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Integrated Climate Assessment for Army Enterprise Planning

Building Maintenance Model User's Guide

Byron M. Garton

July 2019

Information Technology Laboratory

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Building Maintenance Model User's Guide

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Final report

Prepared for U.S. Army Corps of Engineers
Washington, DC 20314-1000

Under Project 402188 Integrated Climate Assessment for Army Enterprise Planning

Abstract

The Building Maintenance Model determines future maintenance costs of military facilities by using a Corrosion Model and a cost estimation formula. The Corrosion Model predicts the corrosion index for various metals at a given site. This is accomplished by applying statistical analysis to the weather data and then mapping the weather data to the atmospheric corrosion data.

This document describes the process of executing the Building Maintenance Model, as it exists at the time of this writing, within the common computational environment established under the software integration effort of the Integrated Climate Assessment for Army Enterprise Planning work package.

Contents

Figures

Figures

Preface

This research was conducted for the U.S. Engineer Research and Development Center-Construction Engineering Research Laboratory (ERDC-CERL) under Project 402188, Integrated Climate Assessment for Army Enterprise Planning. The Technical Monitor was Dr. James D. Westervelt of ERDC-CERL.

The work was performed by the Information Technology Laboratory (ITL), Scientific Software Branch (SSB), of the Computational Science and Engineering Division (CSED). At the time of publication, Mr. Timothy W. Dunaway was Chief of the SSB, Dr. Jerrell R. Ballard was Chief of the CSED, and Mr. Robert M. Wallace was the Technical Director. The Deputy Director of ERDC-ITL was Ms. Patti S. Duett, and the Director was Dr. David A. Horner.

COL Ivan P. Beckman was the Commander of ERDC, and Dr. David W. Pittman was the Director.

1 Introduction

1.1 Background

The potential cost of increased maintenance on metal buildings due to corrosion caused by climate change is a particularly important factor to consider for force stationing analysts. The Building Maintenance Model attempts to predict corrosion to Army facilities where metal is the primary building material. The model predicts a corrosion index for various types of metals when given a relative humidity value as an input variable which is then adjusted for predicted climate change effects. Those corrosion indices are then applied to the identified buildings on each installation using a cost estimation formula to determine the total cost of corrosion for each building. The calculated corrosion cost is intended to be utilized in other force stationing analysis applications as a Military Value Analysis (MVA) attribute.

1.2 Objective

The Building Maintenance Model makes use of a common computational environment and a user assistance application that were implemented as part of the Software Integration effort within the Integrated Climate Assessment for Army Enterprise Planning work package. The virtual environment will be referred to throughout this document as the Virtual Machine or VM, and the user assistance application will be referred to as the Wizard. For more information about the Software Integration effort, the virtual environment, and the user assistance application, refer to *Analytical Model Integration Methods* (Garton 2017).

Executing the Building Maintenance Model is a four-step process that requires using Microsoft Access, Excel, and an internet browser. Each step for viewing and building data sets is thoroughly documented in the following sections to limit user confusion and ensure accurate results.

1.3 Requirements

Software requirements for the Building Maintenance Model include Microsoft Access and Microsoft Excel version 2013 or higher. Data collection prior to model execution requires an internet connection and internet browser.

A working knowledge of Microsoft Office products is recommended as well as a basic understanding of accessing websites and downloading files from the internet.

2 Viewing Computed Data

Unfortunately, output data was not generated for this model prior to the completion of the Software Integration effort. However, new output data may be generated by following the steps detailed in the next section.

3 Building New Data

The procedure for building new data consists of four steps. First, facility data must be collected from the internet. The Headquarters Installation Information System (HQIIS) provides access to a database of all assets known to exist on various Army installations. This database includes buildings and facilities that are of interest to this model. Download the current and historic databases from the Office of the Assistant Chief of Staff for Installation Management's website at http://www.acsim.army.mil/. Existing copies of the database for FY 15, 16, and 17 are located on the VM at `C:\Models\Building-Maintenance\Model`.

