

To: Airport Commission

From: Airport Staff

Subject: Results of a Noise Level Flight Test Utilizing an Aftermarket Muffler System on a Cessna 172 Aircraft

Date: January 28, 2013

Introduction

During December 2012, staff conducted a noise level flight test program to determine the effectiveness of an aftermarket exhaust muffler system in reducing the noise level of a single-engine Cessna 172R aircraft. The Cessna 172 is the most popular flight training aircraft used by flight schools based at Santa Monica Airport. The aftermarket muffler system used in the test was the *Low Noise Engine Exhaust Silencer Kit System* (exhaust silencer) manufactured by *Gomolzig Flugzeug- und Maschinenbau GmbH* – a German-based manufacturer. The exhaust silencer has FAA approval for its use on the Cessna 172R aircraft.

Discussion

The test was conducted in two phases utilizing the same Cessna 172 aircraft. The first phase of the test took place on December 6, 2012 and measured the noise level of the aircraft with the factory installed exhaust muffler system. The second phase was flown on December 17, 2012 and measured the noise level of the aircraft with the aftermarket exhaust muffler system. Weather conditions (e.g. wind speed/direction, temperature and altimeter setting) during both days were practically identical thus eliminating any inconsistencies with the noise measurements caused by atmospheric conditions. Sunset Park residents John Fairweather and Lloyd Saunders observed both phases of the test program and provided feedback as to the effectiveness of the aftermarket exhaust system.

During each test phase the aircraft departed and landed to the west and flew identical takeoff and landing maneuvers designed to simulate typical flight training activity. During each of the phases, noise level measurements were taken from all six of the Airport's remote noise monitoring sites (RMS) located east and west of the runway (see Attachment A). During the analysis of the data, staff determined that the noise events recorded at RMS #1 and #4 represented the clearest depiction of the difference in noise levels between the stock exhaust

and the aftermarket exhaust system. Aircraft generate the highest noise levels during climb out when they are operated at maximum power at low altitudes. Both RMS #1 & RMS #4 are located to the west along the extended centerline of the runway and are ideally situated to capture these noise events. The noise data from the other RMS sites were not as distinct. In some cases the Airport's Airport Noise and Operations Management System (ANOMS) was unable to differentiate the aircraft's noise signature from background noise levels due to high ambient noise levels (i.e. vehicle related noise).

The noise data was processed by the ANOMS and presented as Single Event Noise Exposure Level (SENEL) data which includes the maximum noise level attained during the over-flight and the duration of the noise event. Definitions of Single Event Noise Exposure Level and how it is calculated can be found in Attachment B.

Noise Level Flight Test Results

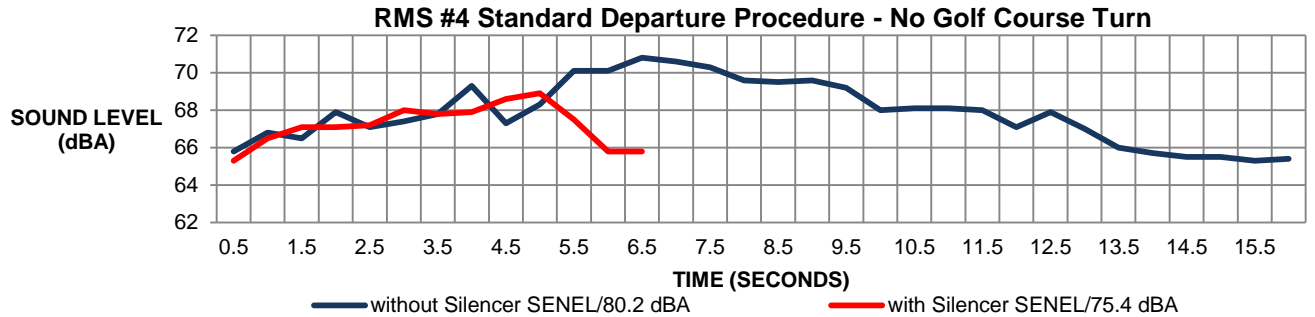
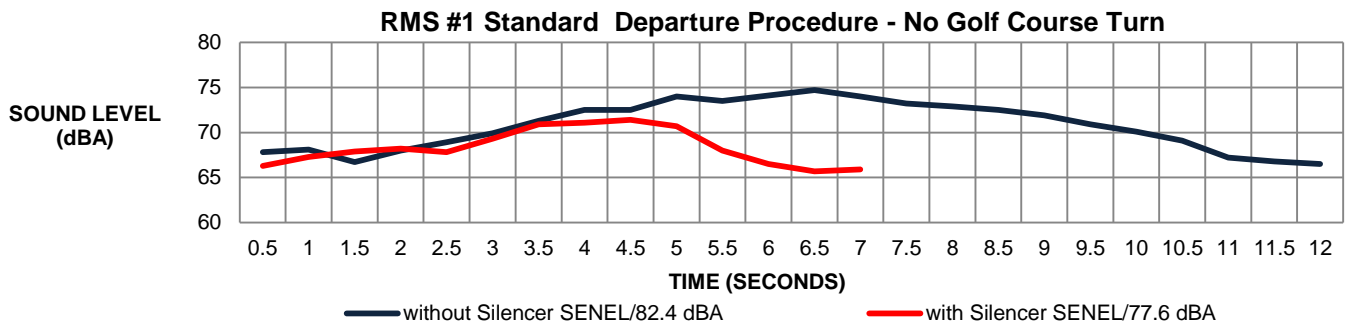
1. Standard Departure Procedure

