Pacific Northwest
National Laboratory
Operated by Battelle for the
U.S. Department of Energy

PNNL-13999 Rev. 1

Testing for Ammonia Odor from Urinals

L.L. Larson

November 2002

Prepared for the U.S. Department of Energy
under Contract DE-AC06-76RL01830

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Acknowledgements

The author wishes to thank Katrina Kam, Oregon State Parks and Recreation, for her assistance in providing requested information about the locations for testing and her guidance in establishing the testing protocol. The author also wishes to thank Betty Merrill, School Program Specialist, Oregon Office of Energy and Rebuild America representative, for her confidence in and recommendation of Pacific Northwest National Laboratory for performing the testing. To both Katrina and Betty, your patience while this document was being written is sincerely appreciated.

Testing for Ammonia Odor from Urinals

Summary

The results from testing at selected Oregon state parks are that there is barely detectible or no detectible ammonia in the non-water using urinals. Detectible levels were well below the average person's threshold for detecting ammonia.

Some cleaning chemicals contain ingredients that are ammonia or ammonia like chemicals. The ammonia levels were detectible, but in only one case might the odor be detected by human smell, and that would be only by smelling the open container or smelling the cleaning chemical's ammonia odor immediately after cleaning.

Floor drains were another source of detectible ammonia or ammonia-like odors. Possible reasons for the odor from floor drains are; the traps do not contain sufficient water thereby enabling sewer gasses to escape into the restroom, cleaning chemicals have accumulated in the trap, extraneous ammonia containing material was tracked into the restroom and rinsed into the drain. An example of tracking ammonia-containing material into the restroom would be fertilizer from a recently fertilized grass area.

For comparative purposes, where available, common water flushed urinals were tested in a manner similar to the non-water urinal testing. Also, toilets in men's and several women's restrooms were tested for ammonia near the upper front of the bowel and at the floor in front of the bowel. No discernable differences in ammonia concentrations were detected between non-water urinals, water urinals and toilets.

Purpose

The Oregon Parks and Recreation Department (OPRD) has undertaken this sustainability initiative in an effort to reduce water consumption at State Parks and to alleviate the often heavy effluent loading on wastewater treatment systems such as drain fields. The elimination and replacement of each water type urinal is estimated to reduce water consumption by 50, 000 gallons per year per urinal and when this number is multiplied by the total number of urinals in the OPRD system, the water conservation effect is exceedingly high even measured on an annual basis.

Calculating the water consumption reduction over the life of a restroom facility more dramatically demonstrates how effectively these devices conserve water. As an example, 1000 installed non water urinals (replacing water type urinals) can save well over one billion gallons of water over a 30 year period. Ultimately, OPRD hopes to demonstrate to the Oregon State Plumbing Board the effectiveness of these devices so as to eventually allow similar uses statewide at any private, commercial or public facility using urinals. The eventual benefits to the Public, as has been demonstrated at several other states across the Country will be reduced water consumption, reduced potential of effluent pollution to water resources and reduced impact to wastewater treatment systems, most notably, the City of Portland wastewater systems and the Willamette River.

This paper reports the results of testing for ammonia odor at non-water urinals installed in selected Oregon State Park restrooms. ‘Non-water urinals’ refers to urinals that are similar to common porcelain water-flushed urinals, except that they do not require flush water.

Background

Working in cooperation with the Oregon Department of Energy and under the auspices of the Department of Energy’s Rebuild America program, the Oregon State Parks requested the independent assistance of Pacific Northwest National Laboratory in assessing ammonia odor from non-water urinals. The first activity in the assessment was to determine an appropriate testing method for ammonia from urinals. Methods for detecting ammonia in restrooms were investigated and an approach was provided to Oregon State Parks and Recreation. See Attachment 1, *Detecting Ammonia from Urinals*.

Oregon State Park System

The mission of the Oregon State Parks and Recreation Department is: “To provide and protect outstanding natural, scenic, cultural, historic and recreational sites for the enjoyment and education of present and future generations.”

As of September 25, 2001, the Oregon State Park System includes 230 properties, of which 179 have developed visitor facilities. There are an additional 57 Willamette River Greenway parcels with developed visitor facilities. The Oregon State Park System has 50 state park campgrounds, totaling 5,650 campsites and 171 day-use parks in the system, totaling 4,500 picnic sites, 63 picnic shelters and 28 group picnic areas.

