# A pilot's guide to cabin air quality and fire safety

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**Airline travelers need** more protection from exposure to tobacco smoke. An important step in this direction would have been the proposed ruling to prohibit smoking on flights of less than two hours—a measure that was passed by the Civil Aeronautics Board in May 1984, only to be rescinded a few hours later, allegedly following political pressure.

## IS VENTILATION ADEQUATE?

At hearings of the Senate Subcommittee on Aviation in 1982 and 1983 on the subject of cabin air quality the Federal Aviation Administration has testified that aircraft ventilation rates compare favorably with recommended standards for non-aviation environments. This position was echoed by the Air Transport Association of America (ATA), the trade organization of airlines in the United States, which based its testimony on a survey of ventilation data reported by airlines. However, much of the ATA data appear to have been based on system design values compiled by aircraft manufacturers. Once the airplane is put into service, these values begin to erode. Actual ventilation capacity is dependent on many factors, such as engine compressor section efficiency, bleed valve operation, air duct cleanliness, security of duct connectors, pressure regulator valve function, air conditioning pack operation, door and window seal integrity, filter porosities, aircraft altitude, and engine revolutions per minute.

During the summer, inadequate airflow through the cabin is a common complaint on the Boeing 727 and the Douglas DC-9. In one case, upon investigation by maintenance workers, a large clamp that secured a rubberized flexible duct connector was found to be loose, and air was leaking out of the connection. Water separator bags on the DC-9 remove condensation from conditioned air and can become clogged and impede air flow. The 727 has a muffler-like device in its duct system to enable quiet and smooth airflow. This muffler uses a fiberglass packing which can work loose and clog a downstream filter. This, too, will impede airflow. The efficiency of air cycle machines (packs) which heat, cool, and dehumidify the air entering the cabin erodes with time and usage. These deficiencies are common to all operators of these jets. The ventilation systems simply do not perform at design specifications after prolonged usage.

In addition to the DC-9 and the 727, the Boeing 757 flies a major share of Eastern Airlines' flights that are less than two hours. This is the newest and most sophisticated jet in the air today, and consequently its ventilation system will operate closer to design specifications than those in older airplanes. However, this is a "catch-22" because the 757's air conditioning system is designed to recirculate a substantial percentage of cabin air. This recirculated air is passed through two filters on its way back to the cabin. Both of these filters are of the fiberglass type which effectively trap only particulate matter and accomplish little or no filtration of odors or gases.

The most obvious evidence that smoking introduces pollutants at a higher rate than the ventilation systems can effectively dissipate is the haze in the back of the airplane. A similar observation is that within seconds after turning off the "No Smoking" sign the pilot of a DC-9 can detect tobacco smoke in the cockpit, which is 20 feet from the passenger section. Flight attendants complain of having to work in a cloud of smoke which hangs at head level. If ventilation capacities were as the engineers say they are, this smoke cloud should never occur, because conditioned air enters the cabin from overhead and is exhausted through floor-level vents. The fact is that this top-to-bottom airflow pattern is not forceful enough to dispell the volume of smoke produced by numerous cigarettes.

The photograph of the outflow valve of a DC-9 (Fig 1) is a graphic illustration of "what you see is what you breathe." The outflow valve is the major exhaust port through which cabin air is vented overboard and is the device that controls cabin pressurization. Its movement between open and closed positions is accomplished by mechanical linkages which become gummed up when tobacco smoke condenses. This stickiness makes smooth operation of the pressurization difficult, if not impossible, much to the discomfort of the passengers' and crews' ears. It can even cause a mechanical failure if the valve becomes stuck in one position.

The figure shows an outflow valve with average contamination. Such a picture is common to all airliners on which smoking is permitted. The B-757 had a higher percentage of dirty valves, which is noteworthy, because the recirculation systems on this airplane and the B-767 are harbingers of aircraft design. The purpose of a recirculation ventilation system is to increase engine fuel economy, which is achieved at the expense of cabin air quality.

