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Publications and Services of the National Bureau of Standards Cryogenics Division Institute for Basic Standards Boulder, Colorado 80302 1953 - 1972

U.S.
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[1] Headquarters and Laboratories at Gaithersburg, Maryland, unless otherwise noted; mailing address Washington, D.C. 20234.
[2] Part of the Center for Radiation Research.
[3] Located at Boulder, Colorado 80302.
[4] Part of the Center for Building Technology.

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Cryogenics Division
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U.S. DEPARTMENT OF COMMERCE, Frederick B. Dent, Secretary
NATIONAL BUREAU OF STANDARDS, Richard W. Roberts, Director

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NATIONAL BUREAU OF STANDARDS
CRYOGENICS DIVISION
INSTITUTE FOR BASIC STANDARDS
Boulder, Colorado 80302

CRYOGENICS DIVISION (275.00)

Determines low temperature properties of solids, fluids, and systems; performs research in cryogenic metrology and fluid transport processes; investigates basic problems and phenomena associated with cryogenic technology; provides consulting service to Government agencies; makes technical information available to the public.

CRYOGENIC TECHNICAL SERVICES SECTION (275.01)

Provides technical services to the Division in support of research programs consisting of engineering design of cryogenic apparatus; fabricates and installs experimental equipment; assists in the operation of experimental test facilities; acquires and maintains supplies and laboratory instruments; operates unique process facilities for research and testing; and procures and distributes liquefied and purified gases.

CRYOGENIC DATA CENTER SECTION (275.02)

Critically evaluates and compiles data on the thermophysical properties of cryogenic fluids, metals, alloys, and dielectrics; operates an automated bibliographic service, including the acquisition, cataloging, coding, storing, and retrieval of pertinent literature; monitors current literature in cryogenics; and furnishes through listings of selected items a current awareness service to the cryogenic community.

CRYOGENIC PROPERTIES OF SOLIDS SECTION (275.03)

Performs basic and applied research on the physical, transport, mechanical, and metallurgical properties of solids, primarily metals. Places special emphasis on the development of accurate and advanced measurement technology, on the generation of standard reference data, and on the development and characterization of standard reference materials.

PROPERTIES OF CRYOGENIC FLUIDS SECTION (275.04)

Measures, computes, and correlates the thermodynamic, electromagnetic, and transport properties of cryogenic fluids throughout a wide range of temperatures and densities; and measures the phase equilibrium properties and excess thermodynamic functions of mixtures of simple dense fluids.

CRYOGENIC SYSTEMS SECTION (275.05)

Measures, analyzes, and correlates the properties of cryogenic systems; investigates basic problems and phenomena associated with cryogenic engineering technology to explain and predict the behavior of cryogenic systems; consults and provides advisory services for other Bureau programs, other Government agencies, and the public; and promotes and establishes cryogenic standard practices.

CRYOGENIC METROLOGY SECTION (275.06)

Investigates fundamental principles of cryogenic measurements; performs research on the basic phenomena that may be applied to cryogenic instruments; studies those properties of materials, matter-matter and matter-energy interactions which could lead to new measurement principles; develops improved cryogenic measurement devices and methodology; evaluates transducers; investigates and recommends application techniques; and consults and provides advisory services for other NBS programs, other Government agencies, and the public.

CRYOELECTRONICS SECTION (275.08)

Investigates the applications of superconductivity and other low temperature phenomena to improve techniques and instruments for making measurements of electrical quantities, including fundamental constants. Demonstrates the feasibility and limitations of radically new instruments. Provides assistance, especially to other NBS divisions, in adapting this new technology to the establishment of standards and measurement science. Performs background research necessary to support these functions.

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Cryogenics Division, Institute for Basic Standards
Boulder, Colorado 80302
1953 - 1972

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This NBS Technical Note catalogs the publications of the Cryogenics Division, along with author and subject indexes, for the period 1953 through 1972. It also contains a listing of available thermodynamic properties charts, bibliographies, and miscellaneous reports of cryogenic interest.

A resume of the activities of and services provided by the Cryogenics Division is also included.

Key words: Author indexes; bibliography; cryogenics; liquefaction; metrology; properties of fluids; properties of solids; subject indexes; superconductivity; transport processes.

Introduction

For a number of years the National Bureau of Standards - Cryogenic Data Center has furnished lists of publications resulting from the work of the NBS-Cryogenics Division. Supplements to these lists have been prepared and sent to persons engaged in cryogenic engineering and research. This Technical Note brings all of this information together in one publication and covers the entire period for which there are publications, 1953 through 1972. A number of indexes, including subject and author, have been included as well as information regarding other services of the Cryogenic Data Center.

Future supplements to this list of publications will be available to anyone asking to be placed on the mailing list. Request for inclusion on the mailing list should be directed to: National Bureau of Standards, Cryogenic Data Center, Boulder, Colorado 80302.

NATIONAL BUREAU OF STANDARDS
CRYOGENICS DIVISION
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List of Publications

NOTICE: Copies of these publications may be obtained as indicated by the superscripts at the end of each item. The superscripts refer to availability and are listed on page 41.

R-1 THE VAPOR PRESSURES OF THE DEUTEROMETHANES, by G. T. Armstrong, F. G. Brickwedde and R. B. Scott. J. Chem. Phys. Vol 21, No. 7, 1297-8 (Jul 1953). (PB172000)[1]

R-2 NBS-AEC CRYOGENIC ENGINEERING LABORATORY. Nat. Bur. Stand. (U. S.), Tech. News Bull. Vol 37, No. 10, 152-8 (Oct 1953). (PB172001)[1]

R-3 LOW-TEMPERATURE LIQUID-LEVEL INDICATOR FOR CONDENSED GASES. Nat. Bur. Stand. (U. S.), Tech. News Bull. Vol 38, No. 1, 3-4 (Jan 1954). (PB172002)[1]

R-4 LIQUID LEVEL INDICATOR FOR CONDENSED GASES AT LOW TEMPERATURES, by W. E. Williams and E. Maxwell. Rev. Sci. Instrum. Vol 25, No. 2, 111-4 (Feb 1954). (PB172003)[1]

R-5 THERMAL CONDUCTIVITY OF METALS AND ALLOYS AT LOW TEMPERATURES, by R. L. Powell and W. A. Blanpied. Nat. Bur. Stand. (U. S.), Circ. No. 556, 68 pages (Sep 1954). (PB172004)[2]

R-6 ADVANCES IN CRYOGENIC ENGINEERING (Proc. 1954 Cryogenic Engineering Conf., Sept. 8-10, Boulder, Colorado; K. D. Timmerhaus, Editor) Vol 1. Plenum Press, New York (1960). (Plenum Press, New York - $25.00)[4]

R-7 A FEW REMARKS ON THE BEGINNINGS OF THE NBS-AEC CRYOGENIC ENGINEERING LABORATORY, by F. G. Brickwedde. Advances in Cryogenic Engineering (Proc. 1954 Cryogenic Engineering Conf.) Vol 1, 1-4. Plenum Press, New York (1960). (PB172005)[1]

R-8 EXPERIMENTAL DEWARS DEVELOPED BY THE NATIONAL BUREAU OF STANDARDS, by B. W. Birmingham, E. H. Brown, C. R. Class and A. F. Schmidt. Paper B-1 in Advances in Cryogenic Engineering (Proc. 1954 Cryogenic Engineering Conf.) Vol 1, 49-61. Plenum Press, New York (1960). (PB172006)[1]

R-9 A RE-LIQUEFYING HYDROGEN REFRIGERATOR, by G. E. McIntosh, D. Mann, J. Macinko and P. C. Vander Arend. Paper B-2 in Advances in Cryogenic Engineering (Proc. 1954 Cryogenic Engineering Conf.) Vol 1, 62-76. Plenum Press, New York (1960). (PB172007)[1]

