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MEASUREMENT OF TEMPERATURE: ADVANCED STATE-OF-THE-ART BIBLIOGRAPHY

Joseph Pearlstein

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DIAMOND ORDNANCE FUZE LABORATORIES
ORDNANCE CORPS ● DEPARTMENT OF THE ARMY
WASHINGTON 25, D. C.

ORDNANCE CORPS

DIAMOND ORDNANCE FUZE LABORATORIES

WASHINGTON 25, D. C.

Robert W. McEvoy, Lt Col
COMMANDING

W. S. Hinman, Jr.
TECHNICAL DIRECTOR

The Diamond Ordnance Fuze Laboratories is a research, development, and engineering installation under the jurisdiction of the Chief of Ordnance.

The Diamond Ordnance Fuze Laboratories was established by the Ordnance Corps, Department of the Army, on 27 September 1953. The nucleus for these Laboratories was the personnel and facilities of the Ordnance Divisions of the National Bureau of Standards.

Typical fields of activity at the Diamond Ordnance Fuze Laboratories include electronics, physics, mechanics, chemistry, and applied mathematics. Examples of topics under these activities are radiation and field studies, circuit devices, chemical problems, and special electron tube design. The programs include all phases from basic research to product design.

The mission of the Laboratories is to:

1. Conduct research and development in the various physical science and engineering fields directed toward meeting the military characteristics for fuzes and related items.

2. Provide consulting and liaison services as required in connection with the development, production, and use of items developed in the laboratories, or of related items.

3. Fabricate models and prototypes of items under development at the laboratories.

4. Perform developmental testing, including destructive testing of prototypes.

5. Serve as principal Nuclear Radiation Effects Research Group to investigate and determine susceptibility of Ordnance electronic materiel to nuclear weapons radiation environment, mechanisms of those effects, and ways and means of developing less susceptible materiel.

6. Maintain and operate for OCO a special library of technical and progress reports, prepared by Army, Navy, Air Force, and their contractors.

7. Perform the Industrial Engineering Support Mission for all proximity fuze items.

8. Administer the Department of the Army Regional Training Center for the District of Columbia, Virginia, and Maryland region.

DIAMOND ORDNANCE FUZE LABORATORIES
ORDNANCE CORPS WASHINGTON 25, D. C.

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by

Joseph Pearlstein

FOR THE COMMANDER:
Approved by

Israel Rotkin
Chief, Laboratory 300

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DISTRIBUTION

ABSTRACT

A bibliography on temperature measurement and control is presented of selected papers given at the Fourth Symposium on Temperature Its Measurement and Control in Science and Industry held in Columbus, Ohio, March 27-31, 1961.

1. INTRODUCTION

This report is a bibliography of selected papers on temperature measurement and control given at the Fourth Symposium on Temperature Its Measurement and Control in Science and Industry held in Columbus, Ohio, March 27-31, 1961. The bibliography lists only the titles of the papers, the authors, and organizations that have conducted or sponsored the work. As an aid to the reader, the titles of the related papers listed in the bibliography are grouped under common headings, as shown in the table of contents. Although excellent summaries of all the papers are given in a 115-page Program*, it is felt that this selected bibliography will have value as a rapid guide for surveying the current state-of-the-art on temperature measurement and control in areas of interest to the U. S. Army Ordnance Corps.

This is one of a series of reports that have been issued in conformance with the requirements of an Ordnance Corps project established at DOFL for the dissemination of information in the "transducer or phenomena areas of direct interest to the Ordnance Corps."

A list of reports that have been issued under the Ordnance Corps Transducer Project at DOFL is given in the appendix.

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* Copies of the Program (Temperature Its Measurement & Control in Science & Industry, Columbus, Ohio, March 27-31, 1961) were furnished to all those who registered for attendance at the Symposium. Additional copies of the Program may be purchased for $5.00 per copy from the American Institute of Physics, 335E. 45 Street, New York 17, New York.

