Appendix B – Sample MOPs and Forms

****The following sections containing Methods of Procedure (MOP) and sample forms should be provided to the contractor who will be performing the Ventilation Verification assessment. These MOPs and sample forms are for general guidance and, if used, should be altered to meet actual site conditions and any applicable local or state guidance. ****

I. Section 1 - Overview

A. Overview Sample Form

Ventilation Verification and Energy Optimization Assessment

Unit	
Model Number	
Serial Number	SAMPLE
SEER Rating Seasonal Energy Efficiency Ratio	
Refrigerant	

☐	**Filtration -** Review system capacity and airflow to determine the highest Minimum Efficiency Reporting Value (MERV) filtration for eliminating contagions, replace or upgrade filters where needed, and verify that such filters are installed correctly.
☐	**Ventilation Rate** - Calculation of the required outside air rates for each occupied area based on the anticipated occupancy and physical verification that the ventilation rate meets or exceeds the minimum ventilation set forth by the local jurisdiction in all modes of operation. • Outside Air • Exhaust Air
☐	**Ventilation System Operation** - Physically test all ventilation components for proper operation. • Economizer • Demand Control Ventilation
☐	**Air Distribution** - Verify all ventilation is reaching the served zone, how air is distributed, and that there is adequate distribution. • Inlet Total • Outlet Total
☐	**Building Pressure -** Verify a slight positive building pressure and a negative pressure for contaminant rooms temporarily occupied by sick patrons.
☐	**General Maintenance.** Verify coil condition, condensate drainage, cooling coil air temperature differential (entering and leaving dry bulb), heat exchanger operation, and drive assembly. Recommendations for additional maintenance, replacement or upgrades shall be recorded in the HVAC Assessment Report
☐	**Operational Controls -** Review of HVAC control sequences to verify systems will maintain intended ventilation, temperature, and humidity conditions during operation. Verify a daily flush is scheduled in accordance with current ASHRAE recommendations and any applicable local or state guidance.

☐	**CO_2 Monitoring -** To ensure proper ventilation is maintained during building operation, at least one CO_2 monitor shall be installed in each zone of the building.
☐	**Limited or No Existing Mechanical Ventilation (If Applicable)** - In cases where there is limited or no existing mechanical ventilation, the assessment would then focus on available options and provide the design professional with documentation required to provide ventilation options with limited assumptions.
☐	**HVAC Assessment Report -** Preparation of an HVAC Assessment Report that includes documentation of all verifications and deficiencies.
☐	**Energy and Ventilation Upgrades -** Upon completion of the HVAC Assessment Report, a design professional shall review and determine if upgrades can be made to the HVAC system to increase energy efficiency, filtration, disinfection, and ventilation.

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II. Section 2 - Filtration

A. Filtration Sample Form

Ventilation Verification and Energy Optimization Assessment

☐	**Existing Filter Data**

• Document rating of existing filters.	
• Document filters size/depth/quantity.	

Size:	Depth:	Quantity:	MERV:
Size:	Depth:	Quantity:	MERV:

• Is the filter installed correctly? *If not document the deficiency and take any measurements required to make the repair.*	Y/N
• Are the frames and filter bank free of any openings around the filters that would allow for untreated air to bypass the filters? *If not document the deficiency and take any measurements required to make the repair.*	Y/N
• Determine type of motor and control (ECM, VFD, Belt, Direct). ○ Document nameplate and installed components as applicable.	

Motor		
Manufacturer =	Model =	Phase =
HP =	Frame =	RPM =
HZ =	Service Factor =	Amps =
Volts =	ECM = Y/N	
Drive Assembly	Belt Driven ☐	Direct Drive ☐
Belt(s) Number=	Belt Type=	Belt Length:

Center to Center =			
Motor Sheave	Model:	Shaft Size:	Position (if Variable):
Fan Sheave	Model:	Shaft Size:	

Variable Frequency Drive (VFD)	Yes ☐	No ☐
Manufacturer =	Model =	Operating Hz: • Full cooling or High Fan Speed

• With unit operating at full cooling, or high fan speed, what is the filter pressure drop?	In. w.c.

☐	**MERV 13 Verification**
• MERV 13 or better filtration is installed.	Y/N

• If MERV 13 or better filtration is not installed, perform the following steps to determine the highest Minimum Efficiency Reporting Value (MERV) filtration that can be installed without adversely impacting equipment.		
• Obtain the existing filters new and final pressure drop from the manufacturer.		☐
• Posture the unit to provide full cooling, or high fan speed, and disable the economizer.		☐
• With the existing filters installed, perform and document a static pressure profile, temperature profile, fan RPM, Motor RPM, voltage and amps.		☐
ESP Δ =	TSP Δ =	Filter SP Δ =
Fan RPM =	Motor RPM =	Mixed Air (RA+OSA) Temp =
Supply Temp =	Voltage =	Amps =
Hertz (Hz) =		
• Using the previously recorded data as a baseline, determine the maximum filter pressure drop, without adversely impacting equipment, by adding material to the filter until the measured or calculated airflow drops by no more than 5%.[2] • Primary Method to verify airflow - Directly measure the change in airflow if accessible and efficient. • Secondary Method – Calculate the change in airflow ○ $CFM_N = CFM_O \times \sqrt{\frac{SP_N}{SP_O}}$		In. w.c
• With the maximum pressure drop achieved, document static pressure profile, temperature profile, fan RPM, Motor RPM, voltage amps, and note the ability to increase fan speed if needed.		☐
ESP Δ =	TSP Δ =	Filter SP Δ =
Fan RPM =	Motor RPM =	Mixed Air (RA+OSA) Temp =
Supply Temp =	Voltage =	Amps =
Hertz (Hz) =		
• Verify air volume, under maximum pressure drop condition, is within manufacturers specifications. Commonly specified as: • Minimum CFM per ton (or) • Minimum Supply Air Temperature		☐
• If applicable, document and take any measurements required to increase the filter frames to accommodate deeper filters.		☐
• Remove added material and provide documentation in the assessment report so a licensed professional can determine the highest MERV filtration that can be installed with the existing		☐

