

Health Consultation

KIDDIE KAMPUS DAYCARE CENTER – GASOLINE VAPOR INTRUSION

VILLAGE OF JACKSON, WASHINGTON COUNTY, WISCONSIN

SEPTEMBER 22, 2008

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
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Division of Health Assessment and Consultation
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HEALTH CONSULTATION

KIDDIE KAMPUS DAYCARE CENTER – GASOLINE VAPOR INTRUSION

VILLAGE OF JACKSON, WASHINGTON COUNTY, WISCONSIN

Prepared By:

Wisconsin Department of Health Services
Madison, Wisconsin

Under cooperative agreement with
The Agency for Toxic Substances and Disease Registry

Summary and Statement of Issues

The Wisconsin Department of Health Services, Division of Public Health (DPH), was requested to evaluate the health implications of gasoline vapors inside of a daycare center that shared a building with a gasoline station. DPH found that long term exposure to the highest measured benzene level in the daycare center posed an unacceptable increased cancer risk and is a future *public health hazard*, but short term exposures were a *no apparent public health hazard* for cancer. Benzene posed a *no apparent public hazard* for non-cancer health effects for children and adults. Xylene in indoor air was a *no apparent public health hazard* for adults, but an *indeterminate public health hazard* for children. DPH recommended that the daycare center operations move to another location until actions are taken that will ensure that gasoline vapors will not reach the daycare center building. Even though data and information does not suggest that children were harmed by short term exposures to gasoline vapors, to address family concerns and as a precautionary measure it is reasonable for children to receive a medical examination by their health care provider.

Background

DPH was requested by the Washington County Health Department (WCHD) to evaluate the human health implications of gasoline vapors in the indoor air of the Kiddie Kampus Daycare Center, located at N168 W22224 Main Street, Village of Jackson, Washington County. The daycare center is located on the rear, northern side and lower floor of a two-level building. On the front, southern, upper level is a discount store, a pizza carry-out store, accountant's office, a vacant office, with the convenience/gasoline station store (Figure 1). Typically the daycare center has 18 to 20 staff and provides care during weekdays to between 80 and 90 children, with ages ranging from 6 weeks to 12 years of age.

During the week of July 21, 2008, staff noticed the appearance of strong gasoline odors in the daycare center. In response, they contacted the Wisconsin Department of Children and Family Services, which subsequently contacted WCHD and DPH.

On August 13, 2008, staff from WCHD and DPH visited and evaluated the daycare center for gasoline vapors (WCHD 8/13/2008). The director of the daycare center reported that gasoline-like odors first appeared in the building during the week of July 21, 2008, with odors noticed inside of the daycare center art storage room, which is in the rear of the daycare center. The owner of the convenience/gasoline station store said the appearance of this odor in the daycare center resulted in the discovery of a gasoline leak and there was a subsequent removal of a reported 20 gallons of gasoline from a containment crock located beneath the pump island, which is approximately 50 feet south of the convenience/gasoline station store. At this time it is unclear how vapors migrated into indoor air of the building from a gasoline product release beneath the pump island.

During the August 13th visit by health agency staff, it was reported that one daycare center teacher started having headaches when they smelled the gasoline odors. However, it was also reported there were other, external factors unrelated to the daycare center that this headache was

also in part attributable to. Daycare staff said parents were becoming concerned about the odor and for the well being of their children.



Figure 1 - Kiddie Kampus Daycare Center, Jackson, Wisconsin.

In an attempt to mitigate these gasoline odors, the convenience/gasoline station store owner hired a HVAC contractor to install flexible, clothes dryer-type ventilation hoses. This temporary system was intended to mechanically vent odors to outdoor air from the day care center's front entry, the 3-Year Old Child room, the laundry room, the furnace room, and the gas station's storage room. Staff said that prior to installing this temporary ventilation system, gasoline odors appeared in the Baby Room, the 3-Year Old Child room, the laundry, and other classrooms around 4:00 pm each day. However, after the system was installed, at times odors became worse in all rooms of the daycare center. Then once the windows were opened, staff reported that odors notably decreased.

