

# Staying cool in Bahrain

By Andrew Stamer

Outside Freedom Souq's structure lies the craftwork of civil engineers, and on the inside mechanical engineers transform the desert heat into cool comfort.

The two-story Freedom Souq consolidates a gym and fitness center, food court, Navy Exchange, two movie theaters, and many other operations under one roof – serving the U.S. Navy and other tenants in Manama, Bahrain.

Civil engineers are responsible for all design surrounding and leading up to 1.5 meters from the building. This work includes but is not limited to roadways, landscaping, water supply and drainage.

In the last 10 years, growth on Naval Support Activity Bahrain has been phenomenal.

The base's original master plan has essentially doubled while the amount of land has remained the same, said Mike Wheeler, a civil engineer who worked on Freedom Souq.

All work flows from the architect, who is in charge of the overall look of the building and its layout. Everyone involved has to work together to make sure the original plan melds with the different engineering disciplines.

In the construction of Freedom Souq, the civil engineer's part dealt

mostly with drainage, which was the most involved and complex issue.

"Because of the high water table, we couldn't put in underground drainage," said Wheeler. "When you go underground, you're into the ground water in Bahrain."

The solution was to use surface drainage, he said.

When it rains, the water finds its way to retention ponds through the overland flow. These ponds collect the water, which sits until it dries or infiltrates into the ground, Wheeler said.

The sand in Bahrain is so fine the water collected in the retention ponds generally sits until it infiltrates into the ground or evaporates, Wheeler said.

The team considered placing water pumps in the ponds to pump out excess water. The assessment indicated that it was unnecessary because rain doesn't occur often in Bahrain, and therefore the additional cost for operating and maintaining the equipment wasn't justified. Accordingly, retention ponds were a more feasible and less expensive option for storm water.

In the earliest stages of design, the civil engineer works with mechanical and electrical engineers, along with the architect, to make sure the building's

utilities are laid in a way that will match the mechanical and electrical engineer's vision, Wheeler said.

A big part of the civil work is tying into preexisting infrastructure, such as water and sewer pipes, he said.

They also have to coordinate with the architect because some aesthetic design elements lie outside of the architect's design responsibilities, such as landscaping and hardscaping (inanimate elements of landscaping, especially masonry and woodwork), he said.

Another piece to this construction was the amount of coordination it took to keep the base operating normally while this building was being constructed.

"We had to separate usable living and working areas from the construction," Wheeler said. They also had to coordinate a route so other contractors could go through the construction site to get to other job sites on the base.

This meant temporary fences had to be placed, roads and walkways rerouted, and the arrangement had to be flexible because these patterns and fences would change throughout the building process.

## Mechanical Engineering

Where the civil engineer's work ends, at the magic 1.5 meter cutoff, the mechanical engineer's work begins.

Their job is to bring the plumbing, water and sewer into the building. They also bring in the heating, ventilation and air conditioning, said Tom Stephenson, a mechanical engineer who worked on Freedom Souq. In other buildings they may bring compressed air, fuel distribution systems and other industrial systems, depending on the facility.

"The HVAC part is by far and away the most effort," he said. "What we're doing is taking a proposed building and looking at it from a heat gain standpoint."

Some heat sources seem obvious while others may not.

"The first and primary source ... is the sun. That's a big one – especially in



Photo courtesy Bahrain Resident Office

Contractors build a road outside of Freedom Souq as part of the civil engineering effort.

the Middle East,” Stephenson said.

Other heat sources include lights, computers, copy machines, printers, refrigerators, coffee and tea pots, and a slew of others, he said.

People are another source of heat. Because there is a physical fitness center, even more heat will be generated by people. The more activity a person does, the more heat energy they produce, said Stephenson.

“We have to take the heat energy that’s being generated in the building and put it outside,” he said. And that’s done with the HVAC system.

Following the Department of Defense guidelines, mechanical engineers have to provide a certain amount of outside air at a specific rate depending on the size and use of the building, he said.

For Freedom Souq this means bringing in and changing out 40,000 cubic feet per minute, or “about twice the volume of a comfortable home in Winchester with 10-foot ceilings,” Stephenson said.

There is more to the mechanical engineer’s mission than simply bringing in air. They must cool the air, and in the hot, humid air of Bahrain, they must also remove the moisture, he said.

If this moisture isn’t removed, the cooling will create “a cold, clammy feel to the building,” he said.

And all of the moisture taken out of the air amounts to about 4,800 gallons of water per day, Stephenson said.

To do this, the building was divided into three separate buildings, each with its own set of designated chillers for a total capacity of 1,200 tons of cooling. The chillers or air-conditioning units were placed on top of the building because available land on the base is a valuable commodity.

In all nine chillers were placed – three are used as backups in case of breakdowns, Stephenson said.

Eighty-four air handlers push all of this air through the building’s ductwork. While some of the ductwork is hidden, exposed ductwork was rounded as an architectural element to the building, Stephenson said.

Another feat for the monstrous building was to provide enough hot

water. Large water heaters were installed for the different activities that required this demand – the biggest demand coming from the locker rooms, he said.

“It was a team effort. We all worked together to ensure that the engineering disciplines meshed to produce a top notch facility,” Stephenson said.

*(Editor’s note: This is the third story on the technical aspects of Naval Support Activity Bahrain’s Freedom Souq. Previous articles have included its architecture, interior design, geotechnical, and structural engineering. The last installment will feature fire protection engineering and electrical engineering conducted on the two-story facility.)*



Photo courtesy Bahrain Resident Office

Workers direct a crane lifting one of Freedom Souq’s air chillers.