DOCKETED

Docket Number:	19-ERDD-01
Project Title:	Research Idea Exchange
TN #:	235425-4
Document Title:	Paul Lieberman Resume
Description:	N/A
Filer:	Patty Paul
Organization:	Lieberman Research Associates
Submitter Role:	Public
Submission Date:	10/26/2020 3:17:57 PM
Docketed Date:	10/26/2020

PAUL LIEBERMAN
DoD *Top Secret* Clearance (IITRI)
DoD *Secret* Clearance (TRW)
DoD *Secret* Clearance (NTS)

Education

B.S.	Aeronautical Engineering - New York University
M.S.	Aeronautical Engineering - Princeton University
Ph.D.	Applied Mechanics - Illinois Institute of Technology

Professional Experience

2000	-present	EnisEnerGen LLC
1999	- present	Lieberman Research Associates
1981	- 1999	NTS Engineering, Los Angeles, CA
1969	- 1981	TRW, Redondo Beach, CA
1957	- 1969	Illinois Institute of Technology/Research Institute (IITRI)
1955	- 1957	Experimental Rocket Engine Test Station, Edwards Air Force Base, CA (1st Lt USAF, Capt USAF Reserve)
1954	Summer	Rocket Department, Bell Aircraft Corp, Buffalo, New York

Awards:
New York State Regents Scholarship (New York University)
Guggenheim Fellowship (Princeton University)

LRA Contracts

- Upgrade Performance Radiation Heat Transfer from Heatwurx System to Road Asphalt, Greenwood Village, Colorado
- Hose-In-Hose Transfer Line Service Life DNFSB Response Support", Defense Nuclear Facilities Safety Board, Washington River Protection Solutions, LLC (WRPS), Richland, Washington
- Liquid Nitrogen Test Facility Design for NASA Orbital Space Plane (Orbital Sciences Corp., Dulles, VA)
- Risk Management and Prevention Program Refrigeration Storage (Smithway Associates, Commerce, California)
- Buckling Test Design and Test Conduct of Orion Rocket Engine Columbium/Titanium Nozzle at High Temperature (Aerojet)
- Explosives Bunker Design (Dynamic Testing Inc (DTI) Site, Rustburg, VA) Liquid Nitrogen Blow-down Test Setup Design (NTS, Santa Clarita, CA))
- Plan and Conduct Lifetime Prediction Tests for Hose-in-Hose Transfer Lines (HIHTL) of
- Radioactive, Warm and Pressurized Waste Water (*CH2M-Hill)*

Specializations

- Compressed Air Energy Storage Systems
- Reduced Natural Gas Consumption for Combustion Turbines
- CO2 Sequestration
- Natural Gas Recovery from Gas Shale and Coal Beds
- Mine Clearance by Directed Strong Shock Pulses
- Toxic Cloud Capture and Incineration
- Liquid Hydrogen Testing

- High Intensity Acoustics and Acoustic Silencers
- Air Blast, Dust and Ground Shock Weapons Effects
- Piezo-Resistive Pressure Gages (>20 kilobars)
- Microwave and Optical Displacement Gages
- Material Equation-of-State, Shock Propagation and Blast Shields

Languages: Fluent in German; Read and Understand Spanish without dictionary, Read and Understand Russian and Hebrew with Dictionary.

PATENTS

1. **Method and Apparatus for Using Wind Turbines to Generate and Supply Power to Locations Remote from the Power Grid**

   US 6,927, 503 B2 **August 9, 2005**

   US 7,067,937 **June 27, 2006**

   US 7,250,691 **July 31, 2007**

   (Original Wind Energy Patent)

   Gear Box in Wind Turbine nacelle drives generator , Emergency fuel burner, Recover compressor waste heat, Solar thermal collector, Mass of liquid inside pressure vessel, Output cold air to air compressor, Output air to refrigeration facility

2. **Method of transporting and storing wind generated energy using a pipeline**
   US 7,504,739 B2 **March 17, 2009**
   US 7,755,212 **July 13, 2010**
   (Pipeline)
   The method involves storing and transporting power in the form of compressed air energy, via a pipeline. The method preferably consists of using at least one power source such as a wind turbine to drive a compressor to compress air into storage, wherein the size and length of the pipeline can be adapted to reduce the pressure losses that are experienced along the length of the pipeline. The facility or community using the energy can use energy in the form of electricity, or to drive pneumatic tools or equipment, or to generate chilled air as a by-product, which can be used for refrigeration, air conditioning or desalination. A utility or grid can be provided to generate compressed air energy when the wind is not blowing, wherein compressed air energy can be produced and stored during low demand periods, and used during high demand periods.

3. **Method of Coordinating and Stabilizing the Delivery of Wind Generated Energy**
   US 6,963,802 B2 **November 8, 2005**
   US 7,308,361 **December 11, 2007**
   US 7,974,742 **July 5, 2011**
   (Coordinating)
   Gear Box in Wind Turbine nacelle drives generator, Use wind predictions, Emergency fuel burner, Recover compressor waste heat, Solar thermal collector, Mass of liquid inside pressure vessel, Output cold air to air compressor, Output air to refrigeration facility.

4. **Method and Apparatus for Storing and Using Energy to Reduce the End-User Cost of Energy**
   US 7,155,912 B2 **January 2, 2007**
   (Co-Generation)
   Gear Box in Wind Turbine nacelle drives generator, Emergency fuel burner, Recover compressor waste heat, Solar thermal collector, Mass of liquid inside pressure vessel, Output cold air to air compressor, Output air to refrigeration facility, Time shifting the electrical power from grid.

5. **Thermal energy storage system using compressed air energy and/or chilled water from desalination processes**
   US 7856843 B2 **Dec 28, 2010**
   Australian 2014202086 (pending) **April 14, 2014**
   Chinese ZL200780046557.7 **October 18, 2007**

South Africa 2009/03446 **October 18, 2009**

(TES)

The invention relates to a universal system for producing cost effective energy particularly for cooling purposes. In one embodiment, wind turbines are used to generate electricity and compressed air energy, wherein the compressed air energy is used to co-generate electricity and chilled air. The chilled air is then used to chill water in either a mixing chamber, or a desalination system, wherein the chilled water is stored in a separation tank, wherein it can later be used to provide cooling for an air conditioning system for a facility. When desalination is used, the system produces chilled fresh drinking water which can be used for air conditioning, and then used as fresh drinking water. Any exhaust chilled air can be used directly for air conditioning.

