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Columbia University Facilities and Operations HVAC O&M Protocols for Covid-19

HVAC O&M Protocols for Covid-19

The following COVID-19 HVAC Operating and Maintenance (O&M) Protocols focus on enhanced maintenance, filtration, and ventilation to address the COVID-19 Pandemic.

The HVAC O&M Protocols were distilled from several sources including:

- Internal CUFO documents
- Authoritative entities such CDC, WHO, ASHRAE, and REHVA
- Recent industry communications such as a COVID-19 Conference Call sponsored by NYECC.

These recommendations are intended for research and academic buildings typical of the Morningside and Manhattanville campuses. These recommendations are not intended for a medical center with a greater number and concentration of infected people.

HVAC O&M Protocols for Covid-19

- **Implement Dedicated Operational and Maintenance Inspections and Procedures to Increase the Reliability of the Existing HVAC systems and Assure Indoor Air Quality (IAQ)**
 - Perform target inspections on key pieces of equipment
 - Increase the frequency of preventative maintenance measures
 - Create a comprehensive Operation and Maintenance Checklist for the Air Handler Units (AHU) based on ASHRAE and BCA recommendations.
- **Enhance Air Filtration of Existing HVAC Equipment by Following CDC, ASHRAE, REHVA Recommendations**
 - Assess air filtration in HVAC systems and comparing it to the ASHRAE recommended filtration.
 - Replace existing unit filter media with MERV 13 or higher where possible. Evaluate existing filter rack support systems, fan/fan motor capabilities, and air flow rate requirements on a case-by-case basis.

HVAC O&M Protocols for Covid-19

- **Enhanced Ventilation to Lessen Potential Concentration of Suspended Particles in the Air Following CDC, ASHRAE, REHVA recommendations**
 - Increase outdoor air ventilation and general exhaust ventilation to greatest extent possible.
 - Minimize or eliminate recirculation of central HVAC air where possible.
 - Evaluate the feasibility, costs and impact on comfort conditions of these measures on a case-by-case basis.
 - Conduct an immediate HVAC investigation pilot program to determine the feasibility, costs and impact on comfort conditions of implementing these ventilation measures.
- **Additional Measures**
 - Increase HVAC Systems hours of operation, 24/7 if possible, to facilitate the removal of virus particles from the building and to reduce the settlement of virus particles onto surfaces.
 - Increase window airing in buildings without central HVAC Systems.
 - Maintain negative pressure in all toilet rooms to sweep air from the room and to minimize fecal-oral transmission from toilet flush aerosol. Operate toilet exhausts 24/7.

HVAC O&M Protocols for Covid-19

- **Research Leading Edge Technology that Could Prevent Propagation of Viruses by Centralized HVAC Systems**
 - Research UV technologies with appropriate wavelengths, such as low-pressure mercury vapor lamps which emit mainly near optimal 253 nm.
 - Where filtration and ventilation solutions are difficult, investigate the possible use of Ultraviolet (UV) technology retrofitted into AHU's, supply ducts, or return ducts.
 - Carefully evaluate on a case-by-case basis as face velocity and contact time requirements typically make the retrofit of UV systems into existing systems physically difficult and costly.

HVAC O&M Matrix -COVID 19 - Recommended Operational and Maintenance Checks with Frequencies

