Substances	Limitations
	6. At levels not to exceed 0.1 percent by weight of vinylidene chloride homopolymers and/or vinylidene chloride copolymers used in accordance with a prior sanction or applicable regulations in Parts 175, 176, and 177 of this chapter. The vinylidene chloride copolymers shall contain not less than 50 weight percent of total polymer units derived from vinylidene chloride. 7. In adhesives used in accordance with § 175.105 of this chapter.
* * * * *	

Any person who will be adversely affected by the following regulation may at any time on or before February 1, 1985 submit to the Dockets Management Branch (address above) written objections thereto and may make a written request for a public hearing on the stated objections. Each objection shall be separately numbered and each numbered objection shall specify with particularity the provision of the regulation to which objection is made. Each numbered objection on which a hearing is requested shall specifically so state; failure to request a hearing for any particular objection shall constitute a waiver of the right to a hearing on that objection. Each numbered objection for which a hearing is requested shall include a detailed description and analysis of the specific factual information intended to be presented in support of the objection in the event that a hearing is held; failure to include such a description and analysis for any particular objection shall constitute a waiver of the right to a hearing on the objection. Three copies of all documents shall be submitted and shall be identified with the docket number found in brackets in the heading of this regulation. Received objections may be seen in the office above between 9 a.m. and 4 p.m., Monday through Friday.

Effective date. This regulation is effective January 2, 1985.

(Secs. 201(s), 409, 72 Stat. 1784–1788 as amended (21 U.S.C. 321(s), 348))

Dated: December 19, 1984.

Sanford A. Miller,

Director, Center for Food Safety and Applied Nutrition.

[FR Doc. 84–34004 Filed 12–31–84; 8:45 am]

BILLING CODE 4160–01–M

21 CFR Part 178

[Docket No. 83F–0134]

Indirect Food Additives: Adjuvants, Production Aids, and Sanitizers; Correction

AGENCY: Food and Drug Administration.

ACTION: Final rule; correction.

SUMMARY: The Food and Drug Administration (FDA) is correcting the final rule that amended the food additive regulations to provide for the safe use of poly [[6-[1,1,3,3-tetramethylbutyl]amino]-*s*-triazine-2,4-diyl][2,2,6,6-tetramethyl-4-piperidyl) imino]hexamethylene[(2,2,6,6-tetramethyl-4-piperidyl)imino]] as a light stabilizer in polypropylene and high-density polyethylene. The docket number was inadvertently written as 84F–0134. This document corrects that error.

EFFECTIVE DATE: November 14, 1984.

FOR FURTHER INFORMATION CONTACT: Agnes Black, Federal Register Writer (HFC–11), Food and Drug Administration, 5600 Fishers Lane, Rockville, MD 20857, 301–443–2994.

SUPPLEMENTARY INFORMATION: In FR Doc. 84–29744 appearing on page 44994 in the issue of Wednesday, November 14, 1984, "Docket No. 84F–0134" is corrected to read "Docket No. 83F–0134."

Dated: December 14, 1984.

Richard J. Ronk,

Acting Director, Center for Food Safety and Applied Nutrition.

[FR Doc. 84–33935 Filed 12–31–84; 8:45 am]

BILLING CODE 4160–01–M

Food and Drug Administration

21 CFR Part 520

Oral Dosage Form New Animal Drugs Not Subject to Certification; Acepromazine Maleate Tablets

Correction

In FR Doc. 84–32817 beginning on page 49090 in the issue of Tuesday, December 18, 1984, make the following correction:

On page 49091, first column, second line from the bottom of the page, the **EFFECTIVE DATE** should have read "December 18, 1984".

BILLING CODE 1505–01–M

DEPARTMENT OF LABOR

Occupational Safety and Health Administration

29 CFR Part 1910

Occupational Exposure to Ethylene Oxide

AGENCY: Occupational Safety and Health Administration (OSHA), Labor.

ACTION: Final Rule: Supplemental statement of reasons.

SUMMARY: On June 22, 1984, the Occupational Safety and Health Administration (OSHA) published a final standard for ethylene oxide (EtO) that established a permissible exposure limit of 1 part EtO per million parts of air determined as an 8-hour time-weighted average (TWA) concentration (29 CFR 1910.1047, 49 FR 25734). The standard also includes provisions for methods of exposure control, personal protective equipment, measurement of employee exposure, training, signs, and labels, medical surveillance, regulated areas, emergencies and recordkeeping. The basis for this action was a determination by OSHA, based on human and animal data, that exposure to EtO presents a carcinogenic, mutagenic, genotoxic, reproductive, neurologic, and sensitization hazard to workers.

During the rulemaking proceedings that led to the establishment of the 1 ppm TWA, the issue of whether there was a need for a short-term exposure limit (STEL) for worker protection from EtO was raised. OSHA reserved decision on the adoption of a STEL at the conclusion of the rulemaking in order to permit peer review of the available evidence and to review more fully the arguments and pertinent data regarding the STEL issue. Upon receipt of the analyses from most of the peer reviewers, OSHA published a notice to that effect on September 19, 1984 (49 FR 36659) and invited public comment on the pertinent issues addressed in the peer reviews. Based on the entire rulemaking record, including the peer reviews and public comments received since June 22, the Assistant Secretary has determined that adoption of a STEL for EtO is not warranted by the available health evidence, and that a STEL is not reasonably necessary or appropriate for inclusion in the final EtO standard. OSHA has also asked that NIOSH fund certain additional studies related to whether a dose-rate relationship can be established for EtO, and OSHA will review the results of

those studies when they become available.

FOR FURTHER INFORMATION CONTACT: Mr. James Foster, Occupational Safety and Health Administration, Office of Public Affairs, Room N 3641, U.S. Department of Labor, 200 Constitution Avenue, NW., Washington, D.C. 20210, Telephone (202) 523–8148.

SUPPLEMENTARY INFORMATION:

I. Events Leading to This Action

On January 26, 1982, OSHA published an Advance Notice of Proposed Rulemaking (47 FR 3566) announcing its intention to conduct a reevaluation of its existing EtO standard of 50 ppm as a TWA. In addition to a request for public comment on the adequacy of 50 ppm as a TWA, comment was also solicited on the question of the necessity of a STEL as follows:

> Is a short-term or ceiling limit for EtO exposures necessary and why, and what would be the technological and economic feasibility of complying with that limit? (47 FR 3566)

On April 21, 1983, OSHA published a Notice of Proposed Rulemaking for EtO that proposed to reduce the permissible 8-hour TWA for EtO from 50 ppm to 1 ppm (48 FR 17284). Although a specific STEL for EtO was not proposed, public comment on that issue was solicited by the following questions:

> Is a short-term or ceiling exposure limit for EtO exposure necessary for the PEL or action level in view of recent information regarding increased spontaneous abortions and chromosome changes in workers exposed to EtO? What monitoring methods and control technology are available to meet such a short-term limit and what would be the economic burdens, if any, of such a limit? (48 FR 17284)

and,

> What are the most suitable methods for determining compliance with EtO permissible exposure limits (PEL's) of 0.5 and 1 ppm as 8-hour time-weighted averages and for ceilings ranging from 5 to 50 ppm for 30 minutes or less? What are the problems associated with such monitoring methods? Do they require special training or experience? Are there serious limitations as to the accuracy or precision of the available sampling techniques? (48 FR 17248)

Numerous comments and other data were received by OSHA in response to the STEL questions set forth in the ANPR and NPRM (Ex. 168). The final EtO rule published on June 22, 1984, (49 FR 25734) reserved decision on the question of whether the standard should contain a STEL (Ex. 167A).

In the June 22, 1984 final rule, OSHA stated that upon its review of comments submitted by the Office of Management and Budget (OMB) pursuant to Executive Order 12291 (Ex 162), OSHA determined that certain issues relating to a STEL were important and merited further consideration. In particular, OSHA believed that questions concerning the following issues merited additional review:

—Quantification of the risk avoided by issuance of the STEL. In light of the requirement of the new standard to meet a 1 ppm PEL;
—The need for a STEL given current exposures and the 1 ppm PEL of the new standard;
—The appropriateness of relying on studies by Hemminki, Yager, and Johnson & Johnson as partial support for the issuance of a STEL;
—A decision by the American Conference of Governmental Industrial Hygienists (ACGIH) not to recommend a STEL for EtO; and
—The economic and technical feasibility of a STEL without the use of respirators.

To develop the fullest possible administrative record, all exhibits in the docket relating to the STEL (compiled as Ex. 168), were submitted to a number of scientifically qualified peer reviewers for comment, analysis, and criticism. The peer reviewers filed statements that were placed in the public docket.

Public comments on the statements filed by the peer reviewers and on the issues raided by OMB on the June 14, 1984 draft standard were solicited by a **Federal Register** notice published September 19, 1984 (49 FR 36659).

As noted by OSHA in its June 22 **Federal Register** notice, the purpose of the extended period of consideration of the STEL issues was to enable peer reviewers and the public to consider the available data on short-term EtO exposures and to submit their detailed evaluations of the evidence to the Agency. This, in turn, would allow OSHA to perform a more comprehensive examination of the need for a STEL, based upon the existing record and the analyses contained in the peer review and public comments. Both of these goals have been accomplished, and OSHA is most appreciative of those persons and organizations that participated in this phase of the rulemaking on EtO.

The peer reviews and public comments were particularly helpful in elucidating and explaining concepts which the Agency had not evaluated in depth in developing the June 22 final rule, but which are of considerable importance in the final determination of the STEL issues. For example, the relevance of the establishment of a dose-rate effect to the need for a STEL is explored at great length in the new materials. The peer reviews, in particular, contain extensive new explanations and evaluations of this relationship as it relates to the available health data on EtO, especially in the area of mutagenesis. The peer reviews and public comments also helped to clarify the positions of various experts and organizations which have been involved in the evaluation of the health evidence. For example, ACGIH employed this extended comment period to clarify its position of STEL-related issues, which was not totally clear during the earlier phase of the proceeding. In these and other details, the materials received by OSHA since June 22 filled a number of gaps in the Agency's knowledge, and have enabled the Agency to reach a final determination on the STEL.

