Waste Monitoring System for Effluents

Los Alamos
NATIONAL LABORATORY

*Los Alamos National Laboratory is operated by the University of California
for the United States Department of Energy under contract W-7405-ENG-36.*

Edited by Vaikunth M. Stewart, Group CIC-1

An Affirmative Action/Equal Opportunity Employer

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither The Regents of the University of California, 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 Regents of the University of California, 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 Regents of the University of California, the United States Government, or any agency thereof.

DISCLAIMER

Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.

Waste Monitoring System for Effluents

J. M. Macdonald

B. Gomez

L. Trujillo

J. E. Malcom

H. Nekimken

N. Pope

R. Bibeau

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

W

Los Alamos
NATIONAL LABORATORY

Los Alamos, New Mexico 87545

MASTER

CONTENTS

ABSTRACT.....	1
I. INTRODUCTION.....	1
II. HISTORY.....	5
III. SYSTEM DESIGN.....	6
A. Methods.....	6
B. Hardware and Software.....	9
C. Phase Implementation.....	13
D. Technical Considerations.....	13
E. Conclusions.....	14
IV. SUMMARY.....	16
REFERENCES.....	17
APPENDIX A: INSTRUMENTATION AND EQUIPMENT LIST.....	19
A. Hardware.....	20
B. Software.....	20
APPENDIX B: TRENDING SCREEN EXAMPLES.....	23
APPENDIX C: SIXNET waste.txt FILE.....	27
APPENDIX D: LSO CONFIGURATION waste.cfg FILE.....	31

WASTE MONITORING SYSTEM FOR EFFLUENTS

by

J. M. Macdonald, B. Gomez, L. Trujillo, J. E. Malcom, H. Nekimken,
N. Pope, and R. Bibeau

ABSTRACT

The waste monitoring system in use at Los Alamos National Laboratory's Plutonium Facility, TA-55, is a computer-based system that provides real-time information on industrial effluents. Remote computers monitor discharge events and data moves from one system to another via a local area network. This report describes the history, system design, summary, instrumentation list, displays, trending screens, and layout of the waste monitoring system.

I. INTRODUCTION

The Nuclear Materials Technology process control team at Los Alamos National Laboratory's Plutonium Facility, TA-55, has developed a waste monitoring system (WMS) for obtaining real-time information about its effluents. The WMS monitors the caustic, acid, and industrial waste pipes that leave the facility. Waste pipes are also monitored as they leave the 100, 200, 300, and 400 areas of building PF-4 at TA-55. Parameters monitored in these waste lines are flow rate, temperature, and gamma-radiation level. The system became functional in January 1994 and is evolving into a larger system. Major topics that this report will explore are the experiences and practical lessons learned from developing this system.

The WMS is located in the basement of TA-55 and by May 1994 had 30 point sensors that monitored temperatures, gamma radiation, and flow rates at 10 locations. Figure 1 is a computer screen display of the system showing the general locations of the sensors. Sensors are strategically placed to allow monitoring personnel to determine the points of origin of waste within the facility. Adding further sensors to the system will allow more detailed tracking of wastes. A very important attribute

of this system is its ability to store all sensor information as computer files for historical archiving. These files provide documentation of compliance and would be useful in the event of any future audits.

Fig. 1. WMS display screen showing sensor locations.

At the heart of the WMS is a computerized supervisory control and data acquisition (SCADA) system. The SCADA system is designed to accomplish the following three primary tasks:

1. provide an interface to WMS sensors
2. record and display data
3. distribute data to other locations via a local area network (LAN).

One benefit resulting from the WMS is the collection and storage of waste discharge information. The system monitors remote contributions to the effluent flow in real-time. The documentation of historical information (Fig. 2) allows management and users to determine the time and date a discharge occurred. This provides crucial plant management and accountability records.

Fig. 2. Printout of effluent data, showing color-coded distributions of measured parameters with time.

Fig. 3. Computer screen display of effluent data, showing color-coded distributions of measured parameters with time.

II. HISTORY

TA-55 became operational in 1978. An internal audit conducted in September 1991 pointed out the need for developing a WMS for the facility. In 1991–92 the Nuclear Materials Processing Group for Nitrate Systems (NMT-2) spearheaded an effort to install sensors on the waste lines at TA-55. Temperature, flow, and gamma radiation were selected as the parameters that would have the highest probability of detecting a discharge. Originally, sensors passed their signals to a chart recorder for permanent historical recording. The chart recorder was located in the basement of TA-55.

