

TECHNICAL AUDIT ASSOCIATES, INC.

585 OENOKE RIDGE
NEW CANAAN, CT 06840

(203) 966-0183

December 15, 1982

Dr. Nunzio J. Palladino, Chairman
Nuclear Regulatory Commission
Washington, DC 20555

Dear Joe:

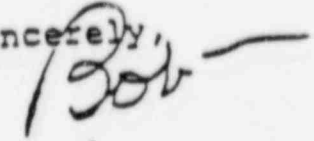
Ed Kintner and I want to thank you, Bill Dircks, Norman Haller, and Dan Garner for the time you spent with us Monday discussing our ideas of a study aimed at improving nuclear design and construction practices.

We did not respond adequately to your question concerning the relevance of such a study to federal regulation, a key point when considering NRC sponsorship. While it is true that our study would focus primarily on industrial practices and only secondarily on regulation practices in the various industries, it is also true that its ultimate aim is to improve nuclear plant quality. In this sense, it is correct to characterize the study as one to improve the quality and safety of the as-built plant. The study's safety connection highlights a feature which was not sufficiently emphasized in our notes or in our discussion with you, but which may bring it more into NRC's proper sphere of responsibility.

We intend to follow through with some of your and Bill Dircks' suggestions. If further consideration by you and your colleagues leads to NRC interest, please advise Ed or me.

It was a pleasure to see you again. We hope you enjoy a pleasant, relaxing holiday.

Sincerely,


Robert V. Laney

RVL:pb

cc: William J. Dirck
E. E. Kintner

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Notes for Discussion with
Chairman Palladino and Mr. Dircks

The integrity of some U. S. nuclear plants is widely believed to be on shaky ground. Substantive design and construction errors have cast doubt on the effectiveness of the process by which U. S. reactors are being built. The utility industry, the NRC, and the public have been dismayed by a succession of apparent blunders and mismanagement having no clear cause nor evident cure. There is agreement only on the effect: to slow construction, increase cost, and squander public confidence.

These events, emphasized in Dr. Palladino's San Francisco speech a year ago, have stimulated considerable NRC and industry activity. The NRC is extending its construction assessments, increasing the number of inspectors, requiring independent design reviews and performing its own design assessments, and conducting regional evaluations. The industry is developing criteria for self-evaluations and conducting workshops to strengthen management's commitment to quality. Both of these remedial programs are, we understand, under continuing review and development.

Without minimizing the importance of these initiatives, we should recognize that they have a serious shortcoming -- they look only inward. Industry self-evaluation criteria are based on best practices of the U. S. nuclear industry. While this has the advantage of working from existing experience, the process is largely one of self-examination. It is not

designed to identify or take advantage of practices in other industries or countries that may also be advantageous in meeting the end objective. In a similar way, expanded NRC initiatives, except for design assessments, appear to consist largely of doing more of or doing better what is already being done. Such purely introspective approaches are unlikely to produce either new ways of viewing the problem or innovative remedies.

It is pertinent to note that other U. S. industries, such as steel, automobiles, and electronics, are discovering that they too must look searchingly at themselves in a wider context. Neither the best technology nor the most effective management practices can safely be assumed to reside in one's own backyard.

A recent report of the National Academy of Engineering, "The Competitive Status of the U. S. Auto Industry," is instructive on the dangers of too much introspection by a troubled industry. After looking closely at automakers abroad, the authors assert that the decline of the U. S. automobile industry is due less to the commonly mentioned causes -- regulation, oil prices, the state of the economy -- than by factors internal to the industry and its productive federation. The report attaches considerable importance to the industry's capacity to view itself critically, and to innovate successfully both in technology and organization.

A nuclear utility chairman expressed a similar thought a few months ago, saying "...Our foreign competitors have gone

about the business of learning how to do things right the first time...We have been busy keeping imperfection under control."

Over the years, other high technology U. S. industries have designed and built complex non-nuclear facilities or equipment requiring great care in design and construction in order to function safely and reliably in hazardous environments. Also, the nuclear industries of other countries have built numerous U. S. style nuclear power plants using somewhat different methods. In the course of doing so these industries have developed their own implicit and formal procedures to ensure the end products meet acceptable levels of safety and reliability. An inspection of the gross difference between DuPont's outstandingly low "disabling accident frequency rate" and others in the chemical industry shows that a well designed, total program for insuring safety in design, construction, and operation can have significant impact.

