

CORPORATE RESUME

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ERA HISTORY AND PHILOSOPHY

Energy Resource Associates was founded in 1981 with the purpose of bringing a new point of view to the field of facilities management and engineering.

ERA's first major undertaking was to develop and put in place an energy services business unit for a Fortune 500 temperature control manufacturer. The purpose of this program was to place ERA's client in a prominent position in the then-emerging energy services industry (now also known by the names "performance contracting" and "demand side management").

At that time the delivery systems for energy services, (the provision of heating, cooling, ventilation and light to the work environment at "least cost") lacked a comprehensive, integrated approach. ERA developed a program that combined high quality financial, engineering, construction, maintenance and project management/administration services in a mutual success (Owner and Energy Service Company) formula. In less than two years from its introduction, this program achieved over 40 million dollars in sales, positioning ERA's client as a premier Energy Services Company, which it remains to this day.

With the maturing of the energy services industry and the maturing of ERA as an organization, ERA diversified its service offerings by adding, most notably, restoration and modernization projects in existing buildings. This market was a natural for ERA given the company's inherent orientation towards and history of working with existing, rather than new buildings. While this market varies enormously with respect to project size, a notable project which ERA successfully undertook was the development and implementation, on a fast-track schedule, of a \$1,600,000 air conditioning installation for the San Francisco Chronicle and Examiner. This project is described elsewhere herein but is most notable in that the total elapsed time from start of design to equipment start-up was less than 6 months.

At ERA commitment creates results. As with any professional services company, ERA has the choice of reasons or results, i.e., we can give our clients reasons for why we could not perform or, we can produce results. We diligently strive for the latter. Our commitment to results at ERA finds itself manifested in a number of attitudes or biases which are prevalent in our work. These include:

- **Willingness to collaborate or join forces with our clients.** When working with our clients we become virtually indistinguishable from client staff in terms of motivation, concern for the task at hand and the results that our client organization is trying to achieve. Free flow of information, opinions and ideas is essential to creating the atmosphere of trust necessary for such a team effort.
- **Orientation toward action.** ERA takes whatever action is necessary to keep its project moving, often involving "hands-on" trial and error experimentation, "straw

man" documents or other progress-stimulating action as appropriate. Because ERA's key professionals have prior experience working for design-build contractors, ERA is uniquely able to act in the field, as opposed to playing the highly theoretical, "stay-in-the-office" role which is unfortunately characteristic of traditional consulting firms.

- **Openness to new ideas.** ERA has a propensity for innovation and is not afraid to "plow new ground" or develop new techniques when traditional approaches will no longer produce optimal results. Integrated design and construction, single-loop variable flow chilled water systems and temporary whole-building field trials of innovative HVAC retrofit are some specific examples.
- **Integration.** ERA takes a multi-disciplinary/systems approach to solving problems. On many of our projects we provide mechanical, electrical, structural and control systems engineering, all under our roof. In addition, we consider that one of our primary tasks is to coordinate and translate between disciplines. Doing so, we provide comprehensive problem solutions that maximize results for the amount of effort input, and minimize the overlap or wasted effort between disciplines. A truly comprehensive, integrated solution to a problem provides the client with a trouble-free path of action to follow.

While energy management remains a special focus of ERA's activities, our unique results-oriented philosophy is applied to all our activities in the field of facilities engineering and management. Indeed, at ERA, "***We make buildings work.***"

ERA SERVICES

ERA provides customized, integrated services in the areas of:

- **Engineering studies of commercial, industrial and institutional facilities for energy conservation and facility upgrade.** These studies generally include detailed field surveys (*which incorporate extensive instrumentation and monitoring of electrical and mechanical equipment*), calibrated computer modeling of the facility to within 10% of actual energy consumption (*as appropriate*), development of multiple conservation and upgrade alternatives (*including preliminary design, development of installation budgets and estimates of energy savings*), and detailed, understandable final reports.
- **Design services for HVAC, mechanical, electrical, structural and control systems.** These services generally include detailed field investigation and measurement, final plans and/or specification, selection of major equipment and construction observation and coordination. In the case of control system design, services frequently include point-to-point wiring diagrams, materials lists and system programming and commissioning. On occasion, we also provide control panel fabrication.
- **Expert witness services.** Because of ERA's staff background in contracting and the firm's focus on work in existing buildings, ERA is uniquely capable in the field of forensic engineering. As a result, ERA frequently provides services focused on determining the true extent and nature of HVAC and other problems in buildings and employing the resulting knowledge in the resolution of legal disputes.
- **Management consulting in the facilities management field.** These services have included staff selection, sub-contract review, review of facilities management plans, pre-acquisition building surveys and review of maintenance and operations procedures. ERA's unique strength in documentation is particularly valuable in these endeavors.
- **Technical training.** Believing that knowing the right question to ask is more valuable than having a pocketful of ready answers, ERA has a strong interest in raising the level of knowledge and professionalism in the facilities engineering field. As a result, over the years, the firm has created and presented numerous training programs for individual clients, temperature control manufacturers, utilities and national engineering societies.
- **Project management consulting.** Our work in this area typically involves project staffing, budgeting, scheduling, and periodic progress review.
- **Energy accounting services** through ERA's proprietary "Energy Accounting Report System", available as both a subscription service or as user-run IBM-PC software.
- **Custom software development,** including programs written in basic or user-friendly menu-driven templates to run within spreadsheet or database programs. These programs are custom-tailored to meet very specific and time-critical administrative or technical needs.

Clients should note the distinctly broad range of services provided by ERA, many of which are not available from traditional consulting firms.

CORPORATE EXPERIENCE

Studies and Investigations:

Alameda County Courthouse and Admin. Building Complex, Oakland, CA	Energy Retrofit Feasibility
Alameda County, Hayward Hall of Justice, Hayward, CA	Indoor Air Quality and HVAC System Evaluation
Alta Bates Medical Center, Berkeley, CA.....	Energy Conservation Potential Assessment
Alvarado Hospital Medical Center, San Diego, CA.....	Energy Conservation Potential Assessment
American President Lines, Oakland, CA.....	Multi-building HVAC System Evaluation
AMEX Life Assurance Company, San Rafael, CA.....	Investigate Electrical Power Distribution Problems
Ampex Corporation, Redwood City, CA.....	Energy Retrofit Feasibility
Apple Computer, Cupertino, CA.....	Investigate Domestic Hot Water System Problems
Applied Materials, Santa Clara, CA.....	Energy Retrofit Feasibility
ARMCO Building, Houston, TX.....	Energy Retrofit Feasibility
Auburn Faith Community Hospital, Auburn, CA	Energy Conservation Potential Assessment
Cal-Bio, Palo Alto, CA	Energy Retrofit Feasibility
California Pacific Medical Center.....	California Campus Energy Conservation Potential Assessment
California Pacific Medical Center.....	California Campus Energy Retrofit Feasibility
California Pacific Medical Center.....	Pacific Campus Energy Conservation Potential Assessment
Campus Crusade, San Bernardino, CA	Investigate Geothermal Conversion
Central Elementary School, Belmont, CA.....	Heating System Restoration Study
Central Square, Houston, TX.....	Energy Retrofit Feasibility
Cetus Corporation, Emeryville, CA	Energy Retrofit Feasibility
City of Fairfield, CA	Energy Retrofit Feasibility
Clorox Building, Oakland, CA	Energy Conservation Potential Assessment
Clorox Building, Oakland, CA	Tenant Energy Use Survey
Coalinga Regional Hospital, Coalinga, CA	Energy Retrofit Feasibility
Delaware State College, Dover, DE.....	Energy Retrofit Feasibility
DMD Building, San Mateo, CA.....	Energy Retrofit Feasibility, HVAC Restoration
East Central University, Ada, OK	Energy Conservation Potential Assessment
Elk Grove High School, Elk Grove, CA.....	Energy Conservation Potential Assessment
Emery Pub, Emeryville, CA	Investigation of Kitchen Hood System Problems
Fannie Mae, Washington, DC	Headquarters Building, Energy Conservation Potential Assessment
Fireman's Fund Life Insurance, San Rafael, CA.....	Investigate Chilled Water System Modifications
Fireman's Fund Life Insurance, San Rafael, CA.....	Evaluate Cooling Tower Modifications
First Nationwide Savings Building, Concord, CA	Energy Retrofit Feasibility
Forum Building, Sacramento, CA.....	Energy Conservation Potential Assessment
Fox Elementary School, Belmont, CA	Heating System Restoration Study
Foothill-De Anza Community College District.....	Develop HVAC Master Plan
Fremont Hospital, Yuba City, CA.....	Energy Conservation Potential Assessment
Fresno Pacific College, Fresno, CA.....	Energy Retrofit Feasibility
Gavilan College, Gilroy, CA.....	Cogeneration Feasibility
General Cinema Theatres, Fremont, CA	Investigate Building Pressurization Problems
General Cinema Theatres, Los Angeles, CA	Investigate HVAC System Problems
Great Western Bank, Palo Alto, CA.....	Investigate HVAC System Problems
Good Samaritan Medical Center, San Jose, CA.....	Energy Conservation Potential Assessment
Hibernia Bank, Walnut Creek, CA	Energy Conservation Potential Assessment
HEAF, Lawrence Livermore Natl. Laboratory, Livermore, CA	Conceptual Design Study
Hexcel Corporation, Dublin, CA.....	Investigate Computer Center HVAC System Problems
Hexcel Corporation, Dublin, CA.....	Evaluate R&D Building HVAC Systems
Hexcel Corporation, Dublin, CA.....	Evaluate New Office Building HVAC Systems
Hill Street Building, Reno, NV.....	Mechanical and Electrical Redevelopment
Hilton Hotel and Casino, Reno, NV.....	Study Cashier's Area HVAC Remodeling
Holiday Inn, Santa Cruz, CA	Energy Retrofit Feasibility
Jesse Jones High School, Houston, TX.....	Energy Retrofit Feasibility

Studies and Investigations, continued...

Jesuit High School, Sacramento, CA	Energy Conservation Potential Assessment
John Muir Medical Center, Walnut Creek, CA	Energy Retrofit Feasibility
John Muir Medical Center, Walnut Creek, CA	Thermal Energy Storage System Feasibility
John Muir Medical Center, Walnut Creek, CA	Develop Emergency Power Master Plan
Laney Community College, Oakland, CA	Master Plan for Swimming Pool Restoration
Liberty Tower Building, Oklahoma City, OK	Energy Retrofit Feasibility
Live Oak High School, Morgan Hill, CA	Energy Retrofit and Cogeneration Feasibility
Los Alamitos High School, Los Alamitos, CA	Energy Retrofit Feasibility
Marin County Civic Center, San Rafael, CA	Central Cooling Plant Retrofit Feasibility
Mark Hopkins Hotel, San Francisco, CA	Energy Retrofit Feasibility
Marshalls, Boston, MA	Energy Retrofit Feasibility
Morgan Hill USD, Morgan Hill, CA	District-Wide Energy Retrofit & Cogeneration Feasibility
Moreland USD, San Jose, CA	Multi-School Heating System Replacement Study
Nesbit Elementary School, Belmont, CA	Heating System Replacement Study
Niagara Falls Convention Center, Niagara Falls, NY	Energy Retrofit Feasibility
North American Mortgage Company	Evaluate HVAC and Thermal Energy Storage System
Northern California Presbyterian Homes, CA	Sequoias-San Francisco Energy Retrofit Feasibility
Northern California Presbyterian Homes, CA	Sequoias-Portola Valley Energy Retrofit Feasibility
Northern California Presbyterian Homes, CA	Tamalpais Energy Retrofit Feasibility
Northern California Presbyterian Homes, CA	Investigate Domestic Water System at the Tamalpais
Northern California Presbyterian Homes, CA	Sequoias-San Francisco Facility Restoration Master Plan
Northern California Presbyterian Homes, CA	Sequoias-Portola Valley Facility Restoration Master Plan
Northern California Presbyterian Homes, CA	Tamalpais Facility Restoration Master Plan
Northern California Presbyterian Homes, CA	Tamalpais Power Distribution Restoration Plan
111 Building, Dayton, OH	Energy Retrofit Feasibility
Ohlone Community College, Fremont, CA	Energy Retrofit Feasibility
One Hallidie Plaza, San Francisco, CA	Energy Retrofit Feasibility
Pacific Gas and Electric Company, San Francisco, CA	Green Lights Program
Pacific Park Plaza, Emeryville, CA	Evaluate Cogeneration System
Pacific Grove USD, Pacific Grove, CA	District-Wide Energy Retrofit & Cogeneration Feasibility
Paramount Studios, Hollywood, CA	Energy Retrofit Feasibility
Pennzoil Place, Houston, TX	Energy Retrofit Feasibility
Piedmont Gardens, Oakland, Ca	Investigate Indoor Air Quality Problems
Pomona Valley Hospital Medical Center, Pomona, CA	Energy Conservation Potential Assessment
Ralston Elementary School, Belmont, CA	Heating System Restoration Study
Remington Properties, Alameda, CA	Investigation of Residential HVAC Systems (Seastrand, Modesto, Stonegate, and Country Club Terrace Projects)
Reno-Sparks YWCA, Reno, NV	Energy Retrofit Feasibility
Republic Bank Center, Hines Interests, Houston TX	Energy Conservation Potential Assessment
Richmond Yacht Club, Richmond, CA	Investigation of Kitchen Hood System Problems
Ridout Hospital, Marysville, CA	Energy Conservation Potential Assessment
Rio Lindo USD, Rio Lindo, CA	District-Wide Energy Retrofit Feasibility
Riordan High School, San Francisco, CA	Energy Retrofit Feasibility, HVAC Restoration
Rockwell International, Downey, CA	Energy Retrofit Feasibility, Buildings 003 & 305
St. Joseph Hospital, Albuquerque, NM	Energy Conservation Potential Assessment
St. Mary of the Plains College, Dodge City, KS	Energy Retrofit Feasibility
St. Mary's Hospital and Medical Center, San Francisco, CA	Energy Retrofit Feasibility
St. Mary's Hospital and Medical Center, San Francisco, CA	Dedicated Surgery Chiller Feasibility
Saltonstall Building, Boston, MA	Ventilation Air Study
San Francisco Newspaper Agency (Examiner & Chronicle)	Study Bldg. for Air Conditioning Installation
San Jose Elks, San Jose, CA	Energy Retrofit Feasibility
San Jose Mercury news, San Jose, CA	Energy Retrofit Feasibility
Santa Cruz County, Santa Cruz, CA	Investigate Clinic HVAC System Problems
Santa Cruz County, Santa Cruz, CA	Investigate Sheriff's Dept. HVAC System problems

Studies and Investigations, continued...