Today, with the completion of the WMS, a user with a networked desktop computer can monitor the sensors, the integrity of the system, and historical records of all past sensor readings, both as raw data and in graphic form. Users may perform many additional analyses of waste discharges that were impossible to perform before the installation of this system. Reliability, ease of use, and historical archiving were improved with this system, and real-time monitoring of multiple sensors was introduced. The present WMS eliminates paper chart recording and supports sitewide efforts toward a paperless work environment.

III. SYSTEM DESIGN

A. Methods

The nucleus of the WMS is a SCADA system computer (Fig. 4) that executes commercial human/machine interface (HMI) software. The HMI software interacts with a Digitronics SIXNET I/O data acquisition and control system. Gamma radiation sensor signals are collected in the instrumentation in the secondary rack that houses data collecting equipment.

The SCADA HMI also provides an interface between the system hardware and the user. A commercial HMI software package is used on an IBM personal computer that uses an Intel 80486 central processing unit and the OS/2 2.1 operating system. The real-time process parameters displayed are of gamma radiation, flow rate, and temperature. Data are periodically archived to computer disks and backup tapes. The OS/2 2.1 multitasking computer operating system simplifies configuration tasks because different computer operations can be performed simultaneously. The SIXNET data acquisition and control system collects signals at two junction boxes (Fig. 5) from flow sensors, gamma radiation sensors, and type-J thermocouples.

Fig. 4. The SCADA system computer (with the gamma rack in the background).

Fig. 5. One of two junction boxes for collection of signals from the sensors.

Sixty-four channels of input are presently available in the system. Thirty channels are currently used to collect signals from the sensors (Figs. 6 and 7), leaving thirty-four channels unused. These unused channels will allow future growth of the system.

Fig. 6. Three flow sensors and three gamma radiation sensors. The gamma sensors hang from the pipes to the right; the flow sensors are the smaller units strapped to the pipes.

Currently, the WMS is only capturing and archiving sensor data. In the near future, an expansion of capabilities to allow grab-sampling of waste streams is envisioned. Valves would be controlled with the HMI software.

The WMS has the capability to set up alarms for discharge events. The developer or user can set up alarms that perform certain functions (such as dial a personal pager or close valves) and emit audible warnings at remote computers running the HMI software.

Fig. 7. A type-J thermocouple lies against a pipe at the top of this figure, which also shows a flow totalizer and one of the valves that might be automatically controlled in future versions of the WMS.

Engineering challenges to the TA-55 WMS included the exposure of the SCADA system to the vibration, dust, and hazards of an industrial situation. One extreme problem faced by people in the basement of TA-55 is the high ambient noise level; hearing protection must always be worn when working there. The SCADA system is housed in an environmental protection rack that is bolted to the basement floor to protect the system if an earthquake should occur. Cooling of the SCADA system rack has not been required, but in another system located in the same facility, computer displays have malfunctioned, probably as a result of heat stress.

Data collected by the SCADA computer are transferred to other computers via an Ethernet LAN. The Large System Onnet (LSO) program from Heuristics transports information stored in the HMI internal database and allows any other computer running the same software to receive the data. Live process data are viewed using the same formatted HMI displays across the network (Figs. 1, 10, and 11 are examples of these displays). The option exists for users to customize their displays, but the maintenance involved in supporting multiple computers using different displays can rapidly become prohibitive. In the TA-55 WMS we recommended using the standard display screens, but we encouraged users to modify the trending screens to allow them to view the process information in the form that best suits their needs. Appendix B and Fig. 3 show examples of the available trending screens.

Fig. 8 is a system block diagram that shows the various components of the TA-55 WMS.

Fig. 8. System block diagram arrows indicate data flow.

The fundamental components of the system are the temperature, flow, and gamma radiation sensors, which collect readings that are forwarded to the SIXNET I/O data acquisition and control system. IOTEST and MUXINT are software used to configure SIXNET. The data from the sensors are then directed to the SCADA system, which converts the data to engineering units and stores them as a computer file. ONSPEC is the HMI software and the main controlling software on the SCADA node. The SCADA computer can also download configuration programs to the data acquisition system. Through the LAN, remote monitoring stations are able to access the information contained on the SCADA node and can receive updates across the network as often as every second.