## CIGARETTE FIRES ALOFT

A fire in the cabin is a dire emergency. Although the

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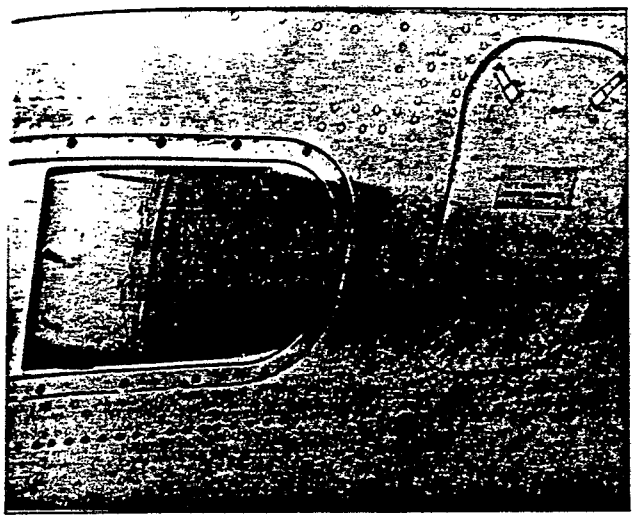

FIGURE 1. The stain adhering to the airplane skin behind the outflow valve of a DC-9 is tobacco smoke condensate, "tar," which can cause a malfunction or even failure of the pressurization system.

airline industry goes to great lengths to make flying the safest form of transportation that exists today, the lighting of cigarettes in airliners is courting disaster. The originally suspected cause of the 1983 Air Canada DC-9 fire that killed 22 persons was the lavatory flush motor; but this has been eliminated as a fire ignition source after tests by the National Transportation Safety Board. Although the contents of the waste bin were not burned due to activation of the fire extinguisher, which is positioned within the waste bin compartment, this does not rule out the possibility of an improperly discarded cigarette as an ignition source. The chute that guides discarded paper towels, tissues, and similar refuse into the trash bin on the DC-9 has narrow dimensions (approximately $2\frac{1}{2}$ in $\times$ 7 in). Passengers push paper towels through the spring loaded door opening and release them, expecting them to fall into the waste receptacle. More often than not, however, the towel lodges in the chute, which stops others from falling through; soon the chute is packed with paper towels. This creates two waste bins, one in the container protected by a fire extinguisher and the other in the chute with no fire protection. Any paper wedged in the chute could have been ignited if a lit cigarette were dropped on top of it.

Another distinct possibility is the tendency of passengers who are not familiar with airplane lavatories to put waste paper into improper places. Since the trash receptacle chute is covered by a spring loaded door and one must read the message on it to know what it is, much waste paper finds its way into any opening, such as an empty Kleenex container, the slot for toilet seat covers, or the paper towel holder. An incompletely extinguished cigarette could just as readily be placed into these areas. The oxidizers added to American tobacco make cigarettes even more hazardous, because the cigarettes will smolder until they are completely burned out. One has only to ask any experienced flight attendant about passengers who have dropped or lost a burning cigarette to learn about such harrowing incidents.

In pilots' flight manuals there is a remedial procedure for almost any failure or emergency that can be imagined, except for an in-flight cabin fire. This is not an inadequacy in training or in the manufacturer's aircraft manual. The truth is that little can be done except fight the fire with a hand-held extinguisher, for which the crew is trained, and land the airplane as soon as possible, hoping the passengers have not suffocated or the crew become incapacitated before they can get safely on the ground. Pilots cannot release the passengers' oxygen masks because they operate under positive flow, and the pure oxygen would turn the airplane into a giant torch.

Prohibiting smoking on short flights would virtually eliminate the possibility of accidental fires, but would raise the specter of surreptitious smoking in the lavatories. Indeed, a lavatory fire allegedly occurred on a DC-9 inbound to Tampa International Airport in 1983. The fire was of sufficient intensity to make the door too hot to touch, and, afterward, the plastic fixtures were found to be melted. It is not known if an attempt was made to fight the fire or if the door was kept closed to contain the smoke, but the flight was concluded safely and the fire was put out on the ground. A discarded cigarette was the suspected cause. These continuing incidents are ample reason to require smoke detectors in the lavatories. The battery powered home-type detector should work well, but the cover should be tamperproof so the battery cannot be disconnected. Also, the lavatory signs should be more prominently displayed and should include a warning about the danger of fire and the presence of a smoke detector.