II. Identification of Peer Reviewers

OSHA requested peer review of the STEL data by 23 individuals and organizations. Reviewers were asked to provide comment on those aspects of the STEL issues that were within their area of expertise (toxicology, epidemiology, industrial hygiene, etc.). OSHA contacted the following peer reviewers (A number in parentheses in the list below reflects OSHA's receipt of the person's review and the exhibit number of that review in Docket H–200):

Elliot Harris, Ph.D, Deputy Director, National Institute for Occupational Safety and Health (Ex. 181)
Ralph Allen, President, American Academy of Industrial Hygiene (Ex. 175)
Vernon L. Carter, Jr., DVM College of Veterinary Medicine, Ohio State University (Ex. 178)
William Kelley, Executive Director, American Conference of Governmental, Industrial Hygienists (Ex. 191)
Dr. Donald Hoops, Executive Director, American Occupational Medical Association (Ex. 186)
Dr. L.B. Russell, President, Environmental Mutagen Society (Ex. 180)
Matilda Babbitz, Executive Director, American Association of Occupational Health Nurses (Ex. 180)
Dr. Fred Oehme, President, Society of Toxicology
Dr. John Crum, Executive Director, American Chemical Society (Ex. 170)
Richard Adamson, Ph.D., National Cancer Institute (Ex. 172)
David P. Rall, M.D., Ph. D., National Institute of Environmental Health Sciences (Ex. 171)

The following 12 members of the Department of Labor's National Advisory Committee on Occupational Safety and Health were also requested to review and submit comments on the STEL issue:

Frank R. Barnako, Chairman of the Board, National Safety Council (Ex. 174)
Joyce C. Hearn, Representative, South Carolina Legislature
Sidney Shindell, M.D., Chairman, Department of Preventive Medicine, The Medical College of Wisconsin (Ex. 176)
Robert B. Taylor, Director, Division of Occupational Safety and Health, Tennessee Department of Labor
Tom Baker, President, Baker Electric Company
Bruce W. Karrh, M.D., Vice President—Safety, Health and Environmental Affairs, E.I. duPont deNemours and Co., Inc. (Ex. 173)
John J. Donlon, Business Manager, Colorado Building and Construction Trades Council
R.V. Durham, Director, Safety and Health Department International Brotherhood of Teamsters, Chauffers, Warehousemen & Helpers of America (Ex. 179)
B. Gawain Bonner, Director, Safety and Health, Tenneco, Inc.
Ronald H. Davis, Vice President, Industrial Relations, Carolina Steel Corporation (Ex. 183)
Marcus M. Key, M.D., Professor of Occupational Medicine, The University of Texas Health Sciences Center (Ex. 177)
William E. McCormick, Former Managing Director, Amercian Industrial Hygiene Association

III. Summary of Peer Reviews and Public Comments

In addition to the peer reviews, OSHA received 41 comments in response to the September 19, 1984, FR notice. Those in opposition to adoption of a STEL generally argued that the available scientific evidence did not justify issuance of a short-term limit. They contended that the STEL must be based on, among other reasons, the observation of either (1) acute effects occurring above a given level or (2) on the demonstration of a dose-rate effect associated with exposure to EtO. Those parties opposing a STEL argued that neither of these effects have been demonstrated to occur from exposure to EtO.

Proponents of adoption of the STEL generally contended that (1) the collective scientific evidence demonstrates adverse reproductive and mutagenic effects attributable to short-term EtO exposures and (2) the STEL is necessary to reduce the significant risk of cancer still present with the 1 ppm TWA. These arguments and others, and the comments presented on both sides of these issues by both public commentors and peer reviewers are discussed below.

A. Comments Opposing a STEL

Parties opposing adopton of a STEL for EtO reiterated several arguments presented prior to this supplemental rulemaking and raised new points, accompanied by new argument and calculations. They argued that:

—No evidence has been presented indicating that the potential effects of exposure to EtO are related to dose-rate (i.e., pattern of exposure);
—The collective findings of Yager, Embree, Generoso, LaBorde and Kimmel, Johnson, Garry, Pero, and Hemminki do not form a reasonable inference for a STEL;
—The STEL is "unsupported b any reasonable risk assessment or inference from the scientific evidence;"
—The studies by Hemminki, Yager, and Johnson and Johnson are flawed and inadequate to support a STEL;
—A STEL can only be justified through quantification of risk;
—Compliance and measurement feasibility for a STEL have not been demonstrated;
—The 1 ppm TWA and 0.5 ppm action level provide adequate protection from short-term exposure;
—The types of controls that will need to be employed to meet the TWA will also result in low short-term exposure;
—There is no established relationship between sister chromatid exchanges and adverse health; and
—The ACGIH has concluded that the toxicological data provides inadequate support for a STEL.

Peer Review Analyses

Those peer reviewers opposing a STEL included:

Dr. Bruce Karrh, Vice-President for Safety, Health and Environmental Affairs, E.I. duPont de Nemours Co. (Ex. 173);

Ralph E. Allan, President, American Academy of Industrial Hygiene (Ex. 175);

Dr. Sidney Shindell, Professor and Chairman of the Department of Preventive Medicine, Medical College of Wisconsin (Ex. 176);

Dr. Marcus Key, Professor of Occupational Medicine at the University of Texas' School of Public Health (Ex. 177);

Dr. Vernon Carter, Consultant in Occupational and Environmental Toxicology (Ex. 178);

Environmental Mutagen Society (committee consisting of Dr. R.J. DuFrain, Senior Scientist of the Medical and Health Science Division of Oak Ridge Associated Universities; Dr. W.M. Generoso, Senior Scientist, Oak Ridge National Laboratory; and Professor S. Abrahamson, Departments of Zoology and Genetics, University of Wisconsin) (Ex. 186); and

Donald L. Hoops, Ph.D., Executive Director, American Occupational Medical Association (review by Ernest M. Dixon, M.D., P.A. Environmental Health Consultants, and G. Anstadt, M.D.) (Ex. 187).

The Environmental Mutagen Society (Ex. 186) provided for review of the EtO STEL data by a committee of experts consisting of Dr. R.J. Du Frain, Senior Scientist of the Medical and Health Science Division of Oak Ridge Associated Universities; Dr. W.M. Generoso, Senior Scientist of the Biology Division, Oak Ridge National Laboratory; and Professor S. Abrahamson, Departments of Zoology and Genetics, University of Wisconsin.

The conclusion of the committee was that:

> The prime issue as we all see it (and have each done considerable research on in our careers) is one of dose and dose—rate. Namely, is the biological outcome (the yield of induced damage) affected by the manner and delivery of the dose (exposure)? The evidence required to support a STEL would have had to demonstrate that for some end-point (SCE, chromosome damage, time to tumor etc.) there was a *greater yield* of damage (effect) from an acute treatment as compared to a chronic or fractionated treatment for *the same total dose.* No such evidence was presented. (emphasis in original) (Ex. 186)

The commitee contended that before a STEL can be justified there would have to be an observed dose rate effect over a certain dose ranged, and at the dose limitation imposed there would be an influence of [cellular] dose rate. They concluded that no such effect has been established in the Yager, Johnson and Johnson, or Hemminki studies.

Specific comments on the Yager, Johnson and Johnson, and Hemminki studies were provided by Generoso and DuFrain. With respect to the Yager study, DuFrain stated:

> In this report in *Science,* 22 individuals were evaluated for SCE frequency in their peripheral blood lymphocytes. Extensive questionnaries were filled out and EtO measurements in the breathing zone of some of these individuals were taken while they were performing their jobs which exposed

them to EtO. Attempts were then made determine their cumulative EtO "dose" in milligrams for the six months preceding the blood collection for SCE analysis of the peripheral lymphocytes. Of the 22 individuals, 16 were listed in the table (2) as 0 dose (5 non-smokers and 11 smokers). In the exposed individuals, there were 3 non-smokers and 3 smokers in the "low-dose" category, and 2 non-smokers in the "high-dose" category, and by *my calculations* I would not declare these groups to be significantly different from their controls (matched for smoking habits). This leaves 3 smokers in the "high-dose" group that show significantly elevated SCE frequencies. From this amount of data one cannot show a dose-response relationship for these short burst-type exposures to EtO. Therefore, this study does not support the inclusion of a STEL. (emphasis in orginal).

With respect to the Johnson and Johnson study, DuFrain stated that that study:

. . . clearly shows that occupational EtO exposure leads to elevated SCE levels in peripheral blood lymphocytes, but I don't think the inference of dose-rate effects are possible from the results. Also, individual "dose" estimates or even speculative calculations were not available for the subjects. I might also point out that the results of this study show smoking, gender, and age are all confounding variable in human lymphocyte SCE analysis, which was not taken into account in the Yager study of 22 individuals. [Ex. 186]

DuFrain further stated that:

The larger Johnson and Johnson study also demonstrates that occupational EtO exposure causes chromosome aberrations and elevates the SCE frequency in peripheral blood lymphocytes of the workers. Of greater concern to me, is the DeMuth letter statement in the last sentence of page 6 that . . . "there is universal agreement that SCEs should not be the basis of regulations because no adverse health effect has been linked to elevated SCEs". This subtle play on words ignores the occurrence of elevated SCEs in blood lymophocytes of individuals with Bloom's syndrome who have incidence of malignancy. What should be stated is that no known adverse health effect has been linked to occupationally elevated SCEs. [Ex. 186]

In addressing the contention that the studies by Yager and Johnson and Johnson are "flawed", DuFrain stated that:

It is true that the research in these two reports does not provide evidence in favor of a STEL in addition to a 1 PPM PEL; however, I question the term "flawed". Both of these studies have used standard or acceptable methods for cytogenetic evaluations, and what appear to be appropriate, or at least acceptable, statistical methodologies. Questioning the use of means and suggesting comparisons of medians is naive in terms of these or any SCE studies, for it is precisely the outlier cells that are of some scientific interest and they do *not* adequately influence the robust statistics such as medians.

With respect to Hemminki, Generoso concluded that although the likelihood that EtO exposure may lead to higher abortion frequency cannot be ruled out, the study "has no bearing whatsoever on the question of dose-rate effect".

In addressing the possible reason for the conclusion that a dose-rate effect has not been observed for EtO, Du Frain offered the following:

. . . for high energy radiation (X or gamma rays) one is unable to determine a difference in biological damage when 1000 millirem is received in one minute or 1 millirem is received per minute over 1,000 minutes or longer, because the total dose is so low, there is no dose rate effect! This may well be a possible outcome resulting from the introduction of a 1 ppm 8-hour limit exposure [for EtO].

Both Generoso and Du Frain suggested that further research be performed in order to resolve this issue.

Bruce W. Karrh, M.D. (Ex 173), of duPont, concluded in his peer review that the key factors in considering adoption of a STEL for EtO are the frequency of excursions that are above the 1 ppm TWA, the variability of EtO concentrations in the workplace, and the availability of supporting health data. Dr. Karrh stated that without sufficient toxicological and exposure data to justify a specific STEL, the excursion limit recommendation by the ACGIH seems appropriate (See discussion under "ACGIH TLV Recommendations").

The American Academy of Industrial Hygiene (AAIH) (Ex. 175) concluded that "the need for a short-term exposure level is not supported by appropriate scientific findings which suggest the elimination or reduction of significant risk of harm."

With respect to the Hogstedt leukemia studies (Exs. 2–8, 2–22) and the Hemminki reproductive study (Ex. 6–7), the AAIH considered them to be "equivocal" and stated further that although it is reasonably clear that EtO is a carcinogen in rats (Exs. 2–9, 6–6, 6–16) and is genotoxic in humans, "a clear demonstration that EtO is a human carcinogen or that it produces reproductive effects has not been made."

