README for Aircraft Air Quality and Bleed Air Contamination Detection [supporting datasets]

William J. Hughes Technical Center, Federal Aviation Administration (FAA), U.S. Department of Transportation (USDOT)
2025-03-04

Links to Dataset

Dataset Archive Link: https://doi.org/10.21949/1524480

Summary of Dataset

The purpose of this project was to provide a data driven process to identify sensor technologies with the potential for detecting and identifying low levels of contaminants that may occasionally be present in aircraft engine bleed air supplies. Bleed air from a ground-based aircraft propulsion engine and an auxiliary power unit (APU) were used to supply air through an ozone/volatile organic compound (VOC) converter to the environmental control system on a Boeing 747, while injecting controlled amounts of fluid contaminants (i.e., aircraft engine oil, hydraulic fluid, and deicing fluid). Measurements of contaminants were performed at the ozone/VOC converter inlet and exit, and at the air conditioning pack exit. Ultrafine particles (UFP) were found to be a sensitive marker for engine oil contamination with measurements at all three locations showing similar, highly elevated UFP concentrations with a mean diameter near 40nm and smaller when the sample stream was cooled to near room temperature. In situ measurements showed that UFPs are generated by condensation and high UFP concentrations were not detected in uncooled bleed air. Oil contamination VOC levels were very low upstream of the ozone/VOC converter at bleed air temperatures up to 220˚C and increased at bleed temperatures of around 315˚C; however, oil contamination VOC levels remained at sub-ppmv levels. Fine particle concentrations also increased with oil contamination at lower bleed air temperatures, but not with temperatures around 315 ˚C. Secondary contaminants including pentanoic acid, heptanoic acid, acetic acid, formaldehyde, and acetaldehyde formed in the ozone/VOC converter as the oil aerosol oxidized. Consideration must be given to contaminant deposition within the bleed air system and sample lines as this deposition may lead to delayed responses and contaminant release during temperature transients. Of the sensor technologies assessed, spectrometers provided the best

opportunity to detect and identify contaminants. Carbon monoxide (CO) measurements confirmed that CO is not generated in sufficient quantities to be of value as a marker for engine oil or hydraulic fluid contamination of bleed air. CO may be useful as a marker for ingestion of engine exhaust in some cases. However, carbon dioxide (CO2) is a much better marker for engine exhaust ingestion.

Table of Contents

Title of Dataset: Aircraft Air Quality and Bleed Air Contamination Detection [supporting datasets]

Description of the Dataset: The purpose of this project was to provide a data driven process to identify sensor technologies with the potential for detecting and identifying low levels of contaminants that may occasionally be present in aircraft engine bleed air supplies. Bleed air from a ground-based aircraft propulsion engine and an auxiliary power unit (APU) were used to supply air through an ozone/volatile organic compound (VOC) converter to the environmental control system on a Boeing 747, while injecting controlled amounts of fluid contaminants (i.e., aircraft engine oil, hydraulic fluid, and deicing fluid). Measurements of contaminants were performed at the ozone/VOC converter inlet and exit, and at the air conditioning pack exit. Ultrafine particles (UFP) were found to be a sensitive marker for engine oil contamination with measurements at all three locations showing similar, highly elevated UFP concentrations with a mean diameter near 40nm and smaller when the sample stream was cooled to near room temperature. In situ measurements showed that UFPs are generated by condensation and high UFP concentrations were not detected in uncooled bleed air. Oil contamination VOC levels were very low upstream of the ozone/VOC converter at bleed air temperatures up to 220˚C and increased at bleed temperatures of around 315˚C; however, oil contamination VOC levels remained at sub-ppmv levels. Fine particle concentrations also increased with oil contamination at lower bleed air temperatures, but not with temperatures around 315 ˚C. Secondary contaminants including pentanoic acid, heptanoic acid, acetic acid, formaldehyde, and acetaldehyde formed in the ozone/VOC converter as the oil aerosol oxidized. Consideration must be given to contaminant deposition within the bleed air system and sample lines as this deposition may lead to delayed responses and contaminant release during temperature transients. Of the sensor technologies assessed, spectrometers provided the best opportunity to detect and identify contaminants. Carbon monoxide (CO) measurements confirmed that CO is not generated in sufficient quantities to be of value as a marker for engine oil or hydraulic fluid contamination of bleed air. CO may be useful as a marker for ingestion of engine exhaust in some cases. However, carbon dioxide (CO_2) is a much better marker for engine exhaust ingestion.