We and several of our associates with whom we have discussed the nuclear problem believe that the program presently envisioned is not enough. (See attached letter from Dr. William H. Pickering.) The record of nuclear construction has been seriously damaged. A program to upgrade and to restore lost credibility should omit no reasonable step which could help, especially the rather obvious one of external comparisons. We believe that there would be value in an objective, searching comparison of the methods used in U. S. nuclear construction with methods used in several other high

technology industries which construct complex systems needing total reliability and integrity. The aim would be to identify practices which have served others well and which are not used in U.S. nuclear construction, but advantageously might be. Industries for comparison could include space launch facilities and space vehicles, commercial aircraft, nuclear submarines, and petrochemical plants. A similar comparison with Japanese and West German nuclear power plant construction methods would be included.

U. S. Non-Nuclear Industries

Our evaluation would encompass the following industries which design and construct plants or equipment that demand high standards of safety and reliability and which must therefore assure the integrity of the design and construction or manufacturing processes:

- Aeronautics, which has developed rigorous design, fabrication, quality control, testing, accident investigation, safety retrofit, and other procedures to insure that commercial aircraft are structurally sound and safe to operate under a variety of stressful conditions.
- Petroleum Refining and Chemical, which has a long history of designing and building large and complex facilities to handle and/or produce products that may be toxic or explosive. Many of the processes involve

temperatures, pressures, corrosive environments, and other factors which press the limits of technology.

- Submarine Construction, which involves the design and fabrication of large, complex vehicles that must operate safely in a hostile environment, where the failure of a single component can imperil the safety of the ship.
- Space, which involves the design and construction of both large and complex launch facilities and the space vehicles themselves. Launch facilities are immense, involving the handling of large amounts of explosive fuels and precise pre-launch checkout of complex control instrumentation. The vehicles themselves have requirements that are analogous to those of submarines.

Method of Operation

The non-nuclear industry review will be accomplished by a Review Panel composed of people who are experienced in the procedures of each of the selected industries, coordinated by people having experience in both the commercial and military nuclear power industries. The Panel will review and compare U. S. nuclear industry practices with those used in the other industries and note implicit or formal procedures used in other industries that appear to be different, and possibly better, than those now in use.

The Review Panel would be a working group and would be responsible for all findings. Each member of the Review Panel would be selected for his "hands-on" experience with design-construction as well as his broad perspective of all design, construction, and QA processes in the industry he represents. While the full Review Panel will participate in the formulation of ultimate findings and written report, two-man subgroups will independently study the practices in each of the selected industry categories, comparing them with the U. S. nuclear industry. The basis for this structure is that such people have the background to recognize quickly the implicit practices that lie behind the formal systems and procedures employed in their industry.

Foreign and non-nuclear industry practices would be assessed by on-site interviews with representatives at various levels as well as the review of selected, pertinent documentation. Particular attention will be paid to evidences of success or deficiency, methods of motivation, and infrastructure relationships which enhance product reliability.

At the conclusion of its work, the Panel would make an oral presentation of its findings, thus affording an opportunity for questioning individual members. Subsequently, the findings would be confirmed in a written report.

The Review Panel would consist of members such as those listed below. Should any member be unable to undertake or to complete this assignment, a fully qualified replacement will be provided.

Nuclear:

Mr. Edwin E. Kintner
Mr. Robert V. Laney

Aviation:

Mr. I. Irving Pinkel
Mr. Wilmot L. Whittier

Pet. & Chem.:

Mr. H. P. Broom
Dr. Dayton E. Clewell

Space:

Mr. William F. Brown, Jr.
Mr. W. H. P. Drummond

Submarine:

Mr. Bjorn Lund
Dr. Herman E. Sheets

Biographical information showing the qualifications and experience of each Review Panel member are attached.

Additional resource persons with special expertise as shown below would be retained to provide guidance and consultation as needed:

Utility Operation:

Mr. Louis H. Roddis, Jr.

Reliability and
Quality Assurance:

Dr. William H. Pickering

Pertinent Laws,
Standards, Regulations:

Mr. William O. Doub

December 7, 1982

R.V.L.
E.E.K.

