THE ENGINEERING DESIGN OF MAN-MACHINE INTERFACE FOR RTS

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ABSTRACT

The purpose of this paper is to present the engineering design of the advanced Man-Machine Interface (MMI) of the Integrated system for Radwaste Treatment and Storage (RTS) facility in Institute of Nuclear Energy Research (INER) Taiwan, ROC. To build the RTS, a multi-function radwaste facility with a total storage of about 10,000 drums, is a five-year project starting in 2000 including intermediate activity waste treatment and combustible waste storage. The completed engineering design of the MMI is based on proven technologies and digital control systems, enhancing the radwaste management efficiency and reliability of operator's performance as well as assuring the dose exposure of personnel meeting the regulation standard. Over past few years, INER has accumulated extensive experience in the area of radwaste treatment and storage. Therefore, we are confident that we will complete this project with fulfillment of the requirements of RTS.

INTRODUCTION

INER has a low-level radwaste (LLW) plant to manage the waste, a large amount of waste come from institutional research activity and others taken over from the nationwide generators, such as hospital, industry, academy, etc. One of the solid waste storage warehouses in plant with 6,000 drums capacity had ever upgraded (1) in a decade. There is a remote operated trolley system employed successfully for drums handling in the warehouse. In recent couple years, for the aims of handling the surface dose rate of the enhancing treatment and storage ability to 20mSv/h, a new multi-function radwaste management facility is being substituted for those three brick wall storage houses. The content of this new RTS facility is listed as follows:

1) Contact handle waste (<2mSv/h) storage, total capacity of about 8,500 drums;

2) 55 gallon waste drum inspection, labeling and assay system;
3) Intermediate activity (>2mSv/h but <20mSv/h) remote handle waste storage, total capacity of about 800 drums;
4) One shielded room served to Mo-99 process liquid waste solidification, and solid waste cut, such as cladding, hull, etc.

The main goals of RTS are operational safety, the radwaste management efficiency, and the reliability of operational performance. To achieve these goals, the centralized MMI (Fig.1.) with integrated operator interface functions will be developed according to the requirements of RTS and the radiation protection plan of INER (2). This MMI design is in fully automatic control and human factor engineering consideration. The key elements of MMI provided the facility' s overall control, display, and alarm equipment are Main Control Room (MCR) complex, characterization system-Waste Drum Inspection System (WDIS), Laser Guide Vehicle (LGV) control system, Radiation Monitoring System, CCTV system, HVAC system, etc.

SYSTEM DESIGN DESCRIPTION

The system design description of MMI is as follows:

1) Main Control Room Complex (Fig. 2.) includes:

- The Computerized Inventory Control System (CICS)

It provides the control, display and alarm functions for the whole facility via Ethernet/TCPIP. By using a graphical operator interface in MCR, it ensures a sub-system overview, including the display of vehicle and layout; the commanding status; system errors and video display of CCTV, etc., as well as to develop a centralized storage management of radioactive waste in CICS. In addition, it provides a graphical view of a storage status, which is represented in charts and databases. As we all know, the quality and reliability of the results of MMI for RTS is directly dependant on the main control software possibilities and performances. By using OLE for Process Control (OPC) technology, we develop the software application in interface of CICS. To interface many complicated sub-systems, RTS demands a different kind of database solution. Also, by using Open Data Base Connectivity (ODBC) as the application-programming interface for database access, and Structured Query Language (SQL) as its database access language, the SQL server provides agility to the data management and analysis. It is a complete database, which will provide powerful, flexible and reliable capabilities, and sure meet the needs of requirements of RTS. This database should be in redundant design, with security protection, user friendly, and easily monitor all information of RTS. Also, the communication network is in dual integrated Ethernet/TCPIP design. As to the UPS, it sustains blackout for 30 minutes to allow database server to store all necessary information immediately. There will be no operational disruption due to facility breakdown and/or maintenance in the automatic CICS.

- The Wide Display Panel

It is a large vertical board, which provides real-time outputs of CCTV and overview of whole facilities conditions, the status of major systems and alarm information for the operating crews.

- The Main Control Consoles (MCC)

It provides all information about control, display, and alarm equipment, such as operating conditions, alarms diagnostics, data logging, RMS and CCTV, for display on the touch-sensitive cathode ray tube (CRT) in the MCC. By using the color-graphic CRT's and fix-position switches on those six workstations in MCC, two operators can control the whole facilities. Moreover, to improve the operation performance, the operator can use one workstation (master) to take care of all major control process of RTS, such as LGV and WDIS. The second workstation (slave) is mainly for backup. The third workstation is to display the dynamic route of LGV; the fourth workstation is to display all information for RMS; the fifth workstation is to display outputs of CCTV; and the last workstation is for data logging. Graphic control on each workstation will have functions including pull down menu & pull up window, event logging and alarm handling.