2. BIBLIOGRAPHY

BASIC CONCEPTS OF TEMPERATURE

Temperature Concept for Systems in Equilibrium, R. B. Lindsay, Brown University.

Thermodynamics and Statistical Mechanics at Negative Absolute Temperatures, N. F. Ramsey, Harvard University.

Nonequilibrium Thermodynamics, H. B. Callen, University of Pennsylvania.

Relaxation of Nonequilibrium Distributions, K. E. Shuler, National Bureau of Standards.

The Role of Temperature in Our Measurement System, A. G. McNish, National Bureau of Standards.

THE TEMPERATURE SCALES

GENERAL

The Pennsylvania State University Thermodynamic Temperature Scale Below 90°K and the Normal Boiling Points of Oxygen and Normal Hydrogen on the Thermodynamic Scale, G. W.Moessen and J. G. Aston, Pennsylvania State University.

Helium Gas Thermometry at Low Temperatures, C. R. Barber, National Physical Lab.

Determination of Absolute Temperatures from Sound Velocity Measurements, G. Cataland, M. H. Edlow and H. H. Plumb, National Bureau of Standards.

The Thermodynamic (Kelvin) Scale, C. M. Herzfeld, National Bureau of Standards.

The Text Revision of the International Temperature Scale of 1948, H. F. Stimson , National Bureau of Standards.

Review of Recent Determinations of Thermodynamic Temperatures of Fixed Points Above 419°, H. Moser, Physikalisch-Technische Bundesanstalt, Braunschweig.

THERMOMETRIC FIXED POINTS, THE HELIUM SCALE

Some Recent Experiments in Mercury Thermometry, J. A. Hall and V. M. Leaver, National Physical Lab. England.

Replacement of Fixed Points on a Temperature Scale, H. Preston-Thomas National Research Council. Ottawa.

Freezing Points of High Purity Metals as Precision Temperature Standards, E. H. McLaren, National Research Council. Ottawa.

On Best Values for the Thermodynamic Temperatures of Thermometric Fixed Points Below 0°C, H. van Dijk, Kamerlingh Onnes Lab. Leiden.

A National Bureau of Standards Gas Thermometer, L. A. Guildner, National Bureau of Standards.

The Liquid Helium Temperature Scale, J. R. Clement, U. S. Naval Research Lab.

The He^3 Scale of Temperatures, T. R. Roberts, S. G. Sydoriak and R. H. Sherman, Los Alamos Scientific Lab.

VERY LOW TEMPERATURES

Thermodynamic Scale of Temperature Below 1°K, R. P. Hudson, National Bureau of Standards.

A Low-Temperature Thermometer Utilizing the Mossbauer Effect, R. D. Taylor, Los Alamos Scientific Lab.

THE PLATINUM RESISTANCE THERMOMETER SCALE

Interpolation of Platinum Resistance Thermometers, R. J. Corruccini, National Bureau of Standards.

Extension of the International Temperature Scale Below -183°C, A. A. F. Harper, W. R. G. Kemp and G. C. Lowenthal, National Bureau of Standards.

Low-Temperature Scales from 90° to 10°K, C. R. Barber, National Physical Labs. England.

On the Methods of Practical Temperature Scale Reduction in the Range 10-90°K, Committee of Standards, Measures, and Measuring Instruments of the Council of Ministers, USSR.

Establishment of Practical Temperature Scale of PRMI in the Range 10-90°K, Committee of Standards, Measures, and Measuring Instruments of the Council of Ministers. USSR.

On the Use of Platinum Thermometers for Thermometry Below 90°K. A Study of Two Possibilities to Relate Resistance Data of Different Platinum Thermometers to Each Other, H. van Dijk, Kamerlingh Onnes Labs. Leiden.

THERMOCOUPLES

Thermocouple Materials, F. R. Caldwell, National Bureau of Standards.