[2] 5% recommendation and maximum pressure drop determination steps derived from: ASHRAE, ASHRAE Epidemic Task Force: Building Readiness (February 1, 2021) (https://www.ashrae.org/file%20library/technical%20resources/covid-19/ashrae-building-readiness.pdf)

	equipment.	
	• Return the unit to normal operation and enable the economizer.	☐
	• Include relevant photographic documentation	☐

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B. Filtration Method of Procedure

Filtration - Review system capacity and airflow to determine the highest Minimum Efficiency Reporting Value (MERV) filtration for eliminating contagions, replace or upgrade filters where needed, and verify that such filters are installed correctly.

1. Existing Filter - Verify and Document
   a. Document rating of existing filters.
   b. Document filters size/depth/quantity.
   c. Is the filter installed correctly? *If not document the deficiency and take any measurements required to make the repair.*
   d. Are the frames and filter bank free of any openings around the filters that would allow for untreated air to bypass the filters? *If not document the deficiency and take any measurements required to make the repair.*
   e. Determine type of motor and control (ECM, VFD, Belt, Direct).
   f. Document nameplate and installed components as applicable.
      i. Motor Nameplate
      ii. Drive Assembly Components
      iii. Variable Frequency Drive (VFD)
2. MERV 13 Filter Verification
   a. All tests shall be completed in a safe manner by personal wearing personal protective equipment.
   b. Verify if MERV 13 or better filtration is installed.
   c. If MERV 13 or better filtration is not installed, perform the following steps to determine the highest Minimum Efficiency Reporting Value (MERV) filtration that can be installed without adversely impacting equipment.
   d. Obtain the existing filters new and final pressure drop from the manufacturer.
   e. Posture the unit to provide full cooling, or high fan speed, and disable the economizer.
   f. With the existing filters installed, perform, and document a static pressure profile, temperature profile, fan RPM, Motor RPM, voltage, and amps.
   g. Using the previously recorded data as a baseline, determine the maximum filter pressure drop, without adversely impacting equipment, by adding temporary Construction Pad Media Filter material to the filter until the measured or calculated airflow drops by no more than 5%.[3]
      i. Primary Method to verify airflow - Directly measure the change in airflow if accessible and efficient.
      ii. Secondary Method – Calculate the change in airflow.
         - $CFM_N = CFM_O \times \sqrt{\frac{SP_N}{SP_O}}$
   h. With the maximum pressure drop achieved, document static pressure profile, temperature profile, fan RPM, Motor RPM, voltage amps, and note the ability to increase fan speed if needed.

[3] 5% recommendation and maximum pressure drop determination steps derived from: ASHRAE, ASHRAE Epidemic Task Force: Building Readiness (February 1, 2021) (https://www.ashrae.org/file%20library/technical%20resources/covid-19/ashrae-building-readiness.pdf)

i. Verify air volume, under maximum pressure drop condition, is within manufacturers specifications. Commonly specified as:
    i. Minimum CFM per ton (or)
    ii. Minimum Supply Air Temperature

j. If applicable, document and take any measurements required to increase the filter frames to accommodate deeper filters.

k. Remove added material and provide documentation in the assessment report so a licensed professional can determine the highest MERV filtration that can be installed with the existing equipment.

l. Return the unit to normal operation and enable the economizer.

m. Include relevant photographic documentation.

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III. Section 3 – Ventilation Rate

A. Ventilation Rate Sample Form

Ventilation Verification and Energy Optimization Assessment

☐	**Determine Minimum Required Outside Air (OSA)**		
	• If available, obtain the design documents and obtain the minimum required OSA.		CFM
	• Determine if the zones actual use and occupancy matches the designs expected use and occupancy.		Y/N
Original Occupancy (Design)	Occupancy Category (Use):	Occupancy:	
How was original occupancy determined?			
Actual Occupancy	Occupancy Category (Use):	Occupancy:	
How was actual occupancy determined?			
	• If Yes, proceed to outside air measurements.		
	• If No, calculate the new minimum outside air rate based on ASHRAE 62.1 or Table 120.1-A of the 2019 Title 24 California Building Energy Efficiency Standards, as required by your local jurisdiction. • See Example at end of document.		CFM