2) Waste Drum Inspection System (WDIS)

Based on the latest of ANSI standards and safety analysis report (3) of this facility, WDIS will be designed to determine the quantity and type of radioactive nuclides present in a 55 gallon drum containing intermediate activity radioactive solidified waste or dry active waste. Also, WDIS will be capable of identifying the radioactive nuclides in the drum and measuring their activities. All uniform and non-uniform waste is calculated in distribution of nuclides and density. The major components of WDIS (Fig. 3.) are:

- Visual Inspection Station associated to a remote bar code reader, is composed of four color Video cameras, which can capture and determine the contamination activity on the surface of the drum automatically;
- Smear Test Station with a robot manipulator is to measure alpha-beta counting for different samples;
- Tomography Gamma Spectroscopy (TGS) plays the major role of WDIS to measure the content and do the non-destructive assay. TGS is also an advanced, effective, and accurate technique for non-uniform drum inspection to evaluate the radioactive waste content;
- Labeling station with two-dimension bar code;

- Conveying system, including a weighing device and fixed position device. That is designed for transferring the drum from the loading platform to the different positions required by the inspection and measurement cycle automatically;
- An overhead crane system with a remote CCD camera.

The measuring time of WDIS is about 50 minutes. All measuring results of WDIS will be transmitted to database via communication network. To optimize the operation of WDIS with several components, one PC performs the supervision of WDIS, and exchanges all information with CICS in MCR.

3) LGV System

It is one of the most important systems in RTS. Each pallet with six drums is automatically transported by LGV. The steering of LGV is based on laser navigation. Along the route path, there are strips of reflective tape at established positions. The laser-beam sweeps and measures the angles to detective tapes. By using three angles data, the vehicle controller calculates the position and controls the vehicle to follow the desired route (Fig. 4.). There is a Windows NT (NT7000) based program in a PC, which controls the functions of LGV via a radio modem (~2.4GHz), along with the laser scanner, and remote control wireless PTL-Type CCTV installed on LGV, operators in MCR can easily control and monitor the situation of waste storage area. Also, the system incorporates with a PC com-card, which allows connections to the other control equipment; such as I/O units, radio modems etc. A graphical operator’ s interface (C-way) functions as display the vehicles, the path layout, commanding status, and the alarm messages, etc. For unexpected condition, the LGV is equipped with a manual control unit with which operator can execute all functions of the vehicle. If any drum fell down, the rescue forklift can get it back to certain place from the certain path.

4) Radiation Monitoring System

It provides area- and air-monitoring detectors in RTS. All surveillance information over RTS will be displayed in CICS, and transmitted to the HP monitoring center in INER via fiber-optic network. Also all information will be saved into the database of RTS. Besides, there are several hand-foot monitoring systems and personnel dose meters, which can assure the operator personnel dose exposure to meet the regulation standard and keep personnel radiation dose ALARA.

5) The Other Facility: such as Security System, Electric Power System, Fire Protection System,

HVAC System etc. In case of abnormalities, the CICS will receive alarms and can quickly respond to the situation.

SUMMARY

To comply with the guideline of LLW facility establishment (4), Fuel Cycle Management Agent of AEC, ROC already approved the preliminary safety analysis of RTS. Following the concept design (5) of RTS, the engineering design of MMI for RTS is already completed. Now, the RTS facility is under construction and the software programming of LGV is under developing and both are expected to be completed in 2002. The HVAC system and the electric power system will be for open bid shortly. Over the past few years, INER has accumulated a vast amount of experience in the area of radwaste treatment and storage as well as in developing MMI techniques. Following the design procedure of RTS, with the review by many experts and dynamic test, FAT, site test and performance test and special QA program, we are confident that this project will be fulfilled in compliance with the requirements and the goals of RTS, and this experience will be very helpful in the next future in radwaste management on Taiwan.

ACKNOWLEDGMENT

Special thanks to Mr. K.F. Tsai of RTS project manager, Dr. B.L. Pen, Mr. D.P. Wang, L.T. Chou, G.W. Chang for their assistance in the conceptual design of RTS, and to the division of I&C and Chemical Engineering of INER for the fully support.

