

FORT WAINWRIGHT ENERGY AND RESILIENCE THERMAL DEGRADATION TESTING PROTOCOL

1. Purpose

The purpose of this protocol is to define a repeatable method of testing the thermal degradation of structures in cold climates, specifically, on Fort Wainwright, AK and Fort Greely, AK. This protocol will also define the method used to measure outdoor variables, meter location recommendations and data management practices best suited for this project.

2. Temperature

Internal building temperature data is needed to identify critical building areas where temperature needs to be controlled to prevent damage to the building components and its systems and to calibrate computer models against real data.

3. Relative Humidity

Internal building relative humidity data is needed to supplement temperature data in identifying critical building areas where temperature needs to be controlled to prevent damage to the building components and its systems and to calibrate computer models against real data.

4. Weather Station

The data gathered by weather stations will be used for reference temperature, humidity, wind speed, and wind direction to identify boundary conditions across the building envelope and to establish temperature and humidity gradients to be used for test results generalization.

5. Step-By-Step Protocol

Step 1: Measurements and Equipment

The following measurements will be made:

- Date / Time
- Interior Temperature
- Interior Relative Humidity
- Exterior Temperature
- Exterior Wind Speed
- Exterior Wind Direction.

All measurements will be taken at a minimum interval of 01 minute. Shorter intervals are acceptable if required. This will give loggers sufficient memory

and battery life to sustain the testing duration. This will also give enough data to create simulations to predict trends.

Step 1a: 4-CH T Loggers

These tests will use wall-mounted HOBO data loggers made by Onset to measure and store the data. These loggers are small (about 2 in. by 4 in.) battery-powered, 4-channel loggers with on-board storage. They can be programmed to log at a variety of time intervals and can store 1.9 million measurements (329 days of T data per channel at 01-minute intervals). For this study we will use the UX120-006M HOBO loggers with four TMC20-HD Temperature probes (Accuracy: $\pm 0.15^{\circ}\text{C}$) for temperature measurements in critical areas. The “Push Button” box in the “Stop Logging” section of the “Launch Logger” window when launching the logger to prevent the accidental termination of data logging.

Step 1b: T&RH Loggers

The T&RH loggers are also wall-mounted HOBO data loggers made by Onset. They are very similar in size and operation, but have the added capability of measuring Relative Humidity. They can be programmed to log at a variety of time intervals and can store 84,650 measurements (52 days of T&RH data at 01-minute intervals). For this study we will use the UX100-003 HOBO loggers (Accuracy – Temp: $\pm 0.21^{\circ}\text{C}$; RH: $\pm 2.5\%$) for T&RH measurements of specified rooms. The “Push Button” box in the “Stop Logging” section of the “Launch Logger” window when launching the logger to prevent the accidental termination of data logging.

Step 1c: Weather Stations

These tests require local weather information to compare with interior sensor data. This will be provided by the on-site weather stations at Fort Wainwright and Fort Greely.

The Fort Wainwright weather station is located next to Bldg. 4070 (CRREL Building) and it consists of a Campbell Scientific CR1000 Datalogger, a Gill Instruments WindSonic anemometer (Accuracy – Dir/Vel: $\pm 2^{\circ}$ @ 12m/s), a Campbell Scientific CS215 air temperature and relative humidity probe (Accuracy – Temp: $\pm 0.4^{\circ}\text{C}$; RH: $\pm 2\%$) and a Vaisala PTB101B barometric pressure sensor (Accuracy – Press: $\pm 1\text{hPa}$ @ -20 to $+40^{\circ}\text{C}$). The anemometer and

air temperature / relative humidity sensors are located 3 meters above ground.

Step 2: Placement Guidelines

The success of this test will depend on careful and consistent placement of the sensors in each structure. Inconsistencies in placement or poorly placed sensors (such as in direct sunlight) will greatly reduce the usefulness of the data and may lead to skewed results. Critical spaces will be instrumented with a higher number of sensors. *See Diagrams in Appendix A.*

Step 2a: 4-CH Placement

The 4-channel Temp loggers should be installed in areas defined as critical locations (critical corners, doorways, etc.). The four TMC20-HD temperature probes will be distributed as follows:

- To the right of the logger
- To the left of the logger
- Above the logger (mounted on ceiling if possible)
- Below the logger (mounted on floor if possible).

The temperature probes can either provide surface or air temperature data, depending on which is required for specific locations.

Step 2b: T&RH Placement

The T&RH loggers should be installed in conjuncture with the 4-channel Temp loggers. Locations that are deemed critical will have at least one T&RH logger installed to measure ambient air temperature and relative humidity. These areas include, but are not limited to: center of external walls, slabs above unheated space and below unheated attics, in the middle of representative rooms on the first, last, and middle floors.