Concerning data in the record relating to SCE's and chromosome aberrations (Exs. 4–10, 4–17, 6–12, 6–13, 6–15, 137 A, B, C, D) AAIH stated that:

There is . . . no current consensus concerning the relationship between DNA damage and the likelihood of an ultimate clinical outcome such as cancer. This is a particular problem given the weak epidemiological evidence associating EO exposure with delayed effects. It should also be borne in mind that although SCEs and chromosome aberrations are indices of DNA damage, the endpoints are different, they are not necessarily correlated, and the relevance of one or the other in a given application is not obvious. (Ex 175).

AAIH also contended that neither the Yager (Exs. 4–10, 6–15), Johnson and Johnson (Exs. 4–17, 137 A, B, C) nor Pero (Ex. 6–13) studies demonstrate that the amount of DNA damage received as a result of short-term exposures to EtO is greater than that received by workers receiving the same cumulative dose of EtO during constant exposure conditions. The AAIH further pointed out that of the studies cited above, "*none of them was designed to test whether the fractionation of the EO dose is more important to the likelihood of a clinical outcome*" (AAIH emphasis). The AAIH concluded that additional research is necessary in order to substantiate the need for adoption of a STEL for EtO.

Sidney Shindell, M.D., (Ex. 176) agreed with the statements (Ex. 162) that ". . . the studies OSHA cites . . . all have major flaws and provide no support for the STEL." Dr. Shindell also contended that "the objective of minimizing or avoiding peak exposures would be more important than enactments of an arbitrary level indicating to what extent this objective needs to be achieved".

Marcus M. Key, M.D. (Ex. 177) agreed with ACGIH's position that suspect human carcinogens such as EtO should not be assigned specific STEL's. In opposing a specific STEL, however, he did express a concern that for these substances "the concentration as a maximum value may be as important as the dose (average concentration x time) in induction of cancer."

Vernon L. Carter, Jr. DVM (Ex. 178) argued that neither the draft STEL risk assessment performed by OSHA, nor the available health data justify adoption of an EtO STEL. (OSHA estimated in its June 14, 1984 draft final standard that the cancer risk of 12–23 per 10,000 with a 1 ppm TWA would be reduced to 4–7 per 10,000 with addition of a 10 ppm STEL.) Dr. Carter stated that "Given the unresolved questions about the use of mathematical models and the relatively small difference between those two sets of numerical values, . . . this alone does not justify a STEL." With regard to the health data, Dr. Carter found the studies by Hemminki, Yager, and Johnson and Johnson to be inconclusive. In addressing the Hemminki study, Dr. Carter stated that:

Although this study indicates that adverse reproductive effects may possibly occur at some undermined level of EtO exposure, it is my opinion that this study does not justify a

10 ppm STEL due to lack of adequate exposure monitoring.

Dr. Carter found that the observed increase in SCE reported in the Yager and Johnson and Johnson studies is "probably valid." With respect to the health implications associated with increased frequency of SCE, however, he stated that:

As yet no relationship has been established between this response and effects of concern such as cancer and reproductive problems. It is my opinion that until such a relationship is better established, a STEL to control this response is not justified. (Ex. 178)

The American Occupational Medical Association (Ex. 187) submitted peer reviews by two of its physician members—Ernest M. Dixon, M.D., P.A., Environmental Health Consultants, and G. Anstadt, M.D.

Dr. Dixon contended that: (1) Short-term low level exposure is not the basic issue with EtO but that the significant risks are related to long-term exposure; (2) none of the health studies (Hemminki, Yager, Johnson and Johnson) adequately addresses short-term exposures at lower levels or demonstrates significant adverse effects; (3) long-term studies are not relevant for addressing short-term effects; (4) that 1 ppm TWA and 0.5 ppm action level provide adequate control from short-term excursions; (5) a short-term exposure limit would result in very little reduction of overall exposure; and (6) a STEL is only appropriate for agents having severe acute toxicity potential. Dr. Anstadt stated that there is no direct evidence to support a short-term exposure limit or to calculate a particular value for one. He also noted that there are presently no appropriate studies addressing the issue of dose-rate and that the issue for the need for a STEL for EtO will not be resolved until appropriate studies are performed.

Public Comment

Commentors opposing issuance of STEL for EtO were in basic agreement that the need for a STEL is unsupported by any reasonable risk assessment or inference from the scientific data. (Exs. 189–1, 189–3, 189–4, 189–6, 189–7, 189–10, 189–15, 189–16, 189–17, 189–18, 189–20, 189–21, 189–25, 189–28, 189–32, 189–28, 189–31, 189–32, 189–36). The American Industrial Hygiene Association (AIHA), stated that a STEL is "without demonstrated necessity" (Ex. 196). Other commentors reiterated the arguments that the studies by Yager, Johnson and Johnson, and Hemminki are sufficiently flawed to preclude them for use as the basis for adoption of a STEL. The Association of Ethylene Oxide Users (Ex. 189–15), Ethylene Oxide Industry Council (Ex. 189–16), and the Health Industry Manufacturers Association (Ex. 189–18) cited the small study population in the Yager study and argued that statistical significance in observed SCE frequencies disappears if median rather than mean SCE rate is used to compare exposed employees with the control group. The Johnson and Johnson study was criticized for its limited study population, the small number of EtO operations tested, the procedures for determining exposure, the methodology used to determine significance of risk, and the possibility that exposure to other chemicals occurred among the study group. The Hemminki study was faulted by these commentors as providing inadequate exposure data, being subject to study group reporting and selection bias and exposure to other chemicals, and inadequate control of other confounding variables.

AIHA (Ex. 196) stated its position succinctly:

The selection of a regulated STEL should not be an arbitrary multiple of the TWA exposure limit but rather should aim at preventing such other adverse effects not common examples of such other effects are (1) a disproportionate increase in responses for excursion doses above the TWA (i.e., nonlinear effects) or (2) the onset of an acute response not important near the TWA (e.g., acute irritation versus chronic damage).

The 3M Company (Ex. 189–32) stated that it "recognizes that the Hemminki, Johnson and Johnson, . . . Yager . . . research raise important questions about the impact of peak exposures" but that the "significance of short-term peak concentrations is, at best, unclear at this time."

In addition to questioning the strength of the Yager and Johnson and Johnson studies, commentors argued that the biological endpoints in those studies, chromosomal aberration and SCE, could not be correlated to the subsequent occurrence of adverse health effects, and more importantly for determining the need for a STEL, these endpoints were not associated with dose-rate effect (Ex. 189–15, 189–16, 189–18, 189–32).

For example, regarding dose-rate the EOIC stated that:

In order for the conclusion to be drawn that short-term exposures to EtO are more effective at inducing SCE in human peripheral lymphocytes than the same dose received over a long time period, such as an 8-hour working day, data for both exposure conditions have to be available and obtained by the same laboratory preferably co-incidentally. (Ex. 189–16)

In commenting on the Johnson and Johnson SCE data, the EOIC stated that:

The data reported by Johnson and Johnson to date on the induction of SCE in persons occupationally exposed to EtO do indicate that there are some increases in some of the exposed groups at some of the sampling times when compared to worksite controls. However, the interpretation and significance of the data is somewhat handicapped by the very small number of individuals in some of the exposed groups, and also by the potential influencing factor of inter-scorer variation. In addition, it is not possible from the data as presented to relate individual exposure or type of exposure to SCE or chromosome aberration frequencies. For these reasons, it is not possible, even if it were desired, to relate frequencies of SCE to the same exposure received chronically as long-term, low exposure rate exposures or intermittently as short-term, higher exposure rate exposures. In addition, as has been discussed already, since SCE frequencies will at best only be indirectly related to exposure, whether chronic or acute, it is not possible to determine the need for or an appropriate value for a STEL from such data. The lack of an association between SCE and adverse human health effects simply adds weight to this view. (Ex. 189–16)

Another major argument raised by commentors in opposition to the need for a STEL for EtO is that the 1 ppm TWA will itself result in appropriate control of short-term exposures (Exs. 189–16, 189–17, 189–18, 189–24, 189–29, 189–32, 189–34, 189–38, 189–40). For example, Union Carbide stated that:

In reality, meeting the 1 ppm TWA$_8$ is, in and of itself, a challenge requiring careful analysis of all potential sources of employee exposure by professional industrial hygienists. Each potential source is addressed on an item-by-item basis, either through engineering controls or other methods. In a mathematical sense, one can allow only very limited short term exposures to occur for a 15 minute period(s) and still meet the PEL. For example, if this is allowed four times per an eight hour shift (8), the excursion would be limited to 8 ppm. If the short term exposure occurs only once per eight-hour shift, a maximum 32 ppm short term exposure level can occur. Both of these hypothetical cases assume no background exposure for the remainder of the employee's eight-hour work shift—an impractical assumption given the reality of plant environmental exposures. [Ex. 189–34]

The EOIC provided the following discussion on the short-term control implied by the 1 ppm TWA (Ex. 189–16)

As the EOIC explained in its earlier comments, the measures necessary to achieve compliance with the new PEL of 1 ppm, measured as an eight-hour, time-weighted average (TWA), will themselves result in adequate control of short-term exposures. There is therefore no need for OSHA to select a single, arbitrary number to

be imposed as a short-term exposure limit applicable to all employers.

First, as a mathematical matter, the PEL of 1 ppm (TWA) sets an effective, maximum short-term exposure limit of 32 ppm, measured over a 15-minute period. Moreover, this maximum short-term level would be allowed *only* if there were absolutely no other exposure to EO the remainder of the working day. Any other exposure would lower the level that could be allowed to occur during the 15-minute period. Because employee exposure to EO will not likely be limited to one 15-minute period, a 1 ppm PEL effectively requires that 15-minute exposures be kept considerably lower than the theoretical 32 ppm level * * * the existence of additional periods of exposure will necessarily result in *lower* maximum short-term exposures for any 15-minute period.

The EOIC goes on to state that:

The position that the engineering controls necessary to achieve the PEL (and especially the action level) require good control of short-term exposure is also supported by the NIOSH peer review comments (Exhibit 181). NIOSH states that the 1 ppm PEL will actually require employers to maintain workplace concentrations near 0.5 ppm in order to ensure that random variation does not result in exposures exceeding the PEL. It further states that "it appears that *some* short-term exposure limit is necessary in order to satisfy the employer that the 1 ppm PEL has not been exceeded." (Emphasis supplied) This is precisely the EOIC point—that the 1 ppm PEL will, as a practical matter, require employers to control short-term exposures. As NIOSH states, employers will be required to reduce short-term exposures to "some", fairly low level. However, the particular level that may be appropriate will vary from facility to facility. There is simply no basis on which to justify a particular, single limit that applies uniformly to every employer * * * a basic tenet of good industrial hygiene to comply with the PEL is that control of overall exposure levels includes control of peak or excursion levels as well. In this regard, the American Conference of Governmental Industrial Hygienists suggests that, as an indication of good process control, exposures should not exceed three times the TWA for more than 30 minutes during the work day and should not exceed five times the TWA. These guidelines, although not easily applicable to very low TWA's (where the allowed range would be extremely small) or to processes where the exposure profile involves episodic fluctuations, suggest that the trained industrial hygienists who will be involved in implementing controls to achieve the PEL will also be concerned with, and will implement controls to reduce, short-term exposures. Finally, it should be noted that compliance with a PEL of 1 ppm (TWA) will require, as OSHA has acknowledged in the standard, the use of respirators at times when employees might be exposed to higher, short-term levels of EO. Thus, these employees will already be protected from peak exposures.