☐	**Verify Minimum Required Outside Air (OSA)**

Steps			**CAV**	**VAV**
1	Disable demand control ventilation (if applicable)	☐ Check if NA	☐	☐
2	Verify unit is not in economizer mode during test (economizer disabled)		☐	☐
3	CAV and VAV testing at full supply airflow			
a.	Adjust supply air to achieve design airflow or maximum airflow at full cooling.			☐
b.	Measured outdoor airflow reading (cfm)		cfm	cfm
c.	Required outdoor airflow (cfm)		cfm	cfm
d.	Time for outside air damper to stabilize after full supply airflow is achieved (minutes):			min
4	VAV testing at reduced supply airflow			
a.	Adjust supply airflow to either the sum of the minimum zone airflows, full heating, or 30% of the total design airflow.			☐
b.	Measured outdoor airflow reading (cfm).			cfm
c.	Required outdoor airflow (cfm)			cfm
d.	Time for outside air damper to stabilize after reduced supply airflow is achieved (minutes):			min
5	Return to initial conditions		☐	☐

6	Calculations		
Determine Percent Outside Air at full supply airflow (%OA_{FA}) for Step 3.			
a.	%OA_{FA} = Measured outdoor airflow reading /Required outdoor airflow. 100 x (Step3b/Step3c)	%	%
b.	%OA_{FA} is within 10% of design Outside Air. (90% ≤ %OA_{FA} ≤ 110%)	P / F	P / F
c.	Outside air damper position stabilizes within 5 minutes. (Step 3d < 5 minutes)		P / F
VAV only: Determine Percent Outside Air at reduced supply airflow (%OA_{RA}) for Step 4.			
a.	%OA_{RA} = Measured outdoor airflow reading /Required outdoor airflow reading. 100 x (Step4b/Step4c)		%
b.	%OA_{RA} is within 10% of design Outside Air. (90% ≤ OA_{RA} ≤ 110%)		P / F
c.	Outside air damper position stabilizes within 5 minutes. (Step 4d < 5 minutes)		P / F

☐	**Increased Outside Air**	
	• Document if the ventilation components can provide increased outside air if recommended.	
	• Document unit model and serial number	
	• Provide documentation, including relevant photographic documentation, in the assessment report so a licensed professional can determine if the minimum outside air should be increased and can be without compromising the system’s ability to maintain space conditions and pressurization.	

Sample calculation of a new minimum outside air rate based on ASHRAE 62.1 or Table 120.1-A of the 2019 Title 24 California Building Energy Efficiency Standards, as required by your local jurisdiction.

- Sample requirement for a 900 square foot meeting room or assembly area.

Standard	Method	15 People	25 People	35 People
ASHRAE 62.1 2019	$10\ CFM/person + 0.12\ CFM/ft^2$	258 CFM	358 CFM	458 CFM
California T24 (2019)	$15\ CFM/person$ **Use Larger**	225 CFM	375 CFM	525 CFM
California Title 24 (2019)	$0.38\ CFM/ft^2$	342 CFM	342 CFM	342 CFM

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B. Ventilation Rate Method of Procedure

Ventilation Rate - Calculation of the required outside air rates for each occupied area based on the anticipated occupancy and physical verification that the ventilation rate meets or exceeds the minimum ventilation set forth by the local jurisdiction in all modes of operation.

1. **Determine Minimum Required Outside Air (OSA)**
   a. If available, obtain the design documents and obtain the minimum required OSA.
   b. Determine if the zones actual use and occupancy matches the designs expected use and occupancy.
      i. Occupancy Rate – Original Design
      ii. Occupancy Category – Original Design
      iii. Occupancy Rate – As Used
      iv. Occupancy Category – As Used
         - Document how was "As Used" determined.
   c. If designs matches "As Used" category and occupancy, proceed to outside air measurements.

   d. If designs does not matches "As Used" category and occupancy, calculate the new minimum outside air rate based on ASHRAE 62.1 or as required by your local jurisdiction.
2. **Verify Minimum Required Outside Air (OSA)**
   a. All tests shall be completed in a safe manner by personal wearing personal protective equipment.
   b. Disable demand control ventilation (if applicable)
   c. Verify unit is not in economizer mode during test (economizer disabled)
   d. CAV and VAV testing at full supply airflow.
      i. Adjust supply air to achieve design airflow or maximum airflow at full cooling.
      ii. Measure outdoor airflow reading (cfm)
      iii. Record required outdoor airflow (cfm)
      iv. Document time for outside air damper to stabilize after full supply airflow is achieved (minutes).
   e. VAV testing at reduced supply airflow.
      i. Adjust supply airflow to either the sum of the minimum zone airflows, full heating, or 30% of the total design airflow.
      ii. Measure outdoor airflow reading (cfm).
      iii. Required outdoor airflow (cfm)
      iv. Document time for outside air damper to stabilize after reduced supply airflow is achieved (minutes).
   f. Return system to initial conditions.
   g. Calculations
      i. Determine Percent Outside Air at full supply airflow ($\%OA_{FA}$).
         - $\%OA_{FA}$ = Measured outdoor airflow reading /Required outdoor airflow.
         - $\%OA_{FA}$ is within 10% of design Outside Air. ($90\% \leq \%OA_{FA} \leq 110\%$)

- Verify that outside air damper position stabilizes within 5 minutes.

ii. VAV only: Determine Percent Outside Air at reduced supply airflow ($\%OA_{RA}$)

- $\%OA_{RA}$ = Measured outdoor airflow reading /Required outdoor airflow reading.
- $\%OA_{RA}$ is within 10% of design Outside Air. ($90\% \leq OA_{RA} \leq 110\%$)
- Verify that outside air damper position stabilizes within 5 minutes.

