Origins of Contaminated Air

Captain Tristan Loraine

Aircraft Cabin Air Conference
19 September 2017
1903 - 1st Flight
1909 - 1st Channel Crossing
1919 - 1st crossing of the Atlantic
1927 - 1st solo crossing of the Atlantic
1938 - 1st Pressurised Airliner

Boeing Model 307 Stratoliner
1939 – 1st Jet Aircraft – He 178
1941 – 1st British Jet Aircraft – E28/39
1942 – 1st US Jet Aircraft - Bell P-59
1947 - 1\textsuperscript{st} Supersonic Flight – X1
1964 - Mach 3+ - XB-70
1921 – 1\textsuperscript{st} Pressurised Aircraft Engineering Division USD-9A
In some early attempts at cabin heating, air was heated by the exhaust manifold and then taken into the cabin. Such air frequently smelled scorched or occasionally smelled of oil. The condition was found unbearable. Even a trace of smell causes extreme discomfort in the air.
1938 - 1\textsuperscript{st} Pressurised Airliner

Boeing Model 307 Stratoliner
Cabin Superchargers – 8,000ft cabin at 15,000ft.
Cabin Blower - AiResearch - Garrett

Lockheed L-647/749 Constellation

First Flew: 1943
B-29 Crews Above 30,000 Feet
Breathe without oxygen masks

AiResearch Pressurized Cabin
Controls make it possible. They promise
a new kind of air travel postwar

Two bombers, B-34 and B-29, have been
flying at such heights that the air
pressure inside was as low as at 30,000
feet or more. At these altitudes, the
air is so thin that it is impossible to
breathe without the aid of oxygen masks.

It was too thin. It isn’t any worse inside the
Boeing B-29 Superfortress. In its pressurized
cabin, AiResearch controls maintain a
constant air pressure at a safe “low altitude.”

And at the same time these controls
maintain a comfortable flow of fresh air
through the cabin.

Here men can live and breathe as at home, without
oxygen masks or heavy, cumbersome clothing, without
nourishment or discomfort however high they fly.

AiResearch engineers worked long and closely
with Boeing and the Army Air Forces to perfect
the pressurized cabin. You’ll hear more about this
miracle of air control. A military achievement vital
today, it will help make possible faster, smoother planes to
speed postwar air travelers through the upper air in
unprecedented comfort. AiResearch Manufacturing
Company, Los Angeles and Phoenix.

Boeing B-29 Superfortress
First Flew: 1942
1944 – Lockheed F-80 Shooting Star

Air taken from the engine blower section is used to pressurise the cockpit.

GE J33-A-23 - Single-stage centrifugal flow - At 30,000ft cabin altitude was 18,000ft.
1947 - Boeing 377 Stratocruiser

Carbon Monoxide Detectors and Filters
Sea level cabin at 15,000ft - Max 6.55 PSI
Improve the text with the following: Purifier
Jet engine and ‘Bleed Air’
1952/53 – J57 Engine

The J57 (JT3) Engine was the first Pratt & Whitney-designed turbojet.

Early use of MIL-L-7808 Synthetic oil Type I or 3 centistoke jet oils
18 December 1953

Boeing Document D-14766-2
B-52 Decontamination Program

- Testing of a filter system
- The possible toxic effect of the contamination is still unknown.
- Smoke or haze is reported in only a few flights.
- Obvious increases in the contamination level were noted during changes in engine power conditions.
• J-57 & T-57 engine contamination problems.
• Apparently the occurrence is completely erratic, with no predictable pattern since contamination has occurred at all modes of airplane operation, such as take-off, high altitude cruise, descent and taxi. So far there is no known condition or sequence of conditions, which will reliably reproduce the trouble.
15 May 1954

WILLIAM J. VAN EVERY
1st Lt, USAF

“At approximately 1530 hours on 15 May 1954, I was flying aircraft number 52-1436, an RB-57A, in a three (3) plane formation from Shaw Air Force Base, South Carolina. Approximately 40 minutes after take-off while flying over an overcast at 7000 feet, I experienced blurred vision, became nauseated and experienced considerable dizziness.