R-10 JOINING ALUMINUM TO STAINLESS STEEL, by M. C. Smith and D. D. Rabb. Paper B-3 in Advances in Cryogenic Engineering (Proc. 1954 Cryogenic Engineering Conf.) Vol 1, 77-86. Plenum Press, New York (1960). (PB172008)[1]

R-11 THE TRANSFER OF LIQUEFIED GASES, by R. B. Jacobs, R. J. Richards and S. B. Schwartz. Paper B-4 in Advances in Cryogenic Engineering (Proc. 1954 Cryogenic Engineering Conf.) Vol 1, 87-94. Plenum Press, New York (1960). (PB172009)[1]

R-12 A TRANSFER LINE FOR LIQUEFIED GASES, by K. B. Martin and O. E. Park. Paper B-5 in Advances in Cryogenic Engineering (Proc. 1954 Cryogenic Engineering Conf.) Vol 1, 95-104. Plenum Press, New York (1960). (PB172010)[1]

R-13 PERFORMANCE OF AN AIR EXPANSION ENGINE, by J. E. Jensen. Paper B-6 in Advances in Cryogenic Engineering (Proc. 1954 Cryogenic Engineering Conf.) Vol 1, 105-10. Plenum Press, New York (1960). (PB172011)[1]

R-14 A HIGH-VACUUM SEAL-OFF VALVE, by R. J. Richards. (a) Paper B-7 in Advances in Cryogenic Engineering (Proc. 1954 Cryogenic Engineering Conf.) Vol 1, 111-3. Plenum Press, New York (1960). (Out of print). (b) Rev. Sci. Instrum. Vol 25, 520-1 (May 1954). (PB172012)[1]

R-15 CONTINUOUS ANALYSIS OF ORTHO-PARAHYDROGEN MIXTURES, by D. H. Weitzel and R. L. Hershey. Paper C-2 in Advances in Cryogenic Engineering (Proc. 1954 Cryogenic Engineering Conf.) Vol 1, 122-5. Plenum Press, New York (1960). (PB172013)[1]

R-16 A HYDROGEN GAS METER UNIT WITH REMOTE TOTALIZATION OF FLOW, by R. H. Kropschot. Paper C-4 in Advances in Cryogenic Engineering (Proc. 1954 Cryogenic Engineering Conf.) Vol 1, 131-7. Plenum Press, New York (1960). (PB172014)[1]

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R-19 A SENSITIVE ELECTRONIC LIQUID LEVEL INDICATOR FOR CONDENSED GASES, by D. W. Braudway, S. B. Schwartz and J. W. Allen. Paper D-2 in Advances in Cryogenic Engineering (Proc. 1954 Cryogenic Engineering Conf.) Vol 1, 154-5. Plenum Press, New York (1960). (PB172017)[1]

R-20 LOW TEMPERATURE ELECTRICAL RESISTANCE OF FIFTEEN COMMERCIAL CONDUCTORS, by O. E. Park, M. M. Fulk and M. M. Reynolds. Paper D-3 in Advances in Cryogenic Engineering (Proc. 1954 Cryogenic Engineering Conf.) Vol 1, 156-7. Plenum Press, New York (1960). (PB172018)[1]

R-21 CARBON RESISTORS AND VARIABLE DIFFERENTIAL TRANSFORMERS FOR LIQUID LEVEL INDICATION, by S. B. Schwartz and A. E. Wilson. Paper D-4 in Advances in Cryogenic Engineering (Proc. 1954 Cryogenic Engineering Conf.) Vol 1, 158-61. Plenum Press, New York (1960). (PB172019)[1]

R-22 MODIFICATION OF A CALORIMETRIC OXYGEN DETECTOR FOR USE WITH NON-EQUILIBRIUM HYDROGEN, by A. E. Wilson, S. B. Schwartz and R. J. Corruccini. Paper D-6 in Advances in Cryogenic Engineering (Proc. 1954 Cryogenic Engineering Conf.)Vol 1, 164-7. Plenum Press, New York (1960). (PB172020)[1]

R-23 TRACE OXYGEN ANALYSIS FOR LIQUID HYDROGEN PRODUCTION, by E. Catalano. Paper D-8 in Advances in Cryogenic Engineering (Proc. 1954 Cryogenic Engineering Conf.) Vol 1, 169-70. Plenum Press, New York (1960). (PB172021)[1]

R-24 VACUUM POWDER INSULATION, by M. M. Reynolds, J. D. Brown, M. M. Fulk, O. E. Park and G. W. Curtis. Paper F-2 in Advances in Cryogenic Engineering (Proc. 1954 Cryogenic Engineering Conf.) Vol 1, 216-23. Plenum Press, New York (1960). (PB172022)[1]

R-25 THERMAL RADIATION ABSORPTION BY METALS, by M. M. Fulk, M. M. Reynolds and O. E. Park. Paper F-3 in Advances in Cryogenic Engineering (Proc. 1954 Cryogenic Engineering Conf.) Vol 1, 224-9. Plenum Press, New York (1960). (PB172023)[1]

R-26 THE MECHANICAL PROPERTIES TESTING PROGRAM AT THE NBS-AEC CRYOGENIC ENGINEERING LABORATORY, by R. H. Kropschot. Paper G-1 in Advances in Cryogenic Engineering (Proc. 1954 Cryogenic Engineering Conf.) Vol 1, 235-41. Plenum Press, New York (1960). (PB172024)[1]

R-27 THERMAL CONDUCTIVITY OF SOLIDS AT LOW TEMPERATURES, by R. L. Powell and D. O. Coffin. Paper G-5 in Advances in Cryogenic Engineering (Proc. 1954 Cryogenic Engineering Conf.) Vol 1, 262-6. Plenum Press, New York (1960). (PB172025)[1]

R-28 ORTHO-PARAHYDROGEN CONVERSION STUDIES, by P. L. Barrick, D. H. Weitzel and T. W. Connolly. Paper H-4 in Advances in Cryogenic Engineering (Proc. 1954 Cryogenic Engineering Conf.) Vol 1, 285-90. Plenum Press, New York (1960). (PB172026)[1]

R-29 VIBRATION TESTING OF AIRBORNE CRYOGENIC EQUIPMENT, by P. R. Weaver, W. E. Smull and E. H. Brown. Paper H-6 in Advances in Cryogenic Engineering (Proc. 1954 Cryogenic Engineering Conf.) Vol 1, 296-301. Plenum Press, New York (1960). (PB172027)[1]

R-30 PERFORMANCE OF NBS HYDROGEN LIQUEFIER PLANT, by V. J. Johnson and W. A. Wilson. Paper J-4 in Advances in Cryogenic Engineering (Proc. 1954 Cryogenic Engineering Conf.) Vol 1, 329-35. Plenum Press, New York (1960). (PB172028)[1]

R-31 CONTINUOUS ANALYSIS OF ORTHOPARAHYDROGEN MIXTURES, by D. H. Weitzel and L. E. White. Rev. Sci. Instrum. Vol 26, No. 3, 290-2 (Mar 1955). (PB172029)[1]

R-32 LOW-TEMPERATURE THERMAL CONDUCTIVITY OF A FREE-MACHINING COPPER, by R. L. Powell and D. O. Coffin. Rev. Sci. Instrum. Vol 26, No. 5, 516 (May 1955). (PB172030)[1]

R-33 VALVE FOR COLD FLUIDS, by R. J. Richards and R. B. Jacobs. Rev. Sci. Instrum. Vol 26, No. 7, 730 (Jul 1955). (PB172031)[1]

R-34 VAPOR PRESSURES OF THE METHANES, by G. T. Armstrong, F. G. Brickwedde and R. B. Scott. J. Res. Nat. Bur. Stand. (U.S.), Vol 55, No. 1, 39-52 (Jul 1955). (PB172032)[1]