The second step in this model is to build a scenario inside the Corrosion Model Database. The database is located within the VM at `C:\Models\Building-Maintenance\Model\CorrosionModel_v101107_nl_2024`. The database may be launched from the Wizard by clicking the Building Maintenance icon from the start screen, then clicking the Open Corrosion Database button on the second model screen. (Figures 1 and 2).

Figure 1. Building Maintenance Model icon on the home screen.

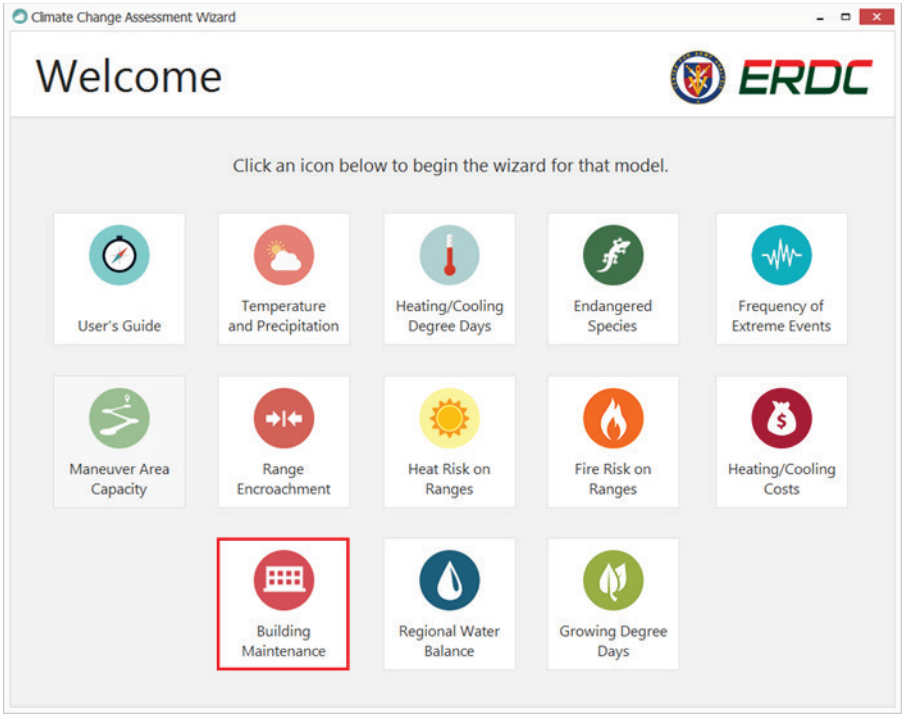
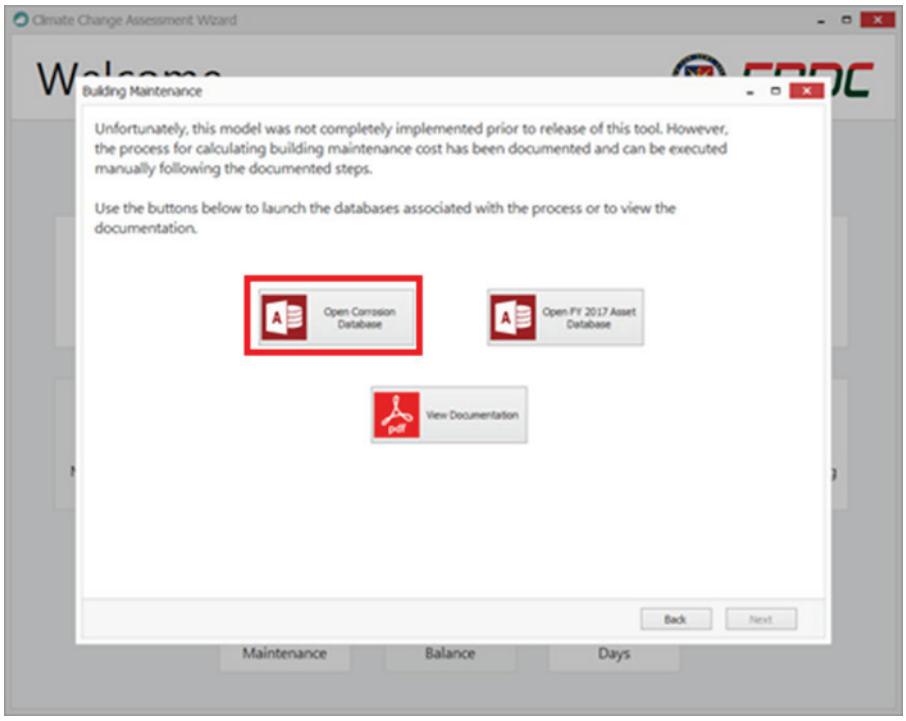
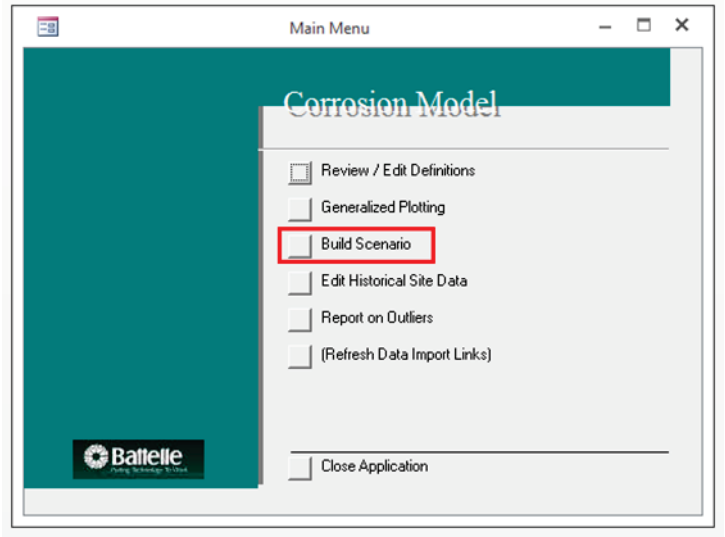


