EXECUTIVE SUMMARY

Climate Management System (CMS) for Corrosion Control Facilities (CCFs)

ESTCP Project EW-201345

MAY 2018

Distribution Statement A
This document has been cleared for public release

Page Intentionally Left Blank

This report was prepared under contract to the Department of Defense Environmental Security Technology Certification Program (ESTCP). The publication of this report does not indicate endorsement by the Department of Defense, nor should the contents be construed as reflecting the official policy or position of the Department of Defense. 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 Department of Defense.

Page Intentionally Left Blank

EXECUTIVE SUMMARY

Project: EW-201345

TABLE OF CONTENTS

Page

1.0 INTRODUCTION 1
2.0 OBJECTIVES 2
3.0 TECHNOLOGY DESCRIPTION 3
4.0 PERFORMANCE ASSESSMENT 7
5.0 COST ASSESSMENT 8
6.0 IMPLEMENTATION ISSUES 9

LIST OF FIGURES

Page

Figure 1. Schematic of Interactions Between Existing System (blue box) and the CMS (red box) 3

Figure 2. Diagram of Existing ICS and CMS Components 4

Figure 3. Screenshot of the Dashboard to Be Displayed on the CMS Terminal in Building 59. 5

Figure 4. Screenshot of the Initial Dashboard to be Displayed on the CMS Terminal in Building 59. 5

Figure 5. Example Summary Energy Usage Report. 6

Figure 6. Predicted and Actual Whole-Building Electricity Usage Before and After the Installation of the CMS. 7

1.0 INTRODUCTION

Many Department of Defense (DoD) facilities include climate-controlled buildings. Industrial buildings in particular may require energy intensive heating and cooling, and these requirements may vary depending on operations. Furthermore, Corrosion Control Facilities (CCFs) pose multiple climate control challenges. For example, depainting and painting aircraft in a hangar requires careful monitoring and control of lighting, air flow, temperature, relative humidity, and concentrations of particulate matter (PM) and volatile organic compounds (VOCs), not only to optimize conditions for depainting and painting but also to ensure the health, safety, and comfort of personnel.

2.0 OBJECTIVES

Minimizing energy use in CCFs can be especially challenging because of the intensity and breadth of environmental control requirements including (i) lighting control; (ii) generating hot water and steam; (iii) providing breathing air; (iv) removing hazardous air pollutants; (v) heating; (vi) cooling, and (vii) meeting air flow standards—all changing with work flow. It is important to manage this energy use carefully.

The 225,000 ft^2 B59 CCF at Robins Air Force Base (AFB) includes the following: two 65,000 ft^2 hangar bays used to depaint and paint aircraft; a small-parts paint bay; common central facility systems; and a process equipment plant. B59 is designed to optimize paint removal and application for C-5, C-17, and other similar-sized aircraft, and increase the level of health and safety for Base employees. B59 uses approximately $1.7M of electricity and $250K of gas per year, or about 8% and 7%, respectively, of the Robins AFB totals ($20.3M and $3.6M, respectively, FY2011).

Generally, the hardware, sensors, and building controls in B59 are designed, sized, and installed properly and, when functioning, operate well to condition B59 as designed. However, observations indicate that lighting is maintained, steam and hot water boilers run, and conditioned air is moved at full flow through hangars even in the absence of aircraft. Therefore, there are energy savings opportunities in B59 related to energy management.

Tools that improve the sensing, tracking, processing, and communication of information among B59 personnel would allow for continuous "retro-commissioning" of the facility for better operation of existing hardware to ultimately decrease energy use while maintaining or improving workflow, product quality, and worker health and safety.

3.0 TECHNOLOGY DESCRIPTION

A Climate Management System (CMS) was designed to increase the ability to identify, prioritize, and communicate needed maintenance, system upgrades, and other energy savings opportunities. CMS desktop software was installed on paint shift supervisor desktops and dashboards were displayed on monitors installed in a highly visible location: the hallway outside the office of the painting supervisor that is immediately next to the entrance to the hangar. The supervisor was asked, when beginning a new shift, to input the specific activity to be performed, and was guided to set the building to the appropriate mode based on the task being performed.

