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BENZENE IN FLORIDA GROUNDWATER

AN ASSESSMENT OF THE SIGNIFICANCE TO HUMAN HEALTH

FLORIDA PETROLEUM COUNCIL
A DIVISION OF THE AMERICAN PETROLEUM INSTITUTE

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EXECUTIVE SUMMARY

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Introduction

The purpose of the *Benzene in Florida Groundwater Study* (Study) is to produce, compile, and analyze all available information and thereby comprehensively characterize the probability of potential adverse health effects from human exposure to benzene via groundwater sources. The ultimate goal is to offer the private and public sectors in Florida a meaningful and well informed selection of potential actions to take regarding benzene in groundwater.

Benzene is a known human carcinogen which has produced an increased incidence of leukemia in highly exposed industrial workers. Carcinogenic effects also have been demonstrated to occur in experimental animals after lifetime exposure to high levels of atmospheric benzene or to large doses given daily by the oral route.

On the other hand, benzene is also a natural substance occurring in low concentrations (parts per million) in many plants and as normal metabolite in certain animals. It is present in higher concentrations in crude petroleum and is a component of motor fuels. Benzene is produced by the combustion of most organic materials and is found in the exhaust of both gasoline and diesel powered vehicles. As a pure raw material, benzene is used in the manufacture of detergents, pesticides, and many other chemical products.

At lower concentrations (parts per billion), benzene is ubiquitous in the environment. All humans have a body content, derived primarily from air and food, which exists in equilibrium with the environment. The regulation of benzene in groundwater at such low levels inevitably requires a consideration of its relationship to drinking water and, in turn, the potential impact of that drinking water on the population health risk from benzene from all environmental sources.

The salient findings of the Study are as follows:

Existing Regulations

The Florida "maximum contaminant level" ("MCL") for benzene in both public drinking water systems and the most common class of groundwater (Class G-II) is one $\mu g/l$ (one part per billion). This health based standard, which is five times lower than the proposed U. S. Environmental Protection Agency (EPA) MCL, is based, in part, upon risk analysis considerations and is expressly left subject to alteration in light of further Agency understanding of what potential risks exist. Current Florida regulations allow for at least some case-by-case flexibility in the application of this stringent one $\mu g/l$ standard in groundwater through the use of "exemptions" and "zones of discharge". Invoking these relief mechanisms essentially requires a further assessment of potential health risks and other factors on a site specific basis.

The State of Florida is expected soon to engage in further rulemaking that will determine what concentrations of benzene may be left in groundwater pursuant to the "State Underground Petroleum Environmental Response Act of 1986" ("SUPER Act"). Special care should be taken to insure that the regulations reflect the best scientific information available.

Hazard Assessment

Available literature on benzene toxicity to humans primarily refers to instances involving high dose levels by inhalation. These observational cohort and epidemiological studies demonstrate that acute and chronic toxicological effects can occur as a result of high exposure to benzene in occupational settings. However, there are no reports of significant toxicological effects as a result of benzene ingestion via drinking water or food.

Avenues of human exposure to benzene include food (beef, eggs, etc.) and ambient and indoor air (vehicular sources, cigarette smoke, etc.). Indoor air sources constitute the most significant contributor of human body content of benzene. Drinking water contributes less than 0.2 percent of the average human exposure to benzene.

In summary, available scientific evidence and theory indicates that exposure to benzene through drinking water is unlikely to cause any significant adverse health effect in humans.

Fate and Transport / Containment of Benzene in Groundwater

Gasoline, which typically contains a small amount of benzene, may leak from underground tanks or pipes and thereby release this petroleum product to unsaturated soils above the water table or directly into groundwater. Gasoline is less dense than water, and the primary response to such releases should be to remove as rapidly as possible (by pumping) all of the "free product" that accumulates on top of the water table. This controls further lateral spreading of contamination and greatly reduces the source of gasoline components leaching as a soluble phase into the groundwater.

Mathematical and computer models are available to predict and simulate the transportation and fate of benzene in subsurface systems vulnerable to contamination in Florida. The models developed in this study demonstrate that natural mitigation by volatilization and biodegradation are important factors in the total mitigation process. Field observations have confirmed predictions by the model for the time to reach low concentrations [i.e., 10-100 $\mu g/l$ (ppb)] of benzene. The model indicates continuing reductions in benzene due to volatilization and biodegradation. However, field data indicate that a "leveling off" occurs within the 10-100 $\mu g/l$ range. Concentrations of benzene below this amount are outside the verifiable range of the model due to the geohydrological

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irregularities, sampling, analytical, and other uncertainties.

Analytical uncertainty in the measurement of benzene below 10 μg/l is high, suggesting that practical demonstration of compliance at low concentrations would be severely complicated by analytical error.

Risk Assessment

The purpose of estimating exposure-related human health risk is to assist in the establishment of regulations that best balance benefits and risks.

In assessing risks associated with the presence of benzene in underground sources of water, several factors weigh in favor of increased flexibility in the Florida benzene groundwater standard because:

- Drinking water exposure to benzene constitutes such a small percentage of total exposure, the relative risk associated with the presence of benzene at concentrations higher than the current Florida MCL is slight;
- Physiological pharmacokinetic considerations show that benzene exposure via water at 20 μg/day (perhaps even higher) would not contribute measurably to the normal body content of benzene; and,
- Quantitative extrapolation of risk is overly conservative.

All previous health risk studies have focused upon the concept of "dose". For an analysis to be truly meaningful, however, it must account for biological processes (pharmacokinetics): i.e., identification of how and at what rates benzene enters the body, is distributed within the body, changes within the body, and is excreted from the body.

The primary factor regulating body content of benzene is average concentration of this constituent in the atmosphere. The body content is usually at an equilibrium with concentrations of benzene in the air due to a relatively quick exchange of benzene across the membranes of the lung. Increments of benzene absorbed from the intestine are largely metabolized in the body with the remainder being excreted by exhalation. Benzene absorbed from the intestine produces only a transitory increase in body content that quickly reverts to a level of equilibrium with the atmosphere.

The variability in an individual's total daily intake of benzene makes it difficult to observe any practical differences caused by changing the benzene intake from drinking water by 20 μg/day (25 μg/l at 0.8 l/day). Even in the statistical analysis of risk associated with benzene at 25 μg/l in drinking water, the upper bound estimate of increased carcinogenic response at that level among individuals *in the exposed population* would be less than 10^5 or, with equal likelihood, it might be essentially zero.