3. **Increased Outside Air**
   a. Document if the ventilation components can provide increased outside air if recommended.
      i. Note OSA inlet size can accommodate additional OSA.
      ii. Note current OSA damper position.
   b. Document unit model and serial number
   c. Provide documentation, including relevant photographic documentation, in the assessment report so a licensed professional can determine if the minimum outside air should be increased and can be without compromising the system's ability to maintain space conditions and pressurization.

IV. Section 4 – Economizer Operation

A. Economizer Operation Sample Form

Ventilation Verification and Energy Optimization Assessment

☐	Verify Economizer Operation

Step	Passing this test verifies the Economizer operates as designed.		Results
Step 1:	Disable demand control ventilation systems (if applicable)		
Step 2:	Enable the economizer and simulate a cooling demand large enough to drive the economizer fully open (record all of the following):		
	a.	Economizer damper modulates 100% open and that the return air damper modulates 100% closed.	P/F
	b.	All applicable fans and dampers operate as intended to maintain building pressure.	P/F
	c.	The unit heating is disabled (if applicable).	P/F
Step 3:	Disable the economizer and simulate a cooling demand (record all of the following):		
	a.	Economizer damper closes to its minimum position.	P/F
	b.	All applicable fans and dampers operate as intended to maintain building pressure.	P/F
	c.	The unit heating is disabled (if unit has heating capability).	P/F
Step 4:	If unit has heating capability, simulate a heating demand and set economizer so that it is capable of operating (i.e., actual outdoor air conditions are below lockout setpoint). (record all of the following):		
	a.	Economizer is at minimum position.	P/F/NA
	b.	Return air damper opens.	P/F/NA
Step 5:	Turn off the unit. Record if the Economizer damper closes completely.		P/F
Step 6:	Restore demand control ventilation systems (if applicable) and remove all system overrides initiated.		

Y/N	Economizer functions as designed	
☐	**If economizer does not function as designed and requires adjustment or repairs:** • Document Required Repairs and Adjustments • Document information required for a repair or adjustment (i.e. measurements, model, serial, etc.)	
	• Include relevant photographic documentation	☐

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B. Economizer Operation Method of Procedure

Economizer Operation - Physically test for proper operation.

1. **Passing this test verifies the Economizer operates as designed.**
    a. Disable demand control ventilation systems (if applicable)
    b. All tests shall be completed in a safe manner by personal wearing personal protective equipment.
    c. Enable the economizer and simulate a cooling demand large enough to drive the economizer fully open (record all the following):
        i. Economizer damper modulates 100% open and that the return air damper modulates 100% closed.
        ii. All applicable fans and dampers operate as intended to maintain building pressure.
        iii. The unit heating is disabled (if applicable).
    d. Disable the economizer and simulate a cooling demand (record all of the following):
        i. Economizer damper closes to its minimum position.
        ii. All applicable fans and dampers operate as intended to maintain building pressure.
        iii. The unit heating is disabled (if unit has heating capability).
    e. If unit has heating capability, simulate a heating demand, and set economizer so that it is capable of operating (i.e., actual outdoor air conditions are below lockout setpoint). (record all of the following):
        i. Economizer is at minimum position.
        ii. Return air damper opens.
    f. Turn off the unit. Record if the Economizer damper closes completely.
    g. Restore demand control ventilation systems (if applicable) and remove all system overrides initiated.
2. **Document if economizer functions as designed.**
    a. If economizer does not function as designed and requires adjustment or repairs:
        i. Document Required Repairs and Adjustments
        ii. Document information required for a repair or adjustment (i.e., measurements, model, serial, etc.)
    b. Include relevant photographic documentation.

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V. Section 5 – Demand Control Ventilation (DCV) Operation

A. Demand Control Ventilation (DCV) Sample Form

Ventilation Verification and Energy Optimization Assessment

☐	**Demand Control Ventilation (DCV) systems shall be verified for proper operation**

Step	Passing this test verifies the DCV and associated CO_2 sensor operates as designed.	Results
1	Prior to functional testing, record the following:	
a.	Disable economizer controls.	
b.	Record outside air CO_2 concentration from dynamic measurement or:	ppm
	Assume outside air concentration if dynamic measure is not included with the system	400 ppm
c.	Record interior CO_2 concentration setpoint (may not exceed Step 1b + 600 ppm)[4]	ppm
2	Simulate a signal at or slightly above the CO_2 concentration setpoint required.	
a.	Apply CO_2 calibration gas at a concentration at or slightly above the setpoint to the sensor.	ppm
b.	For single zone units, verify that the outdoor air damper modulates open to satisfy the total required ventilation air. called for in the Mechanical Schedule.	P/F/NA
c.	For multiple zone units, the zone damper (or outdoor air damper when applicable) modulates open to satisfy the zone ventilation requirements.	P/F/NA
3	Simulate signal well below the CO_2 setpoint. SAMPLE	
a.	Apply CO_2 calibration gas at a concentration well below the setpoint to the sensor or ventilate the sensor as necessary.	ppm
b.	For single zone units, outdoor air damper modulates to the design minimum value.	P/F/NA
c.	For multiple zone units, the zone damper (or outdoor air damper when applicable) modulates to satisfy the reduced zone ventilation requirements.	P/F/NA
4	Verify DCV operation with economizer	
a.	Restore economizer controls and remove all system overrides initiated during the test.	
b.	Apply CO_2 calibration gas at a concentration slightly above the setpoint to the sensor.	ppm
c.	Verify that the outdoor air damper modulates open to satisfy the total ventilation required air.	P/F
5	Remove all system overrides initiated during the test and return system to normal operation.	

