HETA 20010109
Lac Vieux Desert Resort and Casino
Watersmeet, Michigan

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PREFACE

The Hazard Evaluations and Technical Assistance Branch (HETAB) of the National Institute for Occupational Safety and Health (NIOSH) conducts field investigations of possible health hazards in the workplace. These investigations are conducted under the authority of Section 20(a)(6) of the Occupational Safety and Health (OSHA) Act of 1970, 29 U.S.C. 669(a)(6) which authorizes the Secretary of Health and Human Services, following a written request from any employer or authorized representative of employees, to determine whether any substance normally found in the place of employment has potentially toxic effects in such concentrations as used or found.

HETAB also provides, upon request, technical and consultative assistance to Federal, State, and local agencies; labor; industry; and other groups or individuals to control occupational health hazards and to prevent related trauma and disease. Mention of company names or products does not constitute endorsement by NIOSH.

ACKNOWLEDGMENTS AND AVAILABILITY OF REPORT

This report was prepared by Max Kiefer and Lisa Delaney of HETAB, Division of Surveillance, Hazard Evaluations and Field Studies (DSHEFS). Analytical support was provided by the NIOSH Division of Applied Research and Technology. Desktop publishing was performed by Nichole Herbert. Review and preparation for printing were performed by Penny Arthur.

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Highlights of the NIOSH Health Hazard Evaluation

Evaluation of exposure to contaminants during coin and paper counting activities

In January, 2001, NIOSH conducted a health hazard evaluation at the Lac Vieux Desert Resort and Casino. We measured levels of air contaminants during coin counting, the extent of surface contamination from coin dust, and exposure to noise. We reviewed the ventilation system.

What NIOSH Did

- **We collected air samples for metals and dust, and surface samples for metals.**
- **We talked to employees about their health concerns and work area.**
- **We measured exposure to noise during counting activities.**
- **We reviewed the ventilation system supplying the Vault area.**

What NIOSH Found

- **Some workers have nasal, eye, and respiratory irritation**
- **All air samples were within recommended levels**
- **The surface sampling shows that the Hard Count room should be cleaned better.**
- **The ventilation system supplying the Vault area isn't working very well.**
- **The Noise Levels were low.**

What Lac Vieux Desert Resort and Casino Managers Can Do

- **Upgrade the ventilation system in the Vault area.**
- **Improve housekeeping and be sure that metal dust is cleaned up.**
- **Better control tobacco smoking in the employee areas.**

What the Lac Vieux Desert Resort and Casino Employees Can Do

- **Join with Casino management on projects to improve workplace safety and health.**
- **Report problems promptly to management.**

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National Institute for Occupational Safety and Health
NIOSH

Health Hazard Evaluation Report 20010109
Lac Vieux Desert Resort and Casino
Watersmeet, Michigan
March, 2001

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SUMMARY

On December 13, 2000, the National Institute for Occupational Safety and Health (NIOSH) received a management request for a health hazard evaluation (HHE) at the Lac Vieux Desert Resort and Casino in Watersmeet, Michigan to determine if workplace exposures during counting operations are related to reported health problems that some employees have experienced. Specifically, NIOSH was asked to evaluate exposure to metal dust and other contaminants associated with machine counting of coins and paper money at the casino. Reported symptoms included eye, nasal, and respiratory irritation, and other respiratory problems.

On January 25-27, 2001, NIOSH researchers conducted a site visit at the Lac Vieux Desert Resort and Casino. The purpose of this site visit was to review the coin counting process, interview employees, and characterize the work environment to determine factors that may contribute to the reported symptoms. During the first shift (12:00 AM - 8:00 AM) on January 26 and January 27, environmental monitoring was conducted to evaluate count employees personal exposures to nickel, copper, zinc, and other metals that may be present in coin dust, and to the total dust present in both the hard (coin) and soft (paper) counting areas. Surface samples were collected to determine the extent of metal contamination in various areas, and personal noise monitoring was conducted to evaluate worker exposure to noise.

The results of the air sampling showed that for the monitoring period all measured concentrations of nickel, copper, and zinc were below the NIOSH Recommended Exposure Limits (REL) for these substances. The highest measured concentration of nickel was 7 micrograms per cubic meter ($\mu g/m^3$), detected in a sample collected from a coin count worker. The NIOSH REL for nickel is 15 $\mu g/m^3$. The highest copper concentration (24 $\mu g/m^3$) was measured in this same sample. The NIOSH REL for copper dust is 1000 $\mu g/m^3$. All zinc samples were either below the limit of detection (LOD) or between the LOD and the limit of quantitation. The NIOSH REL for zinc oxide is 5000 $\mu g/m^3$. The surface sampling results identified some areas in the coin counting room where additional cleaning is warranted to reduce the potential for spreading metal contamination or generating airborne dust. All measured noise exposures were below the NIOSH REL of 85 decibels on the A-weighting scale (dBA) as a full-shift time-weighted average.

Workers reported nasal, respiratory, and eye irritation; no skin problems were reported by any of the workers. A number of manual lifting activities involving substantial loads and awkward postures were observed, most of which involved handling the coins. Based on a limited review of the ventilation system and information provided by casino employees, it appears the heating, ventilating and air-conditioning system supporting the count areas is insufficient to maintain thermal conditions in an appropriate comfort range. The ventilation in the Soft Count room does not appear to be able to accommodate the number of people that work in this room (conditions are crowded). Temperatures ranging from 73° - 76° F were measured in the work areas (an acceptable range) and the relative humidity in the work areas was lower than desirable (10-11%). These lower humidity levels and insufficient general ventilation could account for some of the eye and nasal irritation that has been experienced by workers.

Exposures to nickel, copper, and zinc during currency counting activities were below recommended limits. The surface sampling results indicate that additional cleaning in the coin counting room is warranted. All measured noise exposures were below recommended limits, however there are opportunities to further reduce noise levels in the Hard Count room. The general ventilation system does not appear to adequately support the Hard Count and Soft Count rooms, particularly the Soft Count room. Relative Humidity levels were low and may account for some of the eye and nasal irritation reported by workers. Tobacco smoke was detected in non-smoking areas indicating that smoke is not being effectively isolated and ventilated. It is possible that the health complaints could be resolved by improving the general indoor environmental quality in the counting area. Recommendations to improve conditions and address ergonomic issues are in the Recommendation section of this report.

Keywords: 7999 (Amusement and Recreation Services, Not Otherwise Classified). Coin Counting, Casino, Gaming Operations, Coin Dust, Paper Currency, Nickel, Zinc, Copper. Surface Sampling, Noise, Respiratory Irritation.

