Illinois Department of
Public Health

George H. Ryan, Governor · John R. Lumpkin, M.D., M.P.H., Director

245 West Roosevelt Road • Building 5 • West Chicago, Illinois 60185-4803

Case #: 701280201

August 30, 2002

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DIVISION OF
ENVIRONMENTAL HEALTH

Mr. Mike Early
Heritage Grove Middle School
12450 S. Van Dyke Rd.
Plainfield, IL 60544

Dear Mr. Early:

On March 7 and 21, 2002, Thomas A. Baughman, Ph.D., Environmental Toxicologist, West Chicago Regional Office, conducted an indoor air investigation at Lincoln School. This was in response to a complaint from a parent.

You provided copies of reports by two environmental consultants. A one page letter from Boelter and Yates said that they examined the backs of bulletin boards for mold content on November 6, 2001. Using surface sampling (method not described), they found mold on the backs of some bulletin boards. Bulletin boards with "light growth" were cleaned, but bulletin boards with "heavy growth" were discarded. Mold samples from three cleaned bulletin boards found no mold contamination. Aspergillus versicolor was the dominant mold on two bulletin boards that were removed and later discarded. Sampling found no mold on a bulletin board with no visible mold contamination. According to you, Boelter and Yates found mold on bulletin boards of Rooms 101, 127, and 139. These bulletin boards were on exterior walls, and all bulletin boards were moved to interior walls.

Bain Environmental took 50 bulk or wipe samples on December 28 and 31, 2001. They used Pathcon Laboratories, which is on the list of Environmental Microbiology Accredited Laboratories (EMLAP) of the American Industrial Hygiene Association, updated March 1, 2001. Pathcon Laboratories reported samples with <1000 colony forming units per gram (cfu/g) as low, 1000 to 100,000 cfu/g as moderate, and >100,000 cfu/g as high; however, Pathcon Laboratories reported that these were not health-based criteria. Forty-four of the samples were in the "low" category, and six samples were in the "moderate" category. In the "moderate" samples, identified fungi included Acremonium, Alternaria, Aspergillus fumigatus, A. niger, Beauveria, Cladosporium, Eurotium, Fusarium, Penicillium, Rhizoctonia, and Rhodotorula.

We sent you our health questionnaire and asked that all your staff fill it out. Twenty-one people out of 125 total staff (17%) completed our health questionnaire. Twenty people (16%) had complaints. Fifteen people (12%) said that temperatures were too hot, and 13 people (10%, and often the same people) said that the temperatures were too cold. Eleven people (9%) complained about a lack of air circulation. Five people (4%) complained about dust in the air, three people (2%) complained about noticeable odors, and one person (1%) complained about disturbing noises. Nine people (7%) reported that problems occurred daily, and eight people (6%) reported that problems occurred all day. Four people (3%) reported no noticeable trend in the occurrence of problems, and two people (2%) reported that problems were worse in the afternoon. In the order of frequency, reported symptoms were headaches (9, 7%), sinus infection (8, 6%), dry/sore throat (7, 6%), fatigue/drowsiness (7, 6%), runny nose (7, 6%), sinus irritation (7, 6%), eye irritation (5, 4%), cough (4, 3%), difficulty breathing (3, 2%), dizziness (2, 2%), rashes (2, 2%), wheezing (2, 2%), abdominal pain (1, 1%), chest pain (1, 1%), diarrhea (1, 1%), and nausea (1, 1%). Five people (4%) reported allergies that might account for some of their symptoms. Three people (2%) said that their symptoms pre-dated the construction of the school. Eight people (6%) reported that problems were worse during the heating season, but only three people (2%) associated problems with cold weather, when the indoor humidity was low. Three people (2%) said that problems were worse during hot humid weather, and two people said that problems were worse when the air-conditioner was operated. Two people (2%) said that problems were worse when the building was ventilated by opening windows. Only one person (1%) associated their symptoms with the flooding.

Our department also sent you our building and ventilation system questionnaire. According to it, the 2-story building was three years old, normally had 1350 occupants, and was on a slab. Windows of the first and second floor classrooms can be opened. Outside air intakes are on the roofs and walls, and they are at least 50 feet from any parking lot or loading dock. The distance of outside air intakes from building exhausts "varies," and the building has no cooling towers. Outside air is always brought into the building, and the ventilation system was designed to meet the current ASHRAE standards. The art room, cafeteria, gymnasiums, locker rooms, offices, music rooms, restrooms, and science rooms (Rooms 110, 118, 130, and 132) are served by one of seven air handling units. Most of the classrooms have unit ventilators. The building has no carbon monoxide detectors. Heating, ventilation, and air-conditioning (HVAC) filters are changed every 60 days, and fans and dampers are examined monthly. The school uses natural gas and hot water heat. On December 18, 2002, 2001 a pipe leak caused water damage in rooms 128, 129, 229, and 231. On February 3, 2001, a pipe leak caused water damage in rooms 136, 137, 138, and 237. The pipes broke because they were too close to an exterior wall and froze. The pipes were moved 10 feet toward the interior of the building to prevent their freezing in the future. The leaks damaged ceiling tiles, carpeting, desks, and other furniture. Water-damaged ceiling tiles were removed and replaced. Water-damaged furniture was removed and cleaned or replaced. Water-damaged carpeting was cleaned. The following cleaning and carpet treatment chemicals have been used in the school:

Product	**Chemicals**	**%**
Betco Gym Trak, wood floor maintenance cleaner	Water	0-100
	Isopropyl alcohol	5-10
	2-butoxyethanol	5-10
	Mixed amphocarboxylates	0-5
	dye	<1
Betco pH7 Ultra, cleaner	Water	>76
	Nonionic surfactant	<10
	Disodium salt of ethylenediaminetetracetic acid (EDTA)	<5
	sodium xylene sulfonate	<5
	citric acid	<1
	perfume oil	<1
	dye	<1
	optical brighteners	<1
Betco Deep Blue Glass Cleaner	2-Butoxyethanol	0-1
	Ammonium hydroxide	<1
Betco Velocity, degreaser	Water	40-45
	Propylene glycol phenyl ether	20-25
	Propylene glycol n-butyl ether	10-15
	Tripropylene glycol methyl ether	5-10
	Anionic surfactant	5-10
	Surfactant hydrotrope	5-10
	Perfume oil	0-5
	Sodium xylene sulfonate	<4
	Isopropyl alcohol	<3

Product	Chemical	%
Best Scent (Herbal Fresh, Lemon Fresh, or New Green)	Water	>80
	Nonionic surfactant	<6
	Perfume oil	<3
	Propylene glycol	<1
	Cationic surfactant	<1
	Dye	<1
Betco Best Scent Ocean Breeze	Water	0-100
	Isopropyl alcohol	0-5
	Nonionic surfactant	0-5
	Propylene glycol	0-5
	Cationic surfactant	0-5
	Malodor counteractant	0-5
	Nonionic surfactant	0-5
	Perfume oil	0-5
	Dye	0-5
Betco Quat Stat (disinfectant, cleaner, detergent, viruscide, deodorizer, mildewstat, and fungalstat)	Water	0-100
	Quaternary amines (Benzyl C12-C18 alkyldimethyl chloride)	0-5
	Quaternary amines (C12-C18 alkyl((ethylphenyl)methyl)dimethyl chlorides)	0-5
	Sodium carbonate	0-5
	Tetrasodium diethylamine tetraacetic acid (EDTA)	0-5
	Nonionic surfactant	0-5

