

PROPOSED PERM.
STANDARD

Washington Bulletin

NATIONAL PETROLEUM REFINERS ASSOCIATION

Founded 1902

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DEPARTMENT OF ENERGY

MAY 31 1977

May 27, 1977

OSHA Proposes Permanent Standard for Benzene

Another step was taken by OSHA today in achieving its goal of reducing employee exposure to benzene in the workplace. In proposing permanent regulation of benzene, the agency has for the most part, avoided declaring more stringent requirements than those in the Emergency Temporary Standard (ETS) which we reported had been stayed by the federal court until a hearing on a permanent stay request on June 6, 1977. (See Washington Bulletin dated May 20, 1977).

There is one specific provision that the proposal contains which will dramatically affect both the refining and petrochemical industries. As in the ETS, the prescribed requirements would not apply to work operations where the only exposure is from liquid mixtures containing 1.0% or less of benzene by volume or the vapors released from these liquids. After one year, the proposal would reduce this exclusion to 0.1%, which would extend coverage to a great proportion of the substances present in facilities processing crude oil or its derivatives.

Other than that change, the proposed final standards are more notable for the issues left unresolved than for any definite decisions on the ultimate terms industry will be required to meet. It appears as though OSHA has chosen to defer further controversy on most of the issues to the public hearing now scheduled for July 19, 1977 and subsequent publication of final rules, by asking for comments on the provisions' "appropriateness." It is reasonable to assume that OSHA does not intend to relax any of the provisions. One could infer that OSHA intends to avoid any protracted debates until after the final standards are promulgated. This means that industry has the burden of insuring that the hearing record is complete in every respect, should any court review of the standard be undertaken. It would then be necessary to prove that OSHA's actions were arbitrary and capricious in order to have a court overturn them.

This proposal does contain several other changes from the ETS that was published on May 3, 1977. The first incorporates an amendment to the ETS published May 24, which extends the exclusion granted to retail automotive service stations back to the storage, transportation, distribution, dispensing, or sale of gasoline as a fuel subsequent to discharge from bulk terminals which receive gasoline by tanker, barge or pipeline. This revision is

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FRIDAY, MAY 27, 1977

PART VI



FROM
NATIONAL PETROLEUM REFINERS ASSOCIATION
WASHINGTON BULLETIN

DEPARTMENT OF LABOR

Occupational Safety and
Health Administration



OCCUPATIONAL EXPOSURE TO BENZENE

Emergency Temporary Standards;
Hearing

MCD 000000345

Sections 2(b) (5) and (6), 20, 21, 22, and 24 of the Act reflect Congress' recognition that conclusive medical or scientific evidence including causative factors, epidemiological studies or dose-response data may not exist for many toxic materials or harmful physical agents. Nevertheless, standards cannot be postponed because definitive medical or scientific evidence is not currently available. Indeed, standards need only be supported by the best available evidence. The legislative history makes it clear that "it is not intended that the Secretary be paralyzed by debate surrounding diverse medical opinion." House Committee on Education and Labor, Report No. 91-1291, 91st Cong., 2d Sessions, p. 18 (1970). This Congressional judgment is supported by the courts which have reviewed standards promulgated under the Act. In sustaining the standard for occupational exposure to vinyl chloride (29 CFR 1910.1017), the U.S. Court of Appeals for the Second Circuit stated that "it remains the duty of the Secretary to act to protect the working man, and to act even in circumstances where existing methodology or research is deficient." *Society of the Plastics Industry Inc. v. Occupational Safety and Health Administration*, 509 F. 2d 1301 (C.A.2 1975), cert den sub nom. *Firestone Plastic Co. v. United States Department of Labor*, 95 S. Ct. 1998, 4 L.Ed. 2d 482 (1975).

A similar rationale was applied by the U.S. Court of Appeals for the District of Columbia Circuit in reviewing the standard for occupational exposure to asbestos (29 CFR 1910.1001). The Court stated that:

Some of the questions involved in the promulgation of these standards are on the frontiers of scientific knowledge, and consequently as to them insufficient data is presently available to make a fully informed factual determination. Decision-making must in that circumstance depend to a greater extent upon policy judgments and less upon purely factual judgments.

Industrial Union Department, AFL-CIO v. Hodgson, 499 F. 2d 467, 474 (C.A. D. C.1974).

In setting standards, the Secretary is expressly required to consider the feasibility of the proposed standards. Senate Committee on Labor and Public Welfare, S. Rep. No. 91-1282, 91st Cong., 2d Sess., p. 58 (1970). Nevertheless, considerations of technological feasibility are not limited to devices already developed and in use. Standards may require improvements in existing technologies or require the development of new technology. *Society of the Plastic Industry, Inc. v. Occupational Safety and Health Administration*, supra at 1309.

Where appropriate, the standards are required to include provisions for labels or other forms of warning to apprise employees of hazards, suitable protective equipment, control procedures, monitoring and measuring of employee exposure, employee access to the results of monitoring, and appropriate medical examinations. Moreover, where a standard prescribes medical examinations or other tests, they must be made available at

no cost to the employees (section 6(b) (7)). Standards may also prescribe recordkeeping requirements where necessary or appropriate for enforcement of the Act or for developing information regarding occupational accidents and illnesses (section 8(c)).

III. SUMMARY AND EXPLANATION OF ADDITIONS TO OR MODIFICATIONS OF THE ETS

The requirements imposed by OSHA in the ETS were those requirements that OSHA considered essential and feasible for employers to meet immediately, pending the development of a permanent standard. The preamble to the ETS explains the purpose and rationale for the provisions of the ETS. The following sections discuss any changes or additions that have been made in this proposal, changes or additions that OSHA believes are more appropriate for a final, permanent standard regulating employee exposure to benzene.

A. Scope and application. In the ETS and its subsequent amendments, OSHA exempted storage, transportation, distribution, dispensing, or sale of gasoline as a fuel subsequent to the discharge of such gasoline from bulk terminals, and exposure to liquids containing benzene in amounts of 1 percent or less by volume.

OSHA recognizes the need for development of appropriate equipment control devices to reduce the loss of gasoline vapors containing benzene. OSHA also recognizes that, while the scope of its statutory obligations may be different than those of the Environmental Protection Agency (EPA), that Agency has a rich background of knowledge in the area of engineering control of hydrocarbon vapors. OSHA announces that it is in the process of establishing with EPA and NIOSH a joint federal agency taskforce to coordinate efforts in reducing worker exposure to benzene in retail automotive gasoline stations, and certain other aspects of transportation, storage, distribution and sale of gasoline and other motor fuels, if the facts warrant. OSHA will decide as a part of this rulemaking whether to include these employers in the final, permanent standard on benzene, to commence an independent rulemaking proceeding concerning worker exposure to benzene at these workplaces or to take other appropriate regulatory action in conjunction with EPA. OSHA is seeking the widest possible public input regarding the appropriate regulatory mechanism for protecting employees exposed to benzene at retail automotive gasoline stations, and during activities related to storage, transportation, and distribution of gasoline. Since other hazardous substances, such as asbestos, are present in gasoline stations, one regulatory option would be a "vertical" standard on all occupational hazards in retail gasoline stations. Moreover, OSHA desires comment on whether certain protective requirements should be included in any standard applying to gasoline stations and related activities, for example limit-

ing use of gasoline as a solvent in such workplaces, and requiring information and training of employees.

As to liquids containing a certain percentage of benzene, the ETS did not apply where the only benzene exposure was from liquids containing benzene in amounts of 1 percent or less by volume. Benzene is a contaminant as well as an additive in a multitude of industrial substances; for example, benzene is found in toluene, gasoline, xylene, petroleum naphthas, and other hydrocarbon derivatives. The degree of benzene contamination in these and other materials is variable depending upon the practices of individual refineries and the material specifications established by many large volume solvent purchasers.

The ETS excluded mixtures containing 1 percent or less benzene by volume based upon OSHA's concern for the feasibility of requiring employers to implement such regulatory activities in so large a number of establishments in a short period of time. Moreover, there is some evidence that employee exposures to these substances are generally less than 1 part per million. However, in this proposal for a permanent standard, OSHA believes that a more careful consideration of this issue is necessary. There is only limited evidence which serves to correlate the potential exposure levels with the amount of benzene contaminant in solvent mixtures. As pointed out in the ETS, there is some indication that exposures resulting from the use of mixtures containing less than 1 percent benzene will generally be less than 1 part per million. However, it is not clear that this would always be the case.

The Arthur D. Little study of technological feasibility and economic impact presents a summary of the data on the benzene content of various solvents and employee exposures that reportedly result from the use of these solvents; for example, within the rubber industry employee exposure to benzene during tire building operations ranges from 1 to 3 parts per million on an 8-hour time weighted average basis. These exposure result from the use of petroleum naphtha (white gasoline) which contains benzene in amounts ranging up to 4 percent by volume.

There appears to be no safe level for exposure to a carcinogen, and particularly as to benzene, as pointed out in the ETS. However, benzene is a widespread contaminant in industrial substances and is present in a large number of workplaces. As noted above, there is limited evidence presently available to predict the exposure that would typically result from the use of many of these substances. OSHA recognizes that the lower the benzene content, generally the lower the worker exposure. Consistent with its general policy of limiting exposure to carcinogens to the lowest feasible level, OSHA intends to exempt from the permanent standard only those substances for which the benzene content has been reduced to the greatest extent feasible.

that the other requirements to regulate exposure to benzene must be imposed, as set forth in the proposal. After the rulemaking record is closed, OSHA will evaluate all the evidence received and issue a final permanent standard based on the entire record.

V. TECHNOLOGICAL FEASIBILITY ASSESSMENT AND ECONOMIC IMPACT STATEMENT

Pursuant to section 6(b) of the Occupational Safety and Health Act and in accordance with Executive Order No. 11949 (42 FR 1017, January 5, 1977), OSHA contracted for and received a technological feasibility assessment and economic impact statement from Arthur D. Little Company. This statement has been reviewed and OSHA concludes that the proposed regulation of benzene is a "major" action. The Assistant Secretary certifies that the economic impact of this proposal has been evaluated.

This statement along with all other references cited and other relevant material, are available for inspection and copying at the OSHA Technical Data Center, Room S6212, Third St. and Constitution Avenue, NW., Washington, D.C. 20210. OSHA invites comments on any of the information contained or conclusions reached, in the statement concerning technological feasibility and economic impact.

VI. ENVIRONMENTAL IMPACT

The preceding description of the proposed standard and its supporting rationale together with that found in the annexed ETS, as well as the following sections on environmental impact, constitute OSHA's draft environmental impact statement on the proposed standard for occupational exposure to benzene.

This statement has been prepared in accordance with the provisions of the National Environmental Policy Act (42 U.S.C. 4321 et. seq.) as well as the guidelines of the Council on Environmental Quality (40 CFR Part 1500) and OSHA's regulations (29 CFR Part 1999). The purpose of this draft environmental impact statement is to aid in the Agency decision making on proposed actions which may have the potential for significantly affecting the quality of the human environment. Written comments and information on the projected impacts of this proposed standard for exposure to benzene are solicited from any interested persons or groups during the period for written comment submissions listed below in this Notice.