Step 2c: Logger Settings

The following settings must be initiated via the Onset software:

- A logger name description should be put in the Onset software and printed on the logger (or a label placed on the logger)
- Logger name description should include: logger serial number, logger type, specific

Fort, building number, room number / name, cardinal direction of wall mounted on

- Naming convention should be: S/N.LoggerType.Location.BldgNo.RoomNo.
- Example name description for UX100 deployed in Room 206, Building 4070 on Ft Wainwright: 20718840.100.W.4070.206
- Probes should be individually labeled for the UX100 logger to give adequate description of deployment location.
- Check to make sure battery level is at 100%
- Sensor on/off state: Do not measure the logger battery voltage during the field test
- A logging interval. Recommended 30 seconds for this test.
- Note the logger timestamp matches your computer's timestamp, make sure the computer's timestamp is consistent with the time zone.
- Stop logging: "When memory fills."

There may be instances where it is impossible to follow above guidelines. In these cases, the installer should use best judgment.

Step 3: Building Requirements

The buildings that are selected for temperature decay testing should follow the below guidelines whenever possible to ensure uniform data collection. It is recommended that all exterior doors remain closed for the duration of the testing.

Step 3a: Personnel Equipment

To maximize the accuracy of interior sensors, it is recommended that personnel turn off all computers, lights and other plug-in electronics to eliminate residual heat sources. All lights, plug-in equipment and the number of people inside the building during the test should be documented.

Step 3b: Building Conditioning

The Department of Public Works (DPW) personnel supporting this test will turn off heating equipment at a designated time after all the loggers have been installed. This time must be recorded. Once the internal temperature of the building has reach approximately 40 °F, the heating equipment should be turned back on. It must be verified visually that the temperature of the building is increasing before personnel leave the building.

Step 4: Documentation

Detailed records of the loggers and the buildings are essential to ensure correct interpretation of the data collected. It is recommended to populate a spreadsheet with all pertinent information.

Step 4a: Logger Information

The following information should be recorded for each logger:

- Logger name (S/N)
- Location (Fort Wainwright/Greely)
- Building Number
- Floor
- Room
- Detailed location (ie. On the North wall 5' above the floor)
- Any extra notes that may be useful.

Step 5: Log Time Duration and Removal

The loggers should be left in place for at least 24 hours before the building conditioning equipment is turned off and at least 24 hours after building temperature has returned to normal to make sure building loads and environmental conditions have stabilized after buildings have been in use by tenants and returned back to normal conditions.

Step 6: Data Collection and Aggregation

The information obtained during testing will be downloaded into Excel documents by team members to analyze.

6. Looking Ahead

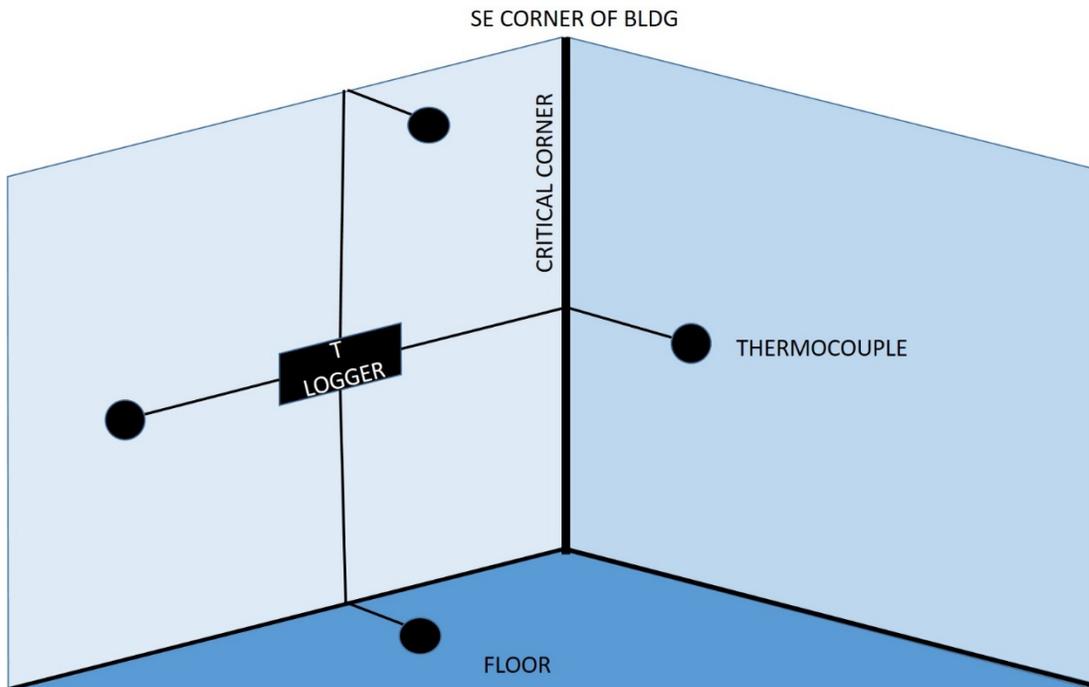
The main goal of the Thermal Degradation testing is to identify critical building areas where temperature needs to be controlled to prevent damage to the building components and its systems and to calibrate the computer model against real data.

The data recorded in this test may also be of interest to other researches to answer research questions. Therefore, when the final analysis report is published, the raw data set will be as accessible as possible.

7. Appendix A – Meter Location Diagrams

The following diagrams are proposed layouts for the logger positions.

7a: UX120-006M HOBO logger w/ TMC20-HD temperature probes



7b: UX100-003 HOBO T&RH logger

