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HETA 99-0060-2766
Continental Express Airlines
Newark, New Jersey

Randy L. Tubbs, Ph.D.

PREFACE

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ACKNOWLEDGMENTS AND AVAILABILITY OF REPORT

This report was prepared by Randy L. Tubbs, Ph.D., of HETAB, Division of Surveillance, Hazard Evaluations and Field Studies (DSHEFS). Desktop publishing was performed by Denise Ratliff. Review and preparation for printing were performed by Penny Arthur.

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Highlights of the NIOSH Health Hazard Evaluation

Noise Exposures to Continental Express Ramp Employees at Newark International Airport

The National Institute for Occupational Safety and Health (NIOSH) was asked by employees and management to look at noise exposures for the ramp employees at the airport. Particular attention was paid to the auxiliary power units (APUs) on the Embraer regional jets.

What NIOSH Did

- # Measured personal noise exposures to ramp employees for one full-shift.
- # Measured the noise produced by the Embraer jet's APU.
- # Measured the APUs of larger jet aircraft used by Continental Airlines.
- # Evaluated the hearing protection given to employees to see how well it works around the APUs.

What NIOSH Found

- # Five of six daily noise doses were higher than OSHA's action level which requires a hearing conservation program for employees.
- # All ramp employees' daily noise exposures exceeded the NIOSH limit for noise.
- # The APU on the Embraer jet was louder than units on the larger aircraft.

What Continental Express Airlines Can Do

- # Continue to provide a hearing conservation program to employees.
- # Make it easy for all employees to have yearly hearing tests.
- # Check with the manufacturer of the regional jet about the husk kit made to quiet the APU. New aircraft purchases should have noise reduction specifications.
- # Impress upon ramp employees to wear hearing protection whenever they are on the flight line.
- # Plan any new facility construction with noise reduction as part of the design.

What the Continental Express Employees Can Do

- # Wear hearing protection whenever you are around aircraft.
- # Make an effort to have a hearing test every year.
- # Use good hearing conservation judgement away from the job.



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Health Hazard Evaluation Report HETA 99-0060-2766

**Continental Express Airlines
Newark, New Jersey
November 1999**

Randy L. Tubbs, Ph.D.

SUMMARY

Employees at Continental Express Airlines in Newark, New Jersey, submitted a request for a health hazard evaluation (HHE) to the National Institute for Occupational Safety and Health (NIOSH) on December 8, 1998. The request concerned noise exposures for employees who work in the ramp area of the airport, servicing inbound and outbound aircraft. One specific area of interest was the auxiliary power units located on the regional jet aircraft and the noise they produce while the unit is operational.

A NIOSH investigator visited the Newark International Airport on June 2-4, 1999, to conduct a site visit. Personal noise dosimetry was conducted on six ramp employees on June 3rd to document their exposures along with area noise measurements made with a real-time analyzer to evaluate the noise levels emitted by the auxiliary power units. The results of the noise survey revealed that none of the six employees measured had noise levels that exceeded the Occupational Safety and Health Administration's (OSHA) permissible exposure limit of 90 A-weighted decibels [dB(A)] as an 8-hour time-weighted average. However, five of the six employees did surpass the action level of 85 dB(A) mandated by OSHA. Additionally, when the personal noise dosimeter results were compared to the NIOSH noise criterion, all employees were in excess of the recommended exposure limit, placing them at risk of occupational noise-induced hearing loss. The real-time spectral measurements made of the auxiliary power units documented exposure levels up to 120 dB(A) for the regional jets flown by Continental Express Airlines. The noise from the power units on these regional jets was also found to be greater than the noise emitted by the larger jets used by Continental Airlines.

The employees of Continental Express Airlines who work on the ramp at Newark International Airport are exposed to noise levels that could be potentially damaging to the hearing. Most of the hearing protection devices that the company offers to their employees should be sufficient to reduce workers' exposures to safe levels if they are worn properly and continuously whenever employees are in the vicinity of the jet aircraft. Recommendations are offered in the report to help reduce noise exposures to employees and to monitor the effectiveness of the hearing conservation program used by the company.

Keywords: SIC 4581 (Airports, Flying Fields, and Airport Terminal Services), noise, jet aircraft, auxiliary power units, APUs, dosimetry, noise spectra, hearing protection devices

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INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH) received a request for a health hazard evaluation (HHE) from employees at Continental Express Airlines in Newark, New Jersey, on December 18, 1998. The employees were concerned about noise levels they experienced on the ramp area as they serviced inbound and outbound aircraft. Of particular concern was the noise emitted by the Embraer RJ 145 regional jet aircraft and its auxiliary power unit (APU) located in the tail of the vehicle. The employees felt that the noise from the aircraft was jeopardizing their hearing, leading to permanent damage to their ears.

Management at Continental Express Airlines was first contacted by a NIOSH investigator in January 1999. It was revealed to NIOSH that a noise dosimeter survey had recently been conducted by Continental's corporate Ground Safety Department in the area of concern to the employees. A copy of that report was forwarded to NIOSH on February 18, 1999. After review of the company's report, the NIOSH investigator determined that a site visit would be necessary to better define the noise exposures the employees experienced. The site visit was conducted on June 2-4, 1999, with an opening conference held on the first day of the visit and closing conference on the last day. Full-shift employee noise monitoring as well as area noise spectrum measurements were performed on June 3, 1999. An interim letter was sent to the requester and company officials outlining the preliminary results and observations of the site visit on June 9, 1999.