Other provisions of the standard, aside from the PEL and the action level, will also contribute to the reduction of short-term exposures. The requirements for employee education and training, and for the preparation of written compliance plans, will ensure that both employers and employees are aware of potential higher exposures. This in turn will lead to the institution of measures to assure control of such exposures.

B. Comments in Support of a STEL

In brief, the peer reviewers and public commentors who favored the need for a STEL expressed the following arguments in support of their position:

—A STEL would reduce the significant risk of cancer still present with the 1 ppm TWA;
—The collective scientific data provide sufficient qualitative support for a STEL, and a quantitative assessment of risk is unnecessary;
—Adverse reproductive and mutagenic effects are attributable to short-term EtO exposure concentrations presently being experienced by workers; although these risks may not be quantifiable they are qualitatively demonstrated;
—Additional documentation suggests that sister chromatid exchange (SCE) should be viewed as an indicator of DNA damage which could potentially lead to the clinical manifestation of cancer; and
—Compliance with a STEL of 10 ppm is feasible.

The peer reviews and public comments provided no new significant studies or other substantive health data in support of the need for a STEL, and essentially relied on the data in the record as of June 22. However, they did contain additional explicit discussion of the rationale for adoption of a STEL.

Peer Review Analyses

Peer reviewers supporting a STEL included:

David Rall, M.D. Ph.D., Director, National Institute of Environmental Health Sciences of the Public Health Service, Department of Health and Human Services (Ex. 171);

R.V. Durham, Director of the Safety and Health Department of the International Brotherhood of Teamsters (Ex. 179);

Matilda Babbitz, R.N., Executive Director of the American Association of Occupational Health Nurses (Ex. 180); and

Elliot Harris, Ph.D., Director, National Institute for Occupational Safety and Health, Public Health Service, DHHS (Ex. 181).

The National Institute of Environmental Health Sciences (NIEHS) contended that a STEL is needed based on exposure pattern (short bursts), epidemiological data on EtO sterilization workers, and supporting data indicating increased chromosomal aberration and sister chromatid exchange frequencies among sterilization workers (Ex. 171). NIEHS pointed to data in the record that shows that short-term exposures experienced by sterilizer workers often exceed 50 ppm (Exs. 4–10, 6–15, 11–106). The Institute indicated that the epidemiological studies by Hogstedt et al. (Ex. 2–8) reporting an increased incidence of leukemia, and Hemminki et al. (Ex. 6–7) reporting significantly elevated spontaneous abortion rates among sterilizer workers, are relevant to the STEL question since the exposure patterns leading to the observed health effects in the studies were short-term in nature. NIEHS acknowledged that the Hogstedt sterilization worker study has several limitations including small cohort size and potential cohort selection bias but contended that the data gain additional importance when viewed in conjunction with another Hogstedt et. al study (Ex. 6–8) that also reports an excess leukemia risk among sterilization workers.

NIEHS acknowledged that there are potential weaknesses in the Hemminki et al. study, including recall or reporting bias introduced by the study questionnaire, a potential cohort selection bias, and inadequate control of confounding factors such as maternal age and prior reproductive or medical history. NIEHS concluded, however, that the Hemminki study demonstrates considerable internal consistency, and that the conclusions of the questionnaire are supported by the hospital discharge data which should be free of reporting bias. Taken in conjunction with supporting bioassay data that demonstrate the feto-toxic potential of EtO, NIEHS states that this study cannot be discounted.

Finally, NIEHS argued that available cytogenic data on EtO workers support the need for a STEL. These studies include those of sterilizer workers by Pero et al. (Ex. 6–13), reporting increased chromosomal aberrations and increased unscheduled DNA synthesis in peripheral blood, and of Johnson and Johnson (Exs. 11–113, 150), reporting increased SCE frequency and a dose-response effect. NIEHS summarized the implications of the cytogenetic data as follows:

The available data demonstrate that sterilization workers may experience increased SCE frequency even given relatively low TWA EtO exposures thus suggesting a possible role for short-term elevated exposures. While the predictive value of SCE data with regard to human health outcome is not yet known, this manifestation is generally regarded as an interaction with DNA material during the synthesis phase of the cell cycle. The importance of SCE data in humans gains

significance given similar findings in exposed animals and positive results of carcinogenesis bioassay studies with ethylene oxide. (Ex. 171)

Adoption of a STEL was also supported by NACOSH member R.V. Durham of the Teamsters Union (Ex. 179). Durham stated that due to the peak nature of the majority of EtO exposures, failure to adopt a STEL would be imprudent industrial hygiene practice. With regard to the epidemiological studies by Hemminki (Ex. 6–7), Yager (Ex. 6–15), and Johnson and Johnson (Exs. 11–113, 150), Durham stated that:

While we have observed some limitations with each of these studies, we feel that as a whole these data comprise a body of overwhelming evidence in support of a STEL. The results of the Hemminki study are strikingly consistent with animal studies. The Yager study results are strikingly consistent with results from animal test systems as well. We believe that such a wealth of information cannot be overlooked. (Ex. 179)

With regard to quantification of the risk avoided by adoption of a STEL, Durham argued that:

Although OSHA was unable to quantitatively assess the risks [in their June 14, 1984 draft final standard] indicated by these studies, they were able to qualitatively infer that the human and animal data on adverse health effects warrant a STEL. We believe, therefore, that contrary to OMB's assertion that OSHA had not met the legal test of "significant risk" under the Supreme Court's Benzene decision, *IUD, AFL–CIO* v. *American Petroleum Institute*, OSHA has made an accurate "inference from the available scientific evidence" in support of a STEL. (Ex. 179)

Finally, Durham cited evidence in the record provided by industry that demonstrates the feasibility of complying with a STEL (Exs. 4–49, 11–68, 11–71, 11–113) and further pointed out that Johnson and Johnson, Texaco, Medtronic, and Rohn and Haas have adopted in-house ceiling levels or peaks ranging from 5 to 15 ppm.

The American Association of Occupational Health Nurses (AAOHN) (Ex. 180) supported the need for a 5 ppm STEL with a ceiling value not to exceed 10 ppm at any time. AAOHN's concern with a STEL for EtO relates to the brief but high exposures to EtO of hospital employees using it as a sterilant. AAOHN pointed to data indicating that EtO exposure increases mutation rates in numerous species, causes dose-related increases in leukemias and other tumors in rats, reduces sperm count and function in monkeys and elevates the frequency of SCEs. With regard to the available studies, AAOHN stated that:

While recognizing the limitations of the preliminary work by Morgan, et al. (1981) and Hogstedt, et al. (1979) we concur with OSHA in the current proposed rule: "OSHA believes exposure to EtO may increase the risk of malignancies, particularly leukemia." The work by Yager (1983) and Johnson and Johnson (1983) only serve to reaffirm this composite view. In view of the consistent findings regarding adverse health effects from low level exposure we feel OSHA appropriately used the studies by Hemminki, Yager, Johnson and Johnson as partial support for the issuance of a STEL.

OSHA states that at the 1 ppm PEL the risk of excess cancer deaths is 1 to 2 cases per 1,000 workers exposed to EtO. We find this risk excessive and recommend an STEL at half the 10 ppm valve proposed by OSHA. Although, 10 ppm for a 15-minute STEL would be desirable over none at all we think EtO exposures greater than 10 ppm should not be permitted. This conclusion is from findings that EtO causes chromosomal damage and thus is a potential human carcinogen and that EtO causes adverse reproductive outcomes in humans.

Due to the extreme intermittancy of exposure and its short duration we strongly feel that without a STEL a TWA standard alone will not adequately protect workers exposed to EtO in hospital sterilizers. (Ex. 180)

The fourth peer reviewer supporting the need for a STEL was the National Institute for Occupational Safety and Health (NIOSH) (Ex. 181). NIOSH pointed to data in the record which indicate that hospital sterilizing staff encounter intermittent peak exposures to EtO and that the best way to control exposures is to control the peak exposures (Yager, Exs. 4–10, 31; Roy, Tr. 216; AFGE, Tr. 1197). NIOSH did not agree with arguments that a 1 ppm TWA will by itself set an effective short-term limit. NIOSH contended that the example that a 1 ppm TWA sets a theoretical maximum 15 minute exposure level of 32 ppm is not a realistic argument. NIOSH stated that:

As detailed above [Ex. 4–10], EtO exposures typically occur as brief peak exposures that appear to range between 75 ppm and 125 ppm over the 3 to 4 minute period required for workers to perform their tasks of removing materials from the sterilizer and transferring them to the aerator. (Ex. 181)

NIOSH further stated that:

* * * when EtO exposures are discussed in terms of 8 hour TWA's or 15 minute periods the significance of the high 3 to 5 minute exposure concentrations documented by Dr. Yager is lost. Clearly, the actual exposure concentrations documented by Dr. Yager [Ex. 4–10, Ex. 31) are not consistent with the theory [of a built in 32 ppm STEL for 15 minutes]. (Ex. 181)

On a related point, as noted earlier, several parties opposing a STEL argued that a 1 ppm TWA would actually result in employers achieving EtO levels below 1 ppm in order to allow a margin of safety and avoid exceeding the PEL due to random variation. NIOSH responded to this argument as follows:

As a practical matter, an employer would have to maintain workplace concentrations in the vicinity of 0.5 ppm in order to ensure that an "exceedence due to random variation" had not occurred. The [32 ppm 15 minute] scenario presented by Drs. Voress and Hecker and Mr. Rampy (of EOIC), however, considers only a 1 ppm PEL and doesn't address the issue of an action level. If short term exposures never exceeded 16 ppm, then an employer could be reasonably assured that 8 hour TWA exposures would not exceed 1 ppm. However, neither the EOIC nor OMB appears to have considered this point. Review of Dr. Yager's data clearly indicates that short term exposures are far in excess of 16 ppm. Therefore, as a practical matter, it appears that some short term exposure limit is necessary in order to satisfy the employer that the 1 ppm PEL has not been exceeded. (Ex. 181)

The necessity of adoption of a STEL based on the studies in the record showing observed adverse health effects was addressed at length by NIOSH. NIOSH contended that a reasonable inference from the collected data can be made that short-term exposure to EtO can lead to adverse health effects in workers. NIOSH argued that: (1) Data demonstrates that EtO reacts with the genetic material of at least 13 different species with the observation of persistence of genetic damage in humans; (2) EtO exposure is capable of producing adverse mutations in mammalian germinal cells that are heritable and which can adversely affect the human genome and reproductive capacity; (3) EtO exposure causes chromosomal aberrations (Yager, Johnson and Johnson) in workers; (4) the basic findings by Hemminki (Ex. 6–7) that spontaneous abortions result from EtO exposure cannot be discounted; and (5) data demonstrates that EtO is a potential human carcinogen.