In this procedure the aircraft initiated its take-off from the beginning of the runway. This test simulated departures and arrivals that occur in both Visual Flight Rule (VFR) and Instrument Flight Rules (IFR) departures. This procedure includes departures during taxi-back operations.

Standard Traffic Pattern Procedures (without overflying the golf course)

Results of the tests indicated that in this procedure the Gomolzig exhaust silencer system reduced the Single Event Noise Exposure Level (SENEL) by 4.8 dBA and reduced the duration of the noise event between 43%-56%.

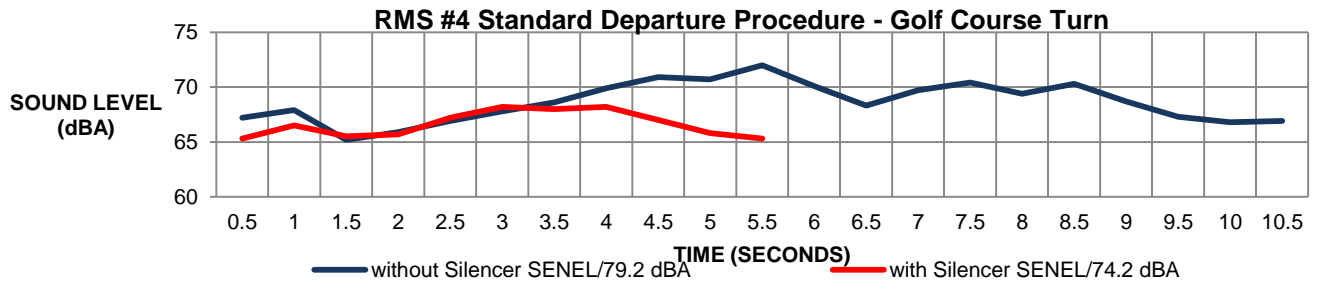
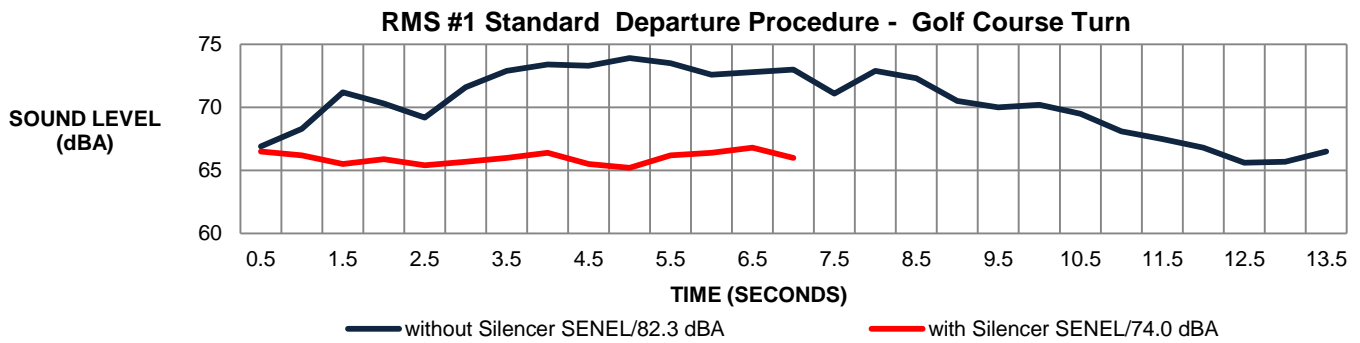
FACTORY INSTALLED EXHAUST MUFFLER				AFTERMARKET EXHAUST MUFFLER		
	SENEL	LMAX	DURATION	SENEL	LMAX	DURATION
RMS01	82.4 dBA	74.7 dBA	14 seconds	77.6 dBA	71.4 dBA	8 seconds
RMS04	80.2 dBA	70.8 dBA	16 seconds	75.4 dBA	68.9 dBA	7 seconds
REDUCTION IN NOISE						
	SENEL	LMAX	DURATION	% of change in duration of sound		
RMS01	4.8 dBA	3.3 dBA	6 seconds	43%		
RMS04	4.8 dBA	1.9 dBA	9 seconds	56%		