In addition to this general request for comment, copies of this proposal and environmental impact statement will be sent to numerous Federal and State agencies, industry representatives, employee unions, and public interest groups with requests for their comments. A copy of this listing is available in the OSHA Technical Data Center, Room S-6212, Department of Labor, Third Street and Constitution Avenue, NW., Washington, D.C. 20210.

Testimony, data, arguments, and related submissions will be received at the public hearing to be held on this proposed

standard on July 19, 1977, provided pre-hearing submission requirements, also outlined below, are complied with.

Additional copies of this proposed standard and draft environmental impact statement are available for review and copying in the OSHA Technical Data Center.

ALTERNATIVES

There are three major areas of regulatory decision making which will affect the impact of the benzene standard on the external environment. These are: (1) the scope and application of the regulation, (2) the airborne permissible exposure limit, and (3) the methods by which compliance is mandated. The purpose of this section is to present the alternatives available. The discussion of the impact of each of these alternatives will be in the following section.

(1) *Scope and application.* The emergency temporary standard (ETS) applied to all establishments in which benzene is present, including "general industry," construction, and maritime. The ETS did not apply, however, to storage, transportation, distribution, dispensing, or sale of gasoline as a fuel subsequent to discharge of such gasoline from bulk terminals nor to operations utilizing liquid mixtures containing 1 percent or less benzene by volume.

This proposal applies to "general industry," construction and maritime. It has retained the exclusion for the storage, transportation, distribution, dispensing, or sale of gasoline as a fuel subsequent to discharge of such gasoline from bulk terminals. Although the proposal retains the ETS exemption of those operations utilizing liquids containing less than 1.0 percent benzene by volume, this exemption would be in effect only for one year. Thereafter, only operations containing 0.1 percent or less benzene by volume would be exempted.

Other options available to OSHA include elimination of the percentage exclusion or the expansion of coverage to retail automotive service stations and a broader range of gasoline industries. Conversely, OSHA could further restrict the scope of the regulation.

(2) *Permissible exposure limit.* The previous OSHA permanent standard for benzene, in effect prior to the issuance of the ETS, prescribed an 8-hour time weighted average (TWA) of 10 ppm with an acceptable ceiling concentration of 25 ppm. In addition, it allowed excursions above the ceiling to a maximum peak concentration of 50 ppm, provided that this peak occurred for no more than 10 minutes in any 8-hour work period. This standard was based largely on benzene's general toxicity rather than on its leukemia hazard.

The proposal establishes an airborne permissible exposure limit (PEL) of 1 ppm with a ceiling limit of 5 ppm exposure averaged over any 15 minute period. The proposal additionally prohibits eye contact and repeated skin exposure to liquid benzene.

The PEL adopted by this proposal was chosen not as a "safe" or "no effect"

level, but on the basis of OSHA's belief that 1 ppm is the lowest level that generally can be achieved. OSHA is mandated by the Act to consider feasibility in setting regulations. However, it is possible that a level lower than 1 ppm could be shown to be feasibly attained either by existing controls or by the development of new controls. In that case, OSHA has the option to regulate to whatever level below 1 ppm is determined to be appropriate.

Another regulatory alternative is to adopt differing standards for different industries, moderating the degree of regulation as deemed necessary for adequate and feasible protection of workers in the various industries where benzene is present.

(3) *Methods of compliance.* OSHA's regulation, 29 CFR 1910.1000, under which benzene was initially regulated, provided that compliance be achieved first through administrative or engineering controls, whenever feasible, and, when such controls were not feasible, through the use of supplementary protective equipment.

This proposal requires the institution of engineering and work practice controls to reduce exposure to or below the PEL. In addition, the proposal requires that a program be established and implemented to reduce exposures to or below the PEL solely by means of engineering and work practice controls. Protective clothing and equipment are also required where necessary to prevent eye contact or repeated skin contact.

Engineering controls may include the installation of local exhaust ventilation, modification of a process so as to reduce emissions, or substitution of another substance for benzene.

Alternatives involved in the compliance section of the regulation are primarily concerned with establishing a particular priority among the types of controls (engineering, work practice, and respiratory protective equipment). Sole reliance on engineering controls or on use of engineering and work practices equally could be required. Another alternative would allow the employer complete freedom in choosing the method of control without any required priority systems. An alternative approach would be to specify controls, such as reformulation of products to decrease benzene content, or the preferential use of vapor recovery systems over ventilation.

Additionally, there are other areas in which alternative actions might variously have impact upon what is considered the external environment. One of these areas is medical surveillance. The ETS provided for the minimum tests considered necessary to determine the effects of exposure to benzene. This proposal requires a more comprehensive evaluation and more sensitive means of detecting changes which may indicate effects of exposure.

It is clear that there are numerous areas with various regulatory approaches which may have differential effects on some aspects of the external environment. The possible impacts of these ap-

PROPOSED RULES

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TABLE II (5).—Benzene emissions to the environment—1971

[In millions of pounds]

Source	Location	Quantity	Media of entry
Commercial benzene production, storage and transport.	Primarily southwest.	79 (assumed 1 pct. of total production).	Air, water.
Commercial benzene usage.	Primarily southwest and northeast.	658 (based on reaction yields).	Do.
Oil spills.	Oceans and rivers.	22-24.	Water.
Motor vehicle emissions.	Similar to population distribution.	1,000.	Air.
Coke ovens.	Primarily, North Central States and Alabama.	122 (1974).	Air.

Source: Modified from Walker, P., "Air Pollution Assessment of Benzene; Mitre Technical Report," MTR-7188 Mitre Corp.; McLean, Va., 1976.

TABLE III (6).—Emission factors for petroleum refineries

Type of process:	Hydrocarbons	Type of process:	Hydrocarbons
Fluid catalytic cracking units (FCC):		Kilograms per thousand liters waste water—	
Pounds per thousand barrels fresh feed.	220	With control.	.023
Kilograms per thousand liters fresh feed.	.630	Without control.	.600
Moving-bed catalytic cracking units (TCC):		Vacuum jets:	
Pounds per thousand barrel fresh feed.	87	Pounds per thousand barrels vacuum distillation—	
Kilograms per thousand liters fresh feed.	.250	With control.	130 ⁽¹⁾
Blowdown systems:		Without control.	
Pounds per thousand barrels refinery capacity—		Kilograms per thousand liters vacuum distillation—	
With control.	5	With control.	(1)
Without control.	300	Without control.	.370
Kilograms per thousand liters refinery capacity—		Cooling tower:	
With control.	.014	Pounds per thousand gallons cooling water.	6
Without control.	.860	Kilograms per thousand liters cooling water.	.72
Process drains:		Miscellaneous losses, pounds per thousand barrels refinery capacity: ¹	
Pounds per thousand barrels waste water—		Pipeline valves and flanges.	28 (.080)
With control.	8	Vessel relief valves.	11 (.031)
Without control.	210	Pump seals.	17 (.049)
		Compressor seals.	5 (.014)
		Other (air blowing, sampling, etcetera).	10 (.029)

¹ Kilograms per thousand liters shown in parentheses.

TABLE IV (6).—Hydrocarbon emission factors for evaporation losses from the storage of petroleum products

Type of tank ¹	Units	Type of material stored	Crude oil
		Gasoline or finished petroleum product	
Fixed roof breathing loss.	Pounds per day—1,000 gal storage capacity....	0.4	0.3
	Kilograms per day—1,000 l storage capacity....	.06	.04
Working loss ² .	Pounds per 1,000 gal throughput.....	11	8
	Kilograms per 1,000 l throughput.....	1.32	.96
Floating roof breathing loss.	Pounds per day—tank.....	(³)	(³)
	Kilograms per day—tank.....	63.5	45.4
Working loss.	Pounds per 1,000 gal throughput.....	(³)	(³)
	Kilograms per 1,000 l throughput.....	(³)	(³)

¹ For tanks equipped with vapor-recovery systems, emissions are negligible.

² An average turnover rate for petroleum storage is approximately 6. Thus, the throughput is equal to 6 times the capacity.

³ 140 (40 to 210), 140 (63.5) based on average conditions and tank diameter of 100 ft (30.5 m); use 40 (18.1 kg) for smaller tanks, 50 ft (15.3 m) diameter; use 210 (95 kg) for larger tanks, 150 ft (45.8 m) diameter.

⁴ 100 (30 to 160). Use 30 (13.6 kg) for smaller tanks, 50 ft (15.3 m) diameter; use 160 (72.5 kg) for larger tanks, 150 ft (45.8 m) diameter.

⁵ Negative.

The Compilation of Air Pollution Emission Factors published by the Environmental Protection Agency states, "There are essentially no emissions from reforming operations" in the petroleum refining industry. However, due to benzene's volatility there is a possibility that some environmental contamination occurs during these operations.

Promulgation of a 1 ppm level for benzene will have the effect of reducing overall emissions for benzene. This results because greater controls will be maintained over leaking process equipment and fugitive emissions. In this case there is an anticipated positive impact

on the external environment of reduced benzene emissions from production sites.

2. *Storage and Transportation.* Since gasoline contains a certain amount of benzene, an alternative to the proposal would also affect gasoline storage and marketing facilities as well as firms distributing gasoline. Expected means of compliance would suggest that engineering controls possibly include internal floating roofs on storage tanks, bottom loading assemblies and vapor condensing and/or return equipment. Tables IV and V illustrate the expected hydrocarbon emission rates (a portion of these amounts are benzene) resulting from

storage and transfer operations (6). The application of vapor return or recovery equipment, as well as internal floating roofs and bottom loading assemblies, will largely eliminate ambient emissions.

3. *Commercial Usage: Chemical Processing.* The chemical process industries utilizing benzene feedstock material were evaluated during the development of the Economic Impact Analysis (EIA) prepared for OSHA by Arthur D. Little. It was determined that these operations were largely in compliance with the previous OSHA standard due to the constraints of closed system operations and the economics of preventing possible losses of feedstock and products. Possible, though infrequent, over-exposures would be due to non-routine situations such as process upsets or equipment failure.

As with the benzene production facilities, engineering controls may be necessary to comply with a 1 ppm benzene standard. Controls would be very similar in type and extent to those used in the production facilities to reduce emissions during process operations and from fugitive sources. The reduction in process and fugitive losses may result in a significant, (though as yet unquantified) reduction in benzene emissions and those of its process intermediates.

4. *Commercial Usage: Solvent Usage.* Another use of benzene is as an industrial solvent. Benzene has been largely removed from solvent applications, often being replaced by toluene, which, however, does contain a small percentage of benzene. Benzene is still found in a limited number of specialized low volume applications such as proprietary adhesives within the rubber industry, and in paint remover formulations.

The purpose of solvent materials is simply to provide a vehicle for solid materials to facilitate the application of solid materials. As such, much of the benzene used as solvent is lost by evaporation upon application. Only a limited number of processes within the adhesives and printing industries utilize vapor recovery equipment as a method of solvent recovery and recycling.