The Oregon State Parks and Recreation Department is assessing implementing "non-water" urinals in state park restrooms. A concern expressed of non-water urinals is odor in the form of ammonia, specifically whether non-water urinals are conducive of ammonia odor because of their lack of flush water.

Detecting Ammonia Odor from Urinals

Detecting ammonia can be accomplished with the human sense of smell, portable instruments and laboratory analysis. The report, *Detecting Ammonia from Urinals,* found in Attachment 1, investigated the myriad of detection methods and recommended the use of the sampler pump and tube. Sampler pumps and tubes are a common ammonia detection tool. Other names include pull-tube or gas detector tube.

Sampling Plan

The sampling plan included visiting selected Oregon State Parks and taking restroom air samples in proximity of the urinals at predetermined locations. Staff from the Oregon State Parks system identified a representative selection of parks having one or more installed non-water urinals. The restroom air sampling was accomplished using the sampler pump and tube method. In addition to the predetermined locations, additional samples were taken as local conditions warranted or indicated.

Oregon State Park Selection

Oregon has several state parks with non-water urinals installed for assessment and testing purposes. From the available complement, Oregon State Parks staff identified six state parks with non-water urinals for ammonia odor testing.

Each park was assigned an alpha identifier, A through F, as a location abbreviation for purposes of the assessment. Each tested park restroom has one of two installed non-water urinals brands, Falcon Water Free® or Waterless®. Table 1 lists the park identifier, name and location, along with the brand and category of construction, either a porcelain vitreous china or non-porcelain, of the non-water urinal. The specific non-porcelain material of construction was not determined as part of the testing, but could include acrylic, resin or fiberglass.

All parks have two non-water urinals installed except for Heritage Landing, which has one. HB Van Duzer has north and south restroom locations; only the north restroom location has non-water urinals installed.

ID	Name and Location	Brand	Material
A	Heritage Landing, Wasco	Waterless	Non-vitreous china
B	Lewis & Clark, Multnomah Falls	Falcon Water Free	Non-vitreous china
C	HB Van Duzer, Tillamook	Waterless	Non-vitreous china
D	Driftwood Beach, Lincoln City	Waterless	Non-vitreous china
E	Cline Falls, Deschutes	Falcon Water Free	Vitreous china
F	Farewell Bend, Baker	Falcon Water Free	Vitreous china

Table 1: Park Names, Locations and non-urinal brand and material

Method

Sampler pumps and tubes, a common ammonia detection tool, were used for ammonia detection. Figure 1 shows a Dräger pump with tubes. The sampler pump and tube method of ammonia detection requires entering the restroom facility and manually drawing the samples according to the pump manufacturer's instructions. The reactant in the sampler tube usually consists of carbon/silica gel beads impregnated with sulfuric acid. The color of the reactant beads within the tube changes in the presence of ammonia and is read from a scale. Figure 2 shows a sampler tube with an indicated ammonia concentration of 5ppm. The sampler tubes are read directly when used with the Dräger bellows pump, which provides a known volume of sampled air.

Figure 1. Dräger bellows sampler pump with tubes.

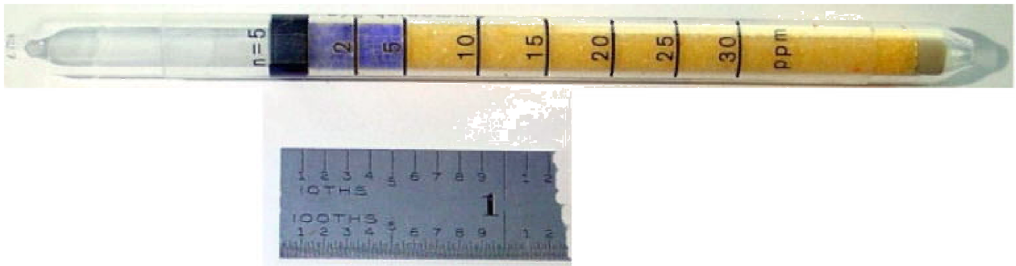

Figure 2. Sampler tube indicating about 5ppm ammonia detected.