R-35 ACTIVITIES OF THE NATIONAL BUREAU OF STANDARDS CRYOGENIC ENGINEERING LABORATORY, by R. B. Scott. In Conference de Physique des Basses Temperatures (Paris, France, Sept. 2-8, 1955) Communication, 368-71. (PB172033)[1]

R-36 SOME ASPECTS OF THE LARGE SCALE LIQUEFACTION OF HYDROGEN, by B. W. Birmingham. Paper 55-2-1 in Proc. Instrum. Soc. Amer. Vol 10, pt. 2, 1-4 (Sep 12-16, 1955). (PB172034)[1]

R-37 LOW TEMPERATURE SCALES FROM 90° to 5° K, by R. B. Scott. In Temperature, Its Measurement and Control in Science and Industry Vol 2, 179-84. Reinhold-Van Nostrand, New York (1955). (PB172035)[1]

R-38 IRON CATALYST FOR PRODUCTION OF LIQUID PARA-HYDROGEN, by D. H. Weitzel and O. E. Park. Rev. Sci. Instrum. Vol 27, No. 1, 57-8 (Jan 1956). (PB172036)[1]

R-39 CRYOGENIC ENGINEERING CONFERENCE. Nat. Bur. Stand. (U. S.), Tech. News Bull. Vol 40, No. 11, 165-6 (Nov 1956). (PB172037)[1]

R-40 HEAT CONDUCTION THROUGH INSULATING SUPPORTS IN VERY LOW TEMPERATURE EQUIPMENT, by R. P. Mikesell and R. B. Scott. J. Res. Nat. Bur. Stand. (U. S.), Vol 57, No. 6, 371-8 (Dec 1956). (PB172038)[1]

R-41 ADVANCES IN CRYOGENIC ENGINEERING (Proc. 1956 Cryogenic Engineering Conf., Sept. 5-7, Boulder, Colorado; K. D. Timmerhaus, Editor) Vol 2. Plenum Press, New York (1960). (Plenum Press, New York - $25.00)[4]

R-42 CATALYSIS OF THE ORTHO-PARAHYDROGEN CONVERSION, by D. H. Weitzel, J. W. Draper, O. E. Park, K. D. Timmerhaus and C. C. Van Valin. Paper A-3 in Advances in Cryogenic Engineering (Proc. 1956 Cryogenic Engineering Conf.) Vol 2, 12-8. Plenum Press, New York (1960). (PB172039)[1]

R-43 A NEW ARRANGEMENT FOR ORTHO-PARA CONVERSION OF LIQUID HYDROGEN IN THE LARGE CEL-NBS LIQUEFIER, by V. J. Johnson. Paper A-4 in Advances in Cryogenic Engineering (Proc. 1956 Cryogenic Engineering Conf.) Vol 2, 19-26. Plenum Press, New York (1960). (PB172040)[1]

R-44 DISTILLATION OF HYDROGEN-DEUTERIUM MIXTURES, by T. M. Flynn, D. H. Weitzel, K. D. Timmerhaus, P. C. Vander Arend and J. W. Draper. Paper A-6 in Advances in Cryogenic Engineering (Proc. 1956 Cryogenic Engineering Conf.) Vol 2, 39-44. Plenum Press, New York (1960). (PB172041)[1]

R-45 BREATHING OXYGEN STORAGE DEWARS, by W. A. Wilson. Paper B-1 in Advances in Cryogenic Engineering (Proc. 1956 Cryogenic Engineering Conf.) Vol 2, 54-8. Plenum Press, New York (1960). (PB172042)[1]

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R-48 CHARACTERISTICS OF SOME INSULATIONS FOR LIQUID OXYGEN TRANSFER LINES, by D. A. Van Gundy and R. B. Jacobs. Paper E-1 in Advances in Cryogenic Engineering (Proc. 1956 Cryogenic Engineering Conf.) Vol 2, 156-62. Plenum Press, New York (1960). (PB172045)[1]

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R-52 PERFORMANCE OF PUMPS WITH LIQUEFIED GASES, by K. B. Martin, R. B. Jacobs and R. J. Hardy. Paper G-6 in Advances in Cryogenic Engineering (Proc. 1956 Cryogenic Engineering Conf.) Vol 2, 295-302. Plenum Press, New York (1960). (PB172049)[1]

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R-54 A LARGE LIQUID HYDROGEN BUBBLE CHAMBER, by D. B. Chelton, D. B. Mann and R. A. Byrns. Paper H-2 in Advances in Cryogenic Engineering (Proc. 1956 Cryogenic Engineering Conf.) Vol 2, 325-9. Plenum Press, New York (1960). (PB172051)[1]

R-55 VACUUM-INSULATED TRANSFER TUBE, by R. B. Jacobs and R. J. Richards. Rev. Sci. Instrum. Vol 28, No. 4, 291-2 (Apr 1957). (PB172052)[1]

R-56 STRENGTH AND FATIGUE OF GLASS AT VERY LOW TEMPERATURES, by R. H. Kropschot and R. P. Mikesell. J. Appl. Phys. Vol 28, No. 5, 610-4 (May 1957). (PB172053)[1]

R-57 VESSELS FOR STORAGE AND TRANSPORT OF LIQUID HYDROGEN, by B. W. Birmingham, E. H. Brown, C. R. Class and A. F. Schmidt. J. Res. Nat. Bur. Stand. (U.S.), Vol 58, No. 5, 243-53 (May 1957). (PB172054)[1]

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R-63 HYDROGEN LIQUEFACTION BY A DUAL PRESSURE PROCESS, by D. B. Chelton, J. Macinko and J. Dean. Refrig. Eng. Vol 65, No. 8, 39-41 (Aug 1957). (PB172060)[1]

R-64 PROPERTIES OF MATERIALS AT LOW TEMPERATURES, by R. J. Corruccini. Chem. Engr. Progr. Vol 53, Part 1, 262-7; Part 2, 342-6; Part 3, 397-402 (Jun, Jul, Aug 1957). (PB172061)[1]

R-65 LARGE BUBBLE CHAMBER. Nat. Bur. Stand. (U.S.), Tech. News Bull. Vol 41, No. 9, 129-30 (Sep 1957). (PB172062)[1]

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R-69 1957 CRYOGENIC ENGINEERING CONFERENCE, Nat. Bur. Stand. (U.S.), Tech. News Bull. Vol 41, No. 11, 177-8 (Nov 1957). (PB172066)[1]

R-70 EMISSIVITIES OF METALLIC SURFACES AT 76°K, by M. M. Fulk and M. M. Reynolds. J. Appl. Phys. Vol 28, No. 12, 1464-7 (Dec 1957). (PB172067)[1]

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R-72 ON THE MOST GENERAL FORM OF THE COMPATIBILITY EQUATIONS AND THE CONDITIONS OF INTEGRABILITY OF STRAIN RATE AND STRAIN, by E. H. Brown. J. Res. Nat. Bur. Stand. (U.S.) Vol 59, No. 6, 421-6 (Dec 1957). (PB172069)[1]

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MR-14c ELASTOMERIC SEALS AND MATERIALS AT CRYOGENIC TEMPERATURES, by D. H. Weitzel, R. F. Robbins and P. R. Ludtke. Wright Air Development Center, Wright-Patterson AFB, Materials Lab., Rept. No. ML-TDR-64-50, Part II (Prepared at National Bureau of Standards, Boulder, Colo., Cryogenics Div., under USAF Delivery Order No. 33(615)64-1002), 100 pages (Mar 1965). Also National Bureau of Standards, Boulder, Colo., Cryogenics Div., Rept. -Unpublished. ($3.00)[6]

