Section 4

Maintaining & Operating Buildings for Optimum Indoor Air Quality

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A. Heating, Ventilation & Air Conditioning (HVAC) Maintenance Program

- Mounds View Public Schools maintains its ventilation systems in each building per the Operating & Maintenance (O&M) Manuals designated for each building's specific air handling unit. The O & M manuals are located at the respective buildings.

- The energy management systems for the ventilation systems supplying each building are maintained by Johnson Controls. The Johnson Controls contact person for the District is Chris Boysen.

1. **Air Handling Unit (AHU)** – The following components of the air handling unit need inspection on a regular basis. This regular maintenance will vary greatly in the different types of air handling units. Service manuals for each air handling unit should be consulted for maintenance schedules. The discussion below concerns regular maintenance to components which is necessary to prevent indoor air quality concerns.

- *Air Filtration System* – Filters are primarily used to remove particles from the air. The type and design of a filter determine its efficiency at removing particles of a given size and the amount of energy needed to pull or push air through the filter. Filters are rated by different standards and test methods such as dust spot and arrestance which measure different aspects of performance. Most filters are rated by ASHRAE Standard 52.1-1992.

  All dirt cannot be eliminated from the HVAC system; however, the amount of dirt present inside the HVAC system can be controlled by proper air filtration.

  Filter information and the filter changing schedule for Mounds View Public Schools can be found in the hard copy of the IAQ Management Plan in the Risk Coordinator's Office.

- *Heating Coils* – The heating coils (reheat coils) are used to increase the temperature of the airstream in the ventilation system and are normally located downstream of the air filtration system. In some systems heating coils can be located anywhere in the HVAC system.

  Heating coils should be inspected annually for accumulation of debris on the upstream side of the coils. These coils normally need to be thoroughly cleaned every 5-10 years. However, unit ventilator coils should be pressure washed on an annual basis.

- *Cooling Coils* – The cooling coils (evaporator coils) are used to decrease the temperature and humidity level of the airstream. During this cooling process, water will condense on to the cooling coils and drip into the dip pan located at the base of the cooling coils. Cooling coils resemble heating coils and are normally located immediately downstream of the heating coils.

  During periods when the humidity levels outdoors are high (outdoor dew points at or above 60 degrees), the relative humidity inside the supply air ductwork in air-conditioned buildings can increase to levels above 70 percent. When outdoor dew points are above 60 degrees, the air entering the cooling coils is dehumidified and water condenses on the cooling coils and is drained away. Air leaving the cooling coils, when the outdoor dew point is above 60 degrees, is typically at a temperature of 50-60 degrees with a relative humidity of 90 percent plus. This environment is ideal for microbe growth if a suitable site for growth and food source exits. There are three potential growth sites in the cooling coil area.

  1. The cooling coils - Debris can build up on the coiling coils (especially on the upstream side of the coils) and act as a food source for the microbes.

  2. The cooling coils drainage area - Debris can build up in the drainage pans and act as a food source for the microbes to grow in this area. In addition, the debris can block the drainage from the cooling coils and cause water to be sprayed or leaked on to the ductwork downstream from the cooling coils. Drainage systems which are not properly engineered will not drain and will allow standing water to accumulate in the drainage pans and/or adjacent ductwork. All drainage pans need to have a water trap (normally at least 3 inches deep) in the drainage system to prevent air from traveling up the drainage system, aspirating water into the airstream. Appropriate chemical tablets in the drain pans will also be helpful in limiting algae growth.

  3. Ductwork downstream and adjacent to cooling coils - Any ductwork in areas where the relative humidity is greater than 70 percent has a good potential for undesirable microbe growth, if a suitable site for growth and a food source exists. The suitable site in many ventilation systems is the porous fibrous glass lining 10 feet upstream and all areas downstream of the cooling coils which the air has to pass by before being distributed throughout the building. The food source is any dust which travels with the air being circulated in the ventilation system which collects on the fibrous glass lined ductwork. The microbes grow on the dirt which has collected on the fibrous glass liner.

FAQs

Should staff be allowed to bring a small humidifier into the school?

Staff should not be allowed to bring a humidifier into the school. Individuals with a physician's prescription for a humidifier should consult with the school nurse and the maintenance personnel. Cool mist and ultrasonic humidifiers will not be allowed in schools. These types of humidifiers can become indoor sources of bacteria even with regular cleaning and disinfection.

Evaporative humidifiers reduce the risk of exposure to bacteria during their operation because no mist is put into the air. While the unit is being cleaned, there may be exposure to bacteria or fungi. Sampling of the water from an evaporative humidifier in an area with high paper use had significant levels of *Stachybotrys chartarum* (Neil Carlson, 1977).

