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Integrated Climate Assessment for Army Enterprise Planning

Building Maintenance Model User's Guide

Byron M. Garton

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Building Maintenance Model User's Guide

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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.

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Contents

Abstract.....	ii
Figures.....	iv
Preface	v
1 Introduction	1
1.1 Background.....	1
1.2 Objective	1
1.3 Requirements	1
2 Viewing Computed Data.....	3
3 Building New Data	4
4 Known Issues and Limitations	12
5 Additional Help	13
References.....	14
Appendix A: Acronyms and Abbreviations	15
Report Documentation Page	

Figures

Figures

Figure 1. Building Maintenance Model icon on the home screen.....	4
Figure 2. Open the corrosion database.....	5
Figure 3. Corrosion Model database start screen.....	5
Figure 4. Relative humidity (RH) formulas.	6
Figure 5. Temperature and Precipitation Model icon.	7
Figure 6. Corrosion scenario built and run.....	8
Figure 7. Open FY 2017 HQIS database.....	9
Figure 8. Execute the query by double clicking it.	9
Figure 9. Use the filter to limit results to the site of current interest.....	10
Figure 10. Export filtered table to Excel spreadsheet.....	10

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_n1_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 t_d = dry bulb temperature (Figure 4).

Figure 4. Relative humidity (RH) formulas.

$$RH \approx 100 - \beta_2 (t - t_d),$$

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

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.

Scenario Builder

Site Corrosion Prediction Model

Site: Jackson

Graph: Predicted vs. Cumulative (All Sites)
for the climates selected here.

☐ Dry ☐ Wet ☐ Extreme ☐ Graph

Scenario: Example1 ☐ On / Off

Metal: AL6061

Actual Historical Values vs. Predicted Values

month / year	RH70	RH80	RH90	Precip (inches)	Chloride (A)	LB	Actual Corrosion mcg/cm2	Predicted Corrosion mcg/cm2	UB
▶ 1 / 2000	65.38091	54	34	10.38	359	0	31	30.2349	71.26503
4 / 2000	63.21180	51	30	7.58	507	15.29815	52	56.80407	98.31
7 / 2000	60.67247	47	26	16.31	1523	50.74529	92	92.52562	134.306
10 / 2000	58.04267	45	27	5.62	2941	93.41795	125	135.4296	177.4413

Scenario Values vs. Predicted Values

month / year	RH70	RH80	RH90	Precip (inches)	Chloride (A)	Initial Corrosion Value LB	Predicted Corrosion mcg/cm2	UB
▶ 0 / 0	0	0	0	0	0	0	39.24737	80.20024
* 0 / 0	0	0	0	0	0	0	0	0

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

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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

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