HETA 97–0115–2718
Northwest Airlines
Wayne County Airport

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PREFACE

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ACKNOWLEDGMENTS AND AVAILABILITY OF REPORT

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SUMMARY

On February 21, 1997, the National Institute for Occupational Safety and Health (NIOSH) received a request from Northwest Airlines (NWA) customer service agents (CSAs) to investigate ongoing health complaints among NWA employees at Wayne County Airport in Detroit, Michigan. Employees expressed concern that certain symptoms such as difficulty breathing, headache, fatigue, and nausea, and miscarriages may be related to the indoor environmental quality (IEQ) at the airport. The requesters identified several agents of concern including malodorous sewer gas, carbon monoxide (CO), carbon dioxide (CO_2), and glycols.

In response to the request, NIOSH investigators reviewed the results of previous IEQ investigations conducted at the airport and visited the airport on February 9–10, 1998. NIOSH investigators focused on those agents which were of the greatest concern to employees and to which exposure seemed plausible. These included measurements of CO and odors. NIOSH also sought to better understand the types and patterns of symptoms experienced by CSAs.

Four– to eight–hour time–weighted average (TWA) CO concentrations in the concourses ranged from 1 to 3 parts per million (ppm), with a peak concentration of 14 ppm. A 4–hour TWA CO concentration of 4 ppm was measured in the baggage room on February 10, with a peak concentration of 58 ppm. Measurements for hydrogen sulfide (H_2S) were obtained at sanitary and storm water drains from which employees claimed malodorous gases had emanated in the past. No H_2S was detected at any of these locations, indicating that H_2S concentrations were less than 0.2 ppm.

A questionnaire showed that the CSAs had either comparable or slightly higher levels of reported symptoms as compared to a reference group of employees in non–industrial workplaces previously evaluated by NIOSH because of indoor environmental concerns. Employees attributed their symptoms to a variety of environmental agents, including jet and diesel exhaust from the planes and baggage tugs, environmental tobacco smoke (ETS) originating from restaurants and bars adjacent to the gate area, and wide temperature fluctuations. They also expressed concern about the stressfulness of their job.

Despite the difficulty in relating all symptoms reported by the CSAs to the work environment, there are conditions at the airport that should be improved, including potential for CO exposures, ETS, transient odors, temperature fluctuations, and communication deficiencies. Recommendations for addressing these conditions and improving employee satisfaction are presented on page 17.

Keywords: SIC 4512 (Air Transportation, Scheduled), airport, indoor air quality, indoor environmental quality, carbon monoxide, environmental tobacco smoke, ETS, IEQ, CO, H_2S, and odors.

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INTRODUCTION

On February 21, 1997, the National Institute for Occupational Safety and Health (NIOSH) received a request from Northwest Airlines (NWA) customer service agents (CSAs) to investigate ongoing health complaints among NWA employees at Wayne County Airport in Detroit, Michigan. Employees expressed concern that certain symptoms such as difficulty breathing, headache, fatigue, nausea, and miscarriages may be related in some way to the indoor environmental quality (IEQ) at the airport. The requesters identified several concerns, including malodorous sewer gas, carbon monoxide (CO) from ground support equipment, carbon dioxide (CO_2), and glycols used for deicing airplanes.

In response to the request, NIOSH investigators reviewed the results of previous IEQ investigations conducted at the airport and visited the airport on February 9–10, 1998, to review the scope and prevalence of the symptoms experienced, observe the configuration of the heating, ventilating, and air–conditioning (HVAC) system, and conduct environmental monitoring.

BACKGROUND

The buildings housing NWA operations are owned by Wayne County. Space within the airport is leased by the airlines operating there. The airport is divided into two terminals: L.C. Smith Terminal, which includes concourses A and B, and J.M. Davey Terminal, which is comprised of concourses C, D, E, F, and G. All of the NWA activities occur in the J.M. Davey Terminal.

At the time of the survey, NWA employed 734 agents at the airport, including 160 CSAs who worked either a day or night shift at the ticket counters. Twenty–five agents worked in concourse C, and approximately 18 CSAs worked in each of the other concourses during a shift. Additionally, about 9 CSAs worked in the baggage claim area. NWA used 50 of their 58 gates to accommodate 450 flights per day.

NWA employees had periodically expressed concern about poor IEQ at the airport dating back to December 1993. Rust Environmental and Infrastructure (Rust) was retained at that time by NWA to identify the source of employee discomfort. Rust evaluated the work environment and concluded that reports of discomfort were related to building renovation which was going on at that time. Periodic episodes continued from 1995 through 1997, the most significant of which occurred in May 1995, when six CSAs were taken to the hospital. Affected employees' carboxyhemoglobin (COHb) levels were measured as an indicator of exposure to CO. Results of those tests indicated that employees were not exposed to CO at levels where adverse health effects would be expected.

In response to employees' concerns, NWA retained industrial hygiene consultation from Rust on two occasions in 1995, and once from Clayton Environmental Consultants in 1996. Consultants' site evaluations consisted of standard IEQ measurements (CO, temperature, and relative humidity [RH]) and the identification of possible odor sources. A low concentration (0.2 parts per million [ppm]) of nitrogen dioxide (NO_2) was detected on one occasion during an investigation in concourses D and F. Also, hydrogen sulfide gas (H_2S) was detected six inches above the sewer drain grate (outdoors) on the service drive between Concourse F and the baggage handling room. Rust identified diesel exhaust as the likely source of NO_2. All other IEQ measures obtained by the consultants were within the parameters favorable to maintaining occupant comfort.

Through conversations with a few CSAs in the weeks leading up to the site visit, it seemed evident that their concerns centered around CO and odors, including exhaust odors from ground support equipment. As NWA had retained qualified industrial hygiene consultants to evaluate standard IEQ measures, and those

evaluations found conditions to be within the comfort range, it did not seem prudent for NIOSH to repeat those efforts. Consequently, rather than taking a broad approach, NIOSH focused on those agents which were of the greatest concern to employees and to which exposure seemed plausible. Therefore, the scope of this evaluation included measurements of CO, identification of pathways by which odors could reach CSAs, and efforts to better understand the types and patterns of symptoms experienced by CSAs.

METHODS

Environmental Monitoring

CO monitoring was conducted using Toxilog Personal Portable Gas Detectors manufactured by Biosystems, Inc. (Rockfall, Connecticut). These real–time, data–logging monitors employ an electrochemical cell to measure the full–shift time–weighted average (TWA) concentration, the maximum 15–minute short–term concentration, and the maximum peak concentration of CO. They were calibrated using a span gas and zeroed in the laboratory prior to their use on–site. A manufacturer representative indicated that a conservative estimate of the accuracy of these instruments is ±5% or ±2 ppm, whichever is greater. The range of these instruments is 0–999 ppm of CO. Potential interfering compounds include sulfur dioxide, NO_2, nitric oxide (NO), and hydrogen.

