Port of Seattle®
SEATTLE-TACOMA INTERNATIONAL AIRPORT

# SEATTLE-TACOMA INTERNATIONAL AIRPORT

## Sound Insulation Repair and Replacement Pilot Program: Assessment Technical Report

**JANUARY 2025**

# SEATTLE-TACOMA INTERNATIONAL AIRPORT

## Sound Insulation Repair and Replacement Pilot Program: Assessment Technical Report

**JANUARY 2025**

**PREPARED FOR**

Port of Seattle
Seattle-Tacoma International Airport

Port of Seattle
SEATTLE-TACOMA INTERNATIONAL AIRPORT

**PREPARED BY**

Environmental Science Associates

ESA

**www.portseattle.org**

# TABLE OF CONTENTS

## APPENDIX A. SURVEY MATERIALS



## APPENDIX B. SURVEY RESULTS



## APPENDIX C. LIFE EXPECTANCY OF BUILDING MATERIALS REFERENCES



## APPENDIX D. SOUND INSULATION TESTING MATERIALS



## FIGURES

## TABLES

SECTION

# 1

# INTRODUCTION

# INTRODUCTION

## 1.1 LIMITED PILOT PROGRAM AND ASSESSMENT OVERVIEW

On February 27, 2024, the Port of Seattle (Port) Commission directed Port staff to conduct an assessment regarding the effectiveness of previously installed, federally funded sound insulation packages in communities around Seattle-Tacoma International Airport (SEA Airport)[1]. The Commission has received feedback from constituents that Port funded sound insulation packages may no longer be as effective due to age and durability. The purpose of the assessment is to understand whether previously installed sound insulation packages may no longer meet the Federal Aviation Authority (FAA) established interior noise standard of less than 45dB DNL and whether such packages may need repair or replacement. This effort was conducted in a deliberate and inclusive manner. The outcome of the assessment would then help define and understand the factors for the potential scale for a limited Pilot Program. These factors included the purpose, eligibility criteria, boundary, testing, funding, and an equitable prioritization process. Results from the assessment are to be presented to the Commission in January 2025.

An initial commitment of $5 million dollars has been authorized to be used in the limited Sound Insulation Repair and Replacement Pilot Program (Pilot Program), which may cover sound insulation design and construction costs. The Commission has also set forth a goal to begin the limited Pilot Program in the year 2025. It is important to note that this program is not associated with the existing SEA Sound Insulation Program, or the Part 150 program that is ongoing at the onset of this assessment.

1 Sound Insulation Repair and Replacement Pilot Program Order.pdf (portseattle.org)

This assessment involved outreach to, and collection of information from, residents via a comprehensive survey, acoustic testing and field assessment of a sampling of residences, analysis of survey and acoustic testing/field assessment results, and a report summarizing the process and conclusions associated with the assessment. The assessment focused on the approximately 3,200[2] single-family residences previously sound insulated within the 2014 SEA Noise Remedy Boundary, and was completed by conducting the following:

- Comprehensive survey of homeowners
- Review and analysis of survey responses
- Selection of homes for acoustic testing and field assessment
- Overview of Building Materials
- Acoustic testing - methodology and results
- Field assessment
- Conclusions and considerations

These steps are described in detail in the sections that follow, with the overarching purpose of this technical report to review and evaluate survey, acoustic testing, and field assessment results to help inform decision-making related to the limited Pilot Program.

2 A total of 3,205 homeowners received sound insulation packages within the 2014 SEA Noise Remedy Boundary. However, several homes have since been identified as demolished resulting in fewer homeowners included in this assessment.

SECTION

# 2

# COMPREHENSIVE SURVEY

# COMPREHENSIVE SURVEY

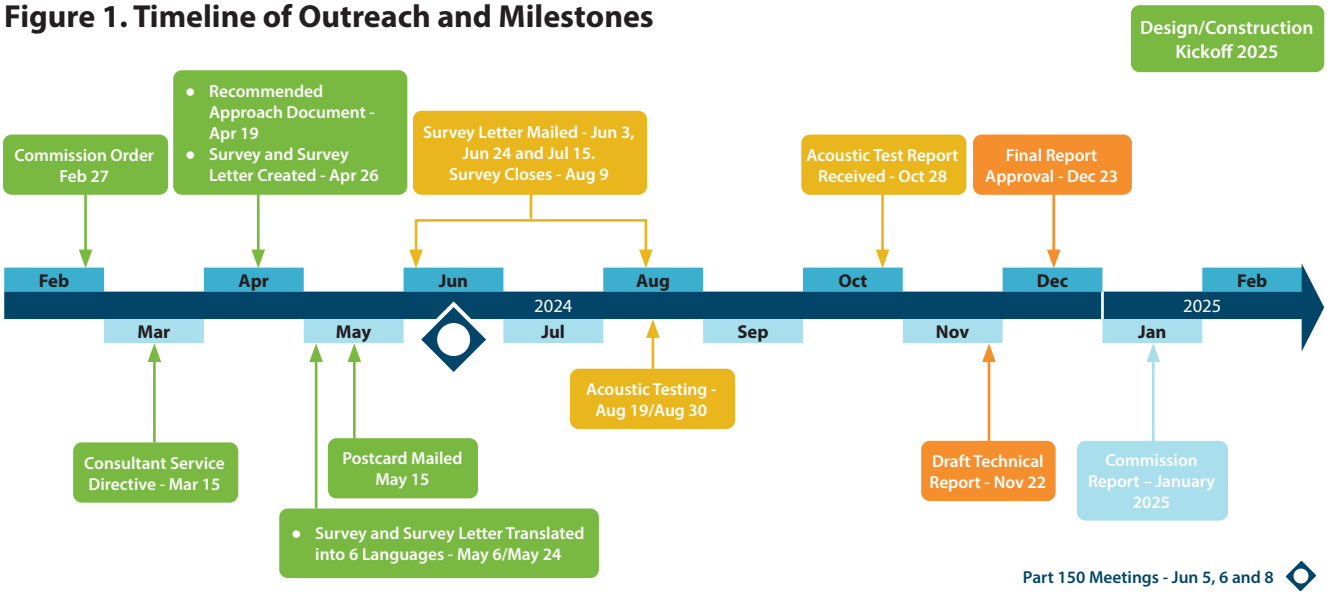
## 2.1 SURVEY OUTREACH

A survey was conducted of all residences that previously received sound insulation treatments and are located within the 2014 SEA Noise Remedy Boundary. The timeline of survey outreach and major milestones are found in **Figure 1**.

### 2.1.1 Postcards

In May 2024, the Port mailed a postcard to each resident that lived at a home that was sound insulated prior to 2015 and is within the 2014 SEA Noise Remedy Boundary stating, "Port of Seattle's Sound Insulation Pilot Program survey will be mailed to you in early June. We look forward to your response." In consultation with the Port's Office of Equity, Diversity, and Inclusion (OEDI) and SEA Airport's External Relations team, these sentences were translated within the same postcard into the Port's Tier 1 and Tier 2 languages.[3] The postcard provided a QR code and the assessments website address.

**Figure 1. Timeline of Outreach and Milestones**




3 Tier 1 and 2 languages consist of Spanish, Vietnamese, Somali, Korean, Amharic, and Chinese.

## 2.1.2 Survey Letters

Beginning in June 2024, the Port mailed a survey letter to each resident who lived at a home that was sound insulated prior to 2015 and located within the 2014 SEA Noise Remedy Boundary, explaining the purpose of the survey and providing access to the survey via a QR code and website. Each letter contained a unique passcode that was linked to the specific home address and only one response could be submitted per address. The survey letter was translated into the Port's Tier 1 and Tier 2 languages and contained within the same envelope.

The letter emphasized the importance of obtaining responses to better understand the existing condition of previously insulated homes and determine the feasibility of establishing a Sound Insulation Repair and Replacement Pilot Program. The survey was anticipated to take approximately 15 minutes to complete.

If a resident was unable to access the survey online, information was provided on how to contact the Noise Programs office so that a hard copy of the survey could be mailed. Residents could also request a translated hard copy of the survey into the Port's Tier 1 and Tier 2 languages.

The initial letter was sent on June 3, 2024, and was followed by two additional letters sent to residents who had not yet responded, on June 24, 2024, and July 15, 2024. The survey letter was mailed three times to obtain high participation and an increased response rate for the survey. The deadline for survey responses was August 9, 2024. A copy of the survey letter is provided in **Appendix A-2.**

## 2.1.3 Survey Questions

Residents who completed the survey online used the Port's Qualtrics web-based survey platform. Qualtrics offers a sophisticated and professional-looking web-based interface coupled with advanced backend functionalities. The survey was designed in consultation with numerous Port divisions, including OEDI. The survey was vetted with the Airport Working Group, Pilot Steering Committee, and StART Aviation Noise Working Group to solicit extensive feedback and refine questions.

The focus of the survey was to be an existing conditions assessment from the residents' point of view. Questions were created to quantify the number and types of common window and door conditions surrounding operation and appearance, even if those items were standard maintenance items. The survey also asked residents if they had replaced their initially installed windows or doors. Two open comment sections were included for residents to share additional comments and up to five photos in each section. To ensure understanding of three common glass conditions, the project team determined that photos should be added to both the survey and the website with detailed technical explanations **(See Section 2.1.4)**.

The survey did not ask any direct questions about ventilation systems as this is a unique site condition that is both difficult to answer and identify any trends in the response data. Notes on the ventilation system are included in the Field Assessment section. A copy of the survey is provided in **Appendix A-3**. Responses can be found in **Appendix B**.

## 2.1.4 Assessment Website

A tab was added to the Sound Insulation website to provide on-going updates for the assessment. The website assisted residents who would be participating in the survey by identifying common concerns that the Port has received feedback about from the community regarding the existing conditions of their sound insulation packages. It included descriptions and information about potential condensation, glass seal failures, and low emissivity (LoE) window coating concerns. The website format allowed for a more detailed description.

# CONDENSATION WEBPAGE

SOURCE: PORT OF SEATTLE, 2024

## Condensation

### What Is Condensation?

Is your glass "sweating" – is water beading or ice forming on the inside surface of your windows? There's a good chance that what you are seeing is condensation, a sign that there is excess humidity in your home. Humidity – water vapor mixed with air – is drawn to the coolest surfaces, such as your window. Cool air cannot hold as much moisture as warm air, so windows and doors often collect this moisture and make it visible. A surface that is cooler than room temperature is more likely to show condensation. Condensation is not a product defect. If you have excess condensation, please explore ways to limit humidity and regularly clean surfaces.

### What Causes Condensation?

Indoor moisture is caused by a variety of factors, including cooking, showering, running dishwashers, storing firewood, pets, fish tanks, plants, clothes dryers that are not vented properly, even breathing. Your new windows are most likely showing condensation more than your old ones because they are more airtight – less air is entering your home from the outside. The air leaking from older windows evaporated the moisture before it could collect.

### Why is condensation forming at the bottom of the window?

Each insulated unit is a sealed atmosphere, and the air in this atmosphere becomes layered, just as in any closed space. Warm air rises, and since humidity is attracted to cooler air, condensation will often show near the bottom of the glass.

# WINDOW GLASS SEAL FAILURE WEBPAGE

SOURCE: PORT OF SEATTLE, 2024

## Window Glass Seal Failure

Your windows have an insulated glass unit (IG) that consists of two panes of glass with a metal spacer in between them that are adhesively sealed to the spacer. If the adhesive seal breaks or releases, air and moisture can enter the space between the 2 panes of glass. When this happens, you might start to notice fogging, moisture and streaking between the panes of glass.

This defect is called a Seal Failure. Because this condition is in between the panes of glass, you are not able to wipe them away.

## LOW EMISSIVITY (LOE) WINDOW COATING DEFECT

SOURCE: PORT OF SEATTLE, 2024

**Low Emissivity (LoE) Window Coating Defect**

Your windows have an insulated glass unit (IG) that consists of two panes of glass with a metal spacer in between them that are adhesively sealed to the spacer. On the inner surface of the glass, a LoE coating is applied. A LoE coating is a microscopic, metallic oxide that is nearly invisible coating that help to improve the energy efficiency of windows by blocking part of the sun's heat in summer and reduces heat from escaping in winter.

