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, totaling 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, totaling more than 30 projects over a 15 year period.

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 (and garnering the facility's Director of Plant Operations, Vince Scoccia, an award as the Association of Energy Engineers' ***International Energy Manger of the Year*** for 1998.

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, development of an emergency power system master plan, a major evaluation of all isolation and negative pressure treatment rooms, and an evaluation of legionella control practices.

PROJECT SUMMARY

CLIENT/FACILITY: John Muir Medical Center

LOCATION: Walnut Creek, California

CONSTRUCTION VALUE: $1,200,000+

***ERA* SERVICES:** Modernize and Expand Chilled Water Plant

DESCRIPTION OF PROJECTS AND SERVICES PROVIDED:

John Muir Medical Center faced a multi-part problem in 1994. The original building chillers were aging and used CFC refrigerants. Operating cost for these chillers was excessive, the total cooling capacity for the 3-phase building was fully employed on a design day (no safety factor!) and the old cooling towers represented a potential legionella threat in their original location immediately next to a main outside air intake.

Working with the Director of Plant Services over a number of years, *ERA* explored numerous chiller plant modernization and expansion alternatives, including thermal storage, gas and steam-fired absorption, individual chiller retrofit and others. Finally, it was determined that replacing the original 800 ton, 2-chiller plant with modern chillers totaling 1100 tons and integrating it with the newer 400 ton plant was the most practical and cost-effective alternative available to the Medical Center. Interestingly, this project was one of *ERA*'s early applications of its ***Virtual Central Plant***™ technology!

Given the task of designing the new plant, *ERA* worked closely with the Medical Center's favored mechanical contractor and developed a project combining many attractive features, including:

- two new, R-22 (convertible to R-134a) centrifugal chillers with very high efficiency (approximately .5 kW/ton)
- removal of existing cooling towers and creation of a new cooling tower platform (allowing the old towers to stay in service right to the cut-over point and the new platform constructed in such a way as to eliminate structural reinforcing of the roof structure, thereby completely avoiding disruption to hospital operations)
- two new, variable-speed, oversized cooling towers to provide very cold condenser water, even on design days
- modifications to the chilled water distribution system to allow either chiller plant to serve the entire facility independently (by means of an inter-plant, variable flow, chilled water transfer pumping system)
- configuration of the new plant's chilled water piping to provide for a dual-loop system (separate building and chiller flow loops) and automatic switchover to a single-loop system for even greater efficiency (once the plant was completely commissioned)
- automation of the entire chilled water operation (consisting of 4 chillers in two plants) - *ERA* performed the detailed final design of the control system and performed all commissioning and programming of the control system and prepared custom operator-terminal graphics to display the new plant in operation - no controls contractor was employed on this project
- temporary interconnection of the two main plants during construction so as to allow chilled water to be delivered to the entire complex during the construction period

Based on *ERA*'s mechanical, electrical, structural and control systems design (and control panel fabrication and commissioning), the project was completed without a single during-construction change order and the plant was brought on line during the early summer of 1995 and performed in such a superior fashion that the remaining plant was able to be left off-line for the entire summer, increasing the original annual savings of approximately $50,000 by another $30,000. The project was featured in an article published in the Winter 1996 edition of *Energy and Environmental Management* (a Penton Media publication).

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: Building Owner Litigants (5)

LOCATION: California

CONSTRUCTION VALUE: approx. $4,000,000

***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.

An expanded summary of *ERA* expert witness cases is also available upon request and reveals that *ERA*'s expert assignments have almost equally been for plaintiffs and defendants, and more than 95% of *ERA*'s cases are settled out of court.

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 nationally-known 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^{o}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.

