

## HMMH

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## TECHNICAL MEMORANDUM

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**To:** Hardy S. Bullock  
Director of Aviation & Community Services  
Truckee Tahoe Airport District  
10356 Truckee Airport Rd.  
Truckee, CA 96160

**From:** Rhea Gundry  
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**Date:** November 13, 2017

**Subject:** Measured Aircraft Noise Comparison

**Reference:** HMMH Project Number 309360.000

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### 1. Introduction



HMMH assisted Truckee Tahoe Airport (TRK) to compare noise levels of three fixed-wing single-engine aircraft: (1) A standard Cessna 172N (N1968F) that is based at TRK, (2) a previously measured<sup>1</sup> RedHawk Cessna 172P (N64686) with a retrofitted Jet A diesel engine and smaller diameter three bladed propeller and (3) a JT-A Skyhawk Cessna 172P (N688CS) from Textron Aviation with a retrofitted diesel engine. TRK arranged for the JT-A Skyhawk to fly in from Kansas for a side-by-side comparison of these aircraft to demonstrate the difference in noise level with the retrofitted diesel engine.

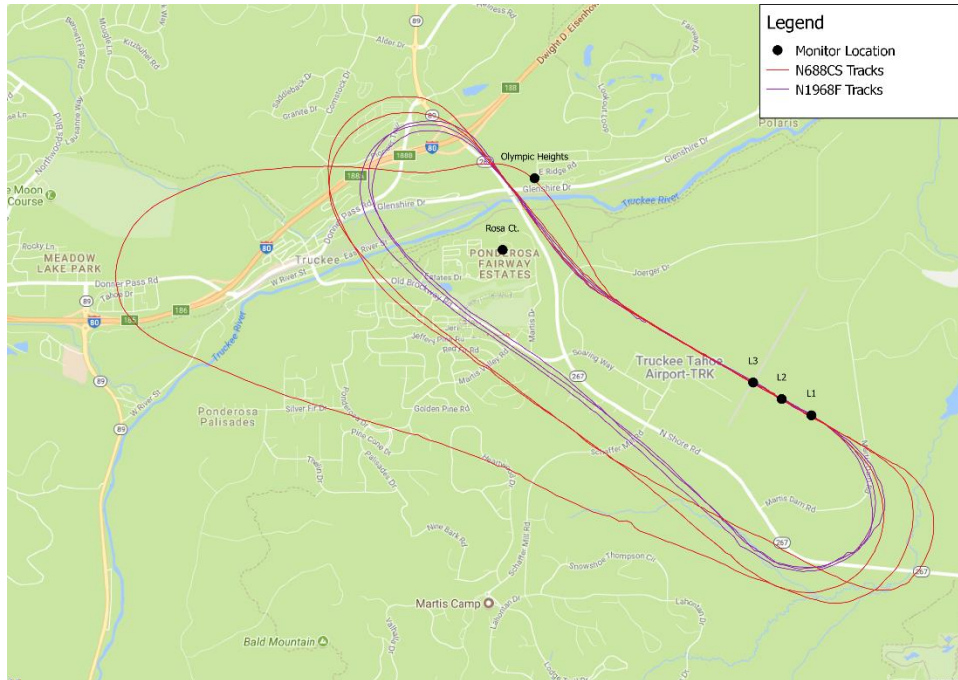
This memorandum provides the results of the noise measurements conducted on October 6, 2017 for the standard Cessna 172N and retrofitted JT-A Skyhawk at TRK and in the nearby surrounding community. These results build on prior noise measurements conducted at and around TRK on June 24, 2015 for the standard Cessna 172N and RedHawk.

### 2. Methodology

HMMH deployed four (4) Rion 32 noise meters on the airfield and in the community to obtain the A-weighted one-second time history noise levels in decibels (dB). Figure 1 shows the locations of each monitoring site and the flight tracks of both aircraft. Observers were stationed with the noise meters to listen and record each flyover event. Using the observer logs and recorded time histories, HMMH calculated the Single Event Noise Exposure Level (SENEL), which is also known as the Sound Exposure Level (SEL), for each of the aircraft noise events captured by the noise meters.