	Perfume oil	0-5
	Dye	0-5
Betco Best Scrub (deep scrub floor cleaner)	Water	90-100
	Mixed amphocarboxylates	0-5
	Propylene glycol	0-5
	Sodium silicate	0-5
	Dispersion of fluorochemicals in water	0-5
	Dye	0-5
Betco Fibre Pro Foam Control (carpet defoamer)	Water	0-10
	Silicone oil	5-10
Betco Fiber Pro Step One	Water	1-100
	Propylene glycol-n-butylether	0-5
	Petroleum distillates (hydrotreated heavy naphtha)	0-5
	Tetrasodium ethylenediaminetetraacetic acid (EDTA)	0-5
	Anionic surfactant	0-5
	Coconut diethanolamide	0-5
	Nonionic surfactant	0-5
	Surfactant hydrotrope	0-5
	Perfume oil	<1
	Malodor counteractant	<1

Betco Fiber Pro CFP (carpet and fabric protector)	Water	0-100
	Dispersion of fluorocarbons in water	45-50
	Sodium lauryl sulfate	0-5
	Isopropyl alcohol	0-5
Betco Carpet Neutrallize and Condition Red and Brown Out	Water	0-100
	Hydrochloric acid	0-5
	Ammonium bifluoride	0-5
	Sodium xylene sulfonate	0-5

Dr. Baughman initially visited the school on March 7, 2002. He examined building components (ceiling tiles, walls) using a Tramex moisture meter. In Rooms 101 and 127, the drywall formerly behind (removed) moldy bulletin boards was dry. The girl's bathroom by Room 127 had experienced a water leak last spring, and its ceiling tiles were dry. In Room 136, the ceiling tiles in the southwestern corner (where the leak occurred) were dry. In Room 139, both bulletin boards were dry. In Rooms 229 and 237, the drywall near the former pipe leak was dry. He did not find any current water leaks or visual evidence of apparent mold growth.

Our department usually does not recommend mold testing, for several reasons:

- No one knows how much mold is bad, and experts differ widely.
- Spore concentrations vary greatly depending on the life cycle of the organism, weather conditions, and activity in the building (e.g., empty versus vacuuming versus many people walking in building).
- Individual susceptibility varies greatly. What does not affect one person may affect another person.
- No one knows the concentrations of mycotoxins needed to cause health problems.
- Most of the molds commonly found indoors after water leaks are not in standard allergy screens.
- The recommended procedures for the cleanup of mold and the prevention of future mold growth are the same, regardless of the type of mold present.

Consequently, we usually do not recommend testing. Instead, we recommend fixing the water problem, and then cleaning all visible mold.

Since mold is virtually everywhere in nature, people are continuously exposed to molds in a variety of locations. However, molds primarily cause health problems when they are present in large numbers, such as in water-damaged and mold-contaminated buildings. Occupants of water-damaged and mold-contaminated buildings are potentially at risk of developing a variety of infectious, toxic, and allergic illnesses.

Infections caused by mold are rare and they are unlikely to be seen in healthy individuals as a result of occupying a building with water damage. Fungal infections have occurred in agricultural workers exposed to high levels of mold spores; however, occupants of offices or residential buildings are generally exposed to much lower levels. The majority of fungi are unable to cause an infection unless an exposed individual is severely immunocompromised. Molds that are capable of surviving the temperatures and conditions typically found in the human body can cause infection. One such mold to which everyone is commonly exposed is *Aspergillus fumigatus*. *Aspergillus fumigatus* can cause a disease of the lungs and other organs resulting in inflammation or death of infected tissues. This disease, known as aspergillosis, develops as a pulmonary infection but can spread to other organs and lead to death.

Some molds can produce a variety of chemicals known as mycotoxins that can cause a variety of health effects. Exposure to mycotoxins occurs when an individual handles mold-contaminated and toxin-containing materials so that skin contact occurs, or when spores are inhaled. When inhaled, these toxins can interfere with normal immune system function, promote an invasive aspergillosis, or stimulate the release of inflammatory agents which play a role in organic dust toxic syndrome. Chronic exposure to certain mycotoxins has been associated with a variety of relatively mild health effects including headaches, sore throats, flu symptoms, diarrhea, fatigue, and general malaise.

The most common health effects related to mold exposure are allergic illnesses. Allergic illnesses include asthma (an increasingly common allergic illness and chronic condition that affects approximately 17 million Americans), allergic sinusitis, and simple allergic reactions. Allergic illnesses are thought to be caused or aggravated by mold. Symptoms of these illnesses may occur when mold, particularly mold spores, are inhaled, but they may also occur when allergic individuals touch mold-contaminated materials. Typical symptoms include:

- Eye, nose, and throat irritation
- Coughing, wheezing, and shortness of breath
- Sinus and nasal congestion
- Sneezing
- Headaches and fatigue
- Rashes and skin irritation

Our department also used Telaire carbon dioxide monitors, with attached Hobo temperature and relative humidity monitors in Rooms 129, 136, 139, and 216, which reportedly had experienced the most complaints. The Hobos also served as data logging devices, and measurements were recorded every 10 minutes. The monitors recorded data from March 7 to March 21, 2002, and results are in Figures 1-12.

Carbon dioxide (CO_2) is a normal component of exhaled breath, so measurements can be used to determine if a sufficient quantity of fresh, outdoor air is being introduced into the indoor environment. 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 schools with 15 cubic feet of outdoor air per minute (cfm) per person. Indoor CO_2 levels are dependent on the outdoor level, but 15 cfm will result in an indoor CO_2 level approximately equivalent to 700 parts per million (ppm) greater than the outdoor level (1). This ventilation rate is expected to reasonably dilute odors and contaminants common to indoor air. Carbon dioxide levels in excess of the ASHRAE standard indicate that an insufficient volume of outdoor air is being supplied to the building to mix with recirculated air. ASHRAE standards are recommended guidelines and not legally enforceable limits.

Complaints of headaches, fatigue, and eye, nose, and throat irritation are commonly reported in buildings where CO_2 is present at high levels, but these symptoms are not caused by CO_2. At the levels typically found in indoor environments CO_2 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 CO_2 levels within a building indicate a lack of ventilation which could allow other contaminants common to office spaces to be present at elevated levels and be responsible for occupant complaints. Inadequate outside air intake also may make other comfort factors such as temperature more noticeable. In spite of the recent media emphasis on molds, inadequate outside air intake actually is the most common cause of indoor air problems.

We use CO_2 as an indirect indicator of the ventilation rate. From the inside and outside CO_2 concentrations, the following formula gives the fresh outside air intake:

cfm/person = $10500/(CO_{2in} - CO_{2out})$, where:

cfm/person = cubic feet per minute per person,

CO_{2in} = inside carbon dioxide concentration (ppm), and

CO_{2out} = outside carbon dioxide concentration (ppm).

Using the data from the Telaire monitors, the following increases in outside air intake are needed:

Location	Maximum Carbon Dioxide (ppm)	Outside Air Intake (cfm/person)	Percent Increase in Outside Air Intake Needed (%)
Room 129	2,485	4.9	210
Room 136	2,485	4.9	210
Room 139	2,290	5.4	180
Room 216	1,600	8.4	79

ppm = Parts per million.
cfm/person = Cubic feet per minute per person.

Using a TSI Q-Trak, we found an instantaneous carbon dioxide concentration of 1,100 ppm in Room 229, showing that its outside air intake was inadequate. However, long-term monitoring data were not available to evaluate the required increase in outside air. Increasing the outside air intake to recommended levels may alleviate some indoor air complaints in the building.

Using the Telaire monitors, our department also examined temperatures in the building. 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 office temperatures be maintained between 68 degrees and 75 degrees (71 degrees is optimal) during the winter months and between 73 degrees and 79 degrees (76 degrees is optimal) during the summer months. Because of individual differences, it is impossible to recommend a thermal environment that will satisfy everyone. The purpose of this standard is to recommend a thermal environment that is acceptable to approximately 80% of the occupants.

Rooms 129, 136, 139, and 216 sometimes exceeded these guidelines, and some large temperature fluctuations occurred. Possible causes of large temperature variations include faulty thermostats, dirty thermostat contacts on older mechanical thermostats, improper thermostat placement, or an unbalanced air handling system (i.e., pressure differences in a ventilation system cause some air outlets to get more or less air than others).

