

## GHPs Improve Housing and Save Energy at Camp Lejeune

*Family housing retrofits financed under a utility energy services contract*



### Utility Services Case Study

#### Case Study

Marine Corps Base Camp Lejeune, “Home of Expeditionary Forces in Readiness,” has cut energy use by 33% in four family housing areas by replacing old heating and cooling equipment with geothermal heat pumps (GHPs, also known as ground-source heat pumps) in 2089 homes. The \$16 million project, one of the largest ever financed by a federal agency under a utility energy services contract (UESC), was undertaken in partnership with Camp Lejeune’s electric utility, Carolina Power & Light (CP&L). Annual savings of almost \$1.5 million from the new GHPs will pay off the financed part of the investment, about \$12.7 million, in ten years.

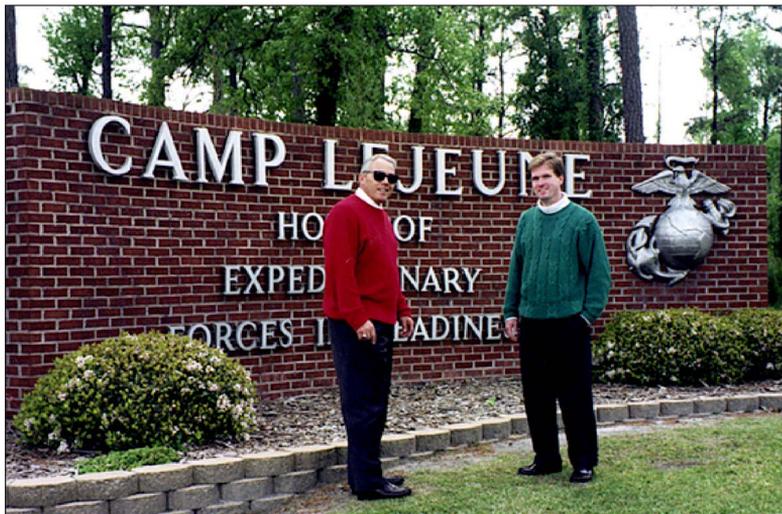
own customers include the residents in the retrofitted houses (including four generals’ homes). Base Housing, Utilities, and Maintenance are part of the Installation & Environment (I&E) organization, led by Col Thomas Phillips, Assistant Chief of Staff. I&E is charged with providing living and training facilities for the Marines and for meeting federal energy goals.

Total customer satisfaction was the goal and teamwork was the method adopted for this project by CP&L and its prime contractor, Strategic Resource Solutions (SRS). This approach fostered good faith and creativity that resulted in the technical success of the project and a good financial deal for Camp

Lejeune. The GHPs have improved the quality of life in family housing on the base and are helping Camp Lejeune meet federal energy and emissions reduction goals.

#### Background

Camp Lejeune, the largest U.S. Marine Corps base in the world, is near Jacksonville, North Carolina, and includes Marine Corps Air Station New River, Camp Johnson, Camp Geiger, and the Marine Corps’ Engineering, Service Support, and Infantry schools. With 45,000 Marines and 4,400 single-family homes, the



Camp Lejeune Energy Manager Jim Sides (right) and Bob Dupuis of CP&L led efforts to develop a \$16 million GHP project for base family housing.

The distinguishing characteristics of this project have as much to do with people and partnerships as with technology. Energy conservation must fit into—even enhance—Camp Lejeune’s mission to train Marines, as well as save energy and money, so it takes a team to fit all the pieces of the project puzzle together. Camp Lejeune Energy Manager Jim Sides championed the GHP project at the hub of a team that included people from the base, CP&L, and contractor companies.

The primary customer at Camp Lejeune was base Family Housing Office Director Kenneth Day, whose

base uses about a quarter of all energy used by the Marine Corps. To Camp Lejeune’s energy and facilities professionals, energy efficiency is important, but never takes precedence over the welfare and morale of the Marines. Energy-efficiency projects at Camp Lejeune must save energy and money without adversely affecting the well-being of the Marines and their families on base.

Camp Lejeune has a history of pursuing energy efficiency and controlling energy costs, but in 1998 it hadn’t yet installed any GHPs. At that time, the GSA areawide contract covering the base’s procurement of

U.S. Department of Energy

Office of Energy Efficiency and Renewable Energy





Almost half of Camp Lejeune's 4477 family housing units were retrofitted with GHPs.

utility commodities was fairly new, and Jim Sides and Bob Dupuis, CP&L Military Accounts Manager, were working on establishing a basic ordering agreement to cover demand-side management services.