Fly Neighborly Traffic Pattern (overfly the golf course)

Results of the tests indicated that in this procedure the Gomolzign exhaust silencer system reduced the Single Event Noise Exposure Level (SENEL) between 5 dBA – 8.3 dBA and reduced the duration of the noise event between 45%-46%.

FACTORY INSTALLED EXHAUST MUFFLER				AFTERMARKET EXHAUST MUFFLER		
	SENEL	LMAX	DURATION	SENEL	LMAX	DURATION
RMS01	82.3 dBA	73.9 dBA	13 seconds	74 dBA	66.8 dBA	7 seconds
RMS04	79.2 dBA	72 dBA	11 seconds	74.2 dBA	68.2 dBA	6 seconds
REDUCTION IN NOISE						
	SENEL	LMAX	DURATION	% of change in duration of sound		
RMS01	8.3 dBA	7.1 dBA	6 seconds	46%		
RMS04	5 dBA	3.8 dBA	5 seconds	45%		



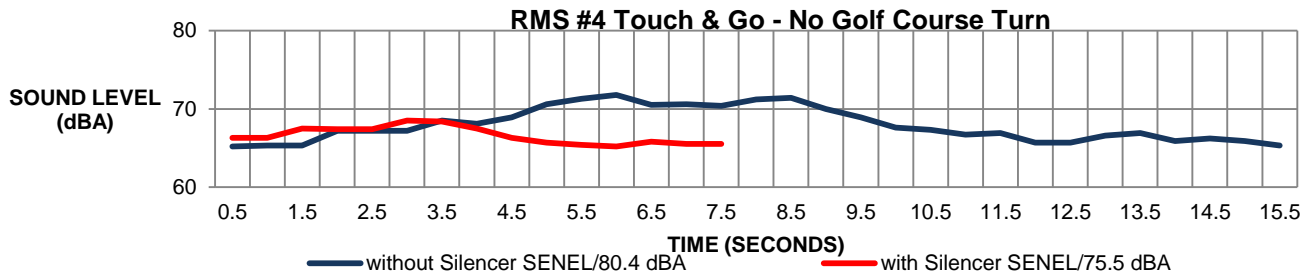
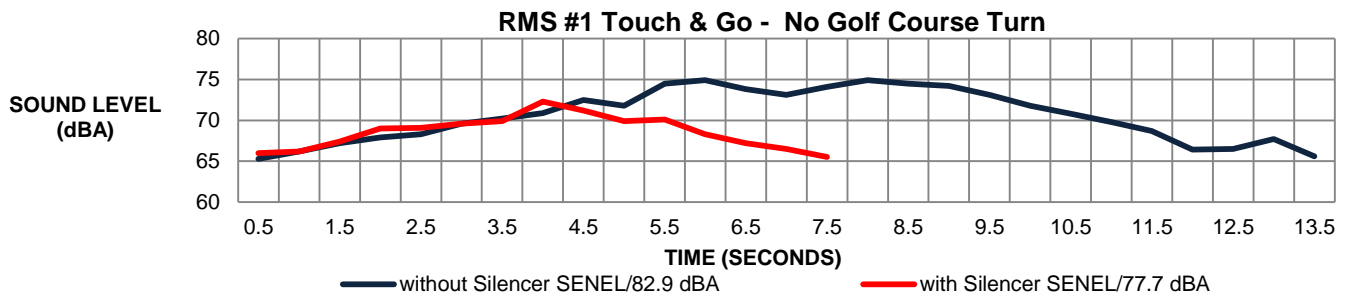
2. Touch & Go Procedure