If the LoE coating fails, you will start to see small spots appear in between the 2 panes of glass. Because this condition is in between the panes of glass, you are not able to wipe them away. Over time, the spots will grow as more of the microscopic, metallic oxide fails; the small spots will become larger areas over time.

## 2.1.5 Information Station at Part 150 Study Kickoff Meetings

In early 2024, the Port initiated a SEA Airport 14 CFR Part 150 Study (Part 150 Study) update. To introduce the Part 150 Study, its timeline, and opportunities for public involvement, the Port hosted public workshops at three separate locations near the Airport on June 5th, 6th, and 8th. Upon arrival, attendees were asked to sign in, given a handout describing the Part 150 process and a comment form and invited to place a sticker on a large map of the Puget Sound area to show where they live. Throughout the room, 22 boards were on display with detailed information on the Part 150 Study and other Airport projects/programs, including a station dedicated to the Sound Insulation Repair and Replacement Pilot Program.

The three workshops had nearly 150 attendees in total including community members, elected officials, and media/press. The team spoke with attendees at project display boards and comment stations and encouraged attendees to provide feedback by submitting verbal comments to a transcriber, a comment form, or the Part 150 website.[4] There were checkboxes on the Comment Form to gain a better understanding of community concerns. One of the most recurrent themes included in the written public comments was related to Port sound insulation packages. Comments included requests for the previously installed packages to be updated and/or reviewed, suggested changes to what is included in the packages, and questions about how packages are awarded.

4 https://seapart150.com/comments/

SECTION

# 3

# OVERVIEW OF BUILDING MATERIALS

# OVERVIEW OF BUILDING MATERIALS

## 3.1 RESEARCH ON BUILDING MATERIALS EXPECTED USEFUL LIFE

The Expected Useful Life (EUL) of building materials is a concept in construction and maintenance planning that refers to the estimated duration that a material or component will perform its intended function under normal conditions before needing significant repair or replacement. This estimation is based on various factors, including the material's inherent properties, environmental conditions, and the quality of installation and maintenance practices. This information is utilized by manufacturers to establish their warranty terms.

In 2006, The National Association of Home Builders (NAHB) updated its Study of Life Expectancy of Home Components by surveying manufacturers, trade associations, and researchers to develop information about the longevity of housing components.[5] The study stated that "Aluminum windows are expected to last between 15 and 20 years while wooden windows should last upwards of 30 years." A note stating that some components of a window may need replacement to achieve this EUL is included in the table pertaining to windows. This could include glass which the study noted has a 10+ year life expectancy.

In 2011, the U.S. Department of Community Affairs (DCA) published the EUL of building products in their 2011 Architectural Manual.[6] The EUL table is still utilized in multiple states, including Washington. The table notes exterior doors should be replaced with an EUL of 10-15 years. Windows (frame and glass) should be replaced in 20-30 years, storm/screens for windows in 10-20 years, and storm doors in 7-15 years depending upon application, maintenance, and repairability.

In 2014, Fannie Mae produced EUL tables as part of their Property Condition Assessment work.[7] The data presented in this document expanded the door category to include sliding glass doors and provided a EUL of 20-30 years. The EUL for windows (frame and glass) was determined to be 30 years, storm/screens for windows 10-15 years, and storm doors 7-10 years depending upon application, maintenance, and repairability.

5 https://www.reservedataanalyst.com/mt-content/uploads/2019/10/national-association-of-home-builders-life-expectancies.pdf (See **Appendix C-1**)
6 https://www.commerce.wa.gov/wp-content/uploads/2016/11/hfu-expected-useful-life-2011.pdf (See **Appendix C-2**)
7 https://multifamily.fanniemae.com/sites/g/files/koqyhd161/files/2019-08/4099f.pdf (See **Appendix C-3**)

The International Association of Certified Home Inspectors (InterNACHI) current Standard Estimated Life Expectancy Chart for Homes indicates aluminum windows EUL range from 15-20 years, vinyl/fiberglass window frames 20-40 years, double-pane glass 8-20 years and sliding glass doors 20 years (with roller replacement).[8] Additionally, their study finds that entry doors (slab) can last as long as the home, however this requires replacing of all gaskets and weatherstripping every 5-8 years. The chart notes that life expectancy varies with usage, weather, installation, maintenance, and quality of materials.

The building industry continues to innovate, and product evolution has improved the EUL in entry doors and vinyl/fiberglass window frames over time as presented in **Table 1**. As various governmental and trade organizations study EUL, they are looking at the functionality of more recent products. There were several consistent findings from these four studies ranging from 2006 to present that would represent products used in sound insulation programs prior to 2014.

Based on these studies the upper EUL of products used before 2014 were limited to 30 years or less. In the case of Aluminum windows, the EUL has remained constant at 15-20 years. Storm windows and doors as well as screens saw a 5-year reduction in EUL overtime and a maximum lifetime of 10-15 years. In the studies, glass/glazing has been viewed with a different, lower EUL than the window frame and is noted with an EUL of 8-20 years.

It is important to note that EUL's of windows focuses on structural integrity, functionality, and aesthetics. They do not account for the acoustic performance of the products, which can vary significantly based on material composition, installation methods, and environmental factors. The FAA commissioned a study through the Association of Clinical Research Professionals (ACRP) to evaluate the deterioration of sound insulation properties in 2013.[9] The report states that while building components and products may deteriorate over time, the reduced performance in noise reduction is not as noticeable. The study notes several factors which may cause issues with the sound insulation product. These include but are not limited to poor workmanship, incorrect installation, and lack of homeowner maintenance. **Section 4** discusses the acoustic performance of sound insulation window and door products.

Table 1. Expected Useful Life (EUL) Studies

| Product Type | 2006 NAHB | 2011 DCA | 2014 Fannie Mae | Current InterNACHI |
|---|---|---|---|---|
| Aluminum Window Frames and Components | 15-20 yrs | - | - | 15-20 yrs |
| Storm/Screen Windows | - | 10-20 yrs | 10-15 yrs | - |
| Glass/Glazing | 10+ yrs | - | - | 8-20 yrs |
| Wood Window Frames | 30 yrs | | | 30+ years |
| All Window Frames Range | - | 20-30 yrs | 30 yrs | - |
| Vinyl/Fiberglass Window Frames | - | - | - | 20-40 yrs |
| Storm Doors | - | 5-15 yrs | 7-10 yrs | - |
| Entry Door – Slab, No Hardware | - | 10-15 yrs | 20-30 yrs | 100 yrs |
| Sliding Doors – with Hardware Replacement | - | - | 20-30 yrs | 20 yrs |

SOURCE: NAHB, 2006; DCA, 2011; HUD, 2014; NACHI, 2022.

8 https://www.nachi.org/life-expectancy.htm (See **Appendix C-4**)
9 https://www.faa.gov/sites/faa.gov/files/2021-11/FAA-190312-007-Aging-Sound-Insulation-Report-to-Congress.pdf

### 3.1.1 Expected Useful Life of Sound Insulation Packages

There are approximately 3,200 single-family residences within the 2014 SEA Noise Remedy Boundary with sound insulation packages. Window and door products have been installed since 1986 and as such, a review of the EUL for these products is necessary to understand the basis of the survey responses and subsequent analyses.

**Table 2** summarizes the EUL of the various sound insulation packages within the 2014 SEA Noise Remedy Boundary. Based on various product types, the table outlines the range of EUL, the year of installation to reach its EUL in 2025, the percentage of product type that have reached their EUL relative to 2025, and the estimated total number of sound insulation products. Each year after 2025 more homes will have reached their EUL timeframe for vinyl frames, entry doors and other products not listed at 100%. Overall, **Table 2** outlines that most sound insulation products installed have or are close to reaching their EUL.

Sound insulation programs utilize products with higher acoustic ratings (e.g. windows and doors) than those used in standard construction. The glazing is typically a thicker, double-pane glass with storm window to enhance the acoustic performance. Insulated window frames are designed with fiberglass or vinyl to ensure they can withstand the elements and include advanced sealing technologies that reduce sound transmission through the window. As noted in the previous section, there is no indication that sound transmission characteristics impact the EUL of the product.

Acoustically treated products are not commercially available for homeowners and require custom design for each house. Most suppliers in this market segment require large minimum orders and seldom work directly with the public. Beyond replacement glass that may be locally sourced, most other parts and hardware are difficult to identify or source. When professional expertise is required, the cost of repairs can meet or exceed the cost of a complete replacement.

Warranties offered by the manufacturer and/or contractor may be past the expiration date. From available records, it appears that many of the warranties offered by product manufacturers were 10-years, other fixed-term or limited lifetime (to the original owner). From **Table 2** above, these warranties would have expired before the EUL for most of the installed building products occurred. In the case of Alpine Window packages, the warranties were voided when the manufacturer sold to Associated Materials through bankruptcy proceedings. The Port has not and does not provide warranties to Sound Insulation Program participants for products, equipment, or installation work.

Table 2. Expected Useful Life (EUL) of Products – 2025 Base Year Comparison

| Product Type | Range of EUL | Year Installed that Reach End of Useful Life by 2025 | Percentage of Product Past Expected Useful Life by 2025 | Estimated Number of Homes with Installed Packages |
|---|---|---|---|---|
| Aluminum Windows | 15-20 yrs | 2005 | 100% | 942 |
| Vinyl Window Frames | 20-30 yrs | 1995 | 38% | 846 |
| Glass/Glazing | 8-20 yrs | 2005 | 99% | 3,161 |
| Storm/Screen Windows | 10-15 yrs | 2010 | 99% | 3,174 |
| Entry Door - Slab but not Hardware | 20-30 yrs | 1995 | 48% | 1,545 |
| Storm Doors | 7-10 yrs | 2015 | 100% | 3,192 |
| Sliding Doors - with Roller Replacement | 20 yrs | 2005 | 99% | 3,161 |

SOURCE: NAHB, 2006; Port of Seattle, 2024; ESA, 2024.

SECTION

# ACOUSTIC TESTING

# 4

# ACOUSTIC TESTING

## 4.1 OVERVIEW OF SOUND INSULATION PRODUCT

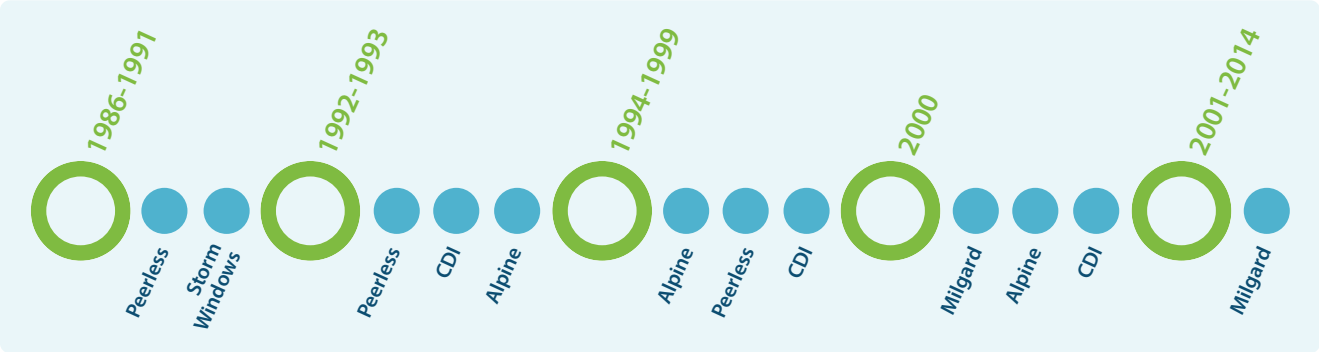
All windows have a Sound Transmission Class (STC)[10] rating. Early in the SEA Sound Insulation Program there were instances in which lower STC products (e.g. STC35) were used and are therefore noted separately herein. The STC rating is determined based on the amount of reduction needed to achieve an interior DNL below the FAA threshold of 45 dB. Window packages installed include Alpine (STC35 and STC44), CDI (STC44), Milgard, Peerless/DeVac (STC35 and STC44), Storm Window Only, and Other. Other denotes unknown manufacturers, no records, or in limited cases, an uncommon manufacturer that was installed.

