C-00871

[4510-26]

Title 29—Labor

CHAPTER XVII—OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION, DEPARTMENT OF LABOR

PART 1910—OCCUPATIONAL SAFETY AND HEALTH STANDARDS

Occupational Exposure to Benzene; Liquid Mixtures

AGENCY: The Occupational Safety and Health Administration, Department of Labor.

ACTION: Final rule.

SUMMARY: This document amends the recently issued occupational safety and health standard for exposure to benzene by: (1) Exempting from all the provisions of the permanent standard for benzene (29 CFR 1910.1028), for the first three years following the effective date of this amendment, liquid mixtures containing 0.5 percent or less benzene, and thereafter liquid mixtures containing 0.1 percent or less benzene; and (2) exempting from the labeling requirements liquid mixtures containing benzene which are already packaged and which contain 5.0 percent or less benzene. The amendments are in response to several petitions concerning the applicability of the benzene standard to liquid mixtures.

EFFECTIVE DATE: June 27, 1978.

FOR FURTHER INFORMATION CONTACT:

Mr. Gail Brinkerhoff, Office of Compliance Programs, OSHA, Third Street and Constitution Avenue NW., Room N3112, Washington, D.C. 20210, telephone 202-523-8034.

SUPPLEMENTARY INFORMATION: These amendments are issued pursuant to sections 4(b) and 6(b) of the Occupational Safety and Health Act of 1970 (the Act) (84 Stat. 1592, 1593; 29 U.S.C. 653, 655), the Secretary of Labor's Order No. 8-76 (41 FR 25059) and 29 CFR Part 1911. These amendments appear at 29 CFR 1910.1028 (a)(2)(iii) and at 29 CFR 1910.1028 (k)(2)(iii).

I. Background

Benzene is a naturally occurring constitutent of crude oil and national gas produced from underground reservoirs and surfacing through wells. There are approximately 630,000 wells in some 10,000 oil and gas fields in the U.S. (exhibit 29D1). One or more reservoirs underlies each of these oil and gas fields (exhibit 29f, p. 2). Since crude oil and natural gas vary in composition and physical properties from reservoir to reservoir (exhibit 29f, p. 2), the benzene content of the fluid at a particular oil or gas field may vary from well to well.

From the wellhead, the reservoir fluid is delivered by flow lines or gathering lines to separation facilities (exhibit 29D1) or field treatment plants (exhibit 29f, p. 4) where it undergoes a number of production treatment steps necessary to produce marketable crude oil, condensates and natural gas streams, as well as a variety of hydrocarbons (exhibit 29f, p. 4).

The benzene content of crude oil ranges from below detectable limits to greater than 1 percent (exhibit 29f, p. 3). Condensates produced from natural gas liquids present in both crude oil and natural gas (exhibit 29f, pp. 2-3) have a higher percentage of benzene than crude, with that percentage ranging from approximately 0.2 to 1.0 percent by volume (exhibit 29D1). The benzene in natural gas varies from 0 to about 4 percent (exhibit 29D1).

From the separation facilities or treatment plants, the crude oil, condensates and liquid and gaseous hydrocarbons are delivered to refineries either by waterway or by pipelines (exhibit 29D1; Comeaux). It is common practice for liquids from a number of fields to be combined into one pipeline stream for transportation do refineries (exhibit 29D1; Comeaux, p. 4).

At the refineries, the crude oil and field condensate liquids are stored in holding tanks prior to processing (exhibit 29f, p. 5). Typical petroleum refining processes are many. Not all refineries have all of these processes since there is specialization, such as fuels, lubes or petro-chemical operations, within refineries (exhibit 29f, p. 5). At all refineries, however, additional benzene is generated during refining by catalytic cracker, reformer and coker operations (exhibit 29f, p. 2; tr. 284).

Petroleum refined products are many and their benzene content varies according to the content of the crude taken into the refinery, the nature or the efficiency of the refining process, and the balance of product demands on the refinery. Thus, the benzene content of product streams within a single company may vary from refinery to refinery or within a single refinery from year to year. The same product from different refineries or at different times from the same refinery, consequently, may have a different benzene content (tr. 284-5). Motor gasoline ranges from 1 to 3 percent benzene by volume (Bailey). Aviation gasoline, specialty naptha solvents and naptha-based, (type B) jet fuels may exceed 1 percent benzene concentrations. Heavier jet fuel (type A), light fuel oils and cutback asphalts may occasionally exceed 0.01 percent benzene. Petrochemical feedstock napthas and certain aromatics, such as toluene may contain up to 1 percent benzene (exhibit 29f, pp. 7-8). This petrochemical feedstock is used to produce ethylbenzene, styrene monomer, cumene, phenol, cyclohexane, and nitrobenzene.

Processed refined petroleum products are distributed through marketing channels, including bulk terminals and bulk plants, to consumers. Initial distribution from the refinery storage facilities may be by pipeline, barge, marine tankers, tank truck or tank car (exhibit 29f, p. 11). These refined products have numerous uses, such as fuels, extractants, processing aids, and solvents in paints, surface coatings, adhesives and pesticides, inks, etc. The benzene content of these products varies from less than one-tenth to a few percent (tr. 284, comment 53, 58, 21, 35).

There are some substitutes for benzene; however, most of the solvent substitutes themselves contain benzene. As indicated below, the percentage of benzene in some substitutes may range up to 4 percent (18-45; tr. 304).

Benzene is also derived from coal. Recovery of coal-derived benzene, primarily as a by-product of the coking process in steel mills, accounts, however, for only 6 percent of the total U.S. production (43 FR 5918). The light oil, which is condensed from coke gases, contains up to 70 percent benzene. This light oil is distilled to produce benzene. Most light oil plants do not produce benzene but sell their light oil to petroleum refineries for further processing. Only 10 light oil plants do produce benzene and these sell it to other users.

II. History of Regulation

On February 10, 1978, a permanent occupational safety and health standard regulating occupational exposure to benzene was published in the Federal Register (43 FR 5918) as 29 CFR 1910.1028. (A correction document was published on March 31, 1978, at 43 FR 13561). This standard required employers to take prescribed measures to control employee exposure to benzene. The standard applied to each place of employment where benzene in any quantity was produced, reacted, released, packaged, repackaged, stored, transported, handled or used. The standard contained no percentage exclusion and applied to work operations involving any amount of benzene.

The permanent benzene standard was developed, pursuant to sections 6(b) and 6(c) of the act, after exhaustive rulemaking which commenced with publication on May 3, 1977 of an Emergency Temporary Standard for Occupational Exposure to Benzene (42 FR 22516). The emergency temporary standard exempted liquid mixtures containing 1 percent or less of benzene volume, or the vapors released from

these liquids. On May 27, 1977, OSHA published a proposed permanent standard to control occupational exposure to benzene (42 FR 27452). This proposed standard would also have exempted work operations where the only exposure to benzene was from liquid mixtures containing 1.0 percent (0.1 percent after 1 year) or less of benzene by volume, or the vapors released from these liquids. On the basis of the record developed in the rulemaking on the permanent benzene standard (Docket H-059), OSHA concluded that there was no consistent predictable relationship shown between the percentage of benzene in a liquid mixture and the resultant airborne exposure to benzene and that, consequently, the percentage proposed exclusion could not be supported (43 FR 5942).