9 November 1982

Mr. Frank B. Jewett, Jr., President
Technical Audit Associates, Inc.
589 Oenoke Ridge
New Canaan, Connecticut 06840

Dear Frank:

It has been a long time since I have corresponded with you about TAA, in fact, I think my last letter suggested that I was going to do some consulting for myself and would probably not have any further association with TAA. However, you have been sending me the TAA Briefs and in the most recent one, there is a discussion regarding your auditing of the nuclear reactor for the Washington Public Power Supply System.

About two years ago, I did a study for EPRI which I believe might be pertinent to your audit. This was an analysis of the techniques used by the space program, both military and civilian, to obtain reliability.¹ The motivation for the study was to see if some of these techniques would be useful for the industry. At that time I was also a member of an advisory committee for the Nuclear Safety Analysis Center of EPRI, and I became reasonably familiar with the problems at Three Mile Island and some of the other plants. It is obvious that the space industry has a much sounder approach to reliability than the nuclear industry. This was a great surprise to me, but there are numerous illustrations of practices which would not be tolerated in the space program, and quite obviously, Three Mile Island need never have happened if some very elementary reliability improvement steps had been taken.

In view of my interest in this field, I am writing to ask whether it would be appropriate for me to participate in some way in your nuclear audit program.

Sincerely,

Bill

W. H. Pickering
President

Reference 1: Reports published by EPRI as
NSAC 4 and NSAC 31

REVIEW PANEL

Biographical Information

Mr. Edwin E. Kintner, Chairman Review Panel, Member Nuclear Sub-Group. Consultant. Member TAA Technical Audit Board. Former Associate Director for Fusion Energy, Office of Energy Research, U.S. Department of Energy. Twenty-two years U. S. Navy, 14 years Naval Reactors Program: Project Officer, U.S.S. Nautilus and Sea Wolf Projects; Head, Advanced Design Group, Naval Reactors Branch; first Nuclear Power Superintendent, Mare Island Naval Shipyard; Assistant Manager for Operations, Pittsburgh Naval Reactors Office; Head, Advanced (Reactor) Design Group (including Shippingport); Manager, Naval Nuclear Program Quality Assurance Program; Head many Audit Reviews for quality in manufacturing plants and shipyards. Two years President and General Manager, South Portland Engineering Co., manufacture of large components for submarines and building medium-size ships. Ten years AEC: Assistant Director for Reactor Engineering and Deputy Director of Reactor Research and Development, responsible for design, development and manufacture of Fast Flux Test Facility and conceptual design of Clinch River Reactor. Two years Energy Research and Development Administration (ERDA): Deputy Director, Head, Magnetic Fusion Program. Five years U.S. Department of Energy (DOE): Head, Magnetic Fusion Program, Office of Energy Technology; Associate Director for Fusion Energy, Office of Energy Research.

Chairman: U.S. delegation, US/USSR, US/Japan Joint Fusion Power Coordinating Committees, U.S. Fusion Power Coordinating Committee; U.S. Representative: International Fusion Research Council, International Energy Agency Fusion Power Coordinating Committee. BS, US Naval Academy; MS naval construction and marine engineering, MS nuclear Physics, MIT.

Robert V. Laney, Deputy Chairman of the Review Panel Member Nuclear Sub-Group. Vice President of TAA, member of Technical Audit Board. Chairman TAA Review Panel, Washington Public Power Supply System, Plant Verification Program Audit, Member Review Panel, Nine Mile Point-2 cost-to-complete audit. Former Deputy Director, Argonne National Laboratory; Vice President and General Manager, Quincy Shipyard Division, General Dynamics; Technical Representative of AEC at Westinghouse Bettis Atomic Power Lab; Project Manager, Naval Reactor Program AEC & Bu Ships. Chairman Engineering Review Team, Wash State Public Power Supply System. Member, GPU & Commonwealth Edison Ad Hoc Advisory Committees on Three Mile Island; Member Presidential Board on National Breeder Reactor Policy. Consultant: Department of Energy; Argonne National Laboratory; MA Attorney General; Commonwealth Edison; State of Illinois. BS, U.S. Naval Academy; MS, M.I.T.; MBA, U. of Chicago.