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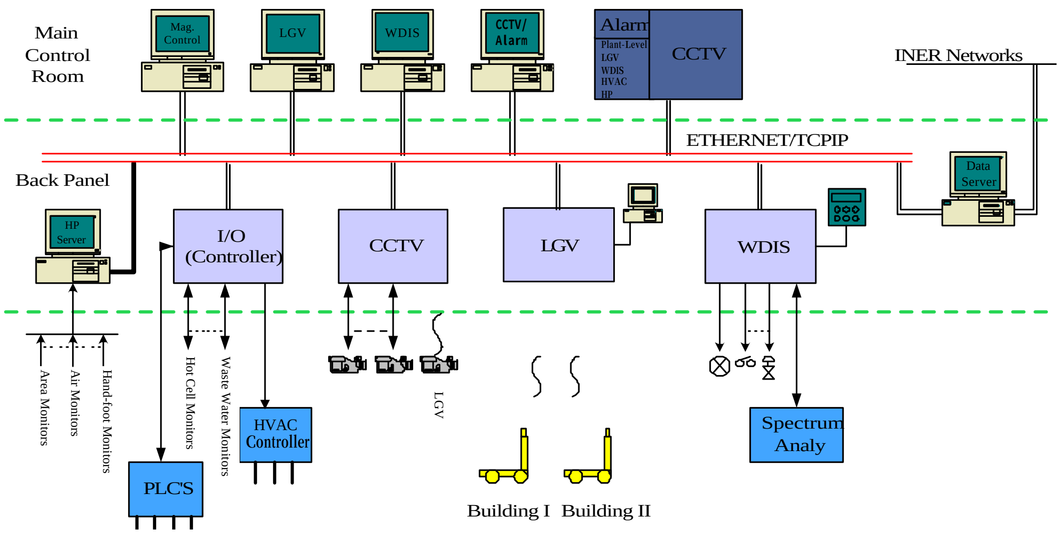

Fig. 1. The system structure of MMI for RTS

Fig. 2. The front view Main Control Room Complex

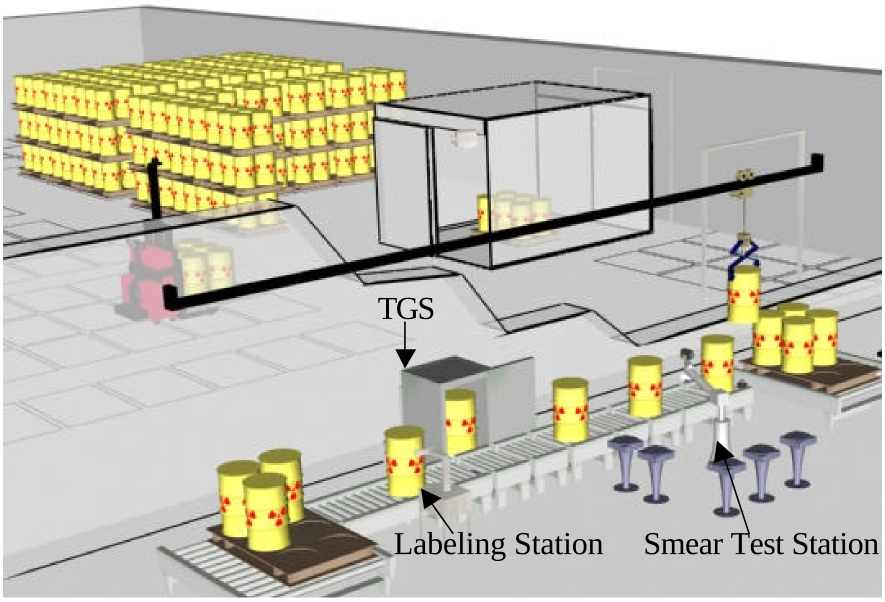

Fig. 3. The major components of WDIS

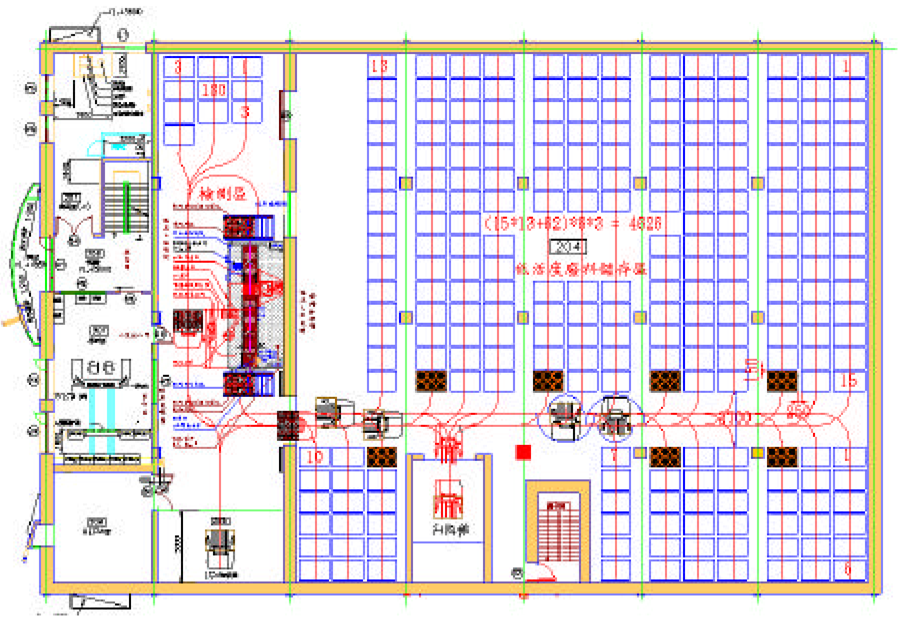

Fig. 4. The path layout of LGV on second floor on RTS