Exposure control of this compound in solvent application involves a variety of alternatives (7). Primary among the control alternatives would be general dilution and local exhaust ventilation systems and product reformulation to either reduce or remove the benzene component. These alternatives will be discussed separately for their possible environmental impacts.

A common method for protecting workers from solvent vapors is to provide adequate ventilation to both dilute the vapors with fresh air and to carry them out of the worker breathing zone. This approach to exposure reduction finds widespread application within industries having adhesive and coating solvent exposures. The necessary equipment and design knowledge for spray booth and ventilation-hood installations is readily available for these applications. In many cases, existing equipment can be adapted to achieve lower exposures by increasing

In its ongoing process of developing water pollution criteria, EPA is currently evaluating aquatic benzene toxicity. At the present time, benzene effluents are controlled as contributors to the total BOD load of industrial effluents. As such, OSHA regulations resulting in slightly more benzene effluent would not conflict with EPA water effluent standards as long as the total BOD (biological oxygen demand) level is controlled. While this relationship in regard to water emissions may change with future standard setting on the part of EPA, it is not expected to alter industry's approach to compliance with OSHA benzene regulations. Since benzene is normally only a portion of the effluent produced by a given industry and it does not offer any unusual problems during water treatment (3) compliance with EPA regulations can be expected to be within industry's capabilities.

The Consumer Product Safety Commission (CPSC) was petitioned on May 8, 1977 by the Health Research Group to ban and recall benzene-containing products by its authority under the Hazardous Substances Act. At this time the agency is reviewing the petition and does intend to respond.

Whatever possible action the CPSC might take should create no interference with OSHA's regulation of occupational exposure to benzene.

REFERENCES

- (1) Seminar on Air Pollution from Motor Vehicles; Technical Coordination, Office of Air Programs, Environmental Protection Agency; 1972.1.
- (2) Air Quality Criteria for Photochemical Oxidants; U.S. Department of Health, Education and Welfare, National Air Pollution Control Administration, No. AP-63, 1970.
- (3) Air Quality Criteria for Hydrocarbons; U.S. Department of Health, Education and Welfare, National Air Pollution Control Administration, No. AP-64, 1970.
- (4) Burghardt, E. and Jelles, R.; Gas Chromatographic Determination of Aromatic Hydrocarbons in Air Using a Semi-Automatic Preconcentration Method; Atmospheric Environ., 9, 355-940; 1975.
- (5) Walker, P.; Air Pollution Assessment of Benzene; Mitre Technical Report, MTR-7188; Mitre Corporation, McLean, Va.; 1976.
- (6) Adapted from: Compilation of Air Pollution Emission Factors (Revised), U.S. Environmental Protection Agency, AP-42; 1972.
- (7) Technology Assessment and Economic Impact Study of an OSHA Regulation for Benzene—Draft Report; for U.S. Department of Labor, Occupational Safety and Administration; Arthur D. Little, Inc., Cambridge, Mass., October 1976.
- (8) Air Pollution Engineering Manual; Danielson, John A., ed.; Environmental Protection Agency, Research Triangle Park, N.C., 1973.
- (9) Ellerhorst, H.; Energy Crisis; Catalyst for Change; Modern Paint and Coatings, p. 31-33; October 1975.
- (10) Policy Statement on Use of the Concept of Photochemical Reactivity or Organic Compounds in State Implementation Plan for Oxidant Control, EPA Quality Office, January 29, 1976.
- (11) Communication with Plant Manager of Durant Paints, Inc., Revere, Massachusetts.
- (12) Communication with Plant Manager of Touraine Paints, Inc., Everett, Massachusetts.

- (13) Howard, P. H. and Sustin, R. R.; Benzene: Environmental Sources of Contamination, Ambient Levels, and Fate; Office of Toxic Substances, U.S. Environmental Protection Agency; EPA 560/5-75-005; December 1974.
- (14) Blamer, M., Saunders, H. L., Grassie, J. F. and Hamson, G. R.; A Small Oil Spill; Environment, 13, 2-12; March 1971.
- (15) Communication with Mr. J. L. Goodier, Bio-Enviro Section, Arthur D. Little, Inc., Cambridge, Massachusetts; December 1976.
- (16) Communication with Mr. G. Hama; Industrial Hygienist, Wayne State University, Detroit, Michigan; December 1976.

VII. PUBLIC PARTICIPATION; NOTICE OF HEARING

Interested persons are invited to submit written data, views and arguments with respect to the ETS and this subsequent proposal. These comments must be postmarked on or before June 27, 1977, and submitted in quadruplicate to the Docket Officer, Docket H-059, Room S6212, U.S. Department of Labor, 3rd Street and Constitution Avenue, N.W., Washington, D.C. 20210. Written submissions must clearly identify the provisions of either the ETS, the proposal, or both which are addressed and the position taken with respect to each issue therein. The data, views and arguments that are submitted will be available for public inspection and copying at the above address. All timely written submissions received will be made a part of the record for this proceeding.

Pursuant to section 6(b)(3) of the Act, an opportunity to submit oral testimony concerning the issues raised by the ETS and the proposed standard, including the economic and environmental impacts, will be provided at an informal public hearing scheduled to begin at 9:30 a.m. on July 19, 1977, in the Auditorium, New Department of Labor Building, 3rd Street and Constitution Avenue, N.W., Washington, D.C., 20210.

NOTICES OF INTENTION TO APPEAR

All persons desiring to participate at the hearing, must file in quadruplicate, a notice of intention to appear, postmarked on or before June 27, 1977 with the OSHA Division of Consumer Affairs, Docket No. H-059, Room N-3635, U.S. Department of Labor, 3rd Street and Constitution Avenue, N.W., Washington, D.C. 20210 (telephone: (202) 523-8024). The notices of intention to appear, which will be available for inspection and copying at the OSHA Technical Data Center-Docket Office (Room S6212), telephone (202) 523-7894, must contain the following information:

- (1) The name, address, and telephone number of each person to appear;
- (2) The capacity in which the person will appear;
- (3) The approximate amount of time requested for the presentation;
- (4) The specific issues that will be addressed;
- (5) A detailed statement of the position that will be taken with respect to each issue addressed; and
- (6) Whether the party intends to submit documentary evidence, and if so, a brief summary of that evidence.

FILING OF TESTIMONY AND EVIDENCE BEFORE HEARING

Any party requesting more than 15 minutes for a presentation at the hearing, or who will submit documentary evidence, must provide in quadruplicate the complete text of testimony, including any documentary evidence to be presented at the hearing, to the OSHA Division of Consumer Affairs. This material must be received by July 11, 1977, and will be available for inspection and copying at the Technical Data Center—Docket Office. Each such submission will be reviewed in light of the amount of time requested in the notice of intention to appear. In those instances where the information contained in the submission does not justify the amount of time requested, a more appropriate amount of time will be allocated and the participant will be notified of that fact.

Any party who has not substantially complied with this requirement may be limited to a 15 minute presentation, and may be requested to return for questioning at a later time.

CONDUCT OF HEARINGS

The hearing will commence at 9:30 a.m. on July 19, 1977, with resolution of any procedural matters relating to the proceeding. The hearing will be conducted in accordance with 29 CFR Part 1911. In view of the ETS and its emergency nature, the hearing will be conducted in as expedited a manner as possible, consistent with a full development of the record and rights of the parties.

The hearings will be presided over by an Administrative Law Judge who will have all the powers necessary or appropriate to conduct a full and fair informal hearing as provided in 29 CFR Part 1911. Following the close of the hearing or of any post hearing comment period that might be provided, the Administrative Law Judge will certify the record to the Assistant Secretary of Labor for Occupational Safety and Health. The proposal will be reviewed in light of all oral and written submissions received as part of the record, and a standard will be issued based on the entire record in this proceeding.

VIII. AUTHORITY

This document was prepared under the direction of Eula Bingham, Assistant Secretary of Labor for Occupational Safety and Health, U.S. Department of Labor, Third Street and Constitution Avenue, N.W., Washington, D.C. 20210.

Accordingly, pursuant to sections 4(b), 6(b), 6(c) and 8(c) of the Occupational Safety and Health Act of 1970 (84 Stat. 1592, 1593, 1596, 1599, 29 U.S.C. 653, 655, 657), the Secretary of Labor's Order No. 8-76 (41 FR 25059), and 29 CFR Part 1911, it is hereby proposed to amend Part 1910 of Title 29, Code of Federal Regulations by amending section 1910.1028 as set forth below. In addition, pursuant to section 4(b)(2) of the Act (84 Stat. 1592; 29 U.S.C. 653), OSHA is of the view that the proposed standard is more effective than the corresponding

achieved by the use of respirators except:

(i) During the time period necessary to install or implement feasible engineering and work practice controls; or

(ii) In work operations such as maintenance and repair activities in which engineering and work practice controls are not feasible; or

(iii) In work situations where feasible engineering and work practice controls are not yet sufficient to reduce exposure to or below the permissible exposure limit; or

(iv) In emergencies.

(2) *Respirator selection.* (i) Where respirators are required under this section, the employer shall select and provide the appropriate respirator from Table I below and shall assure that the employee uses the respirator provided.

(ii) The employer shall select respirators from among those approved by the National Institute for Occupational Safety and Health under the provisions of 30 CFR Part 11.

TABLE I.—RESPIRATORY PROTECTION FOR BENZENE

Concentration of benzene or condition of use	Respirator type
(a) Less than or equal to 10 p/m.	(1) Any chemical cartridge respirator with organic vapor cartridge and; or (2) Any supplied air respirator.
(b) Less than or equal to 50 p/m.	(1) Any chemical cartridge respirator with organic vapor cartridge and full facepiece; or (2) Any supplied air respirator with full facepiece; or (3) Any organic vapor gas mask; or (4) Any self-contained breathing apparatus with full facepiece.
(c) Less than or equal to 1,000 p/m.	(1) Supplied air respirator with half mask in positive pressure mode.
(d) Less than or equal to 2,000 p/m.	(1) Supplied air respirator with full facepiece, helmet, or hood, in positive pressure mode.
(e) Less than or equal to 10,000 p/m.	(1) Supplied air respirator and auxiliary self-contained facepiece in positive pressure mode; or (2) Open circuit self-contained breathing apparatus with full facepiece in positive pressure mode.
(f) Escape	(1) Any organic vapor gas mask; or (2) Any self-contained breathing apparatus with full facepiece.

(3) *Respirator program.* The employer shall institute a respiratory protection program in accordance with § 1910.134 (b), (d), (e) and (f).

(4) *Respirator use.* (i) Where air-purifying respirators are used (cartridge, canister, or gas mask), the employer shall replace the air-purifying canisters or cartridges prior to the expiration of their service life or the end of the shift in which they are first used, whichever occurs first.

(ii) The employer shall assure that the respirator issued to the employee exhibits minimum facepiece leakage and that the respirator is properly fitted.

(iii) The employer shall allow each employee who wears a respirator to wash his or her face and respirator facepiece to prevent skin irritation associated with respirator use.