Sampling Locations

Anthropomorphic data were used to determine the height for sampling points. The sample points, floor to nostril heights, are for the smallest 2.5% of the 95% distribution of the male population (ERDA-76-45-2.) Table 1 shows the anthropomorphic characteristics for the male population used for this testing. The sampling depth used was the distance from the wall to the exterior lip of the urinal. The lateral position was along the centerline of the urinal.

Four separate sample situations were assumed, a standing male adult, a standing four-year old male child, a seated male adult and a seated four-year old male child. The seated sampling locations assume the same adult and child in a wheelchair.

	Adult Male	Child Male, Age 4
Weight	57.9 kg (127.7 lb.)	17 kg (38 lb.)
Height standing	164 cm (64.4 in.)	104 cm (40.9 in.)
Floor to nostril opening standing	148.8 cm (58.6 in.)	91.4 cm (36.0 in.)
Floor to nostril opening sitting	119.9 cm (47.2 in.)[1]	66.3 cm (26.1 in.)[2]

[1] Assumes a 17 inch seat height. [2] Assumes a 9.5 inch seat height

Table 2: Anthropomorphic data for the smallest 2.5% of 95% of the male population

Where more than one urinal was installed at a location, samples were taken at each urinal. Also, ammonia odor samples were taken approximately three inches immediately above the horizontal urinal lip and approximately three inches above the lowest point within each urinal.

Additional sampling locations for detecting the presence of ammonia odor from sources other than the urinals were identified during the testing process at each restroom. These include the floor immediately below the urinal, floor drains, and toilets. Wherever available, cleaning supplies used for restroom servicing were qualitatively tested for the presence of ammonia or ammonia-like chemicals.

Test Equipment

The test equipment complement used in this sampling investigation is listed in Table 2. The sampler pump and tubes were selected for their portability, repeatability and reliability.

In addition to the sampler tubes capable of measuring ammonia odor in the 2-30ppm range, similar sampler tubes capable of measuring ammonia odor in the 5-100ppm range were included in the equipment complement in the event high concentrations of ammonia or ammonia-like compounds were detected in tested cleaning chemicals.

Test Equipment Type	Description
Sampler Pump	Dräger Gas Detection Pump Model: Accuro ARSC-F015 Serial Number: 640000
Sampler Tubes	Dräger Röhrchen Certification: ISO 9001 Range/Batch: 2-30ppm / RM-0811
Thermometer	S-W 76mm laboratory thermometer -20 to 110^{0}C, 1^{0}C increments
Linear Measurements	Contractors retractable tape measure, 25’

Table 3: Test equipment list with descriptions

Tested Oregon State Parks

All but one of the six restrooms are of masonry, brick or block, construction. The exception is Driftwood Beach, a wood frame with lap siding structure. All restrooms have exposed concrete or ceramic tile floors.

Restroom ventilation systems can minimize or exacerbate the buildup of odors. Five of the six restrooms use a passive convection design for ventilation. The passive design has several grills located in the walls near floor level and additional grills located near the ceiling that allow for the intake of outdoor air and exhaust of restroom air. The Driftwood Beach restroom uses passive cross ventilation from open opposing windows.

Park restrooms are cleaned daily, usually in the morning, by Park Rangers or volunteers. Prior to testing, Park Rangers responsible for the park restrooms reported that ammonia was not listed as an ingredient in any of the cleaning chemicals and that they are unaware of any other chemicals that might be used in the restrooms for purposes other than cleaning.

Results

The results from testing at selected Oregon state parks are that there is barely detectible or no detectible ammonia in the non-water using urinals. Detectible levels were well below the average person's threshold for detecting ammonia.

Some cleaning chemicals contain ingredients that are ammonia or ammonia like chemicals. The ammonia levels were detectible, but in only one case might the odor be detected by human smell, and that would be only by smelling the open container or smelling the odor immediately after cleaning.

Floor drains were another source of detectible ammonia or ammonia-like odors. Possible reasons for the odor from floor drains are: the traps do not contain sufficient water, thereby enabling sewer gasses to escape into the restroom; cleaning chemicals have accumulated in the trap; and extraneous ammonia-containing material was tracked into the restroom and rinsed into the drain. An example of tracking ammonia-containing material into the restroom would be fertilizer from a recently fertilized grass area.