School District Performance Contract. In this case a large western school district was sold a financed and guaranteed energy conservation project by a nationally-known temperature control company. Coincident with a "shake-up" in the staffing of the District, an owner's technical representative was hired to audit the project as it was completing construction, and to evaluate a follow-on second-phase contract proposal. The owner's rep found that a significant portion of the work that was called for in the contract was incomplete and that the follow-on contract was not in the owner's best interest (more than 60% of the guaranteed savings were stipulated operations and maintenance savings). The first phase of work was hammered to completion and the second phase was not pursued by the owner. Disgruntled over the outcome, and in trouble because they had spent considerable funds on starting the second phase work already, the performance contractor sued the owner's representative for some $10,000,00 for constructive interference. *ERA* examined the case documents and interviewed select percipient witnesses and concluded that the owner's representative had well met the applicable standard of care in providing services for their owner client. After a couple of years in pending litigation, discovery and deposition, the claim was settled out of court (reportedly without funds changing hands).

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 was 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 arranged by *ERA* for pre-purchase by the Owner, primarily to optimize their selection under the complete control of the Owner and the Engineer, separate from the construction bidding process. This proved very effective in implementing the project smoothly and flawlessly.

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 and to the adjacent oncology center, conceptual design of a new clinical laboratory, design of the Second Floor Nursing Consolidation project, investigation and planning of isolation room upgrade work, investigation of indoor air quality concerns and performing US-EPA ***Energy Star*** certification of the facility.

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: $1,300,000

***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 nominal $1,500,000 remediation project was developed and implemented in mid-1997, and included:

- removal of all 53 secondary pumps - one at each air handling unit
- 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 simply the system)

Following completion of the project, for the first time in 25 years, all portions of the facility were provided with adequate air conditioning!

PROJECT SUMMARY

CLIENT/FACILITY: U.C. Davis Medical Center

LOCATION: Sacramento, California

CONSTRUCTION VALUE: $1,500,000

***ERA* SERVICES:** Investigate High Pressure Steam Supply Options, Design Underground Steam Line

DESCRIPTION OF PROJECT AND SERVICES PROVIDED:

This 500,000 square foot acute care hospital was to be served by the new $65,000,000 central utility plant brought on line during the summer of 1998. Unfortunately the investigation of existing conditions performed by the plant designers incorrectly concluded that the "California Special" steam boiler room in the main hospital could support the steam needs of the main hospital. Upon shutting down the steam supply from the (to be demolished) old steam plant, it was discovered that the in-building steam plant did not have sufficient capacity. Unfortunately, the old steam plant stood in the way of a new wing whose construction was to start immediately upon commissioning of the new central utility plant!

Hired on an emergency basis, *ERA* initially undertook a planning effort which included a steam load analysis development of two conceptual alternatives, one to build a Title-8-complying thermal fluid heater plant, and the other to build a new, 2700 linear feet, underground steam and condensate return system from the new central utility plant. This latter option offered an equivalent price, with the attractiveness of minimal ongoing maintenance.

Hired to implement the new underground steam service, *ERA* incorporated significant creativity and concern for constructibility and long term maintainability into the design process, including:

- re-using the first 200 feet of existing steam lines already run to the research complex close by the central utility plant
- incorporating heavy-duty steam trapping in the pits in lieu of the inexpensive orifice traps incorporated into the central plant work
- addition of sumps, sump pumps and interior lights in the pits along the line, in lieu of abandoning these features (as was done as part of the central plant work)
- researching the high pressure de-superheater in the central plant to determine that an internal parts change-out was all that was required to increase the low pressure steam capacity of the plant
- re-using the extensive CADD resource of the central plant distribution drawings, by adapting the profiles and crossing-utility sections to the steam distribution run (which accelerated design completion considerably)

PROJECT SUMMARY

CLIENT/FACILITY: State of California, Department of General Service
Energy Assessments Section
(formerly the Office of Energy Assessments)

LOCATION: Sacramento, California

CONSTRUCTION VALUE: N/A

***ERA* SERVICES:** Performance Contracting Program Development and Owners Representative Services

DESCRIPTION OF PROJECT AND SERVICES PROVIDED:

In 1996 *ERA* was requested by the State of California's Office of Energy Assessments (OEA) to assist them in preparing model energy services documents. The documents prepared included an RFQ, an Energy Audit Agreement, and an Energy Services Agreement including virtually all the Exhibits. To a significant extent, these documents were modeled after documents that *ERA* had utilized with its own clients to develop and pursue performance contracts for them, including Tenet Healthcare, Foothill-De Anza Community College District, Santa Clara University and San Francisco Unified School District.

