To move their calibration lab to a new location less than 2 miles away, engineers at Northrop Grumman had to plan facilities, work with contractors, and recalibrate test equipment.

By Martin Rowe, Senior Technical Editor

Baltimore, MD—If you’ve ever moved to a new home after first renovating it or if you’ve moved a lab, a production line, or an entire company, then you know that such endeavors require a tremendous amount of work, both before and after the move. You also know that no matter how well you plan the new location’s design and construction, there will be last-minute changes and unexpected problems. That’s what engineers at Northrop Grumman’s calibration lab went through when they moved the electrical and physical calibration labs to a new location. Although the move distance was short (1.7 miles), the amount of work involved was long.

In early 2010, the calibration lab staff, including chief metrologist Bernie McDermott and lab manager Gary Jennings, learned that Northrop Grumman’s Electronic Systems sector was expanding its manufacturing capacity and needed to turn the floor space occupied by the calibration lab into manufacturing space. Management considered outsourcing all calibration, but after a six-month study showed the company would realize a cost savings by keeping the calibration functions in house, they decided to move the lab, a decision that also saved many jobs.

Even before management chose to retain the lab, the staff began planning the new facility. If they had waited for the final decision, they might not have had enough time to build the facility and also pack the lab.

The new facility, known as “Friendship Square,” was previously a warehouse and thus had no interior walls. The lab occupies a quarter of the building, with a museum of electronic equipment and other functions occupying the rest. Working with an architect, Jennings and McDermott developed floor plans as well as plans for electrical requirements, plumbing, parking, and transportation. Because the lab was leaving the main Northrop Grumman facility where most of its customers resided, Jennings and Terry O’Brien, manager of metrology engineering and calibration services, also had to devise a system for transporting test equipment needing calibration between the main buildings and Friendship Square, as well as between the lab and other Northrop Grumman locations in Maryland and Virginia.

Electrical needs
The company moved the electrical and physical calibration labs, but the dimensional calibration lab stayed in place. Why? Because of the tight temperature controls required for a dimensional lab. Moving the dimensional lab would have tripled the...
HVAC cost at the new location. Even with that, planning and moving the two labs cost several million dollars plus construction costs.

In the physical calibration lab, engineers and technicians calibrate equipment for measuring temperature, humidity, vibration, and flow. The electrical lab handles equipment such as oscilloscopes, multimeters, spectrum analyzers, power sensors, and signal sources used to test electronic systems. “Most of our test equipment is used for RF measurements,” said Jennings. Figure 1 shows a typical calibration station in the electrical lab, this one for microwave instrumentation.

The new facility needed single-phase and three-phase AC mains power, both 120 V and 240 V. It required data wiring for the networked calibration stations, and it also needed timing signals. “We needed many different styles of receptacles because our equipment operates throughout the world,” said McDermott. Thus, he had to specify which type of power receptacles the lab needed and where to locate them.

When specifying the power wiring, McDermott had to contend with grounding. The new lab has bonded grounds, which reduce power-line noise compared to the lab’s previous location. Three rods go into the ground under the labs, one in the physical lab and two in the electrical lab. To be effective and to meet building requirements, the ground rods have to go deep enough to reach “virgin soil” that hasn’t been touched in at least 100 years. Jennings estimated that the electrodes are 25 ft underground, and he said they had to be installed before the concrete floor was poured. Braided copper wires come up to make ground points in the labs. To make the grounding accessible to the calibration stations, the electrical lab has copper ground rails just below the electrical conduits that run over the calibration stations. Figure 2 shows one of the rails.

The electrical wiring drop locations were based on plans for calibration-station locations. At first, the floor locations were based on the layout in the old lab, but that changed to improve work flow. Each calibration station has a three-phase power drop with GFIs (ground-fault interrupters). One power phase goes to the station’s controller PC, one powers the calibration instruments, and one powers the equipment under test. “Breaking up power into phases reduces the amount of current per phase,” noted McDermott. “It also provides isolation, and the solid grounding minimizes power-line noise.” To accommodate the three phases and the calibration stations, the lab has a wall of circuit-breaker panels.

McDermott changed the electrical lab floor plan after the move because the electrical layout was designed before the space plan. The locations of calibration stations weren’t optimal. In the previous location, the calibration lab was located along a long hall and was included in plant tours. Thus, the space layout was designed to give visitors a good view of the electrical lab through a window. At Friendship Square, there are fewer tours, so McDermott was free to optimize the floor layout for best work flow.

In addition to power and data wiring, the electrical lab has coax cable for a time-base signal used to synchronize station clocks and provide timing of calibrations. “The communication people ran the coax, but we had to connect it and distribute it to the calibration stations,” said McDermott. “Each station has its own distribution.” Not only did lab personnel have to distribute the clock signals, but they had to do it up to a week after the move because the wiring wasn’t completed in time. Lab personnel had to attach BNC connectors to coax cables...
that electricians ran because electricians typically won’t perform this function.

HVAC is an important aspect of any building, but it is especially important in a calibration lab, where temperature and humidity can affect calibration results. Moving to Friendship Square made the engineers more aware of the HVAC system. In the old facility, the calibration labs were embedded deep within large buildings, virtually unaffected by outside weather changes. In the smaller Friendship Square building, two of the lab’s walls are outer walls, a setup that makes the lab more susceptible to weather changes. The lab needs to maintain temperature to within ±3.3°C.

Because the building had been a warehouse, its HVAC system was sorely inadequate to house a calibration lab. Installing adequate HVAC equipment on the roof required structural improvements that reinforced the roof’s I-beams.

The installed HVAC system was oversized for the calibration lab alone. At the time of the move, there were large unoccupied areas that are now in use. “The oversized HVAC system was short cycling when we moved in,” said McDermott. “Once the rest of the building was occupied, the HVAC system became more stable.”

