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REGISTER OF HYDROGEN TECHNOLOGY EXPERTS

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16. Abstract

This register presents the names of approximately 235 individuals who are considered experts, or very knowledgeable, in various fields of technology related to hydrogen. Approximately 90 organizations are represented. Each person is listed by organizational affiliation, address, and principal area of expertise. The criteria for selection of names for the register are extensive experience in a given field of work, participation in or supervision of relevant research programs, contributions to the literature, or being recognized as an expert in a particular field. The purpose of the register is to present, in easy form, sources of dependable information regarding highly technical areas of hydrogen technology, with particular emphasis on safety. The register includes two indexes: an alphabetical listing of the experts and an alphabetical listing of the organizations with which they are affiliated.

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FOREWORD

This Register is a descriptive listing of experts in many diverse fields of hydrogen technology. Many of the included areas take on considerable importance because of current energy problems. A special effort was made to include most of the work where hydrogen is being used as both an energy source and an energy carrier. An updated document in the future will address other areas such as fluid dynamics, bubble chambers, cryogenic bearings, laser fusion, hydrogen getters, lightning protection, etc. In most cases the area of expertise was described by the expert, accounting for the variations in wording. To assure consistency in the expert's presentation, the ASRDI program manager assumes responsibility in the editing of the descriptive information.

The purpose of this document is to present, in easy reference form, sources of reliable information relating to the various areas of hydrogen technology. The experts, who are points of contact, could be queried by researchers in similar fields of research and development work for unpublished information and more of the details which have not appeared in published reports, journal articles, or society presentations. In addition, further inquiries could be made regarding active current programs where the published results may not appear for several months. No attempt was made to ascertain that persons listed are actually available for extensive consultation. This is left to negotiation between the parties involved.

It should be understood that a document of this type is dated; people retire or change organizational affiliation, fields of interest change, and programs change emphasis and terminate with time. Thus, the document is subject to updating and revision. Retirees who are still active professionally are listed at their last affiliation unless they indicated a preferred alternate address.

Selection for inclusion was based upon the independent judgments of the expert's peers and his appropriate publications in the literature. This is recognized as being an incomplete listing and represents only an initial installment. Nevertheless, it should provide sufficient contacts to those who seek related information. Candidates for a revised register are encouraged.

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1.0 Hydrogen Properties

Experts on thermodynamic, transport, physical, and phase equilibria properties are listed in this section. The experts selected for this section were limited to the United States. However, it should be pointed out that there are many recognized experts on hydrogen properties in other countries, especially the U.S.S.R.

Extensive coverage of hydrogen thermophysical properties is given in an ASRDI companion document: Hydrogen Technological Survey - Thermophysical Properties, edited by R. D. McCarty (NASA SP-3089).

Expert Organization	Expertise
AHLERS, Guenter Bell Laboratories Murray Hill, New Jersey	Specific heat measurements on solid hydrogen and ortho-para rate of conversion measurements on solid hydrogen.
DILLER, D. E. Cryogenics Division National Bureau of Standards Boulder, Colorado	Viscosity, index of refraction, specific heat, PVT, and thermal conductivity measurements on hydrogen.
GOODWIN, R. D. Cryogenics Division National Bureau of Standards Boulder, Colorado	PVT properties, equation of state and thermodynamic functions for hydrogen.
GRILLY, E. R. Los Alamos Scientific Laboratory Los Alamos, New Mexico	PVT properties of liquid and solid hydrogen at pressures to 3500 atm (current); hydrogen, deuterium, and tritium properties, ortho-para conversion of tritium.
HIZA, M. J. Cryogenics Division National Bureau of Standards Boulder, Colorado	Solid-vapor and liquid-vapor phase equilibria of hydrogen mixtures (H_2-CH_4, H_2-C_2H_6, H_2-C_2H_4).
McCARTY, R. D. Cryogenics Division National Bureau of Standards Boulder, Colorado	Thermodynamic transport properties of hydrogen, oxygen, and other cryogens. Editor of ASRDI Hydrogen Technology Survey. Computer programs for thermophysical properties.
MEYER, Horst Department of Physics Duke University Durham, North Carolina	Equation of state, compressibility, thermal expansion, dielectric constant, NMR, and acoustical measurements on solid hydrogen and deuterium. NMR measurements on liquid hydrogen and deuterium.
MILLS, R. L. Los Alamos Scientific Laboratory Los Alamos, New Mexico	High pressure hydrogen PVT measurements to 20 kilobars. Melting curve and volume change properties of hydrogen. Separation of ortho-para states of hydrogen and deuterium.
MULLINS, J. C. Department of Chemical Engineering Clemson University Clemson, North Carolina	Thermodynamic properties of para-hydrogen from 1-22 K.

Expert Organization	Expertise
RODER, H. M. Cryogenics Division National Bureau of Standards Boulder, Colorado	Thermal conductivity measurements, PVT measurements, and calculation of thermodynamic properties for hydrogen. Calculation of thermodynamic properties for oxygen. Edited ASRDI Oxygen Technology Survey - Thermophysical Properties, Vol. 1, NASA SP-3071. Edited ASRDI Oxygen Technology Survey - Density and Liquid Level Measurement, Vol. 5, NASA SP-3083.
STEWART, J. W. Physics Department University of Virginia Charlotteville, Virginia	Conducted early experimental measurements on the compressibility of solid hydrogen (measured ΔV vs pressure @ 4 K). Also made early measurements of the dielectric constant of hydrogen gas in the range 20 to 300 K.
STREET, W. B. U.S. Military Academy West Point, New York	Phase equilibria of hydrogen mixtures (He - H_2, D_2-Ne, and H_2-Ne).
WEBER, L. A. Cryogenics Division National Bureau of Standards Boulder, Colorado	PVT properties and equilibrium thermodynamic properties for hydrogen and oxygen.
WOOLLEY, H. W. National Bureau of Standards, Guest Worker, Heat Division, Equation of State Section Gaithersburg, Maryland	Thermodynamic properties, coexistence curves-application of scaling theory to the critical region, extrapolation of properties to high temperature and high density regions, calculation of ideal gas properties, ortho-para conversion.
ZIEGLER, W. T. School of Chemical Engineering Georgia Institute of Technology Atlanta, Georgia	Thermodynamic properties of para-hydrogen from 2 to 22 K. Phase equilibria studies for binary systems H_2-CF_4 and H_2-$CClF_3$.

2.0 Heat Transfer

The experts listed in this section have performed experimental work to determine the heat transfer characteristics of hydrogen in various boiling modes, states, and environments. Some of the individuals also have expertise in the design of hydrogen or helium heat exchangers.

Expert Organization	Expertise
CLARK, J. A. Department of Mechanical Engineering University of Michigan Ann Arbor, Michigan	Heat transfer to liquid hydrogen at low and high gravity conditions, both single and multi-phase fluids. Temperature measurement of liquid and multi-phase hydrogen at low and high gravity conditions. Drop tower and centrifuge experiments ($a/g = 10^{-3}$ to 10^{5}).
DANEY, D. E. Cryogenics Division National Bureau of Standards Boulder, Colorado	Experimental investigation of turbulent natural convection of liquid hydrogen and liquid deuterium within enclosed vessels, with particular application to moderators and targets.
FLEMING, R. B. General Electric Company Research and Development Center Schenectady, New York	Flow distribution and ultrahigh effectiveness of cryogenic heat exchangers. Participated in the development of the perforated plate heat exchanger. Considerable experience with liquid helium heat exchangers.
HENDRICKS, R. C. NASA - Lewis Research Center Cleveland, Ohio	Experimental and analytical convective heat transfer - two phase, near critical, super critical - and pool boiling (one to ten g's). Choke flow, transfer, and applied thermophysical properties programs.
HSU, Y. Y. Reactor Safety Research Division Energy Research and Development Administration Washington, D.C.	Performed experiments to determine the heat transfer characteristics of liquid hydrogen in the sub and super critical regions; all types of boiling were investigated. Also studied critical discharge parameters.
SIMONEAU, R. J. NASA - Lewis Research Center Cleveland, Ohio	Heat transfer work with hydrogen near the thermodynamic critical region (film boiling). Also experimental work with two-phase choked flow of hydrogen.
SINDT, C. F. Cryogenics Division National Bureau of Standards Boulder, Colorado	Experimental work to determine the convective and nucleate-boiling heat transfer coefficients for normal-boiling liquid, triple-point liquid, and slush hydrogen. Comparison of experimental data to classical heat transfer correlations.

3.0 Hydrogen Production

There are five large hydrogen liquefaction plants currently operating in the United States. The plants are listed in this section, along with the following information: the company operating the plant, the approximate capacity of the plant, the corporate safety director for hydrogen liquefaction, the plant operations manager and superintendent for each facility.

Also listed are experts on hydrogen liquefaction and purification, the ortho-para conversion of hydrogen and its isotopes, and individuals who have performed various types of experimental work on slush and gel hydrogen. Also listed are individuals who are currently trying to produce metallic hydrogen, people who are studying electrolysis systems for producing hydrogen, and people who are studying various thermo-chemical processes and cycles to produce hydrogen.

3.1 Hydrogen Liquefaction Plants in the United States

AIR PRODUCTS AND CHEMICALS, INCORPORATED

Allentown, Pennsylvania
(Presently operating two H_2 liquefaction plants)

Leonard Ball
Allentown, Pennsylvania
Corporate Safety Director over all operations (air separation and H_2 liquefaction plants). Also responsible for rail and truck transport safety.

Hugh Wynn
Allentown, Pennsylvania
Manager of all liquid hydrogen plant operations.

- Long Beach, California LH_2 Plant

Capacity: ∿ 30 tons/day
Plant Manager: N. S. Schoenherr

- New Orleans, Louisiana LH_2 Plant

Capacity: ∿ 30 tons/day
Plant Manager: C. A. Loyd
Cryogenics Superintendent: J. L. Hubbard

UNION CARBIDE CORPORATION, LINDE DIVISION

New York, New York
(Presently operating two H_2 liquefaction plants)
Hydrogen safety at the two Union Carbide liquefaction plants is a prime responsibility of the respective plant managers.

