AGENDA ITEM: 15

TRUCKEE TAHOE AIRPORT DISTRICT

BOARD OF DIRECTOR STAFF REPORT

AGENDA TITLE: **Cessna 172 JT-A Diesel Aircraft Sound Test Results and Discussion of Aircraft Acquisition**

MEETING DATE: **November 29, 2017**

PREPARED BY: **Hardy Bullock, Director of Aviation & Community Services**

RECOMMENDED ACTION: Review the attached report and discuss the Cessna JT-A aircraft noise test results. Provide direction to Staff following discussion or action steps.

DISCUSSION: In an effort to reduce annoyance from repetitive aircraft operations, (touch and go's) staff investigated the emerging diesel aircraft platform as a potential solution. In 2015 the Board and Staff tested a diesel retro fit Red Bird Skyhawk 172. The results showed dramatic reductions in noise at every phase of flight. That report is attached herein for your review (HMMH REDBIRD). Cessna Aircraft has recently debuted a certified, factory built Cessna Skyhawk with a diesel engine. The aircraft is not modified, it is a new certificated general aviation aircraft suitable for training and cross country flight in both IFR and VFR conditions including night flight.

Based on direction from the Board, staff conducted a noise and flight test of this Cessna JT-A aircraft on October 6th using HMMH Noise Consultants. The airborne noise test and static tests used identical methodology to the 2015 Red Bird flight test including the same locally based Cessna Skyhawk training aircraft N1968F. The report dated November 13, 2017 is attached for your review. The test also consisted of flight testing the aircraft by several local pilots. The flight test yielded some interesting results. Of the three aircraft flown the Cessna JT-A provided the best flight experience from a pilot perspective. The new aircraft obviously is equipped better with a full glass Garmin G1000 panel and flies like a new aircraft. The diesel engine produces 155 horsepower constantly turbo normalized so the engine is only slightly affected by altitude and air density. The power band is more consistent as there is no significant loss of horsepower in the climb. The rate of climb is similar to a Cessna Skylane with a 235 horsepower engine although

much smoother and quieter. On a standard temperature day the rate of climb with three people in the aircraft was nearly 900 feet per minute off the runway. The reduction of emissions is considerable as the aircraft only burns about 6-8 gallons of jet fuel per hour. In summary the aircraft performed very well at Truckee and its performance mimicked that of a Cessna Skylane 182. The aircraft climbed fasted thus realizing an earlier power reduction with a commensurate noise duration reduction. The aircraft burns less fuel and has a smoother, quieter power band through the altitude changes reaching cruise flight. Its performance in high density altitude conditions common to Truckee in the summer would be significant based on the turbo normalized diesel.

From a noise perspective the JT-A aircraft was significantly quieter than the standard Cessna 172 Skyhawk (N1968F) in the overflight phase. Decibel is a logarithmic measurement of total sound energy. 2 db is perceptible to the human ear, 3 db is noticeable, 6 db, measured by the human ear is roughly half as loud when compared to the baseline for this type of measurement. The JT-A aircraft was not quieter than N1968F during the 2017 static run-up test. This was puzzling and detailed discussions with HMMH did not yield any answers. The JT-A aircraft was noticeably quieter while taxiing on the ramp. The noise test was inconsistent between 2015 and 2017. Many variables contribute to this, temperature, flight path, wind, pilot, aircraft position, loading etc. In summary HMMH is confident that the JT-A aircraft is around 6 db quieter while flying over neighborhoods adjacent to the airport which while be about 50% quieter to the human ear. The run-up noise from the JT-A is about the same as N1968F. The JT-A climbs faster and has a shorter noise duration as power reductions for landing can be achieved sooner; this reduces noise to the surrounding neighborhoods.

Staff, along with HMMH has concluded the Cessna JT-A diesel aircraft will be noticeably quieter while making repeat operations at Truckee Tahoe airport. This is by design and also a function of increased vertical performance allowing shorter durations of single event noise as power may be reduced sooner as compared to the current training aircraft N1968F. The total acquisition cost of the aircraft, the anticipated rental revenue, and all the associated variable cost are outlined in the attached pro-forma. The lease back concept would allow Sierra Aero to effectively manage the aircraft for instruction and rental purposes while removing one standard Cessna Skyhawk from their available fleet. Provisions within the leaseback agreement would outline acceptable pilot conduct including compliance with all noise abatement procedures, curfews, and routes. The available revenue after cost will be returned to the District. The reductions in community annoyance would be subsidized at a rate equal to the net operating revenue which will be negative over the ten year term. Again, the Board is not expected to make a financial decision immediately. This report is useful for planning purposes and is designed to give the Board and Staff some planning direction on next steps.

WHAT'S NEXT: Direct Staff to bring forward final financial pro-forma supporting material and sample lease back agreements to Sierra Aero. Alternatively direct Staff on potential next steps if any.

FISCAL IMPACT: Potentially significant. Total cost is approximately $515,000 for aircraft acquisition including sales tax, licensing, etc. Per the proforma, the aircraft generates revenue to offset a portion of these costs. The aircraft is a tangible asset which could be sold if the program is deemed unsuccessful recovering a significant portion of the initial acquisition costs. Funding is budgeted in the CY2018 Budget.

PUBLIC COMMUNICATIONS: Staff announced the test to all the surrounding neighborhoods within the regular media channels. Additional communications to the flight instructor community took place by phone. Additional outreach efforts included multiple discussions and noticed public Board meetings.

