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ENGINEERING DATA TRANSMITTAL

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APPROVED FOR PUBLIC RELEASE

WHC Information Release Administration Specialist:

V.L. Birkland

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April 27, 1995

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7. Abstract This document defines the plan, deliverables, and schedule to develop software for the aging waste tank farm MICON computer control system.		

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8. RELEASE STAMP

SOFTWARE DEVELOPMENT PLAN
FOR THE
241-AY AND 241-AZ TANK FARM
MICON AUTOMATION SYSTEM

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1.0 INTRODUCTION

1.1 PURPOSE

Project W-030 will install a new tank ventilation system for the 241-AV and 241-AZ Tank Farm facilities. The controls for this system will be provided by a MICON¹ Distributed Control System (DCS), which will also be installed by Project W-030. The DCS permits development of the system configuration, sometimes referred to as application software, that will be used to monitor and control plant systems. This document describes the plan for developing the system configuration.

1.2 DEFINITIONS

Application Software

Software designed to fulfill specific needs of a user; for example, software for navigation, payroll, or process control. (IEEE Std. 610.12-1990). For this DCS, applications are the programs and displays created for and/or by the user for the SPARC II workstations and the U-32¹ and RCM-32¹ controllers.

A/S OPEN¹

The brand name of a Distributed Control System supplied by the MICON Company (Powell Process Systems) of Houston, Texas.

A/S VIEW¹

The proprietary operation and configuration software provided by the MICON Company for the MICON A/S OPEN Distributed Control System. This is the user interface software on a SPARC II workstation.

Controller

- [1] Sometimes generically refers to an RCM-32 or U-32 programmable controller (see RCM-32 and U-32).
- [2] Sometimes refers to an analog control device (see PID Controller).

1. MICON, U-32, RCM-32, A/S OPEN, and A/S VIEW are trademarks of MICON-Powell Process Systems, Inc.

Distributed Control System (DCS)

A computer system that divides responsibilities up between several types of computers. This type of system allows one computer to perform control at a local level while networked to others that provide display and control to the operator.

GPLI

The General Purpose Local Area Network (LAN) Interface (GPLI-32) serves as a universal communications interface, or bridge, between the Sun operator/engineer workstations and the field control processors (RCM-32 and U-32).

Group

- [1] A level of access to plant components related to the MICON system. Access levels are defined for each individual or group of individuals.
- [2] Sometimes refers to MICON group displays.

Intelligent Operator Keyboard (IOK)

A dedicated, non-QWERTY keyboard used to access displays on a SPARC II workstation and control plant processes.

Local Area Network (LAN)

A data highway used to pass information between the GPLIs and U-32s. It uses a token-passing carrier-based protocol.

Local Control Unit (LCU)

A process control cabinet containing up to two U-32 controllers, several RCM-32 process controllers, a communications bus, a Local Operator Interface, and miscellaneous hardware (racks, cooling fans, power supplies).

Local Operator Interface (LOI)

A personal computer clone with an amber electroluminescent touch screen display located in the door of an LCU cabinet. The touch screen is visible from the outside of the cabinet. An LOI can display information for signals and tags residing in the LCU. This information is in the form of MICON group displays and simple alarm messages. Graphics cannot be displayed on an LOI.

RCM-32

A multi-loop programmable controller capable of reading real world inputs, providing outputs, processing data, performing continuous PID control, logic control, and limited batch control.

System Configuration

The completed databases which establish a specific control and display strategy on the DCS for the plant.

Tag

A generic term for variables (analog and discrete) defined by the A/S VIEW software and used by the programmable controllers to process input and output data as specified by the executable logic files.

Transceiver

A device which allows ethernet devices to be connected to an ethernet Local Area Network.

U-32

A multi-loop programmable controller with dual network communications capability. The U-32 distributes data between the RCM-32 and GPLI. Like the RCM-32, the U-32 is capable of processing data, performing continuous PID control, logic control, and limited batch control.