B. Hardware and Software

The following sensors were selected for the WMS:

1. Type-J surface-mount thermocouple temperature sensors that indicate chiller or steam activities in the plant,
2. 4–20-mA ultrasonic flow sensors that indicate discharge activities, and
3. 0–10-Vdc NaI sensors that detect gamma radiation from radionuclides.

Data are acquired through the two networked SIXNET I/O hardware devices, which have all sensors connected to them. The Digitronics SIXNET system is a general data acquisition tool configured to accept several signal protocols, including 0–5 Vdc, 4–20 mA, 0–10 Vdc, and 120 Vac. Up to 64 separate analog signals can be collected. The types and ranges of the signals are user-selected by switch settings or through software. SIXNET remote units communicate with a coprocessor adapter in the computer by a simple two-wire network link.

The SIXNET hardware configuration programs IOTEST and MUXINT reside on the SCADA computer and are used to configure the SIXNET data acquisition system. These programs are used at system start-up and for troubleshooting diagnostics of the SIXNET system. The menu-driven utility IOTEST starts SIXNET each time a user powers up the system. IOTEST can also be used to quickly determine if the user is receiving data from the sensors. A second software utility, MUXINT, is used to configure the 60-IOMUX data collection units, which are part of the SIXNET system.

Data sent to the computer from SIXNET are converted into a format that the HMI software can use through a separate program (the device I/O driver). The algorithm to convert the data into a particular range or engineering unit resides in a text

file that can be modified as required. Additional configuration information about the hardware and the timing of the data acquisition are also stored in this file. A sample file, waste.txt, can be found in Appendix C. The device I/O driver converts the raw data into standard engineering units and places the information into the HMI internal database.

The HMI internal database resides in the volatile memory of the computer. The person configuring the database usually associates a tag name with the value received from SIXNET. This provides easy reference to the data points. For example, EUR400 from SIXNET is given a tag name of AT34D11 in the HMI software. An acid temperature sensor, on the 300/400 waste line, located at column D11 in the basement, is called AT34D11. An eighth character position exists for the reference signal that is used in gamma-sensor calibrations. Figure 9 shows a breakout example of this tag name.

Fig. 9. Tag name breakout example.

It is extremely important to reserve a block of parametric numbers for the automation of multiple processes, and it is recommended that the developer clearly assign a specific range of values to this particular process. In the WMS, all engineering units real (EUR) HMI data table values are assigned numbers in the range from 400 to 599 as indicated in the waste.txt file in Appendix C. This approach is highly desirable, especially if there are additional processes that will be running on the remote systems. Conflicts and confusion would certainly arise if these same EUR numbers were used by another process.

Displays 32 and 33 (Figs. 10 and 11) are diagnostic screens that quickly summarize the sensor readings. These two screens were more heavily relied upon when the system was first installed. They are still used today to provide a quick cross-reference between tag names and I/O driver values.

NMT-2 ONSPEC			
Switch	Commands	Run	Link
?	32	SELECT DISPLAY	MORE
AIN#0 22.9 EUR400 AT34D11	AIN#0 17.1 EUR408 XTXXXX	AIN16 8.8 FLOW 01 EUR416 AF34D11	AIN24 8.8 FLOW 09 EUR424 XFXXXX
AIN#1 20.7 EUR401 AT34D07	AIN#9 17.6 EUR409 XTXXXX	AIN17 8.1 FLOW 02 EUR417 AF34D07	AIN25 8.8 FLOW 10 EUR425 XFXXXX X
AIN#2 25.3 EUR402 IT34D07	AIN10 17.4 EUR410 XTXXXX	AIN18 8.1 FLOW 03 EUR418 IF34D07	AIN26 8.8 FLOW 11 EUR426 XFXXXX
AIN#3 20.7 EUR403 CT34D07	AIN11 17.4 EUR411 XTXXXX	AIN19 5.9 FLOW 04 EUR419 CF34D07	AIN27 8.8 FLOW 12 EUR427 XFXXXX
AIN#4 18.8 EUR404 AT12E06	AIN12 17.3 EUR412 XTXXXX	AIN20 1.9 FLOW 05 EUR420 AF12E06	AIN28 8.8 FLOW 13 EUR428 XFXXXX
AIN#5 18.5 EUR405 IT12E06	AIN13 17.6 EUR413 XTXXXX	AIN21 8.8 FLOW 06 EUR421 IF12E06	AIN29 8.8 FLOW 14 EUR429 XFXXXX
AIN#6 18.9 EUR406 CT12E06	AIN14 17.4 EUR414 XTXXXX	AIN22 8.1 FLOW 07 EUR422 CF12E06	AIN30 8.8 SPARE EUR430 XXXXXX
EUR407 XTXXXX	EUR415 XTXXXX	EUR423 XFXXXX	
AIN#7 17.3 EUR407 XTXXXX	AIN15 17.4	AIN23 8.8 FLOW 08	AIN31 21.7 AMBIENT
00:12:15 51 DOMAIN DOMAIN CONTROLLER 1 CON OK 500059			

Fig. 10. Display screen 32.

