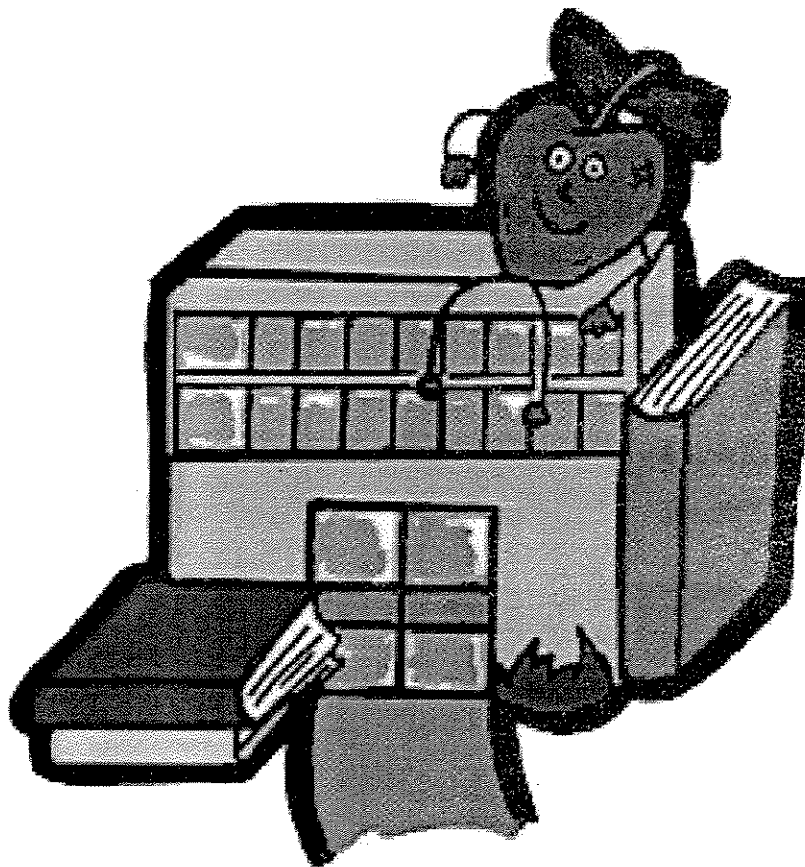


INDOOR ENVIRONMENTAL QUALITY INVESTIGATION

**Franklin School
1006 Mt. Mission Road
Metropolis, Massac County, Illinois
IDPH File No. 503240401**



**Illinois Department of Public Health
Division of Environmental Health
Toxicology Program
April 2004**

PURPOSE

The Illinois Department of Public Health (IDPH) performed an indoor environmental quality (IEQ) investigation at the Franklin School in response to concerns from administration and staff about perceived indoor air quality problems in the school building. Our investigation included a visual inspection of the school building and its heating, ventilating, and air conditioning (HVAC) system and environmental monitoring.

BACKGROUND AND STATEMENT OF ISSUES

On Wednesday, March 24, 2004, staff from the IDPH Marion Regional Office Toxicology Section conducted an inspection at Franklin School in rural Metropolis, IL. The inspection was initiated after receiving a request for assistance from the building Principal.

According to the Principal, staff complained of chronic respiratory symptoms that they feel may be related to the school building. Interviews with various staff at the time of the inspection revealed complaints of building stuffiness and symptoms of chronic respiratory and sinus problems. Absentee rates of the students were monitored by school administration with no increase or trend of excessive absenteeism observed.

Franklin School is a rural elementary school approximately 2 miles northwest of Metropolis, Illinois. The surrounding area is primarily agricultural. The building houses Pre-Kindergarten through 6th grade with a population of 225 students and 15-20 staff. The original building is an older one-story brick structure. A new gymnasium and two classrooms have been added to the original structure. A stairway was added to the original gymnasium converting this area into a second floor library and computer lab with the kitchen under this area on the first floor. Adjacent to the kitchen and across the hall from the school office is the room housing the gas-operated boiler that heats the majority of the building.

The floors in the hallway and classrooms are covered in tile. Walk-off mats are at exterior entrances. Operable windows to the outside are throughout the building. Each classroom has a window air-conditioning unit for cooling during warmer months. The heat is provided by a boiler/hot water system. The hot water pipes pass through unit ventilators in each classroom. The unit ventilators do not have outside air intakes.

A visible inspection of the interior and exterior of the building did not identify any areas of current water damage or active water leaks. A couple of stained ceiling tiles from previous roof leaks were noted. A clogged gutter was allowing water to pond on the roof of an exit door overhang on the west side of the building. Some of the classrooms did appear stuffy, particularly those on the west side of the building because of the sun coming through the windows. (The time of the inspection was approximately 3:30pm; outside weather conditions were sunny with a temperature of 60°F).

RESULTS

Ventilation assessment monitoring for carbon dioxide (CO₂), temperature (°F), and relative humidity (%RH) was conducted from March 24 – April 6, 2004. One machine that included monitoring for carbon monoxide (CO) was also placed in the building (library). Machines were placed in the following rooms:

1. 4th Grade Classroom (22 students)
2. 5th Grade Classroom (28 students)
3. Pre-K Classroom (23 students)(on separate heating/air handling unit)
4. Teacher's Lounge (no operable windows to the outside)
5. Library (Mon-Thurs in-school detention area; Friday classrooms visit)

Graphs illustrating results of the monitoring are attached to this report in Appendix 1. (Note: The measurements in the Library include CO. The library area is above the room housing the gas-powered boiler).

Carbon Dioxide

Carbon dioxide is a normal constituent of exhaled breath and is commonly used as a screening tool to evaluate whether adequate volumes of fresh outdoor air are being introduced into a building. The American Society of Heating, Refrigerating, and Air-conditioning Engineers (ASHRAE) maintains a standard which specifies minimum ventilation rates and indoor air quality that would be acceptable to occupants. This standard presently recommends providing school classrooms with 15 cubic feet of outdoor air per minute (cfm) per person. Indoor CO₂ levels are dependent on the outdoor level, but 15 cfm will result in an indoor CO₂ level approximately equivalent to 700 ppm greater than the outdoor level. This ventilation rate is expected to reasonably dilute odors and contaminants common to school classrooms. Carbon dioxide levels in excess of ASHRAE's standard indicate that an insufficient volume of outdoor air is being supplied to the building to mix with recirculated air.

Complaints of headaches, fatigue, and eye, nose, and throat irritation are commonly reported in buildings where CO₂ is present at high levels, but these symptoms are not caused by CO₂. At the levels typically found in indoor environments CO₂ is not a health hazard, and several studies have demonstrated that it will not cause measurable health effects until it is present at levels much greater than the current occupational guideline (5,000 ppm) enforced by the Occupational Safety and Health Administration (OSHA). High CO₂ levels within a building indicate a lack of ventilation that could allow other contaminants common to buildings to be present at elevated levels and be responsible for occupant complaints.

Carbon dioxide levels recorded in the monitored classrooms in the school consistently exceeded 1,000 ppm during periods of occupancy. The CO₂ levels generally peaked at about 2:00PM. As the attached graphs illustrate, the CO₂ level does fluctuate throughout the day, depending on occupancy and activities such as opening windows/doors.

Carbon Monoxide

Carbon monoxide is a combustion by-product that can be present in a building for a variety of reasons. Potential sources of CO are furnaces, boilers and other appliances that burn fossil fuels. Tobacco smoke and automobile exhaust also can be a source of CO. CO can elevate to dangerous levels within a building if combustion appliances are not vented properly, the opening to an exhaust flue or chimney is blocked, a flue pipe is cracked or disconnected, or a back draft exists. A back draft can occur when the air pressure inside a building is less than the air pressure outside, causing exhaust to “spill” inward.