SAMPLE MOTION(S): Discussion item only

ATTACHMENTS:
KTRK – Turbo Skyhawk – Proforma
HMMH REDBIRD
Skyhawk_JTA_ProductCard
TRK_AircraftNoiseComparisonResultMemorandum_Final

Truckee Tahoe Airport District
Cessna 172JT-A - Turbo Skyhawk
Financial Proforma - Results & Assumptions
9/19/17

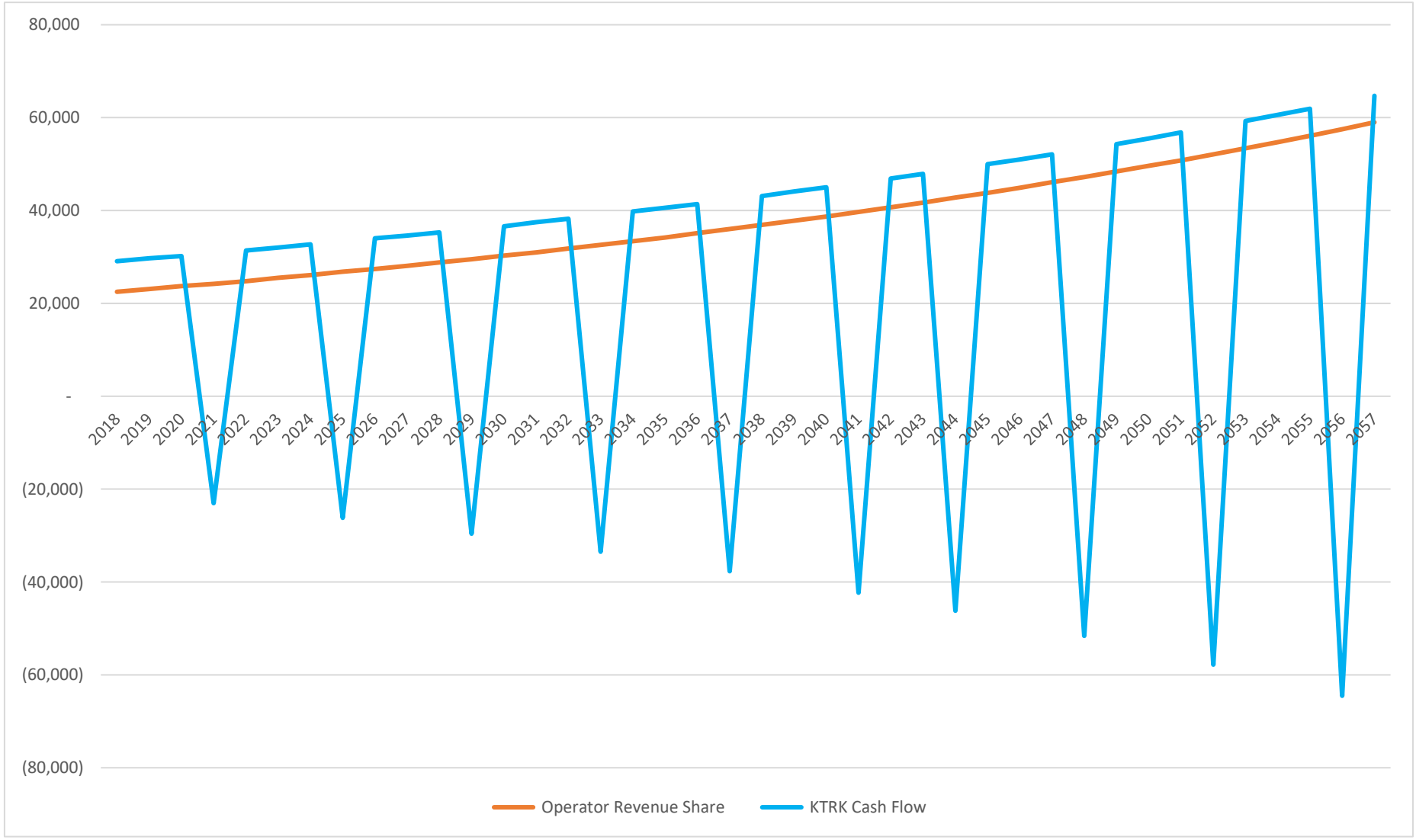
Results

		2018-2027	2028-2037	2038-2047	2048-2057	Total
Total Net Cash Flow						
Revenue		1,008,400	1,290,700	1,652,300	2,115,000	6,066,400
Expenditures						
Acquisition Cost		492,600	-	-	-	492,600
Operations		342,200	438,300	561,100	718,000	2,059,600
Maintenance		281,500	433,100	458,500	701,000	1,874,100
Total Expenditures		1,116,300	871,400	1,019,600	1,419,000	4,426,300
Total Net Cash Flow		(107,900)	419,300	632,700	696,000	1,640,100
KTRK Cash Flow						
Total Net Cash Flow		(107,900)	419,300	632,700	696,000	1,640,100
Operator Share	25.00%	(252,200)	(322,700)	(413,100)	(528,800)	(1,516,800)
Fuel Gross Margin		72,000	72,000	72,000	72,000	288,000
Net KTRK Cash Flow		(288,100)	168,600	291,600	239,200	411,300
Payback Period (Break-Even)						2040