Santa Cruz County, Santa Cruz, CA	Emergency Generator Plans, 3 Buildings
Santa Cruz County Sanitation District.....	Investigate Pumping Plant HVAC System Problems
Sandy Plaza, Sunnyvale, CA	Energy Retrofit Feasibility
Security Pacific Building, Walnut Creek, CA	Energy Retrofit Feasibility
Sierra Nevada Memorial Hospital, Grass Valley, CA	Energy Retrofit Feasibility
Sierra Nevada Memorial Hospital, Grass Valley, CA	New Chilled Water Plant Conceptual Design Study
Sierra Nevada Memorial Hospital, Grass Valley, CA	Thermal Energy Storage System Feasibility
Sierra Nevada Memorial Hospital, Grass Valley, CA	Evaluate Isolation Room HVAC Systems
Sierra Nevada Memorial Hospital, Grass Valley, CA	New Clinical Laboratory Conceptual Design Study
Sierra Nevada Memorial Hospital, Grass Valley, CA	Indoor Air Quality and HVAC System Evaluation, OPC
Simons Hardware, Walnut Creek, CA	Energy Retrofit Feasibility
Solano Community College, Fairfield, CA.....	Central Plant Modernization/Thermal Energy Storage Feasibility
Sonoma County Administration Center, Santa Rosa, CA.....	Central Plant/Thermal Energy Storage Expansion
Sonoma County Administration Center, Santa Rosa, CA.....	Evaluate Air Handling Systems Throughout Complex
State of California, Dept. of Gen. Services, Stockton State Bldg.	Energy Retrofit Feasibility
Stevens Center, San Jose, CA	Energy Retrofit Feasibility
Stockton Unified School District, Stockton, CA	Stagg High School Energy Retrofit Feasibility
Stockton Unified School District, Stockton, CA	Edison High School Energy Retrofit Feasibility
Stockton Unified School District, Stockton, CA	Franklin High School Energy Retrofit Feasibility
Stonestown Building, San Francisco, CA.....	Energy Retrofit Feasibility
Sweeny Community Hospital, Sweeny TX.....	Energy Retrofit Feasibility, HVAC Modernization
Texas Building, Dallas, TX	Energy Retrofit Feasibility
Tulane University Medical School, New Orleans, LA.....	Energy Retrofit Feasibility
University of California Davis Medical Center, Davis, CA	Investigate Chilled Water Distribution System
University of California Davis Medical Center, Davis, CA	Study New Process Steam Plant for Main Hospital
University of Judaism, Los Angeles, CA.....	Energy Retrofit Feasibility
University of Texas, Austin, Dobie Center	Energy Retrofit Feasibility
U.S. Postal Service, Processing & Distribution Center, Stockton, CA.....	Energy Retrofit Feasibility
U.S. Postal Service, Airmail Distribution Center, San Francisco International.....	Energy Retrofit Feasibility
U.S. Postal Service, Processing & Distribution Center, San Francisco, CA	High Voltage Switchgear Study
Utah State University, Logan, UT	Energy Conservation Potential Assessment
Vallco Financial Center, Cupertino, CA.....	Energy Retrofit Feasibility and HVAC Restoration
Ventura County Medical Center, Ventura, CA.....	Energy Conservation Potential Assessment
Veterans Administration Medical Center, Livermore, CA.....	5 Year Energy Management Plan
William Morris Agency, Beverly Hills, CA	Energy Retrofit Feasibility
Woodcourt II, Woodland Hills, CA.....	Energy Retrofit Feasibility
Xerox - PARC, Palo Alto, CA	Investigate Research Building Pressurization Problems
Xicor, Milpitas, CA	Investigate Chilled Water System
Yuba City High School, Yuba City, CA.....	Energy Retrofit Feasibility
475 14th Street, Oakland, CA.....	Energy Retrofit Feasibility
505 14th Street, Oakland, CA.....	Energy Retrofit Feasibility
1333 Broadway, Oakland, CA	Energy Retrofit Feasibility
1611 Borel Place, San Mateo, CA	Energy Retrofit Feasibility
1650 Borel Place, San Mateo, CA	Energy Retrofit Feasibility
1777 Borel Place, San Mateo, CA	Energy Retrofit Feasibility

Project Design:

Alameda County Courthouse and Administration Building Complex, Oakland, CA	Energy Retrofit
Belmont School District, Central Elementary School, Belmont, CA.....	Heating System Restoration
Belmont School District, Cipriani Elementary School, Belmont, CA.....	Heating System Replacement
Belmont School District, Fox Elementary School, Belmont, CA	Heating System Restoration
Belmont School District, Nesbit Elementary School, Belmont, CA.....	Heating System Replacement
Belmont School District, Ralston Middle School, Belmont, CA	Heating System Restoration

Project Design, continued...

Carlin Gold Mining Co., Carlin, NV.....	New Mill HVAC Systems
Cetus Corporation, Emeryville, CA	New Laboratory HVAC Installation
Cetus Corporation, Emeryville, CA	New Chiller Installation
City of Livermore, Multi-Service Center, Livermore, CA.....	Energy Retrofit
City of Livermore, Golf Course Clubhouse and Pro Shop, Livermore, CA.....	HVAC System Replacement
College of Marin, Kentfield, CA.....	Asbestos Abatement at the P. E. Complex
College of Marin, Kentfield, CA.....	Variable Speed Drive Replacement, Kentfield Library
DMD Building, San Mateo, CA.....	Energy Retrofit and HVAC Restoration
Fenestra Winery, Livermore, CA.....	New HVAC for Barrel Room and Tasting Room
Fireman's Fund Life Insurance, San Rafael, CA.....	Data Center HVAC Remodel
First Nationwide Savings, Concord, CA.....	Energy Retrofit
Foothill-De Anza Community College Dist.	HVAC Remodel for the ATC Secondary Effects Building
General Cinema Theatres, Fremont, CA	Modify HVAC Return Air/Exhaust System
General Cinema Theatres, Los Angeles, CA	New Chiller, Pneumatic Controls and Ductwork
Golden Pacific Brewing	Low-Temperature Refrigeration System for New Brewery
Great Western Bank, Palo Alto, CA.....	New Chilled Water Coils, Chilled Water Pump and Controls
Health Sonics, Livermore, CA	Modify Curing Oven
Hilton Hotel and Casino, Reno, NV.....	Cashier's Area HVAC Remodel
Hilton Hotel and Casino, Reno, NV.....	Housekeeping Department HVAC Replacement
John Muir Medical Center, Walnut Creek, CA	HVAC and Building Automation Retrofit
John Muir Medical Center, Walnut Creek, CA	Supply Chilled Water to Data Center HVAC
John Muir Medical Center, Walnut Creek, CA	Supply Chilled Water to MRI Center HVAC
John Muir Medical Center, Walnut Creek, CA	Interconnect Chilled Water Plants
John Muir Medical Center, Walnut Creek, CA	Install DDC Controls for MRI HVAC System
John Muir Medical Center, Walnut Creek, CA	Replace Chilled Water Coil for Surgery HVAC System
John Muir Medical Center, Walnut Creek, CA	Install DDC Controls for Zone Terminal Boxes
John Muir Medical Center, Walnut Creek, CA	Install DDC Controls for Secondary CHW/HW Pumps
John Muir Medical Center, Walnut Creek, CA	Fuel Oil Tank and Piping
John Muir Medical Center, Walnut Creek, CA	Modernize and Expand Chilled Water Plant
John Muir Medical Center, Walnut Creek, CA	Building Automation and Controls for Administration Building
John Muir Medical Center, Walnut Creek, CA	Expand Fire Alarm System
Laney Community College, Oakland, CA	Repair Earthquake Damage to Swimming Pool
Laney Community College, Oakland, CA	Replace Steam Distribution system in Dry Cleaning Lab
Live Oak High School, Morgan Hill, CA	Energy Retrofit/Cogeneration
Lone Star Industries Quality Control Lab, San Ramon, CA.....	New Mechanical and Electrical Systems
Marin County Civic Center, San Rafael, CA	Replace Administration Building Chilled Water Plant
Marin County Civic Center, San Rafael, CA.....	Replace Hall of Justice Chilled Water Plant
Morgan Hill Unified School District, Morgan Hill, CA.....	District-Wide Energy Retrofit & Cogeneration
Northern California Presbyterian Homes, Greenbrae, CA.....	New Domestic Water System
Northern California Presbyterian Homes, Greenbrae, CA.....	New Garage Lighting System
Northern California Presbyterian Homes, Portola Valley, CA.....	Emergency Generator for the Health Center
Ohlone Community College, Fremont, CA	Replace Swimming Pool Boilers
One Hallidie Plaza, San Francisco, CA.....	Energy Retrofit
One Hallidie Plaza, San Francisco	Remodel Lighting Control System
Pacific Lithograph, San Francisco, CA	Remodel and Install Photo Lab HVAC Systems
Pacific Park Plaza, Emeryville, CA	Retrofit Heating System and Boiler Controls
Piedmont Gardens, Oakland, CA.....	Upgrade Heating System Distribution Piping
Publishers Group West, Emeryville, CA.....	Air Conditioning for New Offices
Riordan High School, San Francisco, CA	Energy Retrofit and HVAC System Replacement
The San Francisco Chronicle, San Francisco, CA.....	Editorial Dept. HVAC Remodel
The San Francisco Examiner, San Francisco, CA	Editorial Dept. HVAC Remodel
Saipan International Airport.....	Control Systems for New Air Traffic Control Tower
San Francisco Newspaper Agency, San Francisco, CA.....	Central Air Conditioning Plant Installation
San Francisco Newspaper Agency, San Francisco, CA.....	Energy Retrofit

Project Design, continued...

San Francisco Newspaper Agency, San Francisco, CA.....	Boiler Plant Modernization
San Jose Mercury News, San Jose, CA.....	Energy Retrofit
Santa Cruz County, Santa Cruz, CA	Redesign HVAC System for Clinic, 1080 Emeline St.
Santa Cruz County, Santa Cruz, CA	Replace Outside Air Dampers, Government Center
Santa Cruz County, Santa Cruz, CA	Redesign HVAC System for Pharmacy, 1080 Emeline St.
Santa Cruz County, Santa Cruz, CA	Install Outside Air Economizer Systems, 1080 Emeline St.
Santa Cruz County, Santa Cruz, CA	Modify Heating System, 1430 Freedom Blvd.
Santa Cruz County Sanitation District.....	Install Air Conditioning and New Temperature Controls
Santa Cruz County, Santa Cruz, CA	Install Seismic Snubbers on Government Center HVAC Equipment
Santa Cruz County, Santa Cruz, CA	Replace HVAC Systems at Juvenile Hall
Santa Cruz County, Santa Cruz, CA	Install Heating & Ventilation System for Morgue
Santa Cruz County, Santa Cruz, CA	Upgrade & Repair Heating & Ventilation Systems at Emeline Ave. Complex
Santa Cruz County, Santa Cruz, CA	Install Emergency Generators at 3 Buildings
Santa Cruz County, Santa Cruz, CA	Install Emergency Generator at Juvenile Hall
Santa Cruz County, Santa Cruz, CA	Install Dedicated HVAC for Sheriff's 991 Department
Santa Cruz County, Santa Cruz, CA	Install Emergency Generator at Womens Jail, Blaine Street
Sierra Nevada Memorial Hospital, Grass Valley, CA	Energy Retrofit
Sierra Nevada Memorial Hospital, Grass Valley, CA	Install Temporary Chiller for Surgery
Sierra Nevada Memorial Hospital, Grass Valley, CA	Install Critical Area Chiller
Sierra Nevada Memorial Hospital, Grass Valley, CA	Expand & Modernize Chilled Water Plant
Sierra Nevada Memorial Hospital, Grass Valley, CA	Extend Critical Chilled Water System to Outpatient Wing
Sierra Nevada Memorial Hospital, Grass Valley, CA	Remodel Second Floor for Nursing Consolidation
Sierra Nevada Memorial Hospital, Grass Valley, CA	Isolation Room Ventilation Upgrade and Pressure Monitoring
Sierra Nevada Memorial Hospital, Grass Valley, CA	ER Triage, ER-3 Negative Pressure Treatment
Sierra Nevada Memorial Hospital, Grass Valley, CA	WICU, Labor Immersion
Simons Hardware, Walnut Creek, CA	Energy Retrofit
Sonoma County Administration Center, Santa Rosa, CA.....	Remove Heat Recovery on Central Plant Chillers
Sonoma County Administration Center, Santa Rosa, CA.....	Central Plant Condenser Water System Upgrade
Southwall Corporation, Milpitas, CA	Install -22°F Glycol Chiller System
Stonestown Building, San Francisco, Ca.....	Energy Retrofit
St Mary's Elementary School, Walnut Creek, CA.....	Air Conditioning Installation
Tenet Healthcare, Indio , CA	Expand & Modernize Central Utility Plant
Tulane University, New Orleans, LA	Energy Retrofit
University of California Davis Medical Center, Davis, CA	Upgrade Chilled Water Distribution System
University of California Davis Medical Center, Davis, CA	Redesign Chilled Water Interface at Main Hospital
University of California, Davis Medical Center, Davis, CA	Install Underground Steam Line to Main Hospital
University of California, San Francisco.....	Install Health Science Building Potable Water System
University of Judaism, Los Angeles, CA.....	Energy Retrofit
U.S. Postal Service, San Francisco International Airmail Distribution Center.....	Energy Retrofit
U.S. Postal Service, San Francisco Processing & Distribution Center	New Compressed Air Plant
U.S. Postal Service, San Francisco Processing & Distribution Center	Modify High Voltage Switchgear
U.S. Postal Service, San Francisco Processing & Distribution Center	Energy Retrofit
U.S. Postal Service, Stockton Processing & Distribution Center	Energy Retrofit
V.A. Medical Center, Martinez, CA	Expand Building Automation System
V.A. Medical Center, Livermore, CA	Install Lighting Control System
V.A. Medical Center, Livermore, CA	Replace Exterior Lighting
V.A. Medical Center, Livermore, CA	Replace Underground Signal Conduit
Xicor Corporation, San Jose, CA	Upgrade Chilled Water Distribution System
120 Montgomery Street, San Francisco, CA.....	Integrated CFC-Retrofit of Chilled Water Plant
1611 Borel Place, San Mateo, CA	Energy Retrofit
1650 Borel Place, San Mateo, CA	Energy Retrofit
1777 Borel Place, San Mateo, CA	Energy Retrofit

Project Design, continued...