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INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH) received a request for a health hazard evaluation (HHE) at the Lac Vieux Desert Resort and Casino in Watersmeet, Michigan on December 13, 2000. NIOSH was asked to evaluate workplace exposures during coin counting operations and determine if reported health problems that some employees have experienced are related to the work environment. Reported symptoms included eye, nose, and throat discomfort and respiratory problems.

In response to this request, on January 25-26, 2001, NIOSH investigators conducted a site visit at the Lac Vieux Desert Resort and Casino. During this site visit, environmental monitoring was conducted to evaluate worker exposure to contaminants during counting of coin and paper currency, assess surfaces for metal contamination, and measure noise levels in the work areas. A letter providing the results of the air and surface monitoring was sent to the requestor on March 15, 2001.

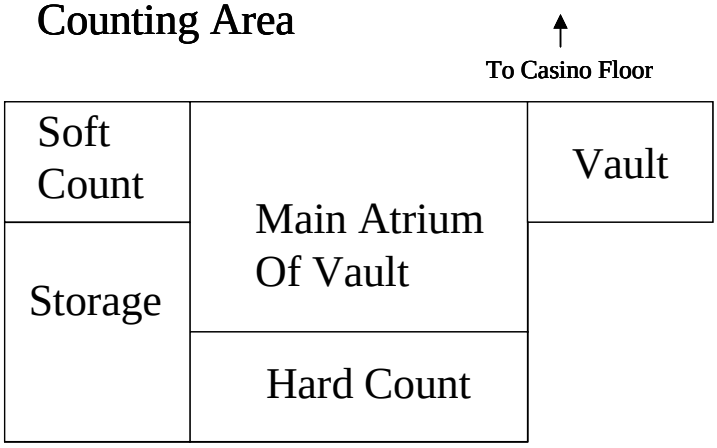
BACKGROUND

Casino

The Lac Vieux Desert Resort and Casino employs approximately 450 workers and began operations in 1996. The single-story casino adjoins a hotel and restaurant, and is operated by the Lac Vieux Desert Band of Lake Superior Chippewa Indians. Gaming activities take place in a large open area containing approximately 600 slot machines and tables for various card and other casino games. The casino operates 24 hours a day, 365 days a year. Various slot machines are designed for different currency denominations including nickels, quarters, half-dollars, coin dollars, and paper currency. Additionally, there are casino-specific "tokens" that may be used in some of the machines and gaming activities.

Counting Process

Lac Vieux Casino Vault and Counting Area



Casino proceeds are counted primarily during the first shift (1 AM - 9 AM). Although there is some coin counting during the day shift; paper currency is only counted during the first shift. A crew of 8 workers is responsible for counting tasks, with 3-4 workers assigned to paper and the remainder to coin counting. Money is first collected from the slot machines, and this activity entails a major portion of the work shift. At the start of the shift, the count crew systematically removes paper and coin currency from each slot machine on the casino floor. A row of machines is isolated from customers, and a worker opens the machine, removes the coin

container, and installs a replacement container. Each container is identified to correlate with a specific machine.

After collection, money is transported on a cart to the vault area where coins are taken to the "Hard" count room and paper currency is taken to the "Soft" count room. Access to the vault is restricted and the area is under video surveillance. Each counting room is constructed of concrete block with a concrete floor and a suspended ceiling (ceiling height is 9 feet). The paper count room has a large glass window to allow for observation from outside the room, and is approximately 144 ft^2 in size. There are two paper counting machines in this room. The coin count room is much larger (approximately 480 ft^2) and contains six top-loading machines that count and roll coins. There have been no changes to the style of counting machine used at the casino. The coin counting machines can count up to 3000 coins and wrap 40 rolls of coins per minute. The paper counting machines can count up to 1000 notes per minute of mixed currency.

Air Quality Concerns

Employee concerns with their work environment and exposure to dust from counting have been primarily noted by the first shift counting crew, when the bulk of the counting takes place; no problems were reported by the day shift crew. In response, the ventilation system was evaluated and a recommendation was proposed by the tribal council for coin workers to wear respirators during counting. To address worker concerns and ensure that this activity was evaluated, and because there was a lack of information in the literature on the potential for exposure to metals and other contaminants during counting, the Tribal Safety Officer requested that NIOSH conduct an HHE.

METHODS

Upon receipt of the HHE request, additional information regarding the reported health problems and suspect environmental contaminants was obtained. Prior to the site visit, literature reviews were conducted to obtain information from previous casino evaluations. After arrival at the casino and meeting with employee, Indian Health Service, and management representatives, the work areas where currency counting occurs were reviewed and an environmental monitoring strategy was finalized. The specific monitoring methodology used during this HHE is described below.

Air Sampling

Full shift PBZ exposures to total dust and metal dust in the Hard and Soft Count room were monitored using SKC® Universal Samplers (PCXR4), sampling pumps. Three Soft Count and four Hard Count workers were monitored on January 26; three Hard Count and two Soft Count workers were monitored on January 27. Flow rates of approximately 2 liters per minute (l/m) were used to obtain the samples. The sampling pumps were pre- and post-calibrated with a primary standard (BIOS®) to verify flow rate. The filters were placed as close as possible to the workers' breathing zone and connected via Tygon® tubing to the sampling pump. Count workers wore the sampling pump and filter for the entire work shift. Management and employee representatives indicated that counting activity was higher on day one (representative of a busy Summer night) and normal for the Winter season on day two of the sampling. After collection, the samples were sent to the NIOSH contract laboratory (DataChem, Salt Lake City) for analysis.

The samples were collected on tared 37 millimeter (mm), 5 micrometer (μm) pore size, poly-vinyl chloride (PVC) filters in the closed-face mode, and analyzed gravimetrically to determine the total dust concentration according to NIOSH method 0500. An element specific analysis was also conducted on the samples, according to NIOSH method 7300, to differentiate and quantify 27 metal species with an emphasis on nickel, copper, and zinc. With this technique, the sample filters are microwave digested in an acid mixture, and analyzed with an inductively coupled plasma emission spectrometer.[1]

Surface Sampling

Surface wipe samples were collected to determine the presence and extent of metal dust surface contamination in certain areas in the casino. These samples were collected with commercially available pre-moistened Wash 'n Dri™ hand wipes according to the monitoring protocol described in the NIOSH Manual of Analytical Methods, 4th edition.[2] For analytical purposes a companion sample was collected adjacent to the first area sampled using another manufacturers' sampling media (Ghost Wipe). A clean pair of disposable gloves was worn during the collection of each sample to prevent cross contamination. Using a template, 100 square centimeters of surface area were wiped with each hand wipe. The samples and field blanks were sealed in labeled sample containers and sent via overnight express to the NIOSH contract laboratory (Data Chem, Salt Lake City, UT) for metals analysis. The samples were analyzed according to NIOSH method 7300 by first digesting the sample in an acid mixture and using an inductively coupled plasma spectrometer to measure 27 different metals.

