



Brandan G Dodds, MS, CIH

Esperanza Lutheran Church HVAC COVID-19 Review and Inspection

November 11, 2020.



Introduction

In order to determine if the HVAC (Heating Ventilation Air Conditioning) systems of the Main Sanctuary and the adjoining Fellowship Hall at Esperanza Lutheran Church were operating per recommended guidelines, a ventilation study was commissioned and conducted. This study was to document the characteristics of the HVAC system and system components, and to provide recommendations in accordance with guidance documents such as the CDC's COVID-19 Considerations for Communities of Faith. Brandan Dodds, MS, CIH was contracted to perform these services through Yellowbird.

Background

The World Health Organization declared COVID-19 a global pandemic in March of 2020. Over the subsequent weeks and months, various strategies were developed and then implemented to help reduce exposures and transmission of the virus. These strategies include:

- Cleaning and disinfecting
- Personal hygiene (hand washing and sanitizing, covering face when sneezing or coughing)
- Social distancing
- Limiting room occupancy
- Wearing cloth face coverings and N95 respirators
- Establishing quarantine protocols
- Conducting monitoring, testing, and training
- Inspecting and characterizing building systems – which includes ventilation studies.

Many organizations throughout the world adopted some or all of these suggestions to address the risk of exposure to the virus and to protect the health of their workers, students, the general public, contractors, and visitors. Some organizations added other strategies such as personnel temperature checks, additional receptacles for tissues and trash, erecting physical barriers, strategically placing information signs, establishing one-way travel at choke points, and installing floor markings.

Guidelines

CDC guidelines and other experts recommend that to control the indoor transmission of the COVID-19 virus, ventilation rates be increased in buildings and as much fresh air as possible be introduced to the occupied areas. It has been shown that adequate and appropriate ventilation can statistically lower the risk of viral infections. They suggest taking some or all of the steps below to improve ventilation in buildings:

- Establish and maintain communication with local and State authorities to determine current mitigation levels in your community.
- Provide protections for staff and congregants at [higher risk for severe illness](#) from COVID-19. Offer options for staff at [higher risk for severe illness](#) (including older adults and people of all ages with certain underlying medical conditions) that limit their exposure risk. Offer options for congregants at [higher risk of severe illness](#) that limit their exposure risk (e.g., remote participation in services).
- Consistent with applicable federal and State laws and regulations, put in place policies that protect the privacy and confidentiality of people at [higher risk for severe illness](#) regarding underlying medical conditions.
- Encourage any organizations that share or use the facilities to also follow these considerations as applicable.



- If your community provides social services in the facility as part of its mission, consult CDC's information for [schools](#) and [businesses and workplaces](#), as relevant, for helpful information.

ASHRAE, the American Society of Heating, Refrigerating and Air-Conditioning Engineers, has published COVID resources including developing guidelines for building reopening – Building Readiness, to specifically address ventilation systems and to minimize the risks of disease transfer. Their documents have specific recommendations for increasing ventilation rates, improved filtration, energy recovery, building re-opening, and building exhaust. This should be referred to for additional guidance.

Building/Room Information

This study looked at the following rooms at Esperanza Lutheran Church, located at 2601 E. Thunderhill Place, Phoenix, AZ, 85048:

- The Main Sanctuary, which is approximately 2464 sq. ft. The sanctuary is supplied by four air conditioning units, each servicing their respective quadrants. The room has a height of about 24 feet, which angles up beginning at the 10 feet mark up to the cathedral ceiling. The cubic feet, or volume, of the Sanctuary is 41888 cu. ft.
 - Room Volume: $44' \times 56' \times 10' + 1/2(44' \times 56' \times 14') = 24640$ cubic feet + 17248 cubic feet = 41888 cu. ft.
- The Fellowship Hall is adjacent to the Sanctuary and is used in conjunction with it during special services such as Christmas Eve and Easter. The Hall has two HVAC units each supplying half the room's air.
 - Sq Ft – $28' \times 38' = 1064$ sq. ft.
 - Volume – $28' \times 38' \times 10' = 10640$ cu.ft.

