A SUMMARY OF PUBLISHED IN-FLIGHT AIR QUALITY STUDIES

Over the last twenty years, there have been a number of studies published dealing with various components of in-flight air quality. Because of the controversy about ETS, many of those studies have included measurements of a component used as a marker for ETS exposure. In all of these published studies the reported levels of the ETS marker were far below any occupational standard.

1. As early as 1971 the US Federal Aviation Authority and the National Institute of Occupational Health looked at smoking in aircraft and selected carbon monoxide as an indicator of ETS. The investigators reported mean levels of 2.8 ppm with a maximum of 5.0 ppm and concluded:

   > "The environmental measurements made in the aircraft for carbon monoxide were extremely low; much lower than ambient concentrations in urban environments. All measurements were 5 ppm or less. These low concentrations of carbon monoxide result from the rapid exchange of air aboard the aircraft (the equivalent of one complete airchange each 3-4 minutes) and the relative pollution-free air entering the aircraft at the cruising altitudes of the test flights."

2. In 1977, a French study recorded similar findings. Also using carbon monoxide as a marker they reported a maximum of 5.0 ppm "at the end of the longest day flights when a large number of smokers were on board."

3. Nicotine as a marker specific to ETS exposure was first reported by Muramatsu in a study aboard domestic Japanese carriers in 1984. Mean values of 15.2 ug/m^3 were reported.

4. In 1987, Muramatsu again looked at nicotine and compared smoking and nonsmoking sections. He reported arithmetic mean values of 13.5 ug/m^3 in smoking and 5.3 ug/m^3 in nonsmoking. These correlated well with the results reported the same year by Oldaker who used a different method of data collection.

5. Oldaker reported mean nicotine concentrations of 9.3 ug/m^3 in smoking and 5.5 ug/m^3 in nonsmoking aboard narrow body aircraft on US domestic flights.

6. In this same year, 1987, the US Department of Transportation (DOT) rejected a proposed ban recommended by the National Academy of Sciences because it was not supported by data associating health effects and tobacco smoke exposure aboard aircraft. Nonetheless, the next year, Congress voted to impose a temporary (2 year) ban on smoking aboard domestic flights of two hours or less. The DOT subsequently issued a request for proposals to monitor in-flight exposures to tobacco smoke and other indoor air constituents for the purpose of aiding Congressional deliberations on this subject. However, Congress decided not to wait for the results of the study, which became available several months after it had voted to impose the permanent ban.

   The final DOT report contained data for selected constituents from tobacco smoke and other sources collected aboard commercial flights, as well as a theoretical health risk assessment based upon the data. The data on tobacco smoke constituents suggest that individuals seated in nonsmoking sections are exposed to extremely low levels of those constituents. Again, nicotine levels of 13.4 ug/m^3 in smoking and below 0.3 ug/m^3 in nonsmoking compared well to values previously reported. These data would seem to justify the assumption that separate seating minimizes the nonsmoker's exposure to cigarette smoke. The data did, however, indicate relatively high levels of carbon dioxide from passenger respiration on the majority of all flights, which in turn suggests the possibility of poor ventilation and poor air quality regardless of the presence or absence of cigarette smokers. (The principal author of this study did take a closer look at the carbon dioxide levels [see Nagda: 1991]).

7. Drake reported to the Air Transport Research International Forum in 1988 (published in 1990) results of ETS measurements in smoking and nonsmoking sections on wide body aircraft on US/Asia international routes which were comparable to those previously reported by Muramatsu and Oldaker [see Oldaker: 1990 same study].

8. A Canadian study in 1989 seem to indicate that passengers who are adjacent to the smoking sections on commercial flights may be exposed to some cigarette smoke and that nonsmoking passengers in the nonsmoking sections report cigarette smoke from the smoking sections to be both irritating and annoying. The study involved four flight attendants and five passengers on four flights.

9. The most comprehensive testing and analysis of aircraft cabin air quality to date is a study conducted in Europe in 1989. The results indicate that total exposure to tobacco smoke aboard aircraft is "rather small and insignificant in comparison to total life exposure to air pollution." The researchers concluded that possible health effects were "not likely to have been elicited" by such exposures aboard flights. They further suggested, "Some passengers and cabin crew might have experienced eye and upper respiratory tract irritation and annoyance at the highest exposure levels recorded. These effects could have been potentiated by the low humidity, high temperature and high carbon dioxide levels found."