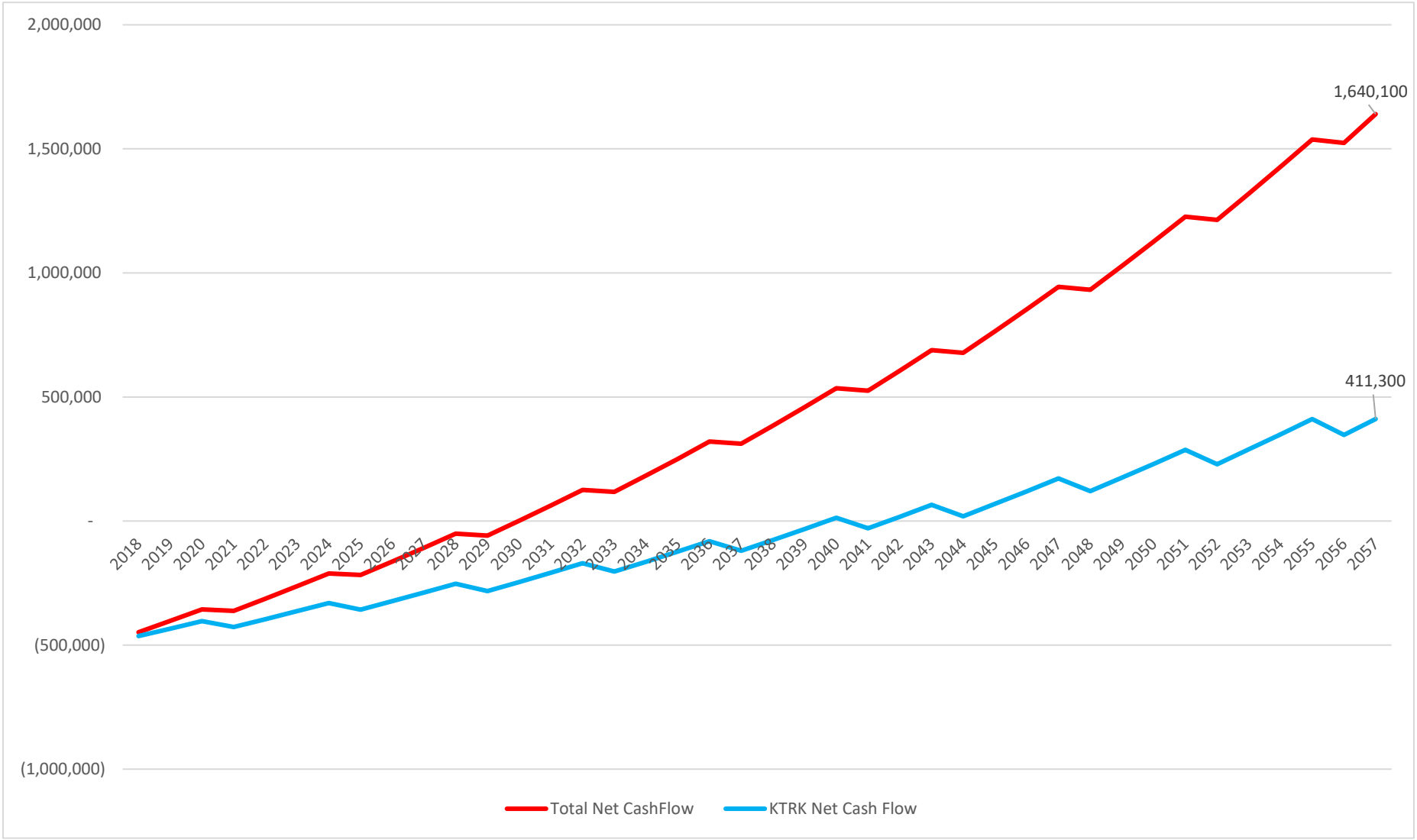
Assumptions

Revenue			
Rate / Hour		150	
Hours / Year		600	
Inflation Factor		2.50%	
Revenue Split		25.00%	
Expenditures			
Acquisition Cost			
Purchase Price		435,000	
Sales Tax	7.50%	32,600	
Upfit & Contingency		25,000	
Total Acquisition Cost		492,600	
Operations			
Gallons / Hour		6	need verification
Fuel $ / Gallon		5.00	Jet A or Diesel
Fuel $ Gross Margin / Gallon		2.00	Recovered by KTRK
Storage / Month		380	
Insurance / Year		8,000	
Operations			
100 Hour Inspection - Cost		2,500	
Engine & Prop Replacement - Cost		50,000	
Engine & Prop Replacement - Hours		2,300	

Truckee Tahoe Airport District
Cessna 172JT-A - Turbo Skyhawk
Annual Cash Flow - After Acquisition
9/19/2017



Truckee Tahoe Airport District
Cessna 172JT-A - Turbo Skyhawk
Cumulative Cash Flow
9/19/2017



Truckee Tahoe Airport District
Cessna 172JT-A - Turbo Skyhawk
Sensitivity Tables - Rental Rate & Hours/Year - 40 Year Return
9/19/2017

Total Net Cash Flow

Rental Rate and Hours/Year Sensitivity - 40 Year Return

Hours / Year	Rental Rate / Hour 150	155	160	165	170	175	180
500	1,180,400	1,348,600	1,517,500	**1,685,800**	**1,854,200**	**2,022,600**	**2,191,400**
550	1,410,800	1,596,600	**1,781,400**	**1,966,700**	**2,151,900**	**2,337,500**	**2,522,700**
600	**1,640,100**	**1,842,000**	**2,044,400**	**2,246,400**	**2,448,800**	**2,651,200**	**2,853,000**
650	**1,870,700**	**2,089,800**	**2,308,500**	**2,527,600**	**2,746,500**	**2,966,000**	**3,184,900**
700	**2,097,600**	**2,333,300**	**2,569,100**	**2,804,900**	**3,040,700**	**3,277,100**	**3,512,800**
750	**2,329,200**	**2,581,800**	**2,834,600**	**3,087,200**	**3,340,100**	**3,592,600**	**3,845,600**
800	**2,690,600**	**2,960,300**	**3,229,700**	**3,499,300**	**3,769,000**	**4,038,400**	**4,308,200**

KTRK Net Cash Flow

Rental Rate and Hours/Year Sensitivity - 40 Year Return

Hours / Year	Rental Rate / Hour 150	155	160	165	170	175	180
500	156,400	281,900	408,900	**535,000**	**661,400**	**787,500**	**914,600**
550	284,000	**423,500**	**562,100**	**701,000**	**839,900**	**979,400**	**1,118,000**
600	**411,300**	**562,500**	**714,400**	**865,700**	**1,017,400**	**1,169,100**	**1,320,700**
650	**539,100**	**703,400**	**867,600**	**1,032,100**	**1,196,000**	**1,360,500**	**1,525,000**
700	**663,500**	**840,400**	**1,017,200**	**1,194,300**	**1,370,900**	**1,548,200**	**1,725,300**
750	**793,000**	**982,500**	**1,171,800**	**1,361,300**	**1,551,100**	**1,740,700**	**1,929,900**
800	**1,051,800**	**1,254,300**	**1,456,500**	**1,658,800**	**1,861,300**	**2,062,600**	**2,265,300**

Truckee Tahoe Airport District
Cessna 172JT-A - Turbo Skyhawk
Sensitivity Tables - Rental Rate & Operator Share - 40 Year Return
9/19/2017