H_2S measurements were obtained using Drager colorimetric detector tubes. The basis for this tube is a chemical reaction of H_2S with the tube filling, which leads to a discoloration of the filling proportionate to the mass of H_2S present in the sampled air.[1]

Medical Assessment

The medical assessment focused on addressing two major questions. First, we evaluated records to determine whether there was any medical evidence of significant overexposure to CO. Second, we evaluated the prevalence of symptoms which have previously been associated with indoor environmental problems, in order to compare this work environment with other non–industrial facilities NIOSH has evaluated.

More specifically, the evaluation consisted of three components:

1. informal interviews with CSAs during their rest breaks in the employee lounges,

2. a review of cases seen at the contract occupational health center, with a focus on cases seen because of possible CO overexposure, and

3. administration of a standardized environmental quality questionnaire to a sample of CSAs.

The aim of the standardized questionnaire was to compare the prevalence of symptoms at the Wayne County Airport with the those found in a series of studies that NIOSH conducted in 1993 to evaluate 2,435 workers in 80 different office buildings where complaints had also been registered concerning the quality of the indoor environment. The questionnaire inquired about a series of symptoms which were initially developed for a joint NIOSH–Environmental Protection Agency (EPA) study of IEQ problems. The case definition which has been used in these studies for a potentially work–related symptom was a reported symptom (such as dry, itchy, or irritated eyes) experienced one day or more per week over the past four weeks which got better when the person was away from work. The questionnaire also addressed complaints about the air quality and the presence of allergies, sinus problems, and asthma.[2]

EVALUATION CRITERIA

Indoor Environmental Quality (IEQ)

NIOSH investigators have completed over 1200 investigations of occupational indoor environments in a wide variety of non–industrial settings. The majority of these investigations have been conducted since 1979.

The symptoms and health complaints reported to NIOSH by building occupants have been diverse and usually not suggestive of any particular medical diagnosis or readily associated with a causative agent. A typical spectrum of symptoms has included headaches, unusual fatigue, varying degrees of itching or burning eyes, irritations of the skin, nasal congestion, dry or irritated throats, and other respiratory irritations. Typically, the workplace environment has been implicated because workers report that their symptoms lessen or resolve when they leave the building.

A number of published studies have reported a high prevalence of symptoms among occupants of office buildings.[3, 4, 5, 6, 7] Scientists investigating indoor environmental problems believe there are multiple factors contributing to building–related occupant complaints.[8,9] Among these factors are imprecisely defined characteristics of HVAC systems, cumulative effects of exposure to low concentrations of multiple chemical pollutants, odors, elevated concentrations of particulate matter, microbiological contamination, and physical factors such as thermal comfort, lighting, and noise.[10, 11, 12, 13, 14, 15] Indoor environmental pollutants can arise from either outdoor sources or indoor sources.[16]

There are also reports describing results which show that occupant perceptions of the indoor environment are more closely related than any measured indoor contaminant or condition to the occurrence of symptoms.[17,18,19] Some studies have shown relationships between psychological, social, and organizational factors in the workplace and the occurrence of symptoms and comfort complaints.[20, 21, 22]

Less often, an illness may be found to be specifically related to something in the building environment. Some examples of potentially building–related illnesses are allergic rhinitis, allergic asthma, hypersensitivity pneumonitis, Legionnaires' disease, Pontiac fever, CO poisoning, and reaction to boiler corrosion inhibitors. The first three conditions can be caused by various microorganisms or other organic material. Legionnaires' disease and Pontiac fever are caused by Legionella bacteria. Sources of CO include vehicle exhaust, inadequately ventilated kerosene heaters, or other fuel–burning appliances. Exposure to boiler additives can occur if boiler steam is used for humidification or is released by accident.

Problems NIOSH investigators have found in the non–industrial indoor environment have included poor air quality due to ventilation system deficiencies, overcrowding, volatile organic chemicals from office furnishings, machines, structural components of the building and contents, tobacco smoke, microbiological contamination, and outside air pollutants; comfort problems due to improper temperature and RH conditions, poor lighting, and unacceptable noise levels; adverse ergonomic conditions; and job–related psychosocial stressors. In most cases, however, these problems could not be directly linked to the reported health effects.

Standards specifically for the non–industrial indoor environment do not exist. NIOSH, the Occupational Safety and Health Administration (OSHA) and the American Conference of Governmental Industrial Hygienists (ACGIH®) have published regulatory standards or recommended limits for occupational exposures.[23, 24, 25] With few exceptions, pollutant concentrations observed in the office work environment fall well below these published

occupational standards or recommended exposure limits. The American Society of Heating, Refrigerating, and Air–Conditioning Engineers (ASHRAE) has published recommended building ventilation design criteria and thermal comfort guidelines.[26, 27] The ACGIH has also developed a manual of guidelines for approaching investigations of building–related complaints that might be caused by airborne living organisms or their effluent.[28]

Measurement of indoor environmental contaminants has rarely been shown to be helpful in determining the cause of symptoms and complaints except where there are strong or unusual sources, or a proven relationship between a contaminant and a building–related illness. The effects of exposure to the usual low–level concentrations of particles and variable mixtures of organic materials found are troublesome to understand. However, measuring ventilation and comfort indicators such as CO_2, temperature, and RH, is useful in the early stages of an investigation in providing information relative to the proper functioning and control of HVAC systems.

Carbon Monoxide (CO)

CO is a colorless, odorless, tasteless gas which can be a product of the incomplete combustion of organic compounds. CO rapidly diffuses across alveolar, capillary, and placental membranes to bind with heme in the blood. Blood has an estimated 210–250 times greater affinity for CO than oxygen, thereby interfering with oxygen uptake and delivery to the body. Additionally, once absorbed into the bloodstream, the half–life of CO is approximately 5 hours. Overexposure to CO can result in headache, drowsiness, dizziness, nausea, vomiting, collapse, myocardial ischemia, and death.[29]

The body compensates for hypoxic stress due to CO exposure by increasing cardiac output, thereby increasing blood flow to specific oxygen–demanding organs (the brain, the heart). This ability may be limited by pre–existing conditions which inhibit increased cardiac output, (i.e., heart and/or respiratory disease). Of particular concern is the case of the pregnant worker, whose endogenous COHb level can be elevated three fold[30] and whose oxygen consumption is 15–25% higher than normal. Additionally, the mother's blood may have 20–30% reduced oxygen–carrying capacity due to lower hemoglobin levels.[31] Exposure to CO can increase the COHb level in the fetus's blood above the endogenous levels, which are already close to critical levels. Additionally, the developing fetus does not have the ability to compensate for hypoxia through increases in cardiac output. Decreased birth weights and fetal death have been documented at moderate CO exposure (30 ppm) in laboratory animals.[30] A well–established relationship exists between smoking and low fetal birth weight; CO is suspected to be one of the primary etiologic agents responsible for this effect.

