Investigation of the Moisture Buffering Potential of Magnesium Oxide Board

Introduction

- Excess humidity is one of the main factors affecting building envelope failures.
- Additionally, it creates a favorable environment for mold growth on the interior finish of the building envelope which pose respiratory health risks to occupants.
- Controlling indoor humidity within an acceptable range is therefore important.
- Indoor humidity control is typically achieved by ventilation, however, excess ventilation negatively impacts the building energy performance.
- By employing interior finishes with moisture buffering potential; the ability of materials to absorb excess moisture when the indoor humidity is high and vice versa, indoor humidity control can be achieved passively thereby reducing the ventilation energy requirements.
- More benefits attributed to this moisture buffering phenomenon are: reduction of building latent heat load, cooling load and equipment size.
- Knowing that the moisture buffering potential varies for different materials, that of Magnesia board; a relatively new product, is not known and is investigated in this research project.

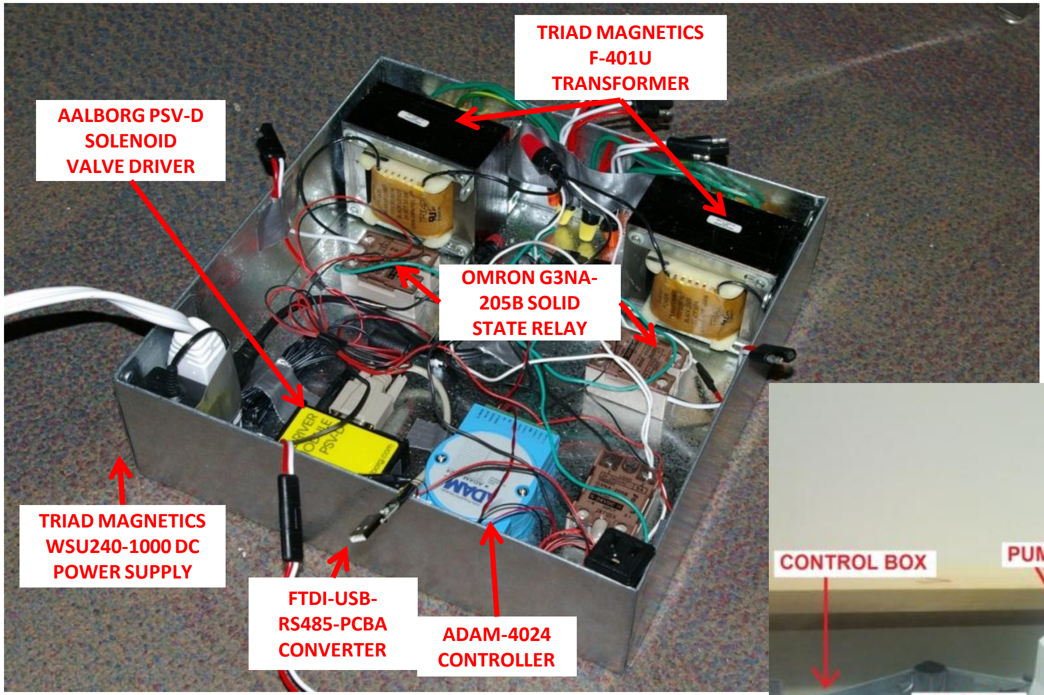
Research Scope

- The objective of this project was to investigate the moisture buffering potential of Magnesia board under different operation scenarios.
- This involved monitoring two identical side-by-side buildings while measuring the indoor air temperature and relative humidity to evaluate the moisture buffering potential.
- These two test buildings are called the Whole-Building Performance Research Laboratory (WBPRL).
- One of the buildings is set as a reference building and the second one as a test building.
- The interior of the reference building is finished with gypsum panels; the most common interior finish, and the test building will be finished with the magnesia board.
- Both buildings are exposed to the identical indoor hygrothermal loads generated by an in-house developed Indoor simulation system.
- The different operation scenarios are designed to access the effect of finishing, occupancy density, ventilation rate and control strategy and a combination.

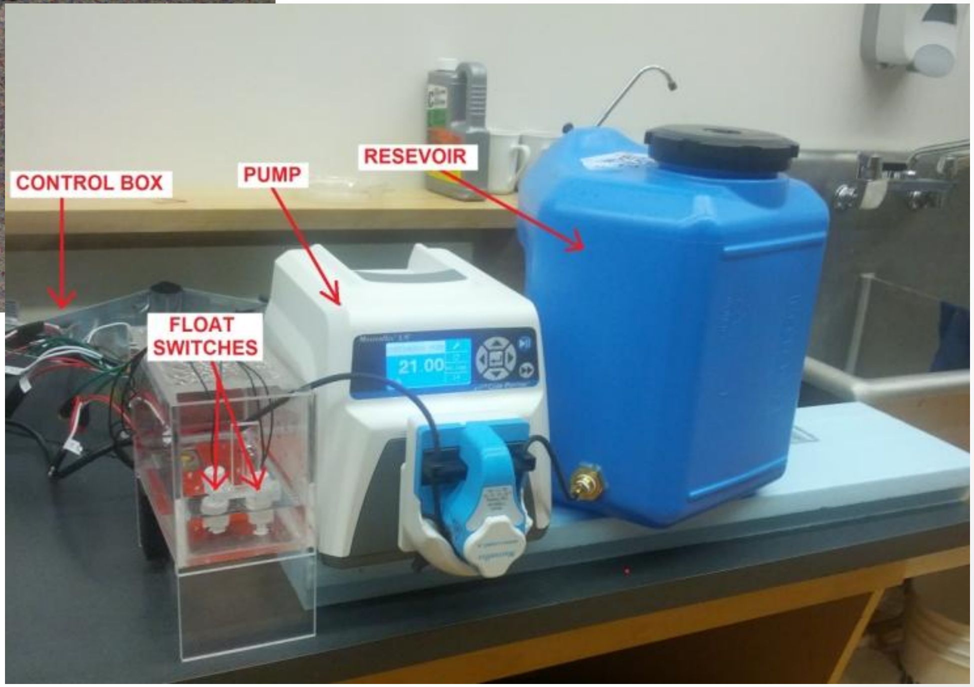
Whole-Building Performance Research Laboratory (WBPRL)

