US Army Corps
of Engineers
Construction Engineering
Research Laboratories

USACERL Technical Report 98/108
August 1998

Remote Monitoring of Fluid Storage Tanks at Watervliet Arsenal, New York

by
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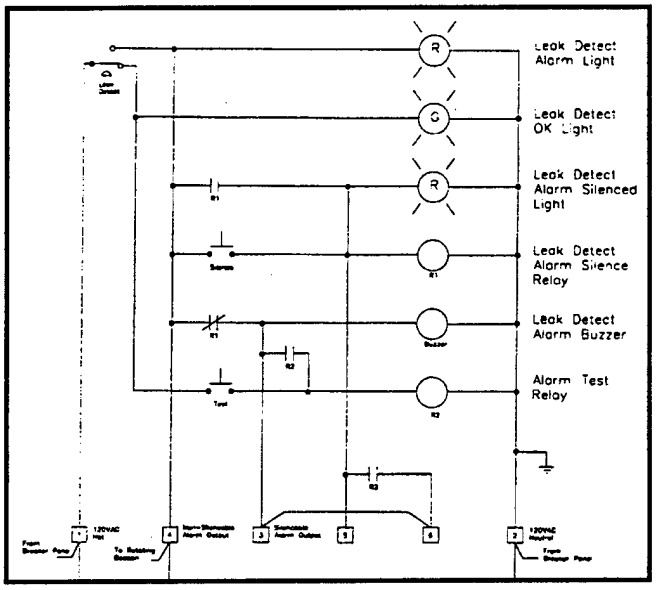

To expedite monitoring of the widely dispersed storage tanks at Watervliet Arsenal (WVA), this study proposed to automate tank-level monitors at Watervliet Arsenal, New York, and designed and installed a system to:

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REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. AGENCY USE ONLY *(Leave Blank)*	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	August 1998	Final

4. TITLE AND SUBTITLE
Remote Monitoring of Fluid Storage Tanks at Watervliet Arsenal, New York

5. FUNDING NUMBERS
MIPR
W52EU270578976

6. AUTHOR(S)
Jearldine Northrup, Joyce C. Baird, Don Schefler, and Philip Darcy

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
U.S. Army Construction Engineering Research Laboratories (USACERL)
P.O. Box 9005
Champaign, IL 61826-9005

8. PERFORMING ORGANIZATION REPORT NUMBER
TR 98/108

9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)
Watervliet Arsenal
ATTN: WVA
Pollution Prevention Manager
Watervliet Arsenal, New York 12189

10. SPONSORING / MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES
Copies are available from the National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161.

12a. DISTRIBUTION / AVAILABILITY STATEMENT
Approved for public release; distribution is unlimited.

12b. DISTRIBUTION CODE

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To expedite monitoring of the widely dispersed storage tanks at Watervliet Arsenal (WVA), this study proposed to automate tank-level monitors at Watervliet Arsenal, New York, and designed and installed a system to:

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14. SUBJECT TERMS
Watervliet Arsenal, NY
fluid storage tanks
remote monitoring
pollution prevention

15. NUMBER OF PAGES
24

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
Unclassified	Unclassified	Unclassified	SAR

Foreword

This study was conducted for Watervliet Arsenal (WVA) located in Watervliet, New York, under Work Unit VK7, "Storage Tanks." The work was funded by Military Interdepartmental Purchase Request (MIPR) No. W52EU270578976 and is the continuation of work begun in Fiscal Year 1996 (FY96). The project addresses the remote monitoring of fluid storage tanks. The technical monitor was Mr. Phil Darcy (WVA).

The work was performed by the Industrial Operations Division (UL-I) of the Utilities and Industrial Operations Laboratory (UL), U.S. Army Construction Engineering Research Laboratories (CERL). Consultants Mountain States Environmental (MSE) Technology Applications (TA), Inc., Butte, MT, provided engineering services, construction and installation of equipment, and technology testing services for the installation of remote monitoring systems. Don Schiller is associated with MSE. The CERL principal investigator was Jearldine I. Northrup. Walter J. Mikucki is Chief, CECER-UL-I; Dr. John Bandy is Laboratory Operations Chief, CECER-UL; and Gary W. Schanche was the responsible Technical Director, CECER-TD. The CERL technical editor was William J. Wolfe, Technical Resources.