In 1972, NIOSH published a criteria document recommending that occupational exposures to CO be maintained to a level that will not induce a shift in COHb level greater than 5%.[32] NIOSH established a recommended exposure limits (REL) for CO of 35 ppm as a TWA for an 8–hour workday and a ceiling concentration of 200 ppm. A ceiling concentration is an exposure concentration which should not be exceeded at any time during the workshift.

The OSHA Permissible Exposure Limits (PEL) for CO is 50 ppm for an 8–hour TWA.[33] In 1996, ACGIH revised its recommended occupational exposure criteria for CO.[34] The ACGIH recommends that occupational exposure to CO be based upon exposure levels that will maintain shifts in blood COHb levels to below 3.5%. This 3.5% caboxyhemoglobin criterion was established "to minimize adverse neurobehavioral changes, and to maintain cardiovascular exercise capacity." The ACGIH recommendation also provides "a margin of safety for individuals particularly susceptible to the adverse effects of CO exposure,

including pregnant workers (i.e., the fetus) and those with chronic heart and respiratory disease." The ACGIH Threshold Limit Value(TLV®) for CO is 25 ppm as an 8–hour TWA.

OBSERVATIONS AND RESULTS

Environmental Measurements

CO monitoring results are summarized in Table 1, located at the end of the report. A series of figures are also provided to illustrate the results. TWA (averaged over sampling periods ranging from 4–11 hours) concentrations in the concourses ranged from 1 ppm, at several gates both days, to 3 ppm, at gate E9 on February 10. A TWA concentration of 4 ppm was measured in the baggage room on February 10. The highest peak CO concentration measured in the terminal was 14 ppm at gate C7 on February 9. The highest peak measured in the baggage area was 58 ppm.

Measurements for H_2S were obtained at sanitary and storm water drains from which employees claimed malodorous gases had emanated in the past. No H_2S was detected at any of these locations, indicating that H_2S concentrations were less than 0.2 ppm.

Observations

- Many of the fresh air intakes that supply fresh air to the gates are located at ground level, near areas of vehicular activity. Signs reading "Fresh Air Intake, No Vehicle Idling within 30 ft. radius" or "No Parking" were posted by some of the air intakes. Yellow paint used in 1996 to delineate no parking zones around the air intakes had faded and was only noticeable around a few intakes.

- Several unattended tugs were observed idling. No idling tuggs were observed next to fresh air intakes.

- Ground crew members said that training in the location/identification of fresh air intakes and the potential impact of idling vehicles on building air quality was briefly touched upon in their general procedural training. According to one individual from ground operations, awareness training about the hazards of idling vehicles had been stressed more in recent months.

- Smoking was permitted within lounges in the concourses. The lounges provided very poor enclosure and insufficient ventilation to contain the environmental tobacco smoke (ETS). At times, smoke was observed billowing from lounges into the main concourse, and was evident at nearby gates.

- With the exception of concourse C, the employee work areas (out of public view) are substandard. Many areas were dirty, and a few appeared to be of inferior general upkeep and cleanliness relative to the public areas of the terminal.

Medical

Informal Interviews

During informal interviews, workers reported a variety of symptoms such as shortness of breath, dizziness, and rapid heart rate while working at certain gates. They also reported a variety of irritating odors including jet and diesel exhaust from the planes and tugs, tobacco odors originating from restaurants and bars adjacent to the gate area, "sewer odors" with no clear origin, and other unexplained but annoying chemical odors. In addition, they expressed concerns about the stressfulness of their job, which is in part due to their contact with the public and the variety of difficult situations that can arise during travel, such as inebriated customers or unavoidable

delayed flights. Finally, they reported wide fluctuations in temperatures in the gate area due to the rapid change in the number of travelers in the gate area immediately before and after a plane is loaded.

Clinic Records

NIOSH investigators visited the clinic that provides occupational health services for Northwest Airline employees. The clinic reported drawing COHb levels on three days, August 29, 1996, September 2, 1996, and January 2, 1997. A total of seven CSAs were seen because of acute symptoms potentially due to CO overexposure. COHb levels in all seven CSAs were within the normal range, suggesting that no overexposure to CO had occurred. The levels in the nonsmokers ranged between 2.1 and 2.7 % of hemoglobin which is well below the ACGIH® limit of 3.5% of hemoglobin and are below that considered to be associated with acute or chronic health effects. The smokers had slightly higher levels, ranging from 3.4 up to 8.1 % of hemoglobin, which is also within the typical range for smokers.

Questionnaire

The questionnaire was distributed to workers who were in the break lounges during the first and second shift on concourse C, during the first shift in concourse E, and during second shift on concourse D. The questionnaires were completed by the workers during their official break times.

On the day of the survey, in concourse C, 30 CSAs worked first shift and 39 second shift. Of these 69 workers, 56 (81%) completed the questionnaire. In concourse D on second shift there were 20 CSAs and on concourse E on day shift there were 17. The response rates on both D and E were much lower because many CSAs did not go to the break room during their scheduled break time. Of the 37 CSAs working on D and E, only 19 (51%) completed the questionnaire. Because of the low response rates the results from concourses D & E were combined and reported separately from Concourse C.

The results of this questionnaire were compared with the results of a series of surveys that NIOSH conducted in 1993 to evaluate 2,435 workers in 80 different office buildings where complaints had also been registered concerning the quality of the indoor air environment. The comparison population was 66% female, and 19% were current smokers. The population of CSAs samples was 78% female and 20% were current smokers. Tables 2, 3, and 4 show the results of the questionnaire with reference to the comparison population.