Overview of Test Facilities

Occupancy Simulation System

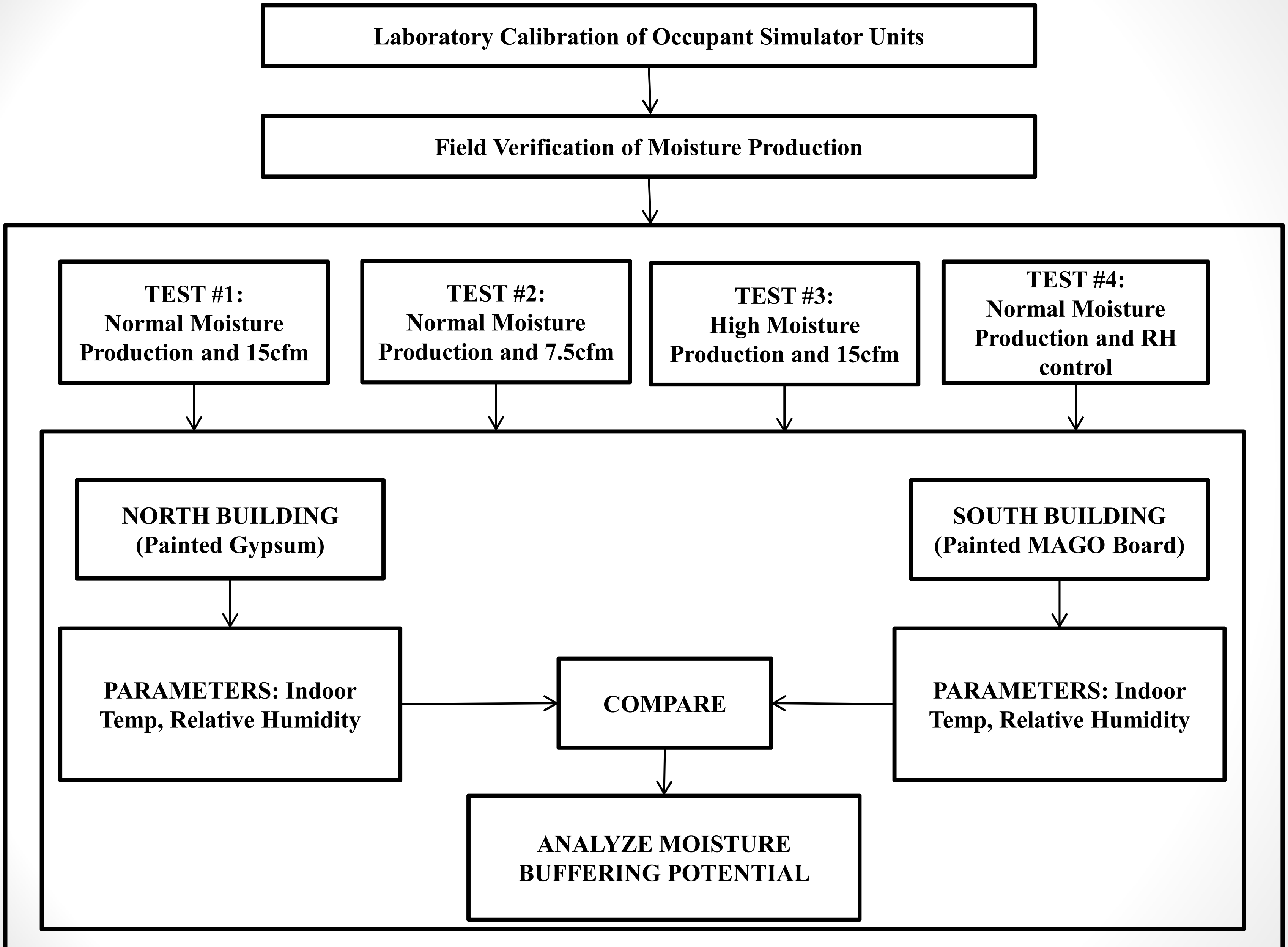


Occupant simulation system control box



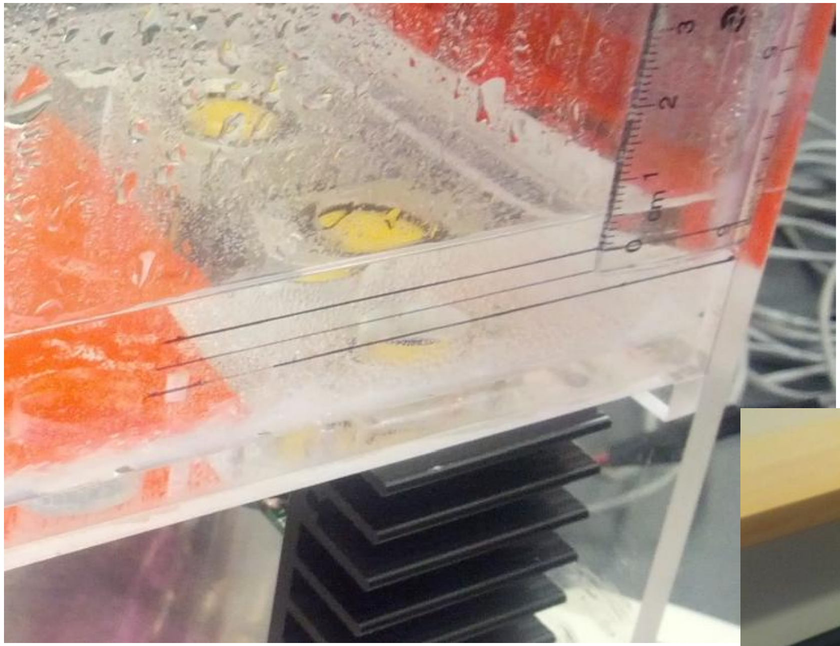
Humidification system components of the occupant simulator system

Methodology

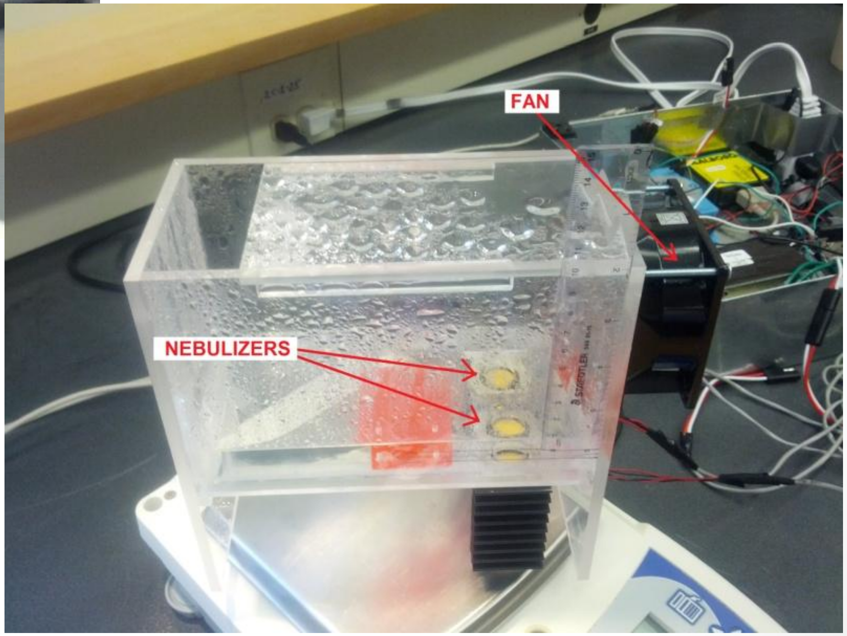

Laboratory Calibration of Occupant Simulator Units
Field Verification of Moisture Production
TEST #1: Normal Moisture Production and 15cfm
TEST #2: Normal Moisture Production and 7.5cfm
TEST #3: High Moisture Production and 15cfm
TEST #4: Normal Moisture Production and RH control
NORTH BUILDING (Painted Gypsum)
SOUTH BUILDING (Painted MAGO Board)
PARAMETERS: Indoor Temp, Relative Humidity
COMPARE
PARAMETERS: Indoor Temp, Relative Humidity
ANALYZE MOISTURE BUFFERING POTENTIAL

Phase I: Laboratory Calibration of the Occupant Simulator Units

Calibration Procedure

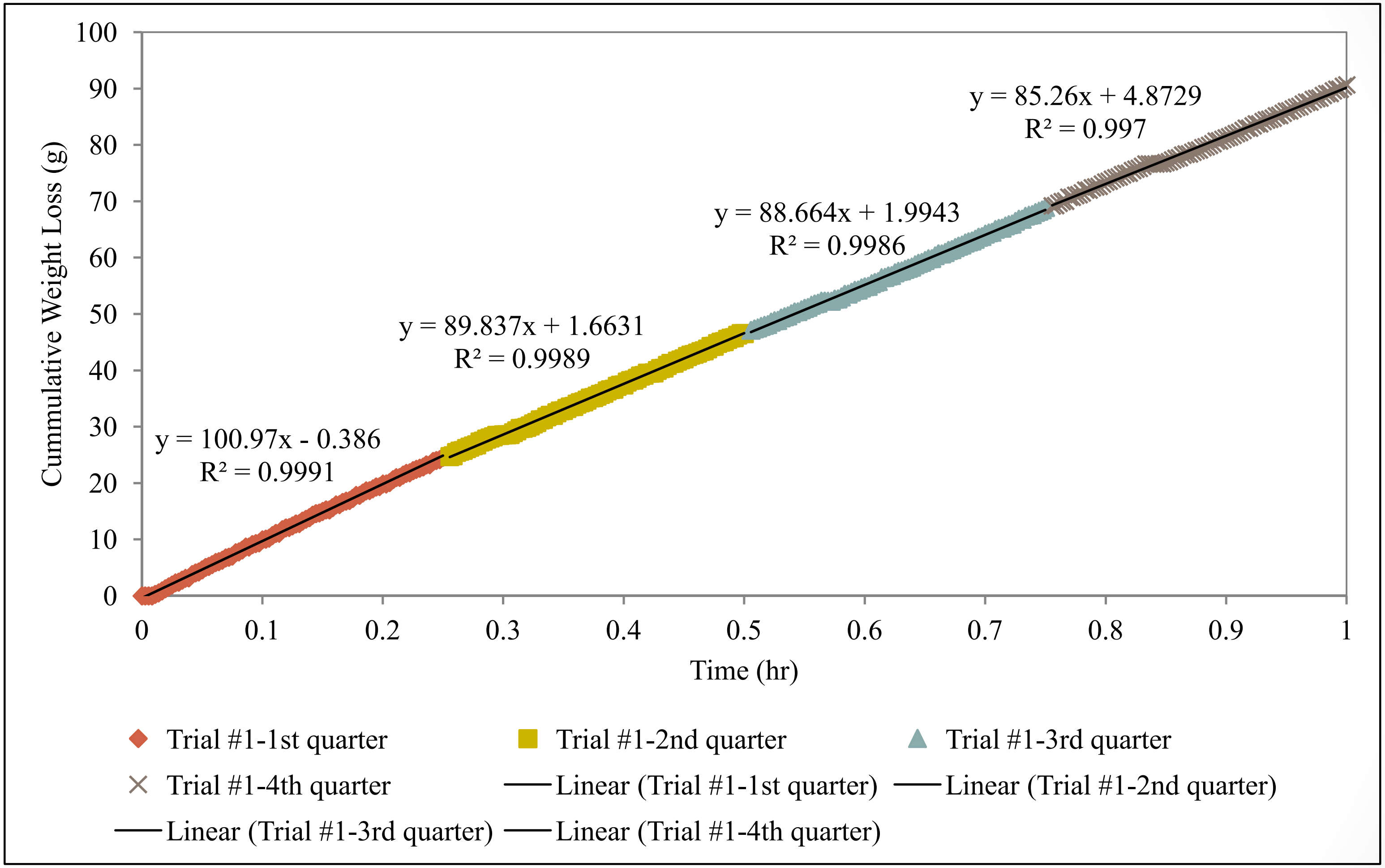


Determination of pump refill water level trigger



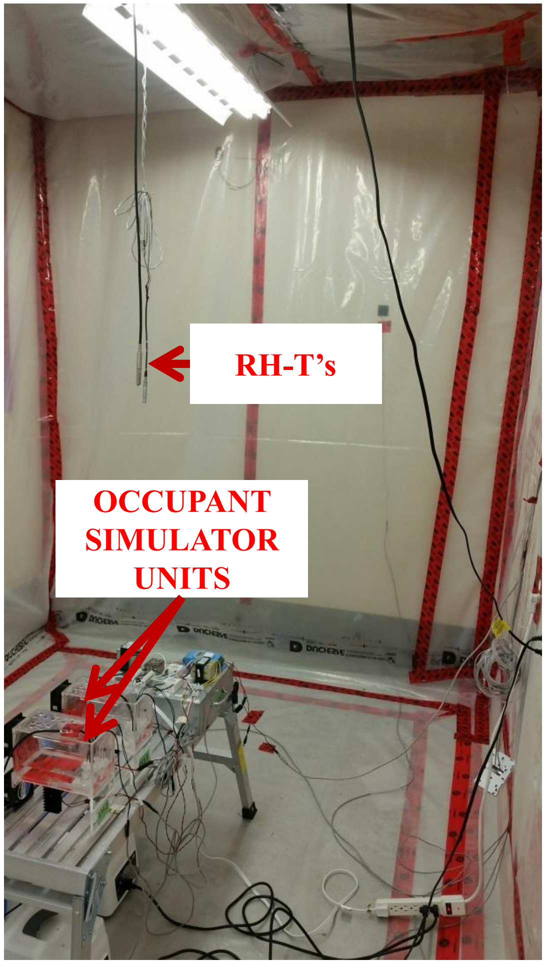
Laboratory setup for calibration of the indoor simulation units

