Acorn Consulting Services, LLC
Outline of Professional Services

ACS provides Professional Consulting Engineering services to corporate and governmental clients as well as to attorneys. These services relate to the analysis of complex facilities from the planning stage to mature facilities that either do not function properly, or are in need of renovation or retrofit.

The areas of professional services provided by William R. Acorn, PE as a solo consultant include:

- Forensic Engineering Consulting and Expert Witness Services
- Programming
- Strategic Planning
- Project Delivery Strategies
- Code Compliance and Permitting Strategies
- Design Review

Owner's Representative: Acting as an extension of the owner's facilities engineering team, ACS helps to guide the design and construction process by assisting with scoping and programming, reviewing the design of the project A/E firm or Design/Builder and in general, providing an objective, experienced evaluation of the overall project delivery process. In this role, ACS' objective is to help guide and shape in a positive way, the designs and decisions that flow naturally from the team's best ideas, in answer to the owner's needs, goals and budgetary constraints rather than to produce the detailed designs.

Training: ACS has presented workshops for years in the areas of codes/permitting and cleanroom design. Working with trusted consultants/colleagues, recent additions to the course offerings include; comprehensive, interactive programs related to Project Delivery and Advanced Technology Facility Design.

Strategic Planning: ACS provides objective planning processes that can apply to up or down sizing, new capacity, replacement facilities or de-commissioning of existing facilities. These services are developed and structured to most effectively utilize the client's current staff in a way that leverages their resources and talent to develop meaningful strategies that will improve operational outcomes.

Programming: ACS assists owners and their A/E teams to evaluate facility capacity goals, facts and needs in order to establish a comprehensive view of the means to best quantify, qualify and accomplish their objectives for effective facility operations. A well conceived Program serves as the cornerstone for the delivery of a cost effective project.

Forensic Consulting: Acting as a consultant or expert witness in the evaluation of facility systems that have either failed or are the subject of disputes of some form, ACS utilizes experience gained in the design and analysis of similar projects to analyze the situation and objectively render opinions in terms of cause/effect. These services are typically provided to the legal profession on behalf of their clients, although ACS is occasionally directly engaged by one of the participants in a dispute.

WILLIAM R. ACORN, P.E.

PRINCIPAL ENGINEER

OVERVIEW OF PROFESSIONAL EXPERIENCE

William R. Acorn is principal and founder of Acorn Consulting Services. For over 30 years, he has been involved in the analysis and design of hundreds of projects ranging from institutional laboratories to cleanroom facilities for the semiconductor industry. His active consulting practice involves all aspects of project delivery in the built environment, including code compliance for controlled and hazardous environments. He has received numerous awards for technical excellence and is recognized for his technical achievements, innovation and foresight by peers, associates and clients in the advanced technology industry.

Mr. Acorn has extensive experience as an expert analyst of system design, system failures, code compliance issues and cause/effect relationships of problems related to the built environment. Bill has been utilized as a "mediator" to help resolve differences between owners and code compliance agencies to expedite projects. As a forensic analyst and expert witness, Bill has represented both plaintiff and defendant in a variety of jurisdictions. Forensic assignments include projects dealing with HVAC systems, refrigeration systems, cleanrooms for the semiconductor industry, fires and explosions, pressure vessels, pipelines, Legionnaires disease, and various types of product liability.

As the author of the book - **Code Compliance for Advanced Technology Facilities**, Mr. Acorn is widely recognized as an authority on the subject and regularly delivers seminars and workshops to industry and academia on hazardous occupancy code compliance. As an Adjunct Professor at the University of Wisconsin, Milwaukee, he delivers seminars several times a year through their continuing engineering education program at various locations throughout the U.S. Mr. Acorn regularly consults with the regulatory community concerning issues of life safety in semiconductor and similar facilities. In addition, Mr. Acorn was a contributing author to the **Semiconductor Safety Handbook** edited by Richard A. Bolmen, Jr.

Mr. Acorn has been involved since the inception of the "Center for Research and Education in Advanced Technology Environments" at Arizona State University, known as **CREATE.** This Center is charged with research and development in the design and construction of advanced technology facilities. He is an Adjunct Professor actively involved in the highly acclaimed course CON 598 "Design and Construction of Advanced Technology Facilities" at the Arizona State University, Del E. Webb School of Construction within the College of Engineering. He served as the Visiting Eminent Scholar for Cleanroom Design and Construction in the Del E. Webb School in 1997, during which time he delivered a course on expedited project delivery techniques.

