted in advance.

- The Army Metrology and Calibration Center is making further revisions to the latest draft of the MIL-C-45662B in response to constructive criticisms received from the Project Team and other Consultants.

- Tolerancing problems appear to be widespread in industry but are not always recognized. The team suggests that typical questions to be answered in determining the presence of the problem are divided into two parts 1) those related to RESULTS and 2) those related to EFFORT. Typical questions in each category are given:

  **RESULTS**
  
a) Do you find that most tolerances are round number values or sets of numbers, e.g. 1%, 5%, .001, .005? Do you ever see ±.004, ±.007, etc?
  
b) Are out-of-tolerance parts accepted frequently when submitted for material review?
  
c) Do engineers demand and defend certain tolerance values but back off and accept less if faced with high test equipment costs?
  
d) Do you ever get complaints from Assembly that parts which are correct to blueprint dimensions will not work when assembled?

  **EFFORT**
  
a) Are tolerancing practices spelled out in writing in some formal type of standard practice instruction?
  
b) Are tolerances covered in design reviews?
  
c) Who has responsibility for establishing the tightest tolerances, and what experience and background is called for in the job description?
  
d) Are the accuracies of test instruments taken into account in determining the degree of product tolerance?
NEW NBS CALIBRATION SERVICES

10-KILO-OHM STANDARD RESISTORS

During the past several years there has been a growing need for increased accuracy in the measurement of resistance at the kilo-ohm level. This need has been felt especially by the electronics industry, the military services, and the industrial standards laboratories.

To help provide the required accuracy, the NBS Institute for Basic Standards is now reporting calibration results for certain new-type 10-kilo-ohm standard resistors to 0.1 ppm. In the new calibration service, the total uncertainty for the measurement process is 0.0001 percent based on an estimated 3-sigma limit for random errors. This is a seven-fold improvement in measurement uncertainty compared with the service offered on older-type 10-kilo-ohm units, and is equal to the present uncertainty given in reports of calibration for Thomas-type 1-ohm standards.

The recent commercial appearance of several improved types of 10-kilo-ohm standard resistors having low temperature coefficients and low apparent time constants has warranted this additional service. The new 10-kilo-ohm calibration service is not designed to replace that currently available to owners of Thomas-type 1-ohm standards, but rather to supplement this service by providing an additional high-accuracy reference point in the resistance spectrum. There is no change in the accuracy statement applicable to the older-type 10-kilo-ohm standards.

Laboratories now employing some form of "boot-strap" technique in calibrating their various resistance standards from a one-ohm reference unit may find the new 10-kilo-ohm standards quite useful in the process, especially when there is need to go to very high values on the resistance scale. In addition, the 10-kilo-ohm level is of great importance because modern methods for the absolute measurement of resistance, starting from computable capacitors, assign values in absolute measure to standard resistors at this point in the scale of resistance values.

Data showing the accuracies now available at NBS for calibration of resistors are given in table 1. Note that the uncertainty of measurement in the new calibration service (10,000-ohm entry) is equivalent to that for 1-ohm measurements, offering a convenient point to begin a boot-strap operation to higher values.

Because of the considerable amount of work required in calibrating 10-kilo-ohm standards in terms of the unit maintained at the 1-ohm level, the new service will be available only at periodic intervals. Clients interested in this service should make a written request to

Chester Peterson
Chief, Resistance & Reactance Section
National Bureau of Standards
B146 Metrology Building
Washington, D.C. 20234
Requests will be acknowledged as received and at suitable intervals of time (3 to 6 months), a measurement date will be announced. All owners will then be notified to submit their standards.