MR-15 CALCULATION OF THE VAPOR PRESSURE AND HEATS OF VAPORIZATION AND SUBLIMATION OF LIQUIDS AND SOLIDS, ESPECIALLY BELOW ONE ATMOSPHERE. IV. NITROGEN AND FLUORINE, by W. T. Ziegler and J. C. Mullins. Georgia Inst. of Tech., Atlanta, Engineering Experiment Station, Tech. Rept. No. 1 (Prepared under NBS Contr. No. CST-7404), 59 pages (Apr 1963). (PB168896)[2]

MR-16 CALCULATION OF THE VAPOR PRESSURE AND HEATS OF VAPORIZATION AND SUBLIMATION OF LIQUIDS AND SOLIDS, ESPECIALLY BELOW ONE ATMOSPHERE. V. CARBON MONOXIDE AND CARBON DIOXIDE, by J. C. Mullins, B. S. Kirk and W. T. Ziegler. Georgia Inst. of Tech., Atlanta, Engineering Experiment Station, Tech. Rept. No. 2 (Prepared under NBS Contr. No. CST-7404), 81 pages (Aug 1963). (PB172349)[2]

MR-17 CALCULATION OF THE VAPOR PRESSURE AND HEATS OF VAPORIZATION AND SUBLIMATION OF LIQUIDS AND SOLIDS, BELOW ONE ATMOSPHERE PRESSURE. VI. KRYPTON, by W. T. Ziegler, D. W. Yarbrough and J. C. Mullins. Georgia Inst. of Tech., Atlanta, Engineering Experiment Station, Tech. Rept. No. 1 (Prepared under NBS Contr. No. CST-1154), 44 pages (Jul 1964). (PB172350)[2]

MR-18 TABLES OF THERMAL PROPERTIES OF GASES, by J. Hilsenrath, C. W. Beckett, W. S. Benedict, L. Fano, et al. Nat. Bur. Stand. (U.S.), Circ. No. 564, 488 pages (Nov 1955). (Microfiche - $4.50)[6] (Pergamon Press, London and New York - $20.00)[4]

MR-19 ON THE FORMULATION AND NUMERICAL EVALUATION OF A SET OF TWO-PHASE FLOW EQUATIONS MODELLING THE COOLDOWN PROCESS, by S. Jarvis, Jr. Nat. Bur. Stand. (U.S.), Tech. Note No. 301, 48 pages (Jan 1965). (C13.46:301 - 55¢)[3]

MR-20 CALCULATION OF THE VAPOR PRESSURE AND HEATS OF VAPORIZATION AND SUBLIMATION OF LIQUIDS AND SOLIDS BELOW ONE ATMOSPHERE PRESSURE. VII. ETHANE, by W. T. Ziegler, B. S. Kirk, J. C. Mullins and A. R. Berquist. Georgia Inst. of Tech., Atlanta, Engineering Experiment Station, Tech. Rept. No. 2 (Prepared under NBS Contr. No. CST--1154), 65 pages (Dec 1964). (PB172351)[2]

MR-21 STABILITY OF TWO-PHASE ANNULAR FLOW IN A VERTICAL PIPE, by S. Jarvis, Jr. Nat. Bur. Stand. (U.S.), Tech. Note No. 314, 92 pages (Jun 1965). (C13.46:314 - 55¢)[2]

MR-22 THE THERMODYNAMIC PROPERTIES OF OXYGEN, by R. B. Stewart. Iowa Univ., Iowa City, Ph.D. Dissertation, 209 pages (Jun 1966). ($5.00)[6]

MR-23 CALCULATION OF THE VAPOR PRESSURE AND HEATS OF VAPORIZATION AND SUBLIMATION OF LIQUIDS AND SOLIDS BELOW ONE ATMOSPHERE PRESSURE. VIII. XENON, by W. T. Ziegler, J. C. Mullins and A. R. Berquist. Georgia Inst. of Tech., Atlanta, Engineering Experiment Station, Tech. Rept. No. 3 (Prepared under NBS Contr. No. CST-1154), 49 pages (Apr 1966). (PB173797)[2]

MR-23a THE SYSTEM HELIUM-ARGON FROM 65 TO 140 K UP TO PRESSURES OF 120 ATM. CORRELATION OF AVAILABLE PHASE EQUILIBRIUM DATA, by J. C. Mullins and W. T. Ziegler. Georgia Inst. of Tech., Atlanta, Engineering Experiment Station, Tech. Rept. No. 3 (Prepared under NBS Contr. No. CST-1154), 69 pages (Jan 1965). (Request from Georgia Institute of Technology, Engineering Experiment Station, Atlanta, Ga.)[4]

MR-24 THERMODYNAMIC PROPERTIES OF ARGON IN THE LIQUID AND GASEOUS STATE FOR TEMPERATURES FROM THE TRIPLE POINT TO 300°K WITH PRESSURES TO 1000 ATMOSPHERES, by A. L. Gosman. Iowa State Univ., Ames, Ph. D. Dissertation, 238 pages (Aug 1965). (Available from University Microfilms, Ann Arbor, Michigan, Order No. 66-3434 - Xerography $10.80; Microfilm $3.10)

MR-25 TWO-PHASE, TWO-COMPONENT CRITICAL FLOW IN A VENTURI, by R. V. Smith. Oxford Univ., England, Ph. D. Dissertation, 235 pages (Jun 1968). ($4.00)[6]

MR-26 CALCULATION OF THE VAPOR PRESSURE AND HEATS OF VAPORIZATION AND SUBLIMATION OF LIQUIDS AND SOLIDS BELOW ONE ATMOSPHERE PRESSURE. IX. NEON, by W. T. Ziegler, G. N. Brown and J. D. Garber. Georgia Inst. of Tech., Atlanta, Engineering Experiment Station, Tech. Rept. No. 1 (Prepared under NBS Contr. No. CST-7973), 64 pages (May 1970). ($2.50)[6]

MR-27 SPECTRAL RADIATIVE PROPERTIES OF TRANSITION METALS AT LIQUID HELIUM TEMPERATURES, by M. C. Jones. California Univ., Berkeley, Ph. D. Dissertation, 106 pages (Dec 1970). ($4.00)[6]

MR-28 TECHNICAL MANUAL OF OXYGEN/NITROGEN CRYOGENIC SYSTEMS. Naval Air Systems Command, Washington, D. C., Rept. No. NAVAIR 06-3-501, 427 pages (Mar 1971). (No charge for single copy)[6]

Thermodynamic Properties Charts

Single copies of the following charts are available from National Bureau of Standards, Cryogenic Data Center, Boulder, Colorado 80302, at no charge. Additional copies of charts D-1 through D-57 may be purchased from National Technical Information Service, Springfield, Virginia 22151 (Order by PB No. --price $1.00 each regardless of size). Charts D-58 through D-67 are available from NBS Cryogenic Data Center only (request by D No.).

D-1 TEMPERATURE-ENTROPY DIAGRAM OF HELIUM (1 to 40°K; .001 to 100 atm.). Leiden Univ., Netherlands, Kamerlingh Onnes Lab. (1941). PB172352-1 - 8 1/2" x 11" size; PB172352-3 - 17" x 22" size.

D-2 TEMPERATURE-ENTROPY DIAGRAM OF HELIUM (20 to 500°K; .03 to 300 atm.). Leiden Univ., Netherlands, Kamerlingh Onnes Lab. (1941). PB172353-1 - 8 1/2" x 11" size; PB172353-3 - 17" x 22" size.

D-3 TEMPERATURE-ENTROPY DIAGRAM OF HELIUM (20 to 300°K; 0.1 to 100 atm.). National Bureau of Standards, Boulder, Colo., Cryogenics Div. (1961). From: Nat. Bur. Stand. (U.S.), Res. Pap. 1932 (1948). PB172354-1 - 8 1/2" x 11" size; PB172354-3 - 17" x 22" size.