Figure 2. Open the corrosion database.



Once the Corrosion Model database has been launched, click the *Build Scenario* button within the start screen (Figure 3).

Figure 3. Corrosion Model database start screen.



For each location analyzed, required inputs for the scenario are 12-month weather data variables for precipitation, RH70, RH80, RH90, and chloride, where *RH* stands for Relative Humidity. This data should be calculated in a separate effort, preferably in a spreadsheet, then copied

manually into the model. The following equations should be used to calculate RH, where t = wet bulb temperature and *td*= dry bulb temperature (Figure 4).

Figure 4. Relative humidity (RH) formulas.

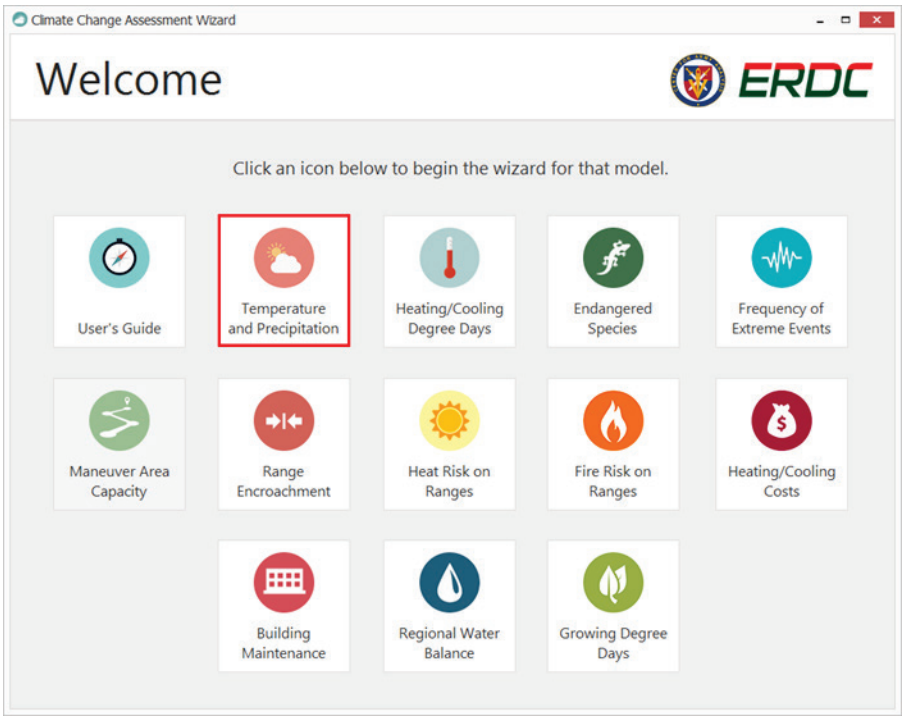
$$\mathrm{RH} \approx 100 - \beta_2 \left(t - t_d\right),$$