COL James A. Walter is Commander and Dr. Michael J. O'Connor is Director of CERL.

Contents

1 Introduction

Background

Fluid storage tanks on Army installations that are used to hold hazardous materials can pose a unique challenge to the installation's Environmental Compliance Officer. If a leak or spill from such a storage tank occurs, quick response to the emergency is essential to prevent damage to the environment and to avoid the resultant clean-up cost, which can total in the thousands of dollars. However, installations can find it difficult to achieve quick emergency response when storage tanks are physically separated by large distances, when manpower to monitor tank conditions is short, or when automated monitoring systems are installed, but are not supplemented with a communication system to "sound the alarm" when a leak or spill occurs.

In fact, Army installations commonly automate the monitoring of hazardous materials by using appropriate environmental pollution control equipment (PCE). However, PCE on Army installations is typically not consolidated in any one area, but may be distributed across the installation. In times of reduced manpower, delegating the task of monitoring storage tanks and "sounding the alarm" in emergencies to existing personnel is expensive and resource-intensive. A logical alternative that conserves both labor and resources is to automate and centralize monitoring and alarm functions by establishing a communication system between the tanks and a central office, such as the environmental office. In this study, Watervliet Arsenal (WVA) requested the U.S. Army Construction Engineering Research Laboratories (CERL) to explore options to automate fluid storage tank level monitors and to recommend a safe, reliable system for that installation.

Objectives

The objectives of this study were to explore options to automate tank-level monitors at Watervliet Arsenal, NY, and to recommend a system to:

1. Monitor the installation's widely dispersed tanks
2. Alert the Compliance Officer when a leak or overflow exists
3. Provide a basis for an optimized, cost effective method to schedule waste removal from hazardous materials storage tanks, and to refill fuel tanks with minimal risk of leaks and spillage.

Approach

1. The CERL principal investigator visited WVA and met with the principal project engineer before commencing the project. Three more meetings with WVA staff and CERL researchers were planned, two before the project's initiation and one after project completion.
2. The storage tank configuration at WVA (Figure 1) was reviewed.
3. A remote-monitoring system was designed to meet the monitoring needs of the installation, including sensors, software, hardware, and connections.
4. Thirteen fluid storage tanks were configured into the automated remote-monitoring system. (Table 1 lists the installation status as of 10 October 1997.)
5. Further changes were proposed to complete the system and to enhance its utility as an emergency and compliance monitoring tool.

Scope

The automated monitoring system described in this study was proposed to meet the specific needs of WVA. Note that, in accordance with regulatory requirements, WVA has and will continue to perform monthly visual surveillance at the site of each storage tank. However, other military installations with similar fluid storage tank configurations may use the information in this report as a basis to design remote monitoring systems to meet their specific needs.

Mode of Technology Transfer

A 2-hour training session for compliance officers and firemen will be provided to instruct WVA personnel in the use of the monitoring equipment. A CERL technical report will document the procedures adopted to implement and operate the Storage Tank Remote Monitoring System.