Total Net Cash Flow

Rental Rate and Operator Share Sensitivity - 40 Year Return

Operator Share	Rental Rate / Hour 150	155	160	165	170	175	180
22%	1,640,100	1,842,000	2,044,400	2,246,400	2,448,800	2,651,200	2,853,000
23%	1,640,100	1,842,000	2,044,400	2,246,400	2,448,800	2,651,200	2,853,000
24%	1,640,100	1,842,000	2,044,400	2,246,400	2,448,800	2,651,200	2,853,000
25%	1,640,100	1,842,000	2,044,400	2,246,400	2,448,800	2,651,200	2,853,000
26%	1,640,100	1,842,000	2,044,400	2,246,400	2,448,800	2,651,200	2,853,000
27%	1,640,100	1,842,000	2,044,400	2,246,400	2,448,800	2,651,200	2,853,000
28%	1,640,100	1,842,000	2,044,400	2,246,400	2,448,800	2,651,200	2,853,000
29%	1,640,100	1,842,000	2,044,400	2,246,400	2,448,800	2,651,200	2,853,000
30%	1,640,100	1,842,000	2,044,400	2,246,400	2,448,800	2,651,200	2,853,000

KTRK Net Cash Floq

Rental Rate and Operator Share Sensitivity - 40 Year Return

Operator Share	Rental Rate / Hour 150	155	160	165	170	175	180
22%	593,600	751,100	908,900	1,066,400	1,224,300	1,382,100	1,539,700
23%	533,100	688,200	844,000	999,800	1,155,400	1,311,300	1,467,100
24%	472,100	625,500	779,200	933,000	1,087,000	1,240,700	1,394,600
25%	411,300	562,500	714,400	865,700	1,017,400	1,169,100	1,320,700
26%	350,700	500,200	649,900	799,600	949,100	1,098,900	1,248,000
27%	290,100	437,800	585,600	732,600	880,600	1,028,100	1,175,400
28%	229,500	374,900	520,600	665,900	811,800	957,300	1,102,300
29%	169,000	312,200	456,200	599,500	743,300	886,500	1,030,200
30%	108,000	249,400	391,000	532,400	674,300	816,100	956,700

Truckee Tahoe Airport District
Cessna 172JT-A - Turbo Skyhawk
Sensitivity Tables - Hours/Year & Operator Share - 40 Year Return
9/19/2017

Total Net Cash Flow

Hours/Year and Operator Share Sensitivity - 40 Year Return

Operator Share	Hours / Year						
	500	550	600	650	700	750	800
22%	1,180,400	1,410,800	**1,640,100**	**1,870,700**	**2,097,600**	**2,329,200**	**2,690,600**
23%	1,180,400	1,410,800	**1,640,100**	**1,870,700**	**2,097,600**	**2,329,200**	**2,690,600**
24%	1,180,400	1,410,800	**1,640,100**	**1,870,700**	**2,097,600**	**2,329,200**	**2,690,600**
25%	1,180,400	1,410,800	**1,640,100**	**1,870,700**	**2,097,600**	**2,329,200**	**2,690,600**
26%	1,180,400	1,410,800	**1,640,100**	**1,870,700**	**2,097,600**	**2,329,200**	**2,690,600**
27%	1,180,400	1,410,800	**1,640,100**	**1,870,700**	**2,097,600**	**2,329,200**	**2,690,600**
28%	1,180,400	1,410,800	**1,640,100**	**1,870,700**	**2,097,600**	**2,329,200**	**2,690,600**
29%	1,180,400	1,410,800	**1,640,100**	**1,870,700**	**2,097,600**	**2,329,200**	**2,690,600**
30%	1,180,400	1,410,800	**1,640,100**	**1,870,700**	**2,097,600**	**2,329,200**	**2,690,600**

KTRK Net Cash Flow

Hours/Year and Operator Share Sensitivity - 40 Year Return

Operator Share	Hours / Year						
	500	550	600	650	700	750	800
22%	308,400	**451,400**	**593,600**	**736,800**	**876,500**	**1,021,000**	**1,294,900**
23%	257,600	395,500	**533,100**	**671,000**	**805,700**	**944,800**	**1,214,500**
24%	206,800	340,300	**472,100**	**605,400**	**735,100**	**869,200**	**1,133,400**
25%	156,400	284,000	**411,300**	**539,100**	**663,500**	**793,000**	**1,051,800**
26%	105,900	228,500	350,700	**473,800**	**593,300**	**717,700**	**971,300**
27%	55,300	173,500	290,100	408,300	**522,500**	**642,000**	**890,400**
28%	4,700	117,800	229,500	342,200	**451,700**	**566,400**	**810,000**
29%	(45,500)	61,900	169,000	276,500	380,900	**490,400**	**728,900**
30%	(96,300)	6,500	108,000	211,100	310,500	**413,700**	**647,800**

Truckee Tahoe Airport District
Cessna 172JT-A - Turbo Skyhawk
Financial Proforma - Summary
9/19/17