$$\beta_2 = \frac{L\left(\mathrm{RH} - 100\right)}{R_w T T_d \ln\left(\frac{\mathrm{RH}}{100}\right)} = \beta_1 \left[\frac{\left(\frac{\mathrm{RH}}{100} - 1\right)}{\ln\left(\frac{\mathrm{RH}}{100}\right)}\right].$$

This equation is further defined by Lawrence (2005) on page 229. This document is located within the VM at `C:\Models\Building-Maintenance\Documentation\BAMS-86-2-225.pdf`.

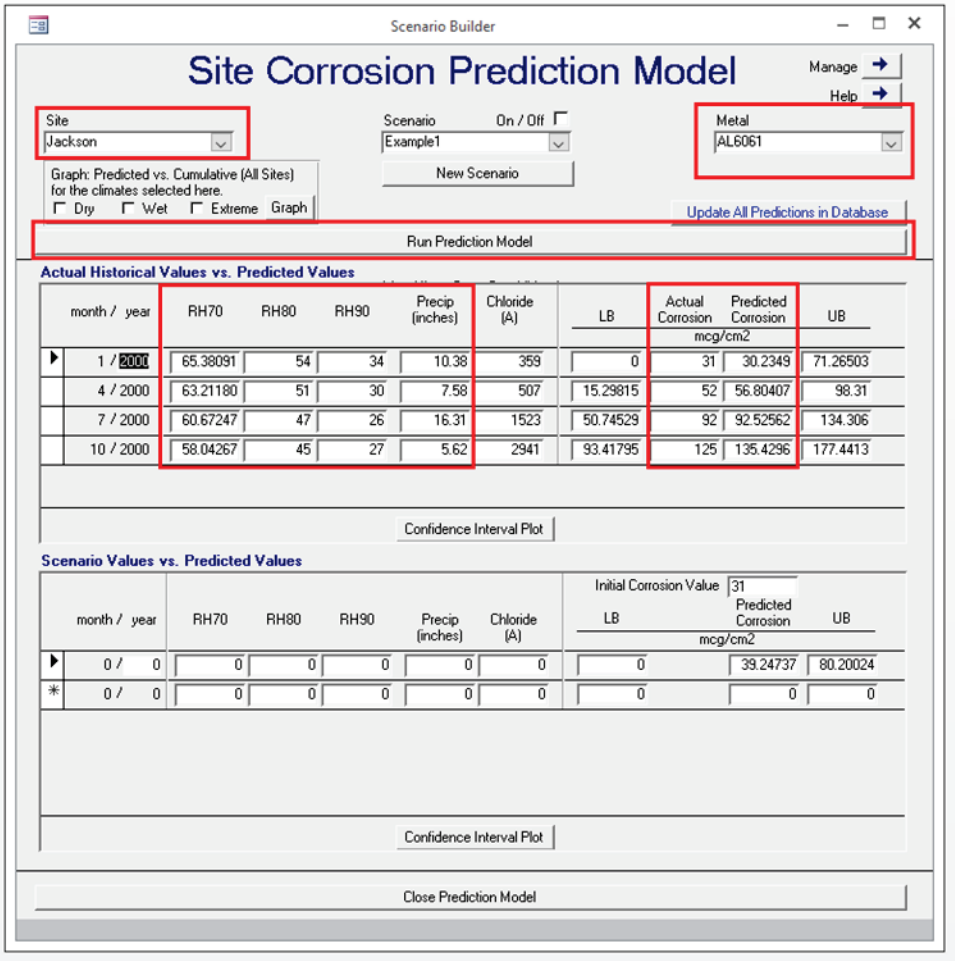
Precipitation values should be acquired from the Temperature and Precipitation Model which is accessed within the Wizard by clicking the Temperature and Precipitation icon from the Wizard start screen (Figure 5). Refer to the user's guide for that model for more information on how to obtain precipitation values. The guide is located on the VM at `C:\Models\Help-Documents\PDF\Temp Precip User Guide.pdf`.