Y/N	**DCV functions as designed with the established setpoint (1b)**
☐	**If No, and the DCV requires adjustment or repairs:** • Document Required Repairs and Adjustments • Document information required for a repair or adjustment (i.e. measurements, model, serial, etc.)
☐	**Disabled DCV During Pandemic:** The ASHRAE Epidemic Task Force recommends that DCV systems be disabled during epidemic conditions to dilute potential airborne contaminants.
☐	**Enabled DCV During Pandemic with Reduced Setpoint:** Alternative option to disabling DCV, is to lower the CO_2 setpoint of the DCV system to 750 ppm, as recommended by the WCEC[5], which will provide additional ventilation while still saving energy during reduced occupancy periods.
☐	Include relevant photographic documentation
If the demand control ventilation, is operated, but cannot maintain average daily maximum CO_2 levels	

[4] Or as required by applicable local, state, or provincial guidance.

[5] The CO_2 set point of 750 ppm is recommended by the UC Davis Western Cooling Efficiency Center. A setpoint of 750 ppm will approximately double the ventilation provided when compared to a typical setpoint of 1,000-1,100 ppm.

below 1,100 ppm, it shall be disabled until the DCV system can be repaired, unless disabling the control would adversely affect operation of the overall system. When disabling a demand control ventilation system, the system must be configured to meet the minimum ventilation rate requirements and tested and adjusted.

B. Demand Control Ventilation (DCV) Method of Procedure

Demand Control Ventilation (DCV) - Physically test for proper operation.

1. **Passing this test verifies the DCV and associated CO_2 sensor operates as designed.**
    a. Prior to functional testing, record the following:
        i. Disable economizer controls.
        ii. Record outside measured air CO_2 concentration from dynamic measurement or assume an outside air concentration of 400 ppm, if dynamic measure is not included with the system.
        iii. Record interior CO_2 concentration setpoint (may not exceed Determined outside ppm + 600 ppm)
            - Setpoint to be verified by local jurisdiction or design professional recommendations.
    b. All tests shall be completed in a safe manner by personal wearing personal protective equipment.

    c. Simulate a signal at or slightly above the CO_2 concentration setpoint required.
        i. Apply CO_2 calibration gas at a concentration at or slightly above the setpoint to the sensor.
        ii. For single zone units, verify that the outdoor air damper modulates open to satisfy the total required ventilation air. called for in the Mechanical Schedule.
        iii. For multiple zone units, the zone damper (or outdoor air damper when applicable) modulates open to satisfy the zone ventilation requirements.
    d. Simulate signal well below the CO_2 setpoint.
        i. Apply CO_2 calibration gas at a concentration well below the setpoint to the sensor or ventilate the sensor, as necessary.
        ii. For single zone units, outdoor air damper modulates to the design minimum value.
        iii. For multiple zone units, the zone damper (or outdoor air damper when applicable) modulates to satisfy the reduced zone ventilation requirements.
    e. Verify DCV operation with economizer.
        i. Restore economizer controls and remove all system overrides initiated during the test.
        ii. Apply CO_2 calibration gas at a concentration slightly above the setpoint to the sensor.
        iii. Verify that the outdoor air damper modulates open to satisfy the total ventilation required air.
    f. Remove all system overrides initiated during the test and return system to normal operation.
2. **Document if DCV functions as designed.**
    a. If No, and the DCV requires adjustment or repairs:
        i. Document Required Repairs and Adjustments
        ii. Document information required for a repair or adjustment (i.e., measurements, model, serial, etc.)
    b. Determine if DCV will be enabled or disabled during pandemic.

i. Disabled DCV During Pandemic:
   - The ASHRAE Epidemic Task Force recommends that DCV systems be disabled during epidemic conditions to dilute potential airborne contaminants.

ii. Enabled DCV During Pandemic with Reduced Setpoint:
   - Alternative option to disabling DCV, is to lower the CO_2 setpoint of the DCV system to 750 ppm, as recommended by the WCEC[6], which will provide additional ventilation while still saving energy during reduced occupancy periods.

c. Include relevant photographic documentation.

d. If the demand control ventilation, is operated, but cannot maintain average daily maximum CO_2 levels below 1,100 ppm, it shall be disabled until the DCV system can be repaired, unless disabling the control would adversely affect operation of the overall system. When disabling a demand control ventilation system, the system must be configured to meet the minimum ventilation rate requirements and tested and adjusted.

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[6] The CO_2 set point of 750 ppm is recommended by the UC Davis Western Cooling Efficiency Center. A setpoint of 750 ppm will approximately double the ventilation provided when compared to a typical setpoint of 1,000-1,100 ppm.