Conclusions

- Once detected on the groundwater, free phase petroleum hydrocarbons should be removed as quickly as possible to minimize the spread of the contaminant plume.
- Plume intercept technology is effective in cleaning up gasoline spill sites to low concentrations of benzene. Once benzene has reached about 100 μg/l in the groundwater, continued use of this cleanup action will not yield a substantial improvement over natural processes. Trace residual hydrocarbons left in the subsurface at these concentrations will degrade in time through natural processes.
- Geohydrological models which predict the relationship between sources of contamination and aquifers are useful tools as planning guides in projecting the extent of contamination and in evaluating cleanup strategies.
- The present Florida benzene water quality standard of one μg/l benzene is unnecessarily restrictive, both from a perspective of feasible site remedial action and from the standpoint of risk to public health and safety. In the 10-100 μg/l concentration range, the risk associated with benzene in groundwater is exceedingly small.
- A drinking water standard which limits intake of benzene from this source to 20 μg/day (25 μg/l at 0.8 l/day) is more than adequate to avoid any detectable risk of leukemia. Such standard should be applied only under circumstances where the groundwater will be used directly for human consumption.
- Should groundwater with traces of benzene be needed as a drinking water source, it may be more economical to treat the water at the well outlet rather than in the aquifer.

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NOTE TO READER:

Authors have been free to select data for their work. The American Petroleum Institute has not imposed a requirement to use a given data set. This flexibility does not alter the overall conclusions but should be considered in comparing work by different authors.

Although specific models have been used in this study, other models may be equally valid.

PART TWO: HAZARD ASSESSMENT

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2-1 TOXICOLOGICAL EFFECTS OF BENZENE

2-1.1 Introduction

Several excellent reviews of the toxicological properties of benzene have been published recently: Fishbein (Ref. 2-1.9 [14]), Synder (Ref. 2-1.9 [32]), Aksoy (Ref. 2-1.9 [1]) and Mehlman (Ref. 2-1.9 [22]). This section will therefore address only selected aspects of the extremely large toxicological data base available for this compound in order to provide a perspective from which to evaluate other parts of this document.

2-1.2 Major Sources of Human Benzene Exposure

It must be appreciated that benzene is ubiquitous. According to estimates from the National Research Council (Ref. 2-1.9 [24]), the dietary intake of benzene may be as high as 250 μg daily, perhaps explaining benzene concentrations of 8-20 ppb in the breath of individuals with no known exposure to this compound. The benzene content of specific foods is reported to range from 2 ppb for canned beef to 2100 ppb for a boiled egg (Ref. 2-1.9 [23]). Recent results from the National Toxicology Program (Ref. 2-1.9 [25]) indicate that virtually 100% of benzene administered orally is absorbed into the body.

Benzene concentrations in ambient air (urban and rural) have been estimated to range from 1-100 ppb (Ref. 2-1.9 [17]). Urban air is reported to contain higher levels than rural air, presumably due to the contribution of automotive emissions of benzene (Ref. 2-1.9 [5]). After reviewing these data, the National Research Council (1980) calculated that an individual living in an urban environment containing a mean atmospheric benzene concentration of 16 ppb (50 μg/m³) who breathes an average of 24 m³ of air per day and absorbs approximately 50% of the dose (i.e., equilibrium state) will absorb approximately 600 μg of benzene daily.

[16 ppb = 50 μg/m³ x 24 m³/day x 50% absorption = 600 μg/day]

Benzene is present in cigarette smoke at levels of 47-64 ppm, leading to estimates of the amount of benzene inhaled from a single cigarettes ranging from 10-31 μg. Using the upper estimate, a person smoking two packs (i.e., 40 cigarettes) per day will absorb up to 992 μg of benzene (assumes 80% of dose is absorbed; non-equilibrium state). [Note: This discussion will not consider the contribution of secondary inhalation of cigarette smoke to the overall benzene exposure of a non-smoker.]

[40 cigarettes/day x 31 μg benzene/cigarette x 80% absorption = 992 μg/day]

The solubility of benzene in water is reported to be 1780 mg/l at 25 C (Ref. 2-1.9 [2]). In a report issued by the EPA Office of Drinking Water (Ref. 2-1.9 [11]), it was estimated that 97.7% of the population served by public water systems is receiving water either free of benzene contamination or having levels less than 0.5 μg/l. Estimates of daily human water consumption range from 0.8 to 2 l/day. Assuming that the average adult consumes 2 liters of water daily, it can be calculated that drinking water with a benzene content of 0.5 μg/l would contribute 1 μg of benzene to the average daily dose (100% absorption assumed).

[0.5 μg/l x 2 l/day = 1.0 μg/day]

Summarizing the above calculations for what are considered major sources of human benzene exposure:

	Non-Smoker	Smoker
Food	250 μg/day	250 μg/day
Air	600 μg/day	600 μg/day
Cigarettes	—	992 μg/day
Water	1 μg/day	1 μg/day
TOTAL	851 μg/day	1843 μg/day

2-1.3 The Pharmacokinetics of Benzene

The primary routes of benzene exposure are considered to be oral and inhalation. While there are data that benzene applied as a liquid or in solution to human skin can be absorbed fairly rapidly (Ref. 2-1.9 [4]), this route is generally discounted as being significant because of the rapid evaporation of benzene which effectively reduces the time of skin contact.

Recent data from the National Toxicology Program (Ref. 2-1.9 [26]) indicates that virtually all of an oral dose of benzene dissolved in vegetable oil is absorbed in rats and mice. It is reasonable to assume that dietary fiber content may reduce both the rate and efficiency of benzene absorption somewhat by complexing the hydrocarbon, but experimental evidence for this is unavailable. To be conservative, 100% absorption of benzene from food and water was assumed in the above calculations.

The respiratory absorption of a hydrocarbon vapor such as benzene is a complex process which has only partially been characterized. Initially, when an animal (or man) is placed into an atmosphere containing benzene vapor, virtually all of the hydrocarbon is absorbed into the blood stream and then distributed to the various tissues of the body. Each tissue will absorb some of the benzene from the blood with some tissues (e.g., those having a high

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content of fat) absorbing relatively greater proportions of benzene compared to other tissues. The benzene absorbed by each tissue may be sequestered, released back to the blood unchanged, or processed by the specific metabolic enzymes which characterize the cells of that tissue. In time, a state of dynamic equilibrium (often called "steady state") is established between the air, blood, and other body compartments. As more benzene is absorbed from the air, some of the previously absorbed benzene is exhaled unchanged from the body, some is metabolized to specific derivatives which may be further metabolized even in other distant tissues, and some is removed by the kidneys and excreted in the urine. As the animal approaches steady state, the apparent (i.e., net) absorption of the compound into the body can be seen to decrease substantially. As noted in Section 2-1.2 above, conservative estimates of 50-80% absorption have been assumed in calculating the contribution of ambient air and cigarette smoking to the total burden of benzene. Recent data from the NTP (1986) indicate that from a 6 hour exposure to 11 ppm of benzene vapor, the apparent absorption of benzene in mice is 50%, whereas at 1000 ppm, the apparent absorption is 9.7%. Values for similarly exposed rats are 33% absorption at 13 ppm and 15% absorption at 870 ppm.

Significant differences in the respiratory characteristics of commonly used laboratory animals exist and greatly influence the amount and rate at which a hydrocarbon vapor is absorbed into the body. Small animals, with their high metabolic rate, must have a relatively large supply of oxygen to the body (Ref. 2-1.9 [34]). While this could have been accomplished evolutionarily by development of larger lungs relative to their body size, small animals such as mice and rats instead breathe more rapidly. It might be expected therefore that rodents should reach steady state more quickly than a man exposed to the same vapor concentration, but definitive experimental data in this regard have not been identified.