Platinum Metal Thermocouples, E. D. Zysk, Engelhard Industries.

The Use of Refractory Metals for High-Temperature Thermocouples, J. C. Lachman and J. A. McGurty.

Measurement of Thermal EMF Characteristics I. Thermal EMF Instability, F. W. Kuether, Honeywell Research Center.

Measurement of Thermal EMF Characteristics II. Thermal EMF Scatter, F. W. Kuether, Honeywell Research Center.

Some Experiences with Noble Metal, Metal-Sheathed Thermocouples, W. E. Bostwick, Lawrence Radiation Lab.

Reference Tables for 40% Iridium-60% Rhodium vs Iridium Thermocouples, G. F. Blackburn, National Bureau of Standards.

Platinel-A Noble Metal Thermocouple, D. J. Accinno and J. F. Schneider, Engelhard Industries.

High-Temperature Thermocouples Using Nonmetallic Members, E. Franks, Morgan Crucible Co. London.

Fibro Pt for Thermal Elements, J. S. Hill, Engelhard Industries.

General Principles of Thermoelectric Thermometry, D. I. Finch, Leeds & Northrup Co.

CALIBRATION & STANDARDIZATION

Temperature Standards and Practices in a Large Industrial Company, S. C. Richardson, General Electric.

An Industrial Thermocouple Calibration Facility, W. G. Trabold, Research Labs. General Motors.

Automation in the Calibration of Platinum vs Platinum-Rhodium Thermocouples, J. P. Evans and K. P. Hannon, National Bureau of Standards.

COLD WORKING, HEAT TREATMENT, NUCLEAR IRRADIATION, SPECIAL TECHNIQUES

Effect of Cold Working upon Thermoelements, D. D. Pollock and D. I. Finch, Leeds & Northrup Co.

Effects of Cold Working Heat Treatment, and Oxidation on the Thermal EMF of Nickel-Base Thermoelements, J. F. Potts, Jr., and D. L. McElroy, Oak Ridge National Lab.

Effects of Nuclear Radiation on Thermocouples, M. J. Kelly, W. W. Johnston and C. D. Baumann, Oak Ridge National Lab.

Operation of Thermocouples under Conditions of High Temperature and Nuclear Radiation, G. F. Levy and R. R. Fouse, The Marquardt Corp.

Gradient Approach to Thermocouple Circuitry, R. J. Moffat, Research Labs. General Motors.

The Intermittent Thermometer: A New Technique for the Measurement of Extreme Temperatures, S. D. Raezer and H. L. Olsen, Applied Physics Lab. Johns Hopkins University.

Estimating the Necessity of a High Recovery Factor Thermocouple for Particular Operating Conditions, P. K. Stein, Arizona State University and Stein Engineering Service.

Estimating the Radiation and Conduction Errors in Thermocouples, P. K. Stein, Arizona State University and Stein Engineering Service.

Thermal EMF Stability of Nickel-Base Alloys in the Temperature Range 150° to 1000°C, J. F. Potts, Jr. and D. L. McElroy, Oak Ridge National Lab.

Drift Studies on Chromel-P/Alumel Thermocouples in Helium Atmosphere, R. L. Bennett, W. M. McClain and W. T. Rainey, Jr., Oak Ridge National Lab.

SURFACE TEMPERATURE MEASUREMENTS

Accuracy and Response of Thermocouples for Surface and Fluid Temperature Measurements, S. J. Green and T. W. Hunt, Bettis Lab.

Measurement of the Surface Temperature of Nuclear Fuel Elements, W. E. Browning, Jr., and H. L. Hemphill, Oak Ridge National Lab.

Thermocouples for Measurement of Transient Surface Temperature, C. E. Moeller, Midwest Research Institute, Kansas.

A Thermocouple for Measurement of Temperature Transients in Forging Dies, C. W. Vigor and J. R. Hornaday, Jr., Research Labs. General Motors.