		1 2018	2 2019	3 2020	4 2021	5 2022	6 2023	7 2024	8 2025	9 2026	10 2027	1-10 2018-2027	11 2028-2037	12 2038-2047	13 2048-2057	Total
Revenue																
Rate / Hour		150	150	150	150	150	150	150	150	150	150	150	150	150	150	
Hours		600	600	600	600	600	600	600	600	600	600	6,000	6,000	6,000	6,000	24,000
Revenue before inflation		90,000	90,000	90,000	90,000	90,000	90,000	90,000	90,000	90,000	90,000	900,000	900,000	900,000	900,000	3,600,000
Inflation Factor	2.50%	100.00%	102.50%	105.06%	107.69%	110.38%	113.14%	115.97%	118.87%	121.84%	124.89%	112.04%	143.41%	183.59%	235.00%	
Total Revenue		90,000	92,300	94,600	96,900	99,300	101,800	104,400	107,000	109,700	112,400	1,008,400	1,290,700	1,652,300	2,115,000	6,066,400
Expenditures																
Acquisition Cost		492,600	-	-	-	-	-	-	-	-	-	492,600	-	-	-	492,600
Operations																
Fuel																
Hours / Year		600	600	600	600	600	600	600	600	600	600	6,000	6,000	6,000	6,000	24,000
Rate / Hour		6	6	6	6	6	6	6	6	6	6	6	6	6	6	
Total Gallons / Year		3,600	3,600	3,600	3,600	3,600	3,600	3,600	3,600	3,600	3,600	36,000	36,000	36,000	36,000	144,000
Fuel $ / Gallon		5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	
Total Fuel Cost		18,000	18,000	18,000	18,000	18,000	18,000	18,000	18,000	18,000	18,000	180,000	180,000	180,000	180,000	720,000
Storage		4,560	4,560	4,560	4,560	4,560	4,560	4,560	4,560	4,560	4,560	45,600	45,600	45,600	45,600	182,400
Insurance		8,000	8,000	8,000	8,000	8,000	8,000	8,000	8,000	8,000	8,000	80,000	80,000	80,000	80,000	320,000
Total Operations		30,560	30,560	30,560	30,560	30,560	30,560	30,560	30,560	30,560	30,560	305,600	305,600	305,600	305,600	1,222,400
Maintenance																
Annual Maintenance																
100 Hour Inspection - Cost		2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	
100 Hour Inspections		6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	60.00	60.00	60.00	60.00	240.00
Annual Maintenance		15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	150,000	150,000	150,000	150,000	600,000
Engine & Prop Replacement																
Engine & Prop Replacement - Cost		50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	
Engine & Prop Replacements		-	-	-	1	-	-	-	1	-	-	2	3	2	3	12
Engine & Prop Replacement - Cost		-	-	-	50,000	-	-	-	50,000	-	-	100,000	150,000	100,000	150,000	500,000
Total Maintenance		15,000	15,000	15,000	65,000	15,000	15,000	15,000	65,000	15,000	15,000	250,000	300,000	250,000	300,000	1,350,000
Total Cost		538,160	45,560	45,560	95,560	45,560	45,560	45,560	95,560	45,560	45,560	1,048,200	605,600	555,600	605,600	3,863,200
Inflation Factor		100.00%	102.50%	105.06%	107.69%	110.38%	113.14%	115.97%	118.87%	121.84%	124.89%	112.04%	143.41%	183.59%	235.00%	
Total Cost after Inflation		538,200	46,700	47,900	102,900	50,300	51,500	52,800	113,600	55,500	56,900	1,116,300	871,400	1,019,600	1,419,000	4,426,300
Total Net Cash Flow		(448,200)	45,600	46,700	(6,000)	49,000	50,300	51,600	(6,600)	54,200	55,500	(107,900)	419,300	632,700	696,000	1,640,100
KTRK Net Cash Flow																
Total Net Cash Flow		(448,200)	45,600	46,700	(6,000)	49,000	50,300	51,600	(6,600)	54,200	55,500	(107,900)	419,300	632,700	696,000	1,640,100
Operator Share		(22,500)	(23,100)	(23,700)	(24,200)	(24,800)	(25,500)	(26,100)	(26,800)	(27,400)	(28,100)	(252,200)	(322,700)	(413,100)	(528,800)	(1,516,800)
Fuel Gross Margin		7,200	7,200	7,200	7,200	7,200	7,200	7,200	7,200	7,200	7,200	72,000	72,000	72,000	72,000	288,000
KTRK Net Cash Flow		(463,500)	29,700	30,200	(23,000)	31,400	32,000	32,700	(26,200)	34,000	34,600	(288,100)	168,600	291,600	239,200	411,300

HMMH
8880 Cal Center Drive, Suite 430
Sacramento, California 95826
916.368.0707
www.hmmh.com

MEMORANDUM

To:	Hardy S. Bullock Director of Aviation & Community Services Truckee Tahoe Airport District 10356 Truckee Airport Rd. Truckee, CA 96160
From:	Rhea A. Gundry Senior Consultant
Date:	July 9, 2015
Subject:	Measured Aircraft Noise Comparison
Reference:	HMMH Job No.307560.000

HMMH assisted Truckee Tahoe Airport (TRK) to compare noise levels of two, fixed wing single-engine aircraft: (1) A standard Cessna 172N (N1968F) that is based at TRK and (2) A RedHawk Cessna 172P (N64686) with a retrofitted Jet A diesel engine and smaller diameter three bladed propeller. TRK arranged for the RedHawk to fly in from Texas for a side by side comparison of these nearly identical aircraft to demonstrate the difference in noise level with the retrofitted diesel engine.

This memorandum provides the results of the noise measurements conducted on June 24, 2015 at TRK and in the nearby surrounding community.

HMMH deployed four (4) Rion 22 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. 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 demonstration aircraft noise events captured by the noise meters.

Formatted: Font: 14 pt

Commented [RAH1]: Can we get the flight tracks in KML files format to display on google earth?

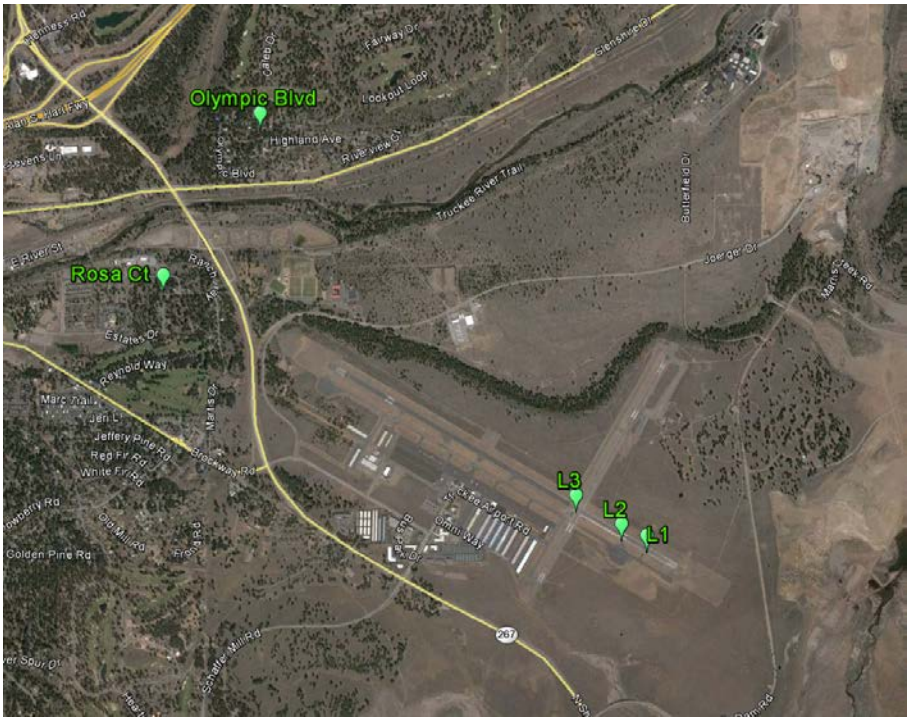


Figure 1 Noise Monitoring Sites

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

Table 1 shows the measured noise levels of both aircraft for each of the above identified aircraft events and the noise level difference between the standard aircraft and the retrofitted (RedHawk) aircraft. The RedHawk, with the retrofitted diesel engine, is approximately 8 dB quieter than the standard (non-retrofitted aircraft) on the airfield. The arrival event, touchdown and final taxi, is the exception with the RedHawk only 2 dB quieter.