Dataset Archive Link: https://doi.org/10.21949/1524480

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Geographic location of data collection: United States (GeoNames URI: http://sws.geonames.org/6252001/)

Information about funding sources that supported the collection of the data: This project was funded through the US Department of Transportation's Federal Aviation Administration through the William J. Hughes Technical Center. The contract number is: 693KA9-20-P-00033.

B. Sharing/Access and Policies Information

Recommended citation for the data:

> Jones, Byron W. *"Aircraft Air Quality and Bleed Air Contamination Detection [supporting datasets]"* (2022), Federal Aviation Administration, William J. Hughes Technical Center https://doi.org/10.21949/1524480

Was data derived from another source?: Partially, most is original data. Read more about the dataset in Section C. Data and Related Files Overview

This document was created to meet the requirements enumerated in the U.S. Department of Transportation's Plan to Increase Public Access to the Results of Federally-Funded Scientific Research Version 1.1 and Guidelines suggested by the DOT Public Access website, in effect and current as of December 03, 2020.

C. Data and Related Files Overview

The dataset for the report Aircraft Air Quality and Bleed Air Contamination Detection contains many files. The complete file list can be found below.

Original File List for the 87301_DATASET.zip

1. 2020-11-12 APS.xlsx
2. 2020-11-13 APS.xlsx
3. 2020-11-12-13 Log.xlsx
4. 2020-11-12 SMPS.xlsx
5. 2020-11-13 SMPS.xlsx
6. 2021-07-16 APS bleed.xlsx
7. 2021-08-02 APS bleed.xlsx
8. 2021-08-02 APS outside.xlsx
9. 2021-08-03 APS bleed.xlsx
10. 2021-08-03 APS outside.xlsx
11. 2021-08-04 APS bleed.xlsx
12. 2021-08-04 APS outside.xlsx
13. 2021-07-16 CO2.xlsx
14. 2021-08-02 CO2.xlsx
15. 2021-08-03 CO2.xlsx
16. 2021-08-04 CO2.xlsx

17. 2021-07-16 log.xlsx
18. 2021-08-02-04 Log.xlsx
19. 2021-08-04 Piera bleed.xlsx
20. 2021-08-04 Pierra outside.xlsx
21. 2021-07-16 SD.xlsx
22. 2021-08-02 SD.xlsx
23. 2021-08-03 SD.xlsx
24. 2021-08-04 SD.xlsx
25. 2021-07-16 SMPS.xlsx
26. 2021-08-02 SMPS.xlsx
27. 2021-08-03 SMPS.xlsx
28. 2021-08-04 SMPS.xlsx
29. 2021-07-16 Temp.xlsx
30. 2021-08-02 TEMP.xlsx
31. 2021-08-03 TEMP.xlsx
32. 2021-08-04 TEMP.xlsx
33. 2021-06-24 APS bleed.xlsx
34. 2021-06-24 outside.xlsx
35. 2021-06-25 APS bleed.xlsx
36. 2021-06-25 APS outside.xlsx
37. 2021-06-24 CO2.xlsx
38. 2021-06-25 CO2.xlsm
39. 2021-06-21-25 Log.xlsx
40. 2021-06-24 Log.xlsx
41. 2021-06-25 Log.xlsx
42. 2021-06-24 Piera bleed.csv
43. 2021-06-24 Piera outside.csv
44. 2021-06-25 Piera bleed.csv
45. 2021-06-25 Piera outsdie.csv
46. 2021-06-24 SD.xlsx
47. 2021-06-25 SD.xlsx
48. 2021-03-24 SMPS.xlsx
49. 2021-03-25 SMPS.xlsx
50. 2021-06-24 TEMP.xlsx
51. 2021-06-25 TEMP.xlsx
52. 2021-03-26 APS.xlsx
53. 2021-03-26 Log.xlsx
54. 2021-03-26 SMPS.xlsx