The work to enhance the documentation of previously installed sound insulated packages began in 2022 when the SEA Sound Insulation Program staff undertook a project to review the historic paper files. During this 18-month project, 7,297 sound insulation package files were reviewed, cataloged, and design documents digitized. This project informed the understanding of what products were used in individual homes and time periods. Not all sound insulation package files were found in the archive. When no file was found, product(s) were noted as "No Record". When a file contained window manufacturer information or an STC rating, that was noted. In some cases, the manufacturer was not noted in the file, and in those instances the product(s) were noted as "Unknown". The design documents included basic ventilation changes but were limited to whether or not work was performed, and did not include the details of what type of work was conducted. The outcome of this project allowed for the various sound insulation packages to be linked with the survey data.

**Figure 2** provides an outline of which window manufacturers were most commonly installed from the inception of the SEA Sound Insulation Program through 2014. Window and door manufacturers have changed over time. Manufacturers used in the SEA Sound Insulation Program were used by other airport sound insulation programs during the same time periods. There were multiple manufacturers available between 1992-2002 and homeowners had the ability to select the product from these manufacturers. **Table 3** provides a complete list of window manufacturers used.

10 Sound transmission class (STC) is a single number rating of the sound isolation of building products and/or wall assemblies. A higher STC rating equates higher sound isolation.

**Figure 2. Timeline of Window Product Manufacturer Installation**




Source: Port of Seattle , 2024.

Table 3. Timeline of Window Product Manufacturer Installation

| Manufacturer | 1986 | 1987 | 1989 | 1989 | 1990 | 1991 | 1992 |
|---|---|---|---|---|---|---|---|
| DeVac/Peerless | 1 | - | 5 | 17 | 47 | 83 | 59 |
| Storm only | - | - | 3 | 2 | - | 26 | 26 |
| Alpine | - | - | - | - | - | - | 5 |
| CDI | - | - | - | - | - | - | 8 |
| Other | 3 | - | 1 | - | 3 | 4 | 10 |
| No Record/Unknown | 6 | 2 | 3 | 44 | 40 | 32 | 51 |
| **Total** | **10** | **2** | **12** | **63** | **90** | **145** | **159** |

| Manufacturer | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 |
|---|---|---|---|---|---|---|---|
| DeVac/Peerless | 79 | 40 | 30 | 12 | 24 | 31 | 36 |
| Storm only | 18 | 7 | 2 | - | - | - | - |
| Alpine | 7 | 102 | 106 | 66 | 117 | 145 | 124 |
| CDI | 12 | 14 | 5 | 2 | 6 | 20 | 44 |
| Milgard | 3 | 3 | 1 | - | 2 | 2 | 3 |
| STC35 | - | 11 | 6 | - | - | - | - |
| STC44 | - | 74 | 75 | 105 | 65 | 6 | 1 |
| Other | 9 | 8 | 1 | 5 | 1 | - | - |
| No Record/Unknown | 56 | 97 | 298 | 230 | 92 | 22 | 17 |
| **Total** | **184** | **356** | **524** | **420** | **307** | **226** | **225** |

Table 3. Timeline of Window Product Manufacturer Installation

| Manufacturer | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 |
|---|---|---|---|---|---|---|---|
| DeVac/Peerless | 7 | - | - | - | - | - | - |
| Alpine | 62 | 8 | 5 | - | 1 | - | - |
| CDI | 24 | 2 | - | - | - | - | - |
| Milgard | 52 | 49 | 47 | 61 | 41 | 33 | 5 |
| STC44 | - | 1 | - | - | - | - | - |
| Other | - | 2 | 1 | - | - | - | - |
| No Record/Unknown | 11 | 15 | 4 | 3 | 6 | 3 | - |
| **Total** | **156** | **77** | **57** | **64** | **48** | **36** | **5** |

| Manufacturer | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 |
|---|---|---|---|---|---|---|---|---|
| Milgard | 2 | - | - | 1 | - | - | 1 | - |
| No Record/Unknown | - | 1 | 2 | 2 | 5 | 7 | 2 | 3 |
| **Total** | **2** | **1** | **2** | **3** | **5** | **7** | **3** | **3** |

SOURCE: Port of Seattle, 2024; ESA, 2024.

# 4.2 SELECTION OF HOMES TO BE TESTED

The acoustic testing phase of this assessment is focused on understanding the acoustic performance of previously installed sound insulation packages. The test allows for a comparison of the acoustic performance of products with resident observed conditions versus those with no reported conditions. The process included examining the sound insulation package installed, including window and door operation and glass condition. The field assessment occurred concurrently with acoustic testing and was intended to provide an evaluation of window and door products across the 30-home sample, and to confirm that each product was installed as part of a sound insulation package.

The selection of homes for the acoustic testing phase of this assessment was based on an analysis of survey responses. Survey responses were grouped by the year of installation and manufacturer. The groups were then compared to the distribution of the Port's entire Sound Insulation Program from 1986 to 2014. To narrow down the selection to the 30 available acoustic testing appointments, the reported condition of the respondents' windows was also considered. This additional criterion helped determine if specific window conditions could lead to a degradation in acoustic performance.

Approximately 3,200 single-family residences were treated as part of the Port's Sound Insulation Program between the years of 1986 and 2014. Utilizing the Port's Sound Insulation Program database, previously treated residences were grouped as follows, based on year of installation: 1986-1993, 1994, 1995, 1996, 1997, 1998-1999, 2000-2003, and 2004-2014. The total number of residences treated within each group was then compared to the overall number of residences treated in the entire timeframe to determine targeted testing percentages by group. **Table 4** provides the final targeted testing percentages for each of those groups. The distribution is based on the number of survey responses received.

Table 4. Targeted Testing Percentages of Survey Respondents by Year Grouping

| 1986-1993 | 1994 | 1995 | 1996 | 1997 | 1998-1999 | 2000-2003 | 2004-2014 |
|---|---|---|---|---|---|---|---|
| 20% | 13% | 17% | 13% | 10% | 13% | 10% | 3% |

SOURCE: Port of Seattle, 2024; ESA, 2024.

Table 5. Targeted Testing Numbers by Package Year and Manufacturer Grouping

| Manufacturer | 1986-1993 | 1994 | 1995 | 1996 | 1997 | 1998-1999 | 2000-2003 | 2004-2014 |
|---|---|---|---|---|---|---|---|---|
| CDI/DeVAC | 2 | - | 1 | - | - | - | - | - |
| Alpine | 2 | 2 | 3 | 3 | 2 | 3 | - | - |
| Milgard | - | - | - | - | - | - | 2 | 1 |
| STC 35/30/36 | 2 | 1 | - | - | - | - | - | - |
| Unknown/STC 44 | - | 1 | 1 | 1 | 1 | 1 | 1 | - |
| **Total** | **6** | **4** | **5** | **4** | **3** | **4** | **3** | **1** |

SOURCE: Port of Seattle, 2024; ESA, 2024.

Next, utilizing the Port's Sound Insulation Program database, the number of residences to test within each group was determined based upon the proportional distribution of the manufacturer of the products installed (when noted in the file). Manufacturer groupings were CDI/DeVAC, Alpine, Milgard, performance criteria of STC 35/30/36, and Unknown/STC 44 (when a manufacturer was not specifically noted in the file). The Unknown category was included to ensure that the results were inclusive and that any unknown manufacturers were not potentially ignored. Port staff and their consultants aimed to identify a known manufacturer when they conducted the field assessment. **Table 5** provides the final targeted number of residences for each of these acoustic testing groups by the year the package was installed.

Acoustic testing and field assessments could only be completed for residences where the homeowner agreed to participate based upon their survey response. Utilizing the information in the table above, in conjunction with survey responses, residences were identified to be included as part of acoustic testing and field assessments. Additional selection considerations included but were not limited to:

- Test windows and doors with no reported concerns to validate performance factors.
- Test windows and doors where the manufacturer is not known and based on assessment results and year of installation attempt to identify the manufacturer.
- Test windows and doors that have reported concerns, as noted in the survey responses, including 20-50% of products observed with the following condition:
  - Condensation
  - Seal failure
  - LoE coating
  - Change in appearance
  - Mold and/or other changes in their home (as noted in the 'open comment' field from the survey).

An initial 30 residences were emailed on July 15, 2024, to participate in acoustic testing and field assessment. A total of 12 responded and were scheduled. An additional 20 residences were emailed on July 19, 2024, and five responded and were scheduled. On July 22, 2024, 30 more were emailed and eight responded and were scheduled. Three more were emailed on July 23, 2024, and one responded and was scheduled. Lastly, 10 more were emailed on July 24, 2024, and four responded and were scheduled.

The email sent to the residents explained that acoustic testing and field assessment would involve measuring sound levels inside and outside of their residence and would take approximately two hours. The email provided five date options and three start times for each of those dates. It asked if they wanted to participate, they respond with their first, second, and third choices.

A total of 30 residences were confirmed and scheduled to be acoustically tested and inspected and ensured four alternates in case of cancellations. The Port had four cancellations and used all four alternates. **Table 6** provides the final number of residences by year and manufacturer grouping to be acoustically tested and inspected.

Table 6. Final Residential Testing by Year and Manufacturer Grouping

| Manufacturer | 1986-1993 | 1994 | 1995 | 1996 | 1997 | 1998-1999 | 2000-2003 | 2004-2014 |
|---|---|---|---|---|---|---|---|---|
| CDI/DeVAC | 3 | - | 1 | - | - | - | - | - |
| Alpine | | 2 | 3 | 3 | 2 | 3 | - | - |
| Milgard | - | - | - | - | - | - | 2 | 1 |
| STC 35/30/36 | 1 | - | - | - | - | - | - | - |
| Unknown/STC 44 | 1 | - | 2 | 3 | 2 | 1 | | - |
| **Total** | **5** | **2** | **6** | **6** | **4** | **4** | **2** | **1** |

SOURCE: Port of Seattle, 2024; ESA, 2024.

# 4.3 ACOUSTIC TESTING METHODOLOGY

HMMH conducted acoustic testing between August 19th and 30th, 2024. Testing conformed to the Acoustical Test Plan (ATP) for SEA, which was approved by the FAA on February 17, 2017. It was developed and implemented in accordance with FAA Advisory Circular (AC), 150/5000-9A, Announcement of Availability – Report No. DOT/FAA/PP/92-5, Guidelines for the Sound Insulation of Residents Exposed to Aircraft Noise, issued in 1992.[11] The purpose of the ATP is to provide a clear and consistent method for performing sound attenuation assessments of single-family residential structures.

As detailed in the ATP, the Outdoor-Indoor Noise Reduction (OINR) of a façade exposed to loudspeaker generated sound is calculated as the difference between the exterior and interior sound levels, as measured during acoustic testing, and is a function of each of the one-third or octave frequency bands. The Noise Level Reduction (NLR) is a single-number metric representing the difference between an A-weighted exterior aircraft noise spectrum of a Boeing 737-800, per the FAA-approved ATP, and the corresponding A-weighted interior noise level.

The interior DNL, which determines eligibility for sound insulation, is calculated by subtracting the NLR from the DNL contour interval each residence falls within. The overall interior DNL value for each residence is the average interior DNL of each individual habitable room.[12] This test incorporates the effects of the entire building façade, which includes but is not limited to, wall construction, windows, and doors. For a house to test eligible, the average interior DNL of each habitable room must be greater than or equal to 45 dB.

11 https://www.faa.gov/documentLibrary/media/Advisory_Circular/150_5000_9a_withReport.pdf

12 Habitable rooms are defined as spaces used for living, cooking, sleeping, or eating, and must have electricity and insulated ceiling. Such rooms include living rooms, family rooms, dining rooms, kitchens, bedrooms, offices, and dens. Bathroom and garages are not considered habitable spaces.

A Sound Insulation Effectiveness (SIE) value was calculated for select windows and doors using the same test procedure outlined above. The SIE acoustic rating, which is more comparable to the Outdoor-Indoor Transmission Class (OITC), indicates the noise reduction performance of an individual window or door over a broader frequency range (80 to 4000 Hz). These lower frequencies are often associated with external noise. OITC is focused on sound deadening performance instead of sound transmission, which is the focus of STC ratings. Both STC and OITC ratings inform window or door selection with higher ratings providing greater sound reduction. The rates do not carry the same numeric values as they are evaluating different characteristics.