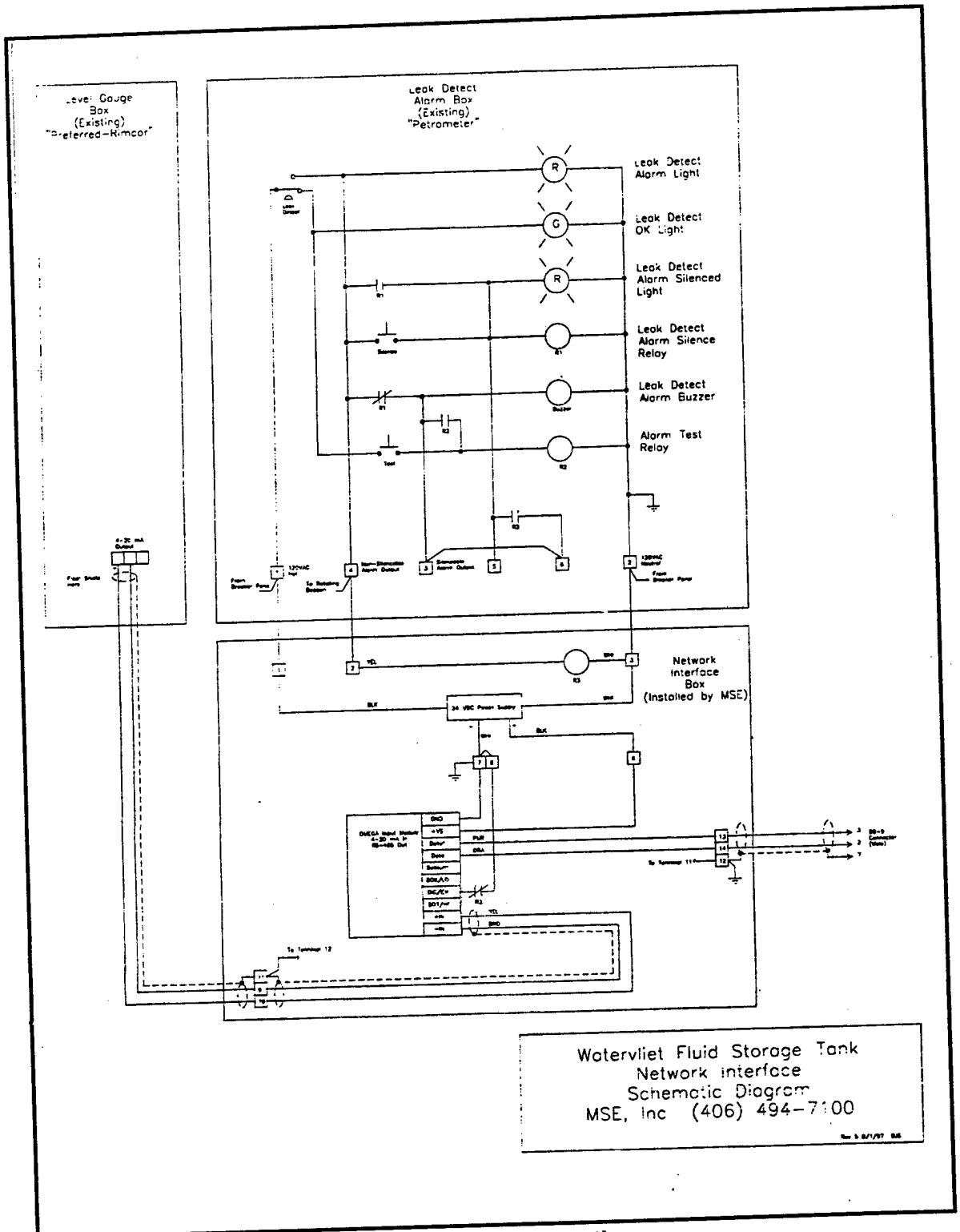

Figure 1. Watervliet fluid storage tank network schematic.

Table 1. Fluid storage tank monitoring project installation status as of 10 October 1997.

Tank	UG/ AG	Cont.	Instru-ments	Local	Func-tional?	Capacity	Status	Proposed for Completion
1	U	WO	Leak Alm/ Level	141	NO	8,000	No phone line available	Propose radio link to Bldg. 145
2	U	SPILL COLL BASIN	Leak Alm/ Level	149	NO	1,000	No phone line available	Propose radio link to Bldg. 145
3	U	2FO	Leak Alm/ Level	145	YES	2,000	OK	Completed
8	U	WO	Leak Alm/ Level	135/(125)	YES	2,000	OK	Completed
9	U	WO	Leak Alm/ Level	115	YES	1,000	OK	Completed
10	U	WO	Leak Alm/ Level	110S	YES	1,000	OK	Completed
11	U	WO	Leak Alm/ Level	11ON	YES	1,000	OK	Completed
12	U	WO	Leak Alm/ Level	44	YES	1,000	OK	Completed
13	U	WO	Leak Alm/ Level	15N	YES	1,000	OK	Completed
14	U	GASOL	Leak Alm/ Level	15S	YES	5,000	OK	Completed
15	U	WO	Leak Alm/ Level	35S	YES	1,000	OK	Completed except leak alarm test push button does not work on existing tank insterstitial alarm box. Repair not in work scope.
16	U	WO	Leak Alm/ Level	20/(25)	NO	2,000	OK except phone line does not work	Completed except changing telephone wires and testing.
22	U	2FO	Leak Alm/ Level	132	YES	500	OK	Completed
23	U	WO	Leak Alm/ Level	35W	YES	1,000	OK	Completed
25	U	WO	Level	36	NO	5,000	No measurements or alarms available to hook up to. Tank will be replaced soon with double walled tank, including alarm and level measurement	Hooked to LI-342 in IWTP control panel and connected to phone line. When tank upgrade is complete, the level measurement will be available for activation in the firehouse. Any leak detection from the new tank will require wiring to IWTP control panel.
28	U	DIES	Leak Alm/ Level	116	YES	4,000	OK	Completed