Following this assignment, *ERA* was further selected by OEA from among more than 30 consultants to be the State's sole consultant for performance contracting in State facilities (and other OEA client facilities). Among the services provided were included:

- Updating of the model documents to meet the State's new contracting methodology, which was ultimately configured to create a "pool" of pre-qualified ESCo's operating under a master agreement with the State.

- Updating of the ESCo RFQ to create the pool. This RFQ was unique in that it required an open book methodology of doing business (so as to avoid some of the more notorious abuses of the past – such at the State of Arizona debacle) and required full disclosure by prospective ESCo's of all recent projects in the state and all recent legal disputes of any type. This approach dramatically "raised the bar" as regards the standards of business conduct and established a fair, level, and ethical playing field – which was sorely needed.

- Review of OEA client performance contracting documents and ESCo proposals. In these cases the owners were extremely pleased to have input and counsel – so much so that they significantly modified their plans (see letter of commendation from Marysville Unified School District as an example).

- Meeting with potential OEA clients so as to assist them in their performance contracting planning.

Following delays due to the limitations of enabling legislation (AB 1890, the Electric Restructuring Act, had to be amended by the legislature), the creation of the ESCo pool proceeded in mid-1999.

PROJECT SUMMARY

CLIENT/FACILITY: San Francisco Unified School District

LOCATION: San Francisco, California

CONSTRUCTION VALUE: $22,000,000

***ERA* SERVICES:** Performance Contracting Program Development and Owners Representative Services

DESCRIPTION OF PROJECT AND SERVICES PROVIDED:

In mid-1998 the San Francisco Unified School District determined that a performance contract would be an appropriate vehicle to implement a large volume of infrastructure renewal and operations and maintenance improvements in their 100+ school sites. *ERA* was engaged as the process got underway (after District selection of an ESCo) to provide a wide variety of project development and owners representative services, including:

- Participation in in-house presentation and explanation of the program to the Superintendent's office and the School Board. This program was approved unanimously by the San Francisco School Board.
- Pre-contract review of contractor scopes of construction and detailed pricing – due to *ERA*'s reputation in the industry, all the key contractors brought their actual cost estimates to the table for *ERA*'s review and analysis. The result of this analysis was identification of opportunities for value engineering of certain portions of the work, recommendations for re-composing of the team to provide sub-contracting economies and re-direction of the final design team.
- Drafting of the actual Energy Services Agreement for the parties. This document served as the "first cut" for the Office of the City Attorney in San Francisco, and was incorporated into the final contract. These documents embodied *ERA*'s high standards for design, design documentation, materials and equipment, installation and measurement and verification.
- Sub-contractor due diligence. As the Energy Services Agreement required approval of the performance contracting team, *ERA* performed due-diligence review of the principal members of the team, including the construction manager, design team, mechanical contractors, lighting contractor, and the building automation contractor. These reviews included on-site inspection of the team members' facilities, review of contracting/engineering licenses, implementation plans, etc.
- Assistance in organizing the Owner's team for managing the project. This involved numerous meetings to present the program to the Owner's operations and maintenance organization, identification of stakeholders and preparing a responsibility and coordination matrix – al of which served to improve involvement on the Owner's side of the table, but also facilitated the ESCo's progress on the project and avoided "U-turns" that would otherwise have occurred due to uninvolved stakeholders potential downstream interference.
- Design review. Final construction documents underwent *ERA* review, prior to implementation.
- Construction observation. As each portion of the work was installed, *ERA* provided on site observation and critique of the work. This activity was accomplished by an on-site *ERA* construction monitor approximately 3 days per week over the 18 month installation period.