# 4.4 ACOUSTIC TESTING RESULTS

**Table 7** summarizes the interior DNL for each manufacturer by year of installation. The overall interior DNL ranged from 35 dB to 44 dB. Results indicate that each of the 30 residences tested have a average interior DNL sound level below the FAA's interior noise threshold of 45 dB DNL and would not qualify under existing FAA sound insulation program eligibility criteria. This suggests that while a product may be at or nearing the EUL of its structural integrity, functionality, and aesthetics, the acoustic performance has not exceeded the FAA's interior noise threshold. The full acoustic test report can be found in Appendix D-1. Acoustic test results are influenced by several factors, which is why there is variability within the same manufacturer. The testing measures the sound transmission though the entire wall assemblies, thus the size of windows, wall construction, siding type and insulation all have some impact, with windows being the most significant. Additionally, interior flooring and furnishing will also slightly affect results. Rooms with minimal furniture, hardwood flooring and blinds will produce a higher test result than ones with carpet, furniture and curtains that would absorb more sound.

The acoustic performance of each window manufacturer remained consistent regardless of installation year. DeVAC/Peerless and Alpine STC35 had the worst performance with the highest interior DNL of 44 dB. Alpine STC44 had the best performance with the lowest interior DNL of 35 dB, 10 dB below the federal threshold of 45 dB. The acoustic performance of Milgard and CDI are similar and ranged from 38-40 dB and 39-40 dB, respectively.

Table 7. Range of Interior DNL of Habitable Rooms by Manufacturer

| Manufacturer | Day-Night Average Sound Level (dB) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1986-1993 | 1994 | 1995 | 1996 | 1997 | 1998-1999 | 2000-2003 | 2004-2014 | Range |
| DeVAC/Peerless | 41-44 | - | 36-41 | - | - | - | - | - | 36-44 |
| Alpine STC44 | - | - | 38-42 | 35-39 | 37-42 | 41 | - | - | 35-42 |
| Alpine STC35 | 44 | 42-44 | - | - | - | - | - | - | 42-44 |
| Milgard | - | - | - | - | - | - | 40 | 38 | 38-40 |
| CDI | - | - | - | - | - | 39-40 | - | - | 39-40 |

SOURCE: HMMH, 2024; Port of Seattle, 2024; ESA, 2024.

**Table 8. Range of Measured Sound Insulation Effectiveness of Windows by Manufacturer**

| Manufacturer | Measured Sound Insulation Effectiveness (dB) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1986-1993 | 1994 | 1995 | 1996 | 1997 | 1998-1999 | 2000-2003 | 2004-2014 | Range |
| DeVAC/Peerless | 27-28 | - | 28-29 | - | - | - | - | - | 27-29 |
| Alpine STC44 | - | - | 23-27 | 28-32 | 24-31 | 28-31 | - | - | 23-32 |
| Alpine STC35 | 25 | 24-28 | - | 28 | - | - | - | - | 24-28 |
| Milgard | - | - | - | - | - | - | 28 | 26-28 | 26-28 |
| CDI | - | - | - | - | - | 27-30 | - | - | 27-30 |

SOURCE: HMMH, 2024; Port of Seattle, 2024; ESA, 2024.

**Table 8** presents the range of SIE for windows by manufacturer and year of installation. The results show a range of performance, spanning from 23 to 32 dB. Despite the 9 dB range observed in individual tests, the average reduction for each manufacturer remained consistent, between 27 and 29 dB. This consistency highlights the effectiveness of the acoustically rated windows over time. The product's acoustic performance, even in the lower STC35 products are adequate to maintain interior DNL's below the FAA threshold.

Included in acoustic testing were market available 1996 Alpine and a 2004 Milgard windows. Both manufacturers tested below an STC35 window at 15dB and 20dB respectively, likely due to the thickness of the glass and airspace used. This highlights the challenge of maintaining acoustic performance with standard, market-available products.

Similarly, **Table 9** presents the range of SIE doors by year of installation. The results also show a significant range of noise reduction, spanning from 17 to 31 dB. Despite the 14 dB variation observed in individual tests, the average noise reduction is 25 dB which is comparable to the SIE performance of doors.

**Table 9. Range of Measured Sound Insulation Effectiveness of Doors**

| Measured Sound Insulation Effectiveness (dB) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 1988-1993 | 1994 | 1995 | 1996 | 1997 | 1998-1999 | 2000-2003 | 2004-2014 | Range | Average |
| 18-28 | 17-31 | 22-31 | 23-29 | 21-28 | 21-29 | 26-29 | - | 17-31 | 25 |

SOURCE: HMMH, 2024; Port of Seattle, 2024; ESA, 2024.

SECTION

# 5

# EXISTING SOUND INSULATION PACKAGES AND REPORTED CONCERNS

# EXISTING SOUND INSULATION PACKAGES AND REPORTED CONCERNS

## 5.1 SURVEY RESPONSE OVERVIEW

Of the approximately 3,200 surveys distributed, the return yielded 1,067 responses (33% response rate). A copy of the survey is provided in **Appendix A-3**. Survey responses were received and are representative of the four jurisdictions surrounding SEA, as shown in **Figure 3**. The figure categorizes each respondent's location and the window manufacturer, providing a generalized view of the geographic distribution of responses. **Table 10** provides a tabular representation of survey responses. This distribution of survey responses was anticipated as the airport operates in north and south flow configurations.

Table 10. Respondent Location Distribution

| Option | Count | Percentage |
|---|---|---|
| Burien | 116 | 10.9% |
| Des Moines | 359 | 33.6% |
| Sea-Tac | 215 | 20.1% |
| Seattle[1] | 377 | 35.3% |
| **Total** | **1,067** | **100.0%** |

SOURCE: Port of Seattle, 2024; ESA, 2024.

Notes:
1 Data is by zip code. Some areas in multiple zip codes list the mail to city as Seattle; these locations include all 3 jurisdictions and a small portion of unincorporated King County.

**Table 11** presents the distribution of survey responses received grouped by the year of installation. The table also compares the distribution of approximately 3,200 installations from 1986 through 2014 indicating that the responses received accurately reflect the variety of packages installed.

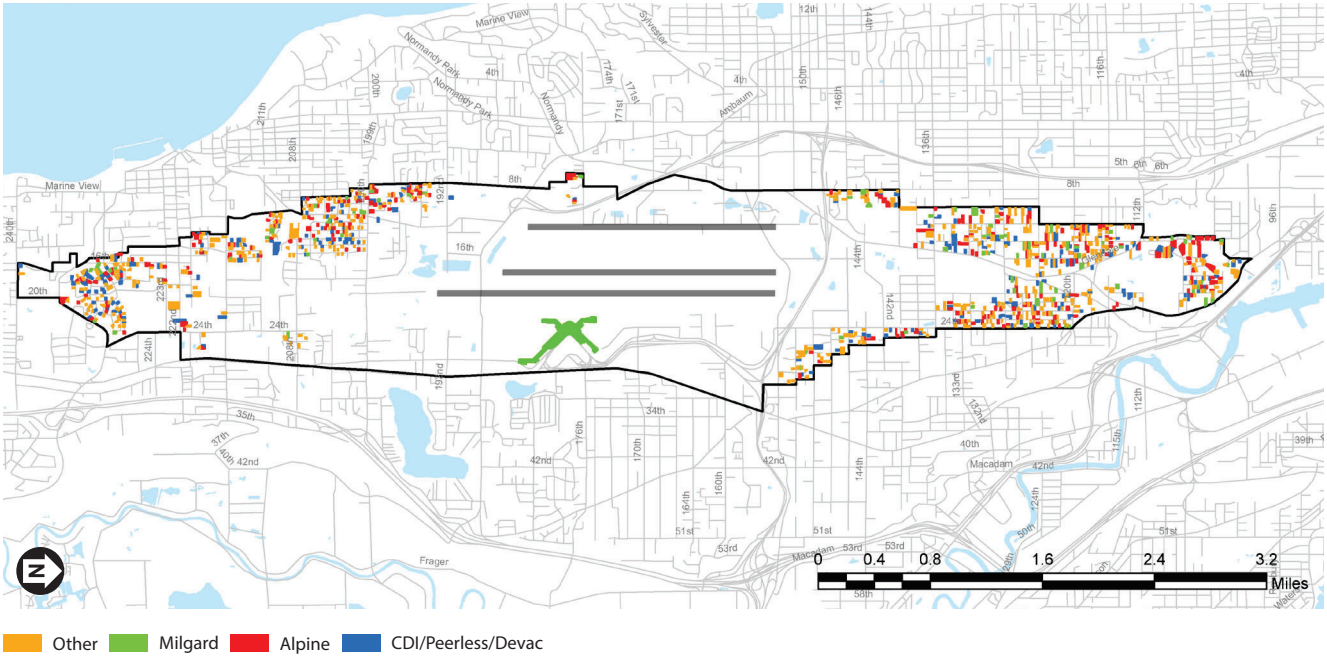
Generalized survey response results in tabular format are in **Appendix B-1**. The analysis of window-specific reported concerns, by manufacturer, can be found in **Appendix B-2**.

Table 11. Year Sound Insulation Package by Response

| Year of Sound Insulation Install | Count | Percentage of Survey Results | Percentage of Insulation Packages (Based on 3,200) |
|---|---|---|---|
| Pre-1993 | 228 | 21.4% | 19.4% |
| 1994 | 119 | 11.2% | 11.4% |
| 1995 | 184 | 17.2% | 17.1% |
| 1996 | 149 | 14.0% | 13.3% |
| 1997 | 96 | 9.0% | 9.7% |
| 1998-1999 | 148 | 13.9% | 14.3% |
| 2000-2003 | 123 | 11.5% | 11.3% |
| Post 2003 | 20 | 1.9% | 3.5% |
| **Total** | **1,067** | **100.0%** | **100.00%** |

SOURCE: Port of Seattle, 2024; ESA, 2024.

## Figure 3. Map of Survey Respondents by Manufacturer




Not an official map.

The Port of Seattle receives funding from the federal government and is required to track demographic data for the constituents they serve. Responses to demographic questions were optional, including household size, race/ethnicity, household income, income by family size, and primary language spoken at home. In some cases, the assessment population of approximately 3,200 was compared to the total population of approximately 38,000 living in the block groups included in the 2014 SEA Noise Remedy Boundary.

Responses to these optional questions provided insights about the surveyed communities. The data highlights that 85.3% of households are 1-4 people and that 74.7% of households are members of the same race/ethnicity. For a comparison of race/ethnicity and primary language between the survey respondents and the residents in the block groups included in the 2014 SEA Noise Remedy Boundary see **Table 12** and **Table 13**.

**Table 12** presents the percentage of race/ethnicity of survey respondents compared to the race/ethnicity of the residents of the block groups included in the 2014 SEA Noise Remedy Boundary, as described in the Port of Seattle's Equity Index, which is an interactive map that displays a visual representation of social and environmental disparities in King County. The index evaluates equity and access to opportunity by neighborhood. Levels of equity are ranked from very low to very high based on data from 21 indicators across four categories: economic, environment, accessibility, and livability.

Table 12. Race/Ethnicity of Survey Respondents

| Race/Ethnicity | Survey | Equity Index |
|---|---|---|
| American Indian or Alaskan Native | 0.6% | 2% |
| Asian or Asian American | 8.2% | 14% |
| Black or African American | 4.1% | 13% |
| Hispanic | 10.5% | 24% |
| Middle Eastern or East African | 0.3% | - |
| Native Hawaiian or Other Pacific Islander | 1.1% | 3% |
| White | 51.3% | 46% |
| Two or more races | 8.8% | 11% |
| Other | 0.2% | 12% |
| Prefer not to answer | 14.9% | - |

SOURCE: Port of Seattle, 2024.

**Table 13** presents the percentage of the primary language spoken by survey respondents compared to the at home languages spoken by residents in the block groups included in the 2014 SEA Noise Remedy Boundary, as described in the Port of Seattle's Equity Index. Information for some of the at home languages is not available at the block group level.

Table 13. Primary Language of Survey Respondents

| Primary Language | Survey | Equity Index |
|---|---|---|
| Amharic | 1.2% | - |
| Chinese | 0.2% | - |
| English | 82.8% | 60% |
| Korean | 0.3% | - |
| Somali | 0.1% | - |
| Spanish | 5.5% | 17% |
| Vietnamese | 2.4% | 5% |
| Prefer not to answer | 4.2% | - |
| Balance of total | 3.3% | 18% |

SOURCE: Port of Seattle, 2024.

