**Monday, May 5, 2025 - 6:00 p.m.**
Brisbane City Hall Annex
25 Park Place | Brisbane, CA 94005
Hybrid Option: https://smcgov.zoom.us/j/93011857218
Call-in: US: +1(669)900-6833 Webinar ID: 930 1185 7218

This meeting of the San Francisco Airport Community Roundtable Ground Based Noise Subcommittee will be in person at the above-mentioned address. Members of the public will be able to participate in the meeting remotely via the Zoom platform or in person at 25 Park Place, Brisbane, CA 94005.

## Public Comment

In-person Participation:
If you wish to speak to the Membership, please fill out a speaker's slip located at the entrance. If you have anything you want to distribute to the Membership and include in the official record, please hand it to the Clerk who will distribute the information to the Membership and Staff.

Via Teleconference (Zoom):
The meeting may be accessed through Zoom online at https://smcgov.zoom.us/j/93011857218
The webinar ID: 930 1185 7218. The meeting may also be accessed via telephone by dialing +1-669-900-6833, entering webinar 930 1185 7218 then pressing #. You will be asked to enter an email address and name. We request that you identify yourself by name as this will be visible online and will be used to notify you that it is your turn to speak. When the Chairperson calls for the item on which you wish you speak click on the "raise-hand" icon. You will then be called on and unmuted to speak.

Written Public Comments:
Written comment should be emailed to sforoundtable@smcgov.org. Your email should include the specific agenda item for which you are submitting a comment. Members of the public are limited to one written comment per agenda item and the length of the emailed comment should be commensurate with two minutes or approximately 300 words. Written comments received by 5:00 pm on the day before the meeting, will be provided to the Roundtable, made publicly available on the website and read during the meeting.

## ADA Requests

Individuals who require special assistance or a disability-related modification or accommodation to participate in this meeting, or who have a disability and wish to request an alternative format for the agenda packet or other writings that may be distributed at the meeting, should contact staff as early as possible but no later than 10:00 am the day before the meeting at SFORoundtable@smcgov.org Notification in advance of the meeting will enable Staff to make reasonable arrangements to ensure accessibility to this meeting, the materials related to it, and your ability to comment.

## AGENDA

1. Call to Order / Roll Call / Declaration of a Quorum Present

2. Public Comment on Items NOT on the Agenda
   Speakers are limited to two minutes. Roundtable members cannot discuss or take action on any matter raised under this item.

3. Introduction and Comments from Subcommittee Chairperson
   Terry O'Connell, City of Brisbane

## REGULAR AGENDA

Public Comment will be received on Regular Agenda items prior to action or discussion by the Roundtable.

| | | | |
|---|---|---|---|
| 4. | Ground-Based Noise Measurement Program Summary of Results | *Information* | Page 3 |
| 5. | Discussion and recommendations for future Ground-Based noise monitoring strategies and priorities | *Information* | |

## UPDATES

| | | | |
|---|---|---|---|
| 6. | Member Updates | *Information* | Verbal |
| 7. | Adjourn | | |

San Francisco International
Airport/Community Roundtable

455 County Center, 2nd Floor
Redwood City, CA 94063
T (650) 363-4220
F (650) 363-4849
www.sforoundtable.org

April 28, 2025

| | |
|---|---|
| TO: | Ground Based Noise (GBN) Subcommittee Members |
| FROM | Vanessa Lee, SFO Roundtable Coordinator |
| SUBJECT: | Ground-Base Noise Measurement Program Summary of Results |

## BACKGROUND

SFO maintains a comprehensive aircraft noise monitoring system to track and manage noise levels in the communities surrounding the Airport. In recent years, concerns have been raised by residents and community representatives that the existing CNEL (Community Noise Equivalent Level) contours may not adequately capture the true aircraft noise environment, particularly in adjacent hillside communities where aircraft do not typically fly overhead. There was also a perception that low-frequency noise might be more prominent in these areas due to the way sound propagates over ground surfaces.

To address these concerns, the SFO Airport/Community Roundtable partnered with its technical consultant, HMMH, and the San Francisco International Airport (SFO) Aircraft Noise Office to design and conduct a targeted noise monitoring program. This initiative, known as the 'Up-the-Hill' noise study, aimed to measure and analyze actual aircraft noise levels in specific communities perceived to be impacted, including Millbrae and Burlingame. The goal was to gather data that would assess and validate these community concerns by examining both standard A-weighted and low-frequency C-weighted sound measurements during typical SFO operational conditions.

## OVERVIEW

The primary objective of the study was to better understand how noise from aircraft departures, particularly from Runways 1L and 1R, propagates into the surrounding communities. Following direction from the Ground-Based Noise (GBN) Subcommittee, a focused project study area was established, targeting locations directly adjacent to and southwest of the runway alignments. Noise monitoring was conducted over a 21-day period, from July 7 to July 27, 2024; and data collection took place at a total of 14 locations, including five temporary portable monitoring sites and nine permanent noise monitoring stations. The geographic range of monitoring included communities in Millbrae, Burlingame, San Bruno, South San Francisco, and Daly City. Both A-weighted (typical human hearing sensitivity) and C-weighted (low-frequency sensitive) sound levels were measured, providing a robust dataset for evaluating community noise exposure relative to standard noise modeling practices.

## SUMMARY OF RESULTS

The study results indicated that noise levels, both A-weighted and C-weighted, within the standard CNEL contours were consistently higher than those measured in adjacent communities outside the contours. The overall findings suggest that low-frequency noise levels remain proportionally consistent with A-weighted noise levels and do not show a distinct pattern of increased exposure in the adjacent communities.

SAN FRANCISCO INTERNATIONAL AIRPORT
CITY & COUNTY OF SAN FRANCISCO

# MEMORANDUM

TO: San Bruno Community

FROM: SAN FRANCISCO INTERNATIONAL AIRPORT AIRCRAFT NOISE OFFICE

SUBJECT: SFO Roundtable *Up-The-Hill* Noise Monitoring Study – July 2024
*SFO Permanent Noise Monitoring Location – Site 1 in San Bruno*

DATE: November 5, 2024

The San Francisco International Airport (SFO) Aircraft Noise Office conducted aircraft noise monitoring in Millbrae and Burlingame to determine the noise levels within the community from aircraft operations at SFO. This noise monitoring was conducted as part of a SFO Airport/Community Roundtable "Up-the-Hill" noise study researching the effects of takeoff and landing noise on communities situated next to the airport. This monitoring lasted for 21 days, occurring between July 7 and July 27, 2024, across 5 one-time monitoring locations and 9 permanent monitoring locations.

San Bruno, South San Francisco, and Daly City are situated adjacent to SFO, with San Bruno sitting directly to the west, South San Francisco to the northwest, and Daly City further northwest. Much of the aircraft noise that reaches San Bruno, South San Francisco, and Daly City is caused by departing aircraft traveling overhead at low altitudes from the west runways, Runways 28L and 28R. But, because of their proximity to the airport, they may also receive noise from takeoffs and landings that do not directly overfly them. Aircraft operations on the airfield, takeoffs (takeoff thrust) and landings (reverse thrust from jet engine thrust reversers) generate noise that travels across the landscape, and it is expected that weather and topography may amplify this noise to nearby communities.

SFO uses both Aircraft Noise Event Extraction Methodology (ANEEM) and Noise Power Distance (NPD) event classification methods and both A-weighted (dBA) and C-weighted (dBC) noise levels to generate this report. ANEEM is newer technology that looks at aircraft in the surrounding area to determine if any spikes in noise based on a floating threshold level may be logically correlated to them. Historically, ANEEM's correlation logic used AEDT modeled noise to classify if the increase in noise was logically generated by an aircraft, but this had to be modified to also look at aircraft thrust and timing to effectively correlate noise spikes to aircraft landing and taking off on or very close to ground level. NPD uses static noise thresholds to determine if spikes in noise qualify as noise events, then looks to see if there are any aircraft in the surrounding area that could be the cause of the noise. The noise monitor NPD threshold for the total monitoring period was 65 dBA. Both ANEEM and NPD first generated events based on A-weighted noise levels, then used the time window of the A-weighted noise events to identify the C-weighted noise events.

During this study, there were approximately 340 noise events per day caused by SFO airfield operations using the ANEEM method. Approximately 100% of all aircraft noise events were from SFO aircraft. Aircraft noise events sources include primarily direct overflights from departing aircraft from SFO's west-facing runways, Runways 28L and 28R. Other airfield operations which could be heard at the monitor included noise from departing aircraft from SFO's north-facing runways, Runways 01L and 01R, and from landing aircraft using thrust reversers to assist with slowing down after touching-down on SFO's west-facing runways, Runways 28L and 28R.

During the monitoring period, the overall Aircraft Community Noise Equivalent Level (CNEL) using ANEEM was 73 dBA and the Aircraft CNEL and Community CNEL using NPD were 73 dBA and 55 dBA, respectively. This noise monitor was located in a busy suburban area with daily ambient noise ranging between 53 and 58 dba. Aircraft noise above ambient levels may have been perceptible by residents. Additionally, the frequency of flights due to the proximity of the Airport may have increased annoyance levels.

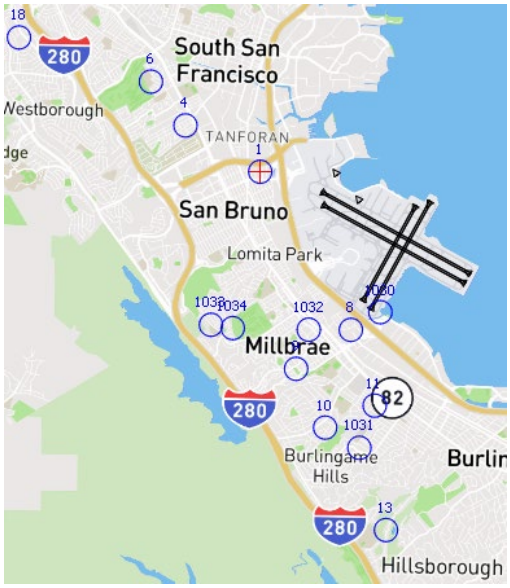
During the monitoring period, the SFO Aircraft Noise Office received 139 noise reports from 7 San Bruno residents. Most noise reports were generated between 8AM and 12AM. Likewise, most of the SFO Aircraft noise events using ANEEM occurred between 1AM and 12AM.

This report includes one evaluation of a 21-day period including 16 parts (charts and graphics) that represent summaries of the aircraft noise-related data (values are subject to rounding) collected during the monitoring period. Each part and key terms used in this report are described in the Appendix and Glossary, respectively.

## A – Monitoring Summary

| | |
|---|---|
| **Monitoring Site** | SFO Site 1, San Bruno |
| **Monitoring Site Elevation (ft)** | 16 |
| **Monitoring Period** | July 7 – July 27, 2024 |
| **Average Ambient Noise (dBA)** | 56 |
| **NPD Community (non-aircraft) CNEL (dBA)** | 55 |
| **NPD Aircraft CNEL (dBA)** | 73 |
| **NPD Avg Daily SFO Noise Events** | 211 |
| **ANEEM Aircraft CNEL (dBA)** | 73 |
| **ANEEM Avg Aircraft SEL (dBA)** | 91 |
| **ANEEM Avg Aircraft SEL (dBC)** | 98 |
| **ANEEM Avg Aircraft Lmax (dBA)** | 73 |
| **ANEEM Avg Aircraft Lmax (dBC)** | 83 |
| **ANEEM Avg Daily SFO Noise Events** | 340 |
| **SFO West Flow** | 100% |
| **SFO Southeast Flow** | 0% |

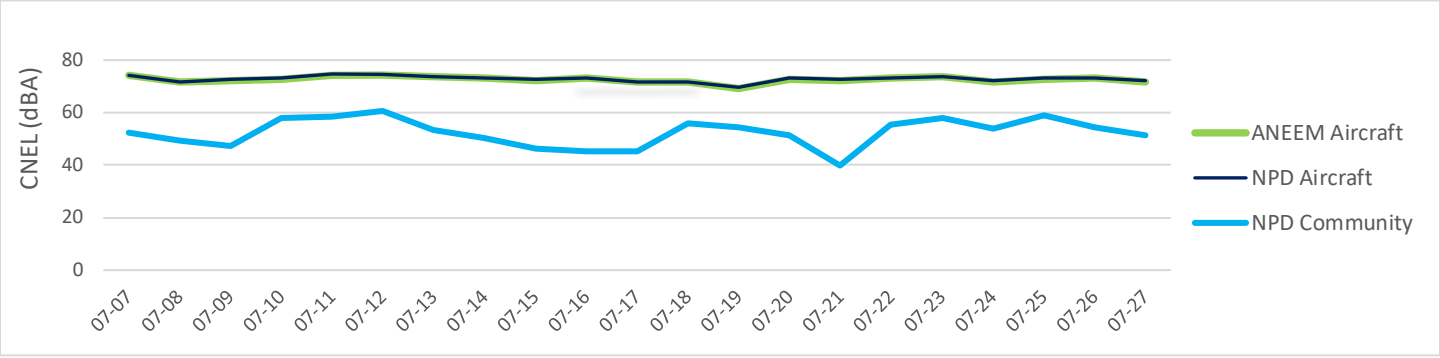
## B – Monitoring Location



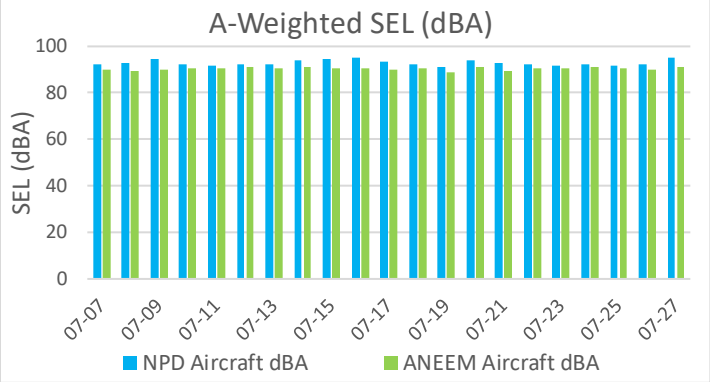

## C – Daily Noise Event Averages

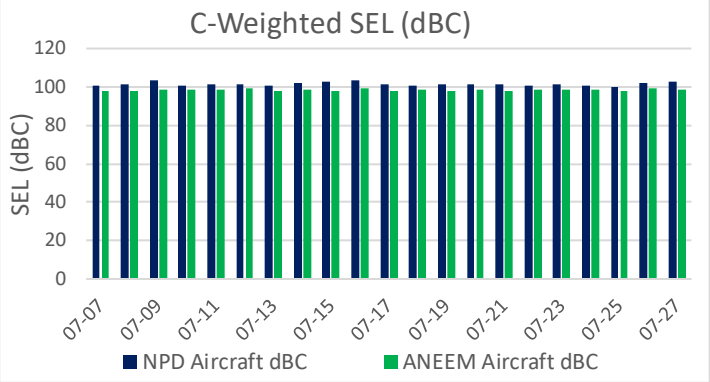
| Day | SFO Aircraft A-Weighted Noise | | | | | | SFO Aircraft C-Weighted Noise | | | | | | Community A-Weighted Noise | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | NPD | | | ANEEM | | | NPD | | | ANEEM | | | NPD | | |
| | Noise Events | Avg SEL | Avg Lmax | Noise Events | Avg SEL | Avg Lmax | Noise Events | Avg SEL | Avg Lmax | Noise Events | Avg SEL | Avg Lmax | Noise Events | Avg SEL | Avg Lmax |
| **07-07** | 253 | 93 | 77 | 411 | 90 | 73 | 253 | 101 | 86 | 411 | 98 | 83 | 115 | 79 | 68 |
| **07-08** | 167 | 93 | 79 | 356 | 90 | 71 | 167 | 102 | 88 | 356 | 98 | 81 | 105 | 78 | 68 |
| **07-09** | 125 | 95 | 84 | 328 | 90 | 71 | 125 | 103 | 90 | 328 | 99 | 82 | 5 | 89 | 73 |
| **07-10** | 257 | 92 | 77 | 328 | 91 | 74 | 257 | 101 | 87 | 328 | 98 | 83 | 281 | 80 | 68 |
| **07-11** | 316 | 92 | 77 | 406 | 91 | 74 | 316 | 101 | 87 | 406 | 99 | 84 | 298 | 80 | 68 |
| **07-12** | 344 | 92 | 76 | 384 | 91 | 75 | 344 | 101 | 87 | 384 | 99 | 85 | 467 | 80 | 68 |
| **07-13** | 280 | 92 | 77 | 418 | 91 | 73 | 280 | 101 | 85 | 418 | 98 | 82 | 122 | 79 | 68 |
| **07-14** | 171 | 94 | 81 | 323 | 91 | 74 | 171 | 102 | 89 | 323 | 99 | 82 | 30 | 84 | 72 |
| **07-15** | 124 | 95 | 85 | 317 | 91 | 72 | 124 | 103 | 91 | 317 | 98 | 81 | 11 | 84 | 71 |
| **07-16** | 108 | 95 | 86 | 321 | 91 | 71 | 108 | 104 | 93 | 321 | 99 | 83 | 8 | 79 | 72 |
| **07-17** | 141 | 93 | 81 | 279 | 90 | 73 | 141 | 102 | 89 | 279 | 98 | 82 | 43 | 77 | 68 |
| **07-18** | 204 | 92 | 78 | 275 | 91 | 74 | 204 | 101 | 87 | 275 | 99 | 84 | 268 | 79 | 68 |
| **07-19** | 178 | 91 | 78 | 274 | 89 | 74 | 178 | 101 | 88 | 274 | 98 | 84 | 169 | 79 | 68 |
| **07-20** | 188 | 94 | 80 | 358 | 91 | 73 | 188 | 102 | 88 | 358 | 99 | 84 | 55 | 81 | 70 |
| **07-21** | 169 | 93 | 81 | 360 | 90 | 72 | 169 | 101 | 88 | 360 | 98 | 82 | 10 | 77 | 68 |
| **07-22** | 264 | 92 | 77 | 373 | 91 | 74 | 264 | 101 | 87 | 373 | 98 | 83 | 240 | 79 | 68 |
| **07-23** | 275 | 92 | 76 | 348 | 91 | 74 | 275 | 101 | 87 | 348 | 99 | 84 | 291 | 80 | 68 |
| **07-24** | 239 | 92 | 78 | 327 | 91 | 75 | 239 | 101 | 87 | 327 | 99 | 84 | 137 | 78 | 68 |
| **07-25** | 269 | 92 | 76 | 331 | 90 | 74 | 269 | 100 | 85 | 331 | 98 | 83 | 381 | 79 | 68 |
| **07-26** | 238 | 92 | 78 | 370 | 90 | 74 | 238 | 102 | 88 | 370 | 99 | 84 | 199 | 79 | 68 |
| **07-27** | 118 | 95 | 86 | 261 | 91 | 73 | 118 | 103 | 91 | 261 | 99 | 81 | 8 | 82 | 71 |
| **Daily Average** | **211** | **93** | **79** | **340** | **91** | **73** | **211** | **101** | **87** | **340** | **98** | **83** | **154** | **80** | **68** |
| **Total Count** | **4,428** | | | **7,148** | | | **4,428** | | | **7,148** | | | **3,243** | | |

## D – Community Noise Equivalent Level



## E – Average Sound Exposure Level



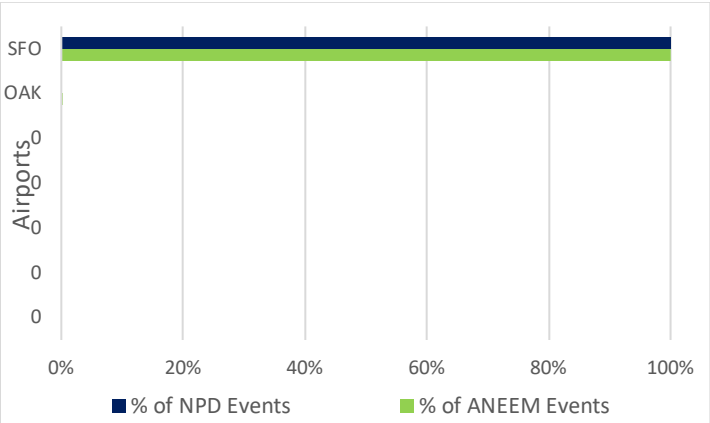




## F – SFO ANEEM Aircraft Noise Events by Time of Day

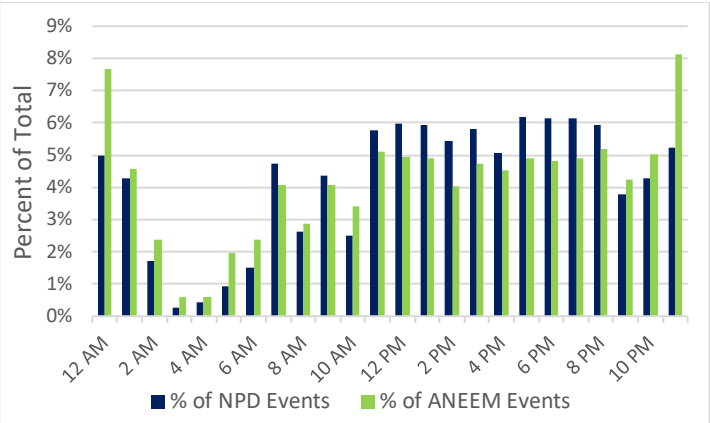
| SFO Aircraft ANEEM A-Weighted Events | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Time of Day | Noise Events | Noise Events % | Daily Avg SEL (dBA) | Min SEL (dBA) | Max SEL (dBA) | Avg Lmax (dBA) | Min Lmax (dBA) | Max Lmax (dBA) | Avg Duration (sec) | Min Duration (sec) | Max Duration (sec) |
| Day (7am–7pm) | 3,742 | 52% | 91 | 69 | 104 | 75 | 60 | 104 | 13 | 4 | 98 |
| Evening (7pm-10pm) | 1,025 | 14% | 89 | 68 | 109 | 73 | 61 | 99 | 13 | 4 | 79 |
| Night (10pm-7am) | 2,381 | 33% | 91 | 59 | 106 | 71 | 53 | 100 | 16 | 4 | 98 |

| SFO Aircraft ANEEM C-Weighted Events | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Time of Day | Noise Events | Noise Events % | Daily Avg SEL (dBC) | Min SEL (dBC) | Max SEL (dBC) | Avg Lmax (dBC) | Min Lmax (dBC) | Max Lmax (dBC) | Avg Duration (sec) | Min Duration (sec) | Max Duration (sec) |
| Day (7am–7pm) | 3,742 | 52% | 99 | 74 | 111 | 85 | 66 | 108 | 13 | 4 | 98 |
| Evening (7pm-10pm) | 1,025 | 14% | 97 | 73 | 112 | 83 | 67 | 103 | 13 | 4 | 79 |
| Night (10pm-7am) | 2,381 | 33% | 98 | 66 | 115 | 80 | 58 | 108 | 16 | 4 | 98 |

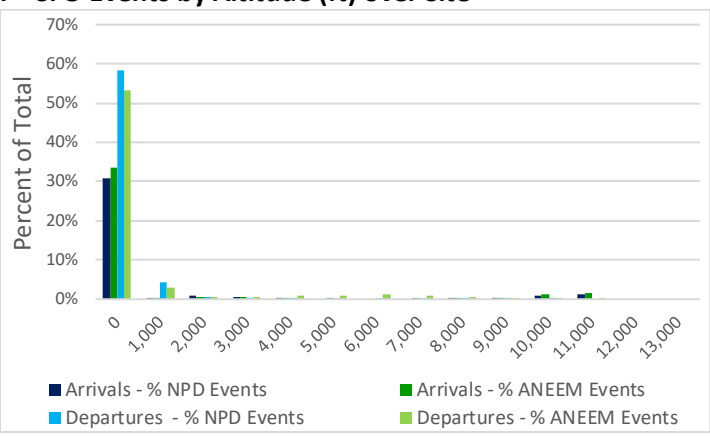
## G – Percentage of Events by Airports



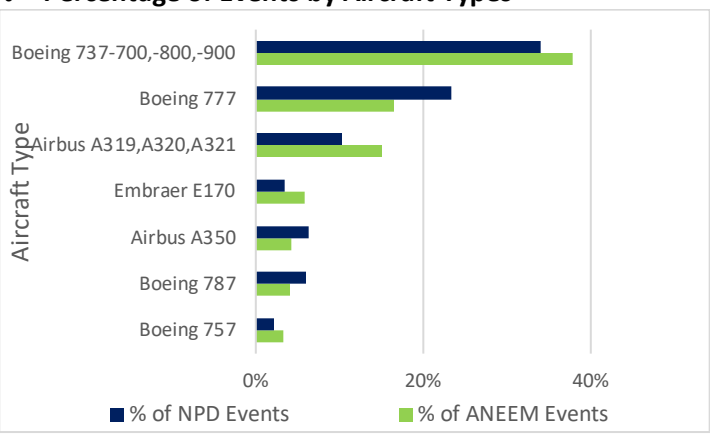

## H – SFO Noise Events by Hour of the Day



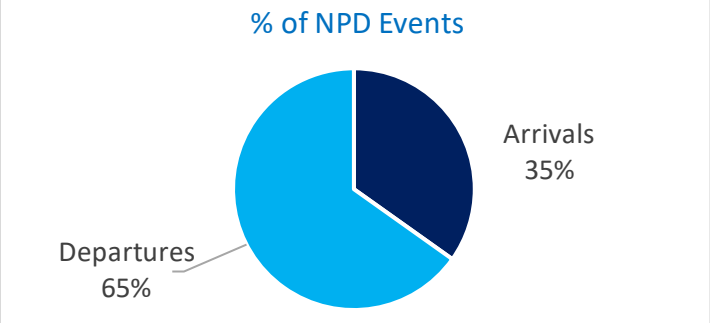

## I – SFO Events by Altitude (ft) over Site

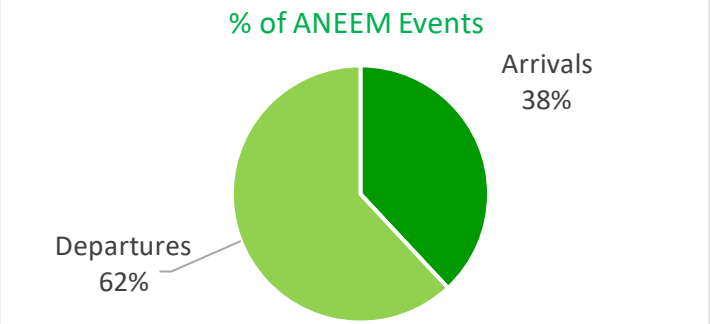



## J – Percentage of Events by Aircraft Types

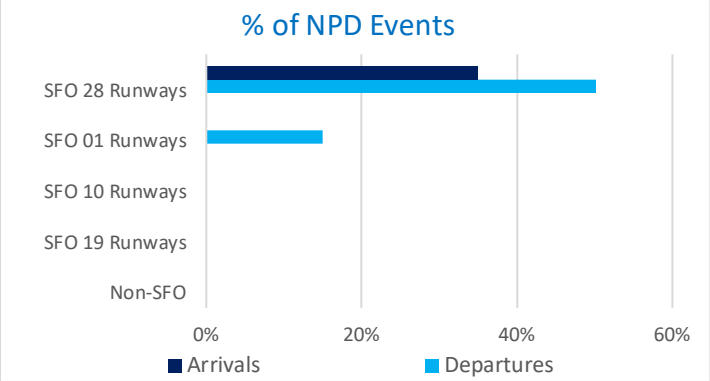


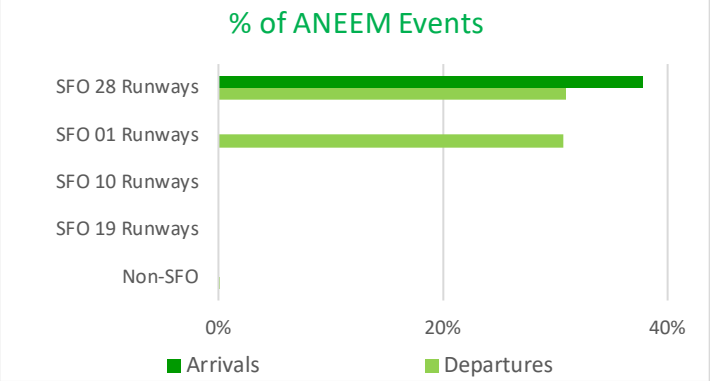
## K – Percentage of Aircraft Events by Operation Type




## L – Percentage of Aircraft Events by Runway and Operation Type

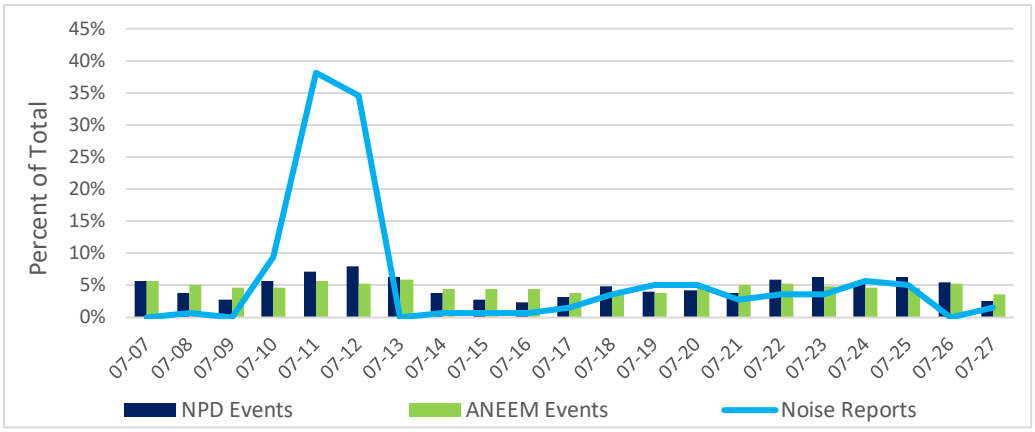


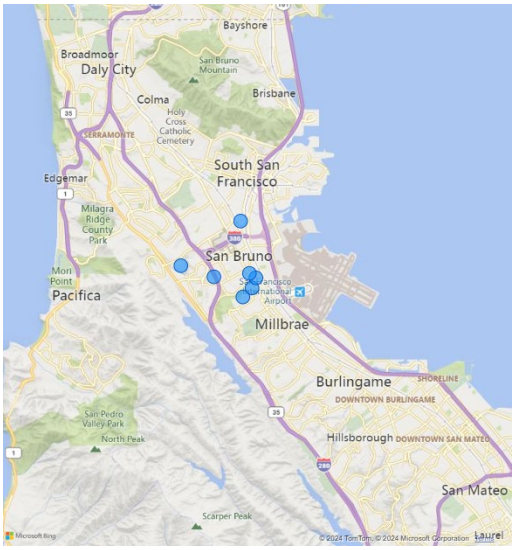

## M – Noise Reporters

| Date | Individual Noise Reporters | Noise Reports |
|---|---|---|
| 07-07 | 0 | 0 |
| 07-08 | 1 | 1 |
| 07-09 | 0 | 0 |
| 07-10 | 1 | 13 |
| 07-11 | 3 | 53 |
| 07-12 | 3 | 48 |
| 07-13 | 0 | 0 |
| 07-14 | 1 | 1 |
| 07-15 | 1 | 1 |
| 07-16 | 1 | 1 |
| 07-17 | 1 | 2 |
| 07-18 | 1 | 5 |
| 07-19 | 1 | 7 |
| 07-20 | 1 | 7 |
| 07-21 | 2 | 4 |
| 07-22 | 1 | 5 |
| 07-23 | 2 | 5 |
| 07-24 | 1 | 8 |
| 07-25 | 2 | 7 |
| 07-26 | 0 | 0 |
| 07-27 | 1 | 2 |
| **Total** | **7** | **139** |

## N – Noise Reports vs Aircraft Noise Events per Day




## O – Noise Reporter Locations




## P – Noise Monitor on Location

## Appendix

*This Appendix describes the sections of the noise monitoring report and a glossary of terms.*

**Part A – Monitoring Summary** lists the monitoring location, elevation, the monitoring time period, and the key monitoring results including the ANEEM Aircraft, NPD Aircraft, and NPD Community Community Noise Equivalent level (CNEL), single event levels in both A and C noise weightings, and air traffic flow breakdown. The CNEL metric is used to assess and regulate aircraft noise exposure in communities surrounding the airport. California Title 21 Noise Regulations established an acceptable level of 65 dBA CNEL.

**Part B – Monitoring Location** illustrates the location of the portable noise monitor and examples of typical SFO flight operations that registered noise events at the portable noise monitor.

**Part C – Daily Noise Event Averages** lists the number of noise events registered at the noise monitor by SFO Aircraft for both A and C noise weightings using ANEEM (green) or NPD (blue) methods during each day of the noise monitoring period. NPD Community noise events by A-weighted noise levels are also included. The noise event levels are expressed as average Sound Exposure Level (SEL) and average peak noise level (Lmax).

**Part D – Community Noise Equivalent Level** shows a chart that compares the ANEEM Aircraft (SFO and non-SFO), NPD Aircraft, and NPD Community CNEL during each day of the monitoring period.

**Part E – Average Sound Exposure Level** (SEL) shows 2 charts comparing the ANEEM Aircraft (SFO and non-SFO) and NPD Aircraft average SEL for A and C-weighted noise levels during each day of the monitoring period.

**Part F – SFO Aircraft Noise Events by Time of Day** lists 2 tables including the daily minimum, maximum, and average SEL, Lmax, duration and number of SFO Aircraft noise events using ANEEM during the Daytime (7am to 7pm), Evening (7pm to 10pm), and Nighttime (10pm to 7am) for both A and C-weighted noise levels during the monitoring period.

**Part G – Percentage of Events by Airports** shows the percentage of aircraft events using ANEEM and NPD by the aircraft's nearest airport of origin or destination. The percentages for both methods each add up to 100%.

**Part H – SFO Noise Event by Hour of the Day** shows the percentage of total SFO Aircraft noise events using ANEEM and NPD by hour of the day. The percentages for both methods each add up to 100%.

**Part I – SFO Departure Events by Altitude (ft) over Site** shows the percentage of SFO Aircraft Departures and Arrivals that registered noise events at the noise monitor using ANEEM and NPD by altitude intervals. Altitudes are relative to mean sea level elevation. Excludes helicopters. The percentages for both methods each add up to 100%.

**Part J – Percentage of Events by Aircraft Types** shows the percentage of aircraft events using ANEEM and NPD by aircraft types. The percentages for both methods each add up to 100%.

**Part K – Percentage of Events by Operation Type** shows the percentage of aircraft noise events registered using ANEEM and NPD by Arrivals and Departures.

**Part L – Percentage of Aircraft Events by Runway and Operation Type** compares the percentage of aircraft noise events registered using ANEEM and NPD by Arrivals and Departures per each SFO runway pair and to non-SFO overflights.

**Part M – Noise Reporters** lists the number of individual noise reporters and noise reports per day registered by individuals living in Millbrae or Burlingame.

**Part N – Noise Reports vs Aircraft Noise Events per Day** compares the number of noise reports to the number of aircraft noise events per day using ANEEM and NPD. The percentages for both methods each add up to 100%.

**Part O – Noise Report Locations** illustrates a map that shows the noise report locations.

**Part P – Noise Monitor on Location** shows photographs of the noise monitoring equipment on location.

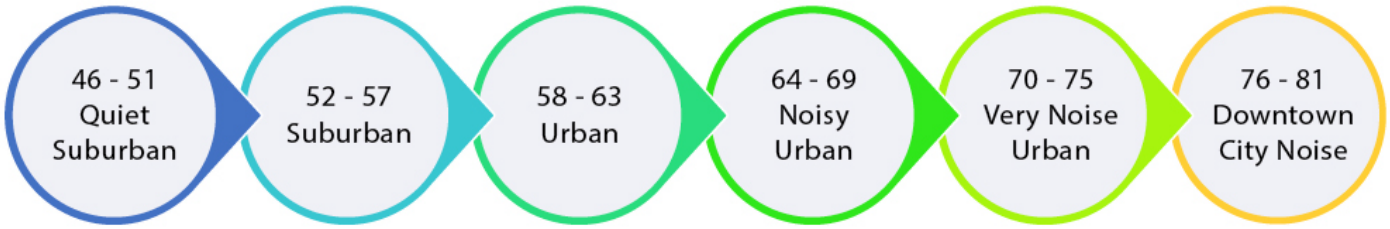
## Glossary

**A-Weighted Noise Level** – Denoted in dBA, is the most common unit used for measuring environmental sound levels. The human ear does not respond equally to different frequencies of sound. An A-weight adjusts the frequency components of sound to conform to your ear's normal response at conversational levels. The FAA and State of the California have adopted the A-weighted sound level for environmental analysis. Sound level meters have an A-weighting network for measuring noise in A-weighted decibels.

**C-Weighted Noise Level** – Denoted in dBC, is a different scale for loudness perception of sound pressure levels than A-weighted noise. A C-weight scale is used to measure sounds with approximately equal sensitivity at all frequencies. The C-weighted scale accounts for low-frequency ranges of sounds more than an A-weighted scale, often resulting in more of the overall noise energy to be included in the measurement.

**California Code of Regulations Title 21, Subchapter 6** – This code describes noise standards by defining metrics terminology and requirements regarding compatible land use. SFO was one of the first airports in the state to achieve a zero impact area within the 65 dB CNEL (Community Noise Equivalent Level) noise contour.

**Community Noise Equivalent Level (CNEL)** – A noise metric required by the California Airport Noise Standards for use by airport proprietors to measure aircraft noise levels. CNEL includes an additional weighting for each event occurring during the evening (7:00 p.m. – 9:59 p.m.) and nighttime (10:00 p.m. – 6:59 a.m.) periods to account for increased sensitivity to noise during these periods. Evening events are treated as though there were three and nighttime events are treated as though there were ten. This results in a 4.77 and 10 dBA penalty for operations occurring in the evening and nighttime periods, respectively. For a more in-depth explanation of CNEL and other technical noise terms, please visit the Federal Aviation Administration (FAA) website. Below is a graphic illustrating types of metropolitan areas and their corresponding CNEL intervals (dBA).




**Decibel (dB)** – A unit used to measure the magnitude or intensity of sound. The decibel uses a logarithmic scale to cover the very large range of sound pressures that can be heard by the human ear. Decibels measure a scale from the threshold of human hearing, 0 dB, upward towards the threshold of pain, about 120-140 dB. Because decibels are such a small measure, they are computed logarithmically and cannot be added arithmetically. A10 dB increase will be perceived by most people to be a doubling in loudness, i.e., 80 dB seems twice as loud as 70 dB. Decibel measurements can be scaled by different frequency ranges, such as by A-Weighted (dBA) and C-Weighted (dBC) scales.

**Maximum Sound Level (Lmax)** – The maximum a-weighted sound level for a given noise event. The peak noise level reached by a single aircraft event.

**Noise Event** – A Noise Event is the measured sound produced by a single source of noise over a duration of time. An aircraft noise event begins when the sound level of a flight operation exceeds a noise threshold and ends when the level drops down below that threshold.

**Sound Exposure Level (SEL)** – SEL is a measure of a single aircraft noise event spread out over its entirety compressed into one second. It allows for a comparison of aircraft noise events of different durations and noise levels. For example, think of the moment you hear a plane from a quarter mile away; we measure from that moment, as the aircraft flies overhead, and until it can't be heard. This is the duration of sound we use and then compress it into one second for a measure. SEL measures noise energy above the threshold (normally 65 dBA for aircraft noise events). This way, any ambient noise is separated out from the measurement.

SAN FRANCISCO INTERNATIONAL AIRPORT
CITY & COUNTY OF SAN FRANCISCO

# MEMORANDUM

TO: South San Francisco Community

FROM: SAN FRANCISCO INTERNATIONAL AIRPORT AIRCRAFT NOISE OFFICE

SUBJECT: SFO Roundtable *Up-The-Hill* Noise Monitoring Study – July 2024
*SFO Permanent Noise Monitoring Location – Site 4 in South San Francisco*

DATE: November 5, 2024

The San Francisco International Airport (SFO) Aircraft Noise Office conducted aircraft noise monitoring in Millbrae and Burlingame to determine the noise levels within the community from aircraft operations at SFO. This noise monitoring was conducted as part of a SFO Airport/Community Roundtable "Up-the-Hill" noise study researching the effects of takeoff and landing noise on communities situated next to the airport. This monitoring lasted for 21 days, occurring between July 7 and July 27, 2024, across 5 one-time monitoring locations and 9 permanent monitoring locations.

San Bruno, South San Francisco, and Daly City are situated adjacent to SFO, with San Bruno sitting directly to the west, South San Francisco to the northwest, and Daly City further northwest. Much of the aircraft noise that reaches San Bruno, South San Francisco, and Daly City is caused by departing aircraft traveling overhead at low altitudes from the west facing runways, Runways 28L and 28R. But, because of their proximity to the airport, they may also receive noise from takeoffs and landings that do not directly overfly them. Aircraft operations on the airfield, takeoffs (takeoff thrust) and landings (reverse thrust from jet engine thrust reverser), generate noise that travels across the landscape, and it is expected that weather and topography may amplify this noise to nearby communities.

SFO uses both Aircraft Noise Event Extraction Methodology (ANEEM) and Noise Power Distance (NPD) event classification methods and both A-weighted (dBA) and C-weighted (dBC) noise levels to generate this report. ANEEM is newer technology that looks at aircraft in the surrounding area to determine if any spikes in noise based on a floating threshold level may be logically correlated to them. Historically, ANEEM's correlation logic used AEDT modeled noise to classify if the increase in noise was logically generated by an aircraft, but this had to be modified to also look at thrust and timing to effectively correlate noise spikes to aircraft landing and taking off on or very close to ground level. NPD uses static noise thresholds to determine if spikes in noise qualify as noise events, then looks to see if there are any aircraft in the surrounding area that could be the cause of the noise. The noise monitor NPD thresholds for the total monitoring period were 62 dBA for daytime and 60 dBA for nighttime. Both ANEEM and NPD first generated events based on A-weighted noise levels, then used the time window of the A-weighted noise events to identify the C-weighted noise events.

During this study, there were approximately 583 noise events per day caused by SFO airfield operations using the ANEEM method. Approximately 100% of all aircraft noise events were from SFO aircraft. Aircraft noise events sources include primarily direct overflights from departing aircraft from SFO's west-facing runways, Runways 28L and 28R. Other airfield operations which could be heard at the monitor included noise from departing aircraft from SFO's North-facing runways, Runways 01L and 01R, and from landing aircraft using thrust reversers thrust to assist with slowing down after touching-down on SFO's West-facing runways, Runways 28L and 28R.

During the monitoring period, the overall Aircraft Community Noise Equivalent Level (CNEL) using ANEEM was 67 dBA and the Aircraft CNEL and Community CNEL using NPD were 67 dBA and 45 dBA, respectively. This noise monitor was located in a suburban area with daily ambient noise ranging between 41 and 49 dba. Aircraft noise above ambient levels

may have been perceptible by residents. Additionally, the frequency of flights due to the proximity of the Airport may have increased annoyance levels.

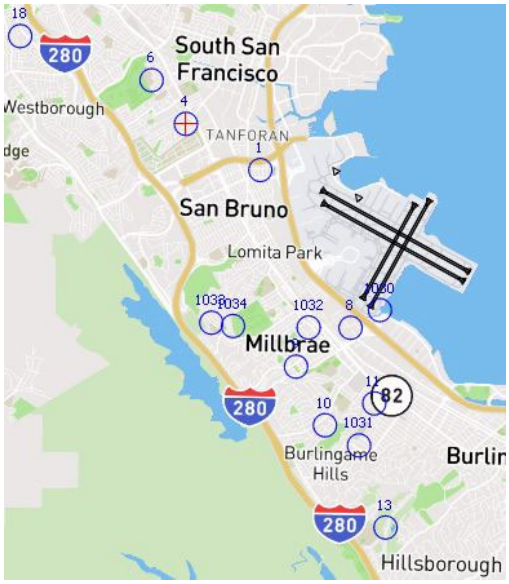
During the monitoring period, the SFO Aircraft Noise Office received 29 noise reports from 7 South San Francisco residents. Most of the noise reports were generated between 2AM and 12AM. Likewise, most of the SFO Aircraft noise events using ANEEM occurred between 8AM and 12AM.

This report includes one evaluation of a 21-day period including 16 parts (charts and graphics) that represent summaries of the aircraft noise-related data (values are subject to rounding) collected during the monitoring period. Each part and key terms used in this report are described in the Appendix and Glossary, respectively.

## A – Monitoring Summary

| | |
|---|---|
| **Monitoring Site** | SFO Site 4, South San Francisco |
| **Monitoring Site Elevation (ft)** | 52 |
| **Monitoring Period** | July 7 – July 27, 2024 |
| **Average Ambient Noise (dBA)** | 47 |
| **NPD Community (non-aircraft) CNEL (dBA)** | 45 |
| **NPD Aircraft CNEL (dBA)** | 67 |
| **NPD Avg Daily SFO Noise Events** | 170 |
| **ANEEM Aircraft CNEL (dBA)** | 67 |
| **ANEEM Avg Aircraft SEL (dBA)** | 83 |
| **ANEEM Avg Aircraft SEL (dBC)** | 94 |
| **ANEEM Avg Aircraft Lmax (dBA)** | 65 |
| **ANEEM Avg Aircraft Lmax (dBC)** | 80 |
| **ANEEM Avg Daily SFO Noise Events** | 582 |
| **SFO West Flow** | 100% |
| **SFO Southeast Flow** | 0% |

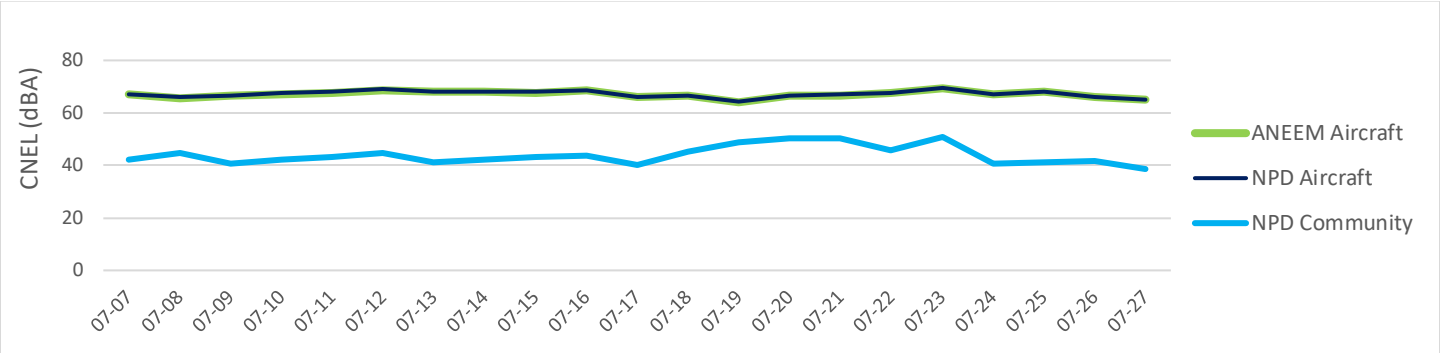
## B – Monitoring Location



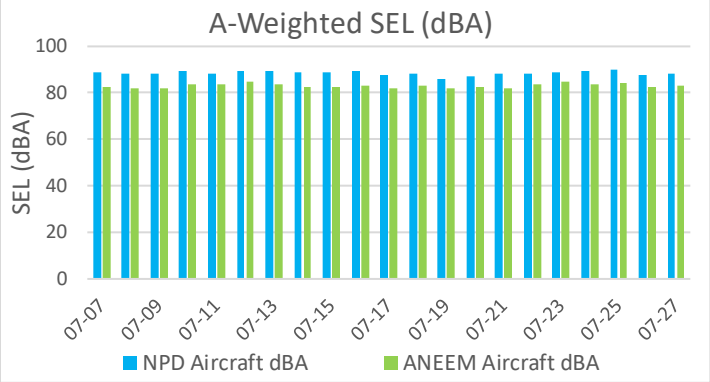

## C – Daily Noise Event Averages

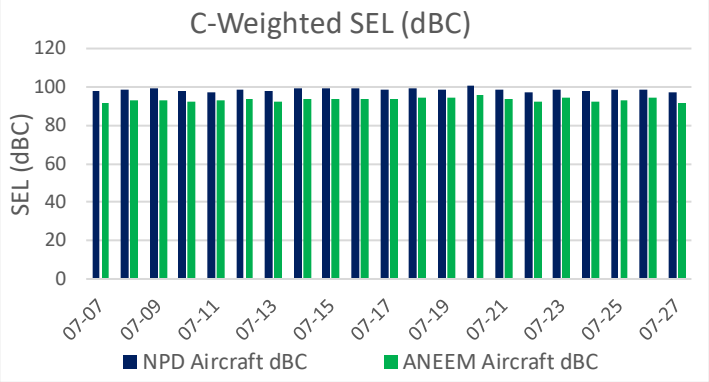
| Day | SFO Aircraft A-Weighted Noise | | | | | | SFO Aircraft C-Weighted Noise | | | | | | Community A-Weighted Noise | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | NPD | | | ANEEM | | | NPD | | | ANEEM | | | NPD | | |
| | Noise Events | Avg SEL | Avg Lmax | Noise Events | Avg SEL | Avg Lmax | Noise Events | Avg SEL | Avg Lmax | Noise Events | Avg SEL | Avg Lmax | Noise Events | Avg SEL | Avg Lmax |
| **07-07** | 142 | 89 | 76 | 587 | 83 | 64 | 142 | 98 | 85 | 587 | 92 | 78 | 11 | 76 | 69 |
| **07-08** | 151 | 88 | 76 | 625 | 82 | 64 | 151 | 99 | 87 | 625 | 93 | 79 | 25 | 80 | 72 |
| **07-09** | 165 | 88 | 76 | 671 | 82 | 64 | 165 | 99 | 87 | 671 | 93 | 78 | 16 | 77 | 70 |
| **07-10** | 148 | 89 | 76 | 486 | 84 | 64 | 148 | 98 | 84 | 486 | 92 | 76 | 12 | 75 | 66 |
| **07-11** | 161 | 88 | 75 | 416 | 84 | 66 | 161 | 97 | 84 | 416 | 93 | 78 | 13 | 77 | 68 |
| **07-12** | 168 | 90 | 76 | 466 | 85 | 67 | 168 | 99 | 86 | 466 | 94 | 81 | 14 | 76 | 68 |
| **07-13** | 180 | 89 | 76 | 693 | 83 | 65 | 180 | 98 | 85 | 693 | 93 | 78 | 12 | 76 | 69 |
| **07-14** | 203 | 89 | 76 | 800 | 83 | 64 | 203 | 99 | 87 | 800 | 94 | 79 | 19 | 79 | 71 |
| **07-15** | 182 | 89 | 76 | 723 | 83 | 65 | 182 | 99 | 87 | 723 | 93 | 80 | 19 | 79 | 70 |
| **07-16** | 159 | 90 | 77 | 676 | 83 | 65 | 159 | 99 | 87 | 676 | 94 | 80 | 18 | 79 | 70 |
| **07-17** | 182 | 88 | 76 | 686 | 82 | 65 | 182 | 99 | 87 | 686 | 94 | 81 | 22 | 76 | 70 |
| **07-18** | 187 | 88 | 75 | 598 | 83 | 66 | 187 | 99 | 88 | 598 | 94 | 81 | 35 | 78 | 71 |
| **07-19** | 180 | 86 | 74 | 490 | 82 | 66 | 180 | 99 | 87 | 490 | 94 | 81 | 38 | 77 | 70 |
| **07-20** | 245 | 87 | 75 | 662 | 83 | 68 | 245 | 100 | 89 | 662 | 96 | 84 | 66 | 78 | 70 |
| **07-21** | 151 | 88 | 76 | 654 | 82 | 64 | 151 | 98 | 86 | 654 | 93 | 81 | 36 | 75 | 68 |
| **07-22** | 186 | 89 | 74 | 508 | 84 | 65 | 186 | 97 | 84 | 508 | 92 | 77 | 36 | 79 | 66 |
| **07-23** | 199 | 89 | 74 | 468 | 85 | 67 | 199 | 99 | 85 | 468 | 94 | 79 | 70 | 77 | 67 |
| **07-24** | 148 | 90 | 76 | 577 | 84 | 65 | 148 | 98 | 85 | 577 | 92 | 78 | 13 | 75 | 68 |
| **07-25** | 115 | 90 | 77 | 431 | 84 | 65 | 115 | 99 | 85 | 431 | 93 | 78 | 13 | 77 | 68 |
| **07-26** | 195 | 87 | 75 | 586 | 83 | 67 | 195 | 99 | 87 | 586 | 94 | 83 | 21 | 77 | 71 |
| **07-27** | 125 | 88 | 77 | 428 | 83 | 64 | 125 | 97 | 84 | 428 | 92 | 77 | 7 | 75 | 68 |
| **Daily Average** | **170** | **89** | **76** | **582** | **83** | **65** | **170** | **99** | **86** | **582** | **94** | **80** | **25** | **78** | **69** |
| **Total Count** | **3,572** | | | **12,231** | | | **3,572** | | | **12,231** | | | **516** | | |

## D – Community Noise Equivalent Level



## E – Average Sound Exposure Level



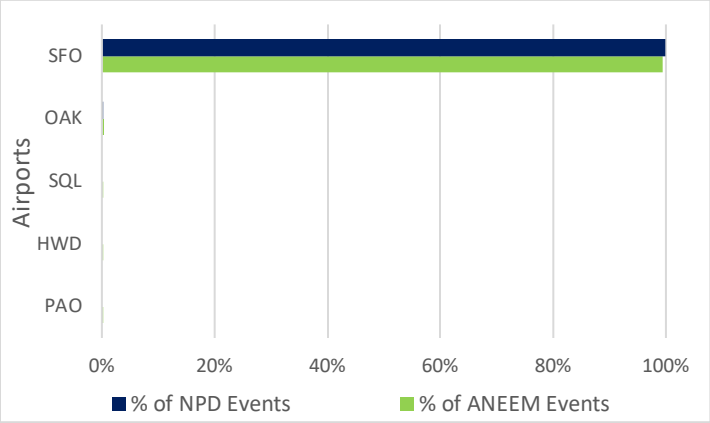




## F – SFO ANEEM Aircraft Noise Events by Time of Day

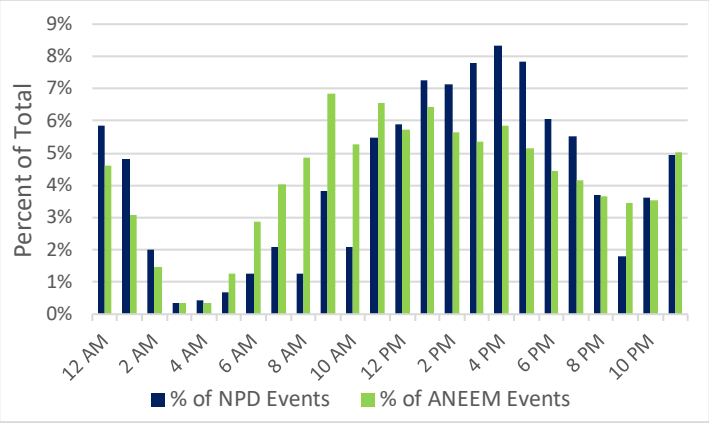
| SFO Aircraft ANEEM A-Weighted Events | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Time of Day | Noise Events | Noise Events % | Daily Avg SEL (dBA) | Min SEL (dBA) | Max SEL (dBA) | Avg Lmax (dBA) | Min Lmax (dBA) | Max Lmax (dBA) | Avg Duration (sec) | Min Duration (sec) | Max Duration (sec) |
| Day (7am–7pm) | 8,103 | 66% | 83 | 57 | 100 | 66 | 49 | 93 | 12 | 4 | 97 |
| Evening (7pm-10pm) | 1,375 | 11% | 82 | 59 | 98 | 65 | 52 | 91 | 12 | 4 | 99 |
| Night (10pm-7am) | 2,753 | 23% | 84 | 50 | 105 | 63 | 43 | 98 | 14 | 4 | 85 |

| SFO Aircraft ANEEM C-Weighted Events | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Time of Day | Noise Events | Noise Events % | Daily Avg SEL (dBC) | Min SEL (dBC) | Max SEL (dBC) | Avg Lmax (dBC) | Min Lmax (dBC) | Max Lmax (dBC) | Avg Duration (sec) | Min Duration (sec) | Max Duration (sec) |
| Day (7am–7pm) | 8,103 | 66% | 94 | 66 | 109 | 81 | 58 | 101 | 12 | 4 | 97 |
| Evening (7pm-10pm) | 1,375 | 11% | 92 | 67 | 108 | 80 | 60 | 99 | 12 | 4 | 99 |
| Night (10pm-7am) | 2,753 | 23% | 93 | 61 | 114 | 76 | 54 | 106 | 14 | 4 | 85 |

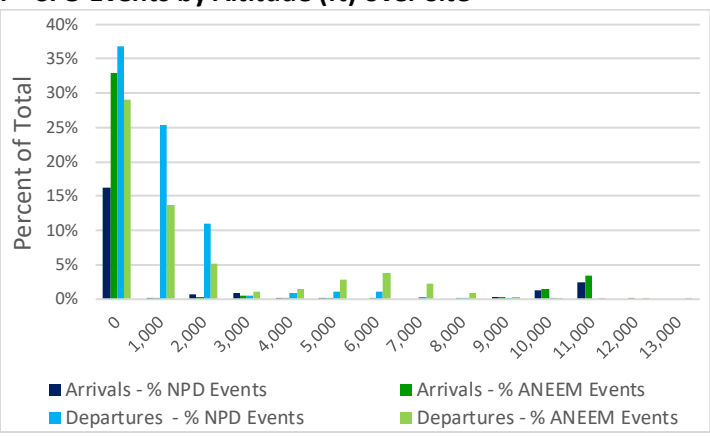
## G – Percentage of Events by Airports



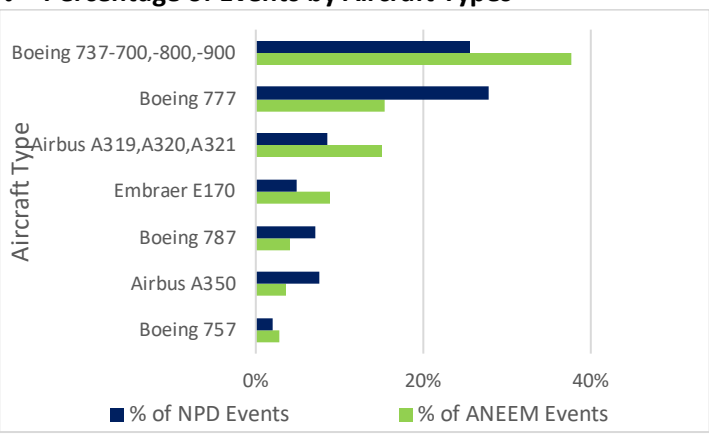

## H – SFO Noise Events by Hour of the Day



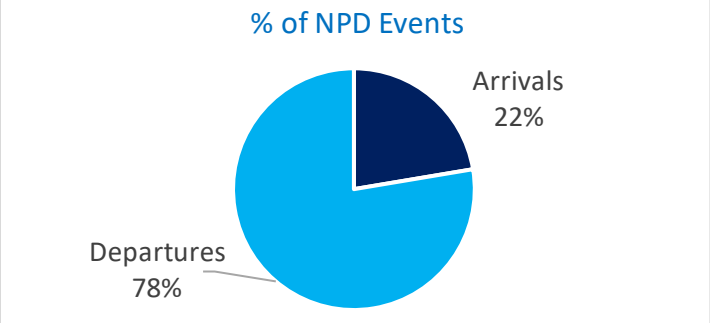

## I – SFO Events by Altitude (ft) over Site

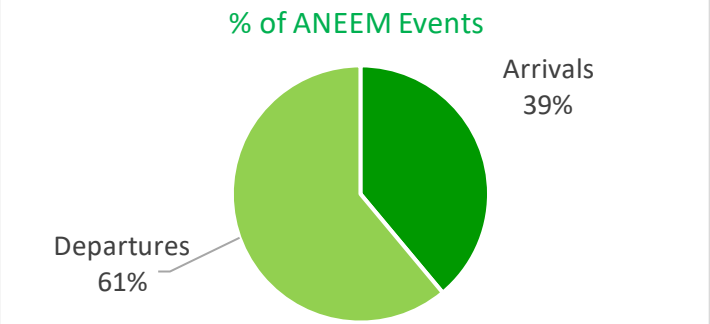



## J – Percentage of Events by Aircraft Types

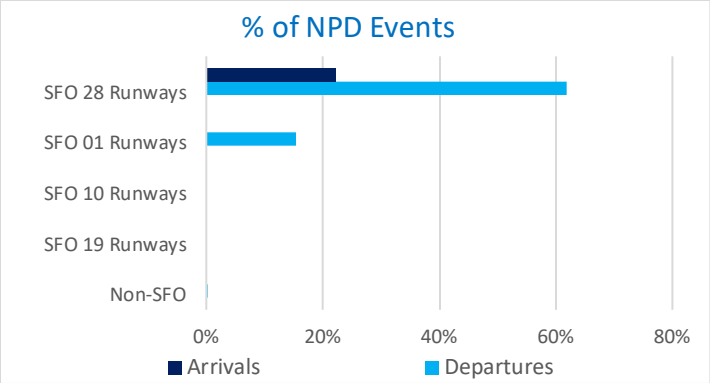


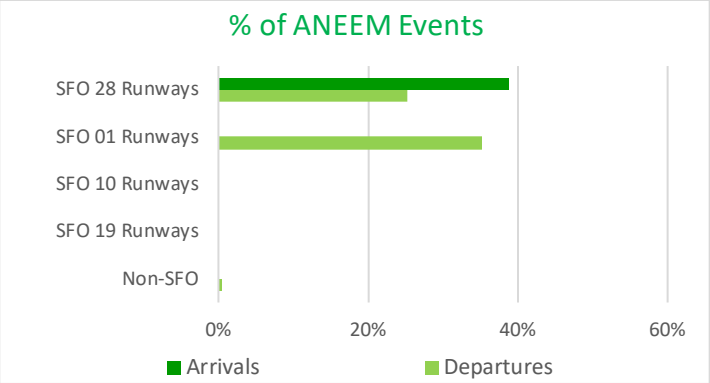
## K – Percentage of Aircraft Events by Operation Type




## L – Percentage of Aircraft Events by Runway and Operation Type

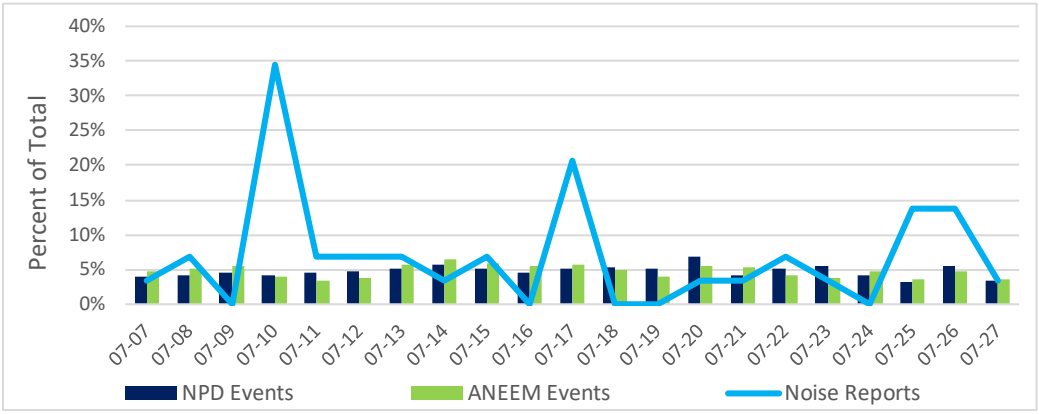


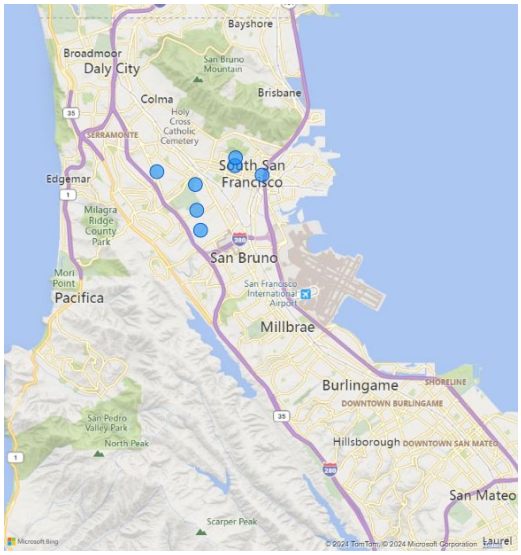

## M – Noise Reporters

| Date | Individual Noise Reporters | Noise Reports |
|---|---|---|
| 07-07 | 1 | 1 |
| 07-08 | 2 | 2 |
| 07-09 | 0 | 0 |
| 07-10 | 3 | 10 |
| 07-11 | 1 | 2 |
| 07-12 | 1 | 2 |
| 07-13 | 1 | 2 |
| 07-14 | 1 | 1 |
| 07-15 | 1 | 2 |
| 07-16 | 0 | 0 |
| 07-17 | 1 | 6 |
| 07-18 | 0 | 0 |
| 07-19 | 0 | 0 |
| 07-20 | 1 | 1 |
| 07-21 | 1 | 1 |
| 07-22 | 2 | 2 |
| 07-23 | 1 | 1 |
| 07-24 | 0 | 0 |
| 07-25 | 1 | 4 |
| 07-26 | 1 | 4 |
| 07-27 | 1 | 1 |
| **Total** | **7** | **29** |

## N – Noise Reports vs Aircraft Noise Events per Day




## O – Noise Reporter Locations




## P – Noise Monitor on Location

## Appendix

*This Appendix describes the sections of the noise monitoring report and a glossary of terms.*

**Part A – Monitoring Summary** lists the monitoring location, elevation, the monitoring time period, and the key monitoring results including the ANEEM Aircraft, NPD Aircraft, and NPD Community Community Noise Equivalent level (CNEL), single event levels in both A and C noise weightings, and air traffic flow breakdown. The CNEL metric is used to assess and regulate aircraft noise exposure in communities surrounding the airport. California Title 21 Noise Regulations established an acceptable level of 65 dBA CNEL.