6. **Desalination method and system using compressed air energy systems**

US 8,695,360 B2	**April 15, 2014**
US 8,863,547	**October 21, 2014**
Australian 2007238919 (pending)	**March 30, 2008**
South Africa 2008/09457	**March 30, 2008**

(Desalination)

The invention relates to a desalination method and system that uses freeze crystallization technology that incorporates the use of compressed air energy as the source for freezing temperatures. When compressed air is released by a turbo expander, chilled air is produced as a by-product, wherein the chilled air is introduced into a crystallization chamber. Also injected into the chamber is a spray cloud of seawater droplets, which has been pre-chilled by heat exchange with the cold chamber walls, and which is then circulated and exposed to the chilled air in the chamber. The sizes of the droplets can vary, but are preferably predetermined, along with the relative temperatures, flows and speeds of the spray and chilled air, such that when the droplets are circulated within the chilled air, and settle at the bottom of the chamber, they are deposited at slightly above the eutectic temperature. This way, the ice/snow mass that forms at the bottom of the chamber will consist of frozen ice crystals, and a residue of salt water brine, which can runoff from the mass, either from the sides, or through any voids or channels that may form within the mass

7. **Desalination method and system using a Continuous Helical Slush Removal System**

US 2010-0018247 A1	**January 28, 2010**
Australia 2014202087	**April 14, 2014**
South Africa 2009/01223	**July 24, 2009**

(Helical Screw)

8. **Mineral recovery system for desalination**

US 8,677,769 B2	**March 25, 2014**

(Mineral Recovery)

The invention relates to a mineral recovery system that processes concentrated brine leftover from a desalination system, wherein the brine is introduced into a crystallization chamber in the form of a spray, and wherein by mixing it with super chilled air from the desalination system, the droplets will flash freeze and form a super chilled slurry mixture, wherein an agitator for mixing the super chilled slurry is provided at or near the bottom of the crystallization chamber. Multiple stilling chambers are preferably provided for further separating the water from the concentrated brine, to produce a heavily concentrated sludge containing mineral solids that can be removed from the brine and recovered for commercial purposes

9. **Method and Apparatus for Removing Carbon Dioxide from Coal Combustion Power Plants**

US 2009/0205364 A1 (Pending)	**August 20, 2009**
Australia 2009206700	**January 23, 2009**
South Africa 201005995	**January 23, 2010**

(CO2 removal)

High mass flow of super chilled air is heat exchanged with the effluent from the smoke stack to extract the CO2 as a mass of dry ice crystals. The dry ice is used in a variety of commercial industries.

10. **Method and Apparatus for Sequestering CO2 Gas and Releasing Natural Gas from Coal and Gas Shale Formations**

U.S. 8,839,875	**September 23, 2014**
US 14/452,845 (pending)	**November 27, 2014**

A system for sequestering CO2 gas and releasing natural gas from underground coal and/or gas shale formations using CO2 gas captured from the flue gas of a coal burning power plant, and processing it to produce cold liquid pressurized CO2, and injecting the cold liquid CO2 under pressure to create fractures within the formation and causing the CO2 to be adsorbed into the coal or gas shale and CH4 to be desorbed, released and recovered. No high volume of water, no toxic additives to the water and no sand proppants are used for hydro-fracture of the gas shale or coal bed.

11. **Method and Apparatus for Using Solar Energy to Enhance the Operation of the Energy Storage System**

US 8,024,928 B2	**September 27, 2011**

(Solar Enhancement)

Nearby solar thermal energy collectors circulate fluid to pressure vessels during daytime

12. **Method and Apparatus for Using Compressed Air to Increase the Efficiency of a Fuel Driven Turbine Generator**

US 8,833,083	**September 16, 2014**
Australia 2009302875 (pending)	**May 5, 2011**

Chinese ZL200998049023.6 **October 6, 2009**

(CTT)

Chilled air from turboexpander combined with ambient air, centrifuged and then sent to electricity Generator Set (GenSet)

13. **Wind Turbine Station and Tower with Vertical Storage Tanks**
    US 14/849,685 (pending) **September 10, 2015**
    (Vertical Tanks)

14. **Method and Apparatus for Using Pressure Cycling and Cold Liquid CO2 for Releasing Natural Gas from Coal and Shale Formations**
    US 8,833,474 **September 16, 2014**
    US14/458,432 (pending) **December 4, 2014**
    (CO2 pressure cycling)
    Higher injection pressures than are conventionally used rubblizes the stratum so that it has more than a hundredfold increase in permeability that permits more rapid removal of the natural gas. Furthermore, the horizontal injection of the LCO2 jet avoids the expense of horizontal drilling. The emphasis herein is the higher pressure used in fracturing to induce rubble.

15. **Method and Apparatus for Using Frozen Carbon Dioxide Blocks or Cylinders to Recover Oil from Abandoned Oil Wells**
    US 14/671,424 (pending) **September 17, 2015**
    (CO2 ice blocks)

16. **Method and Apparatus for Using Wind Energy or Solar Energy for an Underwater and/or for an Under Seabed Compressed Air Energy Storage System**
    US 13/610,044 (Pending) **September 11, 2011**
    (CAES System under water)
    This disclosure refers to the CAES system that is off shore and wherein the pressure vessel and pipes are under water or that are under the soil bed below the water. This permits less costly reinforced concrete pressure vessels. Also the heat input is obtained from the warm seawater via the compressed air pipe between the seabed and the surface.

17. **Method and Apparatus for Integrating On-Shore Green and Other On-Shore Power Sources with a Compressed Air Energy Storage System on a Floating Power Plant.**
    (Floating Power Plant)
    The invention relates to a method and apparatus that shares the cost and areal footprint of the barge floatation platform for a floating power platform (FPP) with the cost and aerial footprint of the high pressure vessels of the compressed air energy storage (CAES)

system. The integration of these two systems provides cost savings and energy consumption savings with potential for desalination.