Survey respondents were also asked about their household income. To account for the higher cost of living in King County compared to the rest of the country, the project team analyzed responses to determine the number of households with 80% of the Area Median Income (AMI) or below. Based on the self-reported income, 34.1% of households were below the 80% AMI threshold used for many low-income qualifying programs based on the 2023 eligibility requirements for affordable housing programs. **Table 14** presents the household income of survey respondents based on family size. Light gray highlight denotes households with an income below 80% AMI.

Table 14. Income by Family Size of Survey Respondents

| | Income by Family Size | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | |
| **Income** | | | | | | | | | | | | **N<80% AMI** |
| Less than $70,650 | 49 | 67 | 29 | 28 | 14 | 9 | 3 | 1 | 2 | 0 | 0 | 202 |
| $70,651 to $80,750 | 13 | 36 | 18 | 12 | 7 | 4 | 4 | 1 | 0 | 0 | 0 | 82 |
| $80,751 to $90,850 | 12 | 19 | 9 | 15 | 4 | 2 | 3 | 0 | 0 | 0 | 0 | 33 |
| $90,851 to $100,900 | 9 | 25 | 17 | 11 | 8 | 3 | 0 | 3 | 1 | 0 | 1 | 27 |
| $100,901 to $109,000 | 3 | 15 | 13 | 9 | 2 | 1 | 0 | 0 | 1 | 0 | 0 | 4 |
| $109,001 to $117,050 | 4 | 10 | 3 | 6 | 3 | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| $117,051 to $125,150 | 0 | 12 | 10 | 10 | 3 | 0 | 3 | 0 | 0 | 0 | 1 | 4 |
| $125,151 to $133,200 | 2 | 13 | 7 | 7 | 3 | 0 | 1 | 0 | 1 | 0 | 0 | 1 |
| $133,201 to $141,300 | 2 | 9 | 7 | 4 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| $141,301 to $149,350 | 1 | 11 | 8 | 2 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $149,351 or more | 10 | 56 | 21 | 26 | 7 | 2 | 1 | 4 | 1 | 0 | 0 | 0 |
| **Prefer not to answer** | **27** | **116** | **49** | **40** | **21** | **10** | **6** | **9** | **2** | **0** | **0** | **-** |

SOURCE: Port of Seattle, 2024.

**Table 15** presents the distribution of survey responses grouped by the product manufacturer. Window and door manufacturers have changed over time. Manufacturers used in the SEA program were used by other airport sound insulation programs during the same time periods. The table also compares the distribution of approximately 3,200 single-family installations from 1986 through 2014 indicating that the responses received closely reflect the distribution of sound insulation packages installed. "Other" includes Port records of Unknown and No Record of manufacturers. These, however, would fall within one of the manufacturers noted in the table. Therefore, the exact percentage of total installations by manufacturer is not known.

Table 15. Comparison of Sound Insulation Packages and Response Distribution by Manufacturer

| Manufacturer | Number of Survey Responses | Percentage of Survey Responses | Percent of Insulation Packages (Based on 3,200) |
|---|---|---|---|
| Alpine STC35 | 30 | 2.8% | 2.0% |
| Alpine STC44 | 225 | 21.1% | 21.4% |
| CDI STC44 | 43 | 4.0% | 4.3% |
| Milgard | 85 | 8.0% | 9.6% |
| Peerless/DeVac | 167 | 15.7% | 14.8% |
| Storm Only | 36 | 3.4% | 2.6% |
| Other/Unknown | 481 | 45.1% | 45.3% |
| **Total** | **1,067** | **100.0%** | **100.0%** |

SOURCE: Port of Seattle, 2024; ESA, 2024.

# 5.2 EXISTING WINDOW AND DOOR PACKAGES AND REPORTED CONCERNS

The sections below provide an overview of each window package, and the corresponding reported concerns noted from survey results. These included operational reported concerns (ease of opening/closing and locking), glass-related reported concerns (condensation, seal failure and LoE), and appearance (change in frame/trim and caulking).

**Table 16** presents survey responses on six window types: Storm Only, Peerless/DeVac, Alpine (STC35), Alpine (STC44), CDI, and Milgard. The table compares operational issues to glass-related issues. Operational concerns identify if a respondent indicated any concerns opening and/or locking windows (i.e. only one of these concerns must be present in a response). Similarly, glass related concerns identify if a respondent indicated any condensation and/or seal failures. As such, results may not match one-to-one to survey results broken out by individual concerns. Windows from "Other" manufacturers are not shown in this comparison.

As shown in the following section, the majority of responses expressed concerns related to a window's ability to properly open and close over all manufacturers. Alpine (STC44), Milgard, and "Other" have the highest reported concerns regarding a window's ability to lock. Between 50% and 75% of responses regarding all window manufacturers reported concerns with condensation on windows. A majority of responses for each window manufacturer reported seal failures, except for Alpine (STC35) and Peerless/DeVac (which does not have a double-pane component). Survey responses reflected less concerns with LoE coating, changes in appearance of frames, trim, or caulking. Overall, the results suggest that there are operational concerns (e.g. opening and/or closing) and glass concerns (e.g. condensation and/or seal failure), that closely align with the data presented in **Table 16**.

No single year in the survey data highlighted elevated reported concerns versus other years. As such, the assessment focused on overall results. For a breakdown of responses by manufacturer and year, see **Appendix B-2**.

Table 16. Window Product Comparison

| Reported Responses | Storm Only | Peerless/DeVac | Alpine (STC35) | Alpine (STC44) | CDI | Milgard |
|---|---|---|---|---|---|---|
| Operational Concerns | 58.3% | 65.3% | 50.0% | 70.7% | 69.8% | 71.8% |
| Glass Concerns | 66.7% | 67.1% | 60.0% | 75.1% | 65.1% | 67.1% |
| No Issue/Unsure | 16.7% | 15.6% | 23.3% | 11.1% | 14.0% | 11.8% |
| **Total Responses** | **36** | **167** | **30** | **225** | **43** | **85** |

SOURCE: Port of Seattle, 2024; ESA, 2024.

## 5.2.1 Alpine (STC35)

The Alpine (STC35) window package was offered between 1987 and 1994. This package is a vinyl, double-pane window without a storm window. The weephole[13] was located near the exterior corners and allowed sufficient space for routine caulking around the window.

There were 30 respondents (2.8% of total survey responses) with Alpine (STC35) windows installed prior to 1993, and in 1995.[14] Responses on Alpine (STC35) windows are presented in **Table 17**. The results indicate that the majority of respondents have concern over condensation and caulking. Concerns over the ease of opening and closing were also frequent as noted by the table. These results align with **Table 16** as 60.0% had reported glass concerns (e.g. condensation and/or seal failure) and 50% reported operational concerns (e.g. opening, closing, and/or locking). See **Table B2-1** through **Table B2-4** in **Appendix B-2** for responses by year.

Table 17. Alpine (STC35) Survey Response of Reported Concerns

| 30 Responses | Open/Close | Locking | Condensation | Seal | LoE Coating | Frame/Trim | Caulking |
|---|---|---|---|---|---|---|---|
| No | 41.4% | 62.1% | 31.0% | 48.3% | 72.4% | 48.3% | 37.9% |
| Yes | 48.3% | 31.0% | 51.7% | 37.9% | 10.3% | 44.8% | 58.6% |
| Not Sure | 10.3% | 6.9% | 17.2% | 13.8% | 17.2% | 6.9% | 3.4% |
| **Total** | **100.0%** | **100.0%** | **100.0%** | **100.0%** | **100.0%** | **100.0%** | **100.0%** |

SOURCE: Port of Seattle, 2024; ESA, 2024.

*Exterior image of an Alpine (STC35) window with weephole (circled in red).*

*Interior image of an Alpine (STC35) window.*

13 A weephole is a small opening in the bottom of window frames that allow water to drain out, designed to prevent water damage and mold and mildew growth.

14 The Port discontinued the installation of Alpine (STC35) window packages in 1994. However, this model was used as an option utilized for owners to replace out of scope locations.

## 5.2.2 Alpine (STC44)

The Alpine (STC44) window packages were offered between 1994 and 2002. These packages included a vinyl, double-pane window and an integrated operable storm window. Picture windows[15] consisted of a double-pane window and an integrated, non-removable storm window. This product had three weephole designs. Through much of 1995, the weephole was similar to the STC35 model. From 1995-1998 the weephole was located in the auxilary channel of the frame. These weepholes were susceptible to being caulked over during installation and/or during routine maintenance. In 1999, the frame was redesigned and the weephole became more pronounced at the angled bottom corner.

There were 225 respondents (21.1% of total survey responses) with Alpine (STC44) windows installed between 1994 and 2002. Responses on Alpine (STC44) windows are presented in **Table 18**. The results indicate that the majority of respondents have concern with ease of opening and closing, locking, condensation, and possible problems with the seal. There are less reported concerns regarding LoE coating, changes to the frame/trim and caulking. These results align with **Table 16** as 70.7% had reported an operation concern (e.g. opening, closing, and/or locking) and reported 75.1% reported glass concerns (e.g. condensation and/or seal failure). See **Table B2-5** through **Table B2-11** in **Appendix B-2** for responses by year.

Table 18. Alpine (STC44) Survey Response of Reported Concerns

| 225 Responses | Open/Close | Locking | Condensation | Seal | LoE Coating | Frame/Trim | Caulking |
|---|---|---|---|---|---|---|---|
| No | 32.7% | 42.3% | 28.7% | 26.6% | 54.8% | 49.8% | 39.0% |
| Yes | 63.7% | 52.7% | 60.1% | 61.3% | 25.8% | 31.7% | 36.2% |
| Not Sure | 3.6% | 5.0% | 11.2% | 12.2% | 19.5% | 18.6% | 24.8% |
| **Total** | **100.0%** | **100.0%** | **100.0%** | **100.0%** | **100.0%** | **100.0%** | **100.0%** |

SOURCE: Port of Seattle, 2024; ESA, 2024.

*Exterior image of an Alpine (STC44) window with weephole (circled in red) covered by caulking and frame damage.*

*Exterior image of a Alpine (STC44) window with weephole (circled in red).*

15 A picture window is large, non-removeable window. Picture windows are typically installed in kitchens and/or living rooms to allow in natural light.

## 5.2.3 CDI (STC44)

The CDI (STC44) window package was offered between 1992 and 2001. This package included a vinyl, double-pane window and an integrated operable storm window. Picture windows consisted of a double-pane window and an integrated, non-removable storm window. The weephole consisted of two slots near the exterior corners and allowed sufficient space for routine caulking around the window.

There were 43 respondents (4.0% of total survey responses) with CDI (STC44) windows installed prior to 1993 and through 2003. Responses on CDI (STC44) windows are presented in **Table 19**. The results indicate that the majority of respondents have concern over the ease of opening and closing, condensation, and seals. Concerns of locking, LoE coating, changes in frame/trim and caulking were less common. These results align with Table 16 as 69.8% had reported an operational concern (e.g. opening, closing, and/or locking) and reported 65.1% reported glass concerns (e.g. condensation and/or seal failure). See **Table B2-12** through **Table B2-18** in **Appendix B-2** for responses by year.

Table 19. CDI (STC44) Survey Response of Reported Concerns

| 43 Responses | Open/Close | Locking | Condensation | Seal | LoE Coating | Frame/Trim | Caulking |
|---|---|---|---|---|---|---|---|
| No | 30.2% | 48.8% | 33.3% | 31.0% | 51.2% | 51.2% | 46.5% |
| Yes | 67.4% | 41.9% | 50.0% | 59.5% | 27.9% | 23.3% | 32.6% |
| Not Sure | 2.3% | 9.3% | 16.7% | 9.5% | 20.9% | 25.6% | 20.9% |
| **Total** | **100.0%** | **100.0%** | **100.0%** | **100.0%** | **100.0%** | **100.0%** | **100.0%** |

SOURCE: Port of Seattle, 2024; ESA, 2024.

*Exterior image of a CDI (STC44) window with dual weephole (circled in red).*

*Interior image of a CDI (STC44) window.*

## 5.2.4 Milgard

The Milgard window package was offered between 1993 and 2014. This package included a vinyl, double-pane window and an integrated operable storm window. Picture windows consisted of a double-pane window and an integrated, non-removable storm window. The weephole was located near the exterior corners and allowed sufficient space for routine caulking around the window.