Figure 5. Temperature and Precipitation Model icon.



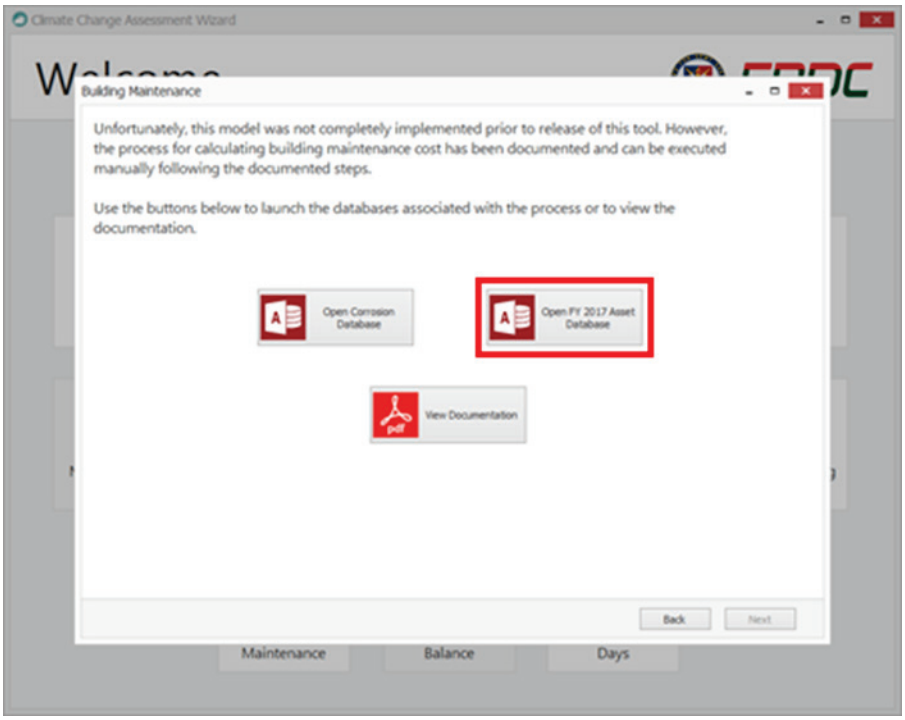
Use the calculated RH values and acquired precipitation values for the location to be analyzed to build the scenario. Once the scenario is properly built, click the *Run Prediction Model* button to calculate a corrosion index value. This value will be used in the final step of the process (Figure 6).

Figure 6. Corrosion scenario built and run.



