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**FINAL REPORT**  
**UNIDO CONTRACT NO. 89/152/SM**  
**BHEARI AIR CONDITIONER TEST FACILITY**

**SUBMITTED BY:**

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**OCTOBER 27, 1992**

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## **INTRODUCTION**

We will discuss the conclusion of the BHEARI ROOM AIR CONDITIONER TEST FACILITY project in terms of: schedules, activities, the resolution of design problems, the completion of the acceptance and training procedure and the outlook for BHEARI's ongoing use of the test facility.

## **BODY**

### **ENGINEERING COMMENTS**

The Project involved the design and construction of a balanced ambient room air conditioner calorimeter test facility to be utilized by the BEIJING HOUSEHOLD ELECTRIC APPLIANCES RESEARCH INSTITUTE, located in Beijing, China.

Although ETL had previously designed and constructed several other similar test facilities, this facility presented some challenges which were new and unique to ETL's engineering staff.

### **SPECIFIC DESIGN CHALLENGES**

- BHEARI had already constructed the space into which the test facility was to be placed, including a pit in the floor of the space to be utilized as part of the insulating air space which surrounds the insulated test room. Fitting the test room, the control room, the reconditioning equipment and the required free working space into the previously constructed space presented a challenge.
- BHEARI required the test facility to be able to test an extremely wide range of air conditioning capacities. Designing a test facility to meet the lower two-thirds of the capacity range, or the upper two-thirds would not have presented a major challenge. Stretching the capacity range of the facility to cover the entire specified range required some unique solutions.
- BHEARI required complete automation of the facility humidification system, including computer acquisition of the precise amounts of water used by the steam generation system. This project represented the first time ETL has implemented such a humidification system in a test facility.

- Limitations on the cost of the test facility require the use of a PC compatible computer system for system control and operator interface. Previous ETL calorimeter designs had used a mini-computer for this level of automation.
- The usage of PC compatible automation introduced a new range of implementation problems and limitations which needed to be overcome. Using the latest available PC technology, these implementation problems were minimized.
- The extremely limited space available for the test facility control room presented a challenge to ETL's engineering staff. The resolution to this challenge actually yielded a control system which we believe will improve reliability, reduce maintenance, and which presents an improved portrayal of system status and testing results to the operator.
- The system user, BHEARI, tended to require significantly more detail concerning site preparation information than ETL encountered in previous client projects. We believe this to be due to cultural differences and logistical concerns. ETL's excellent rapport with the BHEARI staff worked to minimize any problems associated with this situation. While we were unable to provide detailed and specifically design related information such as supply wire sizes and water piping diagrams at a point one month after the program start, as BHEARI wanted, we were able to issue updated drawings which incorporated this detailed information as soon as it was practical to do so. Utilizing this method we were able to avoid issuing corrections to prematurely furnished erroneous data.

## **PROJECT HISTORY AND COMMENTARY**

The Project was essentially tracking to the originally proposed schedule up to the point of delivery of the materials to the site in Beijing, Peoples Republic Of China. The shipment, originally scheduled to leave the United States in August of 1990, actually left the port of New York during September of 1990. Shipment, and clearance through customs in China, which was projected to require 60 days, actually required over 90 days due to a problem clearing customs in China. It was necessary to dispatch Project Manager Louis Fiske to Beijing to assist BHEARI in clearing the shipment through customs.

Upon arrival of the shipment at the project site it soon became obvious that further problems were eminent. Several weeks earlier, ETL had dispatched its construction supervisor to the BHEARI site to supervise BHEARI's construction crew in the construction of the facility, as defined by ETL's proposal and the UNIDO contract. It soon became apparent that BHEARI would not be able to fulfill its construction role, as originally planned. The next twelve months of the project yielded construction progress at a very slow pace, and required ETL to expend approximately 400% more on site labor than was required by the project contract. After several more months of slow progress, the facility construction was finally completed, requiring additional unplanned ETL on site expenditures.

Upon construction completion, in May of 1991, ETL was prepared to proceed with acceptance testing and training, to complete the contract. At this time, BHEARI announced that it was not yet ready to proceed with the final phase of the project, due to the requirement for some other Chinese Agencies to be involved in this phase. In order to minimize the cost overruns involved in this delay, ETL dispatched its personnel back to the U.S.A. to await BHEARI's completion of final preparations for acceptance testing and training.

