Water Efficiency Case Study:
Dartmouth-Hitchcock Medical Center, Lebanon

Dartmouth-Hitchcock Medical Center (DHMC), located in Lebanon, New Hampshire, is one of the few completely new medical centers in the country. This state-of-the-art facility incorporates the Dartmouth College Medical School, Mary Hitchcock Memorial Hospital, Dartmouth-Hitchcock Clinic, and the Veterans Affairs Medical Center in White River Junction, Vermont.

In June of 2000, the Engineering Services division of DHMC initiated an extensive water conservation retrofit. The total cost of the project was about $350,000. This figure includes the cost of the retrofit, consulting fees, and fixture and hardware costs. With an annual savings of $100,000, based on water, sewer, and energy cost reductions, the payback period for the retrofit program will be three and a half years.

The scope of the water efficiency retrofit program addressed both domestic and process water uses. There were very few problems with the retrofit program, despite the extent of it, mainly because of good communication between the facility, consultant, and the end users of the equipment.

Domestic and Kitchen Water Efficiency Measures
As part of the domestic water use retrofit program, DHMC installed low-flow toilets, retrofitted urinals, and placed flow restrictors on sink faucets. There was an initial problem with users double-flushing the low-flow toilets. The equipment installed uses fairly high pressure flows that tend to shred toilet tissue, leading the user to perceive an incomplete flush occurred. User education using informational postings remediated the problem.

Flow control mechanisms were installed on most kitchen equipment and sinks. These controllers were set to the original equipment manufacturer's recommended flow for optimum use of each device.

Process Water Efficiency Practices
Process water efficiency efforts centered on the tempering systems for autoclave wastewater and boiler blowdown, a recirculation system on the reverse osmosis/ deionized (RO/DI) water filtration units, and another recirculation technique on the medical air and vacuum pumps.

Boiler and Autoclave Tempering Systems
The tempering systems on the autoclaves and boilers maintain water temperatures at or below plumbing code standards by periodically injecting cold water into the hot water waste stream. DHMC replaced their mechanical temperature sensors on both systems with a digital control that more effectively measures process water temperatures. The system also continually shoots water to drain even when the autoclaves or boilers aren't running. DHMC considered remedying this situation when the other water efficiency measures were instituted, but decided the necessary changes weren't cost effective.

One problem encountered with the water efficiency improvements to the boiler blowdown tempering system was that when water was released during soot blows, the boilers put out more hot water than the tempering system could handle. The operators now manually activate a bypass valve during soot blows to correct this problem. DHMC also had to add a water pressure regulator and water hammer arrestor on this system due to the on/off action of solenoid-driven devices. The problems occurred because the consulting firm didn't completely understand all aspects of the boiler blowdown operation.

Medical Air and Vacuum Pump Modifications
Medical air must be clean and oil-free for various medical procedures. Since water rather than oil is used as a lubricant, the air is oil-free and clean. Medical air and vacuum pumps are comprised of vanes rotating in a housing. The water makes the seal between the vane and the sidewall of the compressor housing to allow the machine to compress air or pull a vacuum. The water maintains the seal, provides lubrication, and absorbs heat produced by the process. DHMC replaced their old once-through water-intensive process system, served by a municipal water supply, with a closed loop recirculating system and heat exchanger, effectively cutting out nearly all of the wasted water from the old system.

RO/DI System Modifications
Reverse osmosis (R/O) is a water purification process that filters impurities from tap water. R/O forces water under pressure through a semi-permeable membrane that reduces the level of suspended and dissolved solids in the water. This process removes virtually all organic compounds and 90-99 percent of all ions from DHMC's process water. Deionization (D/I) is another water purifying method that removes ions. D/I water is non-reactive and used extensively in chemical tests. Since DHMC houses the research labs for the Dartmouth College Medical School as well as the labs associated with the hospital, a large quantity of purified water is required.

A major drawback to R/O systems is that they tend to reject more water than is produced for process. To remedy this problem, the RO/DI system at DHMC was retrofitted with recirculation pipes that run approximately 50 percent of the reject water back through the membranes for a second pass as opposed to discharging all of the reject water immediately to waste. This water efficiency technique was done in conjunction with the original equipment manufacturer's recommendations and does not affect the final water quality. For another example of this water efficiency technique, see the Millipore case study on the NHDES website.

DHMC attributes the success of its water efficiency program to:

1. Understanding how water is used and transferred into and out of all affected devices and areas.
2. The installation of back-up processes on such sensitive systems as the medical air and vacuum pumps ensuring no loss of service.
3. Teaming with original equipment manufacturers to achieve the water efficiency goals of the project while not affecting the equipment operation.

4. End user buy-in and sign-off of the retrofit equipment and technology.

Although a detailed quantitative analysis of water and cost savings is not available, DHMC feels that their water efficiency efforts have been well worth the initial investment. For further information on their water management program, contact Philip A. Chaput, Energy Engineer, at 603-650-7150 or by email at Philip.A.Chaput@Hitchcock.org.