Other Projects:

Alameda County	Monitor and Evaluate Energy Services Project
Alpine Building, Walnut Creek, CA	Troubleshoot and Reprogram Building Automation System
Archer, McComas & Lageson	Expert Witness, Condominium HVAC Systems
Archer, McComas & Lageson	Expert Witness, County Transit HVAC Systems
Archer, McComas, Breslin, McMahon & Chritton	Expert Witness, Thermal Energy Storage System
Association of Energy Engineers	Seminar: Computerized Building Energy Simulation
Association of Energy Engineers	Seminar: Management, Measurement and Verification of Performance Contracts
California Pacific Medical Center, San Francisco, CA	Develop Energy Management Plan
City of Oakland, CA	Special Building Inspector (Following Oct. 89 Earthquake)
CNA Insurance, San Francisco, CA	Expert Witness on Chiller Failure
Branson Fitzgerald & Howard	Expert Witness, Apartment HVAC Systems
DeBene & Associates	Expert Witness, Residential HVAC Systems
DMD Building, San Mateo, CA	Monitor and Evaluate Energy Retrofit Project
Duke Power, Charlotte, NC	Develop Performance Contracting Program for 2500+ Banking Facilities
Engstrom, Lipscomb & Lack	Expert Witness, Performance Contracting
Fannie Mae	Due Diligence Investigation for DSM Project Funding
Fireman's Fund Life Insurance, San Rafael, CA	Energy Use Allocation for Tenant Billing
Fong & Fong	Expert Witness, Cogeneration System
Foothill-De Anza Community College Dist.	Develop & Manage Energy Services Performance Contracting Program
Fort Bend School District, Fort Bend, TX	Monitor and Evaluate Energy Services Project
Gassett, Perry & Frank	Expert Witness, Condominium HVAC Systems
Great Bear Construction	Evaluation and Correction of Residential HVAC Systems
Greece Unified School District, Rochester, NY	Review Performance Contracting Program
Hughes & Associates	Expert Witness, Residential HVAC Systems
Houston Federal Building	Utility Budget Projection
Jennaro Properties, Stockton, CA	Study Warehouse Refrigeration Options
John Muir Medical Center, Walnut Creek, CA	Annual Utility Budget Preparation
John Muir Medical Center, Walnut Creek, CA	Recommission and Maintain Building Automation System
John Muir Medical Center, Walnut Creek, CA	Create Expert HVAC Operations Monitoring & Analysis System
John Muir Medical Center, Walnut Creek, CA	Develop Capital Project Funding Requests & Justification
John Muir Medical Center, Walnut Creek, CA	Develop & Document Electrical Switchgear Data Base System
Larson & Burnham	Expert Witness, Office Building HVAC Systems
Larson & Burnham	Expert Witness, University Campus Chilled Water Distribution Piping Failure
Law Offices of Jack Provine	Expert Witness, Pacific Park Plaza Condominium Construction Defects
Lawrence Berkeley National Laboratory	Develop DOE-Wide, ESPC, Integrated Chiller Retrofit Program
Alameda County	Monitor and Evaluate Energy Services Project
Mark Hopkins Intercontinental Hotel, San Francisco, CA	Develop & Manage Performance Contracting Program
Marysville Unified School District	Review Performance Contracting Program
Mechanical Service Company Search, San Francisco, CA	Service Contractor Survey
Morrison & Foerster	Expert Witness, Leasehold Facility Maintenance
National Medical Enterprises	Evaluate Corporate Energy Management Program
New People's Baptist Church	Review HVAC Reconstruction Program
Northpointe Center, Dallas, TX	Troubleshoot and Reprogram Building Automation System
Northern California Presbyterian Homes, San Francisco, CA	Expert Witness, Cogeneration System
Oakland Federal Building, Oakland, CA	Utility Budget Projection
One Hallidie Plaza	Tenant Utility Sub-Metering Troubleshooting
Owen & Melbye	Expert Witness, Pharmaceutical Laboratory HVAC Systems
Pacific Gas and Electric Company	Energy Efficiency Consultant
Pacific Gas and Electric Company	Hospital Energy Efficiency Seminar
Pacific Gas and Electric Company	Energy Services Seminar
Pacific Gas and Electric Company	Retrofit Express Rebate Auditor Training
Pacific Gas and Electric Company	Pacific Bell Energy Retrofit Auditor Training

Other Projects, continued...

Pacific Gas and Electric Company HVAC Fundamentals Training
Pacific Gas and Electric Company Audit Grocery Chain Company-Wide Rebate Documentation
Pacific Park Plaza Homeowners Association Expert Witness, Condominium HVAC Systems
Pennzoil Place, Houston, TX Monitor and Evaluate Energy Services Project
Pomona Valley Hospital Medical Center, Pomona, CA Monitor and Evaluate Energy Services Project
Presidio of San Francisco Power Partners DSM Program Contract Negotiations
Ronald J. Souza Expert Witness, Residential Energy Use
Ropers, Majeski Expert Witness, Residential HVAC Systems
Saipan International Airport Control Panel Fabrication for New Air Traffic Control Tower
San Francisco Newspaper Agency (Examiner & Chronicle) Monitor & Evaluate Energy Services Project
San Francisco Newspaper Agency (Examiner & Chronicle) Chief Engineer Search and Selection
San Francisco Newspaper Agency (Examiner & Chronicle) Annual Utility Budget Preparation
Santa Clara University Develop and Manage Energy Services Program
Sedgwick, Detert, Moran & Arnold Expert Witness, Hospital HVAC System
Shell Oil, Westhollow Research Center, Houston, TX Evaluation of Building Automation System
SMACNA (Sheet Metal & Air Conditioning Contractors Natl. Assn.) Technical Consultant to Association
Southern California Edison ENVEST Demand Side Management Program, Service Provider
St. Mary's Hospital, Lewiston, ME Develop Model Performance Contracting Documents
State of California, GSA, Office of Energy Assessments Develop Performance Contracting Program Model Contract
State of California, GSA, Office of Energy Assessments Develop & Manage Performance Contracting Program
Tenet Healthcare Corporation Develop & Manage Corporate-Wide Performance Contracting Program
Tenet Healthcare Corporation Evaluate Lighting Retrofit Project, Park Plaza Hospital

CORPORATE STAFF

PROFESSIONAL STAFF (RESUMES FOLLOWING):

- James P. Waltz, P.E., President, Principal Engineer
- Donald C. Anderson, P.E., Energy Systems Consultant
- Arthur G. Craig, P.E., Project Electrical Engineer
- David J. Cuthbertson, E.I.T., C.E.T., Senior Electrical Engineer
- Timothy L. Denham, Facilities Operations Specialist
- Henry Kwan, P.E., Associate Mechanical Engineer
- Duane M. Robinson, R.A., Architecture Planning and Design Specialist
- James S. Rothfuss, P.E., Senior Electrical Engineer
- Craig D. Shulenberger, E.I.T., Project Mechanical Engineer
- Levi E. Tallett, P.E., Senior Structural Engineer
- Vernon Taylor, Refrigeration Systems Specialist
- Michael J. Waltz, E.I.T., Staff Mechanical Engineer
- Randall J. Zumwalt, C.E.M., Manager, Performance Contracting Services

SUPPORT STAFF:

- Mary Jane Waltz, Vice President
- Tami Zimmerman, Office Manager
- Melanie McGarvey, Administrative Assistant

JAMES P. WALTZ, P.E.

PRESIDENT, PRINCIPAL ENGINEER: Energy Resource Associates, Inc., Livermore, California. In this capacity Mr. Waltz is responsible for the day-to-day conduct of ERA's consulting and engineering activities, including project management, definition and review of technical scope, budget and schedule determination, technical approach and procedures, supervision and execution of detailed analyses, documentation and report writing, and technical staff training and development. Mr. Waltz has personally conducted detailed energy retrofit feasibility studies in more than 30,000,000 square feet of buildings and designed the follow-on retrofit projects in more than 24,000,000 square feet of buildings, including single-loop variable flow chilled water conversions, variable air volume conversions, direct digital, pneumatic and electric controls, building automation systems, lighting control systems, lighting fixture retrofit, cogeneration systems, and air and wet-side economizers. Mr. Waltz performs programming, start-up and trouble-shooting of direct digital control and building automation systems. He has also personally designed central chilled water plants, entire HVAC installations, chilled and hot water distribution systems, fuel oil piping systems, HVAC restorations and numerous other projects. While maintaining a close involvement and active hand in all projects undertaken by the firm, Mr. Waltz is the firm's principal specialist in expert testimony work, training and seminars and management consulting.

ENGINEERING MANAGER: AMTECH Energy Services, Subsidiary of American Building Maintenance Industries, San Francisco, California. Responsible for development and implementation of a streamlined computer assisted approach to identifying, presenting and executing Total Energy Retrofit in large commercial buildings. Major accomplishments included the analysis, development, design and construction supervision of three large Total Energy Retrofit projects. Technical execution activities included training of support personnel in use of TRACE and DOE- 2, supervision of engineering and trade staff, establishing short-cut data collection procedures, cost estimating and defining scope of work, and writing technical proposals.

PROJECT MANAGER: Resource Recovery and Energy Conservation Division, Brown and Caldwell Consulting Engineers, Walnut Creek, California. Responsible for technical and financial accuracy of energy conservation and alternate energy source studies. Trained staff in the proper use of computers to perform energy calculations. Sales engineering activities included target account identification and development, proposal preparation and presentation, and contract negotiations.

DIRECTOR, ENERGY MANAGEMENT GROUP: Lawrence Livermore Laboratory, Livermore, California. Led the energy management program at the Laboratory. Formulated policy, represented the Laboratory in energy related issues involving the Department of Energy. Conducted an active energy conservation publicity campaign for Laboratory employees. Technical accomplishments included the supervision of professional engineers researching improved energy audit techniques and efficient building design and retrofit projects. Taught project engineers the use and application of computer simulation for energy efficient building design which led to the adoption of new energy efficiency building standards at the Laboratory.

SPECIAL ENERGY CONSULTANT: Air Force Logistics Command, Wright-Patterson Air Force Base, Ohio. Responsible for development and implementation of the energy resources program. A major accomplishment was the design and field demonstration of a new concept for using municipal refuse as a district heating boiler fuel. This work led to the passage of a federal law enabling widespread adoption of the process.

STAFF MECHANICAL ENGINEER: Air Force Logistics Command, Wright-Patterson AFB, Ohio. Designed mechanical and HVAC systems, steam distribution, plumbing, etc. Engineering Manager for all Base heating systems (five major coal-fired boiler plants, distribution systems, and heating systems in 500+ buildings). Arranged and supervised field surveys and design work by consultants. Project engineer on a \$30,000,000 boiler modernization/abatement project.

CIVIL AFFAIRS OFFICER (S-5): 101st Aviation Group, 101st Airborne Division, Camp Eagle, Republic of Vietnam. Served as group liaison to local civilian communities. Major additional assignment was as Officer-in-Charge of Echo Sector of the base camp perimeter defense.

PLATOON LEADER: Alpha Battery, 6th Battalion/67th Air Defense Artillery Regiment, 1st Infantry Division, Fort Riley, Kansas. Served as platoon leader for one of four Vulcan cannon platoons for the Battery. Additional assignments were as assistant operations officer for the Battalion staff and as Chemical/Biological/Radiological (CBR) Officer for the Battalion.

PRODUCT ENGINEER: Chrysler Airtemp, Dayton, Ohio. Responsible for developing new and existing air conditioning product lines including prototype building and laboratory testing and modification. Conducted product performance testing, quality control testing, assemblyline trouble shooting, evaluation of purchased components and writing assembly specifications.

EDUCATION:

University of Dayton, Dayton, Ohio - Bachelor of Mechanical Engineering
California State University, Hayward, California - Master of Business Administration

PROFESSIONAL ASSOCIATIONS/DISTINCTIONS:

Registered Professional Engineer in California, Nevada and Ohio
Charter Member, Association of Energy Engineers (AEE)
Certified Energy Manager, Association of Energy Engineers (AEE)
International Energy Engineer of the Year, 1993, Association of Energy Engineers (AEE)
Vice President, Region-V, 1996, 1997, Association of Energy Engineers (AEE)
Member, American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)
Diplomate, American College of Forensic Examiners
Charter Member, Demand Side Management Society (DSMS)
Member, Cogeneration Institute
Member, Association of Energy Services Professionals (AESP)
Member, California Society for Healthcare Engineering (CSHE)

Contributing Editor, *Energy & Environmental Management*, Penton Publishing
PUBLICATIONS:

"Measurement & Verification Options for Performance Contracts." *Energy & Environmental Management*. Spring 1998, pp. 36-43.