55. 2021-04-12 APS.xlsx
56. 2021-04-15 APS.xlsx
57. 2021-04-16 APS.xlsx
58. 2021-04-28 APS.xlsx
59. 2021-05-12 APS.xlsx
60. 2021-04-12 Log.xlsx
61. 2021-04-15 Log.xlsx
62. 2021-04-16 Log.xlsx
63. 2021-04-28 Log.xlsx
64. 2021-05-12 Log.xlsx
65. 2021-04-12 SMPS.xlsx
66. 2021-04-15 SMPS.xlsx
67. 2021-04-16 SMPS.xlsx
68. 2021-04-28 SMPS.xlsx
69. 2021-05-12 SMPS.xlsx
70. 2021-06-22 APS bleed.xlsx
71. 2021-06-22 APS outside.xlsx
72. 2021-06-23 APS bleed.xlsx
73. 2021-06-23 APS outside.xlsx
74. 2021-06-22 CO2.xlsx
75. 2021-06-23 CO2.xlsx
76. 2021-06-21 Log.xlsx
77. 2021-06-21-25 Log.xlsx
78. 2021-06-22 Log.xlsx
79. 2021-06-22 Piera bleed.csv
80. 2021-06-22 Piera outsdie.csv
81. 2021-06-23 Piera bleed.csv
82. 2021-06-23 Piera outside.csv
83. 2021-06-22 SD.xlsx
84. 2021-06-23 SD.xlsm
85. 2021-06-22 SMPS.xlsx
86. 2021-06-23 SMPS.xlsx
87. 2021-03-23 APS.xlsx
88. 2021-03-24 APS.xlsx
89. 2021-03-25 APS.xlsx
90. 2021-03-26 APS.xlsx
91. 2021-03-23 Log.xlsx
92. 2021-03-24 Log.xlsx

93. 2021-03-25 Log.xlsx
94. 2021-03-23 SMPS.xlsx
95. 2021-03-24 SMPS.xlsx
96. 2021-03-25 SMPS.xlsx
97. TSI QTRAC-XP Merged Data March.xlsx
98. 2020-07-24a SMPS.xlsx
99. 2020-07-24c SMPS.xlsx
100. 2020-08-06a SMPS.xlsx
101. 2020-08-07a SMPS.xlsx
102. 2020-08-13a SMPS.xlsx
103. 2020-08-14a SMPS.xlsx
104. 2020-08-31a SMPS.xlsx
105. 2020-09-18a SMPS.xlsx

Additional Preservation Files Created for 87301_DATASET.zip

1. README.md: This is the main documentation file for the project in markdown format.
2. README.pdf: This is the main documentation file for the project in PDF format.
3. 87301.json: This is the DCAT-US JSON metadata file for the dataset.

D. Methodological Information

Description of methods used for collection/generation of data: For the full methodology of each lab report, consult the full publication https://doi.org/10.21949/1524479

Instrument or software-specific information needed to interpret the data: The data and graphs for this dataset package are saved in each Microsoft XLSX file. To access Microsoft Excel files without Microsoft Excel, use Google Sheets or Apache OpenOffice. To view the JSON and Markdown files, use any text viewer, such as Notepad++.

E. Update Log

This README.md file was originally created on 2025-03-04by Peyton Tvrdy (0000-0002-9720-4725), Data Management and Data Curation Fellow, National Transportation Library peyton.tvrdy.ctr@dot.gov

2025-03-04: Original file created