Using a TSI Q-Trak our department found no carbon monoxide in the building. Using a Neotronics, Ltd. NEOTOX-XL, we found no hydrogen sulfide (sewer gas) in the building.

Many of the chemicals in the cleaning products are simple detergents, and their normal use should not cause any health problems in the school. These detergents include anionic, cationic, and nonionic surfactants, amphocarboxylates, sodium xylene sulfonate. Ethylenediaminetetraacetic acid is a chelating agent that is used in detergents, as a food additive, and, in patients poisoned by heavy metals, as a medicine to help remove heavy metals from the body. Its use in detergents should not cause any health problems in the school.

Many of the organic compounds (isopropyl alcohol, glycols, glycol ethers, and petroleum distillates) may cause odors for a short time until they evaporate, with isopropyl alcohol lasting a very short time (it is common rubbing alcohol). At sufficient concentrations, these organic compounds may cause irritation. However, these cleaners probably are mainly used after school and probably dissipate by morning. Increased ventilation (as recommended for general air quality) will enhance this dissipation.

The carpet protectors used in the school coat carpet fibers with a low-toxicity, teflon-like chemical to inhibit staining. They would have no effect on molds and would not prevent future mold growth should water problems recur. The Quat Stat, which contains quaternary amines, would kill molds on contact; however, surface applications of disinfectants may not reach deeply into carpeting. They would have minimal residual action, so they would not stop mold growth should water problems recur. Also, molds do not have to be alive to aggravate allergies and asthma. Replacement of the water-damaged carpeting would have been a better option.

The hydrochloric-acid-containing stain remover is not sufficiently concentrated to be a concern for chemical burns to the skin, although eye protection would be a good precaution during application. Hydrochloric acid evaporates and does not leave a residue. This stain remover would be most effective against rust stains, but it would not be effective at cleaning mold.

Many of the cleaning products contained up to 5% "perfume oil." Although many cleaners have fragrances, 5% is an unusually high concentration. Fragrances do not destroy the chemicals that cause odors. Instead, they attempt to mask odors. Depending on the evaporation rate, they may or may not dissipate rapidly. Ventilation will enhance their dissipation. Some people, particularly those with allergies, are sensitive to some fragrances. In susceptible people, some fragrances can produce mucous membrane irritation. In asthmatics, such irritation may increase the risk of an asthma attack. Ventilation with fresh air or using an exhaust fan are better alternatives than using fragrances.

Our department concluded that in several rooms, the fresh outside air intake was inadequate and needed to be increased. Some rooms experienced temperatures that exceeded the ASHRAE guidelines, and some rooms experienced large temperature fluctuations. No current water leaks were found, and conditions were not conducive to the growth of mold. The past cleaning of carpeting following mold damage may have been inadequate. Replacement of water-damaged carpeting may be an option if increasing the outside air intake and solving the temperature regulation problems fail to alleviate complaints. Using cleaning compounds with less fragrances also may help improve indoor air quality.

Our department recommends:

1. Increasing the outside air intake of the building to 15 cubic feet per minute per person.
2. Determine and remedy the cause(s) of temperature regulation problems in the building.
3. If increasing the outside air intake and solving the temperature regulation problems do not alleviate complaints, consider replacing formerly water-damaged carpeting and using cleaning compounds with less fragrances.
4. Any mold cleanup or remediation plan that does not address underlying moisture problems will ultimately fail.
5. 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. Areas that have been cleaned may also be disinfected using a dilute bleach solution (½ cup of bleach per gallon of water), but it is critical that all visible mold growth and soiling are cleaned off using a soap or detergent solution **before** applying a disinfectant.
6. Minimize dust and debris when removing moldy drywall, carpet, and other materials by misting surfaces with water. Do not dry scrape or sand surfaces contaminated with mold, and do not use hammers when removing drywall.
7. Water-damaged materials and debris should be double bagged, sealed, and the bag wiped clean prior to removal from work areas.
8. Provide continuous ventilation, especially when cleaning agents or disinfectants are used.
9. Wear rubber gloves and protective clothing that are easily cleaned or discarded.
10. The guidelines listed above apply to environments with less than 10 ft^2 of visible contamination. All observed areas with water damage in the school were smaller than 10 ft^2, and visible apparent mold was not observed.

If you have any questions or require additional information, feel free to contact Tom Baughman, Ph.D., Environmental Toxicologist, at (630) 293-6800 or tbaughma@idph.state.il.us.

Sincerely,

S. Lee Wohlwend, PE
Senior Public Service Administrator

cc: IDPH Toxicology Section, Springfield
West Chicago Regional office
Will County Health Department

Figure 1. Temperature in Room 129.

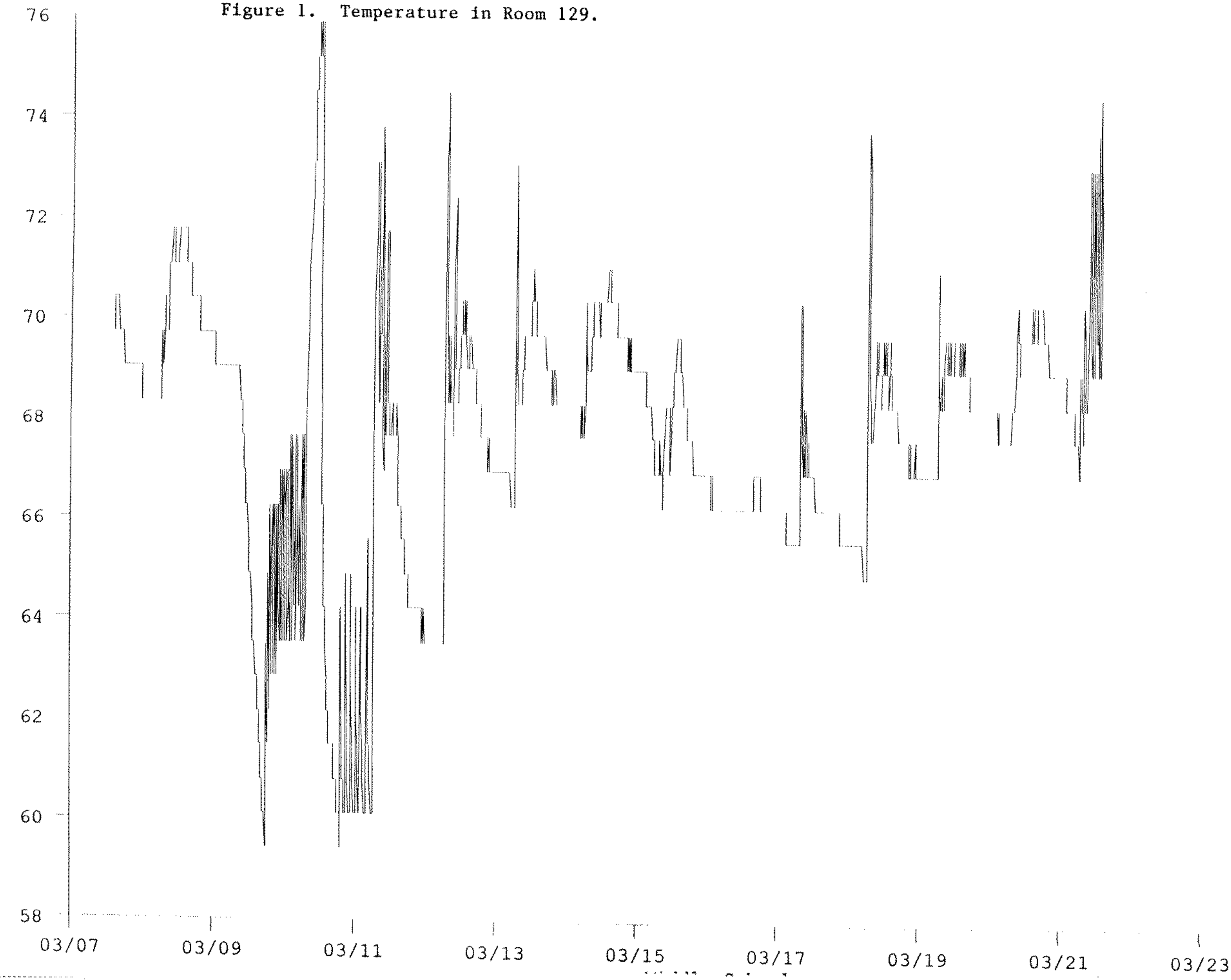

Figure 2. Relative humidity in Room 129.

