AVIATION CLEAN AIR

SURFACE AND AIR PURIFICATION COMPONENT

OZONE EMISSION TEST REPORT

GTR-ACA-OZ-0001

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1.0 Introduction

This report provides test results for two completely separate Ozone Emission testing's regarding the ACA Air and Surface Purification Component (Air Ionizer) performed by UL Environment Inc. (ISO 17025 accredited testing laboratory) and Aviation Clean Air Company.

The intent of ACA company test was to measure the Ozone Concertation by ACA unit(s) in accordance with 14 CFR Part 25. 832 guideline.

The test objectives were;

1) Evaluate and determine the actual Ozone emission by ACA unit within completely controlled isolated environment (ISO 17025) per UL867 Ozone test method / requirements of National Standard,
2) Evaluate and determine actual Ozone emission potential impact by a single or multi ACA units (Up to Qty of 6 Units operational simultaneously) when are installed within a typical controlled midsize to large size aircraft cabin interior.
3) Evaluate and substantiate compliance with 14 CFR Part 25.832 Cabin ozone concentration guidelines.

1.1 ACA Air and Surface Purification Component

The ACA Component produces positive and negative ions in addition to extremely small / negligible quantity of Ozone. The positive and negative ions are carried into the Cabin and Cockpit by the airflow provided by the aircraft Environmental Control System, Ions rapidly and proactively kill pathogens (MRSA, SARS, E.coli, C. diff, Tuberculosis, H1N1, H5N1, Polio, and more) in the air on surfaces plus rapidly controls most undesirable smells (Fuel odors, fuel emissions, body odors, cleaning agent odors, and more) and at the same time reduces allergens (mold spores) throughout the aircraft. The Component is located within the cabin baggage compartment (pressurized area) or upper deck (area above the cabin above the ceiling panels where the transmission ducts and remainder of the environmental conditioning systems located).

1.2 Test Standard / Specification

Number	Title
RTCA/DO-160	Environmental Conditions and Test Procedures for Airborne Equipment.
MIL-STD-810 F	Environmental Test Methods and Engineering Guidelines.
UL867	Ozone Test Method / Requirements of National Standard
ISO/IEC 17025	General requirements for the competence of testing and calibration laboratories

1.3 ACA Documents

Number	Title
ACA-RN-0001 NC	ACA IONIZATION UNIT ASSY DRAWINGS
ATP-ACA-RN-001	ACA IONIZATION UNIT ASSY ACCEPTANCE TEST PROCEDURE

2.0 Test Procedures

2.1 UL Test Procedure

The intent of testing is to identify the maximum values of ozone emission by ACA component, this was accomplished in two ways;

1. “Maximum Measured” is the raw maximum concentration (in ppm) at any given point, the highest point that the unit or component produced at any given point.

2. “5 minute rolling average” this uses a maximum average of 10 data points (accounting for the maximum concentration resulting from the averaging of 10 consecutive data collection points). The term “5 minute rolling average” is based on the fact that out of the whole test, they look for the 10 consecutive data points that represent the highest values. Sample rates are every half minute so 10 data points would be 5 minutes.

So based on the definitions above, the chart and ozone number provided in the report are the highest levels of any raw data points, which accounts for the .028ppm or a “5 minute rolling average” of 10 consecutive data points, which accounts for the .026ppm.

A more realistic “real” number look at the raw data for the unit UL had tested and provide the 3, 6 and 9 hour “true” average and this is the information provided:

- ✓ 0 to 3 hour average: .0165 ppm
- ✓ 0 to 6 hour average: .0150 ppm
- ✓ 0 to 9 hour average: .0145 ppm

2.2 ACA Test Procedure

The intent of ACA company test is to measure the Ozone Concertation by ACA unit(s) in accordance with 14 CFR Part 25. 832 guideline. Test was conducted in accordance with 14 CFR Part 25. 832 guidelines with respect to Atmospheric conditions.