VI. Section 6 – Air Distribution and Building Pressure

A. Air Distribution and Building Pressure Sample Form

Ventilation Verification and Energy Optimization Assessment

Verify Air Distribution and Building Pressurization	
☐	**Supply Outlets –** Measure and document supply air volume (CFM). • Include individual outlet test report • Include duct pitot traverse report (if available)
☐	**Return Inlets** – Measure and document return air volume (CFM). • Include individual inlet test report • Include duct pitot traverse report (if available)
☐	**Exhaust Inlets** – Measure and document return air volume (CFM). • Include individual inlet test report • Include duct pitot traverse report (if available)
☐	**With Power Exhaust disabled (if applicable), determine if** **Measured Supply Air = Measured Outside Air + Measured Return Air** • Document any discrepancies and determine the cause of significant discrepancies (i.e. leakage, ductwork serving other zones, inaccurate measurement location). • Document Building Pressure - Verify pressure differential is within tolerance of design and a negative pressure for contaminant rooms temporarily occupied by sick patrons.

Supply Air	Outside Air	Return Air
=	+	

Building or Zone Pressure	In w.c.	In relation to:	

☐	**With Power Exhaust enabled (if applicable), determine if** **Measured Supply Air slightly greater than Measured Return/Exhaust Air** • Document any discrepancies that do not match design intent. Determine the cause of significant discrepancies (i.e. leakage, ductwork serving other zones, inaccurate measurement location, power exhaust requires adjustment). • Document Building Pressure - Verify pressure differential is within tolerance of design and a negative pressure for contaminant rooms temporarily occupied by sick patrons.

Supply Air	Outside Air	Return & Powered Exhaust Air
=	+	

Building or Zone Pressure	In w.c.	In relation to:	

Y/N	**Air Distribution -** Verify that inlets and outlets are balanced within tolerance of the system design as listed within design documents. • If the original system design values are not available, document available

	information and note unavailability of system design values in the HVAC Assessment Report.
☐	**Air Distribution Notes.** – Note how the air moves from supply to return.
☐	**Repairs and Adjustment.** • Document Required Repairs and Adjustments
☐	Include relevant photographic documentation

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B. Air Distribution and Building Pressure Method of Procedure

Air Distribution - Verify all ventilation is reaching the served zone, how air is distributed, and that there is adequate distribution.

Building Pressure - Verify the pressure differential is within tolerance of design and a negative pressure for contaminant rooms temporarily occupied by sick patrons.

1. **Supply Outlets** – Measure and document supply air volume (CFM).
   a. Include individual outlet test report
   b. Include duct pitot traverse report (if available)
2. **Return Inlets** – Measure and document return air volume (CFM).
   a. Include individual inlet test report
   b. Include duct pitot traverse report (if available)
3. **Exhaust Inlets** – Measure and document return air volume (CFM).
   a. Include individual inlet test report
   b. Include duct pitot traverse report (if available)
4. **With Power Exhaust disabled (if applicable), determine if: Measured Supply Air = Measured Outside Air + Measured Return Air**
   a. Document any discrepancies and determine the cause of significant discrepancies (i.e., leakage, ductwork serving other zones, inaccurate measurement location).
   b. Document Building Pressure - Verify the pressure differential is within tolerance of design and a negative pressure for contaminant rooms temporarily occupied by sick patrons.
5. **With Power Exhaust enabled (if applicable), determine if: Measured Supply Air slightly greater than Measured Return/Exhaust Air**
   a. Document any discrepancies that do not match design intent. Determine the cause of significant discrepancies (i.e., leakage, ductwork serving other zones, inaccurate measurement location, power exhaust requires adjustment).
   b. Document Building Pressure - Verify the pressure differential is within tolerance of design and a negative pressure for contaminant rooms temporarily occupied by sick patrons.
6. **Air Distribution -** Verify that inlets and outlets are balanced within tolerance of the system design as listed within design documents.
   a. If the original system design values are not available, document available information and note unavailability of system design values in the HVAC Assessment Report.
   b. Note how the air moves from supply to return.
   c. Simulate signal well below the CO_2 setpoint.
   d. Document Required Repairs and Adjustments
   e. Include relevant photographic documentation.

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VII. Section 7 – General Maintenance

A. General Maintenance Sample Form

Ventilation Verification and Energy Optimization Assessment

Verify General Maintenance	
☐	**Verify coil condition** - Note downstream and upstream condition
☐	**Verify condensate drainage**
☐	**Temperature Differential (Cooling Mode) -** Measure and Document cooling coil air temperature differential (entering and leaving dry bulb) • If applicable, measure GPM on hydronic systems.
☐	**Temperature Differential (Heating Mode) –** Measure and document air temperature differential (entering and leaving dry bulb) • If applicable, measure GPM on hydronic systems.
☐	**Verify condition of drive assembly**. (if applicable)
☐	**Deficiencies** - Document deficiencies, general condition of unit, and make recommendations for additional maintenance, replacement, or upgrades.
☐	**Repairs and Adjustment.** • Document Required Repairs and Adjustments
☐	Include relevant photographic documentation

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B. General Maintenance Method of Procedure

General Maintenance. Verify coil condition, condensate drainage, cooling coil air temperature differential (entering and leaving dry bulb), heat exchanger operation, and drive assembly. Recommendations for additional maintenance, replacement or upgrades shall be recorded in the HVAC Assessment Report

1. All tests shall be completed in a safe manner by personal wearing personal protective equipment.
2. **Verify coil condition.**
   a. Note downstream and upstream condition.
   b. Note and document any damage.
3. **Verify condensate drainage.**
   a. Document if drain pain is functioning (removes water) or if maintaining, or showing signs of, stagnant water.
   b. Verify trap is installed and trap depth is correct per local code.
   c. Verify condensate drain line is intact and functional.