<table>
<thead>
<tr>
<th>Nominal Resistance (ohms)</th>
<th>Nearest ppm to which reported values are rounded off</th>
<th>Measurement Uncertainty (ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,000,000.</td>
<td>1.</td>
<td>15.</td>
</tr>
<tr>
<td>100,000.</td>
<td>1.</td>
<td>10.</td>
</tr>
<tr>
<td>10,000.</td>
<td>1.</td>
<td>7.</td>
</tr>
<tr>
<td>New-Type Only</td>
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</tr>
<tr>
<td>10,000.*</td>
<td>0.1</td>
<td>1.</td>
</tr>
<tr>
<td>1,000.</td>
<td>1.</td>
<td>5.</td>
</tr>
<tr>
<td>100.</td>
<td>1.</td>
<td>4.</td>
</tr>
<tr>
<td>10.*</td>
<td>1.</td>
<td>4.</td>
</tr>
<tr>
<td>1.*</td>
<td>1.</td>
<td>3.</td>
</tr>
<tr>
<td>Thomas-Type Only</td>
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<tr>
<td>1.*</td>
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<td>1.</td>
</tr>
<tr>
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<td>5.</td>
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<td>12.</td>
</tr>
<tr>
<td>0.0001*</td>
<td>1.</td>
<td>20.</td>
</tr>
</tbody>
</table>

*Four-terminal measurement
IMPROVED SERVICE FOR PLATINUM RESISTANCE THERMOMETERS

The calibration facilities for standard platinum resistance thermometers at the National Bureau of Standards are again fully operational. At the same time, because of changes in equipment and procedure instituted during the suspension of services, the accuracy of some of the services has been improved and the turn-around time for all of them has been shortened materially.

Services were interrupted in the first place because of the move of NBS from its former location in Washington, D.C. to new laboratories in Gaithersburg, Maryland. However, the dismantling of the calibration apparatus, which the process of removal made necessary, gave an excellent opportunity for introducing a number of improvements that were then under development, and this occasioned further delays. Some of the services were resumed over a year ago; others, in particular the calibrations in the low-temperature range between 10 K and 90 K, where changes in apparatus were most extensive, could not be made available again until quite recently.

In the temperature range from about 300 °C to 630 °C (about 573 K to 903 K), calibration errors have been reduced by roughly a factor of two, primarily as a result of substituting the freezing point of zinc for the boiling point of sulfur as a reference temperature. Test results in the 10 K to 90 K range, which are still being analyzed, also show a distinct improvement in accuracy.

Turn-around time has also been substantially improved. For any one specified calibration, the time interval from the date of receipt (of both the Purchase Order and the thermometer) to the date on which the material is shipped back to the customer, is expected not to exceed six weeks. Previously, in contrast, the interval was rarely less than three months.

The services involved are those listed under item numbers 221.113a, 221.113b, 221.113c, 221.113d, 221.113e, 221.113f, 221.113g, and 221.113h, as described in the publication, Calibration and Test Services of the National Bureau of Standards, NBS Special Pub. 250, 1968 Edition.

COAXIAL NOISE GENERATORS

A service for the calibration of coaxial noise generators at 3 MHz has been announced by the Radio Standards Engineering Division (Boulder, Colorado) of the NBS Institute for Basic Standards. This service, which is the first to be offered for noise temperature measurements of noise sources that operate in coaxial systems at high frequencies (nominally from 30 kHz to 1 GHz and above, for coaxial systems), will help industry and scientific laboratories to meet pressing needs for precise measurements of noise power spectral density. It augments a similar service that has been available for rectangular waveguide systems (WR 62, WR 90) in the microwave region (nominally from 1 GHz to 40 GHz and above, for rectangular waveguide systems).

The quantity that is measured in this new service is the noise temperature of random noise generators. The calibration is performed within a 9 kHz bandwidth centered at 3 MHz. Measurement capabilities are in the range of 75 kelvins (K) to 30,000 kelvins. Typical noise generators that will be calibrated under this service are thermal noise generators, shot noise generators...
(temperature-limited diodes and semiconductor diodes), and certain other types of generators using vacuum tubes, gas-discharge tubes, or semiconductors that produce thermal-like noise voltages in the frequency and power range specified.