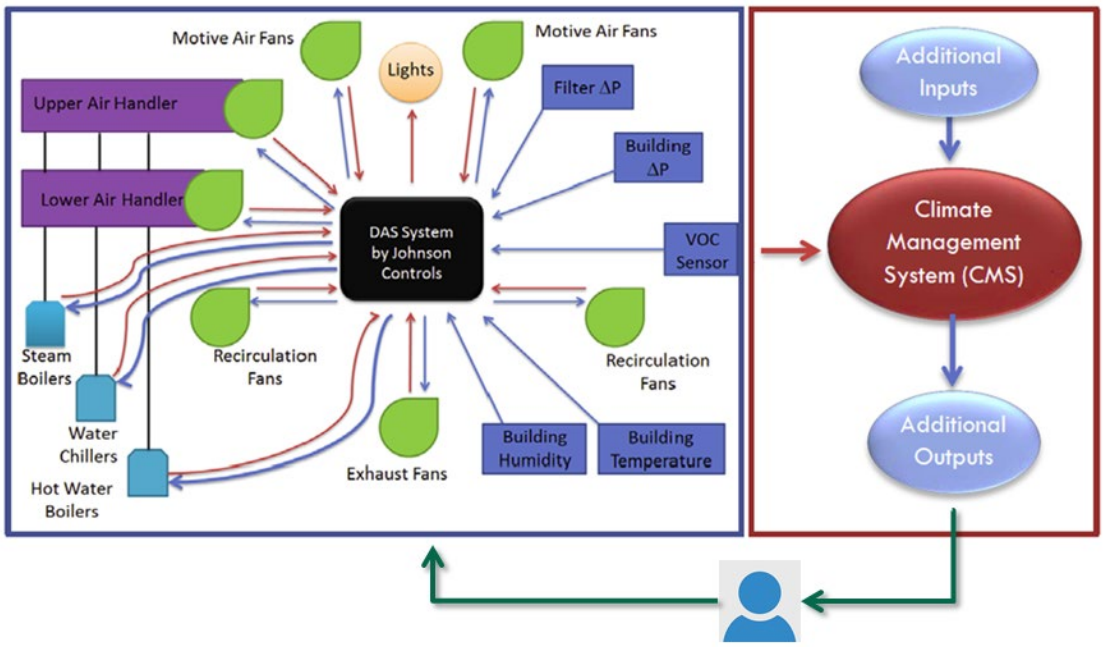

Figure 1. Schematic of Interactions Between Existing System (blue box) and the CMS (red box).

In addition to a real-time dashboard, the team worked with B59's management to develop a summary report, for use by supervisors and other management providing analysis related to overall performance and energy usage. 15-minute interval data from the building automation system (BAS) was periodically downloaded, typically on a one-week frequency, but occasionally more or less frequently, to extract fan speed, mode usage, and other information. Data were reduced, summarized, and reported to appropriate staff at B59. The report provides a color-coded representation of mode usage for the current week of reporting, along with data from the previous three weeks, therefore allowing management to quickly compare mode usage to the tasks that were performed during a given week.

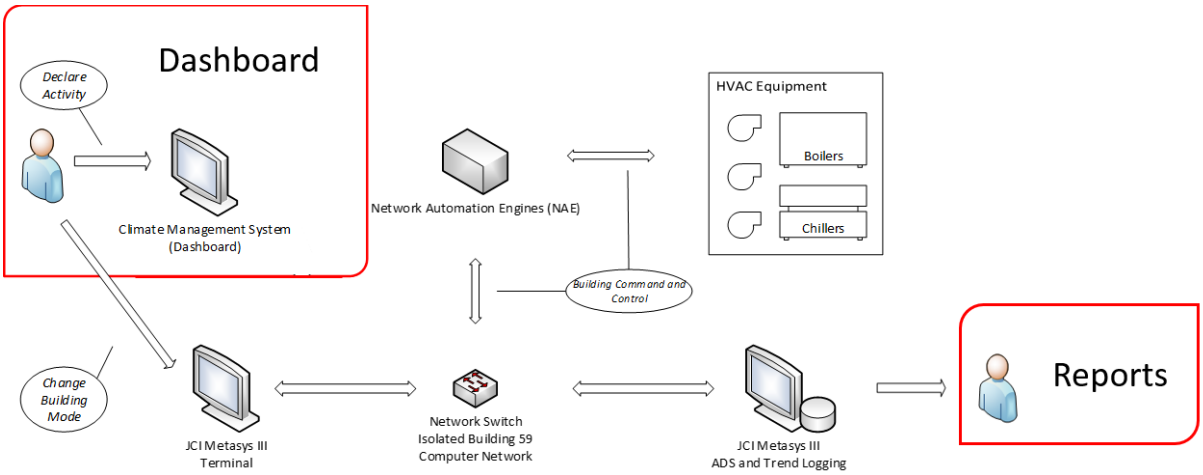

Figure 2. Diagram of Existing ICS and CMS Components.