Carbon monoxide is a colorless, odorless gas that reduces the oxygen-carrying capacity of the blood. At low levels this can cause headaches, nausea, disorientation, weakness and muscle aches. Higher levels can impair judgment, cause paralysis or coma, and death. Because CO is odorless and exposure may result in symptoms similar to those of other common illnesses, the effects may not be recognized until the onset of severe illness.

The background concentration of CO in most buildings would not be expected to exceed 5 ppm. IDPH recommends that CO levels inside buildings not exceed 9 ppm. According to the American Medical Association, health effects can occur after 2-hour exposures to CO concentrations of 100 ppm.

The instrument that was measuring CO levels was placed in the library area. As noted on the enclosed graph, a peak concentration of approximately 30 ppm CO was generally detected in the mornings most likely as a result of firing up the boiler. The CO level then gradually decreased throughout the day to 10 ppm around 1:00PM and 4 ppm by 3:00PM.

Temperature

Temperature is frequently identified in indoor air complaints because it is directly linked to occupant comfort. Excessively high or low temperatures can lead to general thermal discomfort and occupant dissatisfaction. ASHRAE (Standard 55-1992 section 5.1.2) recommends that temperatures be maintained between 68 and 75°F (71°F is optimal) during the winter months and between 73 and 79°F (76°F is optimal) during the summer months. These ranges are generally acceptable for sedentary or slightly active persons.

The temperatures recorded in the school during occupancy generally ranged from 68°F to 75°F. The recorded temperature for each monitored area can be seen on the corresponding graph (Appendix 1).

Relative Humidity

Relative humidity (%RH) is an important factor in indoor air quality because moisture levels are linked to occupant comfort and other considerations. High moisture levels impair the body's ability to lose heat, and can lead to microbial growth. This growth may lead to irritating odors, cause permanent damage to building components, and result in a variety of infectious or allergic illnesses for building occupants. Excessively low moisture levels result in dry air that can irritate the lungs, eyes, nose and throat. ASHRAE (Standard 55-1992) recommends that %RH be maintained between 30% and 60%.

The %RH recorded inside the school during periods of occupancy ranged from approximately 30% to 45%. The recorded %RH for each monitored area can be seen on the corresponding graph (Appendix 1).

CONCLUSIONS AND RECOMMENDATIONS

Based on the information gathered during a visual inspection of the school building and its HVAC systems, environmental monitoring for CO₂, CO, temperature and %RH, and discussions with the building maintenance staff, we have the following conclusions and recommendations:


1. As illustrated on the enclosed graphs, there were periods when CO₂ levels measured in the classrooms exceeded 1,000 ppm during occupancy. Consultation with an HVAC contractor or an architect may provide affordable alternatives to bring fresh-air into the school for better ventilation. Opening outside windows as weather permits and operating the fan on the air conditioner units should also help to provide fresh air ventilation to the school building.
2. Monitoring in the library area identified measurable levels of CO. Levels of CO inside of buildings should not exceed 9 ppm. Levels up to 30 ppm were measured in the school indicating the presence of exhaust gases in the indoor environment. It is believed the CO is associated with the operation of the gas-powered boiler. A qualified individual familiar with the boiler operation should inspect the boiler, flue and chimney to identify why exhaust gases are accumulating inside the school. It is also recommended that all buildings with indoor combustion sources install carbon monoxide detectors approved by Underwriters Laboratories (UL) to continuously monitor for this gas.
3. One of the concerns voiced by staff at the school was mold in the building. No visible areas of mold growth were noted during the inspection. The relative humidity was 30-45%. A plugged gutter on the roof was allowing water to pond on the edge of the roof on the west side of the building above an exterior door. To avoid potential leaks and a chronic water problem, all the gutters should be kept free of debris so water can drain off of the roof and away from the building structure. The school should be regularly inspected for signs of water leaks. When leaks are identified, they should be addressed

immediately. Heavily damaged, porous materials that cannot be thoroughly cleaned and dried should be discarded and replaced. Non-porous surfaces and porous materials that cannot be removed should be cleaned using a soap or detergent solution. There is no practical way to eliminate all molds and mold spores in the indoor environment; the way to control indoor mold growth is to control moisture. Since mold is virtually everywhere in nature, people are continuously exposed to molds in a variety of locations. Molds primarily cause health problems when they are present in large numbers, such as in water-damaged and mold-contaminated buildings.

4. Unit ventilators should be routinely inspected and cleaned. These units are subject to collecting dust and debris that can be a reservoir for allergens. The use of the unit ventilators for storage should also be discouraged.
5. The U.S. Environmental Protection Agency has developed the *Indoor Air Quality (IAQ) Tools for Schools* kit. This kit shows schools how to carry out a practical plan of action to improve indoor air problems at little or no cost using straightforward activities and in-house staff. The kit includes checklists for school employees, a guide for coordinating the checklists, fact sheets on indoor air pollution issues, and sample policies and memos. Information in this kit may be helpful to the district in your continuing effort to address indoor air concerns. A kit is being sent to you under separate cover.