BACKGROUND

Continental Express is the fifth largest U.S. airline based on passenger traffic, with approximately 44 million passengers emplaned in 1998. Continental Express, the company's regional subsidiary airline, serves more than 80 cities in the U.S. It has airport hubs in Cleveland, Ohio; Newark, New Jersey; and Houston, Texas, the corporate headquarters.

Continental Express had a fleet of 91 turboprops and 38 regional jets as of June 1999, including the Embraer RJ145 50-seat regional jet and Embraer Brasilia 120 turboprop airplane. Continental Express has a goal to become an all-jet fleet over the next five years. The Newark International Airport was undergoing renovation of the ramp area during the time of the NIOSH evaluation.

Continental Express aircraft are parked in an open area of the airport and passengers are shuttled to and from the planes and terminal in buses. Up to four rows of aircraft can be parked in Continental Express' ramp area. Approximately 100 ramp personnel work two shifts at the Newark International Airport for Continental Express Airlines. These employees service the aircraft when the planes are on the ground. Their tasks include baggage handling, aircraft maintenance, lavatory service, and catering.

The aircraft taxi to their parking location with the engines operating. Once parked, the pilot will turn off the engine which stops the on-board ventilation system. In order to keep the air in the cabin conditioned or heated, either the APU or ground power unit (GPU) and air conditioning (A/C) cart will be placed in service. The APU is an on-board engine most often located in the tail of the aircraft that supplies power to the aircraft and the ventilation system. On the Embraer Jet, the APU is exhausted down towards the ground through the end of the plane's tail section. The door for the baggage compartment is located adjacent to the tail section on the port side of the aircraft. It was the noise from the APU that was specified in the HHE request as the cause for employees' concerns. To evaluate the noise impact from the APU, personal noise dosimeter measurements were made on Continental Express customer service agents during a full-shift workday along with area spectral measurements at fixed locations around the aircraft. Also, the company's hearing conservation program was reviewed with particular attention paid to the kinds of hearing protection offered to the employees.

METHODS

Quest® Technologies Model Q-300 Noise Dosimeters were worn by employees during the day shift at the Continental Express ramp at the airport. The noise dosimeters were attached to the wearer's belt and a small remote microphone was fastened to the wearer's shirt at a point midway between the ear and the outside of the employee's shoulder. At the end of the shift, the dosimeters were removed and paused to stop data collection. The information was downloaded to a personal computer for interpretation with QuestSuite for Windows® computer software. The dosimeters were calibrated before and after the work shift according to the manufacturer's instructions.

Real-time area noise sampling was conducted with a Larson-Davis Laboratory Model 2800 Real-Time Analyzer and a Larson-Davis Laboratory Model 2559 ½" random incidence response microphone. The analyzer allows for the analysis of noise into its spectral components in a real-time mode. The ½" diameter microphone has a frequency response range (± 2 decibels [dB]) from 4 Hertz (Hz) to 21 kilohertz (kHz) that allows for the analysis of sounds in the region of concern. One-third octave-bands consisting of center frequencies from 20 Hz to 20 kHz were integrated and stored in the analyzer. The analyzer was mounted on a tripod and was placed at various locations around the jet aircraft with the microphone at approximately what would have been the level of employees' ears if they had been in the area. Measurement locations for the Embraer jet were the tail section below the APU, the end of the baggage conveyor, and the mobile stairs that passengers used to enter and exit the aircraft. Similar tail section locations of other Continental jet aircraft were measured to allow comparison of noise levels emitted by other types of APUs.

EVALUATION CRITERIA

As a guide to the evaluation of the hazards posed by workplace exposures, NIOSH field staff employ

environmental evaluation criteria for the assessment of a number of chemical and physical agents. These criteria are intended to suggest levels of exposure to which most workers may be exposed up to 10 hours per day, 40 hours per week for a working lifetime without experiencing adverse health effects. It is, however, important to note that not all workers will be protected from adverse health effects even though their exposures are maintained below these levels. A small percentage may experience adverse health effects because of individual susceptibility, a pre-existing medical condition, and/or a hypersensitivity (allergy). In addition, some hazardous substances may act in combination with other workplace exposures, the general environment, or with medications or personal habits of the worker to produce health effects even if the occupational exposures are controlled at the level set by the criterion. These combined effects are often not considered in the evaluation criteria. Finally, evaluation criteria may change over the years as new information on the toxic effects of an agent become available.

The primary sources of environmental evaluation criteria for the workplace are: (1) NIOSH Recommended Exposure Limits (RELs),¹ (2) the American Conference of Governmental Industrial Hygienists' (ACGIH®) Threshold Limit Values (TLVs®),² and (3) the U.S. Department of Labor, Occupational Safety and Health Administration (OSHA) Permissible Exposure Limits (PELs).³ Employers are encouraged to follow the OSHA limits, the NIOSH RELs, the ACGIH TLVs, or whichever are the more protective criterion.

