NIOSH HEALTH HAZARD EVALUATION REPORT

HETA #2004-0123-2939
City of Liberal Animal Shelter
Liberal, Kansas
May 2004

DEPARTMENT OF HEALTH AND HUMAN SERVICES
Centers for Disease Control and Prevention
National Institute for Occupational Safety and Health

PREFACE

The Hazard Evaluation 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 employers 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.

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ACKNOWLEDGMENTS AND AVAILABILITY OF REPORT

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Highlights of the NIOSH Health Hazard Evaluation

Evaluation of Carbon Monoxide (CO) Exposures during Euthanasia of Animals at the City of Liberal, Kansas, Animal Shelter

The City of Liberal, Kansas asked NIOSH for help in evaluating CO exposures of employees that operate their CO euthanasia chambers. NIOSH assisted the City by measuring CO near the chamber and in the breathing zone of workers that operated the empty chamber for this investigation.

What NIOSH Did

- We measured CO near the chamber and in the breathing zone of two employees.
- We gathered information for the City about proper euthanasia methods; commercially available CO chambers; and the death of an operator of a homemade chamber in Chattanooga, Tennessee.
- We provided educational materials about occupational safety and health to the workers.
- We asked current and past employees about how they operated the chamber and symptoms they may have had when the chamber was operated.

What NIOSH Found

- The CO gas chambers are a potentially serious hazard for the employees.
- The death associated with the use of a similar chamber in Tennessee and the CO levels measured by NIOSH in this investigation indicate that the use of home-made uncontrolled gas chambers for animal euthanasia is not acceptable.

What City Of Liberal Managers Can Do

- Use lethal injection instead of CO for euthanasia.
- Follow existing euthanasia guidelines.
- Purchase an acceptable, commercially-produced CO chamber for euthanasia if the decision is made to continue the use of CO.
- Educate employees about risks and symptoms of CO exposure.
- Assure safe use of such chambers by following all manufacturers' guidelines related to maintenance and procedures.
- Comply with all guidelines and requirements for confined space relevant to operation of CO euthanasia chambers.

What Liberal Animal Shelter Employees Can Do

- Immediately report symptoms of CO exposure to designated health and safety personnel (if CO use is continued).
- Follow work practices defined in the written operational procedures for CO euthanasia chambers.

What To Do For More Information:
We encourage you to read the full report. If you would like a copy, either ask your health and safety representative to make you a copy or call 1-513-841-4252 and ask for HETA Report #2004-0123-2939

Health Hazard Evaluation Report 2004-0123-2939
City of Liberal Animal Shelter
Liberal, Kansas
May 2004

Jane McCammon, MS, CIH

SUMMARY

In February 2004, the City of Liberal, Kansas, asked the National Institute for Occupational Safety and Health (NIOSH) for help in evaluating carbon monoxide (CO) exposures of employees that operate two euthanasia chambers at the city-run animal shelter. The Kansas Animal Health Department suspended use of the unvented chambers during a licensing inspection. The City requested NIOSH assistance in measuring employee CO exposure during operation of the chambers and modifying the chambers so that they could be again be used in a manner that would be acceptable to the Kansas Animal Health Department.

In March 2004, NIOSH responded to the request by using direct-reading monitors to measure CO near the two chambers and in the breathing zone of workers that operated the empty chambers specifically for this investigation. (Operation of the chamber for this investigation was authorized by the licensing organization.) Past and present employees were interviewed about methods used to operate the chambers and symptoms experienced when the chambers were operated. NIOSH also gathered the following information: (1) details about the death of a Tennessee animal shelter worker during operation of a similar chamber; (2) the extent of use of CO euthanasia chambers across the United States; (3) policies and guidelines of the American Veterinary Medical Association (AVMA), the Humane Society of the United States (HSUS), and the National Animal Control Association (NACA) related to the appropriate use of CO for euthanasia in animal shelters; and (4) classification of such chambers as a "confined space" by NIOSH and the Occupational Safety and Health Administration (OSHA).

When CO was introduced into the chamber, CO concentrations near the chamber rapidly exceed the NIOSH ceiling limit of 200 parts per million (ppm). The NIOSH Immediately Dangerous to Life and Health value of 1,200 ppm was exceeded in one instance. Peak CO concentrations in the general area during CO introduction were 800 ppm to 950 ppm, and greater than 1,200 ppm (the maximum range of the sampling instruments). Slowing the delivery rate of CO resulted in much lower concentrations near the chamber. When the chambers were opened, CO concentrations in the general area of the chambers ranged from 400 ppm to >1,200 ppm for several minutes. CO concentrations inside the chambers remained above 1,200 for an undetermined length of time.

Employee exposures during this investigation were impacted by the fact that normal tasks were not conducted, and also that employees appropriately removed themselves from exposure when their CO monitors alerted them to the severity of the hazard. During two occasions of chamber operation, employees were exposed to maximum CO concentrations of 380 ppm and 945 ppm before they were able to move to safer locations.

NIOSH noted several other health and safety deficiencies. There were no confined space entry procedures. Respiratory protection was not available. Operating procedures were undefined. There was no hazard communication program. There was no program for employee training. There were no warning signs related to the CO hazard. There was no emergency action plan. The employer had not assessed the workplace to determine if hazards were present.

The NIOSH investigator concluded that the use of homemade CO chambers, such as the one investigated here, presents an unacceptable health risk to animal shelter employees. Suggestions for reducing this risk are included in the Recommendations section of this report. Modification of the existing chambers was not an acceptable control method, and thus no recommendations were provided in that regard.

Keywords: SIC 0752 (Animal specialty services / animal shelters), carbon monoxide, CO, carboxyhemoglobin, COHb, animal control officer, euthanasia, gas chamber

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INTRODUCTION

On January 27, 2004, as part of a regular licensing inspection, the City of Liberal Animal Shelter was informed by the Kansas Animal Health Department that its carbon monoxide (CO) euthanasia chambers could no longer be used due to inadequate design. Deficiencies noted were the absence of purging and lack of ventilation systems.

In response, a local veterinarian and the State Veterinarian suggested that the City request assistance from the National Institute for Occupational Safety and Health (NIOSH). Citing concern about employee exposure associated with use of the chambers as designed (no exhaust), the city requested assistance of NIOSH on February 2, 2004. NIOSH responded by conducting an investigation at the animal shelter on March 3 and 4, 2004.

BACKGROUND

National euthanasia statistics are difficult to pinpoint because animal care and control agencies are not uniformly required to keep statistics on the number of animals taken in, adopted, euthanized, or reclaimed. There is no reporting structure enabling collection of such figures. However, it is estimated that shelters use euthanasia on 3 – 4 million dogs and cats annually to control the animal population in the United States.[1] This figure represents approximately 50% to 70% of all animals that enter a shelter.[2]

Regulation of euthanasia in animal shelters varies nationwide, but is often covered by a city, county, or state licensing agency. These agencies often incorporate policies of recognized animal welfare agencies for guidelines for acceptable euthanasia methods. Three such agencies are the American Veterinary Medical Association (AVMA), the Humane Society of the United States (HSUS), and the National Animal Control Association (NACA). These groups agree that injection of sodium pentobarbital is the preferred euthanasia method, but also allow for the use of CO euthanasia chambers.