The Lovelace Inhalation Toxicology Research Institute (ITRI), under contract with NTP, have characterized the respiratory parameters of the B6C3F1 mouse and the F344 rat, (unpublished information from the butadiene research program). According to ITRI data, the average B6C3F1 mouse weighed 27.5 g and breathed 35 ml of air per minute (i.e., minute volume); the average F344 rat weighed 392 g and had a minute volume of 289.7 ml. Expressed on a kilogram body weight basis, the minute volume of the mouse is 1274 ml/kg and of the rat is 737 ml/kg. From this perspective, it is understandable why Sabourin *et al.* (1986) concluded that at similar exposure levels of benzene vapor, mice received 150-200% of the dose received by rats per kilogram body weight. Such differences in respiratory characteristics between species are especially important to exposures where the steady state condition has either not been reached or has been perturbed. Consideration of species differences must be incorporated in the quantitative modeling of animal inhalation data for estimation of human health risks. In particular, if one assumes a 70-kg man who breathes 7500 ml of air per minute, it can be calculated that the human minute volume/kg body weight is about one-seventh that of the rat and about one-twelfth that of the mouse.

A similar picture of steady-state equilibrium can be developed for benzene absorbed from the gastrointestinal tract. As noted above, recent data from NTP (Sabourin *et al.*, 1986) suggest that essentially all of a dose of benzene (dissolved in corn oil) administered by gavage is absorbed by rats and mice. Two points should be emphasized with regard to oral exposures. First, the concentration of benzene in the blood as a result of the administration of an oral bolus is seen to be a transient peak or spike. Dissolving benzene in a vehicle such as corn oil essentially results in a retardation in the absorption of benzene into the blood stream, such that all of the benzene is eventually absorbed, but it requires a longer period of time.

Benzene is metabolized via a number of possible pathways, summarized in Figure 2-1.8 [1]. Available information indicates that benzene must be metabolized in order to exert its toxic effects. However, it is not clear at the present time which of the various metabolic pathways activates benzene to more toxic derivatives and which pathways result in detoxification. Various investigators have suggested that toxicity may be the result of covalent binding of benzene metabolites to cellular macromolecules such as DNA and protein, and a reactive benzene epoxide was postulated to be formed during the metabolism of benzene by the cytochrome P-450 enzyme system (Ref. 2-1.9 [19]). Recent data, however, call into question whether benzene oxide is in fact formed to a significant degree during the metabolism of benzene (Ref. 2-1.9 [20]). Investigators at the Chemical Industry Institute of Toxicology (Ref. 2-1.9 [16], [18]) suggest that polyphenol derivatives (e.g., hydroquinone and 1,2,4 -benzenetriol) may be responsible for the toxic effects of benzene, perhaps via the autooxidative formation of highly reactive radicals which could bind to macromolecular targets. Goldstein *et al.* (Ref. 2-1.9 [15]) suggest that the benzene ring is cleaved metabolically forming muconaldehyde which is also capable of reacting with essential macromolecules. The role of various isomers of diphenol formed by cellular peroxidases, such as myeloperoxidase in the bone marrow in benzene toxicity remains to be evaluated (Ref. 2-1.9 [28]). See Figure 2-1.8 [1].

While it is not yet possible to identify which metabolite(s) of benzene is responsible for the profound cellular toxicity associated with this compound, quantitative risk modeling must recognize that significant qualitative and quantitative differences in the specific metabolic pathways for benzene are seen between species. The phenolic metabolites in the urine of benzene-treated mice, for example, have been found to comprise 50-65% *glucuronide* conjugates, 26-38% sulfate conjugates, and approximately 5% unconjugated phenol (Ref. 2-1.9 [33]). In contrast, Cornish and Ryan (Ref. 2-1.9 [6]) observed that approximately 70% of the phenolic metabolites found in the urine of benzene-treated rats were *sulfate* conjugates. In man, virtually all of the phenolic compounds in the urine following benzene exposure exist as *sulfate* conjugates until the concentration of phenol in the urine reaches approximately 400 mg/l when the sulfate pathway has apparently been saturated and products of glucuronide conjugation begin to appear (Ref. 2-1.9 [30]). Such data

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2-4 NONDRINKING-WATER EXPOSURE

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2-4.1 Occurrence

2-4.1(1) Food

Data on the occurrence of benzene in food are limited. Mara and Lee (Ref. 2-4.4 [11]) reported that benzene occurs naturally in fruits, fish, vegetables, nuts, dairy products, beverages, and eggs. These authors report concentrations ranging from 2 micrograms per kilogram (μg/kg) for canned beef to 2,100 μg/kg for eggs. Cooked meats are reported to have higher benzene levels than raw meats, and it is postulated that the increased benzene levels observed after cooking meats is due to the breakdown of aromatic amino acids such and tyrosine (Ref. 2-4.4 [5]).

Low levels (<10 μg/kg) of benzene in food could be due to a partitioning from the ambient levels of atmospheric benzene. The high levels observed in eggs indicate an intrinsic mechanism for the biochemical formation of benzene. Table 2-4.3 [1] summarizes the reported occurrence of benzene in foods.

2-4.1(2) Air

The materials balance for benzene indicates that 95 percent of environmental releases of benzene are to the atmosphere, and three-quarters of this release is associated with fuel combustion (Ref. 2-4.4 [5]). As a result of these emissions, it is not surprising that ambient air levels of benzene have been correlated with traffic volumes (Ref. 2-4.4 [2]).

Atmospheric benzene is ubiquitous; remote regions have measured concentrations usually ranging from 1 to 3.5 micrograms per cubic meter (μg/m^3). Higher levels are observed in urban and industrial environments. Table 2-4.3 [2] summarizes benzene concentration ranges and averages for various atmospheric environments.

Indoor benzene levels have been studied in industrial settings. Inside chemical plants, reported concentrations range from 2,000 to 10,000 μg/m^3. The current Occupational Safety and Health Administration (OSHA) regulation on workplace exposure is 32,000 μg/m^3 (10 parts per million, ppm) for the time-weighted average (TWA) concentration for an 8 hour exposure with a peak maximum concentration of 160,000 μg/m^3 (50 ppm) for any 15 minute period during an 8 hour day (Ref.2-4.4 [1]).

Indoor benzene levels in residences have been reported by Sample and Gilbert (Ref. 2-4.4 [14]) to have a median value of 15.0 μg/m^3 and an arithmetic mean of 25.8 μg/m^3 for 353 nighttime observations of benzene. There is a minimal correlation between indoor concentrations and outside ambient levels. The impact of smoking on indoor benzene concentrations appears to be important in households containing one or more smokers. These households exhibit at least 50 percent greater concentrations than households of nonsmokers. One cigarette can generate approximately 90 micrograms (μg) of benzene (Ref. 2-4.4 [5]). The portion of the benzene in the mainstream smoke is predominantly absorbed by the smoker and not exhaled. Mainstream smoke is that which the smoker inhales; however, the sidestream smoke which is released to the room often contains twice the quantity of some chemicals as the mainstream smoke (Ref.2-4.4 [6]). Therefore, of the 90 μg of benzene released from each cigarette, possibly 60 μg is released to the smoker's environment through the sidestream smoke.