Tank	UG/ AG	Cont.	Instru-ments	Local	Func-tional?	Capacity	Status	Proposed for Completion
29	U	SODIUM HYD	Level	36	NO	6,000	OK – Hooked to LI-011 signal in JWTP control panel. Tank 24 removed	Tank replacement in progress while installing monitoring. Tank level will be available for activation in the firehouse as soon as new tank is connected to level measurements by contractor. If leak detection is required, then will require wiring between contractor box and IWTP control panel. Phone line is connected.
30	A	H2SO4	Level	36	YES	1,200	OK – Hooked to LI-011 signal in JWTP control panel.	Completed
31	U	SOL WO	Leak /Level Alm	36E	YES	12,000	OK – Tank 32 combined with 31 and replaced with vault system. Tank monitor box installed and phone line run; has leak and high level alarms only. Level sensor is not available as electrical signal.	Completed. It may be possible to install level indication for firehouse monitoring with approx. $2000 sensor.
33	U	ACID WASTE	Level	36	NO	75,000	UST monitoring not required per P. Darcy	
34	U	ACID WASTE	Level	36	NO	39,000	UST monitoring not required per P. Darcy	
35	U	CYANID E WASTE	Leak Alm	36	YES	6,000	OK	
36	U	SPILL WO	Leak Alm /Level	150	NO	2,000	Building not yet turned over; cannot install box per P. Darcy. No phone line.	

Tank	UG/ AG	Cont.	Instru-ments	Local	Func-tional?	Capacity	Status	Proposed for Completion
101	A	2FO	High Level Alm	147	NO	425,000	Tank network box installed. 101, 102, 103 has no phone line nearby. Tanks 101, 102, 103 will be combined into one monitoring network box. It has not been determined where the alarm is located.	
102	A	2FO	High Level Alm	147	NO	30,000	102 and 103 connected with pipe and valve. No phone line.	
103	A	2FO	High Level Alm	147	NO	25,000	102 and 103 connected with pipe and valve. No phone line.	
105	A	CO	High Level Alm	116	NO	5,000	Tanks inside building 116 have overfill alarms only. Tanks 105, 106, 107 will be combined into one monitoring network box. The tank network box is installed but not hooked to the overfill alarm relays, nor is power installed to network box. Overfill alarm box is in very bad shape and is unsafe to wire into without violating NEC code.	
106	A	CO	High Level Alm	116	NO	3,000	Tanks inside building 116 have overfill alarm only.	
107	A	CO	High Level Alm	116	NO	3,000	Tanks inside building 116 have overfill alarm only.	

Tank	UG/ AG	Cont.	Instru-ments	Local	Func-tional?	Capacity	Status	Proposed for Completion
108	A	KER	High Level Alm	136	NO	1,000	4 ft diameter tank, 1000-gal., 4-in. and 2-in. threaded holes in top; no level gage, or overfill/leak alarm system installed. Network box is installed, but no power is provided yet.	

2 Storage Tank Monitoring at WVA

The Case for Automation

Technology is advancing at a rapid rate. This is especially true for computerized systems. The major advancement is the phenomenal reduction in cost of computing power. In the past 10 years, the speed of desktop computing systems has increased a thousand fold, while component prices have dropped by a similar factor. The cost to automate certain functions at Army installations is similarly dropping. In the face of rising labor costs, there is a savings incentive to develop technological solutions (automated systems) to replace outmoded labor-intensive methods (thereby freeing personnel for higher priority work, or for tasks that either require human judgment or otherwise cannot be automated). An installation using a centralized control type system can reduce costs by:

1. *Reducing operator training time.* The raw data from the sensor can automatically be converted to a reportable format that the operator reads directly on the console. This eliminates the need for an operator to make the data conversions manually, saves time, and reduces the possibility for error.

2. *Employing more active control strategies.* An example of this is to monitor the electricity used by the PCE. This may be achieved by reducing the amount of electricity used during peak demand periods by staggering the times that the motors across the installation are activated.