OSHA requires an employer to furnish employees a place of employment that is free from recognized hazards that are causing or are likely to cause death or serious physical harm (Occupational Safety and Health Act of 1970 [Public Law 91-596, Sec. 5.(a)(1)]). Thus, employers should understand that not all hazardous chemicals have specific OSHA exposure limits such as PELs and short-term exposure limits (STELs). An employer is still required by OSHA to protect their employees from

hazards, even in the absence of a specific OSHA PEL.

Noise

Noise-induced loss of hearing is an irreversible, sensorineural condition that progresses with exposure. Although hearing ability declines with age (presbycusis) in all populations, exposure to noise produces hearing loss greater than that resulting from the natural aging process. This noise-induced loss is caused by damage to nerve cells of the inner ear (cochlea) and, unlike some conductive hearing disorders, cannot be treated medically.⁴ While loss of hearing may result from a single exposure to a very brief impulse noise or explosion, such traumatic losses are rare. In most cases, noise-induced hearing loss is insidious. Typically, it begins to develop at 4000 or 6000 Hz (the hearing range is 20 Hz to 20000 Hz) and spreads to lower and higher frequencies. Often, material impairment has occurred before the condition is clearly recognized. Such impairment is usually severe enough to permanently affect a person's ability to hear and understand speech under everyday conditions. Although the primary frequencies of human speech range from 200 Hz to 2000 Hz, research has shown that the consonant sounds, which enable people to distinguish words such as "fish" from "fist," have still higher frequency components.⁵

The A-weighted decibel [dB(A)] is the preferred unit for measuring sound levels to assess worker noise exposures. The dB(A) scale is weighted to approximate the sensory response of the human ear to sound frequencies near the threshold of hearing. The decibel unit is dimensionless, and represents the logarithmic relationship of the measured sound pressure level to an arbitrary reference sound pressure (20 micropascals, the normal threshold of human hearing at a frequency of 1000 Hz). Decibel units are used because of the very large range of sound pressure levels which are audible to the human ear. Because the dB(A) scale is logarithmic, increases of 3 dB(A), 10 dB(A), and 20 dB(A) represent a doubling, tenfold increase, and 100-fold increase of sound energy, respectively. It should be

noted that noise exposures expressed in decibels cannot be averaged by taking the simple arithmetic mean.

The OSHA standard for occupational exposure to noise (29 CFR 1910.95)⁶ specifies a maximum PEL of 90 dB(A) for a duration of 8 hours per day. The regulation, in calculating the PEL, uses a 5 dB time/intensity trading relationship, or exchange rate. This means that a person may be exposed to noise levels of 95 dB(A) for no more than 4 hours, to 100 dB(A) for 2 hours, etc. Conversely, up to 16 hours exposure to 85 dB(A) is allowed by this exchange rate. The duration and sound level intensities can be combined in order to calculate a worker's daily noise dose according to the formula:

$$\text{Dose} = 100 \times (C_1/T_1 + C_2/T_2 + \dots + C_n/T_n),$$

where C_n indicates the total time of exposure at a specific noise level and T_n indicates the reference duration for that level as given in Table G-16a of the OSHA noise regulation. During any 24-hour period, a worker is allowed up to 100% of his daily noise dose. Doses greater than 100% are in excess of the OSHA PEL.

The OSHA regulation has an additional action level (AL) of 85 dB(A); an employer shall administer a continuing, effective hearing conservation program when the 8-hour time-weighted average (TWA) value exceeds the AL. The program must include monitoring, employee notification, observation, audiometric testing, hearing protectors, training, and record keeping. All of these requirements are included in 29 CFR 1910.95, paragraphs (c) through (o). Finally, the OSHA noise standard states that when workers are exposed to noise levels in excess of the OSHA PEL of 90 dB(A), feasible engineering or administrative controls shall be implemented to reduce the workers' exposure levels.

NIOSH, in its Criteria for a Recommended Standard,⁷ and the ACGIH², propose exposure criteria of 85 dB(A) as a TWA for 8 hours, 5 dB less than the OSHA standard. The criteria also use a more conservative 3 dB time/intensity trading

relationship in calculating exposure limits. Thus, a worker can be exposed to 85 dB(A) for 8 hours, but to no more than 88 dB(A) for 4 hours or 91 dB(A) for 2 hours.

RESULTS

Six employees volunteered to wear a noise dosimeter for their entire work shift to measure their personal exposures. Two of the customer service agents were assigned to the “Bravo” line on the ramp, three worked the “Charlie” line, and one was responsible for the air conditioning cart and spent much of his day driving the cart to aircraft throughout the ramp area. The weather in the Newark area at the time of the evaluation was good, causing no delays in the arrival or departure of aircraft. Continental Express’ arrivals/departures schedule that was supplied to the NIOSH investigator seemed to be adhered to during the day.

The Quest dosimeters collect data in a way that allows one to directly compare the noise levels with the OSHA PEL and AL, and to the NIOSH REL, i.e., three different criteria are simultaneously used in the calculation of the employee’s noise dose. The OSHA criteria use a 90 dB(A) criterion and 5 dB exchange rate for both the PEL and AL. The difference between the two is the threshold level employed, with a 90 dB(A) threshold used for the PEL and a 80 dB(A) threshold for the AL. Threshold level is the lower limit of noise values included in the calculation of the criteria; values less than the threshold are ignored by the dosimeter. The NIOSH criterion differs in that the criterion is 85 dB(A), the threshold is 80 dB(A) and it uses a 3-dB exchange rate.