There were 85 respondents (8.0% of total survey responses) with Milgard windows installed between 1993 and 2006. Responses on Milgard windows are presented in **Table 20**. The results indicate that the majority of respondents have concern over the ease of opening and closing, locking, and condensation. Concerns of seals, LoE coating, changes in frame/trim and caulking were less common. These results align with **Table 16** as 71.8% reported an operational concern (e.g. opening, closing, and/or locking) and 67.1% reported glass concerns (e.g. condensation and/or seal failure). See **Table B2-19** through **Table B2-25** in **Appendix B-2** for responses by year.

Table 20. Milgard Survey Response of Reported Concerns

| 85 Responses | Open/Close | Locking | Condensation | Seal | LoE Coating | Frame/Trim | Caulking |
|---|---|---|---|---|---|---|---|
| No | 32.9% | 42.4% | 34.1% | 43.5% | 58.8% | 58.8% | 52.9% |
| Yes | 65.9% | 54.1% | 50.6% | 47.1% | 22.4% | 24.7% | 25.9% |
| Not Sure | 1.2% | 3.5% | 15.3% | 9.4% | 18.8% | 16.5% | 21.2% |
| **Total** | **100.0%** | **100.0%** | **100.0%** | **100.0%** | **100.0%** | **100.0%** | **100.0%** |

SOURCE: Port of Seattle, 2024; ESA, 2024.

*Interior image of a Milgard window.*

*Exterior image of a Milgard window with weephole (circled in red).*

## 5.2.5 Peerless/DeVac(STC35 and STC44)

The Peerless/DeVac (STC35 and STC44) window package was offered between 1986 and 2000. This package included an aluminum dual, single-pane storm panel system with a 1.75-to-2-inch airgap in between the storm panels. The weephole was located near the exterior corners and allowed sufficient space for routine caulking around the window.

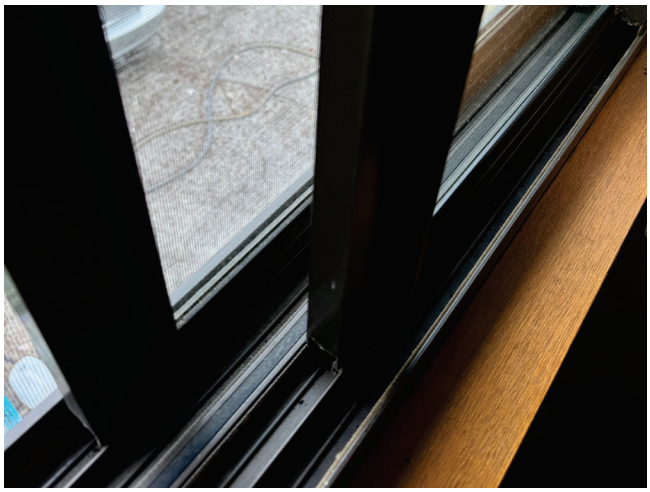
There were four respondents (0.4% of total survey responses) with Peerless/DeVac (STC35) and 163 respondents (15.3% of total survey responses) with Peerless/DeVac (STC44) windows installed between 1986 and 2000. Responses on Peerless/DeVac (STC35 and STC 44) windows are presented in **Table 21**. The results indicate that the majority of respondents have concerns over the ease of opening and closing and condensation. Concerns of locking, seals, LoE coating, changes in frame/trim and caulking were less common. These results align with **Table 16** as 67.1% had reported glass concerns (e.g. condensation and/or seal failure) and 65.3% reported operational concerns (e.g. opening, closing, and/or locking). See Table B2-26 through Table B2-33 in Appendix B-2 for responses by year.

Table 21. Peerless/DeVac (STC35 and STC 44) Survey Response of Reported Concerns

| 167 Responses | Open/Close | Locking | Condensation | Seal | LoE Coating | Frame/Trim | Caulking |
|---|---|---|---|---|---|---|---|
| No | 31.5% | 47.9% | 29.5% | 41.2% | 55.4% | 54.9% | 49.4% |
| Yes | 63.0% | 44.2% | 59.6% | 46.1% | 27.1% | 27.8% | 26.8% |
| Not Sure | 5.5% | 7.9% | 10.8% | 12.7% | 17.5% | 17.3% | 23.8% |
| **Total** | **100.0%** | **100.0%** | **100.0%** | **100.0%** | **100.0%** | **100.0%** | **100.0%** |

SOURCE: Port of Seattle, 2024; ESA, 2024.

*Exterior image of a Peerless/DeVac window with two weepholes (circled in red).*



*Interior image of a Peerless/Devac window.*

## 5.2.6 Storm Window Only

Storm only window packages were offered between 1989 and 1994. This package included adding a single-pane storm window on the interior of the home. The original window would not have been replaced.

There were 36 respondents (3.4% of total survey responses) with a storm only window package installed. Responses on Storm Window Only are presented in **Table 22**. The results indicate that the majority of respondents have concern over the ease of opening and closing, condensation, and seals. Concerns of locking, LoE coating, changes in frame/trim and caulking were less common. These results align with **Table 16** as 66.7% had reported glass concerns (e.g. condensation and/or seal failure) and 58.3% reported operational concerns (e.g. opening, closing, and/or locking). See **Table B2-34** through **Table B2-38** in **Appendix B-2** for responses by year.

Table 22. Storm Window Only Survey Response of Reported Concerns

| 36 Responses | Open/Close | Locking | Condensation | Seal | LoE Coating | Frame/Trim | Caulking |
|---|---|---|---|---|---|---|---|
| No | 45.7% | 54.3% | 22.2% | 25.0% | 51.4% | 50.0% | 50.0% |
| Yes | 51.4% | 40.0% | 55.6% | 55.6% | 28.6% | 36.1% | 33.3% |
| Not Sure | 2.9% | 5.7% | 22.2% | 19.4% | 20.0% | 13.9% | 16.7% |
| **Total** | **100.0%** | **100.0%** | **100.0%** | **100.0%** | **100.0%** | **100.0%** | **100.0%** |

SOURCE: Port of Seattle, 2024; ESA, 2024.

## 5.2.7 Other Window Packages

Window packages from Specialty, Littleton, Pella, Select, Zephyr, and unknown manufacturers were offered between 1986 and 2014. Not all package records noted a window manufacturer, but from the sampling of unknowns performed during the field assessment, six of nine were found to be Alpine and three of nine Peerless/DeVac. Therefore, it is anticipated that the majority of the unknown manufacturers are Alpine, followed by Peerless/DeVac.

There were 481 respondents (45.1% of total survey responses) with "Other" windows installed. Responses on Other Window Packages are presented in **Table 23**. The results indicate that the majority of respondents have concern over the ease of opening and closing, locking, condensation, and seals. Concerns of LoE coating, changes in frame/trim and caulking were less common. See **Table B2-39** through **Table B2-47** in **Appendix B-2** for responses by year.

Table 23. "Other" Window Packages Survey Response of Reported Concerns

| 481 Responses | Open/Close | Locking | Condensation | Seal | LoE Coating | Frame/Trim | Caulking |
|---|---|---|---|---|---|---|---|
| No | 35.8% | 42.5% | 27.7% | 33.9% | 54.1% | 55.2% | 43.4% |
| Yes | 59.8% | 51.2% | 61.1% | 52.4% | 26.3% | 27.4% | 28.8% |
| Not Sure | 4.4% | 6.3% | 11.1% | 13.7% | 19.6% | 17.5% | 27.8% |
| **Total** | **100.0%** | **100.0%** | **100.0%** | **100.0%** | **100.0%** | **100.0%** | **100.0%** |

SOURCE: Port of Seattle, 2024; ESA, 2024.

## 5.2.8 Doors

The installation records for doors only note the supplier, not the manufacturer; moreover, door system (e.g. entry door plus storm door) can vary for the same supplier. Responses on door related concerns are presented in **Table 24**. Overall, a majority of the survey responses reported operational concerns, but most did not report any frame/trim or caulking concerns. See **Table B2-48** through **Table B2-56** in **Appendix B-2** for responses by year. Notes taken during the field assessment phase have been used to supplement the door-related issues analysis.

The field assessment noted that entry doors appeared to be either original, or a newer installation performed by the homeowner, based upon the style of the doors. The Field Assessment also noted that sliding doors were largely not replaced, but rather a sliding storm door installed. In these instances, roughly an 8-inch surround was built on the home to enclose the sliding storm door.

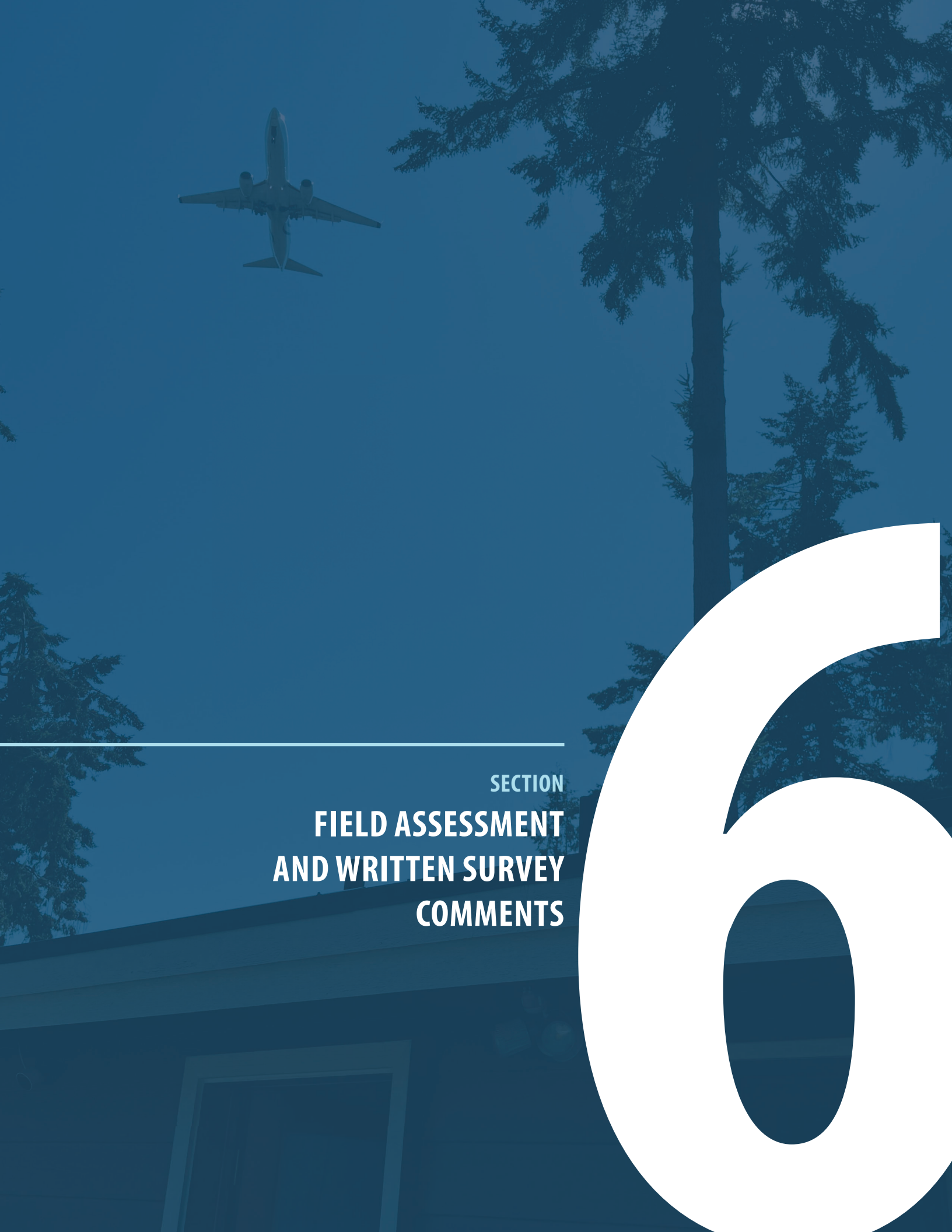
Table 24. All Survey Response of Door Reported Concerns

| 1,067 Responses | Open/Close | Locking | Frame/Trim | Caulking |
|---|---|---|---|---|
| No | 51.5% | 51.9% | 55.1% | 51.7% |
| Yes | 45.1% | 45.5% | 29.7% | 23.7% |
| Not Sure | 3.3% | 2.7% | 15.2% | 24.6% |
| **Total** | **100.0%** | **100.0%** | **100.0%** | **100.0%** |

SOURCE: Port of Seattle, 2024; ESA, 2024.