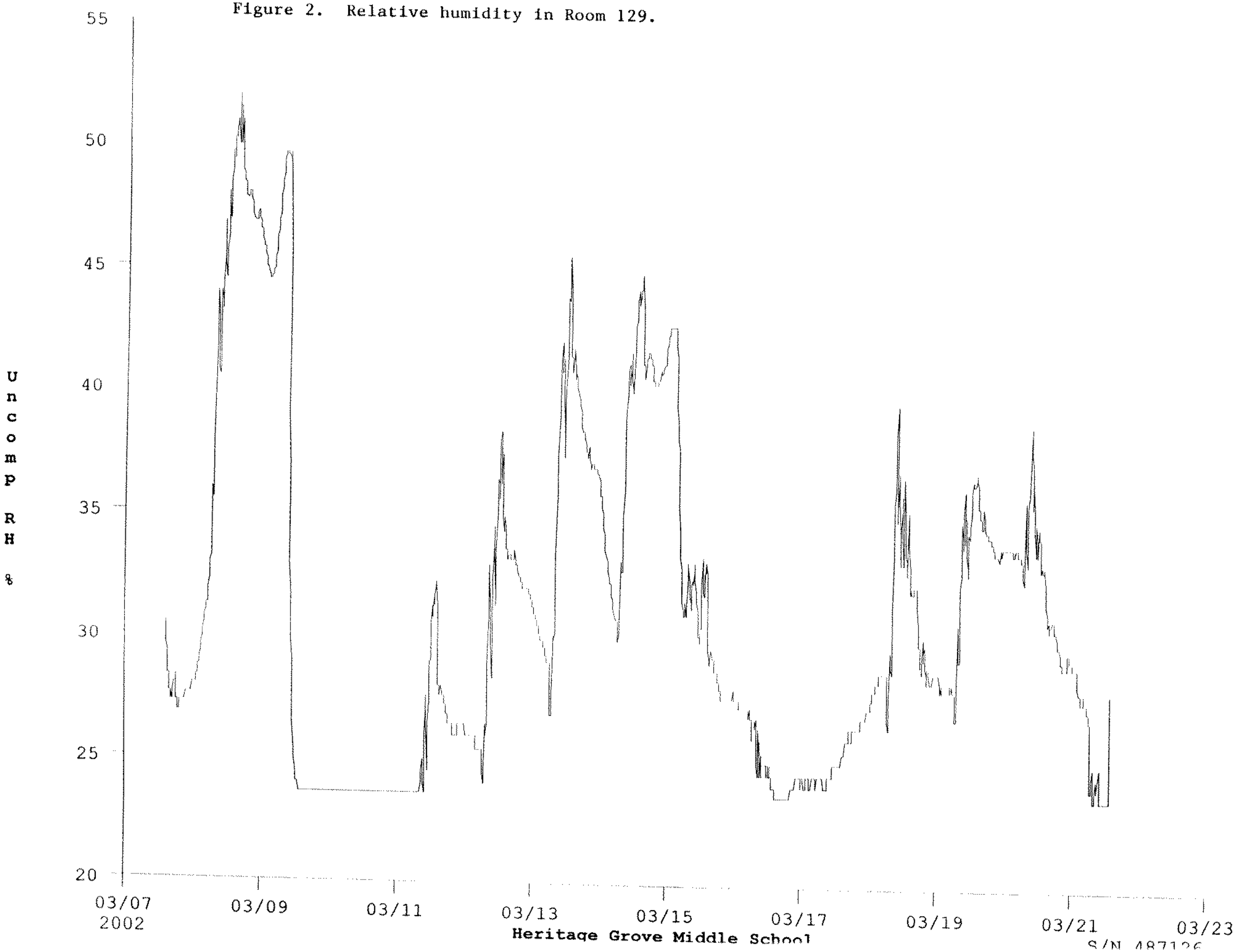

Figure 3. Carbon dioxide concentration in Room 129. One volt = 1,000 ppm.

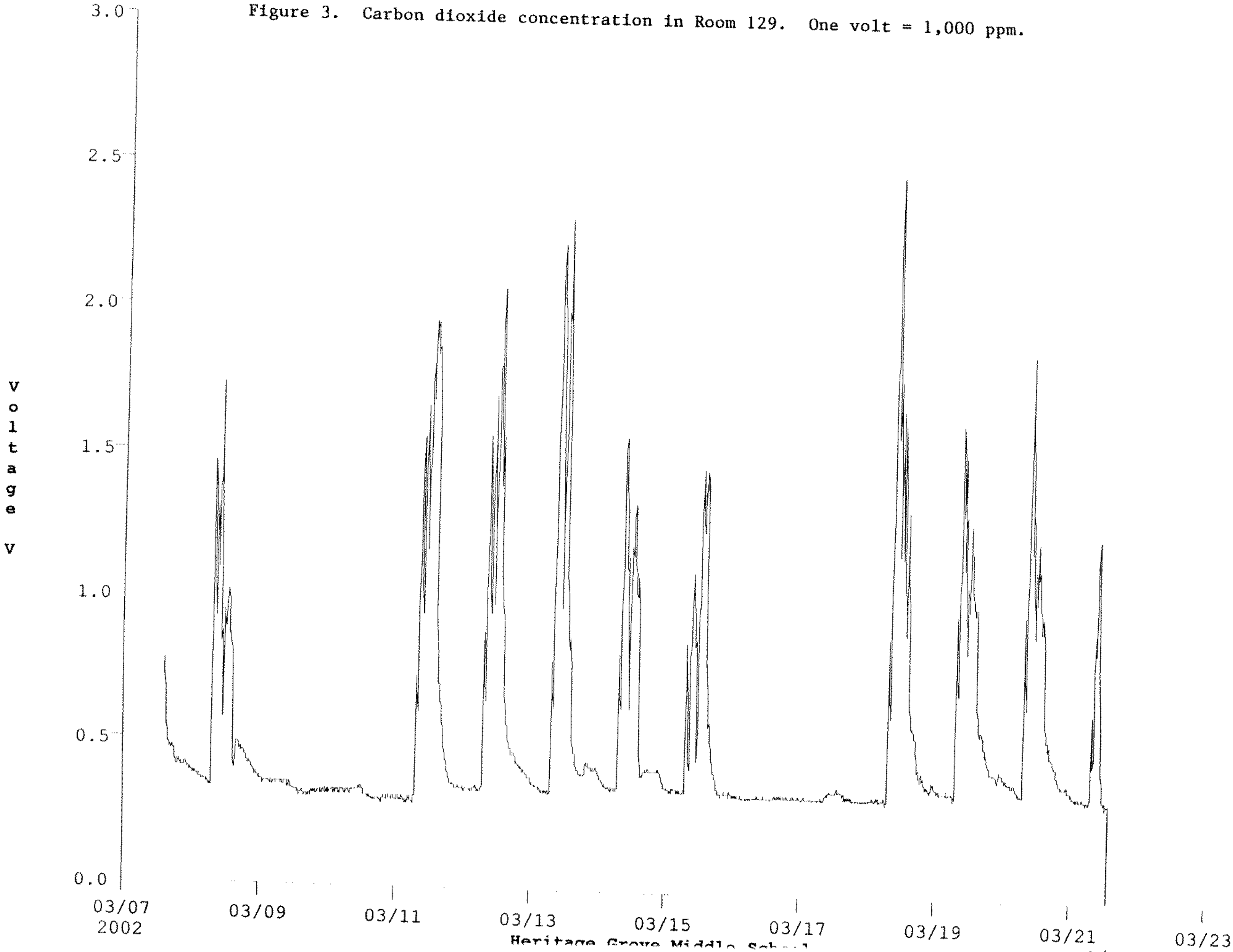

Figure 4. Temperature in Room 136.