US 9,903,272 May 7, 2013

18. Eutectic Freeze Crystallization Spray Chamber

US 15/209,666	**July 13, 2016**
DE 2017.022816522100	**July 13, 2016**
PCT/US17/41569	**July 13, 2016**
TW 8151299	**July 13, 2016**

19. Green Energy Communities

US 15/585,035	**May 2, 2017**
PCT/US18/30727	**May 2, 2017**

20. Gas Turbine System

US 15/632,081	**June 23, 2017**
PCT/US18/25267	**June 23, 2017**

21. Explosive Separation of Impurities from Waste Water in Freeze Crystallization Spray Chambers

US 10,167,205	**January/01/2019.**
DE 2018/022223433400	**February 2, 2018**

22. Enhanced Ice Particle Capture Duct Using Resonance and Turbulence
US 62/62,687,671 June 25, 2108

23. Energy Storage Barge
US 16/042,149 July 23, 2018

24. Efficient Compressed Air Energy Storage Barge
US 62873157 July 11, 2019

25. Wastewater Purification Chamber System and Methods
US 63054698 July 17, 2020

26. System and Methodology of an Enhanced Advanced Adiabatic Compressed Air Energy Storage (E-AA-CAES) System with Heat Transfer from Sun and to Soil
US 63072036 August 28, 2020.

TECHNCAL PAPERS

COMPRESSED AIR ENERGY STORAGE (CAES) SYSTEMS

Hurley W.L., Orthmann, A., Lieberman, P., and Enis, B., "Engineering and Cost Study of an Offshore Wind Farm Compressed Air Energy Storage System", Offshore Energy and Storage, Brest, France OSES2019.

Enis, B. and Lieberman, P. "Economical Combination of Unique Wind Turbine Towers and Transportable Compressed Air Energy Storage (T-CAES) Systems", BIT's 1st New Energy Forum, Session 2 Wind Energy, Shenzhen Convention & Exhibition Center, China, November 4-5, 2011

Enis, B., Lieberman, P. and Rubin I. (Enis WindGen Renewable Energy Systems LLC) van der Linden, S. (Brulin Associates) "Transportable – Compressed Air Energy Storage (T-CAES) System, 1 To 10 Mw and 3 Hours Discharge, Including Solar Irradiation" Power Gen International Conference, Las Vegas, Nevada, December 8 – 10, 2009

Enis, B., Lieberman, P. and Rubin, I. (Enis WindGen Renewable Energy Systems), Pradels, F. (Pacific Industrial Electric) and van der Linden, S. (Brulin Associates LLC), "Integrated Wind Turbine Generator (WTG), Transportable Compressed Air Energy Storage (T-CAES), Desalination And Mineral Recovery Systems", Electrical Energy Storage Systems Applications and Technologies (EESAT 2007), Westin St. Francis Hotel, San Francisco, CA, September 23 – 26, 2007.

Enis, B., Lieberman, P. and Rubin, I, (Enis Windgen® Renewable Energy Systems LLC) and van der Linden, S. (Brulin Associates LLC) "Wind Turbine Generator and Compressed Air Energy Storage System for Production of Electrical Power and Co-generation of Chilled Air for Desalination", 20th International Conference on Efficiency, Cost, Optimization, Simulation and Environmental Impact of Energy Systems, University of Padova, Department of Mechanical Engineering, Padua, Italy, June 25-28, 2007.

Enis, B., Lieberman, P. and Rubin, I, (Enis Windgen® Renewable Energy Systems LLC), Fred Pradels (Pacific Industrial Electric, "Integration Of Wind Turbine Generator And Transportable Compressed Air (T-CAES) System for Electrical Power and Desalination" Power-Gen Renewable Energy and Fuels, Mandalay Bay Convention Center, Las Vegas, March 6-8, 2007.

Enis, B., Lieberman, P. and Rubin, I, (Enis Windgen® Renewable Energy Systems LLC), Bergmann, D and Dirlam R (Mafi-Trench Inc) van der Linden, S. (Brulin Associates LLC), "Turboexpander And Storage Tank Design Considerations For The Transportable Compressed Air Energy Storage (T-CAES) System", POWER-GEN INTERNATIONAL '2006, Orange County Convention Center, 9800 International Drive, Orlando, FL 32819-8199, Nov. 28 - 30, 2006.

Enis, B., Lieberman, P. and Rubin, I, (Enis Windgen® Renewable Energy Systems LLC) van der Linden, S. (Brulin Associates LLC), "Transportable Compressed Air Energy Storage (T-Caes) System Driven By A 2,500-Kw Wind Turbine", 19th International Conference on Efficiency, Cost, Optimization, Simulation and Environmental Impact of Energy Systems, Capsis Hotel, Aghia Pelagia, Crete, Greece, 12-14 July 2006 (Oral Presentation).

Enis, B., Lieberman, P. and Rubin, I, "Transfer Line Compressed Air Energy Storage (TL-CAES) System for a Onshore/Offshore Wind Farm Using 100-mile Long Pneumatic Pipeline", American Wind Energy Association and Department of Energy Conference, Pittsburgh, Pennsylvania, June 4,7, 2006.

Lieberman, P. and Rubin, “Test and Evaluation of Heat Transfer Parameters for Transportable Compressed Air Energy Storage (T-CAES) System”, EESAT 2005, San Francisco, CA October 17-19, 2005

Enis, B., Lieberman, P. and Rubin, I, “Sensitivity Analysis of A Wind Energy Storage System In Above Ground Tanks For Cogeneration Of Chilled Air And Hot Water” Global WINDPOWER Conference, March 28-31, 2004 in Chicago, Illinois, USA

Enis, B., Lieberman, P. and Rubin, I. “Integrated System of Wind Turbines, Small Volume Compressed Air Energy Storage (CAES), Thermal Inertia, Solar Heating and a Fossil Fuel Burner to Supply Uninterrupted Power to Locations Remote from the Power Grid”, American Wind Energy Association and Department of Energy Conference, Austin, Texas, May 18-21, 2003.