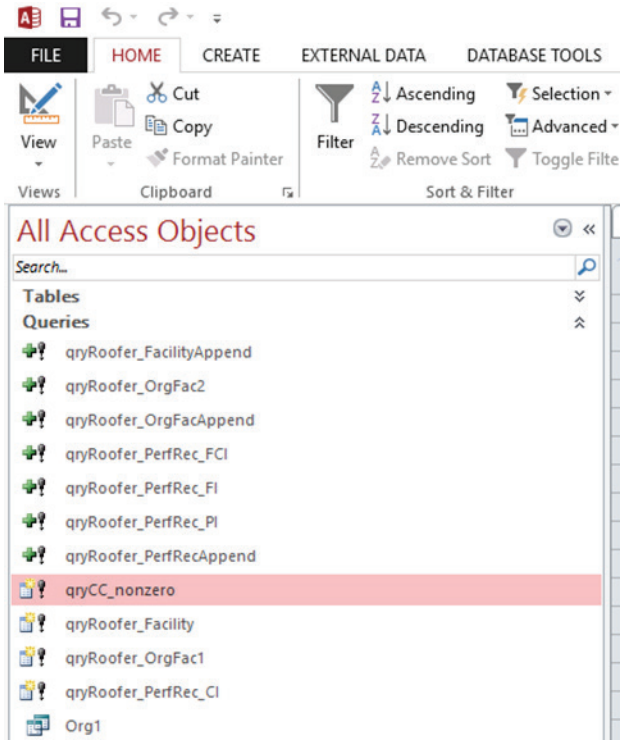
A predefined query is stored within the HQIIS databases. The third step in this model consists of executing that query to isolate asset data that is relevant to the installations that are being analyzed. The database for FY 17 can be launched from the Wizard by clicking the *Open FY 2017 Asset Database* button on the second model screen (Figure 7).

Figure 7. Open FY 2017 HQIIS database.



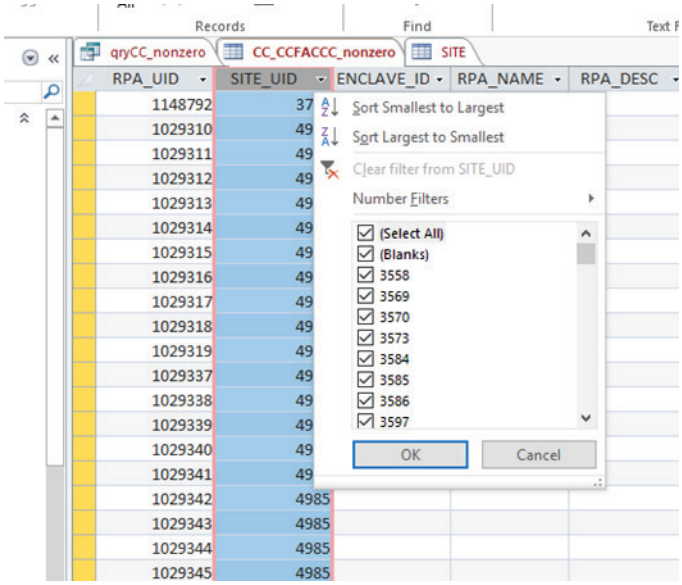
A predefined query named `qryCC_nonzero` is stored within the database. Run the query by double clicking it in the left side panel (Figure 8).

Figure 8. Execute the query by double clicking it.



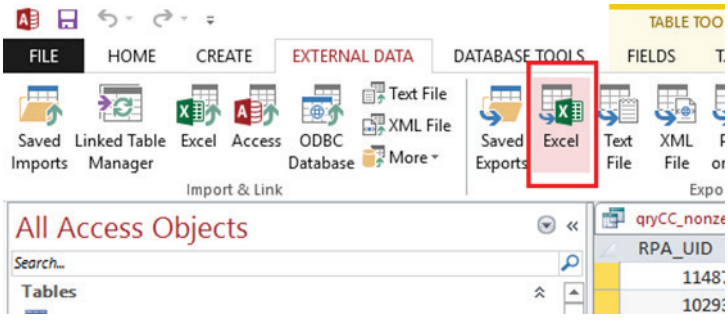
A new table named CC_CCFACCC_nonzero will be created with the query results. Within that table are all the assets of interest to the model for every installation in the database. To filter the results to just the site of current interest, identify the site ID by opening the SITES table. Look through the SITE_NAME field to locate the site of current interest and identify the SITE_UID associated with that site. Use that SITE_UID to filter the results in the CC_CCFACCC_nonzero table by using the filter down arrow (Figure 9).