The technology and timing of this project turned out to be perfect for Camp Lejeune. The heat pumps in almost half of the base's 4,477 housing units had been installed in 1980–82, many were beyond their 15-year nominal service lives, and most were requiring frequent service and repair. Doing nothing wasn't an option any longer, and the Housing Office was preparing to issue an RFP for the first phase of a wholesale like-for-like replacement using budgeted funds. Jim Sides, who had often discussed the benefits of GHPs with CP&L's Bob Dupuis, heard about the plan and saw an opportunity. It was clear to Dupuis that Camp Lejeune could get far greater long-term value from GHPs than from standard air-source heat pumps.

J. O. (Joe) Parks, who was Director of Housing when the project was first proposed, was unaware of the opportunities for financing federal energy projects until Dupuis pitched the idea: "Would you be interested [in installing GHPs] if you could use someone else's money to do it?" Dupuis explained, "I wanted to show them that even though they had cash in hand, they could use that to buy something else they really needed and pay for GHPs with savings."

"It was a good pitch, especially when it's hard to come up with project money," said present Director of Housing, Kenneth Day. He is delighted to have improved base housing and living conditions for his residents now, without waiting through the typical five-year appropriations programming cycle. "We

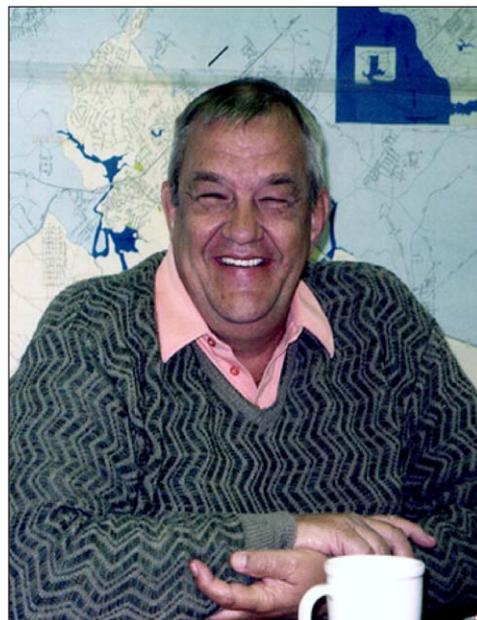
have all new equipment at virtually no expense to us," because cost savings will pay for the project, he said. "I'm going to be paying the electricity bills over the next ten years anyway, whether I put the geothermals in or not, but this way in ten years I get the savings."

### **Project Summary**

#### **Project Development**

The GHP project was Camp Lejeune's biggest energy-efficiency investment ever, first task order under a UESC, and first GHP

retrofit, so nothing about it was "routine." The engineering aspects of project development were coordinated by Jerry Rowlands, an energy engineer and SRS accounts manager at the time, and Don Hamilton, CP&L energy engineer. Rowlands, who had previously led energy conservation programs at Marine Corps headquarters, said that the relative novelty of GHPs and the utility contracting vehicle made the project a unique challenge in his experience.



Kenneth Day, Director of Housing, is pleased to have all new heating and cooling equipment in 2089 family housing units on base.

Also, contracting with the U.S. Marine Corps may be as complicated as it gets. Camp Lejeune's real estate is owned by the U.S. Department of the Navy, of which the USMC is a part. Concurrence in contracting decisions is needed from both the USMC and the Navy, but there is no resident contracting authority at Camp Lejeune. Capital improvements, construction, and other contracting is handled by the Atlantic Division of the Naval Facilities Engineering Command (LANTDIV NAVFAC) in Norfolk, Virginia.

During the summer of 1998, NAVFAC was consulted about the potential GHP project and quickly requested a definitive answer to the bottom-line question: Yes or no, will savings pay for this project in ten years or less? Although the answer would be based on preliminary data, before design work could be done, the numbers had to be much better than ballpark. "We had to have a proposal that was acceptable to everyone, with a construction cost we could live with," said Victor Stephenson, CP&L Federal Contracts Manager.

This first proposal and cost estimate was developed by Rowlands and Hamilton, with help from the International Ground Source Heat Pump Association. To determine feasibility and estimate construction costs, they gathered electricity consumption data, weather data, and utility rates; they developed good estimates of energy consumption and cost; and they did detailed heat loss and heat gain analyses on each type of home to be retrofitted. Their numbers indicated a good opportunity to save energy and money, and a ten-year payback.

LANTDIV agreed that this was a project worth doing, and Camp Lejeune requested that CP&L take the next step by providing a proposal including 35% design and detailed energy survey. At this point the unpredictability factor came into play, and the project was stalled for several months by the Anti-Deficiency Act because no identifiable funds were available to pay for the feasibility study. At the beginning of the next fiscal year funds were identified, and the 35% design was completed in the spring of 1999.