The results of the noise dosimeter evaluation are reported in Table 1. When the data are compared to the three evaluation criteria, all six of the employees’ noise exposures were in excess of the NIOSH REL of 85 dB(A), ranging from 88 to 94 dB(A) for an 8-hour TWA. When the dosimeter data were compared to the OSHA criteria, the employees were all below the PEL of 90 dB(A); however, five of six

employees exceeded the AL criteria of 85 dB(A). The maximum dB(A)-slow noise levels measured during the sampling period were between 111 and 116 dB(A). Inspection of the dosimeter data for the minute-by-minute exposures showed a pattern of intermittent noise levels throughout the work shift. Several times during the day, an employee’s noise exposures would be near 100 dB(A) for a short time period. However, there were also several times where the levels would drop below 75 dB(A) while the employees were working in areas not directly near the aircraft. Examples of these data for the “Charlie” and “Bravo” line employees are shown in Figure 1-2.

Area noise spectral measurements were made throughout the day around aircraft parked in the ramp area and at Continental’s gate areas. Particular attention was paid to the regional jets and to other, larger jets used by Continental Airlines to compare the effects of the APUs on ground personnel. The spectral measurements were taken at locations near the tail, baggage compartment conveyor belt, and stairway used by passengers to enter and exit the aircraft. The results of the overall measurements are summarized in Table 2. The overall area noise measurements clearly show that the APU on the Embraer jets is the loudest noise exposure for ramp employees. The A-weighted levels ranged from 116 to 120 dB(A) while the unweighted noise levels were from 120 to 124 dB sound pressure level (SPL). The measurements made on the five regional jets showed minimal variability. The noise spectrum of the loudest APU measured for the Embraer jet #928 is shown in Figure 3 as an example of the frequency components generated by this piece of equipment. Inspection of the graph shows that the sound levels increase with increasing frequency, with the maximum one-third octave band at 1250 Hz having 122 dB of sound pressure. This pattern of increasing sound levels with increasing frequency was seen in all of the Embraer RJ145 aircraft.

Frequency spectrum measurements were also made of the APUs of four additional larger aircraft flown by Continental Airlines. The results of the overall dB SPL and dB(A) levels are reported in Table 2 and

the graphic presentation of the frequency spectra are shown in Figures 4-7. The loud, high-frequency component seen in the Embraer regional jets' noise pattern is not as great in the larger aircraft. Noise above 500 Hz was always greater for the Embraer RJ145.

During the site visit, Continental officials provided the NIOSH investigator with a list of the hearing protection devices (HPDs) that are provided to their employees. Because the noise measurements determined that the Embraer jet #928 was the loudest piece of equipment that ramp employees worked around, the noise spectrum for this jet was used as the noise spectrum to compute the noise reduction afforded by each of the HPDs used by Continental Express' employees at Newark International Airport. The calculations were done according to the method described in the OSHA noise regulation as the NIOSH Method #1 and the results are shown in Table 3.^{6,8} The attenuation data used in this analysis were those provided by the manufacturers, calculated according to the American National Standards Institute (ANSI) S3.19-1974.⁹ The calculations show that the ear plugs and ear muffs supplied to the employees provide sufficient attenuation to reduce the noise to acceptable levels. The ear muffs reduce the APU noise spectrum to an effective level of 78 dB(A); ear plugs reduce the noise to a range of 78 to 82 dB(A). The three semi-insert, banded devices offer the least amount of attenuation, reducing the noise to levels ranging from 84 to 89 dB(A), values that could be potentially hazardous to the employees' hearing.

DISCUSSION

The noise dosimeter measurements made on the six employees revealed exposure levels that were consistently below OSHA's PEL of 90 dB(A) as an 8-hour TWA. However, the OSHA action level, at which implementation of a hearing conservation program by the employer is required, was exceeded in five of six measurements. One employee who worked in the general ramp area of Continental

Express handling air-conditioning carts had a personal TWA noise level of 83.4 dB(A). When the noise data were compared with the NIOSH recommended exposure limit, all of the employees were found to exceed the REL, accumulating at least 200% of their allowable daily noise dose in the 8-hour shift. The data collected by NIOSH during this health hazard evaluation agree quite well with noise data collected by the Continental Ground Safety Department in December 1998.

Area noise measurements identified the area around the Embraer jet's APU in the tail of the aircraft as the noisiest location for the ramp employees. The noise levels ranged from 116 - 120 dB(A). However, observations of the employees found that the ramp employees do not routinely work in this area. The closest location where they were found to spend appreciable amounts of time is the baggage conveyor where the noise spectrum was measured at 93 - 98 dB(A). An analysis of the HPDs provided to the employees showed that most of them were capable of providing sufficient attenuation to the noise from the APU. However, the semi-insert devices would be lacking if the employees were around the noise for the entire work shift. The comparison of the Embraer regional jet's APU to other, larger jets revealed higher noise levels associated with the Continental Express regional jets. The power unit on the smaller aircraft was at least 18 dB(A) louder than any of the other planes measured during the evaluation.