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

Event	Standard	RedHawk	Difference
L1	98.6	90.1	-8.5
L2	90.9	82.8	-8.0

Formatted: Font: 12 pt

L3-1	94.6	85.8	-8.8
L3-2	72.8	70.5	-2.3
Note: Noise levels presented herein are A-weighted SENEL in dB			

Table 2 and Table 3 show the noise level results for each demonstration aircraft event measured at each community location and the average noise level of all demonstration aircraft events. While the aircraft operations of each aircraft were not completely identical, the pilots attempted to maintain similar aircraft path, altitude and weight for the standard aircraft and the RedHawk. On average the RedHawk is 5 to 10 dB quieter than the standard aircraft, which is in the range of a perception of being "half as loud".

Formatted: Font: 12 pt

Table 2: Noise Levels from Aircraft Operations as Measured at Rosa Ct.

Event	Standard	RedHawk	Difference
E1	78.6	71.2	-7.4
E2	79.0	70.4	-8.7
E3	81.4	78.2	-3.1
Average	79.8	74.8	-5.1
Note: Noise levels presented herein are A-weighted SENEL in dB			

Table 3: Noise Levels from Aircraft Operations as Measured at Olympic Blvd.

Event	Standard	RedHawk	Difference
E1	82.1	72.2	-9.9
E2	83.3	71.9	-11.5
E3	81.3	71.9	-9.4
Average	82.3	72.0	-10.3
Note: Noise levels presented herein are A-weighted SENEL in dB			

Formatted: Font: 12 pt

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 engine. Leq is the equivalent sound level measured throughout the noise event as though the sound level was constant throughout the event. Figure 2 shows a side by side comparison of the directivities of each aircraft in terms of the Leq noise metric.

HMMH
8880 Cal Center Drive, Suite 430
Sacramento, California 95826
916.368.0707
www.hmmh.com

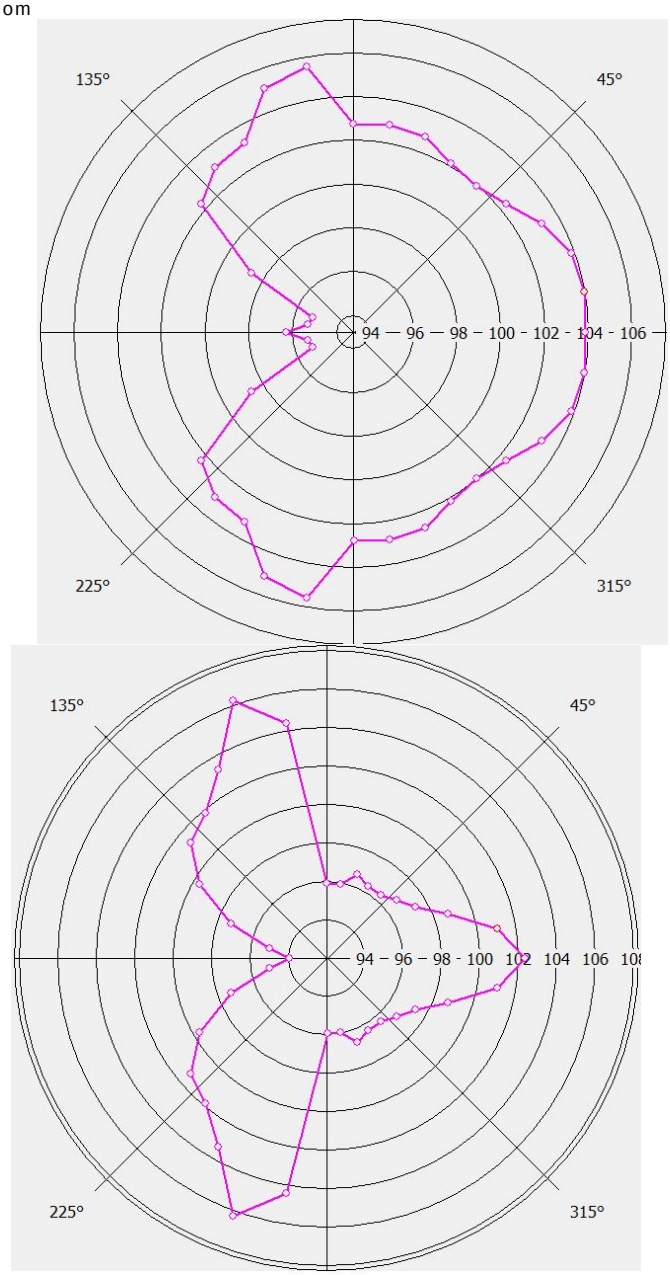


Figure 2 Directivity of 1968F (top) and RedHawk (bottom)

Note: Engine at center, nose/propeller of plane facing 0°

HMMH
1508 Eureka Road, Suite 190
Roseville, CA 95661
916.368.0707
www.hmmh.com

TECHNICAL MEMORANDUM

To:	Hardy S. Bullock Director of Aviation & Community Services Truckee Tahoe Airport District 10356 Truckee Airport Rd. Truckee, CA 96160
From:	Rhea Gundry Scott McIntosh
Date:	November 13, 2017
Subject:	Measured Aircraft Noise Comparison
Reference:	HMMH Project Number 309360.000

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[1] 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 Cessna172N 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.