*Exterior image of a sliding door with storm.*

*Exterior image of a sliding door with storm.*



SECTION

# 6

# FIELD ASSESSMENT AND WRITTEN SURVEY COMMENTS

# FIELD ASSESSMENT AND WRITTEN SURVEY COMMENTS

## 6.1 FIELD ASSESSMENT

The field assessment was conducted concurrently with sound insulation testing to determine if any windows and doors installed as part of a sound insulation package had been replaced, and to validate survey responses on product conditions. C&S Companies, a leading design and engineering firm for the SEA Sound Insulation Program, lead the effort associated with the field assessment, recording detailed notes on each window, door, and providing general observations of ventilation system previously installed. Field assessment notes can be found in **Appendix D-2**.

Within the 30 homes inspected, C&S evaluated 438 windows, 80 entry doors, and 21 slider doors. The condition and operation were assessed and aligned with the survey questions (e.g. residents' concerns with opening, closing, locking, etc.). The breakdown of window types observed is found in **Table 25**.

Table 25. Number of Windows Inspected during Field Assessment

| Window Type | Count |
|---|---|
| Sliding (SL)[1] | 219 |
| Fixed Picture (FX)[2] | 81 |
| Single Hung (SH)[3] | 18 |
| Double Hung (DH)[4] | 70 |
| Awning (AW)[5] | 7 |
| Casement (CW)[6] | 8 |
| Slider/Fix Combination (SL-FX-SL)[7] | 35 |
| **Total** | **438** |

SOURCE: Port of Seattle, 2024; ESA, 2024.

Notes:
1 A sliding window opens and closes by moving horizontally along a track in the window frame.
2 A fixed picture window is a large, non-operable window.
3 Single hung windows have a fixed upper sash and movable lower sash.
4 Double hung window have two sashes (framework that holds glass panes in a window frame) that slide up and down, allowing for ventilation on the top, bottom, or both
5 An awning window opens outward from the bottom and is hinged at the top.
6 A casement window is hinged and opens outward with a crank or lever.
7 A slider/fixed combination is a sliding glass door that that a fixed storm on one side of the door casement.

### 6.1.1 Findings of the Field Assessment

During the field assessment, it was determined that, in many cases, the manufacturer's design of a product was a key contributor to several reported or observed conditions found. Some products limited the ability of the owner/resident or even a professional tradesperson to properly clean and maintain the product. The assessment found that in 66% of the windows observed (291 of 438) residents were not able to adequately clean between moving sashes or fixed picture windows due to a non-removable storm panel.

The manufacturer's design and location of the weepholes was another contributor to the conditions found, most notably with the Alpine STC44 from 1995 to 1998. The design and location of the weepholes made them highly susceptible to being caulked over during installation and/or during routine maintenance. The assessment found that 52% of the windows observed (228 of 438) had either weepholes covered with paint/caulk, or the window was recessed in the opening (where water that should weep out from the jamb collected/puddled under the window on top of the wood trim), thus promoting the potential for water damage. When the weepholes are covered, they may lead to water backing up into the unit and may potentially cause damage to the exterior trim.

The assessment found that 50% of the windows observed (221 of 438) exhibited seal failure and signs of condensation. This was most pronounced on the fixed picture windows and combination windows in which all 116 had signs of seal failure and fading in the fixed portion of the window assembly, which is not accessible due to the manufacturer's design containing a non-removable storm panel. Non-removable storm panels were found across all manufacturers up to 2014.

The assessment found that 49% of the windows observed (157 of 322) had issues with operation, such as opening, closing, being out of square (structurally misaligned), or being out of the sliding track. Approximately 36% of operable windows had problems with locking and 34% had broken hardware such as balancers.

A key installation failure by the contractor was noted on some of the double hung windows in which 33 of 70 were installed by setting a screw in the sill, thereby promoting water damage in the wood framing and rusting/corroding the locking device and balancers.

**Table 26** highlights the various window concerns identified in homes by different manufacturers. Across all manufacturers, seal failure and condensation were the most noted concerns. Caulking concerns were the second most identified concerns in each home of the field assessment. Weephole concerns varied, with Alpine STC44 having the highest rate noted. Operational and hardware concerns were most significant in Alpine STC44 and least significant in Milgard. Similarly, locking concerns were highest in Alpine STC44 and lowest in Milgard. Overall, the most common issues were seal failure, condensation, and caulking, each affecting over 90% of the homes within the field assessment.

Table 26. Percentage of Homes with Noted Window Concerns

| Identified Concerns | Alpine STC35 (3) | Alpine STC44 (15) | CDI STC44 (2) | Milgard (2) | Peerless DeVac (8) | Overall (30) |
|---|---|---|---|---|---|---|
| Seal Failure | 100% | 100% | 100% | 100% | 88% | 97% |
| Condensation | 100% | 100% | 100% | 100% | 88% | 97% |
| Frame | 33% | 73% | 50% | 0% | 63% | 60% |
| Caulking | 100% | 100% | 100% | 100% | 75% | 93% |
| Weepholes | 33% | 80% | 0% | 50% | 25% | 53% |
| Operation | 33% | 73% | 50% | 0% | 63% | 60% |
| Locking | 33% | 80% | 50% | 0% | 38% | 57% |
| Incorrect Install | 0% | 33% | 0% | 0% | 0% | 17% |
| Hardware | 33% | 73% | 50% | 0% | 50% | 57% |

SOURCE: Port of Seattle, 2024; ESA, 2024.

*Photo of window with sill painted over.*

*Photo of window trim deterioration.*

*Image of window balancer issue.*

*Image of window balancer issue.*

*Image of window original entry door with added storm door.*

The assessment of entry doors and sliding doors found that most had not been replaced as part of their original sound insulation work. The work performed was generally to add a storm system to the existing product. With entry doors, 81% (with or without storm door) were out of square (structurally misaligned) or plumb (i.e. not straight) or had visible light coming from the top, bottom, or strike plate side of the door jamb. In most cases, the weatherstripping was either damaged or missing. This finding, however, cannot be attributed to any Port program product, as most entry doors are original to the house.

Sliding doors were also largely not replaced. In all cases where modifications to the sliding doors were found, a 6–8-inch surround enclosure was installed on the home along with a secondary sliding door so that there were now two complete sets of doors. As previously noted, the fixed side of the sliding door and storm were not accessible for cleaning which allowed for potential mold growth and the buildup of other debris.

The ventilation system identified in the homes were non-mechanical vents. This consisted of an exterior vent covering a 4-inch pipe to the interior. The interior cap varied from a fixed cap to a movable cover to regulate the flow of fresh air into the structure. In two homes, the resident noted that in the winter months the wall upon which the non-mechanical vent is installed becomes musty and moldy.

# 6.2 WRITTEN SURVEY COMMENTS

Trends in individual comments were analyzed to supplement tabular survey results with insight gained during the field assessment. The five most common complaints are listed below. Additional details of the field assessment are found in **Section 6.1**.

- Mold and Moisture Issues
  - **Survey Notes -** Approximately 88 respondents reported potential mold growing between panes and on frames due to condensation and leaks. This concern is persistent and worsens during the winter. Concerns related to rusting hardware and moisture damage to frames and walls were also noted.
  - **Field Assessment -** Moisture was noted on numerous window packages and sliding doors. Window weeps were also found to have been covered by paint or caulk-closed due in part to the design and location of the weephole. When the weephole is covered, water is able to back up into the unit and slowly drain into the trim work and may cause deterioration of the trim and/or siding along with causing the caulking to release. In two instances in which the owner noted musty/moldy conditions in the winter months, it was in locations in which there was a non-mechanical vent present as a potential moisture pathway.

*Interior image of a window with possible mold.*

*Exterior image of a window with covered weephole and condensation between glass.*

*Exterior image of a window with weephole.*

*Exterior image of a window and mull covers weephole, as updated install method in and after 1998.*

*Exterior image of a window with trim damage.*

*Interior (upper) and exterior (lower) image of fresh air vent path.*

- Cleaning Difficulties
  - **Survey Notes -** A frequent concern identified by approximately 68 respondents is the difficulty in cleaning between double-pane windows, as well as dirt, fogging, and debris accumulating between the panes. Users also report that some doors are impossible to clean due to their design. These reported concerns were specific to STC44 manufacturers with non-removable storms which accounted for over 75% of the written comments.
  - **Field Assessment -** Multiple challenges were found in the ability to clean and maintain the product. The design of the product(s) created areas that could not be accessed behind fixed storm panels. Picture windows, sliding patio doors and sliding windows with a fixed side all created areas in which neither the owner nor a professional window cleaner could access and clean.

*Image of a window with debris between windowpanes.*

*Image of a window with debris between windowpanes.*

*Image of a window with debris between fixed storm windows.*

- Operational Issues
  - **Survey Notes -** Approximately 135 respondents reported concerns with doors being hard to open, close, or lock. Concerns were also noted over broken mechanisms, such as springs, cranks, and locking hardware.
  - **Field Assessment -** Issues with operation, such as opening, closing, being out of square, being out of tracks, and issues with locking mechanisms were noted. This was found on all product lines inspected in each home, except for Milgard product, for which no operational issue was noted in two homes.

*Image of a window with broken/corroded locks.*

*Image of a window with broken/corroded locks.*

- Seal (non-glass) and Insulation Failures
  - **Survey Notes -** Approximately 99 respondents identified concerns of poor sealing, leading to drafts, water leaks, and sound infiltration from outside. This lack of insulation results in significant heat loss and inadequate noise reduction.
  - **Field Assessment -** Entry doors were found to be out of square or plumb or had visible light coming from the top, bottom, or strike plate side of the door jamb. In most cases, the weatherstripping was either damaged or missing. In most homes the entry doors and sliding patio doors appeared to be the original to the home and were not a part of the sound insulation packages. The door scope was the addition of storm doors to entry and sliding patio doors. With single and double-hung windows in which the balancers were broken, the windows did not fully close and were a source of noise and air penetration.

*Image of single/double hung window with broken balance.*

*Image of an entry door with poor insulation.*

- Structural
  - **Survey Notes -** Approximately 73 respondents reported concerns of cracked glass, warped trim and/or frames and improper installation leading to rot.
  - **Field Assessment -** Issues found with screws set at the bottom of jamb, or piercing the sill down into the frame which allows water pooled within window to seep around screw, promoting water damage in wood framing and rusting/corroding the locking device. In cases in which the weepholes were caulked over, trim was found to be deteriorated.

*Photo of window deterioration.*

*Photo of window with mull leak and trapped debris.*

*Image of screw installed in sill.*

*Image of fresh air intake vent (exterior).*

*Image of fresh air intake vent (exterior).*

*Image of fresh air intake vent (interior).*

*Image of fresh air intake vent (interior).*

SECTION

# 7

# ASSESSMENT CONCLUSIONS

# ASSESSMENT CONCLUSIONS

## 7.1 CONCLUSIONS

One of the primary goals of the assessment was to capture survey responses from homeowners to understand the magnitude of the concerns being reported on the exiting conditions of previously installed sound insulation packages within the 2014 SEA Noise Remedy Boundary. With 33% of homeowners responding to the survey from all geographic areas throughout the targeted areas, this represents a statistically significant quantity from which reported conditions can be understood.

### KEY FINDINGS

Ninety-nine percent (99%) of products in the Assessment, except door slabs, are past their expected useful life. Therefore, in most cases, the reported concerns in the survey relate to situations beyond the Manufacturers' warranty term, (see **Section 3.1.1**). All 30 residences' acoustic tests results were below the FAA established noise standard of less than 45dB DNL threshold. Additional product type evaluations from the survey, independent EUL studies, acoustic test results and the field assessment are highlighted below.

### Aluminum Windows

- The industry expects the EUL of Aluminum Window to be 15-20 years, which represents 100% of the assessment population for this product (see **Table 2**).
- Aluminum windows acoustic testing demonstrated performance below the 45dB threshold (36dB-44dB).
- The survey found that 65.3% had operational reported concerns and 67.1% glass reported concerns.