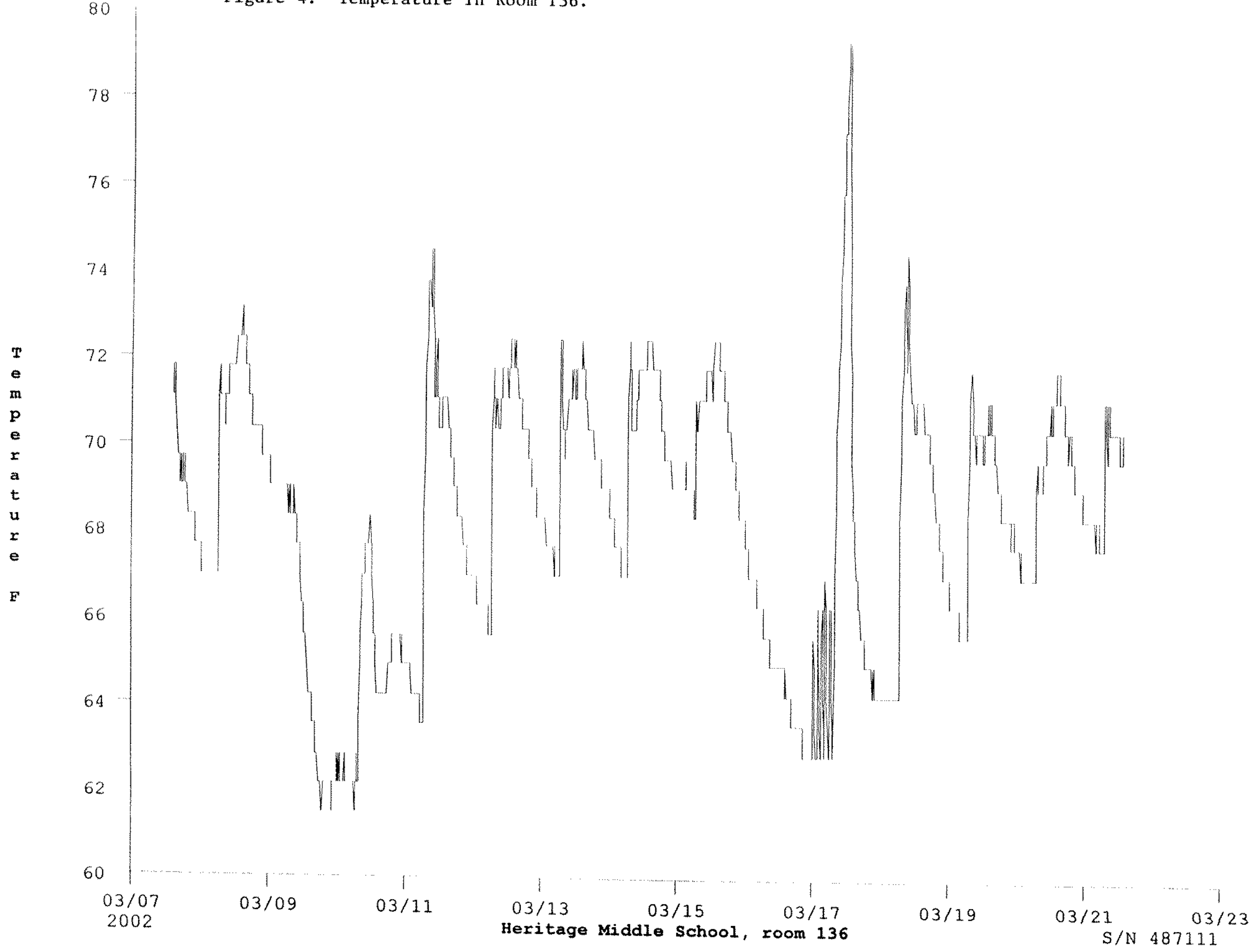

Figure 5. Relative humidity in Room 136.

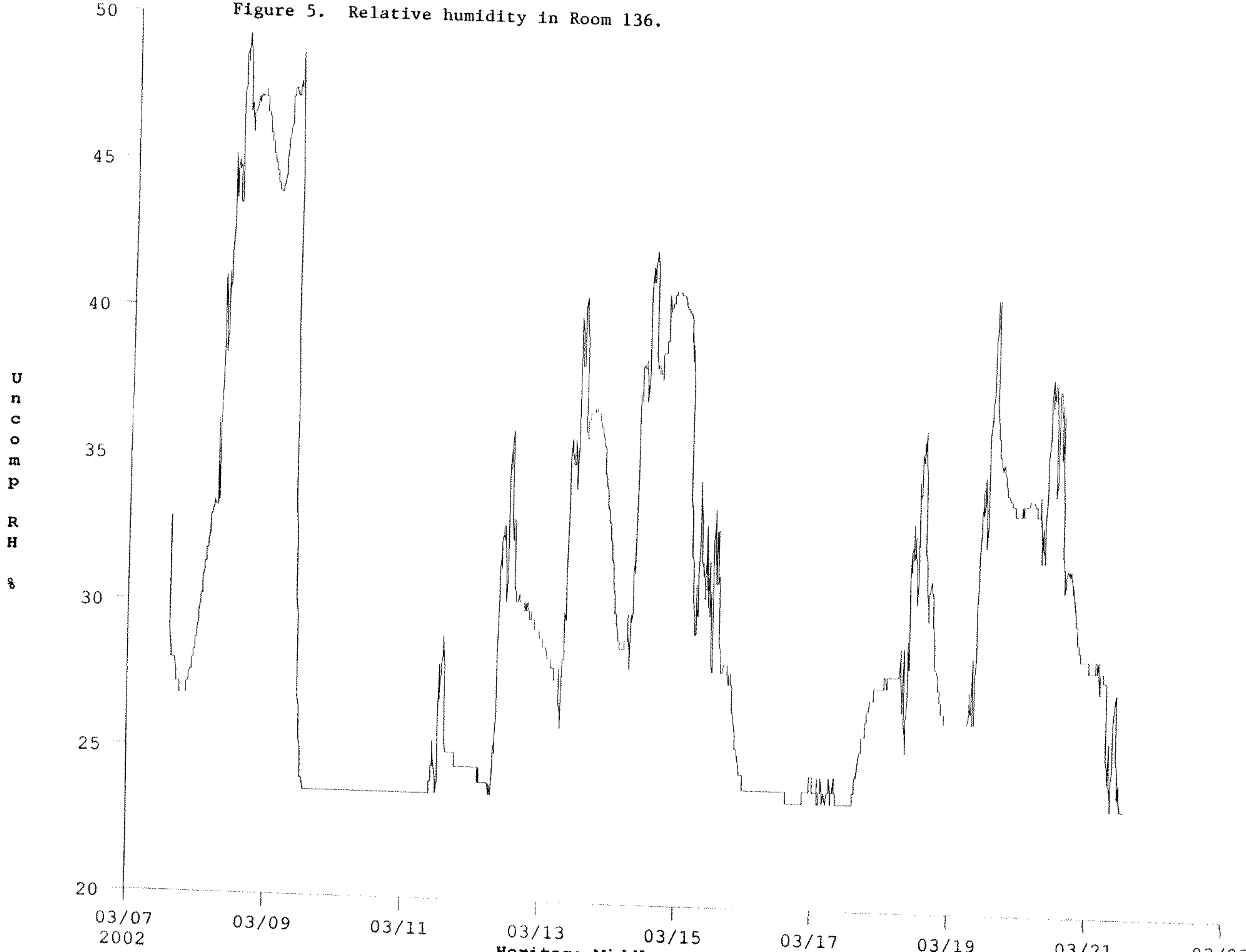

Figure 6. Carbon dioxide concentrations in Room 136. One volt = 1,000 ppm.