Preparer of Report

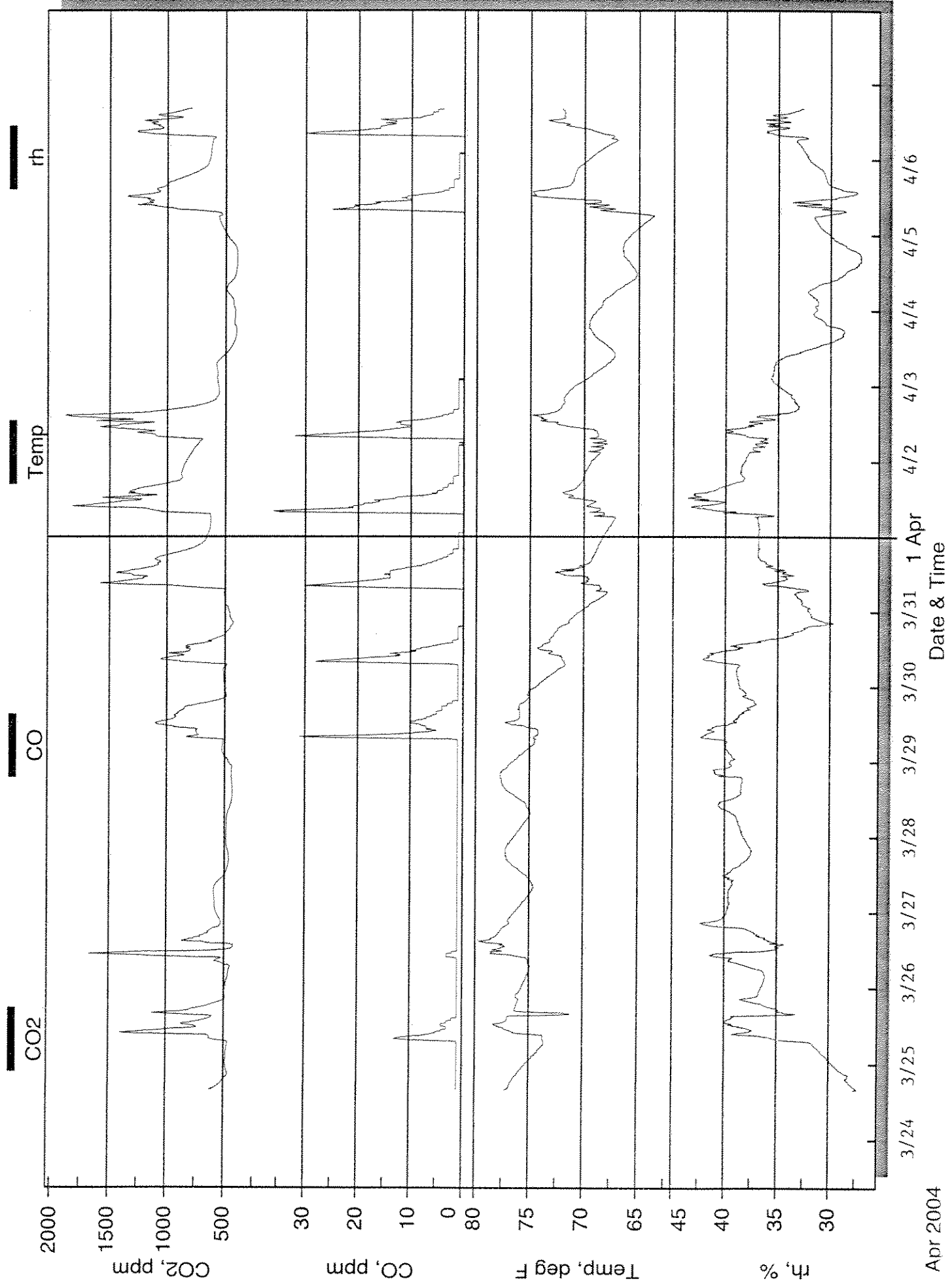
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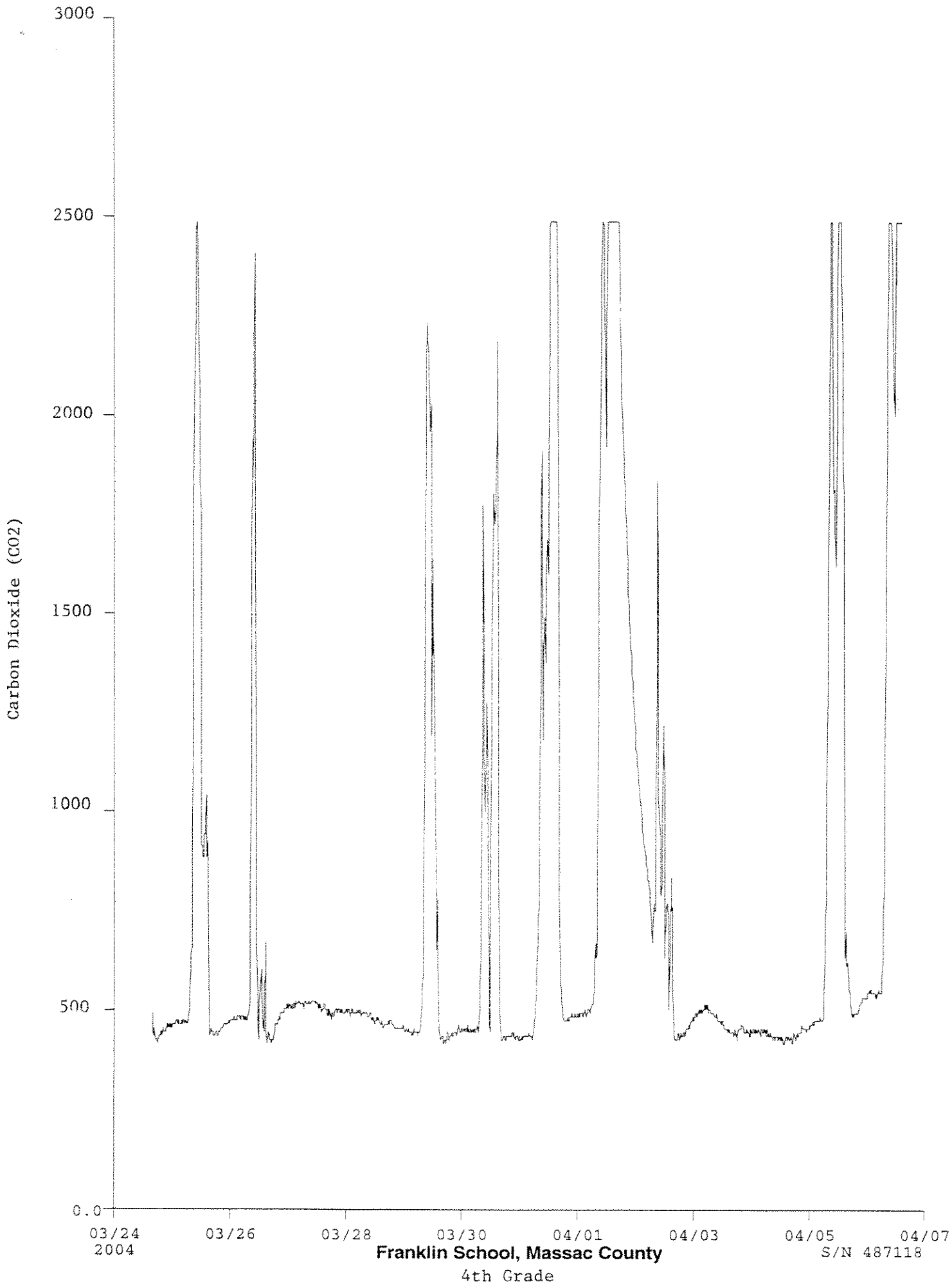
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APPENDIX 1

Graphs illustrating
CO₂, CO, temperature, % RH
4th, 5th, Pre-K Classrooms, Library and Teacher's Lounge