3. *Using nonproprietary central control equipment.* By using nonproprietary central control equipment, an installation can obtain a variety of bids rather than having to justify a sole source procurement when replacing or upgrading equipment.

The simplest way to create a communication link between a remote monitoring site (i.e., fluid storage tanks) and a central office is to use existing telephone

lines to transmit the sensor data in digital form. However, adding telephone lines is expensive (about $40K/mi*). Wireless communication between PCE and a central office can also be established by radio link. In the past, use of single-frequency licensed transmitters was a viable option. Presently, obtaining a frequency in the bands allocated for the military may take months and must be coordinated with the installation communications center to avoid conflict with existing links.

A recent ruling on wireless local area network (LAN) efforts by the Federal Communications Commission (FCC) has authorized unlicensed wireless high-speed data transmission devices. The ruling frees 300 megahertz of spectrum in the 5 gigahertz (GHz) range for unlicensed National Information Infrastructure devices. Users could benefit from the ability to create local networks without wiring their buildings or neighborhoods. On the other hand, users of unlicensed spectra must be willing to accept ambient levels of interference. Users who require no interference or extremely low rates of error would probably prefer to use traditional hard-wired LANs or the more "robust" licensed wireless networks provided by telecommunications companies.

In these new bands, wireless network connections at speeds as fast as 20 megabits per second could be constructed that would cover areas as large as 6 mi in diameter. To allay concerns about interference, the FCC adopted different technical standards for the three bands it authorized. In the lowest band, from 5.15 to 5.25 GHz, broadcast power is limited to 200 milliwatts, a level that allows computers, printers, or servers in one building to effectively communicate. In the second band, from 5.25 to 5.35 GHz, devices could broadcast with 1 Watt of power, allowing effective communications within an installation cantonment area. In the third band, from 5.725 to 5.825 GHz, devices could broadcast with 4 Watts of power, allowing effective communications within a 6-mi radius, depending on local terrain and the number of users.

The Proposed System

This project provided for fabrication and installation of four subsystems and start-up training as follows:

* 1 mi = 1.51 km.

1. Tank monitor network boxes were located at each of the existing tanks (Figure 1). The tank network boxes were fabricated by the contractor using an assembly line method, and the boxes were shipped to the Arsenal and installed. The network boxes were connected to the existing level monitor boxes and to existing phone lines in the communications room where available.

2. A tank status polling system was mounted in available space in existing rack space situated in the communications room. The tank polling system gathered information from all the tanks using a personal computer (PC) and commercial-off-the-shelf (COTS) software. The selected software, Wonderware *FactorySuite*, is built around three core technology modules including visualization, control, and data. Wonderware *FactorySuite* allows applications developers to customize Wonderware modules to meet specific needs.

3. An alarm system was located in the firehouse. Audible and visual alarms, as well as individual tank levels, are available from an operator console including Pentium® personal computer, color display, and alarm printer. Wonderware operator display software exhibits alarms and tank status, keep history, and transfer data to the Watervliet Compliance Officer's computer.

4. A compliance monitoring system was located at the compliance officer's desk. All tank information is available at office SIOWV-ISH (compliance officer area) and other locations on a computer with a printer. The compliance computers and alarm computer are networked using the existing WVA computer network system.

All subsystems were fabricated and tested by Mountain States Environmental (MSE), Technology Applications (TA), Inc. at the Western Environmental Technology Office (WETO) in Butte, MT, before shipping to WVA. The integration and system testing at Watervliet by MSE Technology Applications, Inc. Butte, MT, confirmed full functionality and suitability for the task. The contractor provided engineering services, construction and installation of equipment, technology testing services for the installation of remote monitoring systems designed to monitor any locally provided level, and overfill and leakage sensors at the fluid storage tanks at WVA.

System Implementation

The consequences of overflow from storage tanks range from wasted product to an environmental crisis, depending on the industry and the situation. As an initial step in trying to attain control and prevent leakage, monitoring systems were installed and networked in eight fluid storage tanks at WVA in the first quarter of 1995. The work was conducted by MSE and was accomplished by connecting the monitoring system to the WVA LAN. It was later found that the LAN was not designed for critical alarming system interconnects.