The use of ground power sources does reduce the noise levels to near 90 dB(A), as compared to the 116 - 120 dB(A) noise levels associated with the APU. However, Continental Express mechanics and technicians contend that the use of ground power sources are less reliable, producing electrical power surges that negatively affect the aircraft's onboard computers. Also, the air conditioning unit on the aircraft is pneumatic and can only be operated by the APU or jet engine. That is the reason that a ground A/C cart is brought to jets that do not have the APU running. During the closing meeting of the evaluation, it was noted by an Embraer engineer that

a hush kit for the ERJ 145 regional jet is available to reduce the noise emitted by the APU.

The evaluation of the HPDs offered to employees was done without any derating factor that is required for OSHA compliance activities.¹⁰ The manufacturers' attenuation data were not obtained according to the subject fit method of ANSI S12.6-1997.¹¹ If a derating factor was used in evaluating the HPDs or if subject fit data from the manufacturers of the devices were substituted into the analysis, then the effective levels reported in Table 3 would be higher. Thus, the employees need to be diligent in the selection, use, and care of their HPDs to protect themselves from the risk of hearing loss from the noise of the aircraft and their auxiliary equipment.

CONCLUSIONS

Continental Express ramp employees are exposed to noise levels that could be potentially damaging to their hearing. In most instances, the HPDs that the company provides are effective in reducing the exposures to levels that do not increase their risk of occupational hearing loss. However, because of the exposure levels, Continental Express should continue to provide their employees all of the components of a hearing loss prevention program, including noise monitoring, audiometric testing, HPDs, and recordkeeping. The company should continue to pursue ways to control noise exposures to the ramp employees through changes in work practices, facility redesign, and retrofit controls for the aircraft.

RECOMMENDATIONS

The following recommendations are offered by NIOSH investigators to reduce the risk of occupational noise-induced hearing loss for ramp employees of Continental Express Airlines. The recommendations are based on the measurements made during this evaluation along with observations made of the work environment.

1. Continental Express Airlines needs to continue its efforts in hearing conservation as mandated by OSHA regulations. The personal dosimeter measurements made for this survey revealed that the OSHA action level was exceeded in five of six full-shift measurements.⁶ The NIOSH measurements confirm the company's noise survey conducted in December 1998. Additionally, the NIOSH criterion was exceeded in all six measurements, confirming that the ramp employees are at an increased risk of occupational hearing loss.⁷

2. The auxiliary power units on the Embraer regional jets produce damaging levels of noise. Employees should not be allowed to work near the APUs while they are operational. If mechanical work on the unit necessitates that it be on, then the mechanic should be in double hearing protection, i.e., ear muffs placed over well-fitted ear plugs.

3. Continental Express Airlines should investigate the feasibility of the retrofit muffler noted by the aircraft company's engineer for their existing fleet of Embraer ERJ 145 regional jets. Deliveries of future aircraft should address the issue of noise produced by the power units in the contract specifications. The finding that the noise produced by the APUs on other Continental jets was less than that produced by the regional jet shows that quieter designs are possible.

4. Observations of employees on the ramp during the evaluation revealed that HPD use was not at full compliance. The noise levels produced by the aircraft are sufficient to produce permanent loss of hearing in employees. Therefore, the employees should be expected to comply with the requirement of using hearing protection whenever they are on the ramp.

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Table 1

Personal Noise Dosimeter Results

Continental Express Airlines
 Newark, New Jersey
 HETA 99-0060
 June 3, 1999

| Ramp Location | Sample Time [hh:mm] | OSHA PEL ^a | OSHA AL ^b | NIOSH REL ^c | Maximum Level ^d |
|----------------------------|------------------------|-----------------------|----------------------|------------------------|-------------------------------|
| Bravo Line - "a" | 07:58 | 87.4 dB(A) | 89.3 dB(A) | 93.6 dB(A) | 116.5 dB(A) |
| Charlie Line - "a" | 08:13 | 86.6 dB(A) | 88.4 dB(A) | 91.6 dB(A) | 113.4 dB(A) |
| Bravo Line - "b" | 08:10 | 85.7 dB(A) | 87.3 dB(A) | 92.4 dB(A) | 111.8 dB(A) |
| Charlie Line - "b" | 07:56 | 85.9 dB(A) | 88.3 dB(A) | 91.2 dB(A) | 111.5 dB(A) |
| Charlie Line - "c" | 08:10 | 82.9 dB(A) | 86.2 dB(A) | 89.6 dB(A) | 111.2 dB(A) |
| Ramp Area | 07:19 | 79.0 dB(A) | 83.4 dB(A) | 88.3 dB(A) | 116.3 dB(A) |
| Evaluation Criteria | | 90 dB(A) | 85 dB(A) | 85 dB(A) | |

a = Data collected with a 90 dB criterion, 90 dB threshold, and 5 dB exchange rate.
 b = Data collected with a 90 dB criterion, 80 dB threshold, and 5 dB exchange rate.
 c = Data collected with an 85 dB criterion, 80 dB threshold, and 3 dB exchange rate.
 d = Maximum slow-response level measured during the sampling period.

