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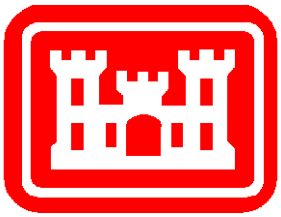
AIR EMISSIONS SOURCE MONITORING TECHNOLOGY IMPLEMENTATION STUDY



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AIR EMISSIONS SOURCE MONITORING SYSTEMS

1. Purpose.

a. The purpose of this Public Works Technical Bulletin (PWTB) is to transmit the results of an air emissions source monitoring technology implementation study conducted at Fort Hood, Texas.

b. All PWTBs are available electronically in Adobe® Acrobat® portable document format [PDF]) through the World Wide Web (WWW) at the National Institute of Building Sciences' Whole Building Design Guide web page, which is accessible through this Universal Resource Locator (URL):

http://www.wbdg.org/ccb/browse_cat.php?o=31&c=215

2. Applicability.

This PWTB applies to all U.S. Army facilities where engineering activities have the responsibility to meet air pollution permit requirements or the requirements of Title V of the Clean Air Act. This report may benefit other military installations with air emissions reporting needs.

3. References.

a. Army Regulation (AR) 200-1: Environmental Protection and Enhancement, 13 December 2007.

b. 1990 Amendments to the Clean Air Act (CAA), Title V Operating Permits, 40 CFR §§70 et seq.

c. Texas Clean Air Act, Permits by Rule (PBR), Title 30, Chapter106, Texas Administrative Code.

d. Executive Order 13514, Federal Leadership in Environmental, Energy, and Economic Performance, October 2009.

4. Discussion.

a. AR 200-1 requires that Army installations comply with federal environmental regulations, including standards for the management of air pollution as established by the U.S. Environmental Protection Agency (USEPA) under the authority of CAA and Amendments of 1990. AR 200-1 can be found at: www.army.mil/usapa/epubs/pdf/r200_1.pdf.

b. CAA Title V (Operating Permits) requires installations to monitor and report emission sources as part of the rule. The CAA Amendments of 1990 authorize state regulatory agencies to administer Title V permits and grant additional air permits not typically covered under Title V, such as the Texas Clean Air Act PBR.

c. Complying with Texas air permit rules involves several monitoring requirements at Army installations in that state. Among these requirements are monitoring fuel usage and air emissions from combustion sources, such as boilers and generators.

d. The purpose of Executive Order 13514 is to achieve a reduction of greenhouse gases (GHG) and improve energy efficiency at federal facilities.

e. In 2006, Fort Hood needed to improve its monitoring of fuel usage and air emissions at various boilers and emergency generators. There was a need to have monitoring systems designed and installed on these sources to meet Title V and PBR permit requirements. The information provided by these systems could be used for: obtaining instant data to demonstrate compliance, meeting recordkeeping requirements, reducing combustible emissions, increasing boiler efficiency, and alleviating time and cost of performing a stack test. A project to design and install monitoring systems was conducted under the Facility Modernization and Sustainability Program (FMSP). That program was administered by the U.S. Army Engineer Research and Development Center–Construction Engineering Research Laboratory

(ERDC–CERL) and executed by MSE Technology Applications, Inc. (MSE) of Butte, Montana.

f. With assistance from the Fort Hood Environmental Department, MSE was able to:(1) determine the minimum measurement and monitoring equipment necessary to achieve Title V compliance, and (2) evaluate alternative fossil fuel flow measurements and air emission monitoring devices for implementation at Fort Hood. MSE designed monitoring systems that use commercially available programmable logic controllers (PLCs), flowmeters, and panels. Part of the design was the programming necessary to operate the systems and to record needed data so that the operators could easily manipulate the data into report form. The systems measure boiler and generator fuel usage and generator runtimes.

g. Monitoring systems were installed on boilers that burn natural gas and fuel oil, generators, and a thermal oxidizer at three Fort Hood buildings:

- Darnall Army Community Hospital – Three large boilers were fitted with systems to monitor the use of both natural gas and fuel oil. The three emergency boilers at DACH were fitted with runtime monitoring systems.

- III Corps Headquarters Building – Three generators were fitted with runtime monitoring systems.