D-4 TEMPERATURE-ENTROPY DIAGRAM OF NORMAL HYDROGEN (0 to 150°K; 0.6 to 300 atm.). National Bureau of Standards, Boulder, Colo., Cryogenics Div. (1960). From: Nat. Bur. Stand. (U.S.), Res. Pap. 1932 (1948). PB172355-1 - 8 1/2" x 11" size; PB172355-3 - 17" x 22" size.

D-5 TEMPERATURE-ENTROPY DIAGRAM OF NORMAL HYDROGEN (130 to 300°K; 0.8 to 600 atm.). National Bureau of Standards, Boulder, Colo., Cryogenics Div. (1960). From: Nat. Bur. Stand. (U.S.), Res. Pap. 1932 (1948). PB172356-1 - 8 1/2" x 11" size; PB172356-3 - 17" x 22" size.

D-6 TEMPERATURE-ENTROPY DIAGRAM OF NEON (55 to 300°K, 0.5 to 90 atm.). National Bureau of Standards, Boulder, Colo., Cryogenics Div. From: A Compendium of the Properties of Materials at Low Temperature - Phase II. R. B. Stewart and V. J. Johnson (General Editors). Wright Air Development Div., Wright-Patterson AFB, Ohio, Tech. Rept. No. WADD 60-56 (1961). PB172357-1 - 8 1/2" x 11" size: PB172357-3 - 17" x 22" size.

D-7 TEMPERATURE-ENTROPY DIAGRAM OF NITROGEN (50 to 450°K; 0.1 to 1200 atm.) Bureau of Mines, Amarillo, Tex. From: Chart by E. S. Burnett (1949). PB172358-1 - 8 1/2" x 11" size; PB172358-3 - 17" x 22" size.

D-8 TEMPERATURE-ENTROPY DIAGRAM OF AIR (70 to 350°K; 1 to 1100 atm.). National Bureau of Standards, Boulder, Colo., Cryogenics Div. (1961). Based on data from Michels, et al., and Claitor, et al. (1954). PB172359-1 - 8 1/2" x 11" size; PB172359-3 - 17" x 22" size.

D-9 PRESSURE-ENTHALPY DIAGRAM OF OXYGEN (100 to 300°K; 1 to 70 atm.). Bureau of Mines (1928). PB172360-1 - 8 1/2" x 11" size.

D-10 PRESSURE-ENTHALPY DIAGRAM OF OXYGEN (-200 to +200°C; 0.10 to 300 atm.). Leiden Univ., Netherlands, Kamerlingh Onnes Lab. (1942). PB172361-1 - 8 1/2" x 11" size; PB172361-3 - 17" x 22" size.

D-11 PRESSURE-ENTHALPY DIAGRAM OF AIR (90 to 315°K; 1 to 250 atm.). From: Air Products Chart, based on Lundstrom's Data. PB172362-1 - 8 1/2" x 11" size; PB172362-3 - 17" x 22" size.

D-12 PRESSURE-ENTHALPY DIAGRAM OF CARBON MONOXIDE (-200 to +200°C; 0.15 to 300 atm.). Leiden Univ., Netherlands, Kamerlingh Onnes Lab. (1942). PB172363-1 - 8 1/2" x 11" size; PB172363-3 - 17" x 22" size.

D-13 COMPRESSIBILITY FACTOR CHART FOR HELIUM; Z vs P (20 to 300°K; 1 to 100 atm.). National Bureau of Standards, Boulder, Colo., Cryogenics Div. From: A Compendium of the Properties of Materials at Low Temperature - Phase II. R. B. Stewart and V. J. Johnson (General Editors). Wright Air Development Div., Wright-Patterson AFB, Ohio, Tech. Rept. No. WADD 60-56 (1961). PB172364-1 - 8 1/2" x 11" size; PB172364-3 - 17" x 22" size.

D-14 COMPRESSIBILITY FACTOR CHART FOR NORMAL HYDROGEN; Z vs P (16 to 300°K; .08 to 800 atm.). National Bureau of Standards, Boulder, Colo., Cryogenics Div. From: A Compendium of the Properties of Materials at Low Temperature - Phase II. R. B. Stewart and V. J. Johnson (General Editors). Wright Air Development Div., Wright-Patterson AFB, Ohio, Tech. Rept. No. WADD 60-56 (1961). PB172365-1 - 8 1/2" x 11" size; PB172365-3 - 17" x 22" size.

D-15 COMPRESSIBILITY FACTOR CHART FOR NEON; Z vs P (55 to 300°K; 20 to 90 atm.). National Bureau of Standards, Boulder, Colo., Cryogenics Div. From: A Compendium of the Properties of Materials at Low Temperature - Phase II. R. B. Stewart and V. J. Johnson (General Editors). Wright Air Development Div., Wright-Patterson AFB, Ohio, Tech. Rept. No. WADD 60-56 (1961). PB172366-1 - 8 1/2" x 11" size; PB172366-3 - 17" x 22" size.

D-16 COMPRESSIBILITY FACTOR CHART FOR NITROGEN; Z vs P (90 to 300°K; 1 to 500 atm.). National Bureau of Standards, Boulder, Colo., Cryogenics Div. From: A Compendium of the Properties of Materials at Low Temperature - Phase II. R. B. Stewart and V. J. Johnson (General Editors). Wright Air Development Div., Wright-Patterson AFB, Ohio, Tech. Rept. No. WADD 60-56 (1961). PB172367-1 - 8 1/2" x 11" size; PB172367-3 - 17" x 22" size.

D-17 COMPRESSIBILITY FACTOR CHART FOR NITROGEN; Z vs P (90 to 300°K; 300 to 3000 atm.). National Bureau of Standards, Boulder, Colo., Cryogenics Div. From: A Compendium of the Properties of Materials at Low Temperature - Phase II. R. B. Stewart and V. J. Johnson (General Editors). Wright Air Development Div., Wright-Patterson AFB, Ohio, Tech. Rept. No. WADD 60-56 (1961). PB172368-1 - 8 1/2" x 11"; PB172368-3 - 17" x 22" size.

D-18A COMPRESSIBILITY FACTOR CHART FOR AIR; Z vs P (90 to 300°K; 0.1 to 600 atm.). National Bureau of Standards, Boulder, Colo., Cryogenics Div. From: A Compendium of the Properties of Materials at Low Temperature - Phase II. R. B. Stewart and V. J. Johnson (General Editors). Wright Air Development Div., Wright-Patterson AFB, Ohio, Tech. Rept. No. WADD 60-56 (1961). PB172369-1 - 8 1/2" x 11" size; PB172369-3 - 17" x 22" size.

D-18B COMPRESSIBILITY FACTOR CHART FOR AIR; Z vs T (75 to 300°K; 1 to 1000 atm.). National Bureau of Standards, Boulder, Colo., Cryogenics Div. From: A Compendium of the Properties of Materials at Low Temperature - Phase II. R. B. Stewart and V. J. Johnson (General Editors). Wright Air Development Div., Wright-Patterson AFB, Ohio, Tech. Rept. No. WADD 60-56 (1961). PB172370-1 - 8 1/2" x 11" size; PB172370-3 - 17" x 22" size.

D-19 COMPRESSIBILITY FACTOR CHART FOR METHANE; Z vs P (122 to 273°K; 1 to 600 atm.). National Bureau of Standards, Boulder, Colo., Cryogenics Div. From: A Compendium of the Properties of Materials at Low Temperature - Phase II. R. B. Stewart and V. J. Johnson (General Editors). Wright Air Development Div., Wright-Patterson AFB, Ohio, Tech. Rept. No. WADD 60-56 (1961). PB172371-1 - 8 1/2" x 11" size; PB172371-3 - 17" x 22" size.

