High Technology Laboratory Measures for Success

By Michael S. Weil
executive editor

**A. O. REED & CO,
San Diego, CA**

The Naval Surface Warfare Center (NSWC), Corona Division, is the Navy's only independent technology analysis and assessment center. Located in Corona, CA, the NSWC is where the Navy's proverbial rubber hits the road. In their words, "The mission of the NSWC Corona Division is to gauge the war-fighting capacity of ships and aircraft, from unit to battle-group level, by assessing the suitability of design, the performance of weapons and equipment, and the adequacy of training."

In order to carry out this mission, NSWC possesses a number of unique capabilities. Foremost among these is the Warfare Assessment and the Naval Measurement Laboratories. The latter was in dire need of updating, and the Department of the Navy was looking to build a new measurement laboratory. The new facility is in a 39,000 sq. ft. single-story building and is earmarked to be Navy's primary measurement facility. It contains laboratories, administrative, as well as warehouse space. Its purpose: to provide critical measurement analysis of numerous top-secret military weapons and their related devices.

The science of measurement analysis is known as "metrology." Measurements by metrologists can be accurate to one millionth of an inch. Part pieces and measuring instruments expand and contract with minute changes in environmental conditions. When this occurs, measurement accuracy is compromised. For this reason, metrology laboratories require precision controlled environments. Precise temperature and humidity control is essential to the measurement process. This includes single point stability (±1.5F), as well as precision vertical / horizontal gradient control (less than ±1.5F). Gradients are measured in time and in space.

For the U.S. Navy's Measurement Laboratory, the precision measurements required the lab areas to be maintained at a constant temperature with only ±0.5F from the floor to the ceiling.

Like many construction projects let by the government, this one had all the potential of a giant plan-and-spec job. Instead, however, the Navy was looking for something better. With budget constraints and an eye toward getting more bang for the buck, the Navy decided to award the contract on a "best value" basis rather than on the traditional low bid.

The U.S. Naval Measurement Laboratory is a new 39,000 sq.ft. facility with very exacting environmental requirements — constant temperatures maintained within ±0.5F from floor to ceiling.

A Design/Build Contest

The field of contractors was narrowed to four general contractors who were asked to put their best ideas forward. The four generals and their teams were then asked to come up with the preliminary designs, with the winner being the team that provided the best design as well as the best value, including building size, amenities, and cost.

A key issue for the customer was the distribution of sensible heat load-producing equipment in the lab. A.O. Reed's solution: to locate this equipment around the exterior wall so some heat went directly to the low wall returns.

One of the general contractors, Erickson-Hall Construction Co., decided the mechanical system would best be designed by a local San Diego contracting firm, with which they'd done business in the past — A.O. Reed and Co.

A.O. Reed, which was founded in 1914, targets the HVAC and plumbing / process piping needs in the commercial, industrial, and institutional marketplace. Vice President of Project Planning and Business Development, Les Osterberger headed up the A.O. Reed mechanical system design team and was responsible for ensuring that the U.S. Navy and Erickson-Hall's expectations were realized.

Osterberger explains that A.). Reed had a great foundation with which to work. "We've worked closely with Erickson-Hall on many laboratory jobs. mostly in the healthcare industry."

Becasue the mesurement lab was somewhat different, Osterberger says that the owner (the U.S. Navy) developed a very detailed project program, which was used by the team in the project design and construction process.

"A.O. Reed has a complete in-house engineering capability," he says, "but this particular project required a design consultant with previous Measurement Laboratory experience. For that reason, we hired San Diego-based LSW Engineers to help us."

Another member of A.O. Reed's team was a company called Control Solutions; a company that Osterberger says is internationally recognized for designing and building of laboratories for metrology. He adds that Control Solutions brought the experience needed to properly commission this technically challenging project.

"Traditional comfort heating and cooling weren't the main objective," he explains. "Precise temperature control to within ±0.5F and humidity control of ±5% were required by the laboratory equipment," he says.

Control Strategies

LSW Engineers developed control strategies for the research facility. LSW Project Manager Larry Brooks says he felt that by using computer-based direct digital controls, and precision sensing and monitoring equipment, the ±0.5F temperature and ±0.5F humidity criteria could be easily met.

He adds, "There was a need for staging the cooling and heating for in-

CATEGORY D

New Construction More than $500,000

WINNER AT A GLANCE

Project Name/Location
U.S. Navy Measurement Lab,
San Diego, CA

Key Customer Contact:
Jennifer Liamas-Rubio,
project manager
David Marcroft,
Laboratory Manager

Nomination Submitted by:
Les Osterberger
vice president, A.O. Reed & Co.
San Diego, CA

THE PROJECT TEAM:

At U.S. Navy Measurement Laboratory
- Jennifer Liamas-Rubio, project manager
- David Marcroft, Laboratory Manager

At A.O. Reed & Co.:
- Les Osterberger, vp project planning/ business development
- Thomas Schodorf, project manager
- Don Williams, piping superintendent
- John Stotz, piping foreman
- Dennis Murphy, sheet metal superintendent
- Dan White, sheet metal foreman
- Jim Henderson, project estimator

At Erickson-Hall Construction (general contractor)
- Michael Hall, project executive
- Randy Hinkle, project manager

At Architects Larsen-Carpenter:
- Chris Gedrose, project architect

At LSW Engineers (mechanical engineers)
- John Littrell, principal
- Larry Brooks, project manager

At Control Solutions (Controls contractor)
- Doug Cooper, project manager

CATEGORY D: New Construction More than $500,000

PROJECT-AT-A-GLANCE

SYSTEM DESCRIPTION:

Like many things that have to do with the military, measuring the efficiency of weapons is a closely guarded secret. The facilities necessary to carry out those measurements require the utmost precision with regard to the maintenance of temperatures humidity within the structure and in the testing labs themselves.