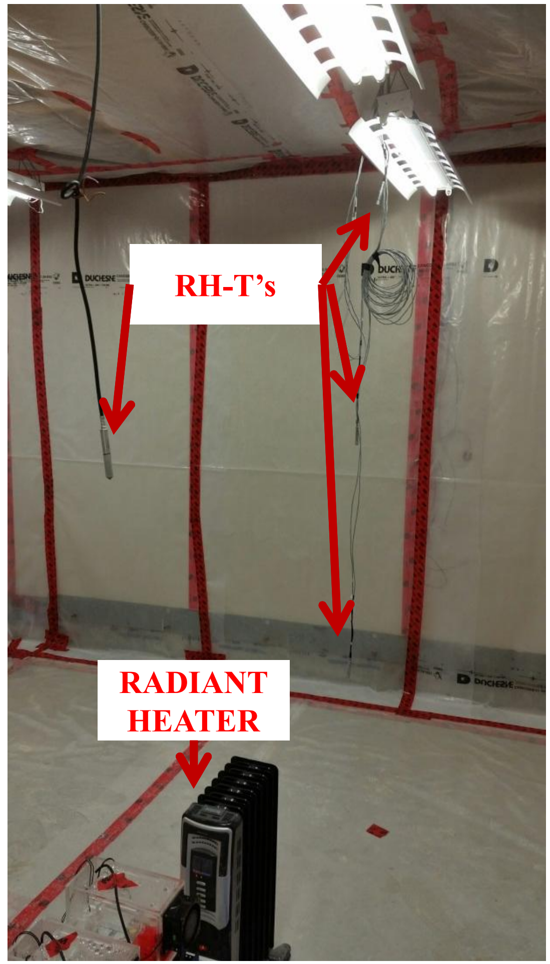
Run #1: Linear fit of cumulative weight loss over time for occupancy simulator unit 1

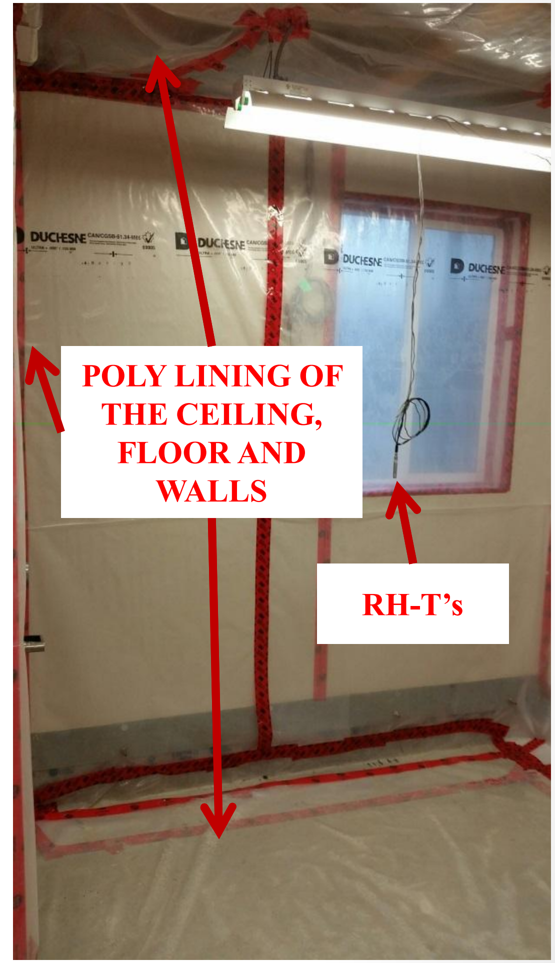


Phase II: Field Verification of the Moisture Production Rate of the Occupant Simulator Units

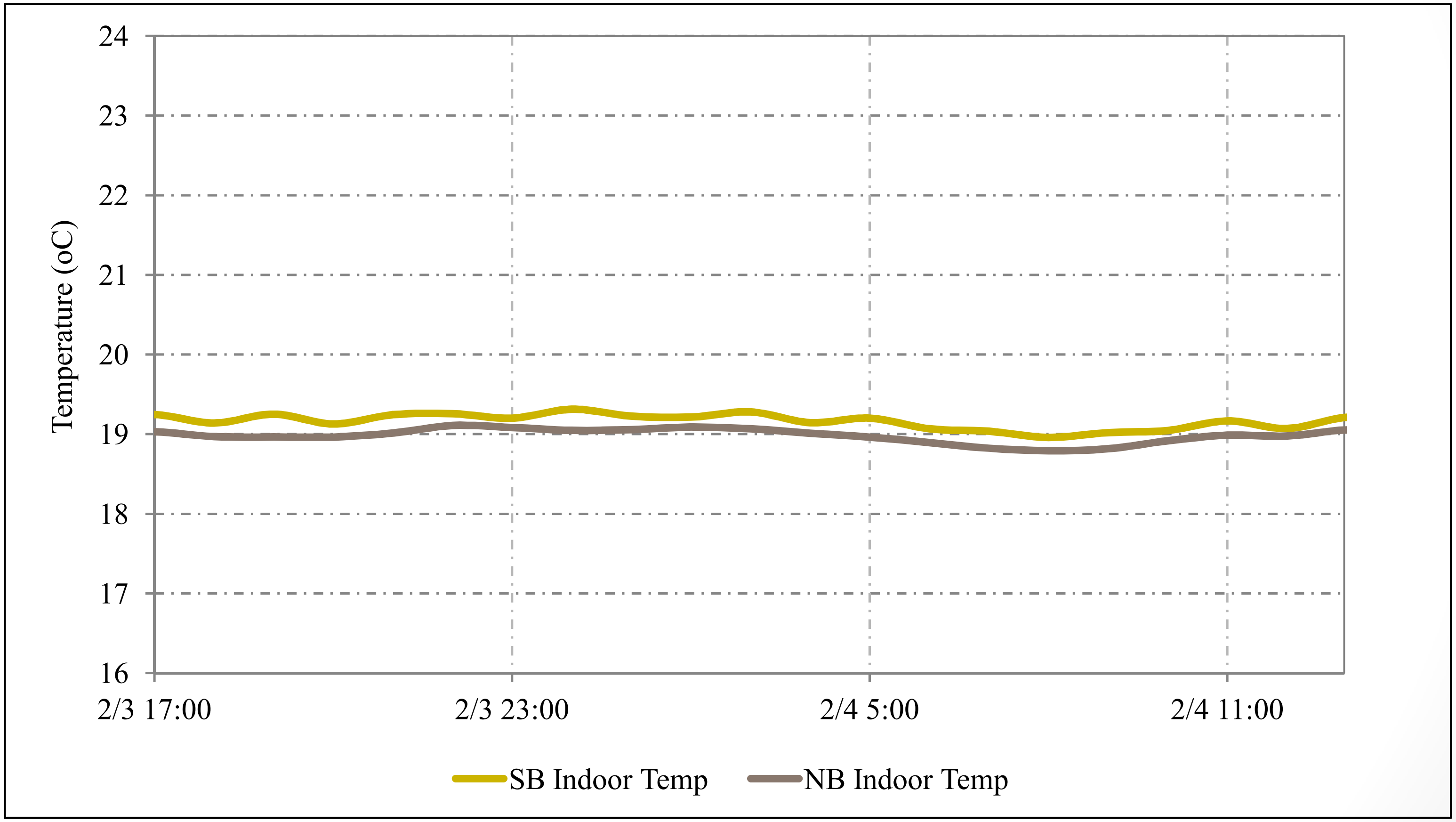
Experimental Setup of WBPRL



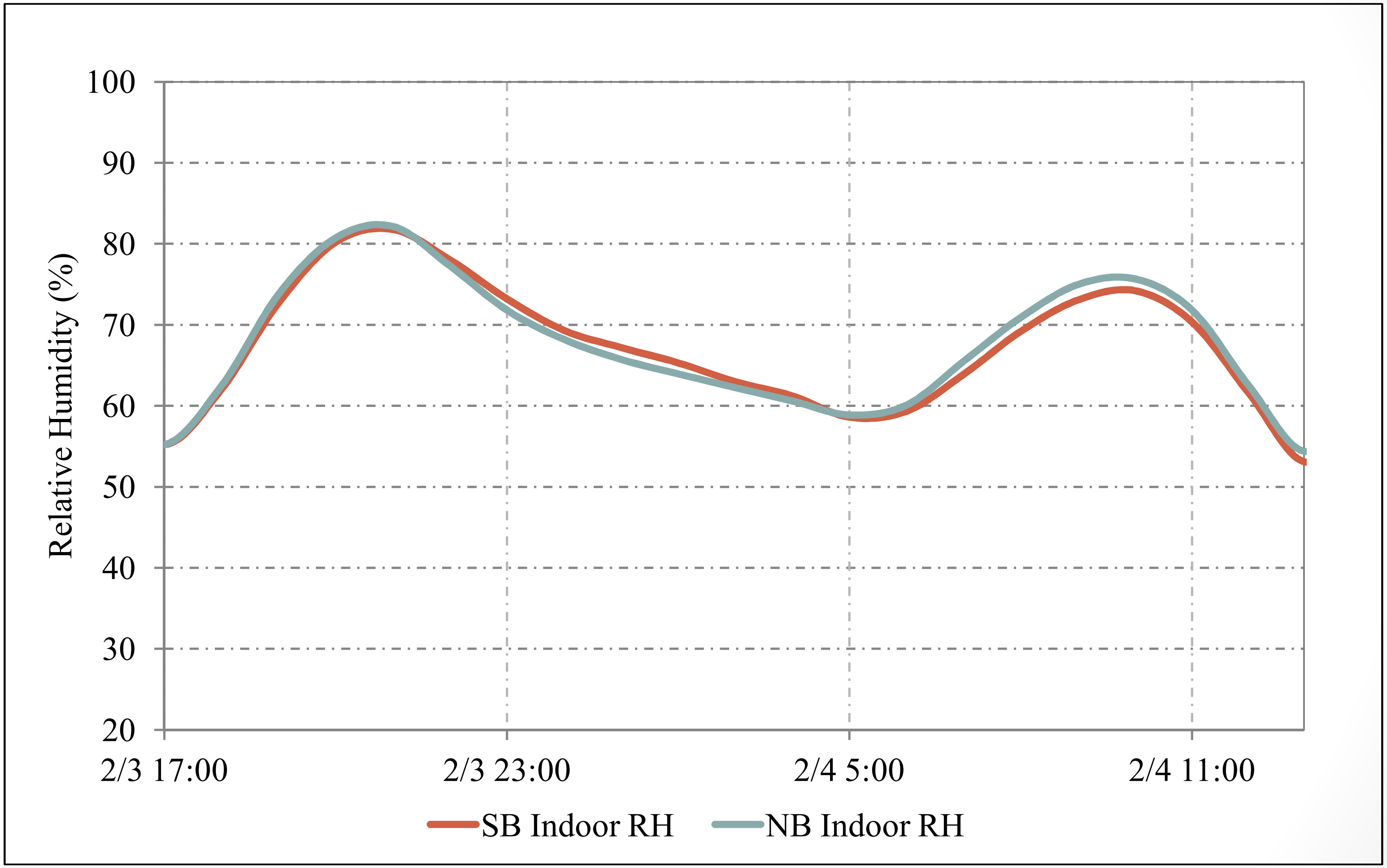




Field verification of the moisture production rate in the north and south building: Indoor temperature comparison