- Building 88027 – The catalytic recuperative thermal oxidizer that treats volatile organic emissions from painting operations was fitted with a natural gas monitoring system.

h. MSE recommended that Fort Hood investigate the possibility of expanding the air emissions source monitoring systems to other generators, boilers, and oxidizers. It may also be possible to link each site with a central monitoring station. This would allow Fort Hood to automatically check the status of each site and to potentially automate air emissions reporting. MSE believes that such systems would be great assets to other military bases with air emissions reporting needs.

i. The systems are expected to provide Fort Hood with an effective method to calculate air emissions from each of the sources. Benefits should include more accurate recordkeeping, less labor, and easier compliance with air pollution regulations.

j. See Appendix A, "Air Emissions Source Monitoring at Fort Hood," for further information regarding the Fort Hood study. Appendix A is the final report submitted by MSE to ERDC-CERL, edited for format and clarity. This report is intended for use by air pollution management personnel at Army installations. However, discussion of the specific monitoring systems and equipment used at Fort Hood is more easily understood by those who have special knowledge of those systems.

k. Appendix B is a glossary of acronyms and abbreviations.

5. Points of Contact.

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Appendix A:
Air Emissions Source Monitoring Project at Fort Hood

Foreword

The project was carried out under the Facility Modernization and Sustainability Program (FMSP) administered by the U.S. Army Engineer Research and Development Center–Construction Engineering Research Laboratory (ERDC–CERL). The study was conducted by MSE Technology Applications, Inc. (MSE) of Butte, Montana.

The major contributors to this project include:

- Mr. David Franklin, MSE Project Manager
- Ms. Kim McClafferty, MSE Project Engineer
- Mr. Jack Joyce, MSE Project Engineer
- Mr. Steve Antonioli, MSE Program Manager
- Mr. Robert Kennedy, Fort Hood
- Mr. Scottie Fiehler, Corps of Engineers, Tulsa District
- Mr. Greg Pullen, Naval Air Systems Command
- Mr. Gary Gerdes, ERDC-CERL FMSP Program Manager

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Introduction

Background

Complying with Clean Air Act (CAA), Title V Operating Permit, and Permit By Rule (PBR) requirements presents multiple problems for Fort Hood. Among these requirements are monitoring for fuel usage and air emissions for various boilers and emergency generators, particularly in the buildings of Darnall Army Community Hospital (DACH) and III Corps Headquarters.

Fort Hood's DACH, Building 36000, operates three, 10.2 million-British thermal units per hour (MBtu/hr), Cleaver Brooks Model CBLE 200-250 boilers that provide steam for hospital operations. These boilers fall under the Installation’s Title V Operating Permit and PBR 106.183. Both of these permits have monitoring requirements that include oxides of sulfur (SOx), opacity, and particulate matter (PM) for the Title V permit and oxides of nitrogen (NOx) for the PBR. The existing equipment could take oxygen readings only.

The primary fuel source for these boilers is natural gas. They also have the capability of operating on diesel fuel oil as a backup. All boilers vent directly to the atmosphere. The Texas Commission on Environmental Quality has the authority to request stack tests for SOx, NOx emissions, opacity, and PM at any time. Fort Hood voluntarily performed a stack test for carbon dioxide, sulfur dioxide, NOx, opacity, and PM on 12 and 17-18 September 2003. The Title V permit also has provisions for alternate measurement of fuel consumption, which allows the Installation to maintain monthly records of fuel usage. The central energy plant originally had one gas meter for all three boilers. That metering setup was not sufficient to meet the permit requirements because there are consumption limits on individual boilers. Because there was no metering system for individual boilers, the possibility of potential emissions problems could not have been investigated properly and any adverse process conditions could not have been corrected.

There are also three diesel-fired 1,000-kilowatt (kW) emergency generators at DACH and three diesel-fired 1,320-kW generators at the III Corps Headquarters, Building 1001. Conditions of the permit for these generators limit their operation to 500 hours annually to avoid triggering Prevention of Significant Deterioration for NOx. The Installation needed a method to validate that these units operate under permit limits.

Fort Hood also has a catalytic recuperative thermal oxidizer on one of its four spray booths at Building 88027. Before this project, natural gas flow rates to this device were not measured for use in the calculation of emissions, as was required. Fuel consumption was being estimated to prepare annual emissions inventories.

Objectives

The primary objective of the project was to design and install monitoring systems on the Fort Hood air emission sources mentioned above. The information provided by these systems could be used for instant data demonstrating compliance, necessary Title V recordkeeping data, reducing combustible emissions, increasing boiler efficiency, and alleviating time and cost of performing a stack test.

Approach

With assistance from the Fort Hood Environmental Department, MSE was able to: (1) determine the minimum measurement and monitoring equipment necessary to achieve Title V compliance and (2) evaluate alternative fossil fuel flow measurements and air emission monitoring devices for implementation at Fort Hood. MSE designed monitoring systems that use commercially available programmable logic controllers (PLCs), flowmeters, and panels. Part of the design was the programming necessary to operate the systems and to record needed data so that the operators could easily manipulate the data into report form. The systems measure boiler and generator fuel usage and generator runtimes.