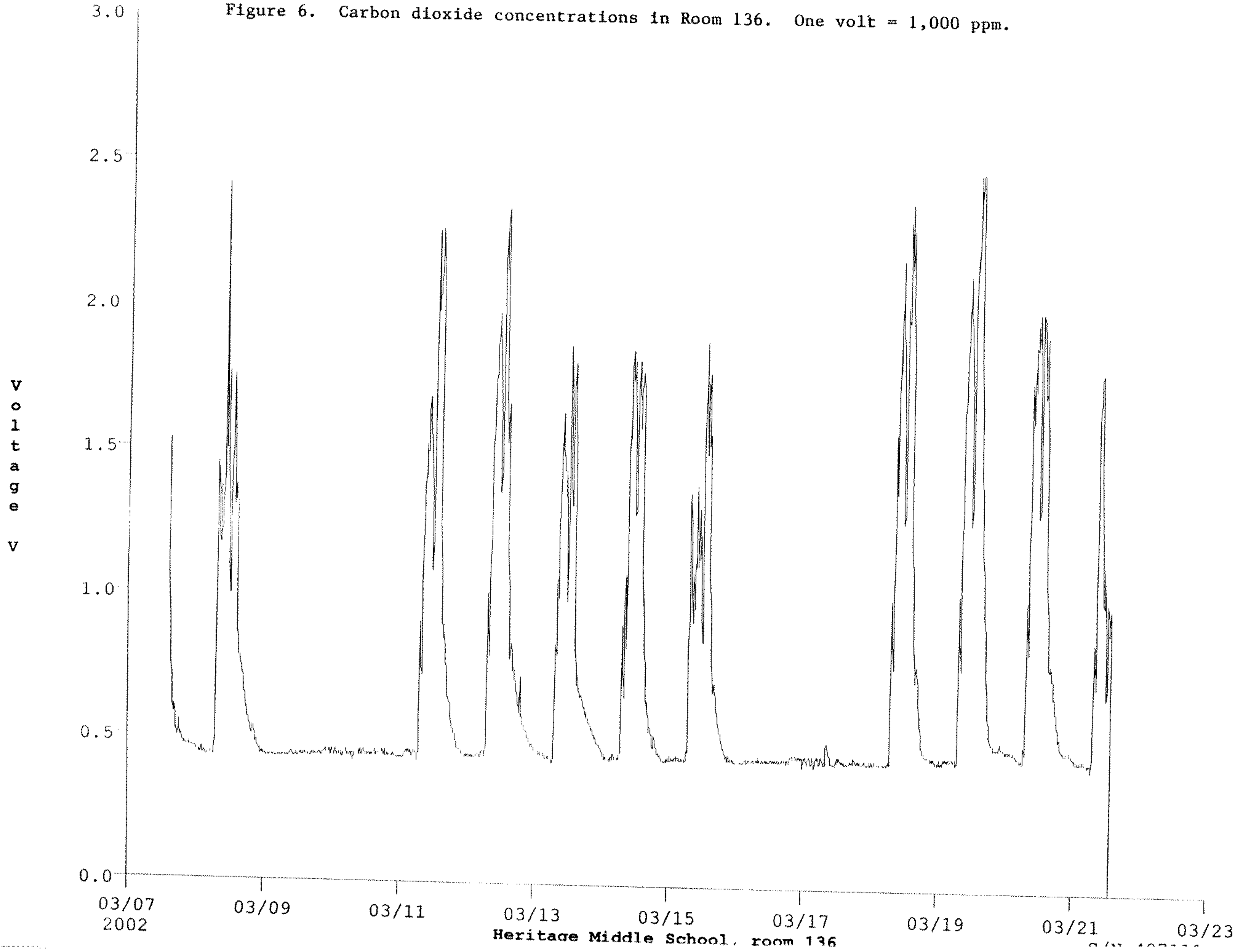

Figure 7. Temperature in Room 139.

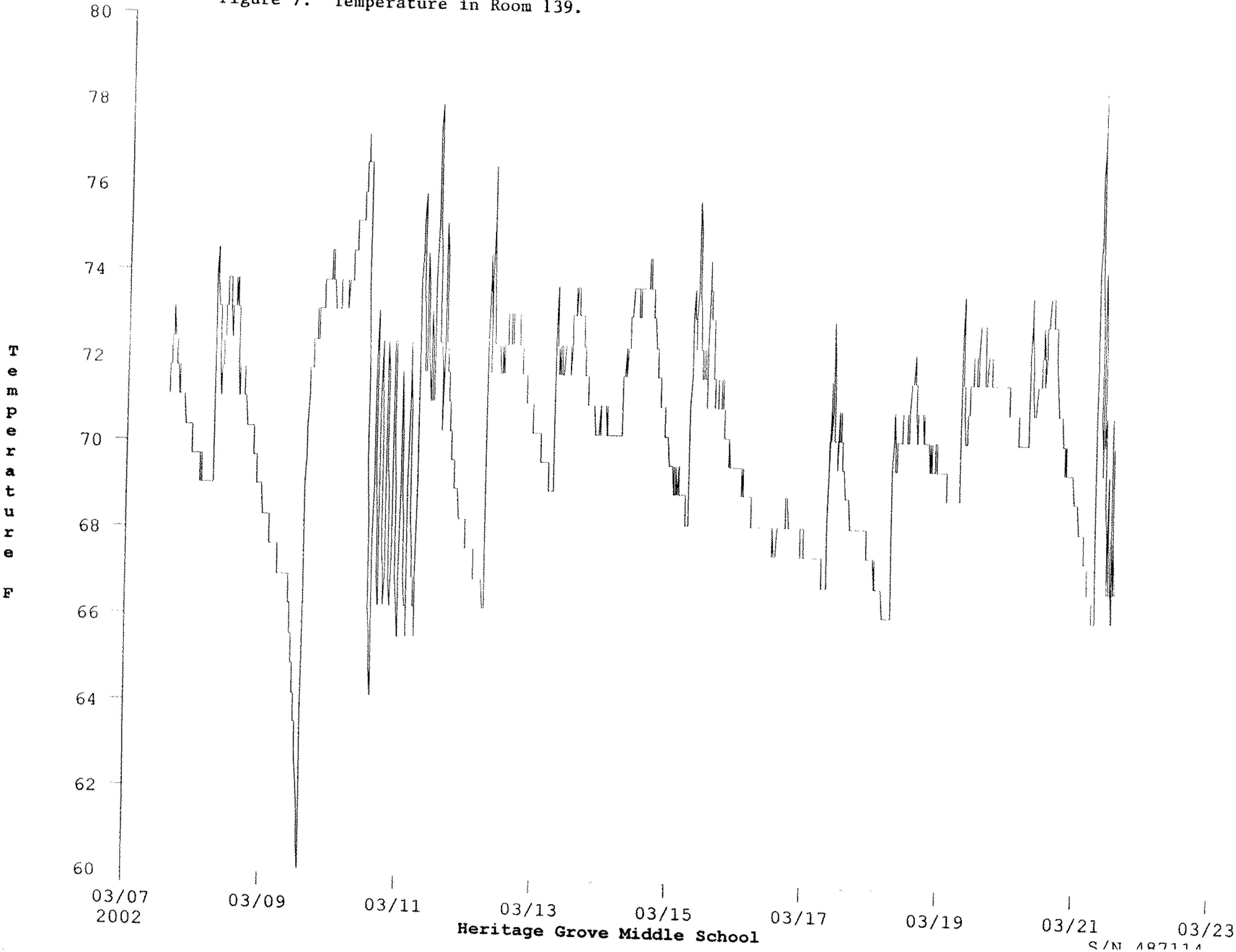

Figure 8. Relative humidity in Room 139.