Enis, B., Lieberman, P. and Rubin, I. ”Method to Coordinate the Use of Three Different Wind Turbine Systems in a Wind Farm Using Small Volume Compressed Air Storage (CAES) to Supply Uninterrupted Power to Locations Remote from the Power Grid”, European Wind Energy Association Conference, Madrid, Spain, June 16-19, 2003

Enis, B., Lieberman, P. and Rubin, I “Operation Of Hybrid Wind Turbine System For Connection To Electric Grid Networks And Cogeneration “ Wind Engineering: the international journal of wind power, The Amset Centre, Horninghold, Leics LE16 8DH,United Kingdom, volume 27, issue 6, Oct/Nov Winter, 2003.

Enis, B., Lieberman, P. and Rubin, “Coordination Of Conventional System, Wind Energy Storage System And Hybrid System For A 40-Megawatt Wind Farm For Operation WITH The Electrical Power Grid” EESAT 2003, San Francisco, CA October 27-29, 2003.

AERODYNAMIC

Lieberman P. and Rehard J., "Test Facility for Dust Laden Air at High Speed and Altitude", 79th Supersonic Tunnel Association Semi-Annual Meeting, University of Texas, March 28-30, 1993.

Lieberman P. and Carlson L. "NTS Rye Canyon 4 Ft by 4 Ft Supersonic Wind Tunnel" 78th Supersonic Tunnel Association Semi-Annual Meeting, Brooklyn Polytechnic University and General Applied Science Laboratories, October 19-20, 1992.

Lieberman, P., "Re-entry Cone Model Testing in a Hypersonic Tunnel" IES Chapter Letter 1992.

STRESS WAVE MOTION IN SOLIDS

Lieberman, P., Shock Impingement Experiments on Crushable Solids, ARF 4132-10, U.S. Atomic Energy Commission, June 1959.

Lieberman, P., Numerical Solution of Wave Propagation Problems in Layered Inelastic Materials, (with T. A. Zaker) Symposium of Computers, Laboratorio National de Engenharia Civil, Avenida do Brasil, Lisbon, Portugal, October, 1962.

Lieberman, P., An Experimental Technique for Measurement of the Wave Propagation in Crushable Materials, 9th Annual Meeting, American Nuclear Society, June 1983.

Lieberman, P., Selection of a Crushable Material for an Efficient Impact Attenuator, 5th U.S. National Congress of Applied Mechanics, Minneapolis, Minnesota, June 1966.

Lieberman, P., Diffraction Around Two Imbedded Cylinders as Applied to HRS Test, 8 January 1970, 13865-6050-RO-00, TRW.

Lieberman, P., Displacement History of Blast Loaded Soils, V&H Laboratory 16430-6191-RO-00, 28 October 1970.

Lieberman, P., Selection of Equations of State for Blast Attenuation, Paper Number 70-WA/APM-12, ASME, 9lst Winter Annual Meeting, December 1970.

Lieberman, P., "Pyrotechnic Plate Analysis and Test Results", Proceedings of the 28th International Instrumentation Symposium, Las Vegas, May 1982, pp 713-733.

Lieberman, P., J. Rehard, J. Czajkowski, "High Level Acoustic Noise, High Temperature Environmental Test Programs", Institute of Environmental Sciences, New Orleans, LA, May 1990.

WAVE MOTION IN FLUIDS

Lieberman, P., and Brown E.A., Pressure Oscillation in a Water Cooled Nuclear Reactor Induced by Water Hammer Waves, Trans. Am. Soc. Mech. Engrs., 820, No. 4, 1960.

Lieberman, P., Blast-Wave Propagation in Hydraulic Conduits, J. Eng. Power, Trans. Am. Soc. Mech. Engrs., 87A, No. 1, 19-28-1965.

Lieberman, P., Design Methods for Missile Site Radar Piping System, U.S. Army Engineer Division, Huntsville, Corps of Engineers, August 1969.

Lieberman, P., Performance of Special Surge Tank to Transients, Ralph M. Parsons Company, L.A., January 1961.

Lieberman, P., O'Neill, J.P., Freeman, D.E., and Gibbs, A.H., Design of a Blast Load Generator for Overpressure Testing, 46th shock and Vibration Symposium, San Diego, California, 21-23 October 1975.

WAVE MOTION IN GASES

Lieberman, P., and Czajkowski, J., "Innovative Acoustics: Focusing on the Effects of Acoustics and Vibration on Payloads at Launch (Space Test Seminar)" Aerospace Testing Expo2005, North America, Long Beach Convention Center, Long Beach, CA, November 8-11, 2005

Lieberman, P., and Czajkowski, J., "Innovative Developments At The NTS Acoustic Reverberant Chamber" Institute of Environmental Sciences and Technology (IEST) Annual Technical Meeting and Exposition, Hyatt Regency Phoenix, Phoenix, Arizona, May 18-21, 2003

Lieberman P., Bocksruker R., Pilgram M., and Vallance C., "Progressive Wave Tube Facility with Additional Capabilities" , 31 st Aerospace Sciences Meeting, AIAA Paper #93-0288, Reno, Nevada, January 11-14, 1993

Lieberman, P. and R. Bocksruker. "Unusual Capabilities of a Circular Progressive Wave Tube", Test, Engineering and Management. Volume 53, Number 6, December/January 1991-1992, pp. 20-24.

Lieberman, P., Design of an Apparatus to Measure the Admittance of a Convergent Nozzle to High-Frequency Longitudinal Oscillations, Princeton University, Department of Aeronautical Engineering, November 1956.

Lieberman, P. and Nakamura, T. Fiber Optic Leak Detection System, Gas Research Institute Technical Report No. 1524, Contract No. 5085-252- 1153, Chicago, Illinois, July 1988 (Final Report).

Lieberman, P., et al. Wind Noise and Durability Study, General Motors Corporation, Buick-Oldsmobile-Cadillac Group, NTS Project 85-1514, Fullerton, California, September, 1985. (Final Report).