Random noise generators are widely used in the measurement of the noise figure of radio receivers and amplifiers. Also, in certain critical applications, such as are found in the fields of radio astronomy and of deep-space probing by satellites, precision noise generators are used to calibrate the system noise temperature to assure maximum range and accuracy. To meet the demands arising from these activities, NBS scientists have worked for several years on a new technique for the precise measurement of noise power spectral density. This technique uses a correlation scheme whereby the power from the noise generator under calibration is compared with the power from a very stable and accurately controllable sinusoidal signal generator. Two very stable and accurately known random noise generators, built at NBS for this service, are used to calibrate the measurement system. One of these generators also serves as the reference standard for calibrating the noise generator under calibration.

An elementary explanation of the measurement technique is as follows. The power from the noise generator under calibration is compared with that from a stable CW generator by adjusting the CW generator power level to produce a null output voltage from the measurement system. Power from a reference standard noise generator is then compared with the power from the CW generator in like manner. The noise temperature of the generator under calibration is computed by the system equation, using the known noise temperature of the reference standard generator, the known relative change in the CW power level, and the empirically determined system parameters.

The measurement apparatus used in this new calibration service is similar to that described previously. Certain operational improvements have been made in the present apparatus, but the overall features are the same.

The two reference standard noise generators are thermal noise generators consisting of passive electrical components immersed in temperature-controlled baths. One noise generator uses a bath of liquid nitrogen which is free to boil at a temperature (about 76 K) determined principally by the ambient atmospheric pressure. The other noise generator uses a bath of silicone oil that is heated to any selected temperature within the range of approximately 325 to 575 K. Both generators have an adjustable source impedance that permits setting the impedance of the reference standard to be the same as that of the noise generator under calibration. This minimizes the measurement error produced by the VSWR of the calibrated noise generator.

With the present apparatus, the uncertainty in the calibrated value of noise temperature is approximately 1 percent of the noise temperature. To realize this degree of accuracy, however, the generator under calibration must have a noise temperature instability no greater than approximately 0.25 percent per hour, and a source impedance instability no greater than 0.04 ohm per hour.

A noise generator submitted for calibration under this service must be either of coaxial design, or have a shielded enclosure with a coaxial fitting. The
output connector should be coaxial, preferably a Type N connector or one of
the several types of precision connectors. If the output connector is not
coaxial, it must be adaptable to coaxial configuration by use of a suitable
adaptor.

The source impedance of the noise generator should be within the range of 50
± 5 + j (0 ± 5) ohms. This corresponds to a maximum VSWR of approximately
1.16:1.

For noise generators whose noise temperature exceeds 30,000 K, a suitable
attenuator must be supplied with the generator to lower the temperature to
within the operating range of the calibration service.

It is anticipated that a calibration service, similar to the one described,
will be available at 30 MHz sometime during 1968. Work is in progress that
will lead to a similar service at 1 GHz. Calibration Services at other
selected frequencies will be made available in accordance with demand.

COAXIAL BOLOMETERS TO 17 GHz

A calibration service for the measurement of effective efficiency of coaxial
bolometer units fitted with 7-mm precision-type connectors has been announced
by the Radio Standards Engineering Division (Boulder, Colorado) of the NBS
Institute for Basic Standards. The recent availability of 7-mm precision-
type connectors has made it possible to extend the frequency range to 17 GHz.
The former calibration range of coaxial bolometer units was limited to 10 GHz.

Coaxial bolometer units calibrated by NBS are used as interlaboratory stan-
dards and form the principal link to the NBS reference standards of radio-
frequency power in coaxial equipment. The calibrated bolometer units can
be used by other standards laboratories to calibrate their power measurement
devices. They also serve as an accurate means of checking the operation of
power measuring systems.