There is little question that the vast majority of the public desires a ban on smoking aboard aircraft. Sensing this, in 1983 the Tobacco Institute, the public relations unit of the tobacco industry, paid workers to collect signatures of air travelers opposed to such restrictions. Individuals reported they were first asked if they smoked. If the answer was "No," the interview was concluded with a "Thank you." If "Yes," they were asked if they would sign a petition to the Civil Aeronautics Board that was worded in such a way as to imply an imminent threat to the freedom

TO THE U.S. CIVIL AERONAUTICS BOARD:

As airline passengers, we OPPOSE any government regulation

- — To ban smoking *entirely* on flights of one or two hours or less
- — To ban smoking *entirely* on planes with fewer than 30 or 60 seats
- — Under which smoking might be banned *entirely* in a compartment if a single passenger complains of "physical illness" from smoke

Smoker/nonsmoker seating works well! Please keep it that way!

FIGURE 2. Top of petition circulated in airports by employees of the Tobacco Institute.

of airline passengers (Fig 2). In order to provide an alternative viewpoint, a group of volunteers from the American Lung Association of Georgia asked 5,502 people in the Atlanta Hartsfield International Airport the following question: The Civil Aeronautics Board has proposed that all smoking be banned on airline flights of one hour or less. Would you be in favor of, neutral to, or opposed to such a regulation? The results were 62% in favor, 24% neutral,

and 14% opposed. The survey was reinforced by subsequent surveys by Midway Airlines, Wein Air Alaska, and *Newsweek*. In view of the frequency of unsolicited comments from individuals critical of the proposal for focusing only on short flights and not on a total ban, it is unlikely that the results of the survey would differ were there a proposal for a ban on smoking on flights of two hours.

From its founding in 1981 to its demise in 1985, Texas-based Muse Air imposed a total smoking ban on its flights. Other carriers such as Rocky Mountain Airways, Hawaiian Air, Aloha Airlines, Mid Pacific Air, and Air Maritime in Canada have also banned smoking. Chicago-based Midway Airlines has offered total nonsmoking flights on an experimental basis, and numerous commuter airlines have been operating nonsmoking flights. Not only is a ban on smoking necessary for improved comfort, health, and safety, but it also appears to be desired by the vast majority of air travelers.

## THE HEALTH OF PILOTS

Although the passenger cabin has been the focus of concern of hearings on smoking aloft, many airline pilots feel that tobacco smoke in the cockpit is a greater threat to their health and the safety of the flight (Fig 3). In 1976 the Public Citizen's Health Research Group, the Aviation Consumer Action Project, and 76 pilots of seven major airlines attempted to have smoking banned in the cockpit but were rebuffed by the Federal Aviation Administration (FAA). The position of the FAA, according to J. Robert Dille, MD, chief of the Civil Aeromedical Institute, is that "our two studies and those of Heimstra suggest that abrupt smoking withdrawal poses a greater threat to aviation safety than crew smoking" (personal communication). What this position fails to address is that there are far more nonsmoking pilots than pilots who smoke, and that a decided majority of the nonsmoking pilots believes that the smoke of others in the close confines of the cockpit is a detriment to one's health and one's ability to be a safe, alert, and competent pilot.


FIGURE 3. Pointing to the possibility that some health problems in nonsmoking pilots are related to exposure to tobacco smoking, the 2,700-member Australian Federation of Air Pilots joined the Australian Medical Association in urging airlines to ban smoking aloft (*Daily Telegraph* (Sydney), October 19, 1982). Airlines have responded by cutting the number of seats at which smoking is permitted.