2.0 SCOPE

2.1 ENGINEERING TASKS AND OBJECTIVES

2.1.1 PROCESS DESIGN

ICF Kaiser Hanford (ICF KH) will provide the design of the instrumentation and controls for the ventilation system. The design has about 500 hardware input and output (I/O) points and a total of about 2000 to 3000 tags. This design consists of the following elements which shall be implemented under contract as application software for the U-32 and RCM-32 controllers and workstation database:

- **Process and Instrumentation Diagrams (P&IDs)** - These drawings are flowsheet-like representations of the process.
- **Logics** - These drawings represent the interlock and miscellaneous logic for the process system controls.
- **Tag Lists** - These lists contain the information for the I/O signals and intermediate tags, such as virtual discretes, virtual analogs, and internal switches.

2.1.2 PROCESS DESIGN IMPLEMENTATION

The process design media outlined above shall be implemented under contract as application software for the U-32 and RCM-32 controllers and workstation database.

2.1.3 OPERATOR INTERFACE DEVELOPMENT

Westinghouse Hanford Company (WHC) plant engineering or an outside contractor will provide operator interface displays for the SPARC II workstations. Interface displays shall include overview graphics, process graphics, process sub-graphics (tabular list of the current values of all tags in a process graphic), interlock graphics, and loop tuning graphics. Additionally, the scope of this work shall include definition of the annunciator windows, group, trend, history, and Local Operator Interface displays.

2.1.4 SOFTWARE VERIFICATION

Software verification requires preparation and performance of an acceptance test procedure (ATP) which is approved by WHC.

ICF KH or an outside contractor will provide an ATP for verification of the application software. The scope of the ATP shall include the controller programs, database elements, and operator interface displays. The acceptance test will be conducted on the Hanford Site and be

witnessed by the outside contractor of software applications, WHC, and (if needed) ICF KH.

2.1.5 DOCUMENTATION

Documentation of the software acceptance test results will be provided by WHC. After software verification is completed, documentation and management of the software configuration for the control system will be provided by WHC.

2.1.6 OTHER

WHC shall provide a technical liaison to support off-site, contract software development. WHC shall also provide system administration and user definitions for the operator workstations.

2.2 DELIVERABLES

The outside contractor of the applications, together with WHC plant engineering, shall deliver a complete DCS configuration capable of controlling the new aging waste ventilation system. Additionally, documentation shall be delivered as required by WHC-CM-4-2, *Quality Assurance Manual*, QR 19.0, "Software Quality Assurance Requirements". Below is a list of deliverables:

ICF KH:

- Process control system design

Outside Contractor:

- Database for SPARC II workstations
- U-32 and RCM-32 applications software

Outside Contractor or WHC:

- Operator interface displays for SPARC II workstations

Outside Contractor or ICF KH:

- Computer software acceptance test procedure

Outside Contractor, WHC, and (if needed) ICF KH:

- Acceptance testing of application software

MICON-Powell:

- User documentation (manuals)

WHC:

- Computer software acceptance test results
- Computer software documentation
- System security definitions
- User documentation (procedures for the DCS only)
- Computer software configuration management plan
- Computer system operation and maintenance plan
- Computer software requirements specification
- Computer software acceptance test results
- Computer software documentation, including design description

3.0 DESCRIPTION

3.1 PHYSICAL DESCRIPTION

3.1.1 HARDWARE

Figure 1: MICON System Architecture

The MICON A/S OPEN Distributed Control System (see Figure 1) consists of four workstations (3 operator, and 1 engineering), a data highway, and six process controller cabinets (4 LCUs and 2 Remote Control Units).

Each console is a Sun Microsystems Scalable Process Architecture (SPARC) II workstation. Each SPARC II provides a video output, an RS-232 serial port, and two ethernet ports (a thick-net and a thin-net). The video port is connected to a high resolution color monitor. The RS-232 port is connected to an Intelligent Operator Keyboard (IOK). The IOK is preprogrammed by the MICON Company and cannot be changed by the user. The thin-net ethernet port is connected to the data highway via a General Purpose Local Area Network (LAN) Interface (GPLI). The GPLIs pass information between the SPARC-based consoles and the process

control cabinets. The thick-net provides a LAN connection between the four SPARC II consoles via a multiport transceiver.