- Ontario, California LH_2 Plant

Capacity: ∿ 30 tons/day
Plant Operations Manager: I. E. Barber
Superintendent of Hydrogen Plant: K. S. Wehr

- Ashtabula, Ohio LH_2 Plant

Capacity: currently 7-1/2 tons/day
Plant Manager: V. E. Kraszeski
Superintendent of Production: D. R. Davis

AIRCO INDUSTRIAL GASES
Division of Air Reduction Company, Inc.
Murray Hill, New Jersey
(Presently operating one H_2 liquefaction plant)

E. F. Szymanski
Murray Hill, New Jersey
Division Safety Director.

- Pedricktown, New Jersey LH_2 Plant

Capacity: ∿ 6 tons/day
Plant Superintendent: W. H. Whitener
Assistant Plant Superintendent: McHough Griffin

3.2 Hydrogen Liquefaction and Purification

Expert Organization	Expertise
JOHNSON, J. E. Product Manager of Hydrogen Linde Division of Union Carbide New York, New York	Process design, energy optimization, and operations analysis of hydrogen liquefaction plants.
JOHNSON, V. J., Guest Worker Cryogenics Division National Bureau of Standards Boulder, Colorado	Process design, gas liquefaction, and operation of liquid hydrogen plants. Chief of the gas liquefaction at the National Bureau of Standards. Former director of the NBS Cryogenic Data Center.
STROBRIDGE, T. R. Cryogenics Division National Bureau of Standards Boulder, Colorado	Thermodynamic analysis of liquefaction cycles - design. Plant operating experience.
VANDER AREND, P. C. Cryogenic Consultants, Inc. Allentown, Pennsylvania	Extensive experience in hydrogen liquefaction, process design, and plant operations. Supervised the initial process design and start up of several hydrogen liquefaction plants.
VOTH, R. O. Cryogenics Division National Bureau of Standards Boulder, Colorado	Thermodynamic analysis of hydrogen liquefaction cycles and design.

3.3 Ortho-Para Conversion

BROWN, L. F. Department of Chemical Engineering University of Colorado Boulder, Colorado	Ortho-para conversion and catalysts to accelerate conversion of hydrogen and its isotopes.
KEELER, R. N. Head, Physics Laboratory Lawrence Livermore Laboratories Livermore, California	Ortho-para conversion, catalysts to accelerate conversion, and isotope separation.
LAPIN, Abraham Air Products and Chemicals, Inc. Allentown, Pennsylvania	Extensive experience in the area of ortho-para conversion of hydrogen; both rate of conversion and catalysts for conversion. Supervised the experimental work on the super catalysts developed at Air Products Company.

Expert Organization	Expertise
MILLS, R. L. Los Alamos Scientific Laboratory Los Alamos, New Mexico	Ortho-para conversion of hydrogen and deuterium. Separation of ortho-para states of hydrogen and deuterium.
3.4 Slush Hydrogen	
DANEY, D. E. Cryogenics Division National Bureau of Standards Boulder, Colorado	Experimental work pumping slush hydrogen with an S-IVB liquid hydrogen centrifugal pump; pump performance and cavitation characteristics. Quality determination of slush using four different methods.
HYDE, E. H. NASA - Marshall Space Flight Center Marshall Space Flight Center, Alabama	Fabrication and operation of a 1500 gallon slush generator with weigh capability, facility includes a 4-inch vacuum-jacketed transfer line, and a 23,000 gallon storage vessel. Slush production and flow instrumentation. Production of slush hydrogen using the freeze-thaw method in a 1500 gallon generator.
KELLER, C. W. Staff Engineer Lockheed Missles and Space Company Sunnyvale, California	Conducted a feasibility study on the application and impact of using slush hydrogen in a liquid hydrogen fueled vehicle. Conducted an experimental program to simulate and verify a vehicle loading process using slush hydrogen.
MANN, D. B. Cryogenics Division National Bureau of Standards Boulder, Colorado	Supervised the experimental work at the National Bureau of Standards to determine production techniques and parameters, storage characteristics, pumping characteristics, and flow characteristics of slush hydrogen. Also supervised the instrumentation program for slush hydrogen.
SINDT, C. F. Cryogenics Division National Bureau of Standards Boulder, Colorado	Experimental work to determine production techniques, flow characteristics, storage and ageing characteristics, and mixing parameters of slush hydrogen. Gelling of slush hydrogen using light hydrocarbons.
3.5 Gel Hydrogen	
TARPLEY, W. B. Organic Recycling, Incorporated West Chester, Pennsylvania	Gelling of LH_2 using carbon black, pryogenic silica, lithium borohydride, and lithium aluminum hydride.

Expert Organization	Expertise
VANDER WALL, E. M. Chemical Processing Research Laboratory Aerojet Liquid Rocket Company Sacramento, California	Gelling of liquid and slush hydrogen using light hydrocarbons, carbon particles, and silicates.
3.6 Metallic Hydrogen	
BROWN, G. V. Chief Magnetics and Cryophysics Branch NASA - Lewis Research Center Cleveland, Ohio	Directing in-house and contract work toward fabricating presses to achieve the 3 megabar range in order to produce the transition from molecular to metallic phase.
HAWKE, R. S. Lawrence Livermore Laboratory Livermore, California	Magnetic compression experiments using liquid and solid hydrogen to produce metallic hydrogen.
HOMAN, C. G. Watervliet Arsenal Watervliet, New York	Metallic hydrogen experiments; 500 kilobars to 1 megabar.
ROGERS, F. J. Lawrence Livermore Laboratory Livermore, California	Theoretical studies on metallic hydrogen.
RUOFF, A. L. Cornell University Ithaca, New York	Experimentalist, producing metallic hydrogen by two methods; compressing solid hydrogen to 3 megabars and the electrolysis of lithium hydride.
SPAIN, I. L. Chemical Engineering Department University of Maryland College Park, Maryland	Experimental program to develop ultra-high pressure techniques for compressing hydrogen to pressures in the range of one megabar.
VAN THIEL, M. Lawrence Livermore Laboratory Livermore, California	Shock wave experiments on solid hydrogen up to 1000 kilobars.
3.7 Electrolysis Systems	
KINCAIDE, W. C. Product Manager of Electro-Chemical Systems Teledyne Isotopes, Incorporated Timoniun, Maryland	Research and development work on small and large electrolysis systems; experimental work with hydrogen generators with capacities from 1 to 200 std. liters/min., and large custom plants with capacities up to tons/day.

Expert Organization	Expertise
SRINIVASAH, S. Brookhaven National Laboratory Electrochemistry Research Division Upton, New York	Systems studies of electrolysis plants. The program plans for a small prototype plant of ∿ 200 kilowatts, and finally construction of a demonstration electrolysis plant of up to 26 megawatts capacity at a utility site.

3.8 Thermo-Chemical Production of Hydrogen

FLOWERS, Ab Manager of Synthetic Fuels Headquarters, American Gas Association Arlington, Virginia	Manager of a program being conducted by the Institute of Gas Technology to screen thermo-chemical cycles to determine which are most feasible for large scale production of hydrogen.
FUNK, J. E. Dean, College of Engineering University of Kentucky Lexington, Kentucky	Theoretical studies and experimental programs investigating the thermo-chemical processes for producing hydrogen. Investigating techniques to evaluate thermo-chemical cycles and determine thermal efficiency. The work also focuses on the process irreversibilities and the need for thermal regeneration.
KRIKORIAN, O. H. Lawrence Livermore Laboratory Livermore, California	Presently conducting experimental work on the feasibility of producing large quantities of hydrogen gas using a thermo-chemical process; selenium is combined with oxides to form selinides, which are then hydrolized with acid to produce H_2Se gas, which is then decomposed to form free H_2 gas and selenium.
NORAD, D. L. Chief, Laser and Energy Systems Branch NASA-Lewis Research Center Cleveland, Ohio	Involved in a joint AEC-NASA effort to study production of hydrogen from nuclear heat using both coal conversion and thermo-chemical processes. Also investigating complete hydrogen energy systems including production, transmission, storage, distribution, end use, and scenarios for implementation.
PANGBORN, J. B. Institute of Gas Technology Chicago, Illinois	Presently investigating the theoretical and experimental aspects of thermo-chemical hydrogen production. Parameters include reaction steps, operating conditions, large-scale hydrogen production facility. Parameters include reaction steps, operating conditions, and economy of operation, with a long term goal of a large-scale hydrogen production facility.

Expert Organization	Expertise
RUSSELL, J. L., Jr. Manager of Special Products General Atomics, Incorporated San Diego, California	Computer search, experimental, and engineering work on thermo-chemical water splitting cycles.
WENTORF, R. H., Jr. General Electric Company Research and Development Center Schenectady, New York	Exploration of potential processes for economical production of hydrogen from water, using fossil fuel, nuclear, or solar energy, and of the use of hydrogen as an ingredient in closed-loop energy storage or delivery methods.

4.0 Materials of Construction

This section contains a listing of individuals having expertise about the various types of materials used in the construction of hydrogen systems. There has been a vast amount of work on hydrogen embrittlement, fracture mechanics, and insulation; however only a small fraction of the experts representing key organizations are listed in this document. A listing of experts on polymeric composites was also included because of the increased use of these composites in superconducting systems. Since multi-layer and powder insulations are used almost exclusively for liquid hydrogen systems, only experts for these types of insulations are listed. Experts on other types of low performance insulation systems were not considered.