Haber, J. and Lieberman, P. Channel Island Sonic Boom Analysis For Titan IV Launches From SLC7, NTS Final Report 1653, November 1988.

Lieberman, P. and A. Edelstein, Acoustic Noise/Temperature Test Program, Institute of Environmental Sciences, Fullerton, CA, October 6, 1989.

Lieberman, P., A High Intensity Acoustic Test Facility Using Hydraulics, 17th Aerospace Testing Seminar, Institute of Environmental Sciences, Manhattan Beach, CA, October 1997.

THERMODYNAMICS

Hacker, D.S., and Lieberman, P., Underwater Ramjets May Drive Subs Faster, SAE Journal Reprint, October 1961.

Lieberman, P., and Hacker, D.S., Thermodynamic Performance Evaluation of a Hydroduct Using a Thermite Fuel, Journal of Hydronautics, Volume 3, July 1969.

HEAT AND MASS TRANSFER

Lieberman, P., Transient and Steady State Heat Transfer Problems Associated with Rockets Utilizing Liquid Oxygen, Rocket Engine Test Laboratory, Edwards Air Force Base, August 1956.

Lieberman, P., and Marshal J., “Proposed Test Facility for 100,000 Pound Thrust Rockets Using Liquid Fluorine” Air Force Flight Test Center, Liquid Propellants Symposium, Proceedings Volume 3, pg 231- , 27-28 March 1957

Lieberman, P., and Lynn, P., Titan IV SRMU Plume Characteristics and Flame Bucket Analysis, Ralph M. Parsons Company, Parsons Project No. 6919, Subcontract 69190001, Pasadena, CA, July 1988.

Edelstein, Arthur and Lieberman, Paul, The NTS Test Bed for Novel HVAC Systems Evaluation, Institute of Environmental Sciences, Los Angeles, California, April 18-21, 1983.

Anderson, D., Edelstein A., Carlson, B. And Lieberman P., Permeation of Hydrogen through Tank Walls at Liquid Hydrogen Temperature, Cryogenic Engineering Conference/International Cryogenic Materials Conference, Portland, Oregon, July 28 to August 1, 1997.

VIBRATION

Lieberman, P., Simulation of Free Flight Structural Characteristics by Captive Missile, I. Computer Analysis, Jet Propulsion, September 1958.

Lieberman, P., J. Czajkowski and J. Rehard, Optical System for Measurement of Pyrotechnic Test Accelerations, Institute of Environmental Sciences, May, 1990.

Lieberman, P., The Dangers of Split Band Testing ,Institute of Environmental Sciences, Los Angeles Chapter, December 1995

Lieberman, P., Overcome the Split Band Vibration Dilemma , Test and Measurements World, April, 1997.

AIR AND SOIL POLLUTION

Proposed Test Facility for 1,000,000 Lb Thrust Rockets Utilizing Liquid Fluorine, (with J. Marshall), Technical Assistant Secretary of Defense, Research and Development, Washington, D.C., March 1957, 3-231-251, Confidential.

Fustos V. And Lieberman P., An Integrated Approach to Bioremediation of Contaminated Soils, Environmental Protection, December,1995.

CORROSION

Accelerated Aging Corrosion Tests for Buried Metal Structures, Pipeline and Gas Journal, October 1996.

SMOKE AND FIRE PROPAGATION

Lieberman, P., and Bell, Diane, Smoke and Fire Propagation in Compartment Spaces, TRW Systems Group, Fall 1972 Meeting of the Western States Section of the Combustion Institute, 7 September 1972, and Fire Prevention, May 1973.

Ship Safety Methodology Development, December 1970/TRW 14762-6001-RO-00.

Lieberman, P. Assembly of a High Altitude Explosive Chamber, 17th Aerospace Testing Seminar, Institute of Environmental Sciences, Manhattan Beach, CA, October 1997.

HIGH ENERGY LASERS

Ackerman, R.A., Chovit, A., Latimore, J.T., Meisenholder, S., Rutkowski, E., Dresser, M.M., and Lieberman, P., Laser Systems Modeling Study, TriService Chemical Laser Symposium, Kirtland Air Force Base, New Mexico, 18-20 February 1976.

Lieberman, P., Anderson, D., White, J., Camouflage Against Laser Beam Detection, F33615-88-C-1800, February 1989.

ELECTROLYTIC GAGES

Measurement of Close-in Stress-Time History in Tuff for the Yuba Event, Defense Atomic Support Agency, DASA 1427, February 1964-5RD.

Close-in Pressure-Time Histories for the FLAT TOP Experiments, Defense Atomic Support Agency, POR(WT)-3004, September 1966.

Close-in Pressure-Time Measurement in Volcanic Tuff, Defense Atomic Support Agency, POR-3028, 6 July 1967, AD 382-8252.

Close-in Stress-Time History Measurements in Granite for the Pile Driver Event, Defense Atomic Support Agency, POR-4002 (WT4002), Confidential FRD.

Theory and Operation of the IITRI Pressure-Time Gages in the 20-200 Kilobar Region, Defense Atomic Support Agency, DASA 2161, November 1968.

Close-in Stress-Time History Measurements, Defense Atomic Support Agency, POR-3017, 5 June 1968, Confidential, FRD (Project TINY TOT), AD 390-7632.

Calibration of IITRI Pressure-Time Gages and Gage System, Defense Atomic Support Agency, DASA 2274, May 1969.

Pressure Time Histories Measured in an Explosively Loaded Granite Column, Instrument Society of America, Preprint Number P7-1-PHYMMID-67, September 11-14, 1967, Chicago, Illinois.

Pressure Time Histories Measured in Explosively Loaded Epoxy Column, XXVI International Congress on Industrial Chemistry, Brussels, Belgium, September 1966.

Experimental Studies of the IITRI Electrolytic Gages in Blast Loaded Granite, Defense Atomic Support Agency, DASA 2190, January 1968.

Intense and Transient Pressure, Temperature, and Irradiation Effects on the Ionization of Water, Defense Atomic Support Agency, DASA 2841, September 1969.