(h) *Protective clothing and equipment.* Where eye or repeated skin contact with liquid benzene may occur, the employer shall provide and assure that employees wear appropriate protective clothing and equipment to protect the area of the body likely to come in contact with liquid benzene.

(i) *Medical surveillance.*

(1) The employer shall make available a medical surveillance program for all employees who are or will be exposed to benzene. The medical surveillance program shall include:

(i) A history which includes past work exposures to benzene or any other hematologic toxins; a family history of blood dyscrasias including hematological neoplasms; a history of blood dyscrasias

including genetically related hemoglobin alterations, bleeding abnormalities, abnormal function of formed blood elements; a history of renal or liver dysfunction; a history of drugs routinely taken, alcoholic intake and systemic infections;

(ii) A complete blood count including red cell count, white cell count, platelet count, hematocrit, hemoglobin, mean corpuscular volume, a differential white blood cell count;

(iii) A reticulocyte count;

(iv) A serum bilirubin; and

(v) Additional tests where, in the opinion of the examining physician, alterations in the components of the blood are related to benzene exposure.

(2) The employer shall assure that all medical procedures are performed by or under the supervision of a licensed physician and provided without cost to the employee.

(3) Medical surveillance and testing of each employee shall be conducted within thirty days of the effective date of this section or within thirty days following placement in a job involving exposure to benzene, and quarterly thereafter.

(4) *Interim examinations.* If the employee is accidentally exposed by ingestion, inhalation or by skin or eye contact under conditions known or suspected to be immediately hazardous, or for any reason develops signs and symptoms commonly associated with toxic exposure to benzene, the employer shall provide appropriate examination and emergency medical treatment.

(5) *Information provided to the physician.* The employer shall provide the following information to the examining physician:

(i) A copy of this regulation and its appendices;

(ii) A description of the affected employee's duties as they relate to the employee's exposure;

(iii) The employee's representative exposure level; and

(iv) A description of any personal protective equipment used or to be used.

(6) *Physician's written opinion.* (i) The employer shall obtain a written opinion from the examining physician which shall include:

(a) The results of medical testing;

(b) The physician's opinion as to whether the employee has any detected medical condition which would place the employee at increased risk of material impairment of the employee's health from exposure to benzene;

(c) Any recommended limitations upon the employee's exposure to benzene or upon the use of protective clothing and equipment such as respirators; and

(d) A statement that the employee has been informed by the physician of any medical conditions which require further examination or treatment.

(ii) The employer shall instruct the physician not to reveal in the written opinion specific findings or diagnoses unrelated to occupational exposure.

(iii) The employer shall provide a copy of the written opinion to the affected employee.

(j) *Employee information and training.*—(1) *Training program.* The employer shall provide a training program for employees assigned to workplaces where benzene is present and shall assure that each affected employee is informed of the following:

(i) The information contained in the substance data sheet for benzene which is contained in Appendix A to this part;

(ii) The quantity, location, manner of use, release or storage of benzene and the specific nature of operations which could result in exposure above the permissible exposure limit, as well as necessary protective steps;

(iii) The purpose, proper use, and limitations of respiratory devices as specified in paragraph (g) of this section and in § 1910.134 (b), (d), (e), and (f) of this Part;

(iv) The purpose and a description of the medical surveillance program required by paragraph (i) of this section and the information contained in Appendix C of this section; and

(v) The contents of this standard.

(2) *Access to training materials.* (i) The employer shall make a copy of this standard and its appendices readily available to all affected employees.

(ii) The employer shall provide, upon request, all materials relating to the employee information and training program to the Assistant Secretary and the Director.

(k) *Signs and labels.* (1) The employer shall post signs in the regulated area bearing the legend:

VII. OBSERVATION OF MONITORING

Your employer is required to perform measurements that are representative of your exposure to benzene and you are entitled to observe the monitoring procedure. You or your representative are entitled to receive an explanation of the measurement procedure, observe the steps taken in the measurement procedure, and to record the results obtained. When the monitoring procedure is taking place in an area where respirators or personal protective clothing and equipment are required to be worn, you must also be provided with, and must wear the protective clothing and equipment.

VIII. ACCESS TO RECORDS

You or your representative are entitled to see the records of measurements of your exposure to benzene upon request to your employer. Your medical examination records can be furnished to your physician upon request to your employer. A copy of the physician's written opinion following medical surveillance shall be supplied to you by your employer.

IX. PRECAUTIONS FOR SAFE USE, HANDLING AND STORAGE

Benzene liquid is highly flammable. It should be stored in tightly closed containers in a cool, well ventilated area. Benzene vapor may form explosive mixtures in air. All sources of ignition must be controlled. You should use non-sparking tools when opening or closing benzene containers. You must ground or bond metal benzene containers. Fire extinguishers, where provided, must be readily available and you should know where they are located and how to operate them. Smoking is prohibited in areas where benzene is used or stored. Ask your supervisor where benzene is used in your work area and for additional plant safety rules.

APPENDIX B—SUBSTANCE TECHNICAL GUIDELINES BENZENE

I. PHYSICAL AND CHEMICAL DATA

- A. *Substance Identification.* 1. Synonyms: Benzol, benzole, coal naphtha, cyclohexatriene, phen, phenyl hydride, pyrobenzol. (Benzin, petroleum benzin, and benzine, do not contain benzene).
2. Formula: C_6H_6 (CAS Registry Number: 000071432).
- B. *Physical Data.* 1. Boiling Point (760 mm Hg): 80.1 C (176F).
2. Specific Gravity (water=1): 0.879.
3. Vapor Density (air=1): 2.7.
4. Melting Point: 5.5 C (42F).
5. Vapor Pressure at 20 C (68F): 75 mm Hg.
6. Solubility in Water: 0.06%.
7. Evaporation Rate (ether=1): 2.8.
8. Appearance and Odor: Clear, colorless liquid with a distinctive sweet odor.

II. FIRE, EXPLOSION AND REACTIVITY HAZARD DATA

- A. *Fire.* 1. Flash Point (closed cup): -11 C (12F).
2. Autoignition Temperature: 580 C (1076F).
3. Flammable Limits in Air, % by Volume: Lower: 1.3%. Upper: 7.1%.
4. Extinguishing Media: Carbon dioxide, dry chemical, or foam.
5. Special Fire-Fighting Procedures: Do not use solid stream of water, since stream will scatter and spread fire. Water spray can be used to keep fire exposed containers cool.
6. Unusual fire and explosion hazards: Benzene is a flammable liquid. Its vapors can form explosive mixtures. All ignition sources must be controlled when benzene is used, handled, or stored. Where liquid or vapor may be released, such areas shall be

considered as hazardous locations. Benzene vapors are heavier than air; thus the vapors may travel along the ground and be ignited by open flames or sparks at locations remote from the site at which benzene is handled.

7. Benzene is classified as a 1 B flammable liquid for the purpose of conforming to the requirements of 29 CFR 1910.106. A concentration exceeding 3250 ppm is considered a potential fire or explosion hazard. Locations where benzene may be present in quantities sufficient to produce explosive or ignitable mixtures are considered Class 1 Group D for the purposes of conforming to the requirement of 29 CFR 1910.309.

B. *Reactivity.* 1. Conditions contributing to instability: Heat.

2. Incompatibility: Heat and oxidizing materials.

3. Hazardous decomposition products: Toxic gases and vapors (such as carbon monoxide).

III. SPILL AND LEAK PROCEDURES

A. *Steps to be taken if the material is released or spilled.* Large amounts of water should be used to flush the spills. Do not flush benzene into a confined space, such as a sewer, because of explosion danger. Remove all ignition sources. Ventilate enclosed places.

B. *Waste Disposal Method.* Disposal methods must conform to other jurisdictional regulations. If allowed, benzene may be disposed of: (a) by absorbing it in dry sand or earth and disposing in a sanitary land fill; (b) if small quantities, by removing it to a safe location from buildings or other combustible sources, pouring it in dry sand or earth and cautiously igniting it; (c) if large quantities, by atomizing it in a suitable combustion chamber.

IV. MONITORING AND MEASUREMENT PROCEDURES

A. *Normal Monitoring Program:* Measurements taken for the purpose of determining employee exposure are best taken so that the representative average 8-hour exposure may be determined from a single 8-hour sample or two (2) 4-hour samples. Short-time interval samples (or grab samples) may also be used to determine average exposure level if a minimum of five (5) measurements are taken in a random manner over the 8-hour work shift. Random sampling means that any portion of the work shift has the same chance of being sampled as any other. The arithmetic average of all such random samples taken on one (1) work shift is an estimate of the employee's average level of exposure for that work shift. NIOSH recommends that samples be collected at a sampling rate of one liter per minute for a minimum of two hours. Air samples should be taken in the employee's breathing zone (air that would nearly represent that inhaled by the employee). Sampling and analysis should be performed by gas absorption tubes with subsequent chemical analysis, by gas chromatography of those areas most likely to represent the highest airborne concentration of benzene where employees are exposed. Methods meeting the prescribed accuracy and precision requirements are available in the "NIOSH Manual of Analytical Methods."

V. MISCELLANEOUS PRECAUTIONS

A. *High Exposures to benzene* can occur when transferring the liquid from one container to another. Such operations should be well ventilated and good work practices should be established to avoid spills.

B. *Non-sparking tools* should be used to open benzene containers which should be effectively grounded and bonded prior to opening and pouring.

C. *Employers should advise employees* of all plant areas and operations where exposure to benzene could occur. A few of the common operations in which high exposures to benzene may be encountered are: manufacture of styrene, phenol, cyclohexane, pesticides, and detergents.

APPENDIX C.—MEDICAL SURVEILLANCE GUIDELINES FOR BENZENE

I. ROUTES OF ENTRY

Inhalation; skin absorption, ingestion.

II. TOXICOLOGY

Benzene is primarily an inhalation hazard. Systemic absorption causes depression of the hematopoietic system. Inhalation of high concentrations can effect the central nervous system function. Aspiration of small amounts of liquid benzene immediately causes pulmonary edema and hemorrhage of pulmonary tissue. Skin absorption through intact skin is possible. Absorption may be accelerated in the case of injured skin, and benzene may be more readily absorbed if it is present in a mixture or as a contaminant in solvents which are readily absorbed. Defatting action of benzene may produce irritation upon repeated or prolonged contact with the skin. High concentrations are irritating to the mucous membranes of the eyes, nose, and respiratory tract.