The Panel on Euthanasia convened by AVMA[3] declared that the use of injectable agents is the most desirable euthanasia method for companion animals, but also stated that it is acceptable to use CO for individual animal or mass euthanasia for dogs, cats, and other small mammals. HSUS policies state that the use of CO, when delivered by a commercially manufactured and equipped chamber, is an acceptable method of euthanasia for some animals.[4] NACA acknowledges that there are agencies legally restricted in their ability to obtain sodium pentobarbital, and in such cases, if CO is the euthanasia method of choice, the shelter must use CO specifically designated for use in euthanasia.

Occupational safety and health concerns associated with the use of CO euthanasia chambers heightened in 2000, when a 39-year-old Animal Humane Officer died while operating a homemade concrete block chamber in a Chattanooga, Tennessee shelter. He was an experienced operator of the chamber; he had used it for approximately 10 years. As part of the investigation of this fatality, the Tennessee Occupational Safety and Health Administration (TOSHA) determined that the animal control officer was exposed to CO in excess of 70,000 parts of CO per million parts of air (ppm), which is rapidly fatal. Tennessee officials ruled that the chamber was a confined space, subject to permitting under OSHA regulations. The chamber operated by the Tennessee victim was slightly smaller (4’ X 4’ X 4’) than the large chamber used in Kansas (4’ X 4’ X 5’).

The animal humane officer in Tennessee was found dead at the scene by two coworkers. Because his death was not witnessed, little is known about the circumstances under which he died. His carboxyhemoglobin (COHb) concentration reported in the medical examiner and laboratory report was >70%. The TOSHA inspection led to fines for extensive violations, including: no confined space permitting and procedures, absence of a hazard communication program; employee overexposure to CO; absence of an implemented written emergency

action plan; failure to properly assess workplace hazards; inadequate employee training; and inadequate signage.

Liberal City representatives were under the impression that the use of CO euthanasia chambers was declining, and noted that theirs was the only one used in Kansas. A search of the internet indicated that CO chambers are extensively used in municipal shelters, particularly in counties removed from large city populations. Table 1 describes the extent of use or banning of CO chambers for euthanasia in U.S. animal shelters, listed by state. The listing was derived from various sources of internet information, including media coverage, letters, municipal government reports, etc.

PROCESS DESCRIPTION

The City of Liberal Animal Shelter has been in operation for approximately 10 years, and was previously managed and/or owned by at least four private groups. The City of Liberal took over operation of the shelter in October 2003.

The shelter employs 4 full-time employees, and has 27 animal bays, 12 portable dog cages, and 18 cat cages. Approximately 60 animals are accepted by the shelter each month, with approximately 10 being claimed by their owner or adopted by new owners. Prior to the recent State inspection, most of the remaining animals were placed in one of two CO euthanasia chambers during twice weekly operation of the chambers. The same person has operated the chambers for the past nine months.

The chambers are shown in Figures 1 and 2. Both chambers are housed in an outdoor enclosure (wooden fence sections approximately 6 feet in height, no roof) adjacent to the building. Both homemade chambers are fabricated from sheet metal. The "dog chamber" measures 4' X 4' X 5' and houses a maximum of seven caged dogs. The "cat chamber" measures 2'4" X 2'8" X 3'1" and houses a maximum of 5 caged cats. The chamber doors are fitted with rubber hosing fashioned as a seal. There is a plexiglass viewing window in the door. The operator loads animals into the chamber, and then locks the door with large butterfly clamps that are manually screwed tight to allow pressurization of the chamber.

A tank of liquefied CO stands between the two cages. CO gas is introduced into either chamber by manual operation of valves controlling the flow of pure CO through small piping that led to two locations on each chamber (one at the bottom and top of each chamber). Each chamber is an otherwise solid metal box with a hinged door covering the full face of the chamber. Because there were no written standard operating procedures and there was considerable confusion about operating parameters, employees had no choice but to guess at how long to leave the valves open, whether to let the CO into the chamber very fast or gradually, how to open the bolted door safely, and how long to wait before removing the dead animals from the chamber.

The delivery rate of CO into the chamber varied widely. The operator opens the valve, pressurizing the chamber at varying rates for 20 to 30 seconds. At this point, the current operator leaves the area, while animals are left in the CO-filled chamber for approximately 20 to 30 minutes. The butterfly clamps are then loosened (with the operator leaning against it to keep the CO contained as long as possible) and the door is opened. The operator reports that this is usually done while holding your breath to avoid the CO.

The doors remain open until the chamber is thought to have aired out (approximately 20 minutes), at which point the dead animals are removed from the cages in the chambers.

Interview of a past shelter employee indicated that very different methods were used to operate the chamber during his employment. He allowed the chamber to air out "long enough to be safe" which he considered to be 1 to 2 minutes. He described experiencing symptoms that were consistent with CO overexposure, but also commented that it was difficult to know if the symptoms were related to CO or stress and smell associated with animal euthanasia .

Since the suspension of use of the CO chambers, the City has been conducting euthanasia by lethal injection through contracted veterinary services, which is cost-prohibitive for this financially troubled shelter. For example, the shelter used these services (comprised of once-a-week visits from the veterinarian to euthanize 41 animals) for three weeks prior to the NIOSH investigation at a cost of $335.00 (which does not account for costs such as employee time, etc.). In comparison, the cost of use of the CO chambers from October 14, 2003, through January 7, 2004, was approximately $375.00 (for 2 ½ tanks of CO).

METHODS

Employee CO exposures were measured using ToxiUltra Atmospheric Monitors (Biometrics, Inc.) with CO sensors. Similar monitors were also placed in the area of the CO chambers (generally one or two on top of the chamber operating at the time, one on the adjacent chamber, and one to the left of the small animal chamber).

All ToxiUltra CO monitors were zeroed and calibrated before each use according to the manufacturer's recommendations. These monitors are direct-reading instruments with data logging capabilities. The instruments were operated in the passive diffusion mode, with a one-minute sampling interval. The highest instantaneous reading of these instruments is approximately 1000 ppm.

During operation, there were no animals in either chamber, and the operator did not perform the usual tasks associated with loading and unloading the chamber and disposing of the dead animals. During the morning of March 3, a light rain was falling, necessitating the use of a tarp to cover the area housing the chambers and related monitoring equipment. This tarp was purchased specifically for this testing, as the shelter does not normally conduct euthanasia in the rain. The tarp was removed prior to the afternoon operation of the chambers.