Expert Organization	Expertise
4.1 Metals	
4.1.1 Hydrogen Embrittlement	
BEACHEM, C. D. Naval Research Laboratory Washington, D.C.	Test methods. Microscopic mechanisms, stress corrosion cracking mechanisms, and fracture mechanics analysis.
CHANDLER, W. T. Rocketdyne Division of Rockwell International Canoga Park, California	Hydrogen environment embrittlement. Effect of high pressure hydrogen on metals and alloys.
GRAY, H. R. Research Metallurgist NASA - Lewis Research Center Cleveland, Ohio	Hydrogen embrittlement of structural materials; iron base alloys, nickel-cobalt base alloys, and titanium base alloys. Hot salt stress corrosion. Responsible for the materials aspect of the NASA - interagency hydrogen energy systems technology study (HEST).
GROENEVELD, T. P. Battelle Memorial Institute Columbus, Ohio	Hydrogen embrittlement of iron and steels, also a few superalloys.
HARRIS, J. A. Pratt and Whitney Aircraft Florida Research and Development Center West Palm Beach, Florida	Investigating the effect of external hydrogen environment embrittlement on the mechanical properties of high nickel alloys and superalloys.
LOGINOW, A. W. U.S. Steel Company Research Laboratories Monroeville, Pennsylvania	Environmental cracking of steels: stress corrosion cracking, cathodic crack propagation, and gaseous hydrogen cracking at pressures to 14,000 psi.
NELSON, H. G. Materials Science Branch Ames Research Center Moffet Field, California	Presently studying the influence of environmental factors on slow crack growth and crack initiation on iron, nickel, titanium, and aluminum base alloys. Attempting to correlate transport kinetics to the environmental influences.
TROIANO, A. R. Case Western Reserve Cleveland, Ohio	Stress corrosion cracking in high strength and austenitic stainless steels, particularly oil and pipeline tubing.

Expert Organization	Expertise
4.1.2 Fracture Mechanics	
BROWN, W. F., Jr. Chief of Fractures Branch of Materials Processing Laboratory NASA - Lewis Research Center Cleveland, Ohio	Mechanical properties testing of aluminum, annealed titanium, nickel steels, copper alloys, and super-alloys.
LANDON, P. R. Lawrence Livermore Laboratories Livermore, California	Specifications for, and welding of, stainless steels. Stability of stainless steels and beryllium. Failure analysis.
REED, R. P. Cryogenics Division National Bureau of Standards Boulder, Colorado	Elastic and elastic-plastic fracture tests and fatigue crack growth rate from 4 to 300 K on structural alloys and welds of cryogenic materials.
WESSEL, E. T. Westinghouse Electric Corporation Research and Development Center Pittsburgh, Pennsylvania	Development and application of advanced fracture mechanics concepts. Currently testing super alloys, superconducting materials, copper, and brazed, soldered, and welded joints at cryogenic temperatures.
4.2 Polymeric Composites	
HERTZ, Julius Convair Division of General Dynamics Corporation San Diego, California	Fabrication, development, and testing of high modulus advanced polymeric composites; graphite reinforced epoxies and polyimides.
KASEN, M. B. Cryogenics Division National Bureau of Standards Boulder, Colorado	Mechanical properties testing of high modulus, advanced composites in the temperature regions 4 to 20 K. Current work is with composites useful in superconducting systems.
MORRIS, E. E. Structural Composites Industries Azuza, California	Filamentary reinforced plastic composites, conventional and advanced. Structural fibers are glass, Kevlar 49, graphite and boron with epoxy and polyimide resins. Current interest is high-strength and low-thermal conductivity composites for cryogenic and superconducting systems.

Expert Organization	Expertise
4.3 Insulations	
BARBER, J. R. Head of Fluid Systems NASA - Lewis Research Center Cleveland, Ohio	Contract manager dealing with the advancement of multi-layer insulation (MLI) technology. Research and evaluation of various types of multi-layer spacer materials. Measurements of MLI performance with boundary temperatures of 40 to 700°R.
CLAPP, M. B. Chicago Bridge and Iron Company Oak Brook, Illinois	Knowledgeable about insulation requirements and criteria of large cryogenic storage vessels. Responsible for the preliminary design of large cryogenic vessels and liquefaction systems.
CONTE, R. R. Minnesota Valley Engineering Company New Prague, Minnesota	Multilayer insulation of cryogenic vessels to 9,000 gallon capacity. Helium boiloff gas radiation shield cooling techniques. High vacuum technology and fabrication techniques.
DIEKMAN, Don Silbrico Corporation Hodgkins, Illinois	Manufacture and installation of perlite in large field-erected cryogenic storage vessels. Job site installation to specifications on moisture, particle size, and density.
HYDE, E. H. NASA - Marshall Space Flight Center Marshall Space Flight Center, Alabama	Superfloc development and testing. Project monitor for NASA-Marshall multilayer and polyphenyl oxide (PPO) foam programs.
KROPSCHOT, R. H. Chief, Cryogenics Division National Bureau of Standards Boulder, Colorado	Research and development work on all types of cryogenic insulations; powder, opacified powders, foams, microspheres, and multilayer insulations. Review articles on cryogenic insulation systems.
MATSCH, L. C. Linde Division of Union Carbide Corporation Tonowanda, New York	Research, development, and testing of all types of multilayer insulations. Development and testing of opacified powders. Ortho-para conversion and catalysts for conversion. Hydrogen getters and sorbents.

Expert Organization	Expertise
PARMLEY, R. T. Lockheed Missiles and Space Company Palo Alto, California	Design, analysis and testing of multi-layer insulations and systems. Research and development of microsphere insulation. Design and environmental testing of 46-inch diameter flight weight spherical LH_2 dewar for space tug using microsphere insulation.
RUCCIA, F. E. Arthur D. Little Company Cambridge, Massachusetts	Development and testing of opacified powders. Basic studies of high performance insulation systems. Feasibility studies of insulation systems for long-term storage of LH_2 in space. Design, development, and fabrication of a double guarded, flat plate calorimeter for study of multi-layer insulation parameters. Design of high performance insulation systems for the Apollo program instrumentation and sensor systems.
TATRO, R. E. Convair Division of General Dynamics Corporation San Diego, California	Research, design, development, and production of superfloc multi-layer insulation. Analysis, design, predicted performance, and environmental testing of 87-inch diameter LH_2 flight weight vessel with superfloc insulation.

5.0 Engineering Systems and Subsystems

Individuals who have expertise in some of the more important subsystems of a hydrogen facility are listed in this section. Experts in the areas of large storage vessels, vacuum-jacketed transfer lines, heat exchangers, liquid hydrogen pumps, refrigerators, non-lubricated compressors, and hydrogen disposal systems are listed. A subsection on non-lubricated compressors was included because these types of compressors are often used in hydrogen systems, and a vast amount of operating experience has been accumulated in using these types of compressors at the helium plants in the U.S. Experts for other subsystems such as vaporizers, purifiers, small storage vessels, portable dewars, high pressure gas banks, cryogenic bearings, hydrogen turbines, and the other types of compressors will possibly be added to a future, more comprehensive register.

Expert Organization	Expertise
5.1 Large Storage Tanks and Vessels (Field Erected)	
BODLEY, R. W. Graver Tank and Manufacturing Company East Chicago, Indiana	Technical information on the design, fabrication, and erection of large cryogenic vessels.
CLAPP, M. B. Chicago Bridge and Iron Oak Brook, Illinois	Leader of an engineering group responsible for estimating costs for inquiries on cryogenic vessels and liquefaction systems, and the preliminary design of the above. Knowledgeable about all technical aspects of cryogenic systems and structures.
MURPHY, J. C. Manager of Engineering Systems Group Pittsburgh - Des Moines Steel Company Neville Island Pittsburgh, Pennsylvania	Design, fabrication, and erection of large cryogenic vessels (LH_2, LO_2, LN_2, and LNG).
5.2 Vacuum-Jacketed Transfer Lines	
BOWERS, W. M. Liquid Metal Engineering Center Atomics International Division of Rockwell International Canoga Park, California	Experience with liquid hydrogen fueled rocket engine test facilities at Rocketdyne. Responsible for maintenance and vacuum integrity of the transfer and run lines. A current member of the ANSI-B31.10 Code for Cryogenic Piping Systems Committee.
EDESKUTY, F. J. Los Alamos Scientific Laboratory Los Alamos, New Mexico	Considerable experience with vacuum-jacketed transfer lines ranging in size from 2-inches to 16-inches diameter. Experience with Invar welding techniques, annular end seals, expansion joints, multi-layer insulation, and sorbents.
HOWARD, F. S. NASA-Kennedy Space Center Kennedy Space Center, Florida	Responsible for maintenance and integrity of the 10-inch vacuum-jacketed LH_2 transfer lines at launch complex 39A and 39B. Initiated design of an annular bellows seal modification at spool piece joints. Supervised rebuilding of the V. J. transfer lines for the Skylab mobile launch platform.
MARTINDALE, D. L. General Manager, Cryolab Division of CTI, Incorporated Los Osos, California	Extensive experience in cryogenic systems. As manager of cryogenic systems for Ametek/Straza, was responsible for supervision of design, development and manufacture of cryogenic systems, components and related products. General manager and project engineer for the cryogenic ducting system with accessories for the Saturn/Apollo project.

Expert Organization	Expertise
MOORE, A. L. Director of Engineering Ametek/Straza Corporation El Cajon, California	Experience in the design, manufacture, and test of vacuum-jacketed transfer lines. Extensive experience with transfer line components: ducting, spool joints, annular end seals, expansion joints, sorbents, and insulation.
MORDHORST, G. D. Cryogenic Engineering Company Division of CTI, Incorporated Denver, Colorado	Active in research, design, and fabrication of vacuum-insulated transfer lines and vacuum-insulated vessels.
SPENCE, R. E. Manager of Standard Products CVI, Incorporated Columbus, Ohio	Experience in the fabrication of vacuum-insulated transfer lines for cryogenic systems. Also valves, field joints and couplings. A member of the ANSI-B31.10 Code for Cryogenic Piping Systems Committee.
5.3 Heat Exchangers	
COWANS, K. W. Kinergetics, Incorporated Tarzana, California	Super high efficiency, counter-current heat exchangers for all cryogenics applications.
FLEMING, R. B. General Electric Company Schnectady, New York	Flow distribution and ultra-high effectiveness of heat exchangers. Helped develop the perforated-plate heat exchanger. Liquid helium heat exchangers.
JACOBS, R. B. R. B. Jacobs Associates, Inc. Boulder, Colorado	Active in heat transfer and heat exchanger design for helium and hydrogen systems; liquefiers, refrigerators, and related equipment.
5.4 Liquid Hydrogen Pumps	
BROOKS, W. S. Manager SSME Turbomachinery Engineering Rocketdyne Division of Rockwell International Canoga Park, California	Design and development of turbomachinery for pumping LH_2 and LO_2 in rocket engines.
CAINE, G. H. Sunstrand Corporation Rockford, Illinois	Research and development on induction motors (1 watt to 50 HP) for cryogenic pump applications. Cryogenic pump design and performance studies for LO_2, LH_2, and LHe. Low NPSH LH_2 boost pump development.