Franklin School
Library





03/24
2004

03/26

03/28

03/30

04/01

04/03

04/05

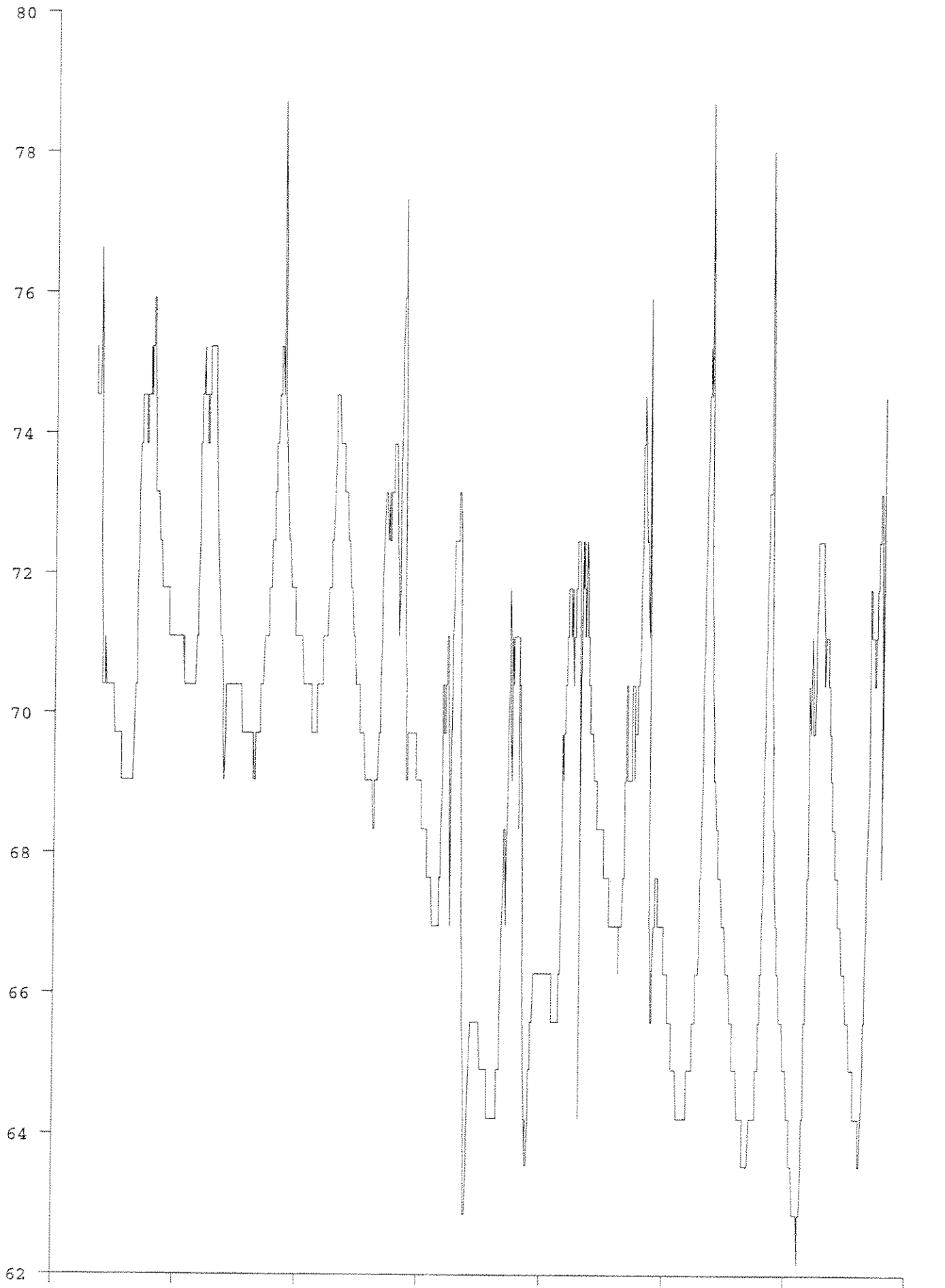
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Franklin School, Massac County

S/N 487118

4th Grade