Gas Temperature Measurements, R. J. Moffat, Research Labs. General Motors.

SPECTROSCOPIC METHODS & PYROMETRY

SPECTROSCOPIC METHODS

Measurements of Electron Density and Temperature in Dense Plasmas by Application of Line Broadening Theory, J. B. Shumaker, and W. L. Wiese, National Bureau of Standards.

Some Equilibrium and Nonequilibrium Characteristics of a Helium Arc, H. J. Kostkowski and A. T. Hattenburg, National Bureau of Standards.

Spectroscopic Diagnostics of a Gerdien Type Plasma Stream Using Argon, W. K. McGregor and M. T. Dooley

Determination of Properties of an Optically Thin Argon Plasma by Spectroscopic Methods, H. N. Olsen, Linde Co.

Use of the Spectral Line Median in Determining Plasma Temperatures, H. Sadjian, General Electric Co.

Some Experimental Aspects of Spectroscopic Gas Temperature Measurements, G. A. Hornbeck and D. E. Erminy, National Bureau of Standards.

Relative Intensity of Spectral Lines, W. E. Hill, General Electric.

Static Temperature Measurement in Gas-Particle Flows, D. J. Carlson, Aeronutronic Inc., Newport Beach, California.

Temperature Measurement on Transient Phenomena, F. Rossler, Institute Franco-Allemand de Recherches de Saint-Louis, France.

Measurement of Transition Probabilities Using a Magnetic Shock Tube, E. A. McLean, U. S. Naval Research Labs.

PHOTOELECTRIC PYROMETRY, GENERAL

Recent Advances in Optical Pyrometry, D. R. Lovejoy, National Bureau of Standards.

Some Radiation Characteristics of Blackbody Sources, K. Franson, S. Katz and E. Raisen, Armour Research Foundation.

High Temperature Spectral Emittance Studies on Some Refractory Metals and Carbides, T. R. Riethof, General Electric.

The NBS Photoelectric Pyrometer, R. D. Lee, National Bureau of Standards.

General Considerations Influencing the Design of a High-Accuracy Pyrometer, G. D. Nutter, Atomics International.

A Precision Photoelectric Optical Pyrometer, J. Middlehurst and T. P. Jones, National Standards Lab.

A Precision Photon Counting Pyrometer, L. H. Treiman, Los Alamos Scientific Lab.

A Completely Transistorized Recording Pyrometer, S. A. Elder, Applied Physics Lab., The Johns Hopkins University.

The Thermopile in Industrial Radiation Pyrometry, E. C. Magison and K. Mellentin, Minneapolis-Honeywell.

PYROMETRY, RADIATING GASES

Spectral Radiometry and Two-Path Pyrometry of Rocket Exhaust Flames, F. S. Simmons and A. G. Debell, Rocketdyne, Canoga Park, California.

A Self-Balancing Line Reversal Pyrometer, D. R. Buchele, Lewis Research Center, National Aeronautics and Space Administration, Cleveland.

Monochromatic Radiation Pyrometry of Hot Gases, Plasmas, and Detonations, R. H. Tourin, Warner and Swasey, New York.

Intercomparison of Several Pyrometers in a High-Temperature Gas Stream, G. E. Glawe, R. C. Johnson, and L. N. Krause, Lewis Research Center, National Aeronautics and Space Administration.

MULTICOLOR PYROMETRY, INCANDESCENT GASES

A Novel Near Infrared, Two-Wavelength Pyrometer, G. J. Hecht, Shell Development Co.

Two-Color Pyrometry, W. E. Hill, General Electric.

A High-Speed Ratio Pyrometer, G. A. Hornbeck, National Bureau of Standards.

Surface Temperature Measurements on Ablating Missile and Satellite Heat Shield Materials, P. L. Hanst, Avco.

Application of Radiation Pyrometry to Glass-Forming Processes, D. A. McGraw and R. G. Mathias.

