Steam Decentralization at Camp Lejeune

Recognizing the U.S. Marine Corps' push for energy reduction, Marine Corps Base Camp Lejeune put forth a concerted effort to evaluate and enhance its heating plant systems.

By Ed Stewart and Elizabeth Smith, P.E., LEED AP

Marine Corps Base Camp Lejeune has multiple district steam utility systems including Hadnot Point, New River Air Station, Camp Johnson, Courthouse Bay, and Camp Geiger. Each location had been utilizing a central steam heating plant to generate and distribute high-pressure steam to over 500 buildings, with more than 50-mi of steam supply and condensate return piping. Above, pre-existing steam distribution at Camp Johnson, N.C. PHOTO COURTESY RMF ENGINEERING

The U.S. Marine Corps has been working to develop and execute a comprehensive energy initiative that will reduce energy use throughout its installations nationwide.

Recognizing this push for energy reduction, Marine Corps Base Camp Lejeune, N.C., has made a concerted effort to evaluate and enhance its existing heating plant systems. The base worked with numerous architect-engineer firms and contractors, including RMF Engineering, to implement a steam decentralization program that has improved energy efficiency and reduced boiler plant emissions, fuel costs, make-up water requirements and distribution losses.

Camp Lejeune is a 246-mi^2 site comprising multiple district steam utility systems, including Hadnot Point, Air Station New River, Camp Johnson, Courthouse Bay, and Camp Geiger. Each location had been utilizing a central steam heating plant to generate and distribute high-pressure steam to more than 500 buildings, with over 50-mi of steam supply and condensate return piping. These existing steam generation and distribution systems were reaching the end of their useful life expectancy and in need of repair and replacement.

The largest pulverized coal-fired boilers date back to the original base development in 1941. Overall, only 50 percent to 60 percent of the heat from the fuel purchased and used at the central plants actually reached the building users. Energy was lost in each system through a combination of inefficiencies including boiler inefficiency, plant losses and distribution losses.

IMPROVING EFFICIENCY

An energy conservation study was initiated in 2010 to examine multiple options for improving efficiency. Based upon a simple payback ranging from 4.1 years at Hadnot Point and up to seven years at Camp Johnson, Camp Lejeune embarked on a $150 million investment to install high-efficient hot water condensing generators throughout its facilities. This represented a large one-of-a-kind project with numerous challenges and multiple phasing requirements to keep the installation in full operation during all work activities.

The plants generated a standard steam pressure of 150-psig, 338°F, which was then distributed to the individual campus buildings. However, the terminal side equipment at these buildings typically utilized 180°F water in air handling units, coils and convectors. In essence, heating energy was supplied at twice the necessary supply temperatures required. The higher the temperatures produced and distributed, the higher the overall energy consumption.

So what was the solution? A total of 641 heating hot water condensing boilers were installed throughout Camp Lejeune and are now producing low temperature hot water in the 90 percent to 96 percent efficiency range, located directly at the end user's location. The condensing boiler efficiencies alone far exceed the average 78 percent generation efficiencies of the central steam plant boilers. In addition, distribution losses were significantly reduced and nearly eliminated. The condensing boiler systems provided maximum achievable efficiencies and eliminated waste. Many of the implemented condensing boiler systems have chlorinated polyvinyl chloride stack outlets because of the low heat content of the flue gases (130°F to 190°F).

Several optimization schemes also were implemented to further system efficiencies:

- Full building automation system monitoring and reporting for quick response.
- Lead/lag cascading boiler load staging for optimum operation of only the required number of units.
- Touch-screen color graphic control modules for control and monitoring.
- Nighttime space setpoint setbacks to reduce energy loads at unoccupied hours.