Expert Organization	Expertise
CONNELLY, R. E. NASA-Lewis Research Center Cleveland, Ohio	LH_2 and LO_2 turbopumps. Project manager of Mark-9 LH_2 turbopump for Rocketdyne. Inducer development work on the F-1 LO_2 pump. Basic research on inducer cavitation of LH_2 turbopumps. Project manager of the Nuclear Engine for Rocket Vehicle Application (NERVA) LH_2 turbopump.
FURST, R. B. Rocketdyne Division of Rockwell International Canoga Park, California	Fluid mechanics design of pumps. Hydrodynamic development of F-1 and J-2 engines for the Saturn program. Authored NASA Monograph on centrifugal pumps.
GINSBURG, Ambrose Chief, Fluid Systems Components Division NASA-Lewis Research Center Cleveland, Ohio	Responsible for the management and supervision of research and development work on liquid hydrogen turbopumps and components.
GROSS, L. A. NASA-Marshall Space Flight Center Marshall Space Flight Center, Alabama	Development, performance and testing of liquid hydrogen pumps.
HAGER, J. A. Manager SSME Fuel Turbomachinery Rocketdyne Division of Rockwell International Canoga Park, California	Design and development of liquid hydrogen pumping for turbomachinery.
HARTMAN, M. J. Chief, Fan and Compressor Branch NASA-Lewis Research Center Cleveland, Ohio	Conducted design and performance studies on axial and centrifugal flow liquid hydrogen pumps. Developed a rationale design approach to predict cavitation performance of hydrogen pump inducers.
MOORE, R. D. Engine Research NASA-Lewis Research Center Cleveland, Ohio	Performed experimental work on cavitation parameters of pumps using liquid hydrogen.
HUPPERT, Murl Aerojet Liquid Rocket Company Sacramento, California	Authored NASA Axial Flow Pump Monograph. Research and development of cryogenic pumps. Pump inducer design, liquid hydrogen pump design for J-2 engine and the NERVA pump.

Expert Organization	Expertise
SPRATLEY, M. L. SSME Development Engineer Rocketdyne Division of Rockwell International Canoga Park, California	Design and development of liquid hydrogen pumping turbomachinery.
ROTHE, Kurt Manager of Rotating Machinery Rocketdyne Division of Rockwell International Canoga Park, California	Extensive experience in turbomachinery field. Manager of turbomachinery for Rocketdyne work on the Apollo and Space Shuttle programs. Supervised selection of the turbomachinery for the space shuttle main engine (SSME). Cavitation studies with LH_2. Pump work with LH_2, LO_2, RP-1, and F_2.
STINSON, H. P. NASA-Marshall Space Flight Center Marshall Space Flight Center, Alabama	Performance, cavitation, testing and development of liquid hydrogen pumps.
WISLICENUS, G. F. 4641 E. Coronado Drive Tucson, Arizona	Extensive experience with turbomachinery of all types; cavitation and performance characteristics of liquid hydrogen pumps. Former consultant to Rocketdyne.

5.5 Refrigerators

COLLINS, S. C. Naval Research Laboratory Washington, D.C.	Research and development of small helium refrigerators. Development of small compressors for refrigerators. Research and development work on LO_2 generators. Small hydrogen liquefiers and expansion engines.
STROBRIDGE, T. R. Cryogenics Division National Bureau of Standards Boulder, Colorado	Cryogenic refrigerators of all sizes (1 watt to 10 kilowatts). Studies of efficiency and performance parameters. Field experience.
STUART, B. W. Cryogenic Technology, Incorporated Waltham, Massachusetts	Research and development of small and large cryogenic refrigeration systems (2 to 200 watts). Hydrogen recondensing and liquefaction refrigerators. Closed cycle refrigeration systems for bubble chambers and accelerators.
VANDER AREND, P. C. Cryogenics Consultants, Incorporated Allentown, Pennsylvania	Extensive experience in the field of cryogenic refrigerator design. Designed the hydrogen refrigerators for several bubble chambers.

Expert Organization	Expertise
5.6 Compressors (non-lubricated)	
DAVIS, Dick, Plant Supt. CHERNOHAN, Glen, Operations Supt. Cities Service Jayhawk Helium Plant Satanta, Kansas	Both diaphragm and dry piston type compressors in use at this facility. Information on maintenance schedules, field experience, diaphragm life, and PTFE piston ring replacement schedule available.
FARRELL, Paul, Plant Supt. JONES, L. B., Maintenance Supvr. Phillips-Greenwood Helium Plant Elkhart, Kansas	Both diaphragm and dry piston type compressors in use at this facility. Operating experience, maintenance schedules, dry piston ring replacement schedules.
PESISCA, Al, Plant Supt. LYNCH, Tom, Maintenance Mgr. Kansas Refined Helium Company Otis, Kansas	Both diaphragm type and dry piston compressors in use at this facility. Information on dry piston ring life, maintenance schedules, typical piston ring life, and valve and diaphragm life is available.
SCHEGEL, Carl, Plant Supt. GAMBLIN, Gurnell, Ass't Plant Supt. U.S. Government Helium Plant Keyes, Oklahoma	Diaphragm type compressors in use at this facility, vast field experience, maintenance schedules, diaphragm change intervals.
5.7 Hydrogen Disposal Systems	
GRUMER, Joseph Bureau of Mines Pittsburgh, Pennsylvania	Performed early evaluation work and experimental tests on hydrogen flare stacks and burn ponds. The main concern was the safety aspects of each disposal system. Parameters investigated were completeness of burning, stability of the flames, and flame-back characteristics of the flare stacks.
HOWARD, F. S. NASA-Kennedy Space Center Kennedy Space Center, Florida	LH_2 burn pond operations at Kennedy Space Center. Siphoning problems, safety, and optimum design criteria.
LAPIN, Abraham Air Products and Chemicals, Inc. Allentown, Pennsylvania	Supervised programs to evaluate and conduct experimental testing with hydrogen flare stacks.

6.0 Transportation Systems for Hydrogen

Individuals listed in this section are deeply involved in the safe transportation and distribution of liquid hydrogen over highways, railways, waterways, and within NASA installations. These experts are knowledgeable about transport trailer design, department of transportation (DoT) requirements, industrial safety regulations, emergency procedures, accident/incident investigation and analysis, and NASA safety regulations and recommended procedures. Experts from industry, NASA, the federal regulatory agencies, and several advisory agencies are included.

Expert Organization	Expertise
6.1 Commercial Operations	
BURKE, Stephen Manager of Chemicals Distribution Air Products and Chemicals, Inc. Allentown, Pennsylvania	In charge of truck-trailer vessel design and any design modifications to the trailers. Knowledgeable of all Department of Transportation (DoT) requirements and special permits to transport LH_2 over the highways.
CAVANNA, C. E. Manager of Engineering LOX Equipment Company Livermore, California	Manufacturers of truck-trailers and rail cars for cryogenic fluids. Extensive design and fabrication experience. Technical information on design, performance, and fabrication of mobile vessels.
HEIBERGER, F. M. Safety Affairs Department Linde Division of Union Carbide Corp. Tarrytown, New York	Corporate safety regulations, emergency procedures, and DoT requirements for truck-trailer and rail transport of liquid hydrogen.
MATTHEWS, R. L. General Manager of Distribution Airco Industrial Gases Murray Hill, New Jersey	Distribution of liquid hydrogen by truck transport, driver training, and DoT requirements and regulations.
TRAMMELL, Byron Manager, Truck Fleet Operations Air Products and Chemicals, Inc. Allentown, Pennsylvania	Supervises truck transport of liquid hydrogen all over the United States. In charge of purchasing and maintaining all truck-transport equipment, driver qualifications and training, special permits for LH_2 transport, federal regulations on hours of service limitations, and emergency procedures.
6.2 NASA Operations	
BAIN, A. L. Systems Engineer NASA-Kennedy Space Center (KSC) Kennedy Space Center, Florida	Responsible for the design, operations, and maintenance of transportation equipment and hardware at KSC. Also responsible for the safe distribution and storage of all propellants at KSC, and for KSC compliance with DoT regulations, state requirements, and the motor carrier safety regulations.

Expert Organization	Expertise
BALL, J. G. Chief, Safety Office NASA-Pasadena Pasadena, California	Responsible for the safe distribution of NASA liquid hydrogen west of the Mississippi. Actively working on hazards analysis and systems analysis of liquid hydrogen; transfer, transport, and storage systems.
HARWOOD, W. R. Manager of Propellants and Pressurants NASA-Headquarters Washington, D.C.	Responsibility for insuring that all NASA facilities have the propellants required; establishes need for and initiates the procurement process. The availability and safe transportation of liquid hydrogen is a major responsibility.
ORDIN, P. M. Program Manager, NASA Aerospace Safety Research and Data Institute NASA-Lewis Research Center Cleveland, Ohio	Knowledgeable in the procedures, guidelines and regulations for liquid hydrogen transportation, distribution and transfer at NASA and NASA Contractor facilities. Prepared hydrogen transportation summary including safety program guidelines to ensure proper driver and handling training and safety procedures.
SHAW, R. C. Chief, Cryogenic and Pressure Section NASA-Marshall Space Flight Center Marshall Space Flight Center, Alabama	Responsible for the transport, distribution, and storage of cryogens and high pressure gases at MSFC. Develops safety criteria and specifications for all the propellant transport trailers used at MSFC.