4. **Temperature Differential (Cooling Mode)**
   a. Measure and Document cooling coil air temperature differential
      i. Obtain entering and leaving dry bulb temperatures.
   b. If applicable, measure GPM on hydronic systems.
5. **Temperature Differential (Heating Mode)**
   a. Measure and document air temperature differential
      i. Obtain entering and leaving dry bulb temperatures.
   a. If applicable, measure GPM on hydronic systems.
6. **Verify condition of drive assembly**. (if applicable)
   a. Document sheave size, model, and number.
   b. Document belt size, model, and number.
   c. Note condition of all applicable components.
7. **Deficiencies**
   a. Document deficiencies, general condition of unit, and make recommendations for additional maintenance, replacement, or upgrades.
8. **Repairs and Adjustment.**
   a. Document Required Repairs and Adjustments
9. Include relevant photographic documentation.

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VIII. Section 8 – Operational Controls

A. Operational Controls Sample Form

Ventilation Verification and Energy Optimization Assessment

Review control sequences to verify systems will maintain intended conditions during building operation.	
☐	**Temperature –** Setpoints match design.
Setpoint	**Design**
☐	**Humidity (if applicable) –** Setpoints match design. • Design professional to determine if setpoint should be adjusted to maintain a relative humidity between 40% and 60%.
Setpoint	**Design**
Ventilation Schedule Operation	
☐	**Ventilation operates continuously during occupied hours.** • Occupied hours to include **<u>all</u>** hours building is occupied by staff or patrons (i.e. teachers, security, janitorial staff, night shift, etc.). • Includes all exhaust fans and fans used to distribute outside air.
☐	**Daily Flush** • Verify a daily flush is scheduled in accordance with current ASHRAE recommendations and any applicable local or state guidance.
☐	**Deficiencies** - Document deficiencies, options for adjustment (i.e. Humidity) and recommendations for additional maintenance, replacement or upgrades.
☐	Include relevant screenshots and photographic documentation

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B. Operational Controls Method of Procedure

Operational Controls - Review of HVAC control sequences to verify systems will maintain intended ventilation, temperature, and humidity conditions during operation. Verify ventilation systems are programmed to flush the building in accordance with current ASHRAE recommendations and any applicable local or state guidance.

1. **Review control sequences to verify systems will maintain intended conditions during building operation.**
    a. **Temperature –** Setpoints match design.
    b. **Humidity (if applicable) –** Setpoints match design.
        i. Licensed professional to determine if setpoint should be adjusted to maintain a relative humidity between 40% and 60%.
    c. **Ventilation operates continuously during occupied hours.**
        i. Occupied hours to include **all** hours building is occupied by staff or patrons (i.e., teachers, security, janitorial staff, night shift, etc.).
        ii. Includes all exhaust fans and fans used to distribute outside air.
    d. **Daily Flush**
        i. Verify a daily flush is scheduled (in accordance with current ASHRAE recommendations and any applicable local or state guidance) as demonstrated by a calculation of flush times per ASHRAE Guidance for Building Readiness[7] or otherwise applicable local or state guidance.
        ii. Document calculated flush time.
    e. **Deficiencies** - Document deficiencies, options for adjustment (i.e. Humidity) and recommendations for additional maintenance, replacement, or upgrades.
    f. Include relevant screenshots and photographic documentation.

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[7] ASHRAE, ASHRAE Epidemic Task Force: Building Readiness (February 1, 2021) (https://www.ashrae.org/file%20library/technical%20resources/covid-19/ashrae-building-readiness.pdf

IX. Section 9 – CO_2 Monitoring

A. CO_2 Monitoring Sample Form

Ventilation Verification and Energy Optimization Assessment

☐	**Verify installation or install a CO_2 monitor.** • All occupied areas shall be equipped with a CO_2 monitor. • General Buildings – At least one CO_2 monitor shall per installed in each zone of the building (where a zone is defined by an area of the building with temperature controlled by a thermostat). The number of CO_2 monitor must also meet or exceed at least one CO_2 monitor per 10,000 square feet of occupied floor space. **CO_2 monitors shall**:
☐	Be hard-wired or plugged-in and mounted to the wall between 3 – 6 feet above the floor and at least 5 feet away from the door and operable windows.
☐	Display the CO_2 readings to the occupants through a display on the device or other means such as a web-based application or cell-phone application.
☐	Notify the building operator through visual indicator on the monitor (e.g. indicator light) or other alert such as e-mail, text, or cell phone application, when the CO_2 levels have exceeded 1,100 ppm.
☐	Maintain a record of previous data which includes at least the maximum CO2 concentration measured.
☐	Have a range of 400 ppm to 2000 ppm or greater;
☐	Be certified by the manufacturer to be accurate within 75 ppm at 1,000 ppm CO2 concentration and is certified by the manufacturer to require calibration no more frequently than once every five years.

Y/N	**Is a CO_2 monitor installed that meets the required features listed above?**	
☐	If installed but lacking required features, what features are missing?	
☐	If installed, document CO_2 monitor nameplate data.	
Manufacturer:		Model:
Serial:		
☐	Include relevant photographic documentation	

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B. CO_2 Monitoring Method of Procedure

CO_2 Monitoring - To ensure proper ventilation is maintained during building operation, at least one CO_2 monitor shall be installed in each zone of the building.