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<sup>1</sup> Measurements conducted on June 24, 2015



**Figure 1. Study Area**  
Source: Map image and data © Google 2017

Three TRK airfield locations along the runway sideline (L1-L3) were measured to capture the difference between four unique elements of an aircraft departure, touch-and-go procedure, and arrival:

- L1) Start of takeoff roll
- L2) Engine rev 1000' down the runway of a touch-and-go procedure
- L3) 1) Touch-and-go procedure at rotation and  
2) Touch down and final taxi on taxiway G

### 3. Noise Measurement Results

Table 1 shows the measured noise levels of each aircraft for the events listed above and the noise level difference between the standard aircraft and the retrofitted aircraft. From the previous report in 2015, we see that the RedHawk, with the retrofitted diesel engine, is consistently approximately 8 dB quieter than the standard Cessna (non-retrofitted) aircraft at sites L1, L2, and L3-1. The JT-A Skyhawk, with the retrofitted diesel engine, did not follow this consistent pattern when compared to the based standard Cessna aircraft, and is the result of inconsistencies in the way each touch-and-go procedure was flown. More specifically, the observed inconsistencies consisted of:

- At site L2, the standard Cessna was in the air over the monitor site with engine at idle coasting to land while the JT-A Skyhawk had just touched down and coasted past the monitor site. Site L2 did not capture engine rev for any of the 2017 tested aircraft.
- At site L3-1, the standard Cessna put wheels down exactly at the monitor site rather than capturing rotation.
- At site L3-2, a taxiing SurfAir aircraft contaminated the standard event.

Site L1, measuring the start of takeoff roll, is the only consistently flown element between both the standard Cessna and the JT-A Skyhawk and shows the JT-A Skyhawk is 2.5 dB quieter on takeoff. Due to the



inconsistencies between the standard aircraft events noted above, a better reference for review of the JT-A Skyhawk results would be to compare them to the 2015 standard Cessna events as shown in Table 2.

**Table 1. Noise Levels from Aircraft Operations as Measured on the TRK Airfield**

Source: HMMH

Event	2015			2017		
	Standard	RedHawk	Difference	Standard	JT-A Skyhawk	Difference
L1	98.6	90.1	-8.5	99.8	97.2	-2.5
L2	90.9	82.8	-8.0	70.6 <sup>1</sup>	75.9 <sup>2</sup>	5.3
L3-1	94.6	85.8	-8.8	72.8 <sup>3</sup>	85.7	12.9
L3-2	72.8	70.5	-2.3	88.5 <sup>4</sup>	70.4	-18.1

Note:  
 1. In air over monitor site with engine at idle, did not capture engine rev  
 2. On runway passing monitor site with engine at idle, did not capture engine rev  
 3. Wheels down, did not capture rotation  
 4. Contaminated event



**Table 2. 2015 vs 2017 Noise Levels from Aircraft Operations as Measured on the TRK Airfield**

Source: HMMH

Event	2015 Standard	2017 JT-A Skyhawk	Difference
L1	98.6	97.2	-1.4
L2	90.9	75.9 <sup>1</sup>	-15.0
L3-1	94.6	85.7	-8.9
L3-2	72.8	70.4	-2.4

Note:  
 1. On runway passing monitor site with engine at idle, did not capture engine rev

Table 3 and Table 4 show the 2017 noise level results for each demonstration aircraft event measured at each community location as well as the logarithmic average noise level of all demonstration aircraft events. Data from the previous 2015 study is also provided for purposes of comparison. While the operations of each aircraft were not identical, the pilots attempted to maintain similar aircraft path, altitude, and weight for the standard Cessna aircraft and the JT-A Skyhawk.

Across all events, the JT-A Skyhawk was between approximately 3 dB to 8 dB quieter at Rosa Ct. and between approximately 2 dB quieter to one-half dB louder at Olympic Blvd. when compared to the standard Cessna. On average, the JT-A Skyhawk was approximately 6 dB quieter than the standard Cessna at Rosa Ct. and 1 dB quieter at Olympic Blvd, respectively. Compared to data from the previous 2015 study, on average, the JT-A Skyhawk was approximately 1 dB quieter at Rosa Ct. and 6 dB louder at Olympic Blvd. than the RedHawk.

**Table 3. Noise Levels from Aircraft Operations as Measured at Rosa Ct.**

Source: HMMH

Event	2015			2017		
	Standard	RedHawk	Difference	Standard	JT-A Skyhawk	Difference
E1	78.6	71.2	-7.4	75.8	72.1	-3.7
E2	79.0	70.4	-8.7	77.7	70.5	-7.2
E3	81.4	78.2	-3.1	79.4	70.9	-8.5
Average	79.8	74.8	-5.1	77.9	71.2	-6.6