The primary advantage of the CMS is that augmentation of existing Industrial Control System (ICSs), rather than replacement, allows the CMS to be readily translated to other DoD facilities. The majority of ICSs operate on "refresh" rate of 20 years, meaning that the physical components including boilers, chillers, fans, and associated sensor networks are replaced on a 20-year cycle. Since the primary purpose of the CMS is to gather building use information and make base personnel more aware of how their use of the existing ICS affects energy consumption rather than direct control of the existing CMS, the system can be installed side-by-side without disrupting the existing ICS.

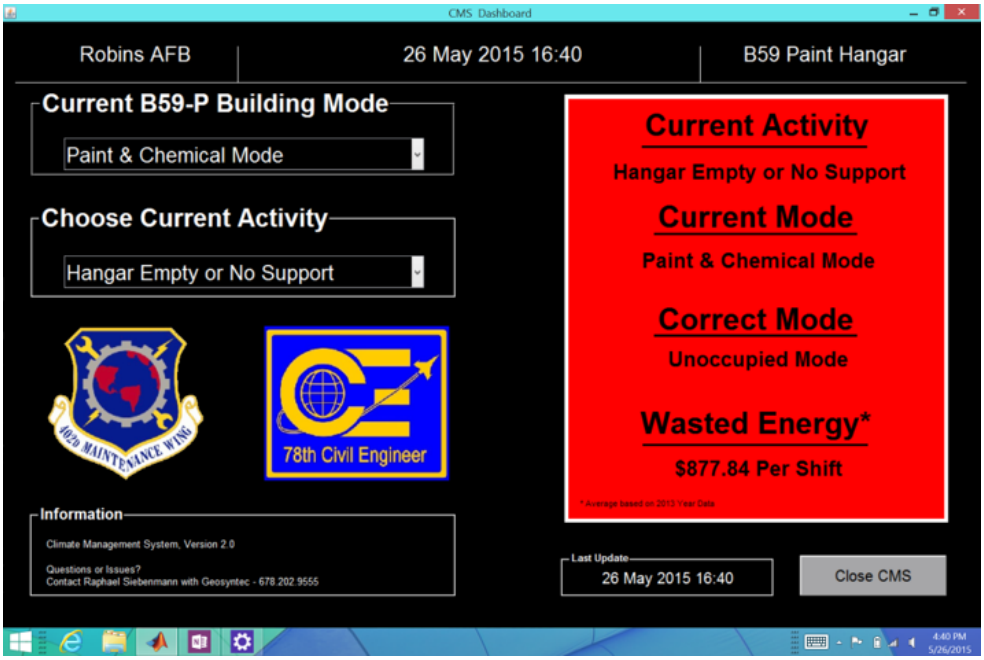

Figure 3. Screenshot of the Dashboard to Be Displayed on the CMS Terminal in Building 59.

The red box indicates that the wrong mode has been selected for the current activity.