6.3 Regulatory Agencies

Department of Transportation

BLACK, W. F. Chief, Hazardous Materials Branch Office of Safety Federal Railroad Administration Washington, D.C.	Knowledgeable about DoT requirements and regulations concerning the transport of liquid hydrogen by rail. Has primary responsibility for the evaluation of hazardous material container design for rail transport.
BOHLMAN, Michael, Lt. Chief of Packaged Cargo Branch of the Cargo and Hazardous Material Division of the U.S. Coast Guard Washington, D.C.	Knowledgeable about shipping LH_2 by waterway transport or barge. No existing regulations on transport of LH_2. Special permits for transport of LH_2 are issued on an individual basis. Technical review of application for LH_2 transport is performed in this office.

Expert Organization	Expertise
MALLEN, Arthur Chief of the Mechanical Engineering Branch of the Office of Hazardous Materials Department of Transportation Washington, D.C.	Knowledgeable about DoT requirements and regulations concerning the transportation of liquid hydrogen by highway and air. Has primary responsibility for evaluation of the hazardous material container design for highway and air transport. Has secondary responsibility for evaluation of rail containers (tank cars for LH_2) for hazardous materials.
RUSSEAU, Gordon Chief of the Office of Hazardous Materials Department of Transportation Washington, D.C.	Knowledgeable about DoT regulation for the transport of LH_2.

6.4 Advisory Agencies

GRAZIANO, R. M. Director, Bureau of Explosives Association of American Railroads Washington, D.C.	Twelve-member committee (composed of six railroad representatives and six industry representatives); approves the design of rail tank cars for LH_2. The committee has no regulatory power but does exercise veto power. Primary function of the Bureau is emergency responsibility when hazardous materials are derailed or present a dangerous situation. Influential in exercising judgment on what may be transported by rail.
OLSEN, E. A. Compressed Gas Association (CGA) New York, New York	Provides staff assistance to the CGA Cryogenic and Low Temperature Committee. The duty of the committee is to develop appropriate recommendations upon matters concerning safety in the transportation, storage, handling, and use of gases or fluids at temperatures below -20°F.

7.0 Instrumentation for Hydrogen Systems

Experts listed in this section have knowledge and experience in measuring temperature, pressure, flow, mass, and liquid level in liquid hydrogen systems. A few of these experts are employed in calibration laboratories for the above instrumentation. A list of experts on combustible gas detectors is also included.

Expert Organization	Expertise
7.1 Temperature Measuring Instruments	
COLLIER, R. S. Cryogenics Division National Bureau of Standards Boulder, Colorado	Carbon thin-film state and temperature sensors in the cryogenic temperature range.
FURUKAWA, G. T. Manager of the Platinum Resistance Thermometry Laboratory National Bureau of Standards Gaithersburg, Maryland	Provides platinum resistance thermometer calibration service to industry. Sixteen calibration points available between 12 and 90 K. Co-author of National Bureau of Standards Monograph 126, Platinum Resistance Thermometry, April, 1973.
POWELL, R. L. Cryogenics Division National Bureau of Standards Boulder, Colorado	Thermocouples, resistance thermometers, and vapor pressure bulbs in the cryogenic temperature range. Reviewed most types of temperature sensors and methodology.
RUBIN, L. G. Francis Bitter National Magnet Lab. Massachusetts Institute of Technology Cambridge, Massachusetts	All types of cryogenic thermometry in low and high magnetic fields (to 200 kilo Gauss). Thermocouples, platinum, germanium, carbon, and thermistor resistance thermometers. Hydrogen vapor pressure bulbs and silicon diode thermometers. Review articles on low-temperature thermometry and methodology.
SCHOOLEY, J. F. Chief, Temperature Section National Bureau of Standards Gaithersburg, Maryland	Cryogenic thermometry of all types. Calibration of thermocouples to 1500°C. Development of superconducting thermometric fixed-point devices for the temperature range from 0.5 to 7 K. Calibration of thermocouples, resistance thermometers, and mercury in glass thermometers for national standards laboratories, industry, and hospitals.
SINCLAIR, D. H. NASA-Lewis Research Center Cleveland, Ohio	Aerospace type of temperature instrumentation. Research, testing, and evaluation of carbon, germanium, and mainly platinum-resistance thermometers. Calibration techniques and stability characteristics of carbon thermometers from 4 to 76 K. Extensive summary and review of platinum-resistance thermometers. Development of resistance thermometer methodology.
SPARKS, L. L. Cryogenics Division National Bureau of Standards Boulder, Colorado	Experimental work to establish national standards for thermocouples in the temperature range 4 to 280 K. Types E, K, T, and KP vs Au Fe thermocouples.

Expert Organization	Expertise
7.2 Pressure Measuring Instruments	
HARMON, H. S. Lead Engineer of Pressure and Thrust NASA-Marshall Space Flight Center Marshall Space Flight Center, Alabama	Aerospace pressure instrumentation. Pressure instrumentation of the RL-10, J-2, and the SSME. Hydrogen embrittlement of transducer diaphragms.
HAYAKAWA, K. K. Space Division of Rockwell International Downey, California	Extensive experience with pressure transducers, mainly the strain gauge types. Currently working on pressure instrumentation associated with the POGO* phenomenon. Author of cryogenic pressure measurement section of NASA-CR 120226, Measurement Component Technology.
HOWARD, J. L. Boeing Aerospace Company Seattle, Washington	Director of the Instrument Society of America, Cryogenics Instrumentation Division. Knowledgeable of work being conducted in most areas of cryogenic instrumentation.
INSKEEP, J. Z. California Institute of Technology Jet Propulsion Laboratory Pasadena, California	Extensive experience with all types of pressure transducers in both aerospace and ground installations. Dynamic response of transducer systems and support electrical equipment.
LEDERER, P. S. Assistant Chief for transducers National Bureau of Standards Gaithersburg, Maryland	Development of reliable and durable calibration and evaluation techniques for pressure transducers. Emphasis is on dynamic calibration. Vibration, temperature cycling, and radiation effects on the repeatability, reliability, and durability of transducer calibrations. POGO transducer evaluation.
STOKES, R. W. Los Alamos Scientific Laboratory Los Alamos, New Mexico	Experience with using quartz piezoelectric type transducers in liquid nitrogen. Dynamic response only. POGO studies.
VOTH, R. O. Cryogenics Division National Bureau of Standards Boulder, Colorado	Overpressure and rupture characteristics of dial gauge bourdon tubes using hydrogen gas, and subsequent case pressure relief characteristics; confinement of fragments and loose parts. (High pressure dial gauges).

* The POGO phenomenon is a descriptive term used for the oscillatory behavior of a rocket vehicle resulting from the coupling between the propellant system and the structural vibrational modes of the vehicle.

Expert Organization	Expertise
7.3 Flow Measuring Instruments	
BRENNAN, J. A. Cryogenics Division National Bureau of Standards Boulder, Colorado	Flow calibration facilities for cryogenic flowmeters. Calibration of flowmeters using LN_2 and LNG.
GOLDSTIEN, J. H. NASA-Marshall Space Flight Center Marshall Space Flight Center, Alabama	Research and development with liquid hydrogen flowmeters for aerospace applications; turbine, orifice, head, and venturi types.
HOBART, H. F. Instrument Development and Applications Office NASA-Lewis Research Center Cleveland, Ohio	Research and development work on turbine-type flowmeters and flowmeter bearings. Liquid hydrogen flow calibration facility with accuracy $< 1\%$. Correlation studies of water and LH_2 flow calibrations. Calibration of LH_2 flowmeters up to 2 pounds/second.
JACOBS, R. B. R. B. Jacobs Associates, Inc. Boulder, Colorado	Cryogenic Flowmeters: Designed and developed a vibrating transducer mass flowmeter for liquid hydrogen.
KLEA, J. A. Rocketdyne Division of Rockwell International	Research, development, and manufacture of the LH_2 and LO_2 flowmeters for the J-2 and F-1 engines, and the space shuttle main engine (SSME). Turbine-type flowmeters.
UDELL, D. R. Space Division of Rockwell International Downey, California	Experience with cryogenic flow measurement. Author of the Cryogenic Flow Measurement section of NASA-CR 120 227, Measurement Component Technology.
WHEELOCK, H. R. Wyle Laboratories Norco, California	Calibration and testing of flowmeters with LO_2 and LH_2 for the X-15, Titan, Centaur, and Saturn vehicles. Calibration and testing of a dynamic response, ultrasonic-type flowmeter for the shuttle program.
7.4 Liquid Level and Quantity Measuring Instruments	
COLLIER, R. S. Cryogenics Division National Bureau of Standards Boulder, Colorado	Carbon thin-film state sensors for point-type liquid-level sensing. Radio Frequency (RF) resonance mass tank gauging.

Expert Organization	Expertise
CRUZ, J. E. Cryogenics Division National Bureau of Standards Boulder, Colorado	Time Domain Reflectometer (TDR) continuous liquid-level sensors.
ELLERBRUCH, D. A. Electromagnetics Division National Bureau of Standards Boulder, Colorado	RF frequency technique of tank mass gauging using LH_2, LO_2, LN_2, and LNG. Sub-critical and super-critical states, and also zero gravity conditions. Spherical vessels up to 50 feet diameter.
HAMLET, J. F. NASA-Marshall Space Flight Center Marshall Space Flight Center, Alabama	Liquid level sensors of all types, especially capacitance-type bullseye point sensors and capacitance-type continuous sensors.
7.5 Combustible Gas Detectors	
DAS, K. B. Senior Specialist Engineer Materials and Processes Group Boeing Aerospace Company Seattle, Washington	Responsible for the development of an ultrasensitive hydrogen detection system and the associated methodology. System may be used for leak detection, combustible gas detection, and detection of hydrogen gas within metals. System described in ASTM-STP 543.
DELAUNE, S. D. Supervisor, Marketing Group Mine Safety Appliances Company Pittsburgh, Pennsylvania	Technical information on combustible gas detectors and alarms.
MACINTYRE, J. R. 231 Queensbury Drive Southwest Huntsville, Alabama	Retired systems engineer for General Electric's Space Division. Developed a selective hydrogen detection system using an activated thin-film sensor. The sensor has very large resistance changes for small amounts of hydrogen (0.1 to 4%) in air. The detection system was developed for continuous monitoring applications but could also be used as a hydrogen leak detection instrument.
PEARSE, J. N. Vice President of Product Design and Research Appleton Electric Company Chicago, Illinois	Technical information on combustible gas detectors and alarms.
PHETTEPLACE, C. J. Bacharach Instrument Company Mountain View, California	Technical information on combustible gas detectors and alarms.