1. Verify and record air supply CFM to test chamber
2. Turn on both fans within test chamber
3. Verify and record initial test chamber
   a. Temperature
   b. Relative humidity
   c. Pressure
4. After approximately 5 Mint record the information per following step
5. Verify and record following:
   a. Start Time
   b. Temperature
   c. Relative humidity
   d. Pressure
   e. Measure and record Ion counts using Ion counter at following location within the test chamber:

i. Approximately At ground level – 9 measurements
ii. Approximately At 32 in High – 9 measurements
iii. Approximately At 72 in High – 9 measurements

f. Measure and record Ozone level using Ozone Meter at following location within the test chamber:

i. Approximately At ground level – 9 measurements
ii. Approximately At 32 in High – 9 measurements
iii. Approximately At 72 in High – 9 measurements

6. After approximately 10 min, repeat Step 5.
7. Randomly , Power / turn on first ACA unit and record

a. ACA unit S/N
b. Unit location within test chamber
c. Time

8. After approximately 5 min, repeat Step 5.
9. After approximately 10 min, repeat Step 5.
10. After approximately 15 min, repeat step 5.
11. Randomly , Power / turn on 2nd ACA unit (total Qty 2 ACA operational) and record

a. ACA unit S/N
b. Unit location within test chamber
c. Time

12. After approximately 5 min, repeat Step 5.
13. After approximately 10 min, repeat Step 5.
14. After approximately 15 min, repeat step 5.
15. Repeat Step 11 to Step 14 for the 3rd (total Qty 3) , 4th (total Qty 4), 5th (total Qty 5) and 6th unit (total Qty 6).
16. Record the test completion time.