Test results in parts per million ammonia are listed in Table 4. No detectible ammonia is shown as a value of "0" parts per million. A value of "1" indicates detected ammonia, but at levels less than the lowest scale reading of 2ppm. Two values listed are where different results were obtained for the higher and lower non-water urinals respectively.

		Test Results – parts per million Ammonia						
ID	**Name**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
A	Heritage Landing	0	1	1	1	2	1	1
B	Lewis & Clark	0	0	0	0	0	0	0
C	HB Van Duzer	0	0	0	0	1/0	1/0	1
D	Driftwood Beach	0	0	0	0	0	0	0
E	Cline Falls	0	0	0	0	0	0	1
F	Farewell Bend	0	0	0	0	1/0	0	2/5

Table 4: Test results

Test #	Test Location[1]
1	Adult standing
2	Child standing
3	Adult seated
4	Child seated
5	Above urinal lip
6	Within urinal
7	Floor

[1] See Table 2 for test location dimensions

Supplemental Tests

Also, for each of the restrooms in the test complement, toilets in men's and in several women's restrooms additional tests were performed for ammonia near the upper front of the bowel and at the floor in front of the bowel.

For comparative purposes, where available, common water flushed urinals were tested in a manner similar to the non-water urinal testing. The only Oregon State Park in the selected test complement with water flushed urinals is the HB Van Duzer south restroom. The HB Van Duzer south restroom was tested using the same methods as used for testing non-water urinals. Arbitrarily selected, and only out of convenience, one additional Oregon State Park and two highway rest stops located in Oregon were similarly tested.

No discernable differences in ammonia concentrations were detected between non-water urinals, water urinals and toilets.

State Park Findings

Location A: Heritage Landing
The Heritage Landing restroom was cleaned about two hours prior to testing. Externally and internally the facility was clean and there was no evidence of inappropriate waste or malicious degradation of the facility that would influence the testing.

The passive ventilation was unobstructed and appeared functioning per design.

There is one non-water urinal installed at Heritage Landing. The urinal installation appeared consistent with the manufacturer's recommendations and there was no evidence of external damage or abuse. Human traffic indicated the urinal was used on several occasions subsequent to cleaning.

Cleaning chemicals were tested and no ammonia or ammonia compounds were detected.

There was no detectible ammonia odor in the restroom at the standing adult male test height. Slightly less than 2ppm was detected at the seated height and urinal lip. The floor immediately below the urinal, floor drains, men's and women's toilets were approximately 1ppm.

Location B: Lewis and Clark
The Lewis and Clark restroom was cleaned about six hours prior to testing. Externally and internally the facility was clean and there was no evidence of inappropriate waste or malicious degradation of the facility that would influence the testing. The floor was slightly wet in places from water tracked in by foot traffic. The floor under the urinals was wet, consisting most likely of tracked-in water and some urine.

The passive ventilation was unobstructed and appeared functioning per design.

There are two non-water urinals installed at Lewis and Clark. Both urinals' installation appeared consistent with the manufacturer's recommendations and there was no evidence of external damage or abuse. Human traffic indicated the urinals were used on several occasions subsequent to cleaning.

Cleaning chemicals were not tested at this location.

There was no detectible ammonia odor at any of the restroom test points. Test points included: male adult and male child, both standing and seated; within the urinal; the floor under each urinal; the floor drain; and men's and women's toilets.

Location C: HB Van Duzer

The HB Van Duzer restroom was cleaned about six hours prior to testing. Externally and internally the facility was clean and there was no evidence of inappropriate waste or malicious degradation of the facility that would influence the testing. There was a faint odor within the restroom, but it was not distinguishable or offensive. The floor was dry and contained some patron-discarded trash.

The passive ventilation appeared unobstructed and was assumed functioning. The assumption was made because neither daylight nor air was detected coming through the grills, nor was there any evidence of modification to the original design.

There are two non-water urinals installed at HB Van Duzer. The urinals' installations appeared consistent with the manufacturer's recommendations and there was no evidence of external damage or abuse. Human traffic indicated the urinals were used on several occasions subsequent to cleaning.