[1] Measurements conducted on June 24, 2015

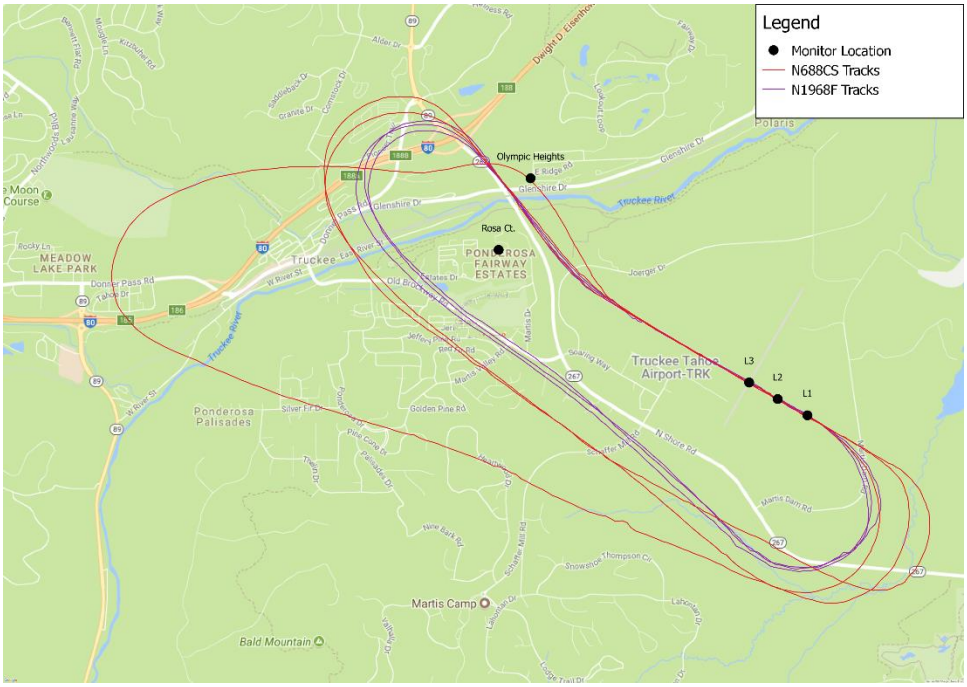


Figure 1. Study Area
Source: Map image and data © Google 2017

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[1]	75.9[2]	5.3
L3-1	94.6	85.8	-8.8	72.8[3]	85.7	12.9
L3-2	72.8	70.5	-2.3	88.5[4]	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[1]	-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.