A process control cabinet, or Local Control Unit (LCU), consists of two U-32 controllers, several RCM-32 process controllers, a communications bus, and a Local Operator Interface (LOI). There are four LCU cabinets, with LCU-3 and LCU-4 each being connected to a Remote Control Unit (RCU). The RCUs (not shown in Figure 1) contain RCM-32 controllers and are connected to the LCUs by an extended field bus. LCU-1 and LCU-2, which are located in separate rooms and separated by a fire barrier, provide for redundancy of safety class 2 controls. Although a U-32 controller can be used to perform control functions, its primary purpose is to pass information along the data highway. Each U-32 has a redundant backup. The RCM-32 controllers perform most of the control and logic functions and provide the wiring terminations for the inputs and outputs to plant equipment. The RCM-32 controllers are not redundant. There are four types of RCM-32s (A, C, D, and Dr) used in this system to handle a variety of analog and digital signals. The U-32s and RCM-32s communicate through a non-redundant field bus. An LOI (not shown in Figure 1) is a personal computer clone with an amber electroluminescent touch screen display located in the door of an LCU cabinet. The touch screen is visible from the outside of the cabinet and can provide operator group-like displays for signals and tags residing in the LCU.

3.1.2 SOFTWARE

Software for the SPARC II workstations consists of four layers. The first layer is the UNIX operating system, and the second is the X-11 windowing system with the Motif (X-Window Motif) graphics user interface (GUI). Both the UNIX operating system and X-Window Motif are provided by Sun Microsystems under the trade name Solaris. The third layer is the A/S VIEW process control software provided by the MICON Company. The last layer is the user configuration, which is a database of all process information that can be displayed and/or recorded by the system.

The U-32 and RCM-32 software consists of three layers. The first is the RTS-C based operating system supplied by the MICON Company. The next layer is the MICON controller program compiler, also supplied by the MICON Company. The third layer is the user configuration program, which is compiled object code. This program is created by the MICON controller program compiler using source code input. The source code, or applications software, is created by the A/S VIEW software in the SPARC II workstations based on user input. The source code is then downloaded over the data highway to the U-32s and RCM-32s, where the source is compiled.

3.1.3 CONTROL SOFTWARE RATIONALE

The overall ventilation control rationale is to start up the ventilation and cooling system with an input command which will activate the proper

sequence to start up the process. Failure of the heater or fan in the on-line ventilation train results in the automatic startup of the backup train.

The process is provided with mechanical redundancy (ie: two filter trains), which are served by redundant control systems in the form of LCU-1 and LCU-2. These two LCUs perform the redundant control functions of the mechanical trains, however, they are not point by point redundant, that is, they are not identical in their connection to the field inputs and outputs. Only the safety class 2 controls (the exhaust fans, filter outlet motor operated valves, and heaters) of the filter trains are redundant within these two LCUs. The inclusion of logic watchdog relays in LCU-1 and LCU-2 allow, to an extent, the controllers of the redundant filter trains to act as a back-up to the controls of the operating train. The meaning of "to an extent" is best revealed by example. For instance, if RCMD 9 in LCU-1 is backed up by RCMD 20 in LCU-2, and if RCMD 9 fails, then RCMD 20 takes over control and each LCU can still control both filter trains. However, if LCU-1 completely fails (ie: fire) or if sufficient RCMs in LCU-1 are failed, then LCU-2 cannot control both filter trains because the controls in LCU-2 are dependent on data from LCU-1 to provide redundant controls to the trains. In this case, LCU-2 can only control the train to which it is dedicated.

3.1.4 SOFTWARE CONFIGURATION PROCESS

Although the configuration of most of the applications shall be performed under contract, except possibly the graphics, a brief description of the configuration process is worthwhile.

The process of setting up the A/S VIEW databases is called configuration and is completed by engineers or technicians. There is usually never a need to provide any programming in the traditional sense. Rarely, if ever, is a computer programmer required. The MICON A/S VIEW software provides all the programming to operate the system, communicate, provide process control, and provide the operator interface. The system only needs to be configured to the application using MICON configuration tools that utilize "fill-in-the-blank" techniques.