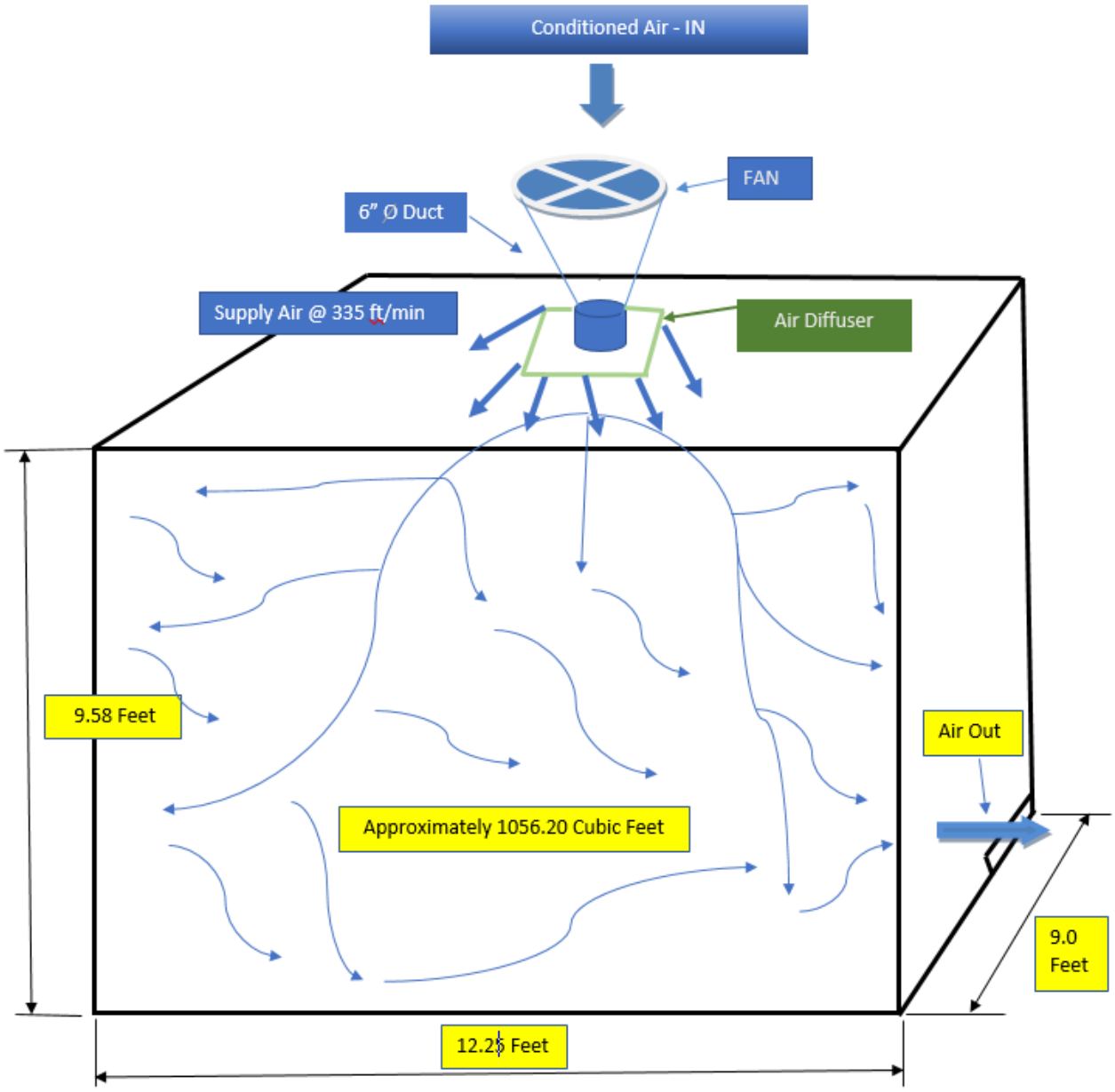

Figure 1. ACA Test Chamber

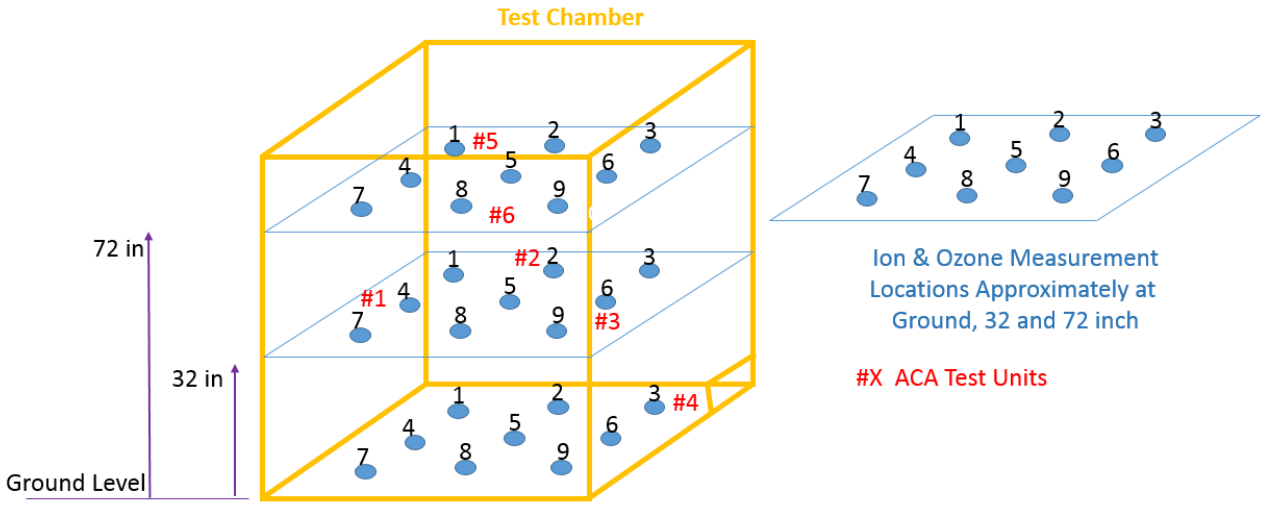

Figure 2. ACA Test Chamber Measurement Location

3.0 Test Results

3.1 UL Test Results

Based on the definitions of two ways to accomplish the values of ozone emission by ACA component, the chart and ozone number provided are the highest levels of any raw data points, which accounts for the .028ppm or a “5 minute rolling average” of 10 consecutive data points, which accounts for the .026ppm (Chart 1).