Two cleaning chemicals used at this location were tested: a spray cleaner in diluted form and a general purpose cleaner that is usually diluted, but can be used in its concentrated form. No ammonia was detected from the spray bottle. The general purpose cleaner did show the presence of ammonia or ammonia-like chemicals. The testing was qualitative by shaking the container, removing the cap then squeezing the container sufficiently to expel some of the gaseous contents, then testing the air about three inches above the container's opening. The qualitative test method provided a vapor that contained about 4ppm.

There was no detectible ammonia odor in the restroom at the standing adult male test height. Trace indications, less than 1ppm, were detected at the seated height, urinal lip, and within the urinal. No ammonia odor was detected near the floor under the urinals and at both men's and women's toilets.

Location D: Driftwood Beach

The Driftwood Beach restroom was cleaned about twenty-one hours prior to testing, according to the Park Ranger, although it had the appearance of being cleaned more recently. Externally and internally the facility was clean and there was no evidence of inappropriate waste or malicious degradation of the facility that would influence the testing. The floor was dry and contained some patron-discarded trash.

The passive ventilation, cross ventilation through open windows, was unobstructed.

There are two non-water urinals installed at Driftwood Beach. The urinals' installation appeared consistent with the manufacturer's recommendations and there was no evidence of external damage or abuse. Human traffic indicated the urinals were used on several occasions subsequent to cleaning.

Two cleaning chemicals used at this location were tested: a spray cleaner in diluted form and a general purpose cleaner that is usually diluted, but can be used in its concentrated form. In opposition to location C, HB Van Duzer, the cleaner in the spray bottle at Driftwood Beach showed the presence of ammonia and the general purpose cleaner showed no detectible ammonia. The testing of both cleaners was qualitative, accomplished by shaking the container, removing the cap, then squeezing the container sufficiently to expel some of the vapor contents, then testing the air about three inches above the container's opening. Qualitative testing of the spray cleaner resulted in about 25ppm ammonia. Similar ammonia concentrations were detectible immediately after spraying the cleaner. Some evidence of ammonia could be smelled within the spray.

There was no detectible ammonia odor in the restroom at any test point. Test points included: male adult and male child, both standing and seated; within the urinal; the floor under each urinal; and men's and women's toilets.

Location E: Cline Falls

The Cline Falls restroom was cleaned about twenty-four hours prior to testing, according to the Park Ranger. Externally and internally the facility was clean and there was no evidence of inappropriate waste or malicious degradation of the facility that would influence the testing. The floor was dry everywhere.

The top openings of the passive ventilation system were covered on the outside with pieces of plywood; the bottom openings were unobstructed. No other ventilation was identified.

There are two non-water urinals installed at Cline Falls. The urinals' installation appeared consistent with the manufacturer's recommendations and there was no evidence of external damage or abuse. Human traffic indicated the urinals were used on several occasions subsequent to cleaning.

Cleaning chemicals were tested and no ammonia or ammonia compounds were detected.

There was no detectible ammonia odor in the restroom at any test point except at the floor drain. Test points included: male adult and male child, both standing and seated; within the urinal; and the floor drain. The floor drain contained approximately 1ppm when tested about two inches over the floor drain grate.

Location F: Farewell Bend

The Farewell Bend restroom was cleaned about five hours prior to testing, according to the Park Ranger. Externally and internally the facility was clean and there was no evidence of inappropriate waste or malicious degradation of the facility that would influence the testing. The floor was dry throughout.

There are two non-water urinals installed at Farewell Bend. The urinals' installation appeared consistent with the manufacturer's recommendations and there was no evidence of external damage or abuse. Human traffic indicated the urinals were used on several occasions subsequent to cleaning.

Two cleaning chemicals used at this location were tested, a spray cleaner in diluted form and a general purpose cleaner that is usually diluted, but can be used in its concentrated form. The cleaner in the spray bottle showed the presence of ammonia or an ammonia-like chemical, and the general purpose cleaner showed no detectible ammonia. The testing of both cleaners was qualitative, accomplished by shaking the container, removing the cap, then squeezing the container sufficiently to expel some of the vapor contents, then testing the air about three inches above the container's opening. Qualitative testing of the spray cleaner resulted in about 1ppm ammonia.

