SOUND DECISIONS:
CONSIDERATIONS WHEN SITING OUTDOOR MECHANICAL EQUIPMENT

Preparing cities for new regulations related to fossil burning appliances

Submitted to:

SILICON VALLEY CLEAN ENERGY

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SILICON VALLEY CLEAN ENERGY

PREFACE

Acknowledgments

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About SVCE

Silicon Valley Clean Energy (SVCE), a Community Choice Energy agency, was formed as a Joint Powers Authority in 2016 and now serves approximately 270,000 residential and commercial electricity customers across a service area comprised of the following 13 communities: Campbell, Cupertino, Gilroy, Los Altos, Los Altos Hills, Los Gatos, Milpitas, Monte Sereno, Morgan Hill, Mountain View, Saratoga, Sunnyvale and Unincorporated Santa Clara County. 97% of electricity customers in SVCE's service area receive their electricity from SVCE. SVCE was formed with the primary intention to address climate change through a variety of services provided to residential and business customers. Since SVCE-provided energy is significantly less carbon-intensive than both general grid power and methane gas combustion, much of SVCE's work has centered on encouraging and supporting building electrification.

About RHA

Richard Heath & Associates, Inc. (RHA) is a Minority Business Enterprise and leading California program design and management firm, specializing in delivering equitable access to energy efficiency, resiliency and beneficial decarbonization. Founded in 1980, RHA's earliest initiatives included partnering with a California utility to pioneer one of the state's first income-qualified energy efficiency programs. RHA has since built on this legacy and operates over 50 programs as a program administrator/implementer, government and utility technical consultant and training organization. This work has helped lead over 2.7 million Californians to more efficient, cleaner energy solutions, healthier homes and lower utility bills.

Disclaimer

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Revision Table

Version	Date	Description
1.0	03/28/24	Initial draft
2.0	04/19/24	Revised per SVCE feedback, added graphics, modified recommendation section
3.0	05/17/24	Revised per stakeholder suggestions

Table of Acronyms, Abbreviations, and Definitions

Abbrev.	Definition
A	Ampere
AHJ	Authority Having Jurisdiction
BEV	Battery Electric Vehicle
CA	California
CEC	California Electric Code
dBA	Decibel
EMS	Energy Management System
EVSE	Electric Vehicle Supply Equipment
GHG	Greenhouse Gas
HEA	Home Energy Analytics
HPWH	Heat Pump Water Heater
NEC	National Electric Code
NFPA	National Fire Protection Association
RHA	Richard Heath & Associates, Inc.
ROW	(public) Right of Way
SME	Subject Matter Expert
SVCE	Silicon Valley Clean Energy

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PURPOSE

This guide is intended to help cities prepare for upcoming changes to rules for the installation of fossil burning appliances while ensuring citizens have equitable access to modern heating and cooling systems that will be required under these new rules. Increasing siting opportunities for outdoor mechanical equipment aids in cleaner, safer more resilient communities.

Health: Replacing natural gas appliances with electric heat pumps improves indoor air quality and reduces building emissions. Heat pumps provide air conditioning, protecting against extreme heat events, while reducing humidity mold risks, and protecting against extreme heat events.

Comfort and Equity: In a warming climate, air conditioning is crucial for community and individual well-being. Updating outdated rules ensures equitable access to modern heating and cooling systems.

Safety: Gas furnaces emit combustion byproducts, including carbon monoxide. By switching to electric heat pumps, you eliminate the risk of carbon monoxide exposure indoors. This is a significant safety benefit. Heat pumps operate without combustion, ensuring that no harmful gases are released inside homes.

WHAT'S INCLUDED

This guide offers research-backed, implementable solutions for updating municipal codes that impact the available siting locations for mechanical equipment. It is focused primarily on condensing units for air conditioners and heat pumps, similar to those shown in Figure 1. These solutions aim to increase available siting options on physically constrained properties while minimizing potential negative impacts on local aesthetics, noise and compliance with local regulations. While the recommendations herein may also apply to commercial sites, specific thresholds recommended here are focused on new and existing residential buildings.

Figure 1: Typical Retrofit Condenser Installation

BACKGROUND

Silicon Valley Clean Energy (SVCE) acknowledges that the placement of exterior mechanical equipment for heat pumps is an important and complex issue in HVAC retrofits and can present challenges for customers, contractors, and municipal staff charged with developing planning policies and issuing building permits. In response, SVCE collaborated with consultant Richard Heath & Associates, Inc (RHA) to create this Informational Guide for planning staff and other stakeholders.

Section 1: Recommendations for Code Updates

By updating municipal codes, noise and zoning ordinances or other locally adopted regulations, cities can have a positive impact on both the cost and availability of air conditioners and heat pumps for homeowners and contractors looking for solutions, while ensuring compliance with all needed fire and life safety requirements. These changes require careful consideration of a variety of factors, as illustrated in Figure 2.

Legal note, adoption of noise-related ordinances is subject to CA laws and regulations, including Health and Safety Code 46000, which states, *"(f) All Californians are entitled to a peaceful and quiet environment without the intrusion of noise which may be hazardous to their health or welfare. (g) It is the policy of the state to provide an environment for all Californians free from noise that jeopardizes their health or welfare."* This code is further reinforced by Section 415 of the California Penal Code, wherein it is illegal for any resident to knowingly create loud and unreasonable noises as a means of disturbing another.

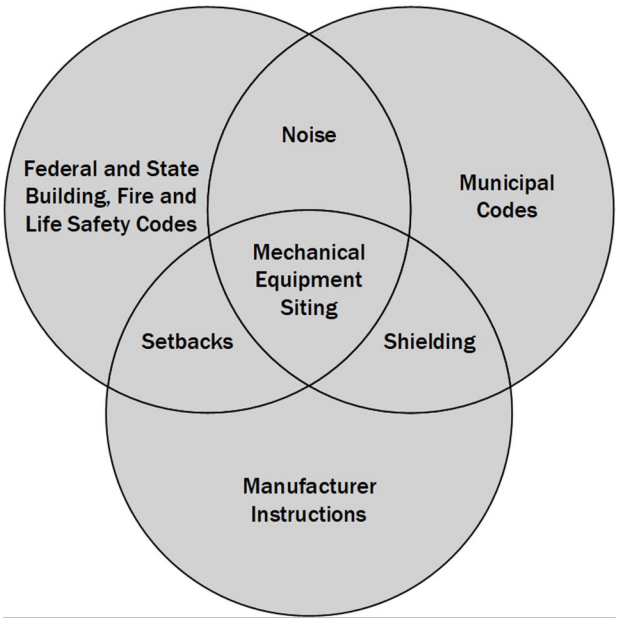

Figure 2: Competing Rules Impacting Siting of Mechanical Equipment

If implemented, the following recommendations will improve the homeowner and contractor options for installing mechanical equipment in space-constrained projects. Specific ordinance language examples are provided in Section 2.