A more realistic “real” number look at the raw data (Charts 2 & 3) for the unit UL had tested and provide the 3, 6 and 9 hour “true” average and this is the information provided:

- ✓ 0 to 3 hour average: .0165 ppm
- ✓ 0 to 6 hour average: .0150 ppm
- ✓ 0 to 9 hour average: .0145 ppm

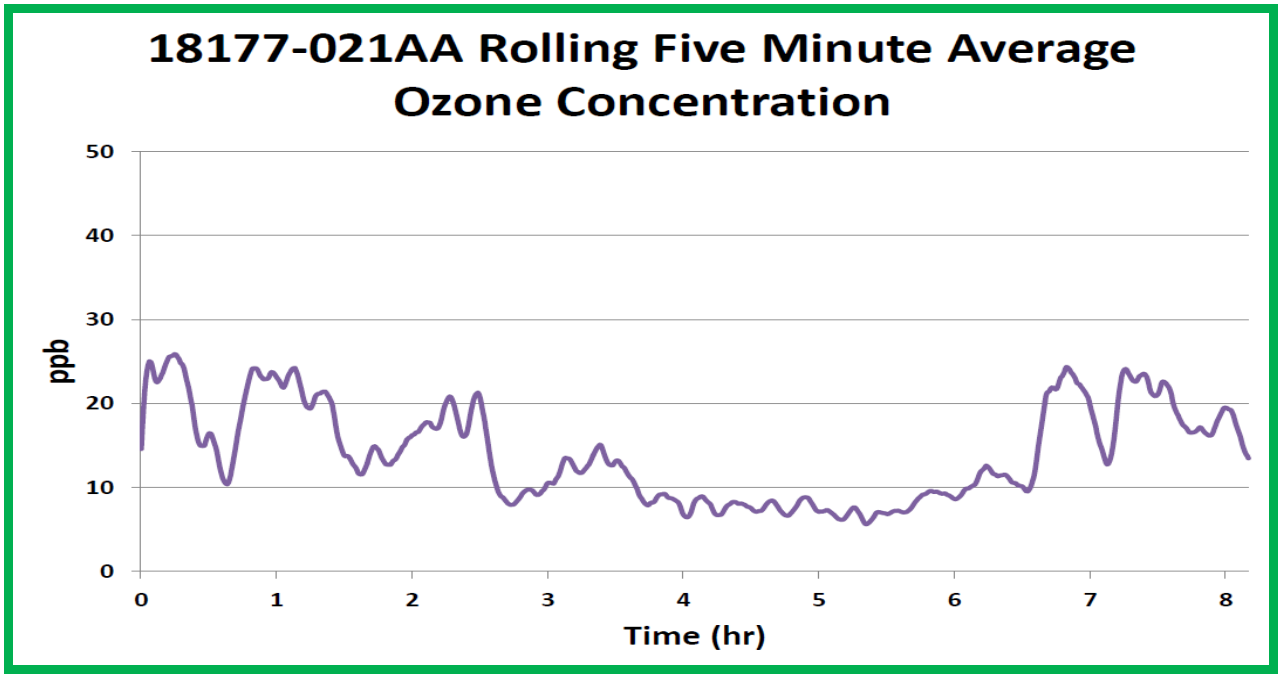

Chart 1. UL Test Results (Rolling Five Minutes Average)