The calibration of coaxial bolometer units in the frequency range of 4 to 17
GHz is based upon two methods of calibrating waveguide bolometer units, used
as working standards, in terms of waveguide reference standards. In the range
of 3.95 to 7.05 GHz use is made of the impedance method of measuring the
efficiency of the working standards. In the range from 7.05 to 17 GHz the
calorimetric method is used. In turn, the waveguide working standards are
used to calibrate coaxial bolometer units by the adapter method, the final
result being an accurate measurement of effective efficiency over a wide fre-
quency range that is obtained by this two-step procedure. Although a trans-
fer is made from one type of transmission line to another in the second step,
the uncertainty in measurement of effective efficiency of a coaxial unit is
reasonably small.

Calibrations can be performed at any rf power level between 1 and 10 milli-
 watts. Limits of uncertainty of measurement are dependent upon the frequency
of calibration and upon impedance characteristics of the bolometer unit. For
a reflection coefficient magnitude no greater than 0.25, the uncertainty is
lowest (+ 0.8 percent) in the range of 7.05 to 12.4 GHz. Similarly, the
limits of uncertainty are ± 1.3 percent in the frequency range of 4 to 7.05
GHz and ± 1.2 percent in the range of 12.4 to 17 GHz.
ADDITIONAL NOISE SOURCE CALIBRATIONS

Calibration services for the measurement of effective noise temperature of noise sources in four additional waveguide sizes have been announced by the Radio Standards Engineering Division (Boulder, Colorado) of the NBS Institute for Basic Standards. The services are available in WR 284 waveguide (2.60-3.95 GHz), WR 75 waveguide (10.0-15.0 GHz), and in the limited ranges of 3.30 to 3.95 GHz for WR 229 waveguide and 8.2 to 10.0 GHz for WR 112 waveguide.

The range of effective noise temperature measurement under conditions of continuous unmodulated operation is 1000 to 300,000 K for noise sources in WR 75 and WR 112 waveguide, and 700 to 300.00 K in WR 299 and WR 284 waveguide. Expressed as excess noise ratio, the range is 4 to 30 dB for noise sources in WR 75 and WR 112 waveguide, and 1.5 to 30 dB in WR 299 and WR 284 waveguide.

At present there are certain limitations to the number of frequencies at which effective noise temperature measurements can be made in the four waveguide sizes. In WR 284 waveguide the suggested frequencies are 2.85, 3.25, and 3.75 GHz. In WR 229 waveguide the only available frequency is 3.75 GHz. A selection of calibration frequencies is available in WR 112 and WR 75 waveguide.

Waveguide noise sources submitted for calibration should have the gas-discharge tube noise generator securely fitted to the waveguide mount which, in turn, must be terminated at one end with a suitable matched load. The waveguide flange for mating of the noise source to the measurement system must be of a cover type as noted below.

Direct current required for normal operation of the gas-discharge tube should not exceed 300 mA but should be sufficient to prevent excessive plasma oscillations. Complete information on the operating current of the tube and a wiring diagram of the noise source must be supplied.

For a reflection coefficient magnitude less than 0.09 (VSWR less than 1.2), the following listing of the limits of uncertainties applies for the effective noise temperatures and excess noise ratios (ENR) for argon-filled gas-discharge noise sources.

<table>
<thead>
<tr>
<th>Waveguide size of noise source</th>
<th>Waveguide flange</th>
<th>Effective noise temperature</th>
<th>Excess noise ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>WR 75 (10.0-15.0 GHz)</td>
<td>Cover Type</td>
<td>± 175 to 225 K</td>
<td>+0.07 to 0.09 dB</td>
</tr>
<tr>
<td>WR 112 (8.2-10.0 GHz)</td>
<td>UG-51/U</td>
<td>± 175 to 225 K</td>
<td>+0.07 to 0.09 dB</td>
</tr>
<tr>
<td>WR 229 (3.30-3.95 GHz)</td>
<td>Cover Type</td>
<td>± 325 to 373 K</td>
<td>+0.13 to 0.15 dB</td>
</tr>
<tr>
<td>WR 284 (2.60-395 GHz)</td>
<td>UG-53/U</td>
<td>± 300 to 350 K</td>
<td>+0.12 to 0.14 dB</td>
</tr>
</tbody>
</table>
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