After promulgation of the final standard which contained no percentage exclusion, OSHA received requests from several employers and employer groups for an administrative stay of the standard or other relief from the provisions of the standard as it applied to work operations where exposure to benzene resulted from liquid mixtures containing small or "trace" amounts of benzene. For reasons set forth in its notice (43 FR 12890, March 28, 1978), OSHA proposed to amend the benzene standard to exclude from its coverage work operations where exposure to benzene is from liquid mixtures containing 0.1 percent or less benzene or the vapors from such liquids. Skin contact with such mixtures would also be excluded from the standard. Pending final action on this proposed amendment, OSHA stayed the application of the provisions of the benzene standard to such work operations (43 FR 12891). Since this stay was immediately effective, OSHA commenced an expedited rulemaking to resolve the percentage exclusion question so that employers could know which, if any, of their operations were excluded from the permanent benzene standard. (A correction document was published on April 4, 1978, at 43 FR 14071). On April 28, 1978, OSHA published a notice of hearing on the proposed amendment (43 FR 18215). The public hearing on this proposal was held on May 23 and May 24 at Washington, D.C. Approximately 40 individuals participated at this hearing. Furthermore, more than 100 comments, arguments, and views were received from interested parties. The verbatim transcript of this hearing, as well as the numerous comments, exhibits, and briefs submitted to OSHA before, during and after the hearing, are part of this rulemaking record, along with portions of the record in the earlier benzene proceeding which were relevant to the issues herein. The rulemaking record was originally scheduled to close on June 8, 1978, but, at the request of participants, was kept open until June 12, 1978.

These amendments are based on a careful consideration of the entire record of the informal rulemaking hearing, including the transcript, exhibits, and prehearing and post-hearing written comments. Copies of the official list of hearing exhibits, comments, and notices of intent to appear at the hearing can be obtained from the Docket Office, Docket H-059A, Room S6212, U.S. Department of Labor, 3rd Street and Constitution Avenue NW., Washington, D.C. 20210.

III. Regulatory Analysis and Environmental Impact

Since an economic impact statement for the permanent standard (43 FR 5918) was prepared by OSHA pursuant to Executive Orders 11821 and 11949, OSHA has not performed a separate regulatory analysis pursuant to Executive Order 12044 (43 FR 12661, March 24, 1978). The economic analysis for the permanent standard considered the economic impact of compliance on employers with operations utilizing liquid mixtures containing any amount of benzene (43 FR 5934-5941). This amendment exempts from the permanent standard operations utilizing 0.5 percent or less benzene (0.1 percent or less after 3 years) and, therefore, reduces the cost of compliance with the standard.

In view of the fact that the amended standard does not require that employers reduce the amount of benzene in their products, costs involved in reducing the percentage of benzene in liquid mixtures in order to avoid coverage by this standard have not been attributed to the amended standard.

The final environmental impact statement published January 1978, prior to the issuance of the permanent benzene standard concluded that the standard would have a beneficial impact on the workplace environment and also that beneficial effects on the environment external to the workplace may also be anticipated. This amendment to the permanent benzene standard may result in employers switching to other solvents (containing lower benzene contamination levels). However, the atmospheric impact of such action is not expected to be significant. Where reformulation is accomplished to reduce organic solvent usage, the atmosphere will realize a reduction in total hydrocarbon load. As these types of actions were addressed in the final environmental impact statement, this amendment is not expected to alter the basic conclusions contained in that document. Accordingly, it was concluded that no new environmental impact statement was necessary for this amendment.

IV. Principal Issues Involved

The following is a discussion of the major issues involved in the rulemaking on the proposed percentage exclusion and an analysis of the evidence submitted into the record. The exhibit numbers refer to the certified exhibit list of docket H-059A. The first number designates the particular exhibit on that list. Where the exhibit contains more than one item, the second number references the particular item of the exhibit. The designation "tr." refers to the transcript of the hearing on percentage exclusion and indicates the pages of that transcript which are referenced. Furthermore, the designation "PC" refers to post hearing comments submitted by interested parties. All references are intended to provide examples of record support for the information stated.

(1) Whether work operations should be exempt from § 1910.1028 where the sole occupational exposure to benzene is from liquid mixtures containing less than a specified percentage of benzene

The majority of those responding recommended that the benzene standard be amended to exclude from its coverage liquid mixtures containing less than a specified percentage of benzene. Reasons in support of this form of exemption varied. Some participants argued that exposure to low levels of benzene does not result in any health hazard, particularly leukemia (tr. 225, 391, 313, and exhibits 18-34, 63, 77, 84, 91). Other participants pointed out that they do not add benzene to their products but that benzene is an unavoidable contaminant in all petroleum based products (tr. 68, 78, 88, 106, 107, 120, 129, 132, 163, 168, 187, 215, and exhibits 18-41, 93, PC-5-8). Oil and gas producers stressed that benzene is a natural contaminant of crude oil and gas and that it is technologically infeasible to remove benzene at the wells (exhibits 18-77, 85, 1, 19). Refiners contended that it is economically prohibitive to remove benzene from their process streams, particularly within a short timeframe (exhibit 18-48). Most industry participants presented data indicating that the low levels of benzene in the liquid mixtures present in their workplaces produced airborne concentrations below the standard's permissible exposure limit of 1 ppm. (This data is discussed below under issue 6.)

Objections to any percentage exclusion for airborne exposure were raised by the Oil, Chemical & Atomic Workers (tr. 400). OCAW argued that, even where low percentages of benzene were present in liquid streams, refinery process units were subject to frequent leaks resulting in employee exposures above 1 ppm. OCAW contend-

ed that only where process units are well maintained, can exposures be reduced to the permissible exposure limit, but that such high quality maintenance cannot be guaranteed (tr. 402).

The United Rubber, Cork, Linoleum & Plastic Workers of America (URW) contended by way of comment that while reduction of the amount of benzene in a liquid can result in reduction of airborne concentrations to conform with a PEL of 1 ppm, reduced levels cannot be attained in certain processes unless ventilation control is provided. URW also objected to permitting dermal contact with benzene mixtures where there has been no documentation of a "no-risk" health factor to benzene on skin contact, and recommended that temporary variances be sought by industry in situations where the use of protective clothing is a problem (exhibit 18-33).

The Public Citizen Health Research Group opposes the proposed amendment on the grounds that there is no safe level for exposure to a carcinogen and that liquid mixtures containing 0.1 percent benzene have been shown to give rise to exposure levels in excess of the PEL of 1 ppm (exhibit 18-94).

For different reasons, the American Petroleum Institute also urged that a percentage exclusion not be adopted, other than possibly for dermal exposure. API's objections to a percentage exclusion were based on the view that the medium or matrix in which benzene is found, the environmental conditions of temperature, humidity, air movement, and physical volume of space, the physical nature of the system in which benzene is found—namely whether in a closed or open system, and work practices are all critical to reduction of benzene exposure. In lieu of a percentage exclusion, API proposed that OSHA limit the scope of the benzene standard by adopting appropriate triggering mechanisms for activation of individual provisions of the standard. Thus, initial monitoring of airborne exposures should occur, in API's view, only when professionals, acting for the employer, have reason to believe that employee exposure is above the level which triggers the monitoring requirement (tr. 353).

Dr. Hervey B. Elkins testified on behalf of AISI that a percentage exemption would be appropriate inasmuch as naturally occurring benzene is found as a contaminant in many liquids employed in industry, formulation of many products will involve ingredients which often contain benzene in small quantities, and many products are made by chemical reactions employing benzene as a raw material. Dr. Elkins indicated that to completely eliminate the last traces of benzene from these materials may be very difficult (PC 82).

(2) WHETHER 0.1 PERCENT BENZENE IS THE APPROPRIATE PERCENTAGE FOR EXEMPTION, OR WHETHER THE PERCENTAGE FIGURE SHOULD BE HIGHER OR LOWER

Some participants supporting a percentage exemption indicated that 0.1 percent would be of no significant benefit to them since the benzene contaminated mixtures they used contained benzene in excess of that figure. They also argued that a higher percentage exemption would be appropriate since the airborne concentrations arising from the higher benzene content mixtures did not generally exceed 1 ppm.