PROJECT SUMMARY

CLIENT/FACILITY: JFK Memorial Hospital

LOCATION: Indio, California

CONSTRUCTION VALUE: $3,500,000+

***ERA* SERVICES:** Central Utility Plant Master Plan, Design Central Utility Plant Expansion and Modernization

DESCRIPTION OF PROJECTS AND SERVICES PROVIDED:

JFK Memorial Hospital is a 130,000 square foot, community, acute-care hospital. The Hospital was built in three main projects over the last 25+ years, and has an unique blend of utility systems and equipment as a result.

With two new expansions planned (a two-story ICU and a one-story LDRP) which would add another 30,000+ square feet, the central utility plant required concurrent upgrade to support these expansions and provide for efficient plant operations in the future. In a one-day, priority effort in January 1999 to scope the needed plant work, *ERA*'s project team surveyed the facility, developed expansion/upgrade scopes and budgets, and presented the results in a written report to the management team the same day.

Shortly thereafter, *ERA* was engaged to prepare the construction documents for this work in two packages, for budgeting purposes.

Phase One included:

- one new 500 ton chiller and associated piping, power, auxiliaries and cooling tower
- conversion of the chilled water system to variable flow (and reducing the number of pumps in the plant from 11 to 8)
- addition of air conditioning to the central plant itself (a necessity in the desert)
- structural work to expand the cooling tower yard to accommodate the new cooling tower
- digital controls and automation of the HVAC systems throughout the site
- new electric service to the entire site and an entire new main switchboard
- planning for the new emergency generators (part of Phase Two)
- coordination of consulting teams working on the expansion projects so as to provide for a utility system interface adjacent to the expanded plant (done in a mechanical vault in the cooling tower yard and in traffic boxes in the roadway adjacent to the new Phase-Two generator site)

Phase Two included:

- a second new cooling tower to serve the two remaining existing chillers -- and to serve the new emergency generators (in lieu of radiators)
- two new 750 kW emergency generators (one for the additions, one for the new chiller/tower) in a new air conditioned structure
- transfer switchgear and related electrical work
- upgrading of the space heating distribution system
- upgrading of the medical air and vacuum systems in the plant

Playing a significant role during construction, *ERA* hand selected prospective contractors, coordinated the bidding and award of the work and placed purchase orders for the major equipment. The project completed construction in early 2002.

A notable feature of the project is the provision of emergency power for the central cooling plant, thereby making JFK with the only hospital in their region capable of continuing surgery operations during extended power outages (which were an ever-present threat during the State's energy crisis of that period).

PROJECT SUMMARY

CLIENT/FACILITY: Marin County Civic Center

LOCATION: San Rafael, California

CONSTRUCTION VALUE: Approximately $1,500,000

***ERA* SERVICES:** 2 Projects: Replace Admin Building Chiller Plant
Replace Hall of Justice Chiller Plant

DESCRIPTION OF PROJECTS 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. Facing an aging chilled water plant and the prospect of CFC abatement, the County hired *ERA* to perform a feasibility study for modernizing the plant. This study identified a 2-phase approach which would replace the oldest (Administration Building) chiller plant in the complex immediately, followed, when funding became available, with the replacement of the newer plant (Courthouse).

Hired to implement the first phase of the project, *ERA* designed a plant replacement project which included:

- a new, R-134a centrifugal chiller with very high efficiency (approximately .5 kw/ton)
- a new, variable-speed, oversized cooling tower to provide very cold condenser water, even on design days
- configuration of the condenser water system so as to eliminate a small tower dedicated to a light-load chiller (the new tower will serve either or both chillers)
- conversion of the chilled water distribution throughout the complex to variable flow
- interconnection of the new and remaining existing chiller plants so as to allow either plant to support the entire complex (this was not previously possible without operation of additional chilled water pumps)
- automation of the entire chilled water operation (consisting of 5 chillers in three different locations)
- temporary interconnection of the two main plants during construction so as to allow chilled water to be delivered to the entire complex during the construction period

While following public bid procurement regulations, *ERA* crafted a contractor qualifications criteria which ensured that only well-qualified contractors would be permitted to submit bids on the project. The result was a trouble-free construction period, with completion of the project without any change orders in May, 1996.