**Part B – Monitoring Location** illustrates the location of the portable noise monitor and examples of typical SFO flight operations that registered noise events at the portable noise monitor.

**Part C – Daily Noise Event Averages** lists the number of noise events registered at the noise monitor by SFO Aircraft for both A and C noise weightings using ANEEM (green) or NPD (blue) methods during each day of the noise monitoring period. NPD Community noise events by A-weighted noise levels are also included. The noise event levels are expressed as average Sound Exposure Level (SEL) and average peak noise level (Lmax).

**Part D – Community Noise Equivalent Level** shows a chart that compares the ANEEM Aircraft (SFO and non-SFO), NPD Aircraft, and NPD Community CNEL during each day of the monitoring period.

**Part E – Average Sound Exposure Level** (SEL) shows 2 charts comparing the ANEEM Aircraft (SFO and non-SFO) and NPD Aircraft average SEL for A and C-weighted noise levels during each day of the monitoring period.

**Part F – SFO Aircraft Noise Events by Time of Day** lists 2 tables including the daily minimum, maximum, and average SEL, Lmax, duration and number of SFO Aircraft noise events using ANEEM during the Daytime (7am to 7pm), Evening (7pm to 10pm), and Nighttime (10pm to 7am) for both A and C-weighted noise levels during the monitoring period.

**Part G – Percentage of Events by Airports** shows the percentage of aircraft events using ANEEM and NPD by the aircraft's nearest airport of origin or destination. The percentages for both methods each add up to 100%.

**Part H – SFO Noise Event by Hour of the Day** shows the percentage of total SFO Aircraft noise events using ANEEM and NPD by hour of the day. The percentages for both methods each add up to 100%.

**Part I – SFO Departure Events by Altitude (ft) over Site** shows the percentage of SFO Aircraft Departures and Arrivals that registered noise events at the noise monitor using ANEEM and NPD by altitude intervals. Altitudes are relative to mean sea level elevation. Excludes helicopters. The percentages for both methods each add up to 100%.

**Part J – Percentage of Events by Aircraft Types** shows the percentage of aircraft events using ANEEM and NPD by aircraft types. The percentages for both methods each add up to 100%.

**Part K – Percentage of Events by Operation Type** shows the percentage of aircraft noise events registered using ANEEM and NPD by Arrivals and Departures.

**Part L – Percentage of Aircraft Events by Runway and Operation Type** compares the percentage of aircraft noise events registered using ANEEM and NPD by Arrivals and Departures per each SFO runway pair and to non-SFO overflights.

**Part M – Noise Reporters** lists the number of individual noise reporters and noise reports per day registered by individuals living in Millbrae or Burlingame.

**Part N – Noise Reports vs Aircraft Noise Events per Day** compares the number of noise reports to the number of aircraft noise events per day using ANEEM and NPD. The percentages for both methods each add up to 100%.

**Part O – Noise Report Locations** illustrates a map that shows the noise report locations.

**Part P – Noise Monitor on Location** shows photographs of the noise monitoring equipment on location.

## Glossary

**A-Weighted Noise Level** – Denoted in dBA, is the most common unit used for measuring environmental sound levels. The human ear does not respond equally to different frequencies of sound. An A-weight adjusts the frequency components of sound to conform to your ear's normal response at conversational levels. The FAA and State of the California have adopted the A-weighted sound level for environmental analysis. Sound level meters have an A-weighting network for measuring noise in A-weighted decibels.

**C-Weighted Noise Level** – Denoted in dBC, is a different scale for loudness perception of sound pressure levels than A-weighted noise. A C-weight scale is used to measure sounds with approximately equal sensitivity at all frequencies. The C-weighted scale accounts for low-frequency ranges of sounds more than an A-weighted scale, often resulting in more of the overall noise energy to be included in the measurement.

**California Code of Regulations Title 21, Subchapter 6** – This code describes noise standards by defining metrics terminology and requirements regarding compatible land use. SFO was one of the first airports in the state to achieve a zero impact area within the 65 dB CNEL (Community Noise Equivalent Level) noise contour.

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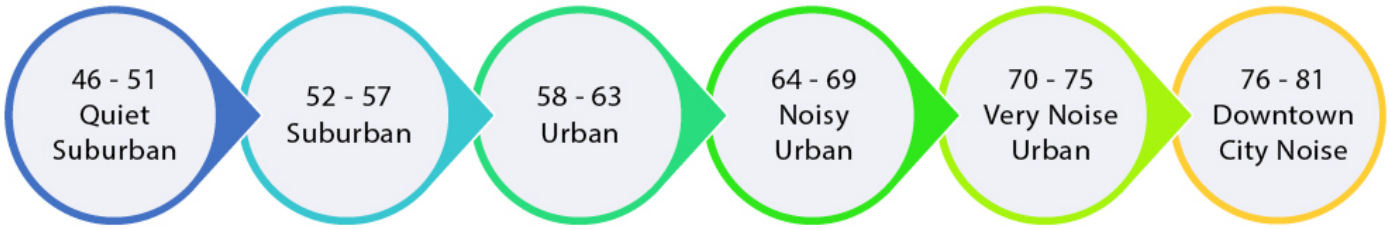


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SAN FRANCISCO INTERNATIONAL AIRPORT
CITY & COUNTY OF SAN FRANCISCO

# MEMORANDUM

TO: South San Francisco Community

FROM: SAN FRANCISCO INTERNATIONAL AIRPORT AIRCRAFT NOISE OFFICE

SUBJECT: SFO Roundtable *Up-The-Hill* Noise Monitoring Study – July 2024
*SFO Permanent Noise Monitoring Location – Site 6 in South San Francisco*

DATE: November 5, 2024

The San Francisco International Airport (SFO) Aircraft Noise Office conducted aircraft noise monitoring in Millbrae and Burlingame to determine the noise levels within the community from aircraft operations at SFO. This noise monitoring was conducted as part of a SFO Airport/Community Roundtable "Up-the-Hill" noise study researching the effects of takeoff and landing noise on communities situated next to the airport. This monitoring lasted for 21 days, occurring between July 7 and July 27, 2024, across 5 one-time monitoring locations and 9 permanent monitoring locations.

San Bruno, South San Francisco, and Daly City are situated adjacent to SFO, with San Bruno sitting directly to the west, South San Francisco to the northwest, and Daly City further northwest. Much of the aircraft noise that reaches San Bruno, South San Francisco, and Daly City is caused by departing aircraft traveling overhead at low altitudes from the west runways, Runways 28L and 28R. But, because of their proximity to the airport, they may also receive noise from takeoffs and landings that do not directly overfly them. Aircraft operations on the airfield, takeoffs (takeoff thrust) and landings (reverse thrust from jet engine thrust reverser), generate noise that travels across the landscape, and it is expected that weather and topography may amplify this noise to nearby communities.

SFO uses both Aircraft Noise Event Extraction Methodology (ANEEM) and Noise Power Distance (NPD) event classification methods and both A-weighted (dBA) and C-weighted (dBC) noise levels to generate this report. ANEEM is newer technology that looks at aircraft in the surrounding area to determine if any spikes in noise based on a floating threshold level may be logically correlated to them. Historically, ANEEM's correlation logic used AEDT modeled noise to classify if the increase in noise was logically generated by an aircraft, but this had to be modified to also look at thrust and timing to effectively correlate noise spikes to aircraft landing and taking off on or very close to ground level. NPD uses static noise thresholds to determine if spikes in noise qualify as noise events, then looks to see if there are any aircraft in the surrounding area that could be the cause of the noise. The noise monitor NPD thresholds for the total monitoring period were 62 dBA for daytime and 60 dBA for nighttime. Both ANEEM and NPD first generated events based on A-weighted noise levels, then used the time window of the A-weighted noise events to identify the C-weighted noise events.

During this study, there were approximately 420 noise events per day caused by SFO airfield operations using the ANEEM method. Approximately 100% of all aircraft noise events were from SFO aircraft. Aircraft noise events sources include primarily direct overflights from departing aircraft from SFO's west-facing runways, Runways 28L and 28R. Other airfield operations which could be heard at the monitor included noise from departing aircraft from SFO's north-facing runways, Runways 01L and 01R, and from landing aircraft using thrust reversers to assist with slowing down after touching-down on SFO's west-facing runways, Runways 28L and 28R.

During the monitoring period, the overall Aircraft Community Noise Equivalent Level (CNEL) using ANEEM was 64 dBA and the Aircraft CNEL and Community CNEL using NPD were 64 dBA and 49 dBA, respectively. This noise monitor was located in a suburban area with daily ambient noise ranging between 39 and 49 dba. Aircraft noise above ambient levels

may have been perceptible by residents. Additionally, the frequency of flights due to the proximity of the Airport may have increased annoyance levels.

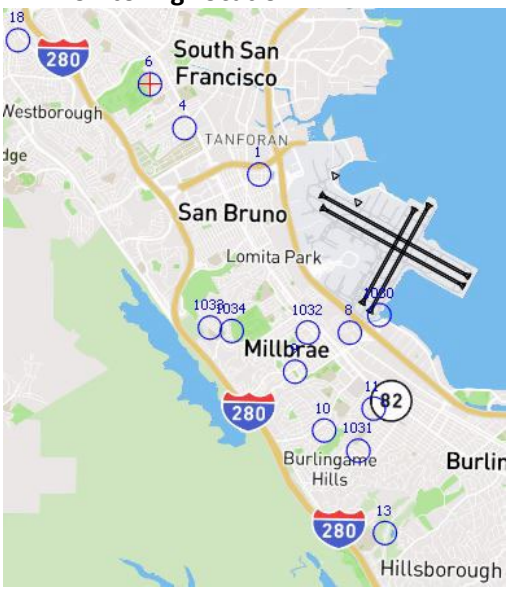
During the monitoring period, the SFO Aircraft Noise Office received 29 noise reports from 7 South San Francisco residents. Most of the noise reports were generated between 2AM and 12AM. Likewise, most of the SFO Aircraft noise events using ANEEM occurred between 9AM and 12AM.

This report includes one evaluation of a 21-day period including 16 parts (charts and graphics) that represent summaries of the aircraft noise-related data (values are subject to rounding) collected during the monitoring period. Each part and key terms used in this report are described in the Appendix and Glossary, respectively.

## A – Monitoring Summary

| | |
|---|---|
| **Monitoring Site** | SFO Site 6, South San Francisco |
| **Monitoring Site Elevation (ft)** | 89 |
| **Monitoring Period** | July 7 – July 27, 2024 |
| **Average Ambient Noise (dBA)** | 46 |
| **NPD Community (non-aircraft) CNEL (dBA)** | 49 |
| **NPD Aircraft CNEL (dBA)** | 64 |
| **NPD Avg Daily SFO Noise Events** | 128 |
| **ANEEM Aircraft CNEL (dBA)** | 64 |
| **ANEEM Avg Aircraft SEL (dBA)** | 82 |
| **ANEEM Avg Aircraft SEL (dBC)** | 91 |
| **ANEEM Avg Aircraft Lmax (dBA)** | 64 |
| **ANEEM Avg Aircraft Lmax (dBC)** | 77 |
| **ANEEM Avg Daily SFO Noise Events** | 420 |
| **SFO West Flow** | 100% |
| **SFO Southeast Flow** | 0% |

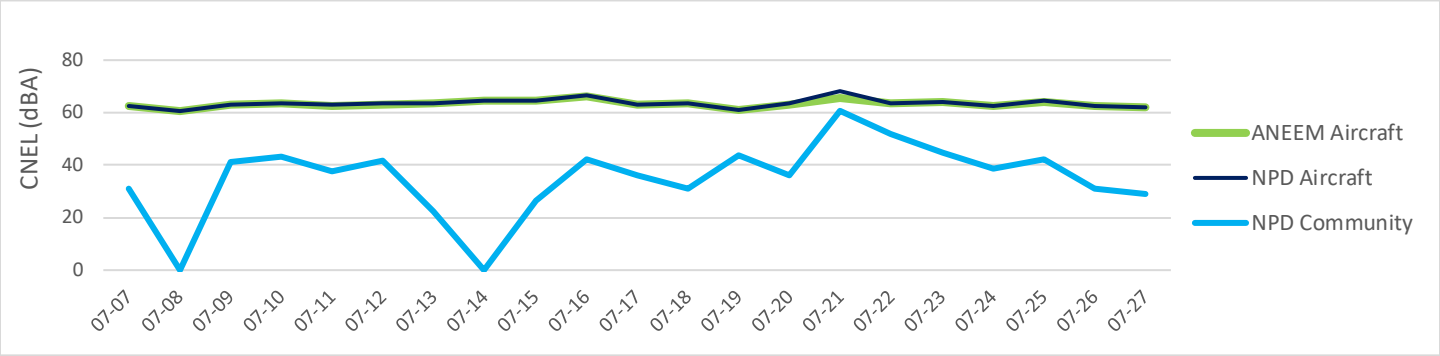
## B – Monitoring Location



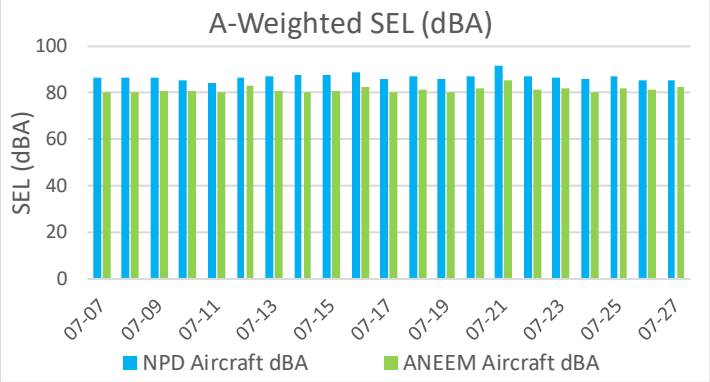

## C – Daily Noise Event Averages

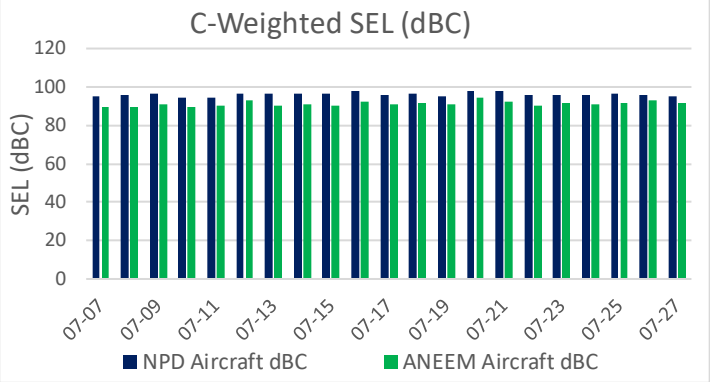
| Day | SFO Aircraft A-Weighted Noise | | | | | | SFO Aircraft C-Weighted Noise | | | | | | Community A-Weighted Noise | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | NPD | | | ANEEM | | | NPD | | | ANEEM | | | NPD | | |
| | Noise Events | Avg SEL | Avg Lmax | Noise Events | Avg SEL | Avg Lmax | Noise Events | Avg SEL | Avg Lmax | Noise Events | Avg SEL | Avg Lmax | Noise Events | Avg SEL | Avg Lmax |
| **07-07** | 108 | 86 | 75 | 424 | 80 | 62 | 108 | 95 | 83 | 424 | 90 | 75 | 1 | 80 | 68 |
| **07-08** | 96 | 87 | 75 | 399 | 80 | 62 | 96 | 96 | 83 | 399 | 90 | 75 | 0 | - | - |
| **07-09** | 117 | 87 | 75 | 447 | 81 | 63 | 117 | 96 | 84 | 447 | 91 | 76 | 9 | 81 | 68 |
| **07-10** | 164 | 85 | 73 | 448 | 81 | 64 | 164 | 94 | 80 | 448 | 90 | 75 | 24 | 78 | 68 |
| **07-11** | 142 | 84 | 72 | 367 | 80 | 65 | 142 | 94 | 81 | 367 | 90 | 76 | 7 | 75 | 65 |
| **07-12** | 111 | 87 | 75 | 261 | 83 | 67 | 111 | 97 | 84 | 261 | 93 | 79 | 2 | 79 | 70 |
| **07-13** | 126 | 87 | 75 | 499 | 81 | 63 | 126 | 96 | 83 | 499 | 90 | 75 | 1 | 72 | 66 |
| **07-14** | 125 | 88 | 75 | 663 | 80 | 61 | 125 | 97 | 84 | 663 | 91 | 76 | 0 | - | - |
| **07-15** | 117 | 88 | 76 | 530 | 81 | 62 | 117 | 97 | 84 | 530 | 90 | 76 | 2 | 77 | 66 |
| **07-16** | 107 | 89 | 77 | 469 | 82 | 62 | 107 | 98 | 85 | 469 | 92 | 77 | 6 | 84 | 69 |
| **07-17** | 150 | 86 | 74 | 508 | 80 | 63 | 150 | 96 | 82 | 508 | 91 | 77 | 12 | 76 | 68 |
| **07-18** | 111 | 87 | 75 | 388 | 81 | 63 | 111 | 97 | 84 | 388 | 92 | 77 | 1 | 71 | 66 |
| **07-19** | 96 | 86 | 74 | 334 | 80 | 63 | 96 | 95 | 82 | 334 | 91 | 75 | 14 | 77 | 65 |
| **07-20** | 115 | 87 | 75 | 372 | 82 | 65 | 115 | 98 | 85 | 372 | 94 | 80 | 2 | 78 | 72 |
| **07-21** | 270 | 92 | 79 | 512 | 85 | 70 | 270 | 98 | 85 | 512 | 93 | 81 | 54 | 93 | 80 |
| **07-22** | 130 | 87 | 74 | 448 | 82 | 64 | 130 | 96 | 82 | 448 | 90 | 75 | 13 | 90 | 70 |
| **07-23** | 128 | 87 | 74 | 372 | 82 | 64 | 128 | 96 | 83 | 372 | 91 | 76 | 9 | 84 | 68 |
| **07-24** | 127 | 86 | 74 | 464 | 80 | 63 | 127 | 96 | 82 | 464 | 91 | 76 | 7 | 77 | 66 |
| **07-25** | 103 | 87 | 75 | 349 | 82 | 64 | 103 | 97 | 83 | 349 | 91 | 77 | 11 | 78 | 67 |
| **07-26** | 125 | 86 | 74 | 320 | 81 | 66 | 125 | 96 | 83 | 320 | 93 | 80 | 1 | 70 | 64 |
| **07-27** | 119 | 86 | 75 | 237 | 83 | 67 | 119 | 95 | 83 | 237 | 92 | 77 | 2 | 75 | 68 |
| **Daily Average** | **128** | **88** | **75** | **420** | **82** | **64** | **128** | **96** | **83** | **420** | **91** | **77** | **8** | **88** | **71** |
| **Total Count** | **2,687** | | | **8,811** | | | **2,687** | | | **8,811** | | | **178** | | |

## D – Community Noise Equivalent Level



## E – Average Sound Exposure Level



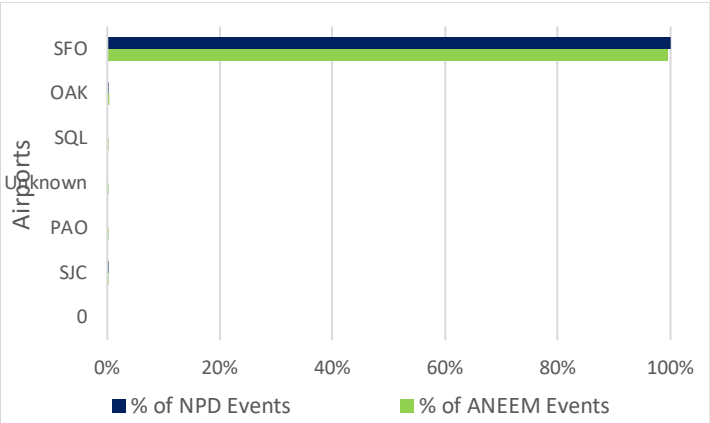




## F – SFO ANEEM Aircraft Noise Events by Time of Day

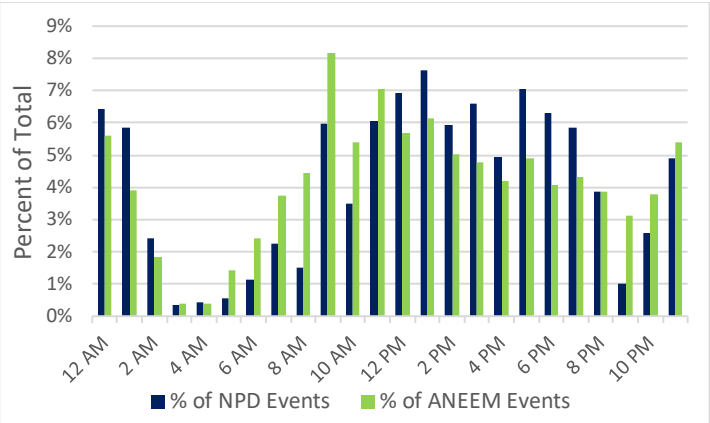
| SFO Aircraft ANEEM A-Weighted Events | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Time of Day | Noise Events | Noise Events % | Daily Avg SEL (dBA) | Min SEL (dBA) | Max SEL (dBA) | Avg Lmax (dBA) | Min Lmax (dBA) | Max Lmax (dBA) | Avg Duration (sec) | Min Duration (sec) | Max Duration (sec) |
| Day (7am–7pm) | 5,602 | 64% | 82 | 56 | 97 | 65 | 49 | 88 | 14 | 4 | 95 |
| Evening (7pm-10pm) | 997 | 11% | 80 | 57 | 96 | 63 | 49 | 87 | 14 | 4 | 79 |
| Night (10pm-7am) | 2,212 | 25% | 81 | 48 | 99 | 62 | 39 | 91 | 15 | 4 | 82 |

| SFO Aircraft ANEEM C-Weighted Events | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Time of Day | Noise Events | Noise Events % | Daily Avg SEL (dBC) | Min SEL (dBC) | Max SEL (dBC) | Avg Lmax (dBC) | Min Lmax (dBC) | Max Lmax (dBC) | Avg Duration (sec) | Min Duration (sec) | Max Duration (sec) |
| Day (7am–7pm) | 5,602 | 64% | 92 | 64 | 107 | 78 | 57 | 101 | 14 | 4 | 95 |
| Evening (7pm-10pm) | 997 | 11% | 90 | 69 | 106 | 76 | 62 | 101 | 14 | 4 | 79 |
| Night (10pm-7am) | 2,212 | 25% | 91 | 59 | 107 | 74 | 54 | 99 | 15 | 4 | 82 |

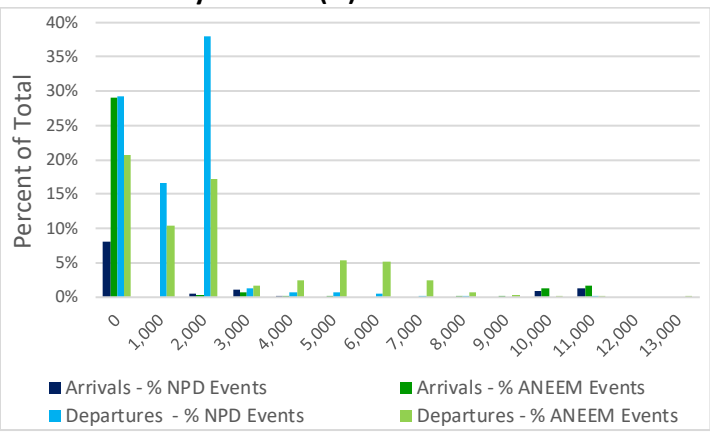
## G – Percentage of Events by Airports



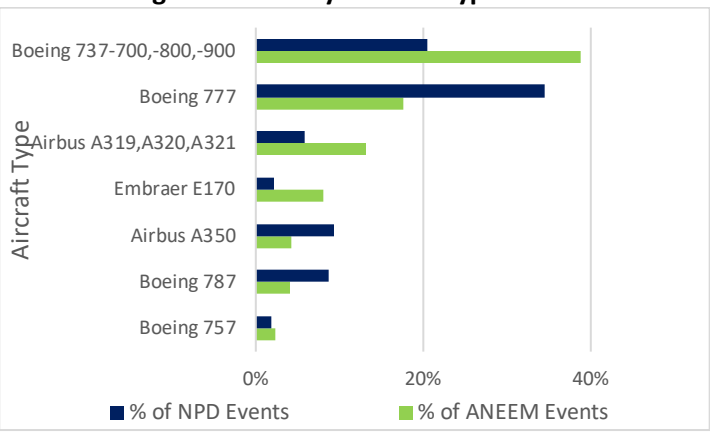

## H – SFO Noise Events by Hour of the Day



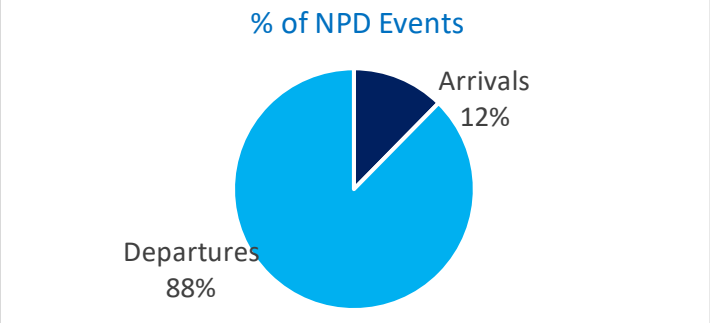

## I – SFO Events by Altitude (ft) over Site

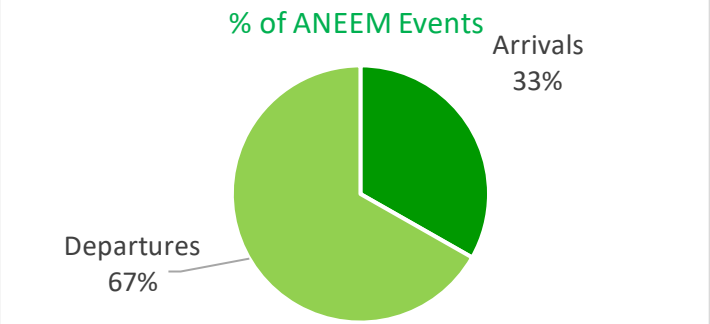



## J – Percentage of Events by Aircraft Types

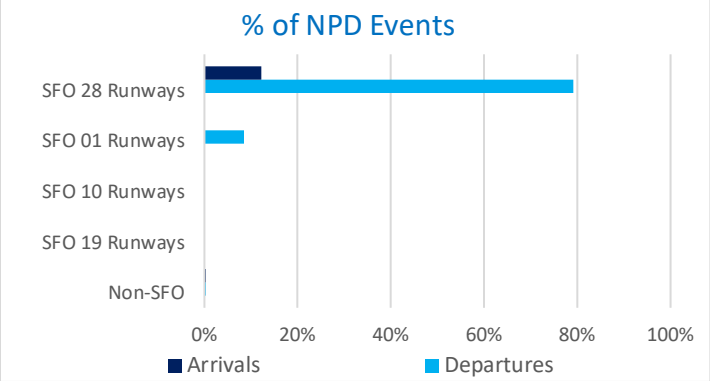


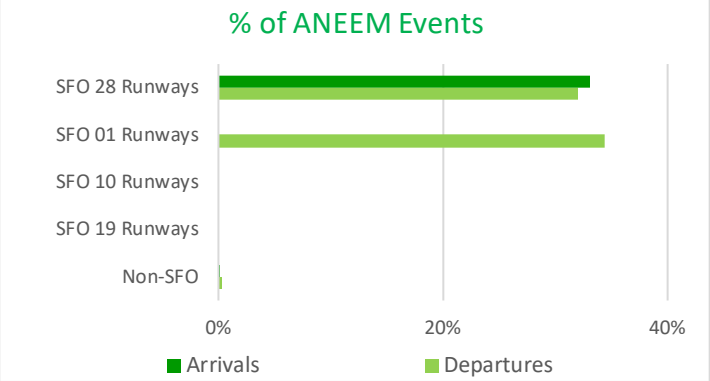
## K – Percentage of Aircraft Events by Operation Type




## L – Percentage of Aircraft Events by Runway and Operation Type

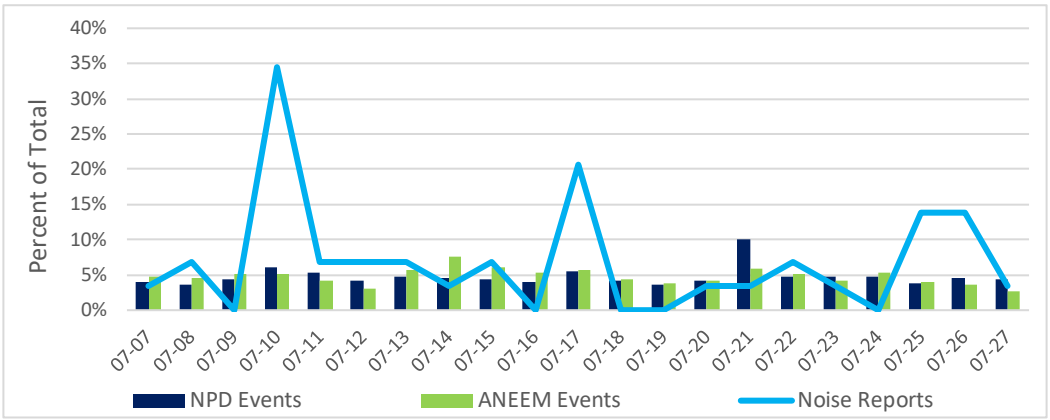


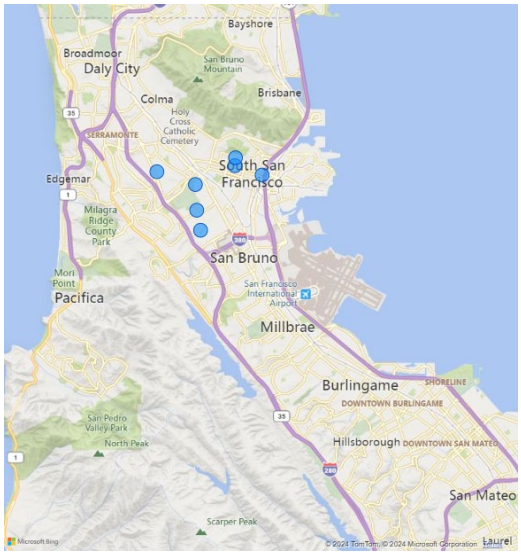

## M – Noise Reporters

| Date | Individual Noise Reporters | Noise Reports |
|---|---|---|
| 07-07 | 1 | 1 |
| 07-08 | 2 | 2 |
| 07-09 | 0 | 0 |
| 07-10 | 3 | 10 |
| 07-11 | 1 | 2 |
| 07-12 | 1 | 2 |
| 07-13 | 1 | 2 |
| 07-14 | 1 | 1 |
| 07-15 | 1 | 2 |
| 07-16 | 0 | 0 |
| 07-17 | 1 | 6 |
| 07-18 | 0 | 0 |
| 07-19 | 0 | 0 |
| 07-20 | 1 | 1 |
| 07-21 | 1 | 1 |
| 07-22 | 2 | 2 |
| 07-23 | 1 | 1 |
| 07-24 | 0 | 0 |
| 07-25 | 1 | 4 |
| 07-26 | 1 | 4 |
| 07-27 | 1 | 1 |
| Total | 7 | 29 |

## N – Noise Reports vs Aircraft Noise Events per Day




## O – Noise Reporter Locations




## P – Noise Monitor on Location

## Appendix

*This Appendix describes the sections of the noise monitoring report and a glossary of terms.*

**Part A – Monitoring Summary** lists the monitoring location, elevation, the monitoring time period, and the key monitoring results including the ANEEM Aircraft, NPD Aircraft, and NPD Community Community Noise Equivalent level (CNEL), single event levels in both A and C noise weightings, and air traffic flow breakdown. The CNEL metric is used to assess and regulate aircraft noise exposure in communities surrounding the airport. California Title 21 Noise Regulations established an acceptable level of 65 dBA CNEL.

**Part B – Monitoring Location** illustrates the location of the portable noise monitor and examples of typical SFO flight operations that registered noise events at the portable noise monitor.

**Part C – Daily Noise Event Averages** lists the number of noise events registered at the noise monitor by SFO Aircraft for both A and C noise weightings using ANEEM (green) or NPD (blue) methods during each day of the noise monitoring period. NPD Community noise events by A-weighted noise levels are also included. The noise event levels are expressed as average Sound Exposure Level (SEL) and average peak noise level (Lmax).

**Part D – Community Noise Equivalent Level** shows a chart that compares the ANEEM Aircraft (SFO and non-SFO), NPD Aircraft, and NPD Community CNEL during each day of the monitoring period.

**Part E – Average Sound Exposure Level** (SEL) shows 2 charts comparing the ANEEM Aircraft (SFO and non-SFO) and NPD Aircraft average SEL for A and C-weighted noise levels during each day of the monitoring period.

**Part F – SFO Aircraft Noise Events by Time of Day** lists 2 tables including the daily minimum, maximum, and average SEL, Lmax, duration and number of SFO Aircraft noise events using ANEEM during the Daytime (7am to 7pm), Evening (7pm to 10pm), and Nighttime (10pm to 7am) for both A and C-weighted noise levels during the monitoring period.

**Part G – Percentage of Events by Airports** shows the percentage of aircraft events using ANEEM and NPD by the aircraft's nearest airport of origin or destination. The percentages for both methods each add up to 100%.

**Part H – SFO Noise Event by Hour of the Day** shows the percentage of total SFO Aircraft noise events using ANEEM and NPD by hour of the day. The percentages for both methods each add up to 100%.

**Part I – SFO Departure Events by Altitude (ft) over Site** shows the percentage of SFO Aircraft Departures and Arrivals that registered noise events at the noise monitor using ANEEM and NPD by altitude intervals. Altitudes are relative to mean sea level elevation. Excludes helicopters. The percentages for both methods each add up to 100%.

**Part J – Percentage of Events by Aircraft Types** shows the percentage of aircraft events using ANEEM and NPD by aircraft types. The percentages for both methods each add up to 100%.

**Part K – Percentage of Events by Operation Type** shows the percentage of aircraft noise events registered using ANEEM and NPD by Arrivals and Departures.

**Part L – Percentage of Aircraft Events by Runway and Operation Type** compares the percentage of aircraft noise events registered using ANEEM and NPD by Arrivals and Departures per each SFO runway pair and to non-SFO overflights.

**Part M – Noise Reporters** lists the number of individual noise reporters and noise reports per day registered by individuals living in Millbrae or Burlingame.

**Part N – Noise Reports vs Aircraft Noise Events per Day** compares the number of noise reports to the number of aircraft noise events per day using ANEEM and NPD. The percentages for both methods each add up to 100%.

**Part O – Noise Report Locations** illustrates a map that shows the noise report locations.

**Part P – Noise Monitor on Location** shows photographs of the noise monitoring equipment on location.

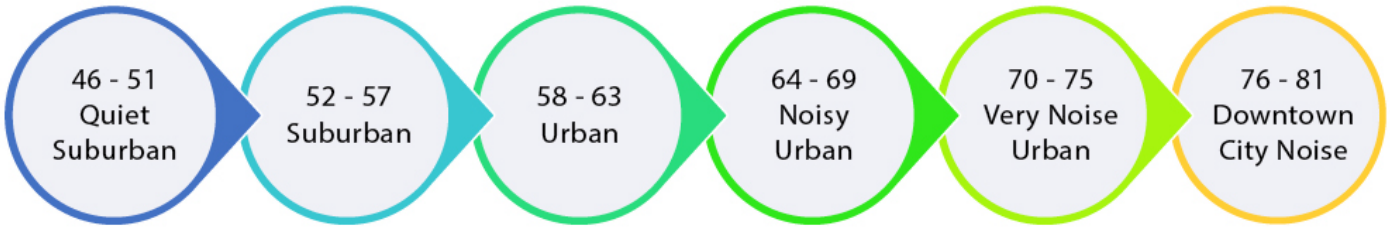
## Glossary

**A-Weighted Noise Level** – Denoted in dBA, is the most common unit used for measuring environmental sound levels. The human ear does not respond equally to different frequencies of sound. An A-weight adjusts the frequency components of sound to conform to your ear's normal response at conversational levels. The FAA and State of the California have adopted the A-weighted sound level for environmental analysis. Sound level meters have an A-weighting network for measuring noise in A-weighted decibels.

**C-Weighted Noise Level** – Denoted in dBC, is a different scale for loudness perception of sound pressure levels than A-weighted noise. A C-weight scale is used to measure sounds with approximately equal sensitivity at all frequencies. The C-weighted scale accounts for low-frequency ranges of sounds more than an A-weighted scale, often resulting in more of the overall noise energy to be included in the measurement.

**California Code of Regulations Title 21, Subchapter 6** – This code describes noise standards by defining metrics terminology and requirements regarding compatible land use. SFO was one of the first airports in the state to achieve a zero impact area within the 65 dB CNEL (Community Noise Equivalent Level) noise contour.

**Community Noise Equivalent Level (CNEL)** – A noise metric required by the California Airport Noise Standards for use by airport proprietors to measure aircraft noise levels. CNEL includes an additional weighting for each event occurring during the evening (7:00 p.m. – 9:59 p.m.) and nighttime (10:00 p.m. – 6:59 a.m.) periods to account for increased sensitivity to noise during these periods. Evening events are treated as though there were three and nighttime events are treated as though there were ten. This results in a 4.77 and 10 dBA penalty for operations occurring in the evening and nighttime periods, respectively. For a more in-depth explanation of CNEL and other technical noise terms, please visit the Federal Aviation Administration (FAA) website. Below is a graphic illustrating types of metropolitan areas and their corresponding CNEL intervals (dBA).




**Decibel (dB)** – A unit used to measure the magnitude or intensity of sound. The decibel uses a logarithmic scale to cover the very large range of sound pressures that can be heard by the human ear. Decibels measure a scale from the threshold of human hearing, 0 dB, upward towards the threshold of pain, about 120-140 dB. Because decibels are such a small measure, they are computed logarithmically and cannot be added arithmetically. A10 dB increase will be perceived by most people to be a doubling in loudness, i.e., 80 dB seems twice as loud as 70 dB. Decibel measurements can be scaled by different frequency ranges, such as by A-Weighted (dBA) and C-Weighted (dBC) scales.

**Maximum Sound Level (Lmax)** – The maximum a-weighted sound level for a given noise event. The peak noise level reached by a single aircraft event.

**Noise Event** – A Noise Event is the measured sound produced by a single source of noise over a duration of time. An aircraft noise event begins when the sound level of a flight operation exceeds a noise threshold and ends when the level drops down below that threshold.

**Sound Exposure Level (SEL)** – SEL is a measure of a single aircraft noise event spread out over its entirety compressed into one second. It allows for a comparison of aircraft noise events of different durations and noise levels. For example, think of the moment you hear a plane from a quarter mile away; we measure from that moment, as the aircraft flies overhead, and until it can't be heard. This is the duration of sound we use and then compress it into one second for a measure. SEL measures noise energy above the threshold (normally 65 dBA for aircraft noise events). This way, any ambient noise is separated out from the measurement.

SAN FRANCISCO INTERNATIONAL AIRPORT
CITY & COUNTY OF SAN FRANCISCO

# MEMORANDUM

TO: Millbrae Community

FROM: SAN FRANCISCO INTERNATIONAL AIRPORT AIRCRAFT NOISE OFFICE

SUBJECT: SFO Roundtable *Up-The-Hill* Noise Monitoring Study – July 2024
*SFO Permanent Noise Monitoring Location – Site 8 in Millbrae*

DATE: November 5, 2024

The San Francisco International Airport (SFO) Aircraft Noise Office conducted aircraft noise monitoring in Millbrae and Burlingame to determine the noise levels within the community from aircraft operations at SFO. This noise monitoring was conducted as part of a SFO Airport/Community Roundtable "Up-the-Hill" noise study researching the effects of takeoff and landing noise on communities situated next to the airport. This monitoring lasted for 21 days, occurring between July 7 and July 27, 2024, across 5 one-time monitoring locations and 9 permanent monitoring locations.

Millbrae, Burlingame, and Hillsborough are situated adjacent to SFO, with Millbrae sitting to the southwest, Burlingame to the south, and Hillsborough further south. Much of the aircraft noise that reaches Millbrae, Burlingame, and Hillsborough is caused by takeoff and landing noise rather than by direct overflights. Aircraft operations on the airfield, takeoffs (takeoff thrust) and landings (reverse thrust from jet engine thrust reversers), generate noise that travels across the landscape, and it is expected that weather and topography may amplify this noise to nearby communities.

SFO uses both Aircraft Noise Event Extraction Methodology (ANEEM) and Noise Power Distance (NPD) event classification methods and both A-weighted (dBA) and C-weighted (dBC) noise levels to generate this report. ANEEM is newer technology that looks at aircraft in the surrounding area to determine if any spikes in noise based on a floating threshold level may be logically correlated to them. Historically, ANEEM's correlation logic used AEDT modeled noise to classify if the increase in noise was logically generated by an aircraft, but this had to be modified to also look at thrust and timing to effectively correlate noise spikes to aircraft landing and taking off on or very close to ground level. NPD uses static noise thresholds to determine if spikes in noise qualify as noise events, then looks to see if there are any aircraft in the surrounding area that could be the cause of the noise. The noise monitor NPD threshold for the total monitoring period was 67 dBA. Both ANEEM and NPD first generated events based on A-weighted noise levels, then used the time window of the A-weighted noise events to identify the C-weighted noise events.

During this study, there were approximately 632 noise events per day caused by SFO airfield operations using the ANEEM method. Approximately 100% of all aircraft noise events were from SFO aircraft. Aircraft noise events sources include primarily departing aircraft from SFO's north-facing runways, Runways 01L and 01R, and from landing aircraft using thrust reversers to assist with slowing down after touching-down on SFO's west-facing runways, Runways 28L and 28R. Other airfield operations which could be heard at the monitor included take-offs from SFO's west-facing runways, Runways 28L and 28R.

During the monitoring period, the overall Aircraft Community Noise Equivalent Level (CNEL) using ANEEM was 60 dBA and the Aircraft CNEL and Community CNEL using NPD were 54 dBA and 47 dBA, respectively. This noise monitor was located in an urban area with daily ambient noise ranging between 47 and 53 dba. Aircraft noise above ambient levels may have been perceptible by residents. Additionally, the frequency of flights due to the proximity of the Airport may have increased annoyance levels.

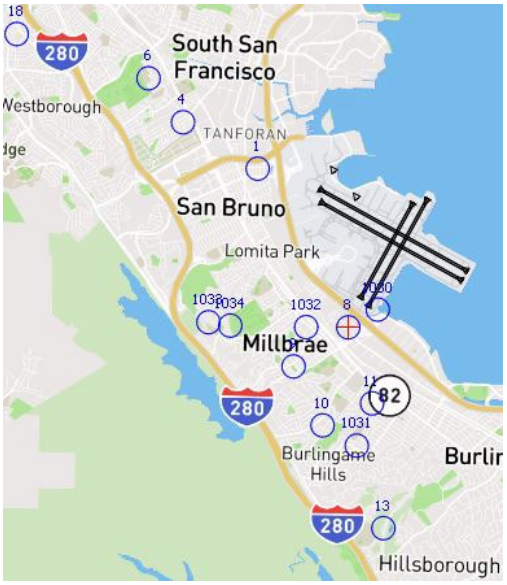
During the monitoring period, the SFO Aircraft Noise Office received 11 noise reports from 4 Millbrae residents. Most of these noise reports were generated between 5AM and 12AM. Likewise, most of the SFO Aircraft noise events using ANEEM occurred between 8AM and 12AM.

This report includes one evaluation of a 21-day period including 16 parts (charts and graphics) that represent summaries of the aircraft noise-related data (values are subject to rounding) collected during the monitoring period. Each part and key terms used in this report are described in the Appendix and Glossary, respectively.