New Optical Methods for the Determination of Thermodynamic Temperatures of Glowing Metals, C. Tingwaldt, Berlin.

Measurement of Surface Temperatures Above 2000°F, W. E. West, and J. W. Maccalous, Martin Co.

A Self-Calibrating High-Temperature Radiation Standard, H. H. Blau Jr., and W. S. Martin, Arthur D. Little, Inc.

An Infrared Radiation Ratio Pyrometer, B. B. Brenden, Hanford Labs.

Micropyrometry, J. E. Bambara, Servo Corp.

An Industrial Radiation Pyrometer Using a Vacuum Bolometer, R. J. Stevens and A. J. Hornfeck, Bailey Meter Co.

SPECTROSCOPIC METHODS & PYROMETRY

Spectroscopic Methods of Temperature Measurements, S. S. Penner, Guggenheim Jet Propulsion Center.

Theory and Methods of Optical Pyrometry, H. J. Kostkowski and R. D. Lee, National Bureau of Standards.

AUTOMATIC METHODS USING PYROMETRY

A Review of Automatic Radiometric Pyrometry, S. Ackerman, Instrument Development Labs.

Automatic Two-Color Pyrometry, B. F. Bonaker, Shaw Instrument Corp.

Design of an Automatic Two-Color Pyrometer, S. Ackerman, Instrument Development Labs.

Design and Performance Characteristics of an Automatic Brightness Pyrometer, J. S. Lord, Instrument Development Labs.

TEMPERATURE INSTRUMENTATION IN BIOPHYSICS AND MEDICINE

Surface Temperature Measurement with Thermocouples, G. W. Molnar and J. C. Rosenbaum, Jr., U. S. Army Medical Research Labs., Kentucky.

Current Methods of Temperature Telemetry in Physiological Research, F. W. Botsch, Quartermaster Research and Engineering Center, Natick, Massachusetts.

GAS THERMOMETERS

Review of the Pneumatic-Probe Thermometer, I. Warshawsky and P. W. Kuhns, Lewis Research Center, National Aeronautics and Space Administration.

Heat Transfer Devices for Determining the Temperature of Flowing Gases, L. N. Krause, G. E. Glawe and R. C. Johnson, Lewis Research Center, National Aeronautics and Space Administration.

The Gas-Viscosity Thermometer and its Potential Usefulness Below 20°K, H. J. Hoge, Quartermaster Research and Engineering Center, Massachusetts.

Improved Sonic Pyrometer, R. T. Terbush, General Engineering Labs. General Electric.

RESISTANCE THERMOMETERS

Standard Platinum Resistance Thermometry, J. L. Riddle, National Bureau of Standards.

Potentiometric Methods of Resistance Measurement, T. M. Dauphinee, National Bureau of Standards.

An Improved Resistance Thermometer Bridge, J. P. Evans, National Bureau of Standards.

Thermistors for Temperature Measurements, C. R. Droms, General Electric.

Germanium Resistance Thermometers, J. E. Kunzler and T. H. Geballe, Bell Telephone.

Resistance Thermometry in the Liquid Helium Temperature Region, G. Cataland, M. H. Edlow and H. H. Plumb, National Bureau of Standards.

Low-Temperature Measurements with Thermistors, H. B. Sachse, Keystone Carbon Co.

Application of Resistance Thermometers in Calorimetry, G. T. Furukawa, National Bureau of Standards.

Stability of Platinum Resistance Thermometers at Temperatures up to +630°C, R. J. Berry, National Bureau of Standards.

Stability and Reproducibility of High-Temperature Platinum Resistance Thermometers, J. P. Evans and G. W. Burns, National Bureau of Standards.

The History of "Pt 27.", E. Wichers, National Bureau of Standards.

Laboratory Control of Production of Platinum for Thermometry, W. Betteridge, D. W. Rhys and D. F. Withers, Mond Nickel Co. London.