The project has been so successful and trouble-free to date, that the County decided to proceed immediately with the second phase design, the Courthouse Building chiller plant, which was completed in late 1997. This project, while somewhat simpler overall, included the re-arrangement of the two series-piped chillers to parallel flow and the arrangement of the existing 2-cell (400 tons each) cooling tower so that regardless of which new chiller is operating (300 and 500 ton machines to replace the existing twin 400 ton units) the chiller that is on line will be served by an oversized tower. This will be done by installing two large, variable speed condenser water pumps (a primary and backup, with pre-set incremental speeds to match the chillers & towers on line) and automatic valves so that a single 400 ton cell will serve the 300 ton unit, and both 400 ton cells will serve the 500 ton unit. Since the Administration Building chiller plant was oversized, only under "emergency" conditions (the inadvertent loss of the new Administration Building plant) will the new 300 and 500 ton chillers need to operate with only 800 tons of cooling tower serving them - meaning that the new chillers will be served with oversized heat rejection equipment under any mode of operation, even thought the existing (non-oversized) cooling towers will be used for the project! This feature is possible due to the innovative approach to the design and the deft employment of the existing, very capable, building automation system already in the building.

In 2001, the County finally approved funding for the Courthouse building project and it was slightly re-designed to include a closed-loop condenser water system along with new cooling towers. This project was bid and successfully constructed and came on line in early 2002.

PROJECT SUMMARY

CLIENT/FACILITY: Foothill - De Anza Community College District

LOCATION: Cupertino, California

CONSTRUCTION VALUE: $5,000,000+

***ERA* SERVICES:** HVAC Plant Master Plan, Performance Contracting Program Development & Management, Underground Utility System Replacement, Expert Witness on Failed Underground Utilities, New Child Care Development Center, Domestic Water Distribution System Rehabilitation and Modernization, Boiler Room Rehabilitation

DESCRIPTION OF PROJECTS AND SERVICES PROVIDED:

Foothill - De Anza Community College District is a 2-campus, 1,000,000 square foot facility which serves the South Bay area of the San Francisco peninsula. The facilities were constructed in the 1970's and, typical to facilities of this circa, have come to need infrastructure renewal and upgrade. Along these lines, *ERA* has been engaged to provide a wide range of services.

ERA's first task was to prepare an HVAC Master Plan and develop the District's Performance Contracting Program. The District was planning to engage a performance contractor, and needed to identify the total HVAC infrastructure renewal needs for overall budgeting purposes. For both of these purposes, *ERA* was hired to prepare an HVAC Master plan, which included inventorying the HVAC systems and equipment, visually inspecting same, and identifying system deficiencies. In addition, the plan included an overall strategy for future HVAC systems, including the consolidation of refrigeration machinery on the De Anza campus by applying *ERA*'s proprietary *Virtual Central Plant* ™ technology (a melding of plant integration, automation and variable flow). In addition, a similar strategy was developed to add air conditioning to the Foothill campus. *ERA* ultimately identified a total budget need in excess of $10,000,000, and managed the District's engagement of a performance contractor to implement a major portion of the needed work.

Our next assignment was to prepare plans and specifications and provide construction management services for the replacement of a section of the underground chilled water and heating hot water distribution system on the De Anza campus, during 1998/1999.

In connection with the remodel of the Firing Range to a classroom facility, *ERA* provided expert witness services regarding the underground heating hot water piping which had failed due to the use of improper joint filler material for the copper piping system.