Noise Monitoring

To continuously monitor noise exposures, Quest® Electronics Model M-27 Noise Logging Dosimeters were worn by employees during their work shift. The dosimeters were calibrated before the work shift according to the manufacturer's instructions. The dosimeters were attached to an employee's belt, and a small remote microphone was fastened to their lapel or shoulder (facing forward) at a mid-point between the ear and the outside of the employee's shoulder. The dosimeters were worn for an entire shift. At the end of a work shift, the dosimeters were removed and paused to stop data collection. The information stored in each dosimeter was then recorded to obtain information regarding the extent of exposure to noise.

Temperature and Relative Humidity

Dry bulb temperatures and percent relative humidity (%RH) measurements were obtained using a TSI Thermoanemometer containing an RH and temperature sensor built into the sampling wand. RH is determined by a capacitive sensor and a thermistor is used for the temperature measurements. The RH sensor can resolve to 0.1% RH with a response time of approximately 50 seconds (range 0 to 100%). The temperature thermistor is accurate to within 0.5°C and has a range of 0 to 60°C. Both sensors had been factory calibrated prior to use.

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. Also, some substances are absorbed by direct contact with the skin and mucous membranes, and thus potentially increases the overall exposure. 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),[3] (2) the American Conference of Governmental Industrial Hygienists' (ACGIH®) Threshold Limit Values (TLVs®),[4] and (3) the U.S. Department of Labor, Occupational Safety and Health Administration (OSHA) Permissible Exposure Limits (PELs).[5] 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 95–596, 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.

A time-weighted average (TWA) exposure refers to the average airborne concentration of a substance during a normal 8-to-10-hour workday. Some substances have recommended STEL or ceiling values which are intended to supplement the TWA where there are recognized toxic effects from higher exposures over the short-term.

Evaluation criteria for the specific materials evaluated during this HHE are presented below.

Metals

Metals comprise the majority of the known elements and have widespread natural occurrence in the environment. Aluminum, for example, is the third most abundant element in the earths crust.[6] Metals have a wide range of properties, uses, and toxicity. Some metals are essential for life while others have no known biologic function. Other metals are capable of producing disease. Some metals that are essential nutrients can be toxic at higher concentrations. Allowable daily intake (food), maximum contaminant level (drinking water), and industrial exposure (e.g., NIOSH RELs) guidelines and regulations have been established for a number of metals.

Inhalation is usually the exposure pathway of concern in industry. However, some metals (e.g., nickel, beryllium, arsenic) can cause skin effects, or, if the metal is in a certain form (e.g., alkyl lead), can be absorbed through the skin.[7] In addition to the species of metal, the toxicity of a metal, and the mode of toxicity, is influenced significantly by its chemical state. The elemental form of a metal, for instance, rarely interacts with biologic systems.[7] Metal hydrides (e.g. arsine) are generally far more acutely toxic than other forms. Soluble

salts of metals are usually more readily absorbed and are possibly more hazardous. The toxic properties of methyl mercury are very different from inorganic mercury.

Despite these difference, there are some toxicologic similarities among the group of metals. Many absorbed metals will accumulate in the kidneys and the bones, and many have long half-lives.[6] Inhalation of high concentrations of metals is irritating and may result in severe respiratory tract damage, including bronchitis, chemical pneumonitis, and pulmonary edema.

Coin Composition

Except for pennies, modern U.S. Mint legal tender coins that are currently in circulation are composed of a copper core with a nickel alloy coating.[8] Quarters and half-dollars contain 8.3% nickel with the balance copper, nickels contain 25% nickel with the balance copper, and Susan B. Anthony dollars contain 12.5% nickel with the balance copper. Sacajawea dollars contain 6% zinc, 3.5% manganese, 2% nickel, with the balance copper. Dimes, which are not used at the Lac Vieux casino, are composed of 8.3% nickel and copper.

Nickel

Nickel is a naturally occurring element in the earths crust and is a hard, silvery-white metal with properties that make it desirable to combine with other metals (such as copper to make coins) to form alloys. Exposure to nickel can occur by inhalation, skin contact, ingestion, or smoking tobacco. The most common adverse health effect associated with exposure to nickel is an allergic reaction.[9] Metallic nickel and certain other nickel compounds can cause a sensitization dermatitis, sometimes referred to as "nickel itch."[10] Once a person becomes sensitized to nickel, any additional contact with the metal will likely produce a reaction, most commonly a skin rash at the site of contact. Nasal irritation and other respiratory disorders have occasionally been reported in workers exposed to nickel aerosols, and breathing high concentrations of nickel compounds can result in effects on the respiratory tract.[10] The National Toxicology Program has concluded that nickel and certain nickel compounds are reasonably anticipated to be human carcinogens based on evidence in experimental animals.[11] NIOSH considers nickel to be a potential occupational carcinogen (lung and nasal cancer) and has established an REL for nickel of 0.015 milligrams per cubic meter (mg/m^3) as a full-shift TWA.[3]

Copper

Copper is a reddish metal that occurs naturally in soil, water, and rock; the average concentration in the earth's crust is about 50 parts per million (ppm).[12] In industry, copper is used extensively in wiring, brass manufacture and other alloy industries. Exposure to copper can occur through inhalation, ingestion, and skin contact. Long term exposure to copper dust can result in eye and nose irritation and cause headaches, nausea and other gastrointestinal effects.[12] Respiratory irritation from exposure to copper dust has also been described.[10] Copper is not considered to be a carcinogen. The NIOSH REL for copper dust is 1 mg/m^3 as a full-shift TWA.[3]

Zinc

Zinc is one of the most common elements in the earth's crust and is found in air, soil, and almost all foods.[13] Zinc is a bluish white shiny metal that is commonly used as a coating for other metals so they do not corrode or rust. It can also be mixed with metals to form alloys such as brass and bronze. Zinc is a major component in galvanized coatings and may also be present in some paints. Welding of galvanized metal will generate zinc

oxide fume. Exposure to zinc fumes can cause metal fume fever, an influenza-like sickness that usually begins several hours after exposure, and may last up to 24 hours.[10,13,14] Dryness or irritation of the throat, a sweet or metallic taste, dry cough, and chest constriction may be experienced by workers exposed to zinc oxide fume.[10] Only freshly formed (nascent) fume appears to cause metal fume fever, and attacks tend to be more severe on the first day of the workweek.[10] Zinc oxide is not considered to be a skin irritant and zinc has not been found to be carcinogenic. The NIOSH REL for zinc oxide as a total dust is 5 mg/m^3 as a full shift TWA, with a 15 minute ceiling limit of 15 mg/m^3.[3]

Particulates/Currency Dust

Regulatory standards exist for respirable particulates for many specific dusts (e.g., silica) and for a more general category termed "particulates not otherwise classified" (PNOC). Dusts considered to be physical irritants for which no substance-specific toxicological data are available are generally placed in this category by OSHA for enforcement purposes.[1] Except for the metal content, the specific components and make-up of the dust present at the Lac Vieux Desert casino were not characterized. As such, dust of this type is typically classified as PNOC. This is because the monitored dust originated from a variety of sources, although the majority probably is generated from the paper currency in the Soft Count room.