When the basement storage room was inspected, health agency staff noted strong odors and readings on the hand-held *ppb-RAE* photo-ionization detector (PID) ranged between 20,000 and 30,000 parts-per-billion (ppb) total volatile organic compounds (VOCs). Daycare center staff reported that soon after odors appeared in the basement daycare center storage room, gasoline odors spread to throughout the rest of the daycare center.

Health agency staff described notable odors when they first entered the daycare center through the front door, which is on the opposite side of the day care center storage room, and in many other rooms. Air screening with the PID throughout the center also found total VOCs at 3,300 ppb in the laundry room, 2,200 ppb in the "Big Room/Lunch Room", 4,860 ppb in the "3 Year-Old Child Room", 8,000 to 10,000 ppb in the "Water Heater Room", and 1,757 ppb in the "Baby

Room”. Screening of outdoor air directly in front of the main entrance to the daycare center found total VOCs at 2,000 ppb.

Prior to leaving the day care center, health agency staff collected 2 indoor air samples. An air sample was collected from the 3 Year-Old Child Room into a 6-liter evacuated Summa[®] canister, and the sample was drawn over 1 hour using an air-flow regulator. The air sample was submitted to the Wisconsin State Laboratory of Hygiene (WSLH) and underwent analysis for VOCs using U.S. EPA Method TO-15a, with the sample divided into two portions and each undergoing a specific analytical screen (one targeted petroleum hydrocarbons and the second targeted toxic organics). Another air sample was collected from the Laundry Room by drawing 23.76 liters of air through a glass tube containing activated carbon. This air sample was also submitted to Wisconsin Occupational Health Laboratory, within the WSLH, and underwent analysis for VOCs following WOHL methods WG006.5 and WG030.3 (based on OSHA Method 7). A summary of the analytical results for these two air samples appear below in Table 1.

Table 1: Summary VOC Analytical Results
 Kiddie Kampus Daycare Center
 Village of Jackson, Washington County, Wisconsin
 August 13, 2008

All concentrations in parts per billion by volume (ppb)

Chemical	Laundry Room	3 Year-Old Child Room		Residential Comparison Value	
	Method: OSHA 7	Method: TO-15a <i>Hydrocarbon Analysis</i>	Method: TO-15a <i>Toxic Organic Analysis</i>	Chronic	Acute
Benzene	nd (<46.0)	15.0*‡	4.0*	0.09	9.0
Ethylbenzene	18.0	190.0	20.0	300	2,000
Hexane	nd (<16.0)	33.0	5.5	57	n/a
Styrene	nt	60.0	nd (<1.5)	234	2,000
Toluene	25.0	580.0	23.0	1,379	1,000
Total Xylenes	840.0*	3,060.0*‡	207.0*	50	2,000

Note: nd (<x) – compound not detected (method detection limit in parentheses)
 nt – compound not analyzed/tested for
 * – level exceeds chronic residential comparison value
 ‡ – level exceeds acute residential comparison value

Results

Air sampling and analytical results found elevated levels for dozens of different VOCs. These VOCs fall into primary categories of 1) the linear chain hydrocarbons typically of alkane and

alkene hydrogen saturation, and 2) cyclic saturated rings and unsaturated aromatic hydrocarbons, including those with benzene ring as the base structure. There were also many tentatively-identified and unidentified hydrocarbon compounds. These analytical results are consistent with the typical chemical constituents of gasoline (ATSDR 1995).

Discussion

It is evident that elevated levels of gasoline vapors were present in the indoor air of the Kiddie Kampus Daycare Center, located in the Village of Jackson, and children and adults who were present in the center also inhaled these gasoline vapors. This is based on combination of reported gasoline-like odors, results of indoor air screening with a PID, and the analytical results of 2 different indoor air samples. These analytical results found a wide array of VOCs that represent the lighter fraction constituents of gasoline.

There were 2 VOCs detected in indoor air, benzene and total xylenes (sum of the 3 xylene isomers), that exceeded their respective chronic residential health-based comparison values. Benzene and xylene also exceeded their acute residential health-based comparison values, which are 9 ppb and 2,000 ppb, respectively.