On March 3, the small chamber was operated first (singly), with two full cycles of closing the chamber, introducing CO, allowing it to sit pressurized for a number of minutes, and then opening the chamber door. The large chamber was then operated (singly) for two full cycles.

On March 4, a steady rain fell preventing sampling until late in the day. This sampling was also carried out in the absence of a tarp covering the area. One full cycle of operation of the large chamber was accomplished on this afternoon.

HEALTH EFFECTS & EVALUATION CRITERIA

Health Effects of CO Exposure

CO is a colorless, odorless, tasteless gas produced by incomplete burning of carbon-containing materials such as gasoline or propane fuel. The initial symptoms of CO poisoning may include headache, dizziness, drowsiness, or nausea. Symptoms may advance to vomiting, loss of consciousness, and collapse if prolonged or high exposures are encountered. If the exposure level is high, loss of consciousness may occur without other symptoms. Coma or death may occur if high exposures continue.[5,6,7,8,9,10] The display of symptoms varies widely from individual to individual and may occur sooner in susceptible individuals such as young or aged people, people with preexisting lung or heart disease, or those living at high altitudes.

Exposure to CO limits the ability of the blood to carry oxygen to the tissues by binding with the hemoglobin to form COHb. Once exposed, the body compensates for the reduced bloodborne oxygen by increasing cardiac output, thereby increasing blood flow to specific oxygen-demanding organs such as the brain and heart. This ability may be limited by preexisting heart or lung diseases that inhibit increased cardiac output.

Blood has an estimated 210-250 times greater affinity for CO than oxygen, thus the presence of

CO in the blood can interfere with oxygen uptake and delivery to the body. Once absorbed into the bloodstream, the half-time of CO disappearance from blood (referred to as the "half-life") varies widely by individual and circumstance (i.e., removal from exposure, initial COHb concentration, partial pressure of oxygen after exposure, etc.). Under normal recovery conditions breathing ambient air, the half-life can be expected to range from 2 to 6.5 hours. This means that if the initial COHb level were 10%, it could be expected to drop to 5% in 2 or more hours, and then 2.5% in another 2 or more hours. If the exposed person is treated with oxygen, as happens in emergency treatment, the half-life time is decreased again by as much as 75% (or to as low as approximately 40 minutes). Delivery of oxygen under pressure (hyperbaric treatment) reduces the half-life to approximately 20 minutes.

Carboxyhemoglogin measurements are typically made when a patient arrives at the hospital or a body arrives at the morgue. The time elapsing between CO exposure and COHb analysis is a likely explanation of the poor clinical correlation between symptoms of CO poisoning and COHb level. This complicates any discussion of "normal" COHb concentrations and COHb concentrations associated with symptoms. COHb concentrations among unexposed non-smokers are typically between 1% - 2%, and for smokers typically between 3%-8%.[11] Exposures resulting in COHb concentrations less than 10% usually cause no appreciable symptoms; exposures resulting in COHb greater than 50% are often fatal. However, COHb levels as low as 1% - 10% have been associated with severe symptoms (including prolonged loss of consciousness), and COHb levels as high as 47% resulted in no associated loss of consciousness.[12] Thus, elevated COHb concentration can only be used to confirm exposure, not to confirm poisoning severity.

CO Occupational Exposure 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 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, which 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)[13], (2) ACGIH® Threshold Limit Values (TLVs®)[14], and (3) the U.S. Department of Labor, Occupational Safety and Health Administration (OSHA) Permissible Exposure Limits (PELs).[15] Employers are encouraged to follow the OSHA limits, the NIOSH RELs, the ACGIH TLVs, or whichever is 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.[16] 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.

Occupational criteria for CO exposure are applicable to employees who may be at risk of CO poisoning. The occupational exposure limits noted below should not be used for interpreting general population exposures because occupational standards are intended for healthy worker populations. The effects of CO are more pronounced in a shorter time if the person is physically active, very young, very old, or has preexisting health conditions such as lung or heart disease. Persons at extremes of age and persons with underlying health conditions may have marked symptoms and may suffer serious complications at lower levels of COHb.[17]

The NIOSH REL for CO is 35 ppm for full shift TWA exposure, with a ceiling limit of 200 ppm which should never be exceeded.[6] The NIOSH REL of 35 ppm is designed to protect workers from health effects associated with COHb levels in excess of 5%.[6] NIOSH has established the immediately dangerous to life and health (IDLH) value for CO as 1,200 ppm.[10] An IDLH value is defined as a concentration at which an immediate or delayed threat to life exists or that would interfere with an individual's ability to escape unaided from a space.

The ACGIH recommends an 8-hour TWA TLV of 25 ppm based upon limiting shifts in COHb levels to less than 3.5%, thus minimizing adverse neurobehavioral changes such as headache, dizziness, etc., and to maintain cardiovascular exercise capacity.[14] ACGIH also recommends that exposures never exceed five times the TLV (thus, never to exceed 125 ppm).[14] ACGIH recommends a Biological Exposure Index (BEI) for end of shift exhaled breath analysis in nonsmoking workers (exposed to CO) of 3.5% COHb (or 20 ppm).[14] The BEI generally indicates a concentration below which nearly all workers should not experience adverse health effects.

The OSHA PEL for CO is 50 ppm for an 8-hour TWA exposure.[15]

Other Relevant Criteria

Certain HSUS and AMVA recommended standards for animal euthanasia impact on occupational exposure. HSUS lists the following minimum requirements and conditions for the use of CO chambers for euthanasia:[4]

> **"The Equipment**: The chamber must be a commercially manufactured unit designed specifically for CO euthanasia and be properly maintained.
>
> It should be stationed and utilized in a well-ventilated area and exhausted to the outside.
>
> If it is designed to euthanize more than one animal at a time, it must be equipped with independent sections or cages to separate incompatible or frightened animals.
>
> The interior of the chamber must be well-lit, and equipped with view-ports, a regulator (which maintains the gas concentration), and flow-meter (which measures the gas concentration).
>
> Only bottled commercial grade gas must be used; engine or chemically-generated gas is not acceptable due to impurities and heat which are painful and inhumane.
>
> The chamber should achieve a minimum of 4%-6% gas (the concentration should never be above 10%, a level at which CO may become explosive) within 20 seconds. The animals must be unconscious within 45-60 seconds, and death must occur within two to four minutes.

Monitoring equipment (such as an alarm) must be used during operation, and the chamber must be thoroughly cleaned after each use.

The Euthanasia Process: A euthanasia technician should be present during the entire cycle in the event there is an equipment malfunction or other problem.

Animals must be left in the chamber and exposed to the gas for a minimum of 30 minutes to ensure death.

The chamber must be fully exhausted before animals are removed.

Positive verification of death must be determined for each animal prior to disposal.

Staff Safety: Staff must be fully notified of the potential health risks involved with using CO.

The use of a CO chamber should be closely monitored and in compliance with OSHA requirements."