Temperature
F



03/24
2004

03/26

03/28

03/30

04/01

04/03

04/05

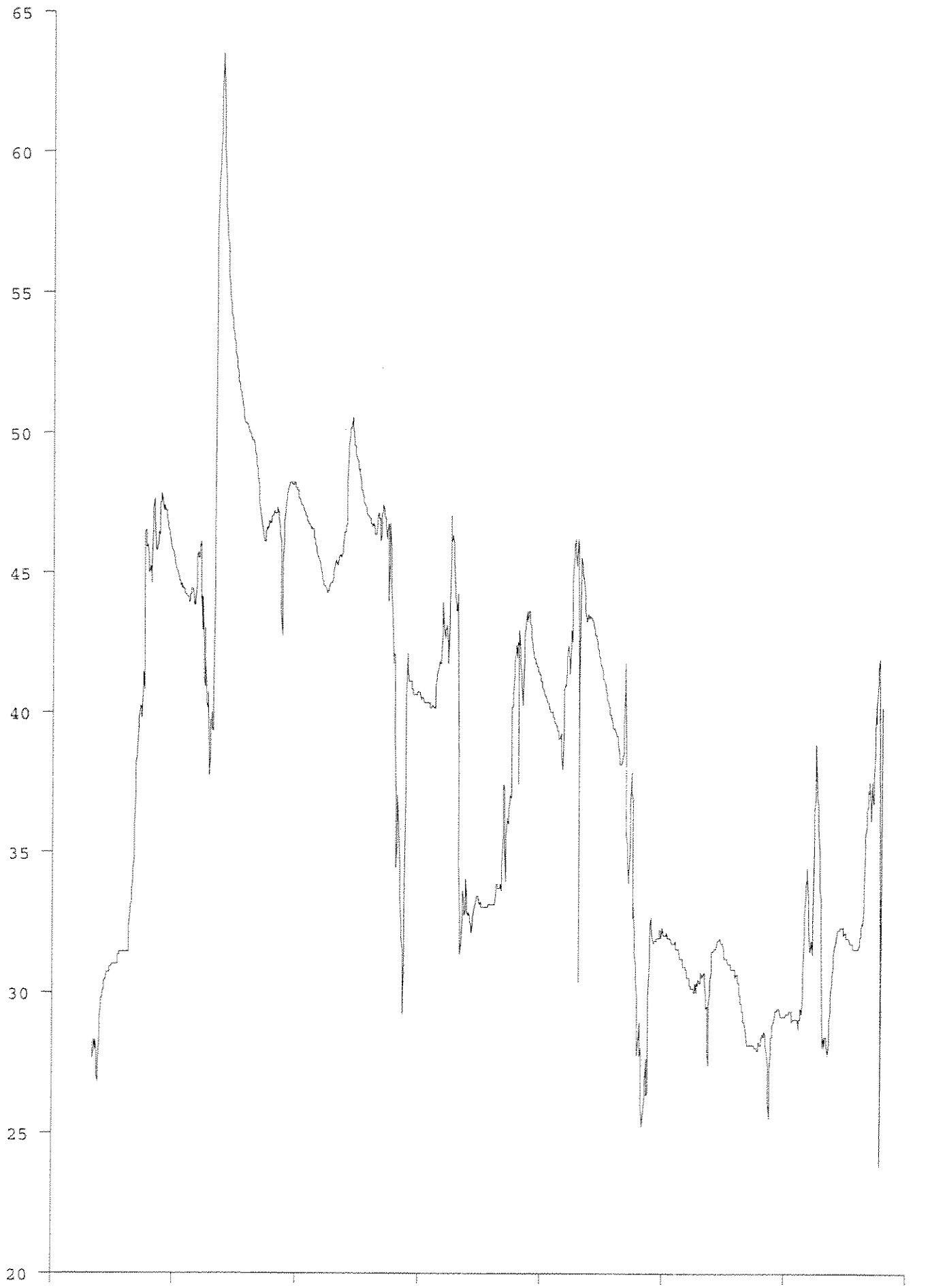
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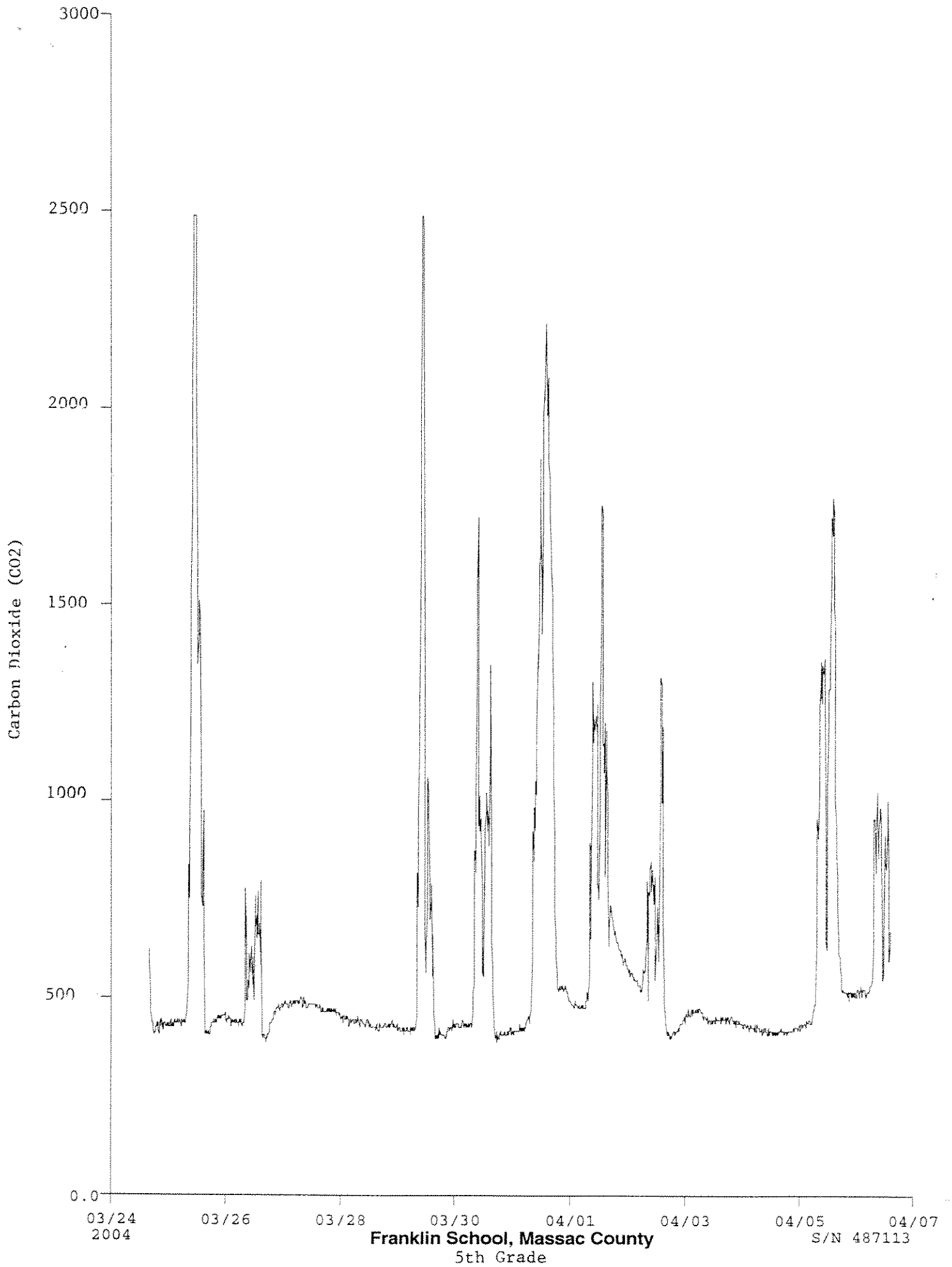
Franklin School, Massac County