A comparison value is not a point at which adverse health effects are likely to occur, but serves as a threshold at which there may be the need for an additional evaluation of the exposure for potential health effects. The chronic comparison values were established based on one year or more of exposure, while acute comparison values were set based on short-term exposures of 14 days or less.

Benzene

The highest benzene levels at the daycare center were detected in the indoor air sample of the 3-Year-Old Child Room, which were at 15.0 and 4.0 ppb. The highest level of 15 ppb exceeds both the acute (14 days or less) and chronic (1 year or longer) comparison values.

The U.S. Environmental Protection Agency (EPA) has classified benzene as a Level A human carcinogen. This is based on studies of workers who for many years breathed very high levels of benzene (> 100,000 ppb) and these workers had elevated rates of certain blood cancers, such as leukemia (ATSDR 2007a). No cancer studies indicate children exposed to benzene have a greater cancer risk than adults. Animal studies of similar benzene exposures also have provided similar evidence of carcinogenicity as human studies. If breathed for a lifetime, the highest level of benzene measured at the daycare center (15 ppb) would be a *future public health hazard* because it would pose an unacceptable increased theoretical risk of developing cancer. However, a short term exposure (less than 1 year) to the highest benzene level did not pose an unacceptable cancer risk and is a *no apparent public health hazard*.

The benzene acute comparison value of 9 ppb is based on a ATSDR Minimal Risk Level (MRL). This MRL was derived from a mouse study reported a Lowest Observed Adverse Effect Level (LOAEL) of 10,000 ppb based on a study of laboratory mice inhaling benzene levels of 10,000

ppb for a duration of 6 days. The mice experience a decreased ability for bone marrow cells to create mature lymphocytes. Studies of workers who were exposed for many years to benzene levels as low as 1,000 ppb also have had adverse impacts to white and red blood cells. While the highest level of benzene measured at the daycare center (15 ppb) was above this acute MRL, a short term exposure is unlikely to result in similar adverse impacts to the blood of children and workers at the day care center. Therefore, a benzene level of 15 ppb was a *no apparent public health hazard* for non-cancer health effects.

Xylene

Xylene was found in indoor air samples collected from both the Laundry Room and the 3 Year-Old Child Room. The highest measured level for sum of the three xylene isomers (xylene) was 3,060 ppb, which exceeds both the acute and chronic comparison values.

While xylene is not classified by the EPA as a carcinogen, respiratory and neurological effects in people are regarded as the most sensitive endpoints for short-term inhalation exposures to xylene. The observed respiratory effects from inhaling high levels of xylene include difficulty breathing, discomfort in the nose and throat, and reduced forced air capacity, while the neurological effects include dizziness, headaches, impaired short-term memory, and increased reaction times. These health effects have been observed in people with xylene exposures less than 14 days and at concentrations ranging between 50,000 and 690,000 ppb. These levels are well above ATSDR's acute comparison value for xylene of 2,000 ppb (ATSDR 2007b). This MRL was extrapolated from a human study that established a LOAEL of 50,000 ppb for xylene. This level of xylene is linked to an increase in headaches, dizziness, and intoxication reported by adult subjects. It should be noted that for 3 consecutive days prior to the visit by state and local health agencies, a daycare center worker reported headaches at work that were associated with the gasoline odor, however there also appears to have been external factors, unrelated to the daycare center, that this headache was also in part attributable to.

Human and laboratory studies have not identified adverse health effects from inhaling xylene at 3,060 ppb for less than 14 days, the highest xylene concentration detected in the daycare center. Such an acute xylene exposure was a *no apparent public health hazard* for adults.

Despite this, children appear to be more sensitive to xylene exposures than adults, which is very important to consider because infants and young children are present at the daycare center for many hours and on a daily basis. Xylene inhalation experiments found that female adult study subjects had a greater decrease in respiratory function than male adult subjects, possibly because women have narrow airways and, as a result, are more sensitive to swelling than men. Young children have even narrower airways and could face an even greater decrease in respiratory function. Additionally, children have a larger brain-weight to body-weight ratio than adults, especially for the first 6 weeks following birth. This suggests the brain of a young child could receive a larger proportional of a xylene dose than a similarly exposed adult, increasing a child's risk to develop neurotoxic effects (ATSDR 2007b). Finally, children have a much higher inhalation-rate to body-weight ratio than adults, resulting in a child's inhalation dose being more than two times than when an adult has the same level of exposure.