AVMA recommendations are very similar to those of HSUS, with the following differences:[3]

Equipment: AVMA does not specifically require that the chamber be of commercial construction. Rather, they state that "the CO chamber must be of the highest quality construction."

AVMA does not specify the use of a regulator and flow meter for gas delivery to the chamber, but rather states: "The CO flow rate should be adequate to rapidly achieve a uniform CO concentration of at least 6% after animals are placed in the chamber."

The Euthanasia Process: AVMA does not address the process itself.

Staff Safety: AVMA wording about staff training differs in that they recommend that personnel using CO be instructed thoroughly in its use and understand its hazards and limitations.

AVMA adds the following safety information: "Safeguards must be taken to prevent exposure of personnel. Any electrical equipment exposed to CO (eg, lights and fans) must be explosion proof."

RESULTS

Results of CO sampling during operation of the chambers are presented in Figures 3 – 7.

CO concentration during introduction of gas into the chamber: Each time the gas was introduced to either chamber, CO poured into the air around the positively pressured chamber through openings in the chamber door. Figures 3 – 6 demonstrate that CO concentrations near the chamber rapidly exceed the NIOSH ceiling limit of 200 ppm during introduction of CO and the NIOSH IDLH value of 1,200 ppm was exceeded in one instance. This happens because there are many leaks around the chamber doors.

Peak CO concentrations in the general area during introduction were 800 ppm to greater than 1200 ppm (the maximum range of the sampling instruments).

On March 4, when the large chamber was operated for one more full cycle (shown in Figure 7), CO concentration in the area of the chambers was noticeably lower, with a maximum of approximately 100 ppm (the operator's peak exposure was 170 ppm). During this cycle, the operator introduced CO into the chamber with more control than before with less of a burst of pressure and a slower delivery rate.

CO concentration when the chambers were opened: Because these chambers are not vented, opening the chamber door represents the largest release of CO into the area occupied by the operator. Peak concentrations following

opening of the chamber ranged from 400 ppm to >1,200 ppm (the maximum capacity of the monitors) in the general area of the chambers. These concentrations remained above the NIOSH ceiling limit of 200 ppm for 2 to 10 minutes.

It is important to note that these concentrations were measured outside the chamber and that the operator did not conduct the regular activities of unloading dead animals. Figure 6 shows that the CO concentrations within the chamber remain above IDLH levels well past the time when external concentrations have dissipated. At 16:19 on the graph in Figure 6, one of the CO monitors from the outside of the chamber was briefly placed within the chamber and indicated that the CO concentration was greater than 1,200 ppm. To corroborate that information, one minute later a second monitor was briefly placed within the chamber, again measuring CO concentrations above the capacity of the instrument. Each monitor was quickly withdrawn to avoid damaging the sensor. This means that the operator is likely to be exposed above IDLH concentrations for an undetermined length of time if the chamber is not actively ventilated.

Employee exposures: Employee exposures during this investigation were impacted by the fact that CO alarms alerted employees to the severity of the hazard during the tasks they were conducting. When alarms sounded, employees wearing monitors appropriately removed themselves from exposure. In addition, normal tasks were not conducted during the operation. Personal monitoring results should be viewed in light of this fact: typical exposures would most likely be higher when actual euthanasia is conducted in these chambers.

The results shown in Figure 3 are perhaps the best indicator of employee exposure during normal operations with no CO alarm. When the valve of the first cylinder of CO was opened (at 11:15), the operator thought the tank was empty. The valve was closed, and the chamber opened – at which point the operator was exposed to CO in excess of 380 ppm. After the tank was replaced with a full tank, and the valve was again opened to introduce CO into the smaller chamber (at 11:43), the operator's exposure rose above the level of alarm (>200 ppm) twice (once during CO introduction and once when the door was opened). During each chamber operation after that, employees were then aware of the hazard and were either kept out of the area or quickly evacuated the area when CO was being delivered or chambers were being opened.

Other findings:
There were no confined space entry procedures.

The employee operating the chamber did this task alone (no observers).

Respiratory protection was not available.

Operating procedures were undefined.

There was no hazard communication program, although there was a Material Safety Data Sheet for the compressed liquid CO.

There was no program for employee training.

There were no warning signs related to the CO hazard.

There was no emergency action plan.

The employer had not assessed the workplace to determine if hazards were present.

There was no way to tell if the CO concentration within the chamber was appropriate for humane euthanasia of the animals.

DISCUSSION

Homemade CO euthanasia chambers and manually operated CO gas chambers with no exhaust ventilation, undetermined times of chamber evacuation, unknown level of chamber pressurization, unknown concentrations of CO in the chambers and breathing zones of the workers are highly hazardous. The body of information discussed in this report (i.e., the fatality associated with the use of a homemade chamber in Tennessee; the CO measurements

demonstrated in this NIOSH investigation; and accepted guidelines of organizations such as HSUS and AVMA indicate that the use of homemade uncontrolled gas chambers for euthanasia with no regard for employee safety is not acceptable. Consequently, there are no recommendations related to modification of the existing homemade chambers used at this animal shelter.

A primary issue for this animal shelter, and apparently shelters across the United States, is the relative financial burden of lethal injection versus CO chamber operation. HSUS presents guidelines for comparing costs of appropriate use of each method, based on the use of a commercially produced euthanasia chamber designed specifically for use with CO.[4] HSUS and TOSHA identified only one such commercially produced euthanasia chamber. Technical information about this chamber is included in Attachment 1.

CONCLUSION

Environmental sampling during staged euthanasia at this animal shelter indicated an unacceptable risk of exposure to excessive levels of CO.

RECOMMENDATIONS

The following recommendations are based on the findings of this investigation and are intended to reduce the health hazard for employees.

1. Continue the use of lethal injection instead of CO for animal euthanasia.

2. If CO is used for euthanasia, purchase an acceptable commercially-produced chamber specifically designed for use with CO. An example of such a chamber is included in Attachment 2.

3. If the decision to use CO for euthanasia is based on comparative costs of each method, use appropriate cost comparison analyses for this decision.[4]

4. Assure the safe use of the commercially produced chamber by periodically measuring CO emitted when the chamber is operated, and by following all manufacturers' guidelines for maintenance and continued use of the product.

5. A CO euthanasia chamber is a confined space, and all relevant guidelines or requirements for such confined spaces should be adhered to when the CO chamber is operated. (Attachment 2). The operator should never unload the chamber until reliable measurements indicate that the chamber has been cleared of high concentrations of CO.

6. Develop a hazard communication program using the OSHA hazard communication standard as a program guideline. Excellent sample programs can be found on the OSHA website.[18]

7. If CO chambers are used, employees operating these chambers should immediately report symptoms of CO exposure to designated health and safety personnel.

8. Develop written operational procedures for animal euthanasia, regardless of the method chosen. Example written procedures of lethal injection are available from HSUS. Operating procedures supplied with commercially available CO chambers serve as an excellent starting point for written procedures if that is the chosen euthanasia method.