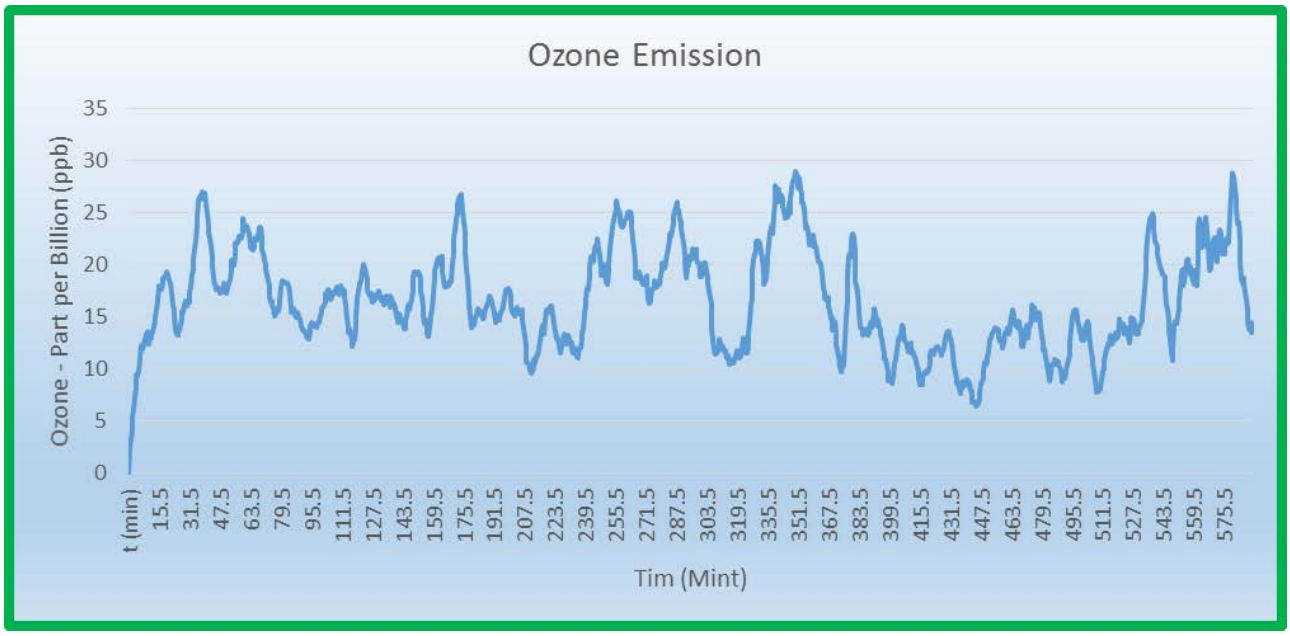

Chart 2. UL Raw Data (Part per Billion)

3.2 ACA Test Results

3.2.1 Test Equipment & Units Under Test

3.2.1.1 Test Equipment

A) Test Meter: Air Ion Counter (1000 ions/cm3) Model AIC, Alpha Labs Inc.
B) Test Meter: Ozone Meter O3, Model D-16
C) Ozone Analyser : UV-106L: Low Concentration Ozone Analyser

3.2.1.2 Units Under Test

Manufacturing: Aviation Clean Air
Model number: ACA-RN-0001
Part number: ACA-RN-0001-01

1) Test Unit 1: S/N, MF Date: 000116, 09/10/2018
2) Test Unit 2: S/N, MF Date: 000117, 09/10/2018
3) Test Unit 3: S/N, MF Date: 000118, 09/10/2018
4) Test Unit 4: S/N, MF Date: 000119, 09/10/2018
5) Test Unit 5: S/N, MF Date: 000120, 09/10/2018
6) Test Unit 6: S/N, MF Date: 000121, 09/10/2018