Recommended changes to municipal codes, standards and ordinances to allow for greater flexibility in the siting of mechanical equipment. Recommend incorporating language specific to HVAC mechanical equipment may include:

- *Exception:* Allow marginally higher dBA levels and reduced setbacks only for water heating and space heating/cooling equipment.
- *Variance:* Leave zoning and noise ordinances as is, with additional higher acceptable levels allowable if the property owner can provide reasonable evidence no other location is available (building department written approval required) or if inverter driven equipment is used.

1.1 Procedural Recommendations

There are several municipal codes affecting mechanical equipment siting that building authorities may need to amend to facilitate easier retrofit installation. The regulations include:

1) Zoning ordinances – Update language regarding setbacks, aesthetics and other relevant topics.
2) Noise ordinances – Update language regarding allowable setbacks, noise levels and mechanical equipment shielding.
3) Reach codes – While they generally do not contain language related to siting mechanical equipment, review reach codes to ensure any changes to other regulations do not conflict with the reach codes.
4) Regulatory documents – When possible, coordinate between departments to update necessary regulatory documents in parallel to ensure accuracy, adoption timeliness and swift implementation.
5) Exceptions – Ordinances should include exceptions for existing buildings where space constraints would otherwise make the siting of mechanical equipment impractical or unnecessarily costly. Specific examples are listed in Section 2.2. However, each jurisdiction must consider its unique building stock, public sentiment, and other factors to determine which exceptions to allow.
6) Stakeholder meetings – Actively promote and host stakeholder engagement meetings early during the updating process to build public buy-in, including with contractors, homeowners' associations, engineers and architects, and the general public.

1.2 Ordinance Recommendations

The following recommendations, while not exhaustive, stem from research on existing codes. They focus on technical thresholds and requirements that allow more flexibility in siting mechanical equipment. Importantly, these guidelines aim to balance individual quality of life with reasonable and legal standards.

1.2.1 Setbacks

Allow mechanical equipment to be installed within the 5-foot setback, with a minimum of 3 feet (36 inches, see Figure 3) net clear space between equipment and fences or other obstructions required for ingress/egress and fire/life safety access, as measured from the nearest point of the equipment to the property line or permanent barrier.

As illustrated in Figure 4 and Figure 5, equipment should be allowed to be installed within the first 5 feet from the building edge in a front yard setback if a) equipment is adequately screened from view with approved materials, b) building setback is a minimum of 15 feet from a public walkway or thoroughfare and c) equipment is no more than 4 feet above grade.

If the current ordinance lacks setback requirements for mechanical equipment, defining a new minimum setback is needed. This may include a distance of at least 3 feet from a property line, along with the use of manufacturer-recommended sound transmission-attenuating materials. The new language may include: *"Equipment must be a minimum of 3 feet from the property line on any side yard utilized for ingress or egress. Additionally, equipment should be installed with manufacturer-recommended mechanical sound transmission-attenuating materials."*

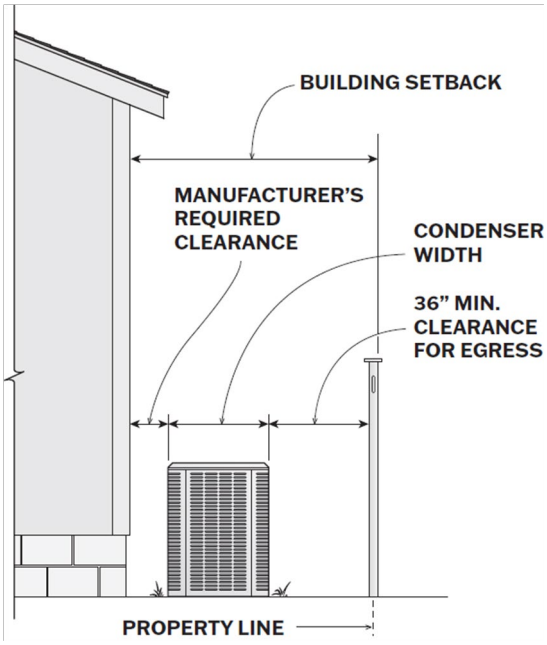

Figure 3: Mechanical Equipment Side Yard Setback Encroachment

Note: Consider language regarding equipment in rear setbacks. This will require further investigation into conditions (alley-loaded, multi-tenant buildings, etc.).

