Timeline of events related to the introduction of ozone exposure standards on commercial aircraft, 1976-1983

Association of Flight Attendants, AFL-CIO – June 2003

Early 1976 - PanAm introduced the B747SP into service, permitting higher altitude flight.

"During the winter of 1976 and the spring of 1977, shortly after the initiation of nonstop flights using the Boeing 747/SP from New York, San Francisco, and LA to Tokyo, a marked increase occurred in the frequency and severity of respiratory complaints – including cough, shortness of breath, chest pain, and even hemoptysis – reported by the flight attendants aboard this aircraft. In addition, during the same time period, some attendants noted a greater frequency of complaints by passengers of cough and difficulty in breathing." (Tashkin et al., p.118)

1976-77 - "NASA Global Atmospheric Sampling Program (GASP) equipped severe commercial aircraft with special equipment to measure atmospheric ozone, and when it was noted that high concentrations of atmospheric ozone correlated well with the reports of physical symptoms, ozone became the suspected cause of the symptoms." (Reed, 1980)

April 1977 - IUFA (union) distributed questionnaire to all 450 flight attendants based in LA about symptoms on 747SP flights. Of these, 258 responded.

August 1977 – Based on input from UCLA, IUFA sent follow-up questionnaires to those 258 that responded about symptoms on 747 flights. Of these, 38 responded.

October 1977 - IUFA sent similar questionnaires with questions about symptoms on the 747SP and the 747 to 850 of 1200 NY-based Pan Am FAs. Of these, 65 responded.

July 1977 - Hearings in US House of Representatives regarding the problem of toxic concentrations of ozone in the cabins of high-altitude commercial aircraft

Early 1978 - CADHS requested CDC involvement in investigating ozone-related symptoms reported by FAs on high altitude flights; CDC, in cooperation with CADHS and UCAL Berkeley surveyed 1330 FAs. Survey supported FAs claims of ozone related symptoms.

1978 - Based on 1977 hearings, FAA issued ozone NPRM No. 78-15 that above FL 180, ozone must not exceed 0.25ppm (peak) at any time and must not exceed 0.1ppm during any flight segment that exceeds four hours; also, FAA clarified that continuous monitoring is not necessary, but that aircraft must equipped with "control devices" and
"the FAA will conduct spot checks to ensure their effectiveness" (43 FR 46034; 5 Oct 1978).

**FAA issued Final Rule** (Amdts. 25-50 and 121-154, Eff. 20 Feb 1980)

**1978 – van Heusden and Mans** published paper that described ozone measurements during two transatlantic flights 24-25 March, 1977 (between Amsterdam and Toronto) on a DC10-30 aircraft operated by KLM; noted that in the economy section, occupants, ambient cigarette smoke, and cabin surfaces had absorbed 40% of the ozone when levels were measured four feet above the floor relative to ceiling height (p 1060); also, "peak readings up to 580ppb were obtained and, for many consecutive hours, the TLV was greatly exceeded...[I]t is clear that the [monitored] flights can certainly be described as unfavorable, but it is also true that ozone concentrations during other flights might be even higher." **Highlights the importance of sampling season and sampling location within the cabin.**

**1980, Reed et al (CADHS) published analysis of questionnaire data obtained from 1330 FAs working for three different airlines; "ozone-toxicity type symptoms were reported three to four times more frequently by FAs with airlines flying at high altitudes than by those with low-flying airlines...[and] symptoms were significantly associated with flight altitude, duration, and type of aircraft."

"The ozone concentration in the cabins of commercial aircraft often exceeds the limit of 0.1ppm recommended for occupational exposure. As early as 1963, studies of flights by US airline companies using a variety of aircraft showed that ozone in excess of 0.1ppm was encountered "a significant amount of time", and that peak levels were as high as 0.35 to 0.4ppm." Referenced (1) Brabets, R "Ozone measurement survey in commercial jet aircraft" FAA Technical Report 1963 and (2) Jaffe, L and Estes, H. "Ozone toxicity in cabins of high altitude aircraft – a review and current program." Aerospace Medicine, 34: 633-643 (1963).

**October 1980 - FAA published AC** to guide operators how to comply with the new ozone regulations.

**1981 - FAA issued another NRPM** issued with proposed modifications to O3 FAR based on ATA proposal; that DESIGN and OP-wise, ozone must not exceed 0.25ppm (peak) at any time above FL 320 (25.832 and 121.578) and 0.1ppm TWA during any segment above FL270 that exceeds four hours (121.578) and exceeds three hours (25.832), relieving cargo operators and "certain four-engine narrow body aircraft" (B727) from having to install ozone converters.


**May 1981 – NIOSH contacted TWA and PanAm medical directors and asked for FA lung function test results** maintained by the companies. TWA records were not
made available, but NIOSH did meet with PanAm, and PanAm agreed to provide NIOSH with FA lung function tests from May 1977 to June 1981 (when they met). NIOSH reviewed these records and found an unexpectedly high prevalence of abnormal lung function among FAs based on the east coast compared to the west coast. NIOSH recommended a follow up study, although there is no record of this.

March 1982 – NIOSH published interim HHE report re. "Flight attendants' health survey" (HETA 81-331), describing their review of Pan Am FA lung function records.

1983 - Tashkin et al (UCLA) paper was published "Respiratory symptoms of flight attendants during high-altitude flight: possible relation to cabin ozone exposure"

1. Twenty-one LA-based PanAm FAs with frequent and moderate to severe symptoms had lung function tests 10-14 days after their last 747SP flight. Lung function tests were basically normal. (Note: Would acute changes in lung function be expected to remain for 10-14 days?)

2. Based on the frequency and proportion of FAs reporting each symptom on the 747SP compared to the 747, symptoms were classified as "definitely", "probably", and "not" associated with the 747SP. These definitions were then compared to experts' assessment of whether a given symptom was "definitely", "probably", or "not" related to ozone exposure. There was a significant association between "definite" and "probable" ozone-related symptoms and 747SP flights. (Note: This methodology would seem to potentially dilute any effect of ozone-related symptoms, since 747 aircraft still fly high enough to encounter ozone; still, would control for other effects such as low RH, reduced pressure, etc.)

Concluded that "ideally, ozone concentration should be measured continuously during flights likely to encounter high ambient ozone levels so that corrective measures (such as descent to a lower altitude) can be implemented in the case of excessive accumulation of ozone in the aircraft cabin." (p.134)

Also, "since minute ventilation can increase three or fourfold as one pushes a heavy cart about and walks vigorously, the exercising flight attendant is exposed to more ozone than the seated passenger or pilot." (p.135)