Mr. Harry P. Broom, Overview Member Review Panel Petroleum Refinery and Chemical Sub-Group. Consultant. Member TAA Technical Audit Board. Former Executive Vice President, Ralph M. Parsons Company. Twenty-six years Parsons: Vice President, President Parsons-Jurden Corporation, Executive Vice President Ralph M. Parsons Corporation. Prior: process development, design and installation: Stone & Webster and Sun Oil, Houdry Process Corporation. Member: American Petroleum Institute, American Institute of Chemical Engineers, American Institute of Mining, Metallurgical and Petroleum Engineers. Licensed Professional Engineer New York and Pennsylvania. BS and Ch. E. University of Pennsylvania.

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Mr. William F. Brown, Jr., Overview Member, Review Panel Space Sub-Group. Retired. Distinguished Research Associate, NASA - Lewis Research Center. Member TAA Technical Audit Board. Former Chief Fracture Branch, NASA - Lewis Research Center; Consultant to: Centaur Rocket Project Office on Weld Quality Control in Main Propellant Tank, Working Group on Storage of Hydrogen Gas at High Pressures, Apollo Program on Fracture Control of S-11 Main Propellant Tanks, Committee on Failure of High Strength Materials, Apollo-13 Accident Review Board, NASA-Industry Panel to Establish Fracture Control for Space Shuttle, Cracking Problems in the Delta Rocket Hydrazine Tanks, Apollo Program on Material Selection for the Solid Propellant Booster Tanks, Space Shuttle Main Engine Ground Test Facility High Pressure Hydrogen System, Stress Corrosion Cracking in the SIB Booster for Apollo-Soyuz Program, Review Team for Investigation of Cracking Problems in the Shuttle Orbiter APU's. Present: Chairman, Air Force-NASA Independent Review Team on Fracture Control of the Aeronautical Support System for the Shuttle Inertial Upper Stage; Chairman, Committee on Materials Information Used in Computerized Structural Design and Manufacturing, National Materials Advisory Board, National Academy of Sciences; Chairman, ASTM Task Group on Dynamic Testing (Nuclear Reactor Pressure Vessel Surveillance Specimen's), Test Group on Fracture Testing of Beryllium. Fellow ASTM. Lincoln Welding Foundation Research Award, ASTM Charles B. Dudley Medal, NASA Medal for Exceptional Scientific Achievement, Apollo Flag Award. BSc and MSc in Metallurgical Engineering, Case Institute of Technology.

Dr. Dayton H. Clewell, Principal Member Review Panel Petroleum Refinery and Chemical Sub-Group. Consultant. Member TAA Technical Audit Board. Director Cordis Corporation and Mobil Research and Development Corporation. Former Senior Vice President, Mobil Oil Corporation. Thirty-nine years Mobil: Director Field Research Laboratories, Dallas, Texas; General Manager Research Department New York; Senior Vice President for Research and Engineering. Member: Climate Research Board, National Research Council; Energy Research Advisory Board, U. S. Department of Energy; MIT Corporation Development Committee, Visiting Committee for Ocean Engineering, Energy Laboratory Advisory Board. Fellow: American Association for the Advancement of Sciences, Woodrow Wilson National Fellowship Foundation. Member: American Physical Society, Sigma XI, National Academy of Engineering. Environmental Conservation Distinguished Service Award, American Institute of Mining and Metallurgical Engineers. BS and Ph. D. in Physics, MIT.

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Mr. William H. P. Drummond, Principal Member Review Panel Space Sub-Group. Retired. Member TAA Technical Audit Board. Thirty nine years Douglas Aircraft Co. and McDonnell Douglas Corp. Former Vice President Engineering McDonnell Douglas Astronautics, 6,000 personnel in design, test and production, Thor, Delta and Saturn Space programs, Spartan and other missiles; Director of Flight and Testing, Douglas Aircraft, AD, A3D, A4D, C-124 and C-133 military aircraft, DC-4, DC-6 and DC-8 commercial aircraft. Member AIAA, Tau Beta Pi, Sigma Xi. BS Aeronautical Engineering, University of Washington; MS Aeronautical Engineering, California Institute of Technology.