## A – Monitoring Summary

| | |
|---|---|
| **Monitoring Site** | SFO Site 8, Millbrae |
| **Monitoring Site Elevation (ft)** | 7 |
| **Monitoring Period** | July 7 – July 27, 2024 |
| **Average Ambient Noise (dBA)** | 50 |
| **NPD Community (non-aircraft) CNEL (dBA)** | 47 |
| **NPD Aircraft CNEL (dBA)** | 54 |
| **NPD Avg Daily SFO Noise Events** | 25 |
| **ANEEM Aircraft CNEL (dBA)** | 60 |
| **ANEEM Avg Aircraft SEL (dBA)** | 76 |
| **ANEEM Avg Aircraft SEL (dBC)** | 89 |
| **ANEEM Avg Aircraft Lmax (dBA)** | 65 |
| **ANEEM Avg Aircraft Lmax (dBC)** | 77 |
| **ANEEM Avg Daily SFO Noise Events** | 632 |
| **SFO West Flow** | 100% |
| **SFO Southeast Flow** | 0% |

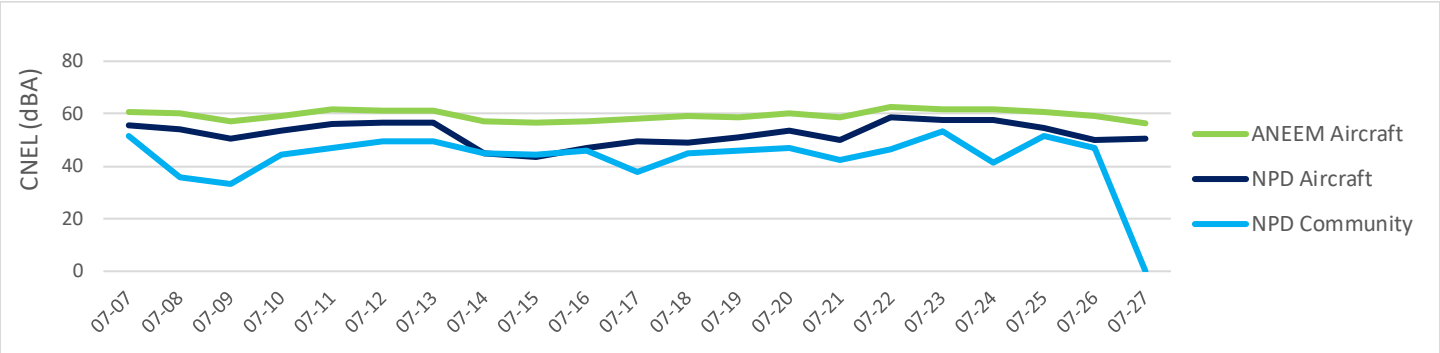
## B – Monitoring Location



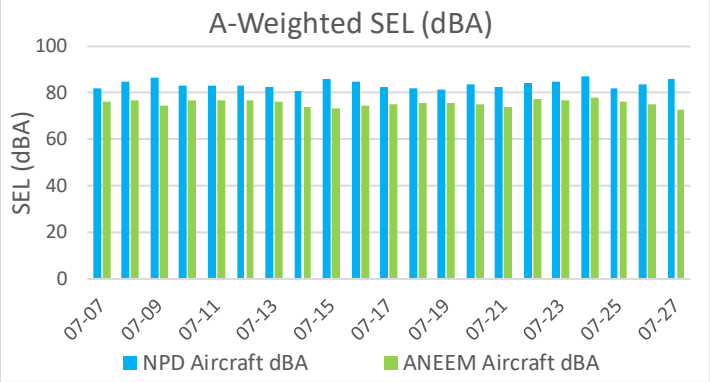

## C – Daily Noise Event Averages

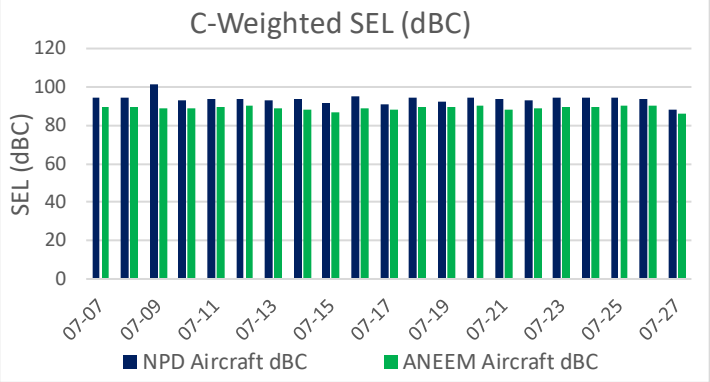
| Day | SFO Aircraft A-Weighted Noise | | | | | | SFO Aircraft C-Weighted Noise | | | | | | Community A-Weighted Noise | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | NPD | | | ANEEM | | | NPD | | | ANEEM | | | NPD | | |
| | Noise Events | Avg SEL | Avg Lmax | Noise Events | Avg SEL | Avg Lmax | Noise Events | Avg SEL | Avg Lmax | Noise Events | Avg SEL | Avg Lmax | Noise Events | Avg SEL | Avg Lmax |
| **07-07** | 32 | 82 | 72 | 665 | 76 | 65 | 32 | 94 | 83 | 665 | 90 | 77 | 9 | 83 | 71 |
| **07-08** | 25 | 85 | 74 | 585 | 77 | 66 | 25 | 95 | 84 | 585 | 90 | 78 | 3 | 80 | 73 |
| **07-09** | 15 | 87 | 76 | 625 | 75 | 62 | 15 | 102 | 84 | 625 | 89 | 76 | 1 | 83 | 73 |
| **07-10** | 52 | 83 | 73 | 682 | 77 | 66 | 52 | 93 | 82 | 682 | 89 | 77 | 5 | 79 | 71 |
| **07-11** | 40 | 83 | 72 | 698 | 77 | 66 | 40 | 94 | 82 | 698 | 90 | 77 | 7 | 82 | 72 |
| **07-12** | 44 | 83 | 72 | 641 | 77 | 66 | 44 | 94 | 82 | 641 | 90 | 78 | 10 | 81 | 72 |
| **07-13** | 36 | 82 | 72 | 626 | 76 | 65 | 36 | 93 | 81 | 626 | 89 | 76 | 8 | 81 | 69 |
| **07-14** | 17 | 81 | 72 | 598 | 74 | 63 | 17 | 94 | 84 | 598 | 88 | 75 | 3 | 80 | 72 |
| **07-15** | 5 | 86 | 76 | 612 | 74 | 62 | 5 | 91 | 81 | 612 | 87 | 75 | 5 | 85 | 76 |
| **07-16** | 13 | 85 | 77 | 614 | 74 | 63 | 13 | 95 | 86 | 614 | 89 | 77 | 5 | 84 | 76 |
| **07-17** | 15 | 83 | 75 | 581 | 75 | 64 | 15 | 91 | 82 | 581 | 88 | 76 | 2 | 82 | 74 |
| **07-18** | 17 | 82 | 73 | 691 | 75 | 65 | 17 | 94 | 83 | 691 | 89 | 77 | 4 | 81 | 71 |
| **07-19** | 19 | 81 | 73 | 565 | 76 | 66 | 19 | 92 | 82 | 565 | 89 | 78 | 3 | 83 | 75 |
| **07-20** | 18 | 83 | 74 | 630 | 75 | 64 | 18 | 94 | 82 | 630 | 90 | 78 | 6 | 82 | 73 |
| **07-21** | 10 | 82 | 72 | 574 | 74 | 62 | 10 | 94 | 82 | 574 | 89 | 76 | 1 | 82 | 71 |
| **07-22** | 46 | 84 | 73 | 755 | 77 | 66 | 46 | 93 | 81 | 755 | 89 | 77 | 8 | 85 | 73 |
| **07-23** | 44 | 85 | 73 | 689 | 77 | 66 | 44 | 95 | 83 | 689 | 90 | 77 | 8 | 86 | 74 |
| **07-24** | 36 | 87 | 74 | 629 | 78 | 66 | 36 | 94 | 83 | 629 | 90 | 77 | 4 | 81 | 72 |
| **07-25** | 29 | 82 | 73 | 648 | 76 | 65 | 29 | 95 | 83 | 648 | 90 | 77 | 11 | 82 | 72 |
| **07-26** | 18 | 84 | 75 | 667 | 75 | 64 | 18 | 94 | 84 | 667 | 90 | 78 | 5 | 80 | 71 |
| **07-27** | 3 | 86 | 79 | 498 | 73 | 61 | 3 | 88 | 81 | 498 | 86 | 74 | 0 | - | - |
| **Daily Average** | **25** | **84** | **73** | **632** | **76** | **65** | **25** | **94** | **83** | **632** | **89** | **77** | **5** | **83** | **72** |
| **Total Count** | **534** | | | **13,273** | | | **534** | | | **13,273** | | | **108** | | |

## D – Community Noise Equivalent Level



## E – Average Sound Exposure Level



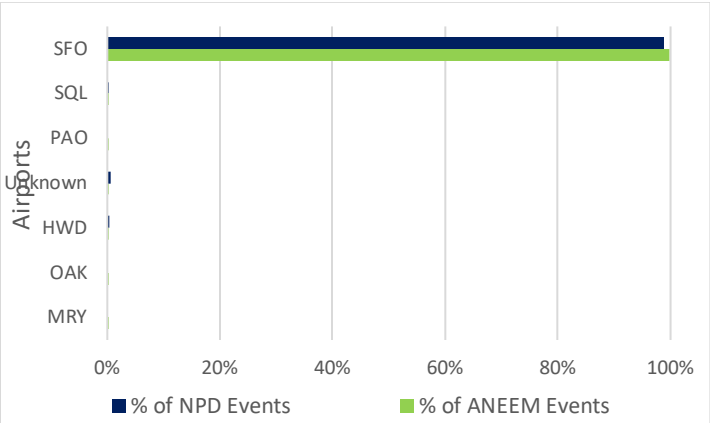




## F – SFO ANEEM Aircraft Noise Events by Time of Day

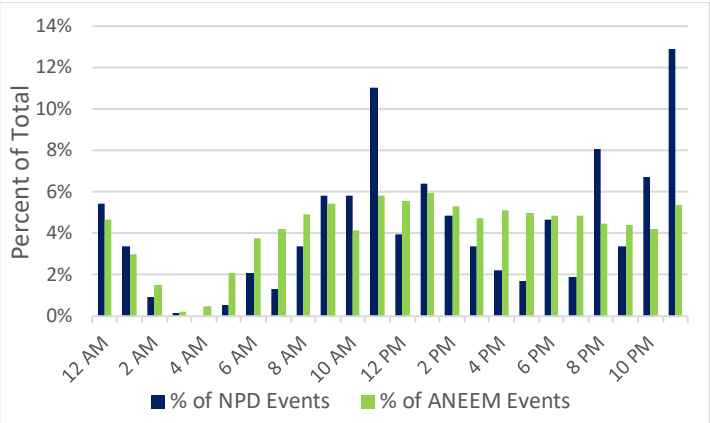
| SFO Aircraft ANEEM A-Weighted Events | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Time of Day | Noise Events | Noise Events % | Daily Avg SEL (dBA) | Min SEL (dBA) | Max SEL (dBA) | Avg Lmax (dBA) | Min Lmax (dBA) | Max Lmax (dBA) | Avg Duration (sec) | Min Duration (sec) | Max Duration (sec) |
| Day (7am–7pm) | 8,090 | 61% | 76 | 60 | 94 | 65 | 53 | 87 | 13 | 4 | 99 |
| Evening (7pm-10pm) | 1,827 | 14% | 76 | 62 | 98 | 65 | 54 | 95 | 13 | 4 | 98 |
| Night (10pm-7am) | 3,356 | 25% | 76 | 55 | 96 | 64 | 46 | 83 | 15 | 4 | 97 |

| SFO Aircraft ANEEM C-Weighted Events | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Time of Day | Noise Events | Noise Events % | Daily Avg SEL (dBC) | Min SEL (dBC) | Max SEL (dBC) | Avg Lmax (dBC) | Min Lmax (dBC) | Max Lmax (dBC) | Avg Duration (sec) | Min Duration (sec) | Max Duration (sec) |
| Day (7am–7pm) | 8,090 | 61% | 89 | 68 | 109 | 77 | 62 | 101 | 13 | 4 | 99 |
| Evening (7pm-10pm) | 1,827 | 14% | 89 | 70 | 104 | 77 | 63 | 97 | 13 | 4 | 98 |
| Night (10pm-7am) | 3,356 | 25% | 89 | 63 | 102 | 76 | 57 | 95 | 15 | 4 | 97 |

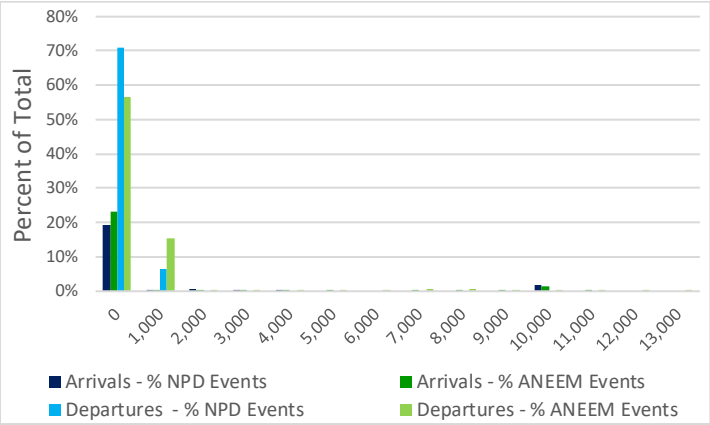
## G – Percentage of Events by Airports



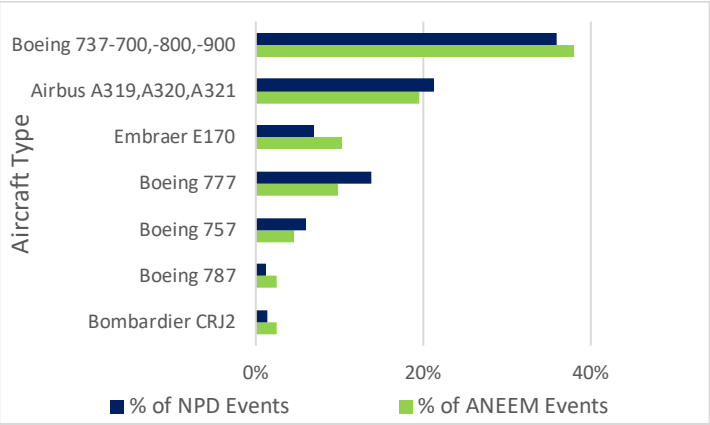

## H – SFO Noise Events by Hour of the Day



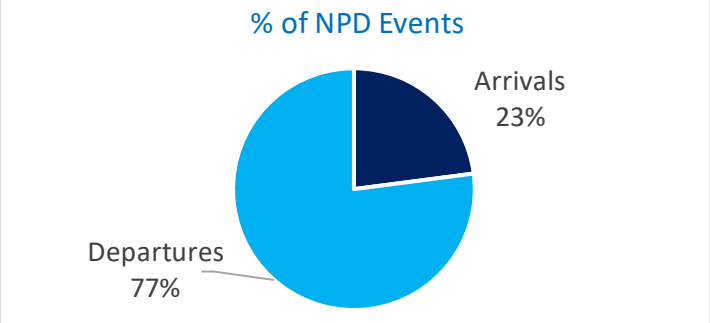

## I – SFO Events by Altitude (ft) over Site

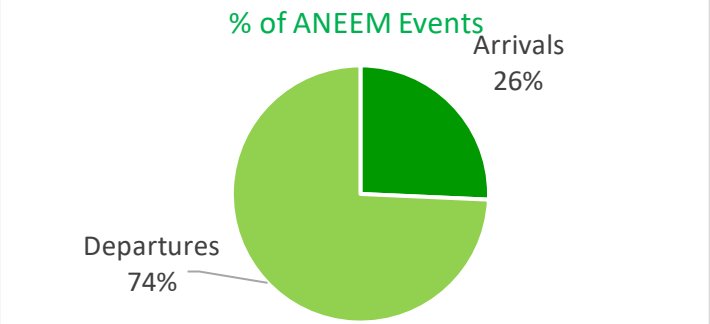



## J – Percentage of Events by Aircraft Types

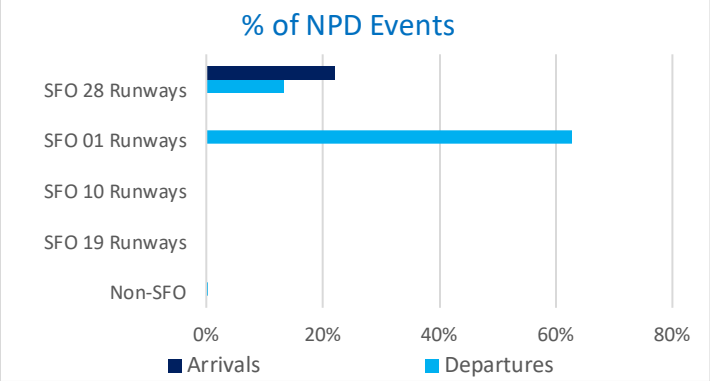


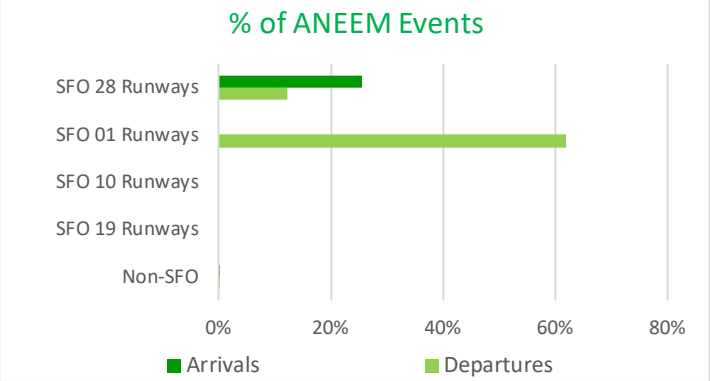
## K – Percentage of Aircraft Events by Operation Type




## L – Percentage of Aircraft Events by Runway and Operation Type

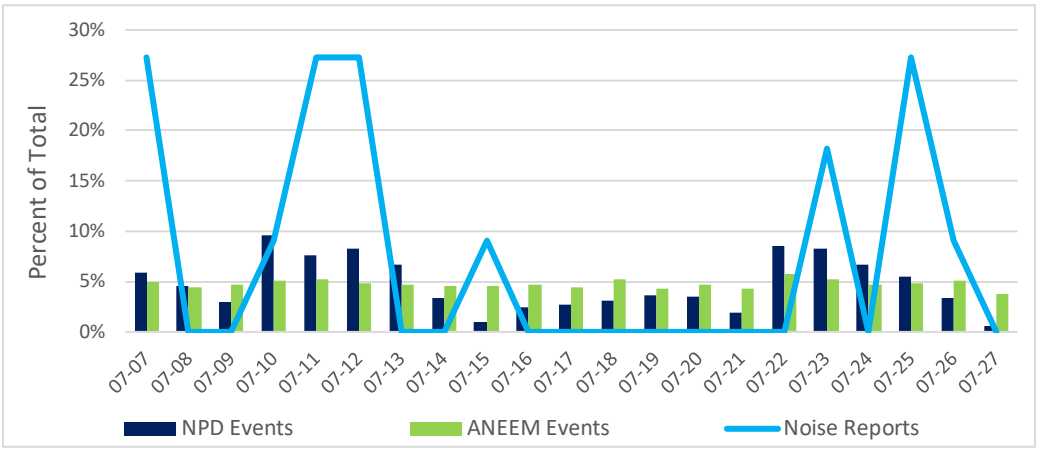


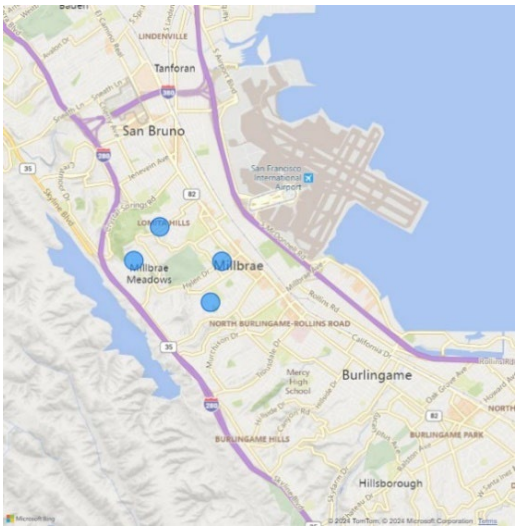

## M – Noise Reporters

| Date | Individual Noise Reporters | Noise Reports |
|---|---|---|
| 07-07 | 1 | 3 |
| 07-08 | 0 | 0 |
| 07-09 | 0 | 0 |
| 07-10 | 1 | 1 |
| 07-11 | 1 | 3 |
| 07-12 | 2 | 3 |
| 07-13 | 0 | 0 |
| 07-14 | 0 | 0 |
| 07-15 | 1 | 1 |
| 07-16 | 0 | 0 |
| 07-17 | 0 | 0 |
| 07-18 | 0 | 0 |
| 07-19 | 0 | 0 |
| 07-20 | 0 | 0 |
| 07-21 | 0 | 0 |
| 07-22 | 0 | 0 |
| 07-23 | 2 | 2 |
| 07-24 | 0 | 0 |
| 07-25 | 1 | 3 |
| 07-26 | 1 | 1 |
| 07-27 | 0 | 0 |
| Total | 4 | 11 |

## N – Noise Reports vs Aircraft Noise Events per Day




## O – Noise Reporter Locations




## P – Noise Monitor on Location

## Appendix

*This Appendix describes the sections of the noise monitoring report and a glossary of terms.*

**Part A – Monitoring Summary** lists the monitoring location, elevation, the monitoring time period, and the key monitoring results including the ANEEM Aircraft, NPD Aircraft, and NPD Community Community Noise Equivalent level (CNEL), single event levels in both A and C noise weightings, and air traffic flow breakdown. The CNEL metric is used to assess and regulate aircraft noise exposure in communities surrounding the airport. California Title 21 Noise Regulations established an acceptable level of 65 dBA CNEL.

**Part B – Monitoring Location** illustrates the location of the portable noise monitor and examples of typical SFO flight operations that registered noise events at the portable noise monitor.

**Part C – Daily Noise Event Averages** lists the number of noise events registered at the noise monitor by SFO Aircraft for both A and C noise weightings using ANEEM (green) or NPD (blue) methods during each day of the noise monitoring period. NPD Community noise events by A-weighted noise levels are also included. The noise event levels are expressed as average Sound Exposure Level (SEL) and average peak noise level (Lmax).

**Part D – Community Noise Equivalent Level** shows a chart that compares the ANEEM Aircraft (SFO and non-SFO), NPD Aircraft, and NPD Community CNEL during each day of the monitoring period.

**Part E – Average Sound Exposure Level** (SEL) shows 2 charts comparing the ANEEM Aircraft (SFO and non-SFO) and NPD Aircraft average SEL for A and C-weighted noise levels during each day of the monitoring period.

**Part F – SFO Aircraft Noise Events by Time of Day** lists 2 tables including the daily minimum, maximum, and average SEL, Lmax, duration and number of SFO Aircraft noise events using ANEEM during the Daytime (7am to 7pm), Evening (7pm to 10pm), and Nighttime (10pm to 7am) for both A and C-weighted noise levels during the monitoring period.

**Part G – Percentage of Events by Airports** shows the percentage of aircraft events using ANEEM and NPD by the aircraft's nearest airport of origin or destination. The percentages for both methods each add up to 100%.

**Part H – SFO Noise Event by Hour of the Day** shows the percentage of total SFO Aircraft noise events using ANEEM and NPD by hour of the day. The percentages for both methods each add up to 100%.

**Part I – SFO Departure Events by Altitude (ft) over Site** shows the percentage of SFO Aircraft Departures and Arrivals that registered noise events at the noise monitor using ANEEM and NPD by altitude intervals. Altitudes are relative to mean sea level elevation. Excludes helicopters. The percentages for both methods each add up to 100%.

**Part J – Percentage of Events by Aircraft Types** shows the percentage of aircraft events using ANEEM and NPD by aircraft types. The percentages for both methods each add up to 100%.

**Part K – Percentage of Events by Operation Type** shows the percentage of aircraft noise events registered using ANEEM and NPD by Arrivals and Departures.

**Part L – Percentage of Aircraft Events by Runway and Operation Type** compares the percentage of aircraft noise events registered using ANEEM and NPD by Arrivals and Departures per each SFO runway pair and to non-SFO overflights.

**Part M – Noise Reporters** lists the number of individual noise reporters and noise reports per day registered by individuals living in Millbrae or Burlingame.

**Part N – Noise Reports vs Aircraft Noise Events per Day** compares the number of noise reports to the number of aircraft noise events per day using ANEEM and NPD. The percentages for both methods each add up to 100%.

**Part O – Noise Report Locations** illustrates a map that shows the noise report locations.

**Part P – Noise Monitor on Location** shows photographs of the noise monitoring equipment on location.

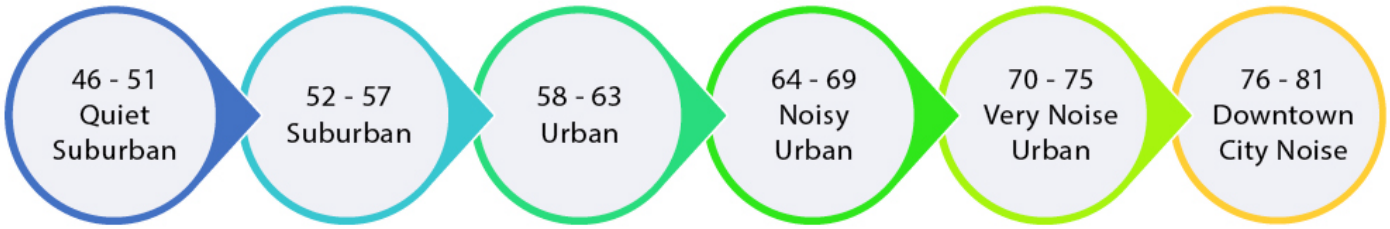
## Glossary

**A-Weighted Noise Level** – Denoted in dBA, is the most common unit used for measuring environmental sound levels. The human ear does not respond equally to different frequencies of sound. An A-weight adjusts the frequency components of sound to conform to your ear's normal response at conversational levels. The FAA and State of the California have adopted the A-weighted sound level for environmental analysis. Sound level meters have an A-weighting network for measuring noise in A-weighted decibels.

**C-Weighted Noise Level** – Denoted in dBC, is a different scale for loudness perception of sound pressure levels than A-weighted noise. A C-weight scale is used to measure sounds with approximately equal sensitivity at all frequencies. The C-weighted scale accounts for low-frequency ranges of sounds more than an A-weighted scale, often resulting in more of the overall noise energy to be included in the measurement.

**California Code of Regulations Title 21, Subchapter 6** – This code describes noise standards by defining metrics terminology and requirements regarding compatible land use. SFO was one of the first airports in the state to achieve a zero impact area within the 65 dB CNEL (Community Noise Equivalent Level) noise contour.

**Community Noise Equivalent Level (CNEL)** – A noise metric required by the California Airport Noise Standards for use by airport proprietors to measure aircraft noise levels. CNEL includes an additional weighting for each event occurring during the evening (7:00 p.m. – 9:59 p.m.) and nighttime (10:00 p.m. – 6:59 a.m.) periods to account for increased sensitivity to noise during these periods. Evening events are treated as though there were three and nighttime events are treated as though there were ten. This results in a 4.77 and 10 dBA penalty for operations occurring in the evening and nighttime periods, respectively. For a more in-depth explanation of CNEL and other technical noise terms, please visit the Federal Aviation Administration (FAA) website. Below is a graphic illustrating types of metropolitan areas and their corresponding CNEL intervals (dBA).




**Decibel (dB)** – A unit used to measure the magnitude or intensity of sound. The decibel uses a logarithmic scale to cover the very large range of sound pressures that can be heard by the human ear. Decibels measure a scale from the threshold of human hearing, 0 dB, upward towards the threshold of pain, about 120-140 dB. Because decibels are such a small measure, they are computed logarithmically and cannot be added arithmetically. A10 dB increase will be perceived by most people to be a doubling in loudness, i.e., 80 dB seems twice as loud as 70 dB. Decibel measurements can be scaled by different frequency ranges, such as by A-Weighted (dBA) and C-Weighted (dBC) scales.

**Maximum Sound Level (Lmax)** – The maximum a-weighted sound level for a given noise event. The peak noise level reached by a single aircraft event.

**Noise Event** – A Noise Event is the measured sound produced by a single source of noise over a duration of time. An aircraft noise event begins when the sound level of a flight operation exceeds a noise threshold and ends when the level drops down below that threshold.

**Sound Exposure Level (SEL)** – SEL is a measure of a single aircraft noise event spread out over its entirety compressed into one second. It allows for a comparison of aircraft noise events of different durations and noise levels. For example, think of the moment you hear a plane from a quarter mile away; we measure from that moment, as the aircraft flies overhead, and until it can't be heard. This is the duration of sound we use and then compress it into one second for a measure. SEL measures noise energy above the threshold (normally 65 dBA for aircraft noise events). This way, any ambient noise is separated out from the measurement.

SAN FRANCISCO INTERNATIONAL AIRPORT
CITY & COUNTY OF SAN FRANCISCO

# MEMORANDUM

TO: Millbrae Community

FROM: SAN FRANCISCO INTERNATIONAL AIRPORT AIRCRAFT NOISE OFFICE

SUBJECT: SFO Roundtable *Up-The-Hill* Noise Monitoring Study – July 2024
*SFO Permanent Noise Monitoring Location – Site 9 in Millbrae*

DATE: November 5, 2024

The San Francisco International Airport (SFO) Aircraft Noise Office conducted aircraft noise monitoring in Millbrae and Burlingame to determine the noise levels within the community from aircraft operations at SFO. This noise monitoring was conducted as part of a SFO Airport/Community Roundtable "Up-the-Hill" noise study researching the effects of takeoff and landing noise on communities situated next to the airport. This monitoring lasted for 21 days, occurring between July 7 and July 27, 2024, across 5 one-time monitoring locations and 9 permanent monitoring locations.

Millbrae, Burlingame, and Hillsborough are situated adjacent to SFO, with Millbrae sitting to the southwest, Burlingame to the south, and Hillsborough further south. Much of the aircraft noise that reaches Millbrae, Burlingame, and Hillsborough is caused by takeoff and landing noise rather than by direct overflights. Aircraft operations on the airfield, takeoffs (takeoff thrust) and landings (reverse thrust from jet engine thrust reversers), generate noise that travels across the landscape, and it is expected that weather and topography may amplify this noise to nearby communities.

SFO uses both Aircraft Noise Event Extraction Methodology (ANEEM) and Noise Power Distance (NPD) event classification methods and both A-weighted (dBA) and C-weighted (dBC) noise levels to generate this report. ANEEM is newer technology that looks at aircraft in the surrounding area to determine if any spikes in noise based on a floating threshold level may be logically correlated to them. Historically, ANEEM's correlation logic used AEDT modeled noise to classify if the increase in noise was logically generated by an aircraft, but this had to be modified to also look at thrust and timing to effectively correlate noise spikes to aircraft landing and taking off on or very close to ground level. NPD uses static noise thresholds to determine if spikes in noise qualify as noise events, then looks to see if there are any aircraft in the surrounding area that could be the cause of the noise. The noise monitor NPD threshold for the total monitoring period was 58 dBA. Both ANEEM and NPD first generated events based on A-weighted noise levels, then used the time window of the A-weighted noise events to identify the C-weighted noise events.

During this study, there were approximately 1037 noise events per day caused by SFO airfield operations using the ANEEM method. Approximately 99% of all aircraft noise events were from SFO aircraft. Aircraft noise events sources include primarily departing aircraft from SFO's north-facing runways, Runways 01L and 01R, and from landing aircraft using thrust reversers to assist with slowing down after touching-down on SFO's west-facing runways, Runways 28L and 28R. Other airfield operations which could be heard at the monitor included take-offs from SFO's west-facing runways, Runways 28L and 28R. In addition to noise from airfield operations, there was also noise from aircraft overflights, majority of which were aircraft from Oakland International Airport (OAK) headed south/southeast utilizing the CNDEL departure procedure. Approximately 1% of all aircraft noise events were from OAK aircraft.

During the monitoring period, the overall Aircraft Community Noise Equivalent Level (CNEL) using ANEEM was 55 dBA and the Aircraft CNEL and Community CNEL using NPD were 54 dBA and 43 dBA, respectively. This noise monitor was located in a quiet suburban area with daily ambient noise ranging between 34 and 44 dba. Aircraft noise above ambient levels may have been perceptible by residents. Additionally, the frequency of flights due to the proximity of the Airport may have increased annoyance levels.

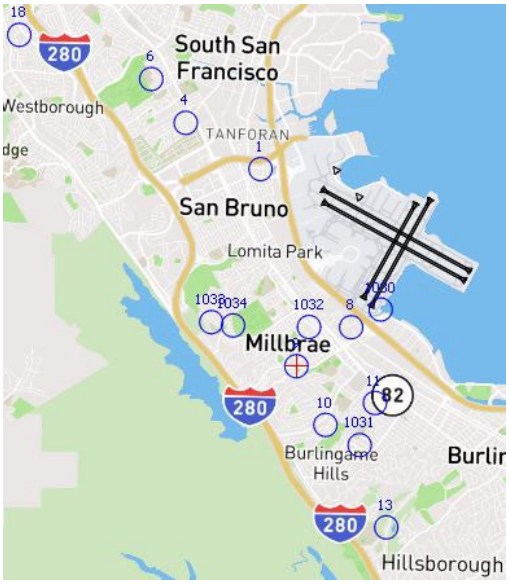
During the monitoring period, the SFO Aircraft Noise Office received 11 noise reports from 4 Millbrae residents. Most of the noise reports were generated between 5AM and 12AM. Likewise, most of the SFO Aircraft noise events using ANEEM occurred between 8AM and 12AM.

This report includes one evaluation of a 21-day period including 16 parts (charts and graphics) that represent summaries of the aircraft noise-related data (values are subject to rounding) collected during the monitoring period. Each part and key terms used in this report are described in the Appendix and Glossary, respectively.

## A – Monitoring Summary

| | |
|---|---|
| **Monitoring Site** | SFO Site 9, Millbrae |
| **Monitoring Site Elevation (ft)** | 157 |
| **Monitoring Period** | July 7 – July 27, 2024 |
| **Average Ambient Noise (dBA)** | 42 |
| **NPD Community (non-aircraft) CNEL (dBA)** | 43 |
| **NPD Aircraft CNEL (dBA)** | 54 |
| **NPD Avg Daily SFO Noise Events** | 118 |
| **ANEEM Aircraft CNEL (dBA)** | 55 |
| **ANEEM Avg Aircraft SEL (dBA)** | 69 |
| **ANEEM Avg Aircraft SEL (dBC)** | 84 |
| **ANEEM Avg Aircraft Lmax (dBA)** | 56 |
| **ANEEM Avg Aircraft Lmax (dBC)** | 70 |
| **ANEEM Avg Daily SFO Noise Events** | 1036 |
| **SFO West Flow** | 100% |
| **SFO Southeast Flow** | 0% |

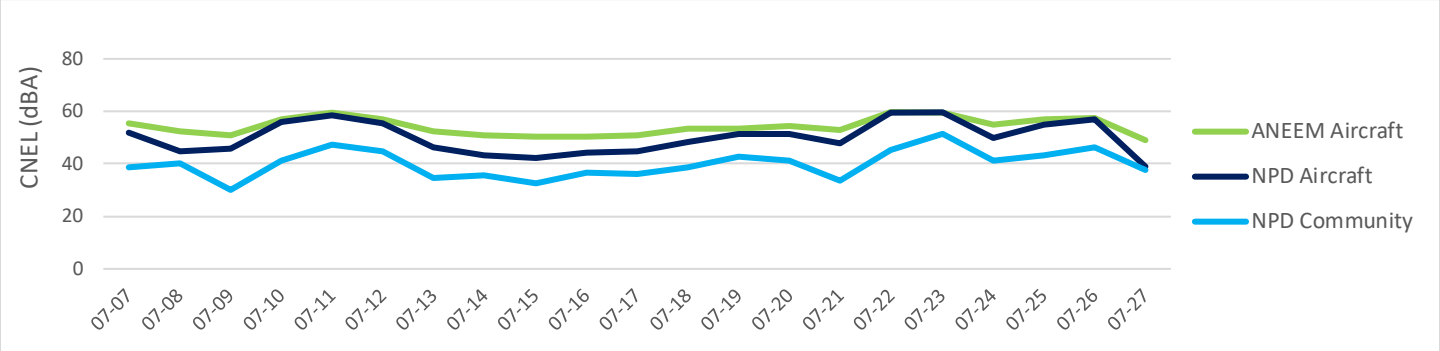
## B – Monitoring Location



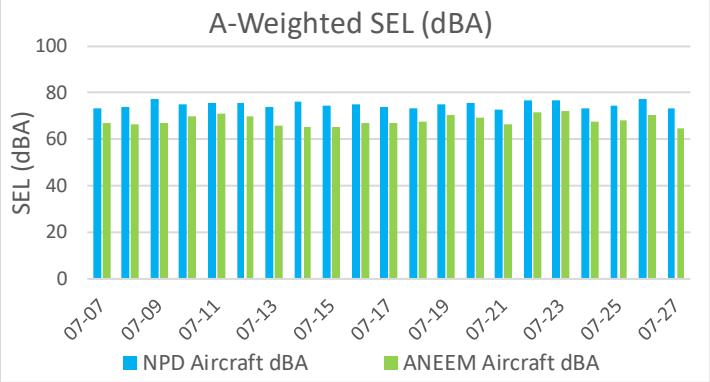

## C – Daily Noise Event Averages

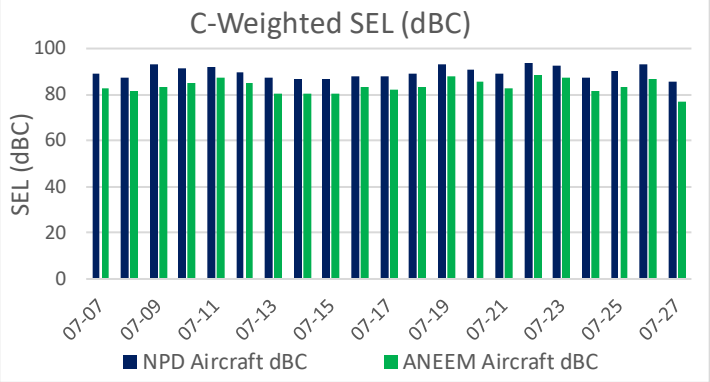
| Day | SFO Aircraft A-Weighted Noise | | | | | | SFO Aircraft C-Weighted Noise | | | | | | Community A-Weighted Noise | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | NPD | | | ANEEM | | | NPD | | | ANEEM | | | NPD | | |
| | Noise Events | Avg SEL | Avg Lmax | Noise Events | Avg SEL | Avg Lmax | Noise Events | Avg SEL | Avg Lmax | Noise Events | Avg SEL | Avg Lmax | Noise Events | Avg SEL | Avg Lmax |
| **07-07** | 77 | 74 | 64 | 1,190 | 67 | 55 | 77 | 89 | 79 | 1,190 | 83 | 68 | 7 | 71 | 63 |
| **07-08** | 55 | 74 | 64 | 1,070 | 67 | 56 | 55 | 88 | 77 | 1,070 | 82 | 68 | 12 | 73 | 64 |
| **07-09** | 52 | 77 | 65 | 1,054 | 67 | 55 | 52 | 93 | 77 | 1,054 | 83 | 70 | 6 | 70 | 62 |
| **07-10** | 198 | 75 | 64 | 1,121 | 70 | 57 | 198 | 91 | 78 | 1,121 | 85 | 70 | 25 | 73 | 63 |
| **07-11** | 280 | 76 | 64 | 1,047 | 71 | 59 | 280 | 92 | 79 | 1,047 | 88 | 73 | 26 | 74 | 63 |
| **07-12** | 195 | 75 | 64 | 1,035 | 70 | 58 | 195 | 90 | 78 | 1,035 | 85 | 72 | 24 | 78 | 64 |
| **07-13** | 51 | 74 | 64 | 1,081 | 66 | 55 | 51 | 88 | 77 | 1,081 | 81 | 68 | 9 | 70 | 63 |
| **07-14** | 21 | 76 | 65 | 1,099 | 66 | 54 | 21 | 87 | 78 | 1,099 | 80 | 67 | 6 | 72 | 63 |
| **07-15** | 23 | 75 | 64 | 1,093 | 65 | 54 | 23 | 87 | 76 | 1,093 | 81 | 68 | 4 | 75 | 67 |
| **07-16** | 47 | 75 | 65 | 938 | 67 | 55 | 47 | 88 | 75 | 938 | 83 | 69 | 13 | 74 | 64 |
| **07-17** | 58 | 74 | 65 | 1,017 | 67 | 55 | 58 | 88 | 79 | 1,017 | 82 | 70 | 6 | 74 | 64 |
| **07-18** | 100 | 73 | 63 | 1,015 | 68 | 56 | 100 | 89 | 79 | 1,015 | 83 | 70 | 7 | 76 | 67 |
| **07-19** | 204 | 75 | 64 | 816 | 70 | 58 | 204 | 93 | 82 | 816 | 88 | 74 | 31 | 76 | 64 |
| **07-20** | 113 | 75 | 64 | 870 | 69 | 57 | 113 | 91 | 80 | 870 | 85 | 72 | 15 | 77 | 64 |
| **07-21** | 55 | 73 | 64 | 991 | 67 | 55 | 55 | 89 | 80 | 991 | 83 | 69 | 9 | 72 | 64 |
| **07-22** | 251 | 77 | 64 | 1,003 | 72 | 58 | 251 | 94 | 80 | 1,003 | 89 | 72 | 30 | 74 | 64 |
| **07-23** | 268 | 77 | 65 | 999 | 72 | 59 | 268 | 93 | 79 | 999 | 87 | 72 | 64 | 75 | 62 |
| **07-24** | 92 | 74 | 64 | 1,179 | 68 | 56 | 92 | 88 | 77 | 1,179 | 81 | 68 | 10 | 74 | 65 |
| **07-25** | 133 | 75 | 64 | 1,163 | 68 | 57 | 133 | 91 | 78 | 1,163 | 83 | 69 | 15 | 75 | 64 |
| **07-26** | 192 | 77 | 64 | 969 | 70 | 57 | 192 | 93 | 80 | 969 | 87 | 71 | 60 | 74 | 62 |
| **07-27** | 15 | 73 | 66 | 1,016 | 65 | 54 | 15 | 85 | 77 | 1,016 | 77 | 65 | 5 | 74 | 67 |
| **Daily Average** | **118** | **76** | **64** | **1,036** | **69** | **56** | **118** | **92** | **79** | **1,036** | **84** | **70** | **18** | **75** | **63** |
| **Total Count** | **2,480** | | | **21,766** | | | **2,480** | | | **21,766** | | | **384** | | |

## D – Community Noise Equivalent Level



## E – Average Sound Exposure Level



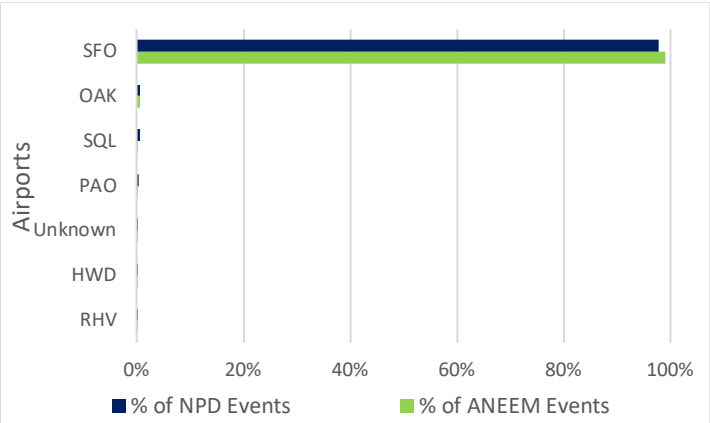




## F – SFO ANEEM Aircraft Noise Events by Time of Day

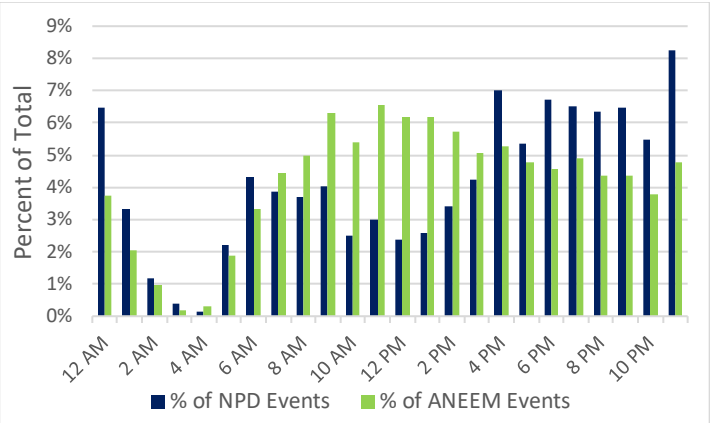
| SFO Aircraft ANEEM A-Weighted Events | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Time of Day | Noise Events | Noise Events % | Daily Avg SEL (dBA) | Min SEL (dBA) | Max SEL (dBA) | Avg Lmax (dBA) | Min Lmax (dBA) | Max Lmax (dBA) | Avg Duration (sec) | Min Duration (sec) | Max Duration (sec) |
| Day (7am–7pm) | 14,233 | 65% | 68 | 51 | 88 | 56 | 45 | 83 | 13 | 4 | 98 |
| Evening (7pm-10pm) | 2,967 | 14% | 69 | 54 | 85 | 57 | 47 | 77 | 15 | 4 | 99 |
| Night (10pm-7am) | 4,566 | 21% | 70 | 45 | 89 | 56 | 37 | 80 | 18 | 4 | 98 |

| SFO Aircraft ANEEM C-Weighted Events | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Time of Day | Noise Events | Noise Events % | Daily Avg SEL (dBC) | Min SEL (dBC) | Max SEL (dBC) | Avg Lmax (dBC) | Min Lmax (dBC) | Max Lmax (dBC) | Avg Duration (sec) | Min Duration (sec) | Max Duration (sec) |
| Day (7am–7pm) | 14,233 | 65% | 83 | 64 | 103 | 70 | 55 | 96 | 13 | 4 | 98 |
| Evening (7pm-10pm) | 2,967 | 14% | 86 | 62 | 102 | 70 | 56 | 93 | 15 | 4 | 99 |
| Night (10pm-7am) | 4,566 | 21% | 87 | 58 | 105 | 70 | 50 | 96 | 18 | 4 | 98 |

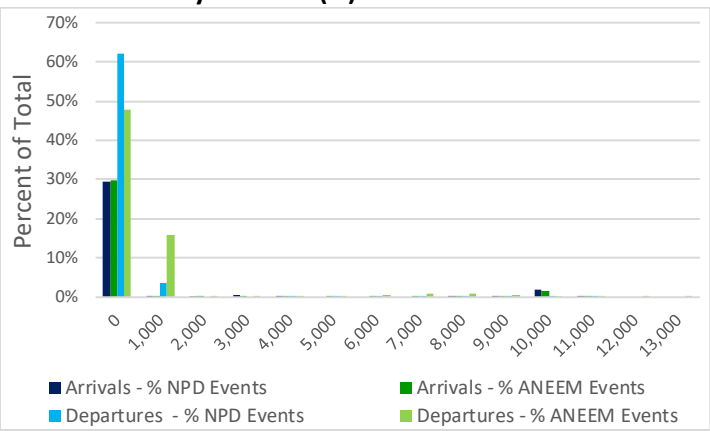
## G – Percentage of Events by Airports



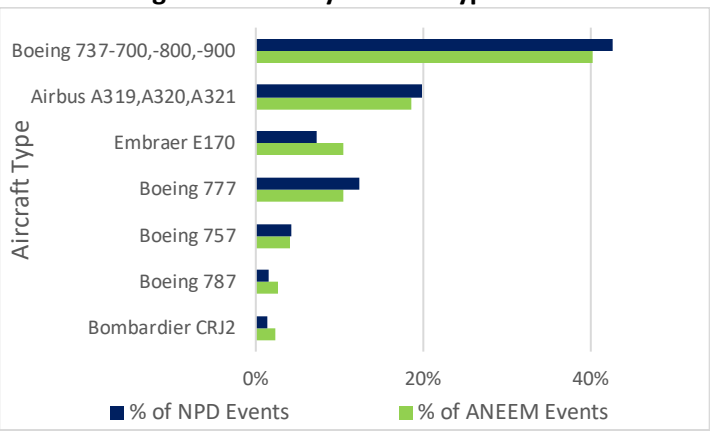

## H – SFO Noise Events by Hour of the Day



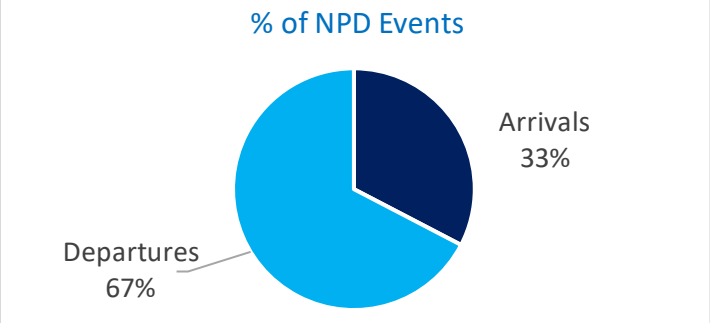

## I – SFO Events by Altitude (ft) over Site

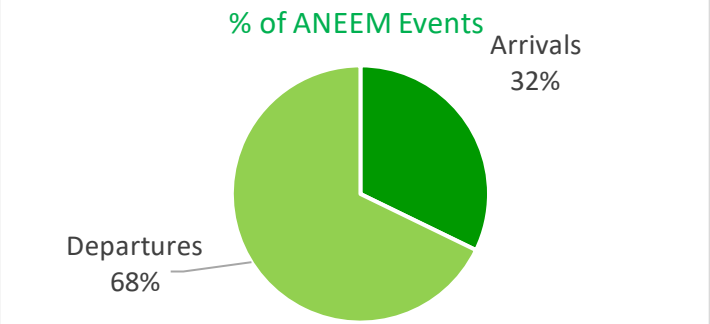



## J – Percentage of Events by Aircraft Types

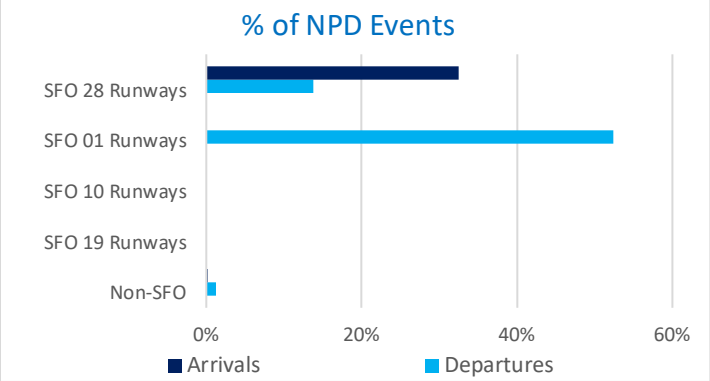


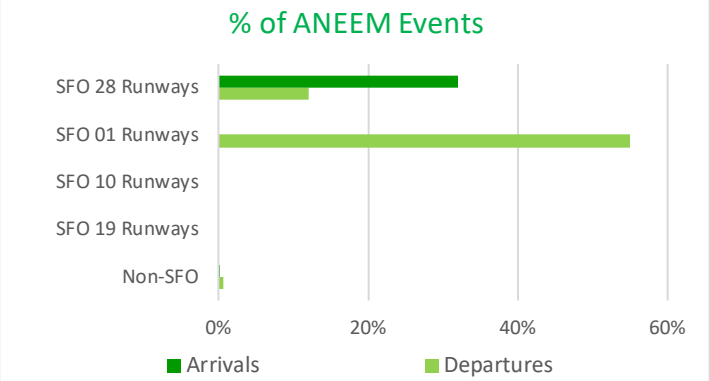
## K – Percentage of Aircraft Events by Operation Type




## L – Percentage of Aircraft Events by Runway and Operation Type

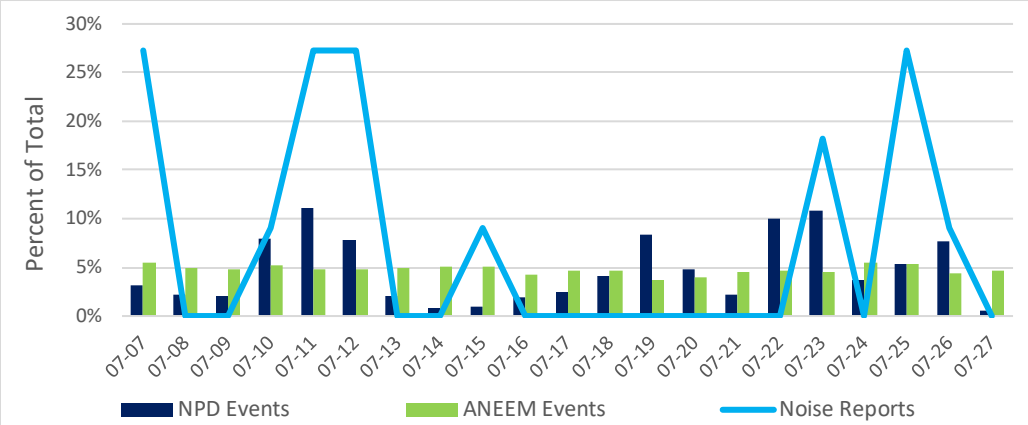


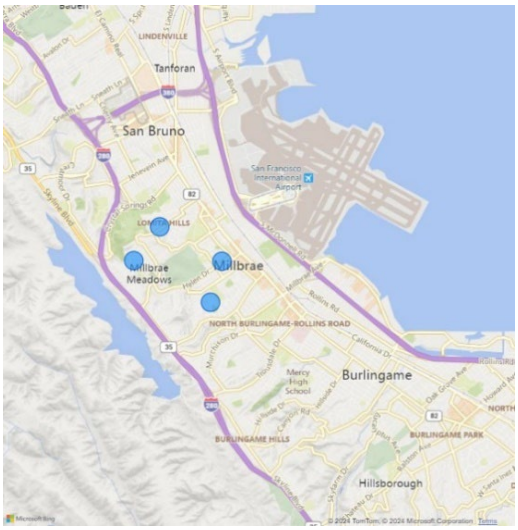

## M – Noise Reporters

| Date | Individual Noise Reporters | Noise Reports |
|---|---|---|
| 07-07 | 1 | 3 |
| 07-08 | 0 | 0 |
| 07-09 | 0 | 0 |
| 07-10 | 1 | 1 |
| 07-11 | 1 | 3 |
| 07-12 | 2 | 3 |
| 07-13 | 0 | 0 |
| 07-14 | 0 | 0 |
| 07-15 | 1 | 1 |
| 07-16 | 0 | 0 |
| 07-17 | 0 | 0 |
| 07-18 | 0 | 0 |
| 07-19 | 0 | 0 |
| 07-20 | 0 | 0 |
| 07-21 | 0 | 0 |
| 07-22 | 0 | 0 |
| 07-23 | 2 | 2 |
| 07-24 | 0 | 0 |
| 07-25 | 1 | 3 |
| 07-26 | 1 | 1 |
| 07-27 | 0 | 0 |
| Total | 4 | 11 |

## N – Noise Reports vs Aircraft Noise Events per Day




## O – Noise Reporter Locations




## P – Noise Monitor on Location

## Appendix

*This Appendix describes the sections of the noise monitoring report and a glossary of terms.*

**Part A – Monitoring Summary** lists the monitoring location, elevation, the monitoring time period, and the key monitoring results including the ANEEM Aircraft, NPD Aircraft, and NPD Community Community Noise Equivalent level (CNEL), single event levels in both A and C noise weightings, and air traffic flow breakdown. The CNEL metric is used to assess and regulate aircraft noise exposure in communities surrounding the airport. California Title 21 Noise Regulations established an acceptable level of 65 dBA CNEL.

**Part B – Monitoring Location** illustrates the location of the portable noise monitor and examples of typical SFO flight operations that registered noise events at the portable noise monitor.

**Part C – Daily Noise Event Averages** lists the number of noise events registered at the noise monitor by SFO Aircraft for both A and C noise weightings using ANEEM (green) or NPD (blue) methods during each day of the noise monitoring period. NPD Community noise events by A-weighted noise levels are also included. The noise event levels are expressed as average Sound Exposure Level (SEL) and average peak noise level (Lmax).

**Part D – Community Noise Equivalent Level** shows a chart that compares the ANEEM Aircraft (SFO and non-SFO), NPD Aircraft, and NPD Community CNEL during each day of the monitoring period.

**Part E – Average Sound Exposure Level** (SEL) shows 2 charts comparing the ANEEM Aircraft (SFO and non-SFO) and NPD Aircraft average SEL for A and C-weighted noise levels during each day of the monitoring period.

**Part F – SFO Aircraft Noise Events by Time of Day** lists 2 tables including the daily minimum, maximum, and average SEL, Lmax, duration and number of SFO Aircraft noise events using ANEEM during the Daytime (7am to 7pm), Evening (7pm to 10pm), and Nighttime (10pm to 7am) for both A and C-weighted noise levels during the monitoring period.

**Part G – Percentage of Events by Airports** shows the percentage of aircraft events using ANEEM and NPD by the aircraft's nearest airport of origin or destination. The percentages for both methods each add up to 100%.

**Part H – SFO Noise Event by Hour of the Day** shows the percentage of total SFO Aircraft noise events using ANEEM and NPD by hour of the day. The percentages for both methods each add up to 100%.

**Part I – SFO Departure Events by Altitude (ft) over Site** shows the percentage of SFO Aircraft Departures and Arrivals that registered noise events at the noise monitor using ANEEM and NPD by altitude intervals. Altitudes are relative to mean sea level elevation. Excludes helicopters. The percentages for both methods each add up to 100%.

**Part J – Percentage of Events by Aircraft Types** shows the percentage of aircraft events using ANEEM and NPD by aircraft types. The percentages for both methods each add up to 100%.

**Part K – Percentage of Events by Operation Type** shows the percentage of aircraft noise events registered using ANEEM and NPD by Arrivals and Departures.

**Part L – Percentage of Aircraft Events by Runway and Operation Type** compares the percentage of aircraft noise events registered using ANEEM and NPD by Arrivals and Departures per each SFO runway pair and to non-SFO overflights.

**Part M – Noise Reporters** lists the number of individual noise reporters and noise reports per day registered by individuals living in Millbrae or Burlingame.

**Part N – Noise Reports vs Aircraft Noise Events per Day** compares the number of noise reports to the number of aircraft noise events per day using ANEEM and NPD. The percentages for both methods each add up to 100%.

**Part O – Noise Report Locations** illustrates a map that shows the noise report locations.

**Part P – Noise Monitor on Location** shows photographs of the noise monitoring equipment on location.

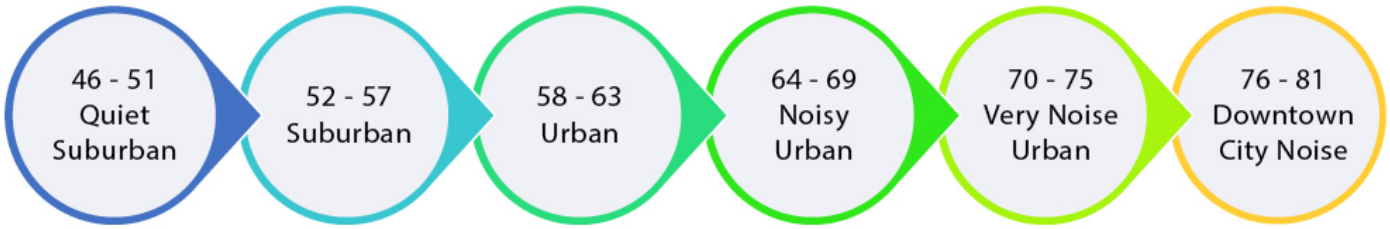
## Glossary

**A-Weighted Noise Level** – Denoted in dBA, is the most common unit used for measuring environmental sound levels. The human ear does not respond equally to different frequencies of sound. An A-weight adjusts the frequency components of sound to conform to your ear's normal response at conversational levels. The FAA and State of the California have adopted the A-weighted sound level for environmental analysis. Sound level meters have an A-weighting network for measuring noise in A-weighted decibels.

**C-Weighted Noise Level** – Denoted in dBC, is a different scale for loudness perception of sound pressure levels than A-weighted noise. A C-weight scale is used to measure sounds with approximately equal sensitivity at all frequencies. The C-weighted scale accounts for low-frequency ranges of sounds more than an A-weighted scale, often resulting in more of the overall noise energy to be included in the measurement.

**California Code of Regulations Title 21, Subchapter 6** – This code describes noise standards by defining metrics terminology and requirements regarding compatible land use. SFO was one of the first airports in the state to achieve a zero impact area within the 65 dB CNEL (Community Noise Equivalent Level) noise contour.

**Community Noise Equivalent Level (CNEL)** – A noise metric required by the California Airport Noise Standards for use by airport proprietors to measure aircraft noise levels. CNEL includes an additional weighting for each event occurring during the evening (7:00 p.m. – 9:59 p.m.) and nighttime (10:00 p.m. – 6:59 a.m.) periods to account for increased sensitivity to noise during these periods. Evening events are treated as though there were three and nighttime events are treated as though there were ten. This results in a 4.77 and 10 dBA penalty for operations occurring in the evening and nighttime periods, respectively. For a more in-depth explanation of CNEL and other technical noise terms, please visit the Federal Aviation Administration (FAA) website. Below is a graphic illustrating types of metropolitan areas and their corresponding CNEL intervals (dBA).




**Decibel (dB)** – A unit used to measure the magnitude or intensity of sound. The decibel uses a logarithmic scale to cover the very large range of sound pressures that can be heard by the human ear. Decibels measure a scale from the threshold of human hearing, 0 dB, upward towards the threshold of pain, about 120-140 dB. Because decibels are such a small measure, they are computed logarithmically and cannot be added arithmetically. A10 dB increase will be perceived by most people to be a doubling in loudness, i.e., 80 dB seems twice as loud as 70 dB. Decibel measurements can be scaled by different frequency ranges, such as by A-Weighted (dBA) and C-Weighted (dBC) scales.

**Maximum Sound Level (Lmax)** – The maximum a-weighted sound level for a given noise event. The peak noise level reached by a single aircraft event.

**Noise Event** – A Noise Event is the measured sound produced by a single source of noise over a duration of time. An aircraft noise event begins when the sound level of a flight operation exceeds a noise threshold and ends when the level drops down below that threshold.

**Sound Exposure Level (SEL)** – SEL is a measure of a single aircraft noise event spread out over its entirety compressed into one second. It allows for a comparison of aircraft noise events of different durations and noise levels. For example, think of the moment you hear a plane from a quarter mile away; we measure from that moment, as the aircraft flies overhead, and until it can't be heard. This is the duration of sound we use and then compress it into one second for a measure. SEL measures noise energy above the threshold (normally 65 dBA for aircraft noise events). This way, any ambient noise is separated out from the measurement.

SAN FRANCISCO INTERNATIONAL AIRPORT
CITY & COUNTY OF SAN FRANCISCO

# MEMORANDUM

TO: Burlingame Community

FROM: SAN FRANCISCO INTERNATIONAL AIRPORT AIRCRAFT NOISE OFFICE

SUBJECT: SFO Roundtable *Up-The-Hill* Noise Monitoring Study – July 2024
*SFO Permanent Noise Monitoring Location – Site 10 in Burlingame*

DATE: November 5, 2024

The San Francisco International Airport (SFO) Aircraft Noise Office conducted aircraft noise monitoring in Millbrae and Burlingame to determine the noise levels within the community from aircraft operations at SFO. This noise monitoring was conducted as part of a SFO Airport/Community Roundtable "Up-the-Hill" noise study researching the effects of takeoff and landing noise on communities situated next to the airport. This monitoring lasted for 21 days, occurring between July 7 and July 27, 2024, across 5 one-time monitoring locations and 9 permanent monitoring locations.

Millbrae, Burlingame, and Hillsborough are situated adjacent to SFO, with Millbrae sitting to the southwest, Burlingame to the south, and Hillsborough further south. Much of the aircraft noise that reaches Millbrae, Burlingame, and Hillsborough is caused by takeoff and landing noise rather than by direct overflights. Aircraft operations on the airfield, takeoffs (takeoff thrust) and landings (reverse thrust from jet engine thrust reversers), generate noise that travels across the landscape, and it is expected that weather and topography may amplify this noise to nearby communities.

SFO uses both Aircraft Noise Event Extraction Methodology (ANEEM) and Noise Power Distance (NPD) event classification methods and both A-weighted (dBA) and C-weighted (dBC) noise levels to generate this report. ANEEM is newer technology that looks at aircraft in the surrounding area to determine if any spikes in noise based on a floating threshold level may be logically correlated to them. Historically, ANEEM's correlation logic used AEDT modeled noise to classify if the increase in noise was logically generated by an aircraft, but this had to be modified to also look at thrust and timing to effectively correlate noise spikes to aircraft landing and taking off on or very close to ground level. NPD uses static noise thresholds to determine if spikes in noise qualify as noise events, then looks to see if there are any aircraft in the surrounding area that could be the cause of the noise. The noise monitor NPD threshold for the total monitoring period was 58 dBA. Both ANEEM and NPD first generated events based on A-weighted noise levels, then used the time window of the A-weighted noise events to identify the C-weighted noise events.

During this study, there were approximately 566 noise events per day caused by SFO airfield operations using the ANEEM method. Approximately 99% of all aircraft noise events were from SFO aircraft. Aircraft noise events sources include primarily departing aircraft from SFO's north-facing runways, Runways 01L and 01R, and from landing aircraft using thrust reversers to assist with slowing down after touching-down on SFO's west-facing runways, Runways 28L and 28R. Other airfield operations which could be heard at the monitor included take-offs from SFO's west-facing runways, Runways 28L and 28R. In addition to noise from airfield operations, there was also noise from aircraft overflights, majority of which were aircraft from Oakland International Airport (OAK) headed south/southeast utilizing the CNDEL departure procedure. Approximately 1% of all aircraft noise events were from OAK aircraft.