Monitoring systems were installed at three Fort Hood buildings:

- Darnall Army Community Hospital (Building 36000) – Three large boilers were fitted with systems to monitor the use of both natural gas and fuel oil. The three emergency boilers at DACH were fitted with runtime monitoring systems.

- III Corps Headquarters Building (Building 1001) – Three generators were fitted with runtime monitoring systems.

- Building 88027 – The catalytic recuperative thermal oxidizer that treats volatile organic emissions from painting operations was fitted with a natural gas monitoring system.

Description of Monitoring System Equipment

An air source monitoring system has two major elements: the field software and the field hardware. System information is depicted on a monitor. Typically the operator controls the system through a Human-Machine Interface (HMI). Input to the system normally initiates from the HMI, and the system employs algorithms embedded into its programming that allow local optimization.

Remote field devices (e.g., flowmeters) record data via the HMI. Modbus® is a nonproprietary control protocol that is accommodated by a majority of control vendors. By using this protocol, any of the site systems listed below can adapt and expand in the future without regard to a proprietary architecture but rather with regard to what is best for the system.

- programmable logic controllers (PLCs) such as the Modicon TX Momentum processors and input/output modules
- local HMIs such as the cutler Hammer PanelMate
- field instruments and equipment such as flowmeters (e.g., AW company and Sierra)

Programmable Logic Controllers (PLCs)

PLCs are industrial electronic devices that can be programmed to control and monitor a process. For the Fort Hood equipment, PLCs are used to acquire flow data and runtime status. The following are the emission points to be monitored at remote sites.

- boiler fuel flow rates (natural gas and #2 fuel oil); and
- runtime status from generators

PLCs can be programmed to provide control plus an interface to data, instruments, and field equipment.

Flowmeters and Transmitters

Sierra insertion mass flowmeters (Series 640S) are good for natural gas flow monitoring installations. They have a microprocessor-based transmitter that integrates the function of flow measurement, flow range-adjustment, meter validation, and diagnostics in a probe-mounted housing. These meters may or may not have a local display, depending on the installation site.

The meters incur a low pressure drop, have an output signal of 4–20 milliamps (mA), and include an integral totalizer. They are a reliable solution for low flow sensitivity (for gases) and have a fast response and large range ability.

The AW Company flow "meter" is a composite of several pieces of field equipment. The flow element is a series JVM partnered with a series MAG transmitter. In turn, these transmit the data to the flow-indicating transmitter N-RT-Ex3, which brings the signal into the Modicon module. A local display on the panel is also an AW Company item.

The information from both kinds of meters is sent by a transmitter through a serial port to the HMI. The Flocat transmitter (C-OH70-A Series) is installed on the Flocat C-OH45-E series of flowmeters. The electrical alternating current signal generated by the flowmeter is transformed within this transmitter to a 4- to 20-mA signal. From the flowmeter input, a preamplifier amplifies the input and filters it. The input is then converted into a square wave and sent to the PLC (or a microcontroller). Within the PLC, all the calculations are made to convert this wave to a flow rate.

Installation of Monitoring Systems at Fort Hood

Although the sites at Fort Hood were generic in their needs for reporting, the physical layouts were unique. These sites needed special considerations due to physical limitations or locations of piping and instrumentation. It was also apparent during the initial inspections that these sites had obsolete or outdated meters.

The design chosen included a system that will monitor and control the air emissions fuel usage processes of stationary generators at the DACH (Building 36000) and the III Corps Headquarters (Building 1001). The system also monitored the fuel usage of the catalytic recuperative thermal oxidizer at Building 88027. The monitoring system designed for each site included a PLC, an HMI display panel, and field instruments and equipment such as flow meters.

MSE had specific panel designs for each site, but the commonality between them all was the MSE panel that transmitted data to the local HMI for the operator to easily see. The DACH and III Corps sites required Cutler Hammer PanelMate interfaces. Building 88027 had a regular unmodified MSE panel.

The last step of the system integration was programming the PanelMate and programming for the information data recording. After installation, the information could be easily recorded by the operator and manipulated into report form. In addition, generator runtimes could be accurately recorded.

DACH Building 36000

At the DACH (Figure 1), a panel was installed on the boiler room's east wall. Figure 2 shows the front of the installed panel. New flowmeters were also installed on each boiler. For natural gas, Sierra insertion mass flowmeters (model # 640S-NAA-L13-EN2-P2-V6-DD-9) were used (Figure 3). These have local indicators and a pulse rate of 1 = 2.78 standard cubic feet. A local indicator in the panel counts the totals (AW FEM03-A).

For #2 fuel oil boilers, we installed AW Company positive displacement flow elements (JVM-20 kilovolts) with transmitters (MAG-Ex-AP) on the pipeline (Figure 4). This installation was coupled with the flow-indicating transmitter (AW Company N-RT-Ex3). A local indicator in the panel counts the totals (AW FEM03-A).