Mr. Bjorn Lund, Overview Member Review Panel, Submarine Construction Sub-Group. Consultant. Member TAA Technical Audit Board. Former Manager Engineering Quality Assurance, Electric Boat Division, General Dynamics Corporation. Twenty-five years Electric Boat: Chief Engineer USS Skate Nuclear and Maritime Gas-Cooled Reactor Plant Projects; Project Manager, EBORE Experiment; Head of a Mechanical Research Section; Project Manager NR-1 Power Plant Preliminary Design; Manager NR-1 Apparatus Evaluation; Program Manager, antenna steering carriages for undersea fixed acoustical range (AFAR); Manager of Engineering Quality Assurance; Chairman Trident Submarine Design Review Committee. Prior: Six years Allis-Chalmers General Machinery Division and seven years Kellogg Corporation. Certificate award from Secretary of War for Manhattan District Service, Citation from Naval Underwater Systems Center for Contributions to Project AFAR. Life member ASME. Licensed Professional Engineer Connecticut. Diplom-Vorprüfung, Technical Hochschule, Berlin-Charlottenburg; BS Mechanical Engineering MIT.

Mr. Irving Pinkel, Overview Member Review Panel Aviation Sub-Group. Consultant. Member TAA Technical Audit Board. Former Director, NASA Aerospace Safety Research and Data Institute. Thirty-seven TAA years government service: NACA Langley Research Center, Physics Division; Lewis Research Center, Associate Chief Physics Division, Chief Fluid Systems Components Division; NASA, Director of Aerospace Safety Research and Data Institute. Former Member: NACA Sub-Committees on Aircraft Fire Prevention; Icing Problems, Operating Problems; FAA Committee on Lightning Hazards to Aircraft; NASA Review Team on design of Centaur stage for Atlas-Centaur vehicle, Investigation Team for Apollo 204 and 13 accidents, Commercial aircraft accidents; Source Selection Boards for several major programs (e.g. NERVA). Consultant:

Flight Safety Foundation; USAF, aircraft vulnerability; AEC, safety features of proposed nuclear plants, Los Alamos Scientific Laboratory, Reactor Licensing Department. Fellow American Institute of Aeronautics and Astronautics, New York Academy of Sciences Flight Safety Foundation Award, Laura Tabor Barbour Award, NACA Distinguished Service Medal, NASA Sustained Superior Performance Award, American Institute of Aeronautics and Astronautics Medal for Systems Reliability and Safety. Professional Mechanical Engineer, Ohio. BA with honors University of Pennsylvania.

Dr. Herman E. Sheets, Principal Member of Review Panel Submarine Construction Sub-Group. Director of TAA, member of Technical Audit Board. Member TAA Review Panel and Expert Witness, Indian Point-2 Containment flooding audit. Member Review Panel: Nine Mile Point-2 cost-to-complete audit, Washington Public Power Supply System Plant Verification Program Audit. Direct of Engineering, Analysis and Technology, Inc. Former Chairman and Professor, Ocean Engineering Department, University of Rhode Island; sixteen years, Vice President, Engineering and Research, Electric Boat Division, General Dynamics Corporation; Engineer manager, Goodyear Aircraft; Program Manager, Elliott Co.; Director Research, St. Paul Engineer's Manufacturing Corporation; Chief Engineer, Chamberlain Res. Corp.; Design Engineer, Erste Bruenner Maschinen Fabrik. Cit. Sec. War, Manhattan Project. Members: National Academy of Engineering, New York Academy of Sciences, ASME, ASNE, SNA & ME. Associate Fellow, AIAA. Dipl Ing (1st in class), Tech. Inst., Dresden; Dr. Tech Sci, (award for excellence) Tech Univ, Prague.

Mr. Wilmot L. Whittier, Principal Member Review Panel Aviation Sub-Group. Consultant. Member TAA Technical Audit Board. Former Vice President, General Manager and Vice-Chairman Board of Directors, Douglas Aircraft Company of Canada Limited. Thirty-three years Douglas Aircraft Co: Northrup Division, Head Salvage Inspector; El Segundo Div, Head Liaison Engineer, Chief Draftsman; Tulsa Div, Engineering Manager; El Segundo Div, Chief Service Engineer, Engineering Manager, Factory Superintendent; Long Beach Div, Works Manager, Vice President and Deputy General Manager; Douglas Aircraft Co. of Canada, Ltd., Vice President and General Manager, Vice Chairman Board of Directors Former Consultant General Dynamics, DC-10 Fuselage Sub-Contract; member US Navy BUWEPs Industry Material and Reliability Board. Member American Institute of Aeronautics and Astronautics. Licensed Professional Mechanical Engineer California. UCLA, Physics Major 1930-33.