Field verification of the moisture production rate in the north and south building: Relative humidity comparison

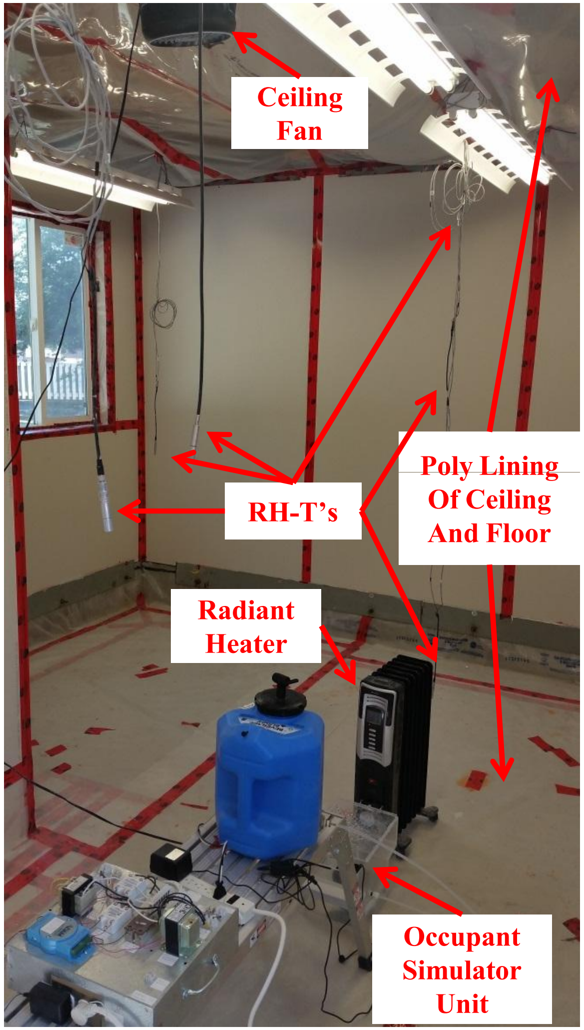


Comparison of the Laboratory derived and field derived calibration rates of the occupant simulator units

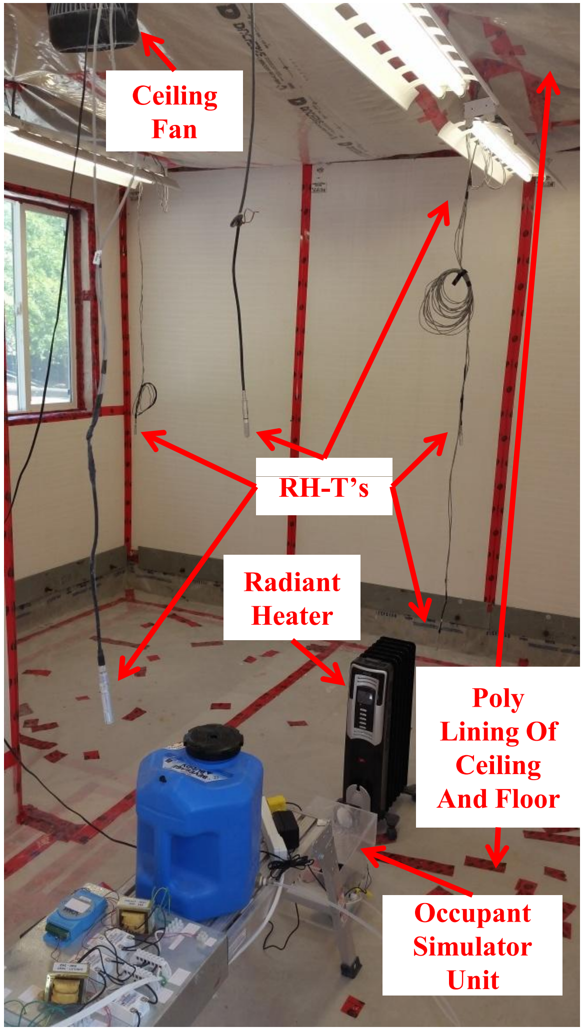
	South Building Occupant Simulator 1	South Building Occupant Simulator 2	North Building Occupant Simulator 1	North Building Occupant Simulator 2
Calibrated Rate [g/hr]	90	141	70	126
Actual Rate [g/hr]	120	189	102	185

Phase III: Field testing of the moisture buffering potential of painted Magnesia board