The OSHA limit for respirable PNOC, sometimes referred to as "inert" or "nuisance" dust, is 15 mg/m^3. Note that the term inert is not appropriate as all dusts will elicit some cellular response in the lung if inhaled in sufficient amounts.[2] The respirable fraction is considered to be that portion of inhaled dust which penetrates to the non-ciliated portions of the lung.[15] In general, particles greater than 7-10 micrometers in diameter (μmd) are all removed in the nasal passages and have little probability of penetrating to the lung. Particles smaller than this can reach the air-exchange regions (alveoli, respiratory bronchioles) of the lung, and are considered more hazardous. The ACGIH has established a TLV of 10 mg/m^3 (total dust) for PNOC as a full-shift TWA.[2] NIOSH has not established an REL for PNOC. The NIOSH REL for cellulose, a primary constituent of paper, is 10 mg/m^3 as a total dust, and 5 mg/m^3 for the respirable fraction.[3] The basis for the cellulose REL is to protect against eye, skin, and physical irritation. Information provided by the Department of Treasury, Bureau of Engraving and Printing, indicates that paper currency dust is evaluated as a PNOC by this agency.[16] Additional data provided by the Bureau of Engraving and Printing indicates that fibers present in paper currency are composed of primarily cotton and flax.

Surface Contamination

Standards defining "acceptable" levels of workplace surface contamination have not been established for most substances. However, wipe samples can provide information regarding the effectiveness of housekeeping practices, the potential for exposure to contaminants by other routes (e.g., surface contamination on a table that is also used for food consumption), the potential for contamination of worker clothing and subsequent transport of the contaminant, and the potential for non-process related activities (e.g., custodial sweeping) to generate airborne contaminants.

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.[17] While loss of hearing may result from a single exposure to a very loud 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.[18]

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 dBA, 10 dBA, and 20 dBA 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 calculating a simple arithmetic mean.

The OSHA standard for occupational exposure to noise (29 CFR 1910.95) specifies a maximum PEL of 90 dB(A)-slow response for a duration of eight hours per day.[19] The regulation, in calculating the PEL, uses a 5 dB time and 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, and so on. Conversely, up to 16 hours of exposure to 85 dB(A) is allowed by this exchange rate. NIOSH, in its original Criteria for a Recommended Standard, proposed a recommended exposure limit of 85 dB(A) for 8 hours, 5 dB less than the OSHA standard.[20] The 1972 NIOSH criteria document also used a 5 dB time/intensity trading relationship in calculating exposure limits. However, in 1995, NIOSH changed its official recommendation for an exchange rate of 5dB to 3dB.[21] The revised NIOSH criteria was formally published in 1998.[22] The ACGIH also changed its TLV in 1994 to a more protective 85 dB(A) for an 8-hour exposure, with the stipulation that a 3 dB exchange rate be used to calculate time-varying noise exposures.[7] Thus, a worker can be exposed to 85 dB(A) for 8 hours, but to only 88 dB(A) for 4 hours or 91 dB(A) for 2 hours.

The duration and sound level intensities can be combined to calculate a worker's daily noise dose according to the following formula:

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

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.[19] 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 also has an action level of 85 dB(A), which stipulates that an employer shall administer a continuing, effective hearing conservation program when the TWA value exceeds the action level. The program must include monitoring, employee notification, observation, audiometric testing, hearing protectors, training programs, and recordkeeping. All of these requirements are included in 29 CFR 1910.95, paragraphs (c) through (o).[19]

Finally, the OSHA noise standard requires 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. However, in 1983, a compliance memorandum (CPL 2-2.35) directed OSHA compliance officers to not cite employers for lack of engineering controls until workers' TWA levels exceeded 100 dB(A), so long as the company had an effective hearing conservation program in place. Even when TWA levels are in excess of 100 dB(A), compliance officers are to use their discretion in issuing fines for lack of engineering controls.

Temperature and Relative Humidity

Temperature and RH measurements are often collected as part of an indoor environmental quality investigation because these parameters affect the perception of comfort in an indoor environment. The perception of thermal comfort is related to one's metabolic heat production, the transfer of heat to the environment, physiological adjustments, and body temperature.[23] Heat transfer from the body to the environment is influenced by factors such as temperature, humidity, air movement, personal activities, and clothing. The American National Standards Institute (ANSI)/ASHRAE Standard 55-1992 specifies conditions in which 80% or more of the occupants would be expected to find the environment thermally acceptable (Figure 1).[24] Assuming slow air movement and 50% RH, the operative temperatures recommended by ASHRAE range from 68-74°F in the winter, and from 73-79°F in the summer. The difference between the two is largely due to seasonal clothing selection. ASHRAE also recommends that RH be maintained between 30 and 60% RH.[24] Excessive humidity can support the growth of microorganisms, some of which may be pathogenic or allergenic. Dry skin, eye and nasal irritation can be experienced under conditions of low relative humidity.[25]