During the monitoring period, the overall Aircraft Community Noise Equivalent Level (CNEL) using ANEEM was 53 dBA and the Aircraft CNEL and Community CNEL using NPD were 50 dBA and 40 dBA, respectively. This noise monitor was located in a suburban area with daily ambient noise ranging between 38 and 45 dba. Aircraft noise above ambient levels may have been perceptible by residents. Additionally, the frequency of flights due to the proximity of the Airport may have increased annoyance levels.

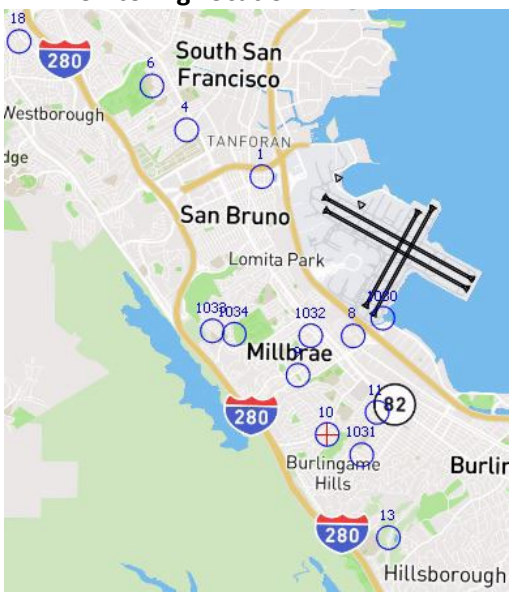
During the monitoring period, the SFO Aircraft Noise Office received 1 noise report from 1 Burlingame resident. The noise report was generated in the 2AM hour. Likewise, most of the SFO Aircraft noise events using ANEEM occurred between 9AM and 12AM.

This report includes one evaluation of a 21-day period including 16 parts (charts and graphics) that represent summaries of the aircraft noise-related data (values are subject to rounding) collected during the monitoring period. Each part and key terms used in this report are described in the Appendix and Glossary, respectively.

## A – Monitoring Summary

| | |
|---|---|
| **Monitoring Site** | SFO Site 10, Burlingame |
| **Monitoring Site Elevation (ft)** | 335 |
| **Monitoring Period** | July 7 – July 27, 2024 |
| **Average Ambient Noise (dBA)** | 42 |
| **NPD Community (non-aircraft) CNEL (dBA)** | 40 |
| **NPD Aircraft CNEL (dBA)** | 50 |
| **NPD Avg Daily SFO Noise Events** | 72 |
| **ANEEM Aircraft CNEL (dBA)** | 53 |
| **ANEEM Avg Aircraft SEL (dBA)** | 70 |
| **ANEEM Avg Aircraft SEL (dBC)** | 88 |
| **ANEEM Avg Aircraft Lmax (dBA)** | 57 |
| **ANEEM Avg Aircraft Lmax (dBC)** | 73 |
| **ANEEM Avg Daily SFO Noise Events** | 566 |
| **SFO West Flow** | 100% |
| **SFO Southeast Flow** | 0% |

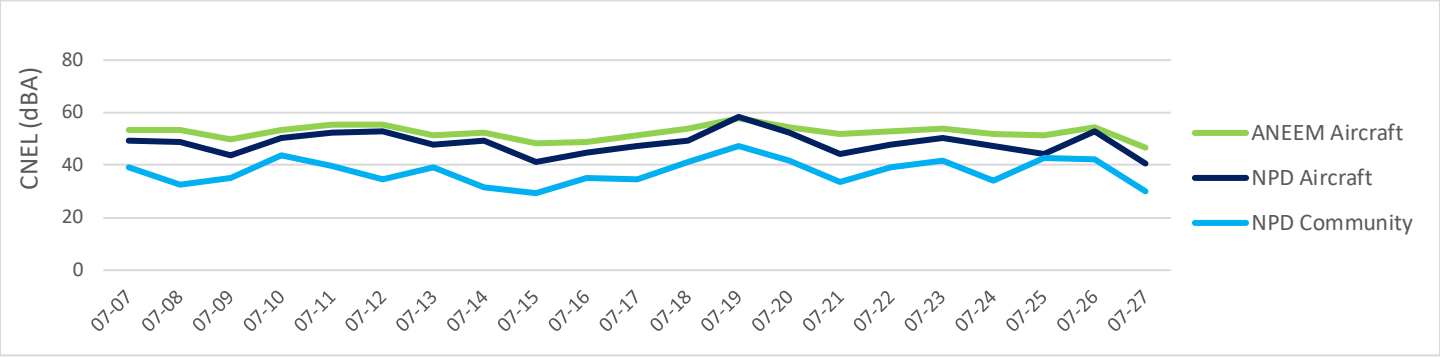
## B – Monitoring Location



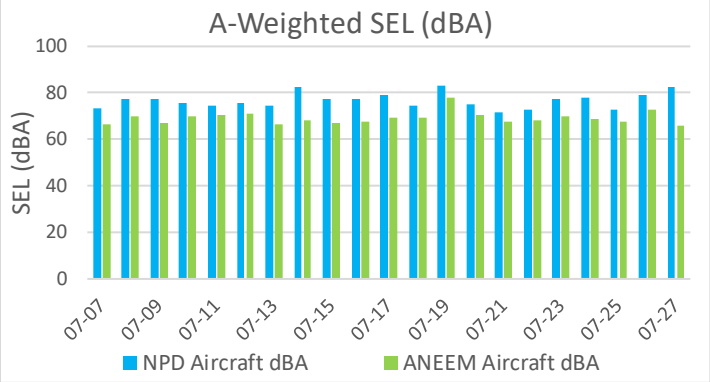

## C – Daily Noise Event Averages

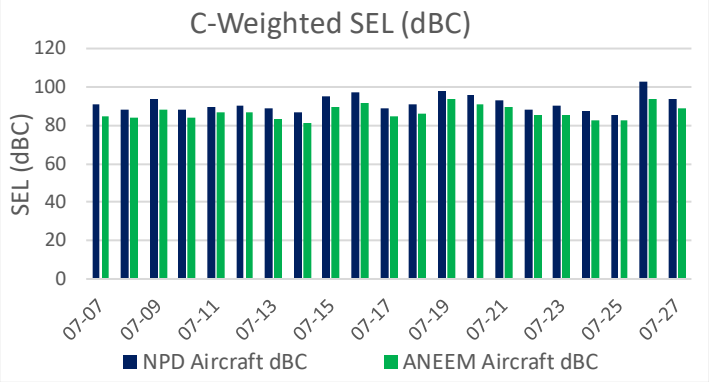
| Day | SFO Aircraft A-Weighted Noise | | | | | | SFO Aircraft C-Weighted Noise | | | | | | Community A-Weighted Noise | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | NPD | | | ANEEM | | | NPD | | | ANEEM | | | NPD | | |
| | Noise Events | Avg SEL | Avg Lmax | Noise Events | Avg SEL | Avg Lmax | Noise Events | Avg SEL | Avg Lmax | Noise Events | Avg SEL | Avg Lmax | Noise Events | Avg SEL | Avg Lmax |
| **07-07** | 42 | 73 | 62 | 651 | 67 | 54 | 42 | 91 | 80 | 651 | 85 | 70 | 3 | 74 | 64 |
| **07-08** | 54 | 78 | 66 | 605 | 70 | 57 | 54 | 88 | 77 | 605 | 84 | 71 | 5 | 75 | 65 |
| **07-09** | 24 | 78 | 65 | 527 | 67 | 56 | 24 | 94 | 80 | 527 | 88 | 75 | 7 | 75 | 66 |
| **07-10** | 85 | 76 | 63 | 667 | 70 | 57 | 85 | 88 | 75 | 667 | 84 | 71 | 17 | 80 | 67 |
| **07-11** | 154 | 75 | 63 | 642 | 71 | 59 | 154 | 90 | 78 | 642 | 87 | 74 | 13 | 72 | 62 |
| **07-12** | 137 | 76 | 63 | 595 | 71 | 58 | 137 | 90 | 78 | 595 | 87 | 73 | 13 | 70 | 62 |
| **07-13** | 25 | 75 | 64 | 569 | 67 | 55 | 25 | 89 | 78 | 569 | 83 | 70 | 5 | 80 | 68 |
| **07-14** | 11 | 83 | 68 | 668 | 68 | 53 | 11 | 87 | 77 | 668 | 81 | 68 | 2 | 71 | 63 |
| **07-15** | 20 | 77 | 66 | 500 | 67 | 55 | 20 | 95 | 81 | 500 | 90 | 75 | 3 | 74 | 64 |
| **07-16** | 27 | 78 | 66 | 465 | 67 | 55 | 27 | 97 | 84 | 465 | 91 | 75 | 6 | 76 | 65 |
| **07-17** | 40 | 80 | 66 | 516 | 69 | 56 | 40 | 89 | 79 | 516 | 84 | 72 | 7 | 73 | 64 |
| **07-18** | 93 | 74 | 63 | 619 | 69 | 58 | 93 | 91 | 79 | 619 | 86 | 73 | 17 | 73 | 63 |
| **07-19** | 242 | 83 | 66 | 629 | 78 | 61 | 242 | 98 | 83 | 629 | 93 | 79 | 43 | 78 | 64 |
| **07-20** | 136 | 75 | 63 | 527 | 71 | 58 | 136 | 96 | 83 | 527 | 91 | 76 | 20 | 73 | 63 |
| **07-21** | 33 | 72 | 62 | 521 | 68 | 56 | 33 | 93 | 82 | 521 | 89 | 74 | 3 | 72 | 63 |
| **07-22** | 89 | 73 | 63 | 610 | 68 | 57 | 89 | 88 | 78 | 610 | 85 | 72 | 8 | 76 | 66 |
| **07-23** | 72 | 77 | 64 | 583 | 70 | 57 | 72 | 90 | 78 | 583 | 85 | 72 | 10 | 73 | 64 |
| **07-24** | 44 | 78 | 65 | 562 | 69 | 55 | 44 | 88 | 77 | 562 | 83 | 69 | 1 | 73 | 65 |
| **07-25** | 43 | 73 | 63 | 493 | 67 | 57 | 43 | 85 | 75 | 493 | 83 | 70 | 5 | 75 | 67 |
| **07-26** | 136 | 79 | 65 | 575 | 73 | 59 | 136 | 103 | 85 | 575 | 93 | 76 | 29 | 75 | 63 |
| **07-27** | 5 | 82 | 69 | 368 | 66 | 54 | 5 | 93 | 81 | 368 | 89 | 73 | 3 | 72 | 65 |
| **Daily Average** | **72** | **79** | **64** | **566** | **70** | **57** | **72** | **96** | **80** | **566** | **88** | **73** | **10** | **76** | **64** |
| **Total Count** | **1,512** | | | **11,892** | | | **1,512** | | | **11,892** | | | **220** | | |

## D – Community Noise Equivalent Level



## E – Average Sound Exposure Level



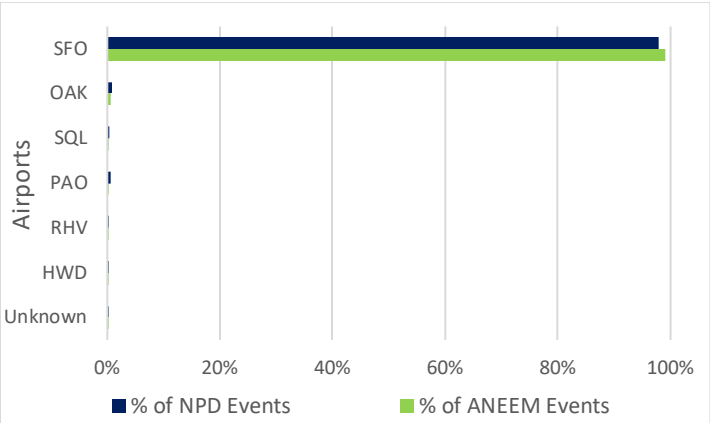




## F – SFO ANEEM Aircraft Noise Events by Time of Day

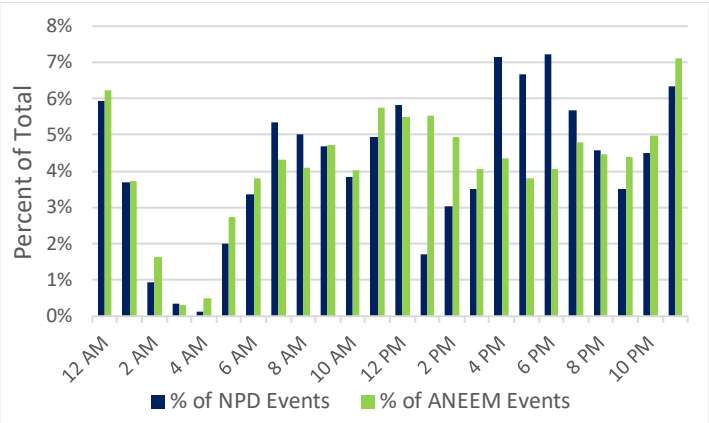
| SFO Aircraft ANEEM A-Weighted Events | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Time of Day | Noise Events | Noise Events % | Daily Avg SEL (dBA) | Min SEL (dBA) | Max SEL (dBA) | Avg Lmax (dBA) | Min Lmax (dBA) | Max Lmax (dBA) | Avg Duration (sec) | Min Duration (sec) | Max Duration (sec) |
| Day (7am–7pm) | 6,566 | 55% | 72 | 54 | 97 | 58 | 46 | 84 | 12 | 4 | 97 |
| Evening (7pm-10pm) | 1,628 | 14% | 69 | 54 | 93 | 57 | 47 | 83 | 14 | 4 | 88 |
| Night (10pm-7am) | 3,698 | 31% | 68 | 45 | 81 | 55 | 37 | 76 | 19 | 4 | 98 |

| SFO Aircraft ANEEM C-Weighted Events | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Time of Day | Noise Events | Noise Events % | Daily Avg SEL (dBC) | Min SEL (dBC) | Max SEL (dBC) | Avg Lmax (dBC) | Min Lmax (dBC) | Max Lmax (dBC) | Avg Duration (sec) | Min Duration (sec) | Max Duration (sec) |
| Day (7am–7pm) | 6,566 | 55% | 89 | 63 | 107 | 74 | 57 | 100 | 12 | 4 | 97 |
| Evening (7pm-10pm) | 1,628 | 14% | 89 | 64 | 105 | 74 | 56 | 97 | 14 | 4 | 88 |
| Night (10pm-7am) | 3,698 | 31% | 86 | 61 | 103 | 71 | 53 | 90 | 19 | 4 | 98 |

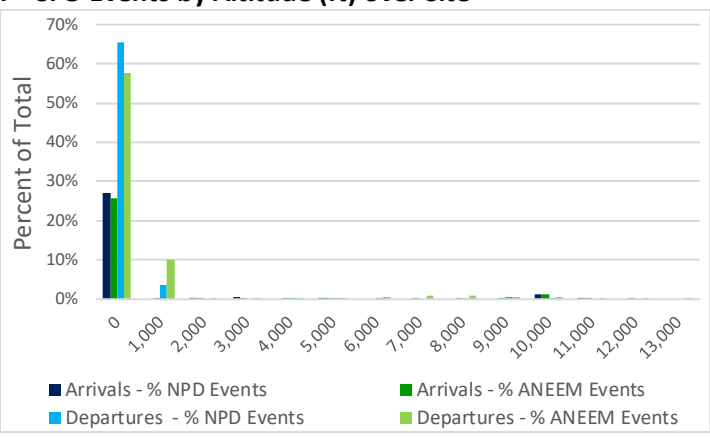
## G – Percentage of Events by Airports



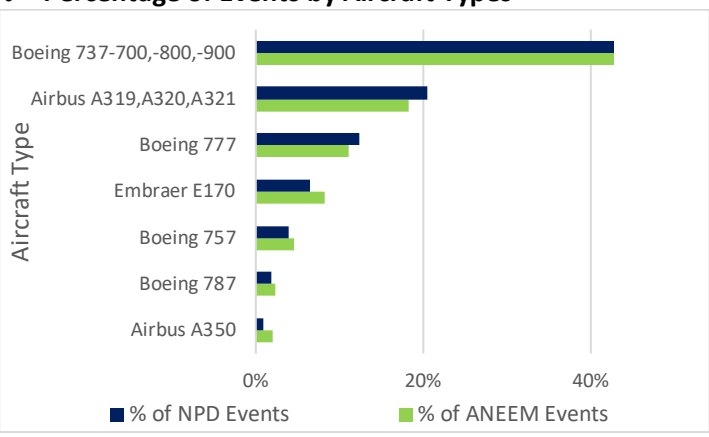

## H – SFO Noise Events by Hour of the Day



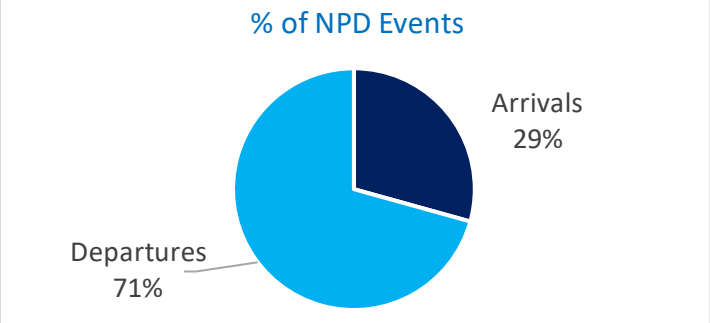

## I – SFO Events by Altitude (ft) over Site

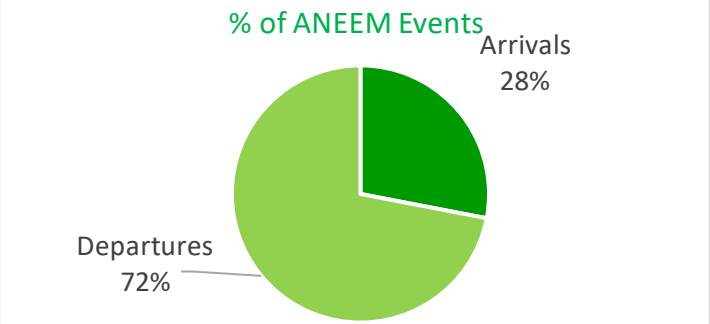



## J – Percentage of Events by Aircraft Types

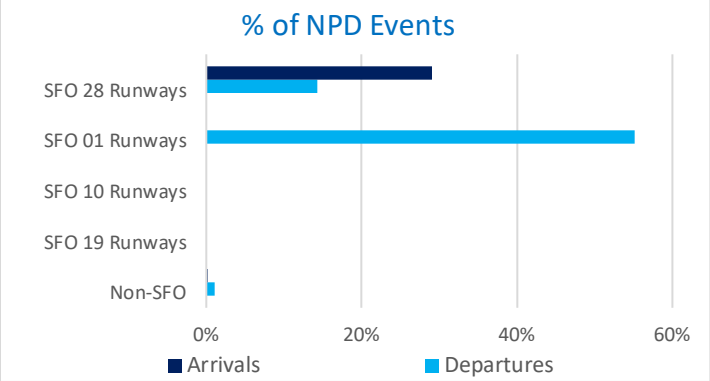


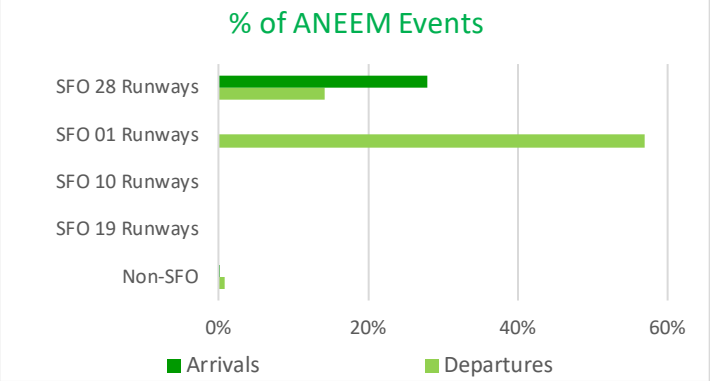
## K – Percentage of Aircraft Events by Operation Type




## L – Percentage of Aircraft Events by Runway and Operation Type

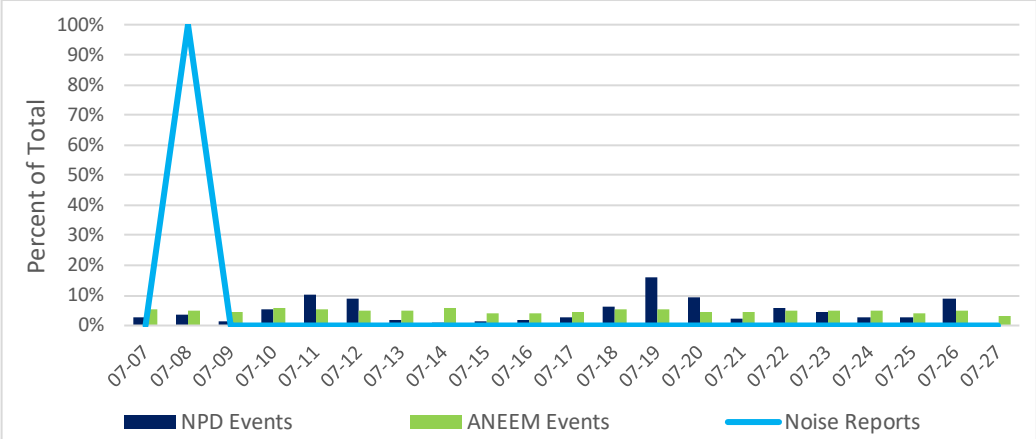


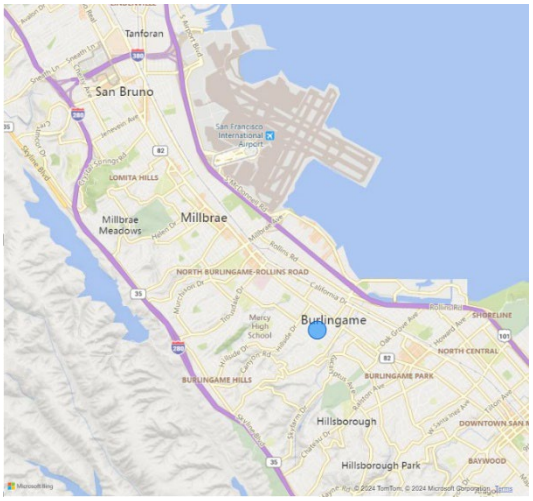

## M – Noise Reporters

| Date | Individual Noise Reporters | Noise Reports |
|---|---|---|
| 07-07 | 0 | 0 |
| 07-08 | 1 | 1 |
| 07-09 | 0 | 0 |
| 07-10 | 0 | 0 |
| 07-11 | 0 | 0 |
| 07-12 | 0 | 0 |
| 07-13 | 0 | 0 |
| 07-14 | 0 | 0 |
| 07-15 | 0 | 0 |
| 07-16 | 0 | 0 |
| 07-17 | 0 | 0 |
| 07-18 | 0 | 0 |
| 07-19 | 0 | 0 |
| 07-20 | 0 | 0 |
| 07-21 | 0 | 0 |
| 07-22 | 0 | 0 |
| 07-23 | 0 | 0 |
| 07-24 | 0 | 0 |
| 07-25 | 0 | 0 |
| 07-26 | 0 | 0 |
| 07-27 | 0 | 0 |
| Total | 1 | 1 |

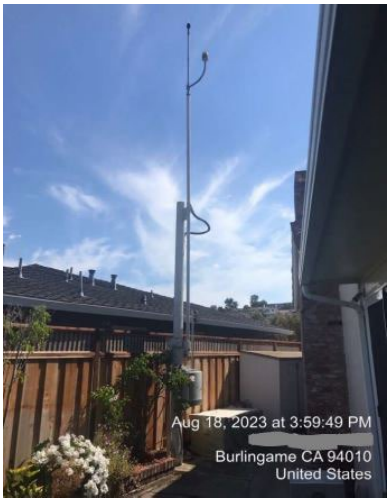
## N – Noise Reports vs Aircraft Noise Events per Day




## O – Noise Reporter Locations




## P – Noise Monitor on Location



## Appendix

*This Appendix describes the sections of the noise monitoring report and a glossary of terms.*

**Part A – Monitoring Summary** lists the monitoring location, elevation, the monitoring time period, and the key monitoring results including the ANEEM Aircraft, NPD Aircraft, and NPD Community Community Noise Equivalent level (CNEL), single event levels in both A and C noise weightings, and air traffic flow breakdown. The CNEL metric is used to assess and regulate aircraft noise exposure in communities surrounding the airport. California Title 21 Noise Regulations established an acceptable level of 65 dBA CNEL.

**Part B – Monitoring Location** illustrates the location of the portable noise monitor and examples of typical SFO flight operations that registered noise events at the portable noise monitor.

**Part C – Daily Noise Event Averages** lists the number of noise events registered at the noise monitor by SFO Aircraft for both A and C noise weightings using ANEEM (green) or NPD (blue) methods during each day of the noise monitoring period. NPD Community noise events by A-weighted noise levels are also included. The noise event levels are expressed as average Sound Exposure Level (SEL) and average peak noise level (Lmax).

**Part D – Community Noise Equivalent Level** shows a chart that compares the ANEEM Aircraft (SFO and non-SFO), NPD Aircraft, and NPD Community CNEL during each day of the monitoring period.

**Part E – Average Sound Exposure Level** (SEL) shows 2 charts comparing the ANEEM Aircraft (SFO and non-SFO) and NPD Aircraft average SEL for A and C-weighted noise levels during each day of the monitoring period.

**Part F – SFO Aircraft Noise Events by Time of Day** lists 2 tables including the daily minimum, maximum, and average SEL, Lmax, duration and number of SFO Aircraft noise events using ANEEM during the Daytime (7am to 7pm), Evening (7pm to 10pm), and Nighttime (10pm to 7am) for both A and C-weighted noise levels during the monitoring period.

**Part G – Percentage of Events by Airports** shows the percentage of aircraft events using ANEEM and NPD by the aircraft's nearest airport of origin or destination. The percentages for both methods each add up to 100%.

**Part H – SFO Noise Event by Hour of the Day** shows the percentage of total SFO Aircraft noise events using ANEEM and NPD by hour of the day. The percentages for both methods each add up to 100%.

**Part I – SFO Departure Events by Altitude (ft) over Site** shows the percentage of SFO Aircraft Departures and Arrivals that registered noise events at the noise monitor using ANEEM and NPD by altitude intervals. Altitudes are relative to mean sea level elevation. Excludes helicopters. The percentages for both methods each add up to 100%.

**Part J – Percentage of Events by Aircraft Types** shows the percentage of aircraft events using ANEEM and NPD by aircraft types. The percentages for both methods each add up to 100%.

**Part K – Percentage of Events by Operation Type** shows the percentage of aircraft noise events registered using ANEEM and NPD by Arrivals and Departures.

**Part L – Percentage of Aircraft Events by Runway and Operation Type** compares the percentage of aircraft noise events registered using ANEEM and NPD by Arrivals and Departures per each SFO runway pair and to non-SFO overflights.

**Part M – Noise Reporters** lists the number of individual noise reporters and noise reports per day registered by individuals living in Millbrae or Burlingame.

**Part N – Noise Reports vs Aircraft Noise Events per Day** compares the number of noise reports to the number of aircraft noise events per day using ANEEM and NPD. The percentages for both methods each add up to 100%.

**Part O – Noise Report Locations** illustrates a map that shows the noise report locations.

**Part P – Noise Monitor on Location** shows photographs of the noise monitoring equipment on location.

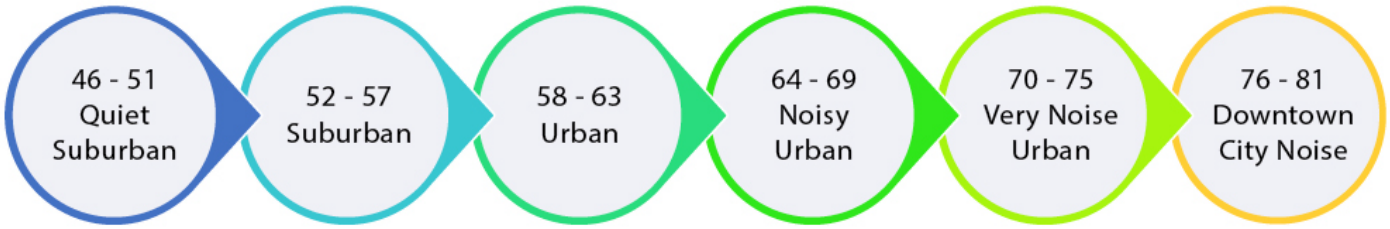
## Glossary

**A-Weighted Noise Level** – Denoted in dBA, is the most common unit used for measuring environmental sound levels. The human ear does not respond equally to different frequencies of sound. An A-weight adjusts the frequency components of sound to conform to your ear's normal response at conversational levels. The FAA and State of the California have adopted the A-weighted sound level for environmental analysis. Sound level meters have an A-weighting network for measuring noise in A-weighted decibels.

**C-Weighted Noise Level** – Denoted in dBC, is a different scale for loudness perception of sound pressure levels than A-weighted noise. A C-weight scale is used to measure sounds with approximately equal sensitivity at all frequencies. The C-weighted scale accounts for low-frequency ranges of sounds more than an A-weighted scale, often resulting in more of the overall noise energy to be included in the measurement.

**California Code of Regulations Title 21, Subchapter 6** – This code describes noise standards by defining metrics terminology and requirements regarding compatible land use. SFO was one of the first airports in the state to achieve a zero impact area within the 65 dB CNEL (Community Noise Equivalent Level) noise contour.

**Community Noise Equivalent Level (CNEL)** – A noise metric required by the California Airport Noise Standards for use by airport proprietors to measure aircraft noise levels. CNEL includes an additional weighting for each event occurring during the evening (7:00 p.m. – 9:59 p.m.) and nighttime (10:00 p.m. – 6:59 a.m.) periods to account for increased sensitivity to noise during these periods. Evening events are treated as though there were three and nighttime events are treated as though there were ten. This results in a 4.77 and 10 dBA penalty for operations occurring in the evening and nighttime periods, respectively. For a more in-depth explanation of CNEL and other technical noise terms, please visit the Federal Aviation Administration (FAA) website. Below is a graphic illustrating types of metropolitan areas and their corresponding CNEL intervals (dBA).




**Decibel (dB)** – A unit used to measure the magnitude or intensity of sound. The decibel uses a logarithmic scale to cover the very large range of sound pressures that can be heard by the human ear. Decibels measure a scale from the threshold of human hearing, 0 dB, upward towards the threshold of pain, about 120-140 dB. Because decibels are such a small measure, they are computed logarithmically and cannot be added arithmetically. A10 dB increase will be perceived by most people to be a doubling in loudness, i.e., 80 dB seems twice as loud as 70 dB. Decibel measurements can be scaled by different frequency ranges, such as by A-Weighted (dBA) and C-Weighted (dBC) scales.

**Maximum Sound Level (Lmax)** – The maximum a-weighted sound level for a given noise event. The peak noise level reached by a single aircraft event.

**Noise Event** – A Noise Event is the measured sound produced by a single source of noise over a duration of time. An aircraft noise event begins when the sound level of a flight operation exceeds a noise threshold and ends when the level drops down below that threshold.

**Sound Exposure Level (SEL)** – SEL is a measure of a single aircraft noise event spread out over its entirety compressed into one second. It allows for a comparison of aircraft noise events of different durations and noise levels. For example, think of the moment you hear a plane from a quarter mile away; we measure from that moment, as the aircraft flies overhead, and until it can't be heard. This is the duration of sound we use and then compress it into one second for a measure. SEL measures noise energy above the threshold (normally 65 dBA for aircraft noise events). This way, any ambient noise is separated out from the measurement.

SAN FRANCISCO INTERNATIONAL AIRPORT
CITY & COUNTY OF SAN FRANCISCO

# MEMORANDUM

TO: Burlingame Community

FROM: SAN FRANCISCO INTERNATIONAL AIRPORT AIRCRAFT NOISE OFFICE

SUBJECT: SFO Roundtable *Up-The-Hill* Noise Monitoring Study – July 2024
*SFO Permanent Noise Monitoring Location – Site 11 in Burlingame*

DATE: November 5, 2024

The San Francisco International Airport (SFO) Aircraft Noise Office conducted aircraft noise monitoring in Millbrae and Burlingame to determine the noise levels within the community from aircraft operations at SFO. This noise monitoring was conducted as part of a SFO Airport/Community Roundtable "Up-the-Hill" noise study researching the effects of takeoff and landing noise on communities situated next to the airport. This monitoring lasted for 21 days, occurring between July 7 and July 27, 2024, across 5 one-time monitoring locations and 9 permanent monitoring locations.

Millbrae, Burlingame, and Hillsborough are situated adjacent to SFO, with Millbrae sitting to the southwest, Burlingame to the south, and Hillsborough further south. Much of the aircraft noise that reaches Millbrae, Burlingame, and Hillsborough is caused by takeoff and landing noise rather than by direct overflights. Aircraft operations on the airfield, takeoffs (takeoff thrust) and landings (reverse thrust from jet engine thrust reverser), generate noise that travels across the landscape, and it is expected that weather and topography may amplify this noise to nearby communities.

SFO uses both Aircraft Noise Event Extraction Methodology (ANEEM) and Noise Power Distance (NPD) event classification methods and both A-weighted (dBA) and C-weighted (dBC) noise levels to generate this report. ANEEM is newer technology that looks at aircraft in the surrounding area to determine if any spikes in noise based on a floating threshold level may be logically correlated to them. Historically, ANEEM's correlation logic used AEDT modeled noise to classify if the increase in noise was logically generated by an aircraft, but this had to be modified to also look at thrust and timing to effectively correlate noise spikes to aircraft landing and taking off on or very close to ground level. NPD uses static noise thresholds to determine if spikes in noise qualify as noise events, then looks to see if there are any aircraft in the surrounding area that could be the cause of the noise. The noise monitor NPD threshold for the total monitoring period was 58 dBA. Both ANEEM and NPD first generated events based on A-weighted noise levels, then used the time window of the A-weighted noise events to identify the C-weighted noise events.

During this study, there were approximately 815 noise events per day caused by SFO airfield operations using the ANEEM method. Approximately 99% of all aircraft noise events were from SFO aircraft. Aircraft noise events sources include primarily departing aircraft from SFO's north-facing runways, Runways 01L and 01R, and from landing aircraft using thrust reversers to assist with slowing down after touching-down on SFO's west-facing runways, Runways 28L and 28R. Other airfield operations which could be heard at the monitor included take-offs from SFO's west-facing runways, Runways 28L and 28R. In addition to noise from airfield operations, there was also noise from aircraft overflights, majority of which were aircraft from Oakland International Airport (OAK) headed south/southeast utilizing the CNDEL departure procedure. Approximately 1% of all aircraft noise events were from OAK aircraft.

During the monitoring period, the overall Aircraft Community Noise Equivalent Level (CNEL) using ANEEM was 54 dBA and the Aircraft CNEL and Community CNEL using NPD were 51 dBA and 42 dBA, respectively. This noise monitor was located in a quiet suburban area with daily ambient noise ranging between 37 and 44 dba. Aircraft noise above ambient levels may have been perceptible by residents. Additionally, the frequency of flights due to the proximity of the Airport may have increased annoyance levels.

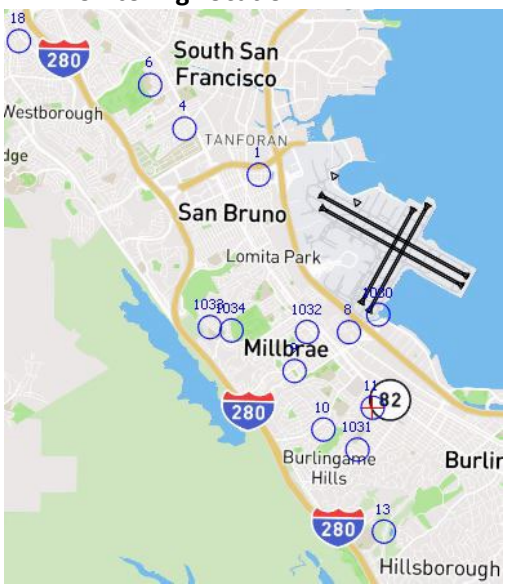
During the monitoring period, the SFO Aircraft Noise Office received 1 noise report from 1 Burlingame resident. The noise report was generated in the 2AM hour. Likewise, the most of the SFO Aircraft noise events using ANEEM occurred between 8AM and 12AM.

This report includes one evaluation of a 21-day period including 16 parts (charts and graphics) that represent summaries of the aircraft noise-related data (values are subject to rounding) collected during the monitoring period. Each part and key terms used in this report are described in the Appendix and Glossary, respectively.

## A – Monitoring Summary

| | |
|---|---|
| **Monitoring Site** | SFO Site 11, Burlingame |
| **Monitoring Site Elevation (ft)** | 62 |
| **Monitoring Period** | July 7 – July 27, 2024 |
| **Average Ambient Noise (dBA)** | 41 |
| **NPD Community (non-aircraft) CNEL (dBA)** | 42 |
| **NPD Aircraft CNEL (dBA)** | 51 |
| **NPD Avg Daily SFO Noise Events** | 73 |
| **ANEEM Aircraft CNEL (dBA)** | 54 |
| **ANEEM Avg Aircraft SEL (dBA)** | 69 |
| **ANEEM Avg Aircraft SEL (dBC)** | 82 |
| **ANEEM Avg Aircraft Lmax (dBA)** | 56 |
| **ANEEM Avg Aircraft Lmax (dBC)** | 69 |
| **ANEEM Avg Daily SFO Noise Events** | 815 |
| **SFO West Flow** | 100% |
| **SFO Southeast Flow** | 0% |

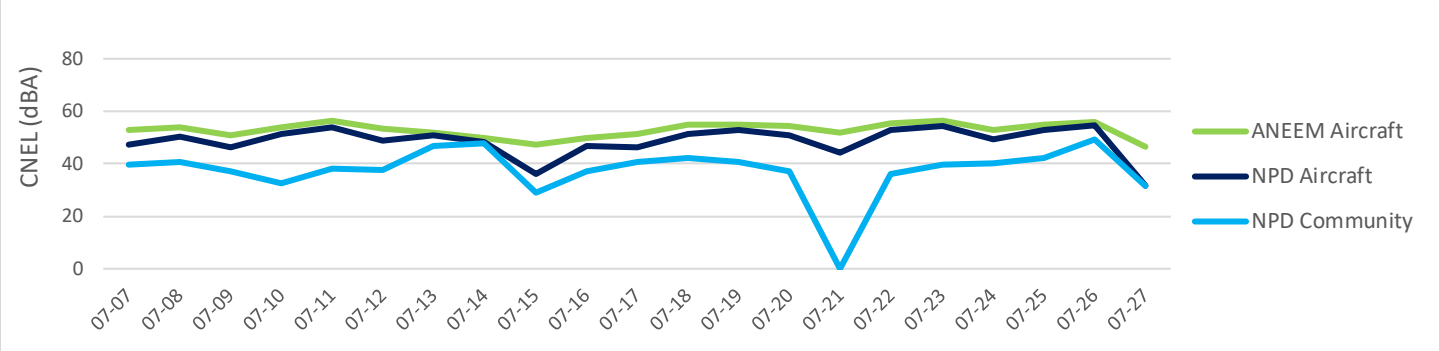
## B – Monitoring Location



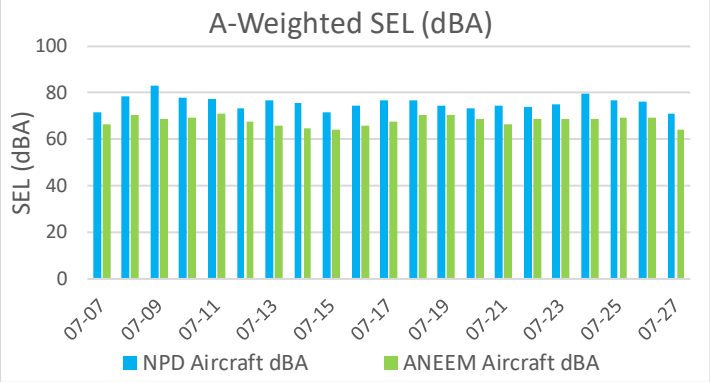

## C – Daily Noise Event Averages

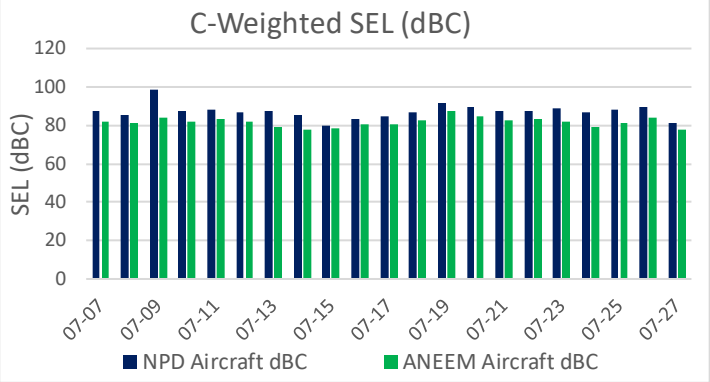
| Day | SFO Aircraft A-Weighted Noise | | | | | | SFO Aircraft C-Weighted Noise | | | | | | Community A-Weighted Noise | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | NPD | | | ANEEM | | | NPD | | | ANEEM | | | NPD | | |
| | Noise Events | Avg SEL | Avg Lmax | Noise Events | Avg SEL | Avg Lmax | Noise Events | Avg SEL | Avg Lmax | Noise Events | Avg SEL | Avg Lmax | Noise Events | Avg SEL | Avg Lmax |
| **07-07** | 41 | 72 | 63 | 808 | 66 | 55 | 41 | 88 | 78 | 808 | 82 | 68 | 4 | 74 | 65 |
| **07-08** | 91 | 78 | 65 | 792 | 70 | 57 | 91 | 85 | 73 | 792 | 82 | 69 | 27 | 75 | 63 |
| **07-09** | 18 | 83 | 67 | 785 | 68 | 55 | 18 | 98 | 79 | 785 | 84 | 70 | 2 | 78 | 70 |
| **07-10** | 92 | 78 | 65 | 937 | 69 | 56 | 92 | 87 | 75 | 937 | 82 | 69 | 4 | 76 | 66 |
| **07-11** | 155 | 77 | 64 | 995 | 71 | 58 | 155 | 88 | 76 | 995 | 83 | 70 | 11 | 74 | 64 |
| **07-12** | 71 | 73 | 64 | 853 | 68 | 57 | 71 | 87 | 76 | 853 | 82 | 69 | 8 | 71 | 63 |
| **07-13** | 23 | 77 | 65 | 746 | 66 | 55 | 23 | 88 | 76 | 746 | 79 | 67 | 6 | 79 | 66 |
| **07-14** | 18 | 76 | 64 | 723 | 65 | 53 | 18 | 85 | 75 | 723 | 78 | 66 | 4 | 81 | 67 |
| **07-15** | 9 | 71 | 64 | 737 | 64 | 53 | 9 | 80 | 72 | 737 | 79 | 67 | 2 | 68 | 63 |
| **07-16** | 26 | 75 | 64 | 787 | 66 | 55 | 26 | 83 | 72 | 787 | 81 | 67 | 2 | 74 | 65 |
| **07-17** | 42 | 77 | 66 | 843 | 68 | 56 | 42 | 85 | 75 | 843 | 80 | 69 | 7 | 81 | 68 |
| **07-18** | 144 | 77 | 65 | 951 | 70 | 58 | 144 | 87 | 76 | 951 | 83 | 70 | 27 | 76 | 65 |
| **07-19** | 206 | 74 | 63 | 789 | 71 | 59 | 206 | 91 | 80 | 789 | 87 | 73 | 17 | 72 | 63 |
| **07-20** | 113 | 73 | 63 | 799 | 69 | 57 | 113 | 89 | 78 | 799 | 85 | 71 | 10 | 73 | 63 |
| **07-21** | 23 | 74 | 64 | 758 | 66 | 55 | 23 | 87 | 78 | 758 | 83 | 69 | 0 | - | - |
| **07-22** | 124 | 74 | 64 | 833 | 69 | 57 | 124 | 87 | 77 | 833 | 83 | 70 | 11 | 70 | 63 |
| **07-23** | 89 | 75 | 64 | 849 | 69 | 57 | 89 | 89 | 78 | 849 | 82 | 68 | 5 | 73 | 65 |
| **07-24** | 47 | 80 | 67 | 844 | 69 | 56 | 47 | 87 | 75 | 844 | 79 | 67 | 7 | 74 | 65 |
| **07-25** | 89 | 77 | 64 | 832 | 69 | 57 | 89 | 88 | 75 | 832 | 81 | 68 | 5 | 85 | 68 |
| **07-26** | 97 | 76 | 65 | 785 | 70 | 57 | 97 | 89 | 76 | 785 | 84 | 70 | 18 | 78 | 66 |
| **07-27** | 10 | 71 | 64 | 669 | 64 | 53 | 10 | 82 | 73 | 669 | 78 | 66 | 3 | 72 | 64 |
| **Daily Average** | **73** | **76** | **64** | **815** | **69** | **56** | **73** | **89** | **76** | **815** | **82** | **69** | **9** | **77** | **64** |
| **Total Count** | **1,528** | | | **17,115** | | | **1,528** | | | **17,115** | | | **180** | | |

## D – Community Noise Equivalent Level



## E – Average Sound Exposure Level



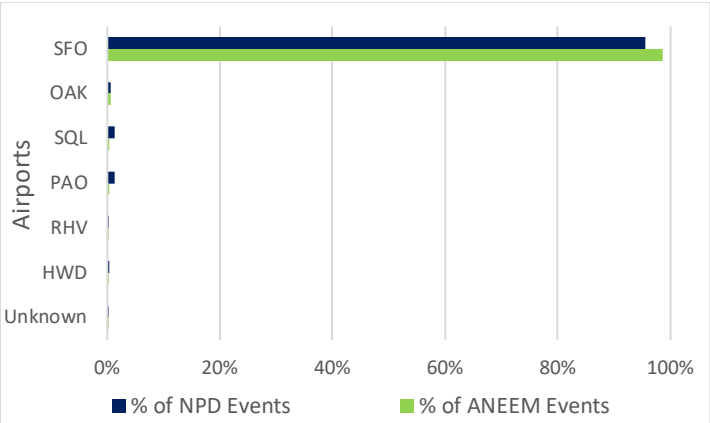




## F – SFO ANEEM Aircraft Noise Events by Time of Day

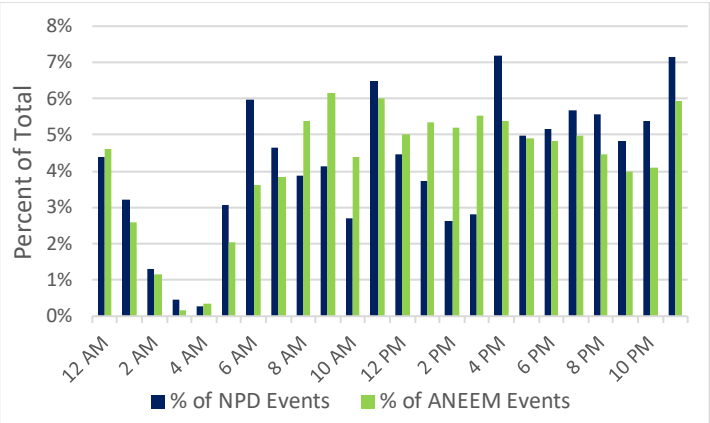
| SFO Aircraft ANEEM A-Weighted Events | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Time of Day | Noise Events | Noise Events % | Daily Avg SEL (dBA) | Min SEL (dBA) | Max SEL (dBA) | Avg Lmax (dBA) | Min Lmax (dBA) | Max Lmax (dBA) | Avg Duration (sec) | Min Duration (sec) | Max Duration (sec) |
| Day (7am–7pm) | 10,617 | 62% | 69 | 50 | 93 | 56 | 43 | 85 | 15 | 4 | 96 |
| Evening (7pm-10pm) | 2,297 | 13% | 68 | 52 | 83 | 56 | 44 | 75 | 16 | 4 | 94 |
| Night (10pm-7am) | 4,201 | 25% | 68 | 47 | 85 | 55 | 40 | 77 | 18 | 4 | 96 |

| SFO Aircraft ANEEM C-Weighted Events | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Time of Day | Noise Events | Noise Events % | Daily Avg SEL (dBC) | Min SEL (dBC) | Max SEL (dBC) | Avg Lmax (dBC) | Min Lmax (dBC) | Max Lmax (dBC) | Avg Duration (sec) | Min Duration (sec) | Max Duration (sec) |
| Day (7am–7pm) | 10,617 | 62% | 82 | 59 | 108 | 69 | 52 | 100 | 15 | 4 | 96 |
| Evening (7pm-10pm) | 2,297 | 13% | 83 | 61 | 100 | 69 | 54 | 90 | 16 | 4 | 94 |
| Night (10pm-7am) | 4,201 | 25% | 83 | 58 | 100 | 69 | 51 | 91 | 18 | 4 | 96 |

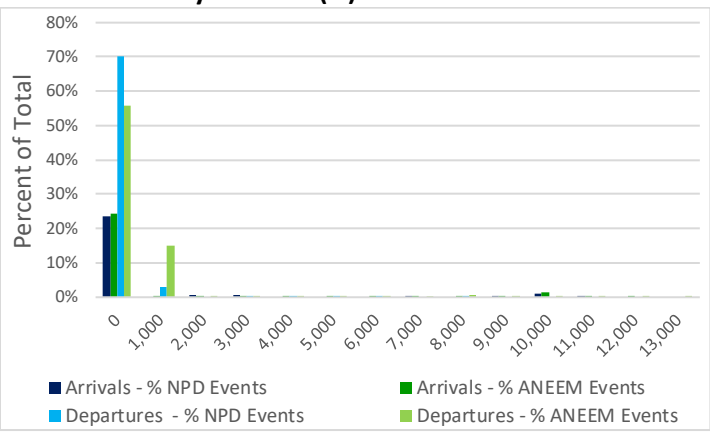
## G – Percentage of Events by Airports



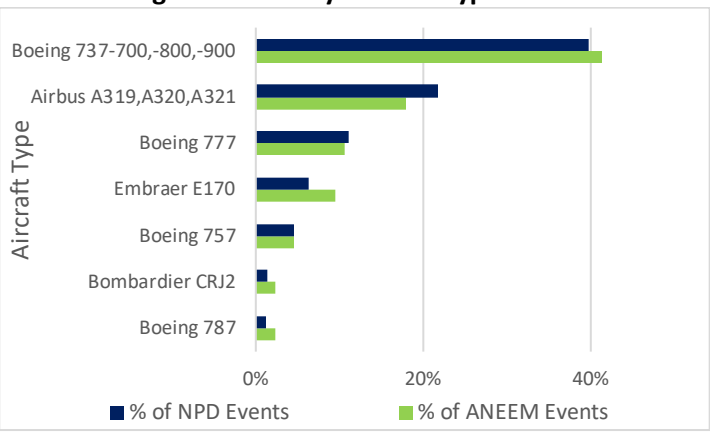

## H – SFO Noise Events by Hour of the Day



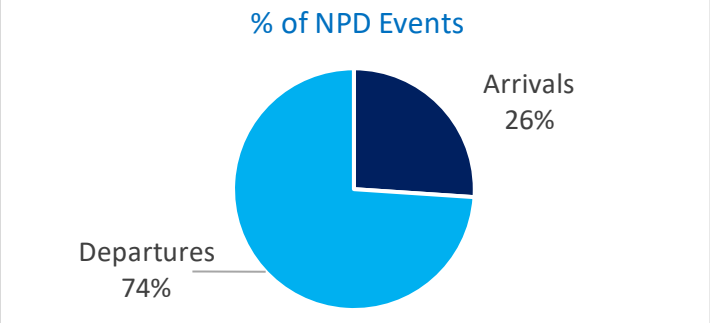

## I – SFO Events by Altitude (ft) over Site

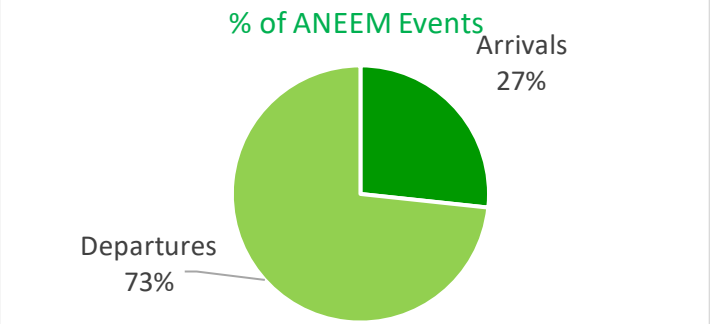



## J – Percentage of Events by Aircraft Types

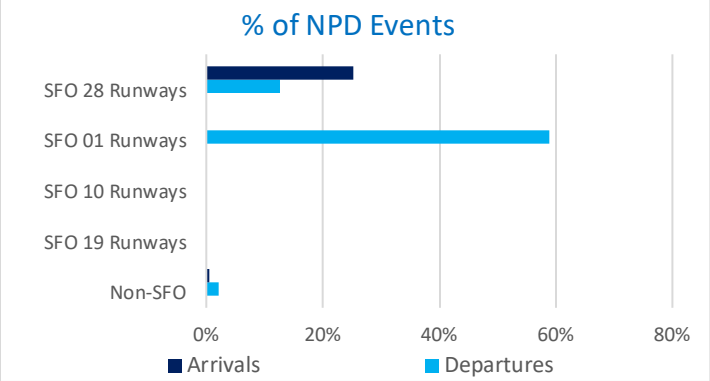


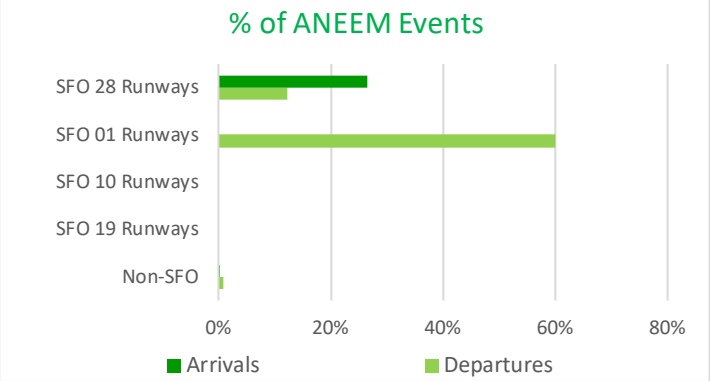
## K – Percentage of Aircraft Events by Operation Type




## L – Percentage of Aircraft Events by Runway and Operation Type

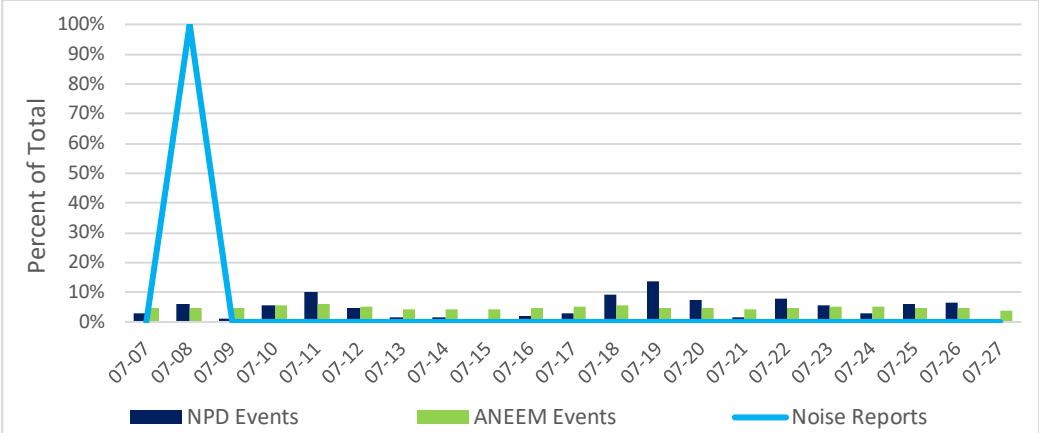


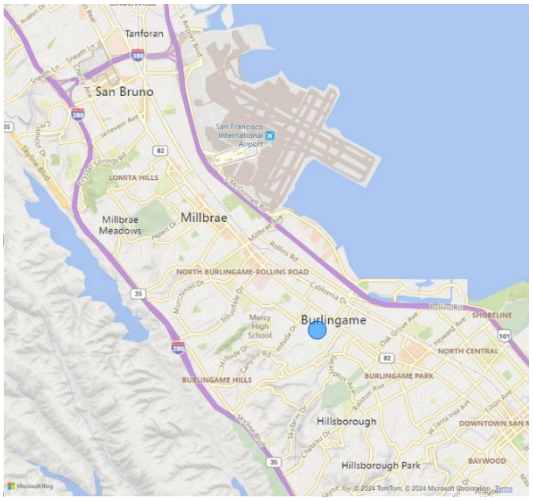

## M – Noise Reporters

| Date | Individual Noise Reporters | Noise Reports |
|---|---|---|
| 07-07 | 0 | 0 |
| 07-08 | 1 | 1 |
| 07-09 | 0 | 0 |
| 07-10 | 0 | 0 |
| 07-11 | 0 | 0 |
| 07-12 | 0 | 0 |
| 07-13 | 0 | 0 |
| 07-14 | 0 | 0 |
| 07-15 | 0 | 0 |
| 07-16 | 0 | 0 |
| 07-17 | 0 | 0 |
| 07-18 | 0 | 0 |
| 07-19 | 0 | 0 |
| 07-20 | 0 | 0 |
| 07-21 | 0 | 0 |
| 07-22 | 0 | 0 |
| 07-23 | 0 | 0 |
| 07-24 | 0 | 0 |
| 07-25 | 0 | 0 |
| 07-26 | 0 | 0 |
| 07-27 | 0 | 0 |
| Total | 1 | 1 |

## N – Noise Reports vs Aircraft Noise Events per Day




## O – Noise Reporter Locations




## P – Noise Monitor on Location

## Appendix

*This Appendix describes the sections of the noise monitoring report and a glossary of terms.*

**Part A – Monitoring Summary** lists the monitoring location, elevation, the monitoring time period, and the key monitoring results including the ANEEM Aircraft, NPD Aircraft, and NPD Community Community Noise Equivalent level (CNEL), single event levels in both A and C noise weightings, and air traffic flow breakdown. The CNEL metric is used to assess and regulate aircraft noise exposure in communities surrounding the airport. California Title 21 Noise Regulations established an acceptable level of 65 dBA CNEL.

**Part B – Monitoring Location** illustrates the location of the portable noise monitor and examples of typical SFO flight operations that registered noise events at the portable noise monitor.