Over the next year, Rowlands led the efforts to produce the final feasibility studies, specifications, and 95% engineering designs that comprised the final proposal, culminating in award of the project to CP&L and SRS in the spring of 2000.

**Construction**

The construction project began in July, and the retrofits were finished in July 2001, three months ahead of schedule. A total of 3500 tons of heat pump

capacity was installed, averaging 1.68 ton per unit. An average of two boreholes per home of 180 feet average depth were drilled for the ground heat exchangers. About 786,000 linear feet of piping, which would reach about 148 miles, was installed in the bores. The GHPs were custom-built for Camp Lejeune by ClimateMaster and were designed for easy installation and dependable operation.

Desuperheaters were added wherever possible to supplement hot water heating. The desuperheaters reduce the cost of water heating significantly when the GHPs are in heating mode and provide hot water essentially for free when the heat pumps are in cooling mode and are dumping excess heat. The GHPs can potentially operate at SEER 20, or up to 25 in combination with desuperheaters.

The GHPs and desuperheaters have reduced energy use by about 33% in the retrofitted houses, and have



Base Maintenance Officer Lt Col Nicholson, Energy Manager Jim Sides, and Utilities Director Steve Soller collaborated with Camp Lejeune's Housing Office and others to make the GHP project work.

reduced base-wide peak demand by about 7%, or 5 MW.

Although maintenance cost savings are not calculated into the payments for the retrofits, the minimal maintenance required for GHPs is a huge advantage, according to Levi Hill, Camp Lejeune's Housing Maintenance Manager. Hill said that now, with GHPs in about 47% of Camp Lejeune's family housing units, his staff finally has time to start taking care of a long list of deferred maintenance tasks. The GHPs are working perfectly, and the hot water heaters, which are no longer overloaded, also require less maintenance. Where the GHPs are installed, the base has also quit using its radio-controlled load





At left, an employee of Humphrey Mechanical Engineering discharges the refrigerant from an old heat pump in preparation for removing it. After installation, the small white box at foundation level seen in the lower left corner of the photo at right is the only outdoor evidence of the new GHPs.

management system to turn water heaters and HVAC systems off during peak load periods, which is appreciated both by residents and by maintenance staff who have fewer calls and complaints to handle.

### Installation

Bob Reiersen, SRS Project Manager, stressed that Camp Lejeune, CP&L, SRS, and all the subcontractors planned and carried out the project as a team, from start to finish. The team agreed from day one that customer satisfaction would be key to a successful project and worked methodically on communicating with residents to minimize the inevitable disruption of installing the GHPs. SRS informed all residents of the planned “invasion,” first by drilling rigs to drill the bores, then by the crews who would take out the old equipment and install the new. The work wouldn’t be finished until the lawns were reseeded where the drilling rigs had worked.

Ultimate customer satisfaction depended on the performance of the new GHPs, and the team decided to do whatever was required to make sure the GHPs would work well. Crews inspected thermostats, water heaters, air ducts, and the spaces where the new units would be installed. Wherever ancillary equipment related to the heat pumps was faulty, worn out, or looked like it might cause a problem, it was fixed or replaced, even though this work was beyond the formal scope of the job. Housing Maintenance supplied parts and, if major repairs were required, some labor.

Reiersen noted that cost containment is also important. “You’ve got to be careful because we’re in the business to save energy and if you throw too

much money at it, we don’t have a project. Still, you need to keep in mind that to get optimal performance all the related parts have to work,” he said.

The team’s approach to the installation phase recognized that the work would disrupt each resident’s routine for a day, but aimed to mitigate the inconvenience as much as possible. Bob Dupuis said, “We wanted to treat the people as you’d want to be treated in your own home, and we tried to be very proactive.”

SRS made appointments with residents and asked that someone be at home when crews were installing the equipment. The intent was to take out the old unit and install the new within one eight-hour working day. If the new unit wasn’t up and running at the end of the day, SRS sent the resident a written apology for the inconvenience, and in some cases flowers or a gift certificate for dinner. On a few cold nights, they paid for some families’ dinner and a night’s stay in a nearby hotel to ease a hardship—if there were a baby in the house, for example.

Dupuis clarified that the percentage of cases calling for such remedies was very small. “You couldn’t afford to do the project if you did that a lot. But if we upset somebody or didn’t do the job the way we said we would, then we took care of it and made it right. We knew, having worked with base housing in the past, that Ken Day’s biggest nightmare is having a lot of phone calls from unhappy residents,” he said.