III. SIGNS AND SYMPTOMS

Benzene is poorly absorbed through the skin; however, direct contact may cause erythema or blistering. Repeated or prolonged contact may result in drying, scaling, dermatitis, or precipitate development of secondary skin infections. Effects of benzene vapor or liquid on the eye are slight. Only at very high concentrations is there any smarting sensation in the eye. Droplet contamination of the eye by benzene causes a moderate burning sensation, but only a slight transient injury of the epithelial cell, with the eye recovering rapidly. Inhalation of high concentrations of benzene may have an initial stimulatory effect on the central nervous system characterized by exhilaration, nervous excitation, and/or giddiness, followed by a period of depression, drowsiness, fatigue, or vertigo. There may be a sensation of tightness in the chest accompanied by breathlessness and ultimately the victim may lose consciousness. Convulsions and tremors occur frequently, and death may follow from respiratory paralysis or circulatory collapse in a few minutes to several hours following severe exposures. The insidious and often irreversible effect on the blood-forming system of prolonged exposure to small quantities of benzene vapor is of extreme importance. These effects have been noted to occur at concentrations of benzene which may not cause irritation of mucous membranes or any unpleasant sensory effects. Early signs and symptoms of benzene morbidity are varied and vague, and not specific for benzene exposure. Subjective complaints of headache, dizziness, and loss of appetite may precede or follow clinical symptomatology. Bleeding from the nose, gums, or mucous membranes and the development of purpuric spots may occur as the condition progresses. Rapid pulse and low blood pressure in addition to a physical appearance of anemia may accompany a subjective complaint of shortness of breath. Clinical evidence of leucopenia and anemia are the most common abnormalities reported, however, macrocytosis and thrombocytopenia are also frequently present. Bone marrow may appear normal, aplastic, hyperplastic or hyperplastic and may not in all situations correlate with peripheral blood findings in-

Title 29—Labor
CHAPTER XVII—OCCUPATIONAL SAFETY
AND HEALTH ADMINISTRATION, DE-
PARTMENT OF LABOR

PART 1910—OCCUPATIONAL SAFETY
AND HEALTH STANDARDS

Emergency Temporary Standard for Occu-
pational Exposure to Benzene; Notice
of Hearing

AGENCY: Occupational Safety and Health Administration, Labor.

ACTION: Emergency Temporary Standard; Notice of Hearing.

SUMMARY: This emergency temporary standard (ETS) is based on the determination that clinical and epidemiological data conclusively establish that employee exposure to benzene presents a leukemia hazard. Therefore, a grave danger currently exists for workers exposed to this cancer hazard and it is necessary to issue an emergency temporary standard to protect them. By this ETS the Occupational Safety and Health Administration (OSHA) limits employee exposure to benzene to 1 part benzene per million parts of air (1 ppm), as an 8 hour time-weighted average concentration, with a ceiling level of 5 ppm for any 15 minute period during the 8 hour day. In addition, the ETS requires the measurement of employee exposure, engineering controls, personal protective equipment and clothing, employee training, medical surveillance, work practices, and record-keeping. The ETS will be superseded by a permanent standard within six months. A public hearing on the permanent standard will commence July 12, 1977.

EFFECTIVE DATE: May 21, 1977.

FOR FURTHER INFORMATION CON-
TACT:

Mr. James Foster, Office of Public Affairs, OSHA, Third Street and Constitution Avenue, N.W., Room N-3641, Washington, D.C. 20210 (202-523-8151).

SUPPLEMENTARY INFORMATION:
APPLICABILITY OF EMERGENCY TEMPORARY
STANDARD

The accompanying document is an emergency temporary standard issued pursuant to sections 6(e) and 8(c) of the Occupational Safety and Health Act of 1970 (the Act) (84 Stat. 1596, 1599; 29 U.S.C. 655, 657), the Secretary of Labor's Order No. 8-78 (41 FR 25059) and 29 CFR Part 1911. The new standard, section 1910.1028, applies to all employments in all industries covered by the Act, including "general industry", construction and maritime. For reasons set out below, the standard does not apply to retail automotive service stations or to operations which use liquid mixtures containing 1 percent or less of benzene; however, these exempted operations are still subject to the requirements contained in the benzene standard at 29 CFR 1910.1000.

In addition, pursuant to section 4(b) (2) of the Act, OSHA has determined that this emergency temporary standard is more effective than corresponding

standards now applicable to the maritime and construction industries and currently contained in Subpart B of Part 1910, and Parts 1915, 1916, 1917, 1918 and 1926 of Title 29, Code of Federal Regulations. Therefore, those corresponding standards are superseded by the new standard in § 1910.1028.

Pursuant to section 6(c) (3) of the Act, OSHA will shortly commence a rulemaking proceeding under section 6(b) of the Act. The emergency temporary standard will serve as a proposed final rule, along with other proposed requirements which will be published in the *FEDERAL REGISTER* pursuant to 29 CFR 1911.12. OSHA will publish an additional proposal in the very near future, encompassing those areas of occupational safety and health considered appropriate for the agency's permanent regulation of benzene. This document sets a public hearing on the permanent benzene standard to begin July 12, 1977.

The development of a permanent standard will be conducted pursuant to the rulemaking procedures of section 6(d) of the Act. The Assistant Secretary's decisions on the provisions of the final standard will be based on the entire record developed, including public comments and the informal rulemaking hearing.

EVENTS LEADING TO THE EMERGENCY
TEMPORARY STANDARD

Benzene has long been recognized as a toxin affecting the hematopoietic (blood forming) system, and a cause and effect relationship between benzene exposure and observed blood abnormalities has been established for man and animals during the last 75 years. The evidence indicating a relationship between benzene exposure and leukemia has been expanding and the international scientific community has increasingly acknowledged that worker exposure to benzene is associated with an increased risk of leukemia. Data made available by the National Institute for Occupational Safety and Health (NIOSH) in the last few weeks on workers exposed to benzene provide conclusive evidence that benzene is a leukemia causing agent and therefore immediate action to protect workers is imperative. (1)

The present OSHA standard for benzene, found in 29 CFR 1910.1000, Table Z-2, was adopted in 1971 under the authority of section 6(a) of the Act from the American National Standards Institute's (ANSI) Z 37.4-1969 standard. That OSHA standard prescribes an 8-hour time-weighted average of 10 ppm with an acceptable ceiling concentration of 25 ppm. In addition, the present standard allows excursions above the ceiling to a maximum peak concentration not to exceed 50 ppm: *Provided*, That such exposure occurs for no more than 10 minutes in any 8-hour work period. Neither the ANSI standard nor the resultant OSHA standard were based on the possible leukemia hazard from exposure to benzene.

In 1974, Aksoy et al. reported that, when contrasted with the general population, shoe workers having prior expo-

sure to benzene had a significant increased incidence of leukemia.

Also in 1974, pursuant to section 22(d) of the Act, the Director of NIOSH submitted to the Secretary of Labor a criteria document concerning occupational exposure to benzene which stated that "the possibility that benzene can induce leukemia cannot be dismissed." (3) However, NIOSH recommended retention of the present permissible exposure limit of 10 ppm and ceiling concentration of 25 ppm as measured over a 10 minute period which recommendation was not based on benzene's potential leukemia hazard.

In a letter to the Secretary of Labor, dated April 23, 1976, the United Rubber, Cork, Linoleum, and Plastic Workers of America urged that an emergency temporary standard regulating occupational exposure to benzene be issued (42). The request was denied on May 18, 1976 by then Secretary of Labor William J. Usery (43).

Less than 1 year ago, the National Academy of Sciences, under contract with the United States Environmental Protection Agency, reviewed the literature concerning health effects of benzene exposure. (4) The Academy concluded that benzene must be considered as a suspect leukemogen.

In August 1976, NIOSH submitted to OSHA an updated criteria document which revised its earlier assessment of 1974. (5) On the basis of a review of old studies and new data, NIOSH concluded that benzene was leukemogenic. This report further pointed out that "it is apparent from the literature that benzene leukemia continues to be reported." NIOSH, therefore, recommended that, since no safe level for benzene exposure could be established "no worker be exposed to benzene in excess of 1 ppm in air". Following publication of the updated criteria document, the Director of NIOSH recommended to the Assistant Secretary of Labor, by letter dated October 27, 1976, that OSHA publish an emergency temporary standard for benzene establishing the exposure level at 1 ppm. (6) Based on the information supplied by NIOSH, OSHA issued on January 4, 1977 voluntary "Guidelines for Control of Occupational Exposure to Benzene," recommending that exposure to benzene in air not exceed an 8-hour time-weighted average of 1 ppm in any 8-hour shift of a 40 hour week. (44)

In January 1977, NIOSH informed OSHA that workplace environments had been found in St. Mary's and Akron, Ohio where a sufficient number of employees had been exposed to benzene for a number of years to facilitate an epidemiological study of health risks. (45) The work-site was a Pliofilm manufacturing plant owned by Goodyear Tire and Rubber Company. The preliminary conclusions of the epidemiological study NIOSH conducted of the pliofilm workers were transmitted to OSHA on April 15, 1977. (46) The NIOSH data demonstrated an incidence of leukemia in workers exposed to benzene that was at least five times the expected incidence. NIOSH concluded that:

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quantities of benzene could be absorbed in the case of injured skin. Moreover, absorption of benzene by the skin may be significantly accelerated when benzene is present in a mixture or as a contaminant in solvents known to be readily absorbed, such as toluene and xylene. (48)

The benzene absorbed by the circulating blood is distributed throughout the body where, because of its liposolubility, it tends to accumulate in various body organs in proportion to their fat content.

Upon removal from benzene exposure, the concentration of benzene in the expired breath follows an exponential decay curve, reflecting removal of benzene from various body compartments. Elimination via this route has been estimated to range from 12 to 50 percent of the total amount of benzene absorbed in humans.

A fraction of the absorbed benzene is eliminated in an unchanged form, primarily in the expired air and, to a minimal extent, in the urine. The remainder of the absorbed benzene is metabolized by enzymes contained in the liver and ultimately to derivatives which are more water soluble thereby facilitating their removal by the kidneys. A first intermediate in the biotransformation of benzene is believed to be benzene epoxide, a highly reactive intermediate and one of several candidates suggested as the active agent responsible for benzene's myelotoxic effects. Phenol, and to a lesser extent, hydroquinone, pyrocatechol, and phenyl-mercapturic acid are the primary metabolites of benzene found in urine.

B. Acute effects. Exposures to high concentrations of benzene produce an almost immediate effect upon the central nervous system. Benzene concentrations of about 30,000 ppm are fatal within minutes, with death occurring from acute circulatory failure or coma, with or without convulsions. Milder exposures produce a period of nervous excitation, euphoria, headache and nausea, followed by a period of depression which can result in cardiovascular collapse and/or unconsciousness. The occurrence of non-specific nervous disturbance as an after-effect of acute exposures is dependent on duration of unconsciousness and/or severity of circulatory failure. Breathlessness, nervous irritability, and unsteadiness in walking have been observed to persist for a period of several weeks. Inhalation of still lower concentrations (250-500 ppm) yields signs and symptoms of mild poisoning, characterized by vertigo, drowsiness, headache, and nausea. Rapid recovery from these symptoms usually occurs following cessation of exposure.

Direct contact with the liquid may cause erythema and blistering. Prolonged or repeated skin contact, even with small quantities of benzene, has been associated with the development of a dry, scaly dermatitis or with secondary infections.