The carcinogenic potential of EtO was described by NIOSH as being relevant to the STEL issue as follows:

There is agreement that EtO is a potential occupational carcinogen. The exact mechanism of the carcinogenic process is, however, debatable. At one extreme, it is argued that only one event is needed to initiate the carcinogenic process; at the other extreme, it is believed that many events are required. In the first example, the response is linear; in the latter example, the response incorporates a threshold concentration below which a response will not occur.

Ethylene oxide appears to exert its effects by alkylation of DNA. Under most circumstances, DNA bases that have been chemically modified are removed. If, however, damage occurs at a rate that

exceeds the cell's ability to effect repair, then the damage is likely to persist. Ehrenberg [8] has reported finding such persistent damage among workers exposed once at high EtO concentrations. It is possible that persistent chromosomal damage is also occurring among workers exposed to EtO during sterilization processes when exposures are typically intermittent peak exposures but well below those described by Ehrenberg [8]. Johnson & Johnson provided testimony that addressed this point: "* * * the time weighted average (TWA) of EtO in the atmosphere may not truly reflect what may be a more important exposure in terms of chromosome effects, i.e., transient high levels ('peak' levels)". (Ex. 137)

This conclusion by Johnson & Johnson was based on the results of their investigation which demonstrated increased frequencies of sister chromatid exchanges among workers whose TWA exposures were calculated to be "* * * up to 10 ppm and above." However, Johnson & Johnson conceded that "* * * the nature of the sterilizer operations at the plants may lead to transient peak exposure levels that quickly return to very low levels."

While none of these studies provide confirmation of the carcinogenic process, they do lend credence to a plausible mechanism of action for ethylene oxide. Such a mechanism appears to involve a delicate balance between DNA damage and repair which may be easily influenced by "peak" EtO exposures. (Ex. 181)

With regard to the argument that OSHA must quantitate the risks associated with short-term exposures to EtO, NIOSH stated that the techniques of quantitative risk assessment are not yet developed to allow such an analysis and that OSHA must, therefore, rely on expert scientific opinion pertaining to the STEL issue.

Finally, NIOSH argued that compliance with STEL is feasible, pointing out that Johnson and Johnson (Ex. 150) has stated that they have been achieving compliance with a 10 ppm, 15 minute STEL since May, 1980.

Public Comment

Ten of the 41 commentors responding to OSHA's September 19, 1984 EtO notice provided statements supporting the need for adoption of a STEL (Exs. 189–2, 189–12, 189–14, 189–19, 189–22, 189–26, 189–27, 189–30, 189–33, 189–39). These commentors contended that qualitative scientific data demonstrate that a STEL is particularly necessary to prevent the occurrence of SCE and spontaneous abortions that result from short-term EtO exposures (Exs. 189–14, 189–19, 189–22, 189–39). They also argued that increased frequency of SCE observed in EtO workers is a predictor of subsequent adverse health effects. For example, the International Chemical Workers Union stated that "Though SCE does not itself represent an adverse health effect, it is a sensitive indicator of chromosomal damage which may predict the development of cancer" (Ex. 189–22). Raymond Tice, Ph.D., Brookhaven National Laboratory, submitted a number of reports presented during the recent International Symposium on Sister Chromatid Exchanges from which he concluded:

> SCEs are a sensitive indicator of DNA damage at the cellular level and, as such, *can* be used as predictors of carcinogenic/teratogenic/mutagenic potential. At present, we are not cognizant fully of which types of DNA damage elicit an SCE response and/or the biological consequences of that damage. Furthermore, SCEs are not elicited by certain classes of genotoxic agents. However, SCEs can be used to indicate damage to DNA induced by EtO and damage to DNA is potentially harmful. Thus, it is entirely appropriate that SCEs be used as an indicator of potential harm. (Ex. 189–13)

Tice also characterized an article by Garry et al. (Ex. 189–14) entitled "Ethylene Oxide Induced Sister Chromatid Exchange in Human Lymphocytes Using a Membrane Dosimetry System" as containing data "indicating dose-rate effects for the induction of SCEs by EtO" (Ex. 189–13).

With respect to the health implications associated with chromosomal aberrations, the American Federation of State, County and Municipal Employees stated that:

> Some commenters have raised the contention that the presence of increased chromosomal aberrations in populations exposed to EtO is not pertinent, since no overt illness is directly attributable to such a finding. (Exs. 152, 153, 11–133, 175, 178, 179). Although this currently is true on an individual basis, it is not true on a population basis. Studies of chromosomal aberrations in populations exposed to ionizing radiation have shown clear dose-related increases both in chromosome aberrations and in various cancers for these populations (Testimony of Geoffery M. Karny before U.S. House of Representatives, October 6, 1982). (Ex. 189–14)

Other commenters contended that short-term limits are necessary to minimize exposures to substances such as EtO, that are considered to be potential carcinogens (Exs. 189–33, 189–39).

Richard Brandt, Industrial Hygienist for the State of Wisconsin comments that a STEL is warranted to prevent the occurrence of lung tissue shock and consequent blood absorption (Ex. 189–2).

In addition to supporting the need for a STEL, commentors addressed the issue of quantification of the risk reduced by issuance of a STEL. The National Union of Hospital and Health Care Employees provided the following discussion:

> In terms of risk reduction, the Calleman article (30) makes a calculation for the risk for the development of cancer after exposure to ethylene oxide. Their calculation indicates that a PEL of .25 ppm would be equivalent to an exposure to five REMS of low LET radiation per year. Five REMS per year is ten times that permitted for pregnant workers and to the nonworking population. There is also growing evidence that five REMS does in fact pose significant risk to the exposed individual. At this exposure risk of 5 REM/year there is significant cancer risk. NIOSH (30) has determined that the risk of cancer from one x-ray is .8 excess cancers per one million. Five REMS would extrapolate to 6.5 excess cancers per million suggesting that even a TLV of .25 ppm is too high, strengthening the case that the TLV–TWA should be .1 ppm, the ceiling .5 ppm to 1 ppm and the STEL .3 to .5 ppm. (Ex.189–39).

The National Safety Council stated that the quantification of the risk in this instance can only be determined qualitatively because of limitations of the science of risk assessment, but that the qualitative scientific evidence on EtO clearly supports the need for a STEL (Ex. 189–12).

IV. The ACGIH TLV Recommendation

A number of commentors opposing adoption of a STEL cited the fact that the American Conference of Governmental Industrial Hygienists (ACGIH) has not recommended a specific STEL for EtO. Commentors supporting adoption of a STEL point out, however, that the ACGIH does recommend adherence to an "excursion limit" for EtO. The following discussion is provided to clarify the implications of the ACGIH position as it relates to the STEL determination by OSHA.

The ACGIH Chemical Substances Threshold Limit Value (TLV) Committee has a long history as a respected group involved in recommending workplace exposure standards for chemicals. This group consists of professional industrial hygienists (and toxicologists), in the employ of various governmental bodies (Federal, State, Cities, Military, Universities), who serve voluntarily on the committee.

In addition, a number of industrial hygienists and toxicologists with private industry also serve, again voluntarily, as consultants to the TLV Committee, attending the regular meetings and making contributions to the development of the TLVs and their documentation. (Only the TLV Committee members vote on Documentations and TLVs to be submitted to the ACGIH Board).

OSHA adopted the 1968 TLVs as Permissible Exposure Limits (PELs) under section 6(a) of the OSH Act in 1971. These 1968 TLVs are still the major

part of the OSHA PELs, those found in Table Z–1, § 1910.1000.

As toxicology has become a more sophisticated science, the TLVs have shifted from TLVs which were originally based primarily on acute exposures and effects, to a range of TLVs, ceiling limits and short term exposure limits based on available exposure information and toxicology data from human exposure, or animal tests.

Currently, the ACGIH TLV Committee uses three basic categories of TLVs:

(a) TLV–TWA (Time Weighted Average)

(b) TLV–STEL (Short-Term Exposure Limit)

(c) TLV–C (Ceiling)

In addition to these, the Committee recommends Excursion Values (to be addressed in greater detail later); provides a "skin" notation in the TLV list to indicate substances absorbed through the skin; establishes special provisions for exposures to mixtures of substances; and provides for special treatment of "nuisance" particulates, simple asphyxiants, and special problems with physical agents which may act to increase the adverse reaction to a substance.

Much emphasis in recent years has been on carcinogenic effects of some chemicals, and the committee has devoted a great deal of effort to addressing this concern. The committee has several general classifications it uses for carcinogenic substances, determined by the level of information available about the substance's effects in humans and experimental animals, and the mechanism of action of the substance. For some substances, no safe level has been determined from the studies.

With regard to STELs, the committee recommends them for toxic substances when the "toxicological evidence" warrants it (Ex. 184). STELs are defined by ACGIH in the TLV booklet as follows:

(b) Threshold Limit Value-Short Term Exposure Limit (TLV–STEL)—the concentration to which workers can be exposed continuously for a short period of time without suffering from: (1) Irritation, (2) chronic or irreversible tissue damage, or (3) narcosis of sufficient degree to increase the likelihood of accidental injury, impair self rescue or materially reduce work efficiency, and provided that the daily TLV–TWA is not exceeded. It is not a separate independent exposure limit, rather it supplements the time-weighted average (TWA) limit where there are recognized acute effects from a substance whose toxic effects are primarily of a chronic nature. STELs are recommended only where toxic effects have been reported from high short-term exposures in either humans or animals.

A STEL is defined as a 15 minute time-weighted average exposure which should not be exceeded at any time during a work day even if the eight-hour time-weighted average is within the TLV. Exposures at the STEL should not be longer than 15 minutes and should not be repeated more than four times per day. There should be at least 60 minutes between successive exposures at the STEL. An averaging period other than 15 minutes may be recommended when this is warranted by observed biological effects.

ACGIH also recommends the use of "Excursion Limits" in those situations where there is not enough toxicological evidence to support a STEL. Excursion Limits have their basis in long experience in industrial hygiene practice and the observation that processes with workplace exposure with high variability are not "under good control" and that efforts must be made to bring these exposures under control. These high degrees of variability may be discovered by monitoring peak exposure levels to determine exposure patterns which may be caused by various aspects of the operation in question, often point source leaks, and work practices.

ACGIH addresses these situations as follows (Ex. 184):

Excursion Limits. For the vast majority of substances with a TLV, there is not enough toxicological data available to warrant a STEL. Nevertheless, excursions above the TWA–TLV should be controlled even where the eight-hour TWA is within recommended limits. Earlier editions of the TLV list included such limits whose values depend on the TWA–TLVs of the substance in question.

While no rigorous rationale was provided for these particular values, the basic concept was intuitive: In a well controlled process exposure, excursions should be held within some reasonable limits. Unfortunately, neither toxicology nor collective industrial hygiene experience provide a solid basis for qualifying what those limits should be. The approach here is that the maximum recommended excursion should be related to the variability generally observed in actual industrial processes.

The ACGIH's recommendation where "Excursion Limits" are applied is that:

Short-term exposures should exceed three times the TLV–TWA for no more than a total of 30 minutes during a work day and under no circumstances should they exceed five times the TLV, provided that the TLV–TWA is not exceeded.