This approach to customer service prevented problems and complaints from spilling over to the Housing and Utilities organizations, and Ken Day was spared the nightmares. Day said, “SRS had



people on call 24/7, 365 days. They were very proactive in going out and taking care of the complaints and concerns of the people. The feedback I'm getting from the residents is very positive, and I'm very satisfied."

### **Benefits of Utility Contracting**

Even though Camp Lejeune's Family Housing Office had money in hand to buy air-source heat pumps, they chose to develop a financed GHP retrofit project in partnership with CP&L because it offered superior long-term value for the base. Housing Director Ken Day said that the cycle to get funds for energy-improvement projects typically takes about five years, and even then, appropriations are never guaranteed. Base Maintenance Officer Lt Col David Nicholson explained that utility financing opened new avenues to meeting Camp Lejeune's energy goals. "Heat pumps aren't a sexy thing. Put them up against a fighter jet for funding, and I can tell you what's going to win. We wouldn't have been able to do this any other way," Nicholson said.

Col Thomas Phillips, Assistant Chief of Staff, I&E, strongly encourages using utility programs to finance energy projects and said, "I can't meet my mandates without funding projects in alternative ways."

### **Lessons Learned**

*"We didn't say we'd be perfect, but we said we'd make it right."* — Bob Dupuis

Any big energy project is a complex, many-faceted endeavor, and chances are that some things will not work perfectly on the first try. The team that made the Camp Lejeune project happen learned that building a strong, good-faith partnership between customer and service provider is the first step to overcoming the inevitable obstacles. Another prime asset is a genuine team commitment to making customer satisfaction the ultimate goal. These precepts are common themes in the lessons learned below.

### **Keys to Success: Planning, Customer Service, and Teamwork**

Bob Reiersen, SRS Project Manager, stresses three factors in the project's success: planning, customer service, and teamwork. "We're firm believers that planning is the key, and planning as a team helps a lot," he said. The ongoing collaboration and communication between the base and the contractors kept all parties focused on common goals and produced some great ideas and creative problem solving.

This approach set a new standard for contractors on

base to live up to, according to Col. Phillips. "I'm very happy with the contracting effort I've seen in the GHP project. I get a little touchy if I hear about contractors driving on grass with heavy equipment, or going into houses and disturbing residents, but SRS and their subcontractors jumped on any problems that came up before I had to get involved. About half of the work on base is done by contractors, and SRS is the best I've dealt with," he said.

### **Budget Protocols**

Victor Stephenson pointed out that cooperation among Camp Lejeune's different organizations was critical to making the project work. Budgeting protocols can be one of the biggest obstacles to implementing financed energy projects at federal sites. At Camp Lejeune, the capital equipment money used to pay for part of the GHP project had to come from some activity/program on the base, but the



GHPs ready to install and installation crew in Midway Park housing area.

energy cost savings would be credited to the utility department. To work through the money trails and come to agreement, Stephenson said, "takes an incredible degree of cooperation." Bob Dupuis confirmed that the project could not have happened without a solid team effort. "Camp Lejeune has wonderful relationships all the way around — everybody is willing to work together," he said.

### **Owning and Fixing Problems**

Camp Lejeune personnel are very pleased with the outcome of the GHP project, but not because everything went perfectly and exactly as planned. In fact, SRS and its subcontractors faced several problems during construction that might have been





Robert Reiersen, SRS Project Manager (left), with satisfied customers Staff Sgt. Joe D. Solis, Melanie Solis, and their daughter, at their home in Senior Enlisted Officers' Family Housing at Camp Lejeune.

expected to cause major conflicts or delays. It was discovered, for example, that the heat exchanger loops on about 50 units were too short to provide the required heating and cooling capacity. To fix the problem, additional bores and loops were installed, without allowing the situation to become Camp Lejeune's problem. The way the CP&L/SRS team handled this and other problems—owning them immediately and fixing them quickly—earned the customer's respect.

**• When you work on the general's house . . .**

When asked about "lessons learned," one of the first things Reiersen said was, "When you work on the general's house, don't assume anything and check everything twice." An installation crew planned to put the new GHP for a general's house in an existing linen closet, but they subsequently decided that a higher-capacity unit was needed there. The larger unit wouldn't fit into the closet, so they decided to put the unit under the house instead where there was plenty of room. The installation was completed and the new unit was working fine—for a while. Without solid support, the unit had lost its footing, tipped, and shut off, as per design specifications. The problem was quickly fixed, and the team logged a valuable lesson learned.