In this procedure the aircraft lands and then immediately takes off without stopping or exiting the runway. This part of the test was designed to simulate pattern flying activity. On both days the aircraft touched down approximately 1,500 feet down the runway before it took off again.

Standard Traffic Pattern Procedures (without overflying the golf course)

Results of the tests indicated that in this procedure the Gomolzig exhaust silencer system reduced the Single Event Noise Exposure Level (SENEL) between 4.9 dBA - 5.2 dBA and reduced the duration of the noise event between 43%-56%.

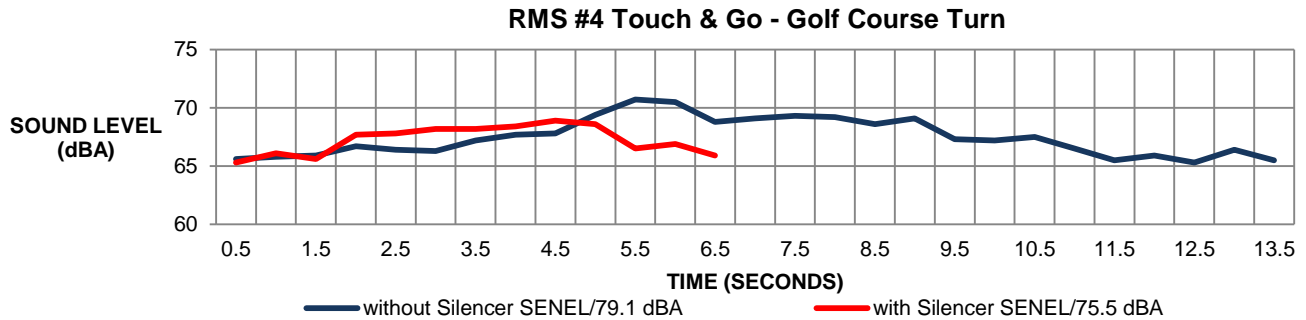
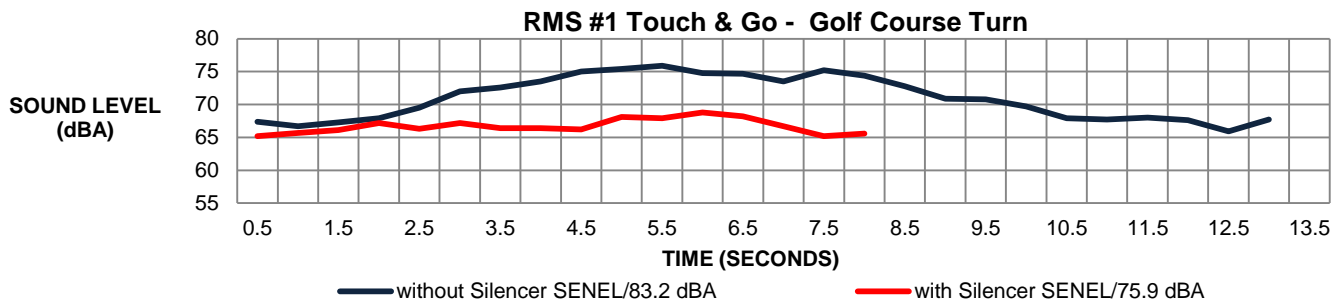
FACTORY INSTALLED EXHAUST MUFFLER				AFTERMARKET EXHAUST MUFFLER		
	SENEL	LMAX	DURATION	SENEL	LMAX	DURATION
RMS01	82.9 dBA	74.9 dBA	14 seconds	77.7 dBA	72.3 dBA	8 seconds
RMS04	80.4 dBA	71.8 dBA	16 seconds	75.5 dBA	68.5 dBA	7 seconds
REDUCTION IN NOISE						
	SENEL	LMAX	DURATION	% of change in duration of sound		
RMS01	5.2 dBA	2.6 dBA	6 seconds	43%		
RMS04	4.9 dBA	3.3 dBA	9 seconds	56%		



Fly Neighborly Traffic Pattern (overfly the golf course)

Results of the tests indicated that in this procedure the Gomolzig exhaust silencer system reduced the Single Event Noise Exposure Level (SENEL) between 3.6 dBA – 7.3 dBA and reduced the duration of the noise event between 38%-50%.