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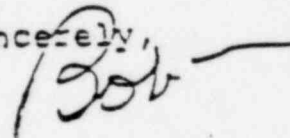
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Pet. & Chem.:	Mr. H. P. Broom Dr. Dayton H. Clewell
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Reliability and Quality Assurance:	Dr. William H. Pickering
Pertinent Laws, Standards, Regulations:	Mr. William O. Doub

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New Canaan, Connecticut 06840

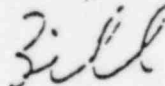
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Sincerely,



W. H. Pickering
President

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NSAC 4 and NSAC 31

REVIEW PANEL

Biographical Information

Mr. Edwin E. Hintner, Chairman Review Panel, Member Nuclear Sub-Group. Consultant. Member TAA Technical Audit Board.
Former Associate Director for Fusion Energy, Office of Energy Research, U.S. Department of Energy. Twenty-two years U. S. Navy, 14 years Naval Reactors Program: Project Officer, U.S.S. Nautilus and Sea Wolf Projects; Head, Advanced Design Group, Naval Reactors Branch; first Nuclear Power Superintendent, Mare Island Naval Shipyard; Assistant Manager for Operations, Pittsburgh Naval Reactors Office; Head, Advanced (Reactor) Design Group (including Shippingport); Manager, Naval Nuclear Program Quality Assurance Program; Head many Audit Reviews for quality in manufacturing plants and shipyards. Two years President and General Manager, South Portland Engineering Co., manufacture of large components for submarines and building medium-size ships. Ten years AEC: Assistant Director for Reactor Engineering and Deputy Director of Reactor Research and Development, responsible for design, development and manufacture of Fast Flux Test Facility and conceptual design of Clinch River Reactor. Two years Energy Research and Development Administration (ERDA): Deputy Director, Head, Magnetic Fusion Program. Five years U.S. Department of Energy (DOE): Head, Magnetic Fusion Program, Office of Energy Technology; Associate Director for Fusion Energy, Office of Energy Research.

Chairman: U.S. delegation, US/USSR, US/Japan Joint Fusion Power Coordinating Committees, U.S. Fusion Power Coordinating Committee; U.S. Representative: International Fusion Research Council, International Energy Agency Fusion Power Coordinating Committee. BS, US Naval Academy; MS naval construction and marine engineering, MS nuclear Physics, MIT.

Robert V. Lancy, Deputy Chairman of the Review Panel Member Nuclear Sub-Group. Vice President of TAA, member of Technical Audit Board. Chairman TAA Review Panel, Washington Public Power Supply System, Plant Verification Program Audit, Member Review Panel, Nine Mile Point-2 cost-to-complete audit. Former Deputy Director, Argonne National Laboratory; Vice President and General Manager, Quincy Shipyard Division, General Dynamics; Technical Representative of AEC at Westinghouse Pettis Atomic Power Lab; Project Manager, Naval Reactor Program AEC & Bu Ships. Chairman Engineering Review Team, Wash State Public Power Supply System. Member, GPU & Commonwealth Edison Ad Hoc Advisory Committees on Three Mile Island; Member Presidential Board on National Breeder Reactor Policy. Consultant: Department of Energy; Argonne National Laboratory; MA Attorney General; Commonwealth Edison; State of Illinois. BS, U.S. Naval Academy; MS, M.I.T.; MBA, U. of Chicago.

Mr. Harry P. Broom, Overview Member Review Panel Petroleum Refinery and Chemical Sub-Group. Consultant. Member TAA Technical Audit Board. Former Executive Vice President, Ralph M. Parsons Company. Twenty-six years Parsons: Vice President, President Parsons-Jurden Corporation, Executive Vice President Ralph M. Parsons Corporation. Prior: process development, design and installation: Stone & Webster and Sun Oil, Houdry Process Corporation. Member: American Petroleum Institute, American Institute of Chemical Engineers, American Institute of Mining, Metallurgical and Petroleum Engineers. Licensed Professional Engineer New York and Pennsylvania. BS and Ch. E. University of Pennsylvania.