Table 2

Area Overall Noise Measurements

Continental Express Airlines
Newark, New Jersey
HETA 99-0060
June 3, 1999

| AIRCRAFT | MEASUREMENT LOCATION | OVERALL NOISE LEVELS | |
|-----------------------|--|----------------------|--------|
| | | dB SPL | dB (A) |
| Embraer RJ 145 - #927 | tail section; APU on | 121 | 117 |
| | baggage conveyor; APU on | 101 | 97 |
| Embraer RJ 145 - #926 | tail section; APU on | 124 | 120 |
| | baggage conveyor; APU on | 97 | 93 |
| | passenger stairs; APU on | 93 | 90 |
| Embraer RJ 145 - #954 | tail section; APU on | 122 | 118 |
| | baggage conveyor; APU on | 102 | 98 |
| | inside baggage compartment; APU on | 93 | 89 |
| Embraer RJ 145 - #948 | tail section; APU on | 120 | 116 |
| | baggage conveyor; APU on | 99 | 96 |
| | passenger stairs; APU on & turboprop aircraft taxiing from line in front | 95 | 90 |
| Embraer RJ 145 - #928 | tail section; APU on | 124 | 120 |
| | baggage conveyor; APU on | 101 | 107 |
| | passenger stairs; APU on | 94 | 92 |
| Embraer RJ 145 - #957 | tail section; APU off; A/C cart running | 100 | 89 |
| DC 10 | tail section; APU on | 106 | 102 |
| Boeing 777 | tail section; APU on | 97 | 90 |
| Boeing 737 | tail section; APU on | 99 | 93 |
| MD 80 | tail section; APU on | 101 | 97 |

Table 3

Evaluation of Hearing Protection Devices

Continental Express Airlines
 Newark, New Jersey
 HETA 99-0060
 June 3, 1999

Embraer RJ145 #928 Octave Band Sound Levels

| | | | | | | | | | | |
|---------------------------------------|------|------|------|-------|-------|-------|------|-------|-------|-------|
| Octave Band Frequency (Hz) | 31.5 | 63 | 125 | 250 | 500 | 1k | 2k | 4k | 8k | 16k |
| Sound Level (dB) | 80.8 | 82.6 | 95.3 | 100.9 | 104.8 | 103.3 | 99.8 | 104.1 | 113.5 | 120.8 |

Hearing Protection Devices' Effective Levels *

| | | | | |
|------------------------|----------------|----------------------------|---|-------------------------|
| HPD Model | EAR Foam Plugs | Peltor Ear Muffs | 3M 1100 Foam Plugs | North Silent Band-It |
| Effective Level | 77.8 dB(A) | 78.2 dB(A) | 81.9 dB(A) | 83.6 dB(A) |
| HPD Model | EAR Caboflex | Moldex Pura-Fit 6900 Plugs | Moldex Jazz Band 6506 (Behind the Head) | Moldex Pocket-Pak Plugs |
| Effective Level | 88.8 dB(A) | 79.4 dB(A) | 84.9 dB(A) | 78.7 dB(A) |

* based on Embraer jet #928 noise spectrum

Figure 1

Noise Dosimeter Results: Bravo Line - "a"
Continental Express Airlines
Newark, New Jersey
HETA 99-0060
June 3, 1999

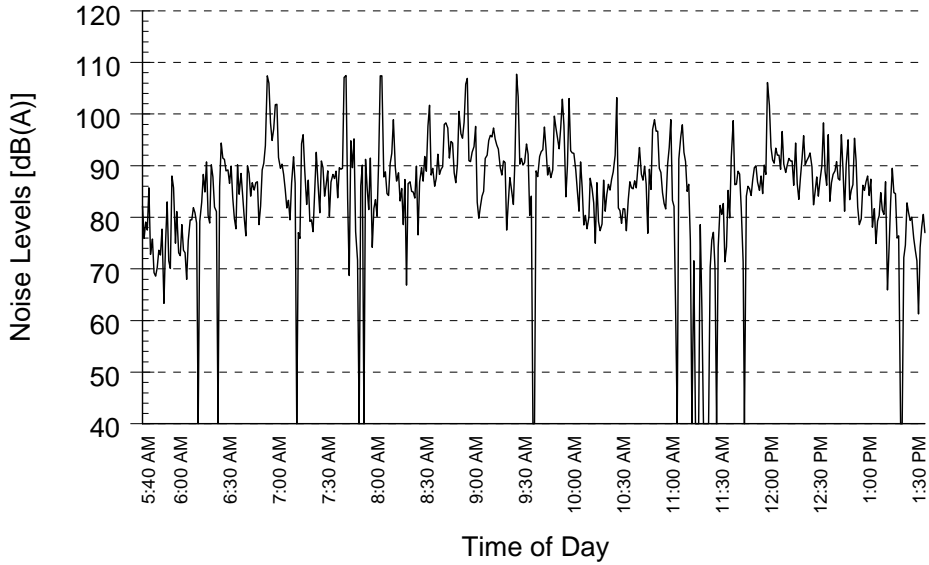


Figure 2

Noise Dosimeter Results: Charlie Line - "a"
Continental Express Airlines
Newark, New Jersey
HETA 99-0060
June 3, 1999