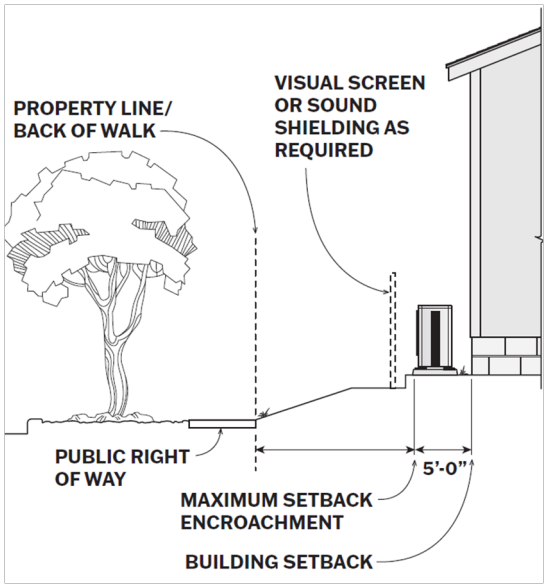

Figure 5: Mechanical Equipment Front Yard Setback Encroachment

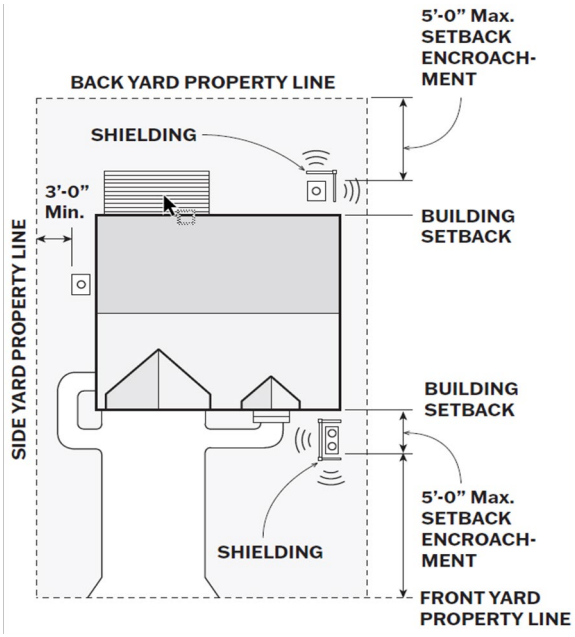

Figure 4: Mechanical Equipment Setback Encroachments

1.2.2 Noise Levels

Depending on the style of heat pump, sound ratings range from 48-75 dBA. This is about the same level as normal conversation. Noise ordinances and the allowable maximum thresholds vary between municipalities based on the time of day and noise source. Cities like Gilroy and Mountain View have already passed amendments that encompass day/night (L_{dn}) and duration, such as L_{10} or 10% of the time. Options for allowable noise level limits might include:

- Option 1: 65 dBA during the day (7:00 a.m. – 10:00 p.m.) and 60 dBA at night (10:01 p.m. – 6:59 a.m.) and with a cumulative period of no more than 50% of operating time (L_{50}).
- Option 2: 60 dBA levels day and night (L_{dn}) or 70 dBA 15% of the time (L_{15}) measured at the property line if no solid barrier at the property line is present (fence, wall, or other sound attenuating shielding).
- Option 3: 60 dBA for inverter driven and 55 dBA for non-inverter driven equipment as measured at the property line if a solid barrier at the property line is present (fence, wall or other sound attenuating shielding is in place, measured on the opposite side of the barrier).

1.2.3 Aesthetic Screening and Acoustic Shielding

Allow mechanical equipment to be installed within the first 5 feet from the building edge of the front or rear setback with appropriate aesthetic screening to maintain visual requirements and dBA levels at the property line or back of the walk (edge of public access). A unique use of fencing used as screening is shown in Figure 6. Not all aesthetic or visual screening provides adequate acoustic or noise shielding.

Figure 6: Equipment Screening

1.2.4 Exceptions and Variances

Examples of potential variances and exceptions allowed under certain conditions include:

1. Hardship variance: If the property owner can provide reasonable evidence that without the variance, installation of mechanical equipment would be either impossible or unreasonably costly (need to define parameters), allow for variance from ordinance thresholds if shown the variance will not negatively impact adjacent properties or the public right-of-way.
2. Setback exceptions: As described in Section 2.2.1, allow for installation of specific electrical equipment (condensers) within setbacks if the property owner can provide reasonable evidence that no other location exists.

Section 2: Specific Recommendations and Examples

Model noise, setback and screening/shielding ordinances are provided below for review and inclusion into code updates. This language is not meant to be exhaustive but rather to provide a starting point for ordinance changes to still meet public protection requirements while increasing options for siting equipment.

2.1 Noise Ordinance

Definitions apply to all 3 examples provided below:

"Decibel (dBA)" means a unit measuring the amplitude of sound or noise, weighted to the range of human hearing (A-weighting scale on a sound level meter).

"L_{30}" means the maximum noise level to be exceeded no more than thirty percent (30%) over the cumulative period.

"L_{50}" means the maximum noise level to be exceeded no more than fifty percent (50%) over the cumulative period.

"Noise level" means the measurement of sound in decibels (dBA) obtained by using a sound level meter at slow response.

2.1.1 Noise Ordinance Example 1

Successfully implemented in several cities, including Ashland, Oregon and in Gilroy, CA; these thresholds use a cumulative period, such as 30% (L_{30}) of operating time at a specific noise level. This is an effective modification to existing code language and has the advantage of allowing temporary fluctuations while still keeping overall thresholds within accepted bounds.

It shall be unlawful to generate noise within the city limits that exceeds the limits established in this section.

1) *Maximum Outdoor Noise Levels*
    a. *Mechanical Equipment Noise Impacting Residential Properties. Fixed-source outdoor mechanical or electrification equipment (e.g., pool, spa, air conditioning or similar equipment) is limited to a maximum of:*
        i. *Sixty-five (65) dBA as measured at the residential property line or seventy (70) dBA (L_{50}) measured at the residential property line. Such noise is limited to the hours of 7:00 a.m. – 10:00 p.m.*
        ii. *Sixty (60) dBA as measured at the residential property line or sixty-five (65) dBA (L_{30}) measured at the residential property line. Such noise is limited to the hours of 10:00 p.m. – 7:00 a.m.*

2.1.2 Noise Ordinance Example 2

Similar to the cumulative reporting example 1, this example 2 includes building type and proximity to major transportation corridors. Providing guidance by building types allows for flexibility.

1) *Residential Noise Limits*
    a. *Fixed-source outdoor mechanical or electrification equipment (e.g., pool, spa, air conditioning or similar equipment).*
        i. *Operational noise shall not exceed sixty (60) dBA during nighttime or sixty-five (65) dBA during daytime hours at any point on the property line of the adjacent single-family or duplex uses.*
        ii. *Operational noise shall not exceed sixty (60) dBA during nighttime or sixty-five (65) dBA during daytime hours on the primary useable open space of multi-family uses.*
        iii. *Operational noise shall not exceed sixty (60) dBA during nighttime or seventy (70) dBA during daytime hours on the primary useable open space of residential uses located along major transportation corridors (freeways, expressways, arterials, and rail lines) or mixed-use residential properties.*

2) *Exceptions to Residential Noise Limits*
    a. *Operational noise for residential air conditioners shall not exceed sixty-five (65) dBA for a cumulative period of no more than 30% (L_{30}) of nighttime hours and shall not exceed seventy (70) dBA for a cumulative period of no more than 50%(L_{50}) of daytime hours.*

2.1.3 Noise Ordinance Example 3

Successfully implemented in Palo Alto, higher allowable noise levels for inverter-based condenser units promote more energy efficient equipment with quieter operation. Additionally, a table of minimum setbacks from the receiving property line simplifies equipment selection and enforcement.