"Don't Ignore Variable Flow." *Contracting Business*. July 1997, pp. 108-114.

"Performance Contracting - How to be Sure it Works Well." *Strategic Planning for Energy and the Environment*. Vol 16, No. 4, 1997, pp. 38-49.

"Variable Flow Chilled Water Systems." *Energy & Environmental Management*. Fall 1996, pp. 44-47.

"How to Marry an ESCo (and not have to worry about divorce)." *Energy & Environmental Management*. Fall 1995, pp. 22-27.

"Whole-Building Energy Efficiency." *Energy Users News*. June 1995, pp. 23-42.

"Finding the Silver Lining in CFC Chiller Retrofit." *RETSIE Proceedings*. 1995

"Integration, Reducing the Cost of CFC Chiller Replacement." *Consulting-Specifying Engineer*. January 1995, pp. 43-48.

"Chapter 16: Computer Software for Energy Audits." *Handbook of Energy Audits*. Fourth Edition, pp. 403-441, The Fairmont Press.

"Chapter 13: Demand-Side Management and the Energy Services Industry." *Retrofitting Buildings for Energy Conservation*. Second Edition, pp. 185-230, The Fairmont Press.

"Computerized Building Simulation... A DSM Strategy?" *GLOBALCON Proceedings*. 1994

"Monitoring and Evaluating DSM and Energy Services Projects." *Cogeneration and Competitive Power Journal*. Vol 8, No. 3, 1993, pp. 62-73.

"Energy Service Projects: Case studies in Success and Failure." *DSM Quarterly*. Summer 1992, pp. 21-26.

"Effective Energy Management Planning." *Hospital Energy Management Strategies Seminar*. PG&E's Pacific Energy Center, 1992

"Practical Experience in Achieving High Levels of Accuracy in Energy Simulations of Existing Buildings." *ASHRAE Transactions*. Symposium AM-92-1-2.

"Variable Flow Conversions for Chillers." *Energy Engineering*. Vol 21, 1989, pp. 59-65.

"Single Loop Variable Flow Chilled Water Systems." *HVAC & Building Systems Congress Proceedings*. 1989

"The Four M's of Energy Management." *Buildings Design Journal*. June 1987, pp. 16-21.

"The Energy Maze: How Computers Can Help You Choose the Right Retrofit Options." *MANAGEMENT Insights*. Winter 1981, pp. 3-11.

"Building Energy Performance Standards: Problem or Opportunity?" *5th Federal Energy Management Program Symposium*. 1979

"Field Demonstration of Refuse Derived Fuel for District Heating at Wright Patterson Air Force Base." *Energy and the Environment Proceedings*. 1975

DONALD C. ANDERSON, P.E.

ENERGY SYSTEMS CONSULTANT: Energy Resource Associates, Inc., Livermore, California. In this capacity Mr. Anderson is in responsible charge of a wide variety of engineering activities associated with the execution of facility investigations and project development. Mr. Anderson's work includes detailed field surveys, data analysis, computerized load calculations, mechanical and electrical system analysis, report writing and direction of other engineering sub consultants.

PRESIDENT: Lafayette Engineers, Inc., Lafayette, California. In this capacity Mr. Anderson directs the firm's day-to-day consulting and engineering activities, including project management, definition and review of technical scope, budget and schedule determination, technical approach and procedures, supervision and execution of detailed analyses, and report writing. The firm's specialization is energy analyses for industrial, school and commercial buildings. Mr. Anderson has personally served as State Energy Auditor Instructor for the State of California's Schools and Hospitals Program.

CORPORATE ENERGY MANAGER: Hexcel Corporation, Dublin, California. Spearheaded creation of the company's energy conservation program, resulting in a 27% reduction of energy use company-wide. Developed long-range plans for energy-efficient siting and layout of production facilities.. Provided liaison to the Department of Energy and other Federal agencies for the corporation. As Engineering Manager for the firm, directed design and construction of new production buildings and equipment, including the successful establishment of 5 production-related patents (in Mr. Anderson's name, assigned to the firm).

ENGINEERING MANAGER FOR PACKAGING SYSTEMS: Schjeldahl Company, Northfield Minnesota. Supervised engineering department in development and implementation of new polyethylene bag manufacturing system. Led marketing effort and industrial expositions promoting new manufacturing process.

MANAGER, PROCESS EQUIPMENT DEVELOPMENT: Proctor & Gamble Company, Cincinnati, Ohio. Management activities included reorganizing the Equipment Development Division and administering the 400+ employee Engineering Division. Technical activities included the design of mechanical equipment for processing lines and design and installation of entire processing lines in plants throughout the U.S. Acquired numerous patents (assigned to the firm). projects, performed energy savings calculations and performed design drafting.

EDUCATION:

Bachelor of Science in Electrical Engineering, University of Minnesota

Graduate, Navy Electronic Technicians School

PROFESSIONAL REGISTRATION AND ASSOCIATIONS:

Registered Professional Engineer, California, Ohio and Minnesota

Member, Association of Energy Engineers (AEE)

ARTHUR G. CRAIG, P.E.

PROJECT ELECTRICAL ENGINEER: Energy Resource Associates, Inc., Livermore, California. In this capacity, Mr. Craig is responsible for electrical and digital control systems engineering activities, including project management, definition and review of technical scope, budget and schedule determination, technical approach and procedures, supervision and execution of detailed analyses, documentation and report writing and project start-up and commissioning.

MANAGER OF ENGINEERING SERVICES: R. F. Mital and Associates, Inc., Pittsburgh, PA. Responsible for marketing of electrical and general engineering services. In addition, he performed power distribution and lighting system design for numerous public and private renovation and new construction projects including schools, churches, retail facilities and municipal water treatment plants. He also provided minor engineering services related to structures, piping design, HVAC and control systems. Supervised the purchase and installation of computer drafting work stations (AutoCad and Softdesk) and equipping the rest of the office with an Ethernet LAN, PC's and software.

MANAGER OF ENGINEERING: Qual-Tech Engineers, Inc., Pittsburgh, PA. Directed and performed electrical engineering work, including industrial plant power distribution systems, high voltage cable fault studies, high voltage transmission lines, production equipment installations and industrial control systems.

ARTHUR G. CRAIG, CONSULTING ENGINEER: Mr. Craig's private practice included electrical system design for commercial office buildings and shopping centers and industrial projects including computerized numerical machine control and wind turbine control systems.

CHIEF ELECTRICAL ENGINEER: Jacob Engineering, Martinez, CA. Supervised the Electrical Design Department on steel industry modernization projects, including demolition and rebuilding of electrical systems, providing for computer controlled production lines, furnaces and shipping areas. He directed the design of high voltage power distribution equipment, motor control centers, alarm and communication facilities and relay protection systems.

SENIOR APPLICATIONS ENGINEER: Aluminum Company of America. Over a career spanning 32 years, Mr Craig held many positions including Senior Applications Engineer. In this position he was responsible for national technical assessment of aluminum applications in the electrical, electronics and power industries. He developed design and engineering practices for aluminum conductors, connectors and other products such as heat sinks. He authored and presented numerous IEEE papers and authored other publications and was active in the Alcoa Wind Turbine Project.

EDUCATION:

University of California, Berkeley
Bachelor of Science, Electrical Engineering

PROFESSIONAL ASSOCIATIONS/DISTINCTIONS:

Registered Professional Engineer, Pennsylvania, California

DAVID J. CUTHBERTSON, E.I.T., C.E.T.

SENIOR ELECTRICAL ENGINEER: Energy Resource Associates, Inc., Livermore, California. As Electrical Systems Consultant, Mr. Cuthbertson is responsible for engineering of electrical power distribution (including emergency power and cogeneration), electrical metering, lighting and electrical control systems, including field surveys, final design, cost estimating, equipment selection, construction supervision, and consultation on start-up, operation and maintenance of electrical systems.

UTILITIES FOREMAN/SUPERVISOR: Port of Oakland, Oakland, California. Supervised electricians, plumbers and BME's in construction and maintenance activities. Prepared budgets and job estimates, did purchasing, and designed field changes on mechanical and electrical systems.

OWNER: Cuthbertson Electric, Dublin, California. Owned and operated this electrical contracting company. Bid and performed electrical contracting work for numerous industrial and commercial clients.

ELECTRICAL DESIGNER: University of California, Lawrence Livermore Laboratory, Livermore, California. Designed building and utility electrical power systems and controls, preparing blueprints drawings and specifications for construction of electrical power systems.

ADMINISTRATIVE ASSISTANT: Lockheed Missiles and Space Co., Sunnyvale, California. Supervised energy conservation program including energy accounting and reporting, and conservation project development and execution.

PLANT ELECTRICIAN: Lockheed Missiles and Space Co., Sunnyvale, California. Performed maintenance and construction work on electrical power and control systems. Served as an Administrative Assistant for one year supervising the energy program which required reporting on and control of the energy conservation program.

EDUCATION:

Diablo Valley College, Pleasant Hill, California
International Correspondence School, Scranton, PA. Electrical Engineering

Las Positas College, Livermore, California
Associate of Arts, Natural Sciences

PROFESSIONAL ASSOCIATIONS/DISTINCTIONS:

Registered Engineer in Training, California

Electrical Contractor License C-10 #382947 (inactive)

Certified Engineering Technician in Electrical Engineering Technology, CET #066547

TIMOTHY L. DENHAM

FACILITIES OPERATIONS SPECIALIST. Energy Resource Associates, Inc., Livermore, California. In this capacity, Mr. Denham performs facility efficiency evaluations relative to plant operations, maintenance and efficiency in acute care hospitals and other facilities, orientated towards cost containment and budget management while maintaining quality. Evaluations include consideration of numerous maintenance functions for central plant equipment, medical gas systems, life safety systems, biomed, and building envelope and grounds. Mr. Denham also supports ERA's Performance Contracting Services program. Serves as internal consultant to the entire firm regarding building codes and regulations (UBC, UMC, NFPA, ADA, Title 22, Title 24, JCAHO, NEC, OSHA, OSHPD, OSA) and other governing agencies related to construction and maintenance.

PROJECT OPERATIONS/MANAGEMENT/CONSULTING. T.D. Enterprises, Campbell, CA. Coordinated projects, construction and installation of equipment in new and existing facilities. Participated in the planning and development of various projects with owners, architects, engineers, contractors, and inspectors. Implemented policies and procedures for personnel, and conducted training programs for various clients.

DIRECTOR/CHIEF ENGINEER. Salinas Valley Memorial Hospital, Salinas, CA. Responsibilities included day to day operation of the Engineering department which included buildings and grounds, Biomedical engineering, and construction projects. Responsible for the evaluation of, hiring of and disciplinary actions for thirty-two employees. Developed and implemented:

- department computer network system
 - work order and preventative maintenance programs
 - annual budgets for Engineering, Biomedical, and construction projects
 - cost containment programs (which included direct management of an Energy Savings Performance Contract with a Fortune-500 ESCo, which exceeded \$500,000/year in savings)
- Revised the preventative maintenance programs in Biomed and Engineering resulting in an additional \$500,000 savings. Chair of the Hazmat committee, Utilities committee, Safety sub-committee. Prepared the Engineering and Biomed Departments for JCAHO. Supervised construction and renovation projects with architects, inspectors, contractors, engineers, and administration.

OPERATIONS MANAGER. Marriott Corporation at O'Connor Hospital, San Jose, CA. As a contract manager, supervised and directed 26 employees including the Chief, and two Assistant Chief Engineers. Involved with architects, contractors, inspectors and engineers on the interstitial construction and the renovation of the Oncology Unit. Assisted with preparation of JCAHO. Participated on safety committee, disaster committee, hazardous materials and various other committees.

ASSISTANT DIRECTOR, PROJECT MANAGEMENT. Good Samaritan Hospital, San Jose, CA. Responsible for building and grounds, architects, engineers, contractors, inspectors,

construction and project implementation. Member of Safety committee, Biohazardous waste committee and Disaster planning committee. Made key decisions in emergency situations. Assisted the Director of Facilities and assumed those responsibilities in his absence. Responsible for the management and supervision of personnel, which included hiring, assignment of staff, evaluations, development of policies and procedures, preventive maintenance programs, and budgets for the engineering/biomed departments. Coordinated energy savings program.

PETTY OFFICER. U.S. Coast Guard Petty Officer - Honorable Discharge.

EDUCATION:

University of Phoenix - Completing BA in Business Administration

San Jose State - Completed courses in engineering and computer science.

San Jose City College - AS Degree in air conditioning and refrigeration. Course work included industrial/construction management and supervision classes. Various course in electronics, computer and industrial arts.

Certificates:

- Project Management/Construction
- Management
- Refrigeration
- Air Conditioning
- Electrical Code
- Sales and Training
- Time Management
- Asbestos Handling
- Energy Management
- Hazmat Program and Training

PROFESSIONAL ASSOCIATIONS/DISTINCTIONS:

Boiler Operator License, San Jose

Member, California Society of Healthcare Engineering (CSHE)

Member, American Society of Healthcare Engineering (ASHE)

Member, American Hospital Association (AHA)

Member, National Fire Protection Association (NFPA)

Member, International Conference of Building Officials (ICBO)

HENRY KWAN, P.E.