With regard to this recommendation, ACGIH states that:

The approach is a considerable simplification of the idea of the log normal concentration distribution but is considered more convenient to use by the practicing industrial hygienist. If exposure excursions are maintained within the recommended limits, the geometric standard deviation of the concentration measurements will be near two and the goal of the recommendation will be accomplished.

When the toxicologic data for a specific substance are available to establish a STEL, this value takes precedence over the excursion limit regardless of whether it is more or less stringent.

In comments submitted to OSHA by ACGIH (Ex. 189–19) ACGIH stated its position with regard to EtO exposure as follows:

The use of specific Short Term Exposure Limit (STEL) by the committee is generally limited to situation, where the committee is advising more restrictive control on short-term exposure than that afforded by the excursion limit for the TWA–TLV. The committee has specifically addressed this issue for ethylene oxide. Committee policy would not require a specific statement on the value of the excursion limit in the documentation for each substance for which a specific Short-Term Exposure Limit (STEL) is not recommended. However, in its meeting on March 26–27, 1984 it specifically directed that just that type of statement be added to the documentation for ethylene oxide (1984 Supplemental Documentation package is enclosed. See page 185.2 (84) second last paragraph. "Because some studies have pointed out the importance of short-term high exposures, the ACGIH considers that control by the excursion limits given in the preface of the TLV booklet will suffice to protect from the adverse effects of ethylene oxide." (Ex. 192)

In its earlier submission (Ex 184), ACGIH had suggested this view:

Traditional industrial hygiene approaches have evaluated either short and/or long term exposures as appropriate. To intimate that short-term measurement is not a traditional industrial hygiene approach shows only a lack of familiarity with the field. I would also suggest that compliance strategy and toxicological justification are not necessarily causally linked. If a short-term limit is needed for ease of compliance monitoring, it can be justified on its own merits.

(The TLV committee, however) did not have the toxicological evidence to recommend a specific STEL more restrictive than the excursion limit on the time-weighted average (TWA–TLV) recommendation. The use of the excursion limit of ACGIH is more restrictive and more protective of worker's health than the short term limit proposed by OSHA . . .

Commentors, both in opposition to adoption of the STEL (EOIC, Ex. 189–16; OMB, Ex–162) and in favor of the STEL: (AFSCME, Ex. 189–14; NIEHS, Ex–171; NIOSH, Ex. 181; AAOHN, Ex. 180) who discuss the ACGIH TLV appear to recognize either the explicit or implicit need to monitor peak exposures in order to gauge the degree to which an operation is in good control or poor control, and what the variation of exposure is around the actual TWA, in the process of controlling exposures to

the prescribed TWA. (The ACGIH concept of "excursion limits" and its relevance to OSHA's STEL determinations are discussed further in section V.3 below).

In summary, the ACGIH has not recommended a STEL for EtO because the TLV Committee has determined that there are insufficient toxicological data to warrant such an action. Specifically, the committee concluded that a STEL for EtO would be recommended "only where toxic effects have been reported from higher short-term exposures in either humans or animals.

V. OSHA's Conclusions

After a thorough review of the entire rulemaking record, including the peer review and public comments received since June 22, OSHA had determined that the available health data on EtO do not necessitate the establishment of a STEL to supplement the 8-hour TWA of 1 ppm. This determination is based on several factors whose significance has been highlighted by many of the comments received by the Agency in response to its **Federal Register** notices of June 22 and September 19. Although no new studies on the health effects of EtO have been submitted to the record during this extended comment period, there has been considerable new documentation of reasons why the existing health data do not necessitate that a STEL be established. OSHA's rationale for not promulgating a STEL is based largely upon this new information, which has provided the agency with clearer and more definitive findings than were available at the time of promulgation of the June 22 final rule. In brief, OSHA's decision not to issue a STEL for EtO centers on three basic findings: First, the available health data do not demonstrate the risks from EtO exposure to be dose rate-dependent. In other words, the studies do not indicate that the risk from exposure to a given dose of EtO are greater when that dose is distributed at high concentrations over a short period of exposure during a workday rather than at a lower concentration during a longer period of time. Second, since the effects of EtO are assumed to be *dose* dependent rather than dose-*rate* dependent, reduction of the total dose is the critical factor in dealing with the significant risks of EtO exposure. Therefore, the 1 ppm TWA is sufficient to minimize significant risk, within the bounds of feasibility. Third, in terms of industrial hygiene and methods of controlling EtO, compliance with the TWA will necessitate the control of short-term exposures, particularly for exployees whose exposure consists primarily of short-term bursts. Therefore, to the extent that good industrial hygiene practice calls for the reduction of short-term peak exposures, the low TWA of 1 ppm will result in the minimization of short term exposures within the workday. Further, where burst-type exposures occur more than once per day, and where there are background levels of EtO between bursts, the TWA will place internal limitations on the levels and durations of such bursts during the workday to assure compliance with the TWA. The following section discusses each of the above findings in detail, together with supporting references to the rulemaking record. In addition to these primary findings, this section will discuss other related reasons which provide further support for the Agency's determination.

1. *Dose-Rate Relationship.* In making its final determination on the STEL issues, OSHA has reevaluated the available health evidence in light of the peer review and public comments received since the June 22 notice was published. Although these submissions to the record included little additional health data, they did provide wide-ranging and expansive discussions of the relevance of the various studies to the setting of a limit on short-term exposures to EtO. In particular, they concentrated on the issue of whether a "dose-rate" relationship had been established between EtO exposures and the various health effects attributed to those exposures. The Agency had not previously addressed this issue in depth, and has since determined that it is particularly important in the EtO context. In brief, if the health effects of EtO are related to the total dose alone, without regard to the temporal distribution of that dose, an 8-hour TWA limit on exposures will reduce the risk of those health effects by limiting the total dose received. However, if the effects from exposure can be shown to be greater when the total dose is received in a short period of time than when it is spread over a longer period, an 8-hour TWA limit alone might not be adequate to reduce the risks. In the event of such a "dose-rate" relationship being established, a STEL might be warranted as a supplement to the TWA in order to provide protection against the additional risk attributable to concentration of the dose over short periods. After a careful evaluation of the peer review and public comments on this issue, and based on the Agency's review of the available studies on the effects of EtO exposure, OSHA has determined that none of the studies on the adverse health effects of EtO have established a dose-rate relationship between the pattern of EtO exposure and an increased risk of impairment of employee health. Accordingly, the Agency has determined that a STEL is not warranted in the final EtO standard.

As discussed above, a finding that is critical in order for OSHA to justify the adoption of an EtO STEL is that evidence demonstrates that for some biological end-point of EtO exposure, there is a "greater yield of damage (effect) from an acute treatment as compared to a chronic or fractionated treatment for the same total dose" (Ex. 186). The studies in the record that have been most commmonly cited as demonstrating that this dose-rate effect is associated with EtO exposure include those by Yager et al. (Exs. 4–10, 6–15, 22), Johnson and Johnson (Exs. 4–17, 137), Garry et al. (Ex. 189–14), Hemminki et al. (Ex. 6–7); and Hogstedt et al (Exs. 2–8, 2–22). The biological end-points observed in these studies include increased frequency of SCE and chromosome aberration in exposed workers (Yager, Johnson and Johnson) and *in vitro* (Garry), increased frequency of spontaneous abortion among EtO sterilizer workers (Hemminki), and increased incidence of leukemia among EtO workers (Hogstedt). OSHA reaffirms its conclusions with respect to these studies that were reached in its final standard for EtO published June 22, 1984 (49 FR 25734). In particular, OSHA determined at that time that ". . . findings in humans and experimental animals exposed to EtO are indicative of damage to genetic material [DNA]. These include hemoglobin alkylation, unscheduled DNA synthesis, sister chromatid exchange [and], chromosomal abnormalities . . ." OSHA further concluded that the available data demonstrate that ". . . EtO exposure may cause an increase in spontaneous abortions" and that "EtO is a potential occupational carcinogen." However, based upon its evaluation of the available health data and in light of the peer review analyses in the record, OSHA is unable at this time to determine that these outcomes are dose-rate effects, in addition to dose-effects.

Before a STEL can be justified based on health effects from short-term exposures "there would have to be an observe dose-rate effect over a certain dose range, and at the dose limitation imposed there would be an influence of [Cellular] dose rate." (Ex. 186). No such evidence has been presented in the rulemaking record. OSHA concurs in the conclusion by the AAIH (Ex. 175) that

none of the pertinent "studies demonstrate that the amount of DNA damage received as a result of short-term exposures to EtO is greater than that received . . . by the same cumulative dose of EtO during constant exposure conditions" and that ". . . *none of them was designed to test whether the fractionation of the EO dose is more important to the likelihood of a clinical outcome*" (AAIH emphasis).

In order to examine the potential for a dose-rate effect for EtO, it must be demonstrated that the effect accrues to a greater degree for a dose over a high dose period than for the same dose being received over longer low dose periods.

Thus, data are needed that compare the biological outcomes that result from the two exposure scenarios. That is, health effects observed in a test group receiving a given total dose over a continous period of time must be compared with the health effects observed in a separate test group receiving the same total dose over a shorter period. In order to examine whether a dose-rate relationship exists, the available data must allow for a comparison between the health effects of short-term exposures and the health effects of continuous exposures, involving the same total dose for the two patterns of exposure. Studies in which the exposed groups have each received mixed exposures, or in which all exposed groups were exposed to the same type of exposure pattern (either short-term or continuous), do not provide the kind of data to allow for that comparison. In the case of EtO, none of the studies which have been cited in support of the STEL are sufficient to enable the Agency to determine the existence of a dose-rate relationship. Accordingly, OSHA has determined that currently available studies do not justify the imposition of a STEL. The following section discusses each of these studies and its limitations in the context of OSHA's determination not to issue a STEL.

With respect to the Yager study, exposures occurred once per day with a mean concentration of 82 ppm over 3.5 minutes. EtO exposure for each worker was expressed as an estimated cumulative dose for the 6-month study period. The study results indicated that workers with cumulative doses of greater than 100 mg of EtO had significantly higher levels of SCE than workers with cumulative doses of less than 100 mg. Though this study does indicate that short-term EtO exposures can result in SCE in workers, the study does not demonstrate, and was not designated to demonstrate, that the amount of SCE observed is greater than that that would be seen in workers receiving the same cumulative dose from continuous exposure.

Dr. Yager has speculated, however, that this study may suggest the existence of a dose-rate effect for EtO. She observed that:

> With the breathing zone data gathered in this study, it may be possible to determine whether the observed increase in SCE's arises exclusively from the cumulative effect of daily exposure or whether some component of the increase results from the rate at which that exposure occurs. Comparison of mean numbers of SCE's induced per cell per unit of cumulative exposure with those reported in a recent animal study (6) indicates that humans may be considerably more sensitive to SCE induction than animals.
>
> This difference would be much less, however, if SCE induction were also a function of dose rate, since the workers were exposed to ETO for short periods at five times the dose rate to which the animals were exposed. (Ex. 6–15)

Dr. Yager concludes that:

> If a dose rate effect is found for humans . . . then the evdence of ETO-induced SCE's may suggest that occupational exposure to ETO and other alkylating agents be controlled in terms of both cumulative dose and dose rate. (Ex. 6–15)

The animal study cited by Yager involved exposure of groups of rabbits to 0, 10, 50 or 250 ppm EtO by inhalation for 6 hours per day, 5 days per week for 12 weeks. A statistically significant increase in mean SCE was seen in the rabbits exposed to 50 and 250 ppm of EtO, but not at 10 ppm.