8.0 Hydrogen Applications

This section lists experts who are working in various areas where hydrogen is used as a fuel or an energy carrier. Listed are experts on rocket propulsion who have done research and development work on various rocket engines and systems during the space program; from its inception up to and including work on the advanced space shuttle. Included are experts who were involved in the early experimental tests using hydrogen for fuel in modified conventional aircraft as well as the individuals pursuing the research and development work on the present hydrogen fueled supersonic and hypersonic research aircraft. Individuals who are doing basic research work with metal hydrides and the use of metal hydrides in hydrogen energy storage systems are listed. Also listed are experts on hydrogen-air and hydrogen-oxygen fuel cells and their application in future energy systems. Another category lists experts who are investigating the performance and emission parameters in using hydrogen for fuel in internal combustion engines. The last category is a listing of experts who are currently doing economic and technical feasibility studies on total hydrogen energy systems.

Expert Organization	Expertise
8.1 Rocket Propulsion (LH_2-LO_2)	
DOMOKUS, S. J. Vice President of Advanced Programs Rocketdyne Division of Rockwell International Canoga Park, California	Involved in the development of rocket systems for many years. Deeply involved in the reaction control systems for the Gemini, Apollo, Navajo, and Saturn 1-B vehicles.
DOUGLASS, H. W. Chief Chemical Energy Division NASA-Lewis Research Center Cleveland, Ohio	Participated in the development of the LH_2-LO_2 technology pertinent to the Space Tug and the Advanced Space Shuttle propulsion systems. Basic research in combustion technology in low-gravity environment; flame behavior, propagation, extinguishment, and fire safety in space.
EIDSON, B. L. General Dynamics Corporation San Diego, California	Worked on the Centaur program since its inception. Feed system design, tankage and outlet design, boost pump design, and integration tests between the fuel system and the RL-10 engine. Main propulsion attitude control systems for the shuttle interim upper stage and the Space Tug.
EK, M. C. Vice President of Engineering Rocketdyne Division of Rockwell International Canoga Park, California	Vast experience in the design, development, and testing of all types of liquid rocket engines.
GOETZ, O. K. NASA-Marshall Space Flight Center Marshall Space Flight Center, Alabama	Systems level work and in-house testing of individual engine components. Presently associated with the space shuttle main engine.
GREGORY, J. W. Chief, Rocket Systems Branch NASA-Lewis Research Center Cleveland, Ohio	Developing a high performance hydrogen-oxygen engine (20,000 pounds thrust) for use on the Space Tug. R&D work being conducted on various new components; LH_2 pump, LO_2 pump, thrust chamber, injector and preburner.
HENNINGS, Glen Chief Power Experiments Branch NASA-Lewis Research Center Cleveland, Ohio	Extensive experience in propulsion systems as chief of the Rocket Systems Division at the Plumbrook Facility of the Lewis Research Center; components work, data acquisition, systems operations, testing of complete engine systems. Fuel systems testing on rockets and turbojets.

Expert Organization	Expertise
LOMBARDO, J. A. Chief, Propulsion Division NASA-Marshall Space Flight Center Marshall Space Flight Center, Alabama	Early jet engine work with Pratt and Whitney Company. Problems, investigations, and analysis work with the RL-10, J-2, F-1, H-1, and the space shuttle main engine (SSME). Heavily involved with H_2-O_2 engine technology.
MULREADY, R. C. Pratt & Whitney Division of United Aircraft Corporation East Hartford, Connecticut	Research and development work on an LH_2 fueled J-57 aircraft engine, a 304 demonstration engine, and the RL-10 rocket engine.
REUEL, N. C. Vice President and Program Manager of SSME Rocketdyne Division of Rockwell International Canoga Park, California	Extensive experience in rocket engine development. Program manager for development of the J-2 engine, and has been associated with every other rocket engine development program at Rocketdyne.
RODGERS, R. N. NASA-Marshall Space Flight Center Marshall Space Flight Center, Alabama	Worked with various aspects of the J-2 engine development program, and currently the SSME development program system tests. Responsibility for integration of engine into vehicle launch procedures.
STOFAN, A. J. Director of Launch Vehicles NASA-Lewis Research Center Cleveland, Ohio	Responsible for the management of the Atlas-Centaur and the Titan-Centaur launch vehicle programs.
STREETMAN, J. W. General Dynamics Corporation San Diego, California	LH_2 and LO_2 feed system design and engine inlet requirements for the Centaur and Atlas vehicles. Integration of the feed system to the engine requirements.
8.2 Hydrogen Fueled Aircraft	
BREWER, G. D. Advanced Development Projects Lockheed California Company Burbank, California	Recently completed a study for NASA-Ames Research Center on the feasibility of using liquid hydrogen as a fuel for a supersonic transport, and a similar study for NASA-Langley Research Center for subsonic passenger and cargo type of aircraft.

Expert Organization	Expertise
HENRY, J. R. NASA-Langley Research Center Hampton, Virginia	Presently developing design technology to integrate a hydrogen fueled scram jet engine with the air frame of the vehicle. Mach range of 3 to 11. Extensive experience with jet engine research.
MACKLEY, E. A. Program Manager, Hypersonic Research Engine (HRE) NASA-Langley Research Center Hampton, Virginia	Research and development work on hypersonic propulsion systems and engines using hydrogen for fuel. Simulated structural and engine testing in the NASA-LeRC Plumbrook Hypersonic Tunnel Facility at Mach 5, 6, and 7. Dual mode ram jet engines.
ORDIN, P. M. Program Manager, NASA Aerospace Safety Research and Data Institute NASA-Lewis Research Center Cleveland, Ohio	Research and development work resulting in the successful flight testing of a workable liquid hydrogen fuel system on a B-57 airplane.
RICH, B. R. Head, Advanced Development Projects Lockheed California Company Burbank, California	Early research and development work on the CL-400 supersonic plane which used hydrogen fuel in a Pratt & Whitney gas turbine engine. Paper studies for hydrogen fueled supersonic aircraft for NASA-Ames Research Center and subsonic aircraft for NASA-Langley Research Center.
RUBERT, K. F. Department of Mechanical and Aerospace Engineering University of Tennessee Space Institute Tullahoma, Tennessee	Formerly, project manager at NASA-Langley for the research and development work on the hypersonic research engine (HRE). The HRE is a Mach 4 to Mach 8 hydrogen cooled and fueled flight weight dual-mode combustion ram jet.
8.3 Hydrogen Superconducting Systems	
ARP, V. D. Cryogenics Division National Bureau of Standards Boulder, Colorado	Feasibility study of refrigerating superconducting transmission lines with subcooled liquid or slush hydrogen.
8.4 Metal Hydrides	
BILLINGS, R. E. Billings Energy Research Corp. Provo, Utah	Research and development work on most types of metal hydrides. Production of commercial metal hydride tanks. Use of metal hydrides to store hydrogen fuel for autos. Research and design work on inexpensive electrolysis units for charging metal hydride tanks with hydrogen.

Expert Organization	Expertise
DOUGLASS, D. L. Materials Department University of California Los Angeles, California	Physical chemistry and physical metallurgy of hydride formation and dissociation. Main interest is in the higher capacity magnesium alloy hydrides (Mg-10Al and Mg-25Ni).
LUNDIN, C. E. Denver Research Institute University of Denver Denver, Colorado	Basic research on the stable and newer unstable class of metallic hydrides; kinetics of sorption and desorption, thermodynamic properties, enhancement of properties for an ideal storage material, contamination and poisoning characteristics. Safety aspects and characteristics of iron-titanium hydride; possibilities of a pyroforic dust explosion, effect of shock, impact, static electricity, and flammability of the solid material.
POWERS, G. J. Department of Chemical Engineering Carnegie-Mellon Institute Pittsburgh, Pennsylvania	Conducting a chemical engineering analysis of the heat and mass transfer with reaction in metal hydrides. Applications are automobile hydride storage of hydrogen and solar energy hydrogen hydride storage schemes.
REILLY, J. J. Brookhaven National Laboratory Upton, New York	Physical research on metal hydrides. Studies on new hydride materials and development work on existing materials.
SCHIRBER, J. E. Sandia Laboratories Albuquerque, New Mexico	Theory and experimentation on superconducting palladium and palladium alloy hydrides and deuterides. Other work within the group includes NMR studies, diffusion and permeation studies on rare earth and transition metal hydrides, also theoretical work on the electronic properties of metal hydrides.
VOOK, F. L. Department Head of Radiation and Device Physics Research Sandia Laboratories Albuquerque, New Mexico	Surface theory and experimentation on ion implantation and modification of metal hydride surfaces.