There was no detectible ammonia odor in the restroom at the standing and seated male test heights. Approximately 1ppm was detected near the urinal lip and within the urinal of the higher installed urinal. No ammonia odor was detected at similar locations of the adjacent lower installed urinal. No ammonia odor was detected near the floor under the urinals and at both men's and women's toilets. There is a floor drain under each of the two urinals. One floor drain tested at 2ppm and the other at 5ppm. Water was not evident within the drain trap, possibly indicating that the detected ammonia was the result of sewer gas. On the assumption that both restrooms shared the same sewer system, the drain in the women's restroom was tested. No ammonia was detected at the floor drain in the women's restroom and water was evident within the trap.

Attachments

Attachment 1, *Detecting Ammonia from Urinals*
Attachment 2, *Sampling Form*

Figures

Tables

References

ERDA-76-45-2, *Human Factors in Design* Energy Research and Development Administration, February 1976

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ATTACHMENT 1

Detecting Ammonia from Urinals

Introduction

Ammonia's pungent odor, when smelled in restroom facilities, is commonly associated with poor hygiene and less than healthy conditions. Ammonia in restrooms can come from many sources, commonly from the breakdown of urea in urine. Urinals, by their design as a urine collection system, are particularly suspect as malodorous ammonia generators. Toilets and surfaces that are exposed to residual urine are also suspect.

Testing only urinals for ammonia without contaminating the tests from restroom ammonia generated at other locations can be a challenge. Testing different styles, brands, water and waterless urinals for ammonia requires the appropriate equipment, a skilled equipment operator and a test plan.

The sampler pump system is recommended for testing for ammonia as a malodorous substance from urinals. Operator training is required to ensure the proper use and operation of sampler pumps and tubes. OSHA CAS Number: 7664-41-7 can be used as the testing plan, or the OSHA procedure can be modified to serve as a custom targeted protocol.

Purpose

This paper describes and recommends methods for detecting ammonia produced from residual urine in restrooms.

Ammonia

Ammonia is a colorless, malodorous substance with a characteristic odor commonly referred to as sharp or pungent. Its molecular formula is NH_3, its formula weight is 17.03 and its density with respect to air is 0.5967. Ammonia exists naturally in the air at between one and five parts per billion.

Ammonia in Restrooms

Higher than naturally occurring ammonia levels can be detected in restrooms. Urine produces the odor of ammonia, if left standing, because of the breakdown of urea. When smelled in restroom facilities, ammonia's pungent odor is commonly associated with poor hygiene and less than healthy conditions. Several ingested foods, drugs and bacterial infections produce other specific odors in urine that can contribute to a malodorous restroom.

Individual Sensitivity

The odor detection threshold for ammonia varies greatly among individuals. Because of variations in individuals' odor reaction and sensitivity, describing odors and establishing detection thresholds is unavoidably subjective. Generally, individual detection of ammonia is in the range of 1 to 20 parts per million (ppm.)

The OSHA short-term permissible exposure limit in any working environment is 35 ppm and a total weighted average of 50 ppm, which is well above the detection threshold for most all individuals.

Buildup

Ammonia buildup can exacerbate the problem of dealing with ammonia odor. Buildup more often occurs in cold conditions when buildings are closed. It is especially prevalent when ventilation is lacking or obstructed. Prior to any testing for ammonia, the facility should be checked for an installed ventilation system appropriate for the restroom facility, and the ventilation system tested for proper operation.

Methods of Detection

Detection of ammonia can be accomplished with the human sense of smell, portable instruments and laboratory analysis. Each has its advantages and drawbacks. The following describes the more common and readily available testing methods for ammonia that can be applicable to restroom facilities.

Subjective

The subjective determination of ammonia in restroom facilities is based on the human nose and its sensitivity to odors. Determinations can be performed based on an internally developed methodology or a standard methodology.

A recognized subjective odor evaluation test is from the American National Standards Institute (ANSI). ANSI Z124.9 *American National Standard for Plastic Urinal Fixtures*, section 7. The ANSI protocol provides a third-party testing methodology for odor evaluation.