1) *Exterior noise limits.*
    a. *Mechanical or electrification equipment shall be deemed to comply with this noise ordinance if the equipment complies with the maximum equipment sound levels and is placed at the setbacks established in Table 1 - Setback Requirements.*

Table 1: Sample Setback Requirements

Equipment Sound Level (dBA)	Equipment Sound Level (dBA) for Inverter Equipment	Minimum Setback from Receiving Property Line (ft.)
55	60	3
57	63	4
59	64	5
61	65	6
62	66	7
64	68	8
65	69	9
66	71	10

2.2 Setbacks

Similar to the Cities of Campbell, Milpitas and Mountain View, requiring a three-foot setback for mechanical equipment with exceptions for encroachments will allow for streamlined permitting.

2.2.1 Mechanical Equipment Setback Example

1) *Mechanical or electrification equipment, including, but not limited to, air conditioner units, can encroach into the required side or rear yard setback but must be at least three (3) feet from the property line unless otherwise approved, in writing, by the local Building Official. No mechanical equipment can be located within the front yard setback or be visible from the public street.*
2) *Exceptions to the setback line requirements are as follows:*
    a. *Mechanical or electrification equipment may be located in a street-side yard setback but must be within a fenced yard consistent with fence setback requirements and traffic safety visibility area(s).*
    b. *When an acceptable side or rear yard location is not available, mechanical equipment may encroach into the required front and side yard setback so long as it is properly screened from view from a public Right of Way (ROW), adheres to the city mechanical equipment noise ordinances and written approval has been obtained from the local Building Official.*

2.3 Screening or Shielding

Simple and effective guidance for screening/shielding (similar to those implemented in Morgan Hill and Mountain View, CA) allow for both noise and aesthetic concerns to be addressed through mitigations.

2.3.1 Screening Mechanical Equipment from Public (ROW) View

1) *Roof- or ground-mounted mechanical or electrification equipment, including, but not limited to, air conditioning units, shall be visually screened from public view. When feasible, roof-mounted mechanical equipment shall be incorporated into the roof design in such a way that it becomes an integral part of the architecture or is concealed from view. Replacement of existing equipment shall trigger this requirement. Mechanical equipment shall be screened as follows:*
    a. *Acceptable screening methods include, but are not limited to, architectural elements, fences and landscaping.*
    b. *Screening or shielding shall not inhibit the proper, safe operation of the mechanical equipment, nor shall it encroach into the required clearances for service and operation, as specified by the manufacturer*.

Section 3: Additional Resources

The following sections are provided as reference information and to compile research findings for cities evaluating these updates. For all thirteen member agencies, code language was reviewed and sited. Ordinance documents from three communities (Menlo Park, Palo Alto and Ashland) that recently passed codes related to noise, setbacks and aesthetics are included.

The key findings from relevant code inquiries, important contextual references and technical data that informed the recommendations and form the basis of the model ordinance language. Information was acquired through four primary activities: 1) Evaluating model communities, 2) Conducting stakeholder interviews to gain local perspectives and insights, 3) Reviewing staff reports, presentations and local authority having jurisdiction's (AHJ) municipal codes and ordinances and 4) reviewing equipment manufacturers specifications and requirements.

3.1 Research Findings Key Takeaways

Key findings are summarized below. Emphasis is placed on challenges facing the siting of new mechanical equipment in residential retrofit applications.

1) There are discrepancies among member agencies in allowable noise levels (dBA) and the published peak levels from manufacturers, as illustrated in Figure 7.
    a. Thresholds for member agency ordinances ranged from 40 dBA to 65 dBA.
    b. The rated dBA levels for manufacturers reported at 3 feet away ranged from:
        i. Low-profile side-discharge "suitcase" style condensers: Average of 58 dBA

ii. Traditional vertical discharge "cube" style condensers: Average of 74 dBA

c. It is uncommon for the noise of a new heat pump sited near the property line to affect the neighboring indoor occupants when their windows are closed. Older existing units have higher dBA levels, which leads to this common misconception.