**• Natural Human Aversion to Change**

Throughout the construction period, SRS and its subcontractors handled service calls on the new GHPs, and soon realized that the retrofit job entailed

a great deal more than one mechanical installation per house. Most of the new units functioned properly from day one, but many of the residents didn't understand their controls or how they functioned. Many also thought that the GHPs were doing all the water heating (inadequately) and didn't understand that their water heaters had been turned down to 120 degrees to comply with a U.S. Military law. Reiersen said that they handled many service calls that had nothing to do with the GHPs. Regardless, Reiersen always treated the residents as his valued customers, and remains

convinced that this is key to a successful project.

The most persistent and frequent problem has involved dealing with the natural human tendency to dislike change and fear the unknown, according to Reiersen. "It's not an insurmountable problem, and our attitude is that we will deal with it, but it takes a lot of time," he said.

**• Resident Surveys**

SRS went the extra mile in customer service by mailing out customer surveys to find out how they could make the construction situation better for the residents. The survey results indicated high percentages of satisfaction but also showed SRS a few areas where improvements were possible. As a result of insights gained from survey responses, SRS improved their communication with residents about how the new systems worked and distributed an informational letter about the GHP project to all residents for a second time. The survey results also indicated that residents' first impressions of the project could be improved and led SRS to change the way they made their initial contacts with residents.

**• Money Well Spent**

An unusual cold snap in December 2000, when about half of the GHPs had been installed, was a severe test of the GHPs' capabilities. Even though the GHPs worked fine (and much better than the air-source heat pumps), many residents just felt cold, as temperatures stayed near or below freezing for more than two weeks. Reiersen answered a service call one night to



quickly fix a small problem with a GHP in a house where a couple with a new baby lived. Reierson decided then to provide a portable heater for them to use until the weather warmed up. The next day, Reierson suggested and the team decided to purchase every oil-filled radiant heater (the safest kind of portable heater) in lower North Carolina to supplement the residents' heat. Reierson said, "We thought it was money well spent. We kept our customers satisfied. We just gave them heaters because they were cold, even though the units were functioning great. We gave a lot of heaters to people with air-source heat pumps, too." (The heaters also came in handy while the short loops were being replaced.) When Ken Day and Lt Col Nicholson talk about the heaters it's clear that they were surprised and impressed by Reierson's response to the situation and that he's earned near-hero status in their eyes.

• **Equipment Quality Assurance**

A quality energy project obviously depends on the quality of the new equipment, so the team gave careful consideration to choosing a supplier for the GHPs. Before signing the contract with ClimateMaster, Reierson and several others spent two days at their plant in Oklahoma City doing hands-on inspections of the recommended heat pump unit and its design, the factory, and the manufacturing process. After joining the team, ClimateMaster helped train and certify contractor and Camp Lejeune personnel as GHP installers. "We've had ClimateMaster right with us every step of the way," Reierson said.

ClimateMaster's experience in the field and their

commitment to the team concept passed the test when a problem with the GHPs surfaced during the cold snap. A few families actually were cold because their GHPs, which seemed to have insufficient coolant, were not functioning properly. The team decided to shut the project down to determine the extent of the problem. ClimateMaster staff came to Camp Lejeune



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and determined that the problem had originated in the manufacturing of the units, which had all been charged with coolant and sealed at the factory. ClimateMaster bench-checked all uninstalled units and didn't find many problems, but found enough to warrant checking all the units that were already installed. ClimateMaster made sure all the GHPs at Camp Lejeune were fixed and has since changed their manufacturing process to prevent reoccurrence of this problem.

**Looking Ahead**

A number of new energy-efficiency projects are in progress at Camp Lejeune, and more are in development. Upgrading systems to monitor and manage energy use on the base is a high priority involving 23 new master electric meters and a



Workers complete the last stage of the construction project: repairing and reseeding lawns.





A GHP retrofit of Camp Lejeune's Marston Pavilion conference center is underway.

SiteNet system to integrate operation of power systems and load management plans. The base is installing infrared heat in hangars, implementing other lighting upgrades, and implementing a range of other improvements in projects financed by utility contracts and energy savings performance contracts, or paid for by appropriated funds. A GHP retrofit for the Marston Pavilion conference center is underway, and the base is studying the feasibility of GHP retrofits for more family housing units.

According to Col Phillips, GHPs will figure prominently in Camp Lejeune's energy strategy: "Meeting our energy goals is hard to do because our customer isn't focused on this, and there are too many competing priorities; but GHPs are exciting—I can start showing some progress toward the goal and see the graph start going in the other direction."

### *For More Information*

For more information about the project please contact:

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