Recommended maintenance checks post COVID-19 operation	Inspection Frequency	Service Schedule	Service Description	Comment	Enhancement for COVID - 19
FILTER SECTION					
Pre-filters					
Filters clean - record pressure differential	Monthly	During occupied building hours	Record pressure differential	Currently done at filter replacement	For AHUs not reporting back to BMS, equipment upgrades might be required with associated engineering support to retrofit existing equipment.
Filters dirty - DP> X in Hg then replace filters	Bi-Monthly (every two months)	Unoccupied building hours	As needed or every two months, whichever comes first	Done monthly, current practices exceed recommendations	Change pre-filters more frequently to deter larger size particles and protect final and after filters. Potential increase of man power requirements and materials needs to be assessed.
Filter rack in good condition/no gaps/rusty or bent frames	Bi-Monthly	Unoccupied building hours	Inspect filter rack during filter replacement. If damage is found in filter racks, brackets, bent frames, or gaps are detected, schedule repair during unoccupied hours	This activity is performed annually	Activity will be performed during filter replacement. Inspect filter structure carefully while replacing filters. Additional manpower might be needed due to increased inspection frequency. For ongoing efforts, recommend adding requirement to CU Standards for AHU retrofits
Final Filters					
Filters clean - record pressure differential	Quarterly	During occupied building hours	Record pressure differential	Currently done at filter replacement	For AHUs not reporting back to BMS, equipment upgrades might be required with associated engineering support to retrofit existing equipment.
Filters dirty - DP > X in Hg then replace filters	As needed - Semi-Annually	Unoccupied building hours	As needed or Semi-annually, whichever comes first based on filter loading as indicated by differential pressure gauges.	Final filters are replaced annually	Change final filters more frequently to deter larger size particles and protect after filters. Potential increase of man power requirements and materials
Filter rack in good condition/no gaps/rusty or bent frames	As needed - Semi-Annually	Unoccupied building hours	Inspect filter rack during filter replacement. If damage is found in filter racks, brackets, bent frames, or gaps are detected, schedule repair during unoccupied hours	This activity is performed annually	Activity will be performed during filter replacement. Inspect filter structure carefully while replacing filters. Additional manpower might be needed due to increased inspection frequency. For ongoing efforts, recommend adding requirement to CU Standards for AHU retrofits
After Filters					
Filters clean - record pressure differential	Quarterly	During occupied building hours	Record pressure differential	Currently done at filter replacement	For AHUs not reporting back to BMS, equipment upgrades might be required with associated engineering support to retrofit existing equipment.
Filters dirty - DP > X in Hg then replace filters	As needed - Annually	Unoccupied building hours	As needed or annually, whichever comes first based on filter loading as indicated by differential pressure gauges.	Final filters are replaced annually	Change after filters more frequently to deter larger size particles and protect occupants. Potential increase of man power requirements and materials
Filter rack in good condition/no gaps/rusty or bent frames	As needed - Annually	Unoccupied building hours	Inspect filter rack during filter replacement. If damage is found in filter racks, brackets, bent frames, or gaps are detected, schedule repair during unoccupied hours	This activity is performed annually	Activity will be performed during filter replacement. Inspect filter structure carefully while replacing filters. Additional manpower might be needed due to increased inspection frequency. For ongoing efforts, recommend adding requirement to CU Standards for AHU retrofits
Recommended functional checks post COVID-19 operation	Inspection Frequency	Service Schedule	Service Description	Comment	Enhancement for COVID - 19
DAMPERS					
Inspect (visual) OA dampers and actuators	Once prior to Occupancy - Quarterly thereafter.	Unoccupied building hours	Check all OA dampers stroke fully and close tightly once prior to normal occupancy. Afterwards, inspect quarterly.	This activity is performed semi-annually with switchover	(1) Enhancement. If issues with dampers/actuators are detected, schedule repair ASAP. Additional manpower may be needed due to increased frequency of inspection. Recommend retrofit of existing equipment not tied to BMS with associated technical support and engineering.
Check operation of OA dampers and actuators	Semi-Annually	Unoccupied building hours	Check all OA dampers stroke fully and close tightly during seasonal switchover. If issues are found, schedule repair during unoccupied hours	This activity is performed annually	(1) Comment is applicable to all damper types
Inspect (visual) of RA dampers and actuators	Once prior to Occupancy - Quarterly thereafter.	Unoccupied building hours	Check all RA dampers stroke fully and close tightly once prior to normal occupancy. Afterwards, inspect quarterly.	This activity is performed semi-annually with switchover	(1) Comment is applicable to all damper types
Check operation of RA Dampers and actuators	Semi-Annually	Unoccupied building hours	Check all RA dampers stroke fully and close tightly during seasonal switchover. If issues are found, schedule repair during unoccupied hours	This activity is performed annually	(1) Comment is applicable to all damper types
Inspect (visual) MA dampers and actuators	Once prior to Occupancy - Quarterly thereafter.	Unoccupied building hours	Check all MA dampers stroke fully and close tightly once prior to normal occupancy. Afterwards, inspect quarterly.	This activity is performed semi-annually with switchover	(1) Comment is applicable to all damper types