Expert Organization	Expertise
8.5 Hydrogen Fuel Cells	
ADLHART, O. J. Manager of Energy Systems Englehard Industries Newark, New Jersey	Research and development work on hydrogen-air fuel cells. Author of book entitled, "Handbook of Energy Technology."
AUSTIN, L. G. Department of Material Sciences Pennsylvania State University University Park, Pennsylvania	Research and consulting work on fuel cells for the Army Material Command, NASA, and the National Science Foundation. Author of NASA SP-120, Fuel Cells. Co-author of Handbook of Fuel Cell Technology. Areas of expertise: electrocatalysis, theories of electrode behavior, power losses of electrodes, and cell optimization.
BAKER, B. S. Energy Research Corporation Bethel, Connecticut	Research and development work on fuel cells and metal hydrides. Investigation of thermal and chemical compatibility between nickel and silver batteries and metal hydride hydrogen storage systems. H_2-O_2 and H_2-Air Fuel Cell research.
CHAPMAN, L. E. Manager of Engineering General Electric Co. Lynn, Massachusetts	Research and development work on H_2-O_2 type fuel cells for space applications. Fuel cells have a solid polymer type of electrolyte. Life support systems.
DUSENBURY, Bill Branch Chief, Power Generation Branch NASA-Johnson Space Center Houston, Texas	Monitor of NASA research and development contracts for H_2-O_2 fuel cells for space-craft applications. Subsystem responsibility for flight-type fuel cell systems.
KING, J. M., Jr. Pratt & Whitney Division of United Aircraft Corporation South Windsor Engineering Facility South Windsor, Connecticut	Project engineer responsible for evaluation of advanced applications of fuel cell power plants. Experience in directing the analysis of technical and economic requirements for fuel cells; analysis of alternate fuel cell concepts and in establishing their technological goals.
THALLER, L. H. Fuel Cells Systems Section, NASA-Lewis Research Center Cleveland, Ohio	Development work on advanced type of light weight H_2-O_2 fuel cells. Potassium hydroxide and water electrolyte.

Expert Organization	Expertise
8.6 Internal Combustion Engines	
ADT, R. R., Jr. Mechanical Engineering Department University of Miami Miami, Florida	Performance and emissions studies on two automobile engines that have been modified to run on hydrogen-air mixtures. Engine power output is controlled by varying the fuel-air ratio. Achieving high part load efficiencies and low nitrous oxide levels.
BILLINGS, R. E. Billings Energy Research Corp. Provo, Utah	Investigation of techniques and parameters for using hydrogen as fuel in standard spark plug engines, Wankel and Sachs rotary engines, and also diesel engines. Use of metal hydrides to store hydrogen fuel.
de BOER, P. C. T. Sibley School of Mechanical and Aerospace Engineering Cornell University Ithaca, New York	Experimental program to determine efficiency, performance, and nitrous oxide emissions of internal combustion engines fueled with hydrogen. Direct cylinder injection of hydrogen, compression ignition, rate of combustion, and pre-ignition characteristics. Use of exhaust heat to convert liquid hydrogen to gaseous hydrogen at high pressure.
MCLEAN, W. J. Sibley School of Mechanical and Aerospace Engineering Cornell University Ithaca, New York	Working with analytical models of the hydrogen fueled reciprocating engine. The models are useful for predicting performance and emissions for engines fueled with hydrogen (or other alternative fuels) operating over wide ranges of engine design parameters, load, and fuel-air mixtures.
SCHOEPPEL, R. J. School of Mechanical Engineering Oklahoma State Engineering School Stillwater, Oklahoma	Research and development work using a dual fuel (hydrogen and hydrocarbons) concept for internal combustion engines. Fuels are not premixed and the H_2-HC ratio can be varied full range. Hydrocarbons are carbureted into the engine and the hydrogen is injected into the combustion chamber.

Expert Organization	Expertise
VAN VORST, W. D. Engineering Systems Department University of California Los Angeles, California	Comparison studies between hydrogen and gasoline fueled engines. Using water injection and exhaust gas recycling to control combustion rate of hydrogen fuel. Monitoring exhaust emissions. Two types of speed control: quality governing and ordinary throttling.
WEIL, K. H. Former Head, Department of Mechanical Engineering Stevens Institute of Technology Hoboken, New Jersey	Worked on conversion of existing internal combustion engines to hydrogen operation. Present research and development comprises hydrogen generation, storage, transportation, distribution and energy conversion. Special Consultant for hydrogen systems to National Academy of Sciences and National Research Council, Washington, D.C.

8.7 Hydrogen Fuel, General

ESCHER, W. J. D. Escher Technology Associates St. Johns, Michigan	Technological consulting in the area of hydrogen energy-environment. Special interest in the application of hydrogen to solar energy systems and to advanced transportation vehicles.
GREGORY, D. P. Institute of Gas Technology Chicago, Illinois	Studies of total hydrogen energy systems in which hydrogen replaces natural gas systems. Studies of hydrogen as a means of using nuclear energy in chemical, steel production, and the transportation industries. Pipeline transmission of hydrogen gas.
HOFFMAN, K. C. Head of Engineering Systems Div. SALZANO, F. J. Mgr. of Hydrogen Storage and Production Project Brookhaven National Laboratory Upton, New York	Systems analysis of methods for storing energy. Comparison of various methods of storing hydrogen with the main emphasis on using metal hydrides. Physical research of metal hydride materials. System studies for using stored hydrogen gas for peak loading by public utilities. Systems studies of electrolysis plants.
HORD, Jesse Cryogenics Division National Bureau of Standards Boulder, Colorado	Economic and technical feasibility studies of hydrogen-energy systems.

Expert Organization	Expertise
JOHNSON, J. E. Project Manager of Hydrogen Linde Division of Union Carbide Corp. New York, New York	Hydrogen fuel logistics. Methods of manufacture, distribution, and economics of supply.
MICHEL, J. W. Acting Technical Assistant of Advanced Energy Systems Linde Division of Union Carbide Corp. Oak Ridge National Laboratory Oak Ridge, Tennessee	Interest in all aspects of the hydrogen economy. Two experimental programs on fuel production; one on thermochemical methods of producing hydrogen and another program studying methods of producing fuel from garbage and farm waste.
NORAD, D. L. Chief, Laser and Energy Systems Branch NASA-Lewis Research Center Cleveland, Ohio	Studying techniques for using hydrogen for energy storage. Investigating complete hydrogen energy systems including production, transmission, storage, distribution, end use, and scenarios for implementation. Also involved in a joint AEC-NASA effort to study production of hydrogen from nuclear heat (using both coal conversion and thermochemical processes).

9.0 Safety and Hazards

This section contains a listing of individuals who are very knowledgeable about the hazards and safety requirements associated with hydrogen systems. There is a listing of experts who have had extensive experience in the storage and handling of liquid and gaseous hydrogen. Also listed is a group of people who are knowledgeable about the electrical codes and the electrical equipment to be used in class 1, Group B hazardous environments. There is a list of experts who have managed, supervised or conducted experimental work on hydrogen fires, explosions, and spills, and studied the parameters involved. Also included is a listing of experts who have been deeply involved in hydrogen safety since the early 1950's; a good share of these individuals have participated in the investigation of hydrogen incidents and accidents in recent years.

Expert Organization	Expertise
9.1 Storage and Handling of Hydrogen	
BAIN, A. L. Systems Engineer NASA - Kennedy Space Center Kennedy Space Center, Florida	Systems engineer in the support operations at KSC. Extensive experience with the storage, trailer transport, and distribution of LH_2 and LO_2 and the liquid to gas conversion systems at KSC.
BOWERS, W. M. Liquid Metal Engineering Center Atomics International Division of Rockwell International Canoga Park, California	Formerly, a facility engineer for an LH_2 fueled rocket engine test complex at Rocketdyne. Considerable experience with storage, handling, and testing with liquid hydrogen.
HENNINGS, Glen Chief Power Experiments Branch NASA - Lewis Research Center Cleveland, Ohio	Extensive experience with the storage, handling, and testing with hydrogen, oxygen, and fluorine at the Plumbrook and Lewis Research Center. Supervised liquid hydrogen transfer from 34,000 gallon rail tank cars; and use of the rail tank cars for run tanks during testing of liquid hydrogen pumps. Participated in the design and construction of large hydrogen storage and transport vessels for the Plumbrook facility.
SHAW, R. C. Chief, Cryogenic and Pressurant Section NASA-Marshall Space Flight Center Marshall Space Flight Center, Alabama	Responsible for the transport, distribution, and storage of cryogens and high pressure gases at MSFC. Responsibility for developing safety criteria and specifications for all the propellant transport trailers used at MSFC.
SIEWERT, R. D. ASRDI Program Manager NASA - Lewis Research Center Cleveland, Ohio	Helped supervise the storage and handling of liquid hydrogen at the Plumbrook facility for 12 years. Participated in the testing of rocket engine pumps at Plumbrook. Responsibility for the safety aspects of storage, transfer, and experimental operations with liquid hydrogen at the Plumbrook Test Facility.
WARD, R. G. Chief, Launch Operations Fuel Systems NASA-Kennedy Space Center Kennedy Space Center, Florida	Early experience with the Atlas program at General Dynamics. Extensive experience in handling RP-1 and liquid hydrogen for the Saturn and Atlas vehicles at Kennedy Space Center.

Expert Organization	Expertise
9.2 Electrical Codes and Equipment	
HALL, L. J. Engineering Mgr., Engineering Div. The Association of Mill and Elevator Insurance Companies (Mill Mutual) Chicago, Illinois	Chairman of the National Electric Code Panel 14. Extensive experience in the fire prevention field. Evaluation and survey of firms for fire hazards, and for meeting fire prevention standards for hazardous locations.
PEARSE, J. N. Appleton Electric Company Chicago, Illinois	Technical service and advice for Class 1, Group B hazardous location electrical equipment.
SCHRAM, P. J. Underwriters Laboratories, Inc. Northbrook, Illinois	Member of Panel 14, National Electric Code Committee. Manager of the section testing all electrical equipment for hazardous locations at Underwriters Laboratories. Type of equipment includes switching, lighting, and process and control equipment.
SHORT, W. A. Crouse-Hinds Company Syracuse, New York	Technical service and advice for Class 1, Group B hazardous location electrical equipment.
9.3 Hydrogen Fires, Explosions and Spills	
ALLAN, D. S. Arthur D. Little Company Cambridge, Massachusetts	Responsible for the early work by A. D. Little Company to determine the hazards associated with storing and handling large quantities of liquid hydrogen. Conducted unconfined LH_2 spill tests to analyze and determine the detonability of hydrogen vapor clouds. Spills of LH_2 with LO_2 were also conducted. Parameters examined were ignition sources, detonability range, electrostatic charge, explosive yield, and thermal radiation.
ATKINS, J. R. Director of Safety Office NASA-Kennedy Space Center Kennedy Space Center, Florida	A study manager for project PYRO; Investigation of LO_2-LH_2, TNT equivalencies, investigation of triggering methods for large spills of LO_2-LH_2, and other studies associated with triggering mechanisms of LO_2-LH_2 mixtures.