Calibration sheets for each meter are available in the Operations and Maintenance (O&M) manuals. All signals verified that the PLC input calculations were correct within the PLC.

The generator runtime status signals were taken from the panels of each generator (Figure 5). The information available was only runtime data for generators; consequently, approximate fuel usage was obtained by multiplying runtime by the maximum burn rate of the generators. This "field decision" was made because generators typically have a supply line, a return line, and (most critical) a day tank, which makes it extremely difficult to measure actual fuel usage. These signals were input to the panel, and operation was verified after the work was completed by checking the input light-emitting diodes (LEDs) on the input/output base. All information was sent via the Modicon modules to the Cutler Hammer PanelMate HMI for recording and viewing operations.

Figure 1. Boilers at DACH.

Figure 2. Front of MSE-installed DACH panel.

Figure 3. Gas meter on a DACH boiler.

Figure 4. Oil meter on a DACH boiler.

Figure 5. Generator panel at DACH.

III Corps Headquarters (Building 1001)

At III Corps, the MSE panel was installed on the south wall of the generator room (Figure 6). Power for the MSE panel was taken from the panel in the E181 Mechanical Room. From the panel, individual wires go to each runtime contact on each generator.

The generator runtime status signals were the only information needed from this site (Figure 7). Like the generators at DACH, the information available was only runtime data; consequently, approximated fuel usage was obtained by multiplying runtime by the maximum burn rate of the generators. These signals were input to the panel, and proper operation was verified after the work was complete by checking the input LEDs on the input/output base. All information was sent via the Modicon modules to the Cutler Hammer PanelMate HMI for recording and viewing operations.

Figure 6. MSE panel at III Corps Headquarters building.

Figure 7. Generator panel at III Corps Headquarters building.

Paint Booth Building 88027

At Building 88027, the MSE panel was installed outside of the building (Figure 8 and Figure 9).

Figure 8. Panel on exterior of Building 88027.

Figure 9. Inside of exterior panel at Building 88027.

Power for the MSE panel was taken from the nearby voltage at open circuit (VOC) panel. New flowmeter wires were installed from the MSE panel to the meter.

A new Sierra insertion mass flowmeter for natural gas (model # 640S-NAA-L09-EN4 [40 ft]-P2-V6-DD-9) was installed on the gas inlet pipe for the catalytic recuperative thermal oxidizer (Figure 10 and Figure 11). Calibration sheets for the meter are available in the O&M manuals. All signals verified that the PLC input calculations were correct within the PLC.

Figure 10. Sierra meter at Building 88027.

Figure 11. Sierra meter remote display at Building 88027.

Discussion and Recommendations

MSE personnel made a follow-up visit to Fort Hood to inspect the air emissions source monitoring systems in October 2006. Except for the HMI display at DACH, all displays appeared to be functioning correctly. The operators at each installation confirmed that they were using the systems.

MSE found that the HMI display of generator runtimes at DACH was not reporting correctly, even though the LED readouts on the same panel appeared to be displaying correctly. The cause of the display error was not determined. MSE recommended troubleshooting the runtime programming on the HMI at DACH.

MSE also recommended that Fort Hood investigate the possibility of expanding the system to other generators, boilers, and oxidizers. It may also be possible to link each site with a central monitoring station, which would allow Fort Hood to automatically check the status of each site and to potentially automate air emissions reporting.

The systems were expected to provide Fort Hood with an effective method to calculate air emissions from each of the sources. Benefits should include more accurate recordkeeping, less labor, and easier compliance with air pollution regulations.

MSE believes that such systems would be great assets to other military bases with air emissions reporting needs.

Appendix B:
Acronyms and Abbreviations

Term	Spellout
AR	Army Regulation
CERL	Construction Engineering Research Laboratory
CFR	Code of the Federal Regulations
CAA	Clean Air Act
DA	Department of the Army
DACH	Darnall Army Community Hospital
ERDC	Engineer Research and Development Center
FMSP	Facility Modernization and Sustainability Program
GHG	greenhouse gases
HMI	human machine interface
HQUSACE	Headquarters, U.S. Army Corps of Engineers
kW	kilowatt
LED	light emitting diode
mA	milliamp
Mbtu/hr	million British thermal units per hour
MSE	MSE Technology Application, Inc.
NOx	oxides of nitrogen
O&M	operations and maintenance
PBR	permit by rule
PDF	portable document format
PLC	programmable logic controller
PM	particulate matter
POC	point of contact
PWTB	Public Works Technical Bulletin
SOx	oxides of sulfur
URL	Univeral Resource Locator
USEPA	U.S. Environmental Protection Agency
VOC	voltage at open circuit
WWW	World Wide Web