Experimental Setup of WBPRL

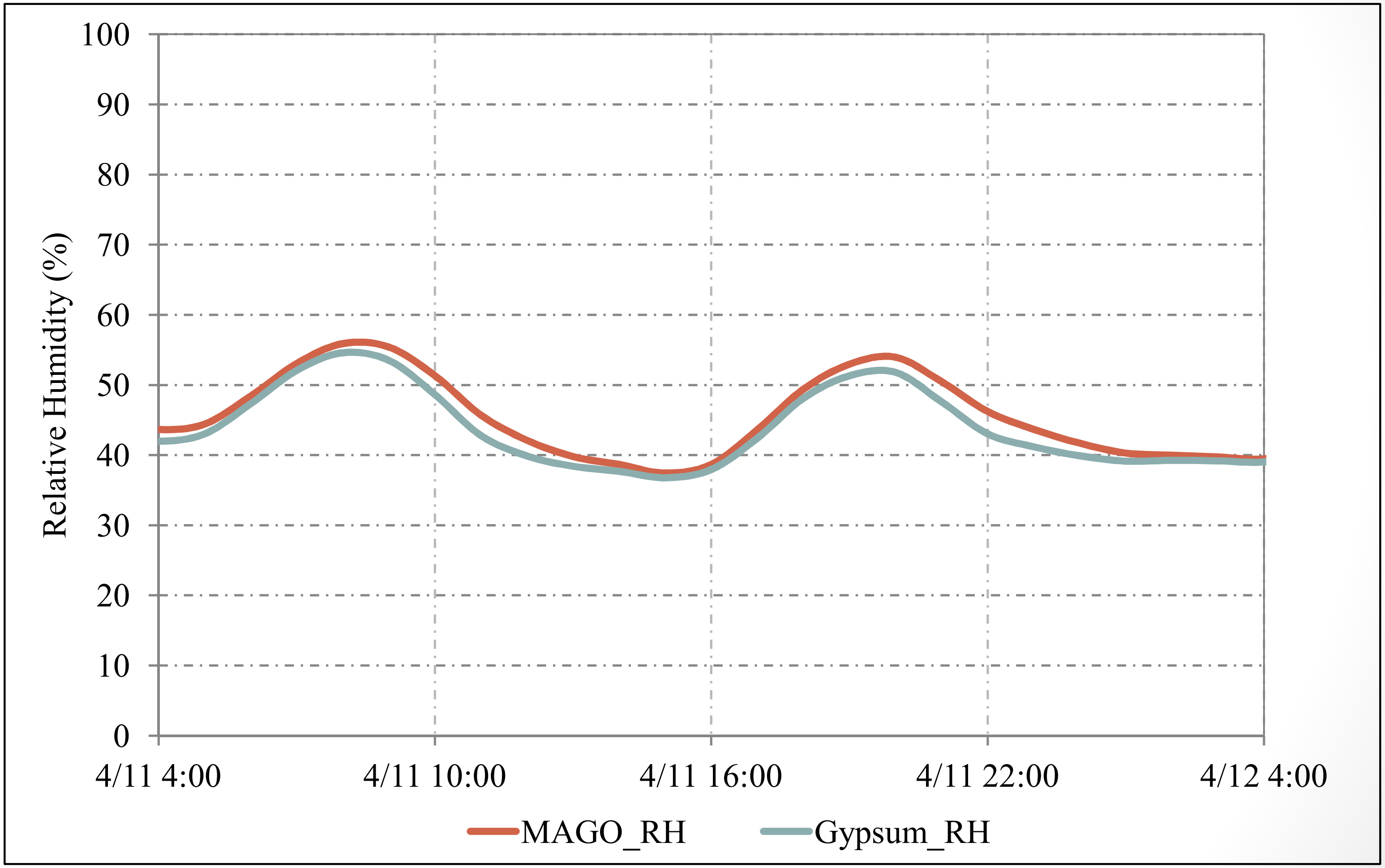


North Building: Gypsum Board

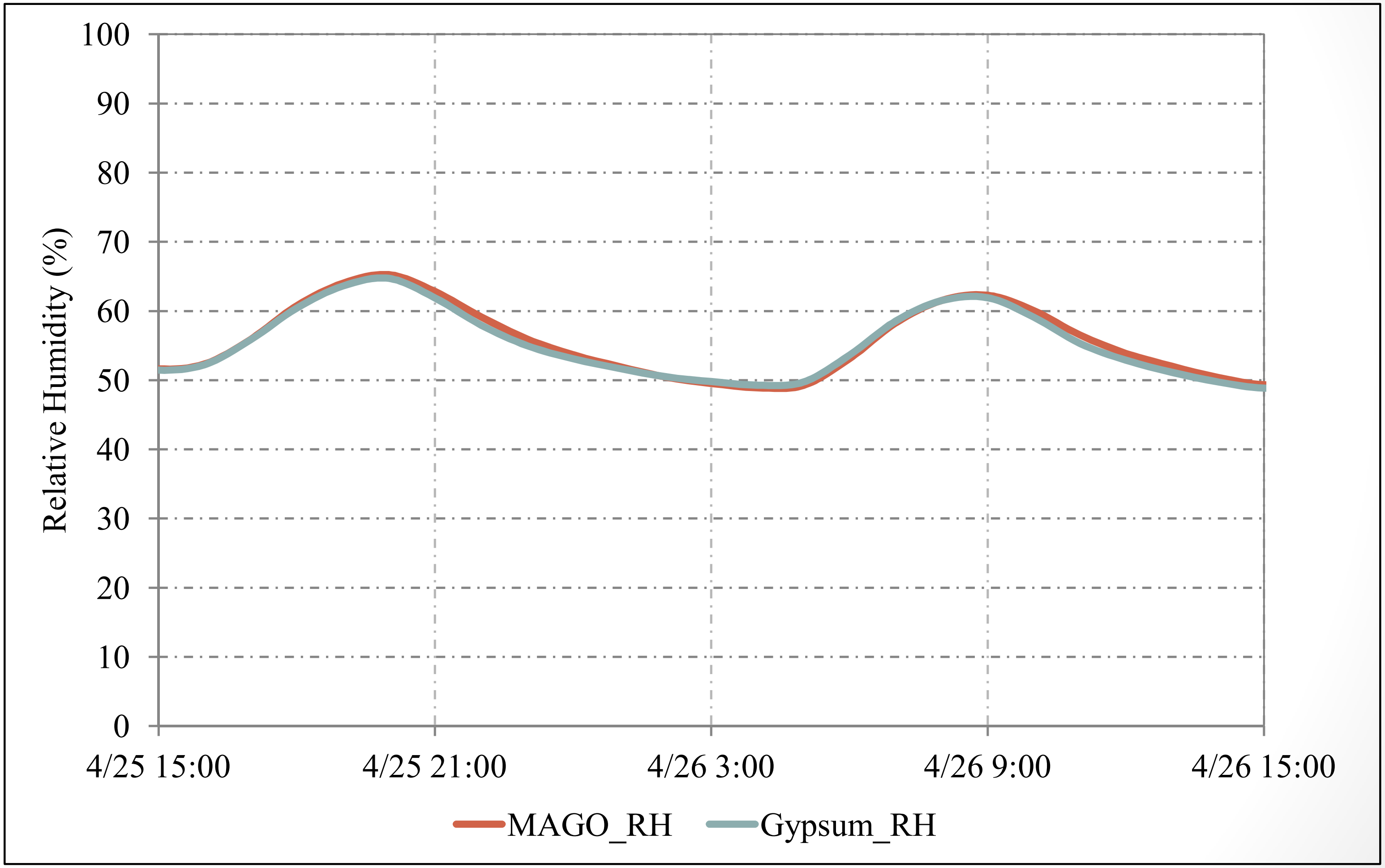


South Building: MAGO Board

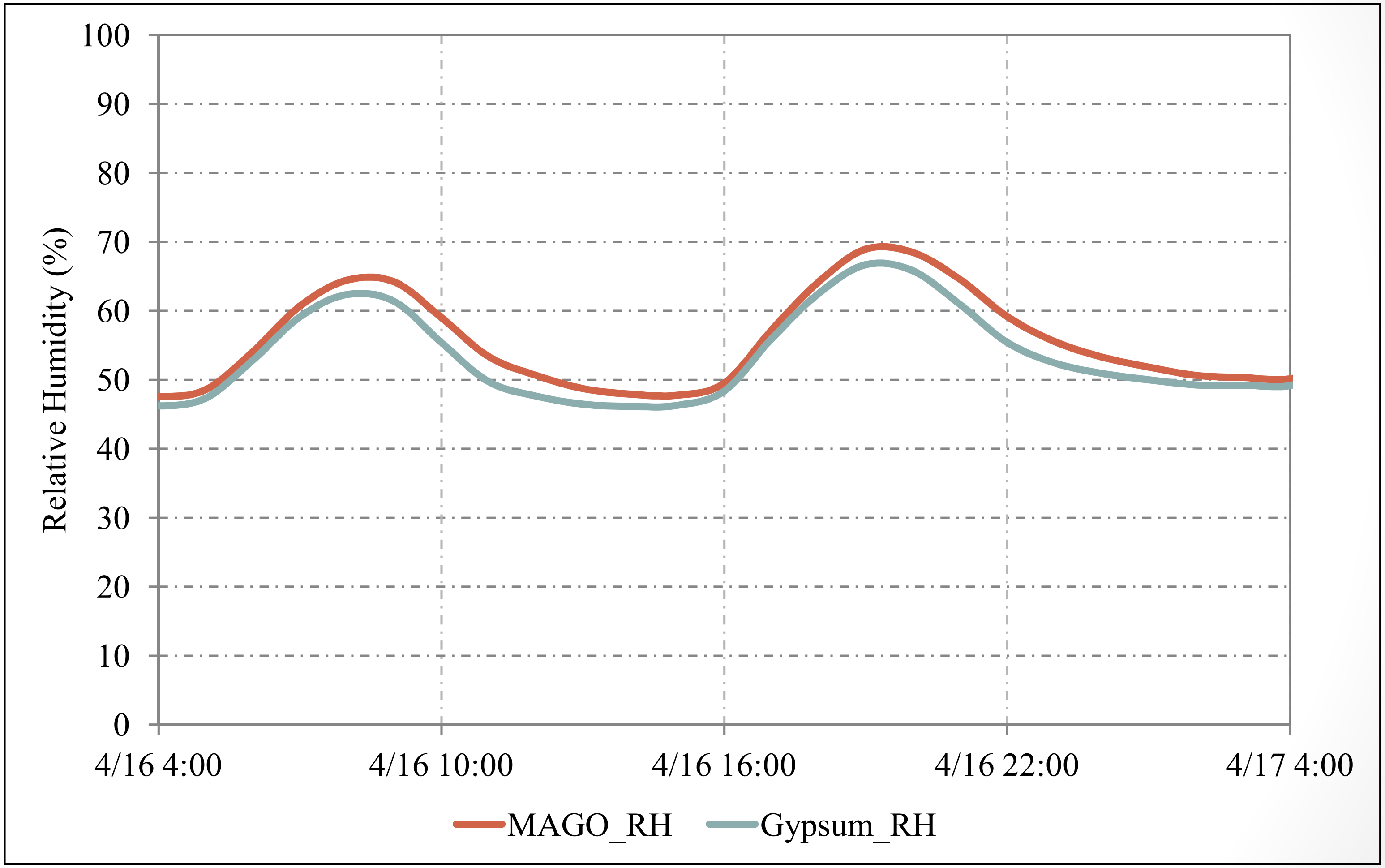
Test case #1: Relative humidity comparison of both buildings exposed to normal moisture production and normal ventilation rate



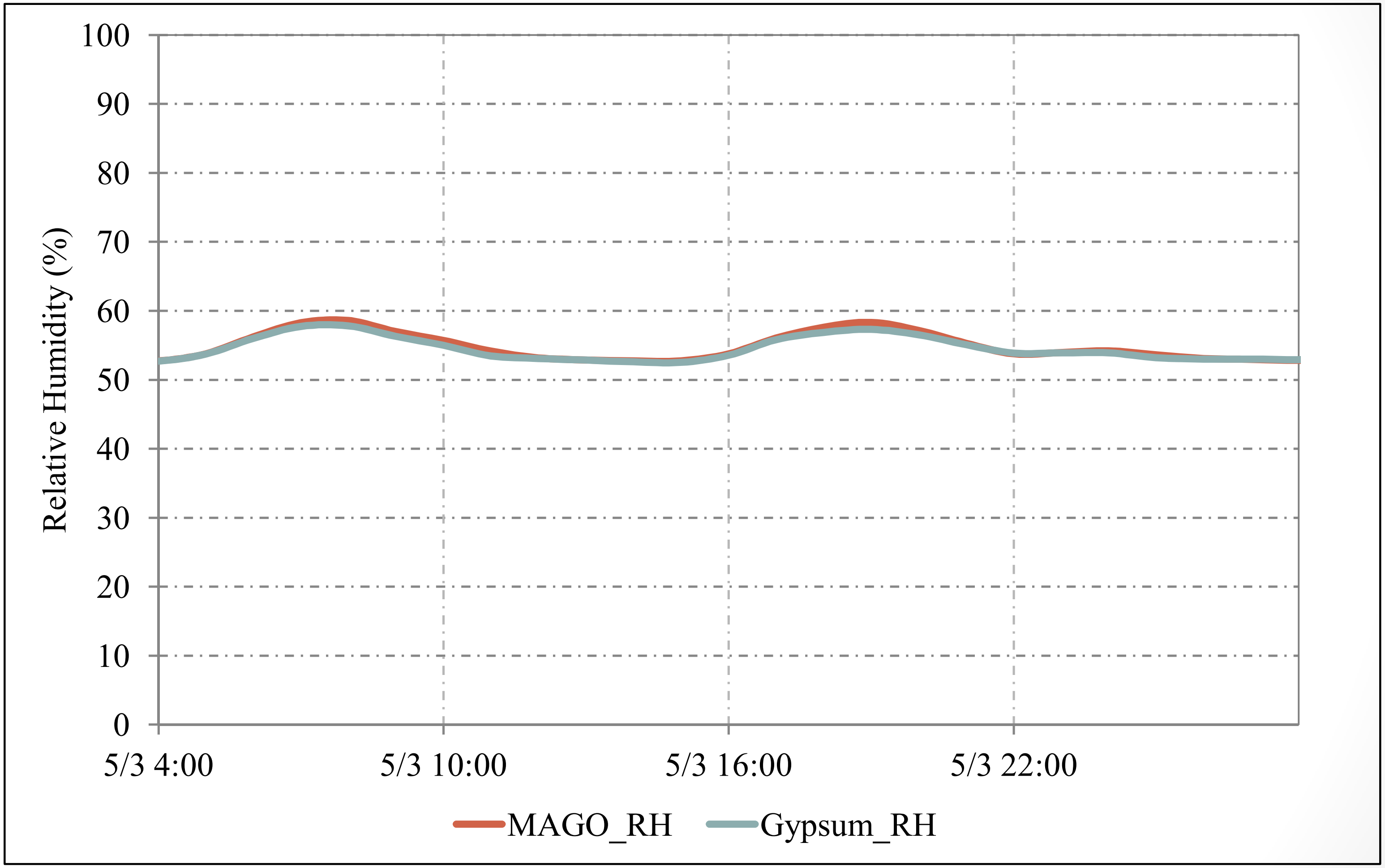
Test case #2: Relative humidity comparison of both buildings exposed to normal moisture production and low ventilation rate