Mr. Acorn holds a U.S. patent for a unique, linear control damper widely used in the cleanroom industry for the management of process air flow.

A Registered Professional Mechanical Engineer in the States of Arizona, California, Colorado, Illinois, New Mexico, New York, Nevada, Oregon, Texas and Utah. In addition, he is registered with the National Council of Examiners for Engineering and Surveying.

PROFESSIONAL ACHIEVEMENTS AND QUALIFICATIONS

- **Lawrence Livermore Laboratory – National Ignition Facility, Livermore, Ca:** This project involved the evaluation of the HVAC systems design of the high bay cleanrooms. Design and in-situ performance review of this project and recommendations for cost effective retrofit strategies to ensure compliance with critical environmental control criteria.
- **University of Maryland College Park, Engineering and Applied Sciences Building:** This project involved the design of a semiconductor R&D facility within this new engineering classroom/laboratory building. ACS developed strategies to cost effectively integrate state of the art wafer fabrication facilities into this University teaching and research project with a very tight budget. Approximate total budget $40 M.
- **Forensic Evaluation of Wafer Fab Fire – Asia:** This confidential project involved the forensic evaluation and expert representation of an A/E firm accused of having improperly designed a wafer fabrication facility that was involved in a catastrophic fire. Acorn conducted site visits, reviewed the reports of opposing experts and investigators and developed explanations of the causes of the fire that caused over $400 million in damages.
- **Sandia National Laboratories – MESA Project, Albuquerque, New Mexico:** Acting as the owner's agent, Acorn reviewed the design concepts and proposals of an internationally recognized engineering firm for the MEMS fabrication facility. This assignment involved value engineering, conceptual design, HPM analysis, development of code compliance strategies and overall evaluation of the optimum conceptual design for this project with a total budget in excess of $200 million.
- **Micron Technology Inc., Lehi Utah:** Owner's agent providing design guidance, value engineering, project delivery consulting and oversight for the design of a 300mm wafer fab. Approximate value of base bid - $150 M. 2000 – ongoing.
- **Micron Technology Inc., Lehi Utah:** Owner's agent providing design guidance, conceptual design services and value engineering for the design and construction of a prototypical test facility for semiconductor products. Approximate value of base bid - $45 M. 2000.
- **On Semiconductor, Zener Fab, Phoenix, AZ.**: Evaluation of retrofit and renovation opportunities for an existing wafer fabrication facility. 2000.
- **Medtronic, MicroRel, Wafer Fab Expansion, Tempe, AZ.:** Owner's agent developing conceptual design strategies and cost estimates for the phased expansion of wafer fab capacity. 2000 – ongoing.
- **Etec Systems Inc., Hayward, CA and Hillsboro, OR:** The Hayward project involves a 156,000 SF expansion of existing semiconductor mask writing tools manufacturing facility. The Hillsboro project is a 177,000 SF facility on a green field site with all new utilities and infrastructure. Both projects include tool hook-up and were designed and constructed simultaneously. The approximate total value is $85 million. 1998 to 1999.
- **Hyundai, Eugene OR: Wafer Fab;** As the liaison between Hyundai and the City of Eugene, negotiated code compliance strategies for this 107,00 SF Class 1

cleanroom with approximately 1,000,000 SF of total area. Acorn also reviewed proposals of the owner's design/build contractor on behalf of Hyundai. 1997.