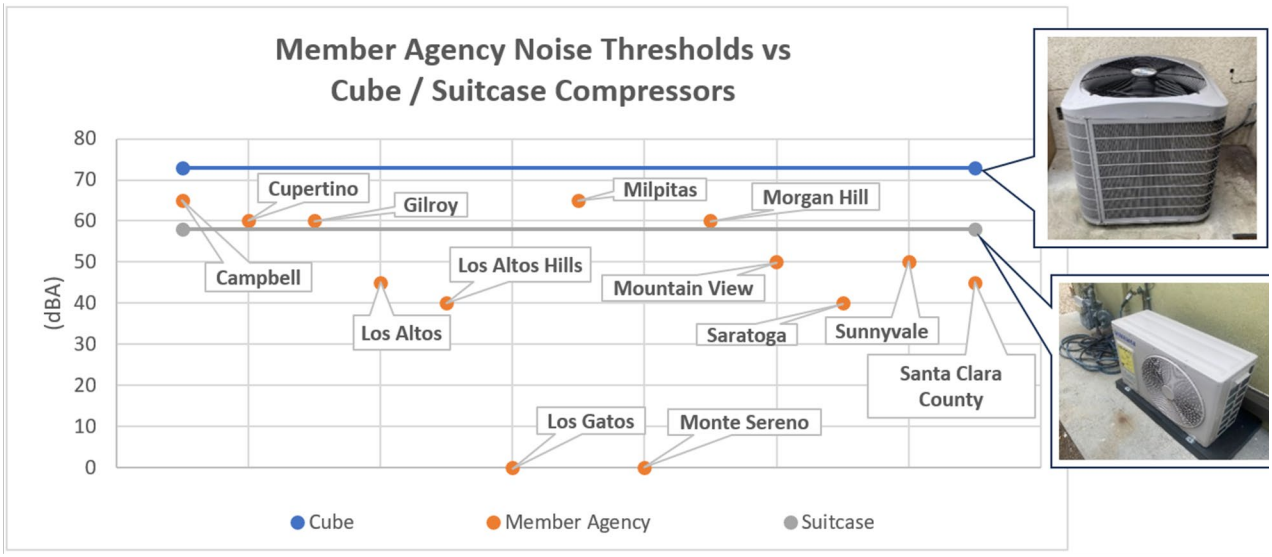

Figure 7: Noise Thresholds and Compressor Types

2) Equipment and building setback requirements are typically defined in zoning ordinances and codes, planned development guidelines and fire/life safety regulations. Mechanical equipment minimum setback of 5 feet from the property line was the most common, with 3 feet being the minimum allowed by some municipalities to allow for adequate utilized for ingress or egress.
3) Several zoning ordinances and codes included language around shielding mechanical equipment from "public view." Public view in this context is defined as view from a public Right of Way (ROW). Specifics varied from municipality to municipality.
4) When considering municipal codes, building codes, ordinances and manufacturer instructions, viable locations for installing heat pump condensers are limited unless the dwelling wall is setback at least 7 feet from the property line on the back or side yard. This 7-foot dwelling setback allows for the back or side yard to accommodate the size of a 3-foot side condenser, the equipment manufacturer's required clearance from the dwelling for proper airflow, and the minimum 3-foot setback requirement from the property line. This issue is exacerbated in areas with site-specific building constraints, such as multi-tenant buildings where condensate/refrigerant line-set may cross property boundaries, attached residences and sites with minimal private yards.
5) While many agencies are aware of the growing need for heat pump installation, few have found adequate compromises for space-constrained properties. There is

some concern about relaxing mechanical equipment design guidelines, with some agencies citing public perception and the potential for increased noise complaints.

6) Many agencies cite understaffing as a barrier to prioritizing code modifications, with planning and building officials struggling with existing workloads. Another barrier cited was the complexity of coordinating planning and building departments, the public engagement process and city council/board of supervisor's approval. Several agencies have observed increased issues with siting mechanical equipment in permit submittals.
    a. Local building stock plays a more significant role than population density alone. For example, Sunnyvale did not cite location of mechanical equipment as an issue, whereas Palo Alto did, yet Sunnyvale's population density (6,800/Sq. Mile) is more than double Palo Alto's (2,871/Sq. Mile).
7) Several cities in the US have already proposed or implemented specific policies. These will be reviewed and incorporated as appropriate into the draft guidelines. These cities include Palo Alto, CA; Ashland, OR Seattle, WA; and various cities across the United Kingdom.
8) There is little empirical evidence regarding the prevalence of customer complaints related to condenser noise or visual aesthetics. Additional research into public noise complaints would be required to better understand public perception.

3.1.1 Noise Thresholds

1) Noise is defined as sound typically received as excessive, disturbing or a nuisance. Noise levels are measured in decibels (dB). To better relate noise levels to human hearing, dBs are typically adjusted using "A-weighting" (dBA).
2) Thresholds differ among member agencies and may depend on:
    a. Time of day
    b. dBA above ambient levels versus absolute levels
    c. Land use (zoning)
    d. Inverter based condenser units versus one and two-speed units
3) Typical sound from a condensing unit is equivalent in dBA levels to normal conversation (see Figure 8). This is an important reference point when considering the impact of noise ordinance modifications.

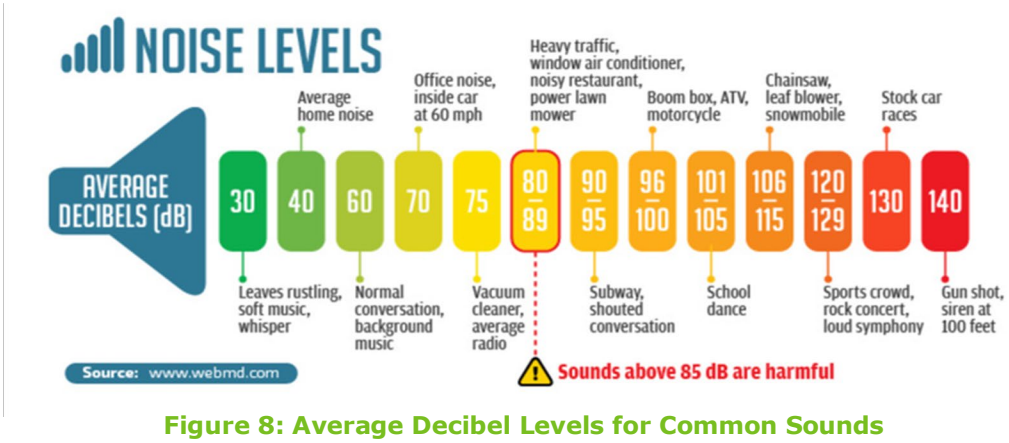

Figure 8: Average Decibel Levels for Common Sounds

3.1.2 Setbacks

1) Setback is defined as the minimum distance of a building edge or equipment from adjacent property line.
2) Minimum setbacks range from 3- to 5-foot.
3) Some agencies do not specify setbacks directly. Where not specified zoning requirements or manufacturer requirements apply.
4) Egress requires 36-inch net clear space between equipment and fences or other obstructions.
5) A table of allowable noise levels at the property line, the distance from the property line and the maximum noise level of the equipment can be found here.

3.1.3 Shielding or Screening

1) Shielding is defined as a physical barrier to reduce noise.
2) Screening is defined as a physical barrier to screen from public view.
3) Consistently required to be "screened from view from a public right of way (ROW)".
4) Both screening and shielding materials may be walls, fencing or landscaping.
5) AC screens or shields are often required when the unit is visible from a public ROW (e.g., from the front yard setbacks and rooftop installations) or when installed on the roof. This presents a challenge when locating wall-mount suitcase units in multi-family or multi-story applications.
6) Language is often vague, referring to "public view" and "screened from view." This document interprets this as view from a public Right of Way (ROW).
7) Screening/Shielding height may be impacted by the line of site requirements in municipal codes.