Using the human sense of smell is convenient and inexpensive, but its inherent subjectivity makes it inaccurate, inconsistent and lacking repeatability. Other odors, pleasant or offensive, can mislead a human tester. The human sense of smell is generally too subjective, especially for ammonia detection in urinals, except when used in controlled testing situations.

Portable Instruments

Portable and handheld instruments provide a spot check of conditions at one specific location at one point or interval in time. Operators require training in the proper application and use of portable instruments, and an operator's skill in using the instrument and interpreting readings can decrease accuracy from manufacturer's ratings.

Passive dosimeter tubes

Passive dosimeter tubes are a single use, relatively inexpensive ammonia detection tool. Cost for a single use passive dosimeter is less than $50 each and prices are reduced for quantity purchases. These glass tubes contain chemicals that react with ammonia. The reactant is usually carbon beads and silica gel impregnated with sulfuric acid and colorimetric indicator chemicals.

This method of testing requires the operator to enter the restroom facility, identify a suitable location for the passive dosimeter tube, secure the tube and log the exposure start time. To begin the test, the ends of the tube are broken off, exposing the reactive chemicals to the air and airborne ammonia. Passive dosimeter tubes rely on the diffusion of air to expose any airborne ammonia to the reactant. Because of the slow rate of diffusion, and especially when ammonia concentrations are low, the tubes are left in the tested environment for several hours. At the end of the test period the operator reads the scale on the tube and determines the ammonia concentration by dividing the reading by the exposure time.

This method of detection has the advantage of being a time-weighted average, rather than a single point in time. However, being a time-weighted average, any short-term peaks in ammonia or other reactive chemical can reduce overall accuracy. Passive dosimeters are potentially exposed to all air within the restroom because of natural diffusion, which is a disadvantage when selective testing for ammonia, such as only from urinals, is desired. Another disadvantage is that the dosimeter tube will be left unattended for several hours and during that time is subject to tampering, vandalism and theft.

The passive dosimeter tube method of ammonia detection can provide an accuracy of plus or minus 20% of actual. The presence of certain other gasses also can increase the error, providing misleading results, although it is unlikely these gasses will be present in restroom facilities.

Passive dosimeters require minimal operator training and are less susceptible to lack of operator skill exacerbating the error.

Sampler pumps and tubes

Sampler pumps and tubes are a common ammonia detection tool. Other names include pull-tube or gas detector tube. Sample pumps and tubes cost several hundred dollars, with costs varying significantly depending upon the capabilities and features of the device.

This method of ammonia detection requires an operator to enter the restroom facility and manually draw the sample. When ammonia concentrations are low, several draws of air are required to ensure an adequate sample. The reactant in the sampler tubes usually consists of carbon/silica gel beads impregnated with sulfuric acid. The color of the reactant beads within the tube changes in the presence of ammonia and is read from a color scale. The scale reading, divided by the air sampled, provides the concentration result.

An advantage of sampler pump testing is the testing can be designed to be very localized, which is especially advantageous for testing specific restroom areas and types of urine collection systems. Another advantage of the sampler pump over the passive dosimeter is that samples can be taken from locations that are inconvenient or inaccessible to a passive dosimeter tube. Also, since the operator is at all times in control of the sampler pump and tubes, tampering, vandalism and theft are unlikely. Additional equipment and training costs are disadvantages of sampler pumps, compared to passive dosimeter tubes.

This method of ammonia detection has an accuracy of plus or minus 25% of actual. The presence of certain other gasses also can increase the error, providing misleading results, although it is unlikely these gasses will be present in restroom facilities.

Operator training is required to ensure the proper use and operation of sampler pumps and tubes. Lack of operator skill can worsen the error and decrease repeatability.

Laboratory Analysis

Chemical analysis

Several chemical analytical procedures are available to test for ammonia; all are inconvenient for direct field testing. Most involve obtaining a sample by passing air through a glass frit bubbler containing sulfuric acid, then analyzing the sample by a colorimetric titration.

Direct detection

Electrochemical sensor or direct detection devices provide continuous monitoring and readout. They can include data logging, set-point alarms and other optional features. Electrochemical sensors require a power source, usually a power supply plugged into a wall outlet. Cost for electrochemical sensors is in the $1,000 to $5,000 range.