Prior to beginning the configuration process, a philosophy of system security is established. Security access levels and breadth of allowed operations are established for the various user groups. The access control programs are pre-existing and are found in the UNIX operating system and A/S VIEW.

Configuration of the U-32 and RCM-32 controllers consists of connecting the inputs and outputs through a series of preprogrammed function blocks. This is done using an A/S VIEW configuration utility. As each function block is called by a user, the utility asks for any information needed to complete the function. All data needed by an operator for monitoring and control are given a unique identifier called a tag. In addition, all display data such as ranges, colors, and descriptions are

assigned during the tagging process. From all of this, A/S VIEW creates a database that it later uses to create the program files for the controllers.

At this point, everything needed for the U-32 and RCM-32 controllers to perform their monitoring and control functions has been completed. All controllers, interlocks, indicators, switches, and alarms have been established. The next step is to create the interface displays that allow operators to interact with these controller configurations.

It is useful to organize the instruments into logical displays and groups to monitor and control the process. In the case of alarm displays and logs, this is done automatically by A/S VIEW. For process control data, however, A/S VIEW offers several different types of displays; group, graphic, annunciator, trends, node status, and LOI. Each type of display, except for LOI displays, can be viewed on a SPARC II workstation color monitor. LOI displays are configured on a workstation then downloaded to an LCU cabinet for viewing on the Local Operator Interface.

The group display is a grouping of up to eight controllers, indicators, and/or switches. The display is pre-formatted, and the user need only fill in the tag names of the instruments to be displayed.

Graphic displays are more of a free form display. Typically, they consist of static and dynamic elements, but may be entirely static as in the case of certain menu or information displays. The user tells the system where process data is to be displayed by specifying the screen location and the tag name of the data. The A/S VIEW software creates a display database from the user's data that it then uses to create the displays.

An annunciator display provides a method of relating alarms to graphic displays. This provides operators quick and easy access to a graphic to determine and diagnose alarms when they occur. Typically, tags are organized into logical groups relating to the plant. The annunciator display is a pre-formatted grouping of 40 windows, and a user can assign up to 24 tags to each window. The user need only select a window, name it, name the associated graphic, and assign tags to the window.

Trend displays are pre-formatted and show the values of analog and digital signals over time. The user arranges signals into groups to be displayed and assigns names to each trend group. Then the user need only fill in the tag names of the instruments to be displayed.

Node Status displays the status (on-line or off-line) of system components. It is pre-formatted, and the user need only select the controllers to be monitored. The LAN Manager utilities are used for this.

LOI displays are pre-formatted, look similar to group displays, and are configured the same way. They are downloaded to the LCU cabinets to provide operators with local monitoring and control functions.

At this point everything needed for monitoring and control has been completed. All controllers, interlocks, indicators, switches, and alarms have been established. In addition, all operator interfaces to the data, signals, and controls have been developed.

3.2 ENGINEERING TASKS

ICF KH shall provide the design for the ventilation system controls. Application software implemented by the outside contractor for the database and U-32 and RCM-32 controllers will be based on this design. The outside contractor or WHC plant engineering shall develop the operator interface displays. The ATP shall be prepared by the outside contractor or ICF KH. The acceptance test will be conducted on the Hanford Site and be witnessed by the outside contractor of software applications, WHC, and (if needed) ICF KH. WHC plant engineering shall document, and manage the system configuration for the MICON distributed control system.

3.3 VERIFICATION

3.3.1 COMMERCIAL SOFTWARE

A Factory Acceptance Test (FAT) of the MICON A/S OPEN DCS, running A/S VIEW revision 2.4.0, was performed prior to its shipment from Houston, Texas in August of 1993. Several eeprom and A/S VIEW updates have been received since then. Therefore, the scope of the Site Acceptance Test (SAT) shall be equivalent to or greater than a typical factory test.

The SAT shall be conducted according to pre-approved procedure, which shall be prepared by the MICON Company and approved by WHC. The MICON Company shall also provide completed test records.