3.2 Additional Findings

3.2.1 Public Perception

A comprehensive planning report on air source heat pumps (ASHPs) from the United Kingdom published in 2023[1] summarizes four studies conducted on public perception of ASHPs (see Figure 9) It should be noted that the studies did not distinguish between condenser noise and interior noise for inside equipment. Some relevant conclusions from the paper are:

1) Public acceptance of condenser noise was high due to its prevalence in Europe.
2) Perception of noise as a disturbance was higher in multi-unit buildings where condensers were co-located in confined areas.
3) In urban areas, ambient noise from traffic, public streets and neighbors were of greater concern.

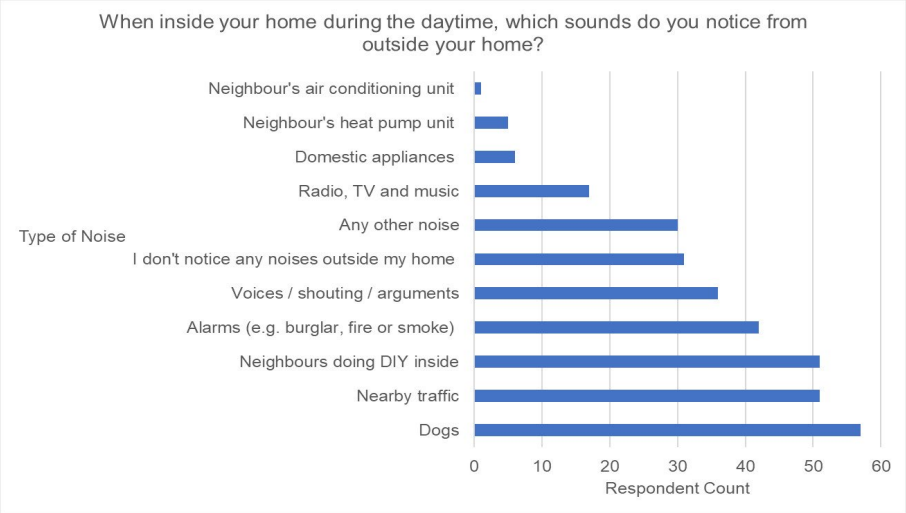

Figure 9: Survey of Noise Concerns[2]

3.2.2 Exemptions and Exceptions for Condensing Units

In interviews and documentation review, exceptions to language in municipal codes and noise ordinances were mentioned. Further investigation into this area is needed, but findings related to this issue include:

1) The City of Palo Alto[3] recently adopted noise ordinance allows for higher allowable noise levels for inverter based condenser units.
2) The United Kingdom study calls for exceptions to encroachment or equipment under certain conditions.
3) In all cases, AHJ staff approval is required before permit issuance. Measurements or manufacturer testing data may be required for submission before approval.

[1] DESNZ Research Paper Number 2023/046. Final Report. "Review of Air Source Heat Pump Noise Emissions, Permitted Development Guidance and Regulations"
[2] DESNZ Research Paper Number 2023/046. Final Report. "Review of Air Source Heat Pump Noise Emissions, Permitted Development Guidance and Regulations" pg. 30
[3] City on Palo Alto Chapter 9.10 NOISE

3.3 Building Codes, Manufacturer Instructions, and Ordinances

The following summarizes critical location and clearance requirements for heat pumps and condensers. It includes citations from:

- Existing building code requirements (CA Building, Mechanical and Energy Codes)
- Manufacturer instructions for both "cube" and "suitcase" style condensing units
- Manufacturer specifications

3.3.1 Heat Pump/Condenser Clearance Requirements

1) Minimum clearance between the heat pump and the adjacent structure, wall or obstruction shall be:
    a. 5 feet from clothes dryer moisture exhaust (2022 California Energy Code §150.0(h)3)
    b. 3 feet from gas meter set assembly (PG&E Electric & Gas Service Requirements 2022-2023 – Greenbook Manual, Section 2.4.2, Figure 2-21)
    c. 4 feet above the unit (manufacturer instructions)
    d. 24 inches on sides containing service and access panels (varies by manufacturer instructions)
    e. 12 inches on all other sides (varies by manufacturer instructions)
2) Outdoor condensers shall rest on a concrete or other approved base extending at least 3 inches above adjoining ground level (California Mechanical Code 904.3.1.1).
3) Required clearance from the property line ranges from 3 to 10 feet, depending on the AHJ (multiple member agencies).
4) Minimum clearance between the heat pump and the adjacent structure/wall/obstruction shall follow the manufacturer's instructions (2022 California Plumbing Code, 504.3).

3.3.2 Equipment Noise and Manufacturer Specifications

RHA reviewed dBA levels from specifications sheets for 30+ models from eight major manufacturers of HVAC condenser units. In addition, RHA reviewed the published dBA levels of 20 heat pump water heaters from three manufacturers. A summary of the listed sound levels of mechanical equipment in Table 2 below.

> Note: *Listed dBA levels are shown at high capacity and/or full power. These levels represent the maximum noise level of the unit, typically present during the start-up phase of the equipment. Manufacturers do not list average noise levels as these levels vary based on mounting, equipment cycling duration and other factors.*

Table 2: Equipment Noise Levels

Compressor Type	Form Factor	dBA Range*	Average Max dBA*
Inverter	Suitcase	48-60	54.8
Inverter	Cube	48-75	69
Single/Two Speed	Cube	51-76	74

*Noise levels are reported at three feet from the unit.

Real world operating dBA levels vary widely. These levels are influenced by equipment accessories and external factors as described below.

1) Manufacturers offer noise attenuation equipment including:
    a. Isolation dampers or pads
    b. Sound attenuation blankets
    c. Shields
    d. Fan blade dampers
2) External factors influencing equipment operating dBA levels include:
    a. Age and condition
    b. Unit size and capacity
    c. Compressor type and/or fan speed
    d. Installation quality
    e. Operating mode (variable speed, single speed)
    f. Inverter driven*

    Note: *Inverter heat pumps, also known as variable-speed heat pumps, have several benefits over traditional systems, including energy efficiency, faster heating and cooling[4], quieter operation and more consistent temperatures[5]*

3.4 Contractor Design Recommendations

1) Select the quietest equipment possible and utilize the manufacturer's noise control packages where applicable.
2) Utilizing landscaping to dampen sound
3) Increasing adjacent fence height (when regulations allow)
4) Locate equipment as far as possible from adjacent property lines or in areas shielded by structures or noise barriers. Acoustical enclosures may not always be feasible noise control options as airflow requirements, setback requirements or other constraints may limit their effectiveness.
5) Orient the equipment to take advantage of the directionality of the noise source (i.e., point the equipment away from known bedroom or other windows that are commonly open).