3.2.2 Test Results / Raw Data (Samples)

A) No ACA Unit Operational

Step 1:	Time:	2:28 PM									
	Chamber Air supply (CFM):	408.4 cfm									
	Chamber Temperature (deg F):	77 f									
	Chamber Relative humidity (%):	36%									
	Chamber Pressure (mb):	971.1 mb									
After 5 Mint											
Step 5:	Start Time:	2:33 PM									
	Chamber Temperature (deg F):	77									
	Chamber Relative humidity (%):	37%									
	Chamber Pressure (mb):	971.1 mb									
			Pos # 1:	Pos #2:	Pos # 3:	Pos #4:	Pos # 5:	Pos #6:	Pos # 7:	Pos #8:	Pos #9:
Step 5(e):	ION Count (Pos):	Ground Level:	0.9	1.01	0.48	0.93	0.29	0.45	0.17	0.08	0.23
		Mid (32 Inch):	0.12	0.07	0.11	0.68	0.56	0.56	0.61	0.58	0.26
		Top (72 Inch):	0.41	0.34	0.34	0.19	0.59	0.48	0.7	0.7	0.83
			Pos # 1:	Pos #2:	Pos # 3:	Pos #4:	Pos # 5:	Pos #6:	Pos # 7:	Pos #8:	Pos #9:
Step 5(e):	ION Count (Neg):	Ground Level:	-.79	-0.51	-0.35	-0.5	-0.2	-0.4	-0.09	-0.03	-0.07
		Mid (32 Inch):	-0.51	-0.99	-0.61	-0.52	-0.88	-0.89	-0.63	-0.64	-0.5
		Top (72 Inch):	-0.95	-0.89	-1.04	-0.64	-0.85	-0.88	-0.59	-1	-0.83
			Pos # 1:	Pos #2:	Pos # 3:	Pos #4:	Pos # 5:	Pos #6:	Pos # 7:	Pos #8:	Pos #9:
Step 5(f):	Ozone Level: (PPM)	Ground Level:	17.9	15	13	10.3	14.3	13.6	13.7	11.6	11.9
	Part per Billion(ppb)	Mid (32 Inch):	14.6	14.3	15.8	16.9	12	14.8	16	13.5	10.9
		Top (72 Inch):	13.7	17.7	14	15.9	11	15	14.7	12.8	14.8
After 10 Mint			Pos # 1:	Pos #2:	Pos # 3:	Pos #4:	Pos # 5:	Pos #6:	Pos # 7:	Pos #8:	Pos #9:
Step 5(f):	Ozone Level:	Ground Level:	13.4	13.8	14.2	11.9	7.8	8.7	11	12.1	13.1
	Part per Billion(ppb)	Mid (32 Inch):	12.4	14.6	15.8	15.5	14.9	14.9	16.2	16.2	14.9
		Top (72 Inch):	16.3	13.4	13.4	10.2	13.2	13.8	13.9	13.2	11.5

Average Measured Ozone - No ACA Unit Operational*:

- ✓ Ground Level: .01263 ppm / 12.63 ppb
- ✓ Mid (32 Inch Height): .01467 ppm / 14.67 ppb
- ✓ Top (72 Inch Height): .01381 ppm / 13.81 ppb

* The intent of this test was to establish baseline for the average Ambient Ozone level in the environment. This “Ambient Ozone” is naturally occurring and existing in the environment.

B) One ACA Unit Operational

After 5 Mint			Pos # 1:	Pos #2:	Pos # 3:	Pos #4:	Pos # 5:	Pos #6:	Pos # 7:	Pos #8:	Pos #9:
Step 5(f):	Ozone Level:	Ground Level:	11.6	14.3	16.5	15.5	11.1	11.5	11	12.1	14.3
	Part per Billion(ppb)	Mid (32 Inch):	13.7	13.7	13.7	15.4	15.3	15.3	13.1	16	16.6
		Top (72 Inch):	13.9	14.4	14.4	15.8	15	13	10.8	11.1	15

After 10 Mint			Pos # 1:	Pos #2:	Pos # 3:	Pos #4:	Pos # 5:	Pos #6:	Pos # 7:	Pos #8:	Pos #9:
Step 5(f):	Ozone Level:	Ground Level:	14.4	15.4	16.4	13.3	12.3	12.3	10.7	10	11.4
	Part per Billion(ppb)	Mid (32 Inch):	12.2	12.8	12.8	13.3	13.1	16.3	17.3	13.2	11.2
		Top (72 Inch):	10.1	10.1	13.3	15.4	11.1	11.1	10.5	11.1	13.4

After 15 Mint			Pos # 1:	Pos #2:	Pos # 3:	Pos #4:	Pos # 5:	Pos #6:	Pos # 7:	Pos #8:	Pos #9:
Step 5(f):	Ozone Level:	Ground Level:	10.7	11.5	11.5	11.3	12.3	12.9	12	9.7	11.4
	Part per Billion(ppb)	Mid (32 Inch):	14.2	11.9	11.9	10	10	10.4	12.1	10.8	8.4
		Top (72 Inch):	11.8	15	14.4	13.2	13.2	11.7	13.5	13.7	11

Average Measured Ozone - One ACA Unit Operational:

- ✓ Ground Level: .01250 ppm / 12.50 ppb
- ✓ Mid (32 Inch Height): .01214 ppm / 13.14 ppb
- ✓ Top (72 Inch Height): .01285 ppm / 12.85 ppb