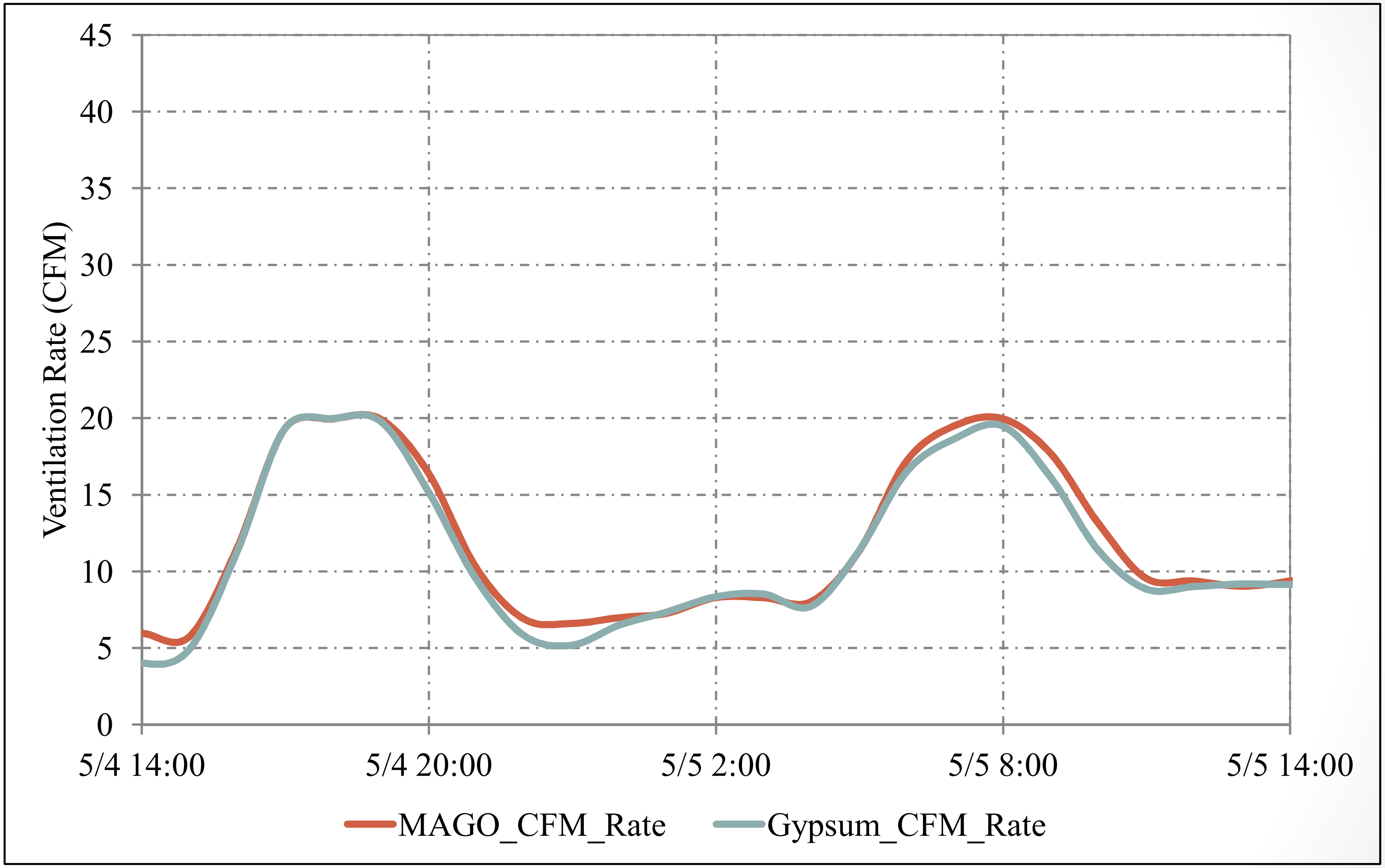
Test case #3: Relative humidity comparison of both buildings exposed to high moisture production and normal ventilation rate



Test case #4: Relative humidity comparison of both buildings exposed to normal moisture production and RH controlled ventilation rate



Test case #4: Ventilation Rate comparison of both buildings exposed to normal moisture production and RH controlled ventilation rate



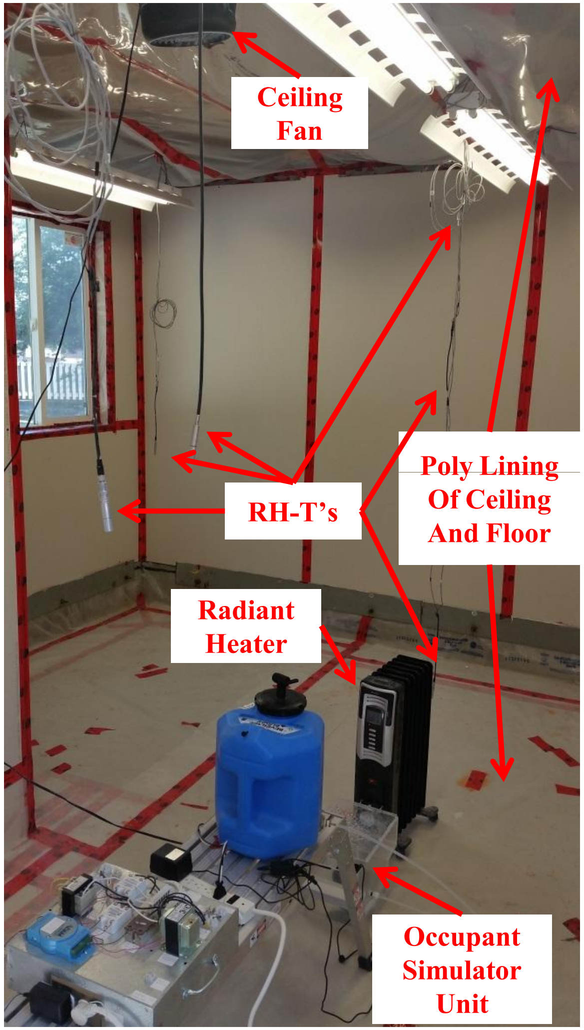
Conclusion

- No measureable difference in moisture buffering performance between the gypsum and magnesia board.
- This is attributed to the interior surface coating of both interior finishes.
- To put in perspective, the permeability of ½” gypsum wall board is 51 perms, according to ASHRAE HOF, priming and coating gypsum has the potential to drop the permeability to about 10 perms.
- Falls under the category of Class II vapor retarders.
- The same could be said about the magnesia board, hence the similarity in moisture buffering performance of both interior finishes.
- In Phase IV of this research project both interior finishes will be tested without the interior primer or paint coating for maximum moisture buffering potential

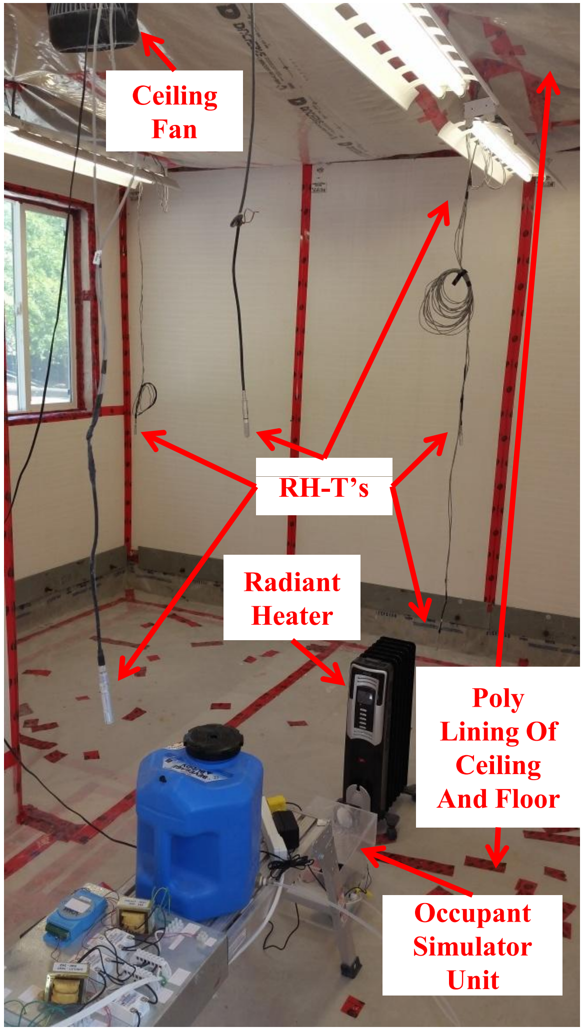
Phase IV:

Investigation of the moisture buffering potential of unpainted Magnesia board

Experimental Setup of WBPRL

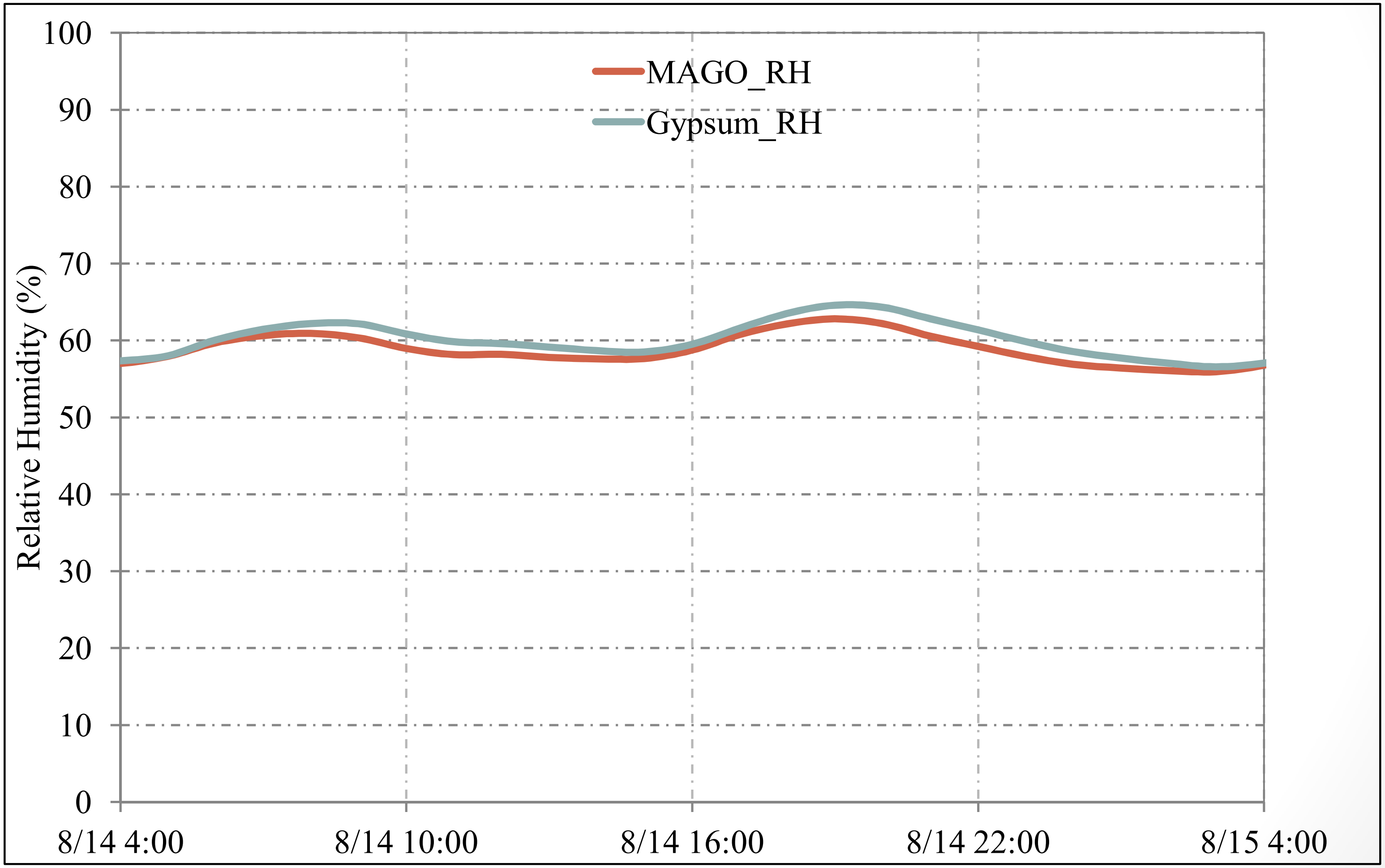


North Building: Gypsum Board

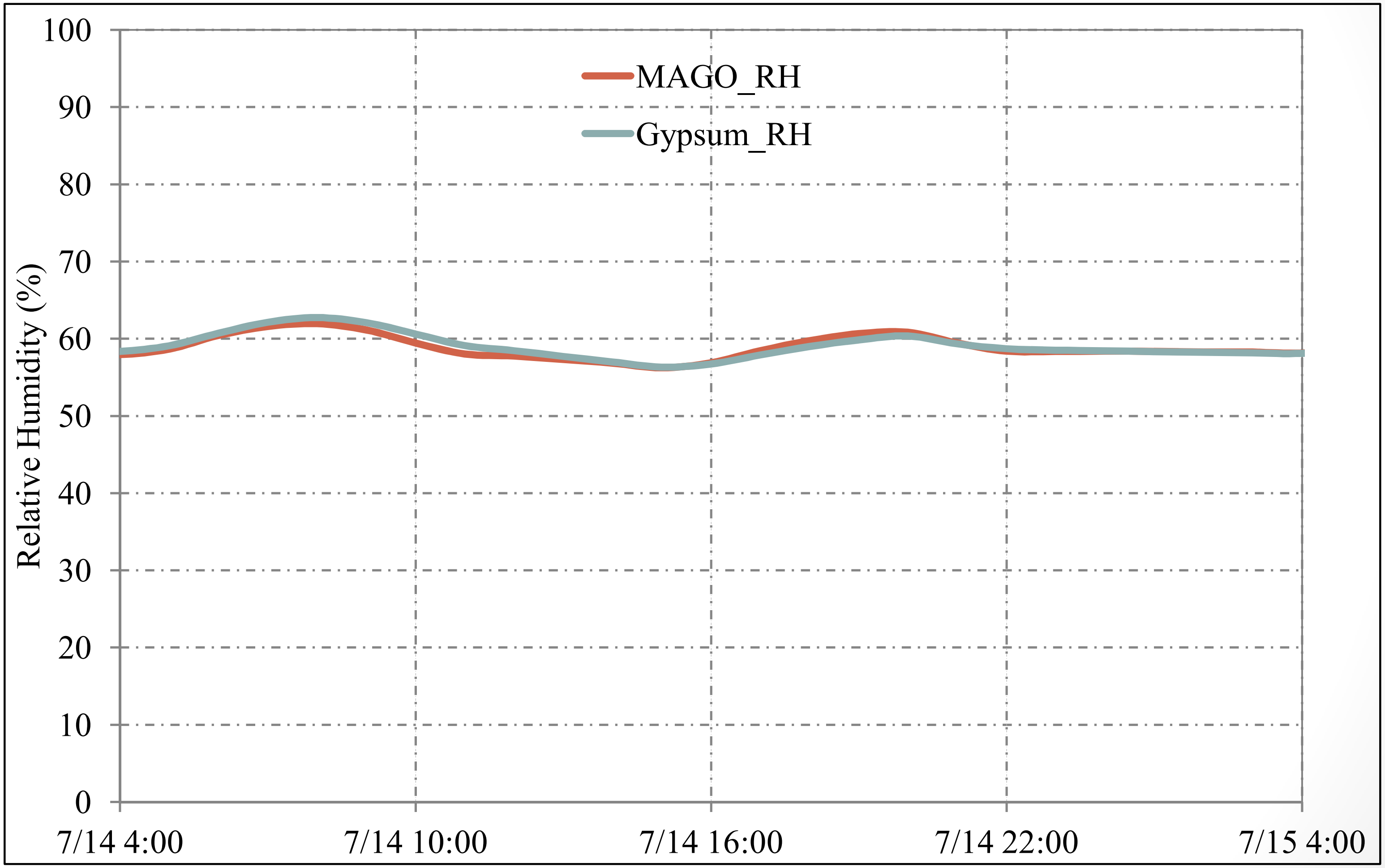


South Building: MAGO Board

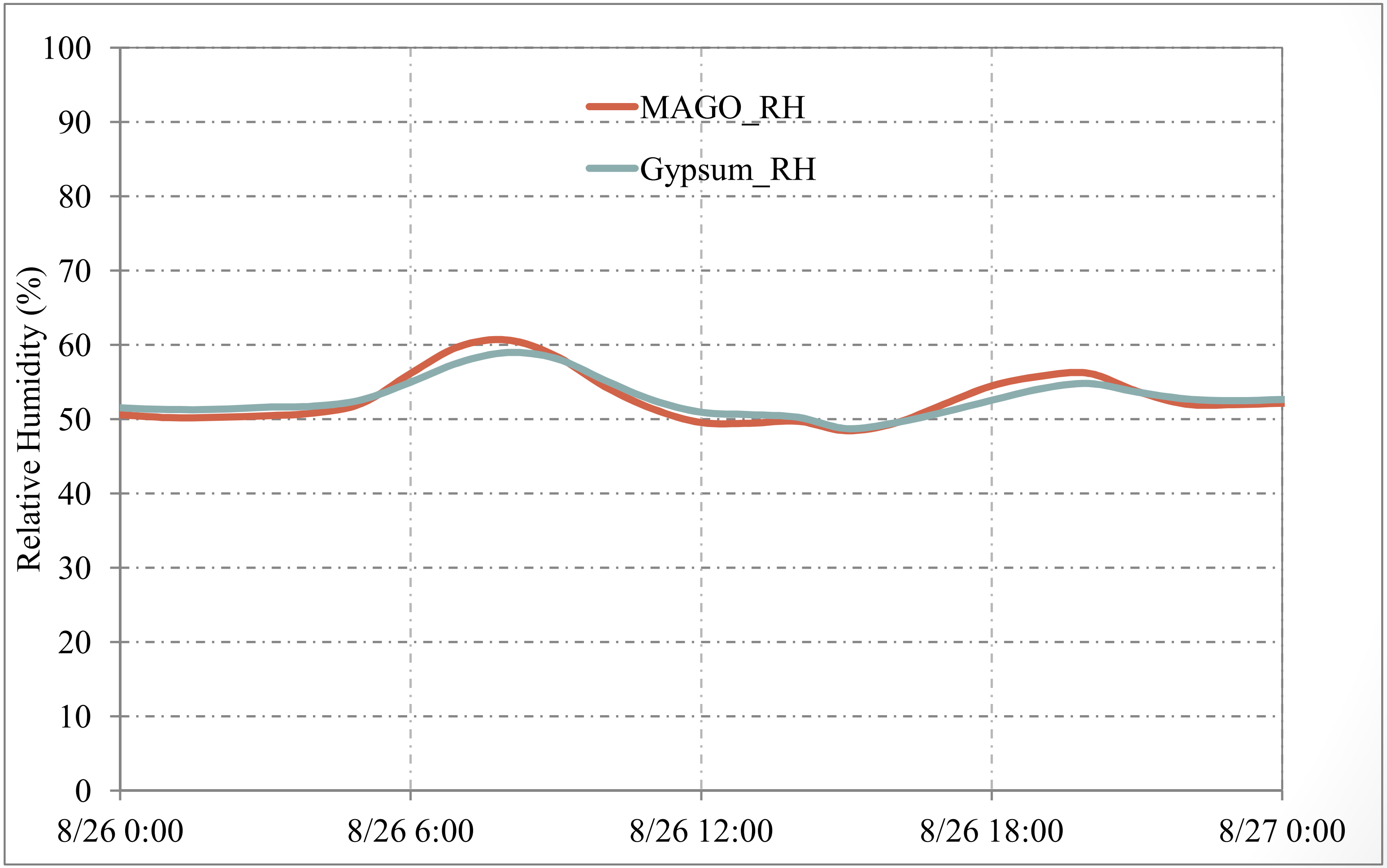
Test case #1: Relative humidity comparison of both buildings exposed to normal moisture production and normal ventilation rate