As part of an expansion program, *ERA* provided the mechanical engineering (and associated structural engineering) for the construction of a new Child Development Center, and the remodel (including complete HVAC replacement) for the adjacent existing Child Development Center.

In early 2000, *ERA* completed the plans and specifications for the complete renewal of four boiler rooms (two on each campus), including the pre-fabrication of modular boiler skids for each room which will allow the upgrading and replacement project to be accomplished during the short summer break.

As part of the 1999 $280,000,000 bond program, *ERA* has developed the first-ever CADD-based as-built of the domestic and fire protection water distribution systems on the campus and as of mid-2000 is developing the details of a major rehabilitation and upgrade program for these systems.

PROJECT SUMMARY

CLIENT/FACILITY: California Polytechnic University

LOCATION: San Luis Obispo, California

CONSTRUCTION VALUE: $3,000,000+

***ERA* SERVICES:** Measurement & Verification and Project Planning Services

DESCRIPTION OF PROJECTS AND SERVICES PROVIDED:

Cal Poly is a 2,500,000+ square foot facility which serves the state as a technical university. The facilities were constructed beginning in the 1940's and have come to need infrastructure renewal and upgrade. Along these lines, *ERA* has been engaged to provide a wide range of services, having been placed under a multi-year engineering services agreement.

ERA's first task has been to provide Measurement and Verification services for the Campus Summer Initiative, which was promulgated by the Public Utilities Commission and passed into law by the State Legislature.

This project consisted of lighting fixture retrofit in approximately 80 buildings, and HVAC automation and controls in approximately 15 buildings. *ERA*'s assignment included:

- advising the client as to project implementation strategies
- review of all contract documents, between the utility company and the university, and between the university and their implementing contractor
- development of a measurement & verification plan
- obtaining utility company acceptance of the plan
- review of contractor-developed design documents
- construction observation
- direction of on-site staff-performed field measurements
- data reduction and analysis
- preparation of a final measurement and verification report

This project was particularly challenging inasmuch as the entire program was implemented under a turkey contract with a Fortune-500 Energy service provider who subcontracted nearly 100% of the auditing, analysis, design and construction work. Coordination among the various entities on the contractor's side of the table was a major challenge.

PROJECT SUMMARY

CLIENT/FACILITY: Alameda County Water District

LOCATION: Fremont, California

CONSTRUCTION VALUE: $1,600,000+

***ERA* SERVICES:** Headquarters Building HVAC System Replacement

DESCRIPTION OF PROJECTS AND SERVICES PROVIDED:

The Alameda County Water District (ACWD) is a public agency (separate from the county itself) which provides domestic water service to the Fremont/Newark/Union City region. Built in 1985, the original building's construction program took a heavily first-cost-oriented approach to the project, with the result that the HVAC system in the building has never actually served that building very well (comfort complaints have been endemic from virtually the building's first occupancy) and the HVAC equipment has suffered greatly from the ravages of weather and time.

ERA's first task was to perform a complete evaluation of the HVAC system, including system airflow measurement by a certified test and balance firm and examination of the primary equipment (chillers and boiler) by senior service technicians. From this investigation a $1,600,000 remediation and renewal program was developed.

Shortly after completing the evaluation and presenting the findings, *ERA* was further engaged to prepare construction documents. The scope of this project included:

- new high efficiency air-cooled chillers (one now, one future), distribution piping, variable flow pumping and an architectural soundwall for the chiller yard
- new high-efficiency heating plant, including redundant boilers and variable flow pumping
- provisions in the cooling and heating plants to accommodate a planned building expansion
- five new rooftop, penthouse-style, variable air volume air handling units
- investigation of structural deficiencies and repair and reinforcement of the roof structure for the new air handling units
- replacement of zone terminal boxes with new high-performance variable volume boxes, including oversized heating coils
- revisions to reheat coil heating hot water piping to accommodate the new boxes (original interior boxes did not incorporate reheat coils)
- modifications to high pressure ductwork, installation of new terminal boxes and revisions to low pressure ductwork to add roughly 15% additional temperature-controlled zones throughout the building
- digital controls and building automation to the occupied zone level - constructed to process control standards
- complete commissioning of the new HVAC system

ERA played a strong role during construction on this public-bid project, including detailed review of the controls contractor's programming of the digital control system, which resulted in the project being successfully completed in mid-2003.