NMT-2 ONSPEC			
Switch	Commands	Run	Link
?	33	SELECT DISPLAY	MORE
AIN#0 381GAMMA 01 EUR465 IGEX17A06	AIN#8 820GAMMA 09 EUR473 AG34D07R	AIN16 807GAMMA 17 EUR481 CG12E06R	AIN24 20.5 25 EUR489 ATEXA06
AIN#1 628GAMMA 02 EUR466 IGEX68A06	AIN#9 558GAMMA 10 EUR474 AG34D07	AIN17 228GAMMA 18 EUR482 CG12E06	AIN25 22.5 26 EUR490 ITEXA06
AIN#2 8GAMMA 03 EUR467 XGXXXX	AIN10 1020GAMMA 11 EUR475 CG34D07R	AIN18 658GAMMA 19 EUR483 IG12E06R	AIN26 20.5 A 27 EUR491 CTEXA06
AIN#3 8GAMMA 04 EUR468 XGXXXX	AIN11 888GAMMA 12 EUR476 CG34D07	AIN19 338GAMMA 20 EUR484 IG12E06	AIN27 8.8 FLOW 28 EUR492 AFEXA06
AIN#4 953GAMMA 05 EUR469 AGEXA06R	AIN12 887GAMMA 13 EUR477 IG34D07R	AIN20 8GAMMA 21 EUR485 XGXXXX	AIN28 1.9 FLOW 29 EUR493 ITEXA06
AIN#5 645GAMMA 06 EUR470 AGEXA06	AIN13 452GAMMA 14 EUR478 IG34D07	AIN21 8GAMMA 22 EUR486 XGXXXX	AIN29 8.8 FLOW 30 EUR494 CFEXA06
AIN#6 1128GAMMA 07 EUR471 CGEXA06R	AIN14 888GAMMA 15 EUR479 AG12E06R	AIN22 8GAMMA 23 EUR487 XGXXXX	AIN30 22.3 EUR495 XXXXXX
EUR472 CGEXA06	EUR480 AG12E06	EUR488 XGXXXX	
AIN#7 3862GAMMA 08 EUR472 CGEXA06	AIN15 438GAMMA 16	AIN23 8GAMMA 24	AIN31 20.7 AMBIENT
00:12:15 51 DOMAIN DOMAIN CONTROLLER 1 CON OK 500083			

Fig. 11. Display screen 33.

The HMI software ONSPEC provides an effective presentation of data from the system sensors via its display screens. Historical data trends from the sensor data are developed and maintained by the HMI software as well. The HMI software also saves data in a binary file format. The files can be saved in daily, weekly, monthly, quarterly, or yearly formats. The WMS uses a monthly file format, and files are stored in the SCADA computer history directory. EUR400M.005 is an example of the EUR400 historical monthly file for May. The monthly data can be exported to other software for evaluation and graphing (see Fig. 2 and Appendix B; note the correlation between temperature and flow-data sets in Fig. 2).

The LSO software module from Heuristics provides swift, accurate, and reliable transfer of the internal database values to other computers on the network. A text configuration file similar to that used for SIXNET is also used with LSO. An example of this file is found in Appendix D. Note that the EUR value ranges from 400 to 599 in this file; this indicates a block move of internal database values across the network.

The WMS is running on a network of over 300 computers. To obtain updates of sensor data at one-second intervals through a remote computer requires considerable network computational resources. We used a network analyzer to determine how the WMS impacts the network. The network analyzer provided information on total network communications and individual machine communication profiles. Of the 10 computers that transfer the greatest quantities of data on the network, 8 are typically used for process control. The network analyzer also identified a possibly critical future problem if additional remote nodes were added to this network. Performance of the total network could degrade, and users might be encumbered by a slow response time. To solve this problem could be costly if expensive hardware were necessary to increase the network communication throughput.