Anomalous Resistance Effects in Small-Diameter Platinum and Platinum-Rhodium Resistance Elements at Temperatures in Excess of 1000°C in a Gaseous Environment, D. Bradley and A. G. Entwistle, University of Leeds.

Recent Developments in Applied Platinum Resistance Thermometry, F. D. Werner, Rosemount Engineering.

Linear Temperature Measurement with Industrial Resistance Thermometers, D. A. Grant and W. F. Hickes, The Foxboro Co.

Calibration Techniques for Precision Platinum Resistance Thermometers, D. Robertson and K. A. Walch, Leeds and Northrup Co.

Precision Resistance Thermometers as Calibration Standards, J. J. Sullivan, U. S. Naval Weapons Plant and F. G. Klock Jr., Bureau of Naval Weapons.

A Facility for Calibration of Platinum Resistance Thermometers, R. B. Smock and O. J. Sewell, U. S. Air Force Standards Calibration and Certification Division.

TEMPERATURE MEASUREMENT IN MOVING SYSTEMS

Heat Flux Probe for Measurement in High-Temperature Gases, L. Fingerson, University of Minnesota.

Rotating Temperature Measurements, C. M. Stanforth, General Electric.

"Morgandyne" Heat-Transfer Transducer and a Flame-Torch Calibration Technique for Hypervelocity Wind Tunnels, C. C. Morgan, and J. C. Andrews, ARO Tenn.

Development of a Resistance Wire Thermometer for Measuring Transient Temperatures in Exhaust Systems of Internal Combustion Engines, R. S. Benson, University of Liverpool and G. W. Brundrett, British Central Electric Generating Board.

High-Temperature Nozzle Flows with Chemical Non-equilibrium , J. G. Hall and A. L. Russo, Cornell Aeronautical Lab.

TEMPERATURE MEASUREMENT IN CRYOGENICS

Liquid Helium Vapor Pressure Methods from 2° to 4°K, G. Cataland, M. H. Edlow and H. H. Plumb, National Bureau of Standards.

Low-Temperature Thermocouples, R. L. Powell, L. P. Caywood, and M. D. Bunch, National Bureau of Standards.

Germanium Thermometers, P. Lindenfeld, Rutgers University.

Suitability of Carbon Resistors for Field Measurements of Temperature in the Range of 35° to 100°R, A. C. Herr, Lewis Research Center, National Aeronautics and Space Administration, Cleveland.

Measurement of Temperature Below 1°K, J. G. Daunt and D. O. Edwards, Ohio State University.

AUTOMATIC METHODS OF TEMPERATURE MEASUREMENT & CONTROL

Systems for Temperature Measurement and Control, E. T. Davis and E. D. Moiles, Leeds & Northrup Co.

Considerations in Designing a Pneumatic Temperature Control System, M. O. Dustin and N. S. Courtright, Bailey Meter Co.

Precision Temperature Control System for Use with Electric Primary Elements, L. H. Gauss, Corning Glass Works and J. A. Dever and H. L. Latham, Jr., Minneapolis-Honeywell Regulator Co.

An Electronic Temperature Controller with Proportional and Reset Action, F. B. Rolfson, Shell Development Co.

Temperature Control and Measurement by a Pneumatic Bridge, J. W. Jensen and P. H. Zabel, Marquardt Corp.

Industrial Applications of Temperature Difference Measurements, R. B. Crawford, Linde Air Products.

TEMPERATURE MEASUREMENT IN ASTROPHYSICS AND GEOPHYSICS

Temperature Measurement from the Optical Continuum, J. B. Zirker, Sacramento Peak Observatory, Sunspot, New Mexico.

Temperature Measurement from Spectral Lines, J. T. Jefferies, National Bureau of Standards, Boulder, Colorado.

Temperature Measurements in the Solar Corona, D. E. Billings, High Altitude Observatory, Boulder, Colorado.