**Part C – Daily Noise Event Averages** lists the number of noise events registered at the noise monitor by SFO Aircraft for both A and C noise weightings using ANEEM (green) or NPD (blue) methods during each day of the noise monitoring period. NPD Community noise events by A-weighted noise levels are also included. The noise event levels are expressed as average Sound Exposure Level (SEL) and average peak noise level (Lmax).

**Part D – Community Noise Equivalent Level** shows a chart that compares the ANEEM Aircraft (SFO and non-SFO), NPD Aircraft, and NPD Community CNEL during each day of the monitoring period.

**Part E – Average Sound Exposure Level** (SEL) shows 2 charts comparing the ANEEM Aircraft (SFO and non-SFO) and NPD Aircraft average SEL for A and C-weighted noise levels during each day of the monitoring period.

**Part F – SFO Aircraft Noise Events by Time of Day** lists 2 tables including the daily minimum, maximum, and average SEL, Lmax, duration and number of SFO Aircraft noise events using ANEEM during the Daytime (7am to 7pm), Evening (7pm to 10pm), and Nighttime (10pm to 7am) for both A and C-weighted noise levels during the monitoring period.

**Part G – Percentage of Events by Airports** shows the percentage of aircraft events using ANEEM and NPD by the aircraft's nearest airport of origin or destination. The percentages for both methods each add up to 100%.

**Part H – SFO Noise Event by Hour of the Day** shows the percentage of total SFO Aircraft noise events using ANEEM and NPD by hour of the day. The percentages for both methods each add up to 100%.

**Part I – SFO Departure Events by Altitude (ft) over Site** shows the percentage of SFO Aircraft Departures and Arrivals that registered noise events at the noise monitor using ANEEM and NPD by altitude intervals. Altitudes are relative to mean sea level elevation. Excludes helicopters. The percentages for both methods each add up to 100%.

**Part J – Percentage of Events by Aircraft Types** shows the percentage of aircraft events using ANEEM and NPD by aircraft types. The percentages for both methods each add up to 100%.

**Part K – Percentage of Events by Operation Type** shows the percentage of aircraft noise events registered using ANEEM and NPD by Arrivals and Departures.

**Part L – Percentage of Aircraft Events by Runway and Operation Type** compares the percentage of aircraft noise events registered using ANEEM and NPD by Arrivals and Departures per each SFO runway pair and to non-SFO overflights.

**Part M – Noise Reporters** lists the number of individual noise reporters and noise reports per day registered by individuals living in Millbrae or Burlingame.

**Part N – Noise Reports vs Aircraft Noise Events per Day** compares the number of noise reports to the number of aircraft noise events per day using ANEEM and NPD. The percentages for both methods each add up to 100%.

**Part O – Noise Report Locations** illustrates a map that shows the noise report locations.

**Part P – Noise Monitor on Location** shows photographs of the noise monitoring equipment on location.

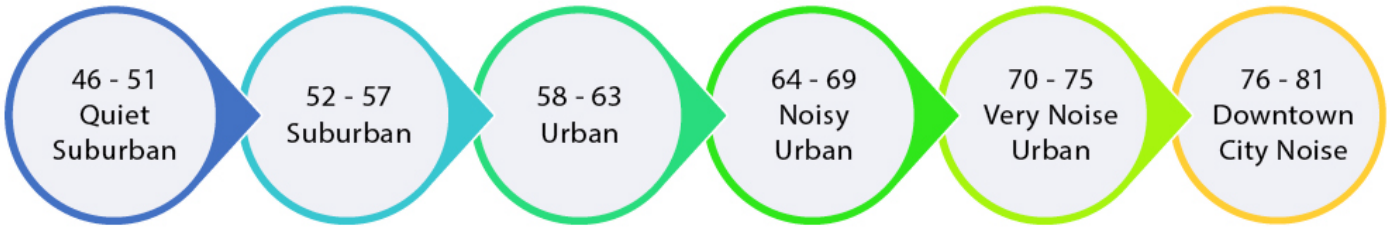
## Glossary

**A-Weighted Noise Level** – Denoted in dBA, is the most common unit used for measuring environmental sound levels. The human ear does not respond equally to different frequencies of sound. An A-weight adjusts the frequency components of sound to conform to your ear's normal response at conversational levels. The FAA and State of the California have adopted the A-weighted sound level for environmental analysis. Sound level meters have an A-weighting network for measuring noise in A-weighted decibels.

**C-Weighted Noise Level** – Denoted in dBC, is a different scale for loudness perception of sound pressure levels than A-weighted noise. A C-weight scale is used to measure sounds with approximately equal sensitivity at all frequencies. The C-weighted scale accounts for low-frequency ranges of sounds more than an A-weighted scale, often resulting in more of the overall noise energy to be included in the measurement.

**California Code of Regulations Title 21, Subchapter 6** – This code describes noise standards by defining metrics terminology and requirements regarding compatible land use. SFO was one of the first airports in the state to achieve a zero impact area within the 65 dB CNEL (Community Noise Equivalent Level) noise contour.

**Community Noise Equivalent Level (CNEL)** – A noise metric required by the California Airport Noise Standards for use by airport proprietors to measure aircraft noise levels. CNEL includes an additional weighting for each event occurring during the evening (7:00 p.m. – 9:59 p.m.) and nighttime (10:00 p.m. – 6:59 a.m.) periods to account for increased sensitivity to noise during these periods. Evening events are treated as though there were three and nighttime events are treated as though there were ten. This results in a 4.77 and 10 dBA penalty for operations occurring in the evening and nighttime periods, respectively. For a more in-depth explanation of CNEL and other technical noise terms, please visit the Federal Aviation Administration (FAA) website. Below is a graphic illustrating types of metropolitan areas and their corresponding CNEL intervals (dBA).




**Decibel (dB)** – A unit used to measure the magnitude or intensity of sound. The decibel uses a logarithmic scale to cover the very large range of sound pressures that can be heard by the human ear. Decibels measure a scale from the threshold of human hearing, 0 dB, upward towards the threshold of pain, about 120-140 dB. Because decibels are such a small measure, they are computed logarithmically and cannot be added arithmetically. A10 dB increase will be perceived by most people to be a doubling in loudness, i.e., 80 dB seems twice as loud as 70 dB. Decibel measurements can be scaled by different frequency ranges, such as by A-Weighted (dBA) and C-Weighted (dBC) scales.

**Maximum Sound Level (Lmax)** – The maximum a-weighted sound level for a given noise event. The peak noise level reached by a single aircraft event.

**Noise Event** – A Noise Event is the measured sound produced by a single source of noise over a duration of time. An aircraft noise event begins when the sound level of a flight operation exceeds a noise threshold and ends when the level drops down below that threshold.

**Sound Exposure Level (SEL)** – SEL is a measure of a single aircraft noise event spread out over its entirety compressed into one second. It allows for a comparison of aircraft noise events of different durations and noise levels. For example, think of the moment you hear a plane from a quarter mile away; we measure from that moment, as the aircraft flies overhead, and until it can't be heard. This is the duration of sound we use and then compress it into one second for a measure. SEL measures noise energy above the threshold (normally 65 dBA for aircraft noise events). This way, any ambient noise is separated out from the measurement.

SAN FRANCISCO INTERNATIONAL AIRPORT
CITY & COUNTY OF SAN FRANCISCO

# MEMORANDUM

TO: Hillsborough Community

FROM: SAN FRANCISCO INTERNATIONAL AIRPORT AIRCRAFT NOISE OFFICE

SUBJECT: SFO Roundtable *Up-The-Hill* Noise Monitoring Study – July 2024
*SFO Permanent Noise Monitoring Location – Site 13 in Hillsborough*

DATE: November 5, 2024

The San Francisco International Airport (SFO) Aircraft Noise Office conducted aircraft noise monitoring in Millbrae and Burlingame to determine the noise levels within the community from aircraft operations at SFO. This noise monitoring was conducted as part of a SFO Airport/Community Roundtable "Up-the-Hill" noise study researching the effects of takeoff and landing noise on communities situated next to the airport. This monitoring lasted for 21 days, occurring between July 7 and July 27, 2024, across 5 one-time monitoring locations and 9 permanent monitoring locations.

Millbrae, Burlingame, and Hillsborough are situated adjacent to SFO, with Millbrae sitting to the southwest, Burlingame to the south, and Hillsborough further south. Much of the aircraft noise that reaches Millbrae, Burlingame, and Hillsborough is caused by takeoff and landing noise rather than by direct overflights. Aircraft operations on the airfield, takeoffs (takeoff thrust) and landings (reverse thrust from jet engine thrust reverser), generate noise that travels across the landscape, and it is expected that weather and topography may amplify this noise to nearby communities.

SFO uses both Aircraft Noise Event Extraction Methodology (ANEEM) and Noise Power Distance (NPD) event classification methods and both A-weighted (dBA) and C-weighted (dBC) noise levels to generate this report. ANEEM is newer technology that looks at aircraft in the surrounding area to determine if any spikes in noise based on a floating threshold level may be logically correlated to them. Historically, ANEEM's correlation logic used AEDT modeled noise to classify if the increase in noise was logically generated by an aircraft, but this had to be modified to also look at thrust and timing to effectively correlate noise spikes to aircraft landing and taking off on or very close to ground level. NPD uses static noise thresholds to determine if spikes in noise qualify as noise events, then looks to see if there are any aircraft in the surrounding area that could be the cause of the noise. The noise monitor NPD threshold for the total monitoring period was 58 dBA. Both ANEEM and NPD first generated events based on A-weighted noise levels, then used the time window of the A-weighted noise events to identify the C-weighted noise events.

During this study, there were approximately 555 noise events per day caused by SFO airfield operations using the ANEEM method. Approximately 99% of all aircraft noise events were from SFO aircraft. Aircraft noise events sources include primarily departing aircraft from SFO's north-facing runways, Runways 01L and 01R, and from landing aircraft using thrust reversers to assist with slowing down after touching-down on SFO's west-facing runways, Runways 28L and 28R. Other airfield operations which could be heard at the monitor included take-offs from SFO's west-facing runways, Runways 28L and 28R. In addition to noise from airfield operations, there was also noise from aircraft overflights, majority of which were aircraft from Oakland International Airport (OAK) headed south/southeast utilizing the CNDEL departure procedure. Approximately 1% of all aircraft noise events were from OAK aircraft.

During the monitoring period, the overall Aircraft Community Noise Equivalent Level (CNEL) using ANEEM was 53 dBA and the Aircraft CNEL and Community CNEL using NPD were 51 dBA and 42 dBA, respectively. This noise monitor was located in a suburban area with daily ambient noise ranging between 36 and 45 dba. Aircraft noise above ambient levels may have been perceptible by residents. Additionally, the frequency of flights due to the proximity of the Airport may have increased annoyance levels.

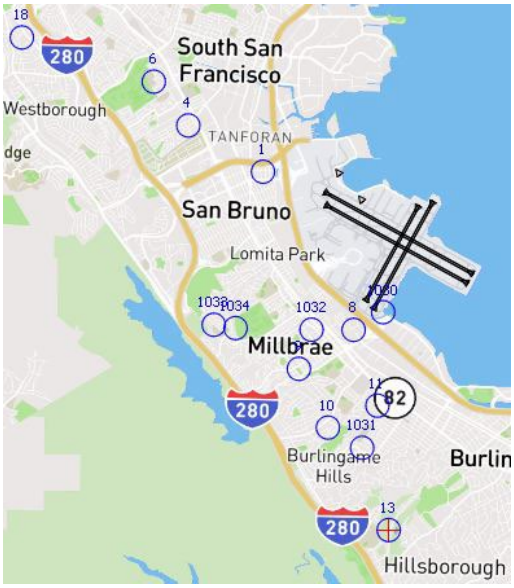
During the monitoring period, the SFO Aircraft Noise Office received 13 noise reports from 4 Hillsborough residents. Most of the noise reports were generated between 8AM and 12AM. Likewise, most of the SFO Aircraft noise events using ANEEM occurred between 7AM and 12AM.

This report includes one evaluation of a 21-day period including 16 parts (charts and graphics) that represent summaries of the aircraft noise-related data (values are subject to rounding) collected during the monitoring period. Each part and key terms used in this report are described in the Appendix and Glossary, respectively.

## A – Monitoring Summary

| | |
|---|---|
| **Monitoring Site** | SFO Site 13, Hillsborough |
| **Monitoring Site Elevation (ft)** | 427 |
| **Monitoring Period** | July 7 – July 27, 2024 |
| **Average Ambient Noise (dBA)** | 42 |
| **NPD Community (non-aircraft) CNEL (dBA)** | 42 |
| **NPD Aircraft CNEL (dBA)** | 51 |
| **NPD Avg Daily SFO Noise Events** | 57 |
| **ANEEM Aircraft CNEL (dBA)** | 53 |
| **ANEEM Avg Aircraft SEL (dBA)** | 70 |
| **ANEEM Avg Aircraft SEL (dBC)** | 85 |
| **ANEEM Avg Aircraft Lmax (dBA)** | 56 |
| **ANEEM Avg Aircraft Lmax (dBC)** | 69 |
| **ANEEM Avg Daily SFO Noise Events** | 555 |
| **SFO West Flow** | 100% |
| **SFO Southeast Flow** | 0% |

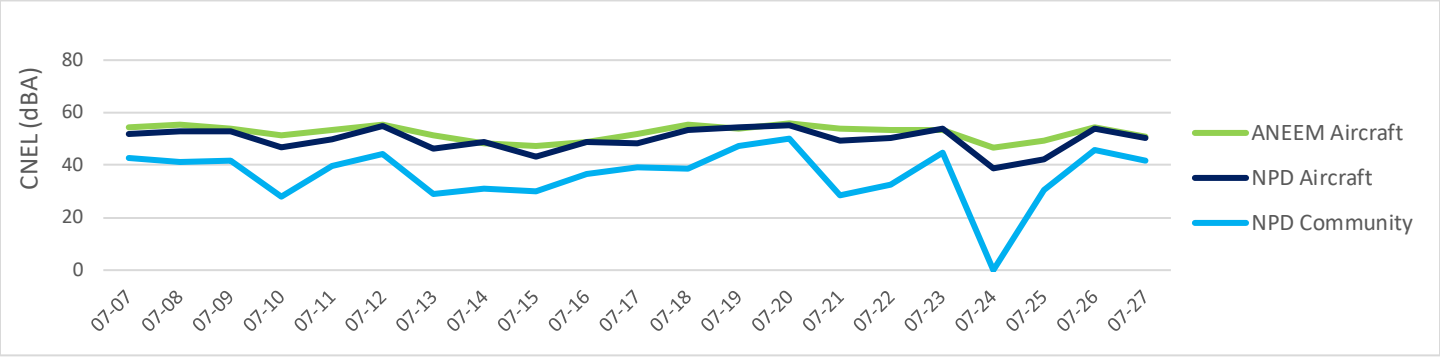
## B – Monitoring Location



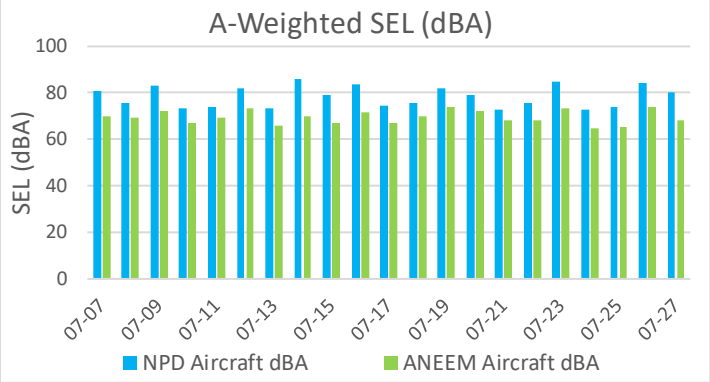

## C – Daily Noise Event Averages

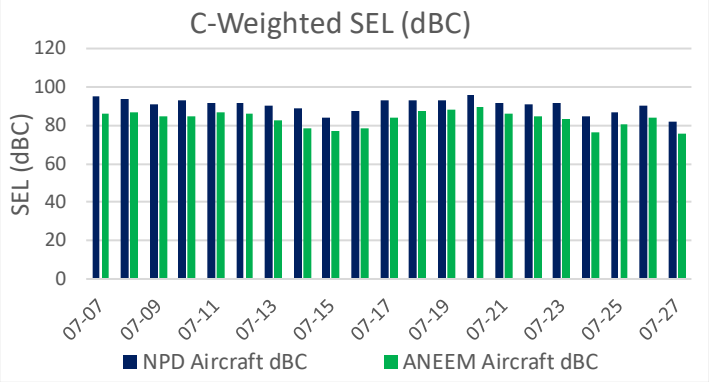
| Day | SFO Aircraft A-Weighted Noise | | | | | | SFO Aircraft C-Weighted Noise | | | | | | Community A-Weighted Noise | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | NPD | | | ANEEM | | | NPD | | | ANEEM | | | NPD | | |
| | Noise Events | Avg SEL | Avg Lmax | Noise Events | Avg SEL | Avg Lmax | Noise Events | Avg SEL | Avg Lmax | Noise Events | Avg SEL | Avg Lmax | Noise Events | Avg SEL | Avg Lmax |
| **07-07** | 44 | 81 | 65 | 585 | 70 | 55 | 44 | 95 | 82 | 585 | 86 | 71 | 8 | 79 | 67 |
| **07-08** | 79 | 76 | 65 | 691 | 69 | 57 | 79 | 93 | 81 | 691 | 87 | 71 | 12 | 73 | 63 |
| **07-09** | 56 | 83 | 66 | 565 | 72 | 56 | 56 | 91 | 77 | 565 | 85 | 70 | 9 | 81 | 65 |
| **07-10** | 38 | 74 | 63 | 648 | 67 | 55 | 38 | 93 | 82 | 648 | 85 | 69 | 3 | 70 | 61 |
| **07-11** | 93 | 74 | 64 | 594 | 69 | 57 | 93 | 92 | 79 | 594 | 87 | 72 | 17 | 73 | 63 |
| **07-12** | 103 | 82 | 66 | 615 | 73 | 57 | 103 | 92 | 79 | 615 | 86 | 71 | 14 | 82 | 64 |
| **07-13** | 18 | 73 | 64 | 555 | 66 | 54 | 18 | 90 | 80 | 555 | 82 | 68 | 2 | 72 | 65 |
| **07-14** | 14 | 87 | 72 | 426 | 70 | 53 | 14 | 89 | 75 | 426 | 78 | 66 | 2 | 78 | 68 |
| **07-15** | 20 | 79 | 68 | 458 | 67 | 55 | 20 | 84 | 71 | 458 | 77 | 65 | 3 | 75 | 67 |
| **07-16** | 26 | 84 | 68 | 350 | 72 | 55 | 26 | 88 | 73 | 350 | 78 | 65 | 5 | 79 | 66 |
| **07-17** | 41 | 75 | 63 | 680 | 67 | 55 | 41 | 93 | 81 | 680 | 84 | 69 | 3 | 79 | 67 |
| **07-18** | 123 | 76 | 64 | 760 | 70 | 57 | 123 | 93 | 80 | 760 | 87 | 71 | 12 | 75 | 65 |
| **07-19** | 120 | 82 | 66 | 532 | 74 | 58 | 120 | 93 | 81 | 532 | 88 | 72 | 27 | 83 | 64 |
| **07-20** | 125 | 79 | 64 | 535 | 72 | 58 | 125 | 95 | 83 | 535 | 90 | 74 | 17 | 87 | 67 |
| **07-21** | 59 | 73 | 62 | 616 | 68 | 56 | 59 | 92 | 81 | 616 | 86 | 72 | 2 | 67 | 61 |
| **07-22** | 54 | 76 | 65 | 599 | 68 | 56 | 54 | 91 | 79 | 599 | 84 | 69 | 3 | 77 | 66 |
| **07-23** | 58 | 85 | 68 | 487 | 73 | 56 | 58 | 91 | 78 | 487 | 84 | 69 | 11 | 83 | 66 |
| **07-24** | 7 | 73 | 64 | 424 | 65 | 54 | 7 | 84 | 73 | 424 | 77 | 65 | 0 | - | - |
| **07-25** | 28 | 74 | 64 | 636 | 66 | 54 | 28 | 87 | 75 | 636 | 80 | 66 | 3 | 74 | 64 |
| **07-26** | 70 | 85 | 67 | 614 | 74 | 56 | 70 | 91 | 77 | 614 | 84 | 69 | 20 | 81 | 65 |
| **07-27** | 11 | 80 | 70 | 276 | 68 | 55 | 11 | 82 | 72 | 276 | 76 | 64 | 3 | 77 | 67 |
| **Daily Average** | **57** | **80** | **65** | **555** | **70** | **56** | **57** | **93** | **79** | **555** | **85** | **69** | **8** | **82** | **65** |
| **Total Count** | **1,187** | | | **11,646** | | | **1,187** | | | **11,646** | | | **176** | | |

## D – Community Noise Equivalent Level



## E – Average Sound Exposure Level



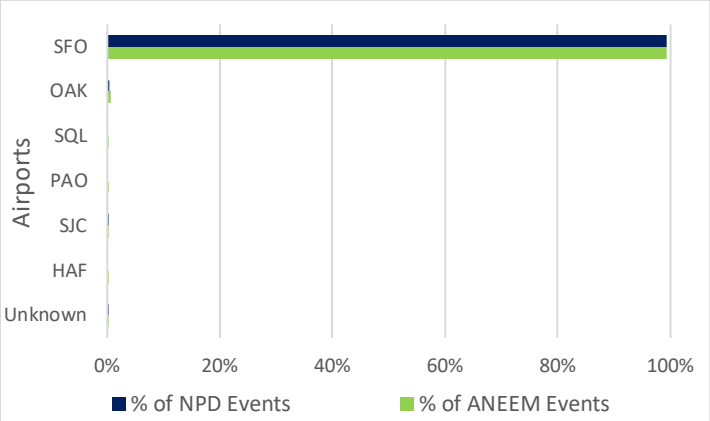




## F – SFO ANEEM Aircraft Noise Events by Time of Day

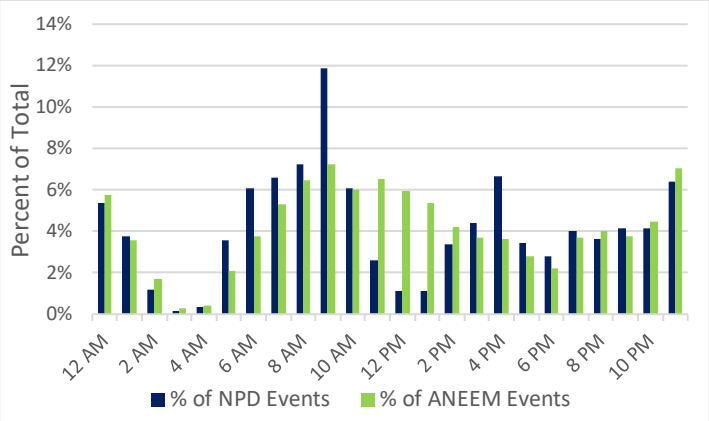
| SFO Aircraft ANEEM A-Weighted Events | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Time of Day | Noise Events | Noise Events % | Daily Avg SEL (dBA) | Min SEL (dBA) | Max SEL (dBA) | Avg Lmax (dBA) | Min Lmax (dBA) | Max Lmax (dBA) | Avg Duration (sec) | Min Duration (sec) | Max Duration (sec) |
| Day (7am–7pm) | 6,922 | 59% | 71 | 52 | 95 | 57 | 45 | 87 | 14 | 4 | 99 |
| Evening (7pm-10pm) | 1,342 | 12% | 69 | 52 | 85 | 56 | 47 | 81 | 16 | 4 | 99 |
| Night (10pm-7am) | 3,382 | 29% | 68 | 45 | 86 | 54 | 37 | 78 | 19 | 4 | 98 |

| SFO Aircraft ANEEM C-Weighted Events | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Time of Day | Noise Events | Noise Events % | Daily Avg SEL (dBC) | Min SEL (dBC) | Max SEL (dBC) | Avg Lmax (dBC) | Min Lmax (dBC) | Max Lmax (dBC) | Avg Duration (sec) | Min Duration (sec) | Max Duration (sec) |
| Day (7am–7pm) | 6,922 | 59% | 84 | 62 | 104 | 69 | 55 | 97 | 14 | 4 | 99 |
| Evening (7pm-10pm) | 1,342 | 12% | 86 | 62 | 102 | 71 | 55 | 92 | 16 | 4 | 99 |
| Night (10pm-7am) | 3,382 | 29% | 87 | 52 | 103 | 71 | 46 | 94 | 19 | 4 | 98 |

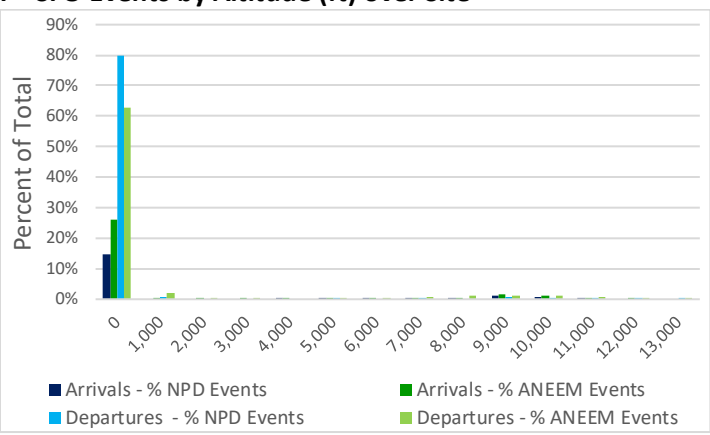
## G – Percentage of Events by Airports



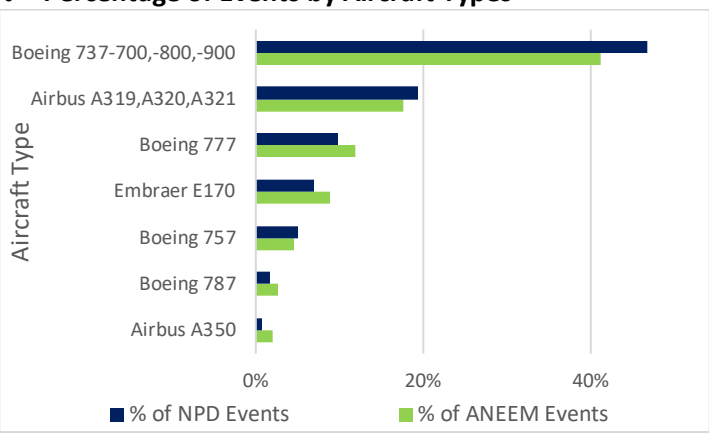

## H – SFO Noise Events by Hour of the Day



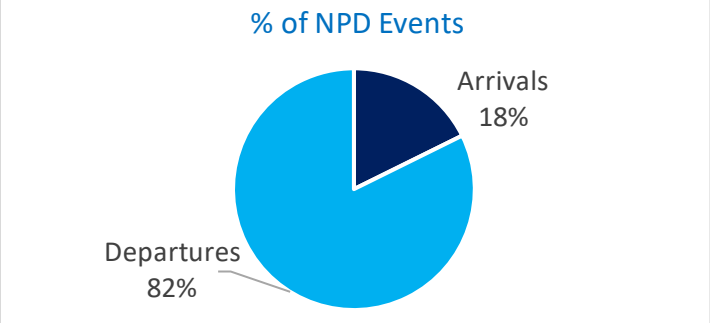

## I – SFO Events by Altitude (ft) over Site

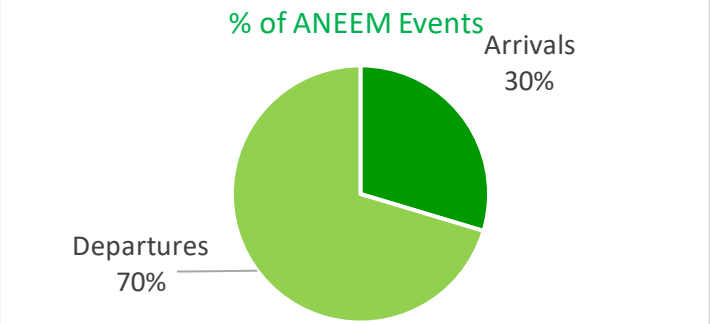



## J – Percentage of Events by Aircraft Types

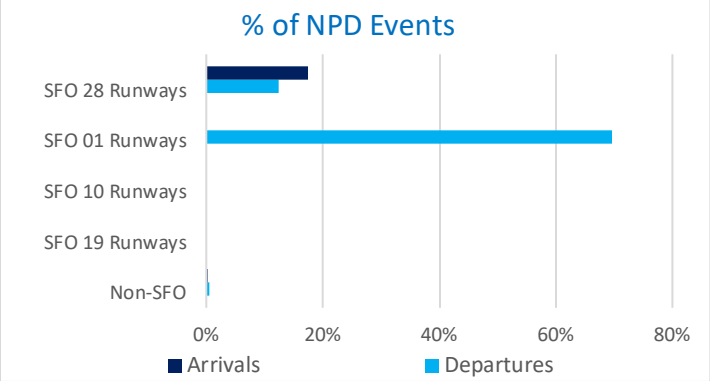


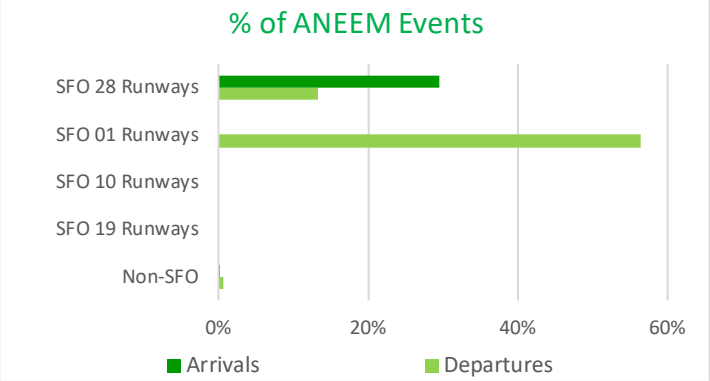
## K – Percentage of Aircraft Events by Operation Type




## L – Percentage of Aircraft Events by Runway and Operation Type

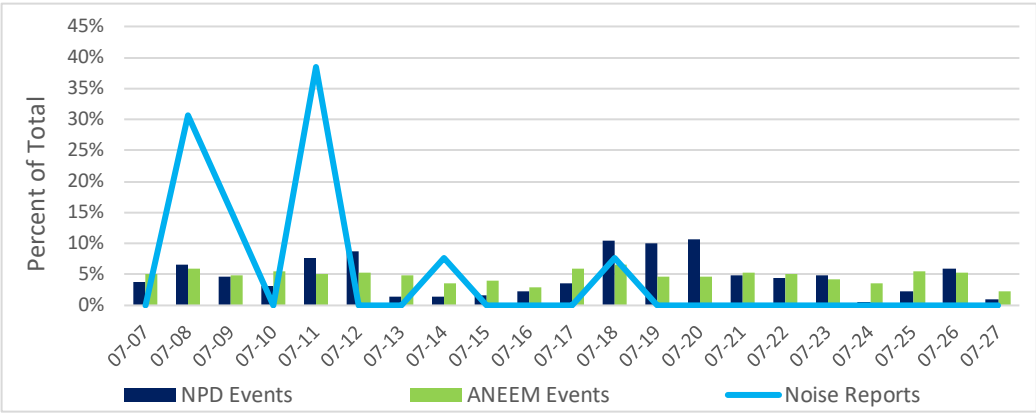


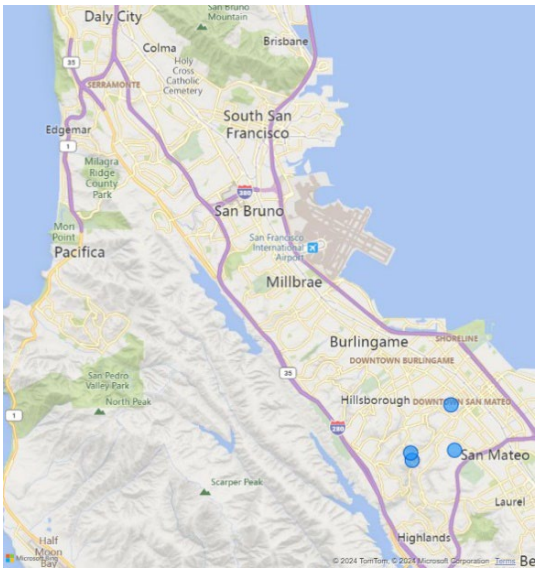

## M – Noise Reporters

| Date | Individual Noise Reporters | Noise Reports |
|---|---|---|
| 07-07 | 0 | 0 |
| 07-08 | 1 | 4 |
| 07-09 | 1 | 2 |
| 07-10 | 0 | 0 |
| 07-11 | 2 | 5 |
| 07-12 | 0 | 0 |
| 07-13 | 0 | 0 |
| 07-14 | 1 | 1 |
| 07-15 | 0 | 0 |
| 07-16 | 0 | 0 |
| 07-17 | 0 | 0 |
| 07-18 | 1 | 1 |
| 07-19 | 0 | 0 |
| 07-20 | 0 | 0 |
| 07-21 | 0 | 0 |
| 07-22 | 0 | 0 |
| 07-23 | 0 | 0 |
| 07-24 | 0 | 0 |
| 07-25 | 0 | 0 |
| 07-26 | 0 | 0 |
| 07-27 | 0 | 0 |
| Total | 4 | 13 |

## N – Noise Reports vs Aircraft Noise Events per Day




## O – Noise Reporter Locations




## P – Noise Monitor on Location

## Appendix

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**Part A – Monitoring Summary** lists the monitoring location, elevation, the monitoring time period, and the key monitoring results including the ANEEM Aircraft, NPD Aircraft, and NPD Community Community Noise Equivalent level (CNEL), single event levels in both A and C noise weightings, and air traffic flow breakdown. The CNEL metric is used to assess and regulate aircraft noise exposure in communities surrounding the airport. California Title 21 Noise Regulations established an acceptable level of 65 dBA CNEL.

**Part B – Monitoring Location** illustrates the location of the portable noise monitor and examples of typical SFO flight operations that registered noise events at the portable noise monitor.

**Part C – Daily Noise Event Averages** lists the number of noise events registered at the noise monitor by SFO Aircraft for both A and C noise weightings using ANEEM (green) or NPD (blue) methods during each day of the noise monitoring period. NPD Community noise events by A-weighted noise levels are also included. The noise event levels are expressed as average Sound Exposure Level (SEL) and average peak noise level (Lmax).

**Part D – Community Noise Equivalent Level** shows a chart that compares the ANEEM Aircraft (SFO and non-SFO), NPD Aircraft, and NPD Community CNEL during each day of the monitoring period.

**Part E – Average Sound Exposure Level** (SEL) shows 2 charts comparing the ANEEM Aircraft (SFO and non-SFO) and NPD Aircraft average SEL for A and C-weighted noise levels during each day of the monitoring period.

**Part F – SFO Aircraft Noise Events by Time of Day** lists 2 tables including the daily minimum, maximum, and average SEL, Lmax, duration and number of SFO Aircraft noise events using ANEEM during the Daytime (7am to 7pm), Evening (7pm to 10pm), and Nighttime (10pm to 7am) for both A and C-weighted noise levels during the monitoring period.

**Part G – Percentage of Events by Airports** shows the percentage of aircraft events using ANEEM and NPD by the aircraft's nearest airport of origin or destination. The percentages for both methods each add up to 100%.

**Part H – SFO Noise Event by Hour of the Day** shows the percentage of total SFO Aircraft noise events using ANEEM and NPD by hour of the day. The percentages for both methods each add up to 100%.

**Part I – SFO Departure Events by Altitude (ft) over Site** shows the percentage of SFO Aircraft Departures and Arrivals that registered noise events at the noise monitor using ANEEM and NPD by altitude intervals. Altitudes are relative to mean sea level elevation. Excludes helicopters. The percentages for both methods each add up to 100%.

**Part J – Percentage of Events by Aircraft Types** shows the percentage of aircraft events using ANEEM and NPD by aircraft types. The percentages for both methods each add up to 100%.

**Part K – Percentage of Events by Operation Type** shows the percentage of aircraft noise events registered using ANEEM and NPD by Arrivals and Departures.

**Part L – Percentage of Aircraft Events by Runway and Operation Type** compares the percentage of aircraft noise events registered using ANEEM and NPD by Arrivals and Departures per each SFO runway pair and to non-SFO overflights.

**Part M – Noise Reporters** lists the number of individual noise reporters and noise reports per day registered by individuals living in Millbrae or Burlingame.

**Part N – Noise Reports vs Aircraft Noise Events per Day** compares the number of noise reports to the number of aircraft noise events per day using ANEEM and NPD. The percentages for both methods each add up to 100%.

**Part O – Noise Report Locations** illustrates a map that shows the noise report locations.

**Part P – Noise Monitor on Location** shows photographs of the noise monitoring equipment on location.

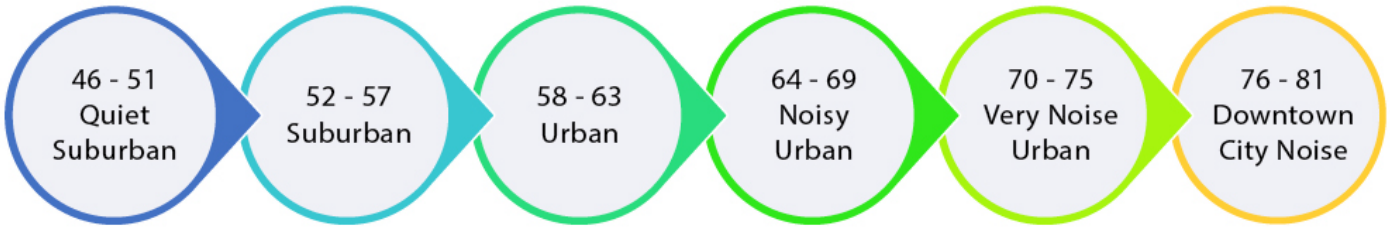
## Glossary

**A-Weighted Noise Level** – Denoted in dBA, is the most common unit used for measuring environmental sound levels. The human ear does not respond equally to different frequencies of sound. An A-weight adjusts the frequency components of sound to conform to your ear's normal response at conversational levels. The FAA and State of the California have adopted the A-weighted sound level for environmental analysis. Sound level meters have an A-weighting network for measuring noise in A-weighted decibels.

**C-Weighted Noise Level** – Denoted in dBC, is a different scale for loudness perception of sound pressure levels than A-weighted noise. A C-weight scale is used to measure sounds with approximately equal sensitivity at all frequencies. The C-weighted scale accounts for low-frequency ranges of sounds more than an A-weighted scale, often resulting in more of the overall noise energy to be included in the measurement.

**California Code of Regulations Title 21, Subchapter 6** – This code describes noise standards by defining metrics terminology and requirements regarding compatible land use. SFO was one of the first airports in the state to achieve a zero impact area within the 65 dB CNEL (Community Noise Equivalent Level) noise contour.

**Community Noise Equivalent Level (CNEL)** – A noise metric required by the California Airport Noise Standards for use by airport proprietors to measure aircraft noise levels. CNEL includes an additional weighting for each event occurring during the evening (7:00 p.m. – 9:59 p.m.) and nighttime (10:00 p.m. – 6:59 a.m.) periods to account for increased sensitivity to noise during these periods. Evening events are treated as though there were three and nighttime events are treated as though there were ten. This results in a 4.77 and 10 dBA penalty for operations occurring in the evening and nighttime periods, respectively. For a more in-depth explanation of CNEL and other technical noise terms, please visit the Federal Aviation Administration (FAA) website. Below is a graphic illustrating types of metropolitan areas and their corresponding CNEL intervals (dBA).




**Decibel (dB)** – A unit used to measure the magnitude or intensity of sound. The decibel uses a logarithmic scale to cover the very large range of sound pressures that can be heard by the human ear. Decibels measure a scale from the threshold of human hearing, 0 dB, upward towards the threshold of pain, about 120-140 dB. Because decibels are such a small measure, they are computed logarithmically and cannot be added arithmetically. A10 dB increase will be perceived by most people to be a doubling in loudness, i.e., 80 dB seems twice as loud as 70 dB. Decibel measurements can be scaled by different frequency ranges, such as by A-Weighted (dBA) and C-Weighted (dBC) scales.

**Maximum Sound Level (Lmax)** – The maximum a-weighted sound level for a given noise event. The peak noise level reached by a single aircraft event.

**Noise Event** – A Noise Event is the measured sound produced by a single source of noise over a duration of time. An aircraft noise event begins when the sound level of a flight operation exceeds a noise threshold and ends when the level drops down below that threshold.

**Sound Exposure Level (SEL)** – SEL is a measure of a single aircraft noise event spread out over its entirety compressed into one second. It allows for a comparison of aircraft noise events of different durations and noise levels. For example, think of the moment you hear a plane from a quarter mile away; we measure from that moment, as the aircraft flies overhead, and until it can't be heard. This is the duration of sound we use and then compress it into one second for a measure. SEL measures noise energy above the threshold (normally 65 dBA for aircraft noise events). This way, any ambient noise is separated out from the measurement.

SAN FRANCISCO INTERNATIONAL AIRPORT
CITY & COUNTY OF SAN FRANCISCO

# MEMORANDUM

TO: Daly City Community

FROM: SAN FRANCISCO INTERNATIONAL AIRPORT AIRCRAFT NOISE OFFICE

SUBJECT: SFO Roundtable *Up-The-Hill* Noise Monitoring Study – July 2024
*SFO Permanent Noise Monitoring Location – Site 18 in Daly City*

DATE: November 5, 2024

The San Francisco International Airport (SFO) Aircraft Noise Office conducted aircraft noise monitoring in Millbrae and Burlingame to determine the noise levels within the community from aircraft operations at SFO. This noise monitoring was conducted as part of a SFO Airport/Community Roundtable "Up-the-Hill" noise study researching the effects of takeoff and landing noise on communities situated next to the airport. This monitoring lasted for 21 days, occurring between July 7 and July 27, 2024, across 5 one-time monitoring locations and 9 permanent monitoring locations.

San Bruno, South San Francisco, and Daly City are situated adjacent to SFO, with San Bruno sitting directly to the west, South San Francisco to the northwest, and Daly City further northwest. Much of the aircraft noise that reaches San Bruno, South San Francisco, and Daly City is caused by departing aircraft traveling overhead at low altitudes from the west facing runways, Runways 28L and 28R. But, because of their proximity to the airport, they may also receive noise from takeoffs and landings that do not directly overfly them. Aircraft operations on the airfield, takeoffs (takeoff thrust) and landings (reverse thrust from jet engine thrust reverser), generate noise that travels across the landscape, and it is expected that weather and topography may amplify this noise to nearby communities.

SFO uses both Aircraft Noise Event Extraction Methodology (ANEEM) and Noise Power Distance (NPD) event classification methods and both A-weighted (dBA) and C-weighted (dBC) noise levels to generate this report. ANEEM is newer technology that looks at aircraft in the surrounding area to determine if any spikes in noise based on a floating threshold level may be logically correlated to them. Historically, ANEEM's correlation logic used AEDT modeled noise to classify if the increase in noise was logically generated by an aircraft, but this had to be modified to also look at thrust and timing to effectively correlate noise spikes to aircraft landing and taking off on or very close to ground level. NPD uses static noise thresholds to determine if spikes in noise qualify as noise events, then looks to see if there are any aircraft in the surrounding area that could be the cause of the noise. The noise monitor NPD threshold for the total monitoring period was 63 dBA. Both ANEEM and NPD first generated events based on A-weighted noise levels, then used the time window of the A-weighted noise events to identify the C-weighted noise events.

During this study, there were approximately 337 noise events per day caused by SFO airfield operations using the ANEEM method. Approximately 100% of all aircraft noise events were from SFO aircraft. Aircraft noise events sources include primarily direct overflights from departing aircraft from SFO's west-facing runways, Runways 28L and 28R. Other airfield operations which could be heard at the monitor included noise from departing aircraft from SFO's north-facing runways, Runways 01L and 01R, and from landing aircraft using thrust reversers to assist with slowing down after touching-down on SFO's West-facing runways, Runways 28L and 28R.

During the monitoring period, the overall Aircraft Community Noise Equivalent Level (CNEL) using ANEEM was 62 dBA and the Aircraft CNEL and Community CNEL using NPD were 62 dBA and 53 dBA, respectively. This noise monitor was located in a busy suburban area with daily ambient noise ranging between 40 and 49 dba. Aircraft noise above ambient levels may have been perceptible by residents. Additionally, the frequency of flights due to the proximity of the Airport may have increased annoyance levels.

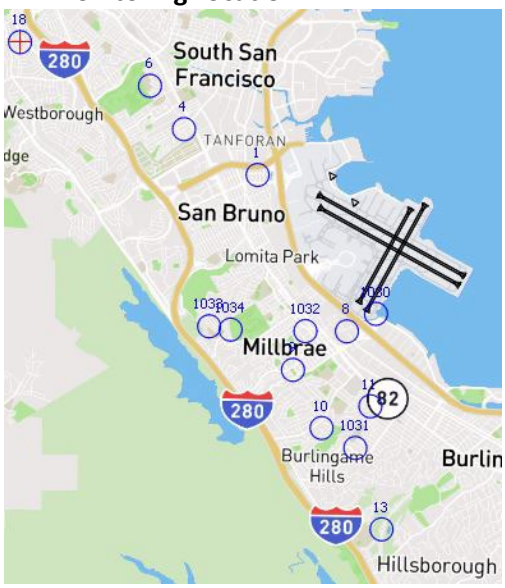
During the monitoring period, the SFO Aircraft Noise Office received 399 noise reports from 6 Daly City residents. Most of the noise reports were generated between 1AM and 12AM. Likewise, most of the SFO Aircraft noise events using ANEEM occurred between 9AM and 12AM.

This report includes one evaluation of a 21-day period including 16 parts (charts and graphics) that represent summaries of the aircraft noise-related data (values are subject to rounding) collected during the monitoring period. Each part and key terms used in this report are described in the Appendix and Glossary, respectively.

## A – Monitoring Summary

| | |
|---|---|
| **Monitoring Site** | SFO Site 18, Daly City |
| **Monitoring Site Elevation (ft)** | 554 |
| **Monitoring Period** | July 7 – July 27, 2024 |
| **Average Ambient Noise (dBA)** | 46 |
| **NPD Community (non-aircraft) CNEL (dBA)** | 53 |
| **NPD Aircraft CNEL (dBA)** | 62 |
| **NPD Avg Daily SFO Noise Events** | 118 |
| **ANEEM Aircraft CNEL (dBA)** | 62 |
| **ANEEM Avg Aircraft SEL (dBA)** | 81 |
| **ANEEM Avg Aircraft SEL (dBC)** | 97 |
| **ANEEM Avg Aircraft Lmax (dBA)** | 67 |
| **ANEEM Avg Aircraft Lmax (dBC)** | 85 |
| **ANEEM Avg Daily SFO Noise Events** | 337 |
| **SFO West Flow** | 100% |
| **SFO Southeast Flow** | 0% |

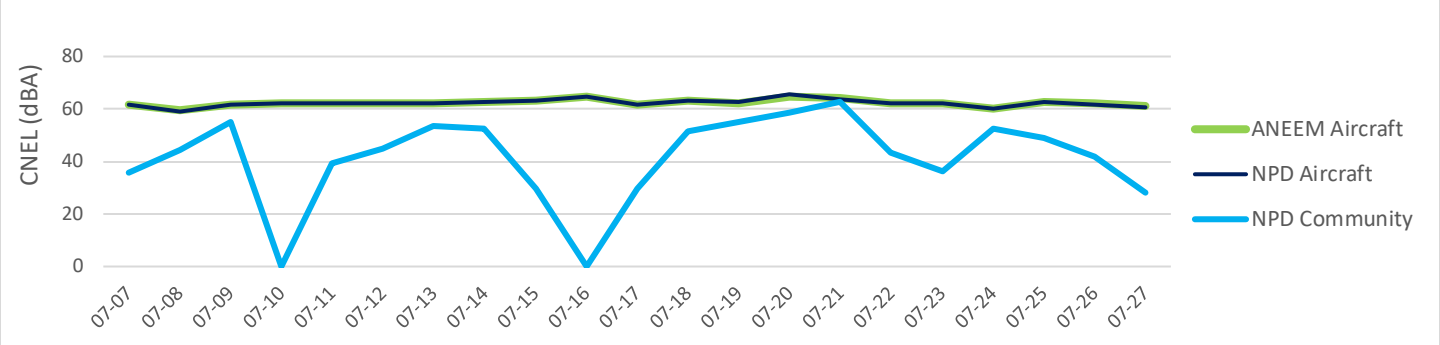
## B – Monitoring Location



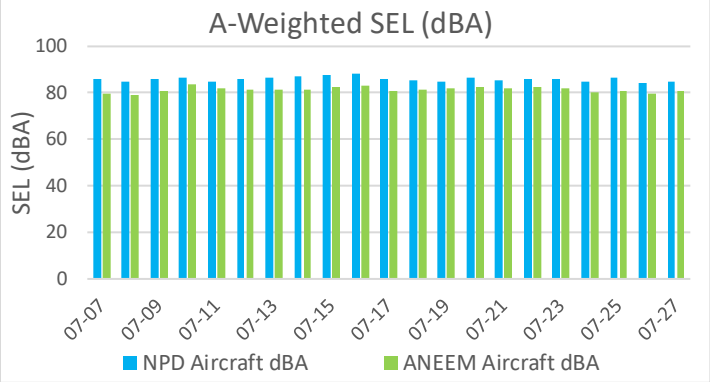

## C – Daily Noise Event Averages

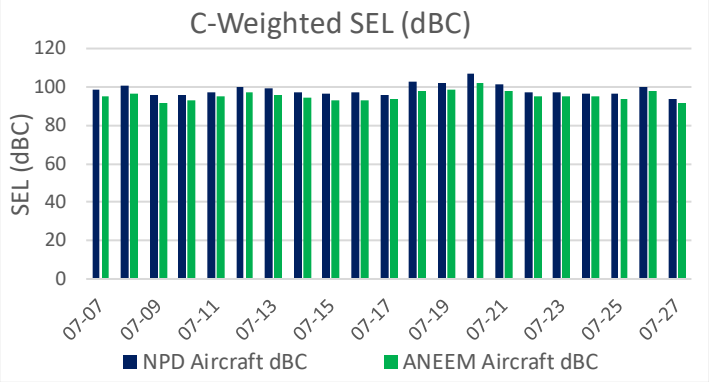
| Day | SFO Aircraft A-Weighted Noise | | | | | | SFO Aircraft C-Weighted Noise | | | | | | Community A-Weighted Noise | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | NPD | | | ANEEM | | | NPD | | | ANEEM | | | NPD | | |
| | Noise Events | Avg SEL | Avg Lmax | Noise Events | Avg SEL | Avg Lmax | Noise Events | Avg SEL | Avg Lmax | Noise Events | Avg SEL | Avg Lmax | Noise Events | Avg SEL | Avg Lmax |
| **07-07** | 94 | 86 | 75 | 432 | 80 | 65 | 94 | 99 | 87 | 432 | 95 | 85 | 5 | 78 | 71 |
| **07-08** | 105 | 85 | 74 | 414 | 79 | 66 | 105 | 101 | 89 | 414 | 97 | 86 | 22 | 80 | 72 |
| **07-09** | 95 | 86 | 75 | 286 | 81 | 63 | 95 | 96 | 84 | 286 | 92 | 80 | 56 | 87 | 70 |
| **07-10** | 88 | 87 | 76 | 170 | 84 | 68 | 88 | 96 | 84 | 170 | 93 | 80 | 0 | - | - |
| **07-11** | 108 | 85 | 75 | 220 | 82 | 69 | 108 | 97 | 85 | 220 | 95 | 83 | 8 | 78 | 70 |
| **07-12** | 118 | 86 | 75 | 325 | 82 | 68 | 118 | 100 | 88 | 325 | 97 | 87 | 24 | 79 | 72 |
| **07-13** | 113 | 86 | 75 | 365 | 81 | 67 | 113 | 99 | 87 | 365 | 96 | 85 | 25 | 80 | 71 |
| **07-14** | 96 | 87 | 76 | 400 | 81 | 65 | 96 | 98 | 86 | 400 | 95 | 83 | 12 | 81 | 72 |
| **07-15** | 99 | 88 | 77 | 330 | 82 | 64 | 99 | 97 | 85 | 330 | 93 | 81 | 1 | 79 | 72 |
| **07-16** | 94 | 88 | 77 | 301 | 83 | 64 | 94 | 97 | 85 | 301 | 93 | 81 | 0 | - | - |
| **07-17** | 105 | 86 | 75 | 339 | 81 | 65 | 105 | 96 | 85 | 339 | 94 | 83 | 1 | 79 | 70 |
| **07-18** | 152 | 85 | 75 | 377 | 81 | 69 | 152 | 103 | 90 | 377 | 98 | 87 | 59 | 81 | 72 |
| **07-19** | 149 | 85 | 74 | 301 | 82 | 70 | 149 | 102 | 91 | 301 | 99 | 89 | 63 | 80 | 72 |
| **07-20** | 269 | 86 | 76 | 503 | 82 | 71 | 269 | 107 | 95 | 503 | 102 | 92 | 137 | 82 | 73 |
| **07-21** | 131 | 85 | 75 | 425 | 82 | 66 | 131 | 102 | 88 | 425 | 98 | 87 | 136 | 81 | 71 |
| **07-22** | 114 | 86 | 75 | 266 | 82 | 68 | 114 | 98 | 86 | 266 | 95 | 82 | 14 | 78 | 71 |
| **07-23** | 92 | 86 | 75 | 238 | 82 | 67 | 92 | 97 | 86 | 238 | 95 | 83 | 8 | 77 | 69 |
| **07-24** | 109 | 85 | 74 | 336 | 80 | 66 | 109 | 97 | 85 | 336 | 95 | 84 | 27 | 88 | 73 |
| **07-25** | 89 | 86 | 75 | 304 | 81 | 65 | 89 | 96 | 85 | 304 | 94 | 83 | 9 | 89 | 76 |
| **07-26** | 144 | 84 | 73 | 471 | 80 | 67 | 144 | 100 | 88 | 471 | 98 | 88 | 20 | 78 | 71 |
| **07-27** | 109 | 85 | 74 | 273 | 81 | 65 | 109 | 94 | 82 | 273 | 92 | 80 | 1 | 78 | 73 |
| **Daily Average** | **118** | **86** | **75** | **337** | **81** | **67** | **118** | **101** | **87** | **337** | **97** | **85** | **30** | **83** | **72** |
| **Total Count** | **2,473** | | | **7,076** | | | **2,473** | | | **7,076** | | | **628** | | |

## D – Community Noise Equivalent Level



## E – Average Sound Exposure Level



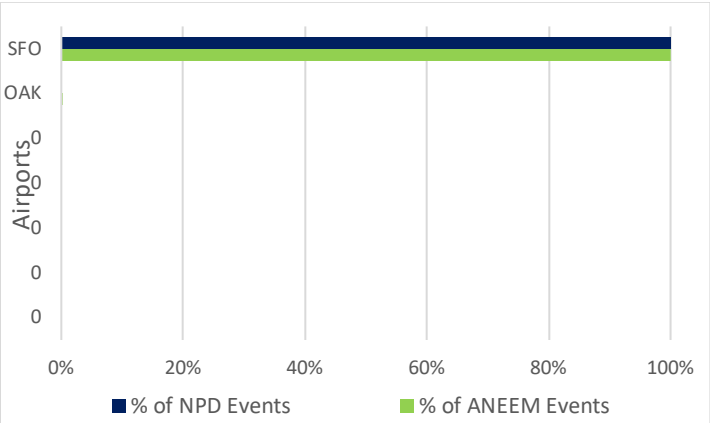




## F – SFO ANEEM Aircraft Noise Events by Time of Day

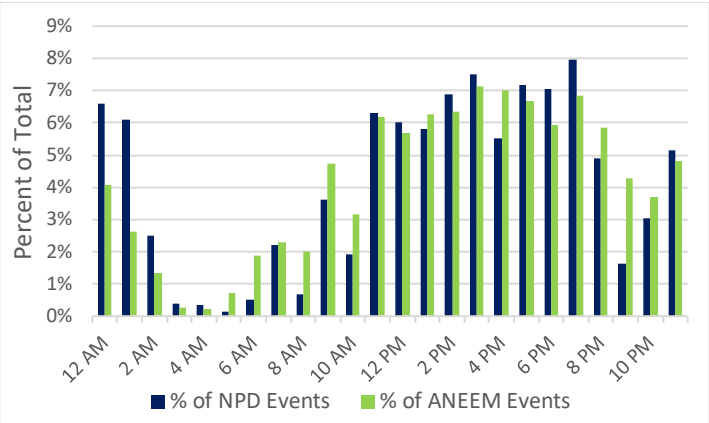
| SFO Aircraft ANEEM A-Weighted Events | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Time of Day | Noise Events | Noise Events % | Daily Avg SEL (dBA) | Min SEL (dBA) | Max SEL (dBA) | Avg Lmax (dBA) | Min Lmax (dBA) | Max Lmax (dBA) | Avg Duration (sec) | Min Duration (sec) | Max Duration (sec) |
| Day (7am–7pm) | 4,485 | 63% | 82 | 57 | 104 | 67 | 50 | 102 | 14 | 4 | 84 |
| Evening (7pm-10pm) | 1,201 | 17% | 79 | 58 | 95 | 66 | 49 | 85 | 13 | 4 | 80 |
| Night (10pm-7am) | 1,390 | 20% | 82 | 50 | 95 | 66 | 43 | 87 | 17 | 4 | 76 |

| SFO Aircraft ANEEM C-Weighted Events | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Time of Day | Noise Events | Noise Events % | Daily Avg SEL (dBC) | Min SEL (dBC) | Max SEL (dBC) | Avg Lmax (dBC) | Min Lmax (dBC) | Max Lmax (dBC) | Avg Duration (sec) | Min Duration (sec) | Max Duration (sec) |
| Day (7am–7pm) | 4,485 | 63% | 97 | 66 | 112 | 85 | 60 | 111 | 14 | 4 | 84 |
| Evening (7pm-10pm) | 1,201 | 17% | 97 | 67 | 109 | 87 | 60 | 102 | 13 | 4 | 80 |
| Night (10pm-7am) | 1,390 | 20% | 95 | 59 | 108 | 82 | 52 | 101 | 17 | 4 | 76 |