Further, industry participants provided evidence that, at present, many suppliers cannot furnish the various benzene-contaminated materials used in their processes with a benzene content as low as 0.1 percent. (This evidence is discussed in detail in issue 5.) For example, tire manufacturers testified that the rubber solvents used in tire building could not be obtained with any confidence that the benzene content would not be up to at least 0.7 percent. They maintained, therefore, that a percentage exemption of at least 0.7 percent would be appropriate, especially to provide relief from the requirement for protective clothing which is infeasible in these operations (tr. 68, 87, 108, 170, 188, 212, 215).

The Adhesives & Sealant Council (tr. 224), Wilhold Glues (tr. 224), St. Clair Rubber Co. (tr. 260), Miracle Adhesive Corp. (tr. 268), DuPont (tr. 313), the American Iron & Steel Institute (tr. 396), and others (exhibits 18-16, 21, 61, 53, 55, 56, 45, 108) suggested that, because of the unavailability of low benzene solvents and the lack of potential for exposure above 1 ppm, that a 1.0 percent exemption would be appropriate. The B. F. Goodrich Co. indicated that while they would be willing to comply with a 0.1 percent exemption as it would apply to generation of airborne concentrations, a special action level of 0.5 percent for activation of dermal protection requirements would be necessary for them to be able to comply with the standard. Other participants argued that 0.1 percent is inappropriate since exposures below 1 ppm occur in such operations as oil and gas production with crude oil and gas liquids containing up to 4 percent benzene (exhibit 18-71, PC 81).

Industry participants endorsing a 0.1 percent exclusion did so primarily because the benzene containing materials used in their operations generally contained less than 0.1 percent benzene and they would thus be exempt from the standard (exhibits 18-29, 37, 46, 70, 89, 106, 107).

Dr. Hervey Elkins testified that, while it may not be possible to establish liquid percentage limits that will guarantee, with complete certainty in every possible situation, airborne concentrations that will not exceed a specified level, it would be logical and appropriate to accept a particular percentage exemption which would most likely, based on calculations of available data, be consistent with a permissible exposure limit of 1 ppm. The calculations provided by Dr. Elkins were based on theoretical considerations, and on extrapolation from data in papers written by him. The mean of all values of benzene percentage limits in liquid mixtures consistent with a permissible exposure level of 1 ppm was calculated by Dr. Elkins to be 0.5 percent (PC 82).

(3) WHAT IS THE CURRENT PERCENTAGE (OR RANGE OF PERCENTAGES) OF BENZENE IN LIQUID PRODUCTS, SUCH AS PRINTING INKS, PETROLEUM SOLVENTS SUITABLE FOR TIRE BUILDING, ADHESIVES, SEALANTS, PAINTS, COATINGS, DETERGENTS, INSECTICIDES, DISINFECTANTS, WAXES, FLOOR FINISHES, CRUDE OIL, PETROLEUM SOLVENTS OF VARYING GRADES, GAS LIQUIDS, LUBRICATING OILS, PETROCHEMICALS, GASOLINE IN REFINERY STREAMS, AND SIMILAR PRODUCTS

Participants who furnished information on this issue generally indicated that, since benzene is primarily a contaminant rather than an intended final ingredient, the benzene content of liquid products would vary not only from supplier to supplier but also from the same supplier. The American Petroleum Institute has indicated that production factors, which cause varying benzene content in their products, include differences in crude runs, the nature and efficiency of individual refinery process and the specific balance of final products produced at any point in time (PC 104).

Tire manufacturers reported rubber solvents used in tire building as containing up to 1.0 percent benzene, with only one supplier claiming capability of supplying solvents with 0.1 percent benzene or less. However, industry analysis of that company's shipments indicated benzene content from 0.097 to 0.137 percent (tr. 88, 95, exhibits 18-45). Petroleum based solvents used in the formulation of adhesives and glues was reported to vary from 0.3 percent to 3 percent (exhibits 18-26), while the finished products and other products such as paints, waxes, floor coatings, and printing inks, normally contain benzene well below 0.1 percent. The benzene content of gasoline was reported as covering a range from 0.5 to 3.5 percent with most samples containing less than 2.0 percent benzene (tr. 344). The American Petroleum Institute submitted results of analyses for benzene on 1,007 samples of crude oil, liquid condensate, natural gas liquids, and gas plant streams. A summary of

this data reveals 49 percent of the samples containing less than 0.1 percent benzene, 34 percent containing between 0.1 and 0.5 percent benzene, 10 percent containing between 0.5 and 1.0 percent benzene, 5 percent containing between 1.0 and 2.0 percent benzene, and 2 percent of the samples containing greater than 2.0 percent benzene (PC 81). Rohm & Haas Co. reported that none of their 2,768 products, primarily synthesized organic chemicals, contained greater than 0.1 percent benzene and that benzene was an unintended contaminant in all but 2 of those products (exhibits 18-31).

(4) WHAT IS THE CURRENT PERCENTAGE (OR RANGE OF PERCENTAGES) OF BENZENE IN OTHER SOLVENTS COMMONLY USED AS SUBSTITUTES FOR BENZENE SUCH AS TOLUENE, XYLENE, HEXANE, AND SOLVENT NAPTHAS

Data provided on this issue came primarily from companies not using benzene as a raw material but using materials such as toluene and xylene and other solvents contaminated with benzene. It was indicated, however, by the rubber manufacturers and adhesives and sealant manufacturers, that reformulation or substitution of materials containing no benzene would be infeasible and could possibly diminish the integrity of the final product (tr. 101, 213, 254, 315).

The benzene levels reported in other solvents were somewhat varied, again due to different suppliers, process conditions and equipment used in their manufacture. As a result, it is difficult to identify specific percentages of benzene content in substitute substances with any degree of accuracy. For example, the Adhesives & Sealant Council, Inc., reported that members whose hexane suppliers are located on the west coast show benzene levels of 0.3 percent or higher, while members in other parts of the country purchase hexane with benzene content typically below 0.1 percent. Ranges of benzene impurity reported by the Council include hexane 0.001-2.3 percent; toluene 0.005-0.24 percent; rubber solvent up to 1.0 percent; naptha 0.1-1.0 percent; and mineral spirits up to 1.0 percent (exhibits 18-45). The National Association of Printing Ink Manufacturers, Inc., indicated the following range of benzene content: heptane 0.1 percent-0.75 percent; heptane ("aromatic free") 0.01-0.02 percent; toluene 0.02-0.1 percent; lactol spirits 0.02-0.1 percent; xylene 0.15 percent; and aliphatic hydrocarbon blend 0.01 percent to 0.02 percent (exhibits 18-83). Other participants reported benzene at or below the 0.1 percent level in toluene, xylene, hexane and solvent napthas (exhibits 18-15, 28, 35, 38, 39, 46, 47, 58, 69, 88) while others reported levels in excess of 0.1 percent (exhibits 18-35, 39, 61, 70, 84, 90) with one report of the benzene content of toluene to be 15 percent (exhibits 18-61).

(5) TO WHAT LEVELS CAN THE PERCENTAGE OF BENZENE BE FEASIBILY REDUCED

Those participants, such as the rubber manufacturers and the adhesives and sealant manufacturers, who obtain their solvents from other sources, could not provide any detailed feasibility assessment since they did not have knowledge of the technological potential of their suppliers to reduce the percentages further than present levels. Further complications involved the refusal of solvent suppliers to guarantee a specific benzene level and the fluctuating benzene content found in a given solvent from supplier to supplier. Some suppliers appear reluctant to certify particular solvents since they have not designed their processes with benzene content specification as a consideration. The Manufacturing & Chemists Association testified that a feasibility assessment can be made only after their determination of the benzene content of streams and products is complete (tr. 286). Solvent purchasers generally indicated that, if the solvent industry is capable of reducing the percentage of benzene over some period of time, they would support a graduated exemption setting lower acceptable levels in the future to coincide with the technological ability of the solvent industry to deliver those percentages in dependable volume shipments sufficient to maintain production and employment (exhibit 18-41, 80).