FACTORY INSTALLED EXHAUST MUFFLER				AFTERMARKET EXHAUST MUFFLER		
	SENEL	LMAX	DURATION	SENEL	LMAX	DURATION
RMS01	83.2 dBA	75.9 dBA	13 seconds	75.9 dBA	68.8 dBA	8 seconds
RMS04	79.1 dBA	70.7 dBA	14 seconds	75.5 dBA	68.9 dBA	7 seconds
REDUCTION IN NOISE						
	SENEL	LMAX	DURATION	% of change in duration of sound		
RMS01	7.3 dBA	7.1 dBA	5 seconds	38%		
RMS04	3.6 dBA	1.8 dBA	7 seconds	50%		



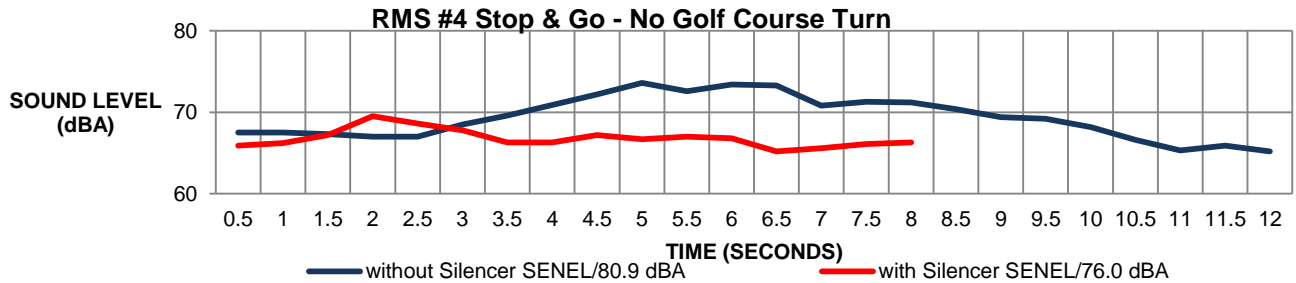
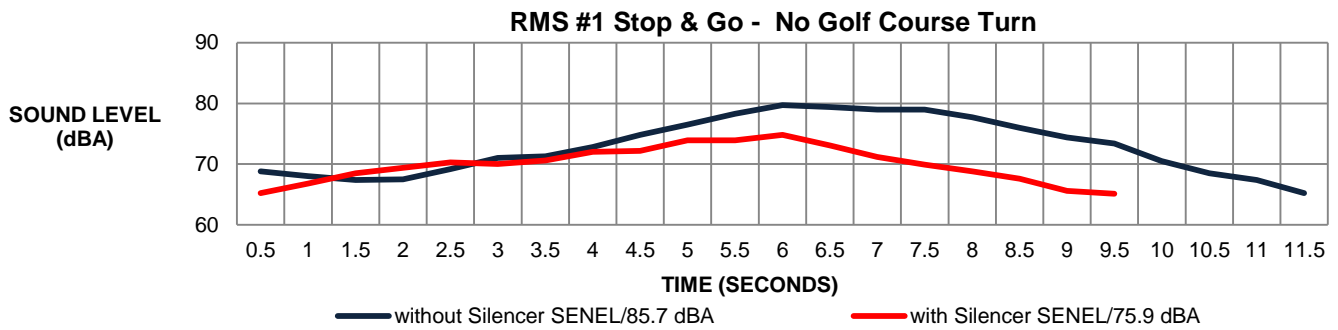
3. Stop & Go Procedure

In this procedure the aircraft lands, comes to a complete stop on the runway and then takes off again. This part of the test was designed to simulate pattern flying activity. On both days the aircraft touched down and came to a complete stop approximately 2,500 feet down the runway before it took off again.