C. Chronic effects. Benzene exerts a primary toxic effect in the bone marrow, the major blood forming organ. Long-term exposures to low concentrations of benzene have been observed to have an initial stimulatory effect on the blood-

forming tissues (bone marrow) followed by aplasia (no cell production) and fatty degeneration. Clinically an initial increase, then decrease, in the red blood cells, white blood cells, or platelets, is seen, with progression if exposures are continued, to aplastic anemia (lack of functioning of bone marrow), leucopenia (decrease in leucocytes which are white blood cells), thrombocytopenia (decrease in platelets), or pancytopenia (decrease in all cells in the peripheral blood). Secondary effects of thrombocytopenia include coagulation disturbances, characterized by increased bleeding time, poor clot retraction, and increased susceptibility to hemorrhaging. This clinical picture of chronic benzene poisoning may exist with or without the physical signs or symptoms of fatigue, vertigo, headache or excessive bleeding.

The following studies are representative, although by no means all inclusive, of the published literature on the chronic effects in humans of benzene exposure. These studies do however illustrate the diversity and variability of effects which dominate the literature on chronic benzene exposure.

1. **Blood dyscrasias.** Greenburg and coworkers' investigation in 1939 of 332 pressmen in three rotogravure printing plants was one of the earliest, comprehensive studies of benzene poisoning. (8) In addition to physical examinations, including medical and occupational histories and laboratory tests, workplace air samples and chemical analysis of ink solvents and thinners were performed in an attempt to provide a correlation with medical findings. Air samples (48) revealed benzene concentrations ranging from 11 ppm to 1060 ppm for 3 plants.

Five workers with the most severe benzene poisoning expressed no subjective complaints and physical examination revealed negative findings. The signs of "poisoning" included a reduction in the number of erythrocytes, leucocytes and platelets.

Greenburg stated that: "These findings illustrate the well-known fact that the effects of benzene may be persistent and also suggest that even before blood changes are apparent, processes may have been initiated that will continue to develop even after exposure to benzene has ceased." The authors also reported that individuals varied greatly in susceptibility, although data on personal monitoring were not available.

In the same year, Mallory et al. reported post-mortem findings in 19 case studies of workers with a history of chronic exposure to benzene. (9) Exposures varied from 6 months to 12 years, but no exposure levels were available. The authors indicated that significant changes were found regularly throughout the entire hematopoietic system including bone marrow, liver, spleen and lymph nodes. Of the 19 case studies, six exhibited hypoplasia of the bone marrow (decreased bone marrow function), whereas nine cases showed hyperplasia (overactivity of the bone marrow), and two were diagnosed as leukemia. The authors con-

cluded that exposure to benzene under varying conditions produced diverse reactions and that individual variation was of great importance.

In 1943, Hardy and Elkins investigated an artificial leather plant in Massachusetts in which a man who had been employed as a coating machine operator for 12 years died of what was diagnosed as benzene poisoning. (10) The subject had worked as a coating machine operator in other locations for 18 years. Fifty-two workers were still employed in the leather plant. Benzene concentrations ranged from 40 to 80 ppm with an average concentration of 60 ppm. Blood studies, performed upon all 52 employees, showed abnormalities in more than one blood component in sixteen of the employees. Abnormalities were observed in hemoglobin, RBC, and WBC counts. There was a wide variation among subjects as to the particular component affected. Six of the 16 employees with blood abnormalities worked in the same coating room as the deceased man. Despite this evidence of blood abnormalities from the laboratory tests, none of the physical examinations revealed any clinical signs or symptoms of overexposure to benzene.

In an epidemiological investigation, Aksoy et al. compared the hematological findings of 100 healthy male subjects (controls) with those of 217 apparently healthy males, 85 percent of whom worked with solvents containing benzene in small shoe shops. (11) The shops were considered unhygienic and poorly ventilated. The concentration of benzene in the working environment ranged from 15 to 30 ppm during non-working hours to 210 ppm when adhesives containing benzene were being used. The duration of employee exposures ranged from 3 months to 17 years. In 51 (23.5 percent) of the 217 employees, hematological abnormalities were found consisting of leucopenia (9.7 percent), thrombocytopenia (1.84 percent), leucopenia associated with thrombocytopenia (4.6 percent) and pancytopenia (2.7 percent). In addition, relative to controls, benzene-exposed workers demonstrated a significant reduction in mean white cell counts and mean platelet counts. The proportion of benzene-exposed workers diagnosed with anemia was increased when compared to controls; however the presence of iron-deficiency anemia could not be ruled out.

In French survey of 45 fatal cases of benzene induced diseases of the blood, covering the years 1947 to 1962, 23 were diagnosed as leukemia and 22 were attributed to aplastic anemia. Of the latter cases, one patient was afflicted after only 2 years exposure to benzene with the remainder having an average exposure of 16 years. (13) The authors also reported that in the cases of aplastic anemia, the evolution of the illness was lengthy. A similar observation was also reported by Vigliani and Forni (1969). (14) Of 32 fatal cases of chronic benzene poisoning seen in the provinces of Milan and Pavia, 18 were due to leukemia and 14 due to aplastic anemia. These authors noted that

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clinics, or from a canvass of the published literature reporting case histories of individuals diagnosed with leukemia. In lieu of quantitative, individual exposure data, subjective evaluations of intensity of exposure have been utilized. The epidemiological evidence has been derived from either the determination of the frequency of chronic benzene exposure among cases of leukemia or from the determination of frequency of, or mortality from, leukemia among employees of work shops that utilize benzene. In other words, in the first method the leukemia is the constant factor of all case studies and the benzene exposure is the variable; while the second method is the reverse, that is, the benzene exposure is the constant factor while leukemia is the variable.

Vigliani and Saita, in their review of 47 individuals suffering from benzene hemopathy between the period of 1942 and 1963, presented clinical and laboratory accounts of six cases, all of whom were diagnosed as having haemocyto-blastic leukemia. (27) The period of exposures of these individuals to either resins, inks, varnishes, or glues containing varying concentrations of benzene ranged up to 19 years. Data on the concentrations of benzene in the workplace environment, with one exception (190-660 ppm) were not available. Although information on previous occupational histories or medical status prior to the final diagnoses were also not available, the authors stated that "attribution of the cases (of leukemia cited) to the exposure cannot be doubted." During the years 1962-1963, when there was sharp rise in the incidence of leukemia among workers exposed to benzene which coincided with an increase in number of benzene poisoning cases for this period, the risk of acute leukemia was estimated to be about 20 times greater than the risk for the general adult population.

Twelve years following the Vigliani and Saita study, Vigliani and Forni observed that in the rotogravure industry, no new cases of aplastic anemia nor of leukemia were found among workers exposed solely to toluene after this solvent was substituted for benzene in 1964. (15) However, these authors noted in 1974 that cases of benzene-induced leukemia with long latency periods may still be occasionally observed. (50) These investigators also observed that workers exposed to toluene did not exhibit chromosomal aberrations, a finding seen in employees who work with benzene.

Sixteen (16) cases of various forms of leukemia developing from long term exposure to benzene were reported by Tareef et al. (28) The duration of exposure ranged between 4 and 27 years. However, no exposure concentrations were reported. In contrast to data previously reported in Italy and Turkey, the authors found evidence of chronic leukemia. Acute leukemia accounted for only 6 of the 16 cases. Three of the six acute leukemias were diagnosed at 2, 4 and 8 years following cessation of benzene exposure. Four of the acute cases underwent a definite period of hema-

tologic shifts ranging from anemia or leucopenia to aplastic anemia and spanning a period of 2 to 10 years. Of the 10 chronic cases reported, none of the patients had hemocytopenic changes prior to the onset of leukemia.

Aksoy et al. reported the deaths, due to leukemia, of four Turkish shoemakers resulting from their exposure to benzene for periods ranging from 6 to 14 years. (29) At the time of the study, air concentrations were found to be between 150-210 ppm of benzene. Previous occupational exposure data was not provided. Two of the four patients developed acute leukemia approximately two and three years after the occurrence of aplastic anemia although the other two did not.

Adding 6 new cases of leukemia associated with exposure to benzene to 26 previously found, between the years 1967 and 1973, Aksoy et al. observed that with the exception of one case of chronic myeloid leukemia, all had various forms of acute leukemia. (30) A preceding period of pancytopenia was reported present in almost 25 percent of the cases, and the interval between the pancytopenic period and the onset of leukemia varied from 6 months to 6 years. Often the clinical findings and blood picture improved considerably before leukemia was diagnosed. During an 8 year period of observation, the incidence of leukemia among shoe-workers chronically exposed to benzene was calculated to be more than twice that experienced by the general population (13.5/100,000 vs. 6/100,000).

Browning tabulated from published studies 61 cases of leukemia among workers exposed to benzene at various concentrations. (31) The majority of cases were of the myeloid series. Browning noted that "benzene leukemia is frequently superimposed on a condition of aplastic anemia, but can develop without a preceding peripheral blood picture characteristic of bone marrow aplasia." She also noted that the transition from aplastic anemia to leukemia was not unknown in the idiopathic forms of leukemias.

DeGowin (32) and others (Vigliani & Saita, Tareef, Aksoy etc.) observed that the development of acute leukemia in some individual cases was preceded by a latency period of up to 15 years following cessation of exposure to benzene. Some of the cases underwent what was considered to be a preleukemic period, which was characterized by leucopenia, anemia, thrombocytopenia, aplastic anemia, pancytopenia or a combination thereof. Other cases developed leukemia without any evidence of anemia. According to Vigliani and Saita, the time delay "does not permit us to attribute the disease to the persistence of benzene in the bone marrow". (27) They suggested, however, that "on the basis of the initiation-promotion theory of the induction of neoplasms, we might regard benzene as an initiator of the leukemia process, but we have no suggestion of a possible promoter."

Based on the hypothesis that the risk of leukemia was higher among workers who were exposed to benzene and medical x-rays, Ichimaru et al. conducted a retrospective epidemiological investigation examining the relationship between occupations and environmental factors, other than A-bomb exposure, and the incidence of leukemia in Nagasaki and Hiroshima between 1945 and 1967. (33) This case control study compared all cases diagnosed as definite or probable leukemias between 1945 and 1967 and residing, at the time of the onset of the disease, in Hiroshima or Nagasaki. Controls were matched for city, sex, date of birth (± 30 months), distance from the atomic bomb explosion, and alive and residing in either city at the time of the onset of the disease in the patient. Four hundred ninety-two leukemia cases were identified, but matched controls could only be obtained for 413. Fifteen occupations were selected in which there had been exposure to either medical x-rays or solvents especially benzene and its derivatives. Three hundred and three adult cases with the onset of leukemia at age 15 years or over and their controls were compared. Eleven of the 15 occupations were selected based on whether there had been a history of such occupations by either the leukemia cases or the controls. Considered as a group, the risk of leukemia was found to be significantly higher (about 2.5 times greater) among those with a history of such occupations in which various volatile solvents were used as compared with those without. The relative risk was 1.8 times higher for chronic leukemia and 2.9 times higher for acute. Eighteen of the leukemia cases associated with solvents were located in distant and non-exposed radiation areas and were considered too far from the A-bomb explosion for radiation to have enhanced the increased risk. Accepting the source of error inherent in the method which was used to collect the data, the results of this study nonetheless reinforce the observation that an increase in leukemia existed in that portion of the population exposed to radiation and employed in an occupation where solvents were used, especially benzene or where exposure to medical x-ray occurred.