ASSOCIATE MECHANICAL ENGINEER: Energy Resource Associates, Inc., Livermore, California. In this capacity, Mr. Kwan performs numerous duties, including energy accounting, field surveys, data analysis, energy savings calculations, cost estimating, computer simulation, residential and non-residential Title-24 preparation, report writing, project layout utilizing CADD, structural CADD drafting and detailing, load calculations, HVAC system design, specification writing, and assists with contractor walk-throughs, construction observation, control system commissioning and start-up troubleshooting.

ASSISTANT ENGINEER: Energy Analysis and Diagnostic Center, San Francisco State University, San Francisco, California. The EADC, a government sponsored organization which provides free energy audits to small and medium sized manufacturing companies to help them save on energy consumption. Mr. Kwan established and maintained contact with clients, presented findings to EADC team members, gathered and analyzed energy conservation actions for manufacturers to save energy, performed detailed engineering calculations to determine energy conservation opportunity along with any rebates given by local municipalities and coordinated, prepared, and wrote detailed energy conservation reports.

TRANSPORTATION COORDINATOR: United States Army Reserve, Pleasanton, California. In this capacity, Mr. Kwan was responsible for developing, planning and scheduling training sessions, supervising sixteen people ensuring their education and accountability, wrote all paperwork for movement of goods and personnel via land, air, or sea, and performed general office work.

EDUCATION:

California State University, San Francisco
Bachelor of Science in Mechanical Engineering

PROFESSIONAL ASSOCIATIONS/DISTINCTIONS:

Registered Professional Engineer, California

DUANE M. ROBINSON, ARCHITECT

ARCHITECTURE PLANNING AND DESIGN SPECIALIST: Energy Resource Associates, Inc., Livermore, California. As an Architecture Planning and Design Specialist, Mr. Robinson is responsible for planning and design of facilities. Mr. Robinson is the company-wide consultant, including expert witness assignments on architecture planning and design.

PRINCIPAL: The Space Management and Design Group, Mariposa, California. Since 1985, in this capacity Mr. Robinson has been directing the firm's day-to-day architectural planning and design activities including, project management, design, planning, review, budget, schedule determination, technical approach, and supervision. The firm's specialization is retail and college facilities. Specific projects include the I. Magnin Palo Alto and Carmel stores which were completed in 1985 and 1986. Additionally, a new 70,000 square foot department store in Woodland, California was finished in 1986. College projects included a new T.V. studio for Foothill College as well as numerous other renovation projects for the Foothill and DeAnza Community College District. More recently, the projects under his direction have been more complex in their scope of work. The projects remain focused in the areas of retail and college facilities, however, the variety has become more extensive and more challenging. Some examples include a 3500 seat "stadium," including press-box, for DeAnza College, a two story 7,000 square foot addition to Foothill College's Campus Center, a major renovation and additions to Rothschild's Specialty Department Store in Oklahoma City (60,000 square feet), a new two story specialty store for McCaulou's Department Store in Napa, California (40,000 square feet), a restaurant called Quiet Storm at the Cannery in San Francisco, and a 10,000 square foot "Gold's Gym" in San Francisco. Ongoing projects for the Foothill and DeAnza College District include classrooms, chemistry and biology buildings and numerous others. I. Magnin Palo Alto and Carmel stores, a 70,000 square foot department store in Woodland, CA, Foothill College, DeAnza College, a major renovation and addition to Rothschild's Specialty Department Store in Oklahoma, a new two story energy analyses for industrial, school and commercial buildings.

EDUCATION:

Bachelor of Architecture, University of Oregon.

PROFESSIONAL ASSOCIATIONS/DISTINCTIONS:

Of significance, Mr. Robinson received a **Certificate of Appreciation and Recognition** for his "bold design, patience and rapport" in the construction of the Foothill College Campus Center Expansion and received a **Design Merit Award** from the Department of the Navy in recognition of exceptional merit for the design of the Enlisted Dining Facility at Castle Air

Force Base, California.

JAMES S. ROTHFUSS, P.E.

SENIOR ELECTRICAL ENGINEER: Energy Resource Associates, Inc., Livermore, California. In this capacity, Mr. Rothfuss is responsible for ERA's electrical engineering activities, including project management, definition and review of technical scope, budget and schedule determination, technical approach and procedures, supervision and execution of detailed analyses, documentation and report writing, and technical staff training and development.

ELECTRICAL PROJECT ENGINEER: Lawrence Livermore National Laboratory, Livermore, California. Responsible for the design and management of various plant and facilities projects, including new facility electrical systems, high voltage power distribution systems, industrial instrumentation and monitoring systems, control and alarm systems and site communications systems.

STAFF ELECTRICAL ENGINEER: Edwards Air Force Base, California. As member of the aircraft instrumentation group, inspected and tested instrumentation systems, devised field retrofit, investigated chronic in-flight systems operational difficulties,, provided input to higher headquarters regarding design and manufacturing of new instrumentation systems.

EDUCATION:

California Polytechnic State University, San Luis Obispo
Bachelor of Science, Electrical Engineering

University of California, Davis
Master of Science in Engineering

PROFESSIONAL ASSOCIATIONS/DISTINCTIONS:

Registered Professional Engineer in California and Nevada

CRAIG D. SHULENBERGER, E.I.T.

PROJECT MECHANICAL ENGINEER: Energy Resource Associates, Inc., Livermore, California. In this capacity, Mr. Shulenberger is in responsible charge of the execution of facility investigations, including field surveys, data analysis, computer simulation, project development, cost estimating and report writing. In addition, Mr. Shulenberger performs final project design, including load calculations, system layout, specification writing, contractor walk-throughs, construction observation and start-up commissioning and troubleshooting. His projects include energy retrofit feasibility studies, HVAC system problem investigations, design of chiller installations, chilled water piping, entire HVAC systems, comprehensive energy retrofit projects, digital control and building automation systems, and HVAC restoration projects. Mr. Shulenberger serves as senior estimator and as CADD consultant for the entire firm.

PROJECT MANAGER/ENGINEER: Comm Air Mechanical Services, Oakland, California. Estimated, designed and managed the installation of HVAC and refrigeration construction projects, including data center and extreme-climate laboratory facilities. Provided engineering support to nine outlying branch offices. Established CADD standards for the company. Performed computerized design calculations, Title-24 compliance and building simulation for energy savings calculations. Maintained engineering department computer database. Procured instruments and maintained certified instrument calibrations for test and balance (TAB) department.

ESTIMATOR: Plant Construction, Inc., San Francisco, California. In this capacity, Mr. Shulenberger estimated construction costs and prepared proposals for various construction projects, including large tenant-improvements, building facade restoration, seismic reinforcement, small new buildings, etc. Maintained the estimating department's database of construction costs, vendors and subcontractors.

ASSISTANT MANAGER: Steel Building Division, Aladdin Heating Corporation, San Leandro, California. Estimated construction costs and developed proposals for new construction and remodels for structural steel and sheet metal buildings. Recruited and managed 10-person clerical and drafting staff. Coordinated field labor for construction of projects.. Purchased specialty materials and prefabricated components for special projects. Handled negotiations with shop labor unions to arrange wage and benefit packages competitive with non-union competitors. Developed and coordinated advertising programs.

PRODUCT ENGINEER: Aladdin Heating Corporation, San Leandro, California. Assembled data and prepared specification compliance documentation for air handling products manufactured by the firm. Prepared component part and assembly drawings, including material lists, for production of custom components. Performed periodic quality control inspections of manufactured products. Developed a computer data base of standard product specifications to assist sales representatives. Developed computer programs to standardize the generation of technical data for equipment submittals. Provided technical support to 20+ nation-wide field sales

representatives. Performed in-field troubleshooting and correction of problems with installed air handling equipment.

EDUCATION:

University of California, Davis

Bachelors Degree: Architectural Design/Systems Engineering

PROFESSIONAL ASSOCIATIONS/DISTINCTIONS:

Registered Engineer in Training, California

Member, American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE)

Member, Association of Energy Engineers (AEE)

Member, California Society for Healthcare Engineering (CSHE)

LEVI E. TALLETT. P.E.

SENIOR STRUCTURAL ENGINEER: Energy Resource Associates, Inc., Livermore California. In this capacity, Mr. Tallett is responsible for structural and seismic engineering analysis and design as it pertains to various HVAC projects. Mr. Tallett's work includes field surveys, computerized design load calculations, cost estimates, and material specification for both new and remodel projects. Mr. Tallett is especially skillful in identifying and implementing innovative techniques for modifying structures to support mechanical systems in ways which create the minimum disruption to in-service facilities during and after construction.

SENIOR ENGINEER: Roberts Engineers & Architects, responsible for structural design in steel, reinforced concrete, timber and masonry for petroleum refineries, commercial buildings and industrial facilities. Recent project include engineering design, and construction document preparation for refinery projects, rail car unloading facilities, seismic analysis of buildings, equipment supports and foundations, computer facilities, and medical facilities. Major areas of experience are site development, structural design of industrial and commercial facilities for both new and rehabilitation projects.

MANAGER OF ENGINEERING: General Consulting Services, Inc., Manager of engineering responsible for all civil/structural engineering design and drawings. Reviewed all calculations and drawings prior to sealing same. The projects consisted of high rise structures of steel and/or prestressed concrete, hospitals, residences and seismic bracing of piping and equipment.

STAFF ENGINEER: M.K. Ferguson Company, responsible for the civil/structural design of light industrial and commercial buildings in accordance with applicable codes, standards and regulations. Directed the preparation of design drawings, developed specifications, coordinated design with other disciplines and resolved field problems during construction.

SENIOR STRUCTURAL ENGINEER: The Rust Engineering Company, prepared preliminary design calculations and sketches to estimate project costs for pulp and paper industry projects. Responsible for development of final design calculations, drawings, specifications and field coordination for buildings and equipment supports of heavy equipment used in the paper industry. Lead structural engineer for \$600 million Boise Cascade Wallua Mill expansion.

SENIOR CIVIL/STRUCTURAL ENGINEER: Vitro Engineering Company, planned, executed and reported on complex civil and structural projects. Was responsible for design adequacy, conformity with approved design, cost and schedule criteria and compliance with applicable codes, standards and nuclear regulations.

Prior to this, spent 15 years in the structural design of multi-story concrete and steel buildings, and one and two story wood structures. Also designed naval ships and supports for heavy machinery on naval vessels as well as gun mounts.

EDUCATION:

Oregon State University
B.S. Civil Engineering

Graduate Courses in Computer and Materials - University of Washington, Seattle

SPECIAL FIELDS OF KNOWLEDGE:

Seismic Analysis of Equipment and Structures
Heavy Machinery Foundation Design
Concrete and Steel Testing and Inspection
Seismic Support Systems for Piping

PROFESSIONAL ASSOCIATIONS/DISTINCTIONS:

Registered Structural Engineer:	Arizona, California, Texas, Washington
Registered Civil Engineer:	California, Oregon, Washington
Registered Land Surveyor:	Oregon, Washington

American Society of Civil Engineers - Life Member

American Concrete Institute - Member

VERNON TAYLOR

REFRIGERATION SYSTEM SPECIALIST: Energy Resource Associates, Inc., Livermore, California. As Refrigeration System Specialist, Mr. Taylor is responsible for field investigation, inspection, troubleshooting and testing of refrigeration systems and machinery, supervising the installation, and start-up of refrigeration systems for ERA's clients. Mr. Taylor is the company-wide consultant, including expert witness assignments, on refrigeration systems, including packaged units, reciprocating, rotary and centrifugal chillers and absorption chillers.

CENTRIFUGAL FIELD SUPERVISOR: CommAir Mechanical Services, Oakland, California. For over 15 years, supervised the installation, maintenance and repair (electrical/mechanical) on lithium bromide absorption chillers, centrifugal chillers, screw and large tonnage reciprocating chillers/direct expansion units. Reviewed contracts related to various tonnage equipment and wrote estimates on incoming work. Systems included sizes ranging from five tons to three thousand tons in buildings, marine, cogeneration and production plants.

AIR CONDITIONING/REFRIGERATION MECHANIC: Operated in this capacity for sixteen years, contracting work for numerous industrial and commercial clients.

PRODUCTION SHOP PLANNER: Mare Island Navel Shipyard, Vallejo, California.

PIPEFITTER: Mare Island Navel Shipyard, Vallejo, California. Nuclear reactors, missile launching equipment, hydraulics.

INSTRUCTOR: (part-time) Contra Costa Community College District. Teaching Apprentice and Journeyman Air Conditioning/Refrigeration classes.

EDUCATION:

AA Degree Solano Community College
University California Extension Classes
Continuing Education, Purdue University, Purdue Indiana
Apprentice Program Graduate, Mare Island Naval Shipyard
Factory Training (York-Borg Warner) absorption, centrifugal and reciprocating chillers and turbo modulators (TM2 variable frequency drive)
Factory training (Graham Company) 1500 and 1600 series variable frequency drives.
Factory training (Dunham Bush) vertical and horizontal screw chillers.
Electronic classes Diablo Valley and Contra Costa Community Colleges.

PROFESSIONAL ASSOCIATIONS/DISTINCTIONS:

California State Teaching Credentials
Member, Diablo Valley College Curriculum Advisory Committee (Air Conditioning/Refrigeration)

California Contractor's Licenses, C-20 and C38

MICHAEL J. WALTZ, E.I.T.

STAFF MECHANICAL ENGINEER: Energy Resource Associates, Inc., Livermore, California. In this capacity, Mr. Waltz performs numerous duties, including energy accounting, field surveys, data analysis, computer simulation, report writing, project layout utilizing CADD, load calculations, specification writing, contractor walk-throughs, construction observation and assists with start-up troubleshooting.

STAFF ENGINEER: County of Alameda, General Services Department, Oakland, California. In this capacity, Mr. Waltz provided day-to-day technical oversight, management and coordination of the County's Demand Side Management program (as a participant in PG&E's Power Saving Partners Program). This work included energy accounting, field surveys and inspections, project planning, data analysis and simulation, report writing, supervision of sub-contractors installing energy retrofit products and negotiations and coordination with PG&E staff and program management consultants.