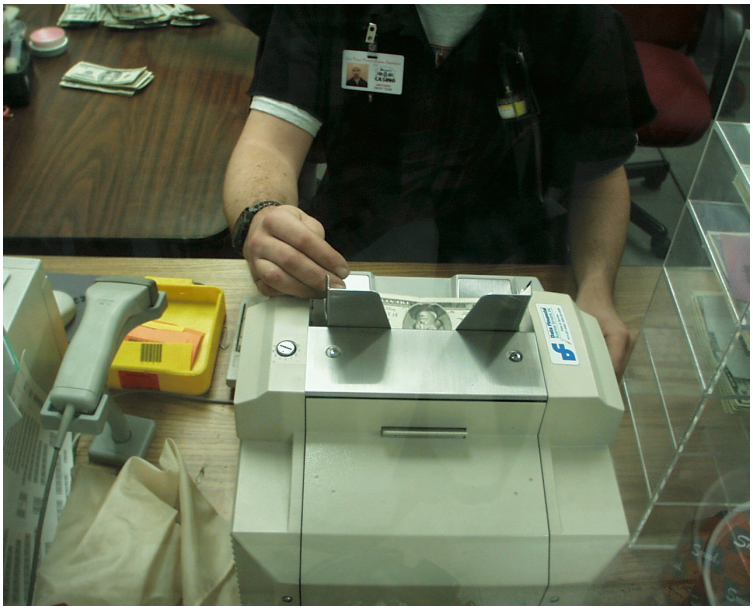
RESULTS

Workplace Observations

No skin problems (e.g., irritation, dermatitis) were reported to the NIOSH investigators by any of the count workers. Employee health concerns appeared to be primarily respiratory in nature, with some reports of "scratchy" eyes, and are perceived to be associated with exposure to dust from the counting operations. Workers also reported that the presence of visible dirt on their hands after handling coins heightened their concern regarding exposure. According to information provided at the opening conference, day-shift count employees have not reported any health issues associated with their work environment. Workers were concerned with maintaining a comfortable work climate from a temperature and relative humidity standpoint. Because of concerns with temperature control, the door to the paper counting room is often open with a

comfort fan in the doorway. Discussions with count employees indicated that during the hotter times of the year the room temperature is very warm and stagnant, and that any generated dust tends to remain airborne in the room for extended periods.

Smoking is restricted to the "smoking" break room and this room is equipped with an exhaust fan. However, tobacco smoke was present elsewhere in areas served by the same air handling system, indicating that smoke is not effectively isolated. Smoking, and food and beverage consumption is not permitted in the counting areas.


Paper Counting Machine

Both coin and paper count workers wear uniforms provided by the casino while on duty. No respirators are worn by any workers during counting activities. Typically, four employees will work in the paper count room at different tasks (e.g., sorting, counting, unloading, stacking). There are two table-top paper counting machines, and considerable manual handling and sorting of the various denominations takes place. Six top loading counting machines are located in the coin room, and there are generally three or four workers assigned to this room. Workers rotate tasks periodically, although one person, because of preference, has always worked in the paper count room. Considerable manual handling of coins occurs as each container must be weighed and recorded; some coin containers weighed over 70 pounds during the NIOSH survey. Each container contains only one denomination (e.g., nickels). The worker will remove the container from a cart, pour the coins into a tared container on the scale, record the weight, and then pour the coins back into a container on the cart. Other workers will then pour the coins into the top loading coin counters where they will be counted and wrapped or bagged. This often requires awkward postures as it is necessary to extend the arms either horizontally or vertically to unload the containers, and the wrapped coins/bags are dispensed at the floor level, requiring employees to remain in a stooped or squatting position. Actual coin counting activities encompassed approximately 2 hours of the work shift on January 26, and 45 minutes on January 27. Paper currency counting comprises a much larger proportion of the work shift.

Opportunities for dust generation occur from machine operation and maintenance activities and a buildup of dust was observed on the paper counting machines. The coin counting machines are periodically cleaned on a monthly basis; compressed air is used to blow dust out of the machines. Workers reportedly wear disposable latex glove when cleaning the machines.

Temperature, Relative Humidity

Temperature and relative humidity measurements were taken periodically throughout the work shift on January 26 and 27. Outdoor conditions were below freezing with occasional snow. The results of the monitoring are shown in the following table:

Lac Vieux Desert Resort Casino Temperature and Relative Humidity Monitoring HETA 20010109 1/26-27/2001			
Location	**Time**	**Temperature °F**	**%Relative Humidity**
Main Vault Area	3:30 AM, 1/26/2001	74	11
Hard Count Room	4:30 AM, 1/26/2001	73	12
Soft Count Room	5:40 AM, 1/26/2001	76	10
Hard Count Room	7:30 AM, 1/27/2001	73	11
Soft Count Room	7:35 AM, 1/27/2001	76	10

As noted in the table, temperatures were higher in the Soft Count room than the Hard Count room, and the measured relative humidity in all areas was well below the desirable range of 30-60 % .

Ventilation

Both counting rooms are ventilated from a central heating, ventilating, and air-conditioning system that also services the employee break rooms (there is a smoking and a non-smoking break room), and administrative offices. Supply air discharges into each room via ceiling mounted diffusers, and return air enters into a common return air plenum (space above the suspended ceiling) through a ceiling-mounted grille. There are two supply air grilles in the Hard Count room and one in the Soft Count room. The air handler units are roof mounted. The area above the suspended ceiling was inspected in both the Soft and Hard Count rooms and found to be clean with no readily identifiable source of contaminants. There is approximately 4.5 feet of plenum space between the suspended ceiling and the true ceiling. The exhaust system in the Soft Count room is likely counter productive as the exhaust grille is very close to the supply diffuser (possibly creating short-circuiting). Additionally, the exhaust discharges directly into the return air plenum and not directly outside. None of the coin machines are equipped with local exhaust ventilation. According to casino representatives, an engineering design to ventilate the machines has been proposed.

Air Sampling Results

The results of the air sampling are shown in table 1. All PBZ samples were collected over the employees full work shift. On January 26, PBZ samples for metals and total weight were collected from three Soft Count and four Hard Count workers. All workers were right handed and the sampling cassette was positioned on the left lapel of the monitored employee. On January 27, PBZ samples were collected from three Hard Count and two Soft Count workers.

As shown in Table 1, all measured PBZ concentrations of nickel, copper, and zinc were below applicable NIOSH RELs during the monitoring period. The highest measured concentrations were from a full-shift PBZ sample collected in the Hard Count area on January 26. A TWA copper concentration of 24 micrograms per cubic meter ($\mu g/m^3$), a TWA nickel concentration of 7 $\mu g/m^3$ nickel, and a TWA zinc concentration that was between the limit of detection (LOD) and limit of quantitation (LOQ) was measured in this sample. All

measured zinc concentrations were either below the LOD or between the LOD and the LOQ. The NIOSH REL for copper dust is 1000 µg/m^3, 15 µg/m^3 for nickel, and 5000 µg/m^3 for zinc. Trace (between the LOD and LOQ) concentrations of some other metals were found on some samples, most were below the LOD. The measured total dust, or gravimetric, concentrations were below guidelines established by the ACGIH and OSHA. NIOSH has not established an REL for total dust.

Although all concentrations were below applicable criteria, one PBZ sample from the Hard Count room on each day monitored showed concentrations of copper and nickel that were much higher than the other samples collected from workers in this area. The samples were collected from different workers, thus it does not appear that it was one particular employees work practices that contributed to the higher result. This variability could be explained by the low concentrations measured during this survey. At low levels, a small change in deposited contaminant can significantly affect the reported concentration. Under these conditions, a small difference in deposited metal on the filter (e.g., from a short term event such as disturbing dust on a machine or surface) could influence the analytical results to a much greater degree than if there were higher concentrations present.