Note: Noise levels presented herein are A-weighted SENEL in dB

**Table 4. Noise Levels from Aircraft Operations as Measured at Olympic Blvd.**

Source: HMMH

Event	2015			2017		
	Standard	RedHawk	Difference	Standard	JT-A Skyhawk	Difference
E1	82.1	72.2	-9.9	80.3	77.5	-2.8
E2	83.3	71.9	-11.5	80.2	77.5	-2.7
E3	81.3	71.9	-9.4	80.4	80.9	0.5
Average	82.3	72.0	-10.3	80.3	78.9	-1.3

Note: Noise levels presented herein are A-weighted SENEL in dB



Using the same Rion noise meters and collecting one-second noise level time histories, HMMH calculated the equivalent sound level, Leq, of a full power run-up at 20-degree increments, 30 feet from each aircraft. Leq is the equivalent sound level measured throughout the noise event as though the sound level was constant throughout the event. For each of the measurements the front wheel of the aircraft was at the circles center with the nose/propeller facing 0 degrees. Figures 2 and 3 show the calculated directivities of the standard Cessna and RedHawk in terms of the Leq noise metric from data recorded during the previous 2015 study. Figures 4 and 5 show the calculated directivities of the standard Cessna and JT-A Skyhawk in terms of the Leq noise metric from 2017 data, respectively.