C. Phase Implementation

The WMS was implemented using a phased implementation approach. The system was tested as extensively as possible in a prototype laboratory before installation. The following tests were conducted in this laboratory:

1. sensors were tested to ensure correct operation
2. the data acquisition system was placed on the network and tested to ensure correct functioning of equipment
3. HMI display and trend screens were created, modified, and approved by users
4. extensive testing and evaluation of the complete system were performed.

When the system was brought on-line for the first time in the final location, it was very easy to troubleshoot problems. Single components of the system were started up one at a time. The second SIXNET data acquisition system was brought on-line only after the first system was operating properly. All sensors were brought on-line in a systematically through the data acquisition system. The result of this phased implementation was a speedy and successful installation of the system.

D. Technical Considerations

Nonintrusive sensors were used for the WMS. All sensors were externally attached to the pipes (Figs. 6 and 7).

The pipe sizes are as follows:

industrial -	2.0-in.
caustic -	1.5-in.
acid -	1.5-in.

SIXNET recommends a Belden Datalene cable #9182 (which is designed for high-speed data transmission in network communication) between the 60-IBM/N adapter and the IOMUX-RUT board on the 60-IOMUX-FEB. A substitute cable description can be found on page 15 of the 60-IBM/N SIXNET Network Co-Processor technical manual.

J-type versus K-type thermocouple evaluations were based primarily on data sensitivity requirements. Because large ranges of temperature data were not expected, K-type thermocouples were not installed in the system.

E. Conclusions

The WMS uses a multitasking operating system in the SCADA and remote nodes. This facilitates developing and accomplishing various concurrent jobs on a single computer system. Major issues to consider are whether drivers for the data acquisition system exist and whether other drivers are available for the selected operating system.

An important consideration is the expected lifetime of the sensors. The expected length of time that sensors typically function must be known in order to estimate the cost of operating the system; this information is usually difficult to obtain.

When installing the WMS in the basement of TA-55, the most common problem was crossed wires. This is a common problem when installing new wires in any project.

A program needs to be developed that tests the sensors and the data acquisition system to ensure the entire system is operating within prescribed parameters. Sensor tagging helps maintenance personnel to easily locate and troubleshoot the system sensors.

Calibration of sensors can be challenging. Attempts to calibrate flow sensors in the system proved to be problematic, because discharging known amounts of water created a waste discharge. Coordinating the discharge observed by a sensor with the actual amount discharged proved difficult. An approach now under consideration is the use of a portable calibrated flow sensor, which would be placed adjacent to the current sensor in the system. The local sensors could then be adjusted to match the reading from the portable calibrated sensor.

The Bicron gamma radiation detectors are seeded with alpha activation methods. This gives a gamma energy peak in the nominal energy region of 800 keV to 1.4 MeV, with a count rate of 1000 cps. The signal channel analyzer (SCA) in the Harshaw amplifier is adjusted so that the counts within this energy region are registered on the first ratemeter. This count is used as an indicator that the electronics are functioning correctly. The analog recorder output of the ratemeter is cabled over to the IOMUX I/O multiplexing unit. These reference signal data are displayed for the operator and archived to computer files.

The model 2030 SCA is adjusted to span a region (from 50 keV to a user-defined upper limit) that would be observed from material that could be present in the waste line. Counts in this region are registered on the second 661 ratemeter in the system and the analog output is taken to the multiplexing unit for system monitoring and display.

The initial sensor adjustments were made using appropriate standards that were placed between the waste lines and the detector face. Periodic checks of the accuracy of the system can be made using these standards.

Deadbands are sensor-change delta values that indicate areas of interest that are stored to a historical file. For example, if a temperature probe deadband is set to 1°C, then only when the temperature changes by 1°C will a new value be written to a file. This reduces the size of the historical data file. Setting deadbands for the sensors requires a thorough knowledge of the potential data points. The system sensors should be monitored closely during the initial start-up of the system to determine what deadbands are needed, and plenty of time should be set aside for setting deadbands in a new system. Deadbands were set and optimized over a three-week period for the TA-55 WMS.

Precautions against power outages and lightning should be incorporated into the system with surge protectors and uninterruptible power supplies. The system should also be tested for its ability to come back on-line after an interruption in power. The TA-55 WMS has responded well to scheduled and unscheduled power outages; the system is able to recover and collect data following an outage.

A backup and redundancy strategy should be implemented for optimal operation of the system. Backups of computer system files and historical files are saved to tape. A second industrial IBM computer is loaded with the required software and can assume the role of the SCADA computer in a short time if the main SCADA computer fails.