10. The ETS measurements of the US/Asia study [see Drake: 1990 same study] were reported also by Oldaker in 1990:

> "Arithmetic mean concentrations of nicotine, RSP and UVPM in nonsmoking sections were 2.3, 15 and 7 ug/m^3, respectively; corresponding arithmetic mean concentrations in smoking sections were 10.6, 39 and 26 ug/m^3, respectively. The effect of smoker segregation on ETS was shown by statistically significant differences ($P < 0.05$) between concentrations of nicotine, RSP and UVPM measured in nonsmoking and smoking sections of the aircraft."

11. In April 1991, a Canadian study reported measurements of air quality on nonsmoking flights would suggest that factors other than tobacco smoke may be major contributors to subjective complaints. The investigators reported: "total particulates levels exceeded comfort criteria even though smoking was not allowed on board." They also reported that carbon dioxide levels were generally high when passenger capacity reached 68% and the relative humidity could reach uncomfortable levels.

12. Later that year, Nagda, the principal author of the DOT report, Koontz and Konheim looked more closely at the results and implications of the measured levels of carbon dioxide in the DOT study [see Nagda: 1989]. (Carbon dioxide (CO_2) is a natural bi-product of human respiration.) They reported relatively high average concentrations of CO_2 at 1615 ppm across all 92 flights with the average somewhat lower on smoking (1568 ppm) than non-smoking (1756 ppm) flights. "Measured concentrations exceeded the ASHRAE standard 62-1989 guideline of 1000 ppm on 87 of the study flights." They further commented, "In the ASHRAE standard, the CO_2 concentration is viewed as an indicator of indoor air quality and the adequacy of ventilation.... However, it has been argued that CO_2 levels may need to be kept even lower (i.e. below 600 ppm) to minimize symptoms such as sleepiness, fatigue, poor concentration or a sensation of stuffiness."

Several reviews of studies of ETS aboard aircraft have reported the following:

13. Ramstrom (Sweden, 1984) in a review for the WHO of ETS related matters and aspects regarding ETS exposure of passengers and crews reported:

> "Even for a frequent traveller the duration of exposure to ETS in aircraft would be so short that there is no reason to believe that any such long-term effects as discussed in section 1.3.1 above would arise. Also for cabin crew the exposure time would be quite short as compared to exposure times at ordinary ground level workplaces. The discussion on effects of ETS exposure in aircraft will therefore be limited to acute effects in terms of irritation and annoyance."

14. Holcomb (USA, 1989) reviewed available data and concluded:

> "The available scientific evidence does not support the prohibition of smoking on commercial aircraft. The data that are available reveal low concentrations of substances that can be traced to ETS in smoking sections, and even lower concentrations in nonsmoking sections, thus confirming the efficacy of current in-flight smoking policies. The available data also suggest that factors or substances other than ETS may be major contributors to subjective complaints of discomfort by passengers and flight crew. Finally, given the limited and intermittent occasions for exposure, even in the case of compromised individuals and cabin attendants, adverse health effects from exposure to ETS aboard aircraft are highly unlikely."

15. Crawford (Australia, 1991) reviewed the ETS exposure studies, including the latest and largest studies from SAS and the US Department of Transportation. His conclusion states:

> "Airline cabin air quality is determined by a combination of chemical and physical factors, not the least of which is proper ventilation. Low humidity, ozone, ETS and reduction in partial pressure of oxygen levels have all been implicated in the effects that are felt in the upper respiratory tract and eyes. Except for carbon dioxide and, sometimes, ozone, airline cabins meet the standards for most occupational settings. However, the air quality of airline cabins could be improved by increased ventilation and filtration."
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> "The very low levels of ETS in airliners do not appear to pose a measurable risk to health of passengers or flight attendants."

Another aspect of air quality that is beginning to get attention is the transmission of airborne pathogens in the aircraft and the dissemination of those pathogens by airline travel.

16. Investigators from the Royal Air Force gave a perspective on feasibility and scope of such contamination in aircraft in a 1989 publication:

> "Rapid air travel has increased the potential for international transmission of infectious diseases. Important aspects of this problem include the transmission of foodborne and waterborne illnesses, the translocation of insect vectors, the rapid transport of individuals with incubating illnesses, the direct transmission of diseases inside aircraft and the transmission of zoonoses through animal transport. Infectious outbreaks on aircraft and in the vicinity of airports have included influenza, staphylococcal gastroenteritis, salmonellosis, cholera and malaria."