- **Intel Corporation, Santa Clara, CA: Mask Manufacturing Facility** for the development and repair of "masks" used in the photolithography process for semiconductor products. The project consisted of conceptual design and cost studies. Approximate value $35 M. 1997.
- **Motorola Inc., Mesa, AZ: MOS 21 Wafer Fab** including more than 30,000 SF of Class 10 Cleanrooms. Approximately 150,000 SF total project. Team approach allowed customer's First Silicon 10 days ahead of schedule and in record time for a 200mm wafer fab start-up. Some tools instated in new industry benchmark installation times. Project also involved the design and construction of a new central chilled water and steam plant, upgrade of RO/DI water plant, upgrade of wastewater treatment plant and upgrade of campus electrical substation. Approximate project value $80 million. 1994 to 1997.
- **SGS-THOMSON Microelectronics**, Inc., Rancho Bernardo, CA: 6" Wafer Fab Expansion and Upgrade, including project management for a 25,000 SF Class 10 fabrication area, 10,000 SF Class 10,000 test area, 30,000 SF Class 10,000 subfab, and a 10,000 SF central utility and HPM Support Facility. Approx. value $30 million**.**
- **Motorola Inc., Phoenix, AZ: Wafer Fab Expansion Feasibility Study and Facility Audit**; Code Compliance Strategies Evaluation. These studies preceded the COM 1 wafer fab constructed at the 52nd Street plant.
- **Motorola Inc., Chandler, AZ: MOS 12 Wafer Fab** with over 200,000 SF of Cleanroom Spaces, Chemical and Gas Storage Areas, Central Utility Plant and Large Office Building. AEC responsible for HVAC systems and coordination of all infrastructure systems. Approx. value of systems designed $25 million.
- **Motorola Inc., Tempe, AZ: CS-1 Gallium Arsenide Wafer Fab** Pilot / R&D Facility. This project was developed in two phases and includes a total of 20,000 SF of class 10 Cleanroom. Approx. value $40 million.
- **Motorola Inc., Mesa, AZ: MOS 6 Class 10 Wafer Fab** renovation and expansion. This total renovation of the existing fab involved the reconstruction of the building shell and complete re-construction of the fab for early DRAM manufacturing. Completed in an expedited manner utilizing partnered contractors and advanced construction management techniques. Approx. value $30 million.
- **Motorola Inc., Mesa, AZ: BP-3 Wafer Fab** renovation and upgrade to improve product yield and facility reliability. Involved the renovation of HVAC, process piping and electrical systems. In addition, a new submicron, photolithography facility was created. Approx. value $15 million.
- **Motorola Inc., Mesa, AZ: Chilled Water Plant** - analysis and design of complete renovation of 12,000 ton central chilled water generation plant. Primary/secondary pumping and substantial energy conservation were achieved. The renovation and re-piping of the plant was accomplished while the cooling loads continued to be served, without interruption of delivery to all critical loads. Approx. value $5 million.
- **Motorola Inc., Austin, TX: MOS 3 Stepper Expansion and HPM Facility** - design and construction of critical manufacturing space including submicron advanced lithography process. Code compliance evaluation and subsequent

development of HPM storage and dispense facility for liquids and gases. Approx. value $15 million.

- **Northern Telecom, Rancho Bernardo, CA:** Wafer Fab Analysis, Master Planning and renovations of operating wafer fab facility. Included the development of Implantation facility in a former storage facility. Approx. value $18 million.
- **IBM Corporation, Tucson, AZ:** Cleanrooms and Laboratories for a variety of R & D and manufacturing operations. Facilities and infrastructure upgrades.
- **Silicon Systems, Inc., Santa Cruz, CA:** Design and Construction Management for 6" Process Tool Hook-up for Wafer Fab. Approx. value $12 million.
- **Intel Corporation, Chandler, AZ:** Feasibility and Code Evaluations for renovation of HPM gas facilities.
- **Symbios Logic Wafer Fab Renovation and Expansion, Colorado Springs:** This project was developed in support of a new technology manufacturing operation. The renovation included upgrade of central utility capabilities (chilled water, scrubbed exhaust, power distribution, etc.) while the adjacent wafer processing facility continued to operate. Mini-environment technology utilized to accommodate process tools. Approx. value $16 million.
- **W.L. Gore Associates - Medical Products Division, Flagstaff, AZ:** Cleanrooms and Laboratory Facilities for specialty medical products.
- **National Semiconductor Corporation, Tucson, AZ:** Cleanrooms and Manufacturing Facilities.
- **Burr-Brown Research Corporation, Tucson, AZ:** Wafer Fab Renovations.
- **St. Joseph's Hospital, Phoenix, AZ:** Energy Analysis; Retrofit Design; Master Planning of HVAC, Electrical and Utility System Capital Expenditures, etc.
- **University of Arizona, Tucson, AZ:** 121,000 SF Agricultural Research Lab and Training Facility on eight levels. Approx. value $25 million.
- **Medtronic Micro-Rel, Phoenix, AZ:** Ceramic Plating Facility Expansion.
- **Hughes Aircraft Company, Tucson, AZ:** Buildings 808, 842 and 847 Mfg./Lab/Computer/Office. Approx. value of facilities $32 million.