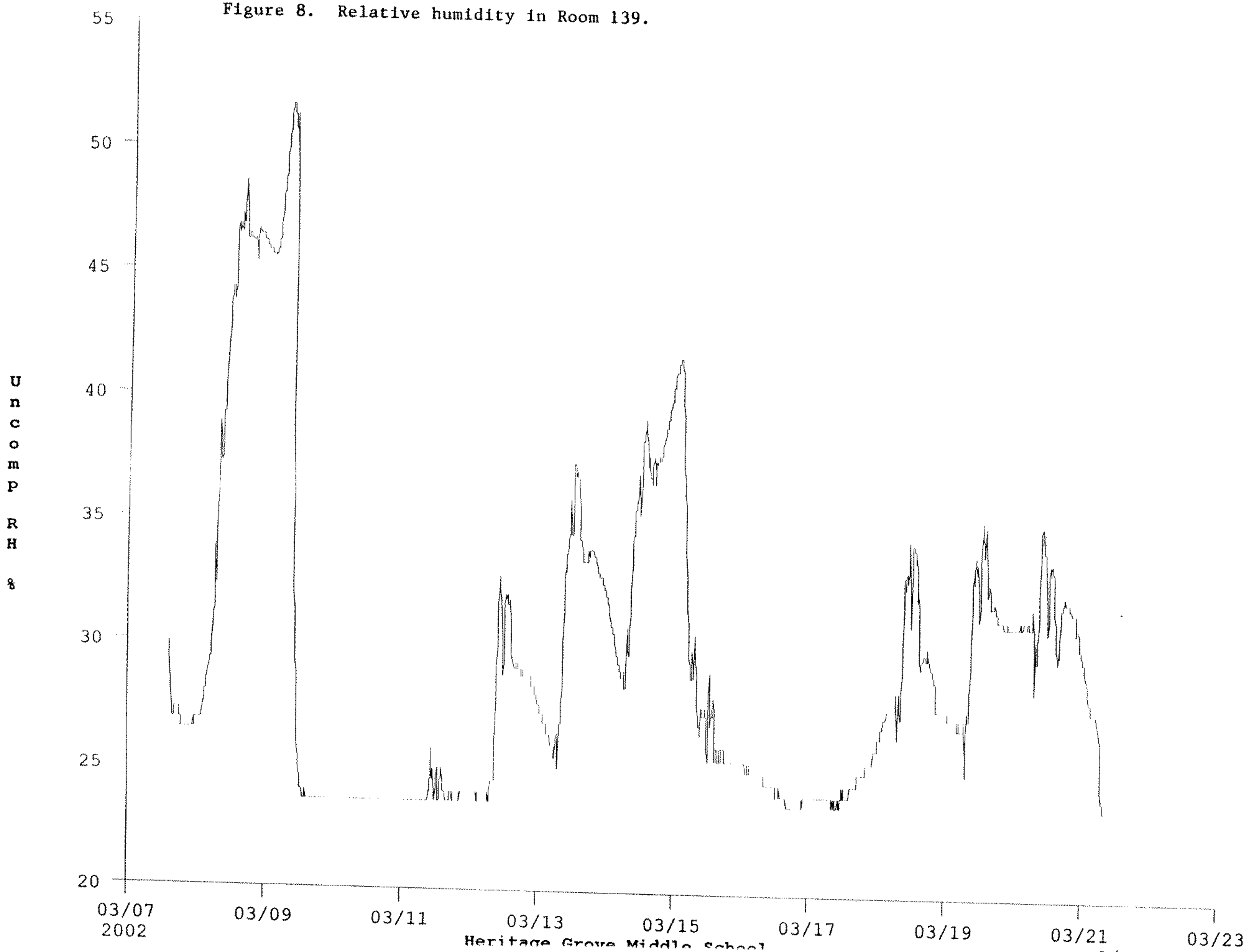

Figure 9. Carbon dioxide concentration in Room 139. One volt = 1,000 ppm.

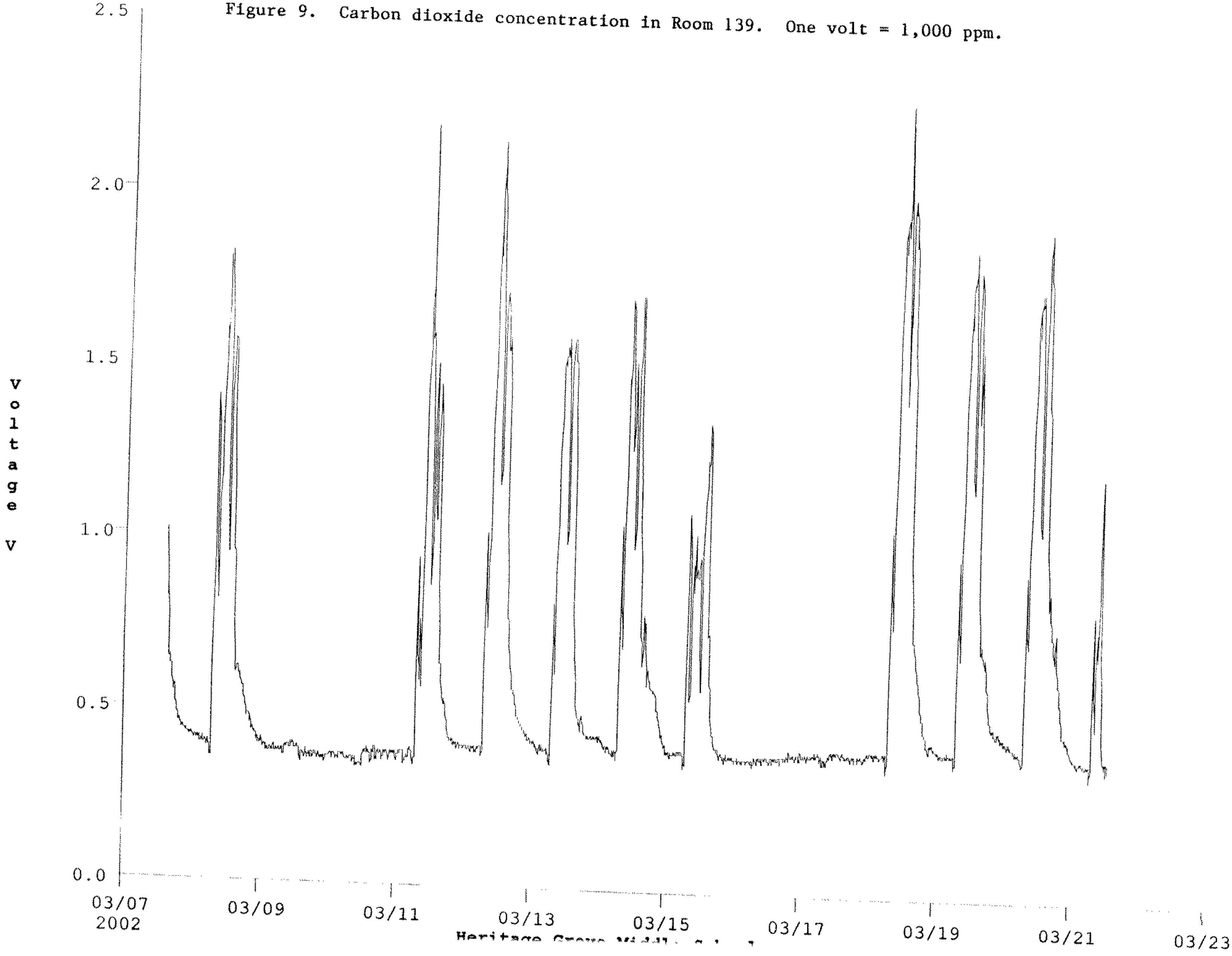

Figure 10. Temperature in Room 216.