17. In 1991, investigators from the Institute of Pathology and Tropical Medicine of the Royal Air Force focused on the interrelationships between air transport and the dissemination of human pathogens. They concluded:

> "The age of mass epidemics associated with travel has passed and spectres such as smallpox and plague are now things of the past. However, the distinction between national and international health problems is becoming ever more blurred and this is due in part to the impact of flight with the resultant mobility of diseases."

If you review all of these reports, it is interesting that in twenty years of looking scientifically at the issue of ETS in aircraft by both individual investigators and government bodies the scientific conclusions remain basically unchanged. It would lead one to speculate that there may be a political agenda in play and not one supported by available scientific data.

1. Federal Aviation Administration and National Institute for Occupational Safety and Health. "Health Aspects of Smoking in Transport Aircraft," US Dept. of Transportation and US Dept. of Health Education and Welfare, 85 pp., 1971.

2. Vieillefond, H., Fourn, P. and Auffrer, R., "Characteristics in the Atmosphere of Long-Range Transport Aircraft Cabins," Aviat. Space Environ. Med., 48, 503-507, 1977.

3. Muramatsu, M., Umemura, S., Okada, T. and Tomita, H., "Estimation of Personal Exposure to Tobacco Smoke with a Newly Developed Nicotine Personal Monitor," Environ. Res. 35, 218-277, 1984.

4. Muramatsu, M., Umemura, S., Fukui, J., Arai, T. and Kira, S., "Estimation of Personal Exposure to Ambient Nicotine in Daily Environment," Int. Arch. Occup. Environ. Health, 59, 545-550, 1987.

5. Oldaker, G.B. III and Conrad, F., "Estimation of Effect of Environmental Tobacco Smoke on Air Quality Within Passenger Cabins of Commercial Aircraft," Environ. Sci. Tech., 21, 994-999, 1987.

6. Nagda, N., et all, "Airline Cabin Environment: Contaminant Measurements, Health Risks and Mitigation Options," Report No. DOT-P-15-89-5, Prepared by GOMET Technologies, Inc., Germantown, Maryland for the US Department of Transportation, Washington, DC , December 1989.

7. Drake, J.W. and Johnson, D.E., "Measurements of Certain Environmental Tobacco Smoke Components on Long-Range Flights," Aviation, Space and Environmental Medicine, pp. 531-545, June 1990.

8. Oldaker, G.B. III, Stancill, W.M., Conrad, F.W. III, Collie, B.B., Fenner, R.A., Lephardt, J.O., Baker, P.G., Lyons-Hart, J., Parrish, M.E., "Estimation of Effect of Environmental Tobacco Smoke on Air Quality Within Passenger Cabins of Commercial Aircraft II", Indoor Air Quality and Ventilation (London: Selper Ltd., 1990): 447-454.

9. Mattson, M.E., Boyd, G., Byar, D., Brown, C., Callahan, J.F., Corle, D., Cullen, J.W., Greenblatt, J., Haley, N.J., Hammond, S.K., Lewtas, J., Reeves, W., "Passive Smoking on Commercial Airline Flights," JAMA, 216:6, 867-872, 1989.

10. Malmfors, T., Thorburn, D., Westlin, A., "Air Quality in Passenger Cabins of DC-9 and MD-80 Aircraft," Environ. Technol. Letters, 10:613-618, 1989.

11. O'Donnell, A., Donnini, G., Nguyen, V.H., "Air Quality, Ventilation, Temperature and Humidity in Aircraft," ASHRAE Journal, pp. 42-46, April 1991.

12. Nagda, N.L., Koontz, M.D. and Konheim, A.G., "Carbon Dioxide Levels in Commercial Airliner Cabins," ASHRAE Journal, pp 35-38, August 1991.

13. Ramstrom, L.M., "Exposure to Environmental Tobacco Smoke (ETS) in Aircraft," WHO, 1984.

14. Holcomb, L., "Impact of Environmental Tobacco Smoke on Airline Cabin Air Quality," Environ. Technol. Letters, 9:509-514, 1988.

15. Crawford, W.A. and Holcomb, L.C., "Environmental Tobacco Smoke (ETS) in Airliners - A Health Hazard?" Aviat. Space Environ. Med., 62:580-586, 1991.

16. Royal, L. and McCourbrey, I., "International Spread of Disease by Air Travel," Am. Fam. Phy., 40(5): 129-136, 1989.

17. Masterton, R.G. and Green, A.D., "Dissemination of Human Pathogens by Airline Travel," J. App. Bact. Sym. Suppl., 70:31S-38S, 1991.