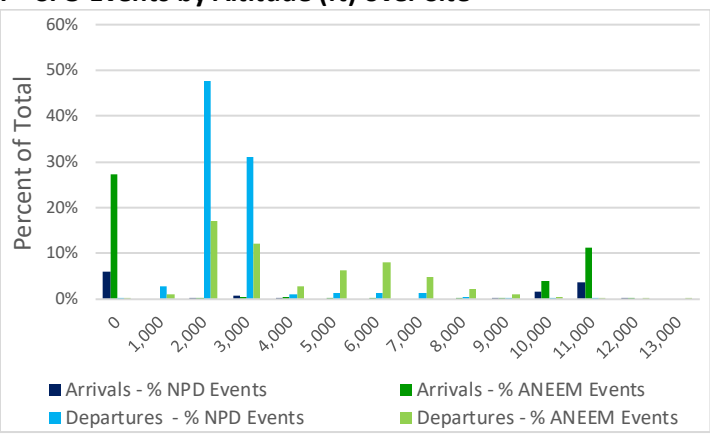
## G – Percentage of Events by Airports



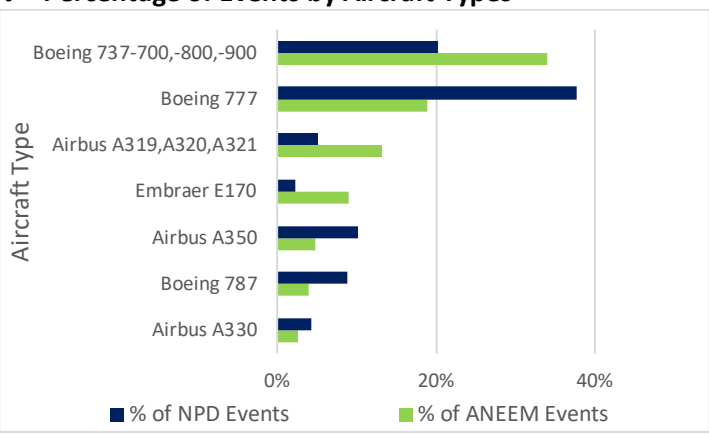

## H – SFO Noise Events by Hour of the Day



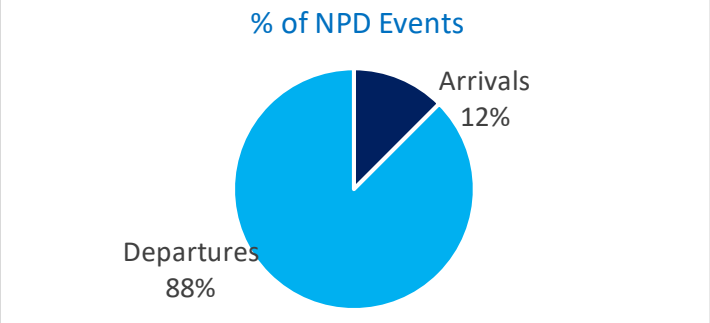

## I – SFO Events by Altitude (ft) over Site

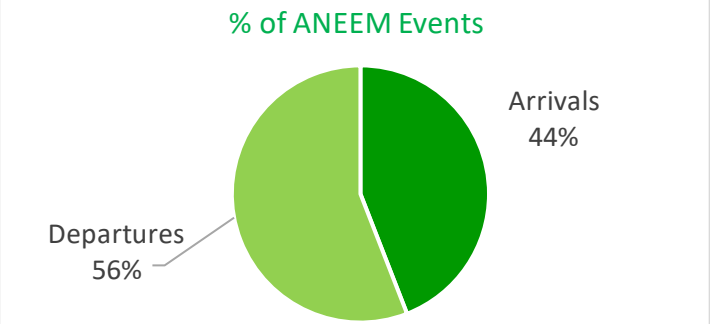



## J – Percentage of Events by Aircraft Types

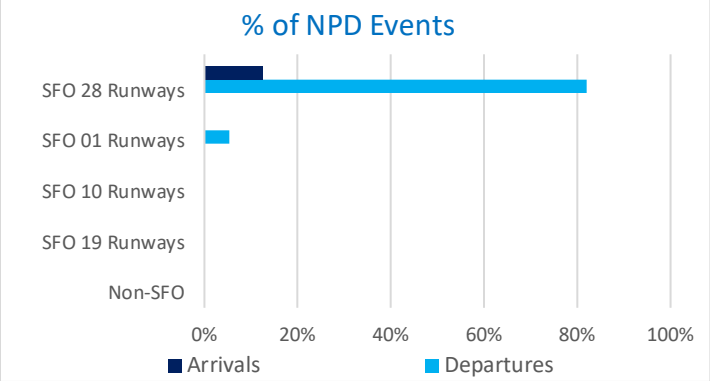


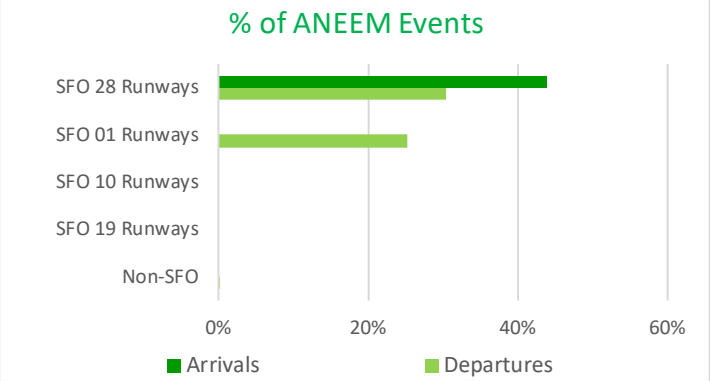
## K – Percentage of Aircraft Events by Operation Type




## L – Percentage of Aircraft Events by Runway and Operation Type

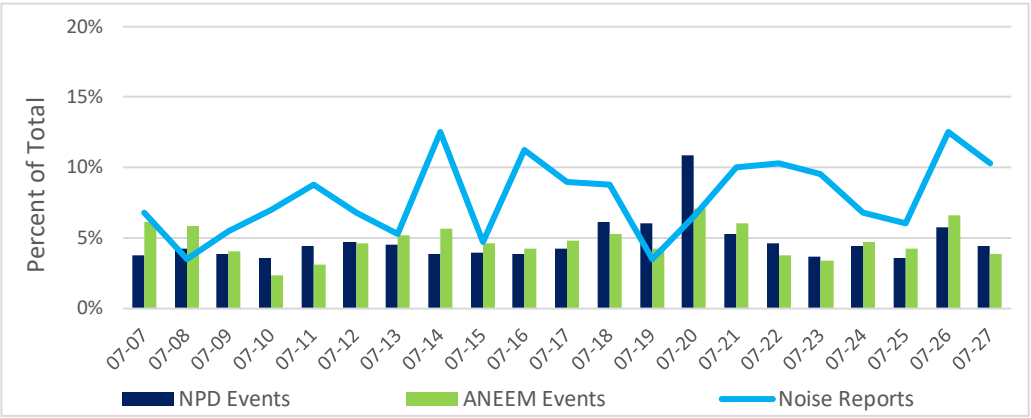



## M – Noise Reporters

| Date | Individual Noise Reporters | Noise Reports |
|---|---|---|
| 07-07 | 2 | 27 |
| 07-08 | 2 | 14 |
| 07-09 | 2 | 22 |
| 07-10 | 2 | 28 |
| 07-11 | 2 | 35 |
| 07-12 | 2 | 27 |
| 07-13 | 2 | 21 |
| 07-14 | 2 | 50 |
| 07-15 | 2 | 19 |
| 07-16 | 3 | 45 |
| 07-17 | 2 | 36 |
| 07-18 | 1 | 35 |
| 07-19 | 1 | 14 |
| 07-20 | 3 | 26 |
| 07-21 | 3 | 40 |
| 07-22 | 2 | 41 |
| 07-23 | 2 | 38 |
| 07-24 | 2 | 27 |
| 07-25 | 2 | 24 |
| 07-26 | 2 | 50 |
| 07-27 | 2 | 41 |
| Total | 6 | 399 |

## N – Noise Reports vs Aircraft Noise Events per Day

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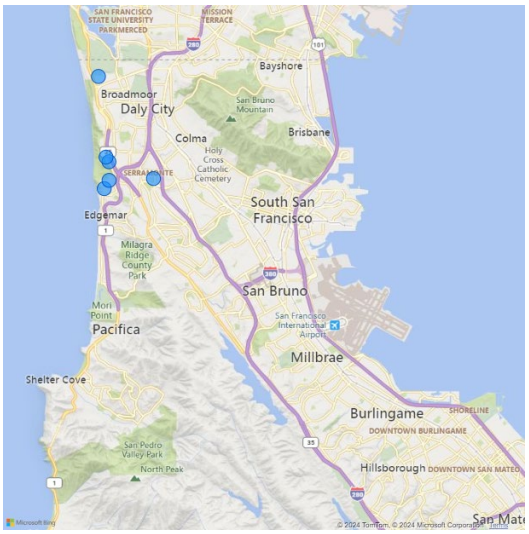


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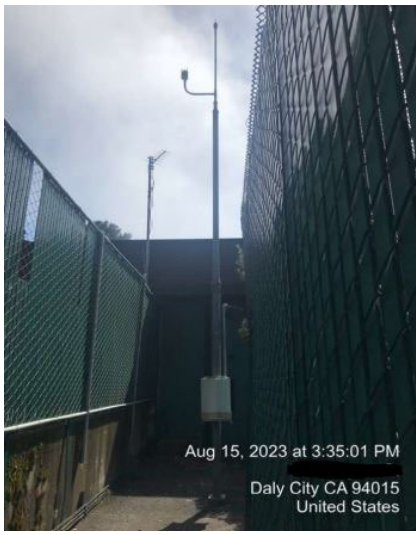

## Appendix

*This Appendix describes the sections of the noise monitoring report and a glossary of terms.*

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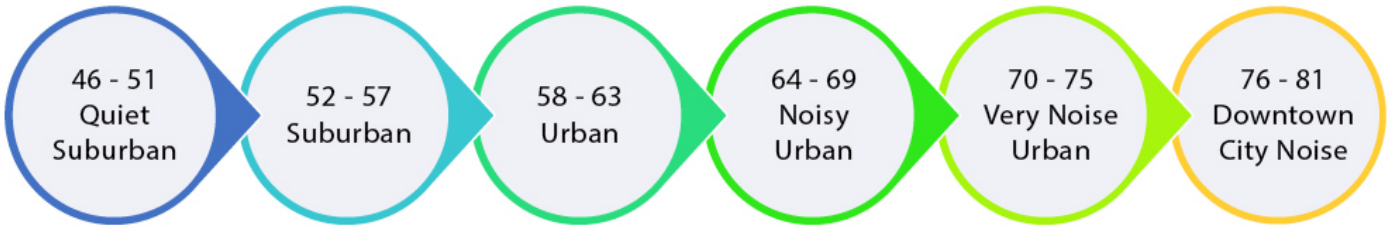
**C-Weighted Noise Level** – Denoted in dBC, is a different scale for loudness perception of sound pressure levels than A-weighted noise. A C-weight scale is used to measure sounds with approximately equal sensitivity at all frequencies. The C-weighted scale accounts for low-frequency ranges of sounds more than an A-weighted scale, often resulting in more of the overall noise energy to be included in the measurement.

**California Code of Regulations Title 21, Subchapter 6** – This code describes noise standards by defining metrics terminology and requirements regarding compatible land use. SFO was one of the first airports in the state to achieve a zero impact area within the 65 dB CNEL (Community Noise Equivalent Level) noise contour.

**Community Noise Equivalent Level (CNEL)** – A noise metric required by the California Airport Noise Standards for use by airport proprietors to measure aircraft noise levels. CNEL includes an additional weighting for each event occurring during the evening (7:00 p.m. – 9:59 p.m.) and nighttime (10:00 p.m. – 6:59 a.m.) periods to account for increased sensitivity to noise during these periods. Evening events are treated as though there were three and nighttime events are treated as though there were ten. This results in a 4.77 and 10 dBA penalty for operations occurring in the evening and nighttime periods, respectively. For a more in-depth explanation of CNEL and other technical noise terms, please visit the Federal Aviation Administration (FAA) website. Below is a graphic illustrating types of metropolitan areas and their corresponding CNEL intervals (dBA).




**Decibel (dB)** – A unit used to measure the magnitude or intensity of sound. The decibel uses a logarithmic scale to cover the very large range of sound pressures that can be heard by the human ear. Decibels measure a scale from the threshold of human hearing, 0 dB, upward towards the threshold of pain, about 120-140 dB. Because decibels are such a small measure, they are computed logarithmically and cannot be added arithmetically. A10 dB increase will be perceived by most people to be a doubling in loudness, i.e., 80 dB seems twice as loud as 70 dB. Decibel measurements can be scaled by different frequency ranges, such as by A-Weighted (dBA) and C-Weighted (dBC) scales.

**Maximum Sound Level (Lmax)** – The maximum a-weighted sound level for a given noise event. The peak noise level reached by a single aircraft event.

**Noise Event** – A Noise Event is the measured sound produced by a single source of noise over a duration of time. An aircraft noise event begins when the sound level of a flight operation exceeds a noise threshold and ends when the level drops down below that threshold.

**Sound Exposure Level (SEL)** – SEL is a measure of a single aircraft noise event spread out over its entirety compressed into one second. It allows for a comparison of aircraft noise events of different durations and noise levels. For example, think of the moment you hear a plane from a quarter mile away; we measure from that moment, as the aircraft flies overhead, and until it can't be heard. This is the duration of sound we use and then compress it into one second for a measure. SEL measures noise energy above the threshold (normally 65 dBA for aircraft noise events). This way, any ambient noise is separated out from the measurement.

SAN FRANCISCO INTERNATIONAL AIRPORT
CITY & COUNTY OF SAN FRANCISCO

# MEMORANDUM

TO: Millbrae Community

FROM: SAN FRANCISCO INTERNATIONAL AIRPORT AIRCRAFT NOISE OFFICE

SUBJECT: SFO Roundtable *Up-The-Hill* Noise Monitoring Study – July 2024
*One-Time Monitoring Location 1: SFO Retention Pond*

DATE: November 5, 2024

The San Francisco International Airport (SFO) Aircraft Noise Office conducted aircraft noise monitoring in Millbrae and Burlingame to determine the noise levels within the community from aircraft operations at SFO. This noise monitoring was conducted as part of a SFO Airport/Community Roundtable "Up-the-Hill" noise study researching the effects of takeoff and landing noise on communities situated next to the airport. This monitoring lasted for 21 days, occurring between July 7 and July 27, 2024, across 5 one-time monitoring locations and 9 permanent monitoring locations.

Millbrae and Burlingame are situated directly adjacent SFO, with Millbrae sitting to the southwest and Burlingame to the south. Much of the aircraft noise that reaches Millbrae and Burlingame is caused by takeoff and landing noise rather than by direct overflights. Aircraft operations on the airfield, takeoffs and landings, generate noise that travels across the landscape, and it is expected that weather and topography may amplify this noise to nearby communities.

SFO uses both Aircraft Noise Event Extraction Methodology (ANEEM) and Noise Power Distance (NPD) event classification methods and both A-weighted (dBA) and C-weighted (dBC) noise levels to generate this report. ANEEM is newer technology that looks at aircraft in the surrounding area to determine if any spikes in noise based on a floating threshold level may logically be correlated to them. Historically, ANEEM's correlation logic used AEDT modeled noise to classify if the increase in noise was logically generated by an aircraft, but this had to be modified to also look at thrust and timing to effectively correlate noise spikes to aircraft landing and taking off on or very close to ground level. NPD uses static noise thresholds to determine if spikes in noise qualify as noise events, then looks to see if there are any aircraft in the surrounding area that could be the cause of the noise. The noise monitor NPD thresholds for the total monitoring period was 80 dBA. Both ANEEM and NPD first generated events based on A-weighted noise levels, then used the time window of the A-weighted noise events to identify the C-weighted noise events.

During this study, there were approximately 475 noise events per day caused by SFO airfield operations using the ANEEM method. Approximately 100% of all aircraft noise events were from SFO aircraft. Aircraft noise events sources include primarily takeoffs from SFO's north-facing runways, Runways 01L and 01R, and from landing aircraft using reverse thrust to assist with slowing down after touching-down on SFO's West-facing runways, Runways 28L and 28R. Other airfield operations which could be heard at the monitor included take-offs from SFO's west-facing runways, Runways 28L and 28R.

During the monitoring period, the overall Aircraft Community Noise Equivalent Level (CNEL) using ANEEM was 81 dBA and the Aircraft CNEL and Community CNEL using NPD were 81 dBA and 67 dBA, respectively. This noise monitor was located next to the start of SFO's Runway 01R, with daily ambient noise ranging between 50 and 55 dBA.

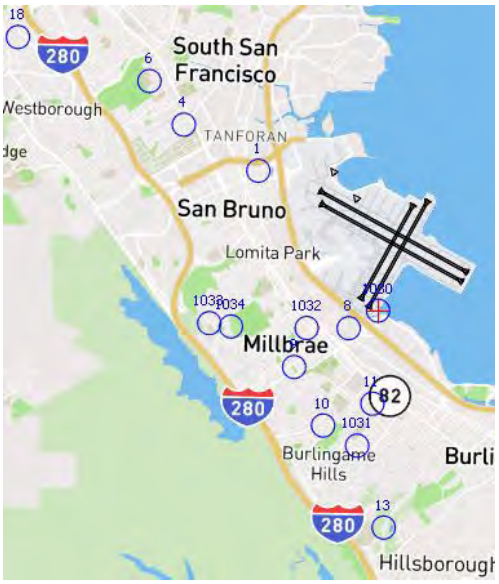
During the monitoring period, the SFO Aircraft Noise Office received 11 noise reports from 4 Burlingame and Millbrae residents. Most of the noise reports were generated between the hours of 5AM and 12AM. Likewise, Most of the SFO Aircraft noise events using ANEEM occurred between 8AM and 12AM.

This report includes one evaluation of a 21-day period including 16 parts (charts and graphics) that represent summaries of the aircraft noise-related data (values are subject to rounding) collected during the monitoring period. Each part and key terms used in this report are described in the Appendix and Glossary, respectively.

## A – Monitoring Summary

| | |
|---|---|
| **Monitoring Site** | SFO Retention Pond |
| **Monitoring Site Elevation (ft)** | 26 |
| **Monitoring Period** | July 7 – July 27, 2024 |
| **Average Ambient Noise (dBA)** | 53 |
| **NPD Community (non-aircraft) CNEL (dBA)** | 67 |
| **NPD Aircraft CNEL (dBA)** | 81 |
| **NPD Avg Daily SFO Noise Events** | 313 |
| **ANEEM Aircraft CNEL (dBA)** | 81 |
| **ANEEM Avg Aircraft SEL (dBA)** | 98 |
| **ANEEM Avg Aircraft SEL (dBC)** | 0 |
| **ANEEM Avg Aircraft Lmax (dBA)** | 84 |
| **ANEEM Avg Aircraft Lmax (dBC)** | 0 |
| **ANEEM Avg Daily SFO Noise Events** | 474 |
| **SFO West Flow** | 100% |
| **SFO Southeast Flow** | 0% |

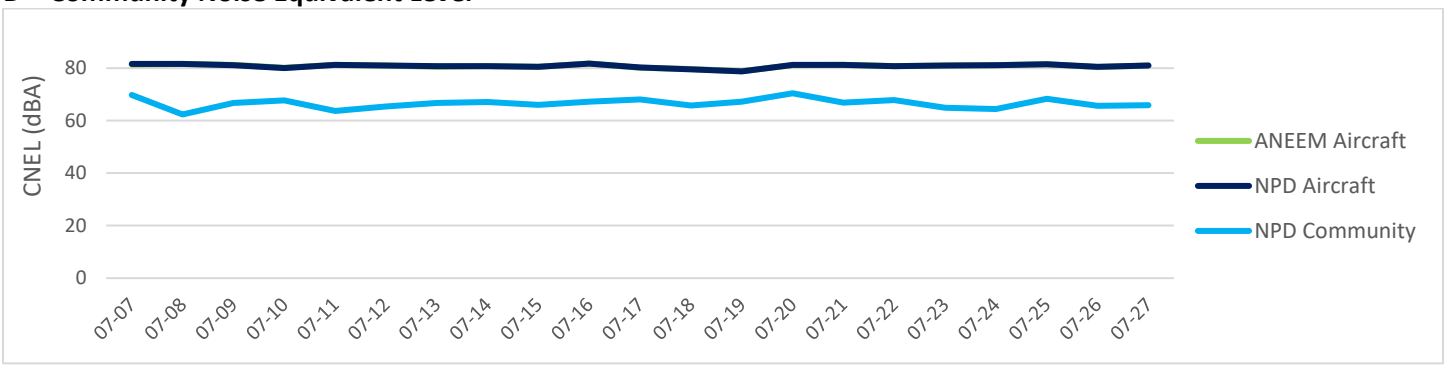
## B – Monitoring Location



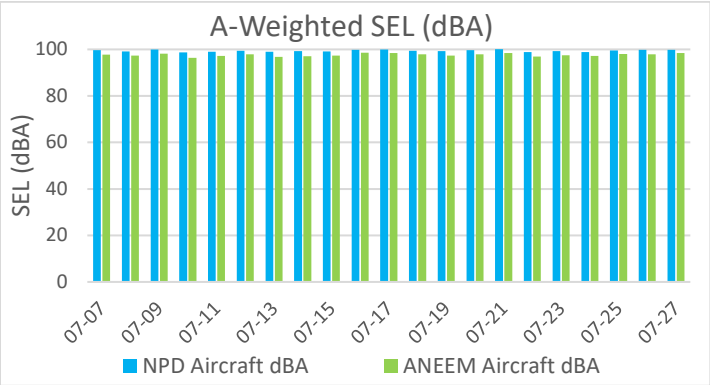

## C – Daily Noise Event Averages

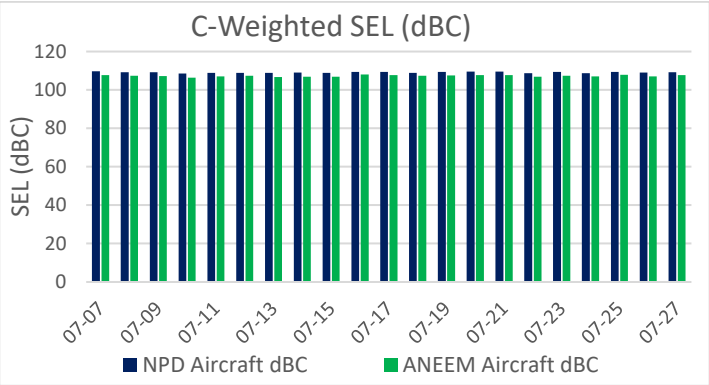
| Day | SFO Aircraft A-Weighted Noise | | | | | | SFO Aircraft C-Weighted Noise | | | | | | Community A-Weighted Noise | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | NPD | | | ANEEM | | | NPD | | | ANEEM | | | NPD | | |
| | Noise Events | Avg SEL | Avg Lmax | Noise Events | Avg SEL | Avg Lmax | Noise Events | Avg SEL | Avg Lmax | Noise Events | Avg SEL | Avg Lmax | Noise Events | Avg SEL | Avg Lmax |
| **07-07** | 315 | 100 | 90 | 480 | 98 | 84 | 315 | 110 | 98 | 480 | 108 | 93 | 61 | 96 | 84 |
| **07-08** | 323 | 99 | 89 | 490 | 97 | 84 | 323 | 109 | 98 | 490 | 107 | 93 | 21 | 92 | 84 |
| **07-09** | 326 | 100 | 90 | 510 | 98 | 85 | 326 | 109 | 98 | 510 | 107 | 93 | 29 | 94 | 85 |
| **07-10** | 273 | 99 | 89 | 488 | 96 | 83 | 273 | 109 | 98 | 488 | 106 | 92 | 27 | 94 | 84 |
| **07-11** | 299 | 99 | 89 | 464 | 97 | 84 | 299 | 109 | 97 | 464 | 107 | 92 | 19 | 96 | 85 |
| **07-12** | 353 | 99 | 89 | 502 | 98 | 85 | 353 | 109 | 98 | 502 | 107 | 93 | 25 | 95 | 85 |
| **07-13** | 288 | 99 | 89 | 475 | 97 | 83 | 288 | 109 | 97 | 475 | 107 | 91 | 29 | 95 | 83 |
| **07-14** | 282 | 99 | 89 | 478 | 97 | 84 | 282 | 109 | 98 | 478 | 107 | 92 | 32 | 96 | 84 |
| **07-15** | 325 | 99 | 90 | 509 | 97 | 84 | 325 | 109 | 98 | 509 | 107 | 92 | 25 | 95 | 84 |
| **07-16** | 347 | 100 | 90 | 470 | 99 | 86 | 347 | 109 | 98 | 470 | 108 | 94 | 40 | 94 | 84 |
| **07-17** | 322 | 100 | 90 | 453 | 98 | 85 | 322 | 109 | 98 | 453 | 108 | 94 | 39 | 96 | 85 |
| **07-18** | 326 | 99 | 90 | 460 | 98 | 86 | 326 | 109 | 97 | 460 | 107 | 93 | 29 | 93 | 85 |
| **07-19** | 249 | 99 | 89 | 389 | 97 | 84 | 249 | 109 | 98 | 389 | 108 | 93 | 35 | 95 | 84 |
| **07-20** | 304 | 100 | 90 | 456 | 98 | 85 | 304 | 110 | 98 | 456 | 108 | 94 | 32 | 96 | 84 |
| **07-21** | 305 | 100 | 90 | 461 | 98 | 85 | 305 | 110 | 98 | 461 | 108 | 93 | 30 | 94 | 85 |
| **07-22** | 280 | 99 | 89 | 440 | 97 | 83 | 280 | 109 | 97 | 440 | 107 | 92 | 34 | 94 | 83 |
| **07-23** | 308 | 99 | 89 | 486 | 97 | 84 | 308 | 109 | 98 | 486 | 107 | 92 | 23 | 94 | 84 |
| **07-24** | 336 | 99 | 89 | 505 | 97 | 84 | 336 | 109 | 97 | 505 | 107 | 92 | 18 | 95 | 85 |
| **07-25** | 346 | 99 | 89 | 472 | 98 | 86 | 346 | 109 | 98 | 472 | 108 | 94 | 34 | 96 | 85 |
| **07-26** | 335 | 100 | 90 | 516 | 98 | 85 | 335 | 109 | 97 | 516 | 107 | 93 | 29 | 94 | 85 |
| **07-27** | 324 | 100 | 90 | 457 | 98 | 85 | 324 | 109 | 98 | 457 | 108 | 93 | 36 | 94 | 84 |
| **Daily Average** | **313** | **99** | **89** | **474** | **98** | **84** | **313** | **109** | **98** | **474** | **107** | **93** | **31** | **95** | **84** |
| **Total Count** | **6,566** | | | **9,961** | | | **6,566** | | | **9,961** | | | **647** | | |

## D – Community Noise Equivalent Level



## E – Average Sound Exposure Level



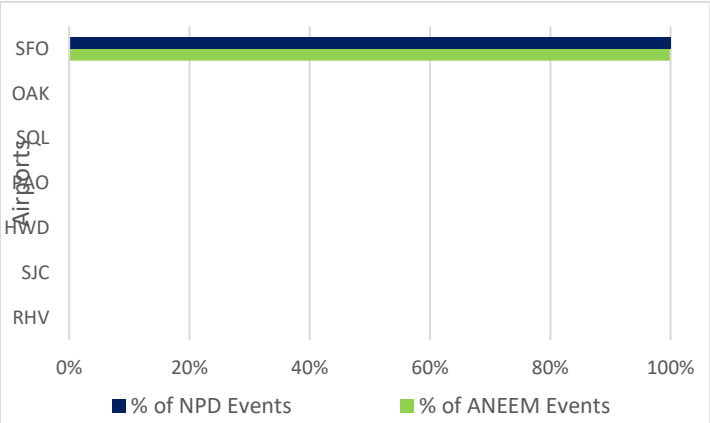




## F – SFO ANEEM Aircraft Noise Events by Time of Day

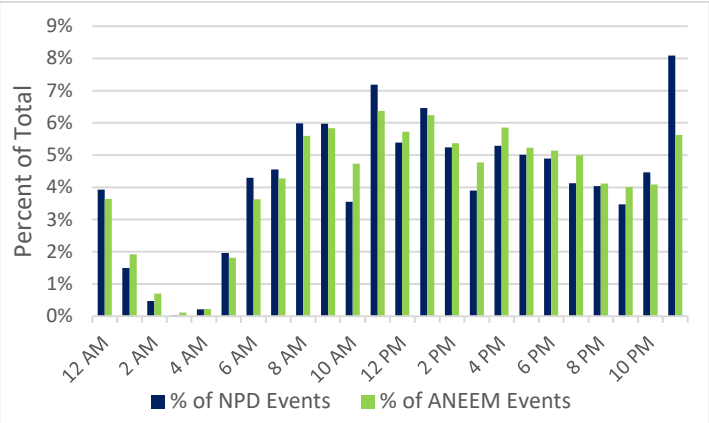
| SFO Aircraft ANEEM A-Weighted Events | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Time of Day | Noise Events | Noise Events % | Daily Avg SEL (dBA) | Min SEL (dBA) | Max SEL (dBA) | Avg Lmax (dBA) | Min Lmax (dBA) | Max Lmax (dBA) | Avg Duration (sec) | Min Duration (sec) | Max Duration (sec) |
| Day (7am–7pm) | 6488 | 65% | 97 | 65 | 108 | 84 | 60 | 101 | 15 | 5 | 72 |
| Evening (7pm-10pm) | 1306 | 13% | 97 | 69 | 108 | 84 | 61 | 100 | 16 | 5 | 70 |
| Night (10pm-7am) | 2167 | 22% | 99 | 66 | 110 | 86 | 57 | 103 | 16 | 5 | 70 |

| SFO Aircraft ANEEM C-Weighted Events | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Time of Day | Noise Events | Noise Events % | Daily Avg SEL (dBC) | Min SEL (dBC) | Max SEL (dBC) | Avg Lmax (dBC) | Min Lmax (dBC) | Max Lmax (dBC) | Avg Duration (sec) | Min Duration (sec) | Max Duration (sec) |
| Day (7am–7pm) | 6488 | 65% | 107 | 75 | 119 | 92 | 69 | 113 | 15 | 5 | 72 |
| Evening (7pm-10pm) | 1306 | 13% | 107 | 77 | 119 | 91 | 69 | 110 | 16 | 5 | 70 |
| Night (10pm-7am) | 2167 | 22% | 109 | 76 | 119 | 94 | 69 | 110 | 16 | 5 | 70 |

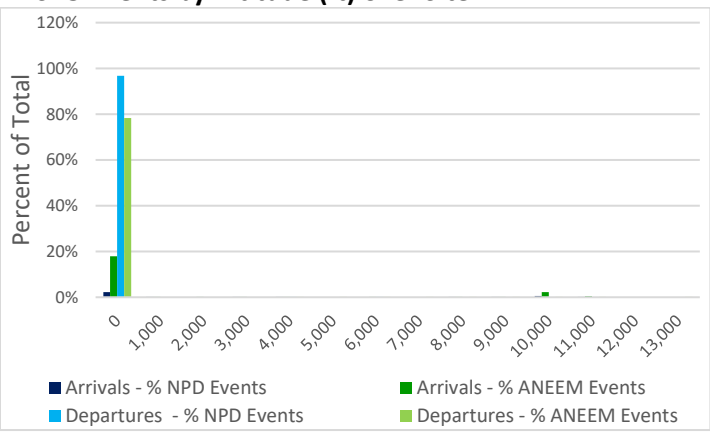
## G – Percentage of Events by Airports



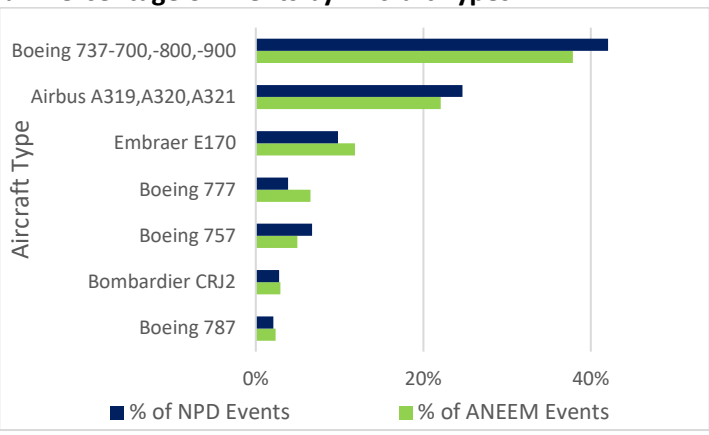

## H – SFO Noise Events by Hour of the Day



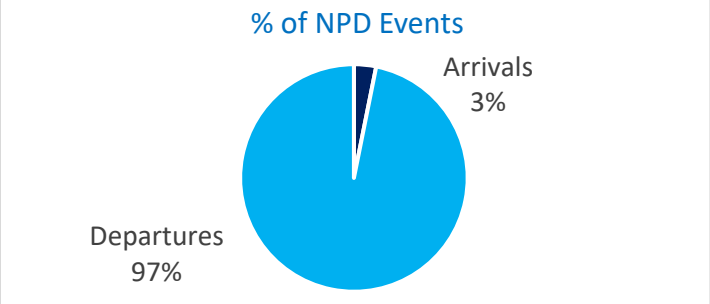

## I – SFO Events by Altitude (ft) over Site

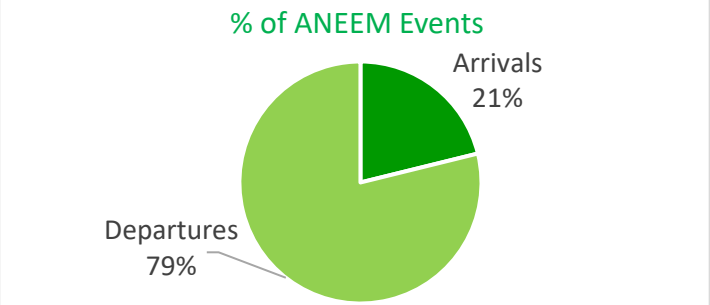



## J – Percentage of Events by Aircraft Types

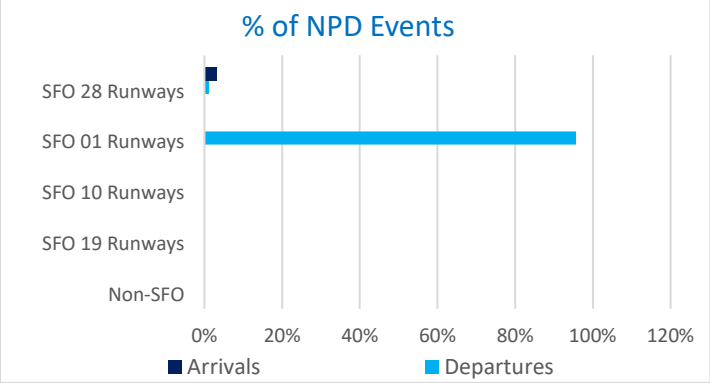


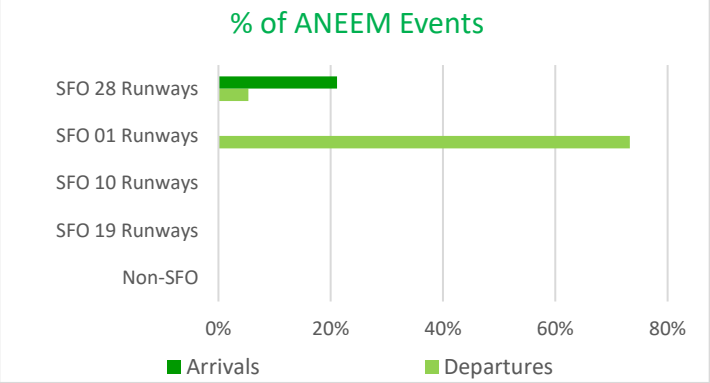
## K – Percentage of Aircraft Events by Operation Type




## L – Percentage of Aircraft Events by Runway and Operation Type

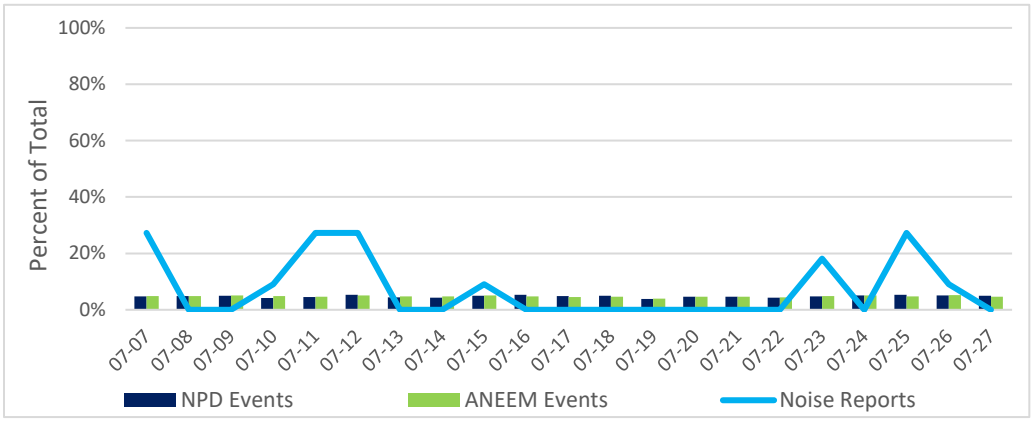


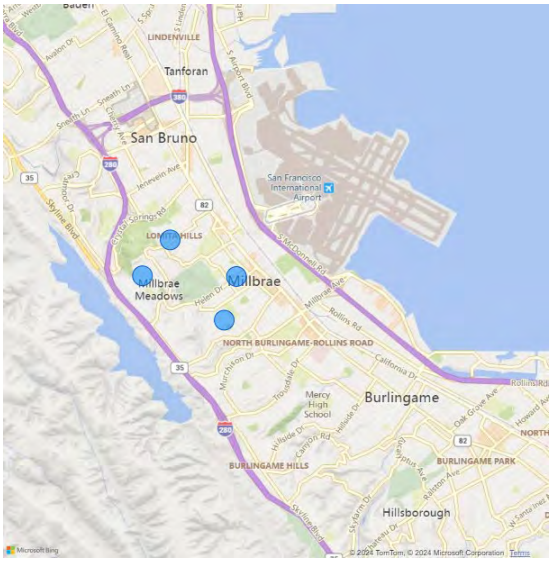

## M – Noise Reporters

| Date | Individual Noise Reporters | Noise Reports |
|---|---|---|
| 07-07 | 1 | 3 |
| 07-08 | 0 | 0 |
| 07-09 | 0 | 0 |
| 07-10 | 1 | 1 |
| 07-11 | 1 | 3 |
| 07-12 | 2 | 3 |
| 07-13 | 0 | 0 |
| 07-14 | 0 | 0 |
| 07-15 | 1 | 1 |
| 07-16 | 0 | 0 |
| 07-17 | 0 | 0 |
| 07-18 | 0 | 0 |
| 07-19 | 0 | 0 |
| 07-20 | 0 | 0 |
| 07-21 | 0 | 0 |
| 07-22 | 0 | 0 |
| 07-23 | 2 | 2 |
| 07-24 | 0 | 0 |
| 07-25 | 1 | 3 |
| 07-26 | 1 | 1 |
| 07-27 | 0 | 0 |
| **Total** | **4** | **11** |

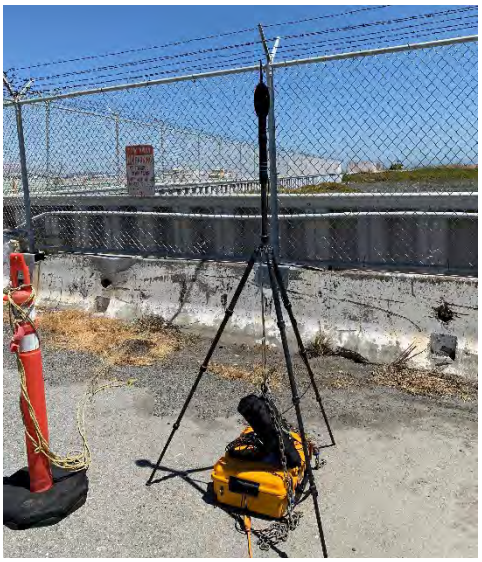
## N – Noise Reports vs Aircraft Noise Events per Day




## O – Noise Reporter Locations




## P – Noise Monitor on Location



## Appendix

*This Appendix describes the sections of the noise monitoring report and a glossary of terms.*

**Part A – Monitoring Summary** lists the monitoring location, elevation, the monitoring time period, and the key monitoring results including the ANEEM Aircraft, NPD Aircraft, and NPD Community Community Noise Equivalent level (CNEL), single event levels in both A and C noise weightings, and air traffic flow breakdown. The CNEL metric is used to assess and regulate aircraft noise exposure in communities surrounding the airport. California Title 21 Noise Regulations established an acceptable level of 65 dBA CNEL.

**Part B – Monitoring Location** illustrates the location of the portable noise monitor and examples of typical SFO flight operations that registered noise events at the portable noise monitor.

**Part C – Daily Noise Event Averages** lists the number of noise events registered at the noise monitor by SFO Aircraft for both A and C noise weightings using ANEEM (green) or NPD (blue) methods during each day of the noise monitoring period. NPD Community noise events by A-weighted noise levels are also included. The noise event levels are expressed as average Sound Exposure Level (SEL) and average peak noise level (Lmax).

**Part D – Community Noise Equivalent Level** shows a chart that compares the ANEEM Aircraft (SFO and non-SFO), NPD Aircraft, and NPD Community CNEL during each day of the monitoring period.

**Part E – Average Sound Exposure Level** (SEL) shows 2 charts comparing the ANEEM Aircraft (SFO and non-SFO) and NPD Aircraft average SEL for A and C-weighted noise levels during each day of the monitoring period.

**Part F – SFO Aircraft Noise Events by Time of Day** lists 2 tables including the daily minimum, maximum, and average SEL, Lmax, duration and number of SFO Aircraft noise events using ANEEM during the Daytime (7am to 7pm), Evening (7pm to 10pm), and Nighttime (10pm to 7am) for both A and C-weighted noise levels during the monitoring period.

**Part G – Percentage of Events by Airports** shows the percentage of aircraft events using ANEEM and NPD by the aircraft's nearest airport of origin or destination. The percentages for both methods each add up to 100%.

**Part H – SFO Noise Event by Hour of the Day** shows the percentage of total SFO Aircraft noise events using ANEEM and NPD by hour of the day. The percentages for both methods each add up to 100%.

**Part I – SFO Departure Events by Altitude (ft) over Site** shows the percentage of SFO Aircraft Departures and Arrivals that registered noise events at the noise monitor using ANEEM and NPD by altitude intervals. Altitudes are relative to mean sea level elevation. Excludes helicopters. The percentages for both methods each add up to 100%.

**Part J – Percentage of Events by Aircraft Types** shows the percentage of aircraft events using ANEEM and NPD by aircraft types. The percentages for both methods each add up to 100%.

**Part K – Percentage of Events by Operation Type** shows the percentage of aircraft noise events registered using ANEEM and NPD by Arrivals and Departures.

**Part L – Percentage of Aircraft Events by Runway and Operation Type** compares the percentage of aircraft noise events registered using ANEEM and NPD by Arrivals and Departures per each SFO runway pair and to non-SFO overflights.

**Part M – Noise Reporters** lists the number of individual noise reporters and noise reports per day registered by individuals living in Millbrae or Burlingame.

**Part N – Noise Reports vs Aircraft Noise Events per Day** compares the number of noise reports to the number of aircraft noise events per day using ANEEM and NPD. The percentages for both methods each add up to 100%.

**Part O – Noise Report Locations** illustrates a map that shows the noise report locations.

**Part P – Noise Monitor on Location** shows photographs of the noise monitoring equipment on location.

## Glossary

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SAN FRANCISCO INTERNATIONAL AIRPORT
CITY & COUNTY OF SAN FRANCISCO

# MEMORANDUM

TO: Burlingame Community

FROM: SAN FRANCISCO INTERNATIONAL AIRPORT AIRCRAFT NOISE OFFICE

SUBJECT: SFO Roundtable *Up-The-Hill* Noise Monitoring Study – July 2024
*One-Time Monitoring Location 2: Central County Fire Department Sta. 35*

DATE: November 5, 2024

The San Francisco International Airport (SFO) Aircraft Noise Office conducted aircraft noise monitoring in Millbrae and Burlingame to determine the noise levels within the community from aircraft operations at SFO. This noise monitoring was conducted as part of a SFO Airport/Community Roundtable "Up-the-Hill" noise study researching the effects of takeoff and landing noise on communities situated next to the airport. This monitoring lasted for 21 days, occurring between July 7 and July 27, 2024, across 5 one-time monitoring locations and 9 permanent monitoring locations.

Millbrae and Burlingame are situated directly adjacent SFO, with Millbrae sitting to the southwest and Burlingame to the south. Much of the aircraft noise that reaches Millbrae and Burlingame is caused by takeoff and landing noise rather than by direct overflights. Aircraft operations on the airfield, takeoffs and landings, generate noise that travels across the landscape, and it is expected that weather and topography may amplify this noise to nearby communities.

SFO uses both Aircraft Noise Event Extraction Methodology (ANEEM) and Noise Power Distance (NPD) event classification methods and both A-weighted (dBA) and C-weighted (dBC) noise levels to generate this report. ANEEM is newer technology that looks at aircraft in the surrounding area to determine if any spikes in noise based on a floating threshold level may logically be correlated to them. Historically, ANEEM's correlation logic used AEDT modeled noise to classify if the increase in noise was logically generated by an aircraft, but this had to be modified to also look at thrust and timing to effectively correlate noise spikes to aircraft landing and taking off on or very close to ground level. NPD uses static noise thresholds to determine if spikes in noise qualify as noise events, then looks to see if there are any aircraft in the surrounding area that could be the cause of the noise. The noise monitor NPD thresholds for the total monitoring period were 55 dBA for daytime and 50 dBA for nighttime. Both ANEEM and NPD first generated events based on A-weighted noise levels, then used the time window of the A-weighted noise events to identify the C-weighted noise events.

During this study, there were approximately 766 noise events per day caused by SFO airfield operations using the ANEEM method. Approximately 95% of all aircraft noise events were from SFO aircraft. Aircraft noise events sources include primarily takeoffs from SFO's north-facing runways, Runways 01L and 01R, and from landing aircraft using reverse thrust to assist with slowing down after touching-down on SFO's west-facing runways, Runways 28L and 28R. Other airfield operations which could be heard at the monitor included take-offs from SFO's west-facing runways, Runways 28L and 28R. In addition to noise from airfield operations, there were also noise from aircraft overflights, majority of which were departing aircraft from OAK headed south/southeast utilizing the CNDEL departure procedure. Approximately 3% of all aircraft noise events were from OAK aircraft.

During the monitoring period, the overall Aircraft Community Noise Equivalent Level (CNEL) using ANEEM was 52 dBA and the Aircraft CNEL and Community CNEL using NPD were 52 dBA and 42 dBA, respectively. This noise monitor was located in a quiet suburban area with daily ambient noise ranging between 32 and 40 dba. Aircraft noise above ambient levels may have been perceptible by residents. Additionally, the frequency of flights due to the proximity of the Airport may have increased annoyance levels.

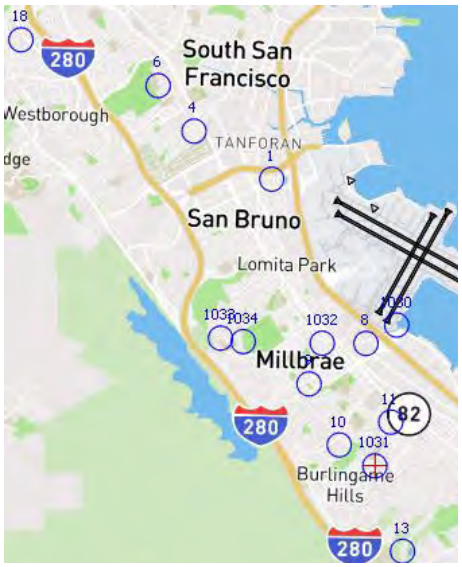
During the monitoring period, the SFO Aircraft Noise Office received 1 noise report from 1 Burlingame resident. The noise report was generated in the 2AM hour. Likewise, most of the SFO Aircraft noise events using ANEEM occurred between 8AM and 12AM.

This report includes one evaluation of a 21-day period including 16 parts (charts and graphics) that represent summaries of the aircraft noise-related data (values are subject to rounding) collected during the monitoring period. Each part and key terms used in this report are described in the Appendix and Glossary, respectively.

## A – Monitoring Summary

| | |
|---|---|
| **Monitoring Site** | Central County Fire Department Sta. 35 |
| **Monitoring Site Elevation (ft)** | 15 |
| **Monitoring Period** | July 7 – July 27, 2024 |
| **Average Ambient Noise (dBA)** | 37 |
| **NPD Community (non-aircraft) CNEL (dBA)** | 42 |
| **NPD Aircraft CNEL (dBA)** | 52 |
| **NPD Avg Daily SFO Noise Events** | 149 |
| **ANEEM Aircraft CNEL (dBA)** | 52 |
| **ANEEM Avg Aircraft SEL (dBA)** | 66 |
| **ANEEM Avg Aircraft SEL (dBC)** | 85 |
| **ANEEM Avg Aircraft Lmax (dBA)** | 51 |
| **ANEEM Avg Aircraft Lmax (dBC)** | 68 |
| **ANEEM Avg Daily SFO Noise Events** | 740 |
| **SFO West Flow** | 100% |
| **SFO Southeast Flow** | 0% |

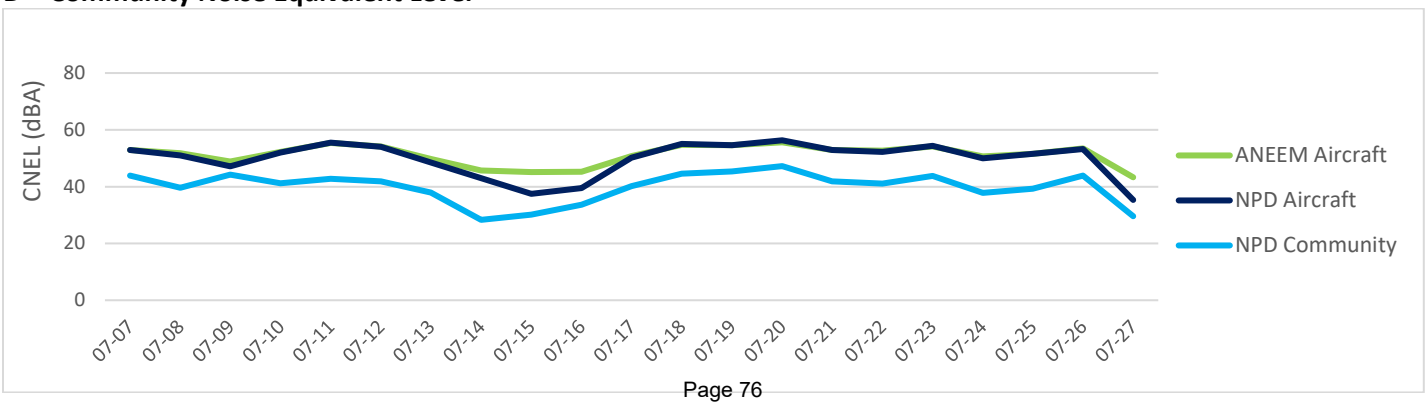
## B – Monitoring Location



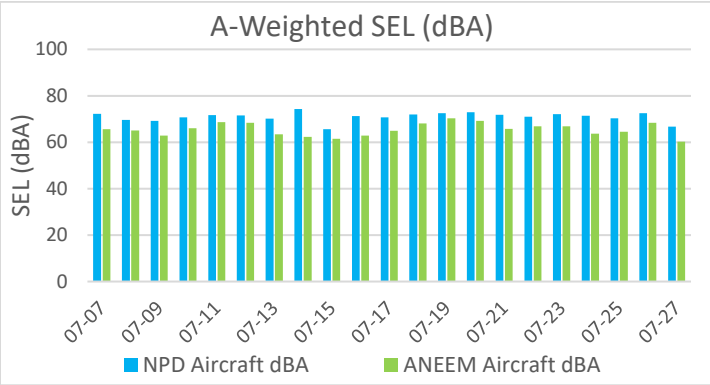

## C – Daily Noise Event Averages

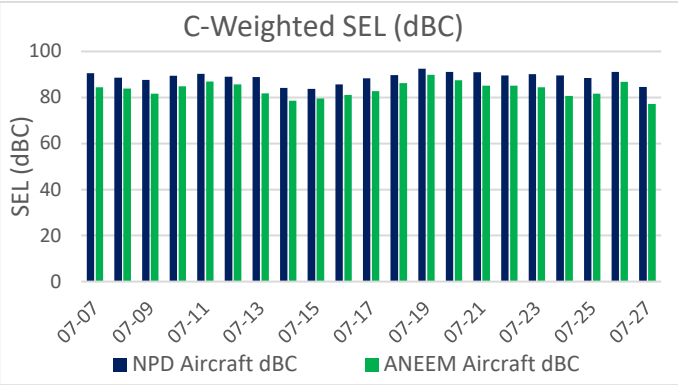
| Day | SFO Aircraft A-Weighted Noise | | | | | | SFO Aircraft C-Weighted Noise | | | | | | Community A-Weighted Noise | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | NPD | | | ANEEM | | | NPD | | | ANEEM | | | NPD | | |
| | Noise Events | Avg SEL | Avg Lmax | Noise Events | Avg SEL | Avg Lmax | Noise Events | Avg SEL | Avg Lmax | Noise Events | Avg SEL | Avg Lmax | Noise Events | Avg SEL | Avg Lmax |
| **07-07** | 112 | 72 | 58 | 681 | 66 | 51 | 112 | 91 | 77 | 681 | 85 | 68 | 50 | 67 | 55 |
| **07-08** | 143 | 70 | 58 | 739 | 65 | 52 | 143 | 89 | 76 | 739 | 84 | 68 | 25 | 66 | 55 |
| **07-09** | 79 | 69 | 58 | 755 | 63 | 49 | 79 | 88 | 75 | 755 | 82 | 67 | 35 | 70 | 58 |
| **07-10** | 163 | 71 | 58 | 756 | 66 | 52 | 163 | 89 | 75 | 756 | 85 | 69 | 44 | 66 | 56 |
| **07-11** | 283 | 72 | 59 | 781 | 69 | 55 | 283 | 90 | 76 | 781 | 87 | 71 | 62 | 66 | 55 |
| **07-12** | 285 | 71 | 60 | 769 | 68 | 55 | 285 | 89 | 74 | 769 | 86 | 70 | 78 | 68 | 58 |
| **07-13** | 75 | 70 | 58 | 699 | 63 | 49 | 75 | 89 | 76 | 699 | 82 | 66 | 15 | 68 | 57 |
| **07-14** | 31 | 75 | 59 | 737 | 62 | 48 | 31 | 84 | 75 | 737 | 79 | 64 | 3 | 65 | 58 |
| **07-15** | 27 | 66 | 57 | 750 | 61 | 48 | 27 | 84 | 73 | 750 | 80 | 65 | 7 | 66 | 58 |
| **07-16** | 37 | 71 | 60 | 703 | 63 | 49 | 37 | 86 | 73 | 703 | 81 | 67 | 15 | 69 | 60 |
| **07-17** | 95 | 71 | 58 | 756 | 65 | 51 | 95 | 88 | 75 | 756 | 83 | 67 | 15 | 69 | 57 |
| **07-18** | 264 | 72 | 60 | 777 | 68 | 54 | 264 | 90 | 76 | 777 | 86 | 71 | 59 | 67 | 56 |
| **07-19** | 334 | 73 | 60 | 687 | 70 | 56 | 334 | 93 | 77 | 687 | 90 | 73 | 99 | 68 | 56 |
| **07-20** | 263 | 73 | 59 | 684 | 69 | 54 | 263 | 91 | 76 | 684 | 88 | 71 | 80 | 68 | 56 |
| **07-21** | 129 | 72 | 59 | 752 | 66 | 51 | 129 | 91 | 77 | 752 | 85 | 69 | 30 | 67 | 55 |
| **07-22** | 178 | 71 | 59 | 723 | 67 | 53 | 178 | 90 | 76 | 723 | 85 | 70 | 40 | 67 | 57 |
| **07-23** | 174 | 72 | 58 | 765 | 67 | 52 | 174 | 90 | 75 | 765 | 85 | 67 | 43 | 67 | 56 |
| **07-24** | 71 | 71 | 59 | 775 | 64 | 50 | 71 | 90 | 75 | 775 | 81 | 64 | 20 | 66 | 55 |
| **07-25** | 123 | 70 | 58 | 747 | 64 | 51 | 123 | 89 | 74 | 747 | 82 | 66 | 33 | 66 | 56 |
| **07-26** | 251 | 72 | 59 | 791 | 68 | 53 | 251 | 91 | 78 | 791 | 87 | 71 | 110 | 69 | 57 |
| **07-27** | 11 | 67 | 58 | 722 | 60 | 47 | 11 | 85 | 73 | 722 | 77 | 63 | 4 | 69 | 60 |
| **Daily Average** | **149** | **72** | **59** | **740** | **66** | **51** | **149** | **90** | **76** | **740** | **85** | **68** | **41** | **68** | **56** |
| **Total Count** | **3,128** | | | **15,549** | | | **3,128** | | | **15,549** | | | **867** | | |

