Final Report Aircraft Air Quality and Bleed Air Contamination Detection: [Supporting Dataset]

Dataset metadata at: https://doi.org/10.21949/1524480

This dataset supports research report: **Final Report Aircraft Air Quality and Bleed Air Contamination Detection**, available at this link: https://doi.org/10.21949/1524479

Dataset Metadata

Dataset Creators: Byron W. Jones. (https://orcid.org/0000-0002-9791-9448)

Corporate Creator: Kansas State University Manhattan, KS 66506 (https://ror.org/05p1j8758)

Corporate Contributor: United States. Department of Transportation. Federal Aviation Administration. William J. Hughes Technical Center (https://ror.org/05q0y0j38)

Report Description: The purpose of this project was to provide a data-driven process to identify sensing technology with good potential for detecting bleed air contamination from engine oil, hydraulic fluid, or deicing fluid. Reports from major aircraft cabin air studies were reviewed to identify the range of constituents that can be expected in cabin air, especially as they pertain to the aforementioned contaminants and their potential markers. One of the projects was the National Aeronautics and Space Administration Vehicle Integrated Propulsion Research (NASA-VIPR) project where controlled amounts of engine oil were injected into the engine compressor of a C-17 transport aircraft and the resulting contaminants in the bleed air measured. Three additional cabin air quality studies conducted on revenue flights were reviewed. These three studies provide data for a combined total of 249 flights on a variety of makes and models of aircraft. These studies provide adequate documentation of typical aircraft cabin air. Information from this review was used to identify potential markers of the bleed air contaminants. Additionally, collaboration was established with several technical committees from the Society of Automotive Engineers (SAE), American Society of Heating, Air-Conditioning and Refrigerating Engineers (ASHRAE), and American Society for Testing and Materials (ASTM) technical committees and with project personnel from the prior European Union Aviation Safety Administration (EASA)-funded cabin air study. There was extensive interaction with SAE E31b and a formal collaboration agreement was established between ASHRAE research project 1830-RP and Kansas State University. Two industry webinars where held to obtain industry input and participation in the industry working group that was formed. Key objectives of the project were to identify sensors and sensing technology with potential for detection of one or more of the three aforementioned bleed air contaminants and to develop a plan for test stand engine experiments to evaluate the sensors with controlled amounts of the three contaminants. Sensors and instruments were identified and a test plan was developed. The detailed plan describing contaminants, rates, and operating conditions is presented in Section 4.11 of this report and instruments recommended for testing are described in Section 5.2. Additionally, through the collaboration with ASHRAE 1830 and the support of the industry working group, many of the experiments identified in the test plan were completed.

About the data: The compressed data files in this zip file are 86 MB in total. The zip file can be unzipped using any zip compression/decompression software. Data files in the zip folder include:.txt files, accessible via any text editor; .docx files, accessible via Microsoft Word or open document programs; .xlsx spreadsheets, accessible via Microsoft Excel or other open spreadsheet programs; and .PDF files, accessible Adobe PDF readers or other PDF reading programs. The .csv, Comma Separated Value, file is a simple format that is designed for a database table and supported by many applications. The .csv file is often used for moving tabular data between two different computer programs, due to its open format. The most common software used to open .csv files are Microsoft Excel and RecordEditor, (for more information on .csv files and software, please visit https://www.file-extensions.org/csv-file-extension).

NTL Data Curation Note: National Transportation Library (NTL) Curation Note: This dataset has been curated to CoreTrustSeal's curation level "A. Active Preservation". To find out more information on CoreTrustSeal's curation levels, please consult their "Curation & Preservation Levels" CoreTrustSeal Discussion Paper" (https://doi.org/10.5281/zenodo.11476980). NTL staff last accessed this dataset at its repository URL on 2025-03-04. If, in the future, you have trouble accessing this dataset, please email NTLDataCurator@dot.gov describing your problem. NTL staff will do its best to assist you at that time.

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

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 (CO_2) 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

Authorship Information:

> *Author Contact Information*
> Name: Byron Jones (https://orcid.org/0000-0002-9791-9448)
> Institution: Kansas State University (ROR ID: https://ror.org/05p1j8758)
> Address: 110 Anderson Hall, 919 Mid-Campus Drive North, Manhattan, KS 66506-0110
> Email: jones@k-state.edu

> *Data Distributor Contact Information*
> Name: National Transportation Library Data Services Team
> Institution: National Transportation Library (ROR ID: https://ror.org/00snbrd52)
> Address: 1200 New Jersey Ave SE, Washington, DC 20590
> Email: NTLDataCurator@dot.gov

> *Organizational Contact Information*
> Name: Stadtmueller, Traci
> Institution: Federal Aviation Administration (ROR ID: https://ror.org/05q0y0j38)
> Address: William J. Hughes Technical Center, Atlantic City International Airport, NJ 08405
> Email: traci.stadtmueller@faa.gov

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