The only specific projection relative to benzene content reduction was in terms of costs. Texaco estimated that benzene reduction in their refinery streams from present levels to 1.0 percent would cost $85 million, a reduction to 0.5 percent would cost $508 million, and a reduction to 0.2 percent would cost $1,381 million. Detailed analysis of how these figures were arrived at however, was not made available (exhibit 18-48). Another study, which addressed the economic impact of reducing benzene content, is the Arthur D. Little study on gasoline, prepared for EPA in February of 1978 (exhibit 12b).

(6) WHAT AIRBORNE CONCENTRATIONS OF BENZENE RESULT FROM THE PERCENTAGE OF BENZENE IN EACH PRODUCT

Comments and testimony presented on this issue generally revealed that in the industrial setting the benzene content of the liquid mixture plays only a part in the resultant airborne concentration to which employees may be exposed. The evidence regarding the other factors affecting airborne concentration are discussed under issue 7.

Monitoring data submitted to the record has provided a reasonable description of expected exposure levels in the various industrial segments affected by the proposed amendment. As previously discussed, Dr. Hervey Elkins submitted calculations indicating that a 0.5 percent benzene content in liquid mixtures would appropriately be consistent with a 1 ppm permissible exposure limit. The monitoring data submitted tends, for most all cases, to support Dr. Elkins' calculations. For example, General Tire & Rubber Co. submitted data for tire building operations which indicated resultant benzene exposures from rubber solvents containing greater than 0.5 percent benzene did exceed 1 ppm, while solvents with benzene content below 0.5 percent did not (exhibit 18-41). Exposures reported by B. F. Goodrich resulting from up to 0.3 percent benzene content indicate that the companion air levels of benzene were below 0.5 ppm in 95 percent of the cases and only one out of 255 samples was as high as 1.1 ppm (exhibit 18-75). While the Goodyear data tended to support the proposition that exposure levels, in practice, will generally not exceed 1 ppm with low benzene content liquid mixtures, Goodyear's data from one tire manufacturing plant using from 0.263 to 0.280 percent benzene content rubber solvents indicated exposures between 1.11 and 1.98 ppm. Goodyear attributed these exposure levels to inadequate ventilation since other monitoring data they submitted from other tire building plants using up to 0.4 percent benzene rubber solvents showed exposure levels not in excess of 0.4 ppm. The adhesive and sealant manufacturers reported that, with liquid mixtures containing up to 1.0 percent benzene, exposure levels never exceeded 1 ppm (exhibit 18-45). Printing ink manufacturers submitted data indicating that, while solvents used contained in some cases in excess of 0.1 percent benzene, exposure levels never exceeded 0.3 ppm (exhibit 18-83). DuPont provided results of tests from paint spraying operations showing that the use of liquid mixtures of 1 percent benzene will not result in airborne concentrations of benzene greater than 5 ppm, in most cases less than 0.5 ppm. Tests were performed with DuPont topcoat paints with 0.05 percent, 0.1 percent, and 1.0 percent benzene added. Benzene was intentionally added to the paints in an attempt to correlate benzene levels in the liquids with airborne benzene concentrations. The highest benzene level obtained was 4.3 ppm with a 1.0 percent benzene spike. Averaged over an 8-hour day, DuPont estimates that normal spraying operations with nonspiked paint will result in employee exposures below 1 ppm. Other DuPont data involving handling of 0.2 to 4.3 percent benzene in gasoline and 0.19 to 0.45 percent benzene in a p-xylene process stream resulted in time-weighted aver-

ages up to 0.38 ppm and 0.15 ppm respectively (exhibit 18-39).

Edison Electric Institute reported that exposures resulting from handling fuel oils containing 0.003 to 0.005 percent benzene resulted in exposures less than 0.2 ppm (exhibit 18-56). Husky Oil Co. reported refinery streams with 0.71 percent benzene and finished gasoline with 0.35 percent benzene as producing exposures of less than 0.11 ppm and 0.042 ppm respectively (exhibit 18-64). Earlier data submitted by NIOSH indicated that fuel oil containing less than 0.1 percent benzene gave rise to benzene concentrations of 60 ppm under conditions of elevated temperature, confined space and possibly inadequate ventilation. NIOSH indicated, however, that the sampling was done with detector tubes which are relatively inaccurate and subject to numerous interferences. (tr. 753-755, July 25, 1977, hearing)

While other participants (exhibits 18-24, 35, 49, 84, 87) supported the proposition that benzene levels in liquid mixtures greater than 0.1 percent would still not generally produce exposures to benzene above 1 ppm, some participants provided data to the contrary. The United Rubber, Cork Linoleum & Plastic Workers of America (URW) (exhibit 18-33) referenced testimony presented by Dr. Robert T. Harris, of the University of North Carolina at the public hearing on the proposed benzene standard (docket H-059), in which Dr. Harris stated that bulk solvent percentages of benzene from 0.5 to 1.07 percent can produce exposure levels below and above 1 ppm, some as high as 12 ppm. The reliability of the results of this study were questioned by Dr. Curtis Smith of the Manufacturing Chemists Association who indicated that the findings as to the presence of benzene in the ambient air could have been artificially high because of interference of ketones which are present in the ambient air around rubber plants (tr. 299). URW submitted other exposure data from an Armstrong tire manufacturing facility (the "Harvard study") also indicating exposure levels above 1 ppm with solvents containing low levels of benzene. A number of participants, including Armstrong, questioned the reliability of the Harvard study (PC 89, 90, 91, 92, 105). Armstrong commented on the study as follows:

> The report itself makes it clear that no analyses were made by the Harvard study during the week of January 9, 1978, with respect to the bulk samples. Reference is made to the analysis by the Armstrong laboratory in June 1977 that benzene in Texol at that time was less than 0.1 volume percent. More than 6 months elapsed between such sampling of the solvent and the air sampling. It is to be regretted that in the only monitoring done to date with respect to an Armstrong facility, and a very limited sampling at that, the monitoring was not accompanied by an analysis of the solvent in use at the time of such monitoring.
>
> In addition, the sample period did not cover the full 8-hour period for computation of the time weighted average (TWA). The TWA, in fact, was estimated from a sampling time of approximately 2 to 3 hours.
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> NIOSH in its Occupational Exposure Sampling Strategy Manual, DHEW (NIOSH) Publication No. 77-173 (January 1977) is critical of partial period sampling. The Manual states, at page 40, that the "sampled portion of the period should cover at least 70 percent to 80 percent of the full period." Indeed, in discussing the validity of a 6-hour TWA exposure average as compared with an 8-hour TWA standard, the Manual states, at page 41, that "[t]his type of measurement should be avoided if possible." It therefore follows that a significantly shorter period is even less valid (PC-91).

Other participants, sharing reservations relative to a particular percent exemption, did so on the grounds that exposure measurements from liquid mixtures containing 0.1 percent or less benzene did or could theoretically produce airborne concentrations of benzene in excess of 1 ppm or that variables such as ventilation, liquid temperature, work practices, etc. affected resultant benzene airborne concentrations to too great an extent to confidently rely on only benzene content for limitation of employee exposures (exhibits 18-32, 61, 72, 79, 92, 94, PC-S-8).