Project at a Glance: Camp Lejeune Steam Decentralization				
	PHASE 1	**PHASE 2**	**PHASE 3**	**PHASE 4**
	New River, Camp Geiger, and Camp Johnson	Hadnot Point, French Creek, and Courthouse Bay	Hadnot Point, French Creek, and Camp Johnson	New River, Hadnot Point, French Creek, and Courthouse Bay
Construction Value	$30,238,097	$55,163,477	$24,423,000	$37,898,833
Heating Hot Water Boilers	209 units ranging from 81-MBH to 750-MBH	309 units ranging from 81-MBH to 3,000-MBH	60 units ranging from 970-MBH to 11,870-MBH (under design)	63 units ranging from 286-MBH to 3,348-MBH (under design)
Domestic Hot Water Systems	61 units ranging from 285-MBH to 399-MBH	57 units ranging from 400-MBH to 2,000-MBH	97 units ranging from 180-MBH to 3,430-MBH (under design)	25 units (under design)
Pool Heaters	3 units all at 400-MBH	7 units ranging from 400-MBH to 800-MBH	N/A	under design
Gas-Fired Water Heaters	60 units ranging from 50-gal to 130-gal	33 units ranging from 100-gal to 130-gal	under design	4 units ranging from 100-gal to 900-gal (under design)
Electric Water Heaters	14 units ranging from 20-gal to 82-gal	7 units ranging from 20-gal to 80-gal.	under design	N/A
Gas-Fired Unit Heaters	112 units ranging from 30-MBH to 250-MBH	389 units ranging from 30-MBH to 350-MBH	under design	42 units all at 100-MBH (under design)
Hot Water Unit Heaters	26 units ranging from 12-MBH to 84-MBH	29 units ranging from 12-MBH to 84-MBH	under design	N/A

*Numbers are subject to change due to design and field changes.

**Table does not reflect all equipment installed/designed (some other equipment such as heat pumps and small package units were installed for small buildings were it was most cost effective).

- Outside air supply temperature reset scheduling to reduce supply temperatures during off-peak periods.
- Out-of-range alarm point annunciation for immediate notification and reporting of any system problems.

After all the facilities have been removed from the steam distribution system, the existing central plants and distribution will be decommissioned and demolished. The steam boiler plant buildings will be demolished and the bricks and steel will be repurposed and recycled for a courtyard.

OPERATIONS & MAINTENANCE

Maintenance is another key factor for converting the base from steam to natural gas. There were major concerns for maintaining the 600-plus boilers. However, upon completion of a cost analysis, RMF Engineering saw that labor and costs for the individual boiler systems would be less than the current maintenance costs for all of the steam generation, distribution, and conversion. The new steam decentralization program will yield approximately $5.7 million of savings in utility costs and $7 million in annual operating and maintenance costs. Additionally, the new condensing boiler operations are closed loop circulation systems, which do not need large make-up water systems. As part of the steam decentralization program, the steam make-up water systems are being virtually eliminated. This will save the base 87-million-gal of make-up water and treatment systems per year.

The majority of the standalone new building equipment systems will fit in the same space previously occupied by steam equipment. In some cases, small mechanical buildings were constructed in existing parking lots to serve a small building complex or as additional mechanical room space. These helped facilitate the phasing of construction so that the new systems could be built and in place before the demolition and tie-in work occurred, with minimal to no disruption to base personnel.

Environmental air pollution considerations were another critical issue the steam decentralization projects could help to address, even eliminate. The main issue was with the Hadnot Point main steam system and the four existing coal-fired boilers. Federal regulations mandated by the Environmental Protection Agency's new Boiler Maximum Achievable Control Technology Standards created a significant financial and technological challenge.

These requirements were leading Camp Lejeune toward spending millions on clean air technologies, including air scrubbers and baghouses. By implementing an all-natural gas fuel base for heating systems, thereby eliminating coal and fuel oil usage, the base was able to avoid the expenditures associated with the clean air technologies.

In addition, the condensing boiler strategies included low nitrogen oxide (20-ppm or less) emission ratings on the burners. Annual energy savings were estimated at 450,000-MBtu/hour, resulting in more than 70,000-T per year of carbon dioxide greenhouse gas emissions reductions.

GENERATING LASTING SAVINGS

Camp Lejeune's $150 million steam decentralization program estimates a 634,000-Mbtu savings per year.

Through reducing air pollution, make-up water requirements, efficiency losses, and maintenance and utility costs, the program is a model to follow for both environmental and financial stewardship.

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Ed Stewart is Senior Project Manager, RMF Engineering; ed.stewart@rmf.com.

Elizabeth Smith, P.E., LEED AP BD+C, is Installation Energy Manager and Mechanical Engineer, Marine Corps Base Camp Lejeune, N.C.; elizabeth.a.smith@usmc.mil.