Workshops, Seminars and Academic Courses:

Mr. Acorn has presented numerous seminars and workshops (varying in length from two hours to three days) including the subjects of Forensic Engineering, Hazardous Occupancy Code Compliance, technical subjects (such as thermodynamics, air handling and distribution, environmental control systems, hydraulics, etc.) related to the design of advanced technology manufacturing and research and development facilities for:

- ***Arizona State University***, Tempe, AZ: Adjunct Professor associated with the development of curriculum for graduate level course Con 598 ***"Design and Construction of Cleanrooms"*** in the Del E. Webb School of Construction, College of Engineering. Instructs in the area of wafer fab cleanroom design and contamination theory and strategies for HVAC systems and overall facility organization. Also teaches module on Code Compliance for Hazardous Occupancies.

- ***University of Wisconsin, Milwaukee***: Course Leader for ***"Code Compliance for Advanced Technology Facilities"*** seminar based upon his textbook of the same name. This two-day course is held several times a year at locations around the country and benefits all who design, build and operate facilities that require a high degree of code compliance. Mr. Acorn is an Adjunct Professor through the UWM Center for Continuing Engineering Education.
- ***University of Arizona***, Tucson, AZ: Visiting Lecturer in the College of Architecture. Developed and presented curriculum and studies in the field of fundamentals and design strategies for ***HVAC Systems*** in buildings. Taught senior-level class part-time from 1974 to 1983. Approximately 100 students per semester.
- Texas Instruments (Dallas Texas) – "Code Compliance for Hazardous Occupancies" May and June, 2000.
- Arizona State University – Cleanroom Construction Workshop – featured lecturer in this one week workshop for industry and academia, sessions presented are "Environmental Systems (HVAC)" and "Code Compliant Design of Hazardous Cleanroom Facilities" – presented twice a year – 1996 through spring 2000.
- Micron Technology Inc. – Project Management and Delivery Systems Workshop – four day workshop for private client at Lehi Utah site. July 2001.
- Semiconductor Safety Association International Symposium – professional development course – "Building Codes and Standards for Environmental Health and Safety Professionals" – New Orleans, April 2001.
- Cleanrooms East 2000 – "Creating a Safer Working Environment in Clean Manufacturing Facilities".
- Cleanrooms East 2000 – Decommissioning an Advanced Technology Manufacturing Facility, Concepts for Demolition of Reuse
- Cleanrooms West 1998 – Environments for Tool Manufacturing – "How to design and build more effective environments for the manufacturing of process tools".
- CleanRooms West '98, "A New Project Delivery Paradigm - Getting to Market Faster through Rational Teaming"
- Arizona State University, Tempe, AZ: Graduate Course - summer 1997 - "Expediting the Delivery of Advanced Technology Factories". ***Visiting Eminent Scholar in Cleanrooms***.
- CleanRooms West '97, "What we need to do now - A New Paradigm in Capacity Enhancement Strategies"
- Intel Corporation (Albuquerque, Chandler and Hillsboro) – "Code Compliance for Hazardous Occupancies". Several sessions 1995 to 1998.
- Motorola, Austin, Mesa and Phoenix – "Code Compliance for Hazardous Occupancies". Several sessions 1992 to 1995.
- Motorola, Mesa, AZ - HVAC System Design Considerations – 1990.
- Hewlett-Packard (San Jose, Corvallis Oregon) – "Code Compliance for Hazardous Occupancies". Several sessions 1996.
- Atmel (Colorado Springs) – "Code Compliance for Hazardous Occupancies". Several sessions 1995 to 1998.