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Recommended functional checks post COVID-19 operation	Inspection Frequency	Service Schedule	Service Description	Comment	Enhancement for COVID - 19
Check operation of MA dampers and actuators	Semi-Annually	Unoccupied building hours	Check all OA dampers stroke fully and close tightly during seasonal switchover. If issues are found, schedule repair during unoccupied hours	This activity is performed annually	(1) Comment is applicable to all damper types
Check all control valves stroke fully and close tightly					
Check preheat steam valves modulates per demand	Quarterly	During occupied building hours	Exercise once prior to normal occupancy. Quarterly thereafter. If valve is not working properly, schedule replacement during unoccupied hours.	Typically, valves are exercised every six months with switchover	(1) Comment is applicable to all damper types
Check chilled water valves modulate per demand	Quarterly	During occupied building hours	Exercise once prior to normal occupancy. Quarterly thereafter. If valve is not working properly, schedule replacement during unoccupied hours.	Typically, valves are exercised every six months with switchover	(1) Comment is applicable to all damper types
Check reheat steam valves modulate per demand	Quarterly	During occupied building hours	Exercise once prior to normal occupancy. Quarterly thereafter. If valve is not working properly, schedule replacement during unoccupied hours.	Typically, valves are exercised every six months with switchover	(1) Comment is applicable to all damper types
Check steam humidification valves modulate per demand	Quarterly	During occupied building hours	Exercise once prior to normal occupancy. Quarterly thereafter. If valve is not working properly, schedule replacement during unoccupied hours.	Typically, valves are exercised every six months with switchover	(1) Comment is applicable to all damper types
Recommended functional checks post COVID-19 operation	Inspection Frequency	Service Schedule	Service Description	Comment	Enhancement for COVID - 19
FANS					
Check for unusual noise or vibration when unit is running	Quarterly	During occupied building hours	Visually and physically inspect unit to detect any unacceptable noises or wobbling	This activity is performed semi annually with switchover	Enhancement to ensure fans are running. Additional manpower may be needed due to increased frequency of inspections. Implementation may impact WO execution. Recommend upgrading to real time belt vibration sensors to the BMS for critical equipment with associated technical and engineering support.
Check operation of all fans					
Check pilot lights are functional.	Monthly	During occupied building hours	Visual inspection	This activity is performed weekly during MER walkthroughs. Replace if light is out.	Replace pilot lights to convey accurate motor status
Supply fan(s) checks					
Check fan and motor alignment and rotation	Semi-Annually	Unoccupied building hours	Fan and motor sheave must be in axial alignment. Shafts are parallel in both the vertical and horizontal planes.	This activity is performed semi-annually with switchover. If issue is detected, schedule corrective action.	NONE
Check fan belt tension and condition	Semi-Annually	Unoccupied building hours	Inspect once prior to normal occupancy. Visually inspect for dryness, cracks and test for belt stiffness and tension. Must not be too loose or too tight.	This activity is performed semi-annually with switchover. If issue is detected, schedule corrective action.	Enhancement to ensure fans are running. Additional manpower may be needed due to increased frequency of inspections
Check fan protective shrouds for belts are in place and secure	Semi-Annually	Unoccupied building hours	Check that supports are properly anchored down and screwed into their frame.	This activity is performed semi-annually with switchover. If issue is detected, schedule corrective action.	NONE
Check supply fan vibration levels for signs of shaft or bearing deterioration.	Semi-Annually	Unoccupied building hours	Check for imbalance and Misalignment.	This activity is performed semi-annually with switchover. If issue is detected, schedule corrective action.	NONE
Record VFD Status (H/O/A)	Monthly	During occupied building hours	Visually record current position of VFD Drive at time of inspection	This activity is performed semi-annually with switchover	Enhancement to ensure fans are running. Additional manpower may be needed due to increased frequency of inspections. Recommend upgrading equipment not tied to the BMS; engineering and technical support will be required to implement upgrade.