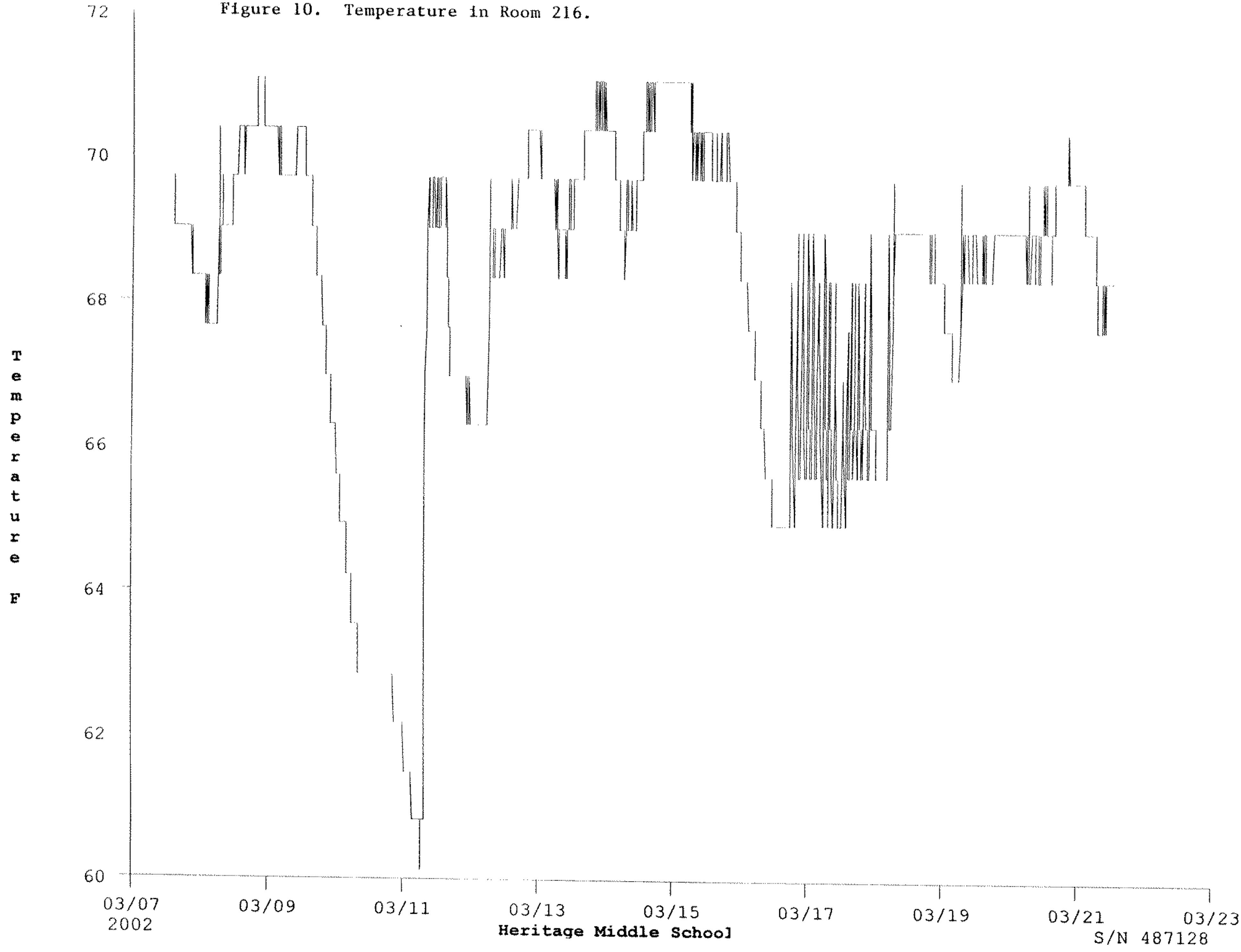

Figure 11. Relative humidity in Room 216.

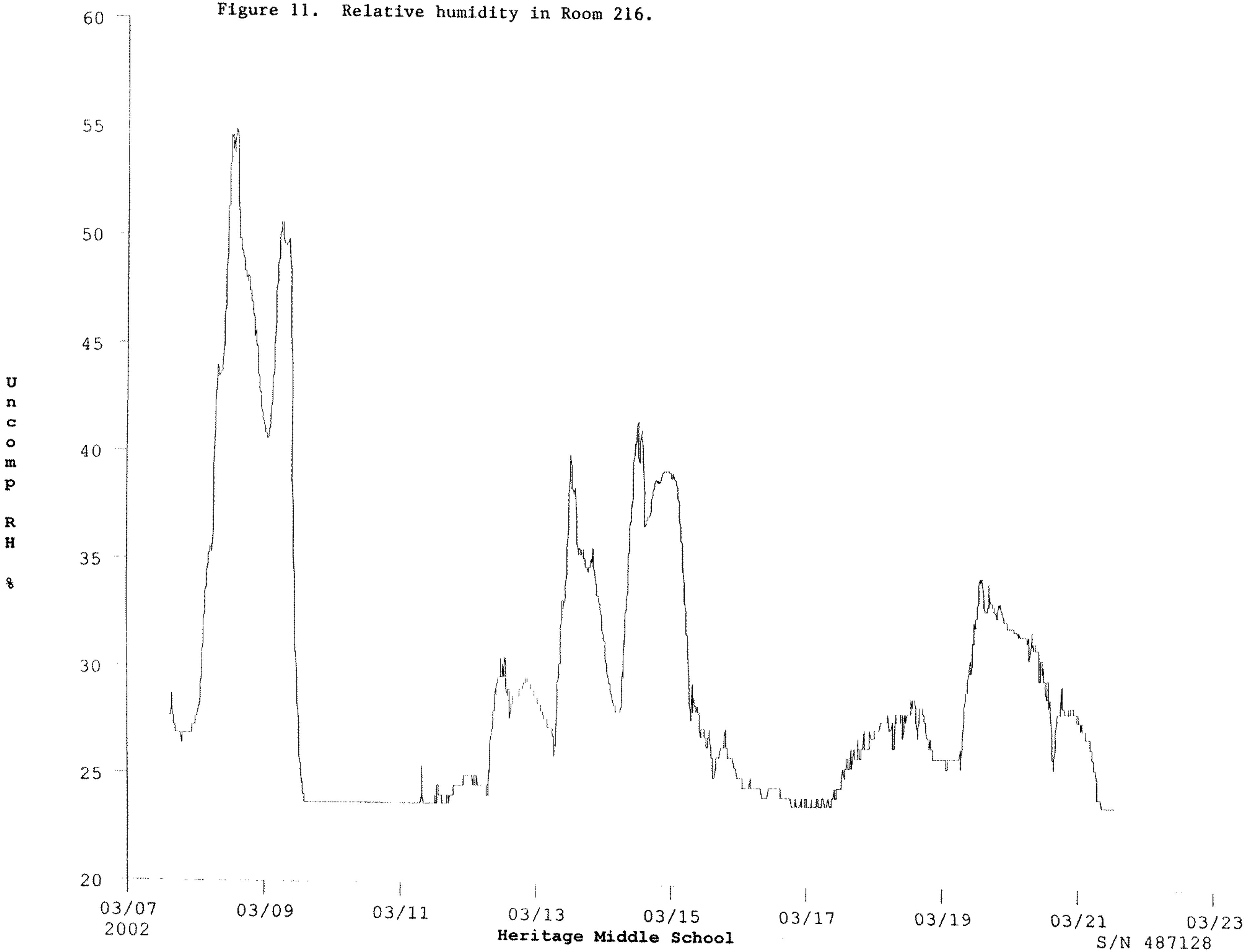

Figure 12. Carbon dioxide concentration in Room 216. One volt = 1,000 ppm.