Mr. William F. Brown, Jr., Overview Member, Review Panel Space Sub-Group. Retired. Distinguished Research Associate, NASA -- Lewis Research Center. Member TAA Technical Audit Board. Former Chief Fracture Branch, NASA - Lewis Research Center; Consultant to: Centaur Rocket Project Office on Weld Quality Control in Main Propellant Tank, Working Group on Storage of Hydrogen Gas at High Pressures, Apollo Program on Fracture Control of S-11 Main Propellant Tanks, Committee on Failure of High Strength Materials, Apollo-13 Accident Review Board, NASA-Industry Panel to Establish Fracture Control for Space Shuttle, Cracking Problems in the Delta Rocket Hydrazine Tanks, Apollo Program on Material Selection for the Solid Propellant Booster Tanks, Space Shuttle Main Engine Ground Test Facility High Pressure Hydrogen System, Stress Corrosion Cracking in the S1B Booster for Apollo-Soyuz Program, Review Team for Investigation of Cracking Problems in the Shuttle Orbiter APU's. Present: Chairman, Air Force-NASA Independent Review Team on Fracture Control of the Aeronautical Support System for the Shuttle Inertial Upper Stage; Chairman, Committee on Materials Information Used in Computerized Structural Design and Manufacturing, National Materials Advisory Board, National Academy of Sciences; Chairman, ASTM Task Group on Dynamic Testing (Nuclear Reactor Pressure Vessel Surveillance Specimen's), Test Group on Fracture Testing of Beryllium. Fellow ASTM. Lincoln Welding Foundation Research Award, ASTM Charles B. Dudley Medal, NASA Medal for Exceptional Scientific Achievement, Apollo Flag Award. BSc and MSc in Metallurgical Engineering, Case Institute of Technology.

Dr. Dayton H. Clewell, Principal Member Review Panel Petroleum Refinery and Chemical Sub-Group. Consultant. Member TAA Technical Audit Board. Director Cordis Corporation and Mobil Research and Development Corporation. Former Senior Vice President, Mobil Oil Corporation. Thirty-nine years Mobil; Director Field Research Laboratories, Dallas, Texas; General Manager Research Department New York; Senior Vice President for Research and Engineering. Member: Climate Research Board, National Research Council; Energy Research Advisory Board, U. S. Department of Energy; MIT Corporation Development Committee, Visiting Committee for Ocean Engineering, Energy Laboratory Advisory Board. Fellow: American Association for the Advancement of Sciences, Woodrow Wilson National Fellowship Foundation. Member: American Physical Society, Sigma XI, National Academy of Engineering. Environmental Conservation Distinguished Service Award, American Institute of Mining and Metallurgical Engineers. BS and Ph. D, in Physics, MIT.

Mr. William H. P. Drummond, Principal Member Review Panel Space Sub-Group. Retired. Member TAA Technical Audit Board. Thirty nine years Douglas Aircraft Co. and McDonnell Douglas Corp. Former Vice President Engineering McDonnell Douglas Astronautics, 6,000 personnel in design, test and production, Thor, Delta and Saturn Space programs, Spartan and other missiles; Director of Flight and Testing, Douglas Aircraft, AD, A2D, A4D, C-124 and C-133 military aircraft, DC-4, DC-6 and DC-8 commercial aircraft. Member AIAA, Tau Beta Pi, Sigma Xi. BS Aeronautical Engineering, University of Washington; MS Aeronautical Engineering, California Institute of Technology.

Mr. Bjorn Lund, Overview Member Review Panel, Submarine Construction Sub-Group. Consultant. Member TAA Technical Audit Board. Former Manager Engineering Quality Assurance, Electric Boat Division, General Dynamics Corporation. Twenty-five years Electric Boat: Chief Engineer USS Skate Nuclear and Maritime Gas-Cooled Reactor Plant Projects; Project Manager, EBOPE Experiment; Head of a Mechanical Research Section; Project Manager NR-1 Power Plant Preliminary Design; Manager NR-1 Apparatus Evaluation; Program Manager, antenna steering carriages for undersea fixed acoustical range (AFAR); Manager of Engineering Quality Assurance; Chairman Trident Submarine Design Review Committee. Prior: Six years Allis-Chalmers General Machinery Division and seven years Kellogg Corporation. Certificate award from Secretary of War for Manhattan District Service, Citation from Naval Underwater Systems Center for Contributions to Project AFAR. Life member ASME. Licensed Professional Engineer Connecticut. Diplom-Vorprüfung, Technical Hochschule, Berlin-Charlottenburg; BS Mechanical Engineering MIT.