2-4.2 Exposure

Reported benzene concentrations in foods do not involve all food groups. It is not known how representative these concentrations are of the concentrations in foods in general. Dietary intake of benzene has been estimated to be as high as 250 micrograms per day (μg/day) from beef, eggs, and rum alone (Ref. 2-4.4 [13]). Assuming that the average adult male weighs 70 kg, an intake of 250 μg/day would be equivalent to 3.6 micrograms per kilogram per day (μg/kg/day). In the absence of further data, Letkiewicz *et al.* (Ref. 2-4.4 [8]) assumed the dietary intake of benzene was at that level. Gilbert *et al.* (Ref. 2-4.4 [5]) estimated the ingestion due to only those foods with reported benzene concentrations (i.e., butter, cooked beef, eggs, and haddock), resulting in a daily ingestion intake of 31 to 108 μg/day.

Exposure to benzene in the atmosphere is highly variable; reported levels range between low parts-per-billion values in outside air to low parts-per-million in certain industrial settings. Median air concentrations of benzene have been calculated by Brodzinsky and Singh (Ref. 2-4.4 [3]) for rural/remote areas (4.5 μg/m^3), urban/suburban areas (8.9 μg/m^3), and source-dominated areas (9.6 μg/m^3). Thus, in urban/ suburban areas, people inhale approximately 180 μg of benzene each day (at 20 cubic meters, m^3, of air inhaled each day). As a comparison, a one-pack-per-day smoker inhales approximately 600 μg/day of benzene from mainstream smoke. Exposure by these routes is substantial, but highly variable in the general population.

Average annual atmospheric benzene concentrations and the size of exposed populations have been calculated by Mara and Lee (Ref. 2-2.4 [11]) based on air dispersion models. Approximately half of the population of the United States was estimated to be exposed to average atmospheric benzene concentrations between 3.5 and 13 μg/m^3.

A newborn, formula-fed infant's respiratory intake of benzene can be expected to range from 1.0 to 2.2 μg/kg/day, whereas the intake of a nonsmoking, 70-kilogram (kg) adult male may vary between 1.5 to 360 μg/kg/day, depending on ambient benzene concentrations (Ref. 2-4.4 [8]).

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TABLE 2-4.3 [1] Foods Reported to Contain Benzene

Fruits[a]	Vegetables[a]	Meat, Fish, and Poultry
Apple	Bean	Cooked beef (2 to 19 μg/kg)[c]
Citrus Fruit	Leek	Chicken (<10 μg/kg)[d]
Cranberry and Bilberry	Mushroom	Egg, hard boiled (500 to 1,900 μg/kg)[e]
Currants	Onion, *roasted*	Egg, uncooked (2100 μg/kg)[h]
Guava	Parsley	Haddock (100 to 200 μg/kg)[f]
Pineapple	Potato	Lamb, heated (<10 μg/kg)[d]
Strawberry	Soya Bean	Mutton, heated (<10 μg/kg)[d]
Tomato	Trassi, *cooked*	Veal, heated (<10 μg/kg)[d]
Nuts[a]	**Dairy Products**	**Beverages**
Filbert, *roasted*	**Butter (0.5 μg/kg)[b]**	**Cocoa[a]**
Peanut, *roasted*	Blue Cheese[a]	Coffee[a]
Macademia Nut	Cheddar Cheese[a]	Jamaican Rum (120 μg/kg)[g]
	Other Cheese[a]	Tea[a]
		Whiskey[a]

[a] Ref. 2-4.4 [16]
[b] Ref. 2-4.4 [15]
[c] Ref. 2-4.4 [13]
[d] Ref. 2-4.4 [12]
[e] Refs. 2-4.4 [9], [10]
[f] Irradiated and non-irradiated haddock, respectively.
[g] Ref. 2-4.4 [7]
[h] Ref. 2-4.4 [11]

Source: Ref. 2-4.4 [5]

TABLE 2-4.3 [2] Summary of Benzene Occurrence in Air

Environment	Benzene Concentration (μg/m³)
Remote (Range)	1 to 3.5
Urban (Range)	4 to 160
Residential — Remote from Traffic (Average)	4.5
Near Chemical Plant (Average)	14
Near Refineries (Average)	9
Gas Stations (Range)	<1 to 32

Sources: Refs. 2-4.4 [5], [8]

MCD 000006170

2-4.4 REFERENCES: NONDRINKING-WATER EXPOSURE

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MCD 000006171

The "Emergency Temporary Standard" (ETS) issued by OSHA for benzene on May 3, 1977 set a TWA limit for benzene at 1 ppm. There was also a "ceiling" limit of 5 ppm over any 15 minute period.

The EIS did not apply to liquids containing <u>benzene in amounts of 1 percent by volume</u> or less, or the vapors released by these liquids.

A proposed permanent Benzene Standard was published by OSHA on May 27, 1977.
It lowered the benzene content from 1.0 vol% to 0.1 vol%. (Personnel monitoring necessary, etc.)

<u>Benzene</u>
Nov. 76 –

Adoption of the standard.

~ Earliest By speci. on Conoco Gasoline

were both shot
& are now again attempting

PPSC 0021.5
T. Dithyswa
76 + 77

Apr. 28 '77

LC Refy

as disc by PPSC.
Local Con
as reg. by ELS 5

~~July~~ '77
Net ...
Fed Regs – 0.5 – 0.7
... – "... B..." ...

<u>5%</u> April '84 – Exxon max wt% 4.9

[16 CFR – 1500.14
(b), (i) sections]

MCD 000006172

Send J. Abbott memo.

See Irene – Thes –
Look over File on Benzene –

KC Hunt / BE Council

The "Emergency Temporary Standard" (ETS) issued by OSHA for benzene on May 3, 1977 set a TWA (8hr) limit for benzene at 1 ppm. There was also a "ceiling" limit of 5 ppm over any 15-minute period.

The ETS did not apply to liquids containing benzene in amounts of 1 percent by volume or less, or the vapors released by these liquids.

A proposed permanent benzene standard was published by OSHA on May 27, 1977

It lowered the benzene content from 1.0 vol% to 0.1 vol%. (Personal monitoring necessary, etc.)

effective 1 year after the adoption of the standard.

The 1977 OSHA [illegible] held shot down in court. They are now again attempting to [illegible] benzene [illegible] cut [illegible]

MCD 000006173

/

Authority under the Federal Hazardous Substances Act is vested in the C.P.S.C. by section 30(a) of the Consumer Product Safety Act.
"The act" means the Federal Hazardous Substances Act as amended by Pub. L. 92-573, sec. 30(a),

16 CFR 1500.14 Products requiring special labeling under section 3(b) of the act

a [illegible]

(3) products containing 5% or more by wt. of benzene
and products containing 10% or more by wt. of toluene, xylene, or petroleum distillates such as kerosene, mineral seal oil, naptha, gasoline mineral spirits, stoddard solvent, and related petroleum distillates.