The primary study referred to by Dille was a Multiple Task Performance Battery administered to 17 non-aviation oriented individuals who were smokers. The sessions consisted of two days of testing. The first day the subjects smoked immediately before the first 30-minute test period and during the 10-minute interludes between the five subsequent 30-minute test periods. The scores obtained were used as baseline scores. The second test day the subjects were allowed to smoke immediately before the first test period, but were denied smoking for the remainder of the three-hour testing period. The results indicated that "when smoking was prohibited, performance was decreased, largely as a result of decrements in tracking [ability]. Decrements in performance were associated with decreased attentiveness, both prior to and after the experiment."

This sample of 17 subjects is too small to use as a basis for a ruling that affects thousands of pilots. To address both sides of this issue the Multiple Task Performance Battery should be administered to a group of nonsmokers. The first day the subjects would breathe ambient air to establish baseline scores. The second day another person would join them in the test compartment who would smoke one or two cigarettes during each 30-minute test period. A decline in scores on the second day might provide revealing information on the ability of nonsmokers to function in a smoky environment. If this were to occur, and in light of the overwhelming number of nonsmoking pilots, then a cockpit smoking policy should be decided in favor of the majority.

Preliminary results of a mail survey of 1,287 Eastern Airlines pilots conducted by the Air Line Pilot Association support such a policy. Four hundred and eighteen pilots replied, of whom 343 identified themselves as nonsmokers. An overwhelming number of respondents felt that smoking in the cockpit is detrimental to health (85% of nonsmokers and 33% of smokers agreed), that the cockpit ventilation system inadequately removes smoke, that smoking in the cockpit is detrimental to crew coordination, and that smoking should be restricted or prohibited in the cockpit.

Federal Aviation Regulation 91.11 states "No person may act as a crewmember of a civil aircraft while using any drug that affects his faculties in any way contrary to safety." Though aviation literature contains some mention of the many detrimental effects that smoking can have on a pilot, there is a total lack of information on the effects of smoke on the nonsmoking pilots who share the same air supply and the same small space. In the recent survey of the Air Line Pilot Association, 85% of the nonsmoking pilots reported some type of adverse physical reaction—principally, eye irritation (74%) and headache (40%)—whereas only 14% of the smoking pilots reported any of these reactions. In the category of non-physical reactions, 76% of the nonsmoking pilots reported some type of adverse reaction (annoyance, 55%; resentment, 31%), whereas only 18% of the smokers did so.

The Soviet airline Aeroflot has a policy that prohibits smoking in the cockpit for five hours, and two hours before landing. Since most flights in the United States are less than two hours a policy should exist that during any such flight smoking should be prohibited unless expressly

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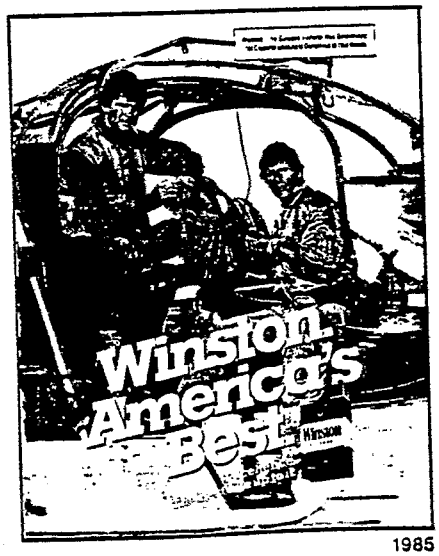

1985

From stunt pilots in the 1920s to astronauts in the 1960s, the airman as hero has been a frequent theme of cigarette advertising aimed at millions of readers of *LIFE* and other magazines. At New York's LaGuardia Field (top left), slower-burning, cooler Camels were depicted as a vital asset for a radio control-room flight superintendent. Just before flying the maiden transcontinental flights of TWA Stratoliner aircraft (top center), the pilots and a national record-holder for flying speed and endurance smoked Camels. Test pilots (top right) and bombardiers (middle left) smoked Camels for steady nerves. Other pilots chose Lucky Strikes (middle center) and America's first commercial jet pilots (middle right) on Pan American smoked Chesterfield in the cockpit. According to RJ Reynolds, helicopter pilots in 1957 (bottom left) and 1985 (bottom center right) demonstrate their manliness by lighting up cigarettes near fuel supplies. [DOC ARCHIVE]

waived by each pilot of the crew.