ENGINEERING ASSOCIATE: In-House Energy Management Program, Lawrence Berkeley Laboratory, Berkeley, CA. Served as Principal Investigator responsible for a petroleum conservation study at the Laboratory. This study, performed singlehandedly, involved a comprehensive analysis of the Laboratory's fleet of vehicles and explored alternate fleet composition, changes in vehicle operations, and alternate fuels and fueling systems. A number of specific projects were developed and their energy and cost savings analyzed. The data gathered and the analyses performed were assembled into a Study Report which was used as supporting documentation for a \$280,000 funding request to the Department of Energy. This study was acknowledged by management as "a significant contribution to the Laboratory's petroleum use reduction efforts."

ENGINEERING ASSISTANT: Energy Management Program, Lawrence Livermore National Laboratory (LLNL), Livermore, CA. Completed computer database of engineering studies. Constructed model solar water heater and model electric wind turbine for Summer Technology Institute. Participated in instruction at same. Took part in field surveys of plant equipment in LLNL facilities with consultants from ABB-Impell, Inc. Verified equipment inventories, recorded nameplate data, took airflow measurements in large built-up air handling units, and drew control diagrams for existing HVAC systems. Performed lighting surveys and conducted off-hours electricity use survey for LLNL facilities.

ENGINEERING TRAINEE: Energy Management Program, Lawrence Livermore National Laboratory, Livermore, CA. Performed Trakload computer simulations of the energy performance of buildings. Developed a library of CADD graphic symbols for use in proposed projects. Catalogued detailed information from over 400 engineering studies.

DATA ANALYST: Energy Resource Associates, Inc., Livermore, CA. Prepared and entered technical data, evaluated output for accuracy and performed associated clerical tasks. Additional tasks included customer service and minor engineering tasks.

EDUCATION:

University of California, San Diego
Bachelor of Science in Mechanical Engineering

University of Illinois, Urbana/Champaign
Graduate studies in Mechanical Engineering

PROFESSIONAL ASSOCIATIONS/DISTINCTIONS:

Registered Engineer in Training, California
California Society of Hospital Engineers, Robert Mack Scholarship, 1989 and 1990

RANDALL J. ZUMWALT, C.E.M.

MANAGER, PERFORMANCE CONTRACTING SERVICES: Energy Resource Associates, Inc., Livermore, California. In this capacity, Mr. Zumwalt is in overall responsible charge of various performance contracting projects, as well as acting as a senior project engineer on his own projects. His projects include managing energy services/performance contracting programs for ERA clients, development of HVAC Master Plans, primary power conversions, energy retrofit feasibility studies, HVAC system problem investigations, design of chiller installations, chilled water piping, entire HVAC systems, comprehensive energy retrofit projects, digital control and building automation systems, and HVAC restoration projects. His personal work includes project development, the execution of facility investigations, including field surveys, data analysis, cost estimating and report writing. Mr. Zumwalt also performs final project design, including load calculations, system layout, specification writing, contractor walk-throughs, construction observation and start-up commissioning and troubleshooting. Mr. Zumwalt serves as a performance contracting consultant for the entire firm.

MANAGER, SOLUTIONS-BASED CONTRACTING: Linford Service Company, Oakland, California. In this capacity, Mr. Zumwalt was in charge of business development for the company in the field of integrated, building energy system infrastructure modernization and upgrading - a novel approach to performance contracting. To bring these services to clients, Mr. Zumwalt performed comprehensive technical and financial assessments of client facilities throughout Linford's California-wide service territory, and developed comprehensive programs to modernize and upgrade clients' facilities - all under a single contract umbrella.

SENIOR PERFORMANCE CONTRACTING ENGINEER: Honeywell, Inc., San Francisco, California. As a key resource for Honeywell's performance contracting program, Mr. Zumwalt performed initial assessments of program potential and detailed scopes of work and energy performance projections in support of sales and marketing staff. On existing accounts, performed post-retrofit performance monitoring and evaluation and in-field trouble-shooting of under-performing projects, and developed and implemented remediation schemes for these projects. Performed numerous detailed feasibility studies and assisted field technicians and system designers in troubleshooting and developing BAS and controls strategies.

REGIONAL FACILITIES MANAGING ENGINEER: National Medical Enterprises, Santa Monica, California (now known as Tenet Healthcare, Inc.). NME is an international healthcare provider with over 140 hospitals and 45,000 employees worldwide and recently merged with American Medical International to form Tenet Healthcare, Inc, headquartered in Dallas, Texas. Established a regional office in Dublin, California, for plant maintenance and energy engineering services for 35 California hospitals. Reported to the Director of Engineering Services in Louisiana and the department head of construction and design located in Santa Monica, California. Provided direction and assistance to NME facilities in a number of areas of facilities management retrofit and construction, including; facility operations surveys for joint commission and in-house requirements, negotiated and managed cost cutting programs in natural gas procurement, utility bill auditing, utility company rate structures, and vendor contracts; reviewed construction documents for consistency with corporate objectives; directed energy reduction programs including preventative maintenance, BAS, complete lighting retrofit, LPA pumps, chiller and boiler retrofit; developed emissions reduction programs for EPA and AQMD compliance

involving, CFC, ETO and NOx; and developed and implemented life safety programs involving medical gases, emergency power, underground storage tank replacements.

PROJECT MANAGER/ENGINEER: CommAir Mechanical Services, Oakland, California.

Provided engineering and sales services on a wide variety of retrofit projects up to \$500,000, including; developing pre-sale mechanical, electrical, structural engineering requirements, and material acquisition plans; estimating, designing, and managing energy retrofit for central chiller, and boiler plants; coordinating all aspects of subcontractors including 20,000 lb. helicopter lifts; in-field system start-up; preparation of as-built drawings, operation and maintenance manuals for clients; and troubleshooting and balancing of hospital HVAC systems to stringent OSHPD (Office of State Health Planning and Development) requirements.

HVAC ENGINEER: California Consulting Associates, San Mateo, California (contracted services). Prepared detailed HVAC system final design on numerous projects and for numerous clients, including:

- Skidmore Owings & Merrill - San Francisco, CA
Pacific Bell Headquarters - San Ramon, CA - HVAC Air Side
- H.K. Ferguson - San Francisco, CA
National Semiconductor - R & D Facility - Class 10 clean room design
- YEI Engineers - Hayward, CA
Cogeneration Plants - Bakersfield, CA - Process piping design
- Ellerbe Alaska - Fairbanks, AK
North Pole High School - HVAC & Arctic Piping Design

MECHANICAL DESIGNER: CH2M HILL International, Corvallis & Portland, Oregon.
Designed and drafted HVAC and piping systems for a variety of industrial projects.

EDUCATION:

Portland Community College
Applied Associate, Mechanical Engineering Technology & Business Administration

PROFESSIONAL ASSOCIATIONS/DISTINCTIONS:

Member, American Society for Hospital Engineering (ASHE)

Member, Association of Energy Engineers (AEE)

Member, and Secretary, San Francisco Chapter, California Society for Healthcare Engineering (CSHE)

PROJECT SUMMARY

CLIENT/FACILITY:	San Francisco Newspaper Agency (Chronicle and Examiner)
LOCATION:	San Francisco, California
CONSTRUCTION VALUE:	\$2,000,000
ERA SERVICES:	Facility Evaluation and Project Development, Mechanical and Electrical Design, miscellaneous services

DESCRIPTION OF PROJECT AND SERVICES PROVIDED:

The San Francisco Chronicle and Examiner and their joint publisher, The San Francisco Newspaper Agency, all jointly occupy a 250,000 square foot facility at the corner of 5th and Mission Streets in San Francisco. The building had historically been occupied since the early 1900's by the Chronicle and was joined by the Examiner in the mid-60's, along with a major addition and modernization of the facility at that time. In spite of this major work and because of the mild summer weather in San Francisco, the building had never been equipped with air conditioning through 1986. In January 1987, The Newspaper Agency asked ERA to evaluate the facility for the addition of air conditioning, keeping both cost and disruption to operations in mind. ERA's report, delivered in February, identified four separate options for adding air conditioning to the building, ranging in price from approximately one and one-half to two million dollars. These options all included the re-use of major portions of the existing heating and ventilating equipment (air handlers and ductwork primarily) while adding a central chilled water plant in a new penthouse, chilled water distribution piping systems, installation of cooling coils in the majority of air handling units, modification of certain air handling units to variable volume (to comply with the California Energy Code), the replacement of a small number of air handling units and new temperature controls on all air handling systems.

The Owners made up their minds quickly on the 1.6 million dollar option (about 500 tons of cooling capacity) and implementation began immediately. As recommended by ERA, the project was conducted as an "integrated-design-and-construction" project. ERA commenced with final mechanical and electrical design immediately. In addition, ERA (utilizing the detailed scope of work documents prepared as a part of the study process above) simultaneously assisted the owner in negotiating fixed price contracts with a selected team of contractors. Design was then completed with the advice and assistance of the contractor team, with final equipment selections and immediate ordering of equipment based on the contractors' most attractive price alternatives. Literally, the design was completed in phase and in tune with the contractors' most immediate needs for equipment ordering and installation details.

Technical features of the project included modification of the building electrical service to serve two new chillers with only a 4 hour power outage, a two-chiller central plant consisting of a reciprocating chiller for low load operation and a centrifugal chiller for peak load operation. The chilled water distribution system is configured as a variable flow system (without separate chiller and building circulation pumps) and all air handling systems were equipped with direct digital control systems interconnected to a central computer for monitoring and control point reset.

As a part of the project, a comfort survey was conducted to identify areas of severe discomfort - more than

due to just the lack of air conditioning. The result was the inclusion of modifications of individual air handling system ductwork to correct severe air distribution problems.

Final Design commenced at the beginning of March and chiller start-up was conducted approximately mid-August (of the same year), bringing the project on line as projected in the initial study.

Other projects accomplished by ERA include remodel of the two Editorial department HVAC systems, replacement of the main building heating boilers, an energy retrofit feasibility study and design of a comprehensive energy retrofit project, monthly energy accounting, annual utility budget preparation and consultation on operating engineers staffing.

PROJECT SUMMARY

CLIENT/FACILITY: Alameda County Courthouse and Administrative Building Complex

LOCATION: Oakland, California

CONSTRUCTION VALUE: \$700,000

ERA SERVICES: Energy Retrofit Feasibility Study, Mechanical and Control System Design, Post-Retrofit Monitoring

DESCRIPTION OF PROJECT AND SERVICES PROVIDED:

The Alameda County Courthouse and Administration Building Complex (CABC) consists of two buildings in downtown Oakland, totalling approximately 465,000 square feet. The Courthouse building was constructed around 1935, while the Administration Building was constructed in 1963. Due to the ages of the buildings and the many remodel projects performed over the years, both the HVAC and lighting systems were a mixed bag of types, condition and efficiency. In fact, more than 40 different air handling systems provide heating and cooling to the building from the shared central heating and cooling plant in the Courthouse Building.

A very detailed energy retrofit feasibility study was conducted of the complex, including the direct measurement of the electrical power demand of every motor and panel, extensive physical examination of the mechanical and lighting systems and preparation of a computer model of the building (using the Trane Company's TRACE program) that agreed within 5% with the actual gas and electric invoices for the base year. A large number of retrofit options were collaboratively explored and examined with the Owner's staff, including simulation on the building model, with the final comprehensive retrofit package consisting of conversion of virtually every HVAC system to variable volume, variable speed drives on larger fan systems, direct digital controls for air handling systems, new pneumatic zone controls (for VAV), the addition of outside air economizers on most systems not so equipped, extensive lighting fixture retrofit and replacement of the existing outmoded (and little used) EMS computer with advanced start/stop functions from the new building automation system (which included a terminal/PC in the chief engineer's office).

A unique feature of the project was the fact that conversion of all mixing systems (double-duct and multi-zone) would allow summer shutdown of the steam distribution system for the first time in the history of the building.

Upon completion of the feasibility study and confirmation on the part of the Owner of the desired package of retrofit work, ERA performed final design, including the precise locating of double duct boxes, preparation of point-to-point wiring diagrams for digital controls, point-to-point connection diagrams for pneumatic controls, double-duct box conversion details, multi-zone to VAV zone modification details, etc.

This work was performed in close coordination with the owner's selected contractor so as to achieve maximum integration of design concepts and the contractor's working knowledge construction methods and of the equipment to be installed. During construction, ERA provided technical guidance and support to the contractor's installing team, so as to avoid problems and optimize the installation.

Subsequent to the completion of construction, ERA provided ongoing monitoring services,, including development of a stipulated-calculation, automated spreadsheet and energy accounting utilizing pre and post-retrofit comparison of utility company invoices. Both of these methods of monitoring of project performance demonstrated that the project met it's savings objectives. In addition, through post-retrofit, on-site observation, ERA identified significant opportunities for enhanced performance of the project.

PROJECT SUMMARY

CLIENT/FACILITY: Borel Place

LOCATION: San Mateo, California

CONSTRUCTION VALUE: \$150,000

ERA SERVICES: Energy Retrofit Study and Project Design

DESCRIPTION OF PROJECT AND SERVICES PROVIDED:

Borel Place is a complex of three tenant-occupied buildings, constructed at different times during the 1970's. Similar to many buildings of the period these buildings suffered from mechanical equipment which was originally constructed to the lowest possible installed cost. The result was a poorly thought out HVAC and temperature control design and cheaply installed equipment that was hard to maintain. During the study phase it was determined that the double duct air conditioning system resulting in the constant mixing of heating and cooling, which was particularly bad due to the direct expansion cooling equipment. While outside-air economizers were added subsequent to the original construction, they had fallen into dis-repair and had the drawback of significantly increasing heating energy consumption (as demonstrated by a computerized analysis of the energy use history of the buildings). In addition, the inflexible electro-mechanical timeclocks used to control the operation of the HVAC systems resulted in excessive operating hours.