S/N 487118

4th Grade

RH %

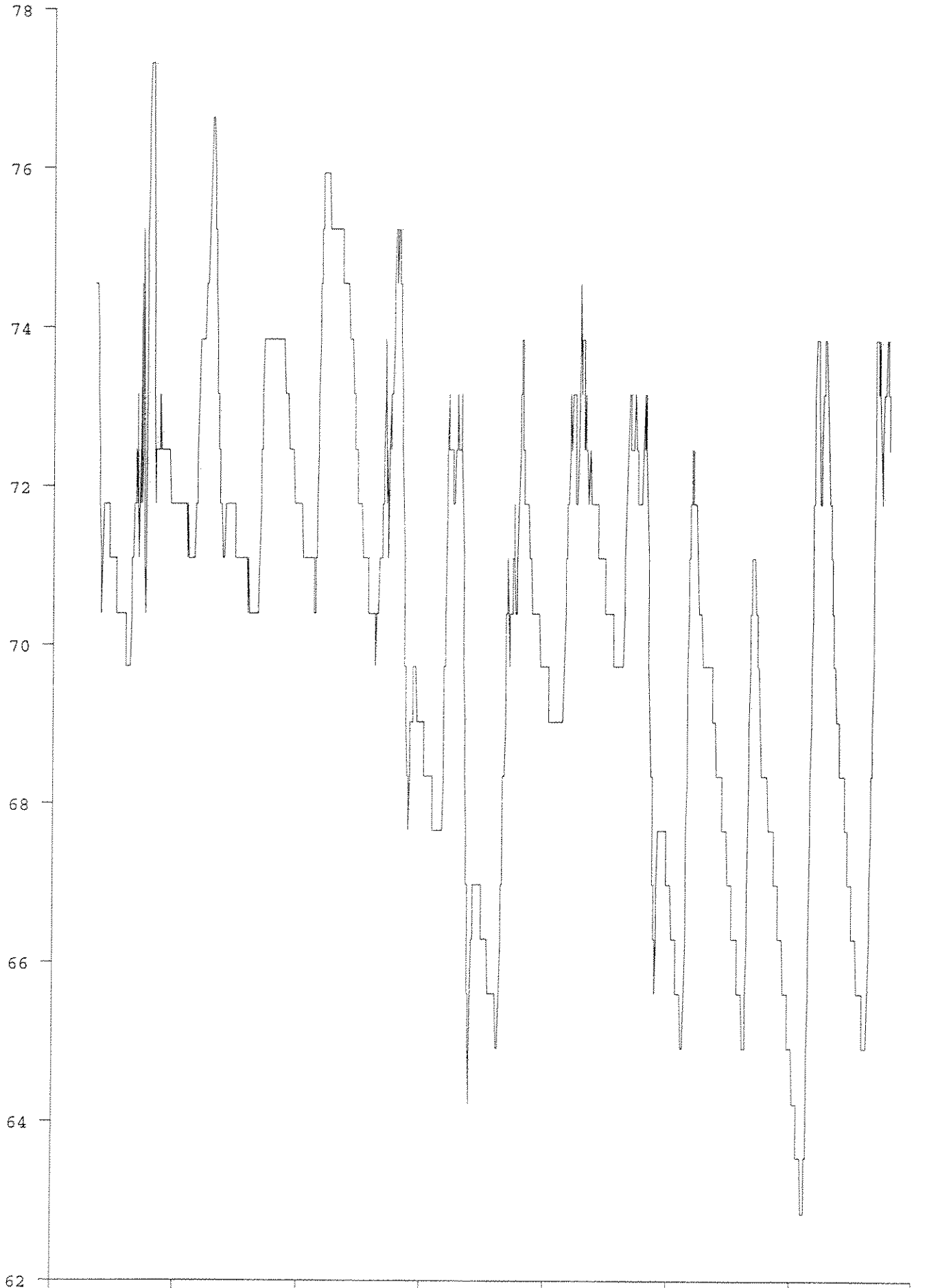




Franklin School, Massac County
5th Grade

S/N 487113

Temperature



03/24
2004

03/26

03/28

03/30

04/01

04/03

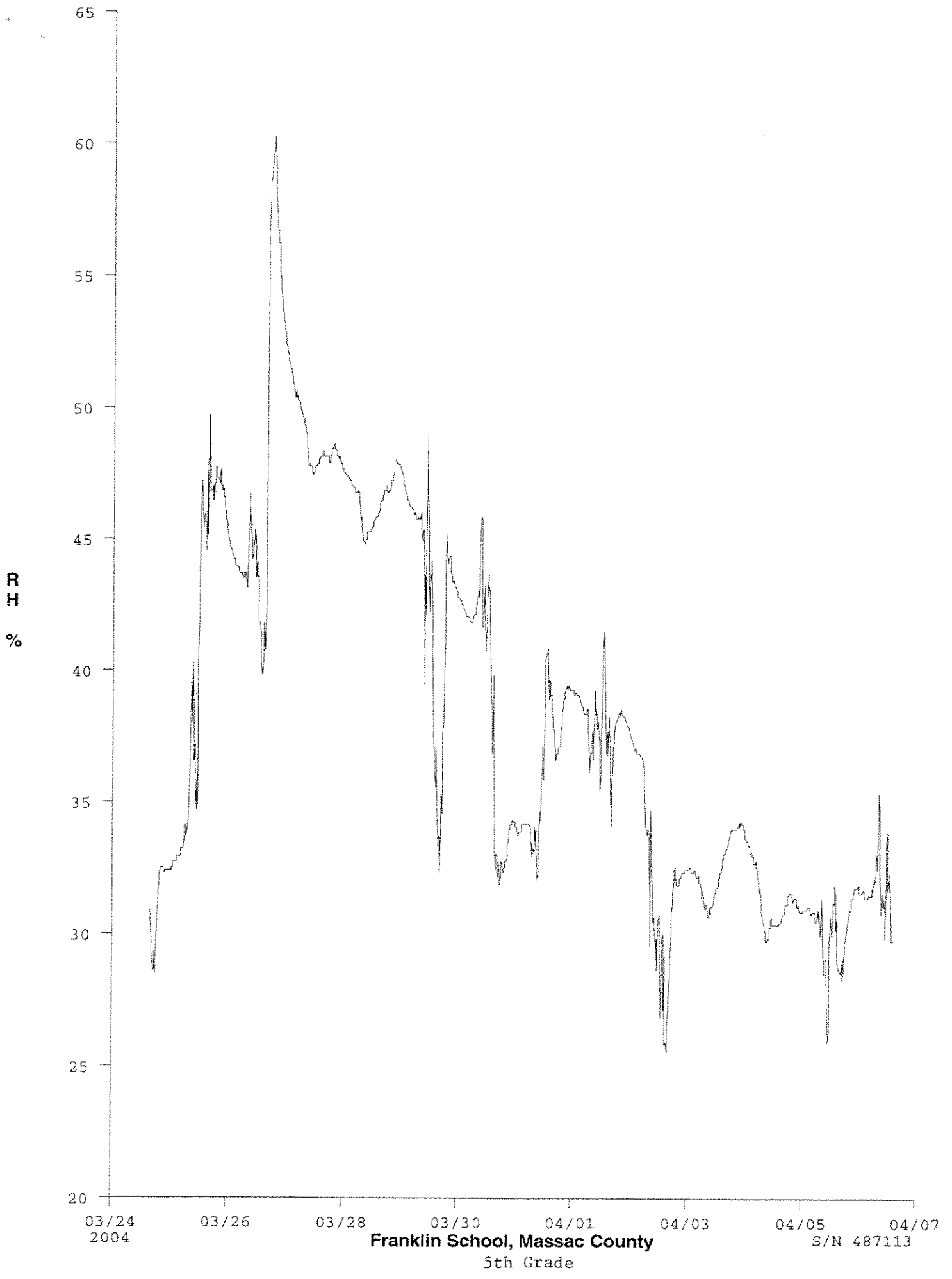
04/05

04/07

Franklin School, Massac County

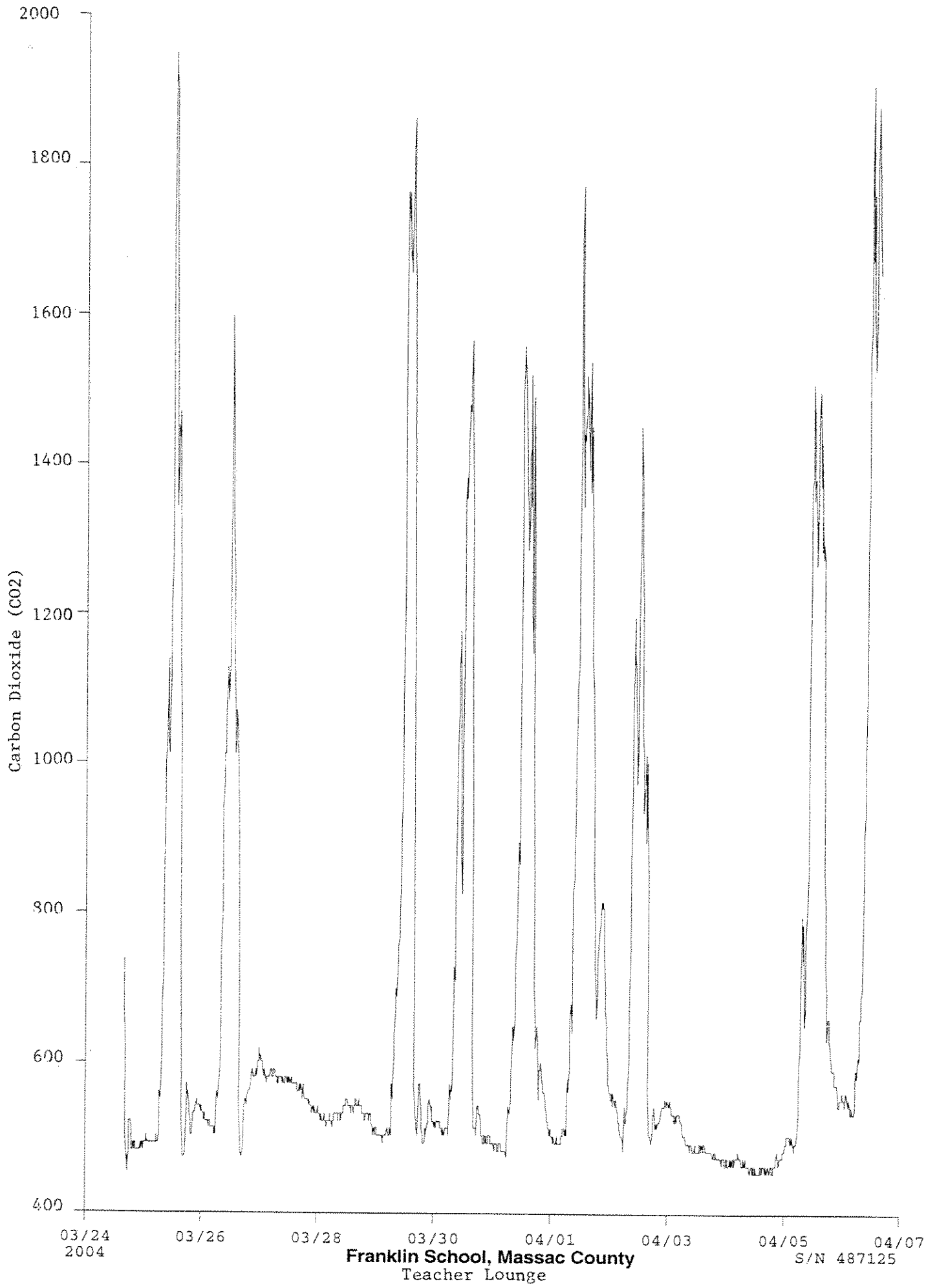
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5th Grade