DISCUSSION AND CONCLUSIONS

The medical survey showed that the CSAs had either comparable or slightly higher prevelence of reported symptoms compared to a reference group of employees in non–industrial workplaces previously evaluated by NIOSH because of indoor environmental complaints. Since the number of CSAs included in this questionnaire is relatively small, it is difficult to interpret the statistical significance of those symptoms that appeared elevated, however it is safe to conclude that the level of symptom complaints at the airport were at least as high as those NIOSH found in previous indoor environmental surveys. Also, the kind of symptoms reported by the CSAs were primarily upper respiratory irritant and atopic complaints (such as eye and nasal irritation), complaints of irritant odors due to chemicals, cigarette smoke, and thermal discomfort. These kinds of complaints are some of the most common complaints found in investigations of IEQ.

A number of studies have attempted to establish a relationship between work–related symptoms in office workers and specific building design characteristics. Although previous epidemiological studies have demonstrated some

relationship between symptoms and the type of ventilation and maintenance of ventilation, as well as certain classes of interior carpets and upholstery, in general it has been difficult to consistently explain all of the causes of these symptoms. In the analysis of the 80 non–industrial workplaces which provided the NIOSH comparison population for this evaluation, associations were found between the symptoms of sneezing, nasal congestion, and eye irritation and factors related to the cleaning and maintenance of the ventilation system.[35] In general, however, it has been concluded that the cause of symptoms in office workers is multifactorial, resulting from a complex combination of building–related factors, work organizational factors, and individual factors. Despite the difficulty in relating all the symptoms reported by the CSAs to specific work exposures, we did observe certain conditions at the airport that should be improved including potential for CO exposures, ETS, transient odors, temperature fluctuations, and communication deficiencies between management and employees.

On the days of the survey, CO concentrations measured in the concourses were at levels below those where adverse health effects would be expected. It is not surprising that CO was detected in the concourses given the location of air intakes and the level of ground activity occurring. Monitoring indicated that on a typical day, CO levels inside the facility remain relatively constant, and did not approach levels of concern. There were, however, conditions observed which could lead to higher CO concentrations in the concourses. Several unattended tugs were observed idling at various locations. Though idling tugs were not observed in close proximity to the air intakes during this evaluation, several employees did report that tugs have been periodically left idling next to ground–level air intakes. If tugs have occasionally idled near the intakes, more of the tug's exhaust would have entrained into the HVAC system, leading to more CO and odors in areas supplied by that HVAC unit. Inadequate training of ground support personnel, poorly marked air intakes, and limited enforcement are precursors which allow for this scenario to occur.

Irritation and annoyance due to cigarette smoke was one of the most common complaints expressed by the CSAs. The combustion of tobacco results in a complex array of air contaminants; smoke from the burning tobacco that is not inhaled by the smoker (side stream smoke), combined with exhaled smoke, is referred to as ETS. Occupational exposure to ETS is recognized as an important public health problem. NIOSH has determined that ETS poses an increased risk of lung cancer and possibly heart disease to occupationally exposed workers and recommends eliminating or restricting tobacco use in the workplace.[36]

The current policy at the airport is to restrict smoking to bar and restaurant areas. The effectiveness of restricting rather than banning smoking depends on the policies adopted for isolating the smoking areas. Some studies suggest that when a company's smoking policy restricts smoking to certain work areas, but does not effectively isolate it, the levels of exposure to nicotine remain significant. One study of 25 office environments found that air samples taken in nonsmoking areas of restricted smoking offices showed significantly higher levels of airborne nicotine than those taken in offices where smoking was banned.[37] A recent study by NIOSH in a casino environment found no difference in levels of blood and urine cotinine (a metabolic by–product of nicotine) in those working at gaming tables where smoking was restricted compared to those where it was not restricted.[38] Therefore, NIOSH recommends that if smoking is restricted rather than banned, it should be isolated in enclosed smoking areas where the air is exhausted directly outside and is not recirculated or mixed with the general dilution ventilation for the building. This is not the current practice at the Wayne County Airport and therefore, building occupants outside the smoking areas may be exposed to ETS.

The CSAs reported a variety of other odors in the gate areas. In an indoor environmental evaluation it is often challenging to distinguish those odors which are producing symptoms of irritation or allergies, such as eye irritation and nasal stuffiness, from those that are merely distasteful (such as the odors from the restaurant exhausts) or unexpected but are not leading to specific health effects. During the two days of the NIOSH evaluation, transient odors due to cigarette smoke, restaurant exhausts, and combustion products from aircraft and support vehicles were evident. The CSAs expressed concern about a "rotten egg" smell which had been periodically evident both inside and outside of the building. Measurements attained by Rust in 1995 affirmed that H_2S was emanating from a storm sewer on the service drive between the baggage handling room and concourse F. Although the odor was not evident, and H_2S was not detected on the days of the NIOSH survey, it is reasonable to assume that the rotten egg odor would be evident near both sanitary and storm sewers under certain conditions. Drains leading to sanitary sewers contain a water–filled trap designed to keep sewer odors from escaping into the occupied areas. If the drain is not used over a period of time, the water will evaporate from the trap, allowing sewer odors to escape into the occupied work areas. Similarly, during prolonged periods of dry weather, when chemicals or other organic debris are not flushed from the sewer, storm water sewers may emit odors as these materials begin to decay.

One commonly mentioned concern among CSAs was temperature fluctuations in the gate areas. Indoor air quality researchers have found that one of the most frequent complaints is thermal discomfort.[39] The CSAs at the airport reported high levels of thermal discomfort with the predominant complaints being that it was too hot. Internal sources of heat gain in a building fall into three general categories: people, lights, and miscellaneous. Typically, a person who is walking and standing, will generate heat at a rate of 500 British thermal units (Btu)/hour.[40] It is understandably difficult to maintain even temperatures given the hourly fluctuations in the number of people in the gate areas.

CSAs are among many workers employed in the service sector who are required as a routine part of their job to interact with customers. Industrial psychologists have observed that in order to be successful at these jobs employees must interact with customers by understanding their perspectives, anticipating their needs, and responding sensitively to those needs.[41] This interaction with the customer is inherently stressful especially in those situations where customers are not always content with the service they are being provided. While even in the most supportive of organizations much of this stress may be unavoidable, it is important that organizations recognize this stress and attempt to minimize sources of stress such as those created by poor indoor environmental conditions and by maintaining open lines of communication.

There is a gap in communication between NWA management and CSAs that seem to foster anxiety among the CSAs. Namely, the hazards of chemical agents present at the airport and the risks posed by those agents at the concentrations typically documented in our and previous surveys, and the proper interpretation of COHb values has not been effectively communicated to CSAs. Recommendations for improving communication regarding indoor environmental concerns form a central part of all IEQ programs. The recommendations for improved communication from the NIOSH and EPA Building Air Quality Guide are included in the recommendations sections.