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Recommended functional checks post COVID-19 operation	Inspection Frequency	Service Schedule	Service Description	Comment	Enhancement for COVID - 19
Return/ Exhaust fan Checks					
Check fan and motor alignment and rotation	Semi-Annually	Unoccupied building hours	Fan and motor sheave must be in axial alignment. Shafts are parallel in both the vertical and horizontal planes.	This activity is performed semi-annually with switchover	NONE
Check fan belt tension and condition	Semi-Annually	Unoccupied building hours	Inspect once prior to normal occupancy. Visually inspect for dryness, cracks and test for belt stiffness and tension. Must not be too loose or too tight.	This activity is performed semi-annually with switchover	Enhancement to ensure fans are running. Additional manpower may be needed due to increased frequency of inspections
Check fan protective shrouds for belts are in place and secure	Semi-Annually	Unoccupied building hours	Check that supports are properly anchored down and screwed into their frame.	This activity is performed semi-annually with switchover	NONE
Check fan vibration levels for signs of shaft or bearing deterioration.	Semi-Annually	Unoccupied building hours	Check for imbalance and Misalignment.	This activity is performed semi-annually with switchover	NONE
Record VFD Status (H/O/A)	Monthly	During occupied building hours	Visually record current position of VFD Drive at time of inspection	This activity is performed semi-annually with switchover	Enhancement to ensure fans are running. Additional manpower may be needed due to increased frequency of inspections. Recommend upgrading equipment not tied to the BMS; engineering and technical support will be required to implement upgrade.
Spill fan(s) rotation correct.					
Check fan and motor alignment and rotation	Semi-Annually	Unoccupied building hours	Fan and motor sheave must be in axial alignment. Shafts are parallel in both the vertical and horizontal planes.	This activity is performed semi-annually with switchover	NONE
Check fan belt tension and condition	Semi-Annually	Unoccupied building hours	Inspect once prior to normal occupancy. Visually inspect for dryness, cracks and test for belt stiffness and tension. Must not be too loose or too tight.	This activity is performed semi-annually with switchover	Enhancement to ensure fans are running. Additional manpower may be needed due to increased frequency of inspections
Check fan protective shrouds for belts are in place and secure	Semi-Annually	Unoccupied building hours	Check that supports are properly anchored down and screwed into their frame.	This activity is performed semi-annually with switchover	NONE
Check fan vibration levels for signs of shaft or bearing deterioration.	Semi-Annually	Unoccupied building hours	Check for imbalance and Misalignment.	This activity is performed semi-annually with switchover	NONE
Record VFD Status (H/O/A)	Monthly	During occupied building hours	Visually record current position of VFD Drive at time of inspection	This activity is performed semi-annually with switchover	Enhancement to ensure fans are running. Additional manpower may be needed due to increased frequency of inspections. Recommend upgrading equipment not tied to the BMS; engineering and technical support will be required to implement upgrade.
Recommended operational checks post COVID-19 operation	Inspection Frequency	Service Schedule	Service Description	Comment	Enhancement for COVID - 19
SENSORS					
Supply static pressure					
Document static pressure setpoint	Once, prior to building being occupied, and again at any occupant request for Supply air check	During occupied building hours	Operations staff to investigate issues upon WO and record static pressure set point in maintenance logs.	Activity is performed upon occupant request for temperature/air flow/humidity check	NONE
Verify static pressure discharge meets setpoint on BMS	Weekly	During occupied building hours	Operations staff to compare set point to design values, and value displayed at BMS and investigate discrepancies.	Activity is performed upon occupant request for temperature/air flow/humidity check	Enhancement to ensure supply air flow is maintained. Typically, activity should be performed quarterly. Additional manpower may be needed due to increased frequency of inspection. Systems not tied to the BMS need to be evaluated for a BMS retrofit. Engineering and technical support may be required for implementation of upgrades.
Supply air temperature					
Document supply air temperature	Once, prior to building being occupied, and again at any occupant request for temperature air check	During occupied building hours	Operations staff to investigate issues upon WO and record SAT in maintenance logs.	Activity is performed upon occupant request for temperature/air flow/humidity check	NONE