CERL used the services of MSE through the Department of Energy (DOE) operating contract for WETO. The contractor (MSE) provided engineering services, construction, installation of equipment, and technology testing services for the installation of remote monitoring systems designed to monitor levels and overfill of fluid storage tanks at WVA. Improvements to the current methods of monitoring will result in lower manpower requirements for maintenance and will provide a more robust system for preventing potential environmental spills at WVA.

There are 18 fluid storage tanks at WVA that are monitored locally for level and overfill. WVA's Advanced Technology and Systems Directorate requested a centralized and cost effective method to monitor the tanks. The project was initiated in FY95 to provide networking as an effective method for monitoring eight tanks. The continuation of this project completed the network link of 12 more tanks to immediate response and compliance reporting centers of all fluid storage tanks.

The existing tank level monitors are currently networked to a 24-hour immediate response center located at the firehouse, where audible/visual alarms and response cues indicate when tank trouble occurs. WVA Environmental Compliance Officer also has an on-demand information system for all tank levels including level, leak status, historical trend, and location map. This system expedites monitoring of the 30 widely dispersed tanks to alert the Compliance Officer if/when a leak or overflow exists. The system provides a basis for an optimized and cost effective method to schedule waste removal from hazardous materials storage tanks and to refill fuel tanks with minimal risk of leaks and spillage.

Tank Network Boxes

The tank network boxes were fabricated by MSE at the WETO Butte facility using an assembly line method. The boxes were shipped to the Arsenal and installed. The network boxes were connected to the existing level monitor boxes and to existing phone lines in the communications room where available. For tanks where existing phone lines are not available, the network in place or other technology will be used.

A number of existing tank level monitors required upgrading to provide the option to allow external communication (4-20 mA loop capability). These modifications were tasked as a subcontract by MSE to Preferred Rimcor Co. of Danbury, CT.

Tank Status Polling System

The tank polling system resides in the communications room and gathers information from all the tanks using a wiring hub. The components were mounted in available space in existing rack space in the communications room.

Alarming System

The audible and visual alarms, as well as individual tank levels are available at the firehouse from a small footprint (24x24-in.) desk with Pentium II 233 MHz personal computer, color display, and alarm printer. Residing in the computer is Wonderware operator display software for indicating alarms and tank status.

Compliance Monitoring System

All tank information is available at office SIOWV-ISH (compliance officer area) on a computer with a printer. The compliance computers and alarm computer are networked using the site Ethernet (Figure 2).