IV. SUMMARY

A feature currently under evaluation for inclusion in the WMS is the ability to quantitatively determine what chemicals (such as nitrates or metals) are leaving the plant. Determination of total volumes of discharges and the maintenance of accurate on-line records in the system are additional areas for development. Control of the timing and nature of waste discharges from the plant can easily be incorporated into this system by installing remotely activated control valves on the pipes (Fig. 7). We expect to expand capabilities and to add more sensors to improve the tracking of waste origination. Testing of new thermocouples for possible inclusion in the system is underway.

The new WMS at TA-55 is a quantum leap forward from its predecessor, the chart recording system. The WMS provides much more information and introduces real-time monitoring capabilities. Its remote monitoring capability provides greater safety and convenience for users and management. Since the system came on-line, it has shown itself several times to be unprecedentedly useful in tracking waste discharges.

REFERENCES

The following companies provided information for this report:

Intel Corporation, P. O. Box 58119, Santa Clara, CA 95052-8119

Heuristics, 9845 Horn road, Sacramento, CA 95827

International Business Machines, Armonk, NY 10504

Digitronics SIXNET, P. O. Box 767, Clifton park, NY 12065

Canberra Industries, Inc., 800 Research Parkway, Meriden, CT 06450

Omega Engineering Inc., P. O. Box 4047, Stanford, CT 06907-0047.

Appendix A
Instrumentation and Equipment List

INSTRUMENTATION AND EQUIPMENT LIST

A. Hardware

The following hardware items are used in the WMS.

Computer. Model Value Point 486 DX2 with 16 MB RAM, VGA graphics, 3.5-in. floppy drive, 200 MB hard drive, keyboard, color monitor, International Business Machines Corporation, Armonk, NY 10504.

Backup Computer. Model 7537 486 SX with 16 MB RAM, math coprocessor, VGA graphics, 3.5-in. floppy drive, 500 MB hard drive, keyboard, 7544 color monitor, International Business Machines Corporation, Armonk, NY 10504.

Data Acquisition System. The system consists of several individual components, including the model 60-IOMUX I/O multiplexing unit, the model 6-IO32 discrete I/O unit, the model 60-AMI analog multiplexor interface, a 60-MPLEX analog input multiplexor, and a model 6MT cable. Digitronics SIXNET, Clifton Park, NY.

Flow Sensor. FD-302, indicator, transmitter ultrasonic flowmeter. Omega Engineering, Inc., P. O. Box 2284, Stamford, CT 06906.

Type-J Thermocouples. Iron-Constantan 304 SS Sheath 1/8-in., 12-in. length. Omega Engineering, Inc., P. O. Box 2284, Stamford, CT 06906.

Gamma Sensors. Model Bicron 2m2/2-AM-241-X, 2-in. sodium-iodide thallium-doped with, B50B01-4 photomultiplier tubes, and a Canberra photomultiplier-tube base-preamplifier model 2007P.

Scada Environmental Rack. Model PC 4610 version 2. Rittal, 3100 Upper Valley Pike, Springfield, OH.

Gamma Rack and Equipment List. The system consists of several individual components. Each detector has a Canberra model 3102D power supply, Harshaw model NA-23 stabilized AMP/SCA, Canberra model 2030 single channel analyzer, and two EG&G Ortec model 661 ratemeters.

B. Software

The following software items are used in the WMS.

Operating System. OS/2 version 2.1 International Business Machines Corporation, Armonk, NY 10504.

HMI Software. ONSPEC 4000 Control Software 2.10, ONSPEC

Digitronics SIXNET I/O driver, OnView with Supertrends electronic trend pen recorder, Large System ONNET version 2.56. Heuristics, Inc., Sacramento, CA 95827.

Network Software. LAN Server or Requestor version 2.10. International Business Machines Corporation, Armonk, NY 10504.

IOMUX and MUXINT, SIXNET configuration software. Digitronics SIXNET, Clifton Park, NY.

Appendix B

Trending Screen Examples

TRENDING SCREEN EXAMPLES

Trending screens are used extensively in the WMS. The displays give a historical perspective of the sensor selected for trending. A maximum of 14 points can be plotted simultaneously on the same screen. These two pages provide examples of printouts of trending screens used in the WMS. Figures 2 and 3 provide color examples of both hard-copy printout and actual monitor images of trending screens.