D-20 TEMPERATURE-ENTROPY CHART FOR PARAHYDROGEN (14 to 100°K; 0.1 to 340 atm.). National Bureau of Standards, Boulder, Colo., Cryogenics Div. From: Nat. Bur. Stand. (U.S.), Monogr. No. 94 (1965). PB172372-1 - 8 1/2" x 11" size; PB172372-3 - 17" x 22" size.

D-20A INTERIM TEMPERATURE-ENTROPY CHART FOR PARAHYDROGEN (In Metric Units; 20 to 100°K; 1 to 340 atm.). National Bureau of Standards, Boulder, Colo., Cryogenics Div. From: Nat. Bur. Stand. (U.S.), Tech. Note No. 130 (1961). PB172373-1 - 8 1/2" x 11" size; PB172373-2 - 11" x 17" size; PB172373-3 - 17" x 22" size.

D-20B INTERIM TEMPERATURE-ENTROPY CHART FOR PARAHYDROGEN (In British Units; 30 to 180°R; 10 to 5000 psia). National Bureau of Standards, Boulder, Colo., Cryogenics Div. From: Nat. Bur. Stand. (U.S.), Tech. Note No. 130 (1961). PB172374-1 - 8 1/2" x 11" size; PB172374-2 - 11" x 17" size; PB172374-3 - 17" x 22" size.

D-21A INTERIM TEMPERATURE-ENTROPY CHART FOR PARAHYDROGEN (In Metric Units; 80 to 300°K; 1 to 100 atm.). National Bureau of Standards, Boulder, Colo., Cryogenics Div. From: Nat. Bur. Stand. (U.S.), Tech. Note No. 130 (1961). PB172375-1 - 8 1/2" x 11" size; PB172375-2 - 11" x 17" size; PB172375-3 - 17" x 22" size.

D-21B INTERIM TEMPERATURE-ENTROPY CHART FOR PARAHYDROGEN (In British Units; 140 to 540°R; 10 to 1500 psia.). National Bureau of Standards, Boulder, Colo., Cryogenics Div. From: Nat. Bur. Stand. (U.S.), Tech. Note No. 130 (1961). PB172376-1 - 8 1/2" x 11" size; PB172376-2 - 11" x 17" size; PB172376-3 - 17" x 22" size.

D-22 ENTHALPY-ENTROPY CHART FOR PARAHYDROGEN (16 to 64°K; 0.3 to 340 atm.). National Bureau of Standards, Boulder, Colo., Cryogenics Div. From: Nat. Bur. Stand. (U.S.), Monogr. No. 94 (1965). PB172377-1 - 8 1/2" x 11" size; PB172377-3 - 17" x 22" size.

D-22A INTERIM ENTHALPY-ENTROPY CHART FOR PARAHYDROGEN (In Metric Units; 20 to 60°K; 1 to 340 atm.). National Bureau of Standards, Boulder, Colo., Cryogenics Div. From: Nat. Bur. Stand. (U.S.), Tech. Note No. 130 (1961). PB172378-1 - 8 1/2" x 11" size; PB172378-2 - 11" x 17" size; PB172378-3 - 17" x 22" size.

D-22B INTERIM ENTHALPY-ENTROPY CHART FOR PARAHYDROGEN (In British Units; 36 to 100°R; 10 to 5000 psia.). National Bureau of Standards, Boulder, Colo., Cryogenics Div. From: Nat. Bur. Stand. (U.S.), Tech. Note No. 130 (1961). PB172379-1 - 8 1/2" x 11" size; PB172379-2 - 11" x 17" size; PB172379-3 - 17" x 22" size.

D-23 TEMPERATURE-ENTROPY DIAGRAM FOR NITROGEN (65 to 300°K; 0.1 to 200 atm.). National Bureau of Standards, Boulder, Colo., Cryogenics Div. From: Nat. Bur. Stand. (U.S.), Tech. Note No. 129 (1962). PB172380-1 - 8 1/2" x 11" size; PB172380-3 - 17" x 22" size.

D-24 TEMPERATURE-ENTROPY DIAGRAM FOR HELIUM (0 to 50°K; 0.5 to 150 atm.). National Bureau of Standards, Boulder, Colo., Cryogenics Div. (1957). From: J. Zelmanov, W. H. Keesom and E. H. Brown Data (1940, 1944, 1958). PB172381-1 - 8 1/2" x 11" size.

D-25 TEMPERATURE-ENTROPY DIAGRAM FOR HELIUM (50 to 100°K; 0.5 to 200 atm.). National Bureau of Standards, Boulder, Colo., Cryogenics Div. (1957). From: W. H. Keesom Data (1940). PB172382-1 - 8 1/2" x 11" size.

D-26 TEMPERATURE-ENTROPY DIAGRAM FOR HELIUM (100 to 200°K; 0.5 to 200 atm.). National Bureau of Standards, Boulder, Colo., Cryogenics Div. (1957). From: W. H. Keesom Data (1940). PB172383-1 - 8 1/2" x 11" size.

D-27 TEMPERATURE-ENTROPY DIAGRAM FOR HELIUM (200 to 400° K; 0.5 to 200 atm.). National Bureau of Standards, Boulder, Colo., Cryogenics Div. (1957). From: W. H. Keesom Data (1940). PB172384-1 - 8 1/2" x 11" size.

D-28 TEMPERATURE-ENTROPY DIAGRAM FOR HYDROGEN (280 to 600°K; 1 to 1200 atm.). National Bureau of Standards, Boulder, Colo., Cryogenics Div. (1960). From: Nat. Bur. Stand. (U.S.), Res. Pap. 1932 (1948). PB172385-1 - 8 1/2" x 11" size; PB172385-2 - 11" x 17" size.

D-42 PRESSURE-ENTHALPY DIAGRAM OF ETHYLENE (-150 to +200°C; .02 to 300 atm.). Leiden Univ., Netherlands, Kamerlingh Onnes Lab. (1941). PB172386-1 - 8 1/2" x 11" size; PB172386-3 - 17" x 22" size.

D-43 PRESSURE-ENTHALPY DIAGRAM OF METHANE (90 to 480°K; 1 to 300 atm.). Leiden Univ., Netherlands, Kamerlingh Onnes Lab. (1940). PB172387-1 - 8 1/2" x 11" size; PB172387-3 - 17" x 22" size.

D-44 COMPRESSIBILITY FACTOR CHART FOR NEON; Z vs P (30 to 300°K; 1 to 200 atm.). National Bureau of Standards, Boulder, Colo., Cryogenics Div. (1962). From: "P-ρ-T Values for Neon from 27° to 300°K for Pressures to 200 Atmospheres Using Corresponding States Theory," by R. D. McCarty, R. B. Stewart and K. D. Timmerhaus. Advances in Cryogenic Engineering, Vol 8, Plenum Press, New York (1963). PB172388-1 - 8 1/2" x 11" size; PB172388-3 - 17" x 22" size.

D-45 INTERIM TEMPERATURE-ENTROPY CHART FOR LIQUID OXYGEN (54 to 100°K; saturated liquid to 200 atm.). National Bureau of Standards, Boulder, Colo., Cryogenics Div. (1963). An extension of the chart contained in The Thermodynamic Properties of Oxygen From 20° to 100°K, by J. C. Mullins, W. T. Ziegler and B. S. Kirk. Georgia Inst. of Tech., Atlanta, Engineering Experiment Station, Tech. Rept. No. 2 (Prepared under NBS Contr. No. CST-7339) (Mar 1962). PB172389-1 - 8 1/2" x 11" size; PB172389-2 - 11" x 17" size.