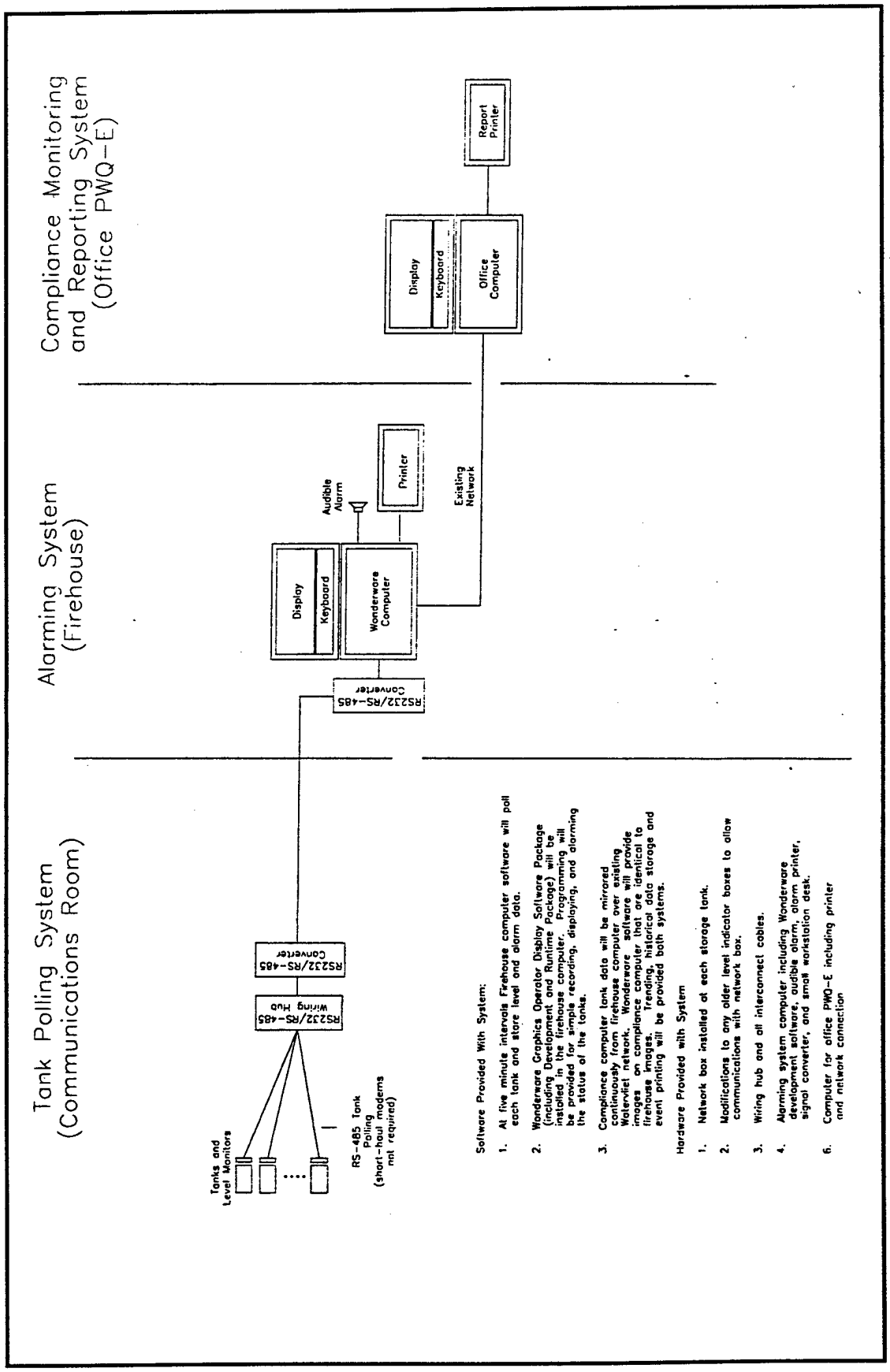

Figure 2. Fluid storage tank alarm network.

Testing and Training

All subsystems were fabricated and tested by MSE at the WETO Butte facility before shipping to WVA. The integration and system testing by MSE at WVA confirmed full functionality and suitability for the task. Two, 2-hour training sessions were included (one for compliance officers and one for firemen).

Project Support

Project support includes the following activities necessary for the advancement of the project, but not defined as major phases. These activities were directed by MSE with assistance from CERL and WVA. These activities include quality assurance; budgeting/scheduling; environmental, safety, and health considerations; travel, training, and general support.

Software Development

The software in the polling system PLC was developed by MSE to periodically scan the data in each tank and deliver the data to the alarm computer. The software in the firehouse alarm computer was also developed by MSE from Wonderware *FactorySuite*. The full development and runtime package of the software was purchased and turned over to WVA for the subsystem.

Data Elements

The Department of the Army has established a standardized format for data elements for use in Department of Defense (DOD) software and computer systems. To ensure interoperability, it is most important that these data standards be used in the development of any computer software systems to be used by DOD. Many computer systems are inaccessible or incompatible with other systems due to their program format. For data to be accessible from one system to another, and to avoid duplication of data elements, the DOD data elements must be used. The DOD Data Administrator for the Defense Information Systems Agency (DISA) has issued guidelines on mapping and matching application data to DOD standard data elements. In developing the software for WVA, these standards were strictly followed. In this phase, CERL has begun to choose the DOD data elements that need to be passed between the program to produce the needed reports. The concept of Data Warehousing was used in the next phase of the environmental management information system (EMIS) Environet. At that time, the data was passed as standard data elements.

3 Conclusion

This study explored options to automate tank-level monitors at WVA, and designed and installed a system to:

1. Monitor the installation's widely dispersed tanks
2. Alert the Compliance Officer when a leak or overflow exists
3. Provide a basis for an optimized, cost effective method to schedule waste removal from hazardous materials storage tanks, and to refill fuel tanks with minimal risk of leaks and spillage.

This part of the project installed remote sensors at 17 of the 30 tanks complete with sensors, software, hardware, and connections to the firehouse and environmental office. Since the work done under this project was based on the availability of phone lines and sensors that were in place, all tanks not connected as of 10 October 1997 will be addressed in the Environet (EMIS) project.

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