

## HEALTHCARE FACILITY PROJECTS

As a part of ERA's regular consulting activities, the firm has taken on numerous projects in healthcare facilities, ranging from energy accounting, master planning efforts, central utility plant upgrades and remodels and additions. A sampling of these assignments includes:

- **John Muir Medical Center - Central Cooling Plant Modernization and Expansion.** 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 publication).

- **Northern California Presbyterian Homes - Mechanical, Electrical and Plumbing System Assessments.** Among their total inventory of facilities, NCPH owns three large retirement/nursing homes in the San Francisco Bay area. These facilities are all about 30 years old and have each begun to show serious deterioration of their HVAC, power distribution and plumbing systems. While each facility has a director of maintenance, it became apparent to corporate management that long term planning for the renewal of these infrastructure systems was beyond the capacity and mandate of the local maintenance staff. As a result, ERA was engaged to perform an assessment of these systems, including documenting the existing conditions (building plans, equipment inventories, photos, infrared testing, etc.), identification of system deficiencies, development of restoration plans, and programming the needed work over the ensuing decade. The results of this effort were assembled into neatly-crafted 3-ring binders for each facility, which will serve as a long term reference document for local and corporate staff for years to come - as well as provide documentary evidence to upper management of the facility restoration needs. Concurrently, due to the extreme deterioration of one facility's galvanized steel domestic water system, ERA performed an in-depth investigation of this system (including non-destructive and destructive testing of the system components such as internal inspection of large hot water storage tanks) and developed (and is now preparing construction documents for) a phased approach to system replacement that will put a new "core" system in place immediately and allow individual dwelling units to be "switched over" to the new system as they are remodeled or as necessitated by localized piping failures.
- **John Muir Medical Center - Emergency Power Master Plan.** Having been built in three major phases over a 35 year period, John Muir Medical Center has found itself with aging and un-integrated utility systems in their 400,000 square foot main hospital building. While ERA had already implemented upgrades and integration of the cooling and building automation systems, the Director of Plant Services was still concerned about the overall reliability and longevity of the hospital's emergency power systems. Accordingly ERA was asked to prepare a master plan for the long term management of these systems. This task included documenting the existing conditions (including a hospital-wide department survey and preparation of CADD single-line power distribution diagrams), identification of system deficiencies and development and budgeting of three alternative plans for system restoration and modernization. Funding of this project is currently programmed for around the year 2000.
- **National Medical Enterprises - Evaluation of Corporate-Wide Building Automation and Energy Management.** While Corporate management had funded the installation of numerous building automation systems over the years, uncertainty existed as to whether the projects had been universally successful and whether other strategies and/or opportunities were being overlooked. As a result, ERA was hired to evaluate the overall energy efficiency of NME's inventory of facilities (totalling some 75+ acute care hospitals nationwide) and the efficacy of

the building automation systems that had been installed. This task included reviewing energy use data for all facilities, interviewing corporate staff, performing site inspection visits for selected sites and preparing a strategic report for the corporation. This report revealed significant success with the program, along with significant organizational infrastructure problems and significant untapped energy efficiency opportunities. Follow-on assignments included the development of a corporate-wide performance contracting program, currently being implemented.

- **JFK Memorial Hospital -- Central Utility Plant Master Plan and Plant Expansion and Modernization Design.** 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 a 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

While the projects were submitted and approved at OSHPD as two separate projects, management changed course and eventually decided to implement in a single program of construction. ERA took the unique approach of then creating a single, integrated set of working

drawings so as to facilitate bidding and construction (while keeping the 2-phase plans on site, but on the shelf, ready for OSHPD inspection). Playing a large 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 mid-2002.

- **U.C. Davis Medical Center - Chilled Water Distribution System Study and Remediation.** Practically since it was first built, this 500,000+ square foot acute care hospital suffered from inadequate cooling in the summer months, with patient room (including surgery recovery rooms!) temperatures exceeding 80°F in the summer months (and frequently approaching 90°F for days at a time)! In the early 1990's, a large project was commissioned to correct this problem, but resulted in making the situation worse, rather than better.

In 1996 ERA was engaged to perform a thorough investigation of the system. This task included preparing floor plans, isometrics and a schematic diagram for the entire chilled water distribution piping system encompassing all of the piping work performed over more than 50 construction projects over the years. These drawings were then verified/corrected in the field with the assistance of the operations and maintenance staff. Next a computer model of the piping system was prepared and this analysis clearly revealed that the use of a constant flow system with booster pumps at each air handling unit was over-pumping the water and actually causing water to flow backwards through significant portions of the piping system. The result, which explained the building's poor cooling performance, was that many air handling units were receiving warm return water instead of cold supply water to their cooling coils. ERA developed a \$1,400,000 remediation plan which consisted of conversion of the entire system to variable flow, elimination of all 53 booster pumps and the installation of digital controls for the new variable speed main chilled water pumps.

This project was implemented in early 1997, with the result that the entire building was comfortable for the first time in 25 years! In addition, the few small areas in the hospital that suffered from cooling problems not related to the flow problems (inadequate airflow, undersized controls, etc.) could be focused on and resolved.

- **U.C. Davis Medical Center - Investigate High Pressure Steam Supply Options, Design Underground Steam Line.** 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 on 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 (reduced design costs considerably)
- **Sierra Nevada Memorial Hospital - Central Cooling Plant Expansion and Modernization.** 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 critical-HVAC 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 was completed over the winter of 1993/94. This project included interconnection to the new building automation system and incorporated 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 completed by ERA, 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.

- **Sierra Nevada Memorial Hospital - MRI/BIC Addition.** Expanding their treatment program offerings, Sierra Nevada embarked on an MRI and Breast Imaging Center project in early 1999. ERA performed the mechanical design on this complex addition, which included a dedicate air handling system, special MRI computer room air conditioning and interconnection of the additions HVAC systems to the existing thermal utilites, including heating hot water, plant chilled water and the building's unique critical HVAC chilled water system ( see discussion of this special utility system which was constructed as part of ERA's central chiller plant project for the Medical Center).