With respect to the interpretation suggested by Yager from comparative analysis of these studies, the Environmental Mutagen Society argued that:

> The other points alluded to in this paper . . . are that there are dose-rate effects for SCE induction by EtO and that humans are more sensitive than rabbits with regard to elevated SCE levels following EtO exposure. Both of these contentions are unquestionably speculation not supported by hard experimental data. First, the species difference. Her protocols for blood lymphocyte culture and BrdUrd levels were different for the two species as were the exposure conditions, and thus, comparisons cannot be made only on the basis of exposure conditions to conclude either a species sensitivity difference or a dose-rate effect. The comparison of short duration exposures in humans (species with long-lived lymphocytes) with continuous exposure in rabbits (species with short-lived lymphocytes) Huff et al., *Mutation Research* 94:349, 1982) is not appropriate without at least the mentioning of either lung physiology or DNA repair differences or some other confounding factors as possibilities. (Ex. 189)

OSHA notes with interest that Dr. Yager has submitted a proposal to NIOSH that would evaluate a dose-rate effect of exposure to EtO on SCE. OSHA supports this further research and has submitted a letter to NIOSH urging funding of this research.

OSHA believes that these studies do raise important questions regarding existence of an EtO dose-rate effect in humans. However, neither OSHA nor Dr. Yager are able to conclude from these data that such an effect exists. (As noted above, Dr. Yager has proposed to conduct further research on dose-rate effects).

The Johnson and Johnson studies (Ex. 4–17, 137 A, B, C, D) were initiated to determine whether employees exposed to EtO showed more chromosome changes than employees thought to be unexposed. OSHA finds no indication in the record that either of the Johnson and Johnson studies were designed to test for dose-rate effects. The observations of SCE in the first study (Ex. 4–17, 137 A, B, C) were based on exposures in three study plants that were expressed only as 8-hour TWA's. The conclusions reached in the second study (Ex. 137D) wee based on historical exposure information which included data from 8-hour TWA samples and short-term exposure samples. As with the Yager data, the Johnson and Johnson data do not include comparative effect analyses from the two exposure scenarios. Thus, OSHA cannot point to either of the Johnson and Johnson studies as demonstrating dose-rate effect. OSHA concurs with the conclusion expressed by the Environmental Mutagen Society that these studies only "demonstrate(s) that occupational EtO exposure causes chromosome aberrations and elevates the SCE frequency in workers" (Ex. 186).

As noted in the June 22 FR notice, OSHA believes that the Hemminki et al. study demonstrates that EtO exposure may also result in spontaneous abortion. However, the study does not show, nor was it designed to show, that brief transient episodes of high exposure to EtO are of greater importance than the total EtO dose in leading to abortion. The results reported by Hemminki were based on estimated TWA exposures and recorded peak exposures. A dose-rate effect cannot be inferred from this report because the study group was subject to both transient and continous EtO exposures, and a comparison of abortion rates from each exposure scenairo was not made. As the committee for the Environmental Mutagen Society concluded, the Hemminki study "has no bearing whatsoever on the question of dose-rate effect" (Ex. 186)

The problem inherent with the use of any of the studies discussed above as demonstrating a dose-rate effect is that the results were seen from exposures to EtO as they actually occur in the workplace. That is, the total dose received by the workers in these studies was from either a combination of short-term and continous EtO exposures (Johnson and Johnson, Hemminki) or short-term exposure only (Yager). As such, they do not provide sufficient data to allow a meaningful comparison of the health effects of short-term excursions of EtO as opposed to the same total dose distributed over longer periods. OSHA believes that it is necessary to have data that compare the biological outcomes that result from the two exposure scenarios before a conclusion can be reached that a dose-rate effect exists. OSHA determined that such data are not presently available with respect to EtO. Assuming NIOSH funds Dr. Yager's further work and possibly other studies in this area, more definitive data may become available in the next year or two. If the data so indicate, OSHA will consider reevaluating the decision it announces today.

Finally, a dose-rate effect is not indicated with respect to the available studies demonstrating the potential carcinogenicity of EtO (Hogstedt et. al., Exs. 2–8, 2–22, and Bushy Run, Ex. 2–9). The Hogstedt studies suffer the same lack of study design to test for dose-rate effect; that is, results of the study were from study populations that were exposed to both continuous and peak EtO exposures over the study period. The Bushy Run study, used by OSHA is quantifying the excess risk of leukemia from exposure to EtO, exposed groups of rats at various EtO concentrations for 6 hours per day, 5 days per week. No comparative short-term exposure study on rats was perfomed. In addition, OSHA has quantified the relationship between dose and carcinogenic response to EtO in tems of a cumulative dose mathematical model, based upon available data and on assumptions set forth both in the risk assessment itself and in the June 22 final rule. Data do not presently exist for OSHA to explore this relationship based on EtO dose pattern.

Thus, OSHA has concluded that presently available data do not demonstrate an association of EtO exposure with a dose-rate effect. Accordingly, OSHA has determined, that adoption of a STEL for EtO is inappropriate.

It should be noted that an *in vitro* study by Garry et al. (Ex. 189–14) did reveal a dose-rate effect of EtO-induced SCE frequencies in EtO-treated human lymphocyte cultures. The ambient exposure doses were 100 ppm, 131 ppm, 218 ppm and 306 ppm for 20 minutes each. The authors conclude that the "data show an incremental change in SCE frequency with applied ambient EO . . .". The authors further state, however, that "Although we indicated that in vitro sensitivity of the SCE technique in human lymphocytes, the data cannot be directly linked to the vivo response" due to factors such as respiratory rate, and EtO protein binding and inactivation.

Both of the Mutagen Society's peer reviewers, Generoso and Dufrain, suggest that further research be performed in order to resolve this issue.

Similarly, the 3M Company (Ex. 189–32) states that it "recognizes that the Hemminki, Johnson and Johnson, . . . Yager . . . research raise important questions about the impact of peak exposures" but that the "significance of short-term peak concentrations is, at best, unclear at this time."

In addressing the possible reason why a dose-rate effect has not been observed for EtO, the Environmental Mutagen Society (Ex. 186) offered the following:

> . . . for high energy radiation (X or gamma rays) one is unable to determine a difference in biological damage when 1000 millirem is received in one minute or 1 millirem is received per minute over 1,000 minutes or longer, because the total dose is so low, there is no dose rate effect. This may well be a possible outcome resulting from the introduction of a 1 ppm 8-hour limit exposure [for EtO].

OSHA agrees that further research may be warranted on the implications of the EtO data dealing with dose-rate effects. Therefore, OSHA has specifically requested that NIOSH fund research proposals to evaluate end-points such as SCE or alkylation in sperm DNA in relation to the existence of a dose-rate effect from exposure to EtO. OSHA will review these studies when the results become available, and will evaluate whether the question of a short-term limit for EtO should be reexamined.

2. *Dose Effects.* OSHA believes that the dose effects that result from exposure to EtO will be significantly reduced by controlling exposures to the 1 ppm TWA and that available data do not demonstrate that this reduction will be jeopardized by the decision to not include a STEL. OSHA continues to believe, as concluded in the final EtO standard, that the risk of damage to genetic material, incidence of cancer, reproductive effects, neurotoxicity and sensitization "will be substantially reduced by promulgation of the 1 ppm TWA". The contol of chronic exposures to EtO is felt to be of primary importance in reducing the risk from the potential effects cited above. As the Agency noted in its June 22 final rule, the Yager and Johnson and Johnson studies indicated that chromosomal aberrations and SCE are induced in workers exposed to EtO levels between 1 and 10 ppm as an 8-hour TWA. Therefore, reduction of the TWA is expected to reduce that total dose and, therefore, should also reduce the incidence of cytogenic effects.

With respect to cancer induction, OSHA has demonstrated a significant reduction in risk from that under the previous TWA of 50 ppm by adoption of the 1 ppm TWA alone. For the cancer causing effects of EtO exposure, there is no indication that short-term high exposures to EtO are more hazardous than an equivalent dose spread over 8 hours.

The fetotoxic and spermatogenic effects which result from EtO exposure were described in the final standard as perhaps being "induced by changes in the DNA and which are known to be produced by many alkylating agents as EtO." There is no scientific consensus that either mutagenesis or other effects on DNA are dose-rate effects. With respect to neurotoxicity and sensitization, OSHA also concluded that" the record as a whole clearly suggests that lowering the TWA [from 50 ppm to 1 ppm] will significantly reduce the risk that employees exposed to EtO will experience from these effects."

Thus, OSHA believes that the 1 ppm TWA, by itself, will provide significant worker protection from the dose-effects associated with exposure to EtO.

This view is supported by a number of commentors (Exs. 189–24, 189–32, 189–35). For example, the R.T. French Company stated that "we believe that the 1 ppm permissible exposure limit as an eight hour TWA is . . . sufficient to protect workers' environment given today's knowledge" (Ex. 189–24). 3M Company (Ex. 189–32) commented that they "agreed with the need for a 1 ppm PEL" . . . and that ". . . 29 CFR 1910.1047 as it stands is a prudent attempt to reduce exposures to extremely low levels, on the basis of chronic animal and epidemiological information gathered to date." Finally, the American Hospital Association characterized the adequacy of OSHA's present EtO standard as follows:

> . . . OSHA published a new standard that reduces permissible exposure to EtO by a factor of 50. Standard requirements cover methods of exposure control, personal protective equipment, measurement of

employee exposures, training, medical surveillance, signs and labels, regulated areas, emergency procedures, and recordkeeping. When fully implemented, this standard should prove highly protective of employee safety and health. Several years in development, this standard calls for most, if not all, of the engineering and work practice controls necessary for reducing exposures to an acceptable level. (Ex. 189–35).

3. *Compliance With the TWA Will Reduce The Magnitude of Short-Term Exposures.* OSHA believes that the compliance program designed to maintain exposure to or below the 1 ppm TWA limit (required by paragraph (f)(1) of the standard) will also substantially reduce the magnitude of the short-term exposures. Although the 8–hour TWA limit allows excursions above the limit (provided that they are compensated by excursions below the limit during the workday), in practice, the workplace controls to reduce TWA exposure will be designed to capture EtO emissions at their source, which is directly related to the magnitude of the short-term exposures. As stated by Ernest M. Dixon, M.D. in a submission by the American Occupational Medical Association: "In meeting the 1 ppm PEL employers will readily deal with the short term exposures; the steps necessary to assure compliance with the 1 ppm PEL would make significant excursions very unlikely—except in accidental or special circumstances where use of respirator protection must be permitted (Ex. 187)". This position is supported by a number of commenters (Exs. 189–16, 189–32, 189–29, 189–24, 189–34, 189–40, 195).