RECOMMENDATIONS

1. Entrainment of ground vehicle exhaust into the concourses should be minimized through the use of proper administrative controls and awareness training. All ground–level air intakes should be identified as no parking/idling areas. In

addition to posting signs at unidentified air intakes, the asphalt should be painted to better delineate areas where vehicles are not permitted. The county had painted these areas in 1996, but the paint has faded, and is barely visible. Additionally, the hazards of vehicular exhaust and a brief explanation of the airflow patterns of HVAC systems should be communicated to all ground operations employees (as part of employee orientation, and subsequently as needed).

2. NIOSH recommends that workers not be involuntarily exposed to ETS. The best method for controlling worker exposure to ETS is to eliminate tobacco use from the workplace and to implement a smoking cessation program for employees. Until tobacco use can be completely eliminated from the airport, NWA/Wayne County should make efforts to protect employees from ETS by isolating areas where smoking is permitted. Smoking lounges should be enclosed and have dedicated ventilation systems to effectively contain and exhaust ETS directly out of doors.

3. Potential sources of malodorous gas (i.e., sewer gas, H_2S) from the sanitary and storm water sewers should be controlled. These gasses will inevitably exist in sanitary sewers as a natural byproduct of decomposition. The pathway by which the odors reach building occupants can be blocked if the traps contain a barrier. Water should periodically be poured into sanitary sewer drains which are not used frequently enough to maintain a water barrier. Efforts should be made to keep the storm sewers flushed during periods of prolonged hot, dry weather.

4. NWA management should retain a qualified engineering firm to evaluate the current HVAC design and thermostat placement to determine if temperature fluctuations could be better controlled.

5. NWA management should assure that their occupational health service provider is effectively communicating medical findings to employees evaluated at the clinic. Additionally, communication should be improved between NWA management and CSAs regarding the hazards of chemicals used at the airport and odors which are periodically evident. Management should respond to, rather than dismiss, concerns expressed by CSAs. Management responsiveness, coupled with effective communication, will foster an environment of trust. Below are some specific recommendations for effective communication from the NIOSH/EPA Building Air Quality Guide.

a. Provide accurate information about factors that effect IEQ.
b. Clarify the responsibilities of each party (i.e., management, employees, contractors).
c. Establish an effective system for logging and responding to complaints should they occur.
d. Maintain the lines of communication.

6. With the exception of the new employee break lounge in concourse C, many of the non–public areas for the NWA employees were dingy and had substandard levels of cleanliness. Providing employees with clean and comfortable work and break areas is important in all work environments but may be particularly important in those such as at NWA where the employees have stressful jobs due to frequent customer interactions.

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Table 1
Northwest Airlines
HETA 97–0115
February 2–3, 1998

Carbon Monoxide (CO) Concentrations Measured at Selected Locations Within the J.M. Davey Terminal, Wayne County Airport

SAMPLING LOCATION	DATE	SAMPLE TIME[1]	PEAK CONCENTRATION[2]	TWA CONCENTRATION[3]
Gate C6	2/9/98	1010–1855	6	2
	2/10/98	0823–1255	6	2
Gate C7	2/9/98	1014–1900	14	2
	2/10/98	0826–1300	12	2
Gate C10	2/1098	0828–1301	6	2
Gate C20	2/9/98	1023–1634	3	1
Gate C25	2/9/98	1026–1830	2	1
Gate E4	2/9/98	0846–1916	6	—[4]
	2/1098	0806–1119	5	2
Gate E9	2/9/98	0850–1921	4	—
	2/10/98	0808–1125	9	3
Gate E15	2/9/98	0852–1925	5	—
	2/10/98	0810–1122	10	—
Gate E18	2/9/98	0854–1930	5	—
	2/10/98	0812–1122	10	2
Baggage Room	2/10/8	0753–1139	58	11

[1] Start and stop time (in military time) for the sampling device.
[2] This is the highest concentration measured during any sample; sampler measures at one–minute intervals.
[3] This column contains the average concentration during the sampling period.
[4] Some of the data could not be retrieved from the sampling device. The symbol – indicates missing data.

Table 2
Northwest Airlines
HETA #97–0115

Prevalence of Symptoms Occurring At Least 1–3 Days per Week that Get Better Away From Work:
Wayne County Airport versus NIOSH Comparison Population*

Symptoms	Concourse C N=56	Concourse D & E N=19	Comparison Population* N=2435
Tired or stained eyes	45%	32%	32%
Dry itchy or irritated eyes	41%	53%	30%
Unusual tiredness, fatigue, or drowsiness	30%	26%	25%
Headache	34%	32%	25%
Tension, irritability or nervousness	38%	53%	23%
Stuffy or runny nose, or sinus congestion	39%	21%	21%
Pain or stiffness in back, shoulders, or neck	30%	32%	21%
Sneezing	11%	16%	18%
Sore or dry throat	38%	32%	16%
Cough	18%	11%	9%
Dry or itchy skin	21%	16%	9%
Difficulty remembering things or concentrating	13%	16%	9%
Dizziness or lightheadedness	25%	16%	8%
Feeling depressed	4%	16%	8%
Shortness of breath	11%	0%	5%
Nausea or upset stomach	14%	5%	5%
Chest tightness	16%	0%	6%
Wheezing	5%	0%	4%

* Office building workers where an indoor air quality complaint had been registered with NIOSH

Table 3
Northwest Airlines
HETA #97–0115

Prevalence of Complaints About Air Quality Which Occurred More Than 1 Day
Per Week During the Previous 4 Weeks

Complaint	Concourse C N = 56	Concourse D & E N = 19	Comparison Population* N = 2435
Too little air movement	70%	58%	50%
Too much air movement	9%	5%	9%
Temperature too hot	66%	89%	35%
Temperature too cold	39%	37%	32%
Too humid	14%	21%	12%
Too dry	66%	47%	35%
Chemical odors	55%	42%	10%
Tobacco smoke odors	63%	58%	15%

* Office building workers where an indoor air quality complaint had been registered with NIOSH

Table 4
Northwest Airlines
HETA #97–0115

Prevalence of Health Conditions Reported by CSAs verses NIOSH Comparison Population*

Condition	Concourse C N = 56	Concourse D & E N = 19	Comparison Population N = 2435
Sinus infection	73%	53%	51%
Asthma	6%	6%	12%
Migraine	26%	39%	22%
Eczema	4%	11%	9%
Hay fever	25%	17%	27%
Dust allergy	42%	28%	29%
Mold allergy	33%	17%	22%
Cat allergy	11%	6%	13%