Franklin School, Massac County
5th Grade

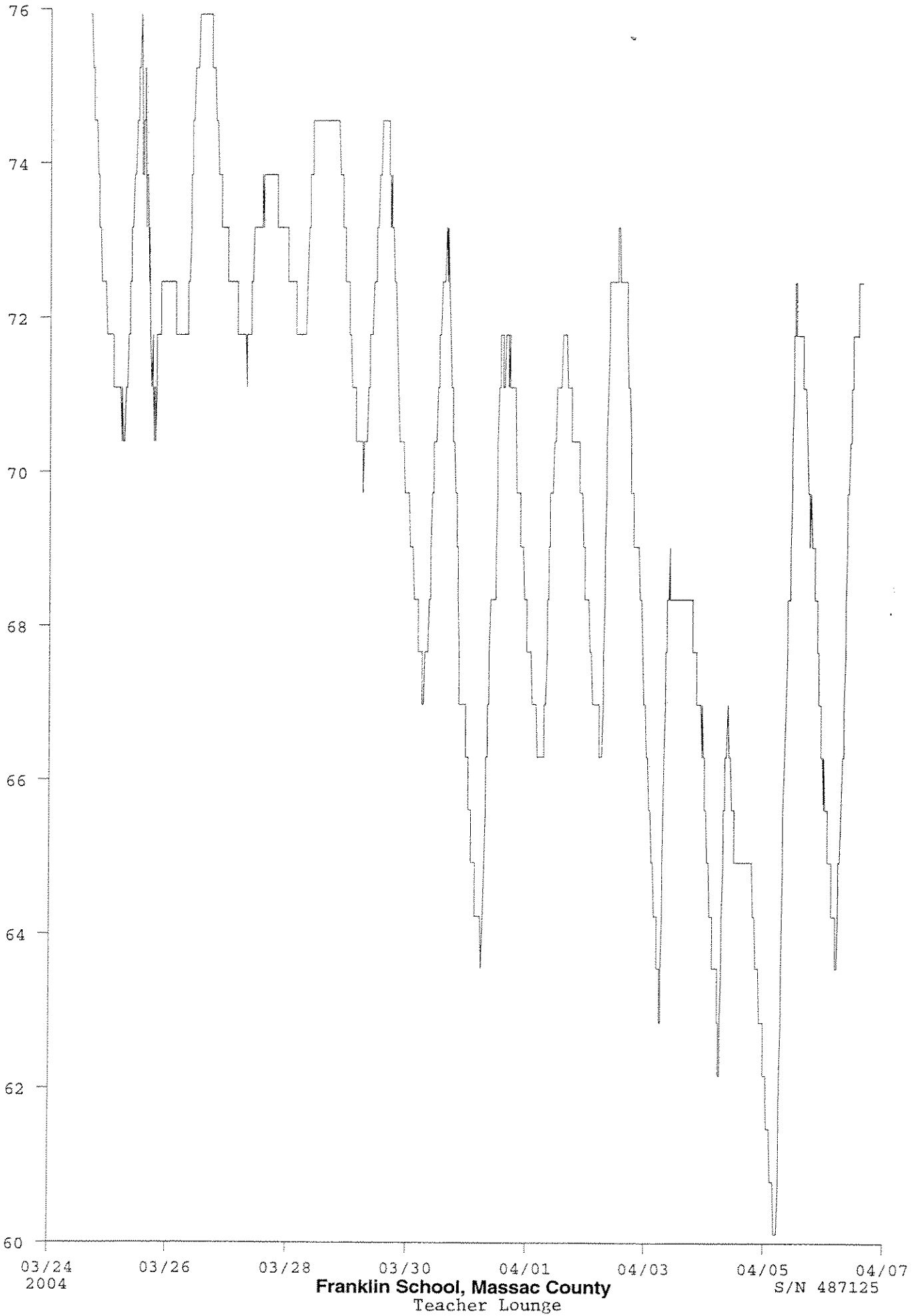
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Franklin School, Massac County
Teacher Lounge

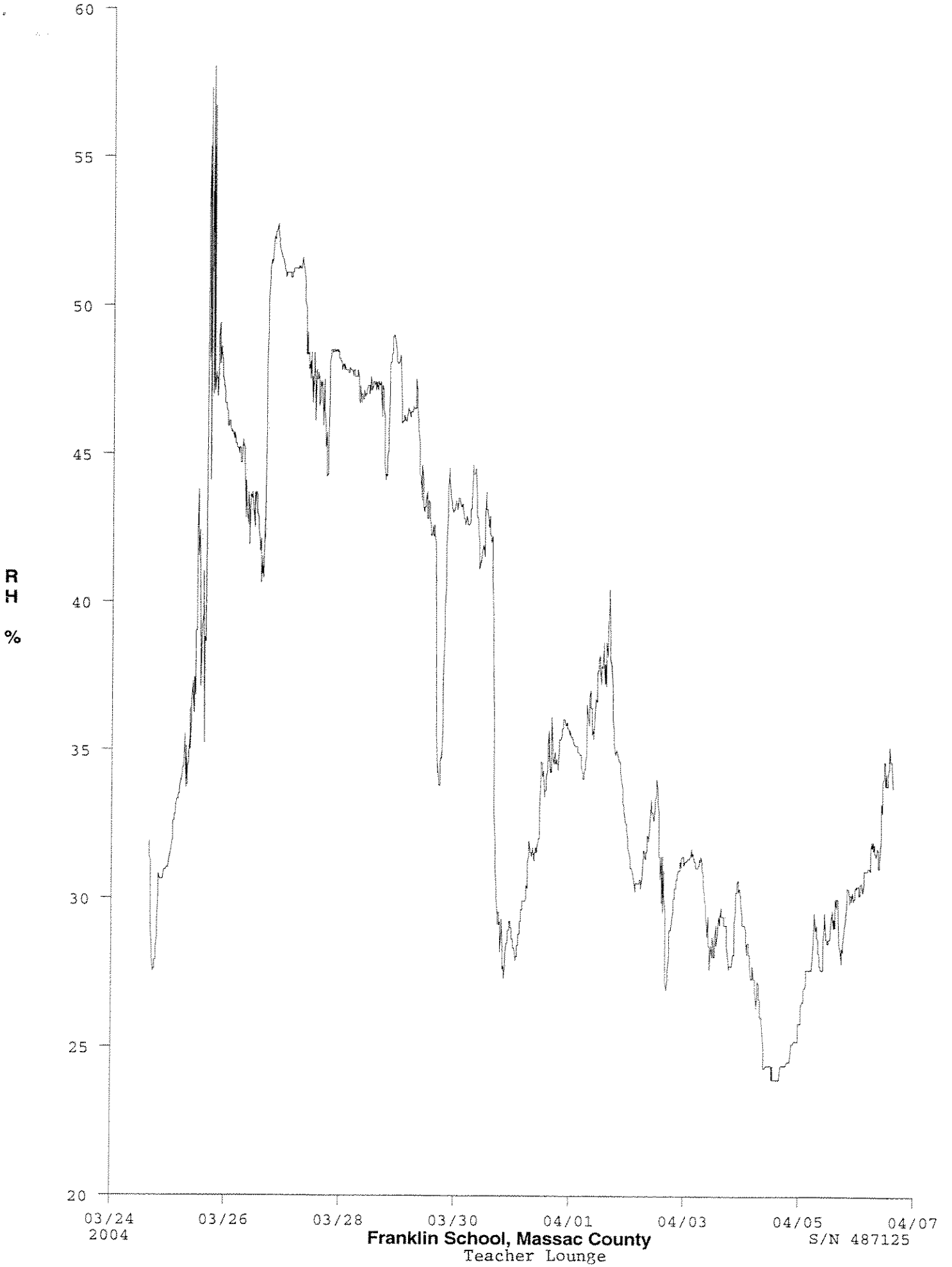
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Temperature
F