3.5 Model Community Ordinances

Below are examples of ordinance language from Menlo Park, Palo Alto and Ashland, all of which recently modified their codes for mechanical equipment associated with beneficial decarbonization. These communities embody ways codes can be successfully modified to support mechanical equipment associated with beneficial decarbonization.

The Menlo Park zoning ordinance may be found here: Title 16 ZONING
The City of Palo Alto noise ordinance may be found here: Chapter 9.10 NOISE
The Ashland, OR noise ordinance may be found here: Chapter 9.08 NUISANCES

[4] Mitsubishi Heating and Air, https://www.mitsubishicomfort.com/articles/keep-warm-this-winter-inverter-technology-for-any-climate
[5] Advantage Heating and Air, https://advantageheatingllc.com/learning-center/inverter-heat-pump/

Section 4: Appendix

This is the Appendix for Considerations and Alternatives for Siting Outdoor Equipment documentation.

4.1 References

Department of Energy. Office of Energy Efficiency and Renewable Energy. "Residential HVAC Installation Practices" 2018.

Air-Conditioning, Heating & Refrigeration Institute. "Standard for Application of Outdoor Unitary Equipment A-Weighted Sound Power Ratings." 2023.

Echo Barrier. "The Decibel Scale Explained" 2019 www.blog.echobarrier.com/blog/the-decibel-scale-explained

Department for Energy Security & Net Zero. United Kingdom. DESNZ Research Paper Number 2023/046. Final Report. "Review of Air Source Heat Pump Noise Emissions, Permitted Development Guidance and Regulations" 2023.

Mitsubishi Heating and Air, https://www.mitsubishicomfort.com/articles/keep-warm-this-winter-inverter-technology-for-any-climate

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Ashland City Charter. "An Ordinance Relating to Noise and Heat Pumps or Mechanical Devices Amending AMC 9.08.170, 9.08.175, AND 15.04.185" 2023.

Paz, Ori. BAYREN Forum. "Removing Known Barriers: Changing Zoning to Help Electrify Existing Homes" December 2023.

City of Campbell. https://www.campbellca.gov/120/Building-Inspection-Division

City of Cupertino. https://www.cupertino.org/our-city/departments/community-development/building

City of Gilroy. https://www.cityofgilroy.org/209/Building-Safety-Division

City of Los Altos. https://www.losaltosca.gov/development-services/page/building-services

Town of Los Altos Hills. https://www.losaltoshills.ca.gov/292/Building-Department

Town of Los Gatos. https://www.losgatosca.gov/220/Building

1) City of Milpitas. https://www.milpitas.gov/195/Building-Permits-Resources

City of Monte Sereno. https://www.montesereno.org/2152/Building-and-Planning-Departments

City of Morgan Hill. https://www.morganhill.ca.gov/150/Building-Fire-Prevention

City of Mountain View. https://www.mountainview.gov/our-city/departments/community-development/building-fire-inspection/building-construction

City of Saratoga. https://www.saratoga.ca.us/151/Building-Division

City of Sunnyvale. https://www.sunnyvale.ca.gov/business-and-development/planning-and-building/building-and-fire-codes

Santa Clara County. https://plandev.sccgov.org/how/apply-permit/building-permit

4.2 Model Communities

Municipal codes and existing and proposed ordinances for mechanical equipment related to noise, setbacks and aesthetics were reviewed to identify how codes were modified to support mechanical equipment related to beneficial decarbonization. Table 3 summarizes the results of 5 of the 15 communities outside of SVCE territory reviewed.

Table 3: Model Communities

City	Noise	Shielding	Setbacks	Reference	Note
Menlo Park, CA	50 dBA during night, 60 dBA during day	Landscaping or fencing required	Equipment enclosures must be at least 3 feet from any side or rear lot line	Title 16 (16.60.010) – Screening & Setback Title 8 (8.06.030) – Noise	Level and day and night
Palo Alto, CA	43 dBA for non-inverter based at property line, 45 dBA for inverter based at property line	Required to be obscured from public view	Variable 3 to 34 feet from property line	Chapter 9.10 (Noise) Title 18 (Zoning)	Higher allowable noise levels for Inverter based condenser units
Ashland, OR	45 dBA for younger than 1981, 50 dBA for older than 1981 during day at property line	None	Mechanical equipment shall not be located between the main structure on the site and any street adjacent to front or side yard	Ashland Muni Code section 9.08.170 9.08.175 [Heat Pumps] Ashland Muni Code Part 18.2	Vintage and level
San Mateo County, CA	50 dBA at night, 55 during the day at property line (7 a.m. to 10 p.m.)	Still under review	Still under review	Chapter 4.88.330 – Noise Control	Level and day and night
Coral	55 dBA at night,	Screened to	25 feet front	Article VI. Noise	Level and day

City	Noise	Shielding	Setbacks	Reference	Note
Gables, FL	60 during day at property line (9 a.m. on weekends/ 7 AM on weekdays to 11 p.m.)	100% opacity	15 feet side street 10 feet rear 20 feet interior side	Article 2. Zoning Districts	and night

4.2.1 Menlo Park

Menlo Park has building codes that encompass electrical equipment like heat pumps. Noise from such equipment must not surpass 50 dBA at night or 60 dBA during the day. The equipment should be housed in an enclosure for protection, noise reduction and aesthetics. Enclosures must not extend more than 4 feet into any required side or rear yard setbacks and must be at least 3 feet from any side or rear lot line. If equipment is adequately screened by landscaping or fencing within the front, side or rear lots and meets setback requirements, enclosure exemptions may apply.

The City of Menlo Park has successfully revised its zoning ordinance to facilitate the beneficial decarbonization of existing homes. Author Ori Paz recently presented the details of this amendment process at a BayREN Forum[6].