C) Two (2) ACA Units Operational

After 5 Mint			Pos # 1:	Pos #2:	Pos # 3:	Pos #4:	Pos # 5:	Pos #6:	Pos # 7:	Pos #8:	Pos #9:
Step 5(f):	Ozone Level:	Ground Level:	13	10.9	12.4	9.6	7.3	15.9	16	12	10.5
	Part per Billion(ppb)	Mid (32 Inch):	10.8	11.9	13.9	12.1	12.5	12.7	10.7	11.8	12.9
		Top (72 Inch):	12.2	10.8	13	14.7	12.9	12.9	15.3	13.8	12.7

After 10 Mint			Pos # 1:	Pos #2:	Pos # 3:	Pos #4:	Pos # 5:	Pos #6:	Pos # 7:	Pos #8:	Pos #9:
Step 5(f):	Ozone Level:	Ground Level:	12.7	14.8	10.5	11.5	14.8	14.5	10.5	11.8	11.5
	Part per Billion(ppb)	Mid (32 Inch):	13.1	12	11.1	8.6	10.9	12.1	12.3	14.5	13.5
		Top (72 Inch):	12.4	11.5	12.8	13.5	14.1	12.6	10	10.7	10.3

After 15 Mint			Pos # 1:	Pos #2:	Pos # 3:	Pos #4:	Pos # 5:	Pos #6:	Pos # 7:	Pos #8:	Pos #9:
Step 5(f):	Ozone Level:	Ground Level:	9.5	6.7	14.4	10.8	14.9	15.6	15.1	16.3	12.8
	Part per Billion(ppb)	Mid (32 Inch):	13.6	13.5	10.6	15	15	13.1	9.6	10.8	11.1
		Top (72 Inch):	11.5	14.1	15.5	13.5	13.6	13.3	14.5	11.8	10.1

Average Measured Ozone - Two (2) ACA Units Operational:

- ✓ Ground Level: .01246 ppm / 12.46 ppb
- ✓ Mid (32 Inch Height): .01221 ppm / 12.21 ppb
- ✓ Top (72 Inch Height): .01274 ppm / 12.74 ppb

D) Six (6) ACA Units Operational

After 5 Mint		6 ACA Unit									
Step 15D:	Start Time:	9:26 PM									
	Chamber Temperature (deg F):	79 F									
	Chamber Relative humidity (%):	36%									
	Chamber Pressure (psi):	973.6 mb									
			Pos # 1:	Pos #2:	Pos # 3:	Pos #4:	Pos # 5:	Pos #6:	Pos # 7:	Pos #8:	Pos #9:
Step 5(e):	ION Count (Pos):	Ground Level:	+1 held	+1 held	+1 held	+1 held	+1 held	+1 held	+1 held	+1 held	+1 held
		Mid (32 Inch):	+1 held	+1 held	+1 held	+1 held	+1 held	+1 held	+1 held	+1 held	+1 held
		Top (72 Inch):	+1 held	+1 held	+1 held	+1 held	+1 held	+1 held	+1 held	+1 held	+1 held
			Pos # 1:	Pos #2:	Pos # 3:	Pos #4:	Pos # 5:	Pos #6:	Pos # 7:	Pos #8:	Pos #9:
Step 5(e):	ION Count (Neg):	Ground Level:	-1 held	-1 held	-1 held	-1 held	-1 held	-1 held	-1 held	-1 held	-1 held
		Mid (32 Inch):	-1 held	-1 held	-1 held	-1 held	-1 held	-1 held	-1 held	-1 held	-1 held
		Top (72 Inch):	-1 held	-1 held	-1 held	-1 held	-1 held	-1 held	-1 held	-1 held	-1 held
			Pos # 1:	Pos #2:	Pos # 3:	Pos #4:	Pos # 5:	Pos #6:	Pos # 7:	Pos #8:	Pos #9:
Step 5(f):	Ozone Level:	Ground Level:	16.7	15.7	14.3	15.2	15.8	13.5	13.3	15.1	14.9
	Part per Billion(ppb)	Mid (32 Inch):	14.2	15	14.9	14.7	16.5	16	16.6	16.3	15.9
		Top (72 Inch):	15.8	16.4	17.2	16.5	12	9.4	13.4	10.4	10.4