(b)
(3) (iii) (c) Requires special labeling for the type products named above i.e.

Danger
Harmful or fatal if swallowed
etc.

MCD 000006174

These are the kinds of warnings on our MSDS sheets for various petroleum products.

The warning for benzene is a little stronger:
[illegible] fatal" if swallowed [illegible]

Title 16 CFR is on Commercial Practices

16 CFR 1500.14 subh 12

Part 1500 belongs to Consumer Product Safety Commission

We don't have it at the lab.

29 CFR 1910.1028

~~29 CFR 1910.20~~

May 3, 1977 proposed OSHA reg. on benzene.

Set a PEL of 1 ppm bz. in air 8 TWA

~~It~~ applied in areas where streams containing more than 1% by vol.

Did not apply to svc. stations.

Also a STEL of 5 ppm over 15 min.

Mary Ann Chance says Medical Lab not have that Title.

Deborah Embrey
2587
at Library

MCD 000006175

§ 1500.14 Products requiring special labeling under section 3(b) of the act.

(a) Human experience, as reported in the scientific literature and to the Poison Control Centers and the National Clearing House for Poison Control Centers, and opinions of informed medical experts establish that the following substances are hazardous:

(1) Diethylene glycol and mixtures containing 10 percent or more by weight of diethylene glycol.

(2) Ethylene glycol and mixtures containing 10 percent or more by weight of ethylene glycol.

(3) Products containing 5 percent or more by weight of benzene (also known as benzol) and products containing 10 percent or more by weight of toluene (also known as toluol), xylene (also known as xylol), or petroleum distillates such as kerosine, mineral seal oil, naphtha, gasoline, mineral spirits, stoddard solvent, and related petroleum distillates.

(4) Methyl alcohol (methanol) and mixtures containing 4 percent or more by weight of methyl alcohol (methanol).

(5) Turpentine (including gum turpentine, gum spirits of turpentine, steam-distilled wood turpentine, sulfate wood turpentine, and destructively distilled wood turpentine) and mixtures containing 10 percent or more by weight of such turpentine.

(b) The Commission finds that the following substances present special hazards and that, for these substances, the labeling required by section 2(p)(1) of the act is not adequate for the protection of the public health. Under section 3(b) of the act, the following specific label statements are deemed necessary to supplement the labeling required by section 2(p)(1) of the act:

(1) *Diethylene glycol.* Because diethylene glycol and mixtures containing 10 percent or more by weight of diethylene glycol are commonly marketed, stored, and used in a manner increasing the possibility of accidental ingestion, such products shall be labeled with the signal word "warning" and the statement "Harmful if swallowed."

(2) *Ethylene glycol.* Because ethylene glycol and mixtures containing 10 percent or more by weight of ethylene glycol are commonly marketed, stored, and used in a manner increasing the possibility of accidental ingestion, such products shall be labeled with the signal word "warning" and the statement "Harmful or fatal if swallowed."

(3) *Benzene, toluene, xylene, petroleum distillates.* **

(i) Because inhalation of the vapors of products containing 5 percent or more by weight of benzene may cause blood dyscrasias, such products shall be labeled with the signal word "danger," the statement of hazard "Vapor harmful," the word "poison," and the skull and crossbones symbol. If the product contains 10 percent or more by weight of benzene, it shall bear the additional statement of hazard "Harmful or fatal if swallowed" and the additional statement "Call physician immediately."

(ii) Because products containing 10 percent or more by weight of toluene, xylene, or any of the other substances listed in paragraph (a)(3) of this section may be aspirated into the lungs, with resulting chemical pneumonitis, pneumonia, and pulmonary edema, such products shall be labeled with the signal word "danger," the statement or hazard "Harmful or fatal if swallowed," and the statement "Call physician immediately."

(iii) Because inhalation of the vapor of products containing 10 percent or more by weight of toluene or xylene may cause systemic injury, such products shall bear the statement of hazard "Vapor harmful" in addition to the statements prescribed in paragraph (b)(3)(ii) of this section.

(4) *Methyl alcohol (methanol).* Because death and blindness can result from the ingestion of methyl alcohol, the label for this substance and for mixtures containing 4 percent or more by weight of this substance shall include the signal word "danger," the additional word "poison," and the skull and crossbones symbol. The statement of hazard shall include "Vapor harmful" and "May be fatal or cause blindness if swallowed." The label shall also bear the statement "Cannot be made nonpoisonous."

(5) *Turpentine.* Because turpentine (including gum turpentine, gum spirits

MCD 000006176

** 3-26-92 A check of the CFR/Fed.Reg. updating information has found no amendments nor proposed amendments to the above 16 CFR Sec. 1500.14(b)(3) since that language was published 1-1-91. --EKB

TABLE II (Continued)

TYPICAL BASE GASOLINE STREAMS

LAKE CHARLES REFINERY - SUMMER 1983

Ponca City Sample No.:	1611	1609	1781
Lake Charles Sample No.:	727	725	858
Stock	No. 2 Reformer Charge	No. 2 Reformate	No. 3 Reformate
Gravity, °API	57.5	49.1	44.4
Distillation, D-86, °F, 760 mm			
IBP	129	115	101
5% Evaporated	181	148	125
10% Evaporated	208	163	146
20% Evaporated	225	184	178
30% Evaporated	234	201	203
50% Evaporated	259	240	246
70% Evaporated	283	278	281
90% Evaporated	312	321	325
95% Evaporated	321	338	344
End Point	339	388	404
Recovery, Vol.%	97	98	98
Reid Vapor Pressure, psi	8.2	5.5	7.9
Sulfur, Wt.%	<0.01	<0.01	<0.01
Aromatics, Vol.%	11	49	63
Olefins, Vol.%	1	1	1
Existent ASTM Gum, mg./100 mls.	<1	2	1
Benzene, Vol.%	1.0	3.8	6.0
Research Octanes			
Clear	53.8	94.7	100.9
0.25 gms./gal. TEL	56.4	96.3	102.0
0.5 gms./gal. TEL	59.4	97.7	102.8
1.5 gms./gal. TEL	68.7	100.0	104.3
Motor Octanes			
Clear	53.4	85.2	89.0
0.25 gms./gal. TEL	56.3	86.6	89.6
0.5 gms./gal. TEL	60.8	88.0	90.2
1.5 gms./gal. TEL	71.4	90.5	92.2

Approved:

Senior Technologist

Gregory Mitacek
Associate Technologist

bp

MCD 000006177

CONTINENTAL OIL COMPANY

PONCA CITY, OKLAHOMA

REFINING TECHNICAL SERVICES LABORATORY

Plt.: PC

File: 662.1
✔924

Date: 6-8-77

LABORATORY NO.: F-25-77

CHARGE: PC 49

SUBJECT: Summary of Benzene Content of Gasoline and Blending Streams - Ponca City Refinery

ANALYTICAL DATA:

Vol.% Benzene of Finished Gasolines

Sample Number	Sample	Sample Date	Benzene, Vol.%
TK 114	Unleaded	March 1977	0.6
TK 151	Regular	March 1977	1.0
TK 101	Premium	March 1977	0.6
TK 150	Regular	5-9-77	0.8
TK 148	Premium	5-9-77	0.2
TK 156	Regular	5-9-77	0.8
TK 156	Regular	5-10-77	1.1
TK 150	Regular	5-10-77	0.9
TK 161	Unleaded	5-10-77	0.6
TK 148	Premium	5-10-77	0.2
TK 155	Regular	5-10-77	0.8
TK 102	Premium	5-10-77	0.6
TK 167	Regular	5-10-77	1.1
TK 114	Unleaded	5-10-77	0.6
TK 156	Regular	5-10-77	0.8
TK 170	Regular	5-10-77	1.1
TK 155	Regular		0.8
TK 167	Conotane	5-12-77	1.1
TK 116	Unleaded	5-12-77	0.6
TK 102	Premium	5-12-77	0.6
TK 153	Wm. Bros. Premium	5-13-77	0.3
TK 151	Wm. Bros. Regular	5-14-77	0.9
TK 156	Regular	5-15-77	0.8
TK 150	Regular	5-17-77	0.8
TK 155	Regular	5-18-77	0.7
TK 167	Regular	5-18-77	1.1
TK 150	R-92	5-20-77	0.9
TK 148	Premium	5-21-77	0.2
TK 149	R-92	5-22-77	1.1
TK 155			0.7
TK 156	R-93	5-24-77	1.0
TK 102		5-24-77	0.3
TK 170		5-25-77	1.1
TK 150		5-25-77	0.9
TK 155	Regular	5-29-77	0.8
TK 153	Premium	5-29-77	0.4

cc: IFW-JLD-(ML-BDB)-KCH-F ✓

MCD 000006179.1

Vol.% Benzene of Finished Gasolines

Sample Number	Sample	Sample Date	Benzene, Vol.%
TK 150	Regular	5-29-77	0.9
TK 641 Commercial jet fuel	Q Grade	5-23-77	<0.1
McConnell Military jet fuel	PC JP-4	6-2-77	0.1

Vol.% Benzene of Refinery Streams

Sample Number	Sample	Sample Date	Benzene, Vol.%
PC 5952	Straight Run Gasoline	4-4-77	1.4
PC 5962	No. 3 Reformer Charge	4-4-77	0.2
PC 5963	No. 3 Reformate	4-4-77	1.3
PC 5965	No. 4 FCC Lt. Gasoline	4-4-77	0.3
PC 5966	No. 4 FCC Heavy Gasoline	4-4-77	<0.1
PC 5954	Coker Gasoline	4-4-77	0.1
PC 5958	No. 5 FCC Heavy Gasoline	4-4-77	0.6
PC 5957	No. 5 FCC Light Gasoline	4-4-77	0.5
	No. 5 FCC Gasoline	5-13-77	0.5
	Cat Poly Gasoline	5-17-77	<0.1
	Straight Run Gasoline	5-12-77	1.0
	No. 2 Reformate	5-26-77	1.2
North Texas	No. 1 CTU Raw Crude	6-7-77	0.1
West Texas + foreign	No. 2 CTU Raw Crude	6-7-77	<0.1
Oklahoma - Kingfisher	No. 4 CTU Raw Crude	6-7-77	0.1
West Texas + foreign	No. 5 CTU Raw Crude	6-7-77	0.1

Melvin McFeatters
Associate Chemist

Approved:

W. S. Orrell
Senior Technologist

bp

Oran D. S. .ey

Conoco

To Ken Hunt Date 7-19-77

Bayer file

For your information -

O.D.S.

K. C. H.
Tech. Ser. Lab.
JUL 20 1977

JMH _____
LNL _____
PJR _____ No!
TEC ~~_____~~ "
~~DDO~~ _____
CKH _____
RSJ _____

Can you believe
0.5 vol. % Cl in
No. 6 fuel oil?

MCD 000006182

► Require employees to remove and leave protective clothing at the point of use, and to require employees to confine the use of the clothing to specific operations.

► Prohibit the storage and consumption of food, beverages, or tobacco in regulated areas.

► Provide for pressure-negative air flow while the MOCA is being transferred from drums to melting facility.

► Provide for reasonable cleaning procedures for surfaces of equipment taken or removed from regulated areas.

► Post at each entrance to regulated areas a sign reading "Restricted Area, Authorized Personnel Only, MOCA."

► Provide to each employee, prior to his being authorized to enter regulated areas, a training and indoctrination program appropriate to comply with the settlement agreement.

► Provide and require the use of approved and properly maintained dust respirators for employees while they are engaged in transferring MOCA from drums to melting facility whenever direct contact with MOCA dust may occur.

No DOL Response

Sather told OSHR that he had not discussed with the Labor Department solicitor's office his assertion that the terms of the agreement form a legal precedent. However, he maintained, "it would be hard for them to say something else should be done" to control MOCA exposure in a similar situation after having reached agreement with Roadway.

A spokesman for the solicitor's office declined immediate comment on Sather's assertion.

Hearings on a new MOCA standard were held in 1975, but no standard was ever issued. Former Assistant Labor Secretary Morton Corn in November 1976 declined a National Institute for Occupational Safety and Health request to issue an emergency MOCA standard, maintaining that such an action would involve "thorny legal problems" for DOL (Current Report, December 9, p. 858).

X

Benzene

GAO WARNS OF POTENTIAL HAZARD IN USE OF RESIDUAL OIL FUEL, URGES OSHA ACTION

The Occupational Safety and Health Administration should give "prompt attention" to a potential benzene hazard among workers in power generation and steam-heating plants, the General Accounting Office urged on July 5.

In a letter to Labor Secretary Ray Marshall, Gregory J. Ahart, director of the GAO human resources division, reported that a GAO investigation had found two leukemia-related deaths among workers at the Naval Regional Medical Center in Portsmouth, Va. Both workers had been employed at the facility's powerhouse, where a residual fuel oil called "number six fuel" is used.

Ahart noted that according to information supplied by the Defense Department's Defense Logistics Agency, the amount of benzene in a batch of number six fuel "could amount" to one-half of one percent by weight.

"Although we are not concluding that there was a direct relationship between exposure to benzene or the other toxic substances which may be found in number six fuel and the two leukemia-related deaths, we believe the evidence on the adverse effects of benzene alone is enough to warrant prompt attention to this matter," Ahart declared.

Both deceased Medical Center employees, Ahart reported, worked in the powerhouse for over 20 years. One worker died of an acute intracerebral hemorrhage due to myelogenous leukemia, and the other from a cerebral hemorrhage resulting from the subacute myelogenous leukemia. Medical records indicated that traces of benzene were found in the latter employee's blood, according to the GAO official.

A 1973 survey by Medical Center industrial hygienists, conducted after the death of the second employee, concluded that "the second employee's problem was not due to exposure to chemical vapors in the work environment," Ahart related. However, he noted, there apparently was no testing for benzene, or taking of air samples.