* Office building workers where an indoor air quality complaint had been registered with NIOSH

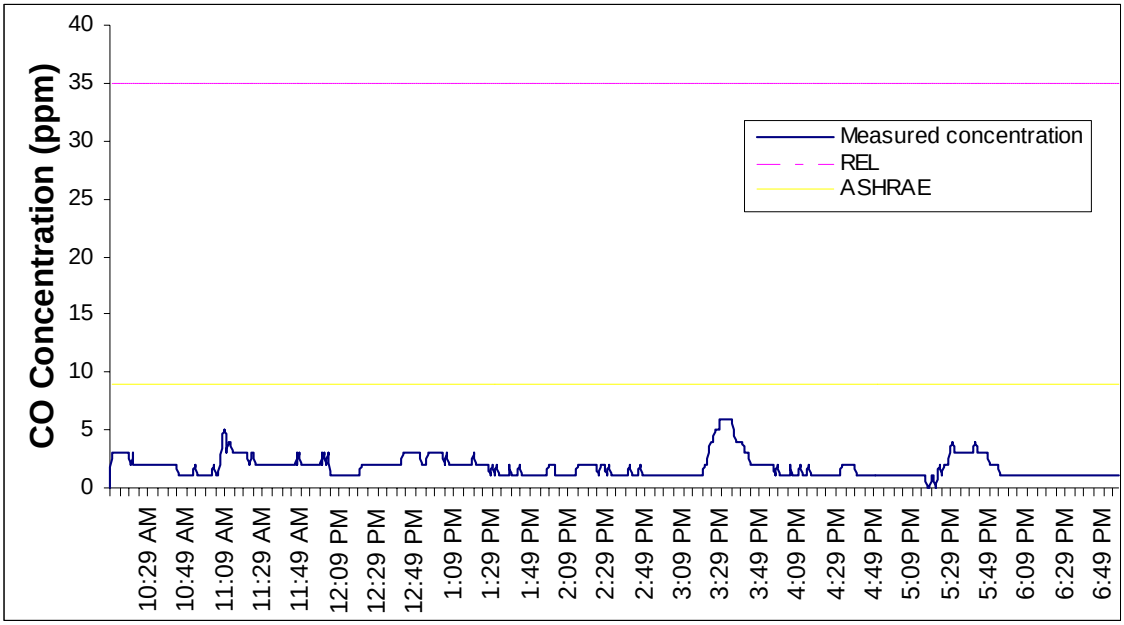

Figure 1
Carbon Monoxide Monitoring Results
February 9, 1998
Gate C6

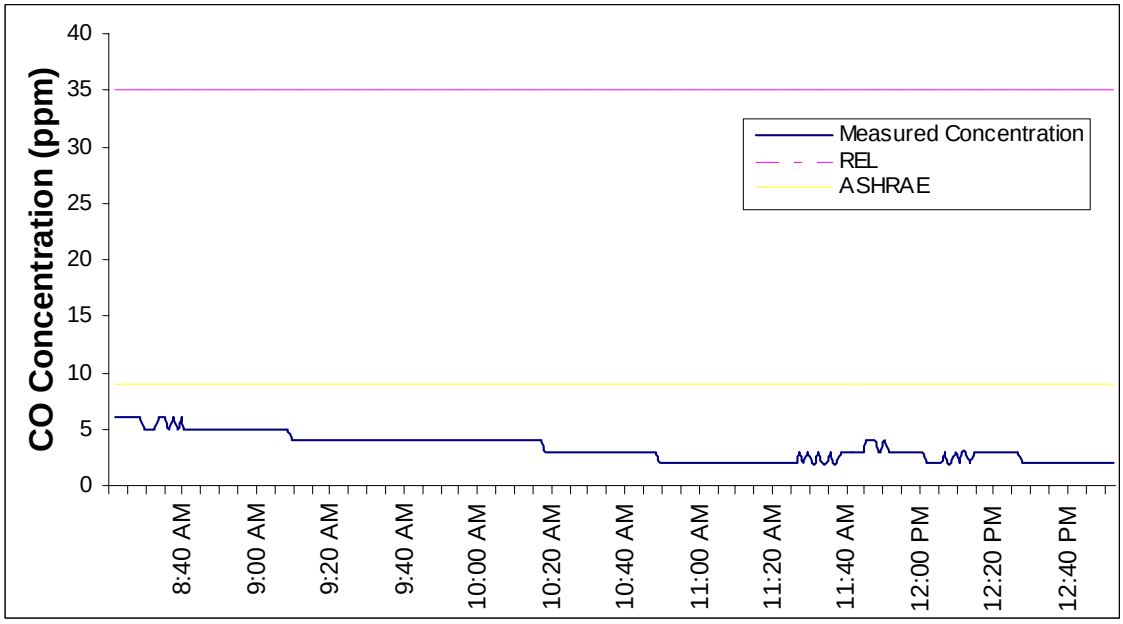

Figure 2
Carbon Monoxide Monitoring Results
February 10, 1998
Gate C6

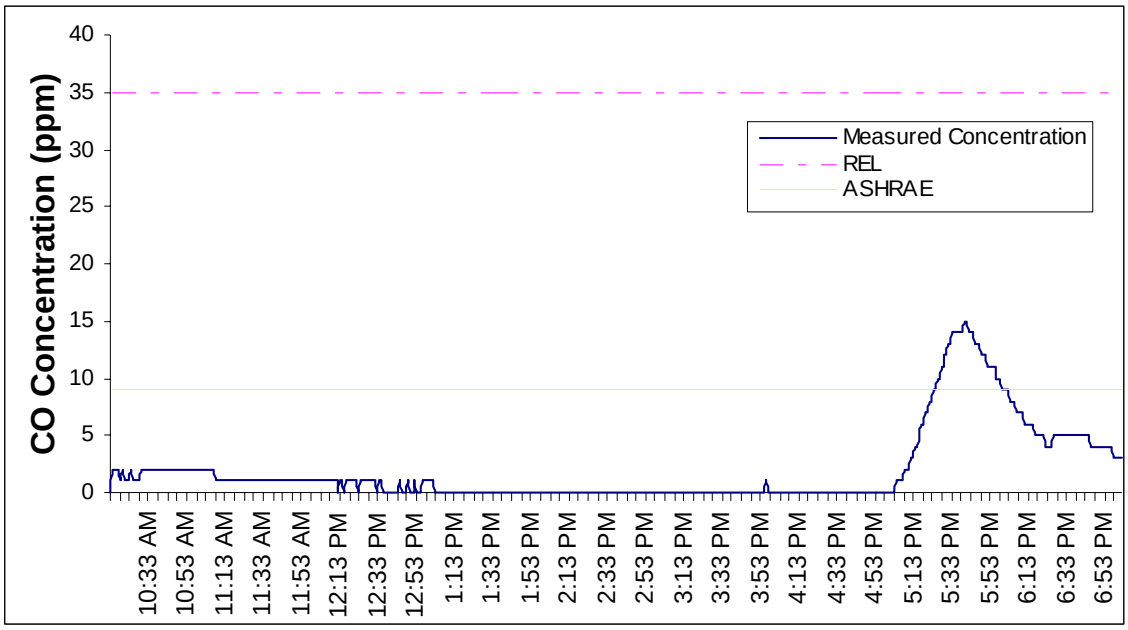

Figure 3