After 10 Mint			Pos # 1:	Pos #2:	Pos # 3:	Pos #4:	Pos # 5:	Pos #6:	Pos # 7:	Pos #8:	Pos #9:
Step 5(f):	Ozone Level:	Ground Level:	15.9	15	13.7	12.4	11.8	13.6	15.8	16.7	13.8
	Part per Billion(ppb)	Mid (32 Inch):	12.3	15.6	17.7	15	13.2	15.2	14.1	13	13.8
		Top (72 Inch):	15.8	15.5	12.8	15.5	19.5	17.7	14.7	15.8	16.4

After 15 Mint			Pos # 1:	Pos #2:	Pos # 3:	Pos #4:	Pos # 5:	Pos #6:	Pos # 7:	Pos #8:	Pos #9:
Step 5(f):	Ozone Level:	Ground Level:	15.2	15.5	14.4	15.2	16.5	17.3	16.5	11.9	12
	Part per Billion(ppb)	Mid (32 Inch):	14.2	15.1	14.1	13.8	15.9	16.6	16.8	15.5	15.5
		Top (72 Inch):	14.9	14.9	14.3	15.5	15.1	15.1	13.7	15.3	15.4

Average Measured Ozone - Six (6) ACA Units Operational:

- ✓ Ground Level: .01473 ppm / 14.73 ppb
- ✓ Mid (32 Inch Height): .01509 ppm / 15.09 ppb
- ✓ Top (72 Inch Height): .01479 ppm / 14.79 ppb

Noes:

A) It needs to be noted that there are naturally occurring Ozone within the nature / ambient as it shown in the base line test results.
B) More than sufficient quantities of both positive and negative ions were being produced by One ACA Component
C) Basically NO change / NO increase or decrease in Ozone levels

3.2.3 Conclusion

After establishing the quantity of naturally occurring positive and negative ions as well as naturally occurring Ozone the results of the ground test are as follows:

A) Ionization:
More than sufficient quantities of both positive and negative ions were being produced by the ACA Component(s) to provide for air purification as well as surface disinfection throughout the space. Confirmation of distribution was observed and recorded using the Alpha Air Ion Counter at 9 stations and 3 elevations throughout the Lab. Furthermore, the results of the ground test are that air ion counts validated the fact that the air flowed throughout the Lab carrying the positive and negative ions produced by the ACA Component(s). This supports the fact that the Component(s), when energized, were functioning properly as designed throughout the test, and in unison (as also designed) with the existing Environmental Control system (ECS) to distribute the ionization. Additional readings confirmed that the ACA Air and Surface Purification System continued to progressively produce and then hold steady, with each Component energized, a quantity of positive and negative ions to produce and then maintain exceptional air quality and surface purification throughout the interior of the Lab.

B) Ozone:
The results of the ground test are that observed and recorded Ozone counts over the duration of the test validated the fact that the air flowing throughout fully control Lab environment showed no increase or decrease in Ozone levels over the base line counts other than naturally occurring Ozone. This supports the fact that the Component(s), when energized, are functioning properly and in unison, while producing no harmful levels of Ozone (as the ACA Components are designed specifically not to produce Ozone), with the existing Environmental Control system (ECS). Additional exhaustive tests confirmed the fact that ACA continued to produce more and more ionization, with each additional Component energized, a quantity of positive and negative ions, to provide exceptional air quality and surface purification throughout the interior of the Lab while producing no increase or decrease in Ozone levels, over the naturally occurring levels of Ozone, throughout the Lab and even at ground level where one would expect the Ozone levels to be at its highest level.

In summary, this test was conducted in accordance with 14 CFR Part 25. 832 guidelines with respect to Atmospheric conditions, using multiple ACA Components (QTY of 1 to 6) operating over an extended time period (4 to 6 hours during each the tests) in a test chamber smaller than any business class or commercial class aircraft and showed no increase or decrease in Ozone levels other than natural fluctuations that were observed over three days of testing.

In conclusion, the ACA component will not increase the existing Ozone levels in the aircraft cabin.