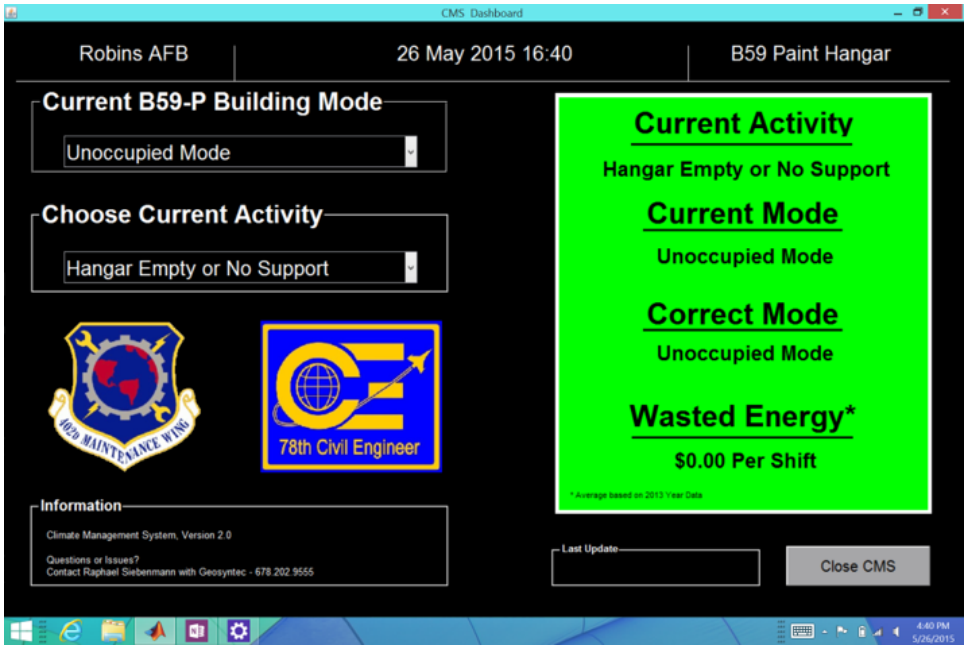

Figure 4. Screenshot of the Initial Dashboard to be Displayed on the CMS Terminal in Building 59.

The green box indicates that the correct mode has been selected for the current activity.

The primary limitation of the technology is reliance on organizational acceptance and organizational behavioral change in a challenging environment. The team observed an overall lack of positive participation from B59 personnel, and fatigue with the system set in quickly. Communication and close coordination with all levels of stakeholders, including upper management, shift supervisors and operators, is required to ensure the CMS is successfully integrated into facility operations.

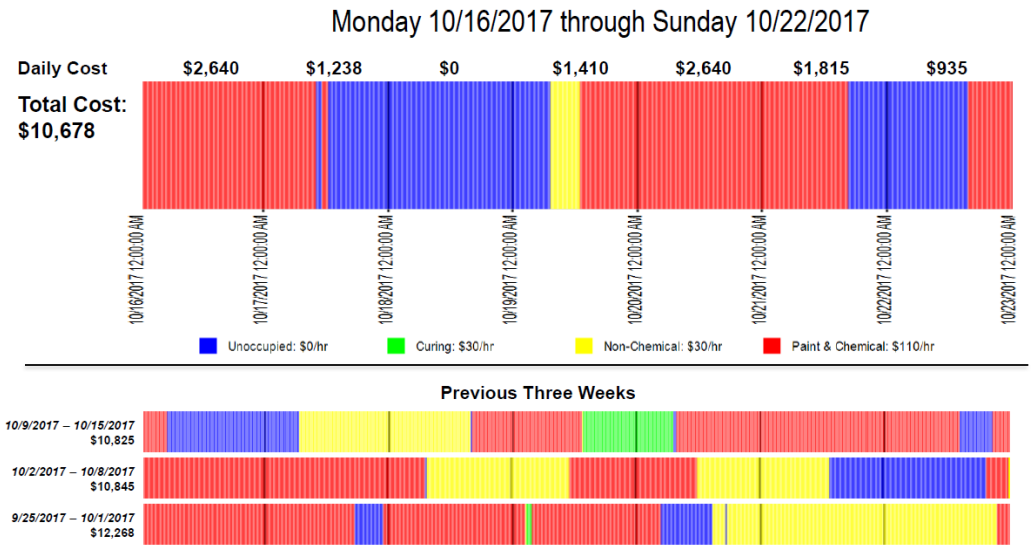

Figure 5. Example Summary Energy Usage Report.

The primary hypothesis tested in this demonstration was if the CMS system could decrease the electricity and gas usage by 10-20% through training and organizational behavior modification that did not involve financial incentives, but rather through providing an increased awareness of excess building energy consumption. The team believed that the core of this savings would be derived by more specifically mapping tasks to operational modes and by providing sustained tracking, assessment, and reporting. In this way, the team believed that the building's ICS would more often be operated in the correct mode and energy consumption would be reduced.