(7) TO WHAT EXTENT DO VARIOUS FACTORS, SUCH AS TEMPERATURE, DILUTION WITH AMBIENT AIR, WORK FACTORS, NATURE OF OPERATIONS, ETC., AFFECT THE RELATIONSHIP BETWEEN THE PERCENTAGES OF BENZENE IN THE VARIOUS PRODUCTS AND RESULTING AIRBORNE CONCENTRATIONS, AND SHOULD ANY EXEMPTION BE LIMITED TO THE USE OF THESE PRODUCTS UNDER PARTICULAR CIRCUMSTANCES

As previously indicated, most participants agreed that factors other than benzene content can play a significant role in resultant airborne concentrations of benzene. Goodyear stated that ventilation, climate, work habits, etc., would definitely affect the airborne concentration of benzene, and submitted monitoring data from an older tire manufacturing facility and two newer plants for comparison. The two newer facilities using rubber solvent containing 0.4 percent and 0.2 to 0.3 percent benzene experienced airborne concentrations of benzene at 0.45 and 0.25 ppm respectively. The older tire plant using rubber solvent with 0.263-0.280 percent benzene experienced airborne concentrations of 1.11 to 1.98 ppm. Goodyear attributed this discrepancy to inadequate ventilation in the older tire manufacturing facility. Goodyear further indicated that, while they could not determine an exact correlation from their data, variables other than benzene content could cause up to an 80 percent variance in resulting airborne concentrations. (PCS-8). Other participants provided either theoretical or actual data indicating exposures greater than 1 ppm from low benzene content mixtures used under conditions of confined space, inadequate ventilation, elevated temperatures etc. (exhibit 18-32, 92). URW submitted previous testimony of Dr. Robert T. Harris presented at the public hearing on the proposed benzene standard (docket H-059) in which Dr. Harris stated that "* * * the lower the benzene content of the solvent, the lower the potential for exposure, but a low benzene content of solvent alone does not assure that a particular air concentration will not be exceeded" (exhibit 18-33).

As mentioned previously, Dr. Hervey Elkins submitted calculations estimating that a 0.5 percent benzene content would not normally be expected to produce airborne concentrations of benzene greater than 1 ppm. Dr. Elkins addressed the affect of other factors on his calculations:

> It is self-evident that the factors mentioned (temperature, ventilation, work practices, nature of operations) will affect the relationship between the percentage of benzene in a liquid product and the resulting concentration of benzene vapor in the air. Important factors not mentioned include the quantity of substance consumed or processed, the area of the liquid surface which is exposed to the air, and the vicosity of the liquid.
>
> The exemption percentages proposed (i.e., 0.5 percent to meet 1 ppm) were based on rather severe conditions: complete or free evaporation of the benzene and other volatile ingredients, limited only by the provision that the permissible limits of the vapors of the other components of the liquid must not be exceeded.
>
> With some high boiling liquids, such as heavy oils and tars, there is little evaporation of the base material, even when heated to temperatures well above the boiling point of benzene. In theory, processes employing such materials at elevated temperatures and with large surface areas exposed (as might occur in certain coating or impregnating processes) could produce concentrations of benzene vapor in the surrounding air in excess of the postulated permissible exposure levels, even when the concentration of benzene in the liquid is less than the limits recommended above.
>
> On the other hand, handling and processing such liquids in enclosed or partially enclosed spaces, with limited exposure of liquid surfaces to air, and at temperature such that the material is not highly fluid, would result in benzene concentrations well below the postulated permissible exposure levels, even when the percentage of benzene in the liquid is in excess of the limits recommended above.
>
> For the sake of simplicity, it is recommended that * * * the 0.5-percent exemption percentage be applied if the airborne permissible exposure limit is 1 ppm—with the proviso that if operations involving heating of the liquids and exposure of large surface areas are carried out, at least a one time monitoring of the area of benzene in air be done, if the benzene content of the liquid exceeds 0.1 percent. (PC-82)

API argued in its post-hearing brief that the record evidence does not identify a specific percentage of benzene which will guarantee that a given PEL will not be exceeded under all work environments and that, therefore, any percentage exemption must also take account of the roles of many other controlling factors. API further stated that, regardless of the benzene content in their streams, the nature of their oil and gas operations is the most important factor in considering potential exposures and need for regulation of their segment of the industry. API witness Dr. William G. Domask testified that:

> It is evident from the data and information presented here that well-maintained, closed-system operations in general represent a low risk for exposure to benzene.
> Specifically, petroleum production, pipeline, and marketing personnel air monitoring data reflect a very low risk of exposure to benzene vapor at all concentration levels of benzene in the liquids handled by these segments of the industry.
> Similarly, data for the closed-system portions of refining operations indicate a very low level of exposure to benzene (PC-81).

While many other participants addressed this issue and acknowledged the significance of factors other than benzene content relative to resultant airborne concentrations of benzene, there were no recommendations relative to a practical translation of requirements for a homogeneous regulatory conclusion which would give full weight to those factors.

(8) TO WHAT EXTENT, AND FOR WHICH LIQUID MIXTURES, ARE BENZENE-FREE SUBSTITUTES AVAILABLE

Most industry participants argued that benzene-free substitutes are not commercially available, are not suitable for their process due to incompatibility with other materials and existing air pollution control systems and methods, are economically prohibitive, or would reduce product performance (exhibit 18-15, 21, 39, 41, 54, 80, 90, 109). The Public Citizen Health Research Group argued that benzene substitutes are available (exhibit 18-94).

However, the record indicates that "benzene-free" substitutes are not generally available for the majority of industrial uses.

(9) IF LIQUID MIXTURES OF SPECIFIED PERCENTAGES ARE EXEMPT FROM THE OTHER PROVISIONS OF THE BENZENE STANDARD, SHOULD THEY NEVERTHELESS BE SUBJECT TO THE LABELLING REQUIREMENTS OF THE STANDARD. CONVERSELY, IF SUCH MIXTURES ARE NOT EXEMPT FROM THIS STANDARD, SHOULD THEY BE EXEMPT FROM THE LABELLING REQUIREMENTS

Industry participants indicated that some relief from the labeling requirements was necessary. They argued that, without some labeling exemption, liquids which contain trace amounts of benzene would require cancer hazard labels. They objected to such labeling on the following grounds: lack of associated health hazard requiring warning; economic burdens; uncontrolled use of warning labels dilutes effectiveness of warning messages; and, the ubiquitous nature of benzene in petroleum distillates. The recommendation of industry participants was that any liquid mixture exemption of a specified percentage should include an exemption from the labeling requirements ((exhibit 18-21, 29, 31, 37, 41, 42, 69, 71, 72, 79, 83).

DuPont testified that, without a labeling exemption to allow additional time to clear existing inventories carrying levels of 0.1 to 1.0 percent benzene, the cost of locating already packaged containers and labeling them would run to about $31 million (tr. 317). DeSoto, a manufacturer of paints, industrial coatings, detergents, furniture and fireplace accessories, estimated their cost of labeling present inventory at $700,000 (exhibit 18-43). Another paint and coatings manufacturer, Pratt & Lambert, Inc., estimated a current inventory of 1.4 million containers, which without an exemption, would cost $700,000 to label (18-44).

(10) OTHER RELATED ISSUES

(a) *Monitoring feasibility.* A number of industry participants provided data indicating potential difficulties in obtaining industrial hygiene and analytical services. The cost burden and reported lack of monitoring service capabilities in some locations which would result if some exemption were not provided to part of the industry, would render compliance with parts of benzene standard impossible (exhibit 18-1, 3, 9, 12, 20, 37, 39, 65, 68, 82, 87).

The Manufacturing Chemists Association stated that analysis for benzene requires equipment which is expensive and which must be operated by specialists. They maintained that, due to interference from other substances, multiple gas chromatography analyses on a single product or use of mass spectrometric equipment together with gas chromatography, available only in large laboratories, are required to produce good analytical results (PC-103). NIOSH addressed the problem of interferences in a post-hearing submission (PC-88) in which they report that work by Levadie and MacAskill, "Analytical Chemistry," 48, 76, 1976, and by Esposito and Jacobs, "American Industrial Hygiene Journal," 38, No. 8, 401, 1977, describes the modifications to the NIOSH sampling and analytical methods for benzene, S311, necessary to solve the problem of interferences arising from ketone materials in the analysis for benzene. NIOSH also noted that the price of mass spectrometer systems has declined steadily over the last five years. It is NIOSH's position, therefore, that benzene can be identified with confidence using the NIOSH recommended method, that interferences can be handled by simple extraction techniques prior to gas chromatography, that detectors or columns are readily available and within the normal financial limitations of most commercial laboratories, and that recourse to mass spectrometry is unnecessary.