3.3.2 APPLICATION SOFTWARE

All software will be verified by testing, which will involve hardware and/or software simulation of signals. Software acceptance testing shall be jointly conducted by WHC plant engineering and the outside contractor of applications. The acceptance test shall be witnessed, as a minimum, by WHC Quality Assurance. The MICON DCS will be staged in the 305 Building in the 300 Area where most of the software verification will be conducted. Depending on W-030 Project schedules, some testing may need to be completed in the 200-East Area after the DCS is relocated to the new Tank Farm control room. A supporting document containing the test records shall be produced upon completion of the software acceptance testing.

Documents will be reviewed and approved according to approval designator. Configuration verification shall be in accordance with WHC-CM-6-1, EP-4.1, "Design Verification Requirements", and WHC-CM-4-2, QR 3.0, "Design Control".

3.4 PROCUREMENT TASKS

The MICON A/S OPEN DCS was purchased as part of Project W-030. In addition, procurement of engineering services to construct the database, controller programs, and/or operator interface displays from Project documentation (P&IDs, logic drawings, tag lists) shall be required to meet Project milestones.

3.5 INSTALLATION TASKS

Project construction forces will perform hardware installation, which is not part of this plan. The software configuration installation shall be performed by WHC plant engineering.

3.6 PRE-OPERATIONAL AND OPERATIONAL TESTS

WHC plant engineering shall perform configuration acceptance testing per WHC-CM-6-1, EP-4.2, "Testing Requirements". Operational testing is not covered by this plan, but shall be conducted by WHC Projects per WHC-CM-6-1, EP-4.2, "Testing Requirements".

Training of process engineers will be provided by WHC plant engineering personnel. This training will familiarize process engineers with the hierarchy and use of video displays. Operator training is not covered by this work plan.

4.0 ORGANIZATION

ICF KH shall design the logic and controls. WHC Projects has responsibility for providing overall management of the W-030 Project. The applications software will be jointly developed by an outside contractor (to develop the database, controller programs, and/or operator interface displays) and by WHC plant engineering.

5.0 SCHEDULES

Table 1 shows the tasks necessary to allow Project W-030 to proceed past November 1, 1995.

Table 1. MICON Configuration Schedule

ITEM	DESCRIPTION	DUE DATE
1	Complete ICF KH design (P&IDs, logics, tag lists)	3-1-95
2	Complete database and controller programs	7-31-95
3	Complete graphics	7-31-95
4	Issue approved software ATP	7-15-95
5	Start software ATP at 305 building	8-1-95
6	Complete software ATP	10-1-95

6.0 COST ESTIMATE

The capital cost estimate for the DCS is described in the Project W-030 engineering study (WHC-SD-W030-ER-003) and is not part of this plan.

7.0 QUALITY ASSURANCE

Approval designators are assigned per WHC-CM-3-5, *Document Control and Records Management Manual*, Section 12.7, "Approval of Environmental, Safety, and Quality Affecting Documents". The ventilation system and DCS contain Safety Class 2 controls per the functional design criteria (WHC-SD-600-FDC-001). Therefore, initial release documentation of the

RCM-32 and U-32 configurations, tag data, and group and graphic displays shall require Safety and Quality Assurance approvals. Additional requirements are described in WHC-CM-4-2, QR 3.0, "Design Controls".

8.0 REFERENCES

- WHC-CM-3-5, *Document Control and Records Management Manual*
 - 12.7 "Approval of Environmental, Safety, and Quality Affecting Documents"
- WHC-CM-3-10, *Software Practices*
- WHC-CM-4-2, *Quality Assurance Manual*
 - QR 3.0, "Design Control"
 - QR 19.0, "Software Quality Assurance Requirements"
- WHC-CM-6-1, *Standard Engineering Practices*
 - EP-4.1, "Design Verification Requirements"
 - EP-4.2, "Testing Requirements"
- WHC-SD-600-FDC-001, "Functional Design Criteria, Project W-030 Tank Farm Ventilation Upgrade"
- WHC-SD-W030-ER-003, "W-030 Tank Farm Ventilation Upgrade"