To cure the building's ills, ERA developed a comprehensive retrofit program consisting of a variable volume retrofit of the double duct HVAC system (including variable speed fan drives, digital controls of the air handling systems and conversion of the double-duct air distribution boxes to variable-volume/double duct boxes), restoration of the outside air economizers and coordinated control of boilers, heating pumps and other auxiliaries through the new building automation system head-end (which was provided with an operator terminal/PC in the building manager's office. Energy savings for these retrofit was analyzed on ERA's proprietary BEST building simulation program.

Upon completion of the study and presentation of the final report, ERA was authorized to prepare final installation documents. This work was performed in collaboration with the owner's selected contractor so as to achieve maximum integration of design concepts and the contractor's working knowledge of the building (the contractor had the service contract for the building). Simplified installation drawings were prepared and each project was installed and put into operation over a 90 day period, including start-up. No tenant disruption was caused during the installation.

Subsequent monitoring of the actual energy saving performance of the retrofit (by comparison of before and after utility company invoices) indicated that the projects were saving more than 93% of the savings projected.

PROJECT SUMMARY

CLIENT/FACILITY: Xerox/Palo Alto Research Center (PARC)

LOCATION: Palo Alto, California

CONSTRUCTION VALUE: \$650,000

ERA SERVICES: Building Ventilation, Pressurization and Energy Retrofit Study

DESCRIPTION OF PROJECT AND SERVICES PROVIDED:

Built in two major phases, this 250,000 square foot facility houses research and development activities and operates on a 24 hour per day basis. Unfortunately, and is commonly the case, the end result of the "Normal" construction process was a building with very good basic equipment, but which was never commissioned properly. In addition, the special needs of a research facility (building pressurization) to maintain a clean interior environment were not met in that the HVAC systems between the first and second construction phases were not coordinated nor were they coordinated with the laboratory exhaust systems (no positive means of providing sufficient pressurization air were provided).

ERA was commissioned to perform an engineering evaluation of the building and its HVAC systems to determine the specific causes and cures for the building's negative static condition. As a secondary goal, ERA was to identify likely energy conservation measures as an offshoot of evaluating the HVAC systems. The study included a complete review of the as-built condition of the building's HVAC and control systems, review of operating procedures, and day and night building pressure surveys, with building pressure measurements performed throughout the building. In addition, air flow readings were taken on all laboratory exhaust systems and building HVAC systems.

The results of the study showed that the original wing was significantly deficient of make up air (HVAC systems were constant volume with fixed outside air quantities). The new wing, while not itself deficient, was configured with a "fan tracking" variable volume HVAC system which "theoretically" would maintain building static pressure (as professed by the control system vendor). Unfortunately, the variable systems lacked the capacity to overcome the total building's negative static condition and had controls that might keep an office building positive but not a laboratory building with its exhaust systems independent of the HVAC equipment. In fact these controls exacerbated the building's negative static problem whenever they were not in the full outside air economizer mode. The final portion of the study involved whole building testing to determine precise quantities of outside air needed to create building pressurization (which is entirely dependent upon the "tightness" of the structure of the building). This was accomplished by manual manipulation the operating configuration of the various HVAC systems (damper positions and return fan shut down) along with building static measurements, until the desired condition was achieved.

As defined in the final report, ERA developed a comprehensive HVAC system modification program consisting of HVAC system modifications to permit higher outside air quantities on constant volume systems and temperature control modifications on all HVAC systems to provide for direct measurement and control of outside air quantities. In addition, numerous energy retrofit measures were identified and budgeted, including variable air volume conversions, installation of variable frequency fan motor drives, and temperature control modifications.

PROJECT SUMMARY

CLIENT/FACILITY:	John Muir Medical Center
LOCATION:	Walnut Creek, California
CONSTRUCTION VALUE:	\$4,000,000+
ERA SERVICES:	Energy Retrofit Study, Energy Retrofit Design and Project Coordination, Building Automation System Management, Energy Accounting, Utility Budget Preparation, Chilled Water Plant Design, Emergency Power Master Plan

DESCRIPTION OF PROJECTS AND SERVICES PROVIDED:

John Muir Medical Center is a 360,000 square foot, regional, acute-care medical center. The Facility was built in three phases over a 25 year period, the most recent phase completed in the fall of 1990. ERA has been given a number of assignments at the facility.

ERA's first assignment, in 1989 was to perform an energy retrofit study of the first two phases. This study resulted in the funding, design and construction, in 1990, of a number of energy conservation measures, including conversion of the chilled water system to variable flow, addition of supply air reset and the installation of condenser water reset controls. This work was done without service disruption to the building's HVAC systems.

In 1991, ERA was engaged to design and coordinate additional energy retrofit work, including interconnection of the original Phase-1/2 chilled water system with the newly completed Phase-3 chilled water system (*these systems were unfortunately constructed as "stand-alone" systems*), and the interconnection of the computer room cooling system to the central chilled water distribution system.

In addition, the 1989 project pointed up the fact that the existing building automation system was significantly antiquated, underutilized and was in need of updating. In a coordinated and integrated fashion, ERA updated this system. This included arranging for a factory systems engineer to convert all digital, stand-alone control panels to the latest factory specs (*done on-site rather than having to ship panels back to the factory individually*) and having the factory systems engineer perform on-site update training of the plant operations personnel. In addition, ERA utilized the new upgraded system's graphics and communications capability by creating custom graphics for all of the hospital's HVAC systems, creating color-coded (*by HVAC system*) floor plans for the hospital and re-writing individual panel programs to simplify them and make use of "global" system variables for control programs in various panels. Besides the on-line graphics, ERA created user's manuals for the plant operators (*including color printouts of all graphics, printouts of all programs in each panel, automation system programming and user's manual and notes, and user's manuals and software manuals for the new operator-terminal personal computers - which ERA purchased and set up on site*). In addition, ERA has created a set of system management procedures for the operation and maintenance of the system and it's terminal computers. The improved effectiveness and utilization of the building automation system, combined with other HVAC hardware retrofit has resulted in the Medical Center's utility consumption actually dropping during a period of increased building square footage coming on line - a documented cost avoidance of more than \$300,000 annually as of the last accounting.

Ongoing work by ERA at John Muir includes continuing recommissioning, upgrading and expansion of the building automation system, off-site monitoring of the building automation system, modification of fuel oil piping and removal of an aged fuel oil storage tank, design of a replacement 1100-ton chilled water plant for the original wing (documented in an article in the Winter 1996 issue of *Energy & Environmental Management* magazine), monthly energy accounting, annual utilities budget preparation, and development of an emergency power system master plan.

PROJECT SUMMARY

CLIENT/FACILITY: Great Western Bank Building

LOCATION: Palo Alto, California

CONSTRUCTION VALUE: \$180,000

ERA SERVICES: HVAC System Investigation and Remediation Design

DESCRIPTION OF PROJECT AND SERVICES PROVIDED:

Primarily a tenant occupied building, the Great Western Bank Building suffered, from "short-cut" design of the HVAC systems by the design-build contractor. The result was an HVAC system that could never provide adequate cooling, regardless of the season of the year. During the study phase it was determined that the original designer made some fundamental conceptual errors in determining the operating parameters of the air handling equipment - which effectively resulted in undersizing of both the airflow and the cooling coils. It appeared that replacement of the air handling units might be the only solution, since they were so severely undersized (the building was uncomfortably warm even during most of the winter months!).

Because of the prohibitively high cost of replacing the air handling units in their interior location on each floor, ERA "re-engineered" the HVAC system from the inside out, assuming that the air handling units themselves could not be replaced, nor could their fan horsepower be increased (due to the limitations of the building's power distribution system). Grinding away with a computerized coil selection program, ERA determined that the air handling units could be made to perform by:

- replacing the existing 4-row chilled water coils with 8-row coils of equal air pressure drop (examination of factory certified dimension drawings confirmed that they would fit in the air handling units)
- increasing the chilled water flow through the coils (feasible with a much higher horsepower pump, and within the allowable flow rate for the chiller)
- reducing the chilled water supply temperature (also with the allowable operating parameters for the chiller)
- installing new air handling unit temperature controls (to reset the planned very-low supply air temperature upwards during cool weather)

Upon completion of the study, ERA was engaged to prepare final installation documents. This work was performed in collaboration with the owner's selected contractor so as to achieve maximum integration of design concepts and the contractor's working knowledge of the building (the contractor had the service contract for the building). Final selection of equipment was made, simplified installation drawings were prepared and the project installed and put into operation over a 90 day period, including start-up. No tenant disruption was caused during the installation (which would have been the case had the conventional approach of replacing the air handling units been followed). Upon completion of the project, the building's HVAC systems provided comfort for the first time in the 15 year life of the building!

PROJECT SUMMARY

CLIENT/FACILITY: General Cinema Theatre

LOCATION: Fremont, California

CONSTRUCTION VALUE: \$80,000

ERA SERVICES: Building Pressurization Investigation and Remediation Design

DESCRIPTION OF PROJECT AND SERVICES PROVIDED:

An 8 cinema theatre, the Fremont Hub General Cinema's HVAC systems were constructed in a design-build fashion. Unfortunately the result of the process was a building that very frequently experienced such severe pressurization that extra employees had to be hired to close exit doors following each show - otherwise they would stand open, allowing unpaid entrance to the theatre. In addition, employees in the ticket office had to be extremely careful in handling paper money as it would otherwise literally "fly" out of their hands through the opening in the ticket booth glass. Finally, additional problems existed with the HVAC systems being noisy, both in the lobby (quite severe) and in the cinemas (not as severe, but critical to the theatre retaining it's LucasFilms "THX" certification).

ERA's first task was to do a thorough survey of the building's HVAC systems. This included contacting the building automation/direct digital control system vendor (and service company) to learn how the building's HVAC systems were controlled and to learn how to override the controls. The next step was to conduct a whole building test, placing all ten HVAC systems alternately into full return air mode and then full outside air mode of operation. Simultaneously, building air pressure measurements were made and automatic door closers tested to determine their status in each mode. Full spectrum sound power tests were also performed at this time to determine whether the cinemas met the THX sound power criteria (NC-30) in each mode of operation.

What was learned from the testing was that the HVAC system design did not utilize return/exhaust fans and required the return/exhaust air to pass from each cinema through a very restrictive return air duct system and (in full outside air mode) through a metal barometric damper. Analysis of the return air/exhaust system revealed that it could not be easily modified to achieve a 0.05 inch static pressure drop (the maximum allowable if handicap-code-complying automatic door closers are to work effectively). As a result, a remediation scheme was developed which included modifications to enlarge the return air pathways (a noise source in full return air mode), addition of powered exhaust fans for full outside air operation, and careful balancing of the supply and exhaust air fans under full outside air operation.

Once this scheme was implemented, the cinemas so modified were brought into perfectly neutral air pressure balance. Interestingly enough, the severe noise problem in the lobby was caused by a mechanical contractor attempting to solve the building pressurization problem (which was most observable at the lobby doors, though it was the same throughout the building) by dampering the supply air flow at the lobby diffusers. Needless to say, this misguided attempt to solve the pressure problem only created another problem (which is frequently the case with HVAC system problems).

PROJECT SUMMARY

CLIENT/FACILITY:	Multiple (4)
LOCATION:	California
CONSTRUCTION VALUE:	approx. \$1,000,000
ERA SERVICES:	Expert Testimony and Dispute Investigations

DESCRIPTION OF PROJECTS AND SERVICES PROVIDED:

The following are brief discussions of four of ERA's more dramatically successful dispute investigations/expert witness efforts.

Third-Party Cogeneration. Engaged by the law firm for the host site, ERA was asked to provide expert witness services regarding a dispute between the host site for a third-party-financed cogeneration system and the cogeneration system vendor. The dispute regarded the monthly billings for the energy provided by the cogeneration system to the site, which the host disbelieved. ERA reviewed the cogeneration system and determined that it was generally well engineered and installed and was providing valuable energy to the site. ERA next reviewed the billings and found them generally to be reasonable. Finally ERA created a fully automated billing spreadsheet and used this spreadsheet to audit the previous two years of invoices. While numerous small errors were found (in both directions), overall the charges were fair. The host site, once seeing that the vendor was not attempting to take advantage and having a tool to check the vendor's invoices (both the vendor and the host were to use the billing spreadsheet in the future), they quickly settled with the vendor.

Office Building Tenant Utilities. Another dispute was between a landlord and a tenant in a large office building (actually two buildings, with the tenant in the smaller of the two). The tenant had been paying a share of the single utility bill for the site on a square footage basis. They suspected this method to be incorrect, installed their own electrical sub-meter, determined that they were grossly over-paying for utilities and stopped paying the landlord for utilities. Asked to mediate, ERA prepared a computer model of the two buildings to allocate energy that could not easily be sub-metered (cooling and heating) and inspected the sub-meter installed by the tenant. The result of the investigation was that the submeter had been incorrectly installed and was reading low (it was only reading two of the three phases). The corrected sub-metered electrical energy use, when combined with a fair share of the cooling and heating energy actually exceeded the per-square-foot charges - much to the chagrin of the tenant and the validation of the landlord.

Hospital Energy Services Project. In another case a large hospital was sold a financed and guaranteed energy conservation project by a Fortune 500 temperature control company. After more than a year of operation the hospital's energy bills were as big as ever, though the vendor insisted the project was saving energy. ERA thoroughly reviewed the various project documentation, surveyed the building and analyzed the hospital's energy bills. ERA determined that the vendor had done a shoddy job of investigation, estimation of energy savings, design and installation. Not only were the potential savings grossly over estimated, but the project itself was completely non functional. In short the utility bills told the truth - no savings were being achieved. Based on the results of ERA's work, the hospital ceased their monthly lease

payments and their monthly service contract payments. The matter is pending litigation.