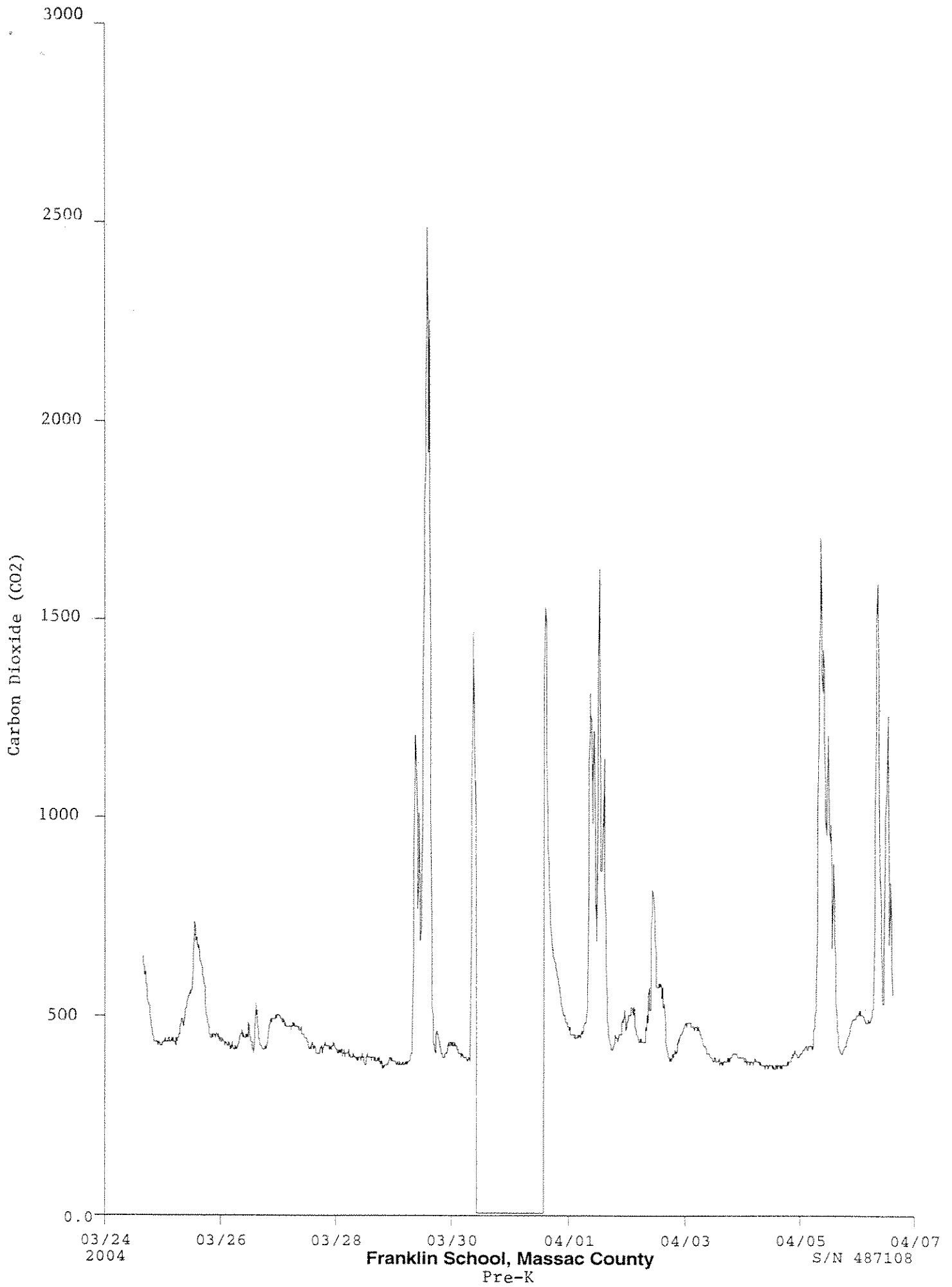
Franklin School, Massac County
Teacher Lounge

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Franklin School, Massac County
Teacher Lounge

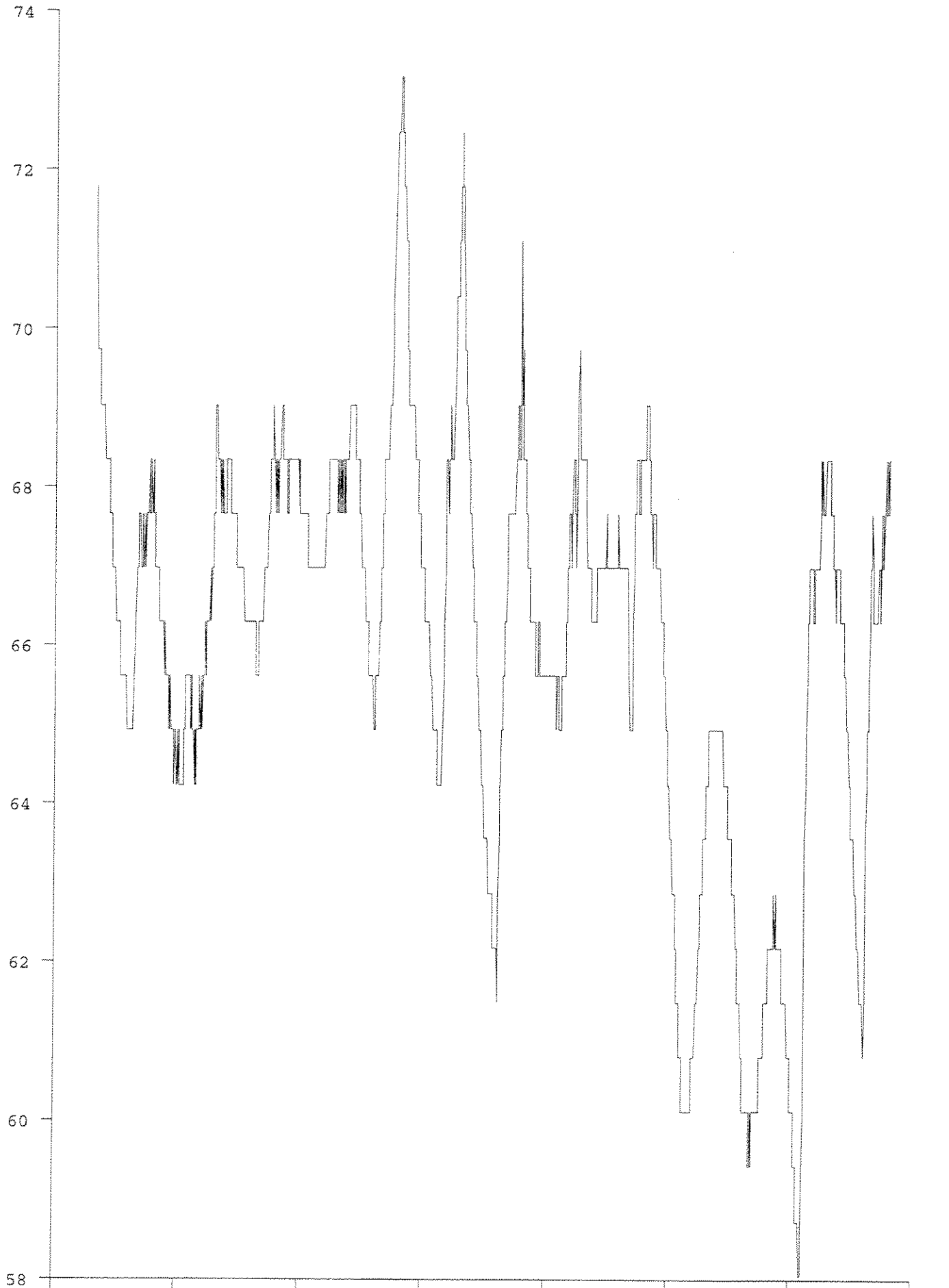
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Franklin School, Massac County
Pre-K

S/N 487108

Temperature



03/24
2004

03/26

03/28

03/30

04/01

04/03

04/05

04/07

Franklin School, Massac County

S/N 487108

Pre-K