## D – Community Noise Equivalent Level



## E – Average Sound Exposure Level



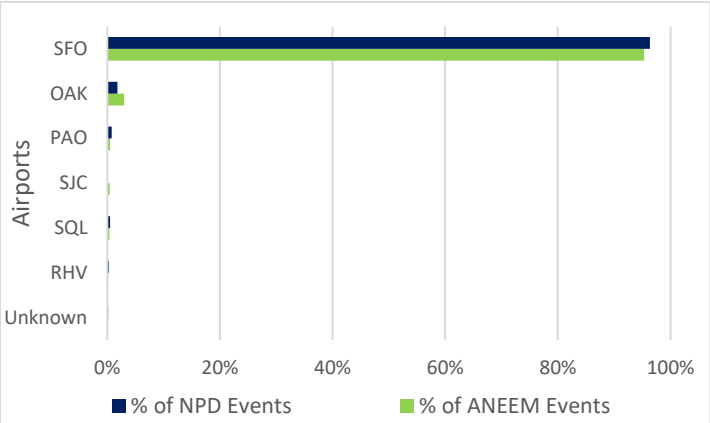




## F – SFO ANEEM Aircraft Noise Events by Time of Day

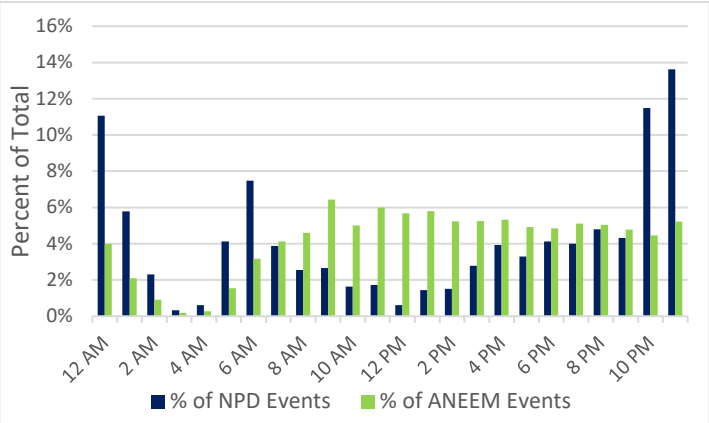
| SFO Aircraft ANEEM A-Weighted Events | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Time of Day | Noise Events | Noise Events % | Daily Avg SEL (dBA) | Min SEL (dBA) | Max SEL (dBA) | Avg Lmax (dBA) | Min Lmax (dBA) | Max Lmax (dBA) | Avg Duration (sec) | Min Duration (sec) | Max Duration (sec) |
| Day (7am–7pm) | 9831 | 63% | 65 | 47 | 84 | 51 | 39 | 79 | 26 | 5 | 72 |
| Evening (7pm-10pm) | 2321 | 15% | 67 | 47 | 82 | 52 | 39 | 73 | 27 | 5 | 72 |
| Night (10pm-7am) | 3397 | 22% | 69 | 44 | 82 | 52 | 36 | 72 | 32 | 5 | 72 |

| SFO Aircraft ANEEM C-Weighted Events | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Time of Day | Noise Events | Noise Events % | Daily Avg SEL (dBC) | Min SEL (dBC) | Max SEL (dBC) | Avg Lmax (dBC) | Min Lmax (dBC) | Max Lmax (dBC) | Avg Duration (sec) | Min Duration (sec) | Max Duration (sec) |
| Day (7am–7pm) | 9831 | 63% | 83 | 58 | 102 | 67 | 50 | 96 | 26 | 5 | 72 |
| Evening (7pm-10pm) | 2321 | 15% | 85 | 58 | 101 | 68 | 52 | 91 | 27 | 5 | 72 |
| Night (10pm-7am) | 3397 | 22% | 87 | 55 | 101 | 70 | 47 | 93 | 32 | 5 | 72 |

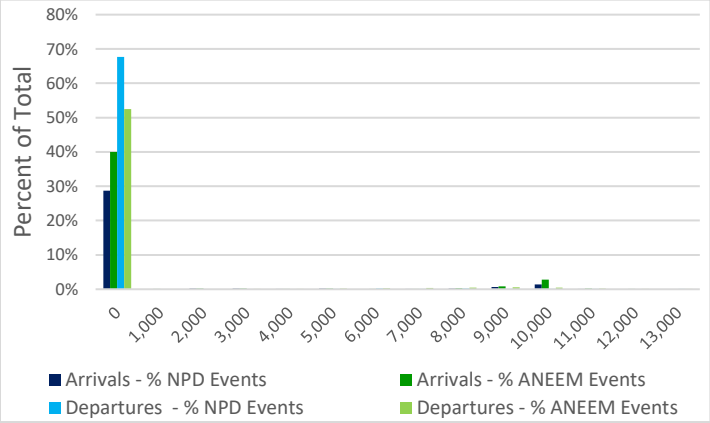
## G – Percentage of Events by Airports



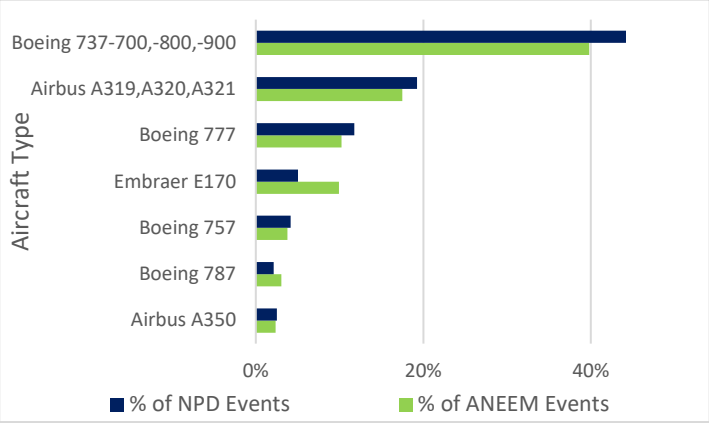

## H – SFO Noise Events by Hour of the Day



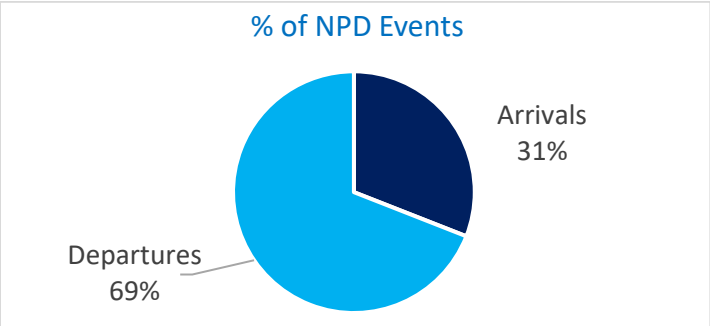

## I – SFO Events by Altitude (ft) over Site

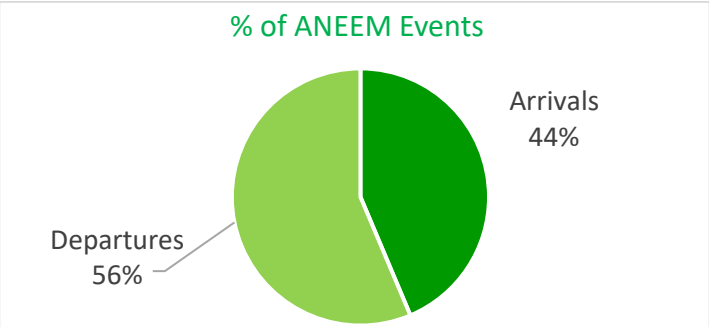



## J – Percentage of Events by Aircraft Types

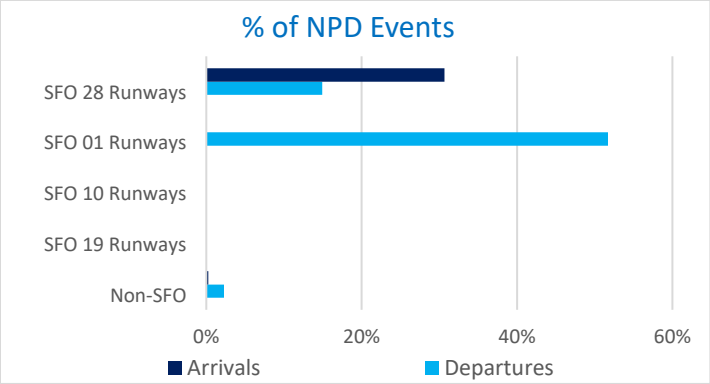


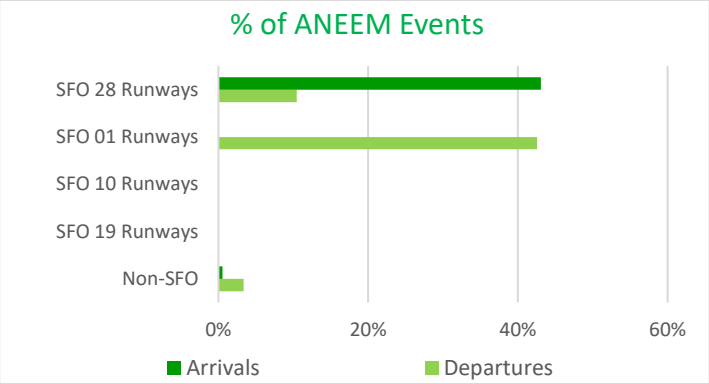
## K – Percentage of Aircraft Events by Operation Type




## L – Percentage of Aircraft Events by Runway and Operation Type

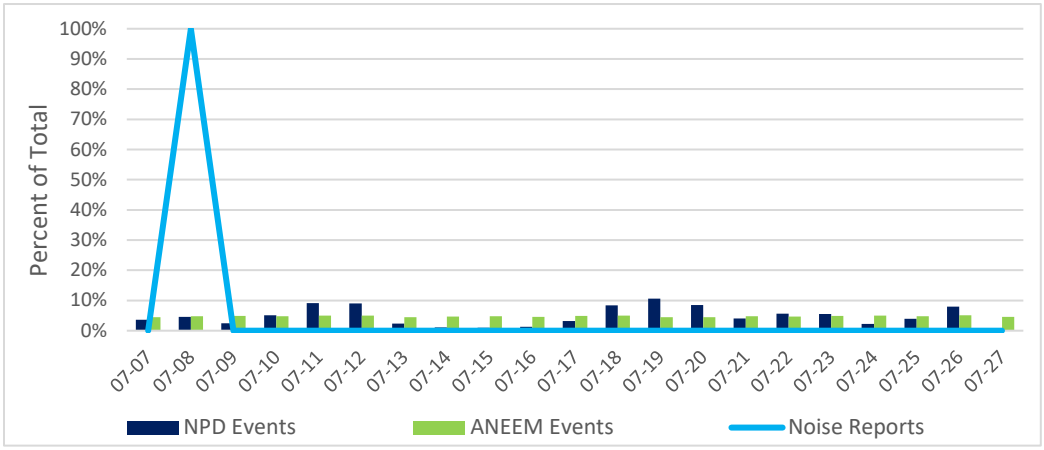


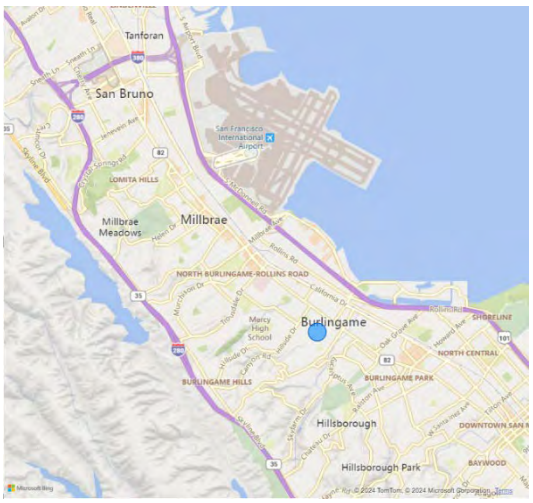

## M – Noise Reporters

| Date | Individual Noise Reporters | Noise Reports |
|---|---|---|
| 07-07 | 0 | 0 |
| 07-08 | 1 | 1 |
| 07-09 | 0 | 0 |
| 07-10 | 0 | 0 |
| 07-11 | 0 | 0 |
| 07-12 | 0 | 0 |
| 07-13 | 0 | 0 |
| 07-14 | 0 | 0 |
| 07-15 | 0 | 0 |
| 07-16 | 0 | 0 |
| 07-17 | 0 | 0 |
| 07-18 | 0 | 0 |
| 07-19 | 0 | 0 |
| 07-20 | 0 | 0 |
| 07-21 | 0 | 0 |
| 07-22 | 0 | 0 |
| 07-23 | 0 | 0 |
| 07-24 | 0 | 0 |
| 07-25 | 0 | 0 |
| 07-26 | 0 | 0 |
| 07-27 | 0 | 0 |
| Total | 1 | 1 |

## N – Noise Reports vs Aircraft Noise Events per Day




## O – Noise Reporter Locations




## P – Noise Monitor on Location

## Appendix

*This Appendix describes the sections of the noise monitoring report and a glossary of terms.*

**Part A – Monitoring Summary** lists the monitoring location, elevation, the monitoring time period, and the key monitoring results including the ANEEM Aircraft, NPD Aircraft, and NPD Community Community Noise Equivalent level (CNEL), single event levels in both A and C noise weightings, and air traffic flow breakdown. The CNEL metric is used to assess and regulate aircraft noise exposure in communities surrounding the airport. California Title 21 Noise Regulations established an acceptable level of 65 dBA CNEL.

**Part B – Monitoring Location** illustrates the location of the portable noise monitor and examples of typical SFO flight operations that registered noise events at the portable noise monitor.

**Part C – Daily Noise Event Averages** lists the number of noise events registered at the noise monitor by SFO Aircraft for both A and C noise weightings using ANEEM (green) or NPD (blue) methods during each day of the noise monitoring period. NPD Community noise events by A-weighted noise levels are also included. The noise event levels are expressed as average Sound Exposure Level (SEL) and average peak noise level (Lmax).

**Part D – Community Noise Equivalent Level** shows a chart that compares the ANEEM Aircraft (SFO and non-SFO), NPD Aircraft, and NPD Community CNEL during each day of the monitoring period.

**Part E – Average Sound Exposure Level** (SEL) shows 2 charts comparing the ANEEM Aircraft (SFO and non-SFO) and NPD Aircraft average SEL for A and C-weighted noise levels during each day of the monitoring period.

**Part F – SFO Aircraft Noise Events by Time of Day** lists 2 tables including the daily minimum, maximum, and average SEL, Lmax, duration and number of SFO Aircraft noise events using ANEEM during the Daytime (7am to 7pm), Evening (7pm to 10pm), and Nighttime (10pm to 7am) for both A and C-weighted noise levels during the monitoring period.

**Part G – Percentage of Events by Airports** shows the percentage of aircraft events using ANEEM and NPD by the aircraft's nearest airport of origin or destination. The percentages for both methods each add up to 100%.

**Part H – SFO Noise Event by Hour of the Day** shows the percentage of total SFO Aircraft noise events using ANEEM and NPD by hour of the day. The percentages for both methods each add up to 100%.

**Part I – SFO Departure Events by Altitude (ft) over Site** shows the percentage of SFO Aircraft Departures and Arrivals that registered noise events at the noise monitor using ANEEM and NPD by altitude intervals. Altitudes are relative to mean sea level elevation. Excludes helicopters. The percentages for both methods each add up to 100%.

**Part J – Percentage of Events by Aircraft Types** shows the percentage of aircraft events using ANEEM and NPD by aircraft types. The percentages for both methods each add up to 100%.

**Part K – Percentage of Events by Operation Type** shows the percentage of aircraft noise events registered using ANEEM and NPD by Arrivals and Departures.

**Part L – Percentage of Aircraft Events by Runway and Operation Type** compares the percentage of aircraft noise events registered using ANEEM and NPD by Arrivals and Departures per each SFO runway pair and to non-SFO overflights.

**Part M – Noise Reporters** lists the number of individual noise reporters and noise reports per day registered by individuals living in Millbrae or Burlingame.

**Part N – Noise Reports vs Aircraft Noise Events per Day** compares the number of noise reports to the number of aircraft noise events per day using ANEEM and NPD. The percentages for both methods each add up to 100%.

**Part O – Noise Report Locations** illustrates a map that shows the noise report locations.

**Part P – Noise Monitor on Location** shows photographs of the noise monitoring equipment on location.

## Glossary

**A-Weighted Noise Level** – Denoted in dBA, is the most common unit used for measuring environmental sound levels. The human ear does not respond equally to different frequencies of sound. An A-weight adjusts the frequency components of sound to conform to your ear's normal response at conversational levels. The FAA and State of the California have adopted the A-weighted sound level for environmental analysis. Sound level meters have an A-weighting network for measuring noise in A-weighted decibels.

**C-Weighted Noise Level** – Denoted in dBC, is a different scale for loudness perception of sound pressure levels than A-weighted noise. A C-weight scale is used to measure sounds with approximately equal sensitivity at all frequencies. The C-weighted scale accounts for low-frequency ranges of sounds more than an A-weighted scale, often resulting in more of the overall noise energy to be included in the measurement.

**California Code of Regulations Title 21, Subchapter 6** – This code describes noise standards by defining metrics terminology and requirements regarding compatible land use. SFO was one of the first airports in the state to achieve a zero impact area within the 65 dB CNEL (Community Noise Equivalent Level) noise contour.

**Community Noise Equivalent Level (CNEL)** – A noise metric required by the California Airport Noise Standards for use by airport proprietors to measure aircraft noise levels. CNEL includes an additional weighting for each event occurring during the evening (7:00 p.m. – 9:59 p.m.) and nighttime (10:00 p.m. – 6:59 a.m.) periods to account for increased sensitivity to noise during these periods. Evening events are treated as though there were three and nighttime events are treated as though there were ten. This results in a 4.77 and 10 dBA penalty for operations occurring in the evening and nighttime periods, respectively. For a more in-depth explanation of CNEL and other technical noise terms, please visit the Federal Aviation Administration (FAA) website. Below is a graphic illustrating types of metropolitan areas and their corresponding CNEL intervals (dBA).


**Decibel (dB)** – A unit used to measure the magnitude or intensity of sound. The decibel uses a logarithmic scale to cover the very large range of sound pressures that can be heard by the human ear. Decibels measure a scale from the threshold of human hearing, 0 dB, upward towards the threshold of pain, about 120-140 dB. Because decibels are such a small measure, they are computed logarithmically and cannot be added arithmetically. A10 dB increase will be perceived by most people to be a doubling in loudness, i.e., 80 dB seems twice as loud as 70 dB. Decibel measurements can be scaled by different frequency ranges, such as by A-Weighted (dBA) and C-Weighted (dBC) scales.

**Maximum Sound Level (Lmax)** – The maximum a-weighted sound level for a given noise event. The peak noise level reached by a single aircraft event.

**Noise Event** – A Noise Event is the measured sound produced by a single source of noise over a duration of time. An aircraft noise event begins when the sound level of a flight operation exceeds a noise threshold and ends when the level drops down below that threshold.

**Sound Exposure Level (SEL)** – SEL is a measure of a single aircraft noise event spread out over its entirety compressed into one second. It allows for a comparison of aircraft noise events of different durations and noise levels. For example, think of the moment you hear a plane from a quarter mile away; we measure from that moment, as the aircraft flies overhead, and until it can't be heard. This is the duration of sound we use and then compress it into one second for a measure. SEL measures noise energy above the threshold (normally 65 dBA for aircraft noise events). This way, any ambient noise is separated out from the measurement.

SAN FRANCISCO INTERNATIONAL AIRPORT
CITY & COUNTY OF SAN FRANCISCO

# MEMORANDUM

TO: Millbrae Community

FROM: SAN FRANCISCO INTERNATIONAL AIRPORT AIRCRAFT NOISE OFFICE

SUBJECT: SFO Roundtable *Up-The-Hill* Noise Monitoring Study – July 2024
*One-Time Monitoring Location 3: Central County Fire Department Sta. 37*

DATE: November 5, 2024

The San Francisco International Airport (SFO) Aircraft Noise Office conducted aircraft noise monitoring in Millbrae and Burlingame to determine the noise levels within the community from aircraft operations at SFO. This noise monitoring was conducted as part of a SFO Airport/Community Roundtable "Up-the-Hill" noise study researching the effects of takeoff and landing noise on communities situated next to the airport. This monitoring lasted for 21 days, occurring between July 7 and July 27, 2024, across 5 one-time monitoring locations and 9 permanent monitoring locations.

Millbrae and Burlingame are situated directly adjacent SFO, with Millbrae sitting to the southwest and Burlingame to the south. Much of the aircraft noise that reaches Millbrae and Burlingame is caused by takeoff and landing noise rather than by direct overflights. Aircraft operations on the airfield, takeoffs and landings, generate noise that travels across the landscape, and it is expected that weather and topography may amplify this noise to nearby communities.

SFO uses both Aircraft Noise Event Extraction Methodology (ANEEM) and Noise Power Distance (NPD) event classification methods and both A-weighted (dBA) and C-weighted (dBC) noise levels to generate this report. ANEEM is newer technology that looks at aircraft in the surrounding area to determine if any spikes in noise based on a floating threshold level may logically be correlated to them. Historically, ANEEM's correlation logic used AEDT modeled noise to classify if the increase in noise was logically generated by an aircraft, but this had to be modified to also look at thrust and timing to effectively correlate noise spikes to aircraft landing and taking off on or very close to ground level. NPD uses static noise thresholds to determine if spikes in noise qualify as noise events, then looks to see if there are any aircraft in the surrounding area that could be the cause of the noise. The noise monitor NPD thresholds for the total monitoring period were 62 dBA for daytime and 57 dBA for nighttime. Both ANEEM and NPD first generated events based on A-weighted noise levels, then used the time window of the A-weighted noise events to identify the C-weighted noise events.

During this study, there were approximately 768 noise events per day caused by SFO airfield operations using the ANEEM method. Approximately 96% of all aircraft noise events were from SFO aircraft. Aircraft noise events sources include primarily takeoffs from SFO's north-facing runways, Runways 01L and 01R, and from landing aircraft using reverse thrust to assist with slowing down after touching-down on SFO's west-facing runways, Runways 28L and 28R. Other airfield operations which could be heard at the monitor included take-offs from SFO's west-facing runways, Runways 28L and 28R. In addition to noise from airfield operations, there were also noise from aircraft overflights, majority of which were departing aircraft from Oakland International Airport (OAK) headed south/southeast utilizing the CNDEL departure procedure. Approximately 3% of all aircraft noise events were from OAK aircraft.

During the monitoring period, the overall Aircraft Community Noise Equivalent Level (CNEL) using ANEEM was 58 dBA and the Aircraft CNEL and Community CNEL using NPD were 57 dBA and 50 dBA, respectively. This noise monitor was located in a busy suburban area with daily ambient noise ranging between 66 and 84 dBA. Aircraft noise above ambient levels may have been perceptible by residents. Additionally, the frequency of flights due to the proximity of the Airport may have increased annoyance levels.

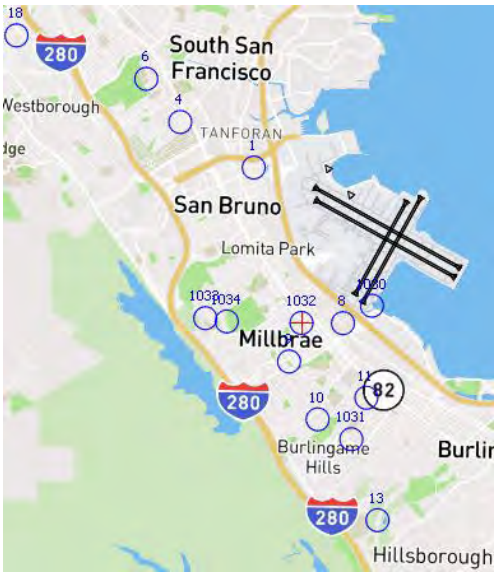
During the monitoring period, the SFO Aircraft Noise Office received 11 noise reports from 4 Millbrae residents. Most of the noise reports were generated between the hours of 5AM – 12AM. Likewise, most of the SFO Aircraft noise events using ANEEM occurred between 8AM – 12AM.

This report includes one evaluation of a 21-day period including 16 parts (charts and graphics) that represent summaries of the aircraft noise-related data (values are subject to rounding) collected during the monitoring period. Each part and key terms used in this report are described in the Appendix and Glossary, respectively.

## A – Monitoring Summary

| | |
|---|---|
| **Monitoring Site** | Central County Fire Department Sta. 37 |
| **Monitoring Site Elevation (ft)** | 66 |
| **Monitoring Period** | July 7 – July 27, 2024 |
| **Average Ambient Noise (dBA)** | 76 |
| **NPD Community (non-aircraft) CNEL (dBA)** | 50 |
| **NPD Aircraft CNEL (dBA)** | 57 |
| **NPD Avg Daily SFO Noise Events** | 133 |
| **ANEEM Aircraft CNEL (dBA)** | 58 |
| **ANEEM Avg Aircraft SEL (dBA)** | 73 |
| **ANEEM Avg Aircraft SEL (dBC)** | 89 |
| **ANEEM Avg Aircraft Lmax (dBA)** | 60 |
| **ANEEM Avg Aircraft Lmax (dBC)** | 75 |
| **ANEEM Avg Daily SFO Noise Events** | 742 |
| **SFO West Flow** | 100% |
| **SFO Southeast Flow** | 0% |

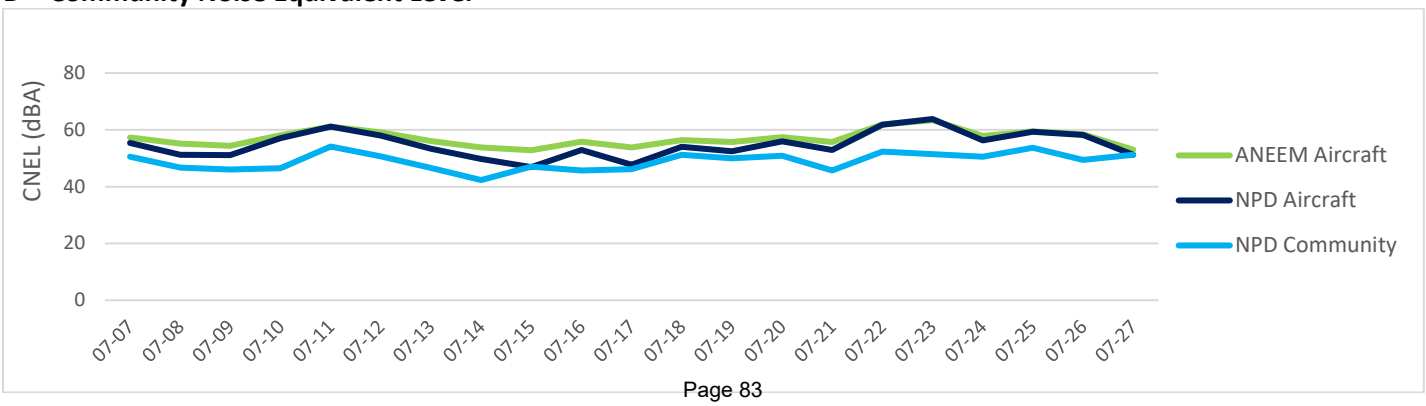
## B – Monitoring Location



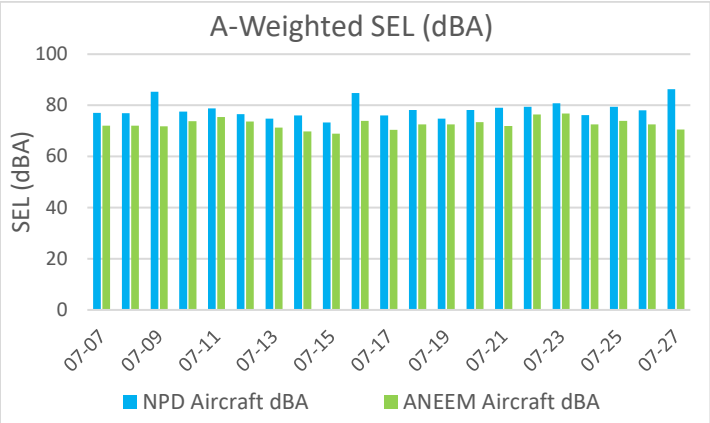

## C – Daily Noise Event Averages

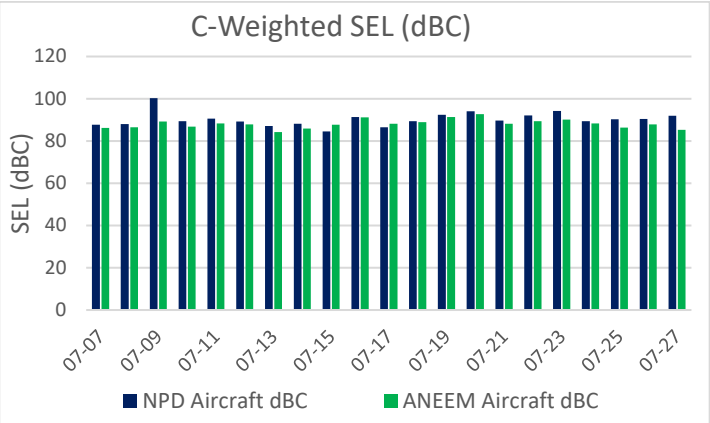
| Day | SFO Aircraft A-Weighted Noise | | | | | | SFO Aircraft C-Weighted Noise | | | | | | Community A-Weighted Noise | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | NPD | | | ANEEM | | | NPD | | | ANEEM | | | NPD | | |
| | Noise Events | Avg SEL | Avg Lmax | Noise Events | Avg SEL | Avg Lmax | Noise Events | Avg SEL | Avg Lmax | Noise Events | Avg SEL | Avg Lmax | Noise Events | Avg SEL | Avg Lmax |
| **07-07** | 130 | 77 | 65 | 771 | 72 | 59 | 130 | 88 | 77 | 771 | 86 | 74 | 71 | 75 | 62 |
| **07-08** | 92 | 77 | 66 | 729 | 72 | 60 | 92 | 88 | 78 | 729 | 87 | 73 | 29 | 75 | 65 |
| **07-09** | 28 | 85 | 69 | 758 | 72 | 57 | 28 | 100 | 80 | 758 | 89 | 74 | 13 | 81 | 67 |
| **07-10** | 204 | 77 | 67 | 759 | 74 | 61 | 204 | 89 | 78 | 759 | 87 | 74 | 38 | 72 | 63 |
| **07-11** | 322 | 79 | 67 | 766 | 75 | 63 | 322 | 91 | 79 | 766 | 88 | 75 | 117 | 78 | 65 |
| **07-12** | 202 | 77 | 66 | 803 | 74 | 62 | 202 | 89 | 78 | 803 | 88 | 76 | 91 | 72 | 62 |
| **07-13** | 119 | 75 | 65 | 716 | 71 | 59 | 119 | 87 | 76 | 716 | 84 | 72 | 36 | 72 | 63 |
| **07-14** | 55 | 76 | 66 | 723 | 70 | 57 | 55 | 88 | 78 | 723 | 86 | 72 | 24 | 74 | 62 |
| **07-15** | 29 | 73 | 64 | 770 | 69 | 57 | 29 | 84 | 75 | 770 | 88 | 74 | 11 | 78 | 67 |
| **07-16** | 44 | 85 | 68 | 787 | 74 | 58 | 44 | 91 | 77 | 787 | 91 | 77 | 16 | 78 | 66 |
| **07-17** | 45 | 75 | 65 | 754 | 70 | 58 | 45 | 87 | 75 | 754 | 88 | 75 | 25 | 76 | 64 |
| **07-18** | 112 | 78 | 65 | 704 | 73 | 60 | 112 | 89 | 78 | 704 | 89 | 76 | 53 | 81 | 64 |
| **07-19** | 106 | 75 | 65 | 607 | 73 | 61 | 106 | 93 | 81 | 607 | 91 | 77 | 68 | 74 | 63 |
| **07-20** | 154 | 78 | 66 | 697 | 73 | 61 | 154 | 94 | 81 | 697 | 93 | 78 | 83 | 75 | 64 |
| **07-21** | 89 | 79 | 65 | 756 | 72 | 58 | 89 | 90 | 78 | 756 | 88 | 74 | 26 | 78 | 65 |
| **07-22** | 304 | 79 | 68 | 724 | 76 | 63 | 304 | 92 | 80 | 724 | 89 | 76 | 79 | 76 | 64 |
| **07-23** | 269 | 81 | 68 | 761 | 77 | 63 | 269 | 94 | 80 | 761 | 90 | 75 | 102 | 73 | 61 |
| **07-24** | 159 | 76 | 65 | 739 | 73 | 61 | 159 | 89 | 77 | 739 | 88 | 74 | 61 | 76 | 63 |
| **07-25** | 174 | 79 | 66 | 728 | 74 | 61 | 174 | 90 | 77 | 728 | 86 | 74 | 78 | 80 | 65 |
| **07-26** | 129 | 78 | 66 | 754 | 72 | 59 | 129 | 91 | 78 | 754 | 88 | 75 | 62 | 74 | 62 |
| **07-27** | 22 | 86 | 69 | 776 | 71 | 56 | 22 | 92 | 78 | 776 | 85 | 72 | 22 | 86 | 68 |
| **Daily Average** | **133** | **79** | **66** | **742** | **73** | **60** | **133** | **91** | **78** | **742** | **89** | **75** | **53** | **77** | **64** |
| **Total Count** | **2,788** | | | **15,582** | | | **2,788** | | | **15,582** | | | **1,105** | | |

## D – Community Noise Equivalent Level



## E – Average Sound Exposure Level



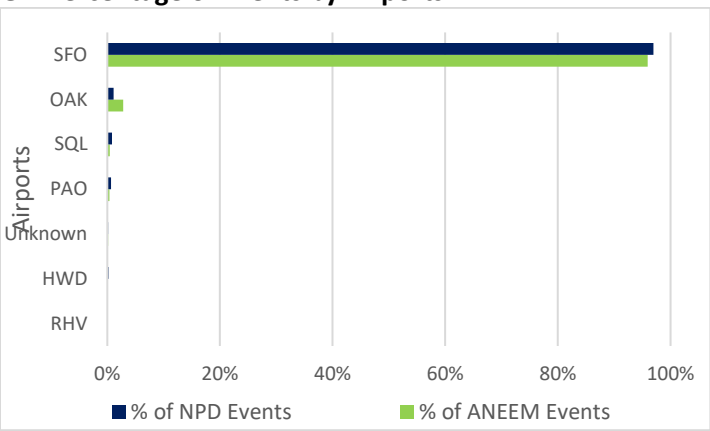




## F – SFO ANEEM Aircraft Noise Events by Time of Day

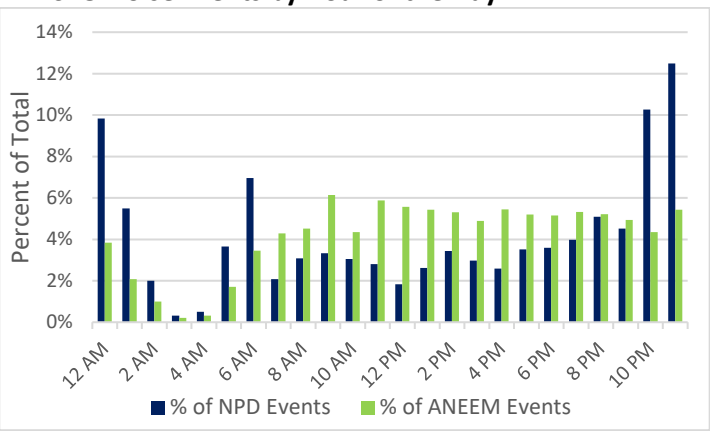
| SFO Aircraft ANEEM A-Weighted Events | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Time of Day | Noise Events | Noise Events % | Daily Avg SEL (dBA) | Min SEL (dBA) | Max SEL (dBA) | Avg Lmax (dBA) | Min Lmax (dBA) | Max Lmax (dBA) | Avg Duration (sec) | Min Duration (sec) | Max Duration (sec) |
| Day (7am–7pm) | 9,685 | 62% | 73 | 57 | 100 | 60 | 49 | 98 | 21 | 5 | 72 |
| Evening (7pm-10pm) | 2,411 | 15% | 73 | 56 | 86 | 60 | 48 | 78 | 23 | 5 | 71 |
| Night (10pm-7am) | 3,486 | 22% | 74 | 52 | 90 | 59 | 44 | 81 | 27 | 5 | 72 |

| SFO Aircraft ANEEM C-Weighted Events | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Time of Day | Noise Events | Noise Events % | Daily Avg SEL (dBC) | Min SEL (dBC) | Max SEL (dBC) | Avg Lmax (dBC) | Min Lmax (dBC) | Max Lmax (dBC) | Avg Duration (sec) | Min Duration (sec) | Max Duration (sec) |
| Day (7am–7pm) | 9,685 | 62% | 89 | 67 | 111 | 76 | 58 | 102 | 21 | 5 | 72 |
| Evening (7pm-10pm) | 2,411 | 15% | 89 | 66 | 104 | 74 | 58 | 99 | 23 | 5 | 71 |
| Night (10pm-7am) | 3,486 | 22% | 88 | 62 | 104 | 72 | 55 | 98 | 27 | 5 | 72 |

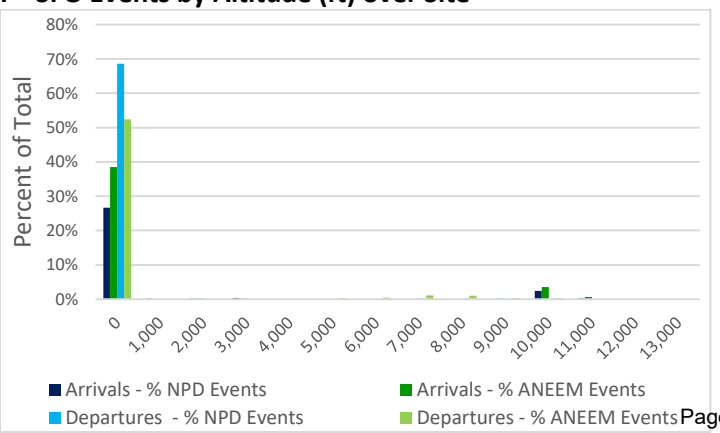
## G – Percentage of Events by Airports



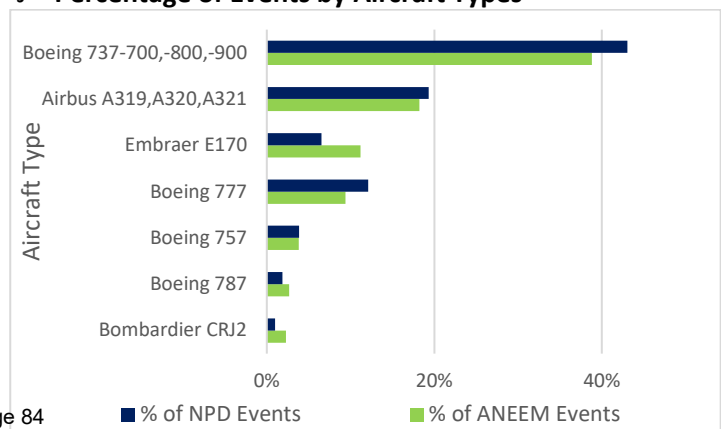

## H – SFO Noise Events by Hour of the Day



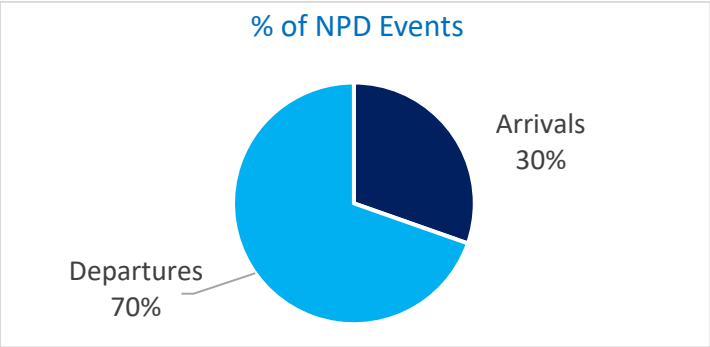

## I – SFO Events by Altitude (ft) over Site

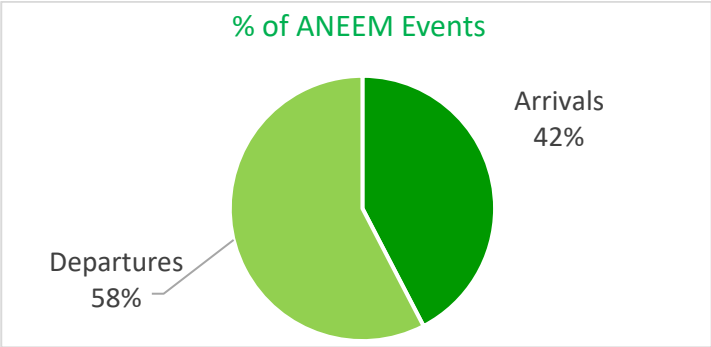



## J – Percentage of Events by Aircraft Types

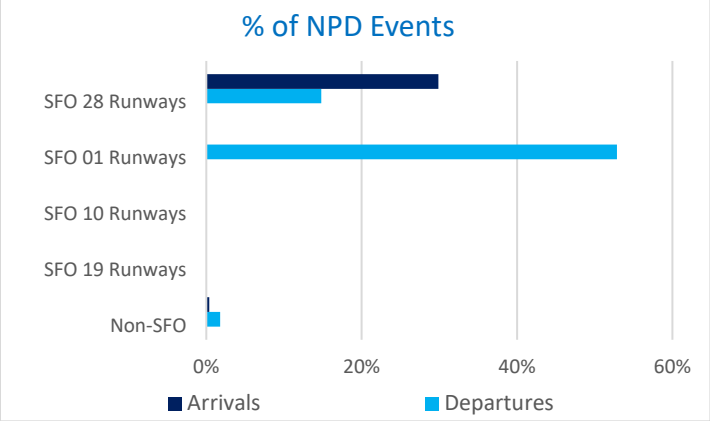


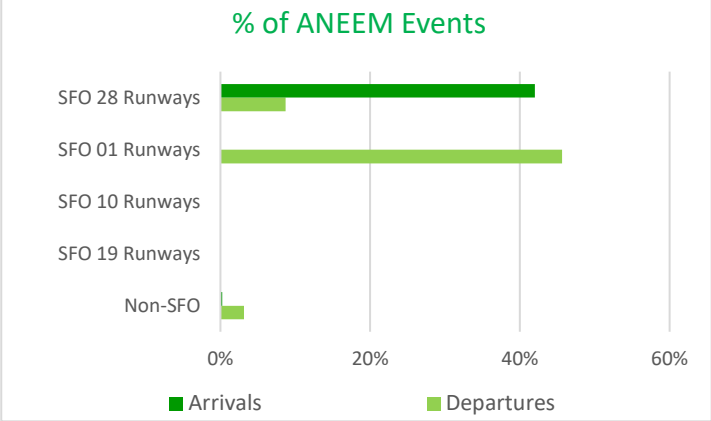
## K – Percentage of Aircraft Events by Operation Type




## L – Percentage of Aircraft Events by Runway and Operation Type

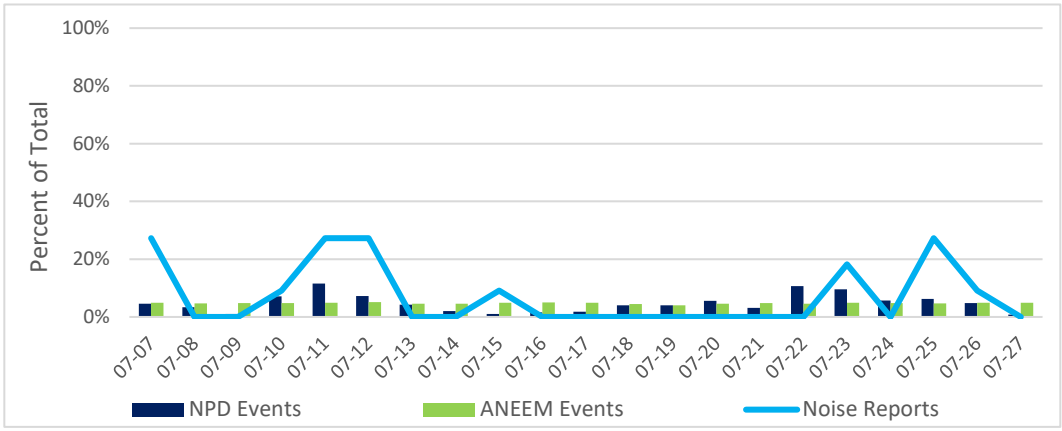


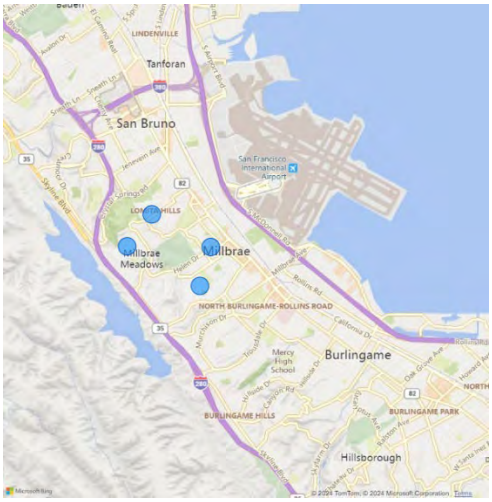

## M – Noise Reporters

| Date | Individual Noise Reporters | Noise Reports |
|---|---|---|
| 07-07 | 1 | 3 |
| 07-08 | 0 | 0 |
| 07-09 | 0 | 0 |
| 07-10 | 1 | 1 |
| 07-11 | 1 | 3 |
| 07-12 | 2 | 3 |
| 07-13 | 0 | 0 |
| 07-14 | 0 | 0 |
| 07-15 | 1 | 1 |
| 07-16 | 0 | 0 |
| 07-17 | 0 | 0 |
| 07-18 | 0 | 0 |
| 07-19 | 0 | 0 |
| 07-20 | 0 | 0 |
| 07-21 | 0 | 0 |
| 07-22 | 0 | 0 |
| 07-23 | 2 | 2 |
| 07-24 | 0 | 0 |
| 07-25 | 1 | 3 |
| 07-26 | 1 | 1 |
| 07-27 | 0 | 0 |
| Total | 4 | 11 |

## N – Noise Reports vs Aircraft Noise Events per Day




## O – Noise Reporter Locations




## P – Noise Monitor on Location

## Appendix

*This Appendix describes the sections of the noise monitoring report and a glossary of terms.*

**Part A – Monitoring Summary** lists the monitoring location, elevation, the monitoring time period, and the key monitoring results including the ANEEM Aircraft, NPD Aircraft, and NPD Community Community Noise Equivalent level (CNEL), single event levels in both A and C noise weightings, and air traffic flow breakdown. The CNEL metric is used to assess and regulate aircraft noise exposure in communities surrounding the airport. California Title 21 Noise Regulations established an acceptable level of 65 dBA CNEL.

**Part B – Monitoring Location** illustrates the location of the portable noise monitor and examples of typical SFO flight operations that registered noise events at the portable noise monitor.

**Part C – Daily Noise Event Averages** lists the number of noise events registered at the noise monitor by SFO Aircraft for both A and C noise weightings using ANEEM (green) or NPD (blue) methods during each day of the noise monitoring period. NPD Community noise events by A-weighted noise levels are also included. The noise event levels are expressed as average Sound Exposure Level (SEL) and average peak noise level (Lmax).

**Part D – Community Noise Equivalent Level** shows a chart that compares the ANEEM Aircraft (SFO and non-SFO), NPD Aircraft, and NPD Community CNEL during each day of the monitoring period.

**Part E – Average Sound Exposure Level** (SEL) shows 2 charts comparing the ANEEM Aircraft (SFO and non-SFO) and NPD Aircraft average SEL for A and C-weighted noise levels during each day of the monitoring period.

**Part F – SFO Aircraft Noise Events by Time of Day** lists 2 tables including the daily minimum, maximum, and average SEL, Lmax, duration and number of SFO Aircraft noise events using ANEEM during the Daytime (7am to 7pm), Evening (7pm to 10pm), and Nighttime (10pm to 7am) for both A and C-weighted noise levels during the monitoring period.

**Part G – Percentage of Events by Airports** shows the percentage of aircraft events using ANEEM and NPD by the aircraft's nearest airport of origin or destination. The percentages for both methods each add up to 100%.

**Part H – SFO Noise Event by Hour of the Day** shows the percentage of total SFO Aircraft noise events using ANEEM and NPD by hour of the day. The percentages for both methods each add up to 100%.

**Part I – SFO Departure Events by Altitude (ft) over Site** shows the percentage of SFO Aircraft Departures and Arrivals that registered noise events at the noise monitor using ANEEM and NPD by altitude intervals. Altitudes are relative to mean sea level elevation. Excludes helicopters. The percentages for both methods each add up to 100%.

**Part J – Percentage of Events by Aircraft Types** shows the percentage of aircraft events using ANEEM and NPD by aircraft types. The percentages for both methods each add up to 100%.

**Part K – Percentage of Events by Operation Type** shows the percentage of aircraft noise events registered using ANEEM and NPD by Arrivals and Departures.

**Part L – Percentage of Aircraft Events by Runway and Operation Type** compares the percentage of aircraft noise events registered using ANEEM and NPD by Arrivals and Departures per each SFO runway pair and to non-SFO overflights.

**Part M – Noise Reporters** lists the number of individual noise reporters and noise reports per day registered by individuals living in Millbrae or Burlingame.

**Part N – Noise Reports vs Aircraft Noise Events per Day** compares the number of noise reports to the number of aircraft noise events per day using ANEEM and NPD. The percentages for both methods each add up to 100%.

**Part O – Noise Report Locations** illustrates a map that shows the noise report locations.

**Part P – Noise Monitor on Location** shows photographs of the noise monitoring equipment on location.

## Glossary

**A-Weighted Noise Level** – Denoted in dBA, is the most common unit used for measuring environmental sound levels. The human ear does not respond equally to different frequencies of sound. An A-weight adjusts the frequency components of sound to conform to your ear's normal response at conversational levels. The FAA and State of the California have adopted the A-weighted sound level for environmental analysis. Sound level meters have an A-weighting network for measuring noise in A-weighted decibels.

**C-Weighted Noise Level** – Denoted in dBC, is a different scale for loudness perception of sound pressure levels than A-weighted noise. A C-weight scale is used to measure sounds with approximately equal sensitivity at all frequencies. The C-weighted scale accounts for low-frequency ranges of sounds more than an A-weighted scale, often resulting in more of the overall noise energy to be included in the measurement.

**California Code of Regulations Title 21, Subchapter 6** – This code describes noise standards by defining metrics terminology and requirements regarding compatible land use. SFO was one of the first airports in the state to achieve a zero impact area within the 65 dB CNEL (Community Noise Equivalent Level) noise contour.

**Community Noise Equivalent Level (CNEL)** – A noise metric required by the California Airport Noise Standards for use by airport proprietors to measure aircraft noise levels. CNEL includes an additional weighting for each event occurring during the evening (7:00 p.m. – 9:59 p.m.) and nighttime (10:00 p.m. – 6:59 a.m.) periods to account for increased sensitivity to noise during these periods. Evening events are treated as though there were three and nighttime events are treated as though there were ten. This results in a 4.77 and 10 dBA penalty for operations occurring in the evening and nighttime periods, respectively. For a more in-depth explanation of CNEL and other technical noise terms, please visit the Federal Aviation Administration (FAA) website. Below is a graphic illustrating types of metropolitan areas and their corresponding CNEL intervals (dBA).


**Decibel (dB)** – A unit used to measure the magnitude or intensity of sound. The decibel uses a logarithmic scale to cover the very large range of sound pressures that can be heard by the human ear. Decibels measure a scale from the threshold of human hearing, 0 dB, upward towards the threshold of pain, about 120-140 dB. Because decibels are such a small measure, they are computed logarithmically and cannot be added arithmetically. A10 dB increase will be perceived by most people to be a doubling in loudness, i.e., 80 dB seems twice as loud as 70 dB. Decibel measurements can be scaled by different frequency ranges, such as by A-Weighted (dBA) and C-Weighted (dBC) scales.

**Maximum Sound Level (Lmax)** – The maximum a-weighted sound level for a given noise event. The peak noise level reached by a single aircraft event.

**Noise Event** – A Noise Event is the measured sound produced by a single source of noise over a duration of time. An aircraft noise event begins when the sound level of a flight operation exceeds a noise threshold and ends when the level drops down below that threshold.

**Sound Exposure Level (SEL)** – SEL is a measure of a single aircraft noise event spread out over its entirety compressed into one second. It allows for a comparison of aircraft noise events of different durations and noise levels. For example, think of the moment you hear a plane from a quarter mile away; we measure from that moment, as the aircraft flies overhead, and until it can't be heard. This is the duration of sound we use and then compress it into one second for a measure. SEL measures noise energy above the threshold (normally 65 dBA for aircraft noise events). This way, any ambient noise is separated out from the measurement.

SAN FRANCISCO INTERNATIONAL AIRPORT
CITY & COUNTY OF SAN FRANCISCO

# MEMORANDUM

TO: Millbrae Community

FROM: SAN FRANCISCO INTERNATIONAL AIRPORT AIRCRAFT NOISE OFFICE

SUBJECT: SFO Roundtable *Up-The-Hill* Noise Monitoring Study – July 2024
*One-Time Monitoring Location 4: SF Public Utilities Commission*

DATE: November 5, 2024

The San Francisco International Airport (SFO) Aircraft Noise Office conducted aircraft noise monitoring in Millbrae and Burlingame to determine the noise levels within the community from aircraft operations at SFO. This noise monitoring was conducted as part of a SFO Airport/Community Roundtable "Up-the-Hill" noise study researching the effects of takeoff and landing noise on communities situated next to the airport. This monitoring lasted for 21 days, occurring between July 7 and July 27, 2024, across 5 one-time monitoring locations and 9 permanent monitoring locations.

Millbrae and Burlingame are situated directly adjacent SFO, with Millbrae sitting to the southwest and Burlingame to the south. Much of the aircraft noise that reaches Millbrae and Burlingame is caused by takeoff and landing noise rather than by direct overflights. Aircraft operations on the airfield, takeoffs and landings, generate noise that travels across the landscape, and it is expected that weather and topography may amplify this noise to nearby communities.

SFO uses both Aircraft Noise Event Extraction Methodology (ANEEM) and Noise Power Distance (NPD) event classification methods and both A-weighted (dBA) and C-weighted (dBC) noise levels to generate this report. ANEEM is newer technology that looks at aircraft in the surrounding area to determine if any spikes in noise based on a floating threshold level may logically be correlated to them. Historically, ANEEM's correlation logic used AEDT modeled noise to classify if the increase in noise was logically generated by an aircraft, but this had to be modified to also look at thrust and timing to effectively correlate noise spikes to aircraft landing and taking off on or very close to ground level. NPD uses static noise thresholds to determine if spikes in noise qualify as noise events, then looks to see if there are any aircraft in the surrounding area that could be the cause of the noise. The noise monitor NPD thresholds for the total monitoring period were 55 dBA for daytime and 50 dBA for nighttime. Both ANEEM and NPD first generated events based on A-weighted noise levels, then used the time window of the A-weighted noise events to identify the C-weighted noise events.

During this study, there were approximately 750 noise events per day caused by SFO airfield operations using the ANEEM method. Approximately 94% of all aircraft noise events were from SFO aircraft. Aircraft noise events sources include primarily takeoffs from SFO's north-facing runways, Runways 01L and 01R, and from landing aircraft using reverse thrust to assist with slowing down after touching-down on SFO's west-facing runways, Runways 28L and 28R. Other airfield operations which could be heard at the monitor included take-offs from SFO's West-facing runways, Runways 28L and 28R. In addition to noise from airfield operations, there were also noise from aircraft overflights, majority of which were departing aircraft from OAK headed south/southeast utilizing the CNDEL departure procedure. Approximately 5% of all aircraft noise events were from OAK aircraft.

During the monitoring period, the overall Aircraft Community Noise Equivalent Level (CNEL) using ANEEM was 57 dBA and the Aircraft CNEL and Community CNEL using NPD were 58 dBA and 48 dBA, respectively. This noise monitor was located in a suburban area with daily ambient noise ranging between 33 and 46 dBA. Aircraft noise above ambient levels may have been perceptible by residents. Additionally, the frequency of flights due to the proximity of the Airport may have increased annoyance levels.

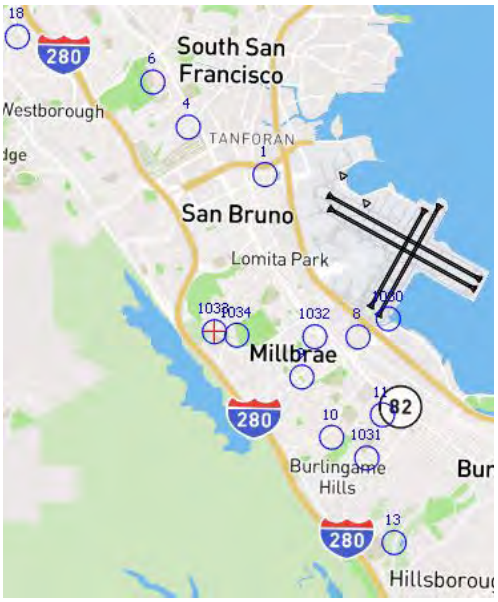
During the monitoring period, the SFO Aircraft Noise Office received 11 noise reports from 4 Burlingame and Millbrae residents. Most of the noise reports were generated between the hours of 5AM and 12AM. Likewise, most of the SFO Aircraft noise events using ANEEM occurred between 8AM and 12AM.

This report includes one evaluation of a 21-day period including 16 parts (charts and graphics) that represent summaries of the aircraft noise-related data (values are subject to rounding) collected during the monitoring period. Each part and key terms used in this report are described in the Appendix and Glossary, respectively.