A bulk sample of metal dust was collected from coin machine #3 on January 26. Analysis of this material indicated the sample composition was primarily copper (42%), nickel (11%), zinc (6.3%) and iron (3.4%). Smaller concentrations of manganese, magnesium, cobalt, chromium, aluminum, and titanium were also detected in the sample.

Surface Sampling Results

Sixteen surface samples for metals analysis were collected in the Hard Count room, Soft Count room, and both break rooms. The results of the surface sampling are depicted in Table 2. The results are reported as the amount of metal detected in micrograms per 100 square centimeters of surface area sampled (µg/100 cm^2). As previously noted, two different types of sampling media were used to collect the samples. This was to help assess the collection and analytical characteristics of the two types of sampling media. The results are not comparable as the deposition of contaminants on a surface are not expected to be uniform. As shown in the table, various levels of metals were found in the areas sampled; the highest amounts were detected in the coin count room. A sample collected from a support beam from the East side of the Hard Count room showed a copper concentration of 30-41 µg/100 cm^2, a nickel concentration of 10 µg/100 cm^2, and a zinc concentration of µg/100 cm^2. Similar levels were found on the supply air diffuser in the Hard Count room. Only very low levels of metals were detected in the Soft Count room and in the employee break rooms.

Noise Monitoring

Personal noise dosimetry was conducted on January 26 and 27 and the results are reported in Table 3. On January 26, three Hard Count and two Soft Count workers were evaluated, and dosimetry was conducted on three Hard Count and one Soft Count worker on January 27. The workers wore the dosimeters for the duration of the workshift.

As shown in the table, the dosimeters provide results which can be compared to different evaluation criteria as described in the Evaluation Criteria section of this report. All results are reported in dBA. The section reporting TWA dB(A) reports the results using three different measurement criteria as an 8-hour time-weighted average regardless of the sample time length. For example, with samples collected for less than 480 minutes, the dosimeter will assume that noise exposure was zero for the remainder of the unsampled period. The

OSHA AL column refers to the OSHA Action Level of 85 db(A) which calls for measuring noise with a threshold level (the sound level below which the instrument "assumes" there is no noise) of 80 db(A) and a 5dB exchange rate (the dose will either double or halve with each 5 dB increase or decrease). The OSHA PEL column refers to the OSHA Permissible Exposure Limit of 90 dB(A), which calls for measuring noise using a threshold of 90 dB(A) and a 5dB exchange rate. The NIOSH REL column refers to the NIOSH REL of 85 dB(A) as measured with no threshold and a 3dB exchange rate. The LAVG dB(A) column refers to the above described criteria, but provides the level measured for the actual time measured, and does not extrapolate to an 8-hr shift. LAVG is always greater than the TWA measurement for sample times less than 8-hours and is always greater than the TWA result for sample times exceeding 8-hours. Because of equipment problems, the NIOSH REL LAVG data was not available. The maximum level column refers to the maximum noise level measured during the monitoring period.

These results show that none of the monitored employees exceeded OSHA or NIOSH criteria for noise exposure. No hearing protection is worn by employees and these results suggest that hearing protection is not required.

The primary source of noise in the coin room is during the transfer of coins from a container into the machine or another container. Coin receptors on the machine are constructed of metal, and there is considerable metal to metal contact which creates the noise.

DISCUSSION

All air sampling results indicated that worker exposure to metals from the coin counting activity were within acceptable limits during the monitoring period. One full-shift sample for nickel (7 $\mu g/m^3$) was one-half of the NIOSH REL, indicating that there is the potential for exposure to metals during coin-counting. Both the nickel and copper concentrations measured on this sample, although below the REL, were much higher than those found on most of the other samples collected from either Hard- or Soft-count employees. However, at these low measured concentrations, a short-term event, such as disturbing metal-containing dust, could affect the result to this degree. Although NIOSH has not established an REL for PNOC, the total gravimetric results were below criteria established by OSHA and ACGIH, and are not suggestive of an airborne dust hazard. The bulk sample results were not surprising and indicated the proportion of metals in the dust sample were consistent with the composition of the coins used at the casino.

Because there are no standards defining acceptable levels of surface contamination, and it is not possible to accurately determine worker dose from a measurement of surface contamination, interpretation of the results is generally qualitative and based on professional judgement. The surface sampling results from this HHE suggest that additional cleaning is warranted in the coin count room, including the supply air diffuser, the metal support beam, and the coin count machines. A more rigorous cleaning regimen is warranted to ensure metal dust is routinely removed and does not accumulate. This is a prudent precautionary measure that will ensure that contamination will not build up to the point that it becomes an exposure concern. The area should be cleaned with a vacuum equipped with a high efficiency particulate air filter, or by wiping down the area with a damp cloth. Dry sweeping or compressed air should not be used. The concentration of metals detected in the break rooms (both smoking and non-smoking) and other areas were very low and do not suggest the need for additional action.

The noise monitoring results indicate that exposure to noise during counting activities is below established occupational criteria. However, there are opportunities to reduce the noise levels in the coin counting room, particularly short term impact noises during the transfer of coins from the container to the counter. This could be accomplished by lining the top loading chute with a dampening material to prevent the "metal-to-metal" contact that occurs when dispensing coins into the counter.

The observed manual lifting activities involving substantial loads (up to 70 pounds) and inefficient worker positions should be addressed to prevent musculo-skeletal injuries. It is possible that some of the lifting tasks could be eliminated (e.g., an extra coin dispensing step during the weighing of coins), and these should be evaluated in a comprehensive fashion.

As only a limited review of the ventilation system was conducted, only general comments can be made. However, the heating, ventilating and air-conditioning system supporting the count areas appeared to be insufficient to maintain conditions in an appropriate comfort range. The ventilation in the Soft Count room does not appear to be able to accommodate the number of people that work in this room; conditions are cramped in this room with four people and the paper carts, and it is likely the heat load is too high for the existing ventilation system. Short-circuiting of the ventilation system likely occurs as the room exhaust (which discharges into the return air plenum) is adjacent the supply air diffuser. An adjacent room used for miscellaneous storage is much larger and converting this room to accommodate paper counting may help alleviate the crowded conditions and favorably improve ventilation (this was a suggestion by some of the casino employees).