I recall no strange or unpleasant odors, nor did I taste anything out of the ordinary. I did feel a definite dryness of mouth and throat. This condition lasted possibly a minute or two. As I became more aware of the situation or nearly to the passing out point I recall dropping back from the formation and opening the clear vision window and unhooking the oxygen mask. Fresh air from this open window seemed to relieve the unpleasant conditions I felt.”
“At approximately 1015 hours on 16 May 1954 I became sick while flying RB-57A aircraft 852-1444. I was flying at 10,000 feet occasionally climbing over clouds up to 12,000 feet, aircraft had no oxygen aboard. I was flying with pressurization on, dump valve closed and full cold position due to heat. After being airborne approximately 45 minutes I became sick (metallic taste) to stomach with dryness of mouth, throat and stomach. Pressurization was turned off and clear vision panel opened and I immediately began feeling better. Flight was continued for about 1 hour and 15 minutes with no further effects during flight or after flight.”
1954 – Dash 80 (Boeing 707)

Turbo compressors
The present studies involving exposure of humans to the cabin air at the engine test facility while the lubricant was sprayed into the intake of the engine demonstrated that illness can occur as a result of such exposure.

Smoke or fog is not an adequate indication that excessive lubricant is being used by the engine as symptoms appeared before amounts of the lubricant great enough to produce smoke were present.

It would be reasonable to expect similar illness following prolonged exposure to even lower concentrations of the lubricant (and/or its breakdown products) than were used in this study.
27 May 1955 – Caravelle 1\textsuperscript{st} Flight

1\textsuperscript{st} airliner to use Bleed air for pressurisation
Aware of oil contamination issue for last two years – suspect compressor bearing seals main source

In-depth look at filter options.

**Solutions:**

The Separate Compressor As A Solution – This method of eliminating contamination is considered to be the most positive... also the heaviest, most complicated and most expensive.
1958 – Douglas DC-8

Turbo compressors
1959 – Convair 880/990

Turbo compressors
1959 - CV 880 – Cabin Compressors
1962 - VC-10

Turbo compressors
1963 - Boeing 727

Bleed Air
After preliminary examination of these possible sources, it appeared to be quite probable that the source of the headaches could be contaminants derived from the engine bleed air source for cabin pressurization. This report is limited to consideration of this aspect, and the analysis of the report quoted in the introduction of this report. The contaminant, from its odor and description by personnel affected, would appear to be an irritant gas, although it may well be accompanied by asphyxiants such as CO or CO₂. This report elaborates on this premise.
1981
BAe 146 arrives

1984 December
SIL 21-7 BAe 146
Service Information
Leaflet: Oil
Contamination of Air Conditioning System

which stated:
“If the system becomes contaminated by oil, unpleasant cabin odour may be alleviated by:”
and goes on to make suggestions of how to manage the problem.

“Captains were making a Public Announcement to passengers and apologising for the “sweaty socks” smell.”
1983
Dr. James Cone M.D.

- Dr. Cone, a US occupational doctor links contaminated air exposures on aircraft with health effects in those exposed.
- Dr. Cone writes a paper for the US union APFA in 1984 recommending crews have some form of portable breathing protection.
Smoking ban on aircraft 1988-2000

The U.S. ban on in-flight smoking began with domestic flights of two hours or less in April 1988, extended to domestic flights of six hours or less in February 1990, and to all domestic and international flights in 2000.

Significant increase in reporting of contaminated air events after the smoking ban.
1999 – “Aerotoxic Syndrome”

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**SUMMARY**

TOXIC FUMES IN FLIGHT DECK

**EVENT AND CAUSE**

WHEN APU AIR INTRODUCED, A STRONG SMELL OF TOXIC FUMES (ENGINE OIL?) FILLED THE FLIGHT DECK.
15 December 2009 - Boeing 787

Electrical Compressors – APU BLEED FREE
A simple choice:
Boeing 737 \( \lor \) Vickers VC-10

Bleed air

Turbo-compressor
NOXIOUS FLUIDS AND GASES IN AVIATION

The symptoms of carbon monoxide poisoning are generally known and may vary with the amount of carbon monoxide content of the blood as shown in table 16. For aviation the only logical method of dealing with this problem is to eliminate carbon monoxide from the cabins and cockpits of aircraft. The onset of carbon monoxide poisoning is so insidious and its effects so disastrous to one piloting an airplane that preventative measures are the only ones to be relied on. While it is desirable that no carbon monoxide be present in aircraft, in single engine airplanes this is often impossible to accomplish and there are always traces of the gas present. In this situation it is necessary to establish
EasyJet to filter toxic air in cabins

The budget carrier is the first to take action over links to an illness long denied by airlines