(b) *Miscellaneous comments.* Due to the unique nature of the motor carrier industry whose employee exposure to benzene is occasional and then only minimal, the National Tank Truck Carriers, Inc. recommended that if OSHA has any concern over motor carrier's employee exposure to benzene, OSHA should petition the Department of Transportation to develop regulations, thus avoiding regulatory imposition by another agency over an already regulated sector (tr. 414).

The National Agricultural Chemicals Association argued that OSHA has no authority to require labeling of pesticide products and no need to duplicate or interfere with the labeling controls imposed by the Environmental Protection Agency (exhibit 18-53).

The National Retail Merchants Association urged an exemption from the standard for retail stores since employee exposure in those stores is from consumer goods which are in closed containers. They also argued that, while paint cans are opened for mixing and coloring, the brief and intermittent nature of the operation would not result in sufficient benzene exposures to merit regulation. NRMA further stated that the standard should not apply to existing inventories since retailers would then be unable to sell products they already owned (exhibit 18-37).

V. Analysis and Feasibility

OSHA has concluded that it is appropriate to amend the permanent benzene standard to provide for a percentage exclusion. Specifically the agency has exempted from all the provisions of the standard for the first 3 years following the effective date of this amendment, liquid mixtures containing 0.5 percent or less benzene, and thereafter liquid mixtures containing 0.1 percent or less benzene. Further, OSHA has exempted from the labelling requirements liquid mixtures containing less than 5.0 percent benzene which are already packaged.

OSHA recognizes that the scope of the permanent benzene standard (29 CFR 1910.1028), unamended, is so broad as to encompass work place operations utilizing liquid mixtures with any amount of benzene however small

(tr. 30). OSHA's view that there is no level of benzene exposure that is without some attendant health risk remains unchanged. However, because of the ubiquitous nature of benzene, i.e., its presence in a myriad number and type of worksites (benzene is a contaminant in most, if not all petroleum-based liquid mixtures), OSHA believes that it is proper to focus industrial hygiene and medical resources on those operations with higher exposures and which present the greatest potential risk to worker health. This decision is in accord with the evidence developed during the recent rulemaking which revealed the need to and appropriateness of limiting the scope of the standard.

The mechanism chosen to effectuate this relief must in OSHA's view be consistent with the intent of the permanent standard, which is to minimize the risk to worker health to the greatest extent feasible. The framework within which the agency has examined this issue was articulated by the Director of OSHA's health standards programs, Grover C. Wrenn, at the outset of the informal hearing:

> Since the standard itself establishes a permissible exposure limit for benzene, we would certainly endeavor to set an exemption which assured that employees exposed to materials exempt from coverage under the regulation are subject to no greater exposure than employees who are subject to the provisions and protection of the standard (tr. 16).
>
> And one of the questions that was raised in the earlier rulemaking and one of the questions that is raised here is the question of the likelihood that exempting any particular category of materials from regulation, under the benzene standard—the likelihood that that exemption would provide a basis for being confident that workers involved with those exempt materials would not be exposed in a manner that was intended to be avoided by the benzene regulation (tr. 16).

The agency has considered and reviewed several approaches for limiting the scope of the permanent benzene standard suggested by participants to the rulemaking. These options included a single percentage exclusion applicable to all provisions of the standard, as was set forth in OSHA's proposed amendment in the FEDERAL REGISTER notices of March 28, 1978 (43 FR 12890) and April 28, 1978 (43 FR 18215). Such an approach was recommended by many participants as cited under the discussion of issue 1. Another option called for a general percentage exclusion, but with different levels for certain provisions of the permanent standard. This type of amendment, which was suggested by the Rubber Manufacturers Association and member companies (Exh. 92), specifically called for a higher percentage exclusion for the dermal and labelling provisions of the standard relative to other sections. A third option was that relief from the standard by based not on a percentage exclusion (with perhaps the exception of the dermal provision) but rather be based upon actual employee exposue levels. This recommendation was made by API, NPRA and member companies and also supported by OCAW (Exh. 104, Tr. 400). A final option would include a general percentage exclusion with the additional proviso that, in the case of severe or unusual work situations, the permissible airborne limits should not be exceeded as determined by monitoring. (Exh 27-C.1, PC-82)

OSHA has carefully evaluated these and other possible approaches and, based upon a review of the evidence and views contained in the rulemaking proceedings, has concluded that a percentage exclusion amendment applicable to all provisions of the standard most adequately satisfies, for regulatory purposes, the dual intention of appropriately limiting the scope of the permanent benzene standard while not exposing exempted employees to greater exposures than employees covered by the standard.

The record evidence of percentage exclusion rulemaking establishes, as shown in the preceding discussion of issues, that a variety of liquid mixtures with small or "trace" amounts of benzene generally result in exposure levels below the permissible exposure limit of the permanent benzene standard in a wide variety of industries. OSHA has determined, by examining the relationship of the percentages of benzene to resultant exposure levels, that generally an appropriate percentage exclusion can assure that employees who would be exempt from the coverage of the benzene standard are not exposed above the level set in the standard (tr. 16). Furthermore, it is OSHA's view that a percentage exclusion will encourage employers to act to reduce the amount of benzene present in liquid mixtures utilized in their workplaces or present in their products and, therefore, reduce the potential health hazard to employees. The record clearly establishes that, since publication of the permanent benzene standard, paint manufacturers and other solvent users have already examined the need for benzene in their liquid mixtures, and have made extensive efforts to obtain solvents with lower percentages of benzene. OSHA believes that an appropriate percentage exclusion will be an incentive to many other employers to reduce benzene levels and thus minimize the leukemia and other health risks to their employees.

In arriving at the conclusion that an "across-the-board" percentage exclusion is the appropriate means to afford an opportunity for relief from the standard without subjecting workers to undue risk, OSHA recognizes that factors other than the benzene content of liquid mixtures can act to significantly modify the resulting levels of airborne exposure. Variables such as the nature of work operations and work practices, and quantifiable parameters such as temperature, size of evaporative area, and especially ventilation all have been shown to play an important role. This data thus supports Dr. Harris's earlier conclusions that there is no necessary correlation between the amount of benzene in liquid mixtures and resulting airborne levels. However, defining the parameters and determining the exact combination of factors which significantly increase exposure, a necessary accomplishment for regulation on this basis, is not possible and no witness could suggest means of doing so. Moreover, the preponderance of evidence submitted to this rulemaking (most of which was not available at the earlier rulemaking) manifestly establishes, based on objective sampling data derived from current industrial settings, that for the vast majority of worksites, small amounts of benzene in liquid mixtures do not result in worker exposures above 1 ppm.

An additional reason for not adopting alternative strategies to amend the permanent standard is that the record did not provide evidence for the need to provide different exemption levels for different provisions. Manufacturers of rubber goods argued that an "action-level" concept be applied to the dermal section of the standard because of the infeasibility of performing certain manual operations in their industry without some skin contact with benzene-containing solvents. However, as was explained in the preamble to the permanent standard, from the point of view of choosing a "safe" level, the permissible exposure limit should be zero (exhibit 3A). In the case of airborne exposure, clearly this was not attainable and their airborne permissible exposure limits established were not "no-effect" levels, rather were based on feasibility considerations. However, with respect to dermal contact, avoidance of skin exposure is feasible for workers in most industrial sectors simply by the use of suitable protective clothing, such as impermeable gloves. OSHA recognizes that in tire-building, the record evidence shows that at present there are no suitable methods available to prevent skin contact with solvents containing a small amount of benzene. However, the record evidence establishes that rubber solvents with 0.5 percent benzene, which are suitable for use in tire operations, are already available in sufficient quantities. Accordingly, the exemption of 0.5 percent liquid mixtures from all the provisions of the benzene standard, will

substantially relieve the feasibility problems in tire building operations. Furthermore, the 3 year stepdown provision of the amendment from 0.5 to 0.1 percent exclusion levels will allow time for increased production of solvents containing lower amounts of benzene and for development and evaluation of alternative methods of compliance with the standard's dermal provision.