1. **Verify installation or install a CO_2 monitor.**
   a. All occupied areas shall be equipped with a CO_2 monitor.
   b. General Buildings – At least one CO_2 monitor shall per installed in each zone of the building (where a zone is defined by an area of the building with temperature controlled by a thermostat). The number of CO_2 monitor must also meet or exceed at least one CO_2 monitor per 10,000 square feet of occupied floor space.
2. **CO_2 monitors shall**:
   a. Be hard-wired or plugged-in and mounted to the wall between 3 – 6 feet above the floor and at least 5 feet away from the door and operable windows.
   b. Display the CO_2 readings to the occupants through a display on the device or other means such as a web-based application or cell-phone application.
   c. Notify the building operator through visual indicator on the monitor (e.g., indicator light) or other alert such as e-mail, text, or cell phone application, when the CO_2 levels have exceeded 1,100 ppm.
   d. Maintain a record of previous data which includes at least the maximum CO_2 concentration measured.
   e. Have a range of 400 ppm to 2000 ppm or greater.
   f. Be certified by the manufacturer to be accurate within 75 ppm at 1,000 ppm CO_2 concentration and is certified by the manufacturer to require calibration no more frequently than once every five years.
3. **Verify CO_2 monitor installed meets the required features.**
   a. If installed but lacking required features, what features are missing?
   b. If installed, document CO_2 monitor nameplate data.
      i. Document Manufacturer
      ii. Document Model
      iii. Document Serial
   c. Include relevant photographic documentation.

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X. Section 10 – Limited or No Existing Mechanical Ventilation

A. Limited or No Existing Mechanical Ventilation Sample Form

Ventilation Verification and Energy Optimization Assessment

Collect and document existing HVAC infrastructure to assist the Design Professional in determining ventilation options.	
☐	**Existing HVAC Infrastructure –** Verify the functionality and document nameplate data on any existing HVAC equipment (i.e., heating only units, exhaust fans, etc.)
☐	Verify and document the location of windows and doors that can be opened. • Verify if windows have any switches or controls that initiate exhaust fans, motorized dampers, or other devices that operate to provide free cooling.
☐	Verification or installation of the CO^2 sensor as detailed in Section 9.
☐	**Collection the following information, in addition to any information requested by a design professional to evaluate options for adding mechanical ventilation.** ☐ Verify existing mechanical, architectural, structural drawings match current conditions. ☐ Provide a sketch of actual roof penetrations, penetration type (i.e., vent pipe) and approximate locations if different from drawings. ☐ Document locations of any vents could contaminate Outside Air (OSA) intake locations. ☐ Photograph existing building, existing mechanical equipment (if applicable) and potential locations for mechanical ventilation equipment. ☐ Document roof and wall type/material to the best of the technician's ability. ☐ Document if existing mechanical equipment can be altered to provide outside air (OSA) or if a Dedicated Outside Air System (DOAS) is required. ☐ Obtain information on central plant capacity (if applicable) ☐ Document whether outside air conditions may make reliance on windows or other sources of non-filtered outside air potentially hazardous to occupants. ☐ Document recommendations for adding mechanical ventilation and filtration where none currently exists or for replacing a mechanical ventilation system where the current system is non-operational or is unable to provide recommended levels of ventilation and filtration.
☐	Include relevant screenshots and photographic documentation. • Include existing building and potential locations for mechanical ventilation equipment.

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B. Limited or No Existing Mechanical Ventilation Method of Procedure

Limited or No Existing Mechanical Ventilation - In cases where there is limited or no existing mechanical ventilation, the assessment would then focus on available options and provide the design professional with documentation to provide ventilation options with limited assumptions.

1. Verify the functionality and document nameplate data on any existing HVAC equipment (i.e., heating only units, exhaust fans, etc.)
2. Verify and document the location of windows and doors that can be opened.
   a. Verify if windows have any switches or controls that initiate exhaust fans, motorized dampers, or other devices.
3. Verification or installation of the CO_2 sensor per section 9.
4. Collection of the following information, in addition to any information requested by a design professional to evaluate options for adding mechanical ventilation.
   a. Verify existing mechanical, architectural, structural drawings match current conditions.
      i. Provide a sketch of actual roof penetrations, penetration type (i.e., vent pipe) and approximate locations if different from drawings.
   b. Document locations of any vents could contaminate Outside Air (OSA) intake locations.
   c. Document locations for potential installation of mechanical ventilation
   d. Photograph existing building, existing mechanical equipment (if applicable) and potential locations for mechanical ventilation equipment.
   e. Document roof and wall type/material to the best of the technician's ability.
   f. Document if existing mechanical equipment can be altered to provide outside air (OSA) or if a Dedicated Outside Air System (DOAS) is required.
   g. Obtain information on central plant capacity (if applicable)
   h. Document whether outside air conditions may make reliance on windows or other sources of non-filtered outside air potentially hazardous to occupants.
   i. Document recommendations for adding mechanical ventilation and filtration where none currently exists or for replacing a mechanical ventilation system where the current system is non-operational or is unable to provide recommended levels of ventilation and filtration.

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