September 17, 2020
TRB #01-20

Technical Resources Bulletin

To: SMACNA Members
SMACNA Chapter Executives

From: Technical Resources Department

Subject: **SMACNA HVAC COVID-19 Guidance**

Introduction

Restoring occupancy of existing buildings that were shut down due to the COVID-19 virus or other reasons must be performed with strict safety procedures to mitigate the risk of exposure to infectious diseases, such as COVID-19.

Several guidelines for this procedure are available. The following are SMACNA's recommended Guidelines to open existing buildings with more specific emphasis on the building's HVAC System. Guidelines from the CDC to wear a face covering, keep at least a 6 ft. social distancing from other people and wash hands regularly (for at least 20 seconds) throughout the day, are very important.

COVID-19 as well as other infectious diseases may be transmitted by droplets and aerosols from coughing, sneezing, shouting and possibly by talking, breathing or any method which expels breath from the human body. The indoor air quality provided by a well-functioning, properly designed and maintained HVAC System should help minimize the spread of infectious diseases. There is a possibility that COVID-19 may be spread by airborne transmission, although it needs more research. Spread of infectious diseases could potentially be assisted by poor or improper ventilation, especially in crowded rooms. We should verify that the ventilation rates are within the required range per building codes, and proper filtering systems are used and maintained to minimize aerosol transmission possibility of the virus. Proper ventilation may be effective in diluting air containing airborne pathogens. This may not be effective on larger droplets, but smaller particles may behave more like gases which can be diluted.

This Guideline discusses the steps that can be taken to ensure that the indoor air quality is satisfactory with adequate outside air to dilute the ventilation air so that it contains a minimal amount of aerosols that could transmit COVID-19.

The ventilation rates which apply to most commercial and institutional buildings are published in Building Codes such as the International Mechanical Code (IMC) or Uniform Mechanical Code (UMC). Ventilation air is that portion of supply air that comes from the outside. Outside air rates are intended to dilute contaminants such as bioeffluents from people and compounds off-gassing from furnishings and construction materials (VOC's). The ventilation rate plus recirculated air that has been treated, should be set to maintain the desired quality of air in the designated space. Ventilation systems should be designed to continuously supply conditioned minimum outdoor airflow to the breathing zone during the period that the building is occupied.

Whatever the ventilation rate is, when reopening an existing building, the building HVAC System should be thoroughly tested and balanced to a state of full, demonstrated and documented working order, making sure the design ventilation rate is met.

Ventilation Rates

Ventilation is both necessary and desirable for the control of air contaminants, moisture and temperature. The effects of inadequate ventilation in protecting building occupant health can be controlled by the quality of indoor air. Habitable and occupiable spaces are ventilated to promote a healthy and comfortable environment for the occupants. Ventilation of specific occupancies is necessary to minimize the potential for toxic or otherwise harmful substances to reach dangerously high concentrations in air.

As an example, **Table 403.3.1.1 Minimum Ventilation Rates**, from the IMC, includes the occupant load utilized for design of ventilation systems. The ventilation rate shall be not less than the number determined from the estimated maximum occupant load rate indicated in Table 403.3.1.1. The table below is excerpted from the Table for an Occupancy Classification of Education.

TABLE 403.3.1.1
MINIMUM VENTILATION RATES

OCCUPANCY CLASSIFICATION	OCCUPANT DENSITY #/1000 FT² [a]	PEOPLE OUTDOOR AIRFLOW RATE IN BREATHING ZONE, R_p CFM/PERSON	AREA OUTDOOR AIRFLOW RATE IN BREATHING ZONE, R_a CFM/FT² [a]	EXHAUST AIRFLOW RATE CFM/FT² [a]
Education				
Art classroom[g]	20	10	0.18	0.7
Auditoriums	150	5	0.06	—
Classrooms (ages 5-8)	25	10	0.12	—
Classrooms (age 9 plus)	35	10	0.12	—
Computer lab	25	10	0.12	—
Corridors (see public spaces)	—	—	—	—
Day care (through age 4)	25	10	0.18	—
Lecture classroom	65	7.5	0.06	—
Lecture hall (fixed seats)	150	7.5	0.06	—
Locker/dressing rooms[g]	—	—	—	0.25
Media center	25	10	0.12	—
Multiuse assembly	100	7.5	0.06	—
Music/theater/dance	35	10	0.06	—
Science laboratories[g]	25	10	0.18	1.0
Smoking lounges[b]	70	60	—	—
Sports locker rooms[g]	—	—	—	0.5
Wood/metal shops[g]	20	10	0.18	0.5

Filtration

Filtration may help mitigate the transmission of infectious diseases. Filter efficiency has been gradually increasing as technology improves. Select filtration levels that are maximized for equipment capabilities. Per ASHRAE guidelines, a Minimum Efficiency Reporting Value (MERV) of 13 or higher should be used if the equipment can handle it. The MERV rating is a filter's ability to capture particles between 0.3 and 10 microns (µm).

The particle size range is the composite particle size efficiency percentage within a range of particle size. The three ranges used in ASHRAE Std 52.2 are E1 -(0.3-1.0 µm), E2 -(1.0-3.0 µm), and E3 -(3.0-10.0 µm). MERV ratings of 13 or higher are efficient at capturing airborne viruses.