9. Post warning signs related to the CO hazard if CO chambers are used.

10. Develop an emergency action plan.

11. Conduct a workplace hazard assessment to define workplace hazards and appropriate methods of control.

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TABLES & FIGURES

Table 1. Examples of Use or Prohibition of Carbon Monoxide Chambers for Euthanasia in U. S. Animal Shelters, by State. HETA 2004-0123-2939, Liberal Kansas

State	Description of Use
CA	Banned the use of CO chambers effective January 1, 2001. In 1999, Sacramento County used a CO euthanasia chamber for 17,000 unwanted pets. They discontinued use of the chamber in 2000.
FL	Lethal injection is specified as the only method allowed.
MD	Prohibits the use of CO chambers.
ME	Lethal injection is specified as the only method allowed.
MN	Hennepin County uses CO euthanasia chambers for 10,000 to 12,000 dogs and cats annually.
MO	The city of St. Joseph uses CO chambers.
NC	Most county animal shelters use gas euthanasia chambers on 37 animals per 1,000 people statewide, or 70% to 91% of those animals making it to the shelter. In the Charlotte region, only Mecklenburg and Burke Counties use lethal injection. Wake County used CO euthanasia for 2,800 animals in 2002. Johnston used gas on 3,614 animals euthanized in 2001. Chatham used gas euthanasia for 98 % of 1,628 animals in 2002.
OH	Of Ohio's 88 counties, 20 use CO chambers to euthanize companion animals, including Richland, Fairfield (30 dogs a week), and Johnston (3,614 animals euthanized with CO in 2001) Counties.
OK	Allows the use of CO chambers.
OR	Lethal injection is specified as the only method allowed.
PA	Lethal injection is specified as the only method allowed.
SC	Allows the use of CO chambers.
TN	Banned the use of CO chambers in 2002.
TX	The manufacturer of one of the only commercially available CO chambers reported that market research estimates indicate that 65% of Texas counties use homemade CO chambers.
UT	In Utah County, CO chambers are the main method used to euthanize animals in animal shelters. In 2002, CO was used on 60% (480) of the 800 animals euthanized monthly. Although Enoch used truck-generated CO to kill 450 animals in 1998, with the annual number declining as publicity about the Enoch chamber rose. According to the chamber manufacturer mentioned above, every UT County has at least one CO chamber.
VA	Of Virginia's 95 counties, 25 to 27 use a CO gas chamber for euthanasia.
WA	The City of Emporia uses CO euthanasia chambers.
WY	Casper recently purchased a CO chamber ($7,500) for euthanasia of animal shelter animals.
General: The only manufacturers of euthanasia chambers specifically designed for use with CO (same company mentioned above) reports having sold 8 units in the past 6 months, with overall sales of approximately 300 such chambers in the previous 26-year history of the company.	

Figure 1. Large CO Euthanasia Chamber

Figure 2. Large and small CO euthanasia chambers and associated CO supply system

Figure 3. CO Concentration during Small Euthanasia Chamber Operation
City of Liberal Animal Shelter - Liberal, Kansas March 3, 2004

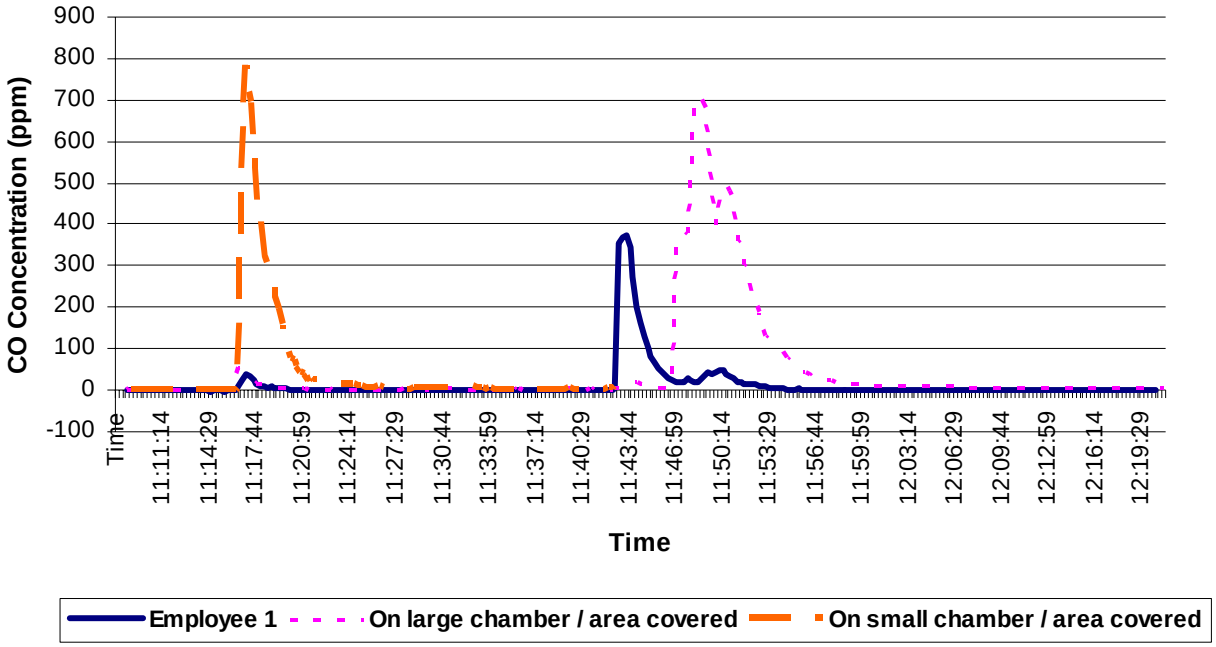


Figure 4. CO Concentration during Small Euthanasia Chamber Operation
City of Liberal Animal Shelter - Liberal, Kansas March 3, 2004