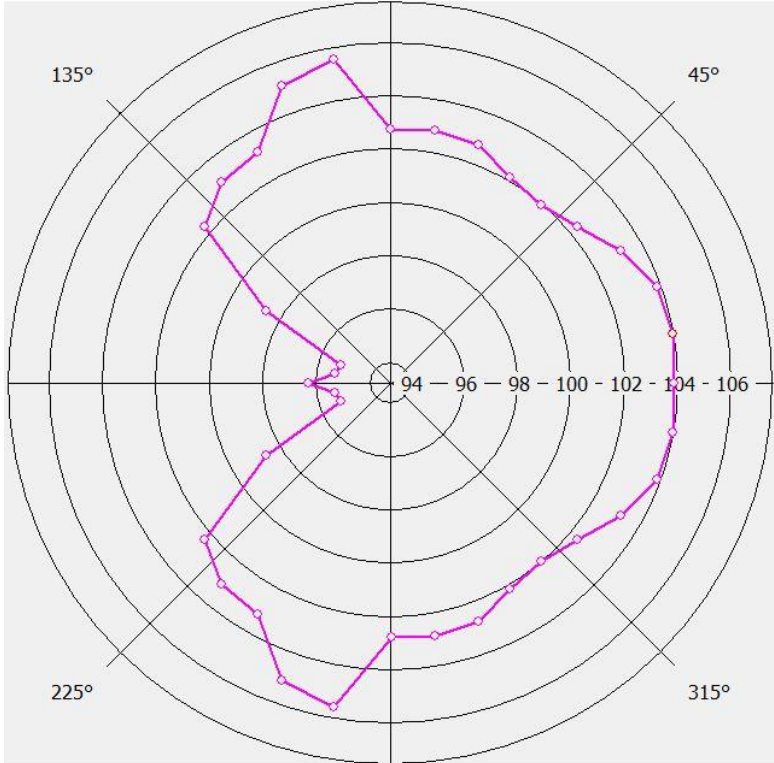


Figure 2. Directivity of N1968F (2015), Standard Cessna

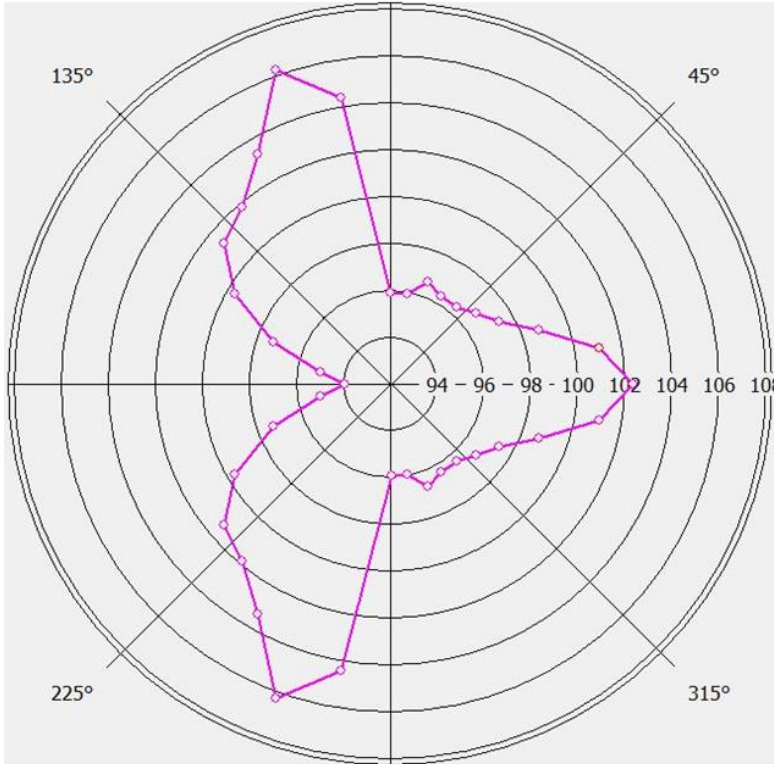
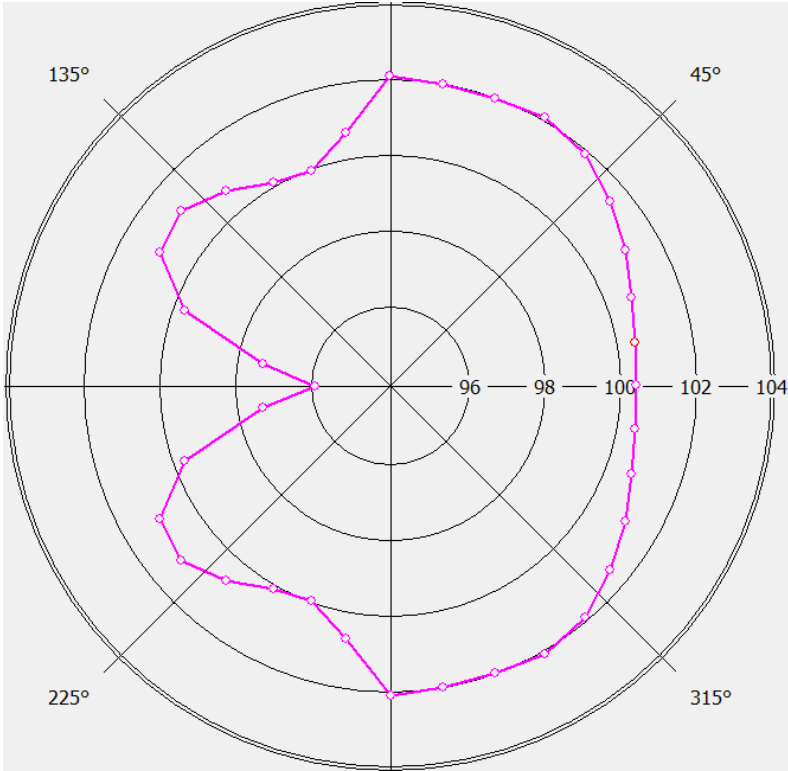
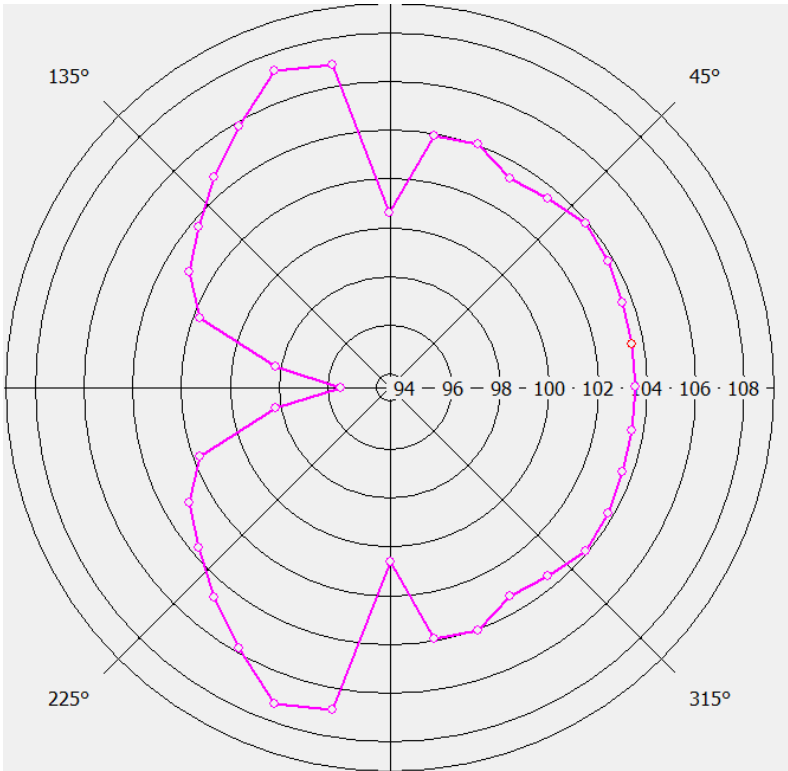