Temperatures ranging from 73° - 76° F were measured in the work areas during the NIOSH survey. The relative humidity in the work areas was lower than desirable (10-11%) and this could account for some of the eye and nasal irritation that has been experienced by workers. The presence of environmental tobacco smoke could also be a contributor to the health complaints.

CONCLUSIONS

Measured exposures to nickel, copper, and zinc during currency counting activities were below applicable exposure criteria and did not show an inhalation hazard for the employees sampled. The surface sampling results indicate that additional cleaning in the coin counting room is warranted to ensure that metal dust does not accumulate. Exposure to noise did not exceed applicable criteria in either the Hard Count or Soft Count work areas. The ventilation system does not appear to adequately provide sufficient quantities of conditioned air to the Hard Count and Soft Count rooms. Of the two rooms, the Soft Count room was the most severely underventilated. Relative Humidity levels were well below acceptable comfort criteria, and these may account for some of the eye and nasal irritation reported by workers. Tobacco smoke was detected in non-smoking areas indicating that smoke is not being effectively isolated and ventilated. As the air sampling did not identify excessive exposures to contaminants from the counting activities, it is possible that many of the health complaints could be resolved by improving the general indoor environmental quality in the counting area. This could be accomplished by ensuring a sufficient amount of conditioned air (temperature and relative humidity within acceptable ranges) is provided to each room, isolating tobacco smoke, improving janitorial practices, and altering maintenance procedures. A number of lifting activities involving heavy loads and awkward postures were observed during this survey, and these should be addressed by conducting a comprehensive ergonomic review of counting tasks.

RECOMMENDATIONS

1. Compressed air should not be used to clean the counting machines and work areas as this will generate airborne contaminants. A vacuum equipped with a high efficiency particulate air filter should be used for cleaning. A moistened cloth could also be used for wiping down areas. Dry sweeping should be avoided.

2. A comprehensive review of the heating, ventilating, and air-conditioning system supporting the count rooms, offices, and break rooms should be conducted by a qualified ventilation engineering firm and modifications/upgrades implemented to ensure sufficient ventilation. The design goal should be to provide a sufficient amount of conditioned outdoor air to each area. Temperature and relative humidity ranges described in ASHRAE standard 55-1992 should be used as design criteria for these two parameters. The ASHRAE standard 62-1999, Ventilation for Acceptable Indoor Air Quality, specifies outdoor air requirements for a variety of commercial facilities.[26] While no specific criteria for casino counting rooms is provided, the outdoor air requirements for a casino are 30 cubic feet per minute per person (cfm/p). Additional ventilation is necessary to accommodate smoking. A general default outside air requirement for non-industrial facilities with no other source of contaminants is 20 cfm/p. The mechanism for isolating tobacco smoke should be improved.

3. Improve area housekeeping in both count rooms. The frequency of cleaning should be increased and all vents, fixtures, tables, etc. should be periodically wiped clean with a moistened cloth. Workers should be encouraged to practice good personal hygiene (thorough hand washing) before eating, drinking, smoking, and at the end of their shift.

4. Investigate the possibility of relocating the Soft Count room to the existing storage room. The storage room is much larger and this may alleviate much of the cramped conditions and stagnant air flow that is currently present in the Soft Count room.

5. Conduct an ergonomic evaluation to assess manual lifting tasks during coin counting. Some activities involved awkward postures and extensive lifting. Workers should be involved in this review to ensure all activities are evaluated and that any modifications made are feasible. Task modifications to reduce the lifting and address posture should be implemented (e.g., evaluate the need to dispense coins into a separate container on the scale and then dispensing the coins back into another container after weighing).

6. Install dampening material to cover the metal load chute of the coin counting machines. This will help reduce impact noise. The machine manufacturer should be contacted for information regarding the feasibility of this type of upgrade.

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Table 1 Lac Vieux Desert Resort andCasino Personal Air Sampling Results - Metals HETA 20010109 1/26/-272001					
Task	**Time (min)**	**Results**			
		Gravimetric (mg/m^3)	**Copper ($\mu g/m^3$)**	**Nickel ($\mu g/m^3$)**	**Zinc ($\mu g/m^3$)**
1/26/2001					
Soft Count	0:55-8:35 (460)	0.04	(0.4)	<0.2	<0.5
Soft Count	1:06-8:33 (447)	0.29	0.5	<0.2	(0.5)
Soft Count	1:19-8:37 (437)	0.14	(0.4)	(0.2)	<0.6
Hard Count	0:59-8:36 (457)	0.21	24.2	7.0	(2.2)
Hard Count	1:01-8:33 (452)	0.06	1	(0.3)	<0.5
Hard Count	1:07-8:33 (446)	0.04	0.8	(0.3)	<0.6
Hard Count	1:03-8:33 (451)	0.23	1.5	(0.4)	<0.6
1/27/2001					
Soft Count	1:00-8:34 (454)	0.13	(0.2)	<0.2	<0.6
Soft Count	1:04-8:34 (449)	0.06	(0.3)	<0.2	<0.5
Hard Count	0:57-8:30 (453)	0.04	0.6	(0.2)	<0.5
Hard Count	0:59-8:27 (448)	0.26	15	4.4	(1.0)
Hard Count	1:02-3:14 (131)*	0.14	(0.4)	<0.8	<1.9
NIOSH REL		**	1000	15	5000

mg/m^3 = milligrams of contaminant per cubic meter of air sampled
$\mu g/m^3$ = micrograms of contaminant per cubic meter of air sampled
1000 micrograms = 1 milligram
< = less than the detectable limit of the analytical method
() = values in parentheses indicate the concentration measured was between the analytical limit of detection (LOD) and the limit of quantification (LOD).
REL = Recommended Exposure Limit
* = Sampling pump failed at 3:14 AM
** = NIOSH does not have an REL for total particulate not otherwise classified (PNOC). The OSHA permissible exposure limit and ACGIH threshold limit value for PNOC is 15 mg/m^3 and 10 mg/m^3, respectively.