Standard Traffic Pattern Procedures (without overflying the golf course)

Results of the tests indicated that in this procedure the Gomolzig exhaust silencer system reduced the Single Event Noise Exposure Level (SENEL) between 4.9 dBA - 5.1 dBA and reduced the duration of the noise event between 17% - 33%.

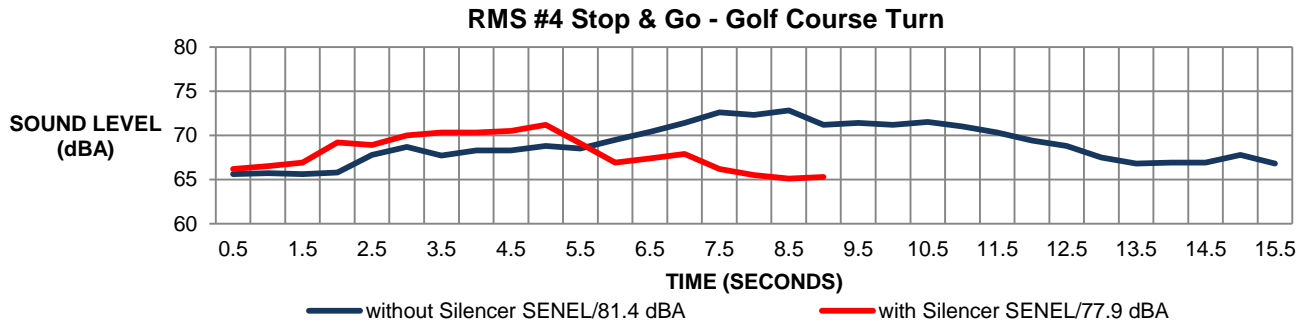
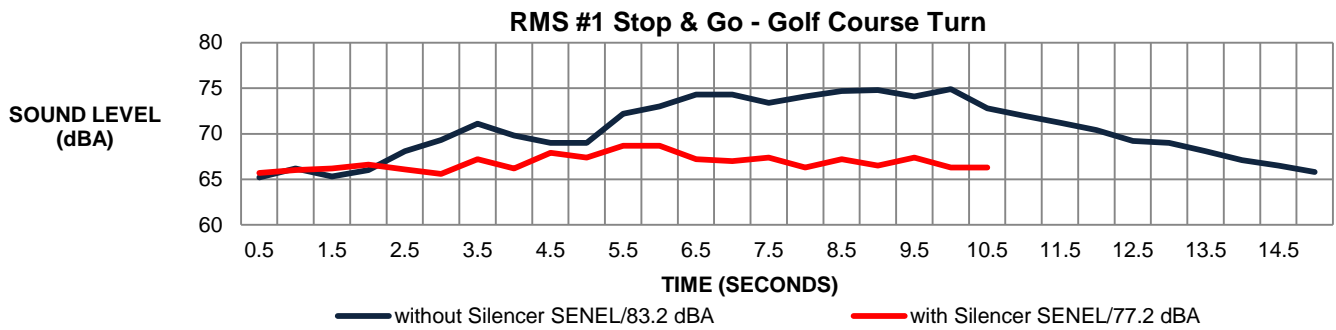
FACTORY INSTALLED EXHAUST MUFFLER				AFTERMARKET EXHAUST MUFFLER		
	SENEL	LMAX	DURATION	SENEL	LMAX	DURATION
RMS01	85.7 dBA	79.7 dBA	12 seconds	80.6 dBA	74.8dBA	10 seconds
RMS04	80.9 dBA	73.6 dBA	12 seconds	76 dBA	69.5 dBA	8 seconds
REDUCTION IN NOISE						
	SENEL	LMAX	DURATION	% of change in duration of sound		
RMS01	5.1 dBA	4.9 dBA	2 seconds	17%		
RMS04	4.9 dBA	4.1 dBA	4 seconds	33%		



Fly Neighborly Traffic Pattern (overfly the golf course)

Results of the tests indicated that in this procedure the Gomolzsig exhaust silencer system reduced the Single Event Noise Exposure Level (SENEL) between 3.5 dBA – 6 dBA and reduced the duration of the noise event between 27% - 44%.