The test design involved a comparison of before and after electricity usage, gas usage, and required costs to determine the effectiveness of the CMS system. The test phases included pretest preparation, baseline measurements, equipment installation, calibration, commissioning, data collection, and data analysis. The baseline measurements were determined from reports from Robins AFB regarding the electricity usage and gas usage as well as historical usage and scheduling data.

4.0 PERFORMANCE ASSESSMENT

Analysis of the data indicate that the CMS did not change the behaviors of B59 staff and thus energy consumption did not achieve the performance targets. However, the potential energy savings at B59 are still significant, and estimated to be on the order of 17% of fan energy and 10% of chiller-energy.

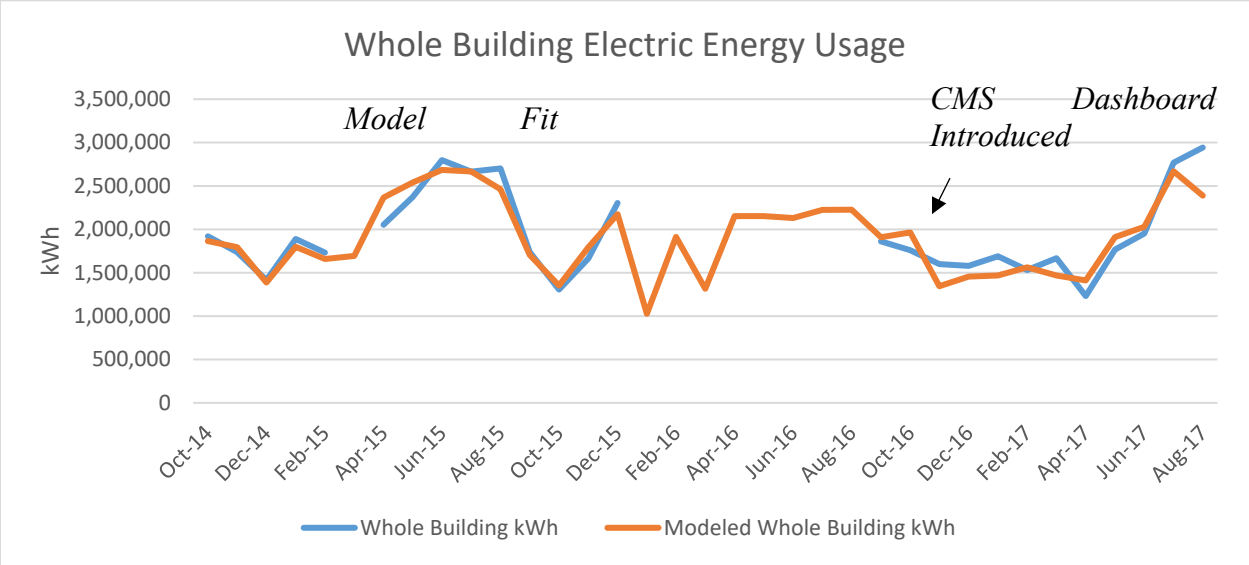

Figure 1. Predicted and Actual Whole-Building Electricity Usage Before and After the Installation of the CMS.

5.0 COST ASSESSMENT

While training sessions with the B59 management and supervisors were held, and the potential for cost savings quantified, at the end of the day, relying on non-financial and social incentives appears to have failed. This leads the team to believe that a financial incentive program to reward use of the CMS would likely yield more positive results, and thus Building Lifecycle Cost scenarios were modeled with financial incentives to understand at which point an incentive program would begin to cost more than the potential energy savings.

6.0 IMPLEMENTATION ISSUES

The primary implementation issue during the demonstration period was the general lack of usage of the CMS. Despite frequent visits by the project team and solicitation of feedback on the performance of the system, it appears that the CMS did not in and of itself result in a change in organizational behavioral modification. It is believed that quickly after installation of the digital signs, fatigue set in and the dashboards and reports developed became something that did not trigger attention.

A significant implementation challenge encountered by the team was the lack of experience with the DoD Risk Management Framework (RMF), which resulted in the extended duration of the demonstration due to the time required to obtain Authorization to Operate (ATO). Recently developed RMF framework training programs, Environmental Security Technology Certification Program (ESTCP) publications, including the current ESTCP Installation Energy and Water web portal provides a wealth of requirements documents, manuals, plans, memos, resources, tools, templates, and checklists that would have been invaluable to the investigative team at the beginning of the project.