This method of testing requires the operator to enter the restroom facility, identify a suitable location for the equipment and perform an installation. If a suitable power source is not available, then the equipment must run on batteries, or power must be brought to the equipment. Once operational, the operator periodically downloads the data from the equipment's memory system or, optionally, the data are sent via radio or telephone to a location of the operator's choice.

Advantages of direct detection devices include ease of operation, continuous monitoring and data analysis. Many direct detection devices can store large amounts of data over extended periods of time. The data can be analyzed for trends, anomalies and related events, such as high ammonia levels during certain times of the day or certain days of the week. Most direct detection devices are used to test for diffused ammonia within the facility, but can be installed for more localized testing. Disadvantages, in addition to their higher cost, include leaving electrochemical sensor devices unattended in restroom facilities, making them susceptible to acts of malicious mischief, vandalism and theft. Electrochemical sensors designed for ammonia can be influenced by some other airborne chemicals.

Once operational, electrochemical sensor devices require no operator intervention and are independent of operator skill, although devices operated from battery power will require periodic battery power checks and replacement.

Gas analyzers

Infrared and chromatograph gas analyzers and similar laboratory instrumentation can provide the greatest accuracy in ammonia levels, limited only by the sampling technique. The cost for the equipment is very high, easily exceeding several thousand dollars. If the equipment and experienced operators already are available, then sampler tubes can be used with this equipment quite inexpensively.

Recommendations

The sampler pump system is recommended for testing for ammonia as a malodorous substance from urinals. A sampler pump is able to acquire samples directly from the immediate area of the urinal minimizing ammonia detection from walls and floors. OSHA CAS Number: 7664-41-7 can be used as the testing procedure, or the OSHA procedure can be modified to serve as a custom targeted protocol.

The test range of 1-10 ppm is recommended for restrooms. The range is below most individuals' detection threshold, but high enough to indicate sufficient ammonia that would be detectible by many individuals.

Passive dosimeter tubes are recommended as the simplest and most cost effective method for determining overall ammonia levels in restrooms. Passive dosimeters also are available in many test ranges. Like sampler pump and tube dosimeter testing, the OSHA CAS Number: 7664-41-7 can be used directly or modified.

Resources

Product suppliers and manufacturers are included for convenience, not as a recommendation.

ANSI

http://www.ansi.org Homepage for the American National Standards Institute
http://www.nssn.org/ Location to order a copy of ANSI Z124.9

OSHA

http://www.osha-slc.gov/dts/sltc/methods/inorganic/id188/id188.html OSHA in the workplace atmospheres solid sorbent test methods.
http://www.osha-slc.gov/dts/chemicalsampling/data/CH_218300.html OSHA chemical sampling information and exposure limits for ammonia.

Product Manufacturers

http://www.skcinc.com Homepage for SKC Incorporated, a supplier of sampling technologies.
http://www.westernsafety.com/detectube1.html Source for Gastec brand detector tubes
http://www.afcintl.com/ Manufacturer of portable instruments.
http://www.hoskin.ca Manufacturer of portable instruments and detector tubes.

ATTACHMENT 2

Ammonia Sampling

Location:

A	**Heritage Landing** – Deschutes	**B**	**Lewis & Clark** – SRS Multnomah
C	**HB Ban Duzer** (north restroom)	**D**	**Driftwood Beach** – SRA Lincoln Beach
E	**Cline Falls** – SSV Deschutes	**F**	**Farewell Bend** – SRA Baker

General

Date:	**Ambient temp**:
Time:	**Elevation/atm. press**.:

Building Restroom:

Indoor temp:
Number water urinals & type/style:
Number toilets & type/style:
Ventilation type:
Ventilation condition/status:
Last cleaned:
General condition/comments:

Dry Urinals Sampling

#	Brand Code	Model/ Style	Sample Location	Result ppm	*	Notes
1						
2						
3						
4						
5						
6						
7						

Brand codes
F=Falcon
W=Waterless
X=Other

* Batch codes
A=RM-0811
B=RM-0812
C=SC-0271

☐ Check if notes on back

Signature____

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