DOE/ER/12982--1

DE93 008292

CONTROL CONSOLE REPLACEMENT AT THE WPI REACTOR

A Report to the Department of Energy

University Reactor Instrumentation Program

RECEIVED
FEB 23 1993
OSTI

DOE Contract No. DE-FG02-90ER12982

DOE Report Number DOE-ER-12982-1

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

MASTER

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

INTRODUCTION

With partial funding from the Department of Energy (DOE) University Reactor Instrumentation Upgrade Program (DOE Grant No. DE-FG02-90ER12982), the original control console at the Worcester Polytechnic Institute (WPI) Reactor has been replaced with a modern system. The new console maintains the original design bases and functionality while utilizing current technology. An advanced remote monitoring system has been added to augment the educational capabilities of the reactor.

Designed and built by General Electric in 1959, the open pool nuclear training reactor at WPI was one of the first such facilities in the nation located on a university campus. Devoted to undergraduate use, the reactor and its related facilities have been since used to train two generations of nuclear engineers and scientists for the nuclear industry. The reactor power level was upgraded from 1 to 10 kW in 1969, and its operating license was renewed for 20 years in 1983. In 1988, the reactor was converted to low enriched uranium. The low power output of the reactor and ergonomic facility design make it an ideal tool for undergraduate nuclear engineering education and other training.

DESCRIPTION

Due to the small scope of the reactor safety system (RSS) at the WPI Reactor and also by utilizing presently used newer nuclear instrumentation, a complete replacement of the control console was achievable with a two-year grant from DOE. The goals of the console replacement project were established once notification of

the grant was received in September of 1991. A new console incorporating modern instrumentation along with the newest components of the original console would be designed, built, installed , and tested within the funds allotted by DOE and while maintaining minimal disruption to the academic programs. The replacement would be done under a 10CFR 50.59 analysis to eliminate need for a license amendment. This constraint along with budgetary considerations would preclude the possibility of replacement with a digital control system.

With the first phase funding from the grant available, a bidding process was initiated with bids eventually received from four firms. In March of 1992, Innovative Control Products (ICP) of East Douglas, Massachusetts was chosen as the general contractor. A contract for the console was finalized two months later, once it became certain the second phase of the funding would be available.

ICP divided the project scope into five parts. The first detailed replacing the existing control cabinet with a custom framed enclosure and replacing the chart recorders, panel meters, contactors, control relays, alarm panel, and all indicators with state-of-the-art components. All electromechanical components would be installed and wired to the existing control logic design. The second concerned the transfer of relatively new components from the old console to the new console. Included were the NIM based high voltage power supplies and start-up instrumentation, a log power/period amplifier purchased under the same DOE grant in 1990, in-house designed and built linear power amplifiers, control

element position indicators, and pool water temperature and conductivity meters. The third specified engineering considerations. A complete CAD package would be provided and include all layouts, material bills, and wiring diagrams employing a comprehensive numbering system for ease of system tracing. The fourth considered field installation, including replacement of all existing wiring from the reactor to the console with a junction box at the reactor bridge for ease of test, replacement, and future enhancement. The last part detailed various upgrades. These included: control element drive motor conversion, rebuilt magnet power supplies, an automatic pool fill controller, a start-up detector drive mechanism, an uninteruptable power supply for the radiation monitors, and an advanced monitoring system.

Among the upgrades to be provided, the advanced monitoring system will significantly enhance the versatility of the reactor as a teaching tool. The system incorporates a microprocessor based programmable logic controller (PLC) to collect control logic and operations status information. This information is then disseminated to an operator interface terminal (OIT) which is programmed to create detailed graphical images and descriptions of all systems in "real-time". In addition to acting as a "simulator" for training, the system may be used for data acquisition of power history or other trending.

Although the system may have been used for initiation of control actions, it was decided to limit the OIT as a monitoring system remote from the control console and avoid the possibilities

of an unreviewed safety question under 10CFR 50.59 and a subsequent license amendment.

RESULTS

During the design phase of the project, a careful review of the project implications was performed using the appropriate guidance[1,2]. It was determined and documented that the console replacement and remote placement of the OIT did not constitute an unreviewed safety question (USQ). Under the three criteria of the USQ, (1) the new system would not increase the probability or consequences of an accident or equipment malfunction since the original redundancy and independence of the channels and subsystems would be maintained, (2) it would not create an accident or equipment malfunction different from those previously evaluated since the console functionality would not change (ie. hard-wired logic relays compared to microprocessor logic) and the OIT would be isolated physically and electronically from the console, and (3) the margins of safety defined in the Technical Specifications would not be reduced.

Additionally, it was determined the WPI Reactor is considered a negligible-risk research reactor[3,4]. Such a reactor would produce no or negligible radiological consequences for a complete failure of the RSS during the most adverse Design Basis Event. As designed and subsequently upgraded, the RSS for the WPI Reactor exceeds the design criteria specified in the Standard for this category of reactor.

Along with ICP personnel, the WPI staff reviewed the design requirements, the eventual design reconfiguration, the system construction, and component documentation. A site acceptance plan was developed to test and document all functional aspects of the console. At this writing, testing of the new console is still in process.

CONCLUSION

Modern equipment is essential to attract students to careers in nuclear engineering and related sciences and to convince them that nuclear technology is vibrant and has growth potential. Academically, training engineers and scientists with the technology of today is far more effective than using the technology of 1959. Just as important, a modern system will help convince our hundreds of yearly visitors that nuclear technology is safe while benefiting society, especially as the nuclear industry prepares to relicense the current generation of power plants and proceeds towards the new generation of nuclear power reactors.

REFERENCES

1. "Guidelines for 10 CFR 50.59 Safety Evaluations," NSAC-125, Nuclear Management and Resources Council (1989).

2. "Quality Assurance Program Requirements for Research Reactors," ANSI/ANS 15.8, American National Standards Institute (1976).

3. "Criteria for the Reactor Safety Systems of Research Reactors," ANSI/ANS 15.15, American National Standards Institute (1978).

4. "Safety Evaluation Report Related to the Renewal of the Operating License for the Worcester Polytechnic Institute Open-Pool Training Reactor," NUREG-0912, U.S. Nuclear Regulatory Commission (1982).

END

DATE
FILMED
5/04/93