Paragraph (f)(1)(i) of the final standard requires that "the employer shall institute engineering controls and work practices to reduce and maintain employee exposure to or below the TWA, except to the extent that such controls are not feasible." OSHA described the types of controls that would have to be implemented as a result of this requirement in the "Feasibility of the 1 ppm TWA" section of the preamble to the EtO standard, at 49 FR 25768. OSHA concluded that the EtO producer and ethoxylator industry sectors would use conventional technology to meet the 1 ppm TWA. Controls include use of rupture disks for minimizing low-level leakage from pressure relief devices; closed sampling devices at process sampling locations, and vapor-tight unloading connections, magnetic level gauges, and nitrogen purge systems on tank car loading facilities. These controls reduce short-term exposure as well as the TWA exposure. For operators of large industrial sterilizers, engineering and work practices include changer evacuation systems, liquid/gas separation units to prevent excessive EtO emissions during chamber evacuation, local exhaust hoods installed over the sterilizer door, local ventilation of aeration chambers, and allowing the sterilizer contents to aerate for a short period of time after opening the sterilizer door. Hospital sterilizers are smaller than sterilizers used by medical product manufacturers, but the control of EtO involves the same principles and types of control equipment and methodology used for industrial sterilizers.

OSHA found that the smaller size of hospital sterilizers makes controlling EtO exposures in hospitals generally easier than in industries using large sterilizers. As in the chemical industry sectors, these controls will reduce short-term exposure along with the TWA exposure. For example, opening the sterilizer door by an employee can cause a high short-term exposure that contributes to the TWA exposure; both exposures are reduced if the sterilization chamber is evacuated before the door is opened.

Several commentors expressed concern that EtO exposure could be very high for short periods of time (such as 500 ppm for 1 minute) if a STEL were not adopted (Exs. 171, 180, 181, 189–19, 189–22). Even though a 1 ppm TWA theoretically and mathematically allows a 15 minute STEL of 32 ppm (if the background concentration is zero for the remaining portion of the day), an actual high exposure duration of 3 to 5 minutes is the norm for sterilizer operations. This would permit hypothetical exposures up to 160 ppm and would still meet the 1 ppm TWA assuming no further EtO exposure for the remainder of the 8-hour shift. OSHA believes, however, that in actuality, compliance with the 8-hour TWA will not allow high excursions of this degree. The reason is that there are low level EtO background concentrations in the workplaces where EtO is being used, and these background concentrations must be taken into account in calculating an employeee's daily dose of EtO. Such background levels can often result from offgassing of sterilized products, for example. The existence of such background EtO levels, together with the need to control the daily dose to a TWA of 1 ppm, makes it unlikely for an individual excursion to reach the mathematical possibility of 32 ppm for 15 minutes without resulting in an 8-hour TWA above 1 ppm. Further, the closer the background concentration gets to 1 ppm, the lower the permissible excursions will be in order for total exposure to be within the TWA. Several parties (Exs. 189–16, 189–34, 197) noted that an assumption of no background exposure from EtO for the remainder of the shift is "an impractical assumption given the reality of . . . environmenal exposures" (Ex. 189–34) and that these additional exposures will necessarily require the employer to further limit short-term exposures.

In addition, where more than one short-term exposure contributes to the 8 hour TWA exposure, an increase in the number of short-term exposures decreases the allowable magnitude of each excursion. Further, even the theoretical 32 ppm 15 minute limit that is "built into" a 1 ppm TWA is only possible under a unique set of circumstances, where that 15 minutes period represents an employee's only source of EtO exposure in an entire 8-hour workday. For example, for an employee who is exposed to three 15 minute sterilizer openings per day the magnitude of these exposures must be limited far below the 32 ppm figure (closer to 10 ppm) to keep the day's TWA below 1 ppm. When background EtO levels are considered, these excursions must be limited even more. In this way, the TWA itself does act as a check on the number and extent of short term exposures during the day.

It should also be pointed out that to achieve the TWA, the reduction of short-term exposures represents the most effective menthod of reducing the total dose of EtO for most employees, particularly those exposed to EtO releases from sterilizers. This reflects the technical and practical realities of controlling exposures at their source to minimize the total dose during the workday.

OSHA has determined that short-term exposures to EtO have not been demonstrated to be more harmful than the same total dose of EtO received over a longer period of time during the workday. Therefore, the need to control short-term exposures is only important insofar as it relates to the resultant reduction of total dose. Further, the control of short-term excursions are a necessary part of the overall compliance program for the 1 ppm TWA.

Therefore, OSHA believes that employers attempting to reduce overall exposures to the 1 ppm TWA will by necessity have to apply good industrial hygiene practice of controlling short-term levels, and that background levels and the number of short-term excursions will be factors to be considered in achieving compliance with the TWA.

OSHA also notes that the concept of "excursion limits" developed by ACGIH

is based upon the in-plant variability of contaminant concentrations. It appears to be applied as a rule-of-thumb for industrial hygienists when assessing worker exposures and control technologies. The excursion limit concept was intended by ACGIH to apply to all workplaces, regardless of the nature of the industry (that is, outdoor vs. indoor, or hospital vs. chemical formulating plant), and to cover virtually all substances in the TLV list regardless of their toxicity or properties (including the nature of the toxic effects, whether they be irritation, central nervous system depression, and carcinogenicity; rate of absorption by the human body, and the degree of protection provided by the ACGIH TLV). OSHA agrees with ACGIH that in evaluating the available means of controlling employee exposures to any toxic substance, good industrial hygiene practice calls for assessing the extent of short-term excursions within the workday. However, ACGIH's reasoning for the excursion limits, which is not tied to findings of specific health effects for EtO, does not warrant the imposition of a STEL for EtO by OSHA. The toxic properties of EtO do not support the need for a mandatory short-term standard, and the current 1 ppm 8-hour TWA, as discussed, will result in adequate control of EtO excursions.

In conclusion, while OSHA has determined that a STEL for EtO is not necessary or appropriate for inclusion in the final standard at this time, the Agency strongly reaffirms its determinations contained in the June 22, 1984 final rule, as to the need for and feasibility of the 1 ppm TWA and other provisions of the EtO standard. The record clearly indicates that a reduction of the TWA from 50 ppm to 1 ppm will substantially reduce the significant risks of EtO exposure, within the bounds of feasibility. In addition, the other protective provisions of the standard, such as exposure monitoring and employee training, will reduce the health risks of EtO exposure below those projected by the Agency's risk assessment for the 1 ppm TWA alone. OSHA believes that by reducing the total EtO dose through establishment of a 1 ppm TWA, and by including other ameliorative provisions in the standard, a substantial reduction of the adverse health effects of EtO will be achieved.

VI. Authority

This document was prepared under the direction of Robert A. Rowland, Assistant Secretary of Labor for Occupational Safety and Health, 200 Constitution Ave., NW., Washington, D.C. 20210.

This action is taken pursuant to sections 4(b), 6(b), and 8(c) of the Occupational Safety and Health Act of 1970 (84 Stat. 1592, 1593, 1599, 29 U.S.C. 653, 655, 657), Secretary of Labor's Order No. 9–83 (48 FR 35736) and 20 CFR Part 1911.

List of Subjects in 29 CFR Part 1910

Ethylene Oxide, Occupational safety and health, Chemicals, Cancer, Health, Risk assessment.

Robert A. Rowland,

Assistant Secretary of Labor.

[FR Doc. 84–33949 Filed 12–31–84; 8:45 am]

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DEPARTMENT OF DEFENSE

Office of the Secretary

32 CFR Part 166

Defense Contracting; Reporting Procedures on Defense Related Employment

AGENCY: Office of the Secretary, DoD.

ACTION: Amendment of final rule.

SUMMARY: This rule is the fiscal year 1984 update of the section listing DoD contractors receiving negotiated contract awards of $10 million or more. The regulation is published to comply with the provisions of Section 1, Pub. L. 97–295, October 12, 1982; 10 U.S.C. 2397.

EFFECTIVE DATE: September 30, 1984.

ADDRESS: Information Operations and Reports, Washington Headquarters Services, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA, 22202–4302.

FOR FURTHER INFORMATION CONTACT: Mr. J.R. Sungenis, telephone (202) 746–0334.

SUPPLEMENTARY INFORMATION: In FR Doc. 70–15846 appearing in the **Federal Register** on November 25, 1970 (35 FR 18040), the Office of the Secretary of Defense published a final rule establishing criteria, prescribing procedures, and assigning responsibilities for monitoring contracting within the Department of Defense. Subsequently, paragraphs (a) and (d) of § 166.11, which constitute the lest of DoD contractors receiving negotiated contract awards for $10 million or more, were updated for fiscal years 1971 (36 FR 18464); 1972 (37 FR 18727); 1973 (38 FR 25990); 1974 (39 FR 32985); 1975 (40 FR 44135); 1976 (41 FR 20466); 1977 (43 FR 1617); 1978 (44 FR 3049); 1979 (44 FR 75631); 1980 (45 FR 83486); 1981 (46 FR 60821); 1982 (47 FR 56847); and 1983 (48 FR 55728).

List of Subjects in 32 CFR Part 166

Armed forces, Government employees, Government procurement, Information requirements.

PART 166—[AMENDED]

Accordingly, for FY 1984, § 166.11 of this part is revised to read as follows:

§ 166.11 Department of Defense contractors receiving negotiated contract awards of $10 million or more.

Fiscal Year 1984:

A & S Tribal Industries
A A I Corp.
A A R Corp.
A B A Industries, Inc.
A L M, Inc.
A L S Electronics
A M General Corp.
A T O, Inc.
Abex Corp.
Abercrombie, R.C.
Action Mfg. Co.
Actus Corp.
Advanced Technology, Inc.
Aero Corp.
Aerojet General Corp.
Aerojet Strategic Propulsion Co.
Aerojet Tech Systems Co.
Aeronca, Inc.
Aeroquip Corp.
Aerospace Corp.
Airspace Technology Corp.
Alfab, Inc.
All Bann Enterprises, Inc.
Alliance Properties, Inc.
Allied Corp.
Alpha Industries, Inc.
Altama Delta Corp.
American Airlines, Inc.
American Cyanamid Co., Inc.
American Development Corp.
American Electronic Laboratories, Inc.
American Express Co.
American Management Systems, Inc.
American Petrofina Co. of Texas
American President Lines, Ltd.
American Systems Corp.
American Telephone & Telegraph Co.
American Teleservices
Amertex Enterprises, Inc.
Ametek, Inc.
Amex Systems, Inc.
Amoco Production Co., Inc. (Del.)
Ampex Corp.
Amron Corp.
Analysis & Technology, Inc.
Analytic Sciences Corp.
Analytic Services, Inc.
Analytical Systems Engnr. Corp.
Analytics, Inc.
Anderson, M.C.
Andrews & Parrish Co.
Arcwel Corp.
Arete Associates
Argo Systems, Inc.