Expert Organization	Expertise
FLETCHER, R. F. NASA-Johnson Space Center Houston, Texas	Project manager for the Gemini Fireball Program; a series of tests to determine the explosion parameters and TNT equivalencies of LO_2 mixed with RP-1 and LH_2. Investigated the explosion characteristics of LO_2 mixed with RP-1 and LH_2 in rarified environments. Participated as a member of the Panel 7 investigation team for the Apollo 13 Incident. Participated in a NASA shuttle program study to determine if the initiation of the liquid propellants would tend to detonate the solid propellants on the shuttle vehicle.
HORD, Jesse Cryogenics Division National Bureau of Standards Boulder, Colorado	Analysis and synthesis of explosion criteria for liquid hydrogen test facilities.
PROFFIT, R. L. Program Manager of Environmental Analysis Laboratory Lockheed Electronics Co. Las Vegas, Nevada	Developed five different methods for the visualization of hydrogen fires; ultraviolet television, infrared television, infrared photography, ultraviolet photography, and an infrared telescope employing an image converter tube. Participated in the development of the AC/DC hydrogen fire detection system; NASA SP-5092.
REIDER, Roy Los Alamos Scientific Laboratory Los Alamos, New Mexico	Performed unconfined experiments wherein hydrogen gas was released in air at a high flow rate (120 pounds/second). Auto ignition occurred and a deflagration of explosive rapidity occurred. Accoustical, ignition, deflagration and explosive damage data were obtained.
RIEHL, W. A. Deputy Chief of Nonmetallic Materials NASA-Marshall Space Flight Center Marshall Space Flight Center, Alabama	Extensive research and development on the blast hazards of hydrogen in space vehicle liquid propellant systems within NASA-MSFC. Also assisted in directing project PYRO* (current basis for prediction of liquid propellant blast hazards).

* Project "PYRO" was a joint NASA/USAF liquid propellant explosive hazards program to determine the blast and thermal characteristics of the three liquid propellant combinations in most common use in military missiles and space vehicles.

Expert Organization	Expertise
SIEWERT, R. D. ASRDI Program Manager NASA - Lewis Research Center Cleveland, Ohio	Working in the area of fragments and explosions for all types of explosive materials. Program manager for a study grant entitled, The Analysis of the Structure of Blastwaves from Accident Explosions. A member of the technical steering committee for the safety and environmental protection group in JANNAF.
ULLIAN, L. J. Senior Ordinance Engineer Missiles Systems Safety Division (SEN) Headquarters Air Force Eastern Test Range Patrick Air Force Base, Florida	Participated in range safety work at Patrick Air Force Base. Participated as a Study Manager for project PYRO. Conducted and monitored an experimental program and study of the relationship of the interaction of liquid propellant initiation on the detonation of solid propellants.
VAN DOLAH, R. W. Research Director of Pittsburgh Mining and Safety Research Center Bureau of Mines Pittsburgh, Pennsylvania	Involved in active research, consultation, and accident investigation over a wide range of fires and explosions. Served as a member of the Apollo 204 Incident review board. Consultant to the AEC on hydrogen safety and nuclear reactors. Directed some early small scale experimental work on hydrogen spills, and subsequent work on LNG spills. Served as Chairman of the Advisory Committee of the Armed Services Safety Explosive Board.
ZABETAKIS, M. G. Mining Enforcement and Safety Administration Arlington, Virginia	Considerable experience in the field of hydrogen fires and explosions. Conducted the research necessary to prepare the Air Force quantity-distance tables for siting hydrogen storage vessels and experiments. Has participated as an expert in over 100 investigations of fires and explosions (all types) throughout the country.

Expert Organization	Expertise
9.4 Hydrogen Safety and Accident Investigations	
ATKINS, J. R. Director of Safety Office Kennedy Space Center Kennedy Space Center, Florida	Director of all safety operations (launch and ground support) at Kennedy Space Center. Extensive operational experience with LH_2 and LO_2 safety.
BALL, L. W. Director of Safety and Awareness NASA-Marshall Space Flight Center Marshall Space Flight Center, Alabama	Exercises management controls over the design, manufacturing, and use of hydrogen equipment. Responsible for the operational readiness inspections of hydrogen facilities.
BELLES, F. E. Manager of Research and Development American Gas Association Research Laboratories Cleveland, Ohio	Recently retired from NASA-Lewis Research Center as Director of the NASA Aerospace Safety Research and Data Institute (ASRDI). Presently doing research and development work on natural gas utilization, particularly product safety with respect to gas appliances. Area of expertise developed at NASA-Lewis includes combustion, fire hazards, detonation, cryogenic systems, and hydrogen safety. Participated in several NASA investigations involving hydrogen fires.
CHELTON, D. B. Cryogenics Division National Bureau of Standards Boulder, Colorado	Very active in the field of hydrogen safety. Participated as a member of the investigation team for the Cambridge Electron Accelerator explosion and fire. Participated as a member of the Manned Space Center Apollo 13 Incident investigation team. Participated in the investigation of the LNG storage tank explosion on Staten Island. Participated in hydrogen safety reviews of liquid hydrogen bubble chambers and rocket launch facilities. Author of several publications on hydrogen safety and technology.
CONLON, J. W. Chief Operations Safety Office NASA-Johnson Space Center Houston, Texas	Responsible for the overall operational safety of the Space Shuttle operations and hazardous manned testing. A member of the investigation team for the Apollo 204 accident, and also participated in the investigation of the Apollo 13 incident.

Expert Organization	Expertise
EDESKUTY, F. J. Los Alamos Scientific Lab. (LASL) Los Alamos, New Mexico	Member of the Apollo 13 Incident investigation team. Member of the LASL LH_2 safety committee and a member of the LASL meson physics safety committee.
HERNANDEZ, H. P. Lawrence Berkeley Laboratory Berkeley, California	Extensive safety experience in the area of liquid hydrogen bubble chambers. Conducted an external review of the safety aspects of the National Accelerator Laboratory (NAL) 15-foot LH_2 bubble chamber. Participated as a member of the safety investigation team for the Cambridge Electron Accelerator explosion and fire.
MCKINLEY, Clyde Director of Research and Development Cryogenic Systems Division Air Products and Chemicals, Inc. Allentown, Pennsylvania	Extensive experience in hydrogen safety. Participated in the investigations of several incidents at Air Products hydrogen liquefaction facilities at West Palm Beach, Florida.
ORDIN, P. M. Program Manager, NASA Aerospace Safety Research and Data Institute NASA-Lewis Research Center Cleveland, Ohio	Extensive experience in the field of safety with both hydrogen and oxygen. Fluid flow and flight safety studies for NERVA program and for ground and flight operations of early hydrogen aircraft.
PINKEL, Irving - Consultant 4671 West 210th Street Fairview Park, Ohio	Extensive experience in the design and development of LH_2 pumps and fuel systems for hydrogen fueled aircraft. Principal investigator for the Apollo 204 fire and participated as a member of Apollo 13 accident investigating team. Worked as Chief of the Fluid Systems Components Division at NASA-Lewis, and retired from NASA-Lewis as Director of the NASA Aerospace Safety Research and Data Institute (ASRDI). Previous experience at Bureau of Mines was involved with hydrogenation experiments and the design of a plant for the hydrogenation of coal.
REIDER, Roy Los Alamos Scientific Laboratory Los Alamos, New Mexico	Safety Director for the Los Alamos Scientific Laboratory. Active in LH_2 safety work for many years. Consultant to the advisory committee on reactor safeguards.

Expert Organization	Expertise
SCHLAFKE, A. P., Jr. Division Chief of Mechanical Engineering Brookhaven National Laboratory Upton, New York	Chairman of the Brookhaven Laboratory Cryogenic Safety Committee. Presently Manager of the Cryogenic Support and Design Group for the alternating gradient synchrotron. Participated as a member of the safety investigation team for the Cambridge Electron Accelerator explosion and fire.
SCHMIDT, A. F. Cryogenics Division National Bureau of Standards Boulder, Colorado	Extensive liquid hydrogen safety experience. Consultant to NASA, AEC, and USAF on hydrogen safety. Member of National Bureau of Standards Cryogenics Division Hydrogen Safety Committee.
ULLIAN, L. J. Senior Ordinance Engineer Missiles Systems Safety Div. (SEN) Hdqrs., Air Force Eastern Test Range (ETR) Patrick Air Force Base, Florida	Participated in range safety work at Patrick Air Force Base. Performed an investigation and study of all full scale Launch Vehicle Aborts at the Eastern Test Range and the Western Test Range. Involved in the siting and safety planning for firing tests of the first vehicle to use hydrogen. Participated as part of the investigation team for the Apollo 204 fire, the Sycamore Canyon Saturn S-IV fire and explosion, and the Atlas-Centaur launch pad liftoff failure which resulted in a fire and explosion.
ZABETAKIS, M. G. Mining Enforcement and Safety Administration Arlington, Virginia	Extensive experience in the field of hydrogen safety, fires and explosions; has participated in the investigation of over 100 fires and explosions (all types) throughout the United States. Authored the book, "Safety with Cryogenic Fluids," and has participated in many investigations on hazards involving hydrogen safety. Was in charge of the explosion portion of the investigation of the LNG storage tank disaster on Staten Island, and later participated in a grand jury hearing and subsequent House of Representatives hearings. Participated in the investigation of the Minuteman silo fire and explosion. Participated in the investigation of the fire and explosion at the Sacramento test firing stand involving an S-IV test bird.

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