Figure 3. Directivity of N64686 (2015), RedHawk



**Figure 4. Directivity of N1968F (2017), Standard Cessna**  
Note: Scale for this directivity plot is different from the rest with a range of 96 dB – 104 dB



**Figure 5. Directivity of N688CS (2017), JT-A Skyhawk**

As shown in Figures 4 and 5, the 2017 calculated run-up directivity JT-A Skyhawk is greater than that of the standard Cessna in terms of maximum calculated noise levels. The standard Cessna maximum 2017 calculated noise level was approximately 102 dB, where the JT-A Cessna 2017 calculated noise level was 107 dB, respectively. Figures 4 and 5 also show the 2017 calculated directivity of the JT-A Skyhawk extends further to the left, right, front, and rear of the aircraft when compared to the 2017 calculated directivity of the standard Cessna. The JT-A Skyhawk 2017 calculated directivity reached levels of approximately 104 dB at the 45, 135, 225, and 315 degree measurement points on the front left, rear left, rear right, and front right sides of the aircraft when compared to the standard Cessna's 2017 calculated directivity levels of approximately 102 dB, respectively.

Compared to the 2015 calculated run-up directivity of the RedHawk as shown in Figure 3, the JT-A Skyhawk 2017 calculated run-up directivity maximum noise levels were greater than those of the RedHawk. The RedHawk maximum 2015 calculated noise level was approximately 106 dB, where the JT-A Cessna 2017 calculated noise level was 107 dB, respectively. Figures 3 and 5 also show the 2017 calculated directivity of the JT-A Skyhawk extends further to the left, right, front, and rear of the aircraft when compared to the 2015 calculated directivity of the RedHawk. The JT-A Skyhawk 2017 calculated directivity reached levels of approximately 104 dB at the 45, 135, 225, and 315 degree measurement points on the front left, rear left, rear right, and front right sides of the aircraft. Where the RedHawk's 2015 calculated directivity reached levels of approximately 97 dB at the 45 and 315-degree measurement points on the front left and right sides of the aircraft and 102 dB at the 135 and 225-degree measurement points, respectively.



#### **4. Conclusions**

The 2017 on-airfield measurements of the JT-A Skyhawk did not follow a consistent pattern of noise reduction when compared the 2017 on-airfield measured values of the standard Cessna or 2015 on-airfield measured values of the RedHawk. This was largely due to inconsistencies in the pattern flown between the standard Cessna and JT-A Skyhawk during the 2017 measurement period. However, when compared to the 2015 on-airfield measured values for the standard Cessna and RedHawk, the JT-A Skyhawk demonstrated consistent measured noise reductions of between approximately 1 and 9 dB over the standard Cessna.

The 2017 community event measurements for the JT-A Skyhawk demonstrated the JT-A Skyhawk was between approximately 3 dB to 8 dB quieter at Rosa Ct. and between approximately 2 dB quieter to one-half dB louder at Olympic Blvd. when compared to the standard Cessna. In the previous 2015 Study, the community event measurements demonstrated the RedHawk was between approximately 3 dB to 7 dB quieter at Rosa Ct. and between approximately 9 dB to 11 dB quieter to at Olympic Blvd when compared to the standard Cessna. On average, the JT-A Skyhawk was approximately 6 dB quieter than the standard Cessna at Rosa Ct. and 1 dB quieter at Olympic Blvd. Compared to data from the previous 2015 study, the JT-A Skyhawk was, on average, approximately 1 dB quieter at Rosa Ct. and 6 dB louder at Olympic Blvd. when compared to the RedHawk at both locations.

Finally, the 2017 calculated run-up directivity for JT-A Skyhawk was greater than that of the standard Cessna and RedHawk in terms of maximum calculated noise levels and extent of noise around the aircraft. The standard Cessna maximum 2017 calculated noise level was approximately 102 dB versus the JT-A Cessna 2017 calculated noise level of 107 dB, and RedHawk's 2015 calculated noise level of 106 dB. Furthermore, The JT-A Skyhawk 2017 calculated directivity reached levels of approximately 104 dB at the measurement points on the front left, rear left, rear right, and front right sides of the aircraft. This is greater than the 2017 standard Cessna calculated directivity levels of 102 dB at the same measurement locations, and the 2015 RedHawk calculated directivity levels of 102 dB on the rear left and right sides of the aircraft and 97 dB on the front left and right sides of the aircraft, respectively.