These above considerations are important when assessing child exposures to the highest xylene level in the day care center. This is particularly important given the small difference between the xylene level that children at the daycare were exposed to and the lowest adverse effect observed in adults, a child's higher sensitivity to xylene, and that children receive twice the inhalation dose than adults when breathing the same air. However, there is insufficient information to conclude that short term exposures to the highest measured xylene level is likely to cause adverse health effects in children. As a result, DPH finds that the highest measured xylene level was an *indeterminate public health hazard* for children.

Gasoline & Chemical Mixtures

It is difficult to comprehensively assess how human health is impacted by inhaling elevated levels of gasoline vapors. Gasoline is a refined mixture of the lighter fractions of petroleum and the chemical composition can vary, depending on a number of factors. Gasoline can contain over 150 chemical constituents and many have known toxic properties, with some more potent than others, but most of these chemicals do not have an established concentration of an acceptable exposure threshold for drinking or breathing that is protective of human health. Since the chemical composition of gasoline can easily vary, its toxicity also varies.

Unfortunately, we only have a limited understanding about how inhaling known mixtures of gasoline-related chemicals will adversely affect human health. It is evident that at certain doses, each chemical in gasoline will be harmful to one or more organ systems of the body, and the impact of multiple chemicals on each system can be additive. Even less is understood about whether there may be an interaction of these chemicals that is multiplicative or even synergistic in its adverse impacts on human and animal health.

However, in order to protect public health in the future DPH recommended that the daycare center operations move to another location until actions are taken that will ensure that no gasoline vapors will reach the building that has housed the daycare center.

Gasoline Odors

Gasoline has a unique odor characteristic that people often recognize. The human sense of smell often notices faint gasoline odors when field instrumentation is unable to report its presence. While some people are not bothered by faint gasoline odors, some people find such an odor to be irritating, and results in headaches, and burning eyes and respiratory tract. For many people, a short term exposure to strong gasoline odors often results in such irritation. Prolonged exposure to high levels gasoline can be severely harmful to human health and even result in death (ATSDR 1995).

Because of the low odor threshold that humans have for gasoline, the mere presence of a gasoline odor in indoor air can be a health concern. As demonstrated by indoor air sampling data from the daycare center, noticing gasoline odors indicates a person is being exposed to a mixture of petroleum-related chemicals that have toxic properties. While it can be difficult to assess how each situation of gasoline vapors may be adversely impacting human health, it is the general

recommendation of DHS that the odor of gasoline in indoor air is a health concern and poses an unacceptable exposure that should be halted as soon as possible.

Fire or Explosive Hazards

The accumulation of gasoline vapors, particularly inside of a confined or poorly ventilated space, can reach levels that may result in flammable or even explosive conditions. The lower-explosive-limit (LEL) for gasoline is when vapors occupy 1.4 percent of the volume of air (NIOSH 2005). DPH measured the highest level of total VOCs measured inside of the basement storage room at 30,000 ppb, which is equivalent to 0.003 percent of the volume of air and 467 times below the LEL for gasoline. Therefore, at 30,000 ppb gasoline vapors inside of the day care center did not pose an explosive hazard.

However, when gasoline vapors are migrating underground away from a product source beneath the pump island and along a preferential pathway, vapor concentrations will exceed the LEL at either the source or somewhere along the pathway. A future gasoline product release and other factors could result in an increased level of gasoline vapors that will migrate towards the building and enter the basement. While it is difficult to estimate the probability of such a situation, it is plausible that a future release at the pump island could result in gasoline vapors levels in the basement exceeding the LEL, even for a very short term, which could result in catastrophic explosion. This raises additional concerns about the overall safety of situating a child care center on the lower level a building with a prior indoor air gasoline vapor release.