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Recommended operational checks post COVID-19 operation	Inspection Frequency	Service Schedule	Service Description	Comment	Enhancement for COVID - 19
Verify supply air temperature meets setpoint on BMS	Weekly	During occupied building hours	Operations staff to compare supply air temperature set point to design values, and value displayed at BMS and investigate discrepancies.	Activity is performed upon occupant request for temperature/air flow/humidity check	Enhancement to ensure supply air temperature is maintained. Typically, activity should be performed quarterly. Additional manpower may be needed due to increased frequency of inspection. Systems not tied to the BMS need to be evaluated for a BMS retrofit. Engineering and technical support may be required for implementation of upgrades.
Relative humidity control (for environment under RH control)					
Relative humidity control, manual reading	Bi-Weekly (every two weeks)	During occupied building hours	Operations staff to check space RH level at a designated RH space sensor.	Activity is performed upon occupant request for temperature/air flow/humidity check	Enhancement to ensure RH doesn't fall or rise to alarm levels. Evaluating man power increase to meet additional requests
Relative humidity control , BMS reading	Weekly	During occupied building hours	Operations staff to check space RH levels at BMS workstation.	Activity is performed upon occupant request for temperature/air flow/humidity check	Enhancement to ensure RH doesn't fall or rise to alarm levels. Evaluating man power increase to meet additional requests
Document relative humidity setpoint	Weekly	During occupied building hours	Operations staff to record readings (both manual and BMS readings) weekly, in maintenance logs.	Activity is performed upon occupant request for temperature/air flow/humidity check	Enhancement to ensure RH doesn't fall or rise to alarm levels. Evaluating man power increase to meet additional requests
Verify relative humidity in supply air meets setpoint	Bi-Weekly	During occupied building hours	Operations staff to compare room relative humidity set point meets design set point and that room sensor display matches BMS display, and investigate any discrepancies.	Activity is performed upon occupant request for temperature/air flow/humidity check	Enhancement to ensure RH doesn't fall or rise to alarm levels. Evaluating man power increase to meet additional requests
Supply air checks	Upon WO request	During occupied building hours	Operations staff investigate supply air volume recorded by AFMS (at BMS)	Activity is performed upon occupant request for temperature/air flow/humidity check	Enhancement to ensure proper air flow is delivered
Record supply air CFM from AFMS	After request is fulfilled	During occupied building hours	Operations staff to record supply air volume in maintenance logs.	Activity is performed upon occupant request for temperature/air flow/humidity check	NONE
Compare supply CFM reading from AFMS to design supply air for accuracy	After request is fulfilled	During occupied building hours	Operations staff to compare recorded supply air flow to design flow and flow displayed at BMS, and investigate any discrepancies.	Activity is performed upon occupant request for temperature/air flow/humidity check	NONE
Confirm calibration date has not expired. Record calibration date.	Once, prior to building being occupied	During occupied building hours	Operations staff to check AFMS calibration date, and if expired schedule calibration.	Activity is performed upon occupant request for temperature/air flow/humidity check	NONE
Schedule calibration of AFMS if issue is detected	As needed, if calibration is expired.	During occupied building hours	Following calibration, operations staff to record new calibration date in maintenance logs.	Activity is performed upon occupant request for temperature/air flow/humidity check	NONE
Outside Air - Ventilation checks	Once, prior to building being occupied, and again at any occupant request for Supply air check	During occupied building hours	Operations staff investigate outside air volume recorded by AFMS (at BMS)	Activity is performed upon occupant request for temperature/air flow/humidity check	Enhancement to ensure proper air flow is delivered
Record outside air CFM from AFMS	Following each ventilation check.	During occupied building hours	Operations staff to record outside air volume in maintenance logs.	Activity is performed upon occupant request for temperature/air flow/humidity check	NONE
Compare outside air CFM reading from AFMS to design outside air for accuracy at BMS	Weekly	During occupied building hours	Operations staff to compare recorded outside air flow to design flow and flow displayed at BMS, and investigate any discrepancies.	Activity is performed upon occupant request for temperature/air flow/humidity check	Enhancement to ensure proper air flow is delivered. Investigating potential increase on manpower to adhere to inspection schedule. Document reference set points in CMMS or BMS for operators reference.