February 1, 1995 Temperature Plots

Deg. C

Industrial line summary for January 1994

Appendix C
SIXNET waste.txt File

SIXNET waste.txt File

The following is the SIXNET waste.txt file:

```
; CONFIGURATION FILE FOR THE DIGITRONICS SIXNET I/O
DRIVER.
;
DELAY=10
;
;CYCLE   COMMAND      ADDRESS START-ID END-ID
CONV     V1    V2
;
1    DIN  0    DII[400]      DII[407]
;5    AIN  0    EUR[1]       EUR[4]          B    0.0  5.0

;
;          PF-3 BASEMENT JUCTION BOX #1
;          60-MPLEX-32 ISOLATED ANALOG INPUTS
;
5    AIN  00    EUR(400) * L 0 0.1 ;..... TEMP # 01
5    AIN  01    EUR(401) * L 0 0.1 ;..... TEMP # 02
5    AIN  02    EUR(402) * L 0 0.1 ;..... TEMP # 03
5    AIN  03    EUR(403) * L 0 0.1 ;..... TEMP # 04
5    AIN  04    EUR(404) * L 0 0.1 ;..... TEMP # 05
5    AIN  05    EUR(405) * L 0 0.1 ;..... TEMP # 06
5    AIN  06    EUR(406) * L 0 0.1 ;..... TEMP # 07
5    AIN  07    EUR(407) * L 0 0.1 ;..... TEMP # 08

5    AIN  08    EUR(408) * L 0 0.1 ;..... TEMP # 09
5    AIN  09    EUR(409) * L 0 0.1 ;..... TEMP # 10
5    AIN  10    EUR(410) * L 0 0.1 ;..... TEMP # 11
5    AIN  11    EUR(411) * L 0 0.1 ;..... TEMP # 12
5    AIN  12    EUR(412) * L 0 0.1 ;..... TEMP # 13
5    AIN  13    EUR(413) * L 0 0.1 ;..... TEMP # 14
5    AIN  14    EUR(414) * L 0 0.1 ;..... TEMP # 15
5    AIN  15    EUR(415) * L 0 0.1 ;..... TEMP # 16

5    AIN  16    EUR(416) * B 0 100 ;..... FLOW # 17
5    AIN  17    EUR(417) * B 0 100 ;..... FLOW # 18
5    AIN  18    EUR(418) * B 0 100 ;..... FLOW # 19
```

```

5    AIN  19    EUR(419) * B 0 100 ;..... FLOW  # 20
5    AIN  20    EUR(420) * B 0 100 ;..... FLOW  # 21
5    AIN  21    EUR(421) * B 0 100 ;..... FLOW  # 22
5    AIN  22    EUR(422) * B 0 100 ;..... FLOW  # 23
5    AIN  23    EUR(423) * B 0 100 ;..... FLOW  # 24

5    AIN  24    EUR(424) * B 0 100 ;..... FLOW  # 25
5    AIN  25    EUR(425) * B 0 100 ;..... FLOW  # 26
5    AIN  26    EUR(426) * B 0 100 ;..... FLOW  # 27
5    AIN  27    EUR(427) * B 0 100 ;..... FLOW  # 28
5    AIN  28    EUR(428) * B 0 100 ;..... FLOW  # 29
5    AIN  29    EUR(429) * B 0 100 ;..... FLOW  # 30
5    AIN  30    EUR(430) * B 0 100 ;..... FLOW  # 31
5    AIN  31    EUR(431) * L 0 0.1 ;..... MUXTEMP #
32

```

; EURS FOR WASTE MONITOR JUNCTION BOX #2 PF-4
BASEMENT (A-06)

```

5    AIN  32    EUR(465) * B 0 5000 ;..... GAMMA #01
5    AIN  33    EUR(466) * B 0 5000 ;..... GAMMA #02
5    AIN  34    EUR(467) * B 0 5000 ;..... GAMMA #03
5    AIN  35    EUR(468) * B 0 5000 ;..... GAMMA #04
5    AIN  36    EUR(469) * B 0 5000 ;..... GAMMA #05
5    AIN  37    EUR(470) * B 0 5000 ;..... GAMMA #06
5    AIN  38    EUR(471) * B 0 5000 ;..... GAMMA #07
5    AIN  39    EUR(472) * B 0 5000 ;..... GAMMA #08

5    AIN  40    EUR(473) * B 0 5000 ;..... GAMMA #09
5    AIN  41    EUR(474) * B 0 5000 ;..... GAMMA #10
5    AIN  42    EUR(475) * B 0 5000 ;..... GAMMA #11
5    AIN  43    EUR(476) * B 0 5000 ;..... GAMMA #12
5    AIN  44    EUR(477) * B 0 5000 ;..... GAMMA #13
5    AIN  45    EUR(478) * B 0 5000 ;..... GAMMA #14
5    AIN  46    EUR(479) * B 0 5000 ;..... GAMMA #15
5    AIN  47    EUR(480) * B 0 5000 ;..... GAMMA #16