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If existing equipment does not utilize MERV 13 filters, you may want to do an analysis to see if the equipment can be upgraded by:

- Calculate the velocity of the existing filter bank and determine the existing pressure drop when clean (typically 300 – 500 fpm).
- Determine the pressure drop of the filter when loaded (ready to be changed). SMACNA recommends installation of a differential pressure gauge (potentially incorporating this point into the Building Automation System). This can also help determine when the MERV 13 filter should be changed.
- Calculate the pressure drop if a MERV 13 filter is installed. These filters should be changed every 1-3 months as needed.
- Review the original design to see if there will be enough static pressure to overcome the pressure drop.
- Determine if more external static is needed and its effect on the existing fan.
- If not enough static, consider upgrading the motor to increase the available static pressure or adjust the variable frequency drive to increase the static pressure. Consult the fan curve to ensure the additional RPM does exceed the design plot.

If MERV 13 filters cannot be installed, look at other ways to increase filtration. Recirculation HEPA filters for the occupied space, air ionization systems, Germicidal Ultraviolet treatment or other method.

Germicidal UV (GUV) refers to using ultraviolet radiant energy that has been shown to kill bacteria and spores and to inactivate viruses. It has commonly been referred to as ultraviolet germicidal irradiation (UVGI). Wavelengths in the photobiological ultraviolet spectral band known as the "UV-C," from 200 to 280 nanometers (nm), have been shown to be the most effective for disinfection. UV-C can effectively inactivate the SARS-CoV-2 virus responsible for coronavirus disease (COVID-19). There is research underway to determine the degree of airborne spread because virus particles are so small that they remain suspended in air, although it currently is not clear how much of the virus responsible for COVID-19 is spread by the airborne route. A knowledgeable consultant is recommended and the Centers for Disease Control and Prevention (CDC) has guidelines for the use of UVGI lamps in air handling units as a supplemental control measure for air disinfection.

<u>HVAC Equipment</u>

A game plan should be developed to reopen existing buildings that includes a scope of the HVAC equipment, subsystems and systems to be checked. It should include:

- The Owner's Project Requirements.
- Statement of design or operations intent.
- Schedule information.
- List of equipment and systems needing to be re-commissioned.
- List of sub trades, suppliers, and other contractors (most commonly the controls contractor) who will be involved in the commissioning process.
- All submittal data and controls sequence descriptions needed to prepare checklists.

Prestart checklist and functional performance checks must be defined for many types of equipment including:

- Hot water and steam boilers; with atmospheric or power burners; gas, oil, or combination gas/oil fired.
- Chillers; with reciprocating, scroll, screw, magnetic-bearing, or centrifugal compressors; air- or water- cooled; with or without condensers; and including heat recovery models.
- Cooling towers, closed-circuit heat rejectors, and both air-cooled and evaporative condensers.
- Hot water, chilled water, and condensing water pumps associated with the preceding.
- Constant volume, single zone air systems (including all components such as fans, coils, furnaces, condensing units, dampers, and controls, as applicable).
- Condensing boilers.
- Primary and secondary piping systems.
- Variable flow piping or pumping systems.
- Variable Air Volume (VAV) Systems including various components such as terminal units and Variable Frequency Drives (VFD).

Any or all of this equipment is important to proper air distribution at the proper indoor air quality and temperature, with the proper amount of makeup (outdoor) air. If existing equipment is not adequate, especially if modifications to overcome additional pressure drops of MERV 13 or other filters, upgrades or new equipment should be considered. Once the air passes through the air cleaners it passes through the thermal conditioner which alters the incoming air's temperature and humidity, so it is suitable for distribution. An air mover pulls the air through the air cleaner and thermal conditioner as well as pushes air through the air distribution system. This is usually a mechanical fan, of which there are many types. The fan must provide the work to overcome the systems resistances as well as provide the correct volume of air. The air distribution system is most often ductwork that needs to carry the clean conditioned air to the zone or space requiring a portion of the air volume supplied by the fan. Air distribution systems should be balanced so that the scheduled amount of clean air gets to the right zone.

Owners

The owner's occupancy requirements for the building should be included in the Owner's Project Requirements (OPR) document for reopening the existing building. For HVAC Systems, the following are relevant specially to minimize the spread of COVID-19:

- Space temperature and humidity criteria.
- Thermal zoning criteria.
- Thermal load generated by illumination and occupancy requirements.
- Ventilation requirements including filtration and related indoor air quality criteria.
- System balancing requirements.
- Building energy use.
- Commissioning.
- Budget (first cost, operating cost, lifecycle cost).

The owner wants the facility to operate in accordance with the design intent with the correct ventilation rates that may help reduce the spread of COVID-19 and other contaminants, maintain thermal comfort, operate efficiently and produce a high level of occupant satisfaction. If the occupants are students, their comfort, with the proper ventilation, can enhance the learning process. If the occupants are employees, their satisfaction can reduce turnover and improve productivity.