Some participants suggested that a higher exemption level apply to labeling (Tr. 68, 188). OSHA does not agree. The labeling requirement of the permanent standard serves to inform the worker of the hazard associated with working with benzene containing liquid mixtures. Use of a higher percentage exemption for this provision could result in the employee not being apprised of the danger in situations where exposure might be excessive.

API has argued that an "across the board" percentage exclusion is not an effective method by which to amend the standard, and that, in general, an exemption predicated on exposure levels is a better way of dealing with the problem presented by liquid mixtures containing small quantities of benzene (PC 104). While acknowledging that there are other factors in addition to benzene concentration which may significantly affect airborne exposure levels, OSHA believes that there is sufficient record evidence which demonstrates that with low levels of benzene contamination airborne exposures are generally below the PEL and frequently below the action level. Many participants in the rulemaking also supported this conclusion. Furthermore, API's recommendation that various provisions of the permanent standard be triggered by workers' exposure levels is, to a great degree, already incorporated into the standard by OSHA's use of the action level concept. The objective of the benzene standard is to provide necessary protection to employees from the hazards of benzene exposure, and to this end, the standard imposes upon employers different compliance requirements depending on the level of employee exposure, with minimal requirements imposed where employee exposure is below the action level.

The primary difference between API's suggested use of an "exposure determination" and OSHA's decision reflected in the standard is that API would not require initial monitoring in all cases but rather would rely upon professional judgment to determine whether various provisions of the standard apply. However, it should be noted that API's judgment as to which operations in the petroleum industry have low exposures is based upon objective sampling data submitted to this record; to the extent that such data exists the initial monitoring requirements of the permanent standard may be satisfied.

OSHA recognizes that conditions, such as elevated temperatures, inadequate ventilation, confined space, quantity of material used etc., could in some cases act to produce exposures above the PEL even if the same benzene percentages would in other operations result in exposures less than the PEL. However, as already stated, the record does not provide a sufficient basis upon which to identify and define these variables for regulatory purposes.

The results of monitoring of employee exposure submitted by numerous participants demonstrates that, by and large, the use or presence of liquid mixtures containing benzene with maximum concentrations of 0.5 percent benzene results in airborne concentrations of less than 1 ppm and frequently less than the action level of 0.5 ppm. However, the low airborne concentrations reported are not necessarily due to the inherent nature of the liquid mixtures utilized (exhibit 18-32), but rather are in part the result of the maintenance and effectiveness of engineering controls to limit exposures. Therefore, maintenance of these low exposure levels can be dependent upon the continued use of engineering controls. This is illustrated by the testimony of Goodyear which shows that, in contrast to the majority of their operations, which indicated that use of solvents containing up to 0.4 percent did not result in exposure levels greater than 0.4 ppm, in one plant with inadequate ventilation, exposures greater than 1 ppm were observed when the solvent utilized contained only 0.26 to 0.28 percent benzene. (PC-S-8). In the case of refineries, although the benzene content of liquid streams may range up to 3.5 percent by volume or higher, the great majority of worker exposures are less than 0.5 ppm (tr. 339-345.) It is evident that such low exposures in the petroleum industry are due to the outdoor setting and, importantly, to the use of closed systems. Although not always explicitly stated, the low exposures measured in some situations, such as the use of benzene-containing solvents by rubber manufacturers, appears to be the result of engineering controls as well as effective work practices.

Close examination of Dr. Elkins' calculations also indicates that a percentage exclusion level of 0.5 percent may not be sufficiently conservative. His calculated average of all values of benzene percentage limits, which was consistent with exposures of 10 ppm (the time-weighted average PEL of the previous standard) was approximately 1 percent when utilizing a total upper limit concentration of 500 ppm for petroleum distillates (PC-82). If the same underlying assumption is used (rather than utilizing NIOSH's recommended 350 milligrams per cubic meter which is not presently in effect) to calculate the percentage of benzene in a liquid mixture consistent with the 1 ppm PEL of the permanent standard, the mean value would decline approximately 10-fold or to a level of about 0.1 percent benzene in liquid mixtures (tr. 393-94). Elkins' data takes into account abnormal worst case work situations. Therefore, a 0.1 percent exclusion level should maintain workplace levels at below the permissible exposure limit even in the abnormal work situations cited by Dr. Elkins.

In adopting an across the board exclusion level, two problems arise: (1) In some cases, where the benzene stream content is in excess of the prescribed percentage and the standard there applies, exposures may well be below the PEL or action level; and (2) in certain cases, the exemption of work operations where the benzene content of liquids are below the prescribed exclusion level may produce exposures in excess of the PEL.

In the first case, although exposures may be low, the potential exists for excessive exposures, such as in the case of leaks, spills and process upsets from enclosed systems. The agency believes, that because of this potential, the requirements of the permanent standard are necessary for the protection of employees working in such areas. In the second situation, this agency recognizes that adoption of a 0.1 percent exclusion level does not, in all cases, assure that resulting airborne exposures will necessarily not exceed the action level of 0.5 ppm or even the permissible exposure limit of 1 ppm. OSHA further recognize that 0.5 percent factors other than the percentage of benzene may become more significant in determining exposure levels. However, the record does not indicate that exposures greater than 1 ppm have been demonstrated to be commonly found in existing industrial situations where benzene levels in liquid mixtures are less then 0.1 percent.

Ideally, the percentage exclusion level chosen should be so low as to assure that in all instances, the PEL will not be exceeded. Participants representing users of benzene-containing solvent mixtures who recommended exemption levels of 0.5 to 1 percent, conceded that they would readily utilize solvents containing even less benzene if they were available. While some participants from industry testified that they were able to obtain solvents with less than 0.1 percent on a regular basis, the record evidence demonstrates that for most industrial processes liquid mixtures containing 0.1 percent or less benzene are not commercially available at this time.

Thus, the percentage exemption level chosen by OSHA for amendment purposes must take into account the feasibility of supplying large volumes of liquids containing less than a specific amount of benzene to a multitude of industrial users.

Testimony from the producers of liquid mixtures which contain varying amounts of benzene indicate that the benzene which is present is there only as a contaminant and generally is not intentionally added to produce a particular property in the formulations or products. Furthermore, while it appears to be impossible to exclude very small amounts of benzene in many of these products, MCA witnesses observed that the technology currently exists to produce liquid mixtures containing 0.1 percent or less of benzene (tr. 278). However, their testimony also demonstrated that reduction of benzene content to the 0.1 percent level is not a simple undertaking. Because benzene is a widespread contaminant in most petroleum-based liquid products, some time will be required to complete testing to determine the current levels of benzene in their products. Once this process is complete, industry will require an additional period of time to implement appropriate process changes which would assure low level benzene content. This latter phase is in some instances complex, as the percent of benzene is dependent upon existing production factors, such as differences in crude runs, the nature and efficiency of individual refinery processes and the specific balance of final products produced at a given point in time. In addition, it appears that market conditions may also be a significant factor determining the degree to which benzene has been extracted from petroleum-based streams. The record also indicates that only in the recent past have producers of benzene-containing liquids given significant consideration to the benzene content of their products (tr. 286).