```

Waste Monitoring System for Effluents

```

5   AIN  48   EUR(481) * B  0  5000 ;..... GAMMA  #17
5   AIN  49   EUR(482) * B  0  5000 ;..... GAMMA  #18
5   AIN  50   EUR(483) * B  0  5000 ;..... GAMMA  #19
5   AIN  51   EUR(484) * B  0  5000 ;..... GAMMA  #20
5   AIN  52   EUR(485) * B  0  5000 ;..... GAMMA  #21
5   AIN  53   EUR(486) * B  0  5000 ;..... GAMMA  #22
5   AIN  54   EUR(487) * B  0  5000 ;..... GAMMA  #23
5   AIN  55   EUR(488) * B  0  5000 ;..... GAMMA  #24

```

```

5   AIN  56   EUR(489) * L  0  0.1 ;..... TEMP   # 25
5   AIN  57   EUR(490) * L  0  0.1 ;..... TEMP   # 26
5   AIN  58   EUR(491) * L  0  0.1 ;..... TEMP   # 27
5   AIN  59   EUR(492) * B  0  100 ;..... FLOW    # 28
5   AIN  60   EUR(493) * B  0  100 ;..... FLOW    # 29
5   AIN  61   EUR(494) * B  0  100 ;..... FLOW    # 30
5   AIN  62   EUR(495) * B  0  5.0 ;..... GAMMA  # 31
5   AIN  63   EUR(496) * L  0  0.1 ;..... MUXTEMP

```

; OUTPUT LIST

```

I   DOUT      0   DOO[400]  *
I   DOUT      1   DOO[401]  *
I   DOUT      2   DOO[402]  *
I   DOUT      3   DOO[403]  *
I   DOUT      4   DOO[404]  *
I   DOUT      5   DOO[405]  *
I   DOUT      6   DOO[406]  *
I   DOUT      7   DOO[407]  *

```

END.

Appendix D
LSO Configuration waste.cfg File

LSO Configuration waste.cfg File

The following is the LSO configuration text waste.cfg file.

```
;system configuration definition
COMPUTERNAME = waste
FUNCTION = CONSOLE
CYCLESUSPEND = 500
WRITESUSPEND = 50
NETWORK = ON
```

```
;REMOTE INFO
STATION = SOUNDER
PROTOCOL = NETBIOS
CLASS = MASTER
```

NTLIST

;Network TAG List for this node

;ALIAS	TABLE	START	END		DRIVER	TAGGED	
SOURCE GLOBAL							
WASTE_EUR	EUR	400	599	Y	Y	Y	N
WASTE_DOO	DOO	400	599	Y	N	Y	N
WASTE_DII	DII	400	599	Y	N	Y	N
WASTE_FLG	FLG	400	599	Y	Y	Y	N
\$STA_WASTE	FLG	3740	3740	N	N	Y	N
\$IN_WASTE	EUR	3740	3740	N	N	Y	N
\$OUT_WASTE	EUR	3741	3741	N	N	Y	N
ONSPEC_WASTE	FLG	127	127	N	N	Y	N
LSO_WASTE	FLG	118	118	N	N	Y	N
LOG_WASTE	STR	110	110	N	N	Y	N
SEC_WASTE	EUI	110	110	N	N	Y	N
DRIVE1_WASTE	DII	128	128	N	N	Y	N

```
INPUT
;CYCLE          CONDITION
1              (ON)
; Network Tag List for this input condition
*
```

```
OUTPUT
;CYCLE          CONDITION
1              (ON)
; Network Tag List for this output condition
WASTE_EUR
WASTE_DOO
WASTE_DII
WASTE_FLG
```

```
$STA_WASTE
$IN_WASTE
$OUT_WASTE
ONSPEC_WASTE
LSO_WASTE
LOG_WASTE
SEC_WASTE
DRIVE1_WASTE
```