FACTORY INSTALLED EXHAUST MUFFLER				AFTERMARKET EXHAUST MUFFLER		
	SENEL	LMAX	DURATION	SENEL	LMAX	DURATION
RMS01	83.2 dBA	74.9 dBA	15 seconds	77.2 dBA	68.7 dBA	11 seconds
RMS04	81.4 dBA	72.8 dBA	16 seconds	77.9 dBA	71.2 dBA	9 seconds
REDUCTION IN NOISE						
	SENEL	LMAX	DURATION	% of change in duration of sound		
RMS01	6 dBA	6.2 dBA	4 seconds	27%		
RMS04	3.5 dBA	1.6 dBA	7 seconds	44%		



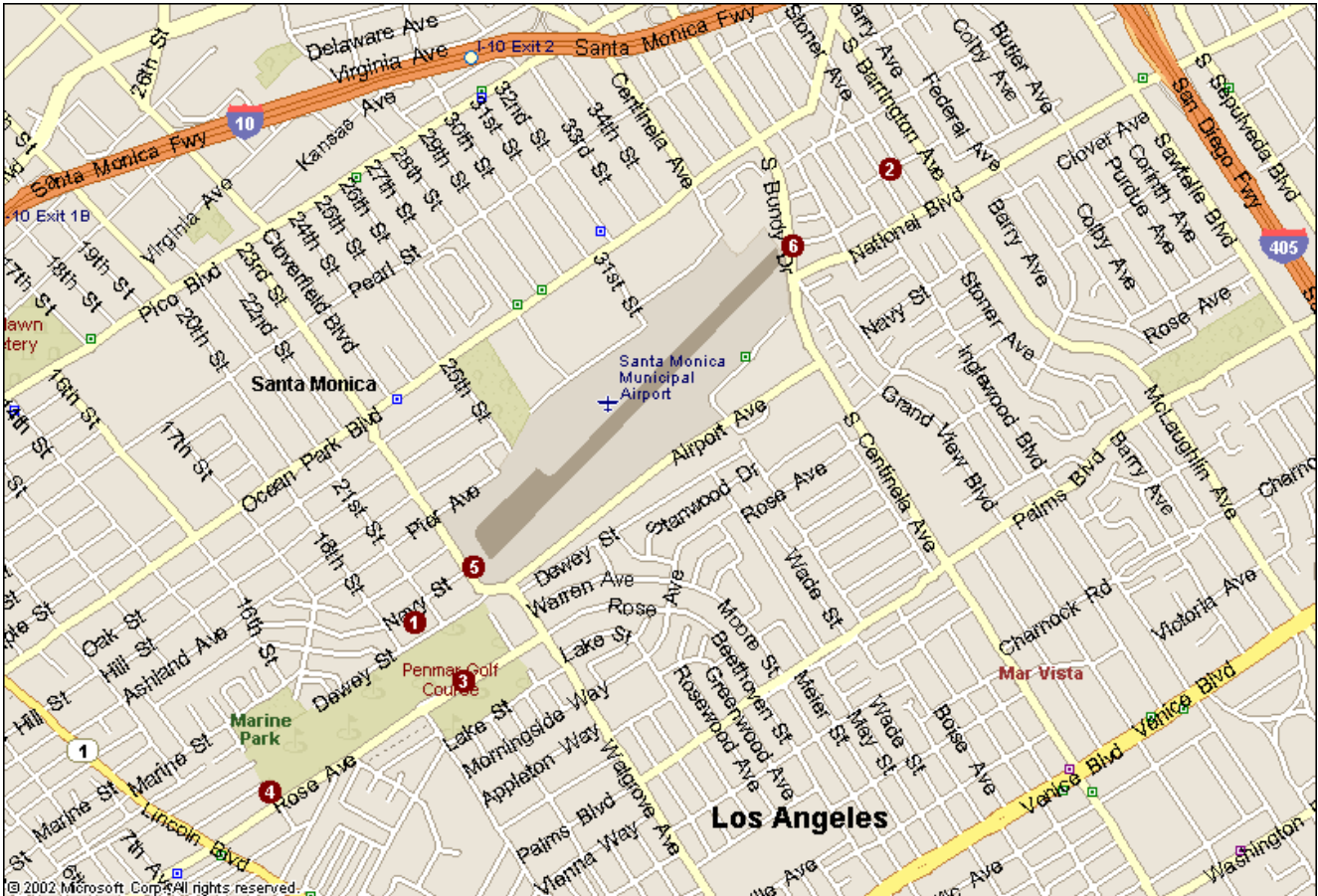
Conclusion

The results of the Noise Level Flight Test Program indicate that the Gomolzig exhaust silencer system was effective in reducing the noise levels of the Cessna 172. Single Event Noise Exposure Level (SENEL) was reduced at RMS01 between 4.8 dBA to 8.3 dBA and at RMS04 between 3.5 dBA to 5 dBA. The duration of the noise event was reduced at RMS01 between 2 to 6 seconds (or approximately 17% to 46%) and at RMS04 between 4 to 9 seconds (or approximately 33% - 56%) less than the aircraft equipped with the factory installed exhaust system.

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 Stelios Makrides

ATTACHMENT A Location of Remote Noise Monitoring Stations (RMS)

- RMS – 1** 18th Street, Between Dewey Street & Navy Street, Santa Monica
- RMS – 2** Sardis Street and Granville Street, West Los Angeles
- RMS – 3** Penmar Golf Course, 1233 Rose Avenue, Venice
- RMS – 4** West end of Penmar Golf Course on Warren Avenue, Venice
- RMS – 5** 23rd Street & Navy Street, Santa Monica