Field Services

Initially to establish the baseline levels for the study, readings were made outdoors with an IAQ (Indoor Air Quality) monitor and quantified the levels of CO₂, CO, Relative Humidity, and Temperature. After these readings were defined, monitoring began indoors. Air supplied to the rooms was measured at the air supply vents to determine air changes per hour (ACH). ACH for each room was calculated by measuring airflow from the room supply vents using a hot wire anemometer and the room's physical characteristics. The sanctuary has four air units, and the Fellowship Hall has two. During this study, the unit that services the east end of the Fellowship hall was inoperative. Two supply registers into the foyer are fed from the SW and NW units from the Main Sanctuary. It was relayed that the bathroom is supplied air from one of the Fellowship Hall units.

Conditions

On the morning of the study the outdoor temperature was 46 °F. The wind was calm and less than 2 MPH. Skies were clear. No activities, meetings, or gatherings were taking place in the Sanctuary on the morning of the study.

Sampling (Approach and Tasks)

On November 11th, beginning at 8:00 a.m., surveys were begun at Esperanza Lutheran Church to characterize the indoor air environment in Main Sanctuary and the Fellowship Hall. Air sampling was conducted and quantified the follow:

CO₂ – Carbon Dioxide. CO₂ is produced by exhaled breath and is an indication of how much fresh air is being delivered by the HVAC system. Outdoors the CO₂ level ranges between 300 and 500 ppm. When occupied, indoors has a typical level of 700 ppm. If indoor CO₂ levels are over 1030 ppm it could indicate that increased fresh air may be necessary.

CO – Carbon Monoxide. CO is a byproduct of incomplete combustion and could be an indicator of outside contamination being brought indoors, a leaking gas furnace, use of a wood stove, or a smoldering fireplace.

RH – Relative Humidity. Along with temperature, RH is an indicator of overall comfort. The feeling of comfort varies between areas of the country and individuals, but most find the environment comfortable when the RH is less than 50%.

An initial sampling was conducted to set the baseline of outdoor air as well as the unoccupied rooms. Additional room sampling was made two hours later in the Main Sanctuary.

Results

Air monitoring

The outdoor levels of CO₂ were as expected, 445-455 ppm (parts per million). There was no indication of CO. The temperature outside was 46° F, and the relative humidity was measured at 40%.

Indoors the CO₂ was just slightly higher at 470 ppm. This low level was mostly due to two outside doors being open during the study and the rooms being unoccupied. At the conclusion of the ventilation review, the CO₂ was at 465 ppm. Temperature indoors was 67° F, and the RH was 27%.

Physical HVAC systems review:

The four HVAC units in the Main Sanctuary range in ages from 24 years to only several months, but all seem to be operating as expected. Three units have regular disposable filters, and one unit has a filter that is washable and reusable. Only the units on the east side draw 100% outdoor air. The units on the west recirculate only. Only one of the two units in the Fellowship Hall was operational.

In the Main Sanctuary, the Air Changes per Hour (ACH) was calculated at 9.1. There is not a standard for ACH, however prior to COVID, recommendations called for at least 6 ACH. With COVID, the recommended range is now between 8 and 12. The Main Sanctuary appears to have sufficient ACH to meet the recommendations.

In the Fellowship Hall with one unit in operation, the ACH was calculated to be 6.1. If the other unit functions as well when brought online, the ACH in the Fellowship Hall should be satisfactory.

Conclusions and Recommendations

In order to properly prepare for occupancy and limit the potential exposure and transmission of COVID-19, it is recommended that Esperanza Lutheran Church ensure they follow state and local government rules and regulations regarding COVID and review and incorporate where possible the CDC Guidelines for Communities of Faith when gatherings in person are taking place. Some of these recommendations are:

- Space families or social groups apart by six feet. Use colored tape, paper signs, or other methods on chairs to indicate where not to sit.
- Require face coverings for those over two years old and who have the physical capability to wear them. Have face coverings available for those who do not bring their own.
- Establish hand sanitizing stations in several locations in the rooms.
- Determine if surfaces that are continually touched, like door handles, can be addressed to eliminate this exposure.