Carbon Monoxide Monitoring Results
February 9, 1998
Gate C7

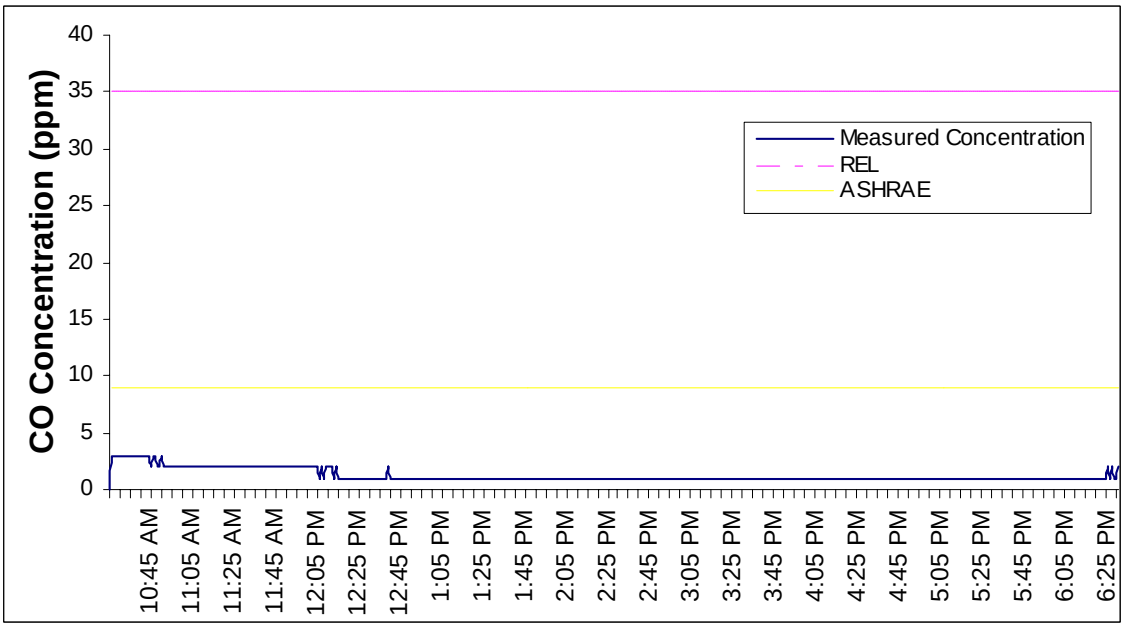

Figure 4
Carbon Monoxide Monitoring Results
February 9, 1998
Gate C25

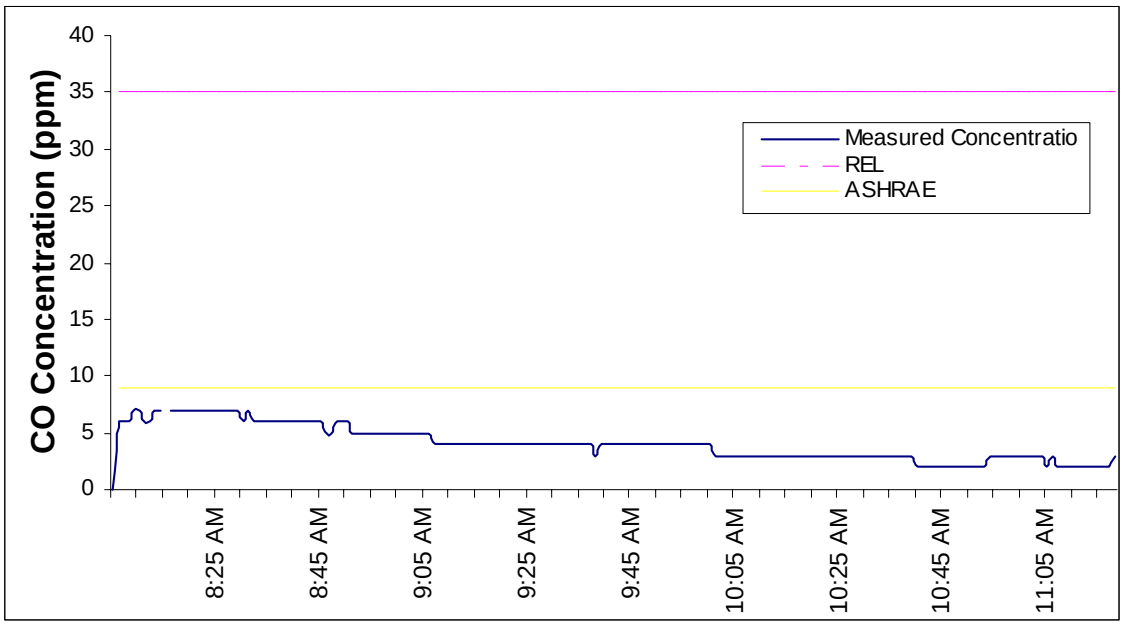

Figure 5
Carbon Monoxide Monitoring Results
February 10, 1998
Gate E4

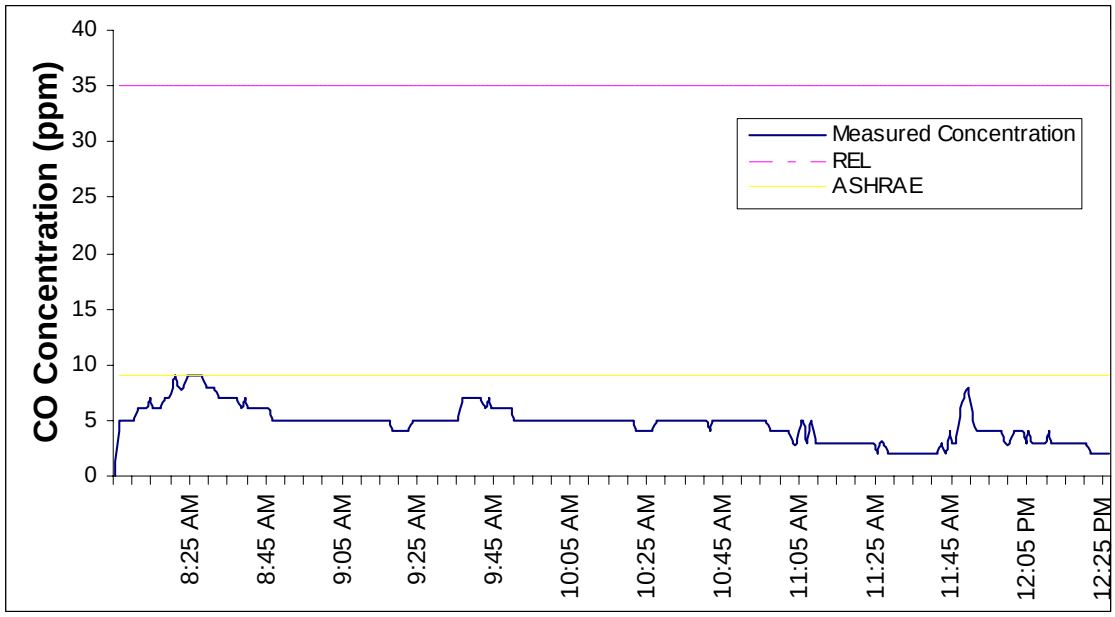

Figure 6
Carbon Monoxide Monitoring Results
February 10, 1998