Thorpe, then Associate Medical Director for the Exxon Corporation, on the other hand, reported that the incidence of leukemia among a population of 33,000 workers exposed to low levels of benzene over a ten year period (1962-1972) was not significantly different when compared with the general population. (34)

This study has been severely criticized by Brown for its relaxed case-finding techniques and the methods of analyses. (35) Thus, the conclusions derived from this study must be viewed in the light of serious methodological problems which were encountered in the collection and treatment of the data. These problems, which were also acknowledged by Thorpe, included: (1) the low incidence of leukemia in the general population; (2) the validity of the diagnosis of leukemia, (3) the quantitative determina-

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tion through the skin may be enhanced when it occurs in combination with other solvents. (48) Once absorbed, the benzene is distributed throughout the body by the blood.

C. Notification of use. The standard requires employers to notify OSHA of the location of workplaces in which benzene is used and to describe the conditions of use and protective measures in effect. This requirement is designed to assure compliance during the effective period of this ETS.

D. Monitoring of exposure. The standard requires employers to monitor each workplace where benzene is present to determine employee exposure. Such determinations may be made by monitoring and measurements which are representative of each employee's exposure to benzene over an 8-hour period. Actual measurements of airborne concentrations of benzene are required in order to determine employee exposure to benzene. However, employers do not have to measure the exposure of each individual employee.

Where the initial measurements reveal benzene exposure to be above the permissible exposure limit, monthly monitoring is required. Measurements which reveal levels of exposure to benzene below the permissible exposure limit require quarterly monitoring.

The results of the exposure measurement program determine what further action must be taken by the employer. In addition to monthly monitoring, measurement of exposures above the permissible exposure limit require the employer to institute controls to reduce the exposure to or below the permissible exposure limit. A monitoring requirement is necessary in the ETS to reduce employee exposure.

In establishing the monitoring and measurement requirements of this standard, OSHA has considered the importance of such activities to identifying exposed employees and their levels of exposure so that appropriate protective measures may be taken. OSHA has also considered the question of the feasibility of immediately complying with the monitoring requirements specified.

Performing the required measurements of employee exposure to benzene will generally involve the use of portable battery-powered air sampling pumps worn by the employee during the sampling period, charcoal tubes for absorption of the benzene, and access to appropriate laboratory facilities for subsequent analysis of the charcoal tube samples. The laboratory analysis would usually be performed using gas chromatographs, a technique commonly available in analytical laboratories and utilized for the analysis of a wide range of air contaminants found in samples of the workplace environment and general community. The standard provides that the initial sampling must be conducted and results obtained within 30 days of the effective date of the standard, which would be almost 60 days following publication of the standard. The standard does not require a separate measurement for each affected employee. It requires only that

sufficient measurements are obtained to be representative of the exposure of all affected employees.

OSHA notes that the monitoring requirements will arise principally in the industries engaged in benzene production, gasoline production, and related chemical industries. These industries are generally regarded to be at the forefront of all industries with respect to existing industrial hygiene and occupational health programs. Many of the employers in these industries have extensive professional and technical staffs and established employee health programs which include periodic measurement of employee exposure to benzene. Thus these employers are expected to have little difficulty in complying with the monitoring requirements of this standard. Some of these employers have had to acquire much of the apparatus and equipment required for measuring employee exposure to benzene in order to comply with other occupational health standards previously issued by this Agency. For example, those employers engaged in manufacturing or use of vinyl chloride and polyvinyl chloride and employers engaged in the operation of coke ovens—one source of benzene production, will find that much of the effort made earlier in complying with the standards for vinyl chloride and coke oven emissions will be applicable to the requirements under this standard for measuring employee exposure to benzene.

There are approximately eight manufacturers of suitable sampling pumps. While it is not possible to know the total number of pumps immediately available from these manufacturers, one of the major manufacturers has indicated an ability to deliver 200 immediately and 800 within 45 days. That manufacturer estimated that the entire industry is capable of delivering up to 2,000 pumps in no more than 60 days from now. OSHA believes this capacity is adequate to meet the additional needs of employers who do not presently have a sufficient number of these sampling pumps. Moreover, the standard does not require that the employer own the equipment and do this monitoring himself; the utilization of consultants or contractors is another choice available to many employers.

For the above reasons, the Assistant Secretary concludes that the monitoring and measurement requirements of this emergency standard are feasible.

E. Methods of compliance. The standard requires employee exposure to benzene to be reduced to 1 ppm by engineering controls, work practices and respiratory protection. The emergency standard reflects a preference for the use of engineering controls, work practices and, where possible, substitution because of the greater reliability of these control techniques. (See, for example, the standards on vinyl chloride, § 1910.1017, and coke oven emissions § 1910.1029, and the reasons given therein.)

Thus, employers are required to institute feasible engineering controls and work practices as soon as possible to reduce employee exposure to or below the

permissible exposure limits. In operations where engineering controls and work practices do not completely reduce exposure to the permissible level, they must still be implemented to reduce exposures to the lowest practicable level and supplemented by respirators.

OSHA recognizes that initial compliance may involve the use of respirators in many instances until engineering controls are installed and work practices initiated.

Based on a review of the Arthur D. Little Co. study and data furnished by respirator manufacturers, OSHA has determined that the availability of respirators of the required types, especially the air-purifying respirators and replacement cartridges, is adequate to meet the needs of employers who will require them for compliance with the ETS. For example, there are several manufacturers of air-purifying respirators for use against benzene. One of these manufacturers has indicated that it currently has in stock 100,000 replacement cartridges more than normal order requirements, can deliver more than 250,000 cartridges per month, and is presently increasing production capacity for this type of respirator. Additionally, OSHA is aware that respirators are currently available for use by employees in many job categories in the industries covered by this standard, such as the petroleum refining, petrochemical, chemical, and related industries.

OSHA estimates that approximately 30,000 of the 150,000 employees affected by this standard would have to be furnished respirators for use some of the time during the initial period of compliance with this standard. In view of the current existence of suitable respirators in many workplaces where they would be needed and the ability of the respirator manufacturers and suppliers to supply promptly on receipt of order additional respirators needed to comply, OSHA concludes that the respirator requirements of this standard are feasible.

F. Medical surveillance. The standard requires employers to institute a limited program of medical surveillance for all employees exposed to benzene. The purposes of these medical surveillance requirements are to determine the effects of exposure on the blood forming systems of the employees, to detect blood abnormalities, and to ensure that symptoms of overexposure to benzene are recognized as early as possible. The standard provides that this medical testing shall be conducted within 30 days of the effective date of the standard and quarterly thereafter. The medical surveillance requirements are limited to those minimum tests considered necessary for the emergency standard. (41) The standard also requires a medical history to be taken for every employee who may be exposed to benzene.

Facilities for performing such routine blood tests are readily available in all parts of the country and OSHA has concluded that compliance with this limited medical testing requirement is immediately feasible.

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VI. ENVIRONMENTAL AND ECONOMIC IMPACTS

The National Environmental Policy Act of 1969 (42 U.S.C. 4321 et seq.) and regulations issued thereunder (29 CFR Part 1999) require that Federal agencies assess their proposed major actions to determine whether a significant impact on the quality of the human environment may result, and if necessary to prepare an environmental impact statement. An environmental impact statement on the regulation of occupational exposure to benzene will be prepared and made available as required during the rulemaking proceedings under section 6(b) of the Act. Because of the emergency nature of this standard, no environmental impact statement can be prepared or is required for the emergency temporary standard. In addition, notice is hereby given that an economic impact analysis under Executive Order 11849 (42 FR 1017) and applicable procedures will be prepared and made available prior to the promulgation

"Director" means the Director, National Institute for Occupational Safety and Health, U.S. Department of Health, Education, and Welfare, or designee.

"OSHA Area Office" means the Area Office of the Occupational Safety and Health Administration having jurisdiction over the geographic area where the employer's establishment is located.

(c) *Exposure limits.*—(1) *Permissible airborne exposure limits.* (i) The employer shall assure that no employee is exposed to an airborne concentration of benzene in excess of 1 part benzene per million parts of air (1 ppm), as an 8-hour time-weighted average.

(ii) The employer shall assure that no employee is exposed to an airborne concentration of benzene in excess of 5 ppm as averaged over any 15 minute period.

(2) *Dermal and eye exposure limit.* The employer shall assure that no employee is exposed to eye contact or repeated skin contact with benzene.

(d) *Notification of use.* Within 30 days of the effective date of this section, every employer who has a place of employment where benzene is present, shall report the following information to the nearest OSHA area office for each such establishment:

(1) The address and location of each establishment where employee exposure to benzene occurs;

(2) A brief description of each process or operation which may result in employee exposure to benzene;

(3) The number of employees engaged in each process or operation which may result in exposure to benzene and an estimate of the frequency and degree of exposure that results; and

(4) A brief description of the employee safety and health program as it relates to limitation of employee exposure to benzene.

(e) *Exposure monitoring and measurement.*—(1) *Initial monitoring.* (i) Each employer who has a place of employment where benzene is present, shall monitor each such workplace and work operation to determine the airborne concentrations of benzene to which employees may be exposed. This determination shall be made by monitoring and measurements which are representative of each employee's exposure to benzene over an 8-hour period.

(ii) Each employer, who has a place of employment in which benzene is present, shall inspect each workplace and work operation to determine if any employee may be exposed to benzene through eye contact or repeated skin contact.

(2) *Frequency of monitoring.* The monitoring required under paragraph (e) (1) of this section shall be conducted, and the results obtained, within thirty days of the effective date of this section and thereafter repeated quarterly for employees whose exposure is found to be

less than 1 ppm, and monthly for those employees whose exposure is found to be in excess of the permissible exposure limit. The employer shall continue monthly measurements until at least two consecutive measurements taken at least seven (7) days apart are below the permissible exposure limit, and thereafter the employer shall measure quarterly.

(3) *Additional monitoring.* Whenever there has been a production, process, or control change which may result in new or additional exposure to benzene, or whenever the employer has any other reason to suspect a change which may result in new or additional exposures to benzene, additional monitoring which complies with paragraph (e) (1) of this section shall be made.

(4) *Employee notification.* (i) Within 5 working days after the receipt of measurement results, the employer shall notify each employee in writing of the exposure measurements which represent that employee's exposure.

(ii) Where the results reveal the employee's exposure to be over the permissible exposure limit, this notification shall also include the corrective action being taken to reduce exposure to or below the permissible exposure limit.

(5) *Accuracy of measurement.* The method of measurement shall have an accuracy, to a confidence level of 95 percent, of not less than plus or minus 25 percent for concentrations of benzene greater than or equal to 1 ppm.

(6) *Employee exposure.* For the purposes of this section, employee exposure is that exposure which would occur if the employee were not using a respirator.