MICROWAVE GAGE

Close-In Pressure and Displacement Measurements in Mine Ore, DASA 2321, Defense Atomic Support Agency, Washington, DC, August 1969, Lieberman, p., Nagumo, G., Miller, D., and Knox, R.

Development of a Microwave System for Particle and Shock Velocity Measurement using a Piezoresistive Dielectric/Dielectric Waveguide, DASA 2335 (AD 861 566 L), Defense Atomic Support Agency, Washington, DC, October 1969, Lieberman, P., Nagumo, G., and Miller, D.

Piezoresistive Dielectric/Dielectric Microwave Waveguide, AFWL-TR-73-37, Kirtland AFB, February 1973, Lieberman, P.

Close-in Ground Displacement Measurements Using a Microwave Waveguide, AFWL-TR-73-78, Kirtland AFB, February 1973, Lieberman, P.

Radial Wall Displacement History by Microwave Waveguide Measurements in Project "HYBLA GOLD", Defense Nuclear Agency, Washington, DC, December 1977, Lieberman, P.

Development of Microwave Instrumentation for use in Automobile Crash Testing, Technical Report No. 1662, Ford Motor Company, January 1989, Lieberman, P.

GROUND MOTION AND AIR BLAST GAGES

Particle Velocity History Measurements and Canister/Medium Interaction, Instrumentation for Nuclear Weapons Effects Simulation Symposium, Air Force Special Weapons Center, Albuquerque, NM, March 12-13, 1970.

Evaluation, Calibration, and Assessment Techniques and Equipment for Air Blast and Ground Motion Gages Used in the USAF HEST Facility, Instrumentation for Nuclear Weapons Effects Simulation Symposium, Air Force Special Weapons Center, Albuquerque, NM, March 12-13, 1970.

INFRARED SCANNING

Lieberman, P., Elliott Raisen and Richard Joyce, Operation of MINE SHAFT - Use of Infrared Imagery to Track In-Flight Ejecta Produced by a 100- Ton TNT Detonation on Granite, IITRI, May 1970.

Lieberman, P., and Elliott Raisen, Studies to Determine the Feasibility of Measuring Airborne Debris in Dust and Hot Gas Environments Using an Infrared Scanning Camera, DASA 2400.

VISIBLE, INFRARED, AND MICROWAVE EXTINCTION MEASUREMENTS IN AIR BLAST DRIVEN DUST CLOUDS

Dynamic Dust Measurements Project MIXED COMPANY, Project Officers Report, DNA 6611, February 1973.

Dynamic Dust Measurement for Project MIXED COMPANY, (Summary) DNA, Long Range Planning Committee Meeting, Stanford Research Institute, 1973.

Dynamic Dust Measurement for Middle Gust Event II, (Summary), DNA, Long Range Planning Committee Meeting, Stanford Research Institute, 1973.

Dynamic Dust Measurement for Middle Gust Event II, Final Report, March 1, 1973, Contract DNA 2882F.

Measurement in Airblast, Part A - Optical Temperature Measurement, Part B - Novel Measurement Techniques, Defense Nuclear Agency, Washington D.C., DNAOOI-77-C-0141, October 1, 1977.

PROJECT 136 "HAVE NAME"

Instrumentation Feasibility and Demonstration Program, 22 July 1976.
Air Force Systems Evaluation, Statistical Method Demonstration, 31 August 1976.
Air Force Systems Evaluation, Titan II Weapon System, 15 September 1977.
Air Force System Evaluation, KC-135 Aircraft, 31 March 1977.
Air Force Systems Evaluation, F-4 Aircraft, 31 March 1977.
Air Force Systems Evaluation, B-52 G&H, 29 October 1976.
Air Force System Evaluation Addendum, B-52 Aircraft, 15 September 1977.
Project 136 Test Plan Summary, 30 September 1977.
Air Force System Evaluation - Norad Facility, 31 March 1977.
Air Force System Evaluation - SAC Command Post, 31 March 1977.
Air Force Field Test Support - Otis Air Force Base Building Test, 31 March 1977.
Volume I Implementation Procedure for Evaluation of System Survivability, 31 March 1977.
Review of Carbon Fiber Composites Hazards Test Program - Naval Research Laboratory, 25 May 1978.
C^3I Systems Vulnerability/Survivability Test Analysis Report Feldberg Autovon Site, Rome Air Development Center, Griffiss Air Force Base, New York, Contract #F30602-79-C-0073, July 1980.

AGING AND RELIABILITY/RISK

Lieberman, P. "HIHTL Service Life DNFSB Response Support", Defense Nuclear Facilities Safety Board, Washington River Protection Solutions, LLC (WRPS), SOLICITATION NUMBER 238386, September 30, 2011.

Lieberman P. and Onesto A. "Banded (BAND-IT) and Swaged Hose-In-Hose Transfer Line (HIHTL) Assembly, Service Life Verification Program", CH2M HILL Hanford Group, April 19, 2004.

Lieberman, P. (Instructor), "Nuclear Aging Analysis", ASME Pressure Vessel and Piping Short Course Program, Orlando, Florida 1982.

Lieberman, P. and Rowan, W. "Design Failure Mode and Effects Analysis D/FMEA Tutorial", American Society for Quality Control, Detroit, October 1988.

Lieberman, P., Wood, S., Trinh, Y. and Raphael, R., Nuclear Environment Qualification of Motor Control Centers and AC Distribution Panels Installed in the Susquehanna Steam Generating Plants 1 and 2, Bechtel Power Corporation, Analysis Report Number 548-9304, Rev. 1, San Francisco, CA, April 1982.

Lieberman, Dr. Paul, Wood, Sandra H., Smith, Mark, Alternatives in the Thermal Aging Analysis of Safety-Related Nuclear Power Equipment, The American Society of Mechanical Engineers, Report Number 83-PVP-75, New York, N.Y.

Haber, J., Legg, M., Lieberman, P., Earthquake Risk Assessment, March-April 1989 Issue of Risk Management Report.

SHEAROGRAPHY

Lieberman, P. Shearographic Nondestructive Testing, 12th Aerospace Testing Seminar, March 1990, Institute of Environmental Sciences, Manhattan Beach, CA.