## A – Monitoring Summary

| | |
|---|---|
| **Monitoring Site** | SF Public Utilities Commission |
| **Monitoring Site Elevation (ft)** | 466 |
| **Monitoring Period** | July 7 – July 27, 2024 |
| **Average Ambient Noise (dBA)** | 41 |
| **NPD Community (non-aircraft) CNEL (dBA)** | 48 |
| **NPD Aircraft CNEL (dBA)** | 58 |
| **NPD Avg Daily SFO Noise Events** | 346 |
| **ANEEM Aircraft CNEL (dBA)** | 57 |
| **ANEEM Avg Aircraft SEL (dBA)** | 72 |
| **ANEEM Avg Aircraft SEL (dBC)** | 87 |
| **ANEEM Avg Aircraft Lmax (dBA)** | 57 |
| **ANEEM Avg Aircraft Lmax (dBC)** | 72 |
| **ANEEM Avg Daily SFO Noise Events** | 718 |
| **SFO West Flow** | 100% |
| **SFO Southeast Flow** | 0% |

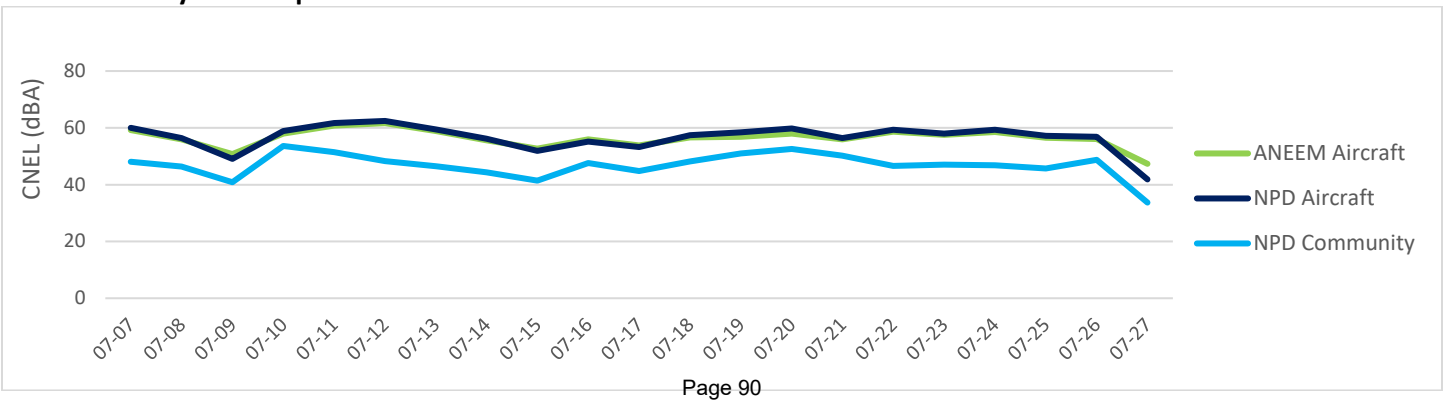
## B – Monitoring Location



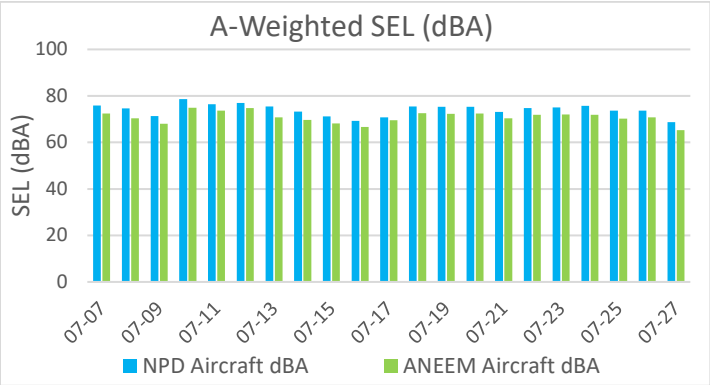

## C – Daily Noise Event Averages

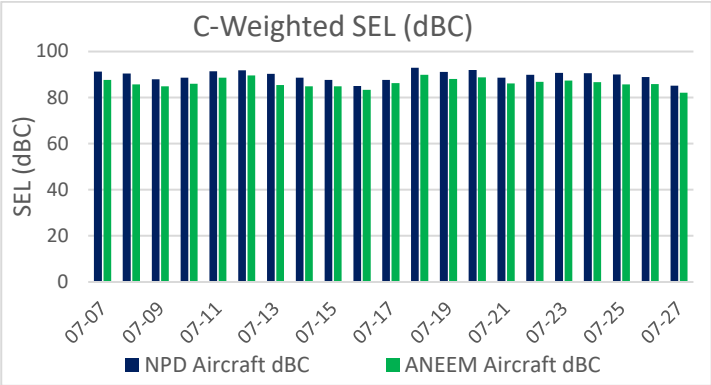
| Day | SFO Aircraft A-Weighted Noise | | | | | | SFO Aircraft C-Weighted Noise | | | | | | Community A-Weighted Noise | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | NPD | | | ANEEM | | | NPD | | | ANEEM | | | NPD | | |
| | Noise Events | Avg SEL | Avg Lmax | Noise Events | Avg SEL | Avg Lmax | Noise Events | Avg SEL | Avg Lmax | Noise Events | Avg SEL | Avg Lmax | Noise Events | Avg SEL | Avg Lmax |
| **07-07** | 389 | 76 | 63 | 795 | 73 | 57 | 389 | 91 | 76 | 795 | 88 | 72 | 91 | 69 | 57 |
| **07-08** | 270 | 75 | 61 | 752 | 71 | 56 | 270 | 90 | 76 | 752 | 86 | 70 | 91 | 68 | 57 |
| **07-09** | 229 | 71 | 59 | 713 | 68 | 54 | 229 | 88 | 76 | 713 | 85 | 71 | 48 | 69 | 58 |
| **07-10** | 445 | 79 | 62 | 826 | 75 | 59 | 445 | 89 | 75 | 826 | 86 | 72 | 112 | 82 | 58 |
| **07-11** | 481 | 76 | 63 | 818 | 74 | 59 | 481 | 91 | 77 | 818 | 89 | 73 | 142 | 70 | 56 |
| **07-12** | 549 | 77 | 64 | 815 | 75 | 61 | 549 | 92 | 77 | 815 | 90 | 74 | 107 | 69 | 56 |
| **07-13** | 252 | 76 | 63 | 777 | 71 | 56 | 252 | 90 | 76 | 777 | 86 | 69 | 78 | 68 | 56 |
| **07-14** | 315 | 73 | 61 | 797 | 70 | 56 | 315 | 89 | 75 | 797 | 85 | 71 | 99 | 67 | 57 |
| **07-15** | 255 | 71 | 59 | 796 | 68 | 55 | 255 | 88 | 75 | 796 | 85 | 71 | 62 | 67 | 57 |
| **07-16** | 14 | 69 | 58 | 30 | 67 | 52 | 14 | 85 | 74 | 30 | 83 | 69 | 5 | 66 | 56 |
| **07-17** | 261 | 71 | 59 | 446 | 70 | 57 | 261 | 88 | 76 | 446 | 86 | 74 | 82 | 67 | 57 |
| **07-18** | 507 | 75 | 62 | 798 | 73 | 59 | 507 | 93 | 78 | 798 | 90 | 74 | 128 | 73 | 59 |
| **07-19** | 451 | 75 | 61 | 661 | 72 | 58 | 451 | 91 | 78 | 661 | 88 | 74 | 247 | 71 | 57 |
| **07-20** | 547 | 75 | 61 | 736 | 73 | 59 | 547 | 92 | 79 | 736 | 89 | 76 | 202 | 72 | 58 |
| **07-21** | 368 | 73 | 60 | 767 | 70 | 56 | 368 | 89 | 75 | 767 | 86 | 73 | 192 | 68 | 56 |
| **07-22** | 400 | 75 | 62 | 786 | 72 | 58 | 400 | 90 | 76 | 786 | 87 | 72 | 88 | 68 | 55 |
| **07-23** | 389 | 75 | 62 | 787 | 72 | 58 | 389 | 91 | 76 | 787 | 88 | 71 | 104 | 68 | 55 |
| **07-24** | 363 | 76 | 62 | 817 | 72 | 57 | 363 | 91 | 75 | 817 | 87 | 70 | 73 | 69 | 55 |
| **07-25** | 341 | 74 | 61 | 801 | 70 | 57 | 341 | 90 | 76 | 801 | 86 | 71 | 78 | 69 | 56 |
| **07-26** | 382 | 74 | 61 | 762 | 71 | 56 | 382 | 89 | 75 | 762 | 86 | 71 | 136 | 68 | 56 |
| **07-27** | 55 | 69 | 58 | 605 | 65 | 51 | 55 | 85 | 74 | 605 | 82 | 69 | 15 | 66 | 56 |
| **Daily Average** | **346** | **75** | **61** | **718** | **72** | **57** | **346** | **91** | **76** | **718** | **87** | **72** | **104** | **72** | **57** |
| **Total Count** | **7,263** | | | **15,085** | | | **7,263** | | | **15,085** | | | **2,180** | | |

## D – Community Noise Equivalent Level



## E – Average Sound Exposure Level



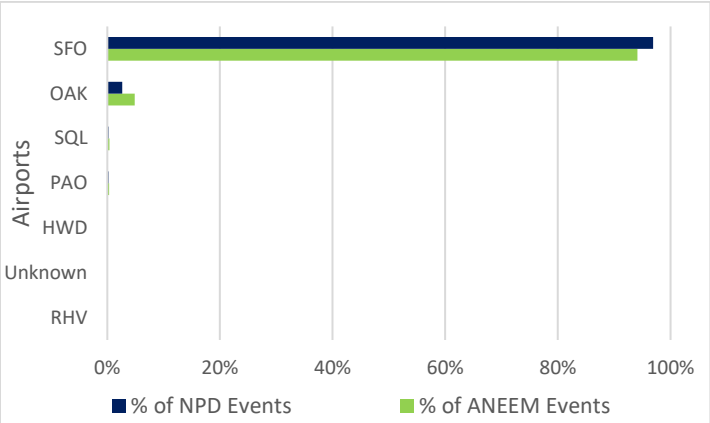




## F – SFO ANEEM Aircraft Noise Events by Time of Day

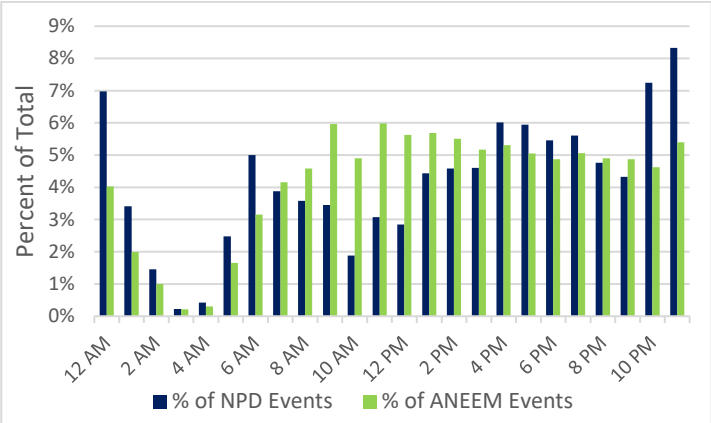
| SFO Aircraft ANEEM A-Weighted Events | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Time of Day | Noise Events | Noise Events % | Daily Avg SEL (dBA) | Min SEL (dBA) | Max SEL (dBA) | Avg Lmax (dBA) | Min Lmax (dBA) | Max Lmax (dBA) | Avg Duration (sec) | Min Duration (sec) | Max Duration (sec) |
| Day (7am–7pm) | 9475 | 63% | 71 | 48 | 97 | 57 | 40 | 86 | 26 | 5 | 72 |
| Evening (7pm-10pm) | 2238 | 15% | 71 | 52 | 85 | 57 | 43 | 76 | 26 | 5 | 71 |
| Night (10pm-7am) | 3372 | 22% | 73 | 43 | 88 | 58 | 37 | 79 | 29 | 5 | 71 |

| SFO Aircraft ANEEM C-Weighted Events | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Time of Day | Noise Events | Noise Events % | Daily Avg SEL (dBC) | Min SEL (dBC) | Max SEL (dBC) | Avg Lmax (dBC) | Min Lmax (dBC) | Max Lmax (dBC) | Avg Duration (sec) | Min Duration (sec) | Max Duration (sec) |
| Day (7am–7pm) | 9475 | 63% | 87 | 61 | 107 | 72 | 54 | 100 | 26 | 5 | 72 |
| Evening (7pm-10pm) | 2238 | 15% | 87 | 61 | 104 | 72 | 53 | 100 | 26 | 5 | 71 |
| Night (10pm-7am) | 3372 | 22% | 88 | 58 | 105 | 72 | 51 | 97 | 29 | 5 | 71 |

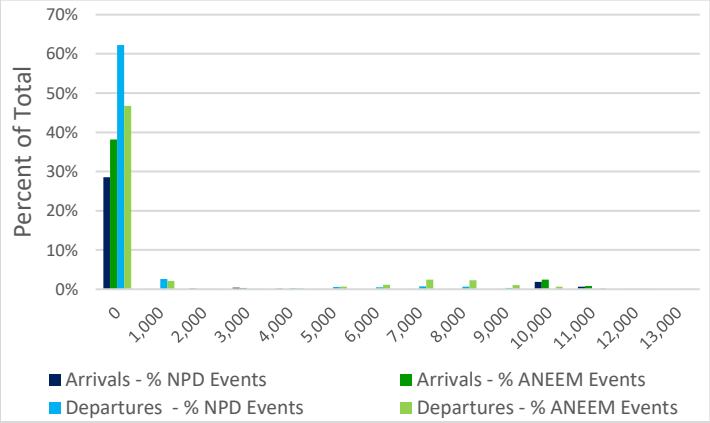
## G – Percentage of Events by Airports



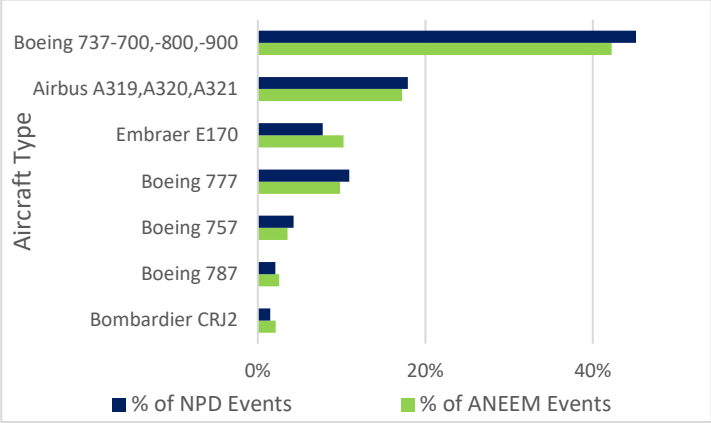

## H – SFO Noise Events by Hour of the Day



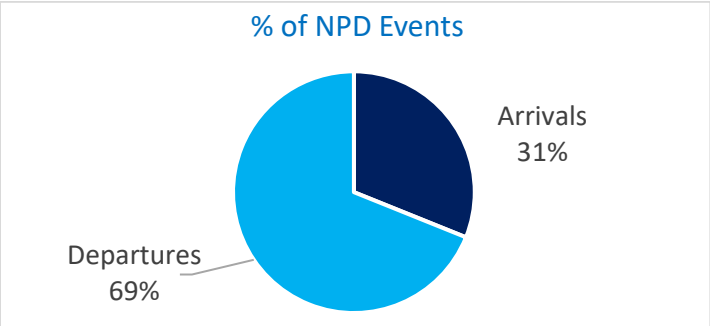

## I – SFO Events by Altitude (ft) over Site

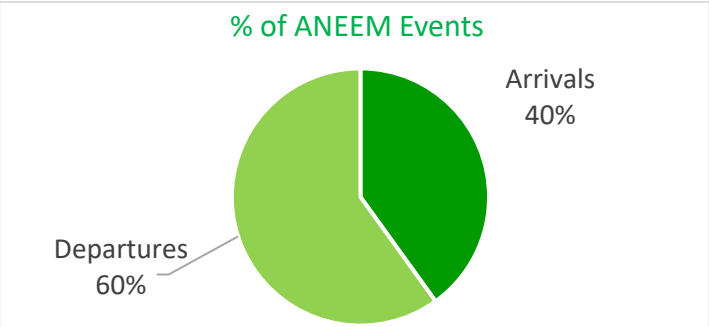



## J – Percentage of Events by Aircraft Types

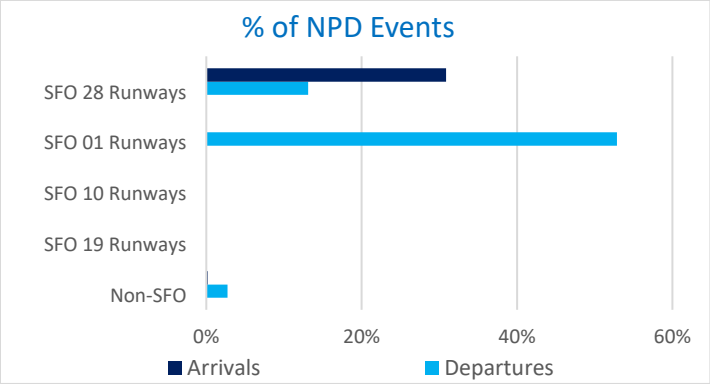


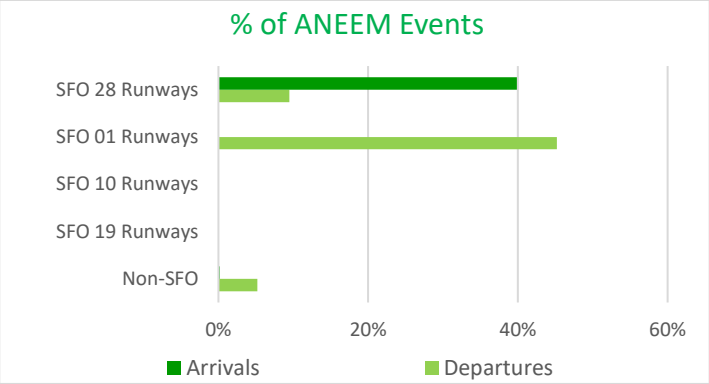
## K – Percentage of Aircraft Events by Operation Type




## L – Percentage of Aircraft Events by Runway and Operation Type

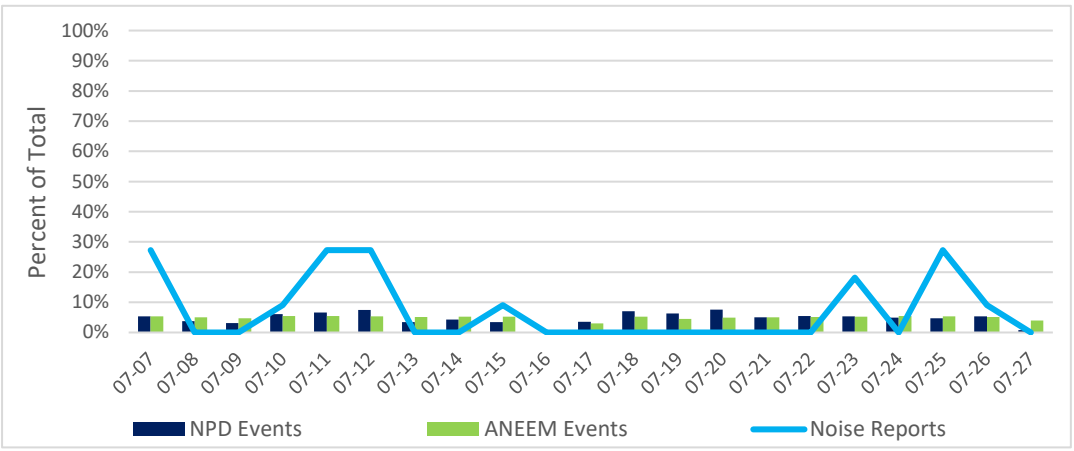


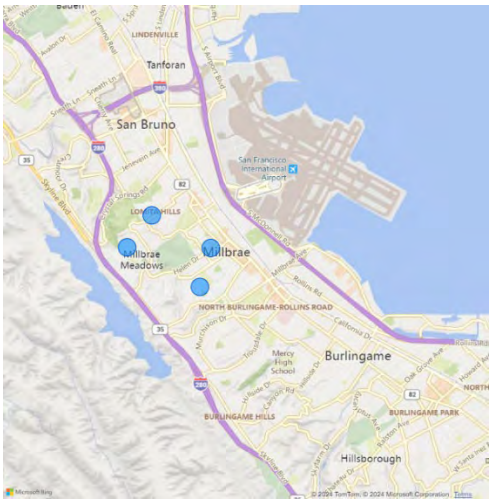

## M – Noise Reporters

| Date | Individual Noise Reporters | Noise Reports |
|---|---|---|
| 07-07 | 1 | 3 |
| 07-08 | 0 | 0 |
| 07-09 | 0 | 0 |
| 07-10 | 1 | 1 |
| 07-11 | 1 | 3 |
| 07-12 | 2 | 3 |
| 07-13 | 0 | 0 |
| 07-14 | 0 | 0 |
| 07-15 | 1 | 1 |
| 07-16 | 0 | 0 |
| 07-17 | 0 | 0 |
| 07-18 | 0 | 0 |
| 07-19 | 0 | 0 |
| 07-20 | 0 | 0 |
| 07-21 | 0 | 0 |
| 07-22 | 0 | 0 |
| 07-23 | 2 | 2 |
| 07-24 | 0 | 0 |
| 07-25 | 1 | 3 |
| 07-26 | 1 | 1 |
| 07-27 | 0 | 0 |
| **Total** | **4** | **11** |

## N – Noise Reports vs Aircraft Noise Events per Day




## O – Noise Reporter Locations




## P – Noise Monitor on Location

## Appendix

*This Appendix describes the sections of the noise monitoring report and a glossary of terms.*

**Part A – Monitoring Summary** lists the monitoring location, elevation, the monitoring time period, and the key monitoring results including the ANEEM Aircraft, NPD Aircraft, and NPD Community Community Noise Equivalent level (CNEL), single event levels in both A and C noise weightings, and air traffic flow breakdown. The CNEL metric is used to assess and regulate aircraft noise exposure in communities surrounding the airport. California Title 21 Noise Regulations established an acceptable level of 65 dBA CNEL.

**Part B – Monitoring Location** illustrates the location of the portable noise monitor and examples of typical SFO flight operations that registered noise events at the portable noise monitor.

**Part C – Daily Noise Event Averages** lists the number of noise events registered at the noise monitor by SFO Aircraft for both A and C noise weightings using ANEEM (green) or NPD (blue) methods during each day of the noise monitoring period. NPD Community noise events by A-weighted noise levels are also included. The noise event levels are expressed as average Sound Exposure Level (SEL) and average peak noise level (Lmax).

**Part D – Community Noise Equivalent Level** shows a chart that compares the ANEEM Aircraft (SFO and non-SFO), NPD Aircraft, and NPD Community CNEL during each day of the monitoring period.

**Part E – Average Sound Exposure Level** (SEL) shows 2 charts comparing the ANEEM Aircraft (SFO and non-SFO) and NPD Aircraft average SEL for A and C-weighted noise levels during each day of the monitoring period.

**Part F – SFO Aircraft Noise Events by Time of Day** lists 2 tables including the daily minimum, maximum, and average SEL, Lmax, duration and number of SFO Aircraft noise events using ANEEM during the Daytime (7am to 7pm), Evening (7pm to 10pm), and Nighttime (10pm to 7am) for both A and C-weighted noise levels during the monitoring period.

**Part G – Percentage of Events by Airports** shows the percentage of aircraft events using ANEEM and NPD by the aircraft's nearest airport of origin or destination. The percentages for both methods each add up to 100%.

**Part H – SFO Noise Event by Hour of the Day** shows the percentage of total SFO Aircraft noise events using ANEEM and NPD by hour of the day. The percentages for both methods each add up to 100%.

**Part I – SFO Departure Events by Altitude (ft) over Site** shows the percentage of SFO Aircraft Departures and Arrivals that registered noise events at the noise monitor using ANEEM and NPD by altitude intervals. Altitudes are relative to mean sea level elevation. Excludes helicopters. The percentages for both methods each add up to 100%.

**Part J – Percentage of Events by Aircraft Types** shows the percentage of aircraft events using ANEEM and NPD by aircraft types. The percentages for both methods each add up to 100%.

**Part K – Percentage of Events by Operation Type** shows the percentage of aircraft noise events registered using ANEEM and NPD by Arrivals and Departures.

**Part L – Percentage of Aircraft Events by Runway and Operation Type** compares the percentage of aircraft noise events registered using ANEEM and NPD by Arrivals and Departures per each SFO runway pair and to non-SFO overflights.

**Part M – Noise Reporters** lists the number of individual noise reporters and noise reports per day registered by individuals living in Millbrae or Burlingame.

**Part N – Noise Reports vs Aircraft Noise Events per Day** compares the number of noise reports to the number of aircraft noise events per day using ANEEM and NPD. The percentages for both methods each add up to 100%.

**Part O – Noise Report Locations** illustrates a map that shows the noise report locations.

**Part P – Noise Monitor on Location** shows photographs of the noise monitoring equipment on location.

## Glossary

**A-Weighted Noise Level** – Denoted in dBA, is the most common unit used for measuring environmental sound levels. The human ear does not respond equally to different frequencies of sound. An A-weight adjusts the frequency components of sound to conform to your ear's normal response at conversational levels. The FAA and State of the California have adopted the A-weighted sound level for environmental analysis. Sound level meters have an A-weighting network for measuring noise in A-weighted decibels.

**C-Weighted Noise Level** – Denoted in dBC, is a different scale for loudness perception of sound pressure levels than A-weighted noise. A C-weight scale is used to measure sounds with approximately equal sensitivity at all frequencies. The C-weighted scale accounts for low-frequency ranges of sounds more than an A-weighted scale, often resulting in more of the overall noise energy to be included in the measurement.

**California Code of Regulations Title 21, Subchapter 6** – This code describes noise standards by defining metrics terminology and requirements regarding compatible land use. SFO was one of the first airports in the state to achieve a zero impact area within the 65 dB CNEL (Community Noise Equivalent Level) noise contour.

**Community Noise Equivalent Level (CNEL)** – A noise metric required by the California Airport Noise Standards for use by airport proprietors to measure aircraft noise levels. CNEL includes an additional weighting for each event occurring during the evening (7:00 p.m. – 9:59 p.m.) and nighttime (10:00 p.m. – 6:59 a.m.) periods to account for increased sensitivity to noise during these periods. Evening events are treated as though there were three and nighttime events are treated as though there were ten. This results in a 4.77 and 10 dBA penalty for operations occurring in the evening and nighttime periods, respectively. For a more in-depth explanation of CNEL and other technical noise terms, please visit the Federal Aviation Administration (FAA) website. Below is a graphic illustrating types of metropolitan areas and their corresponding CNEL intervals (dBA).


**Decibel (dB)** – A unit used to measure the magnitude or intensity of sound. The decibel uses a logarithmic scale to cover the very large range of sound pressures that can be heard by the human ear. Decibels measure a scale from the threshold of human hearing, 0 dB, upward towards the threshold of pain, about 120-140 dB. Because decibels are such a small measure, they are computed logarithmically and cannot be added arithmetically. A10 dB increase will be perceived by most people to be a doubling in loudness, i.e., 80 dB seems twice as loud as 70 dB. Decibel measurements can be scaled by different frequency ranges, such as by A-Weighted (dBA) and C-Weighted (dBC) scales.

**Maximum Sound Level (Lmax)** – The maximum a-weighted sound level for a given noise event. The peak noise level reached by a single aircraft event.

**Noise Event** – A Noise Event is the measured sound produced by a single source of noise over a duration of time. An aircraft noise event begins when the sound level of a flight operation exceeds a noise threshold and ends when the level drops down below that threshold.

**Sound Exposure Level (SEL)** – SEL is a measure of a single aircraft noise event spread out over its entirety compressed into one second. It allows for a comparison of aircraft noise events of different durations and noise levels. For example, think of the moment you hear a plane from a quarter mile away; we measure from that moment, as the aircraft flies overhead, and until it can't be heard. This is the duration of sound we use and then compress it into one second for a measure. SEL measures noise energy above the threshold (normally 65 dBA for aircraft noise events). This way, any ambient noise is separated out from the measurement.

SAN FRANCISCO INTERNATIONAL AIRPORT
CITY & COUNTY OF SAN FRANCISCO

# MEMORANDUM

TO: Millbrae Community

FROM: SAN FRANCISCO INTERNATIONAL AIRPORT AIRCRAFT NOISE OFFICE

SUBJECT: SFO Roundtable *Up-The-Hill* Noise Monitoring Study – July 2024
*One-Time Monitoring Location 5: Ridgewood Drive*

DATE: November 5, 2024

The San Francisco International Airport (SFO) Aircraft Noise Office conducted aircraft noise monitoring in Millbrae and Burlingame to determine the noise levels within the community from aircraft operations at SFO. This noise monitoring was conducted as part of a SFO Airport/Community Roundtable "Up-the-Hill" noise study researching the effects of takeoff and landing noise on communities situated next to the airport. This monitoring lasted for 21 days, occurring between July 7 and July 27, 2024, across 5 one-time monitoring locations and 9 permanent monitoring locations.

Millbrae and Burlingame are situated directly adjacent SFO, with Millbrae sitting to the southwest and Burlingame to the south. Much of the aircraft noise that reaches Millbrae and Burlingame is caused by takeoff and landing noise rather than by direct overflights. Aircraft operations on the airfield, takeoffs and landings, generate noise that travels across the landscape, and it is expected that weather and topography may amplify this noise to nearby communities.

SFO uses both Aircraft Noise Event Extraction Methodology (ANEEM) and Noise Power Distance (NPD) event classification methods and both A-weighted (dBA) and C-weighted (dBC) noise levels to generate this report. ANEEM is newer technology that looks at aircraft in the surrounding area to determine if any spikes in noise based on a floating threshold level may logically be correlated to them. Historically, ANEEM's correlation logic used AEDT modeled noise to classify if the increase in noise was logically generated by an aircraft, but this had to be modified to also look at thrust and timing to effectively correlate noise spikes to aircraft landing and taking off on or very close to ground level. NPD uses static noise thresholds to determine if spikes in noise qualify as noise events, then looks to see if there are any aircraft in the surrounding area that could be the cause of the noise. The noise monitor NPD thresholds for the total monitoring period were 53 dBA for daytime and 48 dBA for nighttime. Both ANEEM and NPD first generated events based on A-weighted noise levels, then used the time window of the A-weighted noise events to identify the C-weighted noise events.

During this study, there were approximately 774 noise events per day caused by SFO airfield operations using the ANEEM method. Approximately 94% of all aircraft noise events were from SFO aircraft. Aircraft noise events sources include primarily takeoffs from SFO's north-facing runways, Runways 01L and 01R, and from landing aircraft using reverse thrust to assist with slowing down after touching-down on SFO's west-facing runways, Runways 28L and 28R. Other airfield operations which could be heard at the monitor included take-offs from SFO's west-facing runways, Runways 28L and 28R. In addition to noise from airfield operations, there were also noise from aircraft overflights, majority of which were departing aircraft from Oakland International Airport (OAK) headed south/southeast utilizing the CNDEL departure procedure. Approximately 5% of all aircraft noise events were from OAK aircraft.

During the monitoring period, the overall Aircraft Community Noise Equivalent Level (CNEL) using ANEEM was 58 dBA and the Aircraft CNEL and Community CNEL using NPD were 59 dBA and 48 dBA, respectively. This noise monitor was located in a quiet suburban area with daily ambient noise ranging between 31 and 42 dBA. Aircraft noise above ambient levels may have been perceptible by residents. Additionally, the frequency of flights due to the proximity of the Airport may have increased annoyance levels.

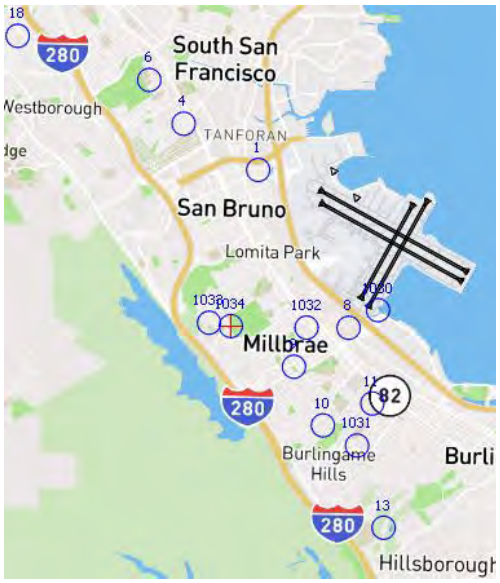
During the monitoring period, the SFO Aircraft Noise Office received 11 noise reports from 4 Millbrae residents. Most of the noise reports were generated between the hours of 5AM and 12AM. Likewise, most of the SFO Aircraft noise events using ANEEM occurred between 8AM and 12AM.

This report includes one evaluation of a 21-day period including 16 parts (charts and graphics) that represent summaries of the aircraft noise-related data (values are subject to rounding) collected during the monitoring period. Each part and key terms used in this report are described in the Appendix and Glossary, respectively.

## A – Monitoring Summary

| | |
|---|---|
| **Monitoring Site** | Ridgewood Dr |
| **Monitoring Site Elevation (ft)** | 316 |
| **Monitoring Period** | July 7 – July 27, 2024 |
| **Average Ambient Noise (dBA)** | 39 |
| **NPD Community (non-aircraft) CNEL (dBA)** | 48 |
| **NPD Aircraft CNEL (dBA)** | 59 |
| **NPD Avg Daily SFO Noise Events** | 387 |
| **ANEEM Aircraft CNEL (dBA)** | 58 |
| **ANEEM Avg Aircraft SEL (dBA)** | 71 |
| **ANEEM Avg Aircraft SEL (dBC)** | 90 |
| **ANEEM Avg Aircraft Lmax (dBA)** | 56 |
| **ANEEM Avg Aircraft Lmax (dBC)** | 73 |
| **ANEEM Avg Daily SFO Noise Events** | 742 |
| **SFO West Flow** | 100% |
| **SFO Southeast Flow** | 0% |

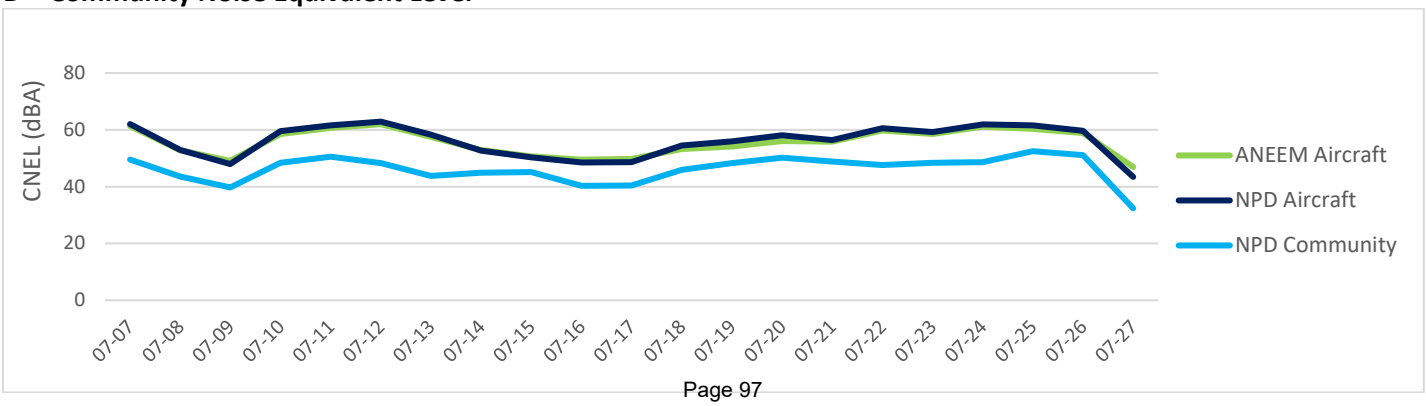
## B – Monitoring Location



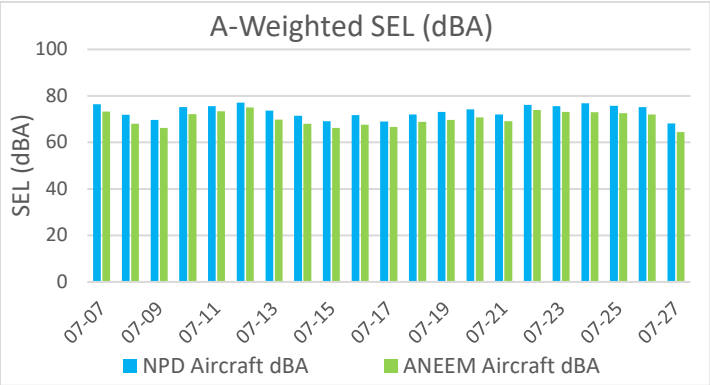

## C – Daily Noise Event Averages

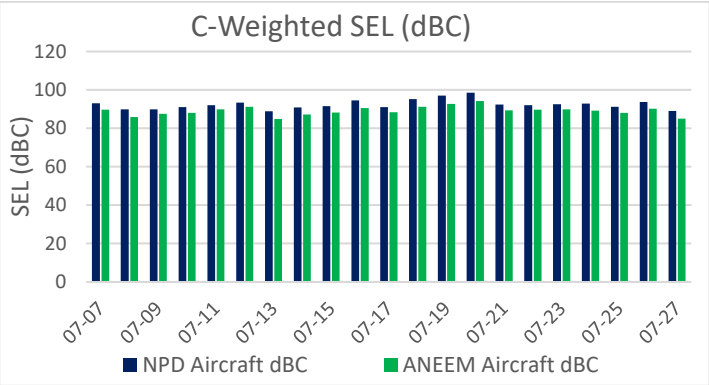
| Day | SFO Aircraft A-Weighted Noise | | | | | | SFO Aircraft C-Weighted Noise | | | | | | Community A-Weighted Noise | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | NPD | | | ANEEM | | | NPD | | | ANEEM | | | NPD | | |
| | Noise Events | Avg SEL | Avg Lmax | Noise Events | Avg SEL | Avg Lmax | Noise Events | Avg SEL | Avg Lmax | Noise Events | Avg SEL | Avg Lmax | Noise Events | Avg SEL | Avg Lmax |
| **07-07** | 418 | 77 | 62 | 798 | 73 | 56 | 418 | 93 | 77 | 798 | 90 | 72 | 120 | 69 | 55 |
| **07-08** | 282 | 72 | 58 | 733 | 68 | 54 | 282 | 90 | 75 | 733 | 86 | 70 | 91 | 66 | 55 |
| **07-09** | 232 | 70 | 57 | 670 | 66 | 53 | 232 | 90 | 77 | 670 | 88 | 74 | 69 | 68 | 56 |
| **07-10** | 449 | 75 | 61 | 792 | 72 | 57 | 449 | 91 | 76 | 792 | 88 | 72 | 128 | 70 | 57 |
| **07-11** | 570 | 76 | 62 | 813 | 74 | 59 | 570 | 92 | 76 | 813 | 90 | 74 | 164 | 69 | 55 |
| **07-12** | 606 | 77 | 63 | 816 | 75 | 60 | 606 | 93 | 77 | 816 | 91 | 75 | 162 | 68 | 55 |
| **07-13** | 318 | 74 | 60 | 759 | 70 | 55 | 318 | 89 | 74 | 759 | 85 | 70 | 84 | 65 | 54 |
| **07-14** | 308 | 72 | 59 | 778 | 68 | 54 | 308 | 91 | 76 | 778 | 87 | 72 | 122 | 66 | 55 |
| **07-15** | 260 | 69 | 57 | 722 | 66 | 53 | 260 | 92 | 78 | 722 | 88 | 74 | 85 | 68 | 56 |
| **07-16** | 255 | 72 | 57 | 682 | 68 | 53 | 255 | 95 | 81 | 682 | 91 | 75 | 121 | 67 | 55 |
| **07-17** | 298 | 69 | 57 | 726 | 66 | 53 | 298 | 91 | 77 | 726 | 88 | 73 | 95 | 65 | 55 |
| **07-18** | 482 | 72 | 59 | 770 | 69 | 56 | 482 | 95 | 78 | 770 | 91 | 74 | 161 | 68 | 55 |
| **07-19** | 440 | 73 | 59 | 649 | 70 | 57 | 440 | 97 | 82 | 649 | 93 | 77 | 191 | 69 | 55 |
| **07-20** | 532 | 74 | 60 | 717 | 71 | 58 | 532 | 99 | 83 | 717 | 94 | 79 | 197 | 71 | 57 |
| **07-21** | 337 | 72 | 58 | 688 | 69 | 55 | 337 | 93 | 77 | 688 | 89 | 74 | 207 | 66 | 55 |
| **07-22** | 516 | 76 | 62 | 745 | 74 | 59 | 516 | 92 | 76 | 745 | 90 | 73 | 184 | 68 | 55 |
| **07-23** | 486 | 76 | 61 | 779 | 73 | 58 | 486 | 93 | 76 | 779 | 90 | 72 | 166 | 67 | 54 |
| **07-24** | 383 | 77 | 62 | 813 | 73 | 56 | 383 | 93 | 76 | 813 | 89 | 71 | 127 | 68 | 53 |
| **07-25** | 423 | 76 | 61 | 758 | 73 | 57 | 423 | 91 | 76 | 758 | 88 | 72 | 100 | 72 | 55 |
| **07-26** | 448 | 75 | 60 | 755 | 72 | 56 | 448 | 94 | 78 | 755 | 90 | 75 | 177 | 70 | 55 |
| **07-27** | 90 | 68 | 57 | 625 | 64 | 51 | 90 | 89 | 75 | 625 | 85 | 70 | 16 | 67 | 56 |
| **Daily Average** | **387** | **75** | **60** | **742** | **71** | **56** | **387** | **94** | **77** | **742** | **90** | **73** | **132** | **69** | **55** |
| **Total Count** | **8,133** | | | **15,588** | | | **8,133** | | | **15,588** | | | **2,767** | | |

## D – Community Noise Equivalent Level



## E – Average Sound Exposure Level



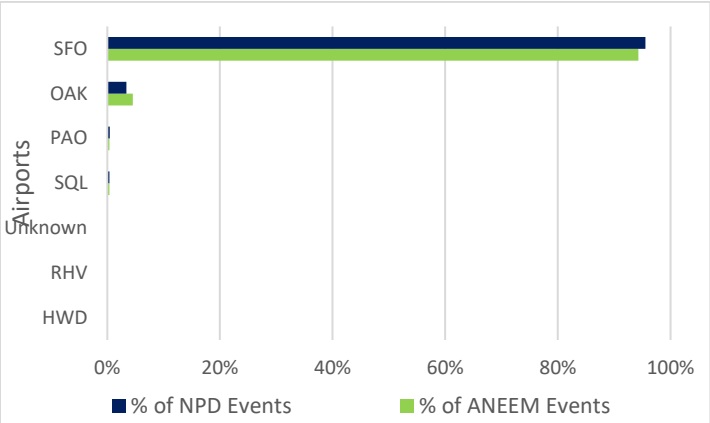




## F – SFO ANEEM Aircraft Noise Events by Time of Day

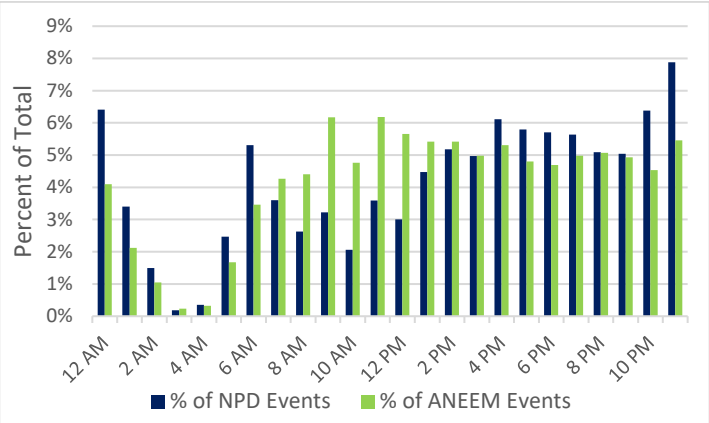
| SFO Aircraft ANEEM A-Weighted Events | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Time of Day | Noise Events | Noise Events % | Daily Avg SEL (dBA) | Min SEL (dBA) | Max SEL (dBA) | Avg Lmax (dBA) | Min Lmax (dBA) | Max Lmax (dBA) | Avg Duration (sec) | Min Duration (sec) | Max Duration (sec) |
| Day (7am–7pm) | 9676 | 62% | 70 | 49 | 88 | 55 | 42 | 82 | 25 | 5 | 71 |
| Evening (7pm-10pm) | 2336 | 15% | 72 | 51 | 89 | 57 | 44 | 80 | 24 | 5 | 72 |
| Night (10pm-7am) | 3576 | 23% | 74 | 44 | 88 | 57 | 36 | 80 | 29 | 5 | 72 |

| SFO Aircraft ANEEM C-Weighted Events | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Time of Day | Noise Events | Noise Events % | Daily Avg SEL (dBC) | Min SEL (dBC) | Max SEL (dBC) | Avg Lmax (dBC) | Min Lmax (dBC) | Max Lmax (dBC) | Avg Duration (sec) | Min Duration (sec) | Max Duration (sec) |
| Day (7am–7pm) | 9676 | 62% | 89 | 62 | 107 | 73 | 53 | 98 | 25 | 5 | 71 |
| Evening (7pm-10pm) | 2336 | 15% | 91 | 60 | 110 | 74 | 53 | 98 | 24 | 5 | 72 |
| Night (10pm-7am) | 3576 | 23% | 91 | 57 | 107 | 73 | 47 | 98 | 29 | 5 | 72 |

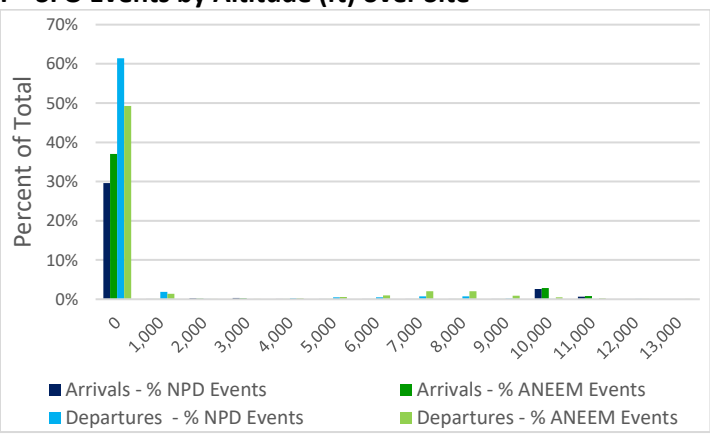
## G – Percentage of Events by Airports



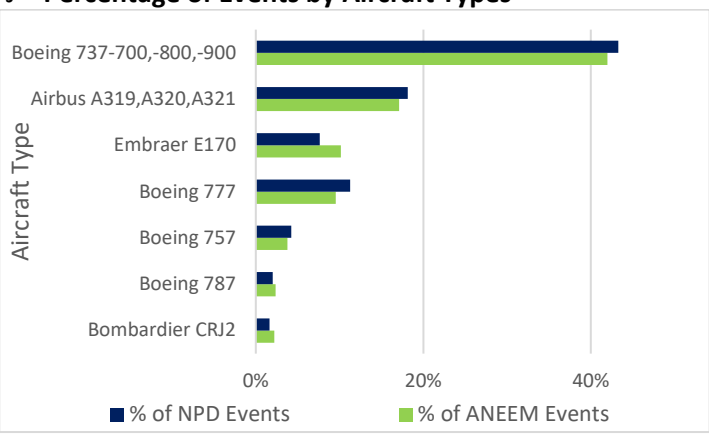

## H – SFO Noise Events by Hour of the Day



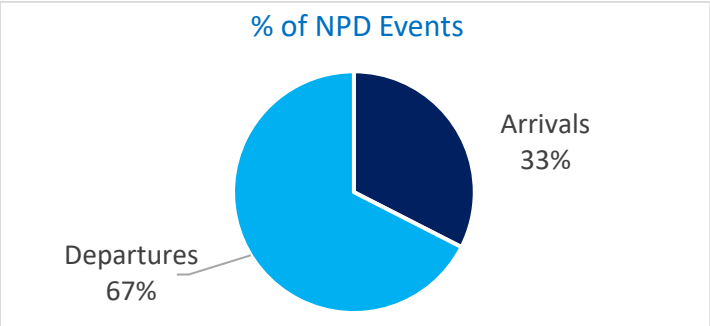

## I – SFO Events by Altitude (ft) over Site

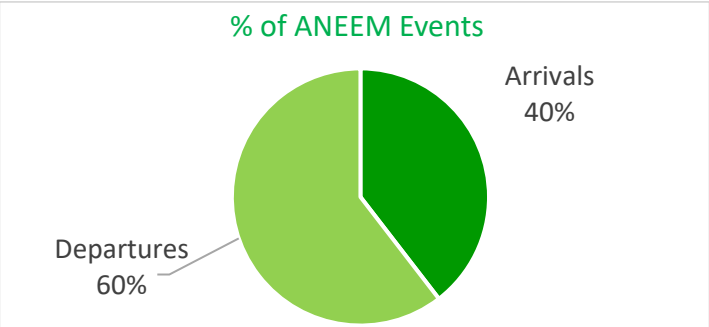



## J – Percentage of Events by Aircraft Types

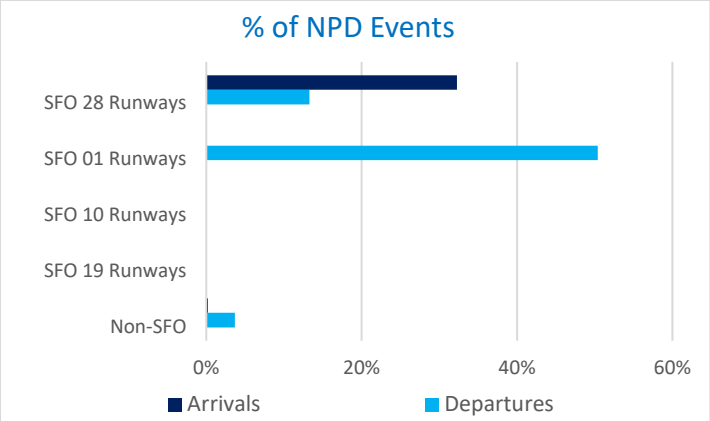


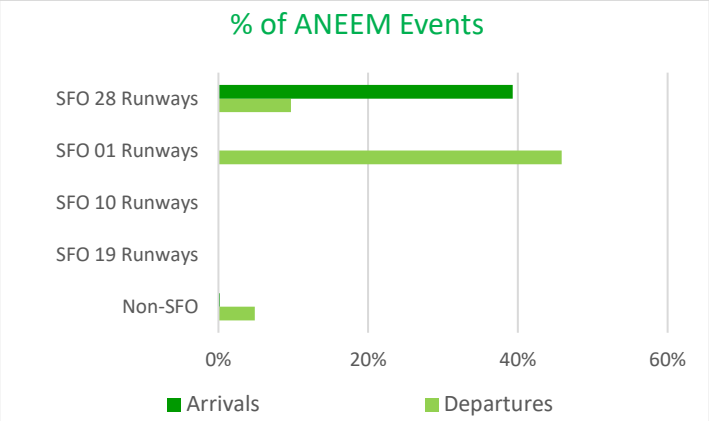
## K – Percentage of Aircraft Events by Operation Type




## L – Percentage of Aircraft Events by Runway and Operation Type

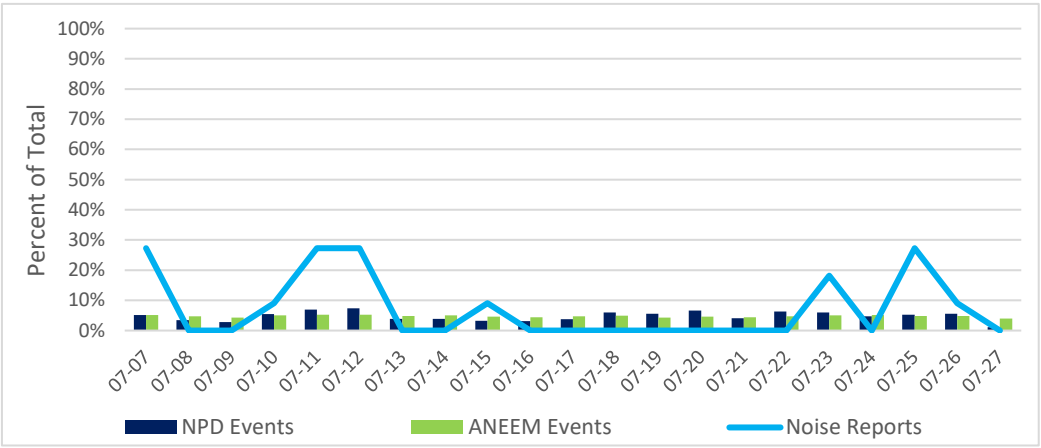


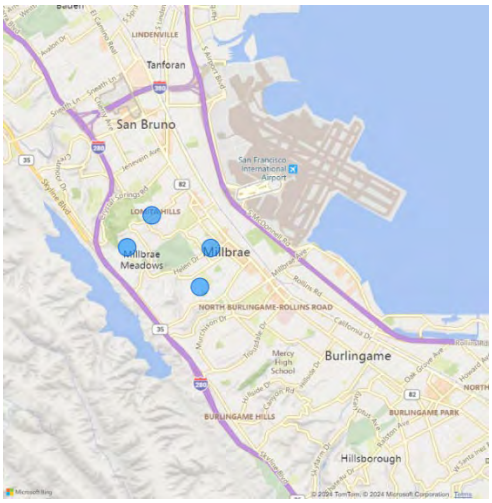

## M – Noise Reporters

| Date | Individual Noise Reporters | Noise Reports |
|---|---|---|
| 07-07 | 1 | 3 |
| 07-08 | 0 | 0 |
| 07-09 | 0 | 0 |
| 07-10 | 1 | 1 |
| 07-11 | 1 | 3 |
| 07-12 | 2 | 3 |
| 07-13 | 0 | 0 |
| 07-14 | 0 | 0 |
| 07-15 | 1 | 1 |
| 07-16 | 0 | 0 |
| 07-17 | 0 | 0 |
| 07-18 | 0 | 0 |
| 07-19 | 0 | 0 |
| 07-20 | 0 | 0 |
| 07-21 | 0 | 0 |
| 07-22 | 0 | 0 |
| 07-23 | 2 | 2 |
| 07-24 | 0 | 0 |
| 07-25 | 1 | 3 |
| 07-26 | 1 | 1 |
| 07-27 | 0 | 0 |
| **Total** | **4** | **11** |

## N – Noise Reports vs Aircraft Noise Events per Day




## O – Noise Reporter Locations




## P – Noise Monitor on Location

## Appendix

*This Appendix describes the sections of the noise monitoring report and a glossary of terms.*

**Part A – Monitoring Summary** lists the monitoring location, elevation, the monitoring time period, and the key monitoring results including the ANEEM Aircraft, NPD Aircraft, and NPD Community Community Noise Equivalent level (CNEL), single event levels in both A and C noise weightings, and air traffic flow breakdown. The CNEL metric is used to assess and regulate aircraft noise exposure in communities surrounding the airport. California Title 21 Noise Regulations established an acceptable level of 65 dBA CNEL.

**Part B – Monitoring Location** illustrates the location of the portable noise monitor and examples of typical SFO flight operations that registered noise events at the portable noise monitor.

**Part C – Daily Noise Event Averages** lists the number of noise events registered at the noise monitor by SFO Aircraft for both A and C noise weightings using ANEEM (green) or NPD (blue) methods during each day of the noise monitoring period. NPD Community noise events by A-weighted noise levels are also included. The noise event levels are expressed as average Sound Exposure Level (SEL) and average peak noise level (Lmax).

**Part D – Community Noise Equivalent Level** shows a chart that compares the ANEEM Aircraft (SFO and non-SFO), NPD Aircraft, and NPD Community CNEL during each day of the monitoring period.

**Part E – Average Sound Exposure Level** (SEL) shows 2 charts comparing the ANEEM Aircraft (SFO and non-SFO) and NPD Aircraft average SEL for A and C-weighted noise levels during each day of the monitoring period.

**Part F – SFO Aircraft Noise Events by Time of Day** lists 2 tables including the daily minimum, maximum, and average SEL, Lmax, duration and number of SFO Aircraft noise events using ANEEM during the Daytime (7am to 7pm), Evening (7pm to 10pm), and Nighttime (10pm to 7am) for both A and C-weighted noise levels during the monitoring period.

**Part G – Percentage of Events by Airports** shows the percentage of aircraft events using ANEEM and NPD by the aircraft's nearest airport of origin or destination. The percentages for both methods each add up to 100%.

**Part H – SFO Noise Event by Hour of the Day** shows the percentage of total SFO Aircraft noise events using ANEEM and NPD by hour of the day. The percentages for both methods each add up to 100%.

**Part I – SFO Departure Events by Altitude (ft) over Site** shows the percentage of SFO Aircraft Departures and Arrivals that registered noise events at the noise monitor using ANEEM and NPD by altitude intervals. Altitudes are relative to mean sea level elevation. Excludes helicopters. The percentages for both methods each add up to 100%.

**Part J – Percentage of Events by Aircraft Types** shows the percentage of aircraft events using ANEEM and NPD by aircraft types. The percentages for both methods each add up to 100%.

**Part K – Percentage of Events by Operation Type** shows the percentage of aircraft noise events registered using ANEEM and NPD by Arrivals and Departures.

**Part L – Percentage of Aircraft Events by Runway and Operation Type** compares the percentage of aircraft noise events registered using ANEEM and NPD by Arrivals and Departures per each SFO runway pair and to non-SFO overflights.

**Part M – Noise Reporters** lists the number of individual noise reporters and noise reports per day registered by individuals living in Millbrae or Burlingame.

**Part N – Noise Reports vs Aircraft Noise Events per Day** compares the number of noise reports to the number of aircraft noise events per day using ANEEM and NPD. The percentages for both methods each add up to 100%.

**Part O – Noise Report Locations** illustrates a map that shows the noise report locations.

**Part P – Noise Monitor on Location** shows photographs of the noise monitoring equipment on location.

## Glossary

**A-Weighted Noise Level** – Denoted in dBA, is the most common unit used for measuring environmental sound levels. The human ear does not respond equally to different frequencies of sound. An A-weight adjusts the frequency components of sound to conform to your ear's normal response at conversational levels. The FAA and State of the California have adopted the A-weighted sound level for environmental analysis. Sound level meters have an A-weighting network for measuring noise in A-weighted decibels.

**C-Weighted Noise Level** – Denoted in dBC, is a different scale for loudness perception of sound pressure levels than A-weighted noise. A C-weight scale is used to measure sounds with approximately equal sensitivity at all frequencies. The C-weighted scale accounts for low-frequency ranges of sounds more than an A-weighted scale, often resulting in more of the overall noise energy to be included in the measurement.

**California Code of Regulations Title 21, Subchapter 6** – This code describes noise standards by defining metrics terminology and requirements regarding compatible land use. SFO was one of the first airports in the state to achieve a zero impact area within the 65 dB CNEL (Community Noise Equivalent Level) noise contour.

**Community Noise Equivalent Level (CNEL)** – A noise metric required by the California Airport Noise Standards for use by airport proprietors to measure aircraft noise levels. CNEL includes an additional weighting for each event occurring during the evening (7:00 p.m. – 9:59 p.m.) and nighttime (10:00 p.m. – 6:59 a.m.) periods to account for increased sensitivity to noise during these periods. Evening events are treated as though there were three and nighttime events are treated as though there were ten. This results in a 4.77 and 10 dBA penalty for operations occurring in the evening and nighttime periods, respectively. For a more in-depth explanation of CNEL and other technical noise terms, please visit the Federal Aviation Administration (FAA) website. Below is a graphic illustrating types of metropolitan areas and their corresponding CNEL intervals (dBA).


**Decibel (dB)** – A unit used to measure the magnitude or intensity of sound. The decibel uses a logarithmic scale to cover the very large range of sound pressures that can be heard by the human ear. Decibels measure a scale from the threshold of human hearing, 0 dB, upward towards the threshold of pain, about 120-140 dB. Because decibels are such a small measure, they are computed logarithmically and cannot be added arithmetically. A10 dB increase will be perceived by most people to be a doubling in loudness, i.e., 80 dB seems twice as loud as 70 dB. Decibel measurements can be scaled by different frequency ranges, such as by A-Weighted (dBA) and C-Weighted (dBC) scales.

**Maximum Sound Level (Lmax)** – The maximum a-weighted sound level for a given noise event. The peak noise level reached by a single aircraft event.

**Noise Event** – A Noise Event is the measured sound produced by a single source of noise over a duration of time. An aircraft noise event begins when the sound level of a flight operation exceeds a noise threshold and ends when the level drops down below that threshold.

**Sound Exposure Level (SEL)** – SEL is a measure of a single aircraft noise event spread out over its entirety compressed into one second. It allows for a comparison of aircraft noise events of different durations and noise levels. For example, think of the moment you hear a plane from a quarter mile away; we measure from that moment, as the aircraft flies overhead, and until it can't be heard. This is the duration of sound we use and then compress it into one second for a measure. SEL measures noise energy above the threshold (normally 65 dBA for aircraft noise events). This way, any ambient noise is separated out from the measurement.