Condominium Construction Defects. Engaged by the law firm for the Pacific Park Plaza Homeowners Association, ERA was asked to provide expert witness services regarding a dispute between the homeowners association and the developer of the property. The principal defects centered around a faultily-constructed building envelope employing a pre-fabricated panel system (EIFIS) and the HVAC systems installed in the individual dwelling units. Investigation revealed that these defects were interrelated in that the building site was a notoriously windy one and the HVAC was suspected to be strongly affected by excessive infiltration through the defective envelope under windy conditions. In addition to consulting with the structural/general construction experts who conducted air-door dwelling unit pressurization and infiltration characterization studies, ERA instrumented a number of occupied residences to develop infiltration/HVAC-performance correlation data. ERA's investigation protocol included inspection and testing of each heat-pump unit, monitoring HVAC system performance, directly measuring and recording the actual building envelope pressure differential and the installation, and installation and monitoring of an on-site weather station. The result of the investigation was demonstration that the performance of the HVAC system was driven almost exclusively by infiltration (*residences on the windward side of the building experienced continuous HVAC system heating operation and loss of space temperature control during windy conditions at ambient temperatures as warm as 50°F!*). These irrefutable findings contributed to the rapid, large (\$19,300,000 as reported in the media), out-of-court settlement of the case - which had been in progress for some years.

PROJECT SUMMARY

CLIENT/FACILITY: Marin County Civic Center

LOCATION: San Rafael, California

CONSTRUCTION VALUE: approx. \$1,000,000

ERA SERVICES: Post-Retrofit Evaluation of Energy Retrofit Project

DESCRIPTION OF PROJECT AND SERVICES PROVIDED:

The Marin County Civic Center is a somewhat famous building, due to its unique architecture and the fact that it was Frank Lloyd Wright's last project. A little more than a year following the implementation of an energy retrofit project at the facility, there existed a variety of opinions regarding the effectiveness of the project. The varying opinions were held by the local utility company (Pacific Gas and Electric Company) the Owner (the County of Marin), and the installing contractor. Not only did the utility and the Owner need to come to agreement so as to finalize payment of a rebate for the project, but the Owner's management organization lacked confidence in the project and were uncertain whether to proceed with similar energy efficiency investments.

With the agreement of all the parties, ERA was engaged to evaluate the project. The work included the following steps:

- review of the original rebate application, including supporting calculations
- review of other project documentation, including as-built drawings and retrofit project drawings
- an on-site observational survey of the facility, its HVAC systems and the retrofit work performed, including interviews with building operating personnel and installing contractor personnel
- computerized energy accounting and analysis of utility consumption data for two years prior and one year following the retrofit
- detailed analysis of the rebate application and savings calculations
- recalculation of the savings utilizing a California Energy Commission-approved building simulation program
- preparation of a final report of the results of the work

As determined from the investigation and analysis, the following findings were reported:

1. The original estimate of savings was optimistic, primarily due to fundamental flaws in the original building simulation used for estimating savings. Re-preparing the computer model of the building resulted in a reduction of the estimate of savings of approximately 50%.
2. The energy retrofit project was essentially well-conceived and well-implemented. It attacked fundamental inefficiencies inherent in the building's design, rectified those inefficiencies and is performing well.
3. The project is achieving approximately 50% of it's original estimate of savings. While not the return on investment desired or anticipated by the Owner, the return on investment is attractive compared to other financial instruments currently available to the Owner.
4. The project could have easily been more extensive in nature. A number of additional energy retrofit projects could also have been implemented, but were ignored.

Based on the final report, the utility company and the Owner were able to finalize the rebate transaction and the installing contractor was able to re-evaluate their energy analysis procedures.

PROJECT SUMMARY

CLIENT/FACILITY:	Sierra Nevada Memorial Hospital
LOCATION:	Grass Valley, California
CONSTRUCTION VALUE:	\$1,000,000+
ERA SERVICES:	Energy Retrofit Study, Energy Retrofit Design and Project Coordination, Energy Accounting, Critical HVAC Chiller Design, Chilled Water Plant Design, Grant/Rebate Application Preparation, Extension of Critical HVAC Chilled Water System, New Clinical Lab Conceptual Design, Second Floor Nursing Consolidation Design, Investigation of Isolation Room HVAC, and Indoor Air Quality and HVAC Evaluation

DESCRIPTION OF PROJECTS AND SERVICES PROVIDED:

Sierra Nevada Memorial Hospital is a 200,000 square foot, community, acute-care hospital. The Hospital was built in thirteen different projects over the last 30+ years, the most recent being the new south wing which added another 60,000 square feet to the facility. ERA has been given a variety of assignments at the Hospital.

ERA's first assignment, in early 1991 was to perform an energy retrofit study of the first two phases. This study resulted in the funding, design and construction during 1992, of a number of energy conservation measures, including conversion of the a variety of air handling systems to incremental air flow control (including variable speed drives on fan motors), the installation of a facility-wide building automation system (including direct digital controls for all HVAC systems) and lighting fixture retrofit and lighting controls. The study was presented both to the California Energy Commission and Pacific Gas and Electric and netted grants and rebates totalling nearly \$190,000.

In 1992, ERA was engaged to perform a conceptual design study for the expansion and modernization of the building's central cooling equipment. Typical of most hospitals, building expansion design teams had bypassed the integration of utility systems as being beyond the scope of their purview and designed new, stand-alone, central cooling plants for each wing. With the new wing under design, the Hospital would have had a total of three plants. As suggested to the Hospital, ERA undertook to investigate how the existing plants could be restored and simultaneously expanded, both to renew the failing old equipment and provide additional capacity for the new wing. The resulting study identified a plant that could be built within the confines of the existing building, would integrate all cooling operations, provide chiller redundancy for greater reliability and would convert the entire plant to variable flow operation for improved energy efficiency. In addition, the study identified a serious system deficiency wherein small, critical HVAC systems had been added to the chilled water system without the incorporation of outside air economizers - resulting in the central plant having to run 24 hours per day, 365 days per year. A dedicated, compact chilled water system (with its own water-side economizer) was incorporated into the project to take this burden off the central plant.

ERA was subsequently engaged to perform final design on this project in a phased fashion, the first phase

of which (the dedicated chilled water system) was completed during early 1993 and interestingly included pre-purchasing of the chiller and it's temporary installation to support surgery (which was in desperate need of cooling due to the deterioration of the existing main plant) during the summer of 1992. ERA provided critical commissioning services for this small system, which had to be brought on line smoothly so as to prevent disruption of Cat Scan operations. The main chilled water plant expansion and modernization phase (the bulk of the work) has been designed and will be completed over the winter of 1993/94. This project includes interconnection to the new building automation system and incorporates oversized heat rejection equipment to maximize available PG&E rebates. In addition, the key equipment (chillers and cooling towers) were pre-purchased by the Owner, primarily to optimize their selection under the complete control of the Owner, separate from the construction bidding process.

As a "side-effect" of the energy retrofit and chilled water plant projects, ERA was also asked to evaluate digital zone controls as an option for the new wing HVAC systems. While this was determined to be attractive (since the marginal cost was small for new construction), in the process of the analysis, it was discovered that the out-of-state HVAC design engineers had configured the new wing air handling systems without outside air economizers, which would have put the central cooling plant back into 24 hour, 365 day operation. This oversight was brought to the attention of the Director of Plant Operations and immediately corrected through directed re-design of the systems.

Additional work at this facility has included design of an extension of the critical HVAC chiller system to the new outpatient wing, conceptual design of a new clinical laboratory, design of the Second Floor Nursing Consolidation project, investigation and planning of isolation room upgrade work, and investigation of indoor air quality concerns.

PROJECT SUMMARY

CLIENT/FACILITY: County of Alameda, Hayward Hall of Justice

LOCATION: Hayward, California

CONSTRUCTION VALUE: \$200,000

ERA SERVICES: Indoor Air Quality and HVAC System Evaluation

DESCRIPTION OF PROJECT AND SERVICES PROVIDED:

Housing the south-County courts and associated offices (sheriff, district attorneys, various court clerks, etc.), this building suffered from significant occupant dissatisfaction with the indoor air environment in the building.

ERA was hired to evaluate the problem complaints, taking both an indoor air quality (industrial hygiene) approach to the problem evaluation, as well as a stem-to-stern evaluation of the design, physical condition and operation of the HVAC system and its controls. This work included setting up numerous air sampling stations throughout the occupied space as well as performing instantaneous ventilation measurements by means of control system manipulation (to place the HVAC systems in their "default" ventilation mode) and the use of a tracer gas (sulfur hexafluoride) to directly measure effective ventilation rates. Volatile organic compounds (VOC), formaldehyde, total suspended particulates, airborne viable fungi, carbon monoxide and carbon dioxide concentrations were monitored. Total system airflow was directly measured by the test-and-balance members of the project team under minimum and maximum ventilation control modes. In addition, selected high-complaint areas had their room air distribution measured and compared to original design values. Furthermore, numerous temperature monitors were installed throughout the HVAC systems and the occupied spaces and this data was later graphically analyzed to observe out-of-bounds control system excursions.

The results of the evaluation were somewhat typical of most buildings with indoor air quality complaints. The principal problems were those of inadequate outside air ventilation and poor comfort. No air pollutants were found in concentrations above accepted standards of exposure. However, in order to reduce energy use and cost, the building's HVAC systems were being operated in a fashion that thwarted the temperature control system (reheat air conditioning with boilers shut down), resulting in some portions of the building almost always being uncomfortable and other portions passing in and out of acceptable comfort regimes on an almost random basis. In addition, the aging and excessively complex pneumatic control system was being manipulated by inadequately trained maintenance staff, with the result that very little ventilation air was frequently brought into the building. These two circumstances contributed to very poor occupant satisfaction with the indoor environment.

The solution to the problems consisted of a number of steps, including:

- discontinuance of the use of a rooftop patio area (adjacent to the ventilation air intakes) as a designated smoking area
- interim re-activation of the building boilers and training of the operating engineers regarding the ventilation damper controls
- replacement of the pneumatic control system with a digital control system with remote monitoring capability
- conversion of the HVAC air handling systems to variable volume to allow boiler shutdown while still providing space comfort
- correction of other minor deficiencies associated with restroom exhaust fans and air conditioning

condensate drain pans

PROJECT SUMMARY

CLIENT/FACILITY:	U.C. Davis Medical Center
LOCATION:	Sacramento, California
CONSTRUCTION VALUE:	\$1,500,000
ERA SERVICES:	Investigate Chilled Water Distribution System, Design Remediation Project

DESCRIPTION OF PROJECT AND SERVICES PROVIDED:

This 500,000 square foot acute care hospital suffered from an HVAC system which could not provide adequate comfort during the cooling season. For example, even areas as critical as ICU patient rooms were recorded at temperatures in the high 80's for days at a time. Based on cursory investigation by in-house facilities design and construction staff, the chilled water distribution system was suspected as being the principal cause of the HVAC system's non-performance and the need for an investigation was determined. Due to ERA's extensive experience in hands-on investigation and integrated retrofit of chilled water systems, ERA was chosen from among a field of 27 of the best engineering firms in northern California to execute this two-phase (investigation and design) project.

The investigative task was challenging, especially given the age of the facility and the more than 50 sets of construction project as-built drawings which depicted the original construction and myriad of modifications performed to the chilled water system over the years.

Starting with nearly 50 sets of "as-builts", ERA documented the physical arrangement of the chilled water system in CADD and then used these documents as a guide during an exhaustive physical survey of the system and as a means for the Plant Operations & Maintenance staff to add their knowledge of the system to the documentation of the chilled water system. Following the documentation of the actual as-built configuration of the system in CADD, ERA then performed a detailed take-off and entered all the system details into a piping simulation computer program. This program identified existing flow problems and allowed simulation and evaluation of a variable flow retrofit of the system.

The investigation confirmed the initial suspicions that significant flow problems existed with this system. As the system grew over the years, each retrofit designer added their own booster chilled water pump to each system addition, and piped each addition in a fashion that was inconsistent with maintaining control over the distribution of chilled water flow. As a result, the combined flow of the secondary pumps was approximately 50% greater than the flow capacity of the chiller plant. When combined with inconsistent branch piping arrangements, this resulted in reverse flow in the branch piping to numerous air handling units and even in branch mains serving groups of air handling units! This condition was so severe that it was ultimately determined that the total cooling load in the facility exceeded the capacity of the chiller plant, but was not recognized since many air handling units never received sufficiently cold water to perform their intended cooling function.

A remediation project was developed and implemented in mid-1997, and included:

- removal of all secondary pumps at air handling units

- conversion of all chilled water control valves to 2-way control
- correction of minor mis-piped branch lines in various locations
- installation of two large variable-flow chilled water pumps in the chiller plant, along with digital differential pressure pump controls
- conversion of the 2-pipe heating/cooling loop serving one wing to variable flow
- clean-up of the old in-building chiller plant by removing chillers, pumps, piping, etc.
- troubleshooting building automation problems which prevented proper system operation following start-up - this resulted in superior system operation the summer of 1997 (for the first time in 25 years)
- investigation of operating problems following the mid-1998 start-up of the new central chiller plant (the building was in the process of being converted from having its own chillers to being served by a site-wide central chiller plant, but the heat exchanger installed, combined with warmer than designed chilled water from the new central plant resulted in inadequate cooling capacity) - this effort resulted in ERA developing and starting-up a stop-gap scheme for operating one remaining chiller in the building to support the inadequate central plant chilled water supply
- design of the removal of the chilled water heat exchanger in the chiller plant (to permanently fix the problem associated with the too-warm central plant chilled water and to greatly simplify the system)