ELECTROMAGNETIC INTERFERENCE (EMI) AND ELECTROSTATIC DISCHARGE (ESD)

Lieberman P., Gray P. and White J., "Testing Air Bag Inflators for Your Car", Evaluation Engineering, August 1994, pp 92-97

Lieberman P., Electrostatic Discharge Testing, EMC Test and Design, February/March 1995, pp 22-24.

Tran D., Boller D., and Lieberman P., "Jet Engines Need Custom EMI Chambers", Test and Measurement World, February 15, 1997, pp 13-14.

NARRATIVES

Experience

2000 – 2019 **EnisEnerGen, Enis WaterPure, Enis Gas**

Water Purification
Compressed Air Energy Storage
Waterless Fracking

1999- Present **Lieberman Research Associates (LRA), President**

$75,000 Award from California Energy Commission, Energy Innovations Small Grant (EISG) Program, Public Interest Energy Research (PIER) Grant Number 53718A//03-24, "Test and Evaluation of Heat Transfer Parameters for the Transportable Compressed Air Energy Storage (T-CAES) System" November 15, 2004

Was funded by COGEMA Engineering Inc (D.O.E.) for **accelerated ageing tests** of EPDM Hose-In-Hose Transfer Line transferring toxic and radioactive waste at the Hanford Reactor Site.

Prepared several system studies to support patent for pneumatic storage of electrical power generated by wind turbines, solar thermal coils and photovoltaic cells.

Submitted Proposals:

- Storage System for Electrical Power Generated by Wind Turbines
- Wind Concentrator for Application of Wind Turbines to Low Speed Wind Sites
- Ultrasonic Lamb Waves for Non-Destructive Testing
    - Air Force $100,000 SBIR
    - Navy $1,400,000 BAA
- One-way Laser Energy Transmission through Aerosol Cloud for Concealment during Downed-Pilot Rescue.
- Remote neutralization of Land Mines by High Intensity (400-psid), Controlled Pressure History Airblast (>10-milliseconds) with High Directivity.
- Terrorist Bio-Toxic Aerosol Cloud Release, Its Tracking, Engulfment and Destruction.
- Acoustics and Vibration as Enhancement of Water Desalination.
- Helical Vortex Motion Applied to Incoming Saline Solution Around the Reverse Osmosis Membrane Enhances Desalination System.

Developed a theory and a test matrix for an acoustic whistle based on an oscillatory capillary wave jet. The device was tested and operated successfully (for SARA).

1981 - 1999 National Technical Systems (NTS), Chief Scientist

Dr. Lieberman was elected a member of the Fluid Mechanics Technical Committee of the AIAA, 1991-1996.

Member of the AIAA Hypersonic Technologies and Aerospace Planes (HYTASP) Subcommittee since 1991.

Dr. Lieberman chaired the session entitled, Experimental Methods" for the 26th AIAA Fluid Dynamics Conference, June 1995, San Diego, California.

Dr. Lieberman organized and chaired a morning and evening session of the AIAA 31st Aerospace Sciences Meeting in Reno Nevada, January 1993, entitled, " Hypersonic Vehicle System Issues."

Dr. Lieberman chaired a morning session of the AIAA 33rd Aerospace Sciences Meeting in Reno Nevada, January 1995, entitled, "Wind Tunnel Measurement Systems"

Dr. Lieberman prepared and presented a six-day course, "Dedication of Components for Nuclear Power Plants", in Tainan, Taiwan during the summer of 1992.

Dr. Lieberman is Chief Scientist at NTS. He has participated in the complete range of Military Standard testing of components for vibration, shock, pyroshock, acoustic, temperature, temperature shock, temperature and humidity, temperature and altitude, sand, rain, immersion, salt water spray, and solar radiation environmental tests. He also performs reliability analyses of hydraulic and electrical systems, accelerated aging test design, and failure modes and effects analyses. In addition he supports the EMI and electrostatic discharge test facilities. Most recently he has been selecting processes for extracting hydrocarbons, solvents and heavy metals contaminants from both the vadose and saturated soils for use by the NTS Environmental Services Group.

Dr. Lieberman evaluated nuclear reactor components rated for a 10-year lifetime, to check if they can be extended to 40-year lifetime. These activities included a Failure Mode and Effects Analysis (FMEA) and Fault Tree Analysis.

He designed and patented a circular progressive wave tube for testing the Titan IV combustion chamber and nozzle extension wherein an oscillating shock in a supersonic jet generates the high intensity acoustic and ultrasonic power. The acoustic power exceeds that available from conventional modulators, especially in the range of 8,000 to 80,000 Hz. When one oscillating supersonic shock generator (OSSG) is driven by a gaseous oxidizer and another OSSG is driven by a gaseous fuel, there are extremely high temperatures and high acoustic-combined environments which can be obtained in an uncontained space for large and small test articles, with easy access for instrumentation and observation.

He designed a progressive wave facility that generates 190 dB OASPL. A train of blast waves of controlled periods is the basis for its operation. The facility can attain 195 dB OASPL for more than 10 seconds.

Dr. Lieberman reviewed the vacuum extraction. Bio-venting sparging and composting techniques for eliminating hydrocarbon and explosives contamination plumes in the soil. The vacuum extraction technique was selected for the contaminated soil at the Hartwood, Virginia site. Bioremediation proposals were prepared for the USEPA and DOE wherein heavy metals and radionuclides were in the contamination plume. For the Michigan Air National Guard Site in Alpina, Michigan he prepared ozone, oxygen, moisture, bioremediation and thermal treatment combination to remove high molecular weight hydrocarbons from vadose soil and from TPH laden soil and from TPH and lead laden soil; and a lime stabilization and solidification treatment for the leaded soil.

He designed a nuclear air blast simulator to test large shipboard antennas. The shock front was generated by the rapid fracture of a panel of brittle glass, with initial matched pressures on either side of the glass panel. The stored volume of gas and vent hole size controlled the positive phase duration. Designs were prepared to simulate the positive and negative phases of the blast wave. The concept can also be used to test large glass panels for response to sonic booms.
Dr. Lieberman, with Ron Bocksruker, designed a burner for testing aircraft fire wall panels subjected to 550-psia stagnation, pressure and 3,000 ^{o}F flames. He also designed and built an ejector system to test the altitude performance of a special Marquardt cryogenic power plant component for NASP.