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Recommended operational checks post COVID-19 operation	Inspection Frequency	Service Schedule	Service Description	Comment	Enhancement for COVID - 19
Confirm AFMS calibration date has not expired. Record calibration date.	Once, prior to building being occupied	During occupied building hours	Operations staff to check AFMS calibration date, and if expired schedule calibration.	Activity is performed upon occupant request for temperature/air flow/humidity check	NONE
Schedule calibration of AFMS if issue is detected	As needed, if calibration is expired.	During occupied building hours	Following calibration, operations staff to record new calibration date in maintenance logs.	Activity is performed upon occupant request for temperature/air flow/humidity check	NONE
Additional operational ENHANCEMENTS to be evaluated in a unit by unit basis post COVID-19 ECONOMIZER MODE	Inspection Frequency	Service Schedule	Service Description	Comment	Enhancement for COVID - 19

If economizer mode is on, perform the following checks:

Record design minimum outside air CFM	Quarterly	During normal building full service times	Record minimum outside air CFM from design database	Activity is performed when prompted by investigation of potential issues affecting AHU operation	Verification to ensure Economizer Mode is ON to improve minimum OA requirements if sequence is enabled. Investigation is to be conducted on units not being monitored by BMS system to establish baseline. For units not tied to the BMS system, implementation of this routine will require BMS upgrade. Engineering and technical support required for implementation.
Record outside air CFM from AFMS	Quarterly	During normal building full service times	Record outside air CFM from AFMS	Activity is performed when prompted by investigation of potential issues affecting AHU operation	Verification to ensure Economizer Mode is ON to improve minimum OA requirements if sequence is enabled. Investigation is to be conducted on units not being monitored by BMS system. For units not tied to the BMS system, implementation of this routine will require BMS upgrade. Engineering and technical support required for implementation.
Compare outside air CFM reading from AFMS to design outside air for accuracy	Quarterly	During normal building full service times	Compare outside air CFM reading from AFMS to design outside air for accuracy	Activity is performed when prompted by investigation of potential issues affecting AHU operation	Verification to ensure Economizer Mode is ON to improve minimum OA requirements if sequence is enabled. Investigation is to be conducted on units not being monitored by BMS system. For units not tied to the BMS system, implementation of this routine will require BMS upgrade. Engineering and technical support required for implementation.
Confirm AFMS calibration date has not expired. Record calibration date.	Quarterly	During normal building full service times	Confirm AFMS calibration date has not expired. Record calibration date.	Activity is performed when prompted by investigation of potential issues affecting AHU operation	Verification to ensure Economizer Mode is ON to improve minimum OA requirements if sequence is enabled. Investigation is to be conducted on units not being monitored by BMS system. For units not tied to the BMS system, implementation of this routine will require BMS upgrade. Engineering and technical support required for implementation.
Schedule calibration of AFMS if issue is detected	Quarterly	During normal building full service times	Schedule calibration of AFMS if issue is detected	Activity is performed when prompted by investigation of potential issues affecting AHU operation	Verification to ensure Economizer Mode is ON to improve minimum OA requirements if sequence is enabled. Investigation is to be conducted on units not being monitored by BMS system. For units not tied to the BMS system, implementation of this routine will require BMS upgrade. Engineering and technical support required for implementation.

DEMAND CONTROL VENTILATION (DCV)

IF DCV is on - proceed to disable demand control ventilation for COVID-19 operational mode	Quarterly	During normal building full service times	IF DCV is on - proceed to disable demand control ventilation for COVID-19 operational mode	Activity is performed when prompted by investigation of potential issues affecting AHU operation	Disable DCV per ASHRAE recommendation and improve indoor ventilation levels. Field investigation is required to determine which AHUs are provided with DCV. Additional man power and material may be required to modify SOO and implement initiative.
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ENERGY RECOVERY WHEELS (ERW)

Verify there is no cross contamination within ERV enclosure	Quarterly	While building is unoccupied	Verify there is no cross contamination within ERV enclosure	Activity is performed when prompted by investigation of potential issues affecting AHU operation	Check enthalpy wheels for cross contamination per ASHRAE recommendation and disable if issues are found. Field investigation is required to determine which AHUs are provided with ERW. Additional man power may be needed to implement routine checks.
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