Mr. Irving Pinkel, Overview Member Review Panel Aviation Sub-Group. Consultant. Member TAA Technical Audit Board. Former Director, NASA Aerospace Safety Research and Data Institute. Thirty-seven TAA years government service: NASA Langley Research Center, Physics Division; Lewis Research Center, Associate Chief Physics Division, Chief Fluid Systems Components Division; NASA, Director of Aerospace Safety Research and Data Institute. Former Member: NASA Sub-Committees on Aircraft Fire Prevention; Icing Problems, Operating Problems; FAA Committee on Lightning Hazards to Aircraft; NASA Review Team on design of Centaur stage for Atlas-Centaur vehicle, Investigation Team for Apollo 204 and 13 accidents, Commercial aircraft accidents; Source Selection Boards for several major programs (e.g. NERVA). Consultant:

Flight Safety Foundation; USAF, aircraft vulnerability; AEC, safety features of proposed nuclear plants, Los Alamos Scientific Laboratory, Reactor Licensing Department. Fellow American Institute of Aeronautics and Astronautics, New York Academy of Sciences Flight Safety Foundation Award, Laura Tabor Harbour Award, NACA Distinguished Service Medal, NASA Sustained Superior Performance Award, American Institute of Aeronautics and Astronautics Medal for Systems Reliability and Safety. Professional Mechanical Engineer, Ohio. BA with honors University of Pennsylvania.

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Mr. Wilmot L. Whittier, Principal Member Review Panel Aviation Sub-Group. Consultant. Member TAA Technical Audit Board. Former Vice President, General Manager and Vice-Chairman Board of Directors, Douglas Aircraft Company of Canada Limited. Thirty-three years Douglas Aircraft Co: Northrup Division, Head Salvage Inspector; El Segundo Div, Head Liaison Engineer, Chief Draftsman; Tulsa Div, Engineering Manager; El Segundo Div, Chief Service Engineer, Engineering Manager, Factory Superintendent; Long Beach Div, Works Manager, Vice President and Deputy General Manager; Douglas Aircraft Co. of Canada, Ltd., Vice President and General Manager, Vice Chairman Board of Directors Former Consultant General Dynamics, DC-10 Fuselage Sub-Contract; member US Navy BUWEPs Industry Material and Reliability Board. Member American Institute of Aeronautics and Astronautics. Licensed Professional Mechanical Engineer California. UCLA, Physics Major 1930-33.

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Mr. Bjorn Lund, Overview Member Review Panel, Submarine Construction Sub-Group. Consultant. Member TAA Technical Audit Board. Former Manager Engineering Quality Assurance, Electric Boat Division, General Dynamics Corporation. Twenty-five years Electric Boat: Chief Engineer USS Skate Nuclear and Maritime Gas-Cooled Reactor Plant Projects; Project Manager, EBORE Experiment; Head of a Mechanical Research Section; Project Manager NR-1 Power Plant Preliminary Design; Manager NR-1 Apparatus Evaluation; Program Manager, antenna steering carriages for undersea fixed acoustical range (AFAR); Manager of Engineering Quality Assurance; Chairman Trident Submarine Design Review Committee. Prior: Six years Allis-Chalmers General Machinery Division and seven years Kellogg Corporation. Certificate award from Secretary of War for Manhattan District Service, Citation from Naval Underwater Systems Center for Contributions to Project AFAR. Life member ASME. Licensed Professional Engineer Connecticut. Diplom-Vorprüfung, Technical Hochschule, Berlin-Charlottenburg; BS Mechanical Engineering MIT.

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Flight Safety Foundation; USAF, aircraft vulnerability; AEC, safety features of proposed nuclear plants, Los Alamos Scientific Laboratory, Reactor Licensing Department. Fellow American Institute of Aeronautics and Astronautics, New York Academy of Sciences Flight Safety Foundation Award, Laura Tabor Harbour Award, NACA Distinguished Service Medal, NASA Sustained Superior Performance Award, American Institute of Aeronautics and Astronautics Medal for Systems Reliability and Safety. Professional Mechanical Engineer, Ohio. BA with honors University of Pennsylvania.

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