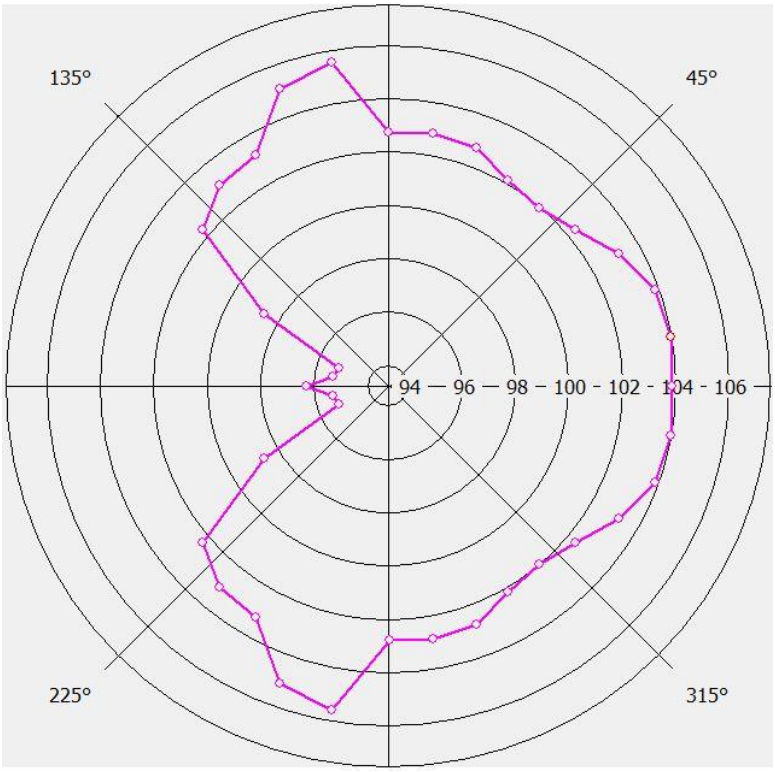


Figure 2. Directivity of N1968F (2015), Standard Cessna

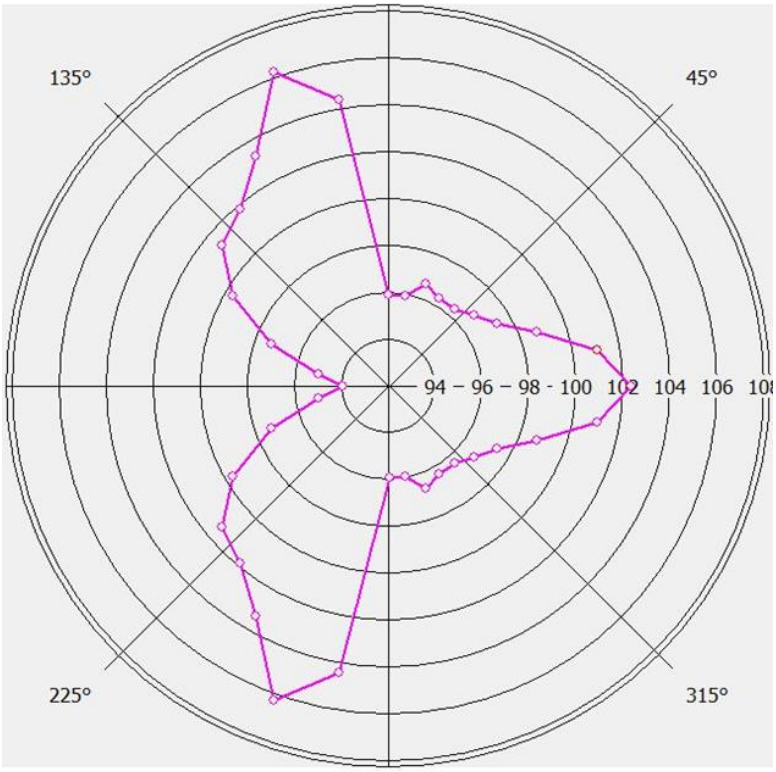


Figure 3. Directivity of N64686 (2015), RedHawk

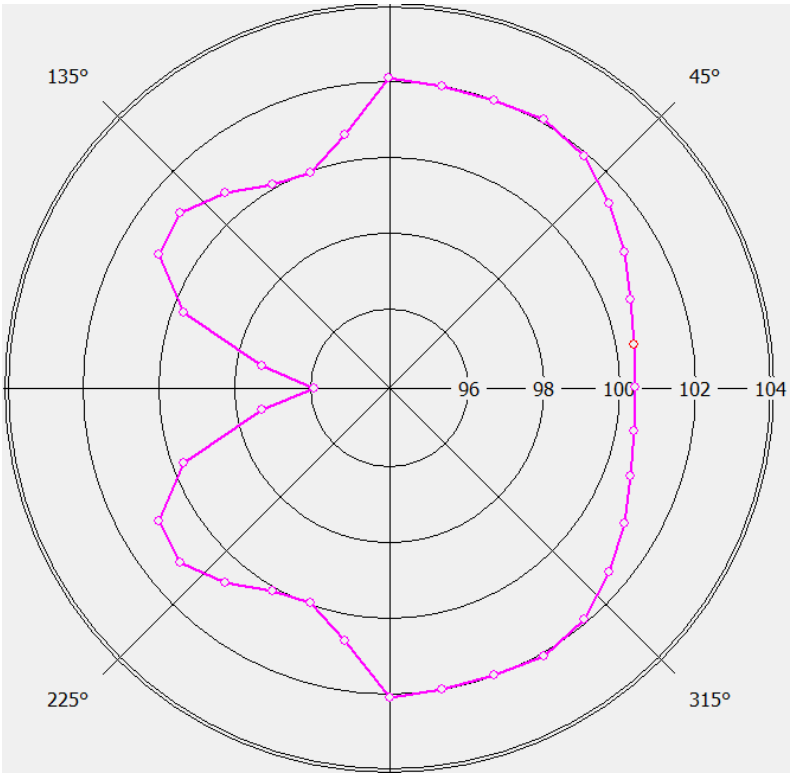


Figure 4. Directivity of N1968F (2017), Standard Cessna
Note: Scale for this directivity plot is different from the rest with a range of 96 dB – 104 dB

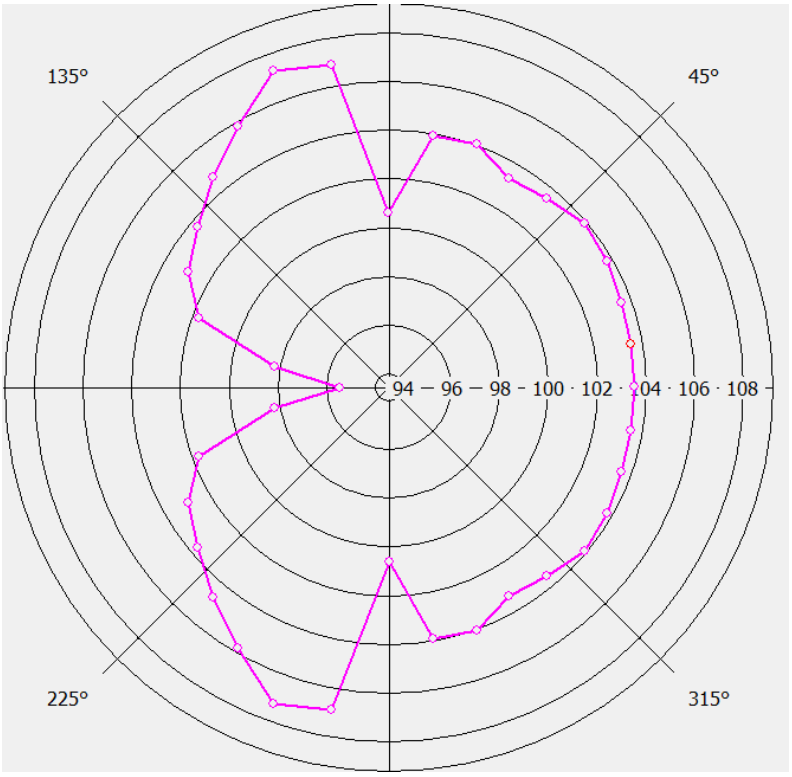


Figure 5. Directivity of N688CS (2017), JT-A Skyhawk

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.

TURBO SKYHAWK JT-A

NEW DIESEL ENGINE ALTERNATIVE

Cessna
TEXTRON AVIATION

CESSNA **TURBO SKYHAWK JT-A**

The Cessna® Turbo Skyhawk® JT-A aircraft features an advanced 155 horsepower turbo diesel Continental CD-155 engine for the world's leading flight trainer. This next generation trainer operates with better fuel efficiency, while preserving the renowned flying characteristics of the legendary Skyhawk.

- **Garmin™ G1000™ NXi avionics with enhanced graphics, faster hardware, new features and optional wireless connectivity**
- **Powered by a 155 hp Continental CD-155 turbo diesel engine burning Jet-A fuel**
- **Single lever power control and engine automation makes flying easy**
- **A 25% reduction in fuel burn at high speed cruise, and a 38% improvement in maximum range over the standard Skyhawk**
- **Proven rugged airframe with forgiving flying characteristics**

DIMENSIONS

Wingspan	36 ft 1 in	(11.00 m)
Length	27 ft 2 in	(8.28 m)
Height	8 ft 11 in	(2.72 m)

ENGINE

Continental CD-155	155 hp

WEIGHTS

Max Takeoff Weight	2,550 lb	(1,157 kg)
Empty Weight	1,780 lb	(807 kg)
Useful Load	772 lb	(350 kg)

PERFORMANCE

Takeoff Ground Roll	944 ft	(288 m)
Max Climb Rate	712 fpm	(217 mpm)
Max Cruise Speed	134 ktas	(248 km/h)
Max Range	885 nm	(1,639 km)

MAX OCCUPANTS	4

* Performance data is based on standard conditions with zero wind. Field performance assumes a level, hard surface, dry runway. Range is based on a ferry mission with 1 pilot at 60% power with 45 minutes reserve. All data is preliminary and subject to change.

Contact your Textron Aviation representative at

U.S. **+1.844.44.TXTAV** | INTERNATIONAL **+1.316.517.8270** | Cessna.com

*Optional equipment may be shown.