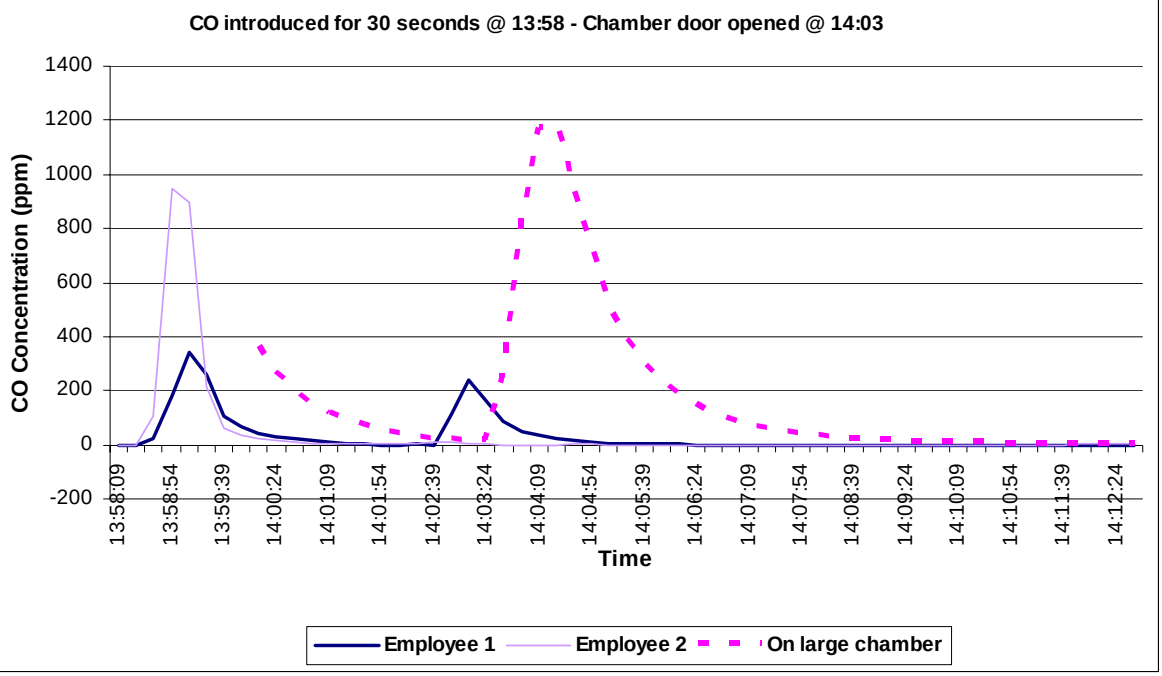
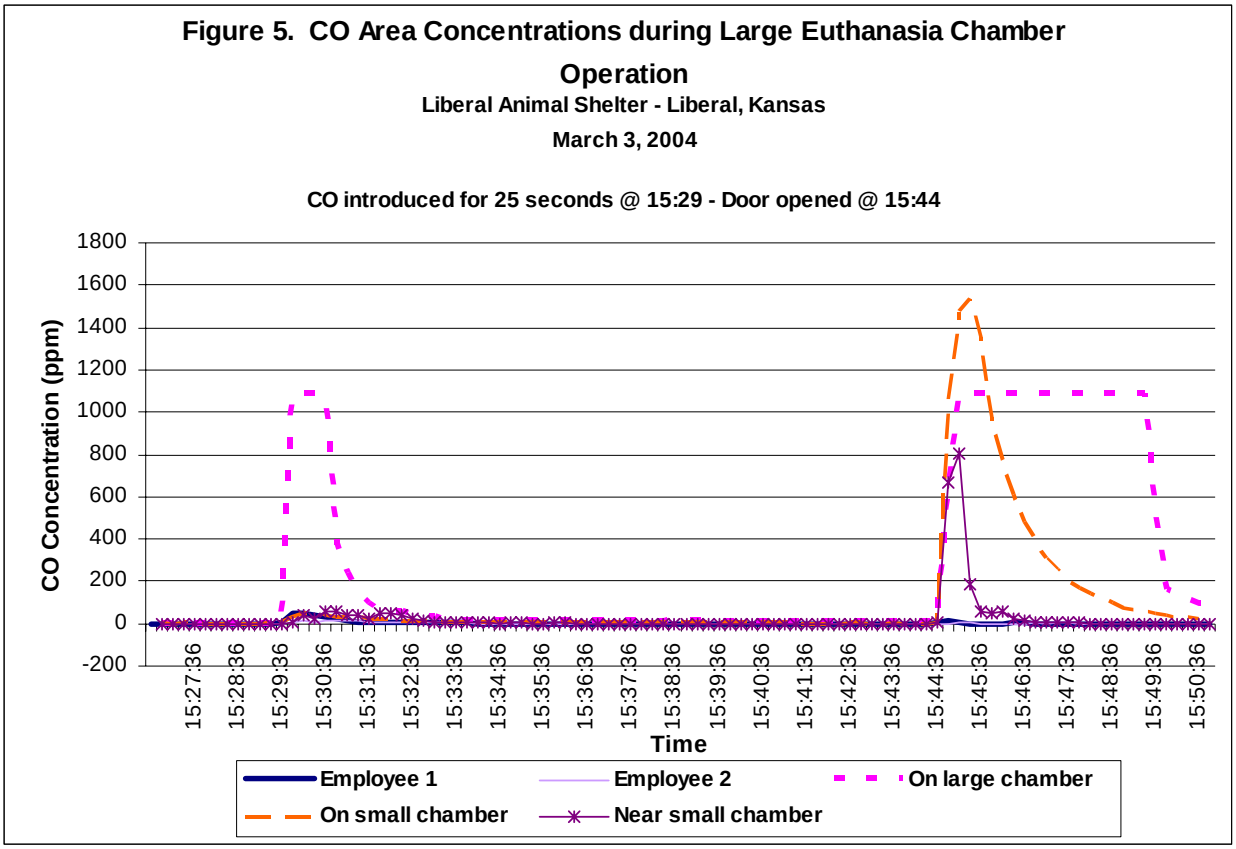