- IESH, International Conference presentation of paper on “Energy Conservation Opportunities in Advanced Technology Factories” – May 1996.
- Northern Telecom (Rancho Bernardo and Ottawa) – “Code Compliance for Hazardous Occupancies” - 1993.
- Austin Major Facilities Users Group - SEMATECH, Advanced Micro Devices, Motorola, IBM, MCC, Texas Instruments- “Code Compliance for Hazardous Occupancies” - 1994.
- San Diego County Fire Prevention Officers Section – “Code Compliance for Hazardous Occupancies”.
- Electric League of Arizona - Energy Conservation and HVAC design
- American Society for Heating, Refrigerating & Air Conditioning (ASHRAE) - Numerous technical seminars including duct design, acoustics, energy conservation, automation and controls, thermodynamics, psychometrics, hydraulics, air distribution, etc.
- National Society of Professional Engineers (NSPE) - Energy Conservation in HVAC System Design and Operation
- National Academy of Forensic Engineers (NAFE) – “Evaluation of Failed HVAC Systems”
- CleanRooms West ’95, “How To Build Cleanrooms Fast”
- CleanRooms West ’93, “Code Compliant Design of Hazardous Occupancy Facilities”
- Electric League of Arizona - Energy Conservation and HVAC design

PROFESSIONAL ORGANIZATIONS:

- Alliance for Construction Excellence – Arizona State University, Tempe, Az.
- ASHRAE (past President of Tucson Chapter)
- Association of Energy Engineers
- American Society of Plumbing Engineers
- American Consulting Engineers Council
- American Institute of Plant Engineers
- National Academy of Forensic Engineers
- National Society of Professional Engineers
- Tau Beta Pi, National Engineering Honorary Society

AWARDS:

- Valley Forward “Award of Merit” for Environmental Excellence - Motorola MOS 21 wafer fab, Mesa Arizona. 1998
- Arizona Consulting Engineers Association's “Outstanding Technological Achievement Award” for Design of AFC 1000 Flow Control Damper, 1992

- Arizona Consulting Engineers Association's "Technical Excellence Award for Mechanical Engineering" for Motorola's MOS 12 Wafer Fab Facility in Chandler, AZ, 1991
- Arizona Consulting Engineers Association's "Technical Excellence Award for Mechanical Engineering" for Motorola's MOS 6 Wafer Fab Facility in Mesa, AZ, 1988
- Electric League's "Energy Efficient Building Award" for Motorola's Wafer Fab Facility in Mesa, AZ, 1988
- Electric League's "Energy Efficient Building Award" for AEC's office building, 1987

PUBLICATIONS:

- **Code Compliance for Advanced Technology Facilities** - A Comprehensive Guide for Semiconductor and Other Hazardous Occupancies. 1993, Noyes Publications – considered the pre-eminent text used by industry worldwide. Library of Congress catalogue number: 93-28549. ISBN: 0-8155-1338-0.
- **Semiconductor Safety Handbook - Chapter 9**, "Building and Fire Codes Impacting the Semiconductor Industry" - edited by Richard A. Bolmen, Jr., 1998, Noyes Publications. Library of Congress catalogue number: 97-24032. ISBN: 0-8155-1418-2.
- "Environmental Controls for Tool Mfg. - Environmental Control Strategies for Production Tool Manufacturing Environments", Proceedings - CleanRooms West, '98
- "A New Project Delivery Paradigm - Getting to Market Faster through Rational Teaming", Proceedings - CleanRooms West, '98
- "Total Energy Management for Wafer Fabs", Visions 1997
- "Total Energy Management Strategies for Wafer Fabs", 1996, IESH
- "Commitment - The Key to Growth and Prosperity," 1996, Visions
- "Facilities System Start-Up & Commissioning - How to get the most of your investment", Visions 1996
- "How Do You Build Cleanrooms Fast," Proceedings - CleanRooms West '95
- "Forensic Engineering Evaluation of Failed HVAC Systems," Journal of the National Academy of Forensic Engineers, December 1990

EDUCATION AND PROFESSIONAL QUALIFICATIONS

Mr. Acorn graduated With Distinction from the University of Arizona in 1971 with a Bachelor of Science degree in Mechanical Engineering. He is a Registered Professional Mechanical Engineer in the States of Arizona, California, Colorado, Illinois, New Mexico, New York, Nevada, Oregon, Texas and Utah. In addition, he is registered with the National Council of Examiners For Engineering and Surveying, Certificate No. 6999.

Mr. Acorn is an Adjunct Professor at; the Arizona State University Del E. Webb School of Construction and the University of Wisconsin, Milwaukee – Center for Continuing Engineering

Education. Mr. Acorn teaches a variety of graduate level courses and workshops for these institutions.