Such is the case for the **U.S. Navy Measurement Laboratory**, located in Corona, CA. The lab is part of the Naval Surface Warfare Center (NSWC), which serves as the U.S. Navy's technical authority for test, measurement, and calibration requirements.

The basic challenge of the project was to design and build a sophisticated environmental system within strict funding limitations. This project consisted of a 39,000 sq. ft. single-story building — including laboratories, administrative, and warehouse space —, which the Navy will use as its primary Measurement Laboratory.

The purpose of this building was to provide critical measurement analysis of numerous top-secret military weapons and related devices. Activities in the lab required very precise temperature and humidity control so that the tolerances in thousandths of an inch could be maintained, measured, and used on the development of military hardware. To take such precise measurements, the laboratories must be maintained at a constant temperature with only ±0.5F from the floor to the ceiling.

This contract was awarded by the government on a "Best Value" basis rather than the lowest bid. The general contractor, Erickson-Hall asked **A.O. Reed & Co.** to be part of its team as the Design/Build mechanical contractor. A.O. Reed took the job and sought outside expertise in designing for a precision laboratory like the Measurement Lab. They brought onboard LSW Engineers to perform this function.

The mechanical system cost was $1.46 million and A.O. Reed paid close attention to laboratory equipment loads and air distribution — including laminar flow ceiling supply air and a low wall perimeter return air system.

PRODUCTS KEY TO SUCCESS

- Air Handlers - 20 Trane 4-pipe constant-volume air-handling units were used to maintain strict temperature and humidity requirements
- Chillers - Two York 135-ton air-cooled chillers provide comfort cooling and redundancy to the overall system.
- Boilers - Two Laars heating hot water boilers are used for space heating.

dividual labs to hold very precise temperature and humidity limits simultaneously. A chilled water system with variable pumping was used to supply each air handler with cooling. An extremely high air exchange rate was accommodated using face and bypass dampers. This avoided excess re-heating."

In addition, Brooks says the final temperature set point was achieved with precision electronic-controlled electric heat in response to a grid of space thermostats. Precision humidity control is achieved by overriding the face / bypass dampers in response to a space humidity sensor.

Meeting the Customer's Needs

Erickson-Hall brought its full Design / Build team to the table, and the U.S. Navy awarded the contract for the Measurement Laboratory to them. The mechanical cost of the project was $1,460,000.

From that point on, the mechanical system design and installation was completely in the hands of A.O. Reed and Co. Key to Osterberger's team was Project Manager Thomas Schodorf. Schodorf worked closely with A.O. Reed's project estimator, Jim Henderson, to make sure the project estimate, with regard to the schedule, manpower, large equipment purchases and delivery, and overall costs remained on target.

"Schodorf also prepared all construction document submittals," Osterberger adds, "and issued the subcontracts, coordinated information."

According to Schodorf, efficiency was certainly one of the customer's key requirements. "From an energy efficiency standpoint, our face and bypass control strategy also aided in reducing power consumption," he explains. "Competing designers were bidding 300 tons of cooling, while we found we could achieve equal results using just 134 tons. The outcome was a considerable reduction in energy use, with a very favorable life cycle cost."

In addition to energy efficiency, the team handled indoor air quality (IAQ) and environmental impact issues through the design of the system. IAQ quality was quite high because of the aforementioned airflow exchange rate and the extensive use of 99.97% HEPA filtration. According to Osterberger, his team's designs minimized any impact to the environment by using high efficiency motors and precision temperature control systems.

Two 135-ton chillers were used to provide the Naval Measurement Lab comfort cooling and system redundancy.

An additional issue A.O. Reed faced was the distribution of the sensible heat load-producing equipment in the lab. This equipment was located around the exterior wall, allowing a portion of the heat to go directly to the low wall returns and not affecting the space sensible control load. Osterberger explains that a sophisticated psychometric analysis was developed to ensure that all conditions were met.

The Metrology of Commissioning

One of the main requirements of the project was the thorough commissioning of the mechanical system. "Commissioning a system of this size and nature requires some serious metrology of our own," Osterberger explains.

With this in mind, the system design was based on achieving the certification objectives. Control Solutions was responsible for the control system design / installation and certification process. A.O. Reed and Control Solutions coordinated with the general contractor to ensure proper wall and roof system design because the walls and roof were integral to the environmental system.

According to Control Solutions Project Manager Doug Cooper, commissioning consisted of seven tests conducted on each lab for a duration of three days per lab.

"The most comprehensive testing was the temperature test," he says. "We used instrumentation that's calibrated in a NIST traceable procedure that includes a temperature bath, electronic super thermometer, data logging instrumentation, and a NIST calibrated super platinum resistence thermometer (SPRT).

"The total expanded uncertainty of the temperature test gear was ±0.0005C," Cooper says.

He explains that the test gear consisted of a calibrated data logger and sensor array. At least 12 sensors were installed at various elevations and locations in each lab. In essence, the entire lab environment was "mapped" to verify compliance with the temperature specification. After the temperature test, the remaining six tests were conducted with instrumentation traceable to NIST.

"We then produced a comprehensive report detailing all tests and their results, which was delivered to the Navy. The test results exceeded their expectations and specifications, and they accepted the metrology lab without further testing."

Says Osterberger, "The success of this project is attributable to an excellent team of highly experienced members consisting of the owner, general contractor, architect, and mechanical consultant. Each team member is well-versed in the the Design / Build project delivery method and this project demonstrates how that method works best." ■