PROJECT SUMMARY

CLIENT/FACILITY: John Muir Medical Center

LOCATION: Walnut Creek, California

CONSTRUCTION VALUE: $600,000+

***ERA* SERVICES:** HVAC Construction Defect Investigation & Remediation, Expert Testimony

DESCRIPTION OF PROJECT AND SERVICES PROVIDED:

John Muir Medical Center is a 360,000 square foot, regional, acute-care medical center in Northern California. In the process of merging with another medical center, the new health services association elected to co-locate all management and financial functions in a shared office facility located between the two acute care hospitals. An existing building was purchased and an architect was hired to oversee the project to rehabilitate the building and convert it from its prior function as a data center. Unfortunately some pre-existing deficiencies in the building's HVAC systems were not addressed, as the architect in charge had their engineering consultants address their work as a tenant improvement project, rather than a base-build rehabilitation (even though a new exterior skin was being put on the building and other basic building elements were being addressed). This resulted in some very untoward HVAC system problems being experienced once the building was occupied. *ERA* was then engaged to perform a rigorous investigation to determine the actual physical conformation of the HVAC systems, and observe and in-situ test the HVAC systems under different various modes of operation. In addition, remediation schemes were developed and expert testimony provided during settlement meetings with the architect.

Our investigation discovered that:

- Under full recirculating air mode (100% return air) air moving through the building by means of many unusual and unintended pathways on its way back to the rooftop air conditioning units (namely the elevator shafts and the stairwells instead of the return air shafts). Under this mode the lower two floors were positively pressurized (air leaking out) and the third floor was negatively pressurized (air leaking in).
- Under "economizer" mode (100% outside air) , the entire building was positively pressurized - so extensively that exterior doors remain open once they have been unlatched.
- The building suffered from a shortage of cooling on hot days.

Insufficient Return Air Pathway.

The first problem was due to the original construction of the building being incomplete in that a contiguous, uninterrupted pathway for the return air from the various occupied spaces back to the rooftop units was not provided. A return air pathway was provided from the ceiling plenum on the first floor all the way to the ceiling plenum on the third floor but was then interrupted. Apparently the original designer somehow hoped that the air from the first and second floors would "magically" combine with the air from the third floor and flow into the return air inlet below each rooftop unit in the ceiling plenum space on the third floor. This intended return air pathway for the first and second floors was insufficient and resulted in the return air seeking its own pathway through the building by means of the path of least resistence, which primarily included three stairwells and the elevator shaft (and other "odd" pathways not observed). This was most disconcerting and would literally cause a "bad hair day" when entering the elevators on the third floor! Furthermore, because the intended return air pathway from the first and second floors was so inadequate, the air conditioning systems were "starving" for air and caused the third floor to be under-pressurized (negative to the outdoors) and drawing air in from the outside at the various exterior doors (including those at executive office patios - quite a problem in rainy winter weather). Conversely, since the air delivered to the first and second floors couldn't easily get back to the rooftop units, these two floors were over-pressurized (positive to the outdoors) and leaked air out of the building at the various exterior doors.

Inadequate Building Pressure Relief for Economizer Operation

The second problem was that no energized means of evacuating air from the building was provided in the original design for operation under an "economizer" cycle. During "economizer" operation the building is flooded with 100% outside air when it is cool outside and the building needs cooling. A "natural" or "barometric" means of building relief was provided in the form of "flapper" relief dampers at the rooftop units. Unfortunately, this natural means of building relief relies upon pressurizing the building and using that pressure to force air up the return air pathway and out through the relief dampers. Again, unfortunately, the amount of pressure required to cause the air to take this pathway results in extremely excessive pressurization of the building, thereby causing the front doors, and other doors, to stand open when the building is in economizer mode of operation. This is particularly troublesome during late evening hours when the building is lightly occupied and the security system goes into alarm any time anyone leaves or enters the building. As a stopgap measure, the economizers were disable, and the building placed on 24 hour operation with the refrigeration compressors providing continuous cooling.