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Knowledgeable technicians are necessary to operate equipment at maximum efficiency. Operators should be part of the game plan to check the equipment. They are part of the team and must be well-trained, and programs should be set up to sustain that knowledge over time as staff changes take place. When operators are knowledgeable, they can properly maintain, identify and fix problems quickly.

Project Management

Project Managers as well as their crew are a vital component of the team to reopen existing buildings. The Project Manager is directly responsible for the quality of workmanship and care when all the systems come together. The following should be included:

- Planning and coordination - Priority items and responsibilities should be identified.
- On-site communication is important and facilitated by the Project Manager and executed by the Superintendent supervising the tradesmen.
- The Project Manager, Supervisor and the crew need to ensure no outstanding deficiencies, when the building is ready to be opened, resulting from prestart checks and functional performance tests. Identify and communicate issues as early as possible. This will usually result in simpler and less costly resolutions and prevent scope creep.
- Published construction schedule with trackable milestones to complete the project on time. Include activities for Testing, Commissioning and Owner Training. Development and distribution of this document to all stakeholders is a critical step to a successful project.
- Document equipment startup; prepare, execute, and record data for each specific piece of equipment. This should aid in warranty administration. Generic forms are unacceptable.
- With proper project management, the owner's project requirements will be met, resulting in overall owner and occupant increased satisfaction.
- The Project Manager should make sure the maintenance crew is well-trained and can sustain the knowledge that they receive. Building Owners and their staff are critical stakeholders in this transition and should place extreme importance on retaining this information. SMACNA recommends video documentation of all training for future reference.
- Because of the importance of capable operations and maintenance in keeping buildings functional, it is an opportunity to convince owners on improved maintenance programs, preventive maintenance agreements and educational programs to train operators to improve their knowledge.
- The owners could also be good references, which could increase demand for the Contractor on other existing buildings that need help mitigating the spread of COVID-19.

Properly reopening existing buildings by following the game plan can clearly benefit owners, tenants, occupants and administrators. Following a well-thought-out game plan which has been carried out competently and thoroughly, the existing building will be opened with systems functioning in an integrated fashion as designed. Environmental conditions and indoor air quality will be in accordance with the design intent. This should give the occupants a high level of satisfaction with their environments which in turn helps to avoid costly problems and helps to reduce excessive vacancies.

Other Considerations

The ***SMACNA HVAC Systems Commissioning Manual*** discusses commissioning of existing buildings. That can apply directly to HVAC equipment. The HVAC System needs to have prestart, start and functionality tests to make sure it is operating within the required levels. In particular, the right amount of ventilation and distributed air need to be verified to help minimize the possible spread of COVID-19. The operation of fans or other equipment need to be verified as well.

Testing, Adjusting and Balancing

The ***SMACNA HVAC Systems Testing, Adjusting and Balancing - Third Edition*** (TAB) manual discusses testing and balancing of existing buildings. To ensure that the air distribution systems in existing buildings work properly, their HVAC System should be rebalanced or recertified. The TAB technician should be trained in the basic fundamentals and procedures of TAB work. In addition, their instruments should all be calibrated to ensure the best accuracy of the measurements. If there are design changes to the air distribution system as part of the opening of the existing building, then the system should be rebalanced. In addition, the changes could increase (or lower) the systems resistance and airflow. The original design with changes should be re-evaluated referencing the ***SMACNA HVAC Systems Duct Design - Fourth Edition*** manual for changes in fittings or layout to see if there are additional pressure losses that cause the design leg or critical path changes and increase the fan total pressure requirements. This could lead to needed modifications, or a new air movement device (a fan change). If there is an increase in operating pressure to an existing ducted distribution system, then duct construction needs to be re-evaluated to see if the right gage/reinforcement is adequate or if it needs upgraded. The gage/reinforcements should be per the ***SMACNA HVAC Duct Construction Standards - Metal and Flexible - Third Edition***. If a new filtration system is installed or just using a more efficient filter, the pressure drop of the filter needs to be evaluated.

Indoor Air Quality

The health of the occupants in a facility should be the primary concern of the building management team responsible for IAQ. The World Health Organization (WHO) states: "Health is a state of complete physical, mental, and social well-being, and not merely the absence of disease or infirmity." The ***SMACNA Indoor Air Quality: A Systems Approach - Third Edition*** manual discussed these issues which may be relevant to containing the spread of COVID-19.

Acceptable air quality is "Air in which there are no known contaminants at harmful concentrations as determined by cognizant authorities and with which a substantial majority (80% or more) of the people exposed do not express dissatisfaction." (ASHRAE) Standard 62.1-2019. ASHRAE and other organizations are studying COVID-19 to see what levels of low ventilation rates that will allow COVID-19 to spread. At least make sure the minimum ventilation rates are followed per the IMC with no less than MERV-13 filtering if possible, changing the filters on a regular basis. One MERV 13 supplier says the filters are designed to trap and block 98% of airborne particles as small as 0.3 microns and last three months. You should check these numbers with your supplier. In addition, the facility should be cleaned at least on a daily basis, and occupants should wash their hands frequently.

If we keep contaminants to a minimum in the airstream, it is much less likely to contribute to the problem of diseases such as COVID-19 spreading.

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