D-46 TEMPERATURE-ENTROPY DIAGRAM FOR OXYGEN (30 to 100°K; 10^{-6} to 1750 mm Hg.). Reprinted from: The Thermodynamic Properties of Oxygen From 20° to 100°K, by J. C. Mullins, W. T. Ziegler, and B. S. Kirk. Georgia Inst. of Tech., Atlanta, Engineering Experiment Station, Tech. Rept. No. 2 (Prepared under NBS Contr. No. CST-7339) (Mar 1962). PB172390-3 - 17" x 22" size.

D-47 TEMPERATURE-ENTROPY DIAGRAM FOR PARAHYDROGEN (4 to 22°K; 10^{-6} to 1000 mm Hg.). Reprinted from: The Thermodynamic Properties of Parahydrogen from 1° to 22°K, by J. C. Mullins, W. T. Ziegler and B. S. Kirk. Georgia Inst. of Tech., Atlanta, Engineering Experiment Station, Tech. Rept. No. 1 (Prepared under NBS Contr. No. CST-7339) (Nov 1961). PB172391-2 - 11" x 17" size.

D-48R TEMPERATURE-ENTROPY DIAGRAM FOR NEON (60 to 300°K; 0.1 to 200 atm.). National Bureau of Standards, Boulder, Colo., Cryogenics Div. (1963). Reprinted from: "Thermodynamic Properties of Neon from 25 to 300°K between 0.1 and 200 Atmospheres," by R. D. McCarty and R. B. Stewart. Advances in Thermophysical Properties at Extreme Temperatures and Pressures, 84-97. American Society of Mechanical Engineers, New York (1965). PB172392-1 - 8 1/2" x 11" size; PB172392-3 - 17" x 22X size.

D-49R TEMPERATURE-ENTROPY DIAGRAM FOR NEON (25 to 80°K; 0.1 to 200 atm.). National Bureau of Standards, Boulder, Colo., Cryogenics Div. (1963). Reprinted from: "Thermodynamic Properties of Neon from 25 to 300°K between 0.1 and 200 Atmospheres," by R. D. McCarty and R. B. Stewart. Advances in Thermophysical Properties at Extreme Temperatures and Pressures, 84-97. American Society of Mechanical Engineers, New York (1965). PB172393-1 - 8 1/2" x 11" size; PB172393-3 - 17" x 22" size.

D-50 COMPRESSIBILITY FACTOR CHART FOR CARBON MONOXIDE; Z vs P (100 to 300°K; 1 to 300 atm.). National Bureau of Standards, Boulder, Colo., Cryogenics Div. Reprinted from: Nat. Bur. Stand. (U.S.), Tech. Note No. 202 (Sep 1963). PB172394-1 - 8 1/2" x 11" size; PB172394-3 - 17" x 22" size.

D-51 TEMPERATURE-ENTROPY DIAGRAM FOR CARBON MONOXIDE (70 to 300°K; 0.1 to 300 atm.). National Bureau of Standards, Boulder, Colo., Cryogenics Div. Reprinted from: Nat. Bur. Stand. (U.S.), Tech. Note No. 202 (Sep 1963). PB172395-1 - 8 1/2" x 11" size; PB172395-3 - 17" x 22" size.

D-52 TEMPERATURE-ENTROPY DIAGRAM FOR HELIUM (15 to 300°K; 0.1 to 100 atm.). National Bureau of Standards, Boulder, Colo., Cryogenics Div. (1964). From: Nat. Bur. Stand. (U.S.), Tech. Note No. 154 (Jan 1962). PB172396-1 - 8 1/2" x 11" size; PB172396-3 - 17" x 22" size.

D-53 TEMPERATURE-ENTROPY DIAGRAM FOR HELIUM (3 to 25°K; 0.5 to 100 atm.). National Bureau of Standards, Boulder, Colo., Cryogenics Div. (1964). From: Nat. Bur. Stand. (U.S.), Tech. Note No. 154 (Jan 1962). PB172397-1 - 8 1/2" x 11" size; PB172397-3 - 17" x 22" size.

D-54 ENTHALPY-ENTROPY CHART FOR HELIUM (3 to 25°K; 1 to 100 atm.). National Bureau of Standards, Boulder, Colo., Cryogenics Div. (1964). From: Nat. Bur. Stand. (U.S.), Tech. Note No. 154 (Jan 1962). PB172398-1 - 8 1/2" x 11" size; PB172398-3 - 17" x 22" size.

D-55 VELOCITY OF SOUND IN GASEOUS HYDROGEN (20 to 300°K; 36 to 500°R). National Bureau of Standards, Boulder, Colo., Cryogenics Div. (1960). From: Nat. Bur. Stand. (U.S.), Res. Pap. 1932 (1948). PB192399-2 - 11" x 17" size.

D-56 TEMPERATURE-ENTROPY CHART FOR OXYGEN (65 to 300°K; .002 to 340 atm.). National Bureau of Standards, Boulder, Colo., Cryogenics Div. From: The Thermodynamic Properties of Oxygen, by R. B. Stewart. Ph.D. Dissertation, University of Iowa, Iowa City (1966). PB173078-1 - 8 1/2" x 11" size; PB173078-2 - 11" x 17" size; PB173078-3 - 17" x 22" size.

D-57 COMPRESSIBILITY FACTOR CHART FOR OXYGEN (70 to 300°K; 1 to 340 atm.). National Bureau of Standards, Boulder, Colo., Cryogenics Div. From: The Thermodynamic Properties of Oxygen, by R. B. Stewart. Ph.D. Dissertation, University of Iowa, Iowa City (1966). PB173079-1 - 8 1/2" x 11" size; PB173079-3 - 17" x 22" size.

D-58 TEMPERATURE-ENTROPY CHART FOR DEUTERIUM (20 to 100°K; 0.1 to 100 atm.). National Bureau of Standards, Boulder, Colo., Cryogenics Div. From: The Thermodynamic Properties of Deuterium, by R. Prydz. M.S. Thesis, University of Colorado, Boulder (1967). 8 1/2" x 11" size and 11" x 17" size.

D-59 TEMPERATURE-ENTROPY CHART FOR DEUTERIUM (80 to 300°K; 1.0 to 400 atm.). National Bureau of Standards, Boulder, Colo., Cryogenics Div. From: The Thermodynamic Properties of Deuterium, by R. Prydz. M.S. Thesis, University of Colorado, Boulder (1967). 8 1/2" x 11" size and 11" x 17" size.

D-60 COMPRESSIBILITY FACTOR CHART FOR DEUTERIUM (20 to 300°K; 3 to 5500 psia.). National Bureau of Standards, Boulder, Colo., Cryogenics Div. From: The Thermodynamic Properties of Deuterium, by R. Prydz. M.S. Thesis, University of Colorado, Boulder (1967). 8 1/2" x 11" size and 11" x 17" size.

D-61 TEMPERATURE-ENTROPY CHART FOR ARGON (85 to 300°K; 0.02 to 1000 atm.). National Bureau of Standards, Boulder, Colo., Cryogenics Div. From: Nat. Stand. Ref. Data Ser., Nat. Bur. Stand. (U.S.), No. 27 (Mar 1969). 8 1/2" x 11" size and 11" x 17" size.

D-62 COMPRESSIBILITY FACTOR CHART FOR ARGON (90 to 300°K; .5 to 500 atm.). National Bureau of Standards, Boulder, Colo., Cryogenics Div. From: Nat. Stand. Ref. Data Ser., Nat. Bur. Stand. (U.S.), No. 27 (Mar 1969). 8 1/2" x 11" size and 11" x 17" size.

D-63 TEMPERATURE-ENTROPY CHART FOR OXYGEN (100 to 600 R; 0.03 to 5000 psia.). National Bureau of Standards, Boulder, Colo., Cryogenics Div. From: Nat. Bur. Stand. (U.S.), Tech. Note No. 384 (Jul 1971). 8 1/2" x 11" size and 17" x 22" size.