Insufficient Cooling Capacity

The third, and final, problem with the building was the fact that the building "occupancy", including human occupant density and the intensive use of computer peripherals along with open office landscape furniture (with built-in lighting), resulted in the building having a greater cooling requirement than could be produced by the rooftop units.

This was evidenced by the numerous "hot" complaints from the occupants and confirmed by the operating engineers who observed the rooftop units being unable to maintain an acceptable temperature of cool air supply to the building (only 65 degree air could be produced on a hot day, with all cooling equipment operating properly). This was further confirmed by the air balance testing done at the completion of the remodeling work which indicates that the intended or "design" airflow into the various spaces exceeded that available from the rooftop units (both as tested and as indicated by the manufacturer's cataloged performance data).

All these problems could be solved by means of opening the roof at the top of the existing shafts, and ducting from there to the rooftop units, adding return/exhaust fans to each of the rooftop units and adding supplemental cooling by means of installing new 2-row cooling coils in the return air chamber of each rooftop unit and supplying the coils with excess capacity from the existing computer room chillers. Most importantly, the project conceived could be implemented without serious disruption to the building due to the bulk of the work essentially re-using existing systems and equipment and being conducted on the rooftop. As an unanticipated bonus, the project would pay for itself in less than 4 years!

While funding on this remediation project was delayed by more important capital projects, it was funded and designed and 2003 and is completing construction in early 2004.

PROJECT SUMMARY

CLIENT/FACILITY: City of Sacramento Convention Center

LOCATION: Sacramento, California

CONSTRUCTION VALUE: $700,000+/-

***ERA* SERVICES:** Central Chiller Plant Master Plan, Design Chiller Plant Modernization

DESCRIPTION OF PROJECTS AND SERVICES PROVIDED:

The Sacramento Convention Center is a 600,000+ meeting and performing arts center in downtown Sacramento, built in 1974 and expanded in 1995. The management of the facility was faced with two serious issues regarding the central cooling operations at the facility. Because of its age, the original chilled water plant's primary equipment had come to the end of its life expectancy and was in need of replacement with environmentally-appropriate equipment (non-CFC refrigerant equipment). In addition, the new plant added in 1995 was not properly integrated with the 1974 plant and the facility has been plagued with a wide range of operating problems which the plant operators only barely managed to overcome so as to keep the plant operating, albeit not very efficiently.

ERA's first phase of work was to perform a complete evaluation of the two plants and make recommendations for modernization and improvement. Following extensive on-site survey and system analysis (including computer simulation of existing and retrofit plant operation), *ERA* determined that the lack of multiple plant integration was actually the more serious of the two problems, and developed a two phase approach to modernizing the plant.

Phase One includes:

- conversion of all chilled water controls valves to two- way configuration
- minor re-piping of chilled water distribution piping, and the addition of a tertiary chilled water pump for a portion of the system
- modification of the digital control system to provide for proper operational sequencing of chillers and auxiliaries, employing *ERA*'s trademarked *Virtual Central Plant* ™ technology (requiring additional D-P sensors and modifications to the existing towers for modified sequencing and coordination with the on-line chillers)
- installation of variable frequency drives on the cooling towers for the newer plant for enhanced energy efficiency

Phase Two includes:

- replacement of the older plant's aging chillers with a new-technology chiller located in the newer plant
- re-piping of the inter-plant piping
- additional cooling tower variable frequency drives on the older towers (to be employed on the new chiller)

Final design of the planned project to commence in early 2004, followed by *ERA*'s intimate involvement and support during bidding, construction and commissioning.