Humidifiers may also over humidify a space and cause moisture condensation on cold services which can lead to mold growth.

Total elimination of microorganisms from buildings is not possible. The goal of building operations is to keep the population of microorganisms within reasonable levels. All buildings should have easy access “clean-out doors” upstream and downstream of cooling coils. The three areas mentioned above need to be cleaned with a cleaning solution in March or April and September or October of each year. This cleaning needs to include ductwork 5 feet upstream and downstream of the cooling coils. This cleaning need only occur in September or October in buildings using high efficient filters, ASHRAE dust spot efficiency greater than 60 percent.

Note: Remove/cover up/coat any fibrous glass interior liners which are present within ten feet upstream and downstream of the cooling coils before cleaning is done in this area. Porous fibrous glass liner are difficult/impossible to clean and should not be present in areas adjacent to cooling coils.

B. Outdoor Air Concerns

In the 19th century it was concluded that 30-40 cubic feet per minute (CFM) of outside fresh air, per person was needed in a building. In the early 20th century the New York School of Comfort recommended 15-20 cfm. Early building codes recommended and/or required 15-25 cfm per person.

The criteria for evaluating indoor air quality has changed over the years. Two organizations have mandatory requirements on fresh air in office areas, the State of Minnesota Building Code (applies to all cities with a population over 2500 and to all areas of 12 counties) and the Minnesota Occupational Safety and Health regulations (MOSHA) which apply statewide.

Minnesota State Building Code - ASHRAE (The American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc.) proposed a guide on outdoor fresh air requirements in buildings in 1973. This guide, with some modifications, was adopted by the State of Minnesota Building Code in 1976 and was the standard until May, 1991, when ASHRAE 62-1989 became the enforceable standard. These new requirements apply to all new buildings and older buildings which have major renovations to their heating, ventilation and air conditioning systems.

What the old building code, which still applies to most buildings, stated was that the outdoor fresh air requirements for a typical office area should be 7 1/2 cfm (cubic feet per minute) of outside air per occupant. There are different ventilation requirements for other types of occupied spaces such as classrooms and conference rooms. Buildings complying with the old code, should maintain the carbon dioxide concentration in occupied spaces (where the source of the carbon dioxide is people’s exhaled breath) below an average of 1,700 ppm.

The ASHRAE 62-1989 requirements are 20 cfm of outside air per expected occupant in office areas, conference rooms, and 15 cfm per expected occupant in reception areas and classrooms. Buildings complying with these regulations should maintain the carbon dioxide concentrations in occupied spaces (where the source of the carbon dioxide is people’s exhaled breaths) under most operating conditions below 1000 ppm.

Minnesota Occupational Safety and Health Regulations (MOSHA) which were adopted from the Minnesota Industrial Commission in 1972, regulate the amount of fresh air that must be provided and distributed in all workrooms. This is covered under Minnesota Rules 5205.01109 “Workroom Ventilation and Temperature.” This regulation states the following:

Subpart 1. Air. Air shall be provided and distributed in all workrooms as required in this code, unless prohibited by process requirements. Outside air shall be provided to all workrooms at the rate of 15 cubic feet per minute per person.

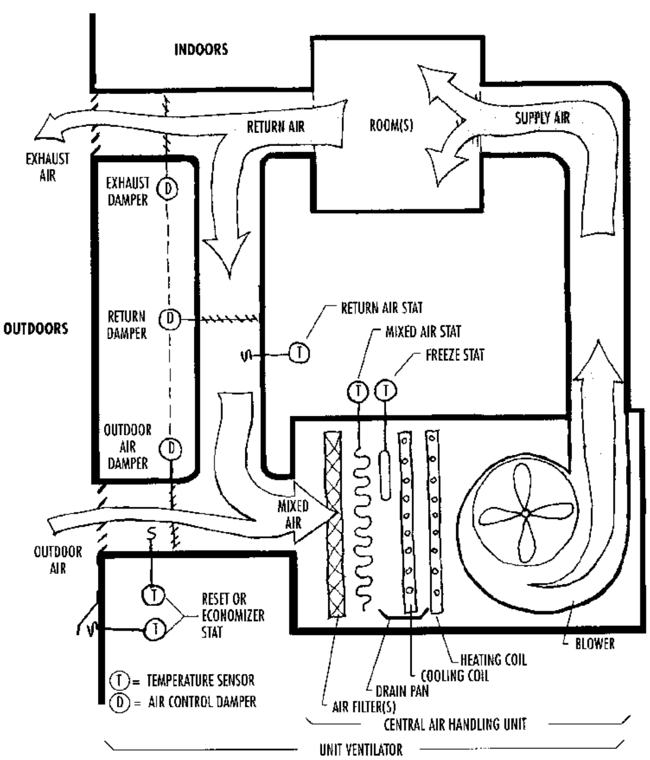
Mounds View Public Schools uses the guidelines established by the Environmental Protection Agency in its “Tools For Schools” packet to calculate the amount of outside air being supplied to each individual. The following provides the formulas used to calculate the amount of outside air per person and a layout of a typical HVAC system.