Dr. Lieberman conceived, wrote proposals, and was awarded such projects as holographic filters for eye protection against laser weapons, shearography for non-destructive testing; giant holographic mirrors that concentrate incoming optical signals at specific locations for target identification; holographic mirrors for solar cells and heating working fluids and camouflage coatings. He also developed an optical displacement gage. He also developed a microwave displacement history gage for automotive crash tests, and a piezoresistive pressure gage (5,000 psid to 450,000 psid) using ammoniated water as the sensing element. He developed a fiber optic cable to detect gas leaks from gas pipes. He evaluated a hydronic heat pump system for saving air conditioning and heating costs in a test HVAC network. He also developed an approach to pyrotechnic shock-plate testing to deliver specific shock spectra.

Dr. Lieberman participated in several large scale studies: Shallow Tunnel Basing Mode for Peacekeeper, the Cofferdam Concept Test Program for an upgraded Minuteman, the Titan IV Flame Deflector Study at Test Stand 1-C, and the DNA Shock Isolation Study for ICBMs in Missile Silos under Advance Threats.

Dr. Lieberman developed the concept of the NTS explosive-driven shock tube system that delivered pre-cursor airblast waveform loads to 1/6-scale models of the Hard Mobile Launcher. The grouser designs of four aerospace companies were evaluated.

1969 - 1981 TRW Systems Group, Vulnerability and Hardness Laboratory

Dr. Lieberman held the position of Senior Program Manger at TRW. Dr. Lieberman partook in the Peacekeeper Program at BMO involving acoustic, seismic, vibration, and infrared measurements as part of the Position Location Uncertainty Program of the Mobile MX in Multiple Shelters.

Dr. Lieberman was the Technical Director of Project HAVE NAME. This project investigated the electrical hazards associated with the release of carbon/graphite fibers from aircraft composite structures. The instrumentation aspects required the application and fielding of infrared light emitter diode detector systems, laser detector systems, radar systems, microwave free-space and microwave line-guided detector systems, high voltage discharge detector systems, infrared imaging camera, and iridium tagging. The system aspects required development of fiber cloud environments in free space as well as in duct systems and compartments, selection of sensitive electrical equipment in these calculated environments, arrangement of this equipment into a fault tree, specification of probability of survival and confidence in this probability of survival for each component over a range of environments, and the Monte Carlo computer calculation of the overall system survivability. These calculations were performed for aircraft, missile facilities, control centers and buildings. Data for the systems studies were obtained by participation in a series of field and laboratory tests at Rome Air Development Center, Naval Surface Weapon Center/Dahlgren Laboratory, Capistrano Test Site, TRW and Naval Weapons Center/China Lake. Additional data was obtained by his participation in the HAVE NAME Aircraft Accident Investigation Team. As Technical Director of Project HAVE NAME, Dr. Paul Lieberman evaluated the effects of selected breakdowns in the Autovon System in Feldberg, Donnersberg, and Kaiserslautern, West Germany; in Uxbridge, England; at NORAD, and at SAC Headquarters. In addition to the system survivability study, he evaluated communication equipment component operations in the Project HAVE NAME environment for the communication equipment aboard the B-52, KC135 and F-4.

Dr. Lieberman performed a concept and feasibility study of giant shock tubes for application to the MX System. He developed a 50-foot diameter by 2,000-feet long 1,200-psi blast facility that was practical for full-scale tests of the MX missile for AFWL/CERF. Structural and gas dynamics, as well as cost considerations, were required. He also performed a concept feasibility and design study and supervised the construction of a 1,000-psi blast facility, 9-feet diameter by 7-feet high, test volume, at Hill AFB for structural tests of the Minuteman splice cases. During a series of field tests in Colorado, Dr. Lieberman developed infrared and microwave instrumentation for measurement of the dust cloud concentration histories that were generated by 50-psi airblast waves from 100-ton explosions. He also introduced the concepts of mass addition and protuberances to attenuate airblast in the MX tunnel basing system, and verified the concept in a series of shock tube tests. He has performed analyses to obtain a closed form analytical solution of stress wave transmission in bilinear, layered media. He has also performed analyses to determine the strain-rate sensitivity of concrete to fast rise-time applied loads, the silo closure slab motion through frozen debris for gas pressurized driver system, the spall criteria in a concrete slab for fast rise-time high intensity thermomechanical waves, the response of the missile launch facility slab closure to impact by high velocity large rocks, and the criteria for placing two silo structures in the rock test bed with no coupling.

1957 - 1969 IIT Research Institute

Dr. Lieberman was a scientific advisor at IIT Research Institute where he conducted study and field test programs leading to the development of instrumentation and facilities in support of HEST and high explosive tests in soils and in rocks. He participated in and was a Project Engineer on several chemical and nuclear detonation test programs including MINE SHAFT, FLAT TOP II, FLAT TOP III, FLAT TOP I, TINY TOT, PILEDRIVER and RED HOT at the Nevada Test Site.

1955 - 1957 Rocket Engine Test Laboratory

At Rocket Engine Test Laboratory, Edwards AFB, Lt. Lieberman established the liquid oxygen boil-off of the Atlas missile and missile test stands, and evaluated preventative measures; he evaluated testing techniques for a 100,000 lb thrust fluorine-ammonia rocket propulsion system, and designed a facility for duplication of missile free flight vibration and altitude pressure conditions.

1955 - 1956 Princeton University

At James Forrestal Research Laboratory, Princeton University, Paul performed analyses in determining the natural frequency of combustion instability associated with the shape of the subsonic portion of convergent-divergent nozzle configurations.

Summer 1954 Bell Aircraft Corporation

During the summer of 1954, Mr. Lieberman developed and used an electrical model of heat transfer in nucleate boiling burnouts associated with coolant fluids in tubular rocket motor combustion chambers.