D-64 MOLLIER DIAGRAM FOR OXYGEN (120 to 540 R; 0.1 to 5000 psia.). National Bureau of Standards, Boulder, Colo., Cryogenics Div. From: Nat. Bur. Stand. (U.S.), Tech. Note No. 384 (Jul 1971). 8 1/2" x 11" size and 17" x 22" size.

D-65 PRESSURE-ENTHALPY CHART FOR OXYGEN (120 to 580 R; 800 to 1050 psia.). National Bureau of Standards, Boulder, Colo., Cryogenics Div. From: Nat. Bur. Stand. (U.S.), Tech. Note No. 384 (Jul 1971). 17" x 22" size.

D-66 ENTHALPY-ENTROPY CHART FOR OXYGEN (120 to 600 R; .03 to 5000 psia.). National Bureau of Standards, Boulder, Colo., Cryogenics Div. (1972). From: Nat. Bur. Stand. (U.S.), Tech. Note No. 384 (Jul 1971). 8 1/2" x 11" size and 17" x 22" size.

D-67 PRESSURE-TEMPERATURE CHART FOR OXYGEN (100 to 600 R; 0 to 5000 psia.). National Bureau of Standards, Boulder, Colo., Cryogenics Div. (1972). From: Nat. Bur. Stand. (U.S.), Tech. Note No. 384 (Jul 1971). 8 1/2" x 11" size and 17" x 22" size.

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Liquefied Natural Gas (LNG) Literature Survey is prepared quarterly for the American Gas Association. The first issue, dated March 1970, contained over 300 references listed under 23 categories. Members of the American Gas Association are eligible to receive a complimentary subscription by requesting it from AGA Headquarters, Attention: Mr. Louis Sarkes. Non-members may order a subscription from National Technical Information Service, Springfield, Va. 22151. The price is $20 per year.

A Superconducting Devices and Materials Literature Survey is prepared quarterly in cooperation with the Office of Naval Research. The March 1972 issue included 318 references indexed under 39 subject headings. Subsequent issues will be somewhat comparable in size. A capsule review of some of the more important papers in each issue was added in 1969. This feature is written by Dr. Robert A. Kamper of NBS. A subscription may be ordered from National Technical Information Service, Springfield, Va. 22151. Price is $20 per year.

Thermodynamic and Transport Properties Data for cryogenic fluids and selected solids can be obtained from Mr. Hans M. Roder, Project Leader for the Data Compilation Group. His telephone number is (303) 499-1000, Ext. 3528. The descriptive list on page 74 shows the computer programs which are available. These computer programs are written in FORTRAN IV language and are currently operational on a CDC 3800 computer. The programs are available at a cost of $50.00 per program which includes a card deck and a sample run on our computer. Inquiries should be addressed to Mr. R. D. McCarty, National Bureau of Standards, Cryogenic Data Center, Boulder, Colorado 80302. Mr. McCarty's telephone number is (303) 499-1000, Ext. 3386.

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CO	NBS TN 202	CO PROPS	BWR, 16	1	400 atm	70-300 K	P-T, ρ-T	P, ρ, T, S, H, U
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F_2	NBS TN 392	SAMPLE, PVT F_2	Poly Int	1	24 MN/m²	TP-300 K	P-T	P, ρ, T, S, H, U, C_p, C_v, $\left(\frac{\partial P}{\partial T}\right)_\rho$, $\left(\frac{\partial P}{\partial \rho}\right)_T$, W
	No reference	Never issued	BWR, 24	2	240 atm	TP-300 K	P-T, ρ-T	P, ρ, T, S, H, U
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	NBS Report-Unpublished	HE PROPS (70)	BWR, 35	2	1000 atm	LP-1500 K	P-T, ρ-T	P, ρ, T, S, H, U, C_p, C_v, $\left(\frac{\partial P}{\partial T}\right)_\rho$, $\left(\frac{\partial P}{\partial \rho}\right)_T$, W
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H_2	NBS Mono 94	THERMO or VALUES	Poly Int	1	340 atm	TP-100 K	P-T	P, ρ, T, S, H, U, C_p, C_v, $\left(\frac{\partial P}{\partial T}\right)_\rho$, $\left(\frac{\partial P}{\partial \rho}\right)_T$, W
	NBS TN 130	PROP TRS and PROP LIQ	BWR, 16 BWR, 16	2 2	340 atm 340 atm	33-300 K TP-32 K	P-T, ρ-T P-T, ρ-T	P, ρ, T, S, H, U
	In Preparation	H2HIP	BWR	2	700 atm	TP-700 K	P-T, ρ-T	P, ρ, T, S, H, U, C_p, C_v, W, η, K
(Para)(Equi)	NBS TN 625	TAB CODE	Lin Int	3	5000 psi	TP-6000 R	P-T, P-H	P, ρ, T, S, H, U, C_p, C_v, K, η, W
Para	NBS TN 617	H_2 PROPS	BWR, 17 THERMO	1 1	10,000 psi 10,000 psi	180-6000 R TP-180 R	P-T, ρ-T P-T	(all of above plus, θ, Φ, β, P_r, σ, γ (and others
CH_4	NBS Report In Preparation	METHERM 4	Non-Ana	1	10,000 psi	TP-500 K	P-T	P, ρ, T, S, H, U, C_p, C_v, $\left(\frac{\partial P}{\partial T}\right)_\rho$, $\left(\frac{\partial P}{\partial \rho}\right)_T$, W
Ne	ASME Advances 65 R-346	NE PROPS	BWR, 18	1	200 atm	25-300 K	P-T, ρ-T	P, ρ, T, S, H, U
N_2	NBS TN - In Preparation	N_2 PROPS	BWR, 32	1	10,000 atm	64-1900 K	P-T, ρ-T	Same as H_2, O_2 and He
O_2	Stewart,	O_2 PROPS	BWR, 32	2	340 atm	65-300 K	P-T, ρ-T	P, ρ, T, S, H, U, C_p, C_v, W
	J. Res. 70, R-559	PVT 02	Poly Int	1	340 atm	TP-300 K	P-T	P, ρ, T, S, H, U, C_p, C_v, $\left(\frac{\partial P}{\rho T}\right)_\rho$, $\left(\frac{\partial P}{\partial \rho}\right)_T$, W
	NBS TN 384	PVT 02 & TEST	Poly Int	1	5000 psi	TP-600 R	P-T	(all of above & θ, Φ, β, Pr, ∝, γ, K, η (and others

Custom Thermocouple Tables

A program for the production of thermocouple tables for cryogenic use has been developed by L. L. Sparks and R. L. Powell of our Cryogenic Properties of Solids Section. The tables are usable from liquid helium temperatures at 4 K to approximately room temperature.

After an individual user makes a spot check of his own thermocouple with its junctions at known temperatures, a computer program is used to compare the results of the spot calibration with an NBS calibration table. The computer then calculates a correction factor and generates a "working" table tailored to the particular thermocouple. The table may be obtained in °C or °K, with any reference temperature within the range of the table. Tables can be generated for most of the commercial, low-temperature, thermocouple materials.

This program is compatible with many types of computers, making possible the use of local computers. The NBS Cryogenic Data Center will furnish, at cost, the materials and instructions necessary for the user to develop his own tables. The materials needed are (1) a thermocouple data deck, and (2) a program deck, written in FORTRAN II, IV, or 3600, which was developed to adjust the "standard" data to fit a particular thermocouple.

It is preferred that the customer use a local computer. If, however, one is not available, the Cryogenic Data Center will process the spot calibration data furnished by the user. For further information, contact L. L. Sparks, National Bureau of Standards, Cryogenics Division, 275.02, Boulder, Colorado 80302 (Phone (303) 499-1000, Extension 3612).

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