Child Health Considerations

DPH recognizes that children can be especially sensitive to environmental contamination. Children are often at greater risk than adults to certain kinds of exposure from hazardous chemicals in the environment. Children engage in activities, such as playing outdoors and frequent hand-to-mouth behaviors, that increase their exposure to hazardous substances. Being much smaller than adults and playing on their hands and knees, children breathe air close to the ground that can have more dust, soil particles, and vapors. Children also have a lower body weight, yet also have a higher intake rate which results in a greater dose to hazardous substances per unit of body weight. For example, it is estimated that an adult male inhales air at the rate of 15.2 m³/day (cubic meters per day) and weighs 70 kg, which is equivalent to 0.22 m³/kg/day. A 1 year old child is estimated to inhale air at 4.3 m³/day and weighs 9.4 kg, which is equivalent to 0.46 m³/kg/day and is twice the inhalation rate (by body weight) than adults. When a child and adult breathe the same air with a known contaminant, the child's inhalation dose is more than two times that of the adult.

Finally, children's bodies are developing and can have longer lasting or even permanent damage if exposures to toxic substances are high enough during critical growth stages. For these reasons, DPH considers children as one of the most sensitive population evaluated in this health consultation, and took this into account children when evaluating exposures to gasoline vapors and its constituents in the day care center.

Available information does not suggest that the health of children at the daycare will be adversely affected by breathing for several weeks the levels of gasoline vapors measured by health agencies. Yet some parents may continue to be concerned about their child's health. To address these concerns and as a precautionary measure, it is reasonable for children to receive a medical examination by the child's health care provider.

Conclusions

The highest measured benzene level in the daycare center was 15 ppb, and a long term exposure to this level posed an unacceptable increased theoretical cancer risk and is *a public health hazard* for children and adults. Short term exposure (less than 1 year) to benzene did not pose an unacceptable cancer risk is a *no apparent public health hazard*. This benzene level also posed a *no apparent public health hazard* for non-cancer health effects for children and adults.

The highest xylene level found in the daycare center was 3,060 ppb, and was not likely to result in adverse health effects for adults. However, there is not sufficient information on whether children would develop an adverse health effects when they are exposed for a short term to this level of xylene. As a result, this level of xylene posed a *no apparent public health hazard* for adults, yet was an *indeterminate public health hazard* for children.

Recommendations

DPH recommended that the daycare center operations relocate to another location until actions are taken that will ensure that gasoline vapors will not reach the building that has housed the daycare center.

While available data and information does not suggest that children at the daycare were harmed by short term exposures to gasoline vapors, to address family concerns and as a precautionary measure, it is reasonable for children to receive a medical examination by their health care provider.

Public Health Action Plan

DPH provided technical assistance to the WCHD by investigating and assessing the presence of gasoline vapors inside of a daycare center in Washington County.

DPH has offered to meet with daycare center staff and parents to discuss and explain the findings of this health consultation, as well as address any health questions or concerns.

DPH will continue assist WCHD by responding to health questions and concerns from the public related to gasoline vapors in the daycare center.

References

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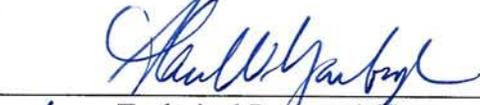
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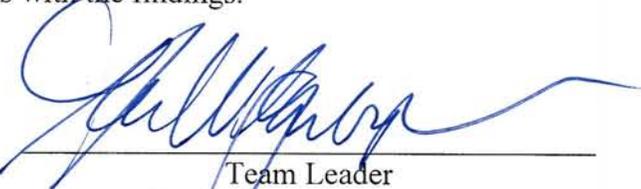
Certification

This Health Consultation on the Kiddie Kampus Daycare Center – Gasoline Vapor Intrusion was prepared by the Wisconsin Department of Health Services under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). It is in accordance with the approved methodology and procedures existing at the time the Health Consultation was begun. Editorial review was provided by the cooperative agreement partner.



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The Division of Health Assessment and Consultation, ATSDR, has reviewed this Health Consultation and concurs with the findings.



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