In the former location, the electrical lab had room–wide temperature and humidity sensors, which is typical of calibration labs. In addition to monitoring temperature and humidity for the whole lab, engineers equipped each calibration station’s equipment rack with temperature/humidity dataloggers from Veriteq Instruments. If either parameter is out of tolerance, the station will shut down. The dataloggers also free technicians from manually entering temperature and humidity data into calibration records.

The lab also has room temperature and humidity sensors because of the location along outer walls. McDermott noted that the HVAC system has improved dramatically in the year since the move. “We’re still getting some variation in temperature and humidity here, but it’s improving.”

**No infrastructure**

Because the calibration lab would no longer reside in the main Baltimore facility, the staff needed to think about infrastructure that they previously had taken for granted. For example, they had to find a way to transport test equipment to and from the lab, as they could no longer simply roll it down the hall. Test equipment now needs to be transported to and from the main buildings as well as between the lab and other Northrop Grumman locations.

The staff set up a truck schedule for moving test equipment among 12 locations. Internal customers at the main facility have a place where they can leave equipment for transport to the lab, which occurs twice a day. Some bring equipment to and from the lab by car.

Because test equipment now travels by vehicle, rather than staying indoors, it’s subjected to outside environmental conditions. Thus, equipment must reach a stable temperature before calibration.

The staff also needed a loading dock at the new facility. Prior to renovation, the building had a ramp that lead to a loading dock, but the ramp was removed to accommodate new walls. The lab now has a hydraulic lift that lets truck drivers move test equipment in and out of the facility.

Other delivery issues arose. For example, the lab used to use the main facility’s shipping and receiving department, but now uses another Northrop Grumman facility known as Troy Hill for shipping and receiving. This has actually worked out better because the main facility’s shipping people were used to dealing with large items such as radar equipment and would sometimes lose track of small items such as temperature probes. Another transportation issue that the lab staff had taken for granted was payroll, which now has to be delivered to Friendship Square.

Before finally moving the lab, the company also had to schedule time to show employees how to reach the new facility. Although the lab was moving just 1.7 miles, some people didn’t know where it was. The company hired buses to bring the technicians and other support staff to see Friendship Square.

**Moving day**

As the scheduled moving day approached, lab staff and employees began packing. But the Friendship Square building wasn’t quite ready, and the contractor responsible for reconfiguring the old lab space began working before the lab had moved out. “They started putting plastic over our equipment to begin renovations on the old location, and we had to work around that,” said McDermott.

Other logistical problems arose. For example, the company had hired a logistics contractor to handle the move, and the contractor marked each item as to its location. Of course, the electrical work wasn’t ready and the flooring was still being installed as the equipment arrived. The movers were forced to leave the calibration stations on the opposite side of the new building from the loading

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Chief metrologist Bernie McDermott was responsible for moving the electrical calibration lab and specifying the lab’s floor layout and wiring. Courtesy of Northrop Grumman.
dock. Lab personnel had to move the stations around the building to get everything in.

Finding a moving company wasn’t easy, either. Jennings explained that they interviewed about a dozen companies, but most didn’t have enough insurance to handle the job. A calibration station can have a million dollars worth of equipment, and with several moving stations, the value of the Northrop Grumman equipment exceeded many movers’ liability insurance. In the end, only a few companies bid on the job.

The lab was shut down for four days—Thursday to Monday—and the move took place over a weekend. Once moved in, the lab’s staff had to not only install the calibration stations but also had to verify that the stations performed as they did before the move. That meant having everything calibrated and proving to an accreditation body that the equipment functioned properly. Because the move was planned well in advance, the staff sent some primary standards such as resistors and temperature probes to NIST for calibration prior to the move. When the calibrations were complete, the standards were shipped to Friendship Square. In other instances, the lab’s instruments were shipped to manufacturers or to an outside calibration lab for calibration over the move date. For some equipment, the staff purchased duplicates to minimize down time.

“We had to requalify the lab,” said McDermott. “A2LA [American Association of Laboratory Accreditation] required objective evidence that our equipment was functioning at a known state for specific measurements. We also had to show that the new lab had environmental stability, but that takes time. I wanted two weeks of stable temperature and humidity to show A2LA. We also had some intermediate checks of our equipment. For example, we had to calibrate some equipment such as VNAs [vector network analyzers]. We checked power sensors against our primary standards. Some equipment required new calibration, but for some, we could just check key points to verify uncertainty.”

The move also forced the lab’s internal customers to plan their calibrations. Well in advance of the move, the lab staff notified customers who had calibrations due during the move to send in their equipment prior to the move so as not to use equipment with expired calibration dates.

As with any renovation and move, unexpected problems occur. Some were small, some were large, and some were just plain unusual. Typical unexpected issues included things like doors that opened into halls. The doors that the contractor installed were solid, which created a safety hazard because someone opening a door couldn’t see someone coming down the hall. To fix the problem, the contractor installed windows in the doors. On a larger scale, some walls were moved several times to accommodate equipment.

The most unusual problem occurred when plumbers uncovered a human skeleton while digging in the ground to install new pipes. Apparently, the building was built over a former grave site. That brought all construction to a halt until the state evaluated the situation.

Moving also provided opportunities for the engineers to evaluate procedures and identify opportunities for improvement. For example, Jennings defines the turnaround time of a calibration as the time from when equipment leaves the customer’s facility to the time it returns. “In the old facility, we’d just put calibrated equipment on a shelf and let the customer retrieve it. Now, we have to take transport time into account.” McDermott still sees the lab environment as a place that needs improvement. “We were the beneficiary of being inside a large facility, and now we have to be more aware of lab conditions,” he said. T&MW