The amendments focused on altering the city's setback and garage clearance requirements to accommodate mechanical equipment better. By adjusting these requirements, they increased the available locations for siting mechanical equipment. The garage clearance modifications also allowed installing heat pump water heaters. This amendment process, which took approximately 18 months to complete, began with defining the scope of the ordinance changes and concluded with an ordinance amendment approval process. Here are some key insights from this process:

- Teamwork and stakeholder buy-in are essential.
- Building a team and fostering collaboration takes time.
- Zoning is a technical field; it's beneficial to collaborate with planners and engineers.
- Workshops should be conducted with those who will implement the changes.
- "Design with the end in mind" is a good policy. It is useful to keep a running draft of the ordinance and consider its implementation throughout the process.
- The public process should be designed into the timeline.
- Work does not occur in isolation. For example, this process ran parallel to the Housing Element update to the General Plan. Cross-regulation impacts must be considered.
- A city attorney should be consulted throughout the process.
- The language and process should be simplified for external stakeholders to provide relevant insights.

[6] Paz, Ori. BAYREN Forum. "Removing Known Barriers: Changing Zoning to Help Electrify Existitn Homes" December 2023.

4.2.2 Palo Alto

The City of Palo Alto recently made changes to their noise ordinance specific to mechanical equipment. It includes a table with permissible sound levels for equipment relative to its distance from the property line as well as higher allowable noise levels for inverter-based condenser units. The Palo Alto noise ordinance may be found here: Chapter 9.10 NOISE. Palo Alto's adopted noise ordinance is somewhat unique because it separates the city into two "noise" zones with varying noise levels for each part of the city.

All mechanical equipment in Palo Alto must be hidden from public view using screens, landscaping or architecture. Residential noise-producing equipment can be located anywhere on the property but must adhere to residential zoning requirements for front yard setbacks for building and building systems. Properties bordering a side street must maintain a minimum 10-foot setback from the street.

Key parts of the ordinance include section 9.10.030 Residential property noise limits.

> *(a) No person shall produce, suffer or allow to be produced by any machine, animal or device, or any combination of same, on residential property, a noise level more than six dB above the local ambient at any point outside of the property plane, except as modified in (c) below.*
>
> *(b)No person shall produce, suffer or allow to be produced by any machine, animal, or device, or any combination of same, on multi-family residential property, a noise level more than six dB above the local ambient three feet from any wall, floor, or ceiling inside any dwelling unit on the same property, when the windows and doors of the dwelling unit are closed, except within the dwelling unit in which the noise source or sources may be located.*
>
> *(c) Electrification Equipment shall be deemed to comply with this Section 9.10.030 if the equipment complies with the maximum equipment sound levels and is placed at the setbacks established in Table 6 - Setback Requirements. As an alternative to compliance with Table 6, a property owner may utilize the limits set forth in subsections (a) and (b) of this Section 9.10.030 if those provisions would be more permissive.*

Table 4: Palo Alto Setback Requirements-Extract

Equipment Sound Level (dBA) West of Foothill Expressway	Equipment Sound Level (dBA) East of Foothill Expressway	Equipment Sound Level (dBA) West of Foothill Expressway for Inverter Pumps	Equipment Sound Level (dBA) East of Foothill Expressway for Inverter Pumps	Minimum Setback from Receiving Property Line (ft.)
43	53	45	55	3
44	54	46	56	4
45	55	47	57	4
46	56	48	58	5
47	57	49	59	5
48	58	50	60	6
49	59	51	61	7
50	60	52	62	7
51	61	53	63	8
52	62	54	64	9
53	63	55	65	10

4.2.3 Ashland, Oregon

In Ashland, Oregon, a draft ordinance codified in Sections 9.08.170 to 9.08.175 was recently approved. It sets noise levels based on equipment age, with 45 dBA allowed for equipment made after 1981 and 50 dBA allowed for equipment made in 1981 or earlier, measured at the property line during the day.

Mechanical equipment must not be situated between the main structure and any adjacent street. The equipment's location should be chosen to keep it out of sight from neighboring public streets. While there are no strict rules for shielding or screening, enclosures for mechanical equipment must not exceed permitted fence heights and must comply with local noise regulations.

The City of Ashland, Oregon, recently sought to amend its ordinances concerning noise levels associated with heat pumps and other mechanical devices. The proposed ordinance introduced definitions for prohibited noise, specifically including heat pumps and mechanical devices, and set noise thresholds.

Ashland adopted a straightforward approach for equipment placement and established a single noise level limit at the property line. This limit is based on the age of the equipment and the noise level produced in any given hour. For equipment manufactured after 1981, the following noise level policy applies:

Any source of noise which exceeds the following standards is considered a public nuisance:
1. Decibel Noise Standards[7]
Allowable Statistical Noise Levels in any One Hour:

7 a.m. to 9 p.m.	*9 p.m. to 7 a.m.*
L50--50 dBA	*L50--45 dBA*
L10--55 dBA	*L10--50 dBA*
L1--60 dBA	*L1--55 dBA*

Where:
L50 = noise level exceeded 50% of the time
L10 = noise level exceeded 10% of the time
L1 = noise level exceeded 1% of the time

4.2.4 San Mateo County

San Mateo County has a noise control ordinance for the placement of mechanical equipment but no additional rules for screening or setbacks. The county uses a cumulative number of minutes and day/night thresholds to set noise limits. For example, a maximum of 55 dBA is allowed for a cumulative amount of 30 minutes in any one-hour time period during day (7 a.m.-10 p.m.), and a maximum of 50 dBA is allowed during the night (10 p.m.-7 a.m.).

4.2.5 Coral Gables, Florida

Coral Gable, Florida, permits noise levels for heat pumps of 55 dBA at night and 60 dBA during the day at the property line (7 a.m.-11 p.m., 9 a.m.-11 p.m. on weekends).

Coral Gables requires that all mechanical equipment be screened to 100% opacity and comply with the setbacks required by the zoning ordinance. The setbacks are as follows for single-family homes: 25 feet from a principal front, 20% or 5 feet from a side interior, 15 feet from a side street, 10 feet from a rear, 10 feet from a rear at an alley, and 35 feet from a waterway.

[7] Ashland City Charter. "An Ordinance Relating to Noise and Heat Pumps or Mechanical Devices Amending AMC 9.08.170, 9.08.175, AND 15.04.185" 2023.