- Incorporate rigorous cleaning and disinfecting practices before, during, and after gatherings.
- During gatherings, establish one-way travel routes for pedestrians, such as entering in from the foyer and exiting from the Fellowship Hall.
- If childcare is provided, follow the CDC guidelines, <https://www.cdc.gov/coronavirus/2019-ncov/community/schools-childcare/guidance-for-childcare.html>.
- Encourage parking separation.
- Assign a staff person to be the COVID point of contact.

The state of California has developed guidance for Places of Worship that can be referenced for additional information and suggestions for added safety. The link to this document is in the Reference section.

Program or physically turn on the ventilation systems to the Main Sanctuary and Fellowship Hall two hours before they are expected to be occupied. Run the system continuously during the service or program, and then for an additional hour once everyone has left.

Upgrade filters in all systems to the highest MERV filter possible. Industry recommendation is for MERV-13 filters for efficient virus-capture, or MERV-14 if the system can accommodate it. The contracted HVAC company will be able to determine what level of filter efficiency the system can accommodate without an unacceptable pressure drop and also the proper filter changeout schedule.

Provide the maximum outdoor air intake possible, keeping in mind the comfort levels of temperature and relative humidity. This can be done by ensuring the system is operating effectively and window and doors are opened or partially opened when possible, given the limitations of room comfort.

If needed, supplement the HVAC system with portable air cleaners. This might be necessary if multiple services are held in a day and there is not enough time to sufficiently purge the rooms before the next group arrives.

The bathrooms only have supply air to them which creates a positive pressure in the rooms. Guidelines suggest negative pressures in bathrooms to prevent contamination of adjoining spaces. Address this with the HVAC contractor to determine if any system modifications can be made.

ASHRAE specifies several checklists in their guidelines that should be used to determine the health of the current HVAC system and to establish a needs list based on the gap analysis of the review. Please see the reference section of this report for the links to their pages.

Possible follow-up studies should be considered to determine the system characteristics during special gatherings and when normal services and operations begin.

Comments

If there are any questions, comments, or additional information needed concerning this report, those can be directed to Brandan Dodds, badodds@msn.com.



Data Tables

Air Quality

Area	Time	CO2	CO	Temp	RH
Outside	8:05 a.m.	450 ppm	0.0	46° F	40%
Inside Sanctuary	8:20 a.m.	470 ppm	0.0	67° F	27%
Inside Sanctuary	10:20 a.m.	465 ppm	0.0	65° F	26.5%

Air Flow

Room	Section	Ave Supply Velocity	Supply Duct Sq Ft	Room Volume	Total Air Flow Rate	Air Changes/Hr
Main Sanctuary				41888 cu ft	6337 cu ft/min	9.1
	SW quadrant	470 ft/min	3.75			
	Foyer S	220 ft/min	0.35		77 cu ft/min	
	NW quadrant	367 ft/min	3.75			
	Foyer N	680 ft/min	0.35		238 cu ft/min	
	NE quadrant	452 ft/min	3.75			
	SE quadrant	401 ft/min	3.75			
Fellowship Hall				10640 cu ft		6.1 (one unit)
	West Side	335 ft/min	3.5			
	East Side	--- ft/min	3.5			

Monitoring Equipment

Testo Smart Probe Hot-Wire Anemometer, Model 405i, Serial No. 48959473

TSI IAQ Monitor, Model 7545, Serial No. T75451734010

Reference Documents

Communities of Faith, CDC, <https://www.cdc.gov/coronavirus/2019-ncov/community/faith-based.html>

Ventilation and Coronavirus (COVID-19) – EPA, <https://www.epa.gov/coronavirus/ventilation-and-coronavirus-covid-19>

COVID-19 Industry Guidance: Places of Worship and Providers of Religious Services and Cultural Ceremonies, <https://files.covid19.ca.gov/pdf/guidance-places-of-worship.pdf>

ASHRAE Technical Resources, Coronavirus Response – ASHRAE, <https://www.ashrae.org/file%20library/technical%20resources/covid-19/ashrae-building-readiness.pdf>.



ASHRAE Handbook – Fundamentals, Indoor Environmental Health,

https://www.ashrae.org/file%20library/technical%20resources/covid-19/i-p_f17_ch10indoorenvironmentalhealth.pdf.

ASHRAE Standard 62.1- 2019, Ventilation for Acceptable Indoor Air Quality