Figure 5. CO Area Concentrations during Large Euthanasia Chamber Operation

Liberal Animal Shelter - Liberal, Kansas

March 3, 2004



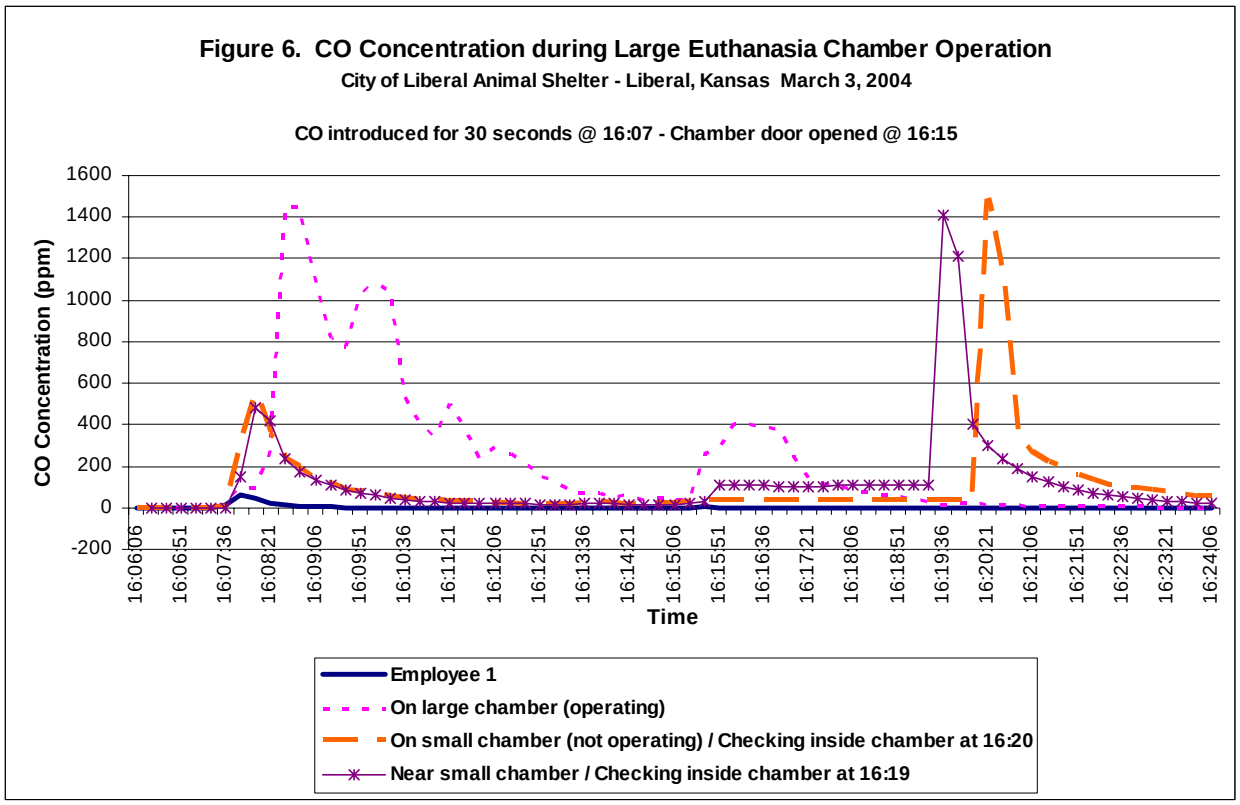


Figure 6. CO Concentration during Large Euthanasia Chamber Operation
City of Liberal Animal Shelter - Liberal, Kansas March 3, 2004
CO introduced for 30 seconds @ 16:07 - Chamber door opened @ 16:15
CO Concentration (ppm)
1600
1400
1200
1000
800
600
400
200
0
-200
16:06:06
16:06:51
16:07:36
16:08:21
16:09:06
16:09:51
16:10:36
16:11:21
16:12:06
16:12:51
16:13:36
16:14:21
16:15:06
16:15:51
16:16:36
16:17:21
16:18:06
16:18:51
16:19:36
16:20:21
16:21:06
16:21:51
16:22:36
16:23:21
16:24:06
Time
Employee 1
On large chamber (operating)
On small chamber (not operating) / Checking inside chamber at 16:20
Near small chamber / Checking inside chamber at 16:19

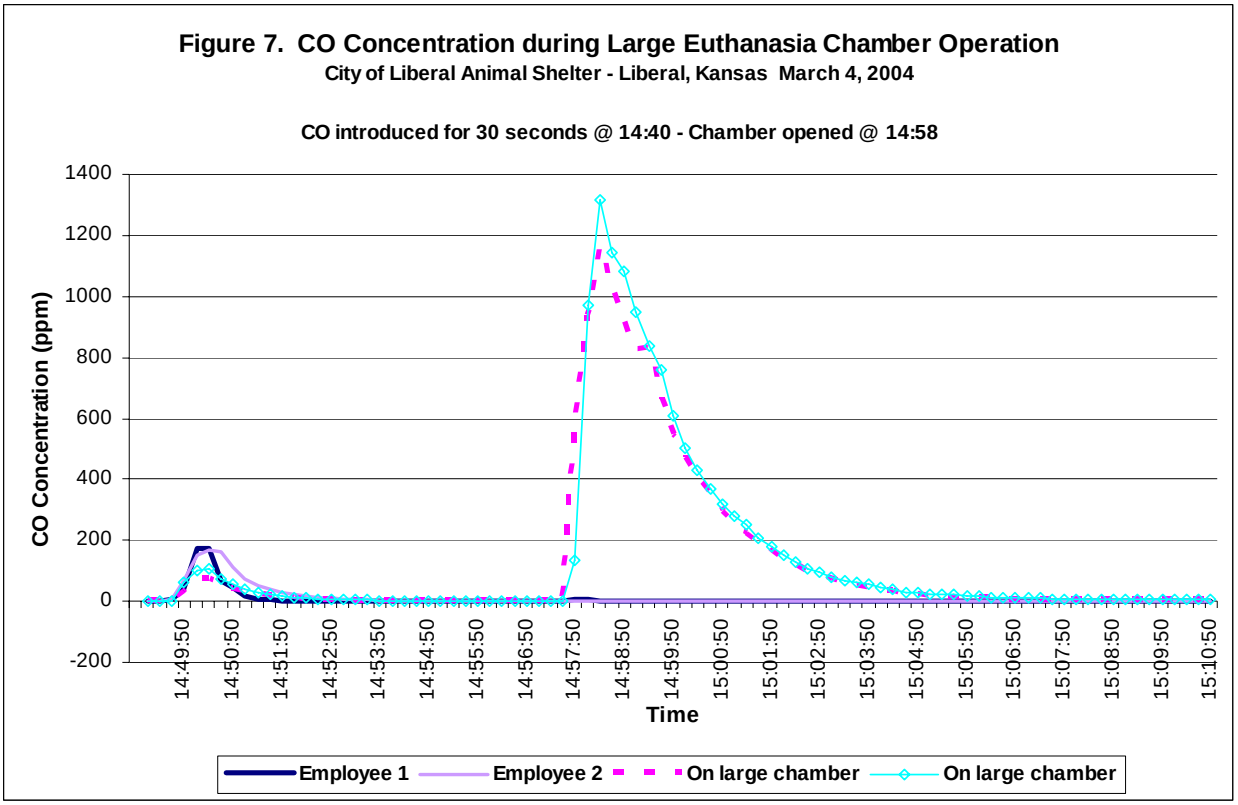


Figure 7. CO Concentration during Large Euthanasia Chamber Operation
City of Liberal Animal Shelter - Liberal, Kansas March 4, 2004
CO introduced for 30 seconds @ 14:40 - Chamber opened @ 14:58
CO Concentration (ppm)
1400
1200
1000
800
600
400
200
0
-200
14:49:50
14:50:50
14:51:50
14:52:50
14:53:50
14:54:50
14:55:50
14:56:50
14:57:50
14:58:50
14:59:50
15:00:50
15:01:50
15:02:50
15:03:50
15:04:50
15:05:50
15:06:50
15:07:50
15:08:50
15:09:50
15:10:50
Time
Employee 1
Employee 2
On large chamber
On large chamber

ATTACHMENT 1

Commercially Produced CO Euthanasia Chamber

AAI MANUFACTURING, LLC.