The field assessment highlighted that the design of the product was a dual, single-pane storm panel system with a 1.75-to-2-inch airgap in between the storm panels. The size of some storm panels and the design that limited the open area and the availability of replacement parts create care and maintenance challenges for this product line.

## Vinyl Window Frames

- The industry expects the EUL of Vinyl window frames to be 20-30 years, which represents 38% of the Assessment population for this product (see **Table 2**).
- Vinyl windows acoustic testing demonstrated performance below the 45dB threshold (36dB-44dB).
- The field assessment provided insights into the design elements of the products used.

The design of fixed picture windows was consistent between the three manufacturers and consisted of a double-pane window with an integrated, non-removable storm window. This design limited the ability of the owner/resident or professional tradesperson to properly clean and maintain the product. Replacement of glass due to a seal failure would be challenging, if not impossible due to the design.

The design and placement of weepholes varied by manufacturer as discussed in Section 5. Weepholes are designed to allow the product to drain water from the frame when the product gets wet. The field assessment found that 175 of the 438 windows had weepholes covered with paint/caulk, or the window was recessed into the exterior trim (this allows for water to potentially be collected/ puddled on the wood trim). In cases in which the weepholes were caulked over, trim was found to be deteriorated. With respect to Alpine Windows, STC 44, the design and location of the weepholes made them highly susceptible to being caulked over either during installation and/or during routine maintenance by homeowner. From 1995-1998 the weephole was located in the auxiliary channel of the frame (see Section 5.2.2). This design location made caulking the parameter of the product challenging. In 1999, the frame was redesigned, and the weephole became more pronounced at the angled bottom corner which eliminated the caulking and drainage challenge.

A key installation failure by the contractor was noted on double hung windows. In 33 of 70 instances, the contractor installed them by setting a screw in the sill, thereby promoting water damage in the wood framing and rusting/ corroding the locking device and balancers over time.

## Hardware

- The industry does not list EUL of hardware but does note hardware replacement as necessary to prolong the overall product EUL (see **Table 2**).
- The survey found that the vinyl STC44 products had reported operational concerns of 69.8% - 71.8%. This included broken locks, balancers and rollers as noted in **Section 6.1.1**.

The ability to perform routine repair and maintenance is limited as most of the hardware components have been discontinued over time. This would also limit the ability to perform selective replacement as a program.

## Glass

- The industry expects the EUL of Glass/Glazing to be 8-20 years, which represents 99% of the assessment population for this product (see **Table 2**).
- The survey found that the reported concern for glass was on 60.0% - 73.1% which was validated during the field assessment.

All glass is beyond its product warranty except for Milgard which provided a limited lifetime warranty (i.e., the warranty is still in effect if property ownership has not changed since the original installation).

Care and maintenance were found to be impacted by the manufacturers' design. The field assessment found that, for 66% of the windows observed (291 of 438), residents were not able to adequately clean between moving sashes or fixed picture windows due to a non-removable storm panel.

## Storm Products

- The industry expects the EUL of Storm products to be 7-10 years, which represents 100% of the assessment population for this product (see **Table 2**).
- Storm products acoustic testing also demonstrated performance below the 45dB interior noise threshold. A more direct comparison was found between residences with Alpine STC35 products (42db-44dB) that do not have a storm panel vs the Alpine STC44 (35dB-42dB) with a storm panel.

Storm panels are used as they improve the acoustic performance. It was observed during the field assessment that the design created spaces that could not be cleaned or maintained. This was most pronounced with picture windows having a non-removable storm panel and sliding doors in which the fixed panels created an area that could not accessed.

## Sliding Doors

- The industry expects the EUL of Sliding Doors (with hardware replacement) to be 20 years, which represents 99% of the assessment population for this product (see **Table 2**).
- The survey found that the percentage of residents reporting concerns with sliding door operation was 45.5% and those expressing concerns with sliding door locking was 45.1%.

The field assessment found that sliding doors were largely not replaced, but rather a sliding storm door installed. In these instances, roughly 8" surround was built on the home to enclose the sliding storm door. The sliding storm door improves acoustic performance, but the field assessment found that the design created an area that could not be accessed and that could not be cleaned or maintained between the fixed panels of the two products.

## Entry Doors Slab

- The industry expects the EUL of Entry Door Slabs (excludes hardware) to be 20-30 years, which represents 48% of the Assessment population for this product (see **Table 2**).
- The survey found that the reported concern for operation was 45.5% and locking as 45.1%.

The field assessment noted that entry doors appeared to be either original, or a newer installation performed by the homeowner, based upon the style of the doors.

## Ventilation

The industry does not list EUL of ventilation systems largely due to the broad range of design options. It is known from Port records that homes received ventilation changes and would have met code requirements at the time of construction. Ventilation changes, as observed during the field assessment, largely consisted of non-mechanical ventilation.

## Repair Options

Glass is one category in which replacement could be an option, however due to the design of non-removable storm panels this would be a difficult potential repair. The ability to perform routine repair and maintenance is limited as most of the hardware components have been discontinued over time. The design of the products and lack of available parts would limit the ability to perform selective replacement as a program. This was validated through an evaluation of San Fransico International Airport's (SFO) repair/replacement programs. Except for Milgard, all other manufacturers used by both SEA and SFO are exclusively being replaced in the SFO program.

# ASSESSMENT CONCLUSIONS

Producing the assessment report that included research of independent EUL studies, a survey, acoustic test results and a field assessment allowed for a comprehensive understanding of the communities' reported concerns that would not have been possible with a single element of study.

**Window Expected Useful Life -** Evaluating four studies that occurred over a 20-year period informed the understanding of product longevity over time. The studies highlight that while the EUL of a window frame or door slab will be 20+ years, the components that make up the finished product, including glass and hardware, have shorter EULs. The studies note that to extend the EUL of the finished product, the ability to replace components, such as glass and hardware will be necessary. Based on this data, the report finds that 99% of the finished products installed prior to 2014 are past their expected useful life. Most of the products are also beyond their manufacturer's warranty period.

**Survey Results -** The survey that was sent to approximately 3,200 residences yielded an excellent response rate of 33% with 1,067 completed surveys. The survey allowed the community to share their concerns in a data-driven manner. Survey responses were reflective of the geographic distribution of sound installation packages throughout the 2014 SEA Noise Remedy Boundary. No trends related to the geographic distribution of the sound installation packages were found.

- The survey response rate mirrored the distribution of the approximately 3,200 installations from 1986 through 2014 indicating that the responses received accurately reflect the variety of packages installed (see **Table 11**).
- The survey responses quantified operational concerns at 50.0-71.8% of residences and glass concerns at 60.0-75.0% of residences (see **Table 16**).
- The data collected demonstrates that the impacts of the overall age and design of the finished product as factors for residential concerns and existing conditions, and not the specific year or product installed.

**Acoustic Testing -** Sound Insulation Programs are acoustic based. Thirty (30) residences were tested proportional to the known manufacturers and years in which sound insulation was installed. The FAA threshold for eligibility is 45dB DNL or greater. None of the 30 residences acoustically tested above this threshold. The acoustic tests results note that unless the product was open, they tested below the 45dB DNL threshold; no other correlation to reported concerns was identified. This finding is consistent with other FAA acoustic test studies from SFO and Boston Logan International Airport (BOS) that show acoustic performance remains below the 45dB DNL over time. Programs in which acoustic testing is a qualifier would limit the number of residences eligible to receive replacement products.

**Field Assessment -** The field assessment provided insights into manufacturers' product design, contractor installations, and owner maintenance of the products that could not be captured through other methods. By doing it in conjunction with the acoustic testing, the 30 homes were selected in a way that is proportional to the known manufacturers and years in which sound insulation was performed. The field assessment found care and maintenance were impacted by the design, especially regarding weepholes, fixed picture windows, and designs that created spaces that could not be cleaned or maintained as well as the limited availability of replacement parts. Sixty-six percent (66%) of the windows observed were not able to adequately clean between moving sashes or fixed picture windows due to a non-removable storm panel. Forty-nine percent (49%) of the windows observed had issues with operation, 36% of operable windows had problems with locking and 34% had broken hardware such as balancers.

## SUMMARY OF CONCLUSIONS

- Extensive outreach was conducted to approximately 3,200 residents.
- A 33% response rate, or 1,067 residents, returned surveys.
- Ninety-nine percent (99%) of the finished products installed prior to 2014 are past their expected useful life. Most of the products are also beyond their manufacturer's warranty period.
- The 30 residences which were acoustically tested all tested below the FAA 45dB DNL threshold and continued to provide effective sound insulation.
- No correlation between reported concerns and acoustic test performance was identified.
- The design of window products is a significant factor in the longevity and repairability and links to the reported concerns of the community.
  - This is especially true regarding weepholes, fixed picture windows and designs that created spaces that could not be cleaned or maintained.
  - For 66% of the windows observed during the field assessment, residents were not able to adequately clean between moving sashes or fixed picture windows due to a non-removable storm panel.
- Contractor installation issues were found in single- and double-hung products.
- The lack of available replacement parts for all manufacturers except Milgard has limited owner/resident ability to perform regular care and maintenance.

SECTION

# 8

# POTENTIAL PROGRAM FUNDING SOURCES

# POTENTIAL PROGRAM FUNDING SOURCES

## 8.1 EXISTING FAA GRANT FUNDING

SEA is one of five airports that are eligible to establish a Pre-1993 Sound Insulation Program. This program requires all homes to be tested utilizing the program's current FAA approved ATP. The home would need to acoustically test at or above 45dB to be eligible. As noted in Section 4.4, the results from this analysis indicate that the 30 homes tested each have an average interior DNL sound level below the FAA threshold of 45dB, making them ineligible for sound insulation treatment through federal funding.

There are approximately 480 homes that received sound insulation prior to 1993 and are within the current 2014 SEA Noise Remedy Boundary. It cannot be said with certainty how many homes may test eligible for this FAA grant program. While the number of homes that would receive replacement may be small, it represents a clear pathway to further engage with the FAA and legislative leaders on the topic of previously installed products. As an Airport Improvement Program (AIP), the costs would be shared with 80% paid by the FAA and 20% by the Port.

## 8.2 POTENTIAL GRANT STYLE FUNDING WITH PENDING SENATE BILL

Similar to section 7.2.1, the legislation proposed by Senator Murray, pending approval of the FY 2025 budget and FAA rules adoption, would mirror the FAA pre-1993 program requirements with a proposed cutoff of pre-2002. The legislation would still require additional actions by the FAA to become a grant program. This recommendation would require acoustic testing on eligible homes within the SEA Noise Remedy Boundary in effect at the time of program expansion. The recommendation would expand the number of potentially eligible homes. However, with the acoustic test requirement, the number of homes that would receive replacement may be small. Based on this assessment, the sound insulation packages installed from 1993 to 2001 tested below the FAA 45dB DNL threshold.

There may be an opportunity for continued advocacy through sharing the findings of the assessment and crafting legislation with eligibility criteria other than an acoustic test exceeding the FAA 45dB DNL threshold.

## 8.3 LOCAL AND STATE PROGRAMS

Washington State created a limited funding source through Senate Bill 5955 (SB 5955). A potential program would be a grant style program administered by the Washington State Department of Commerce. This legislation created a 50% match, up to $1 million for the Port district offering repair or replacement of previously installed sound insulation packages. The Port's funding would come from non-airport revenue such as the tax levy and this may be a one-time funding appropriation.

The Washington State Department of Commerce also offers grants for multiple activities including insulation, weather stripping, ventilation, light bulbs, and HVAC. Window replacement is not currently an eligible scope item. In 2025, King County is planning to expand the scope of its Energize program through ventilation upgrades and HEPA filter systems; this program does not offer window or door replacement as an eligible scope item.

The Port could continue its advocacy with other WA governmental agencies to expand the scope of eligible items within energy efficiency programs Specifically including windows, doors and acoustic products which would also improve the energy efficiency of homes. Window energy ratings, or U-factors, are a critical measure of a window's energy efficiency, indicating how well a window insulates. The U-factor measures the rate of heat transfer through a window, with lower values representing better insulating properties. The Energy Code has changed over time from U factors over 0.40 to the current required U factor of 0.30.