Two studies addressed the economic feasibility of reducing benzene content in certain liquid mixtures (exhibit 18-48; exhibit 12B). However, it is OSHA's view that the cost of reducing benzene content are not attributable to this percentage exclusion amendment. Reducing the benzene content in liquid mixtures in order to avoid coverage by the benzene standard is an option which the employer may exercise; it is not a requirement of the benzene standard that he do so. Employers may prefer to comply with the permanent standard, particularly where their employees are exposed below the action level, in which case the employer would need only to conduct initial measurement, record that measurement and train his employees. Since the standard does not compel reduction of benzene content, it is OSHA's view that costs involved in reducing the percentage of benzene in a liquid are not a consideration in this amendment.

Other than indicating that considerable time would be required to complete analysis of benzene content of their products, (exhibit 18-87) industry did not provide estimates nor specific recommendations as to the time frames required to effect production changes in order to produce liquid mixtures containing 0.1 percent of less of benzene in sufficient quantity to meet the anticipated needs of downstream users. Because of the above considerations, industry participants felt tht OSHA should not at this time adopt a percentage exclusion at the level of 0.1 percent as proposed by the agency. However, it should be noted that the proposed permanent regulation, which did indicate that the agency was considering a 0.1 percent exclusion level, was published over a year prior to the most recent rulemaking. Review of the evidence submitted indicates that while not commercially available on a sufficiently large basis, mixtures with 0.1 percent or less benzene content have been produced and are available on a limited basis and are compatible with most processes requiring such mixtures.

The record evidence further demonstrates that mixtures with a benzene content of up to 0.5 percent are presently available in sufficient quantity to satisfy the needs of affected industrial segments and that suppliers of these liquid mixtures are attempting to reduce the benzene content still further. OSHA has, therefore, concluded that 0.1 percent benzene content can be feasibly attained on a commercial basis at some point in the future.

It is the judgment of the Agency that a period of 3 years is a sufficient and reasonable allowance for development and implementation of means and methods necessary for production of adequate supplies of 0.1 percent benzene content mixtures. Along with the consideration of feasibility, the record evidence indicating a relative lack of suitable "benzene-free" substitutes, dictates the need for providing a period for implementation which would meet the anticipated demand for solvents containing low percentages of benzene. In addition, the 3-year period before the stepdown to the 0.1 percent level, will allow those users of benzene-containing liquid mixtures to test for product integrity before commencing reformulation on a large-scale basis.

By adoption of the 0.5 percent exclusion level initially, many employers engaged in crude oil and gas production activities will be provided relief from all provisions of the permanent standard. The Agency is aware that, by decreasing the exclusion level to 0.1 percent after 3 years, many of the facilities and employees in the petroleum production sector will then be covered by the standard. It is also recognized that since benzene is a naturally-occurring constituent of crude oil and natural gas, its level is not under the control of the employer. However, since compliance requirements of the permanent standard are directly related to the exposure level of the employees, and since it has been demonstrated that exposure levels of personnel in oil and gas production are generally below the action level of 0.5 ppm, the requirements of the permanent standard are minimal beyond the taking of an initial representative exposure measurement. The 3-year delay prior to the step-down to the 0.1 percent level also provides additional time for employers to obtain the required sampling information.

This amendment also exempts from the labelling requirement, liquid mixtures containing 5.0 percent or less benzene if the liquid mixture is already packaged on the effective date of this amendment. Record evidence indicates that there may be a large number of containers already in the channels of commerce, particularly consumer products, that would be subject to the labelling requirement if such an exemption were not provided. While the labelling of existing containers may be possible, it is also clear that it would require a substantial effort. Thus, imposition of the labelling requirement for liquid mixtures already packaged might well result in an excessive disruption of the commercial framework. For liquid mixtures packaged after the effective date of these amendments, the 0.5 percent exemption applies. Those employers who utilize or manufacture liquids containing 0.5 percent or less benzene will have 3 years to meet the labelling requirements, and may be exempt entirely if in that period of time they can reduce benzene concentrations below 0.1 percent.

OSHA has chosen a level of 5 percent or less benzene (by volume) contamination as the boundary for exempting liquid mixtures already packaged. Evidence developed during the rulemaking indicated that there may be some products already in the channels of commerce which may contain benzene well in excess of 1 percent and which may not have been analyzed and which would be difficult to track down. In addition, the 5 percent level chosen is similar to the requirement of the Consumer Product Safety Commission which, under the Federal Hazardous Substance Act Regulations (16 CFR 1500.14(a)(3)), mandates that products with 5 percent or more benzene receive a special label. In products with an average molecular

weight similar to that of benzene, 5 percent by volume is similar to 5.0 percent by weight.

It is the agency's judgment that much of the National Tank Truck Carrier's Association's concerns regarding the imposition of the provisions of the permanent standard on their members will be substantially relieved as users of various liquid mixtures demand products containing less than the prescribed percentage levels of benzene. In the absence of the exercise of authority by the Department of Transportation in this matter, § 1910.1028, as amended, applies to this industry (sec. 4(b)(1)).

EFFECTIVE DATE

This amendment is effective immediately on June 27, 1978. Since this amendment is a rule granting an exemption, the Administrative Procedure Act (5 U.S.C. 553) does not require a 30-day period before the amendment becomes effective. Section 533(d)(1) of the APA exempts rules which grant an exemption or relieve a restriction from the requirement that publication of a substantive rule be made not less than 30 days before its effective date. This amendment exempts from the permanent benzene standard operations utilizing liquid mixtures of 0.5 percent or less (0.1 percent or less after 3 years). Without this amendment, all employers with such operations would be required to implement the various protective requirements of the permanent standard, such as initial monitoring, training and recordkeeping. The amendment relieves them of this burden.

In addition the amendment exempts from the labelling requirements liquid mixtures which are already packaged in containers and which contain 5 percent or less benzene. Such containers would otherwise be subject to the labelling requirements of the standard. The amendment, therefore, relieves employers of the requirements to label these containers.

Accordingly, these amendments are effective June 27, 1978. As with the other operations exempted from § 1910.1028, the benzene standard contained in Table Z-2 of § 1910.1000 will continue to apply to the operations exempted by the amendments.

Upon the publication of this amendment, the limited administrative stay adopted by OSHA in conjunction with this rulemaking (43 FR 12891) is no longer in effect.

VII. 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, 200 Constitution Avenue NW., Washington, D.C. 20210.

Accordingly, pursuant to section 4(b)(2) and 6(b) of the Occupational Safety and Health Act of 1970 (84 Stat. 1592, 1593, 29 U.S.C. 653, 655), the specific statutes referred to in section 4(b)(2), Secretary of Labor's Order No. 8-76 (41 FR 25059), and 29 CFR Part 1911, Part 1910 of Title 29, Code of Federal Regulations, is hereby amended by adding new paragraphs (a)(2)(iii) and (k)(2)(iii) to 29 CFR 1910.1028.

Signed at Washington, D.C., this 21st day of June 1978.

EULA BINGHAM,
Assistant Secretary of Labor.

Part 1910 of Title 29 of the Code of Federal Regulations is hereby amended by adding a new paragraph (a)(2)(iii) and a new paragraph (k)(2)(iii) to § 1910.1028 to read as follows:

§ 1910.1028 Benzene.

(a) *Scope and application.* * * *

(2) This section does not apply to:

* * * * *

(iii) Work operations where the only exposure to benzene is from liquid mixtures containing 0.5 percent (0.1 percent after June 27, 1981) or less of benzene by volume, or the vapors released from such liquids.

* * * * *

(k) *Signs and labels.* * * *

(2) The employer shall assure that caution labels are affixed to all containers of benzene and of products containing any amount of benzene, except:

* * * * *

(iii) Liquid mixtures containing 5.0 percent or less benzene by volume which were packaged before June 27, 1978.

(Secs. 4, 6, 84 Stat. 1593 (29 U.S.C. 653, 655); Secretary of Labor's Order 8-76 (41 FR 25059); 29 CFR Part 1911.)

[FR Doc. 78-17633 Filed 6-21-78; 3:16 pm]