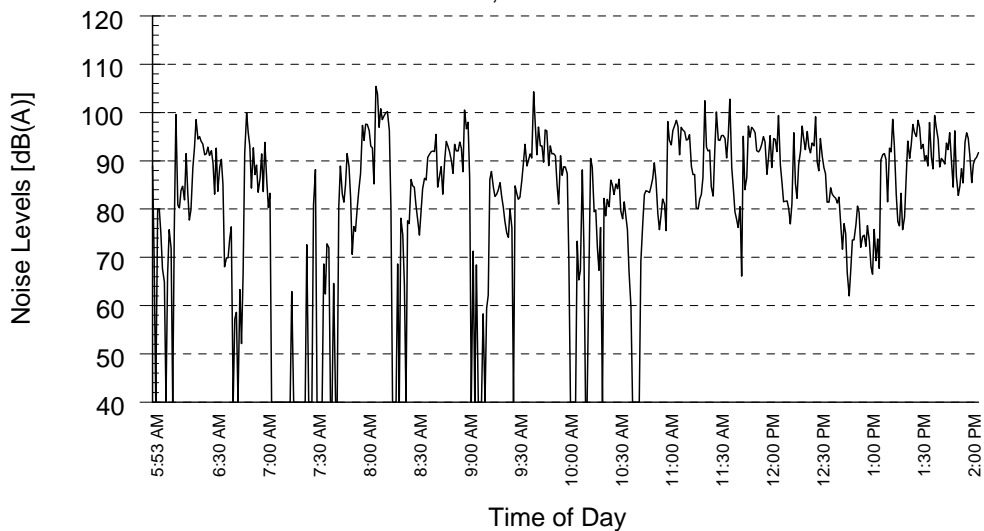


Figure 3

One-Third Octave Band Noise Measurements

Continental Express Airlines
Newark, New Jersey
HETA 99-0060

Embraer #928
below APU in tail section

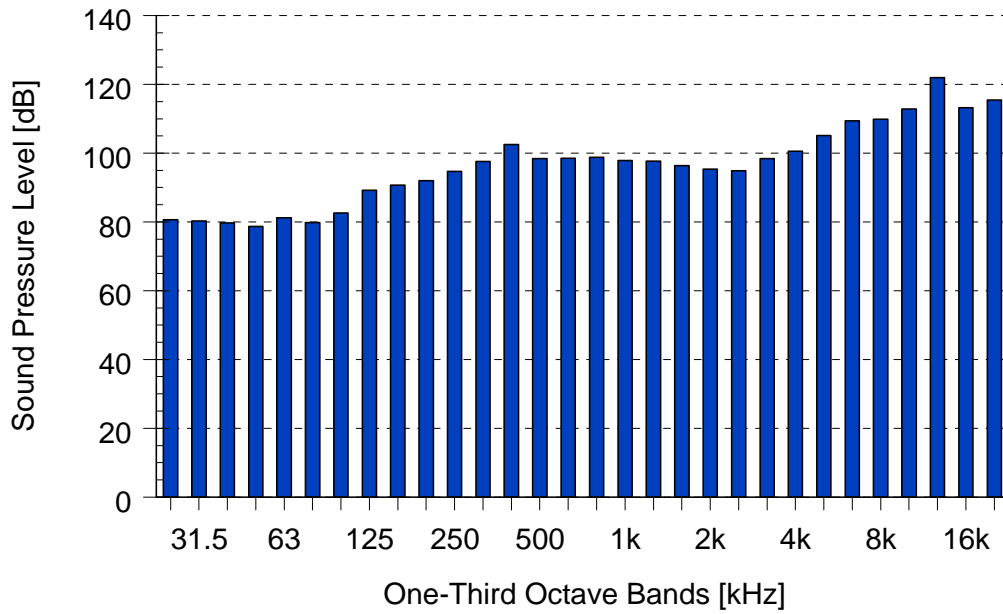


Figure 4
 Below APU in Tail Section
 Continental Express Airlines
 Newark, New Jersey
 HETA 99-0060

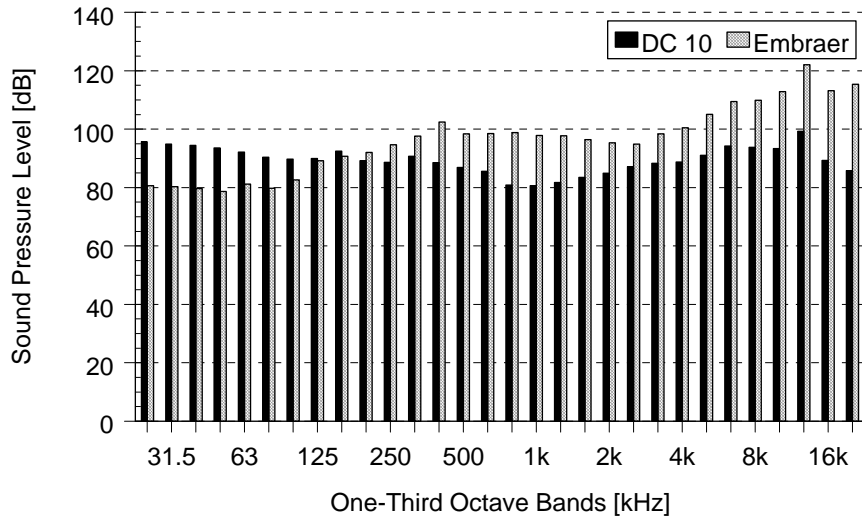


Figure 5
 Below APU in Tail Section
 Continental Express Airlines
 Newark, New Jersey
 HETA 99-0060