In January 1977, at GAO's request, an OSHA industrial hygienist surveyed the powerhouse, took air samples, and analyzed a sample of number six fuel for benzene. GAO found that:

► Air samples taken in the general working areas of the powerhouse showed that benzene vapor concentrations were less than one part per million, although samples taken at fuel filters indicated concentrations exceeding 60 ppm.

► Fuel oil samples indicated a benzene concentration of about one-tenth of one percent by weight.

► Employees who cleaned the fuel filters wore either no gloves or cloth gloves only, so that they "frequently" got the fuel on their hands, arms, and clothing.

► Powerhouse employees were not participating in any medical surveillance program, according to the powerhouse foreman.

Corrective Measures

In a subsequent discussion with Medical Center officials, Ahart stated, the OSHA industrial hygienist recommended that the Medical Center require the use of synthetic material gloves, reengineer the fuel filtration system, and prohibit open buckets of fuel oil in the powerhouse.

Later, in a February 1977 visit, GAO "observed that signs had been posted in the powerhouse cautioning employees to avoid skin contact with the petroleum products in use and informing them of mandatory requirements for protective gloves and respirators," according to Ahart.

Because of "the seriousness of occupational exposure to benzene and other toxic substances which may be found in number six fuel," OSHA should inform federal agencies and private industry of the health hazards which may be created by the handling and use of this and other residual fuel oils, Ahart recommended.

Further, residual fuels should be included as a potential health hazard "which should be checked for during OSHA's inspections and surveys of workplaces," he added. Number six fuel, he noted, is used "extensively" by power generation and steam-heating plants, and its use "could cause dangerous exposure of employees if appropriate safeguards are not taken."

Ahart noted that OSHA in April issued an emergency benzene standard that was to have become effective May 21. However, the standard was stayed temporarily by the Fifth Circuit Court of Appeals, a stay still in effect (Current Report, May 26, p. 1587). A permanent benzene standard was proposed on May 27, hearings on which are to begin July 19 in Washington, D.C. (Current Report, June 2, p. 3).

MCD 000006183

Beryllium

NIOSH STUDY FINDS EXCESS OF CANCER AMONG WORKERS AT EXTRACTION FACILITY

A "significant excess" of cases involving brochogenic cancer and other respiratory and heart diseases occurred among employees exposed to beryllium at a Reading, Pa.,

- EPA proposes a benzene NESHAP for coke oven by-product recovery plants (49 FR 23522-23555, 6 June 1984).

- EPA withdraws the proposed NESHAP for maleic anhydride plants, ethyl benzene/styrene plants, and benzene storage vessels (49 FR 23558-23566, 6 June 1984). [Note: a notice of EPA's proposal to withdraw was published in the 6 March 1984 Federal Register]

- EPA finalizes the benzene NESHAP for fugitive emissions from petroleum refineries and chemical plants (49 FR 23498-23520, 6 June 1984).

THE FINAL FUGITIVE-BENZENE NESHAP

NESHAP apply to both new and existing affected facilities. Compliance is required within 90 days (i.e., starting from June 6) unless a waiver is obtained. Affected facilities in this case are the sum of equipment in benzene service located within a discrete process unit. "Equipment" includes valves, pumps, compressors, pressure relief devices, sampling connections, open-ended valves or lines, flanges and other connectors, and product accumulator vessels. "In benzene service" means containing or contacting a stream that is at least 10 percent benzene by weight. Plant sites that produce less than 1,100 tons of benzene per year are exempt. (~300,000 gals.)

The benzene NESHAP itself is a new Subpart J to 40 CFR Part 61. It appears on p. 23513 of the 6 June 1984 FR notice. Subpart J refers to another new Subpart (i.e., V) for the specific control requirements. Subpart V of Part 61 is an all-purpose NESHAP for volatile hazardous air pollutants (VHAP), of which benzene is the first to be included. Subpart V is also given on page 23513. Requirements under Subpart V of Part 61 are substantially the same as the NSPS (i.e., Part 60) requirements for VOCs from refineries and chemical plants. [Note: on 30 May 1985 (49 FR 22598-22608), EPA finalized the NSPS for fugitive VOCs from refineries, making the control requirements the same as for fugitive VOCs from chemical plants. The chemical plant fugitive VOC NSPS is Subpart VV of 40 CFR Part 60 and is published at 48 FR 48335, 18 October 1983. The refinery fugitive VOC NSPS is now Subpart GGG of 40 CFR Part 60, and refers to Subpart VV (i.e., the chemical plant NSPS) for specific control requirements.]

Again, the practices and control methods required by the fugitive benzene NESHAP are substantially identical to those required by the fugitive VOC NSPS. Basically, the requirements are as follows: (1) periodic leak detection/repair for valves and pumps, and (2) installation of equipment for containing leaks from compressors, sampling connecting systems, open-ended valves/lines, and accumulator vessels.

Initial review shows that no equipment at our domestic refineries is "in benzene service." This is based on the assumption that the 10-percent-benzene criterion is not met during the production of gasoline. That assumption needs to be verified (Recommended Action — K. C. Hunt). Future projects at our refineries could trigger the NESHAP (i.e., for the affected process units only). An example would be the proposed para-xylene project. However, such projects would trigger the NSPS for refinery fugitive VOCs anyway, so that the same requirements would have to be met whether the NESHAP is triggered or not. Thus, no serious

MCD 000006184

BENZENE EMISSIONS

B_3 = 7.37 = 0.264

Vol.% B_3 — Texaco BDB

Gasoline

	SAS Winter 85/86	SAS Spring'86	SAS Summer 87	1987-88 Best Typicals
L. Reg	vol.% 1.3	—	3.4 vol.%	1.1-1.3 Wt.%
U/L	0.9	—	2.1	0.7-1.1
SUL	0.4	—	1.9	0.4-0.6 (w3. blended with alky. if use high sev. Ref. could be 2.6-2)
2.1 5.54) - LSR	1.5 (1.7-1.9 wt.)	1.3	3.2 (4.25 wt.)	1.3-1.4
Cat Poly	<0.1	<0.1	<0.1	<0.1
Alky	0.1	0.2	0.2	<0.1
6.6) - Reformate-Lo(92)	1.9	3.3		2.0-2.7
✓ Hi(>96)	>2.5	3.0	4.3/5.0 (5.6)	3.9-4.5
6.3 6.0) FCC-Lt	0.8	0.8	1.0	1.0-1.3
3.7 7.1) ✓-Hvy	<0.1	0.5	0.8	<0.1-0.4
Coker	0.1			

B_3 = 0.8845

0.73

MCD 000006185

Conoco Inc.
Calculation Sheet

VOL.% BENZENE IN FINISHED GASOLINE

BILLINGS REFINERY				VOL.%
PC 1538	Bi 300	Regular	March 1977	0.9
PC 1539	Bi 301	Premium	March 1977	0.5
PC 5998	SAS	Regular	5-11-77	1.1
PC 5999	SAS	Premium	5-11-77	0.5
PC 5000	SAS	Unleaded	5-11-77	0.7