PO BOX 738
KAYSVILLE, UTAH 84037-0738
PHONE: (801) 390-0700
FAX: (801) 328-8068

PRICE LIST

EFFECTIVE ON ALL PURCHASE ORDERS RECEIVED AFTER JANUARY 1, 2004

MODEL A630

48 ½" WIDE 63 CUBIC FEET
67" HIGH
48" DEEP

SHIPPING WEIGHT: 1100 LBS (APPROX)

PRICE: $14,995.00*

MODEL A300

THIS UNIT IS THE SAME PRICE TO BUILD BUT THE UNIT UNLIKE THE A630 FITS THRU A STANDARD 3FT DOOR FRAME

34 ½" WIDE 30 CUBIC FEET
58" HIGH
48" DEEP

SHIPPING WEIGHT: 900 LBS (APPROX)

PRICE: $14,995.00*

ADDITIONAL CAGE AND CARTS ARE AVAILABLE:

CAGE FOR EITHER SIZE IS $1300.00
CART FOR EITHER SIZE IS $950.00
OR BOTH $2100.00

DELIVERY: APPROX. NINETY DAYS (90) ARO
TERMS: A 50% NON-REFUNDABLE DEPOSIT DUE UPON RECIEPT OF WRITTEN PURCHASE ORDER WHICH IS REQUIRED ON ALL UNITS, REMAINDER DUE UPON DELIVERY OF UNIT.
FREIGHT: VARIES AND DEPENDS ON LOCATION AND IS ADDITIONAL
INSTALLATION: CUSTOMER IS RESPONSIBLE FOR INSTALLATION. INSTALLATION IS AVAILABLE FOR A FEE IF PRE ARRANGED

* PRICE INCLUDES A POWDER COATED EXPANDED METAL CAGE AND CART FOR INDIVIDUAL MODEL. **WE DO NOT** FURNISH CO OR THE CYLINDERS.

ATTACHMENT 2

Confined Space Entry Requirements

Euthanasia chambers such as those described in this report, meet NIOSH and OSHA criteria for a permit-required confined space; therefore, permit-required confined space requirements should be followed before any workers enter this area. OSHA regulation 29 CFR 1910.146 defines a ***confined space*** as a space that meets three criteria: (1) a space that is large enough and configured so that an employee can bodily enter and perform any assigned work; (2) a space that has limited or restricted means for entry or exit (for example, tanks, vessels, storage bins, vaults, and pits that have limited means of entry); and (3) a space that is not designed for continuous employee occupancy. The standard then defines a ***permit–required confined space*** as a space that meets one or more of the following criteria: (1) a space that contains or has a potential to contain a hazardous atmosphere; (2) a space that contains a material that has the potential for engulfing (surrounding and capturing of a person by a liquid or finely divided solid substance that can be aspirated and cause death or that can exert enough pressure to cause death by strangulation, constriction, or crushing) the person entering the space; (3) a space with an internal configuration designed in a way that the person entering the space could be trapped or asphyxiated by inwardly converging walls or by a floor which slopes downward and tapers to a smaller cross section; or (4) a space that contains any other recognized serious safety or health hazard.[1]

NIOSH defines a confined space as "an area which by design has limited openings for entry and exit, unfavorable natural ventilation which could contain (or produce) dangerous air contaminates, and which is not intended for continuous employee occupancy.[2] The NIOSH criteria for working in confined spaces further classifies confined spaces based upon the atmospheric characteristics such as oxygen level, flammability, and toxicity.

As shown in Table 1, if any of the hazards present a situation which is immediately dangerous to life or health (IDLH), the confined space is designated Class A. A Class B confined space has the potential for causing injury and/or illness, but is not an IDLH atmosphere. A Class C confined space is one in which the hazard potential would not require any special modification of the work procedure. Table 2 lists the confined space program elements which are recommended (or must be considered by a qualified person, as defined by the criteria) before entering and during work within confined spaces based on the established hazard classification.

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[1] Code of Federal Regulations [1997]. 29 CFR 1910.146. Washington, DC: U.S. Government Printing Office, Federal Register.

[2] NIOSH [1979]. Criteria for a recommended standard: Working in Confined Spaces. Cincinnati, OH: U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, DHEW (NIOSH) Publication No. 80–106.

Table 1

CONFINED SPACE CLASSIFICATION TABLE

Parameters	Class A	Class B	Class C
Characteristics	Immediately dangerous to life – rescue procedures require the entry of more than one individual fully equipped with life support equipment – maintenance of communication requires an additional standby person stationed within the confined space	Dangerous, but not immediately life threatening – rescue procedures require the entry of no more than one individual fully equipped with life support equipment – indirect visual or auditory communication with workers	Potential hazard – requires no modification of work procedures – standard rescue procedures – direct communication with workers, from outside the confined space
Oxygen	16% or less *(122 mm Hg) or greater than 25% *(190 mm HG)	16.1% to 19.4% *(122 – 147 mm Hg) or 21.5% to 25% (163 – 190 mm Hg)	19.5 % – 21.4% *(148 – 163 mm Hg)
Flammability Characteristics	20% or greater of LFL	10% – 19% LFL	10% LFL or less
Toxicity	**IDLH	greater than contamination level, referenced in 29 CFR Part 1910 Sub Part Z – less than **IDLH	less than contamination level referenced in 29 CFR Part 1910 Sub Part Z

* Based upon a total atmospheric pressure of 760 mm Hg (sea level)
** Immediately Dangerous to Life or Health – as referenced in NIOSH Registry of Toxic and Chemical Substances, Manufacturing Chemists data sheets, industrial hygiene guides or other recognized authorities.

NIOSH [1979]. Criteria for a recommended standard: working in confined spaces. Cincinnati, OH: U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, DHEW (NIOSH) Publication No. 80–106.

Table 2

CHECK LIST OF CONSIDERATIONS FOR ENTRY, WORKING IN AND EXITING CONFINED SPACES

	ITEM	CLASS A	CLASS B	CLASS C
1.	Permit	X	X	X
2.	Atmospheric Testing	X	X	X
3.	Monitoring	X	0	0
4.	Medical Surveillance	X	X	0
5.	Training of Personnel	X	X	X
6.	Labeling and Posting	X	X	X
7.	Preparation			
	Isolate/lockout/tag	X	X	0
	Purge and ventilate	X	X	0
	Cleaning Processes	0	0	0
	Requirements for special equipment/tools	X	X	0
8.	Procedures			
	Initial plan	X	X	X
	Standby	X	X	0
	Communications/observation	X	X	X
	Rescue	X	X	X
	Work	X	X	X
9.	Safety Equipment and Clothing			
	Head protection	0	0	0
	Hearing protection	0	0	0
	Hand protection	0	0	0
	Foot protection	0	0	0
	Body protection	0	0	0
	Respiratory protection	0	0	
	Safety belts	X	X	X
	Life lines, harness	X	0	
10.	Rescue Equipment	X	X	X
11.	Recordkeeping/Exposure	X	X	

X = indicates requirement
0 = indicates determination by the qualified person

NIOSH [1979]. Criteria for a recommended standard: working in confined spaces. Cincinnati, OH: U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, DHEW (NIOSH) Publication No. 80–106.

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National Institute for Occupational Safety and Health
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