Ventilation Rate Calculations (Outside Air, CFM per person)

Using CO_2	
Outside Air (CFM) =	[CR – CS] x Total Airflow (CFM) [CR – CO]
Using Temperature	
Outside Air (CFM) =	$[T_{return\ air}] - [T_{mixed\ air}]$ x Total Airflow (CFM) $[T_{return\ air}] - [T_{outdoor\ air}]$
CFM per person =	Outdoor Air (CFM) # of room occupants

CR	=	CO_2 in return air (ppm)
CS	=	CO_2 in supply air (ppm)
CO	=	CO_2 in outside air (ppm), typically 300-450 ppm
Total Airflow	=	Airflow measured at the diffusers (CFM)
T	=	Temperature in degrees Fahrenheit

Typical HVAC System Layout



A Note About Carbon Dioxide as a Measurement of Ventilation. Carbon dioxide is a normal constituent of exhaled breath and can be used as a screening technique to evaluate whether adequate quantities of fresh outdoor air are being introduced into a building or work area. The outdoor, ambient concentration of carbon dioxide is usually 300-425 ppm (parts per million). Usually the carbon dioxide level is higher inside than outside, even in buildings with few complaints about indoor air quality.

In building areas, where there are sources of carbon dioxide besides peoples' exhaled breaths, the above guidelines cannot be used. Other sources can include exhaust gas from kilns, internal combustion engines, and dry ice. Under these conditions the OSHA standard on carbon dioxide needs to be used to determine whether adequate fresh air is being provided. The OSHA standard on carbon dioxide is an 8-hour time weighted average of 10,000 ppm with a short-term 15-minute average limit of 30,000 ppm.

RECORDKEEPING: Director of Buildings and Grounds and individual building lead custodian will develop a recordkeeping schedule for preventive maintenance of HVAC systems. This system will be based on recommendations by the manufacturer and information contained in the IAQ Management Plan.

HVAC RUNTIME: **All mechanical ventilation should be in operation one hour before and one hour after regular school hours and during custodial cleaning. Additionally, mechanical ventilation should run in areas of partial building usage for school or community groups and no less than one hour after that occupancy.**

C. Temperature Concerns

The sense of thermal comfort (or discomfort) results from an interaction between temperature, relative humidity, air movement, clothing, activity level and individual physiology. Temperature and relative humidity measurements are indicators of thermal comfort.

Temperature and humidity directly affect thermal comfort. There is considerable debate among researchers, indoor air quality professionals and health professionals concerning recommended levels of relative humidity; however, the humidity levels recommended by different organizations generally range between 20 and 60 percent relative humidity.

The following table was adapted from the ASHRAE Standard 55-1992, Thermal Environmental Conditions for Human Occupancy.

Acceptable Ranges of Temperature & Relative Humidity During Summer & Winter Months		
Relative Humidity	**Winter Temperature**	**Summer Temperature**
20%	69.0 – 76.5	74.5 – 80.5
30%	68.5 – 76.0	74.0 – 80.0
40%	68.5 – 75.5	73.5 – 79.5
50%	68.5 – 74.5	73.0 – 79.0
60%	68.0 – 74.0	72.5 – 78.0

The relative humidity levels inside school buildings in Minnesota during the spring, summer and fall tends to be in the range of 30-60 percent and will vary depending on outdoor humidity levels. In the winter months, the relative humidity levels vary a great deal and are normally in the range of 5-40 percent in buildings which do not humidify the air. In buildings which humidify the air, the relative humidity levels are normally in the 20-40 percent range.

In Minnesota, it is recommended that summer temperatures should be 72-78 degrees with a relative humidity of 20-50 percent. The fall, winter and spring temperatures should be 70-74 degrees with a relative humidity of 20-50 percent.

Relative humidity in excess of 50 percent can potentially cause bioaerosol problems (growth of fungi, molds, bacteria, pollen) with building materials or furnishings in the occupied areas.

Note: Due to the existing design of most HVAC systems in the District, it is very possible that relative humidity may drop below 20% during the heating season. The dry air will dehydrate the mucous membrane. Remind building occupants to practice self-management by hydrating themselves by drinking 6-8 glasses (8 oz.) of water daily.

Section 4:
Mounds View AHU Filtration Data

Section 4:
Mounds View 2004 Filter Change Schedule