The rigid code of command authority emanating downward from the captain in an airline cockpit is not well known outside the industry. A first or second officer is hesitant to speak out against a smoking captain in defense of his or her preference for a smoke-free cockpit, for fear of reprisal.

A new cockpit smoking policy would do much to alleviate disputes in airline cockpits and to improve the health of pilots and the safety of flights.

## Who to complain to about smoking aloft?

With the closing of the Civil Aeronautics Board on December 31, 1984 (mandated in airline deregulating legislation enacted in 1978), all matters related to consumer protection in air travel (including smoking) have been shifted to the Department of Transportation (DOT). DOT handles questions and complaints by telephone (202-673-6047) or by mail (Consumer Affairs Division, Room 10405, Office of Community and Consumer Affairs, Office of Governmental Affairs, US Department of Transportation, 400 7th Street SW, Washington, DC 20590).

The Airline Transport Association [spokespersons have] talked about their legal responsibilities as common carriers. The legal responsibility of a common carrier, according to common law going back to the days of stage coaches, is that it must provide the highest possible standards of safety and health for passengers. There is nothing in the common law that requires it to permit anybody to smoke or to drink or to burn incense or to chew or to spit. Yet they talk in terms of "preferences." Somehow they have to accommodate preferences. Yet the Civil Aeronautics Board held from the beginning, and the US Court of Appeals recently reaffirmed— and many airlines have demonstrated— that there is no legal right to smoke aboard an airplane.

For these reasons ASH (Action on Smoking and Health) strongly supports the banning of smoking on short flights. There is no longer any doubt that it would solve the problem. After 10 years of complaints the airlines have done virtually nothing. They have not experimented with other proposals. They have not come up with different ventilation or physical barriers, or a barrier of people who don't care between the smoking and non-smoking sections. They do absolutely nothing and then when proposals are made, they come in and say no, no, no, we oppose it.

It works. Many carriers have banned smoking, and smokers are not climbing the walls or setting fires to the restrooms. Indeed, it is hard to see why anyone should really have to smoke on a short flight. On short flights many smokers fly in the no-smoking section anyway.

And I wonder why it is in the Air Transport Association that they feel that cigarette smokers are somehow entitled to more protection than pipe and cigar smokers. Pipe and cigar smoking is banned by most carriers. Those who derive the same satisfaction from chewing and spitting or who desire to burn incense or do a variety of other things can't do so aboard a plane.

Other privileges such as the use of computers on flights are now being restricted by some of the airlines where it appears to be necessary to protect passengers. Is smoking that much more important?

What arguments do they present to the contrary? Well, it is the usual lawyers' parade of horrors. Let's sit down and find every possible thing that might go wrong. Any regulator knows that these frequently and usually do not occur. They say that it is going to be confusing. Passengers won't know when they can smoke and when they cannot. Could anything be more confusing than their ticket structure? Could anything be more confusing than when you are going to get a movie or not or when you are going to get a snack versus a meal or when you can hang up your large bag or many other amenities? They say that drawing the line is arbitrary. Of course, any line is somewhat arbitrary. We have to draw lines on how much people can drink, or baggage size, or a variety of other limitations ....

The biggest argument, of course, is that it somehow disadvantages people in certain cities, not recognizing that living in certain cities creates lots of problems with regard to air transportation. Smoking is certainly just a small one.

We strongly favor the idea of banning smoking, not just on flights of one hour, but of two. And there are several reasons. First, two hours is consistent with many other situations in everyday life: movies, courtrooms, college seminars, many meetings, and so on. We know of many non-smoking jurors who get excused from jury duty because they can't stand the smoke in the jury room. I have never seen anybody go before a judge and say, "Your Honor, I can't participate in this trial. I've got to smoke every hour on the hour." Smokers can and do reasonably refrain from smoking up to two hours.

Based on the testimony of
John F. Banzhaf, III
Action on Smoking and Health (ASH)
Hearings of Civil Aeronautics Board
February 1983