Figure 9. Use the filter to limit results to the site of current interest.



Use the External Data tab in Access to export the filtered results from table CC_CCFACCC_nonzero to an Excel spreadsheet in preparation for the next step (Figure 10).

Figure 10. Export filtered table to Excel spreadsheet.



The final step in the process is to perform a simple mathematical calculation to determine the total sustainment cost of corrosion. In two empty cells outside of the main data columns in the spreadsheet created

previously, enter the actual and predicted corrosion costs from step one for the appropriate installation. Next, add an additional column to the spreadsheet data and enter a formula to multiply the ratio of the actual vs. predicted corrosion values times in the `SUS_CC column`. For example, if the actual corrosion value is in cell F2, predicted corrosion value is in cell G2, and `SUS_CC` is column D, the formula may look like this: =(F2 / G2) * D2. Copy that formula down to the last row of data using the cell fill handle. The value generated from this calculation is the predicted sustainment cost MVA attribute.

Remember to repeat this process for each installation to be analyzed.

4 Known Issues and Limitations

There are no known issues or limitations to discuss at this time.

5 Additional Help

Additional questions or concerns should be directed to the Program Manager (PM) of the Integrated Climate Assessment for Army Enterprise Planning program.

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217-373-4530

References

Garton, B. M. 2017. *Analytical Model Software Integration Methods*. Special Report on Integrated Climate Assessment for Army Enterprise Planning. ERDC/ITL SR-19-4. Vicksburg, MS: Engineer Research and Development Center, Information Technology Laboratory (ERDC-ITL)

Lawrence, Mark. 2005. *The relationship between relative humidity and the dewpoint temperature in moist air*. Junior Research Group, Department of Atmospheric Chemistry, Max Planck Institute for Chemistry. Mainz, Germany.

Morefield, Sean. 2015. *Development of a predictive corrosion model using locality-specific corrosion indices*. ERDC/CERL TR-09-02. Champaign, IL: Engineer Research and Development Center-Construction Engineering Research Laboratory (ERDC-CERL).

Appendix A: Acronyms and Abbreviations

Term	Definition
ERDC	Engineer Research and Development Center
ERDC-CERL	Engineer Research and Development Center, Construction Engineering Research Laboratory
ERDC-ITL	Engineer Research and Development Center, Information Technology Laboratory
FAC	Facility Analysis Category
GCM	Headquarters Installation Information System
MVA	Military Value Analysis
PM	Program Manager
RH	Relative Humidity

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. REPORT DATE *(DD-MM-YYYY)*	2. REPORT TYPE	3. DATES COVERED *(From - To)*
July 2019	Final	

4. TITLE AND SUBTITLE

Building Maintenance Model User's Guide

5a. CONTRACT NUMBER

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)

Byron M. Garton

5d. PROJECT NUMBER
402188

5e. TASK NUMBER

5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

Information Technology Laboratory
U.S. Army Engineer Research and Development Center
3909 Halls Ferry Road
Vicksburg, MS 39180-6199

8. PERFORMING ORGANIZATION REPORT NUMBER

ERDC/ITL SR-19-5

9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)

U.S. Army Corps of Engineers
Washington, DC 20314-1000

10. SPONSOR/MONITOR'S ACRONYM(S)

11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION / AVAILABILITY STATEMENT

Approved for public release; distribution is unlimited

13. SUPPLEMENTARY NOTES

The Building Maintenance Model determines future maintenance costs of military facilities by using a Corrosion Model and a cost estimation formula. The Corrosion Model predicts the corrosion index for various metals at a given site. This is accomplished by applying statistical analysis to the weather data and then mapping the weather data to the atmospheric corrosion data.

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15. SUBJECT TERMS

Buildings--Maintenance
Maintenance and repair--Costs
Corrosion
Climatic changes--Forecasting
Military bases

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			19b. TELEPHONE NUMBER *(include area code)*
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