During the delay period before ETL could return to the project site, ETL presented UNIDO with a request for additional funding, justified by the need for ETL to make additional trips to the site and expend on site labor not provided for in the contract. This request was approved by UNIDO.

During July of 1991, ETL engineers returned to the BHEARI site to perform the acceptance testing and training required by the contract. Upon their return, which was planned to be three to four weeks in duration, ETL encountered numerous problems which caused additional delays. These problems, which included numerous BHEARI utility failures, the failure of a blower motor in the test facility, the failure of one of the ETL standard test units, and a subsequent breakdown of cooperation between BHEARI and ETL, are well documented in ETL's report to UNIDO dated December 31, 1991, and are not expounded upon in this final report.

The problems encountered during ETL's stay at the BHEARI site during the period between July of 1991 and October of 1991 resulted in ETL finally dispatching its engineering personnel back to ETL headquarters to await a negotiated resolution to the situation. ETL issued a report to UNIDO in December of 1991, detailing the situation at BHEARI. It is assumed that the appropriate authorities in Beijing did the same.

## **ACTIVITIES CULMINATING IN COMPLETION**

During late February of 1992, ETL's James R. Williams visited Vienna to meet with Mr. Kohonen of UNIDO in an effort to resolve the situation and complete the project. As a result of continued dialogue between the parties, a plan and detailed schedule of activities was devised and agreed to by all parties. During early August of 1992, a group of ETL engineers returned to the project site in Beijing to complete the acceptance testing and training.

During the interim period between visits, ETL had shipped to BHEARI a replacement Standard air conditioner and a replacement motor to replace the items which had previously failed. Upon returning to the BHEARI site, ETL personnel installed the replacement items and tested the entire system to assure that all subsystems were functional. Upon close inspection of the system computer files, ETL Project Manager, Louis Fiske, found that BHEARI had been using the test facility extensively during ETL's absence. The computer files revealed that over one hundred tests had been conducted by BHEARI between October of 1991 and July of 1992. Clearly, the test facility had been functioning well during ETL's absence, although a review of the test data in the files did show that line voltage problems at BHEARI had been and may continue to be a problem in operating the facility.

During the period between August 10, 1992 and August 27, 1992, ETL completely tested the Calorimeter system, performed all verification tests as required by the contract, and trained BHEARI personnel in performing the specified heating capacity tests as agreed by all parties prior to ETL's return. During this period BHEARI afforded ETL the utmost cooperation and assistance, for which ETL is highly appreciative. These activities culminated in BHEARI signing documents verifying that ETL had fulfilled the requirements of the contract; and ETL supplying BHEARI documents certifying the quality and function of the test facility. Copies of the documents signed by BHEARI are attached to this report.



## **SUMMARY**

UNIDO Contract 89/152/SM was awarded to ETL Testing Laboratories, Inc., in November of 1989. Tests conducted jointly by BHEARI and ETL Testing Laboratories, Inc., during August of 1992 verified the complete functionality of the Balanced Ambient Calorimeter Test Facility which is the subject of UNIDO CONTRACT 89/152/SM. ETL has supplied BHEARI with the complete testing facility, a detailed set of drawings and schematics, the software operating system and application software, manufacturer's documentation for all major purchased items, a complete set of spare parts as specified in the contract and a set of instructions books suitable for use in operating and maintaining the test facility. The project has been completed to the satisfaction of all parties. The Project completion date was August 27, 1992.

## **TERMINAL SECTION**

BHEARI has become quite proficient in the operation of the Balanced Ambient Calorimeter Test Facility, and the facility has proven to be quite reliable. These facts are readily proven by the large number of tests performed by BHEARI during ETL's absence, without help or consultation from ETL.

The key to effective use of the test facility is to use the test results to assist manufacturers in improving the design of their products. Clearly BHEARI, and the Chinese air conditioner industry, could benefit greatly by an increased ability of BHEARI to utilize the results of tests performed to help manufacturers improve their products, and ultimately the function and efficiency of the air conditioners produced in China. The air conditioner industry in China is expanding rapidly to supply the growing internal market. Even a minimal increase in average air conditioner efficiency could save billions of watts of electrical energy in the near future, conserving China's natural resources and helping minimize the need for additional sources of electrical power.

It is recommended that ETL, or another international expert in air conditioners, be contracted by UNIDO to train BHEARI to effectively use the Calorimeter Test Facility to help Chinese manufacturers increase the function and efficiency of their products. This investment could pay back in millions of dollars in energy cost savings for China.