Gate E9

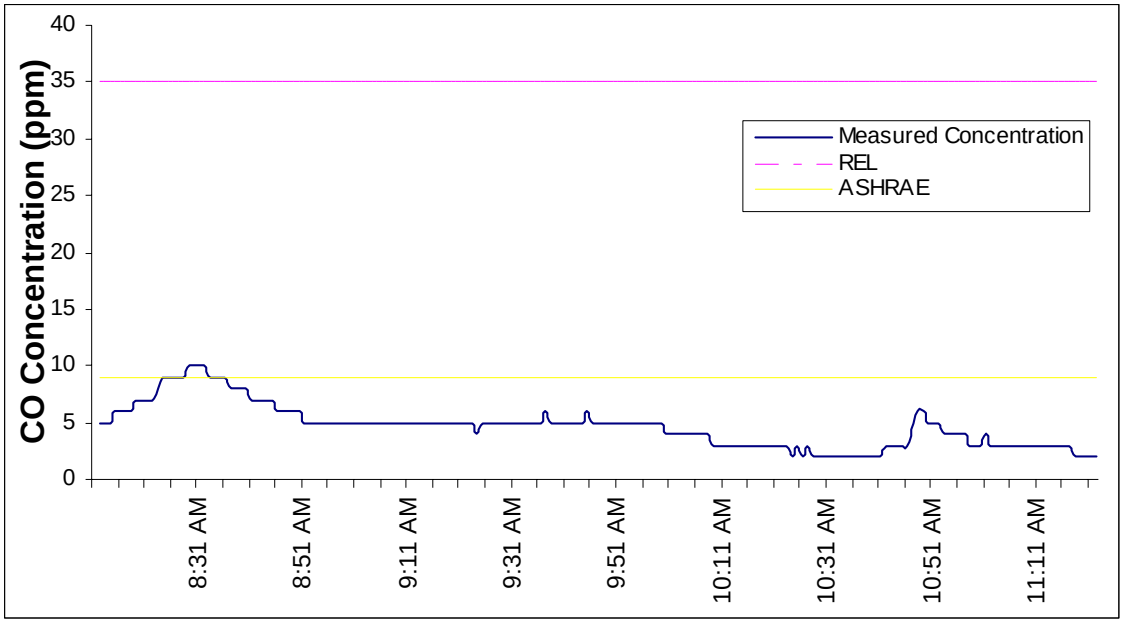

Figure 7
Carbon Monoxide Monitoring Results
February 10, 1998
Gate E18

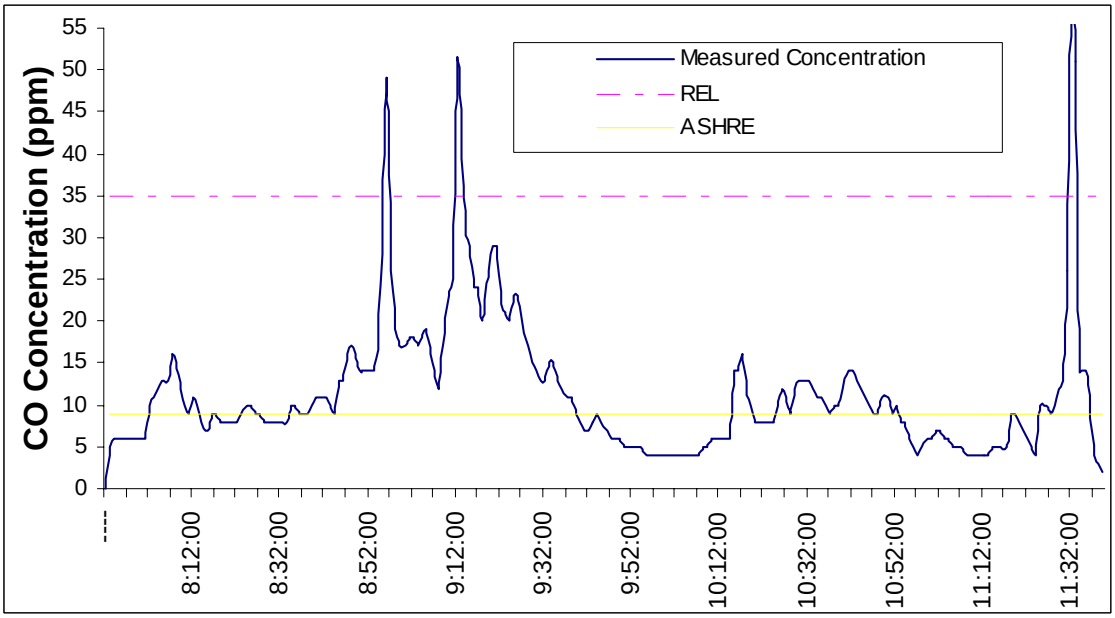

Figure 8
Carbon Monoxide Monitoring Results
February 10, 1998
Baggage Room at Pier 10–11

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Safety and health at work
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