(f) *Methods of compliance.* The employer shall control employee exposures to airborne concentrations of benzene to or below the permissible exposure limit, and shall protect against employee exposure to eye or repeated skin contact with benzene, by engineering controls, work practices and personal protective devices and equipment, as follows:

(1) *Engineering controls.* The employer shall develop and implement, as soon as possible, feasible engineering controls to reduce the airborne concentration of benzene to or below the permissible exposure limit.

(2) *Work practices.* The employer shall examine each work area in which benzene is present and shall institute, as soon as possible, work practices to reduce employee exposure to benzene to or below the permissible exposure limit. The work practices shall be described in writing and shall include, among other things, the following:

(i) Limiting access to work areas where benzene is present to authorized personnel only;

(ii) Prohibiting smoking and the consumption of food and beverages in work areas where benzene is present; and

(iii) Establishing good maintenance and housekeeping including the prompt cleanup of spills, repair of leaks, etc.

(3) *Respiratory protection.* Whenever engineering and work practice controls which can be instituted are not sufficient to reduce exposures to or below the permissible exposure limit, they shall be used nonetheless to reduce exposures to the lowest practicable level, and shall be supplemented by the use of respirators in accordance with paragraph (g) of this section.

(g) *Respirators.*—(1) *Required use.* The employer shall assure that respirators are used where required under this section to reduce employee exposure to or below the permissible exposure limit, and in emergencies.

(2) *Respirator selection.* (i) Where respirators are required under this section, the employer shall select and provide the appropriate respirator from Table I below and shall assure that the employee uses the respirator provided.

(ii) The employer shall select respirators from among those approved by the National Institute for Occupational Safety and Health under the provisions of 30 CFR Part 11.

TABLE I
RESPIRATORY PROTECTION FOR BENZENE

Concentration of benzene or condition of use	Respirator type
(a) Less than or equal to 10 ppm.....	(1) Chemical cartridge respirator with organic vapor cartridges and half mask; or (2) Any supplied air respirator with half mask.
(b) Less than or equal to 50 ppm.....	(1) Chemical cartridge respirator with organic vapor cartridges and full facepiece; or (2) Any supplied air respirator with full facepiece; or (3) Any organic vapor gas mask; or (4) Any self-contained breathing apparatus with full facepiece.
(c) Less than or equal to 1,000 ppm...	(1) Supplied air respirator with half mask in positive pressure mode.
(d) Less than or equal to 2,000 ppm...	(1) Supplied air respirator with full facepiece, helmet, or hood, in positive pressure mode.
(e) Less than or equal to 10,000 ppm...	(1) Supplied air respirator and auxiliary self-contained facepiece in positive pressure mode; or (2) Open circuit self-contained breathing apparatus with full facepiece in positive pressure mode.
(f) Escape.....	(1) Any organic vapor gas mask; or (2) Any self-contained breathing apparatus with full facepiece.

(a) Receive an explanation of the measurement procedures;

(b) Observe all steps related to the measurement of airborne concentrations of benzene performed at the place of exposure; and

(c) Record the results obtained.

(n) Effective date: This section shall become effective May 21, 1977.

(o) *Appendixes.* The information contained in the appendixes is not intended, by itself, to create any additional obligations not otherwise imposed or to detract from any existing obligation.

I. SUBSTANCE IDENTIFICATION

APPENDIX A—SUBSTANCE SAFETY DATA SHEET

BENZENE

A. Substance, Benzene.

B. *Permissible Exposure.* Except as to retail gasoline stations and operations which use liquids containing benzene in amounts greater than 1% by volume, or the benzene vapor released by any such liquids.

4. *Airborne.* 1 part of benzene vapor per million parts of air (1 ppm); time-weighted average (TWA) for an 8-hour workday for a 40-hour week, with a ceiling concentration of 5 ppm.

2. *Dermal.* Eye contact and repeated skin contact with liquid benzene shall be prohibited.

C. *Appearance and odor.* Benzene is a clear, colorless liquid with a pleasant, sweet odor. The odor of benzene does not provide adequate warning of its hazard.

II. HEALTH HAZARD DATA

A. *Ways in which the benzene affects your health.* Benzene can affect your health if you inhale it, or if it comes in contact with your skin or eyes. Benzene may also be harmful if you happen to swallow it.

B. *Effects of overexposure.* 1. *Short-term (acute) overexposure:* If you are overexposed to high concentrations of benzene, well above the levels where its odors are first recognizable, you may feel breathless, irritable, euphoric, or giddy; you may experience irritation in eyes, nose, and respiratory tract. You may develop a headache, feel dizzy, nauseous, or experience unsteadiness in walking. Severe exposures may lead to convulsions.

2. *Long-term (chronic) exposure:* Repeated and prolonged exposure of benzene may cause headache, fatigue, exhaustion, tendency to bleed, nervousness, sleeplessness, shortness of breath, and serious blood disorders, including leukemia.

III. PROTECTIVE CLOTHING AND EQUIPMENT

A. *Respirators.* Respirators are required for those operations in which engineering controls or work practice controls are not available to reduce exposure to the permissible level. If respirators are worn, they must have a National Institute for Occupational Safety and Health (NIOSH) seal of approval. If you experience difficulty breathing while wearing a respirator, tell your employer.

B. *Protective Clothing.* You must wear impervious protective clothing (such as boots, gloves, sleeves, aprons, etc.) over any parts of your body that could be repeatedly exposed to liquid benzene.

C. *Eye and Face Protection.* You must wear splash proof safety goggles if it is possible that benzene may get into your eyes. In addition, you should wear a face shield if your face could be splashed with benzene liquid.

IV. EMERGENCY AND FIRST AID PROCEDURES

A. *Eye and face exposure.* If benzene is splashed in your eyes, wash it out immediately with large amounts of water. Call a doctor as soon as possible.

B. *Skin exposure.* If benzene is spilled on your clothing or skin, remove the contaminated clothing and wash the exposed skin with large amounts of water and soap immediately. Wash contaminated clothing before you wear it again.

C. *Breathing.* If you or any other person breathes in large amounts of benzene, get the exposed person to fresh air at once. Apply artificial respiration if breathing has stopped. Call a doctor as soon as possible.

D. *Swallowing.* If benzene has been swallowed and the patient is conscious, do not induce vomiting. Call a doctor immediately.

V. MEDICAL REQUIREMENTS

If you are exposed to benzene your employer is required to provide the following medical procedures within thirty days of the effective date of this standard, consisting of a medical history and laboratory tests. These tests shall be provided without cost to you.

VII. OBSERVATION OF MONITORING

Your employer is required to perform measurements that are representative of your exposure to benzene and you are entitled to observe the monitoring procedure. You are entitled to receive an explanation of the measurement procedure, observe the steps taken in the measurement procedure, and to record the results obtained. When the monitoring procedure is taking place in an area where respirators or personal protective clothing and equipment are required to be worn, you must also be provided with, and must wear the protective clothing and equipment.

VIII. ACCESS TO RECORDS

You or your representative are entitled to see the records of measurements of your exposure to benzene upon request to your employer. Your medical examination records can be furnished to your physician upon request to your employer.

IX. PRECAUTIONS FOR SAFE USE, HANDLING AND STORAGE

Benzene liquid is highly flammable. It should be stored in tightly closed containers in a cool, well ventilated area. Benzene vapor may form explosive mixtures in air. All sources of ignition must be controlled. You should use non-sparking tools when opening or closing benzene containers. You must ground or bond metal benzene containers. Fire extinguishers, where provided, must be readily available and you should know where they are located and how to operate them. Smoking is prohibited in areas where benzene is used or stored. Ask your supervisor where benzene is used on your work area and for additional plant safety rules.

APPENDIX B—SUBSTANCE TECHNICAL GUIDELINES

BENZENE

I. PHYSICAL AND CHEMICAL DATA

A. Substance Identification

1. *Synonyms.* Benzol, benzole, coal naphtha, cyclohexatriene, phenyl hydride, pyrobenzol, (Benzin, petroleum benzin, and benzine, do not contain benzene).

2. *Formula.* C₆H₆ (CAS Registry Number: 000071452)

B. Physical Data

1. *Boiling point* (760 mm Hg): 80.1 °C (176°F).

2. *Specific Gravity* (water=1): 0.879.

3. *Vapor Density* (air=1): 3.7.

4. *Melting Point:* 5/5 °C (43°F).

5. *Vapor Pressure* at 20 °C (68°F): 75 mm Hg.

6. *Solubility in Water:* .05%.

7. *Evaporation Rate* (ether=1): 3.2.

8. *Appearance and Odor:* Clear, colorless liquid with a distinctive sweet odor.

II. FIRE, EXPLOSION AND REACTIVITY HAZARD DATA

A. *Fire.* 1. *Flash Point* (closed cup): -11 °C (12°F).

2. *Autoignition Temperature:* 560 °C (1076°F).

3. *Flammable Limits in Air, % by Volume:* Lower: 1.3% Upper: 7.1%.

4. *Extinguishing Media:* Carbon dioxide, dry chemical, or foam.

5. *Special Fire-Fighting Procedures:* Do not use solid stream of water, since stream will scatter and spread fire. Water-spray can be used to keep fire exposed containers cool.

6. *Unusual fire and explosion hazards:* Benzene is a flammable liquid. Its vapors can form explosive mixtures. All ignition sources must be controlled when benzene is used, handled, or stored. Where liquid or vapor may be released, such areas shall be considered as hazardous locations. Benzene vapors are heavier than air; thus the vapors may travel along the ground and be ignited by open flames or sparks at locations remote from the site at which benzene is handled.

7. Benzene is classified as a 1 B flammable liquid for the purpose of conforming to the requirements of 29 CFR 1910.106. A concentration exceeding 3250 ppm is considered a potential fire or explosion hazard. Locations where benzene may be present in quantities sufficient to produce explosive or ignitable mixtures are considered Class 1 Group D for the purposes of conforming to the requirements of 29 CFR 1910.309.

B. *Reactivity.* 1. *Conditions contributing to instability:* Heat.

2. *Incompatibility:* Heat and oxidizing materials.

3. *Hazardous decomposition products:* Toxic gases and vapors (such as carbon monoxide).

III. SPILL AND LEAK PROCEDURES

A. *Steps to be taken if the material is released or spilled.* Large amounts of water should be used to flush the spills. Do not flush benzene into confined space, such as a sewer, because of explosion danger. Remove all ignition sources. Ventilate enclosed places.

B. *Waste Disposal Method.* Disposal methods must conform to other jurisdictional regulations. If allowed, benzene may be disposed of: (a) By absorbing it in dry sand or earth and disposing in a sanitary land fill; (b) if small quantities, by removing it to a safe location from buildings or other combustible sources, pouring it in dry sand or earth and cautiously igniting it; (c) if large quantities, by atomizing it in a suitable combustion chamber.

IV. MONITORING AND MEASUREMENT PROCEDURES

A. *Normal Monitoring Program:* Measurements taken for the purpose of determining employee exposure are best taken such that the representative average 8-hour exposure may be determined from a single 8-hour sample or two (2) 4-hour samples. Short-time interval samples (or grab samples) may also be used to determine average exposure level if a minimum of five (5) measurements is taken in a random manner over the 8-hour work shift. Random sampling means that

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