- RMS – 6** Bundy Ave & Clarkson Road/Ct, West Los Angeles

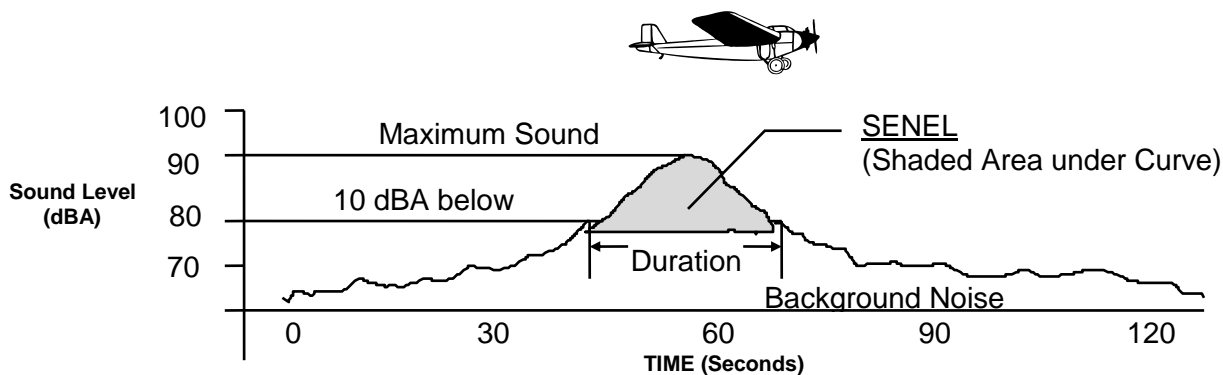


Note: Remote Monitoring Stations 1 & 2 are used for the Enforcement of the 95.0 dBA Single Event Noise Exposure Level (SENEL) maximum allowable noise level.

ATTACHMENT B

Definition of Single Event Noise Exposure Level (SENEL)

As an aircraft approaches each noise monitor, the sound of the aircraft begins to rise above the threshold level. The closer the aircraft gets, the louder it is until the aircraft is at its closest point directly overhead. As the aircraft passes, the noise level decreases until the sound settles below the threshold level. Such a history of a flyover is plotted in the graph below. The highest noise level reached during the flyover is called the “Maximum Noise Level”, or LMax. Referring to the same graph, the area within 10 dB of the LMax is the area from which the SENEL is computed. This metric takes into account the maximum noise level and the duration of the event. The SENEL value is always higher than the LMax value for aircraft events.



Definition of A-Weighted Sound Level (dBA) – The sound pressure level in decibels as measured on a sound level meter using the A-Weighted filter network. The A-weighting filter de-emphasizes the very low and very high frequency components of the sound in a manner similar to the response of the human ear. It is a numerical method of rating human judgment of loudness.