Table 2 Lac Vieux Desert Resort and Casino Surface Sampling Results - Metals HETA 20010109 1/26/2001				
Location	Contaminant	Concentration (µg/100cm^2)		Comments
		Ghost Wipe	Wash 'n Dri	
Soft Count Workstation	Copper Nickel Zinc	0.09 0.02 0.05	0.04 0.04 <LOD	
Hard Count Computer Table	Copper Nickel Zinc	1.6 0.11 0.42	0.44 0.88 0.11	
Coin Room Support Iron, East Side	Copper Nickel Zinc	41 10 2.3	30 12 3.1	Trace lead and silver. Settled dust build up on iron
Top of Coin Machine # 3270	Copper Nickel Zinc	3.7 0.97 0.22	3 0.86 0.98	
Break Room (Smoking) Adjacent MW oven	Copper Nickel Zinc	0.47 0.01 <LOD	0.02 0.004 <LOD	
Break Room (Smoking) Lunch Table	Copper Nickel Zinc	0.34 0.01 0.01	0.03 <LOD 0.68	
Break Room (Non-Smoking) Lunch Table	Copper Nickel Zinc	0.01 0.003 <LOD	0.02 <LOD 0.78	
Supply Diffuser Coin Room	Copper Nickel Zinc	33 8.9 1.72	43 3.18 13	Trace lead, chromium and silver

Notes:

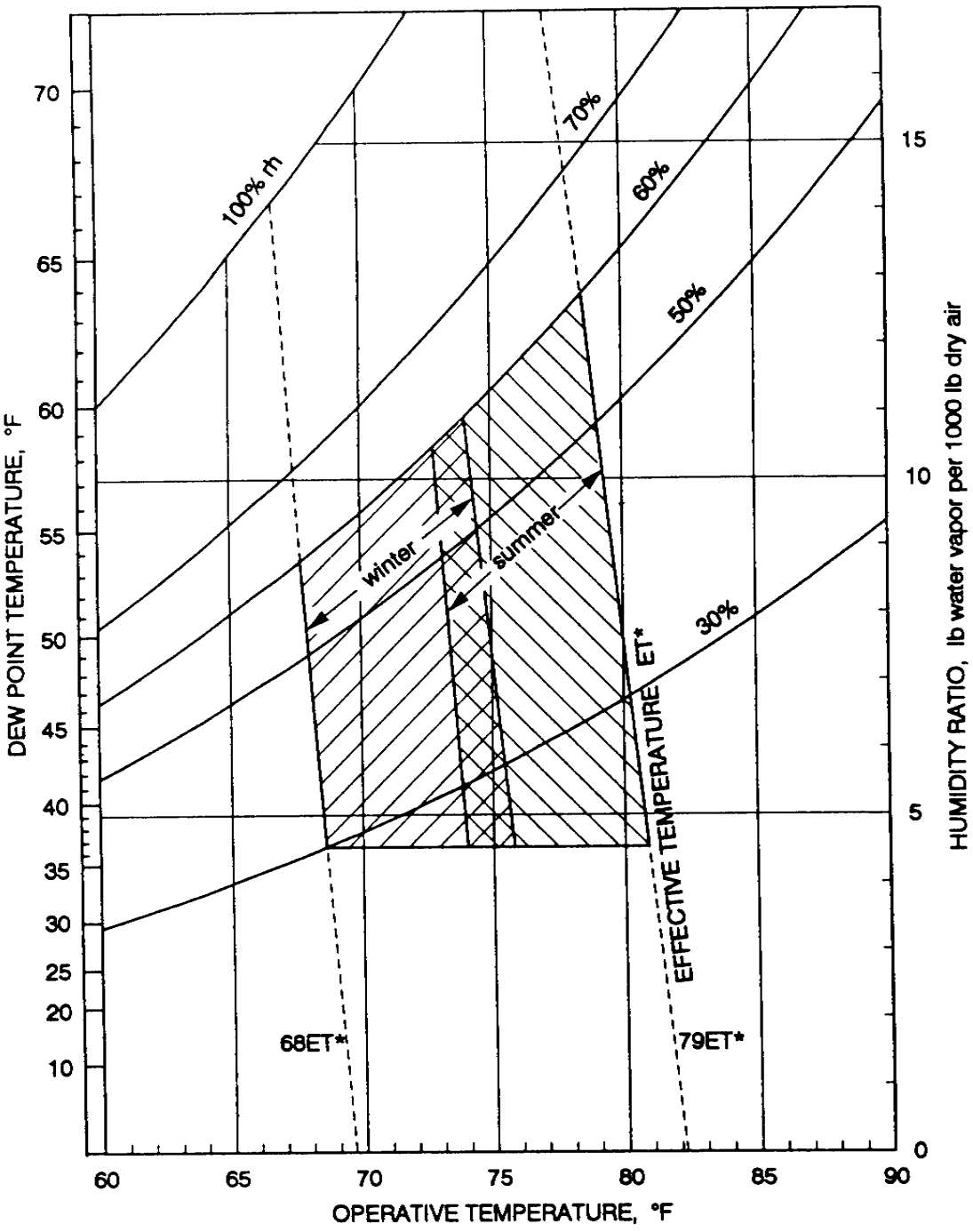
µg/100 cm^2 = micrograms of contaminant per 100 square centimeters of surface area sampled.
<LOD = below the limit of detection when the sample was adjusted for the concentration detected on the field blank
Two types of media were used (Ghost wipes and Wash n' Dri wipes) for analytical purposes to collect the samples. Results are not directly comparable as deposition on surfaces is not expected to be uniform

Table 3
Lac Vieux Desert Resort and Casino
Personal Noise Dosimetry Results
HETA 20010109
1/26-27/2001

			TWA dB(A)			LAVG dB(A)		Max Level
Activity	Date	Sample Time (minutes)	OSHA AL	OSHA PEL	NIOSH REL	80/5	90/5	dB(A)
Opened bill holders in Soft Count room	1/26/01	458	77.7	69.3	77.8	78	69.6	110
Collected change from slots; 5:30 am assisted in Hard Count	Jan 26	458	77.3	69.3	77.7	77.6	69.6	109
Soft Count	Jan 26	448	70.2	57.8	73.5	70.6	58.2	105
Hard Count beginning 4:35 am	Jan 26	497	78.3	73.6	78.9	78.7	74	108.7
Soft Count	Jan 27	452	75.4	66.9	79	75.8	67.3	124.1
Hard Count beginning 4:35 am	Jan 27	456	75.8	66.4	76.4	76.2	66.7	102.7
Hard Count	Jan 27	445	70.8	62.8	74.5	71.3	63.3	
Hard Count	Jan 27	450	73.8	65.1	75.7	74.2	65.6	108.3
Collected change from slots; 7 am assisted in Hard Count	Jan 26	No data due to malfunction of the dosimeter						

Note:
dB(A) = decibel on the A-weighted scale
OSHA AL = OSHA Action Limit for the hearing conservation standard (85 dB(A))
OSHA PEL = OSHA Permissible Exposure Limit (90 dB(A))
NIOSH REL = NIOSH Recommended Exposure Limit (85 dB(A))
TWA = Time weighted average for an 8-hour work shift
LAVG = the average dB(A) level for the actual time period sampled.

Figure 1
ANSI/ASHRAE Standard 55-1992
Thermal Environmental Conditions
for Human Occupancy



For Information on Other
Occupational Safety and Health Concerns

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