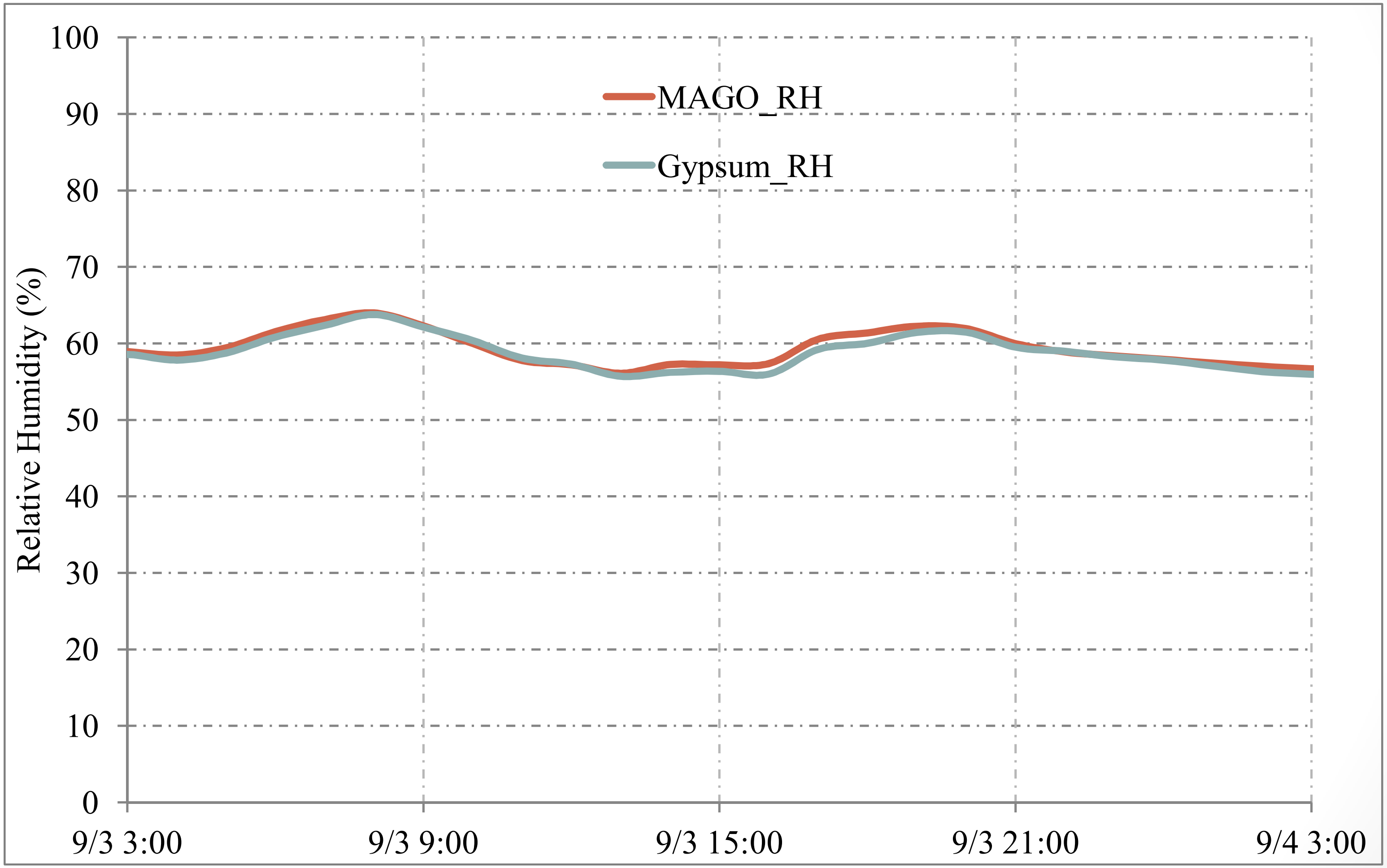
Test case #2: Relative humidity comparison of both buildings exposed to normal moisture production and low ventilation rate



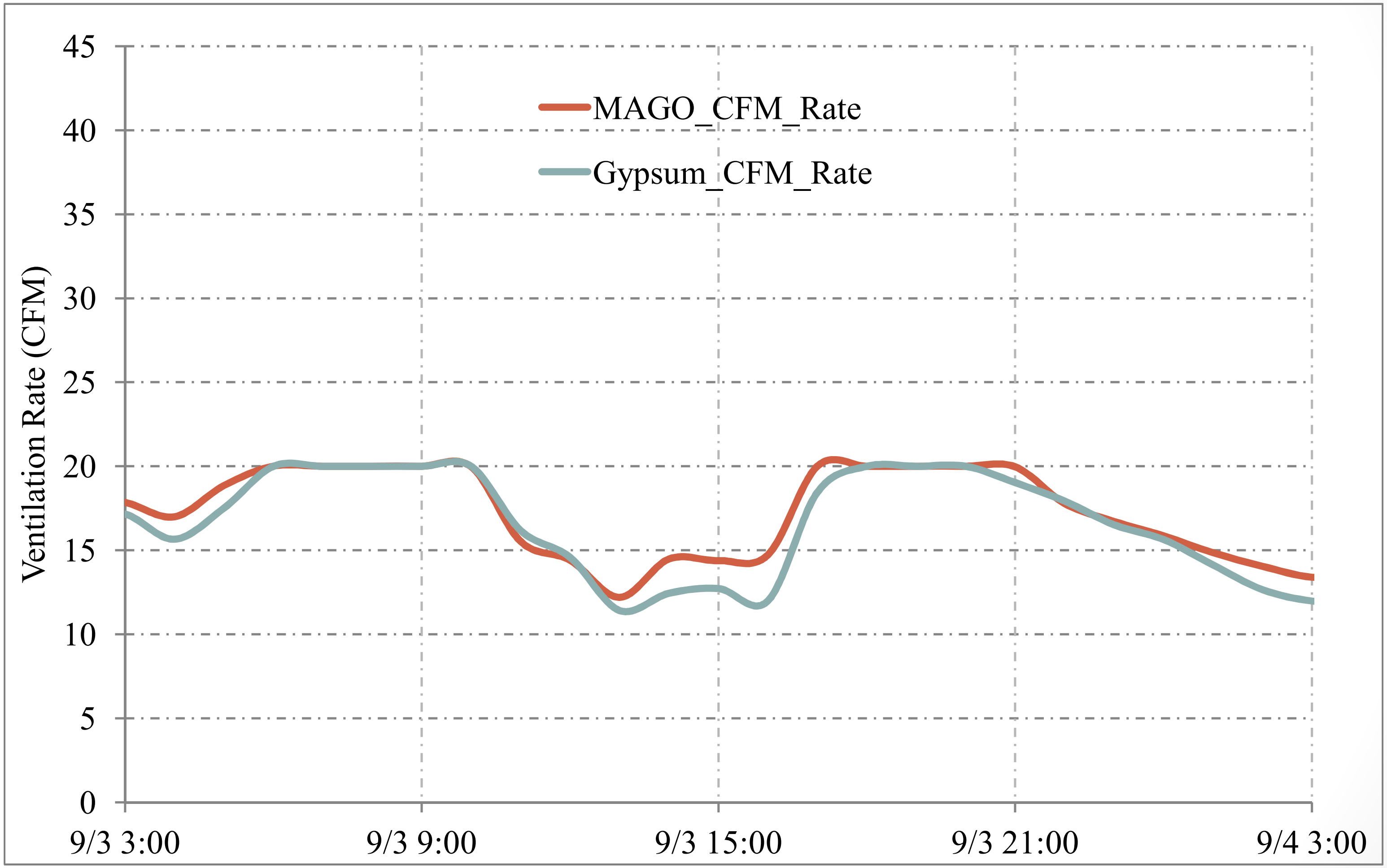
Test case #3: Relative humidity comparison of both buildings exposed to high moisture production and normal ventilation rate



Test case #4: Relative humidity comparison of both buildings exposed to normal moisture production and RH controlled ventilation rate



Test case #4: Ventilation Rate comparison of both buildings exposed to normal moisture production and RH controlled ventilation rate



Conclusion/Further Work

- Magnesia board showed similar moisture buffering capability to gypsum in that the discrepancies in the relative humidity comparisons
- Considering the similar moisture buffering behavior different surface characteristics of both boards, gypsum is more receptive to mold growth as a substrate
- Reason: Gypsum is paper faced compared to the hard and smooth magnesia board surface
- That being said, the experimental setup was designed to investigate the maximum buffering potential and it was found to be significant when compared with the previous phase
- Following, both boards will be coated with high permeable paint to investigate its impact on the moisture buffering.