Temperature Measurements in Solar Prominences, F. Q. Orrall, Sacramento Peak Observatory, New Mexico.

Temperature in Meteor Phenomena, A. F. Cook, Harvard College Observatory.

Measurement of Ocean Temperatures, T. M. Dauphinee and H. Preston-Thomas, National Research Council, Ottawa.

Measurement of the Temperature Structure of the Sea, A. L. Nelson, U. S. Navy Electronics Lab.

The Temperature Structure of the Sea and its Variation with Time, E.C. LaFond, U. S. Navy Electronics Lab.

Measurement of Heat Flow in the Ocean Floor, R. Von Herzen, A. E. Maxwell and J. M. Snodgrass, Scripps Institute of Oceanography.

Temperatures in the Continental Crust, S. P. Clark, Jr., Geophysical Lab. Carnegie Institute of D. C.

Temperature Studies in Permafrost, A. H. LachenBruch, M. C. Brewer, G. W. Greene and B. V. Marshall, U. S. Geological Survey.

The Problem of Atmospheric Temperature Measurement, H. D. Parry, U. S. Weather Bureau.

Atmospheric Temperature Measurements by Aerodynamic and Sound Propagation Techniques, J. W. Peterson, University of Michigan.

Concept of Temperature in the Upper Atmosphere, G. W. Sharp, Lockheed, Palo Alto, California.

MISCELLANEOUS METHODS AND PROBLEMS

Temperature Measurement by Infrared Thermal Images, R. W. Astheimer, Barnes Engineering Co.

Recent Developments in Liquid-in-Glass Thermometry, R. D. Thompson, Taylor Instrument Co.

Thin Film Thermometry in Detonation Research, A. J. Laderman, G. J. Hecht and A. K. Oppenheim, University of California.

Heat Flux Probe for Dynamic Measurements in High-Temperature Gases, L. Fingerson and P. L. Blackshear, University of Minnesota.

A Rocket Engine Heat Flux Transducer, J. J. Vrolyk, Rocketdyne, Canoga Park, California.

Instrumentation for Measuring Gas Temperatures of Rocket Engines, W. F. Netusil, Rocketdyne, Canoga Park, California.

Ultrasonic Temperature Determinations in a Plasma, E. H. Carnevale, H. Poss and J. Yos, Avco.

Plasma Jet Diagnosis Utilizing the Ablating Probe, M. P. Freeman, American Cyanamid Co.

Measurement of the Surface Temperature of Ablating Silica, C. Sherman, Avco.

Measurement of the Temperature Distribution in the Workpiece During Metal-Cutting, M. B. Hollander, American Machine and Foundry.

Determination of Gas Temperatures Using Beta-Ray Gauges or Electron Beam Probes, B. W. Schumacher, Ontario Research Foundation, Toronto.

Absolute Measurement of Temperature of Microwave Noise Sources, A. J. Estin, C. L. Trembath, J. S. Wells and W. C. Daywitt, National Bureau of Standards.

Recent Developments in Fusible Temperature Indicators, D. R. Kasanof and E. Kimmel, The Tempil Corp.

Temperature Measurement by Nuclear Quadrupole Resonance, C. Dean, Allied Research Associates, Mass.

Temperature Measurement with Eddy Currents, R. J. Mouly, Corning Glass Works.

Use of Pyroelectric Devices for Measuring Small Temperature Changes, S. B. Lang, University of California.

Thermometric Cells to Calibrate Mercury-in-Glass Thermometers, D. A. Enagonio, National Bureau of Standards.

SPECIAL SOURCES, ARCS, IMAGE FURNACES

High-Temperature Generation and Control by Thermal Imaging Techniques, P. E. Glaser, Arthur D. Little, Inc., and G. P. Ploetz, Air Force Command and Control Development Division.