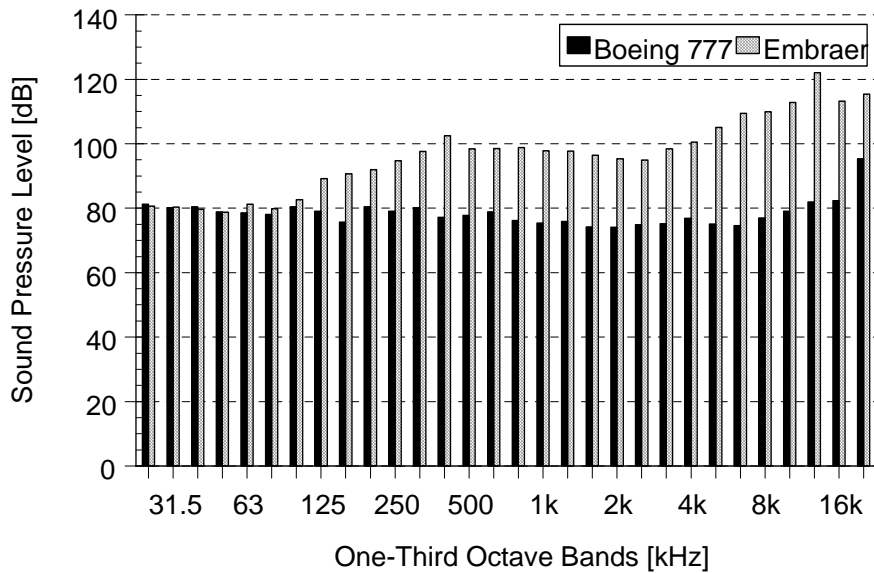


Figure 6

Below APU in Tail Section
Continental Express Airlines
Newark, New Jersey
HETA 99-0060

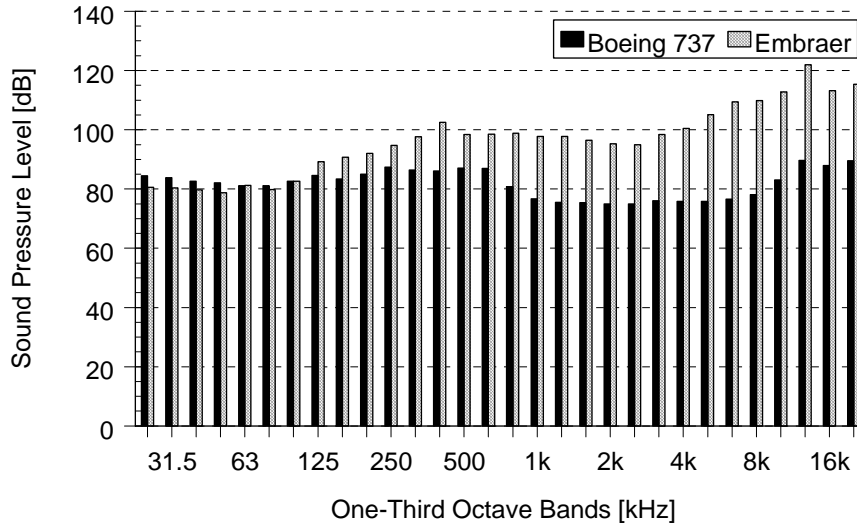
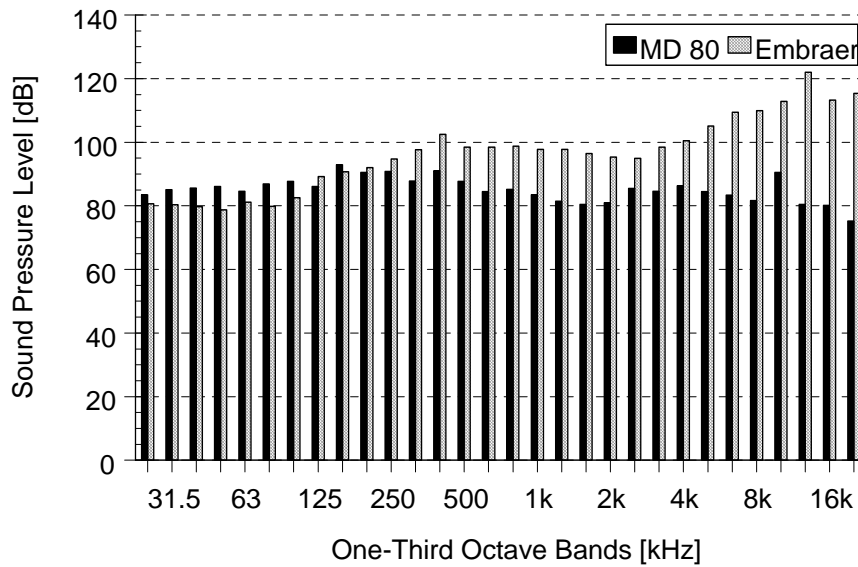


Figure 7

Below APU in Tail Section
Continental Express Airlines
Newark, New Jersey
HETA 99-0060



For Information on Other
Occupational Safety and Health Concerns

Call NIOSH at:
1-800-35-NIOSH (356-4674)
or visit the NIOSH Web site at:
www.cdc.gov/niosh



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