DENVER REFINERY				VOL.%
PC 2419	De 77-124	Unleaded	March 1977	0.5
	Denver	Regular	March 1977	0.5
PC 2426	De 77-128	Premium	March 1977	0.6
PC 2298		Regular		0.6

WRENSHALL REFINERY				VOL.%
PC 1781	Regular		March 1977	0.5
PC 1782	Premium		March 1977	0.7
PC 5001	SAS	Regular		0.7
PC 5002	SAS	Premium		0.8
PC 5003	SAS	Unleaded		0.8

LAKE CHARLES REFINERY				VOL.%
PC 1520	LC 232-77	Unleaded	March 1977	1.5
PC 1521	LC 344-77	Regular	March 1977	1.0
PC 1522	LC 345-77	Premium	May 1977	1.1
PC 1839	LC 640-77	Regular	May 1977	1.1
PC 1840	LC 641-77	Premium	May 1977	1.0
PC 1841	LC 642-77	Unleaded	May 1977	1.1

PARAMOUNT REFINERY				
PC 1434	PTX-2-77	Unleaded	March 1977	1.2
PC 1435	PTX-2A-77	Premium	March 1977	1.0

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(a) Scope and Application

The Standard becomes effective on December 10, 1987, and applies to all occupational exposures to benzene. Attachment 1 outlines the completion dates for the requirements within the standard's sections.

o Exempt:

- Storage, transportation, sale, or use of fuels after final discharge from bulk wholesale facilities.

- Loading and unloading operations at bulk wholesale facilities with vapor control systems for all loading and unloading operations.

- Storage, transportation, distribution or sale of materials containing >0.1% benzene in intact containers or transport pipelines while sealed.

- Containers and pipelines with <0.1% benzene.

- Natural gas processing plants processing gas with <0.1% benzene.

NOTE: Since the potential exists for benzene to concentrate within different streams in natural gas plants, it is recommended that streams be sampled to determine those which may contain >0.1% benzene and that locations be placed under the standard accordingly.

- Oil and gas drilling, production and servicing operations.

- Cleaning and repair of barges and tankers are excluded from:

  (e)(1) Exposure Monitoring - General
  (e)(6) Accuracy of Monitoring
  (f) Methods of Compliance

- Work operations with liquid mixtures containing:

  ≤0.5% benzene - until September 12, 1988
  ≤0.3% benzene - until September 12, 1989
  ≤0.1% benzene - after September 12, 1989

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NOTE: It is recommended that work operations with liquid mixtures containing >0.1% benzene be considered as covered by the standard immediately. This will make compliance assurance less complicated relative to monitoring requirements. Attachment 2 is a list of CONOCO products and intermediate refinery streams which contain >0.1% benzene as reflected on the Conoco Material Safety Data Sheet (MSDS).

All operations must comply with the OSHA Hazard Communication Standard (29 CFR 1910.1200) and the emergency provisions of the benzene standard.

Exemptions are still covered by the previous exposure limits (8-hour TWA = 10 ppm; ceiling = 25 ppm; max peak above ceiling for an 8-hour shift = 50 ppm for 10 minutes max duration).

(b) Definitions

"Authorized person" means any person specifically authorized by the employer whose duties require the person to enter a regulated area, or any person entering such an area as a designated representative of employees for the purpose of exercising the right to observe monitoring and measuring procedures under paragraph (l) of this section, or any other person authorized by the Act or regulations issued under the Act.

"Benzene" (C6H6) (CAS Registry No. 71-43-2) means liquefied or gaseous benzene. It includes benzene contained in liquid mixtures and the benzene vapors released by these liquids. It does not include trace amounts of unreacted benzene contained in solid materials.

"Bulk wholesale storage facility" means a bulk terminal or bulk plant where fuel is stored prior to its delivery to wholesale customers.

"Container" means any barrel, bottle, can, cylinder, drum, reaction vessel, storage tank, or the like, but does not include piping systems.

"Day" means any part of a calendar day.

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"Emergency" means any occurrence such as, but not limited to, equipment failure, rupture of containers, or failure of control equipment which may or does result in an unexpected significant release of benzene.

"Employee exposure" means exposure to airborne benzene which would occur if the employee were not using respiratory protective equipment.

"Regulated area" means any area where airborne concentrations of benzene exceed or can reasonably be expected to exceed, the permissible exposure limits, either the 8-hour time weighted average exposure of 1 ppm or the short-term exposure limit of 5 ppm for 15 minutes.

"Vapor control system" means any equipment used for containing the total vapors displaced during the loading of gasoline, motor fuel or other fuel tank trucks and the displacing of these vapors through a vapor processing system or balancing the vapor with the storage tank. This equipment also includes systems containing the vapors displaced from the storage tank during the unloading of the tank truck which balance the vapors back to the tank truck.

(c) Permissible Exposure Limits (PEL's)

(c)(1) Time-Weighted Average Limit (TWA)

- 1 ppm as an 8-hour TWA.

(c)(2) Short-Term Exposure Limit (STEL)

- 5 ppm as averaged over 15 minutes.

NOTE: There is also an Action Level of 0.5 ppm (8-hour TWA) that effects monitoring, medical surveillance and training requirements.

(d) Regulated Areas

- All locations/operations which exceed or can reasonably be expected to exceed either of the PEL's (TWA or STEL) must be designated as a regulated area. This includes maintenance and other temporary types of operations.

- All regulated areas must be demarcated in a manner that limits employee access into the areas; e.g. ropes, markings, barricades, gates, etc. (See (j) Communication of Benzene Hazards to Employees for sign requirements.)

- Access to regulated areas must be limited to authorized persons.

(e) Exposure Monitoring

(e)(1) General

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- Personal (breathing zone) air samples must be used to determine representative employee exposures.

- Representative 8-hour TWA employee exposures must be based on monitoring representing the full shift exposure for each potentially exposed job classification, on each shift, in each work area covered by the standard. (See Scope & Application for exemptions.)

- STEL measurements are to be based on 15-minute personal air samples measured during tasks where exposure potential is high; e.g. gauging, sampling, opening tanks, lines and process equipment, etc. Grab samples (detector tubes, real time monitors) may be used to determine where 15-minute STEL monitoring is required.

- After the initial monitoring phase, only the shift showing consistently higher exposures for a job classification requires periodic monitoring.

NOTE: It is recommended that passive organic vapor monitors (POVM's)

VOL.% BENZENE OF REFINERY STREAMS

		LAKE CHARLES REFINERY (May 1977)	Vol.%
PC 1842	LC 643-77	Coker Gasoline	0.2
PC 1843	LC 644-77	Thermal Gasoline	0.3
PC 1844	LC 645-77	TCC Gasoline	0.5
PC 1819	LC 646-77	#1 L.S.R.	1.8
PC 1846	LC 644-77	#2 L.S.R.	1.6
PC 1847	LC 648-77	Denuded Casinghead	3.7
PC 1848	LC 649-77	#1 Reformate	0.9
PC 1849	LC 650-77	#2 Reformate	1.0
PC 1850	LC 651-77	Primary Tower OH	2.8