Ultra-High Frequency Induction Furnace, M. H. Leipold and J. L. Taylor, Propulsion Laboratory, California Institute of Technology.

A Scanning Radiation Sampler for Imaging Furnaces, J. C. Cook, Southwest Research Institute.

Method for Reflectance and Temperature Determinations in an Arc Furnace, D. F. Comstock, Arthur D. Little, Inc.

Method of Calibrating and Controlling the Radiant Energy Output of Imaging Furnaces, G. Carter, Naval Materials Labs.

TEMPERATURE IN PLASMAS OVER 100,000°K

Measurement Techniques in High-Energy Plasmas, H. R. Griem, University of Maryland and U. S. Naval Research Laboratory.

Ion Energy Evaluation from Spectrum Line Contours, P. M. Griffin, G. K. Werner and J. R. McNally, Jr., Oak Ridge National Laboratory.

Availability of Atomic Oscillator Strengths for Application to Studies of High-Temperature Plasmas and Atomic Structure, R. Hefferlin, Southern Missionary College, Oak Ridge National Laboratory, and National Bureau of Standards.

Plasma Electron Temperatures by Spectroscopy in the X-Ray Region, T. F. Stratton, Los Alamos Scientific Lab.

Electron Temperature Measurements Above 100,000°K Using Radiation at the Electron Cyclotron Frequency, W. B. Ard, Jr., University of Florida.

3. APPENDIX

List of DOFL Transducer Reports & Technical Memoranda

(Projects 30330 & 30331)

TR-752, A Transducer Information Program for Ordnance, J. Pearlstein, 1 October 1959 (AD 227969)*

TR-753, Searching the Literature for Transducer Information Part I. A Guide to the Literature, J. Pearlstein, 15 October 1959 (AD 228745)

R-300-60-1, Summary of Telemetry Transducer Symposium Sponsored by the Telemetry Working Group of the Inter-Range Instrumentation Group on 15 and 16 February 1960, J. Pearlstein **

TR-836, Measurement of Displacement, Velocity, and Acceleration: Bibliography with Abstracts and Index, J. Pearlstein, 22 August 1960 (AD 243420)

TR-887, Bibliography of NBS Reports on Performance of Telemetry Transducers and Calibration Methods, J. Pearlstein, 12 October 1960 (AD 248534)

TR-888, Notes on the Relationship of Temperature & Resistance, J. Pearlstein, 1 December 1960 (AD 248392)

TR-898, Searching the Literature for Transducer Information Part II. A Survey of the Field, J. Pearlstein, 1 December 1960 (AD 249131)

TR-727, Chemical Transducers, Proposed Program, R. H. Comyn, 28 May 1959

TR-814, A Guide to Selection and Use of Dynamic Pressure Transducers, A. Hausner, September 1959 (AD 233007)

TR-869, Strong Shock Waves in "Polled" Barium Titanate Ceramic Elements, P. S. Brody, 20 October 1960 (AD 248127)

TR-857, Accelerometer Measurements and Projectile Parameters, H. J. Rosenberg, 17 November 1960 (AD 248339)

TR-917, Dielectric Constant of Barium Titanate at 100-kilobars, P. S. Brody and R. H. Wittekindt, 15 March 1961 (AD 253786)

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TR-922, Shape of the Current Output Pulse from a Thin Ferroelectric Cylinder under Shock Compression, R. H. Wittenkindt, 15 May 1961

TM-61-29, Visit to Redstone Arsenal Regarding DOFL Transducer Program, J. Pearlstein, 31 May 1961 **

TM-61-33, Visit to Springfield Armory Regarding DOFL Ordnance Transducer Program, J. Pearlstein, 24 May 1961 **

Proposal No. P 13-21, Research in Transducers, 7 June 1961

TM-61-34, Visit to Ballistic Research Laboratories Regarding DOFL Transducer Program, 1 June 1961, J. Pearlstein, 18 July 1961**

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